Radio Test Report

For

CP-8821 IP Phone with

2.4 GHz /5.0 GHz Wi-Fi Radio 802.11a/ac/b/g/n + Bluetooth v3.0

FCC ID: LDK88211296

UNII-1 (5150-5250 MHz)

Against the following Specifications:

CFR47 Part 15.407

ACCREDITED

Cisco Systems
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Title: See EDCS
Revision: See EDCS

This report replaces any previously entered test report under EDCS – **1484155**. This test report has been electronically authorized and archived using the CISCO Engineering Document Control system. Test Report Template EDCS# 1526148

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Section 1: Overview

1.1 Test Summary

The samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:

Specifications
CFR47 Part 15.407

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB Publication No. 789033 - D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

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Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Radio Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc.

With regard to this assessment, the following points should be noted:

a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).

d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

e) All AC testing was performed at one or more of the following supply voltages:
110V 60 Hz (+/-20%)

2.2 Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + other correction factors [dB]

The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss.

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

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Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.4 10-7
temperature measurements	± 0.54º.
humidity measurements	± 2.3%
DC and low frequency measurements	± 2.5%.

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

30 MHz – 40GHz	+/- 0.38 dB

A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line.

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2.3 Date of testing (initial sample receipt date to last date of testing)

September 08 2015 to June 01 2016

2.4 Report Issue Date

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2.5 Testing facilities

This assessment was performed by:

Testing Laboratories
Cisco Systems, Inc.
125 West Tasman Drive (Building P)
San Jose, CA 95134
USA

Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134
USA

Registration Numbers for Industry Canada

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Building I, 5m Chamber	285 W. Tasman Drive San Jose, California 95134	Company #: 2461M-1
Building N, 5m Chamber	125 Rio Robles, San Jose, California 95134	Company #:

Test Engineer
Danh Le

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2.6 Equipment Assessed (EUT)

CP-8821

2.7 EUT Description

The CP-8821 is the next generation IP Phone with Wi-Fi (802.11a/ac/b/g/n) and Bluetooth module support. The specification is applied to IEEE802.11a/ac/b/g/n + Bluetooth Basic rate/ EDR

Here is a brief summary of the Heracles hardware:

- IEEE 802.11 a/b/g/n/ac compliant wireless LAN
- USB 2.0/OTG interface (Shared with docking connector)
- 2.4-inch TFT LCD display, with 240 x 320 pixels, 16M colors
- Capacitive standard 12-key backlit keypad, 2 soft keys, volume and ringer control hard keys, mute hard key, speakerphone hard key, push-to-talk hard key, dedicated end call button (shared with power-on and off function) and send/dial button, 5-way joystick/navigation keys
- 512MB LPDDR2 RAM, 4GB eMMC flash storage, version4.41
- 2020 mAh removable standard battery
- Ring, Wireless low signal, battery condition and MWI LED
- Shared antenna for 802.11a/b/g/n/ac and Bluetooth Basic rate /EDR.
- Separate ringer and voice speaker
- 3.5 mm headset interface
- Vibrate alert support
- Two Digital Microphone & Two loud speaker Interface
- Audio codec support, MP3, WAV, AAC etc.
- IP67 certified water and dust proof.

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Section 3: Result Summary

Conducted Emissions

Basic Standard	Technical Requirements / Details	Result
15.407	**99% & 26 dB Bandwidth**: The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW. The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.	**Pass**
15.407 (1)(iv)	**Maximum Conducted Output Power**: For an outdoor access point operating in the band 5.15-5.25 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. ...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.	**Pass**
15.407 (1) (iv)	**Power Spectral Density** **15.407** The maximum power spectral density shall not exceed 17 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.	**Pass**
15.407 (b)(7) 15.205 15.209	**Conducted Band Edge into Restricted band**: Unwanted emissions falling within the restricted bands, as defined in FCC 15.205 (a) must also comply with the radiated emission limits specified in FCC 15.209 (a)	**Pass**
15.207	**AC conducted Emissions:** U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.	**Pass**

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Radiated Emissions

Basic Standard	Technical Requirements / Details	Result
15.209 15.407 (b)(1)	**Undesirable Emissions / TX Spurious Emissions:** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the filed strength limits table in part15.209 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 -27dBm/MHz.	**Pass**

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Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for worst Case test Configuration" section of this report for further details on the selection of EUT samples.

4.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01 (Radiated)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-3-2 HER-157 dev	Rootfs8821.10-3-2HER-157-dev	FCH192180BK
S02 (Conducted)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-2-1-HE1-3.1-diagnostics	Sip8821.10-2-1-HE1-3.1-diagnostics	FCH18528TEU

4.2 Antenna Information

The following antennas are supported by this product series.

Frequency (MHz)	Part Number	Antenna Type	Antenna Gain (dBi)
5150-5250	Internal	Monopole	3

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Diagnostic	Diagnostic version allows to do conducted testing at antenna port of EUT. Image version : **Sip8821.10-2-1-HE1-3.1-diagnostics**

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB 789033 D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

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Appendix A: Conducted Test Results

Target Maximum Channel Power
The following table details the maximum supported Total Channel Power for all operating modes.

Operating Mode	Maximum Channel Power (dBm)		
	Frequency (MHz)		
	5180	**5220**	**5240**
802.11a	13	17	17
802.11n HT20	15	17	17
802.11ac VHT20	13	17	17

Operating Mode	Maximum Channel Power (dBm)	
	Frequency (MHz)	
	5190	**5230**
802.11n HT40	13	17
802.11ac VHT40	13	17

Operating Mode	Maximum Channel Power (dBm)
	Frequency (MHz)
	5210
802.11ac VHT80	13

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A.1 Duty Cycle

Duty Cycle Test Requirement
From KDB 789033 D02 General UNII Test Procedures New Rules v01
B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

1. All measurements are to be performed with the EUT transmitting at 100 percent duty cycle at its maximum power control level; however, if 100 percent duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, *T*, are required for each tested mode of operation.

A.1.1 Duty Cycle Test Method

From KDB 789033 D02 General UNII Test Procedures New Rules v01:
B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

The zero-span mode on a spectrum analyzer or EMI receiver, if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ EBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T, where T is defined in section II.B.1.a), and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

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A.1.2 Duty Cycle Data Table

Mode	Data Rate (Mbps)	On-time (ms)	Total on+off Time (ms)	Duty Cycle (%)	Correction Factor (dB)
802.11a	6	1.423	1.53	93.007	0.315
802.11n20	MCS0	1.333	1.433	93.022	0.315
802.11n40	MCS0	0.3533	0.4567	77.360	1.113
802.11ac20	MCS0	1.34	1.443	92.863	0.322
802.11ac40	MCS0	0.670	0.770	87.013	0.605
802.11ac80	MCS0	0.330	0.4333	76.160	1.183

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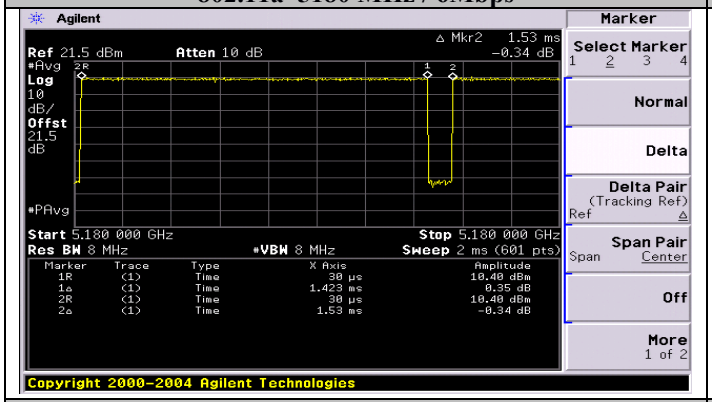
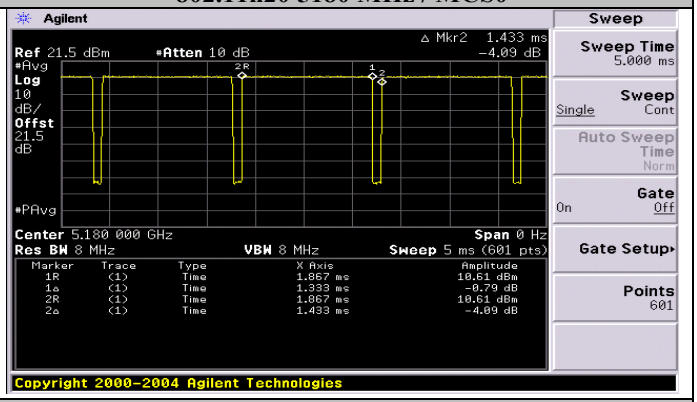
A.1.3 Duty Cycle Graphical Test results

Duty Cycle

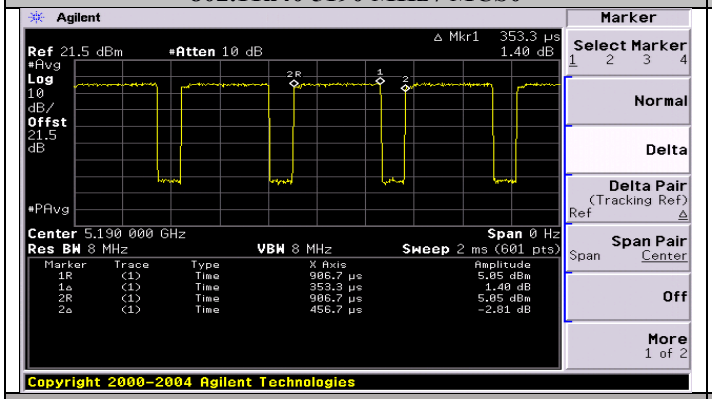
802.11a 5180 MHz / 6Mbps



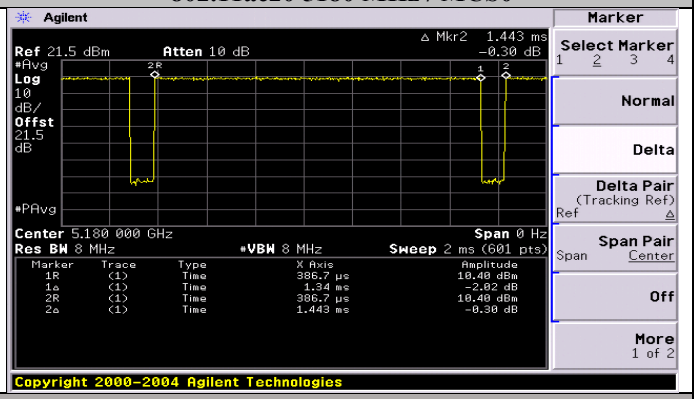
802.11n20 5180 MHz / MCS0



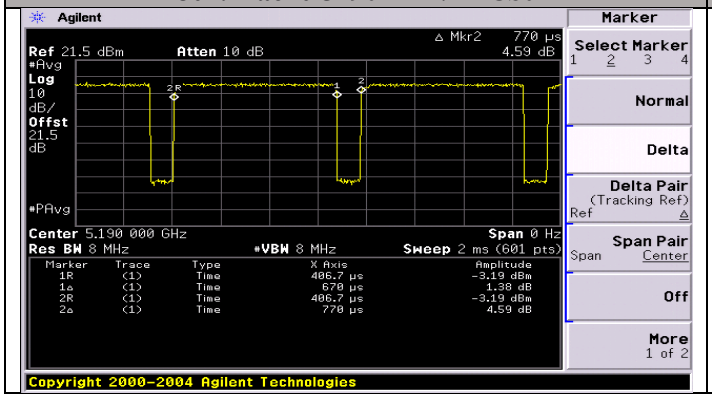
802.11n40 5190 MHz / MCS0



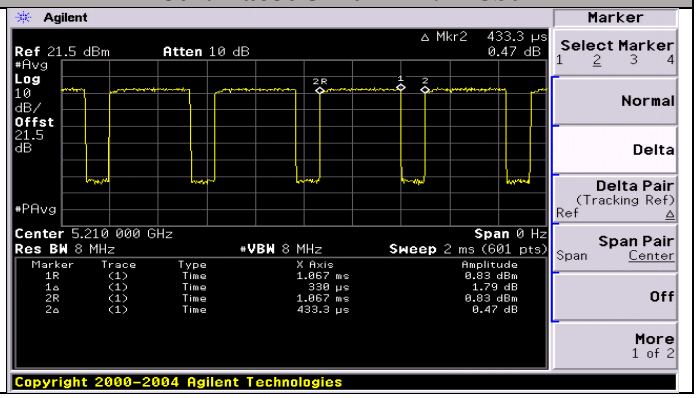
802.11ac20 5180 MHz / MCS0



802.11ac40 5190 MHz/ MCS0



802.11ac80 5210 MHz / MCS0



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A.2 Frequency Stability

A.2.1 Limits.

FCC 15.407(g): 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.

A.2.2 Test Procedure

ANSI C63.10-2013 section 6.8.2

Test Procedure
Unless otherwise specified, these tests shall be made at ambient room temperature An antenna shall be connected to the antenna output terminals of the EUT if possible. If the EUT is equipped with or uses an adjustable-length antenna, then it shall be fully extended. i) Supply the EUT with nominal voltage or install a new or fully charged battery in the EUT. Turn ON the EUT and couple its output to a frequency counter or other frequency-measuring instrument. ii) Tune the EUT to one of the number of frequencies required in 5.6. Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). iii) Measure the frequency at each of the Centre frequencies. iv) Repeat the above procedure at 85% and 115% of the nominal supply voltage as descried in 5.13 v) Change the temperature from

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A.2.3 Frequency Stability Test Data

Temperature	Voltage	Frequency (MHz)	S.A Reading (MHz)	Deviation (ppm)	Limit (ppm)	Result
Mode(Frequency) : 802.11a (5180MHz)						
0 degree	**Low**	**5180**	5180.0235	4.36293436	≤ 20	Pass
	Nominal		5180.0377	4.69111969	≤ 20	Pass
	High		5180.0243	7.27799228	≤ 20	Pass
Normal Temperature	**Low**	**5180**	5179.9983	-0.32818533	≤ 20	Pass
	Nominal		5179.9673	-6.31274131	≤ 20	Pass
	High		5180.0034	0.65637066	≤ 20	Pass
50 degree	**Low**	**5180**	5179.9824	-3.39768340	≤ 20	Pass
	Nominal		5179.9832	-3.24324324	≤ 20	Pass
	High		5179.9883	-2.25868726	≤ 20	Pass
Mode(Frequency) : 802.11a (5220MHz)						
0 degree	**Low**	**5220**	5220.0075	1.436781609	≤ 20	Pass
	Nominal		5220.0410	7.85440613	≤ 20	Pass
	High		5220.0243	4.655172414	≤ 20	Pass
Normal Temperature	**Low**	**5220**	5219.9983	-0.325670498	≤ 20	Pass
	Nominal		5219.9673	-6.264367816	≤ 20	Pass
	High		5220.0025	0.478927203	≤ 20	Pass
50 degree	**Low**	**5220**	5219.9824	-3.37164751	≤ 20	Pass
	Nominal		5219.9824	-3.37164751	≤ 20	Pass
	High		5219.9941	-1.130268199	≤ 20	Pass
Mode(Frequency) : 802.11a (5240MHz)						
0 degree	**Low**	**5240**	5240.0117	2.232824427	≤ 20	Pass
	Nominal		5240.0419	7.996183206	≤ 20	Pass
	High		5240.0251	4.790076336	≤ 20	Pass
Normal Temperature	**Low**	**5240**	5239.9983	-0.324427481	≤ 20	Pass
	Nominal		5239.9673	-6.240458015	≤ 20	Pass
	High		5240.0025	0.477099237	≤ 20	Pass
50 degree	**Low**	**5240**	5239.9824	-3.358778626	≤ 20	Pass
	Nominal		5239.9824	-3.358778626	≤ 20	Pass
	High		5239.9857	-2.729007634	≤ 20	Pass

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Frequency Stability Test Data (continue)

Temperature	Voltage	Frequency (MHz)	S.A Reading (MHz)	Deviation (ppm)	Limit (ppm)	Result
Mode(Frequency) : 802.11n40 (5190MHz)						
0 degree	**Low**	**5190**	5190.0159	3.063583815	≤ 20	Pass
	Nominal		5190.0427	8.227360308	≤ 20	Pass
	High		5190.0243	4.682080925	≤ 20	Pass
Normal Temperature	**Low**	**5190**	5189.9983	-0.32755298	≤ 20	Pass
	Nominal		5189.9673	-6.30057803	≤ 20	Pass
	High		5190.0025	0.481695568	≤ 20	Pass
50 degree	**Low**	**5190**	5189.9824	-3.39113680	≤ 20	Pass
	Nominal		5189.9824	-3.39113680	≤ 20	Pass
	High		5189.9841	-3.06358381	≤ 20	Pass
Mode(Frequency) : 802.11n40 (5230MHz)						
0 degree	**Low**	**5230**	5230.0176	3.36520076	≤ 20	Pass
	Nominal		5230.0444	8.48948375	≤ 20	Pass
	High		5230.0252	4.81835564	≤ 20	Pass
Normal Temperature	**Low**	**5230**	5229.9983	-0.32504780	≤ 20	Pass
	Nominal		5229.9672	-6.27151052	≤ 20	Pass
	High		5230.0017	0.32504780	≤ 20	Pass
50 degree	**Low**	**5230**	5229.9824	-3.36520076	≤ 20	Pass
	Nominal		5229.9824	-3.36520076	≤ 20	Pass
	High		5229.9824	-3.36520076	≤ 20	Pass
Mode(Frequency) : 802.11ac80 (5210MHz)						
0 degree	**Low**	**5210**	5209.9673	3.704414587	≤ 20	Pass
	Nominal		5210.0452	8.6756238	≤ 20	Pass
	High		5210.0243	4.664107486	≤ 20	Pass
Normal Temperature	**Low**	**5210**	5209.9983	-0.326295585	≤ 20	Pass
	Nominal		5209.9673	-6.276391555	≤ 20	Pass
	High		5210.0017	0.326295585	≤ 20	Pass
50 degree	**Low**	**5210**	5209.9824	-3.378119002	≤ 20	Pass
	Nominal		5209.9824	-3.378119002	≤ 20	Pass
	High		5209.9824	-3.378119002	≤ 20	Pass

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A.3 99% and 26dB Bandwidth

The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW.

The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.

A.3.1 Limits.

There is no requirement for the value of bandwidth. Power measurements are made using the 99% Bandwidth as the integration bandwidth.

A.3.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section C (1)

99% BW and EBW (-26dB) Test Procedure
1. Set the radio in the continuous transmitting mode. 2. Allow the trace to stabilize. 3. Setting the x-dB bandwidth mode to -26B and OBW power function to 99% within the measurement set up function. 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement. 5. Capture graphs and record pertinent measurement data.

99% BW and EBW (-26dB) Test parameters
Span = 1.5 x to 5.0 times OBW RBW = approx. 1% to 5% of the OBW VBW ≥ 3 x RBW Detector = Peak or where practical sample shall be used Trace = Max. Hold

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A.3.3 99% and 26dB Bandwidth Data Table

Channel No	Frequency (MHz)	Mode	Data Rate (Mbps)	99% BW (MHz)	26dB BW (MHz)
36	5180	802.11a	6	16.7048	21.330
44	5220	802.11a	6	16.6965	21.465
48	5240	802.11a	6	16.7301	21.311
36	5180	802.11n20	MCS0	17.9024	21.389
44	5220	802.11n20	MCS0	17.8629	21.753
48	5240	802.11n20	MCS0	17.8234	21.608
38	5190	802.11n40	MCS0	36.3522	40.242
46	5230	802.11n40	MCS0	36.3091	39.985
36	5180	802.11ac	MCS0	17.7542	20.959
44	5220	802.11ac	MCS0	17.7528	21.198
48	5240	802.11ac	MCS0	17.7768	21.400
38	5190	802.11ac40	MCS0	36.3139	40.031
46	5230	802.11ac40	MCS0	36.3213	40.117
42	5210	802.11ac80	MCS0	75.5611	80.989

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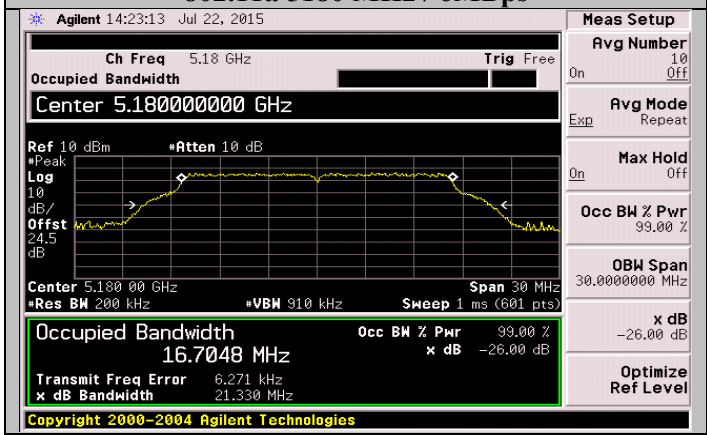
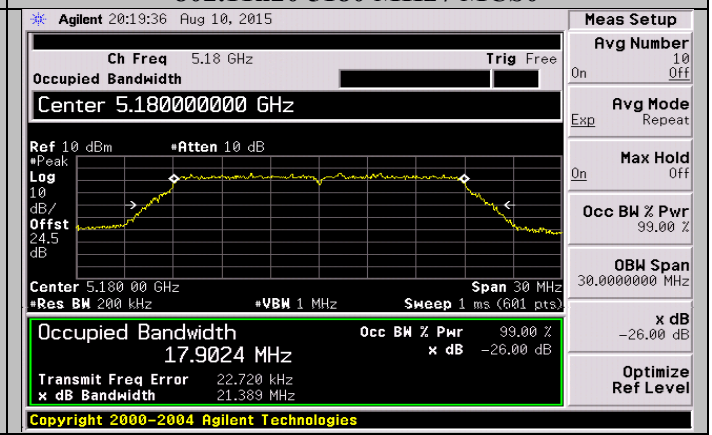
A.3.4 99% Occupied & 26dB Bandwidth Graphical Test Results

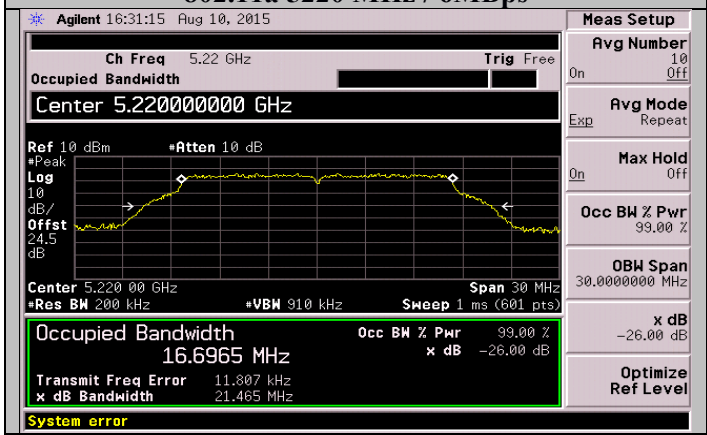
802.11a 5180 MHz / 6MBps



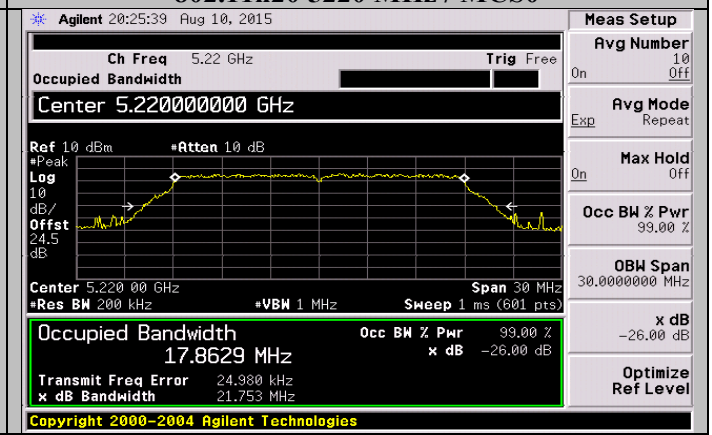
802.11n20 5180 MHz / MCS0



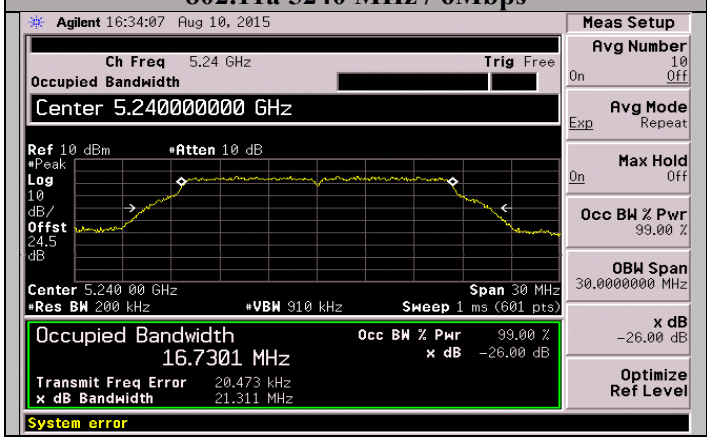
802.11a 5220 MHz / 6MBps



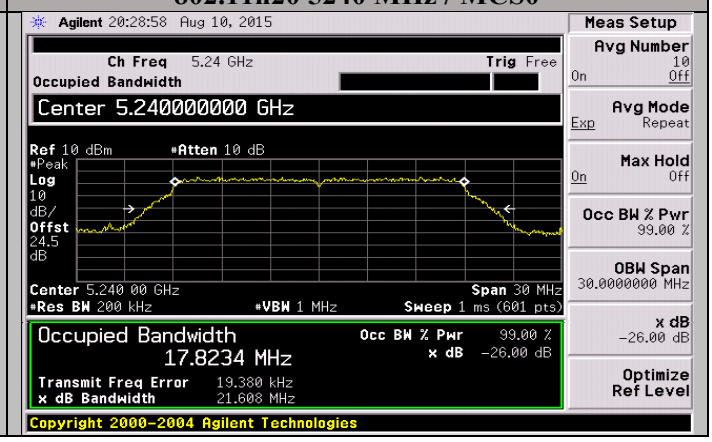
802.11n20 5220 MHz / MCS0



802.11a 5240 MHz / 6Mbps



802.11n20 5240 MHz / MCS0



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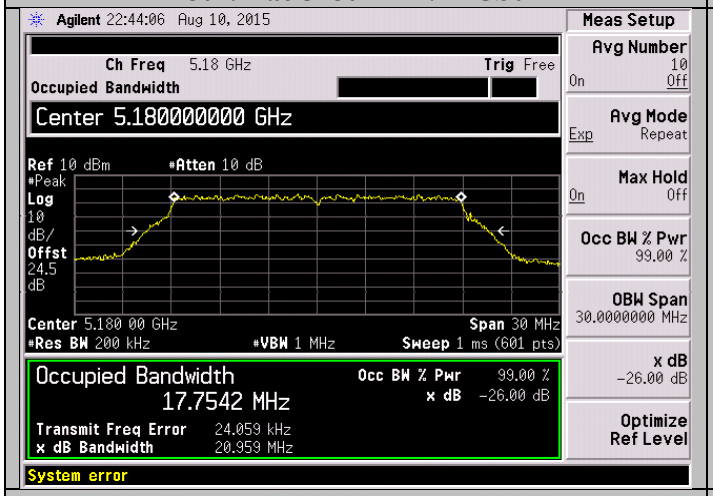
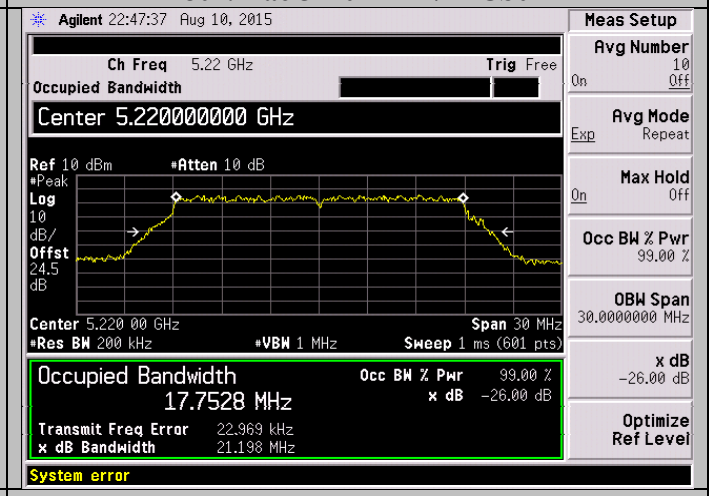
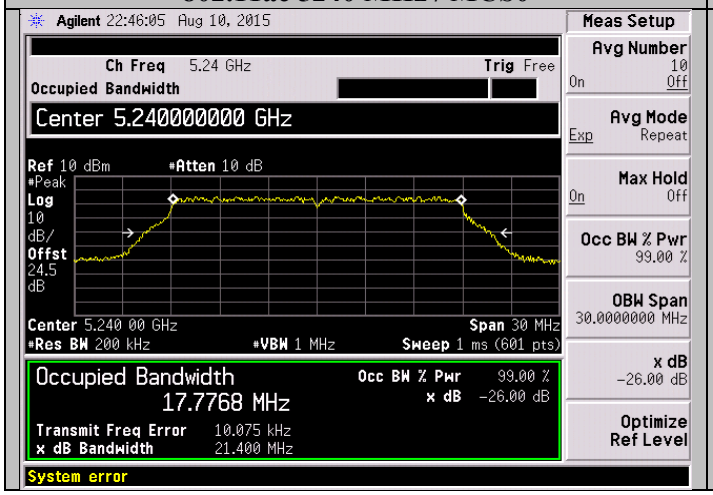
802.11ac 5180MHz / MCS0



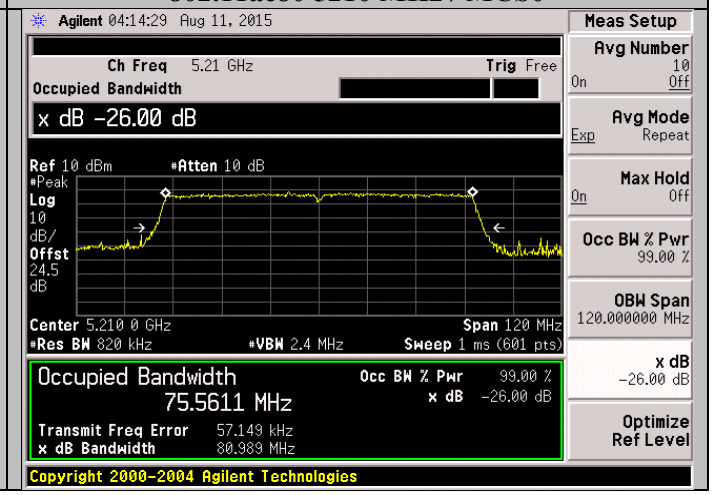
802.11ac 5220 MHz / MCS0



802.11ac 5240 MHz / MCS0



802.11ac80 5210 MHz / MCS0



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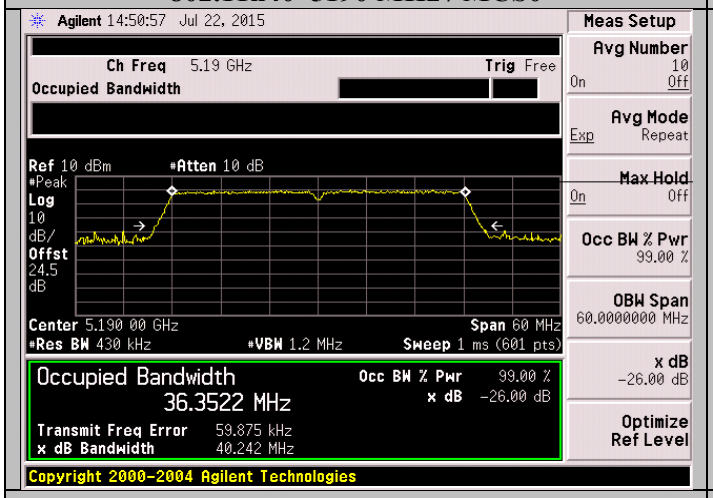
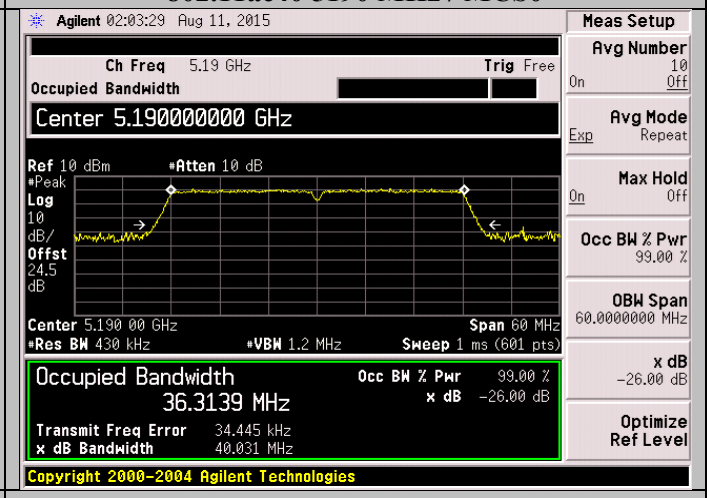
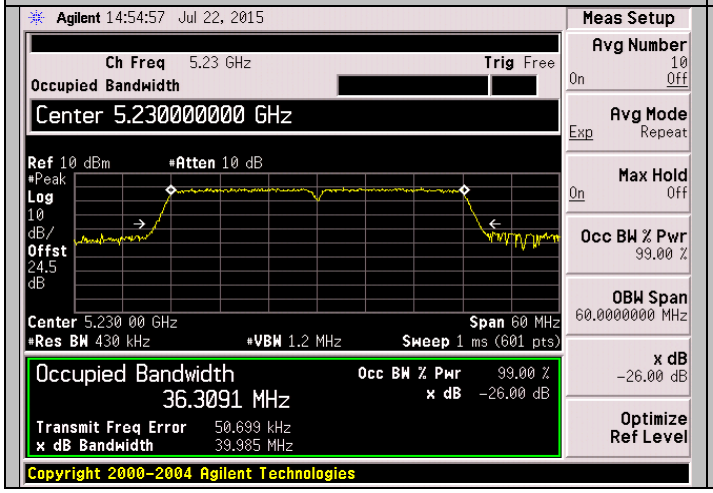
802.11n40 5190 MHz / MCS0



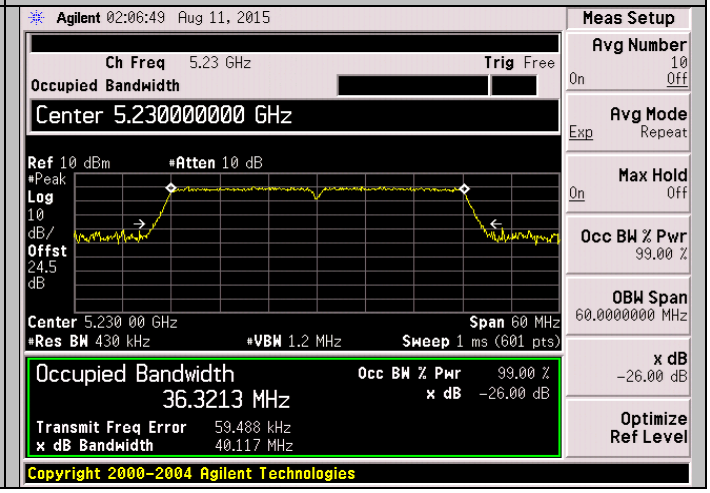
802.11ac40 5190 MHz / MCS0



802.11n40 5230 MHz / MCS0



802.11ac40 5230 MHz / MCS0



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A.4 Maximum Conducted Output Power

Maximum Conducted Output Power is defined as the total transmit power delivered to all antenna when the transmitter is operating at its maximum control level.

A.4.1 Limits.

FCC 15.407(a) (1) (iv).

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. ...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.

A.4.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedures New Rules v01

Test Procedure
1. Set the radio in the transmitting mode 2. Compute power by integrating the spectrum across the EBW (or alternatively entire 99% OBW) of the signal using the instrument's band power measurement function. The integration shall be performed using the spectrum analyzer band-power measurement function with band limits set equal to the EBW or the OBW band edges. 3. Capture graphs and record pertinent measurement data. 4. Make the following adjustments to the peak value of the spectrum, by adding duty cycle correction factor to the measured value

Measurement using a Spectrum Analyzer or EMI Receiver (SA), (d) Method SA-2

Test parameters
(i) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal. (ii) Set RBW = 1 MHz (iii) Set VBW ≥ 3 MHz (iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) (v) Sweep time = auto. (vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode. (vii) Do not use sweep triggering. Allow the sweep to "free run". (viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

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A.4.3 Maximum Conducted Output Power Data Table

Channel No	Frequency (MHz)	Antenna Gain (dBi)	DCCF (dB)	Max Output Power (dBm)	Corrected Max Output Power (dBm)	Limits (dBm)	Results
Mode/Data rate (Mbps): 802.11a/(6Mbps)							
36	5180	3	0.315	13.21	13.525	24	**Pass**
44	5220	3	0.315	16.78	17.095	24	**Pass**
48	5240	3	0.315	16.84	17.155	24	**Pass**
Mode/Data rate (Mbps): 802.11n20/(MCS0)							
36	5180	3	0.315	13.17	13.485	24	**Pass**
44	5220	3	0.315	16.75	17.065	24	**Pass**
48	5240	3	0.315	16.81	17.125	24	**Pass**
Mode/Data rate (Mbps): 802.11n40/(MCS0)							
38	5190	3	1.113	12.53	13.643	24	**Pass**
46	5230	3	1.113	16.46	17.564	24	**Pass**
Mode/Data rate (Mbps): 802.11ac20/(MCS0)							
36	5180	3	0.332	13.15	13.482	24	**Pass**
44	5220	3	0.332	16.75	17.082	24	**Pass**
48	5240	3	0.332	16.78	17.112	24	**Pass**
Mode/Data rate (Mbps): 802.11ac40/(MCS0)							
38	5190	3	0.605	13.08	13.685	24	**Pass**
46	5230	3	0.605	16.91	17.515	24	**Pass**
Mode/Data rate (Mbps): 802.11ac80/(MCS0)							
42	5210	3	1.183	12.61	13.793	24	**Pass**

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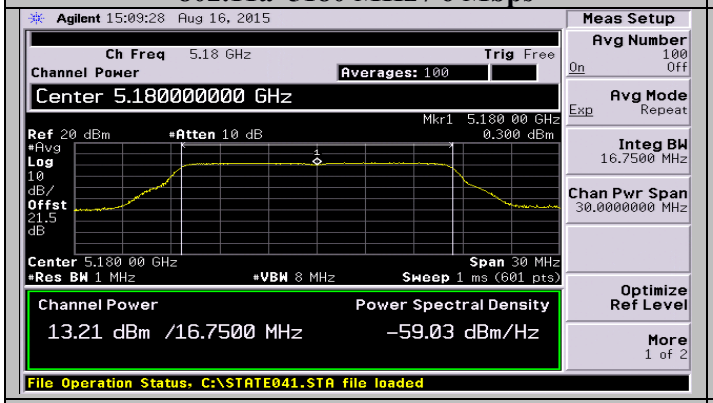
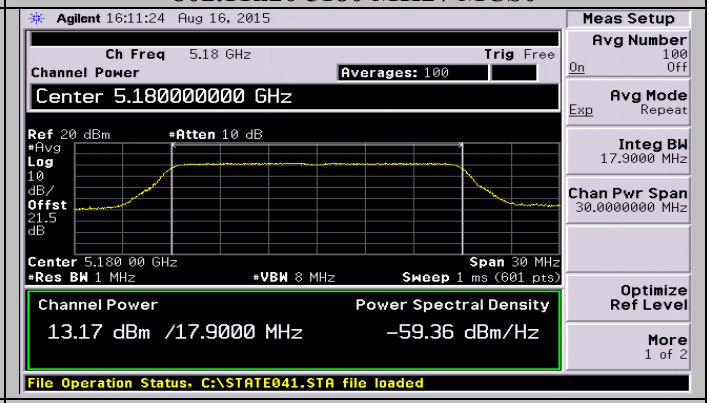
A.4.4 Maximum Conducted Output Power Graphical Test Results

Conducted Output Power

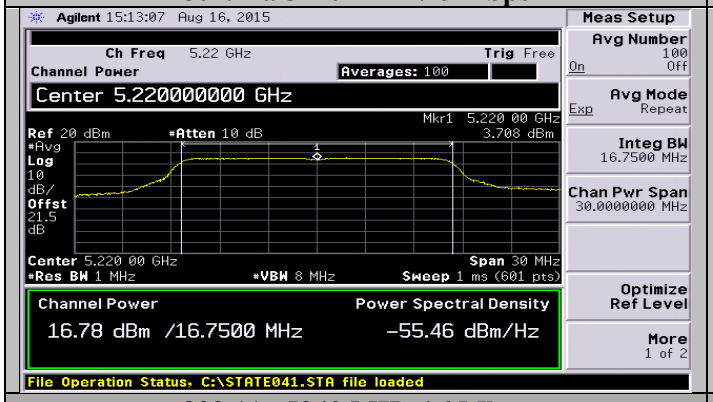
802.11a 5180 MHz / 6 Mbps



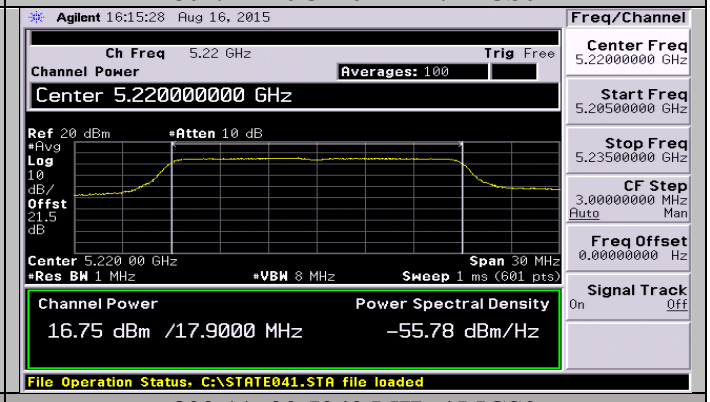
802.11n20 5180 MHz / MCS0



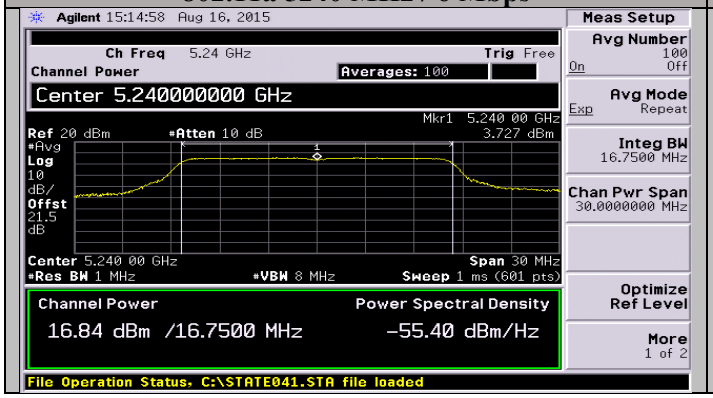
802.11a 5220 MHz / 6 Mbps



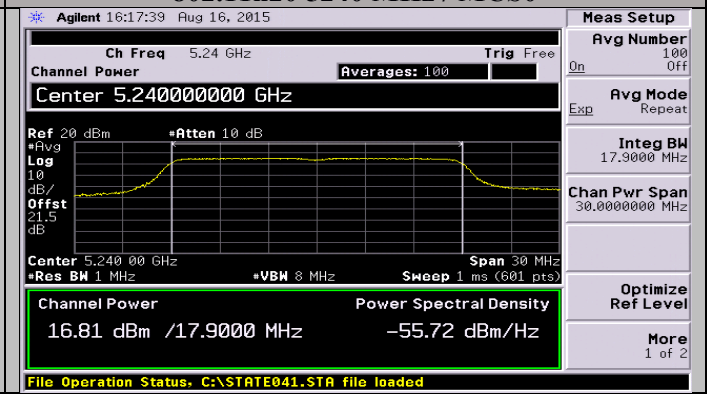
802.11n20 5220 MHz / MCS0



802.11a 5240 MHz / 6 Mbps



802.11n20 5240 MHz / MCS0



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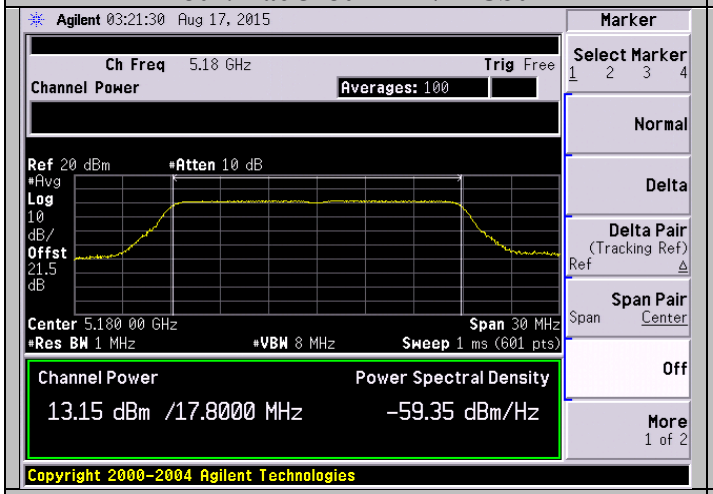
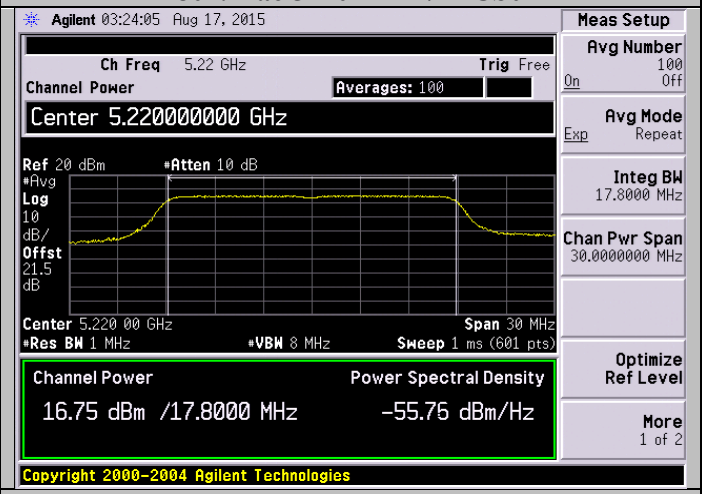
Conducted Output Power

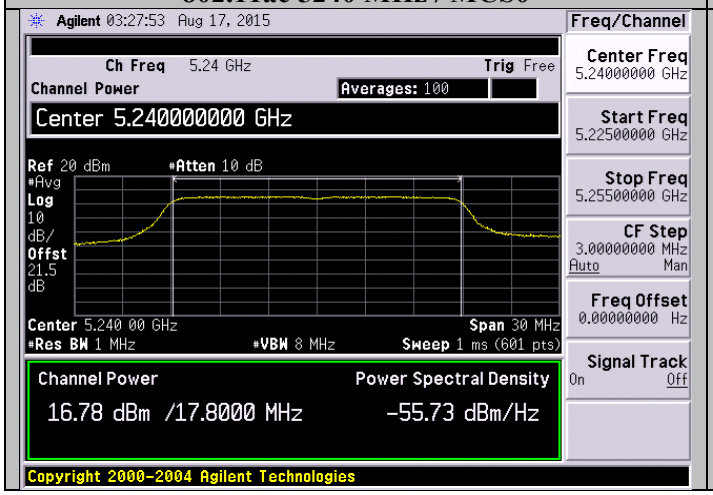
802.11ac 5180 MHz / MCS0



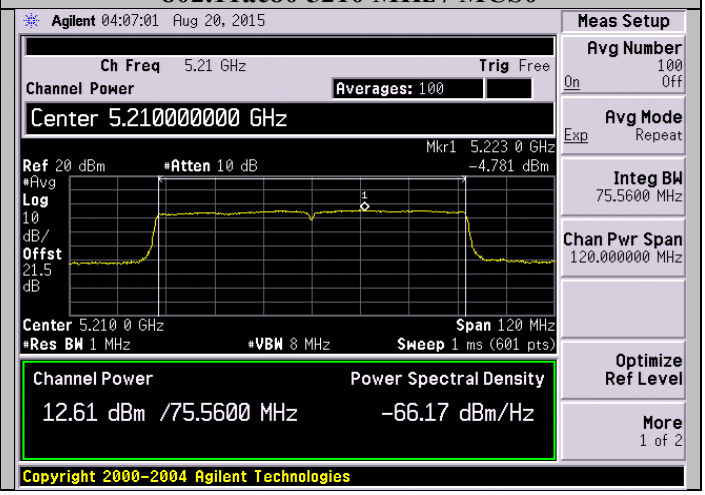
802.11ac 5220 MHz / MCS0



802.11ac 5240 MHz / MCS0



802.11ac80 5210 MHz / MCS0



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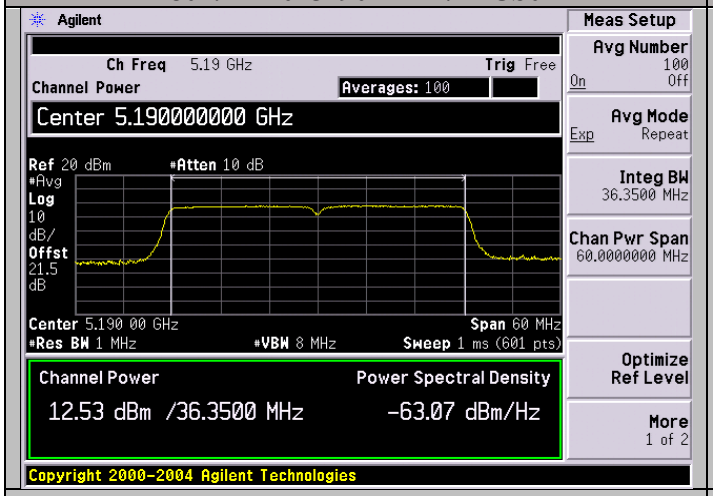
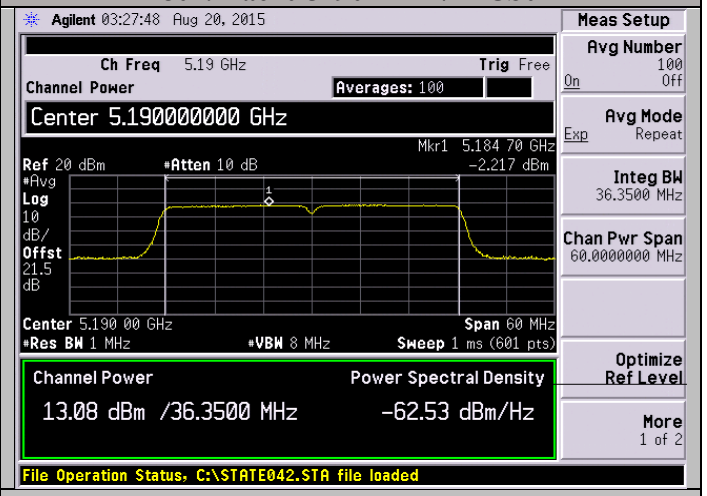
Conducted Output Power

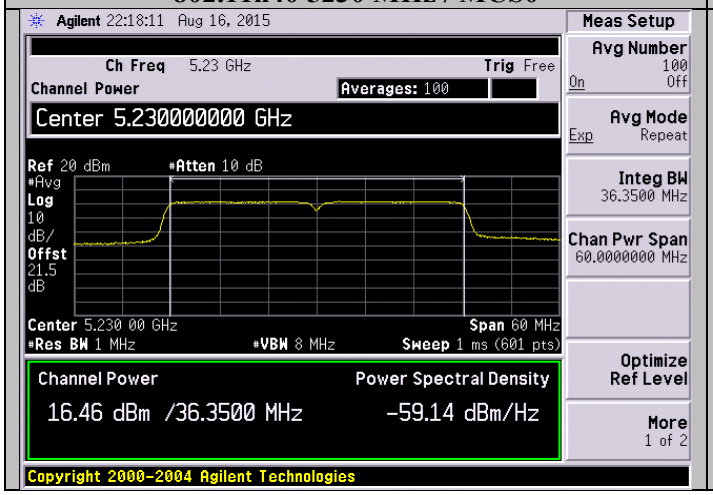
802.11n40 5190 MHz / MCS0



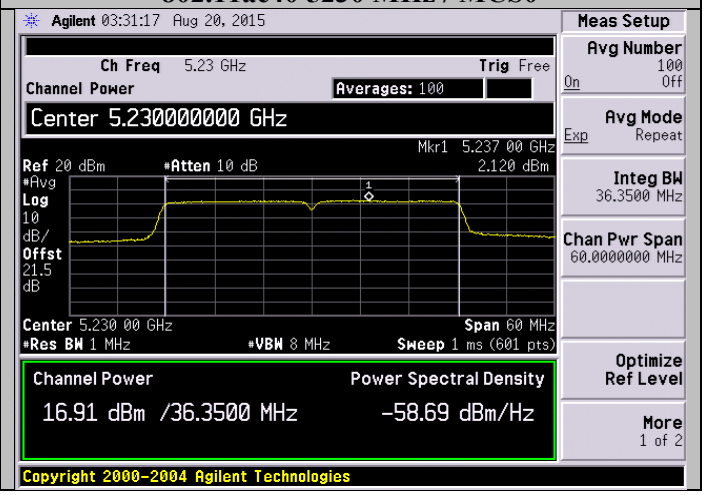
802.11ac40 5190 MHz / MCS0



802.11n40 5230 MHz / MCS0



802.11ac40 5230 MHz / MCS0



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A.5 Power Spectral Density

The Power Spectral Density is the total energy output per unit bandwidth from a pulse or sequence of pulses for which the transmit power is at its maximum level, divided by the total duration of the pulses, This total time does not include the time between pulses during which the transmit power is off or below its maximum level.

A.5.1 Limits.

FCC 15.407(a) (1) (iv)
For mobile and portable client devices in the 5.15-5.25 GHz band…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.

A.5.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedures New Rules v01

Test Procedure
1. Set the radio in the transmitting mode
2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
3. Make the following adjustments to the peak value of the spectrum, by adding duty cycle correction factor to the measured value.
4. Capture graphs and record pertinent measurement data.
5. The result is the Maximum PSD over 1 MHz reference bandwidth.

Measurement using a Spectrum Analyzer or EMI Receiver (SA), (d) Method SA-2

Test parameters
(i) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal. (ii) Set RBW = 1 MHz (iii) Set VBW ≥ 3 MHz (iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) (v) Sweep time = auto. (vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode. (vii) Do not use sweep triggering. Allow the sweep to “free run”. (viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

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A.5.3 Power Spectral Density Data Table

Channel No	Frequency (MHz)	Antenna Gain (dBi)	DCCF (dB)	PSD (dBm/MHz)	Corrected PSD (dBm/MHz)	Limits (dBm/MHz)	Results
Mode/Data rate (Mbps): 802.11a/(6Mbps)							
36	5180	3	0.315	1.72	2.04	11	**Pass**
44	5220	3	0.315	5.42	5.74	11	**Pass**
48	5240	3	0.315	5.44	5.76	11	**Pass**
Mode/Data rate (Mbps): 802.11n20/(MCS0)							
36	5180	3	0.315	1.47	1.79	11	**Pass**
44	5220	3	0.315	2.15	2.47	11	**Pass**
48	5240	3	0.315	4.77	5.09	11	**Pass**
Mode/Data rate (Mbps): 802.11n40/(MCS0)							
38	5190	3	1.113	-1.82	-0.71	11	**Pass**
46	5230	3	1.113	1.72	2.83	11	**Pass**
Mode/Data rate (Mbps): 802.11ac20/(MCS0)							
36	5180	3	0.332	1.72	2.05	11	**Pass**
44	5220	3	0.332	5.36	5.69	11	**Pass**
48	5240	3	0.332	5.21	5.54	11	**Pass**
Mode/Data rate (Mbps): 802.11ac40/(MCS0)							
38	5190	3	0.605	-1.61	-1.01	11	**Pass**
46	5230	3	0.605	2.13	2.74	11	**Pass**

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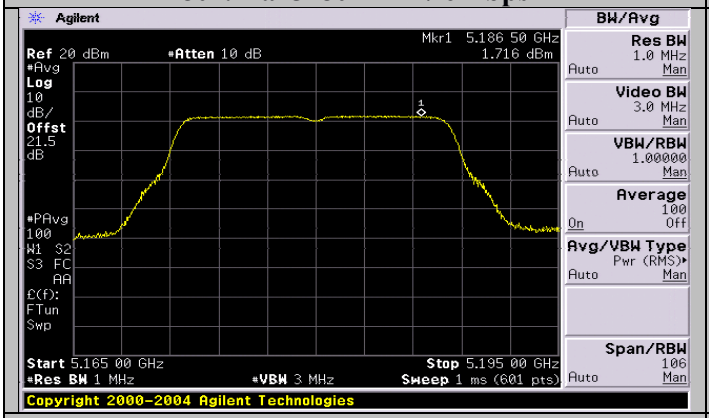
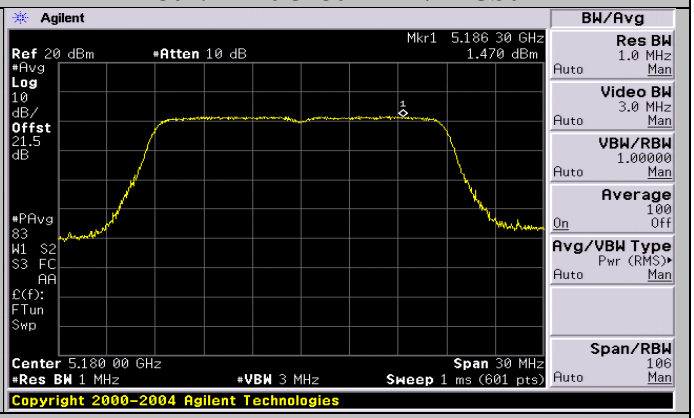
A.5.4 Power Spectral Density Graphical Test Results

Power Spectral Density

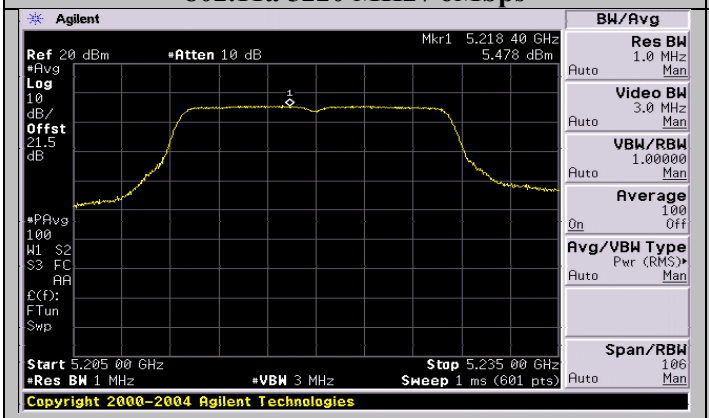
802.11a 5180 MHz / 6Mbps



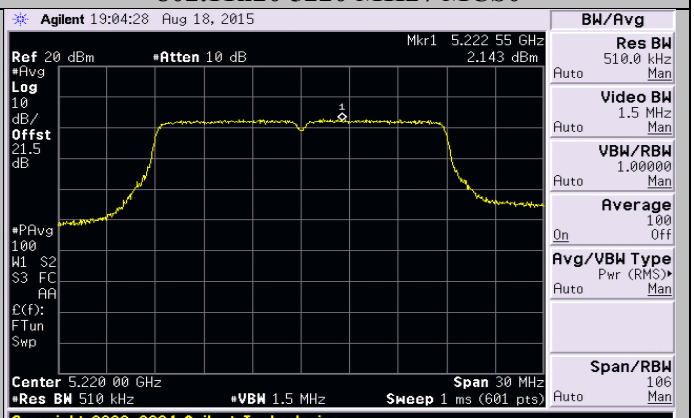
802.11n20 5180 MHz / MCS0



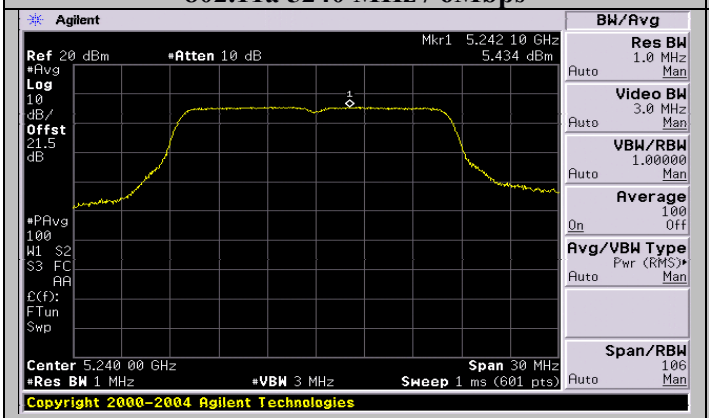
802.11a 5220 MHz / 6Mbps



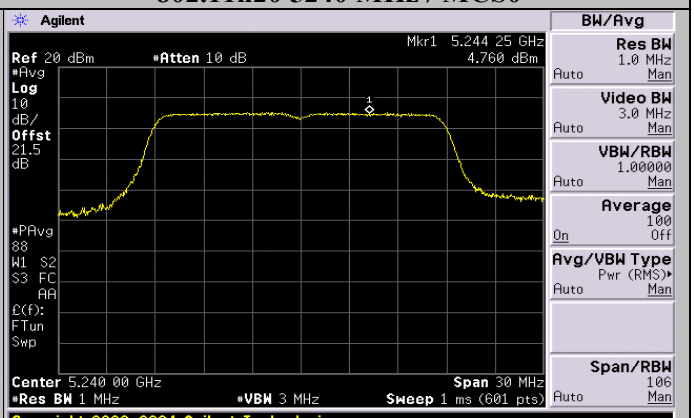
802.11n20 5220 MHz / MCS0



802.11a 5240 MHz / 6Mbps



802.11n20 5240 MHz / MCS0



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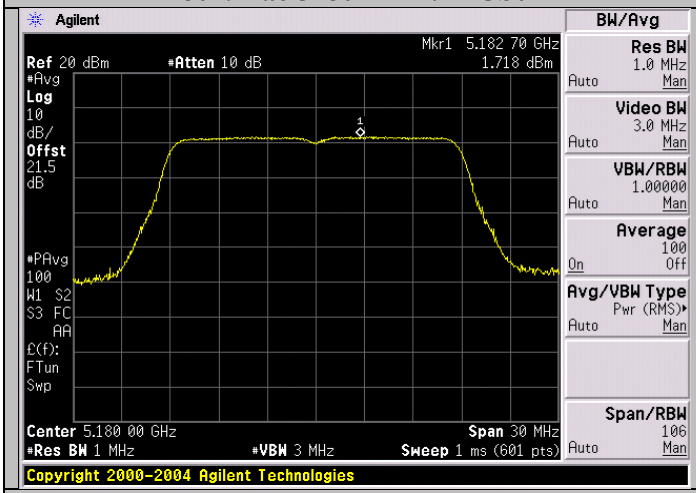
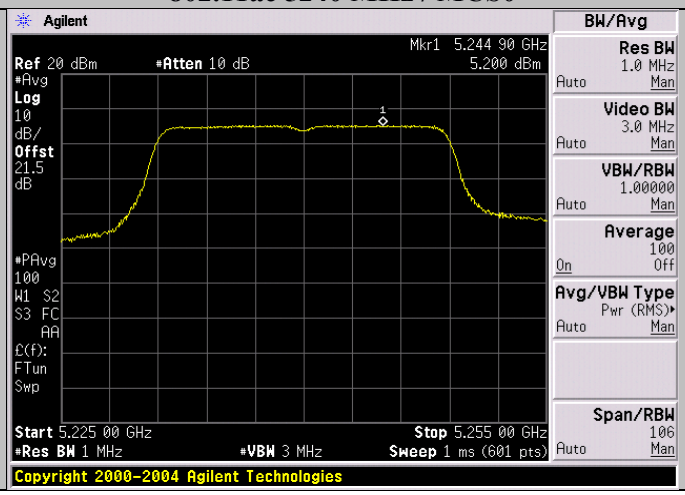
Power Spectral Density

802.11ac 5180 MHz / MCS0



802.11ac 5220 MHz / MCS0

802.11ac 5240 MHz / MCS0



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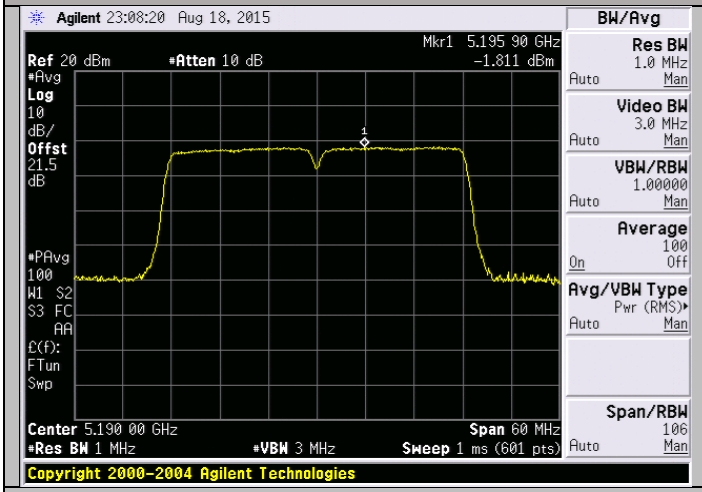
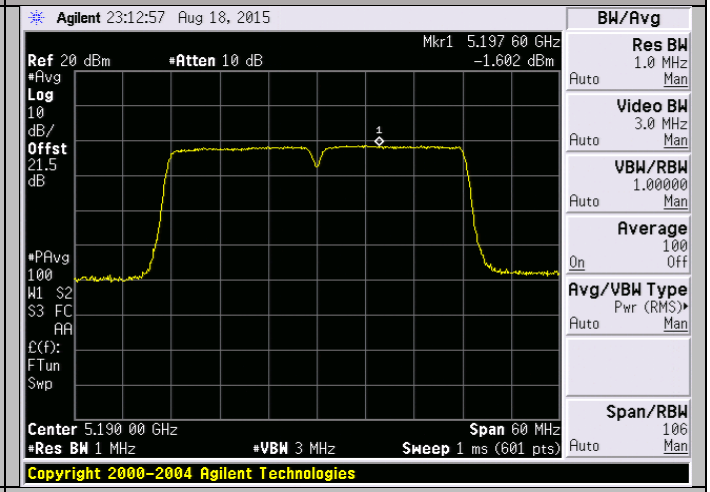
Power Spectral Density

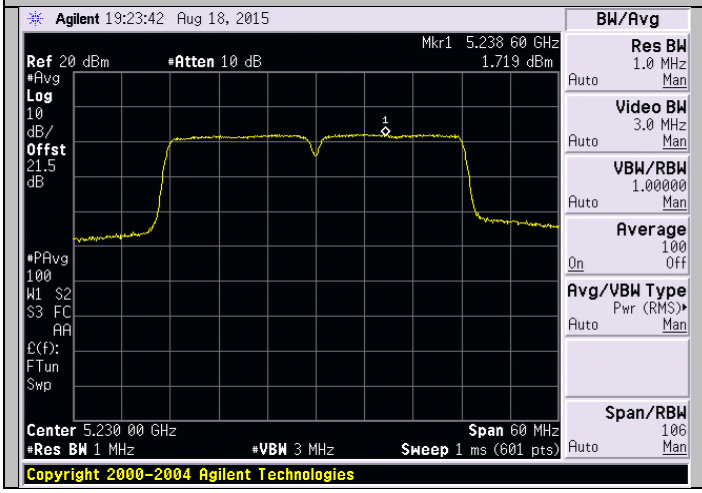
802.11n40 5190 MHz / MCS0



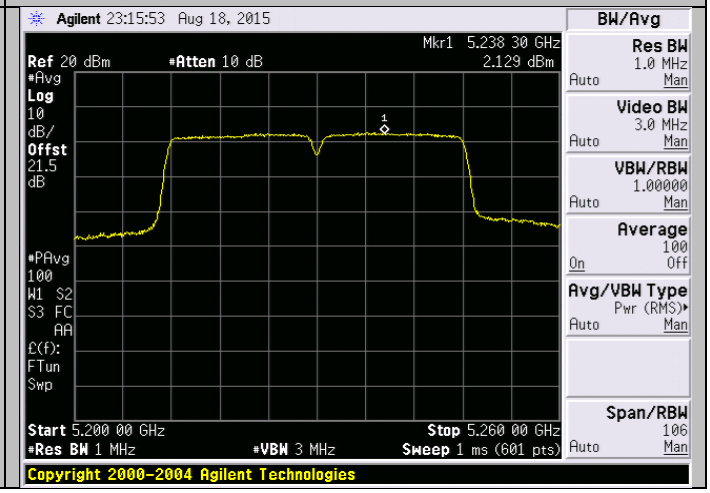
802.11ac40 5190 MHz / MCS0



802.11n40 5230 MHz / MCS0



802.11ac40 5230 MHz / MCS0



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A.6 Conducted Band Edge into Restricted Band

A.6.1 Limits

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

Limit Conversion (field strength to power)

When the DUT power is measured using conducted test method, the field strength limit in dBµV can be converted to power (logarithmic) by using the field strength (linear) approach formula as follows:

eirp = pt x gt = (E x d)^2 / 30

where: **pt** = transmitter output power in watts,
gt = numeric gain of the transmitting antenna (unit less),
E = electric field strength in V/m,
d = measurement distance in meters (m).

From the equation above, unit conversion from log => linear with a known field strength limit of 74 dBµV @ 3 meters distance.

(1) Conversion from dBµV to V

E (v/m) = 10 exp $^{(74 - 120) / 20}$
E (V/m) = **0.0051187**

(2) Power in watts can be derived by using the equation above with known field strength in V/m with using antenna numeric gain of 1.

pt x gt = (E x d)^2 / 30
pt (W) x gt = (0.0051187)^2 x (3)^2 / 30
pt (W) x 1 = (0.0000251188 x 9) / 30
pt (W) = 2.261 x10^{-4} / 30 = **7.535566 x10^{-6}**
pt (mW) = 0.007535566

(3) Convert from linear power to log, using the using the following formula:

dBm = 10 log (mW)
= 10 log (0.007535566)
= -21.23

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A.6.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.1 (c)/ section II G.5 & G.6

Restricted Bands **Test Procedure**
1. The radio is configured in the continuous transmitting mode. 2. Set test parameters for peak measurement. 3. Set start frequency at the beginning of the restricted band and stop frequency at the end of the restricted band of interest. 3. Allow trace to fully stabilize. 4. Use marker peak search function to determine the maximum emissions amplitude within the restricted band. 5. Capture the transmitter waveforms on the spectrum analyzer, and record pertinent measurement data. 6. Set test parameter for average measurement. 7. Repeat step 3 – 5.

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.5

Restricted Bands Peak Measurement **Test parameters**
Span = Enough to capture the full restricted band of interest RBW= 1 MHz VBW ≥ 3 x RBW Detector= Peak Trace Mode= Max. Hold Sweep time= Auto

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.6

Restricted Bands Average Measurement Test parameters
Span = Enough to capture the full restricted band of interest RBW = 1 MHz VBW ≥ 3 x RBW Detector = RMS Averaging Type = Power average (RMS) Trace Average ≥ 100 Sweep time = Auto

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A.6.3 Restricted Bands Recorded Test Data

Operating Frequency (MHz)	Data Rate (Mbps)	Restricted Bands (MHz)	S.A Reading(dbm)	A.G (dBi)	Duty Cycle	E.I.R.P (dBm)	Limit (dBm)	Result
802.11a								
5180	6	4500–5150	-31.89@ 5147.8 MHz	3	N/A	-28.89	-21.2	Pass
5180	6	4500–5150	-48.15@ 5150 MHz*	3	0.315	-44.84*	-41.2*	Pass
802.11n20								
5180	MCS0	4500–5150	-33.91@ 5148.9 MHz	3	N/A	-30.91	-21.2	Pass
5180	MCS0	4500–5150	-47.57@ 5150 MHz*	3	0.315	-44.26*	-41.2*	Pass
802.11ac20								
5180	MCS0	4500–5150	-31.16 @ 5150 MHz	3	N/A	-28.16	-21.2	Pass
5180	MCS0	4500–5150	-46.75 @ 5150 MHz*	3	0.322	-43.43*	-41.2*	Pass
802.11n40								
5190	MCS0	4500–5150	-30.82 @ 5150 MHz	3	N/A	-27.82	-21.2	Pass
5190	MCS0	4500–5150	-46.31@ 5148.9MHz*	3	1.113	-42.20*	-41.2*	Pass
802.11ac40								
5190	MCS0	4500–5150	-27.39 @ 5150 MHz	3	N/A	-24.39	-21.2	Pass
5190	MCS0	4500–5150	-45.54 @ 5150 MHz*	3	0.605	-41.94*	-41.2*	Pass
802.11ac80								
5210	MCS0	4500–5150	-27.92 @ 5141.3 MHz	3	N/A	-24.92	-21.2	Pass
5210	MCS0	4500–5150	-46.46 @ 5121.8 MHz*	3	1.183	-42.28*	-41.2*	Pass

Note: Correction factors (ext. attenuation + cable loss) are compensated in the offset function of the measuring instrument. The readings with * at the end represent measurement in average.

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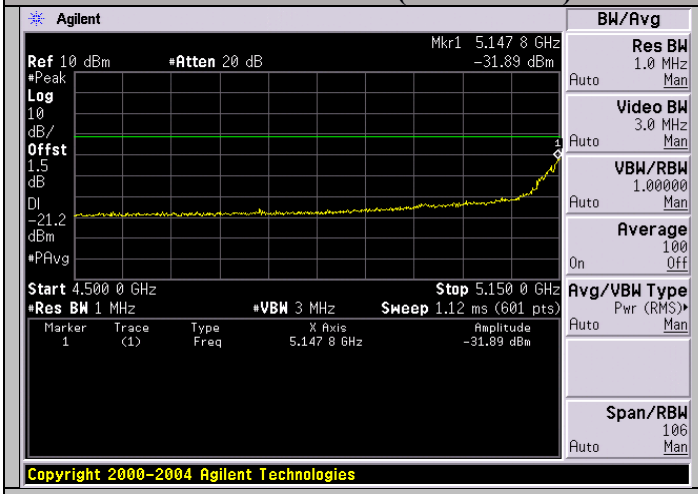
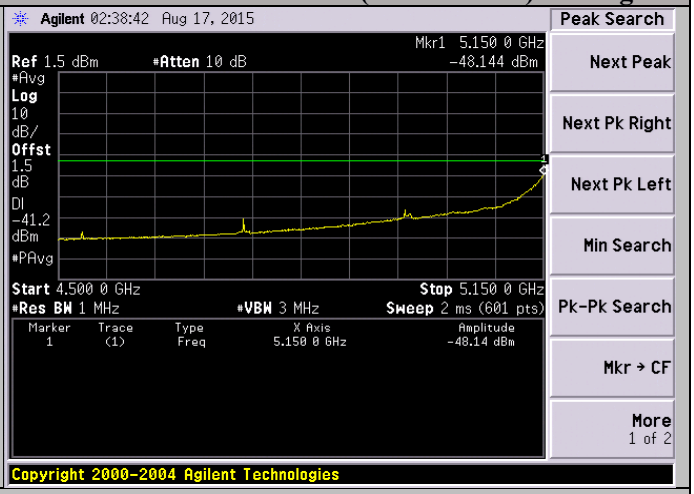
A.6.4 Restricted Bands Graphical Test Results

Restricted Band (4500 MHz – 5150 MHz)

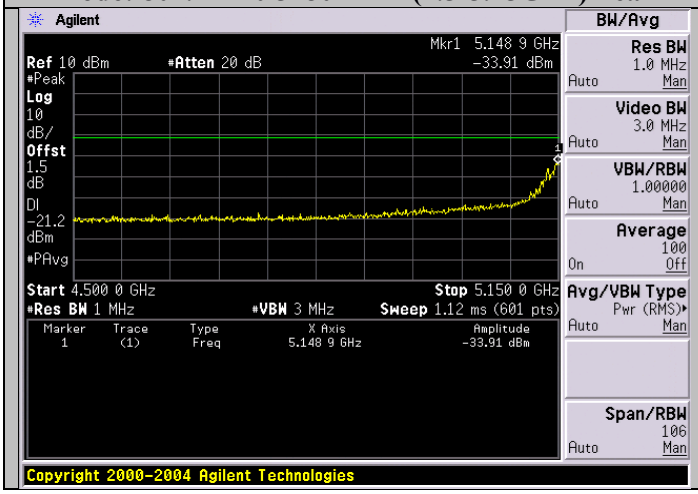
Mode: 802.11a 5180 MHz (4.5-5.15GHz) Peak



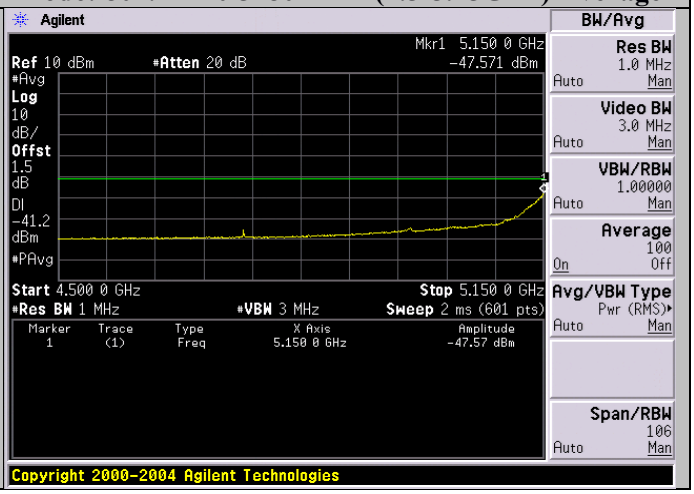
Mode: 802.11a 5180 MHz (4.5-5.15GHz) Average



Mode: 802.11n20 5180 MHz (4.5-5.15GHz) Peak



Mode: 802.11n20 5180 MHz (4.5-5.15GHz) Average



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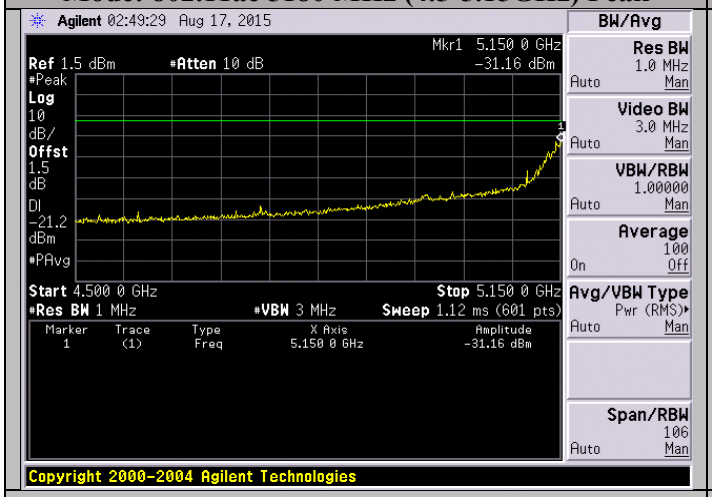
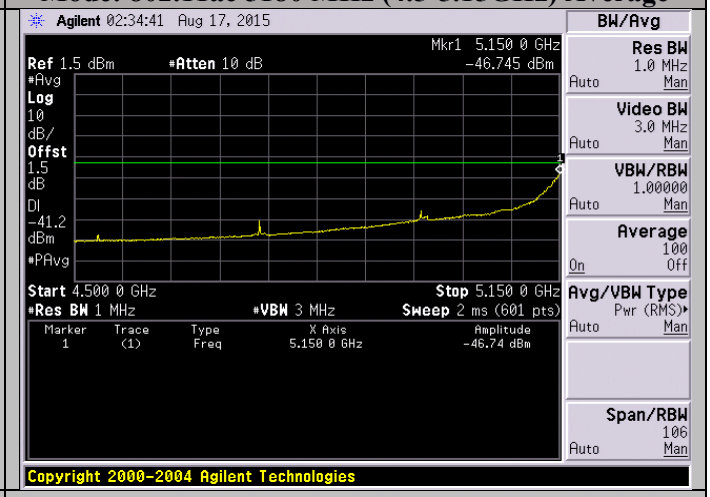
Restricted Band (4500 MHz – 5150 MHz)

Mode: 802.11ac 5180 MHz (4.5-5.15GHz) Peak

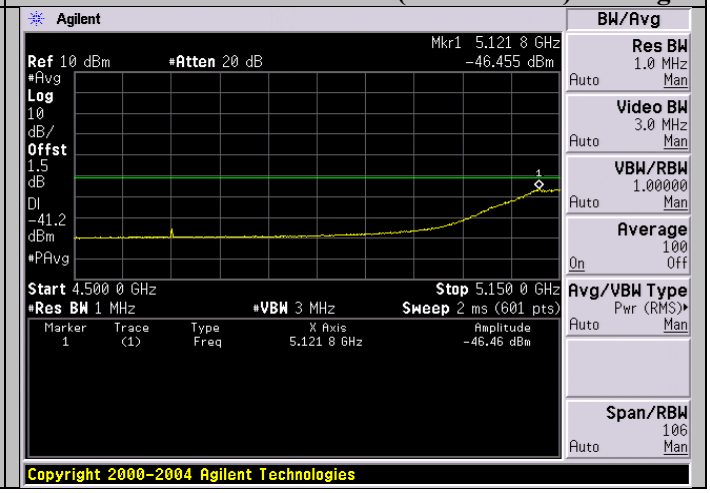


Mode: 802.11ac 5180 MHz (4.5-5.15GHz) Average



Mode: 802.11ac80 5210 MHz (4.5-5.15GHz) Peak

Mode: 802.11ac80 5210 MHz (4.5-5.15GHz) Average



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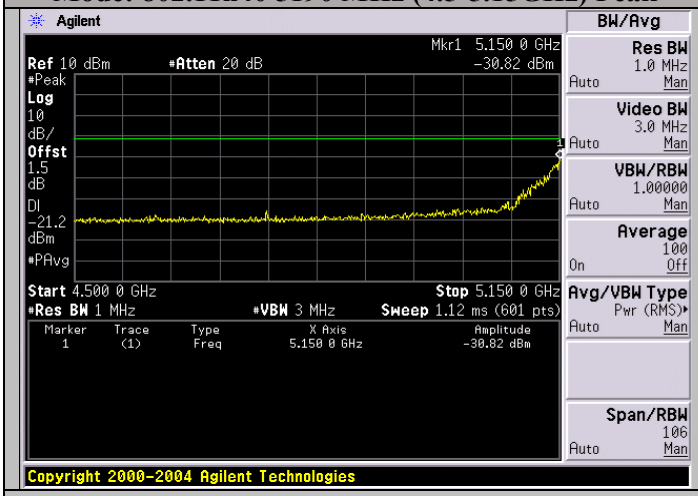
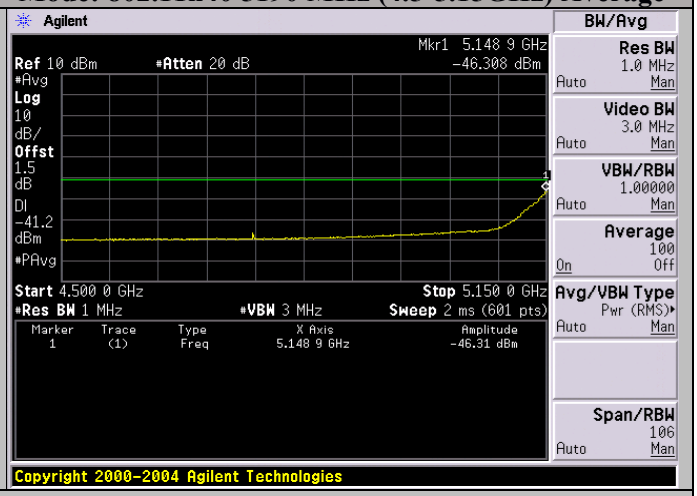
Restricted Band (4500 MHz – 5150 MHz)

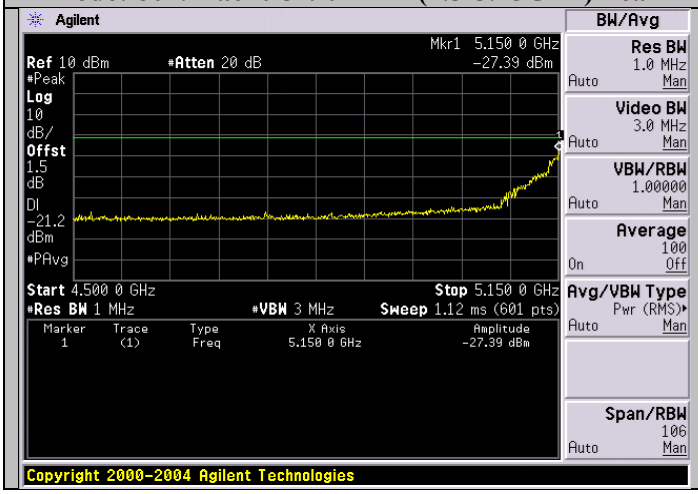
Mode: 802.11n40 5190 MHz (4.5-5.15GHz) Peak



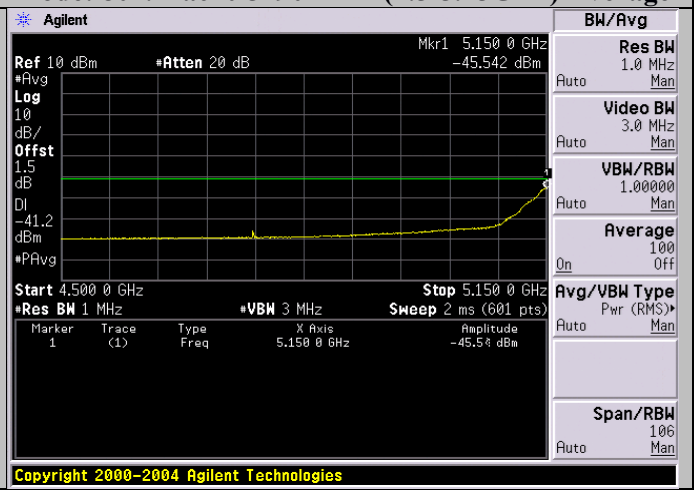
Mode: 802.11n40 5190 MHz (4.5-5.15GHz) Average



Mode: 802.11ac40 5190 MHz (4.5-5.15GHz) Peak



Mode: 802.11ac40 5190 MHz (4.5-5.15GHz) Average



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Appendix B: Radiated Test Results

B1. Radiated Spurious Emissions & Restricted Bands

Unwanted Emissions Outside of the Restricted Bands
Frequency range: Below 1GHz
FCC 15.407 (b) (6): Unwanted emissions below 1GHz must comply with 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 conducted emissions limits set forth in §15.207. Refer to limit section for detailed limits

Frequency range: Above 1GHz
FCC 15.407 (b): Unwanted emissions above 1000 MHz that are outside of the restricted bands are subject to a maximum emission limit of -27 dBm/MHz (or - 17 dBm/MHz). Refer to limit section for detailed limits.

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Restricted Bands

FCC 15.407 (b) (7): The provision of §15.205 apply to intentional radiators operating under FCC 15.407(b).

FCC 15.205 / FCC 15.209
Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Refer to limit section for detailed limits.

Restricted Bands			
MHz	**MHz**	**MHz**	**GHz**
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz

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B.1.1 Limits.

For Restricted bands & below 1GHz
FCC 15.209: The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the table specified in the table in FCC§15.209(a).

FCC15.407 (b) (6): Unwanted emissions below 1GHz must comply with general field strength limits set forth in §15.209.

General Field Strength Limits Table			
Frequency (MHz)	**Field strength (uV/meter)**	**Field strength (dBuV/meter)**	**Measurement distance (meters)**
30-88	100**	40 Qp	3
88-216	150**	43.5 Qp	3
216-960	200**	46 Qp	3
Above 960	500	54 Av / 74 Pk	3

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For Non-Restricted bands above 1GHz

FCC 15.407 (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

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Limit Conversion

When the DUT power is measured using a radiated test configuration, the EIRP can be directly determined using the power (logarithmic) approach as follows:

eirp = pt x gt = (E x d)2/30

where: $\mathbf{p_t}$ = transmitter output power in watts,
$\mathbf{g_t}$ = numeric gain of the transmitting antenna (unit less),
E = electric field strength in V/m,
d = measurement distance in meters (m).

Based on the equation above, unit conversion from log => linear

(1) Conversion from dBm to Watt

W = 10 EXP (-27dBm – 30 /10)
W = 10 EXP (-5.7) = 2 E-6

(2) E Field Strength can be derived by inverse calculation.

E = 9 (**pt** x **gt** x **30) / d**
E = SQRT (2E-6 x 1.0 x 30) / 3 = 0.0026 V/m

(3) Conversion from Linear to Log, using the following formula

Volts to dBuV = 20 log (*Volts)* + 120
E (in dBuV) = 20 Log (0.0026) + 120 = **68.23/m @ 3 meter**

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B.1.2 Test Procedure

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency given below:

(a) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(b) If the equipment operates at or above 10 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

Particular attention should be paid to harmonics and sub-harmonics of the carrier frequency, as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value need not be reported.

For emissions below 1000 MHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. Above 1000 MHz, measurements shall be performed using an average detector with a minimum resolution bandwidth of 1 MHz.

As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization as required, with an equal or greater than the applicable CISPR quasi-peak bandwidth or 1 MHz bandwidth, respectively.

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Ref. ANSI C63.10-2013 section 6.5 & 6.6

Test Procedure
1. Using Vasona software, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 2. Place the radio in continuous transmit mode. Maximize Turntable (find worst case table angle) and maximize Antenna (find worst case height). 3. Use the peak marker function to determine the maximum amplitude level. 4. Center marker frequency and perform final measurement in Quasi-peak (≤ 1Ghz) and Average (above 1 GHz) 5. Record at least 6 highest readings for the worst case operating mode.

ANSI C63.10: 2013 section 4.1.4 / section 12.7.5 (Quasi-Peak), section 12.7.6 (peak), section 12.7.7.3 (average)

Test parameters
(i) Span = Entire frequency range or segment if necessary. (ii) Reference Level = 80 dBuV (iii) RBW = 100 kHz (less than or equal to 1 GHz); 1 MHz (above 1 GHz) (iv) VBW ≥ 3 x RBW (v) Detector = Peak & Quasi-Peak (frequency range 30 MHz to 1 GHz); Peak & Average (frequency range above 1 GHz); Change VBW to 10 Hz for average measurement (vi) Sweep Time = Couple

. The system was evaluated up to 40 GHz but there were no measurable emissions above 18 GHz.
. These data represent the worst case mode data for all supported operating modes and antennas.

Note1: A Notch Filter was used during formal testing from 1 – 18GHz to help prevent the front end of the analyzer from over loading. The Notch filters used are designed to suppress TX fundamental frequency but do not effect harmonics of the fundamental frequency from being measured

Note2: The data displayed on the plots detailed in the graphical test results section were measured using a 'Peak Detector'. Please refer to the results table for the detectors used during formal measurements.

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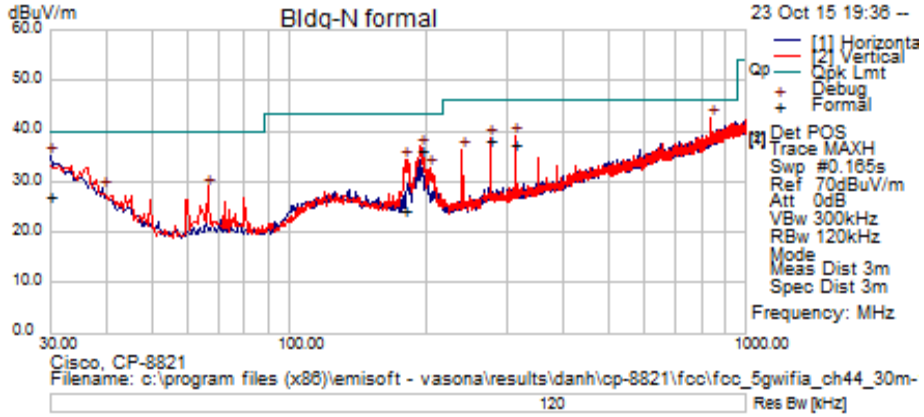
B.1.3 Transmitter Radiated Spurious Emissions Graphical Data Results

Subtest Date:	23-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	802.11a ,Tx Channel 44 (5220 MHz)



Title: **TX Spurious Emissions from 30MHz-1GHz – Ch44 (5220 MHz)**

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
276.4733	22.79	2.11	13.3	38.21	Quasi Max	V	117	24	46	-7.79	Pass	Tx/Ch44
313.3298	21.38	2.25	13.77	37.4	Quasi Max	V	134	154	46	-8.6	Pass	Tx/Ch44
194.3603	22.85	1.77	11.45	36.07	Quasi Max	V	108	182	43.5	-7.43	Pass	Tx/Ch44
179.5698	11.64	1.7	10.92	24.25	Quasi Max	V	203	298	43.5	-19.25	Pass	Tx/Ch44
30.01636	5.43	0.7	20.89	27.02	Quasi Max	H	153	344	40	-12.98	Pass	Tx/Ch44

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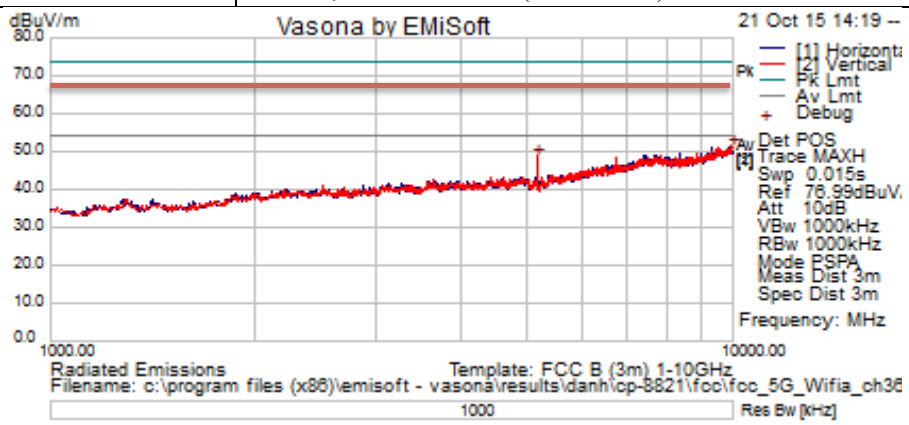
Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1-10GHz
Comments on the above Test Results	802.11a,Tx Channel 36 (5180 MHz)



Title: **TX Spurious Emissions from 1-10GHz – Ch36 (5180 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
9971.875	39.49	15	-2.62	51.37	Peak	V	250	150	54	-2.64	Pass	Tx/Ch36
5173.75	47.4	9.9	-8.55	48.76	Peak	V	375	257	54	-5.24	Pass	Tx/Ch36

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

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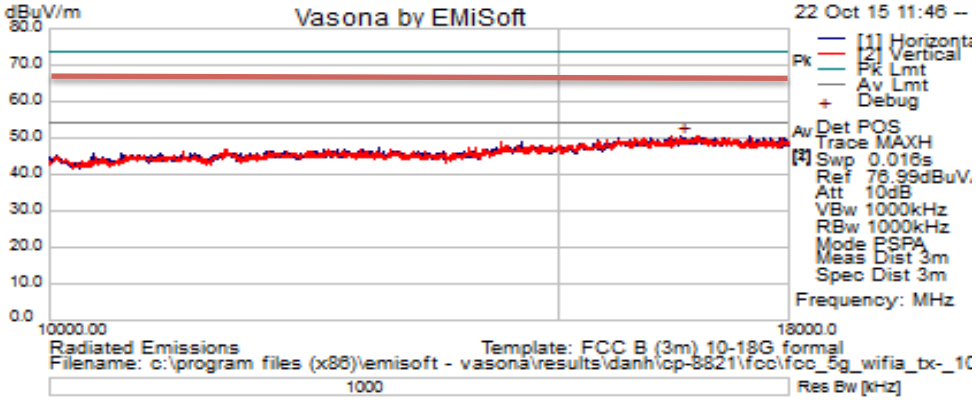
Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a,Tx Channel 36 (5180 MHz)



Title: **TX Spurious Emissions from 10-18GHz – Ch36 (5180 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
16535	43.24	19.46	-11.97	50.74	Peak	H	150	278	54	-3.26	Pass	Tx/Ch36

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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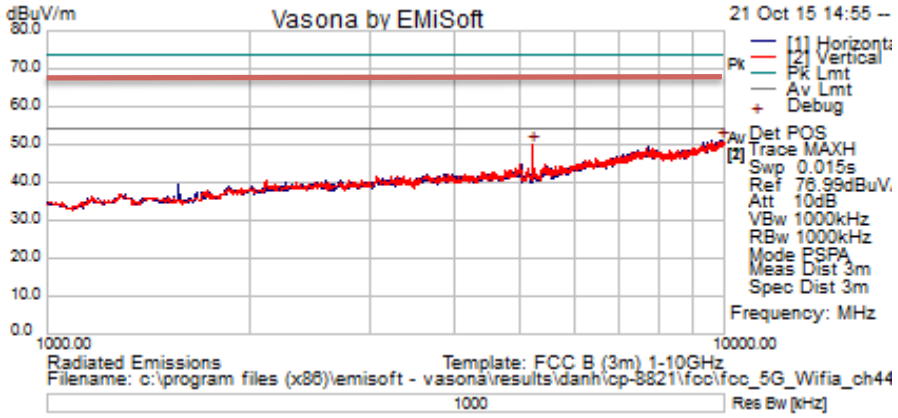
Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1.0-10GHz
Comments on the above Test Results	802.11a,Tx Channel 44 (5220 MHz)



Title: **TX Spurious Emissions from 1-10GHz – Ch44 (5220 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
9915.625	39.29	14	-2.76	51.02	Peak [Scan]	H	100	61	54	-2.98	Pass	Tx/Ch44
5213.125	48.61	10	-8.54	50.03	Peak [Scan]	V	225	100	54	-3.97	Pass	Tx/Ch44

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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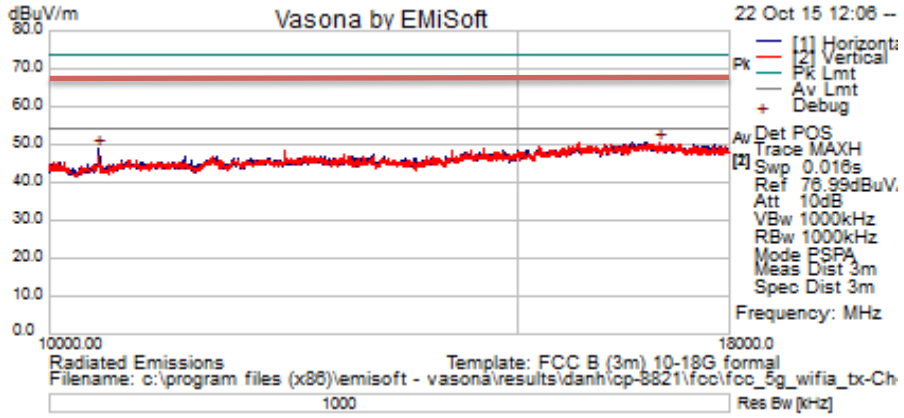
Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a,Tx Channel 44 (5220 MHz)



Title: **TX Spurious Emissions from 10-18GHz – Ch44 (5220 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
16940	43.57	19.73	-12.65	50.65	Peak	V	225	186	54	-3.35	Pass	Tx/Ch44
10435	50.23	14.9	-16.06	49.07	Peak	H	175	304	54	-4.93	Pass	Tx/Ch44

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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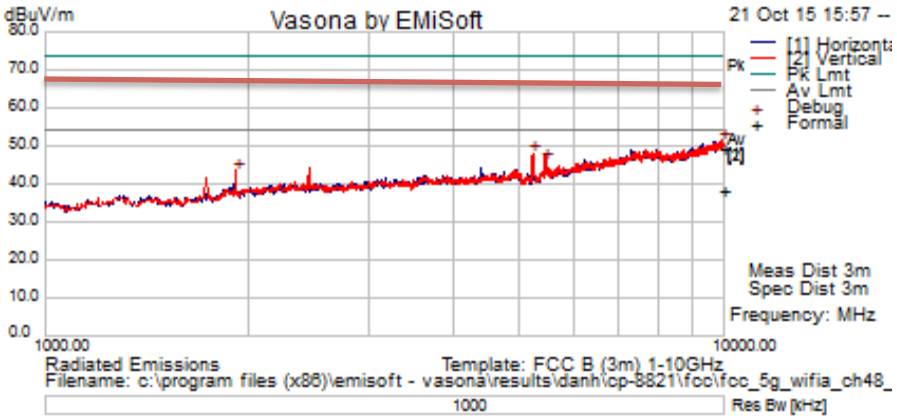
Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1-10GHz
Comments on the above Test Results	802.11a,Tx Channel 48 (5240 MHz)



Title: **TX Spurious Emissions from 1-10GHz – Ch48 (5240 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
1923.234	50.1	5.8	-12.5	43.4	Peak	V	375	65	54.0	-10.6	Pass	Tx/Ch48
5235.625	46.5	10.0	-8.5	48.0	Peak	V	225	103	54.0	-6.0	Pass	Tx/Ch48
5465.573	43.3	10.2	-7.8	45.8	Peak	V	150	343	54.0	-8.2	Pass	Tx/Ch48
9955.000	39.7	14.5	-2.7	51.5	Peak	V	350	13	54.0	-2.5	Pass	Tx/Ch48

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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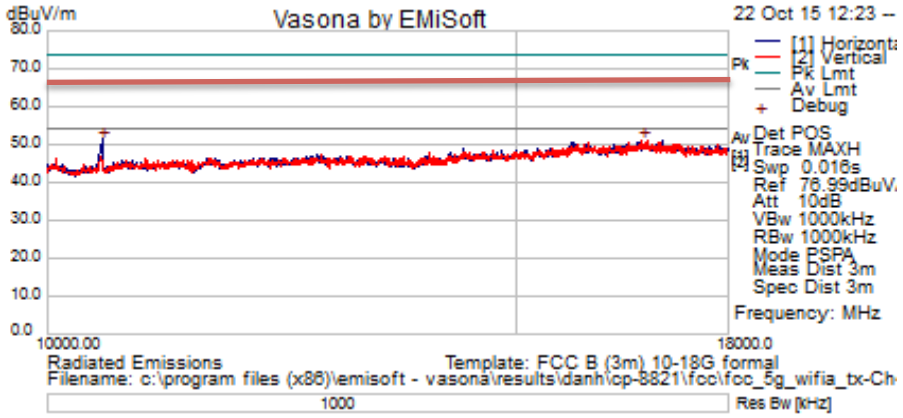
Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a,Tx Channel 48 (5240 MHz)



Title: **TX Spurious Emissions from 10-18GHz – Ch48 (5240 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comment
10490	52.29	14.95	-15.96	51.29	Peak	H	150	293	54	-2.71	Pass	Tx/Ch48
16715	43.93	19.53	-12.18	51.29	Peak	V	225	354	54	-2.71	Pass	Tx/Ch48

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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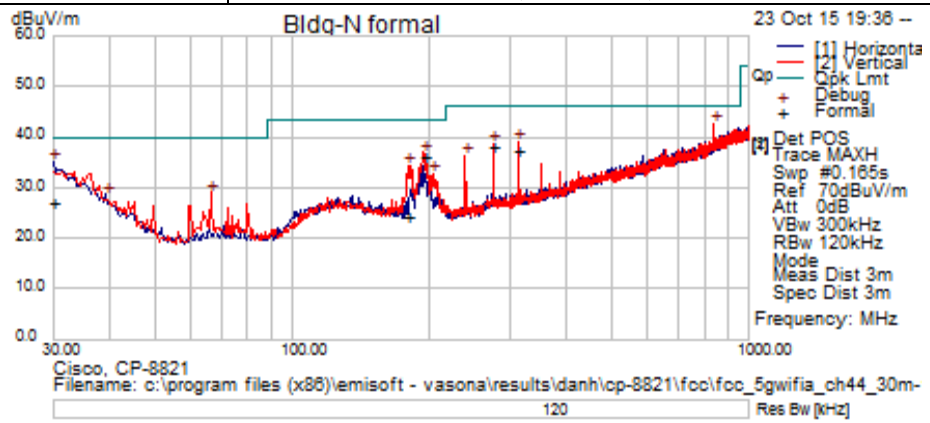
Subtest Date:	23-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	802.11a,Tx Channel 44 (5220 MHz)



Title: **TX Spurious Emissions from 30MHz-1GHz – Ch44 (5220 MHz)**

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
276.4733	22.79	2.11	13.3	38.21	Quasi Max	V	117	24	46	-7.79	Pass	Tx/Ch44
313.3298	21.38	2.25	13.77	37.4	Quasi Max	V	134	154	46	-8.6	Pass	Tx/Ch44
194.3603	22.85	1.77	11.45	36.07	Quasi Max	V	108	182	43.5	-7.43	Pass	Tx/Ch44
179.5698	11.64	1.7	10.92	24.25	Quasi Max	V	203	298	43.5	-19.25	Pass	Tx/Ch44
30.01636	5.43	0.7	20.89	27.02	Quasi Max	H	153	344	40	-12.98	Pass	Tx/Ch44

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B.2 AC Conducted Emissions

B.2.1 Limits.

FCC 15.207

Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table in these sections. The more stringent limit applies at the frequency range boundaries.

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B.2.2 Test Procedure

Measurement requirements
Ref: C63.10:2013, section 6.2.2

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument, or where permitted or required, the emission currents on the power line sensed by a current probe. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the
manufacturer, and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements, using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having a 50 Ω input impedance. All other ports are terminated in 50 Ω loads. Figure 5, Figure 6, and Figure 7 show typical test setups for ac power-line conducted emissions testing (see 6.13). For information about the use of a RF-shielded (screen) room, vertical conducting plane and voltage probe, see ANSI C63.4.

Tabletop devices shall be placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above thereference ground plane. The vertical conducting plane or wall of an RF-shielded (screen) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

Final ac power-line conducted emission measurements
Ref: C63.10:2013, section 6.2.5

Based on the exploratory tests of the EUT performed in 6.2.4, the one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are performed. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation. If the EUT is comprised of equipment units that have their own separate ac power connections, e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network, each
current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be separately measured. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

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Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency. Diagram or photograph the test setup that was used. See Clause 8 for full reporting requirements.

Ref. C63.10:2013, section 6.2

Test Procedure
1. Using Vasona software, configure the spectrum analyzer as below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 2. Set the radio in continuous transmit mode. 3. Connect cable end to LISN Hot port and other cable end to the spectrum Analyzer/EMC receiver RF input port. Terminate the LISN neutral port with a 50 Ω impedance terminator. 4. Sweep the frequency range from 150 kHz to 30 MHz (segment if necessary) 5. Use the peak marker function to determine the maximum amplitude level. 6. Center marker frequency and perform final measurement using applicable detector (Quasi-Pk/Average). 7. Record at least 6 highest reading for the worst case operating modes in Quasi-peak/Average. 8. Repeat the test on Neutral lead. 9. Repeat step 3 – 7 with the radio sets in the Receiver mode. 10. Record at least 6 highest reading in Quasi-peak/Average

Ref. C63.10:2013, section 4 / CISPR16-1-1

Test Parameters
Span = Entire frequency range or segment if necessary. Reference Level = 70 dBuV RBW = 9 kHz VBW ≥ 3 x RBW Sweep Time = Couple Detector = Quasi-Peak & Average

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B.2.3 Recorded Test Data and Graphical Test results

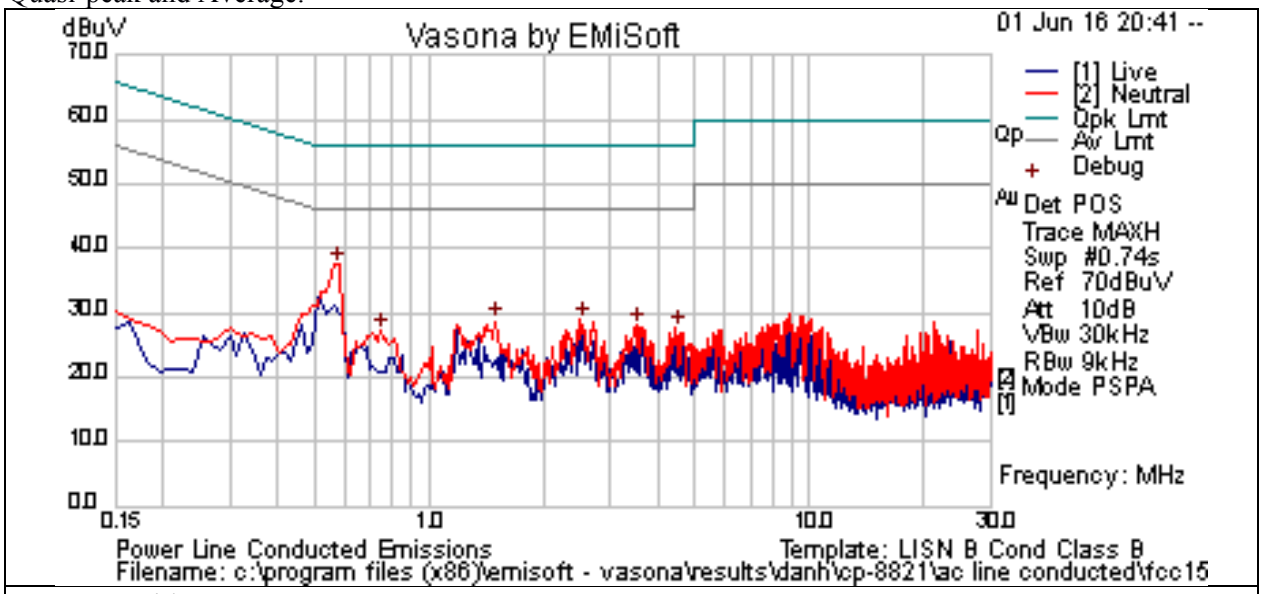
AC Conducted Emissions Test Result Tables for 802.11a / TX Ch44 (Peak, Quasi-Peak & Average)

Subtest Date:	01-Jun-2016
Engineer	Danh Le
Lab Information	Building N, formal room
Subtest Title	Conducted Emissions
Frequency Range	150 kHz - 30 MHz
Comments on the above Test Results	TX Ch44 (5220 MHz) with BPSK modulation – 6 Mbps

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	Factors (dB)	Level (dBuV)	Detector	Lines (Live/Neutral)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
0.5679	17.47	20.04	0.04	37.54	Peak [Scan]	Neutral	46	-8.46	Pass	TX / Ch44
2.50815	8.8	19.99	0.04	28.83	Peak [Scan]	Neutral	46	-17.17	Pass	TX / Ch44
1.49325	8.6	19.99	0.05	28.63	Peak [Scan]	Neutral	46	-17.37	Pass	TX / Ch44
3.52305	7.95	20.02	0.04	28.01	Peak [Scan]	Neutral	46	-17.99	Pass	TX / Ch44
4.47825	7.47	20.04	0.05	27.56	Peak [Scan]	Neutral	46	-18.44	Pass	TX / Ch44
0.747	7.11	20.03	0.04	27.18	Peak [Scan]	Neutral	46	-18.82	Pass	TX / Ch44

AC Conducted Graphical Test Results for 802.11a Mode:

Note: The data displayed on the plots detailed in this section were measured using a 'Peak Detector'. Please refer to the results table for the detectors used during final measurements.
When Peak readings are lower than Quasi-Peak & Average limits, it is not necessary to measure in Quasi-peak and Average.



Title: **TX Conducted Emissions from 150kHz – 30MHz – Ch44 (5220 MHz) - Peak**

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Appendix C: List of Test Equipment Used to perform the test

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due
CIS004882	EMC Test Systems / 3115	Double Ridged Guide Horn Antenna	19-AUG-15	19-Aug-16
CIS041944	Sunol Sciences / JB1	Combination Bi-Log Antenna, 30MHz-2GHz	21-JUL-15	21-JUL-16
CIS18313	HP / 8447D OPT 011	Dual Amplifier (0.1–13000 MHz)	28-APR-15	28-APR-16
CIS005691	Miteq / NSP1800-25-S1	Broadband Preamplifier (1-18GHz)	26-Jun-15	25-JUN-16
CIS39123	Cisco / THO118	Broadband Preamplifier (1-18GHz)	31-Mar15	31-Mar-16
CIS008100	Cisco / NSA 5m Chamber	NSA 5m Chamber	26-AUG-15	26-AUG-16
CIS035624	Rohde & Schwarz / ESCI	EMI Test Receiver	04-JUN-15	04-JUN-16
CIS024905	Agilent / E4440A	Precision Spectrum Analyzer	25-SEP-15	25-SEP-16
CIS44907	Rohde & Schwarz / ESCI	EMI Test Receiver	14-AUG-15	14-AUG-16
CIS08191	Fisher Custom Comm / FCC-450B-2.4-N	Pulse Limiter	07-JUL-15	07-JUL-16
CIS019208	TTE / H785-150K-50-21378	High Pass Filter 150KHz	09-DEC-15	09-DEC-16
CIS006565	Fisher Custom Com / 50/250-50-2-02	LISN (9kHz-30MHz)	03-MAR-16	03-MAR-17
CIS023911	Fisher Custom Com / 50-2-RA-NEMA-5-20R	LISN Receptacle Adaptor	03-MAR-16	03-MAR-17
CIS008531	Huber + Suhner / RG-223	25 ft RG-223 Cable	10-NOV-15	10-NOV-16
CIS051784	Huber+Suhner / Sucoflex 106PA	RF Coaxial Cable, to 18GHz	06-JAN-15	06-JAN-16
CIS023697	Micro-Coax / UFB197C-1-3144-504504	RF Coaxial Cable, to 18GHz, 314.4 in	06-JAN-15	06-JAN-16
CIS008023	Huber+Suhner /Sucoflex SF106A	3 meter Sucoflex cable	06-JAN-15	06-JAN-16
CIS006697	Lufft / 5063-33W	Temperature/Humidity Gauge	09-MAR-15	09-MAR-16
CIS054416	Huber + Suhner/ Sucoflex 106PA	Sucoflex N Type Blue 3ft cable	28-APR-15	28-APR-16
CIS040503	Agilent / E4440A	Precision Spectrum Analyzer	10-JUN-15	10-JUN-16
CIS35619	TestEquity / HalfCube	Temperature Chamber	01-APR-15	01-APR-16
CIS51741	Rohde & Schwarz /NRP-Z81	Power Meter	19-JAN-15	19-JAN-16

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Appendix D: Abbreviation Key and Definitions

The following table defines abbreviations used within this test report.

Abbreviation	Description	Abbreviation	Description
EMC	Electro Magnetic Compatibility	°F	Degrees Fahrenheit
EMI	Electro Magnetic Interference	°C	Degrees Celsius
EUT	Equipment Under Test	Temp	Temperature
ITE	Information Technology Equipment	S/N	Serial Number
TAP	Test Assessment Schedule	Qty	Quantity
ESD	Electro Static Discharge	Emf	Electromotive force
EFT	Electric Fast Transient	RMS	Root mean square
EDCS	Engineering Document Control System	Qp	Quasi Peak
Config	Configuration	Av	Average
CIS#	Cisco Number (unique identification number for Cisco test equipment)	Pk	Peak
Cal	Calibration	kHz	Kilohertz ($1x10^3$)
EN	European Norm	MHz	MegaHertz ($1x10^6$)
IEC	International Electro technical Commission	GHz	Gigahertz ($1x10^9$)
CISPR	International Special Committee on Radio Interference	H	Horizontal
CDN	Coupling/Decoupling Network	V	Vertical
LISN	Line Impedance Stabilization Network	dB	decibel
PE	Protective Earth	V	Volt
GND	Ground	kV	Kilovolt ($1x10^3$)
L1	Line 1	µV	Microvolt ($1x10^{-6}$)
L2	Line2	A	Amp
L3	Line 3	µA	Micro Amp ($1x10^{-6}$)
DC	Direct Current	mS	Milli Second ($1x10^{-3}$)
RAW	Uncorrected measurement value, as indicated by the measuring device	µS	Micro Second ($1x10^{-6}$)
RF	Radio Frequency	µS	Micro Second ($1x10^{-6}$)
SLCE	Signal Line Conducted Emissions	M	Meter
Meas dist	Measurement distance	Spec dist	Specification distance
N/A or NA	Not Applicable	SL	Signal Line (or Telecom Line)
P	Power Line	L	Live Line
N	Neutral Line	R	Return
S	Supply	AC	Alternating Current

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Appendix E: Software Used to Perform Testing

EMIsoft Vasona, version 6.024

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Appendix F: Test Procedures

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB Publication No. 789033 - D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

Test procedures are summarized below:

FCC 5GHz Test Procedures	EDCS # - 1445048
FCC 5GHz RSE Test Procedures	EDCS # - 1511600

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Appendix G: Scope of Accreditation (A2LA certificate number 1178-01)

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

http://www.a2la.org/scopepdf/1178-01.pdf

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Appendix H: Test Assessment Plan

Compliance Test Plan (Excel) EDCS#-1534002
Target Power Tables EDCS#-882940

Appendix I: Worst Case Justification

Worst case modes were selected by ANSI C63.10 2013 Section **5.6.2.2**

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).

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

c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

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