RADIO TEST REPORT

Product	:	802.11ac Ceiling-mount AP
Model Name	:	VigorAP 1000
Series Model	:	VigorAP 1000C
FCC ID	:	VGYAP1000C
Test Regulation	:	FCC 47 CFR Part 15 Subpart E (Section 15.407)
Received Date	:	Feb. 27, 2020
Test Date	:	Apr. 21, 2020 ~ Jun. 23, 2020
Issued Date	:	Jul. 8, 2020
Applicant	:	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

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REVISION HISTORY

Original Test Report No.: 4789387588-US-R1-V0

Rev.	Test report No.	Date	Page revised	Contents
Original	4789387588-US-R1-V0	Jun. 30, 2020	-	Initial issue
-	4789387588-US-R1-V0	Jul. 8, 2020	P.9 P.13 P.46	Modify Note 1. Modify section 6.5. Modify power limit data and note.

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1. Attestation of Test Results

APPLICANT:	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
MANUFACTURER	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
EUT DESCRIPTION:	802.11ac Ceiling-mount AP
BRAND:	DrayTek
MODEL:	VigorAP 1000
SERIES MODEL:	VigorAP 1000C
SAMPLE STAGE:	Engineering sample
DATE of TESTED:	Apr. 21, 2020 ~ Jun. 23, 2020

APPLICABLE STANDARDS

STANDARD	**Test Results**
FCC 47 CFR PART 15 Subpart E (Section 15.407)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:	Approved and Authorized By:
Cindy Hsin Date : Jul. 8, 2020 Project Handler	Howard Kao Date : Jul. 8, 2020 Project Engineer

2. Summary of Test Results

Summary of Test Results		
FCC Clause	**Test Items**	**Result**
15.407(e)	6dB Bandwidth	PASS
15.403(i)	26dB Bandwidth	PASS
2.1049	Occupied Bandwidth	See Note2
15.407(a)(1/3)	Conducted Output Power	PASS
15.407(a)(1/3)	Power Spectral Density	PASS
15.407(g)	Frequency Stability	PASS
15.407(b) (1/4(i/ii)/6)	Radiated Emissions and Band Edge Measurement	PASS
15.407(b)(6)	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

Note:
1. For the Radiated Band Edge and OOBE test plots were recorded in Appendix I, the Radiated Emissions test plots were recorded in Appendix II.
2. The Occupied Bandwidth was reference only.

3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB 789033 D02 General UNII Test Procedure New Rules v02r01, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398

5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

Test Item	Measurement Frequency Range	K	U(dB)
Conducted disturbance at mains terminals ports	0.15MHz ~ 30MHz	2	1.7
RF Conducted	9 kHz - 40GHz	2	1.0
Radiated disturbance below 30MHz	9 kHz - 30 MHz	2	2.2
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	2	5.3
Radiated disturbance above 1GHz	1GHz ~ 40GHz	2	4.8

6. Equipment under Test

6.1. Description of EUT

<table>
<tr><th>Product</th><td colspan="2">802.11ac Ceiling-mount AP</td></tr>
<tr><th>Brand Name</th><td colspan="2">DrayTek</td></tr>
<tr><th>Model Name</th><td colspan="2">VigorAP 1000</td></tr>
<tr><th>Series Model</th><td colspan="2">VigorAP 1000C</td></tr>
<tr><th>S/N</th><td colspan="2">19C001DAA04F33C</td></tr>
<tr><th>Operating Frequency</th><td colspan="2">5180 ~ 5240 MHz
5745 ~ 5825 MHz</td></tr>
<tr><th>Modulation</th><td colspan="2">256QAM, 64QAM, 16QAM, QPSK, BPSK</td></tr>
<tr><th>Transfer Rate</th><td colspan="2">802.11a: up to 54 Mbps
802.11n: up to MCS15
802.11ac: up to MCS9</td></tr>
<tr><th rowspan="6">Number of Channel</th><td rowspan="3">5180 ~ 5240 MHz</td><td>4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)</td></tr>
<tr><td>2 for 802.11n (HT40), 802.11 ac (VHT40)</td></tr>
<tr><td>1 for 802.11ac (VHT80)</td></tr>
<tr><td rowspan="3">5745 ~ 5825 MHz</td><td>5 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)</td></tr>
<tr><td>2 for 802.11n (HT40), 802.11 ac (VHT40)</td></tr>
<tr><td>1 for 802.11ac (VHT80)</td></tr>
<tr><th>Maximum Output Power</th><td colspan="2">Non-Beamforming Mode:
5180 ~ 5240 MHz: 24.90 dBm
5745 ~ 5825 MHz: 24.99 dBm
Beamforming Mode:
5180 ~ 5240 MHz: 20.03 dBm
5745 ~ 5825 MHz: 19.83 dBm</td></tr>
<tr><th>Normal Voltage</th><td colspan="2">12Vdc from adapter</td></tr>
</table>

Note:

1. The models difference table as below:

Main Model	Function				
	Antenna		Wi-Fi		
	PIFA Internal	Dipole External	2.4G	5G1	5G2
VigorAP 1000	-	V	V	V	V
Series Model	**Function difference**				
	Antenna		**Wi-Fi**		
	PIFA Internal	**Dipole External**	**2.4G**	**5G1**	**5G2**
VigorAP 1000C	V	-	V	V	V

- The model: VigorAP 1000C is sold in black and white. The internal structure is the same but the color is different.
- There are two modules in the EUT. For Wi-Fi 5GHz use, 5G1 only supports Tx with UNII-1, and 5G2 only supports Tx with UNII-3.

2. The EUT incorporates a MIMO function. Physically, the EUT provides two completed transmitters and two receivers.

Modulation Mode	Tx,Rx Function
802.11a	2TX,2RX
802.11n (HT20)	2TX,2RX
802.11n (HT40)	2TX,2RX
802.11ac (VHT20)	2TX,2RX
802.11ac (VHT40)	2TX,2RX
802.11ac (VHT80)	2TX,2RX

* The modulation and bandwidth are similar for 802.11n mode for HT20 / HT40 and 802.11ac mode for VHT20 / VHT40, therefore investigated worst case to representative mode in test report.

3. The EUT contains following accessory devices

Product	Brand	Model	Description
Dipole antenna 1	Angeei	DPD2430SRW	Antenna gain: 2.4~2.49GHz: 2.3 dBi 5.15~5.85GHz: 3.5 dBi
Dipole antenna 2	Walsin	RFDPA131300SB LB805	Antenna gain: 2.4~2.49GHz: 2.3 dBi 5.15~5.85GHz: 3.9 dBi
AC adapter	Channel Well Technology	2ABL024F	Input: 100-240V, 50-60Hz, 0.8A Output: 12.0V 2.0A Length: 1.5m
Mounting Bracket	N/A	N/A	N/A
Ethernet Cable	N/A	N/A	Length: 3.0m

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

6.2. Channel List

FOR 5180 ~ 5240MHz

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
42	5210MHz

FOR 5745 ~ 5825MHz:

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz	-	-

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency	Channel	Frequency
151	5755MHz	159	5795MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
155	5775MHz

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	23~26°C / 62~66%RH	120Vac / 60 Hz	Apr. 21, 2020 ~ Jun. 23, 2020	Carlos Chen
Radiated Spurious Emission	966-2	21~27°C / 55~68%RH	120Vac / 60 Hz	Apr. 24, 2020 ~ May 6, 2020	Carlos Chen
AC power Line Conducted Emission	SR1	24~26°C / 63~68%RH	120Vac / 60 Hz	Jun. 11, 2020	Carlos Chen

FCC Test Firm Registration Number: 498077

6.4. Description Of Available Antennas

For VigorAP 1000

Antenna	Brand Name	Model Name	Antenna Type	Antenna Gain(dBi)
Chain(0)	Angeei	DPD2430SRW	Dipole	3.5
Chain(1)	Walsin	RFDPA131300SBLB805	Dipole	3.9

For VigorAP 1000C

Antenna	Brand Name	Model Name	Antenna Type	Antenna Gain(dBi)
Chain(0)	Radiation Technology	C0504-ANG0004	PIFA	2
Chain(1)	Radiation Technology	C0504-ANG0006	PIFA	2

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer’s specification or user’s manual.

6.5. Test Mode Applicability and Tested Channel Detail

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- The fundamental of the EUT was investigated in three orthogonal axes X/Y/Z, it was determined that X axis was worst-case. Therefore, all final radiated testing was performed with the EUT in X axis.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case)
- The difference between the VigorAP1000 and VigorAP1000C is of the antenna type. Therefore, the antenna Port Conducted Measurement is the same, but both of the radiated tests are the complete test.
- After pre-scan, the dipole antenna of Walsin was decided to worst-case and use to all related test for AP1000C.

Non-Beamforming Mode

Model: VigorAP1000

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6.0
	802.11ac (VHT20)		OFDM	36 to 48	36, 44, 48	MCS0
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0
	802.11ac (VHT80)		OFDM	42	42	MCS0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6.0
	802.11ac (VHT20)		OFDM	149 to 165	149, 157, 165	MCS0
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0
	802.11ac (VHT80)		OFDM	155	155	MCS0
Radiated Emissions (Below 1GHz)	802.11ac (VHT40)	5180-5240	OFDM	38 to 46	46	MCS0
AC Power Line Conducted Emission	802.11ac (VHT40)	5180-5240	OFDM	38 to 46	46	MCS0
Antenna Port Conducted Measurement	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6.0
	802.11ac (VHT20)		OFDM	36 to 48	36, 44, 48	MCS0
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0
	802.11ac (VHT80)		OFDM	42	42	MCS0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6.0
	802.11ac (VHT20)		OFDM	149 to 165	149, 157, 165	MCS0
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0
	802.11ac (VHT80)		OFDM	155	155	MCS0

Model: VigorAP1000C

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6.0
	802.11ac (VHT20)		OFDM	36 to 48	36, 44, 48	MCS0
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0
	802.11ac (VHT80)		OFDM	42	42	MCS0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6.0
	802.11ac (VHT20)		OFDM	149 to 165	149, 157, 165	MCS0
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0
	802.11ac (VHT80)		OFDM	155	155	MCS0
Radiated Emissions (Below 1GHz)	802.11a	5180-5240	OFDM	36 to 48	36	6.0
AC Power Line Conducted Emission	802.11a	5180-5240	OFDM	36 to 48	36	6.0

Beamforming Mode

Model: VigorAP1000

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11ac (VHT20)	5180-5240	OFDM	36 to 48	36, 44, 48	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	42	42	MCS0 (Nss1)
	802.11ac (VHT20)	5745-5825	OFDM	149 to 165	149, 157, 165	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	155	155	MCS0 (Nss1)
Radiated Emissions (Below 1GHz)	802.11ac (VHT40)	5180-5240	OFDM	38 to 46	38	MCS0 (Nss1)
Antenna Port Conducted Measurement	802.11ac (VHT20)	5180-5240	OFDM	36 to 48	36, 44, 48	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	42	42	MCS0 (Nss1)
	802.11ac (VHT20)	5745-5825	OFDM	149 to 165	149, 157, 165	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	155	155	MCS0 (Nss1)

Model: VigorAP1000C

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11ac (VHT20)	5180-5240	OFDM	36 to 48	36, 44, 48	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	38 to 46	38, 46	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	42	42	MCS0 (Nss1)
	802.11ac (VHT20)	5745-5825	OFDM	149 to 165	149, 157, 165	MCS0 (Nss1)
	802.11ac (VHT40)		OFDM	151 to 159	151, 159	MCS0 (Nss1)
	802.11ac (VHT80)		OFDM	155	155	MCS0 (Nss1)
Radiated Emissions (Below 1GHz)	802.11ac (VHT80)	5180-5240	OFDM	42	42	MCS0 (Nss1)

Co-Location Mode

Model: VigorAP1000

Test item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions	802.11b	DSSS	DBPSK	1 to 11	6+48+165	1.0
	802.11ac(VHT20)	OFDM	BPSK	36 to 48		MCS0
				149 to 165		

Model: VigorAP1000C

Test item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions	802.11b	DSSS	DBPSK	1 to 11	6+48+149	1.0
	802.11a	OFDM	BPSK	36 to 48		6.0
				149 to 165		

6.6. Duty cycle

Non-Beamforming Mode

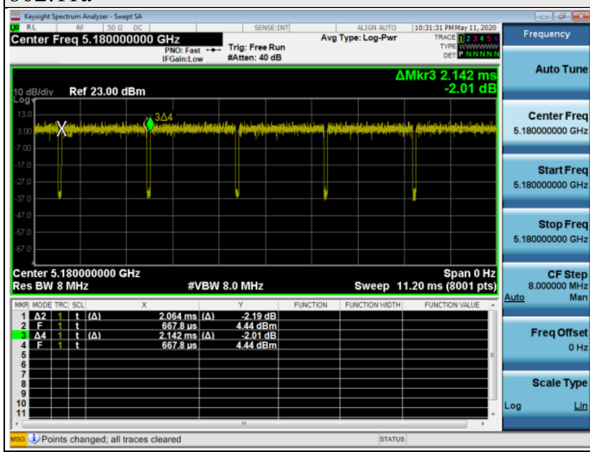
802.11a: Duty cycle = 2.064/2.142 = 0.964, Duty factor = 10 * log(1/0.964) = 0.16

802.11ac (VHT20): 5.011/5.089 = 0.985, duty cycle of test signal is ≥ 98 %, duty factor is not required.

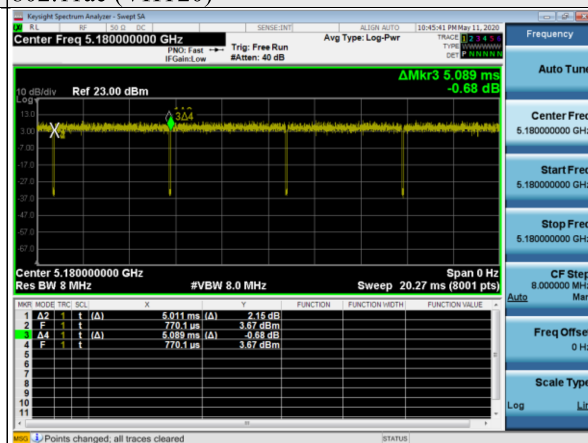
802.11ac (VHT40): Duty cycle = 2.437/2.517 = 0.97, Duty factor = 10 * log(1/0.97) = 0.14

802.11ac (VHT80): Duty cycle = 1.148/1.225 = 0.937, Duty factor = 10 * log(1/0.937) = 0.28

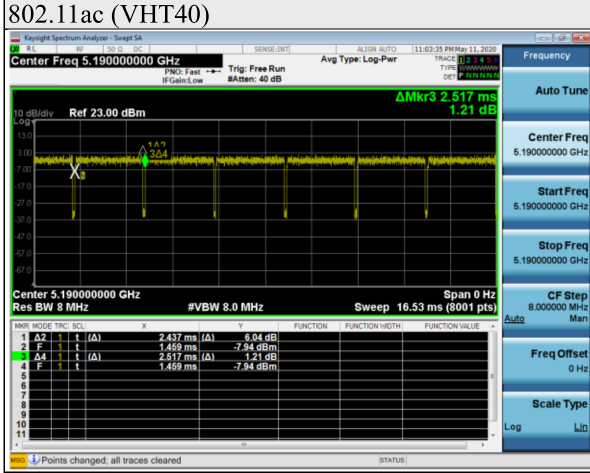
802.11a



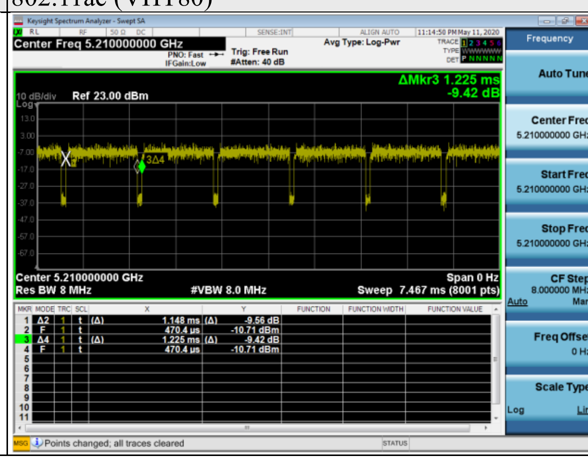
802.11ac (VHT20)



802.11ac (VHT40)



802.11ac (VHT80)



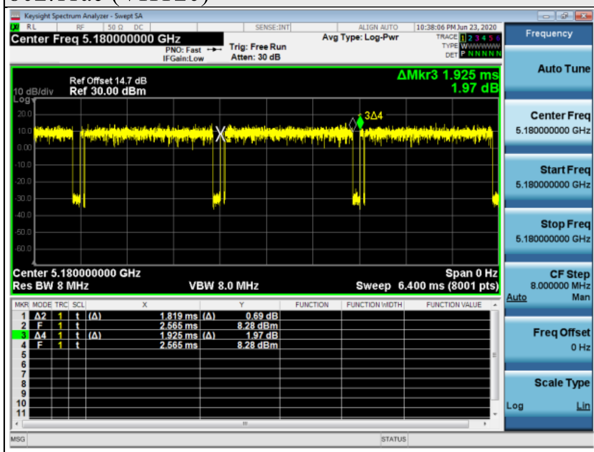
Beamforming Mode

802.11ac (VHT20): Duty cycle = 1.819/1.925 = 0.945, Duty factor = 10 * log(1/0.945) = 0.25

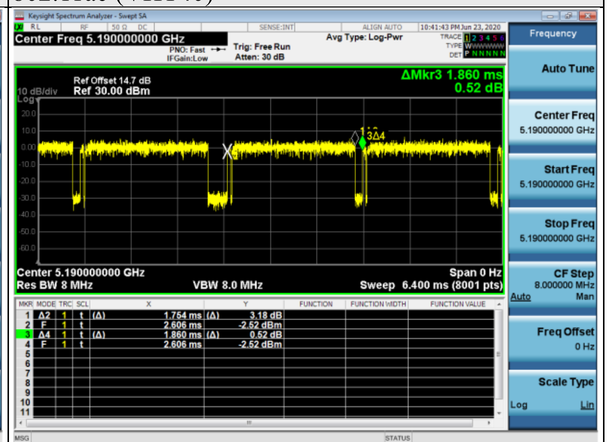
802.11ac (VHT40): Duty cycle = 1.754/1.860 = 0.943, Duty factor = 10 * log(1/0.943) = 0.25

802.11ac (VHT80): Duty cycle = 2.006/2.111 = 0.950, Duty factor = 10 * log(1/0.950) = 0.22

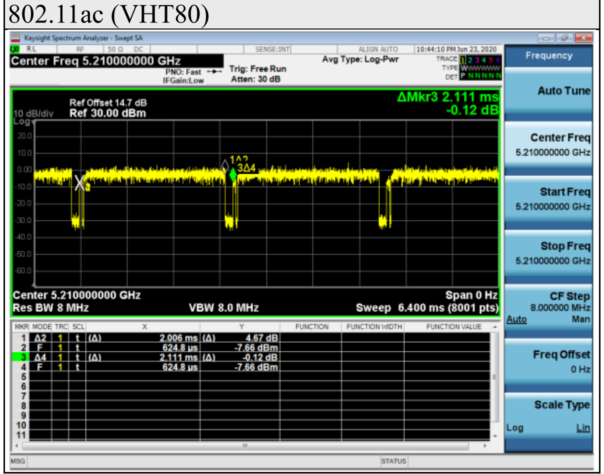
802.11ac (VHT20)



802.11ac (VHT40)



802.11ac (VHT80)



7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Cal. Interval**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	Nov. 13, 2019	1 year
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	Dec. 17, 2019	1 year
Loop Antenna	ETS lindgren	6502	00213440	Dec. 19, 2019	1 year
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	Jan. 3, 2020	1 year
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	Jan. 3, 2020	1 year
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	Dec. 27, 2019	1 year
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	Feb. 4, 2020	1 year
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	Feb. 4, 2020	1 year
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	May 8, 2019 May 19, 2020	1 year
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	Jan. 8, 2020	1 year
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	Jan. 8, 2020	1 year

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Cal. Interval**
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	Nov. 6, 2019	1 year
Pulse Power Sensor	Anrisu	MA2411B	1531202	Dec. 23, 2019	1 year
Power Meter	Anrisu	ML2495A	1645002	Dec. 23, 2019	1 year
Temperature &Humidity Test Chamber	GIANT FORCE	GTH-150-40-CP-AR	MAA1701-010	Mar. 23, 2020	1 year
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	Nov. 19, 2019	1 year
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	Aug. 8, 2019	1 year
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	Aug. 6, 2019	1 year
Cables	HARBOUR INDUSTRIES	LL142	170205-5000-1	Feb. 5, 2020	1 year

UL Software		
Description	**Name**	**Version**
Radiated measurement	EZ_EMC	1.1.4.2
Conducted measurement	Keysight.TestSystem	1.0.0.0
AC power Line Conducted Emission	EZ_EMC	1.1.4.2

8. Description of Test Setup

Support Equipment

Equipment	Brand Name	Model Name	S/N	Remark
Notebook	DELL	Latitude E5470	3JFKWF2	N/A
Notebook	DELL	Latitude E5470	JVSKWF2	N/A
Connector	N/A	N/A	N/A	RJ-45 to RJ-45
USB Device	SP Widget	TOUCH T03	N/A	8GB
PoE injector	Bullet POE	BPI1000-GH	1804240137	I/P: 100-240 Vac O/P: 30W
Rx Device (BF Client)	DrayTek	VigorAP 1000C	N/A	FW: 1.3.3_RC4

I/O Cables

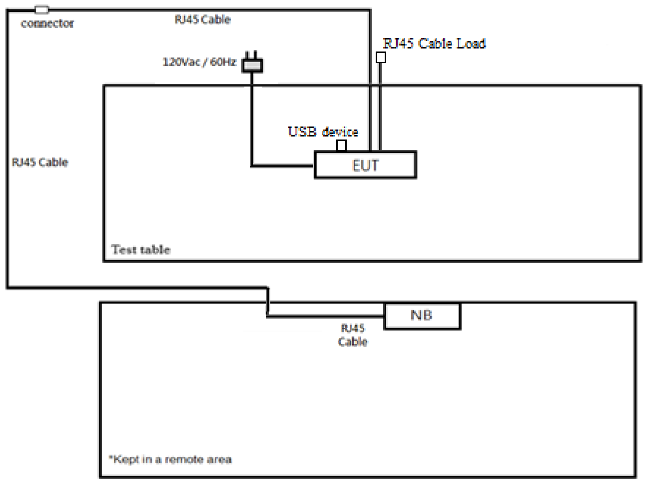
Equipment	Brand Name	Model Name	S/N	Remark
RJ-45 cable	N/A	N/A	N/A	Length : 10m
RJ-45 cable	N/A	N/A	N/A	Length : 1.5m
RJ-45 cable	N/A	N/A	N/A	Length : 1.5m

Test Setup

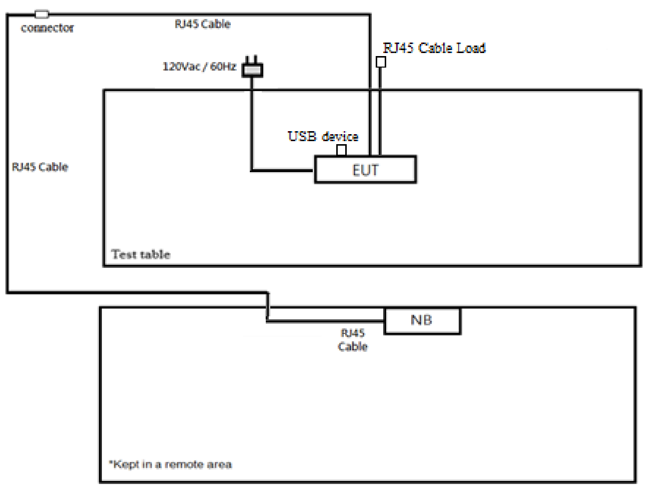
Controlled using a bespoke application (QRCT v3.0.210.0) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test

Non-Beamforming Mode



Beamforming Mode



9. Test Results

9.1. 6dB Bandwidth

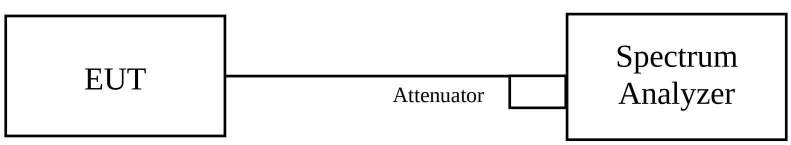
Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz.

Test procedure

a. Set resolution bandwidth (RBW) = 100kHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	16.293	16.361	0.5	Pass
157	5785	16.282	16.323	0.5	Pass
165	5825	16.308	16.316	0.5	Pass

802.11ac (VHT20)

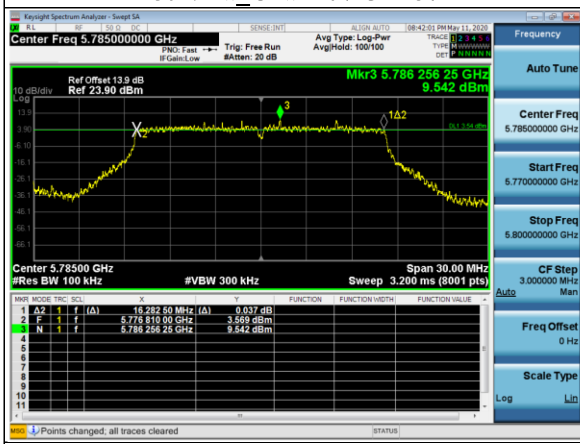
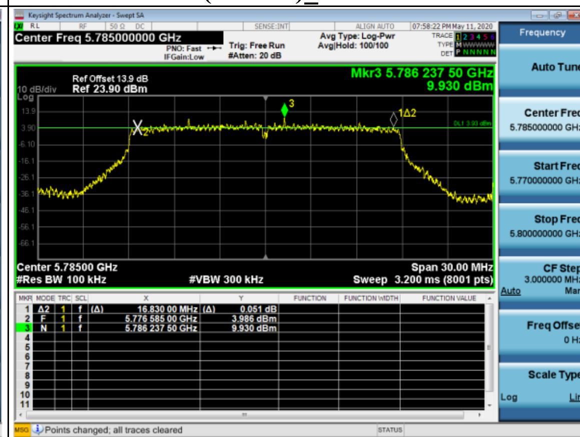
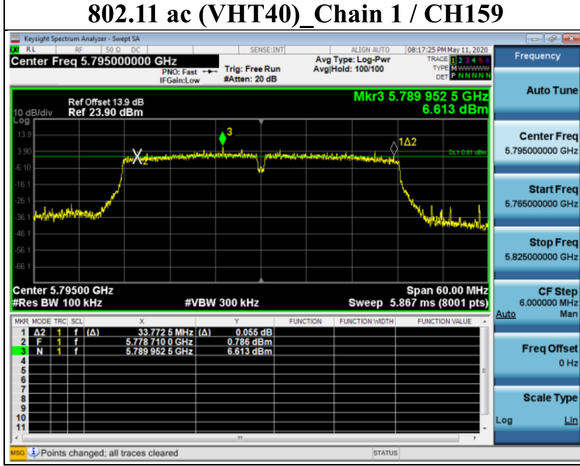
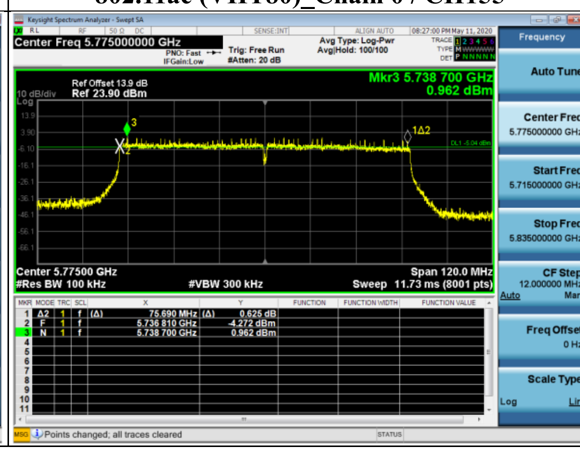
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	17.531	16.923	0.5	Pass
157	5785	16.83	17.283	0.5	Pass
165	5825	17.55	16.927	0.5	Pass

802.11ac (VHT40)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
151	5755	35.662	35.932	0.5	Pass
159	5795	35.317	33.772	0.5	Pass

802.11ac (VHT80)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
155	5775	75.69	75.72	0.5	Pass

Spectrum Plot of Worst Value	
802.11a_Chain 0 / CH157	**802.11 ac (VHT20)_Chain 0 / CH157**
	
802.11 ac (VHT40)_Chain 1 / CH159	**802.11ac (VHT80)_Chain 0 / CH155**
	

Beamforming Mode

802.11ac (VHT20)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	17.745	17.617	0.5	Pass
157	5785	17.67	17.595	0.5	Pass
165	5825	17.572	17.583	0.5	Pass

802.11ac (VHT40)

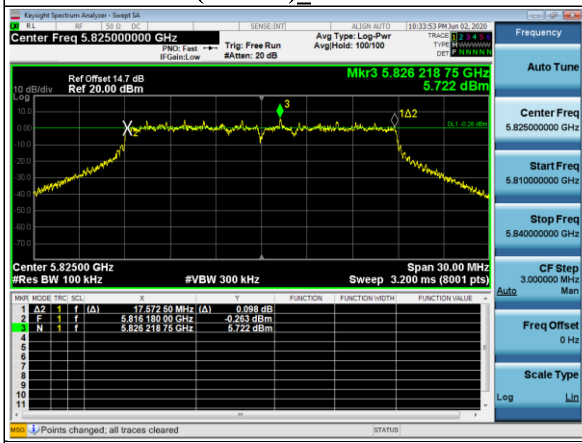
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
151	5755	36.187	35.572	0.5	Pass
159	5795	36.39	36.367	0.5	Pass

802.11ac (VHT80)

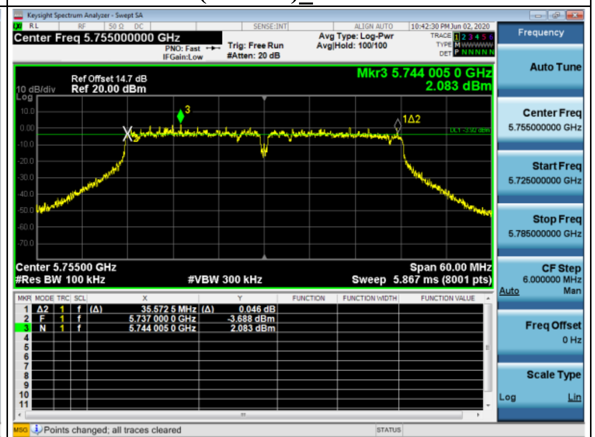
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
155	5775	75.03	74.835	0.5	Pass

Spectrum Plot of Worst Value

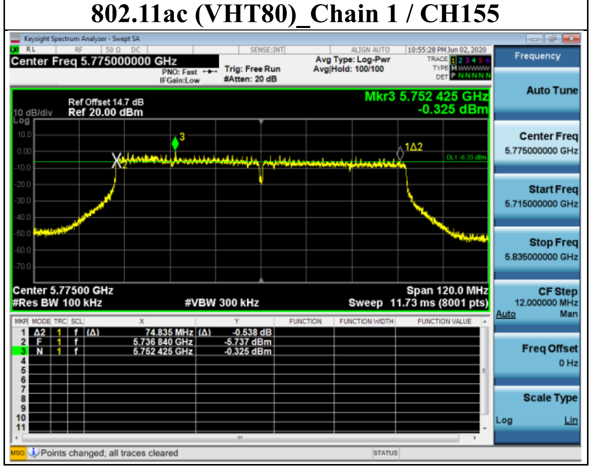
802.11ac (VHT20)_Chain 0 / CH165



802.11ac (VHT40)_Chain 1 / CH151



802.11ac (VHT80)_Chain 1 / CH155

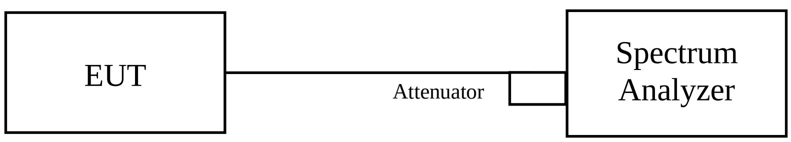


9.2. 26dB Bandwidth

Test procedure

a. Set RBW = approximately 1% of the emission bandwidth.
b. Set the VBW > RBW.
c. Detector = Peak.
d. Trace mode = max hold.
e. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
36	5180	18.19	18.43	PASS
44	5220	18.29	18.47	PASS
48	5240	18.54	19.91	PASS

802.11ac (VHT20)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
36	5180	20.15	20.08	PASS
44	5220	20.46	20.68	PASS
48	5240	23.82	27.29	PASS

802.11ac (VHT40)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
38	5190	39.86	39.59	PASS
46	5230	58.66	55.3	PASS

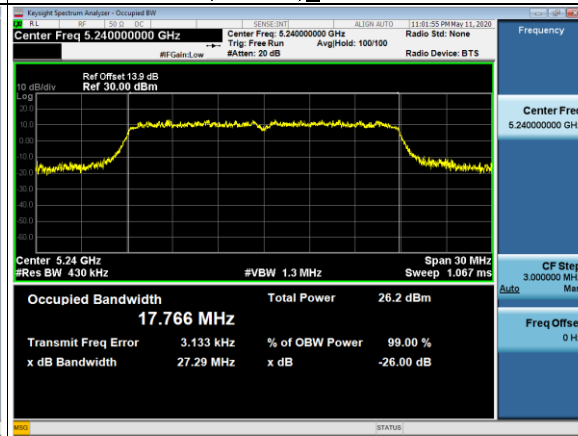
802.11ac (VHT80)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
42	5210	84.61	84.71	PASS

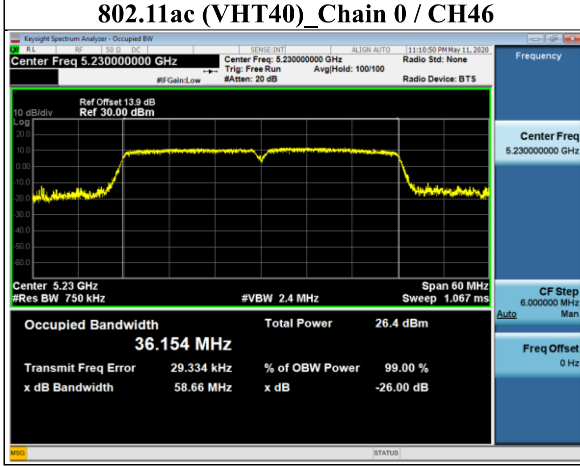
Spectrum Plot of Worst Value

802.11a_Chain 1 / CH48

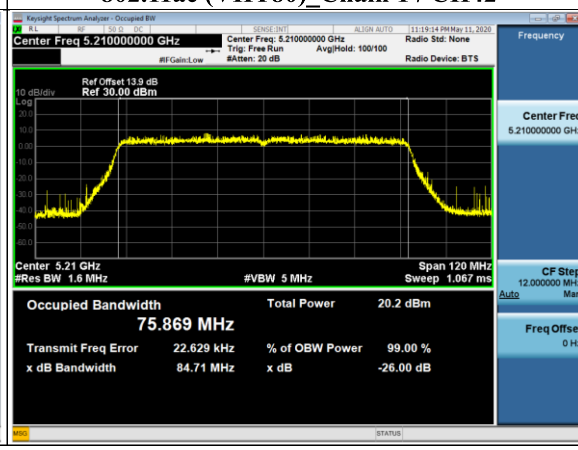
802.11ac (VHT20)_Chain 1 / CH48



802.11ac (VHT40)_Chain 0 / CH46



802.11ac (VHT80)_Chain 1 / CH42



Beamforming Mode

802.11ac (VHT20)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
36	5180	22.9	23.74	PASS
44	5220	20.32	20.34	PASS
48	5240	20.23	20.25	PASS

802.11ac (VHT40)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
38	5190	39.43	45.33	PASS
46	5230	39.59	40.94	PASS

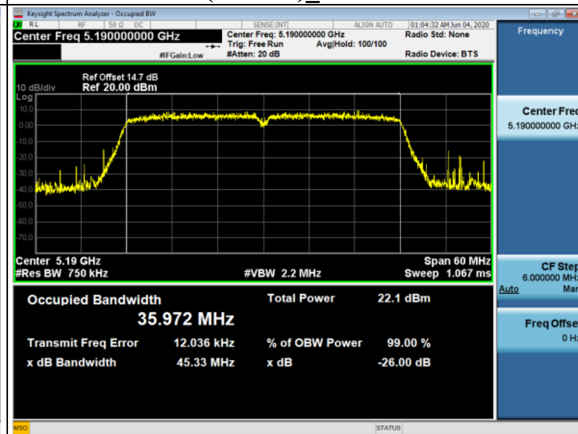
802.11ac (VHT80)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)		PASS / FAIL
		CHAIN 0	CHAIN 1	
42	5210	81.55	83.51	PASS

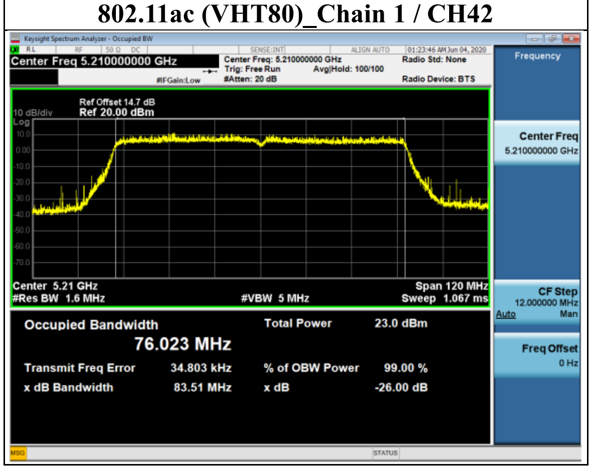
Spectrum Plot of Worst Value

802.11ac (VHT20)_Chain 1 / CH36

802.11ac (VHT40)_Chain 1 / CH38



802.11ac (VHT80)_Chain 1 / CH42

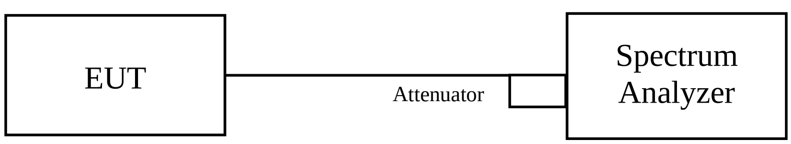


9.3. Occupied Bandwidth

Test procedure

a. Set center frequency to the nominal EUT channel center frequency.
b. Set span = 1.5 times to 5.0 times the OBW.
c. Set RBW = 1% to 5% of the OBW
d. Set VBW ≥ 3 x RBW
e. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f. Use the 99% power bandwidth function of the instrument (if available).
g. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	16.461	16.462
44	5220	16.522	16.508
48	5240	16.585	16.473
149	5745	16.498	16.454
157	5785	16.458	16.477
165	5825	16.517	16.5

802.11ac (VHT20)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	17.645	17.666
44	5220	17.666	17.682
48	5240	17.778	17.677
149	5745	17.669	17.617
157	5785	17.646	17.629
165	5825	17.664	17.632

802.11ac (VHT40)

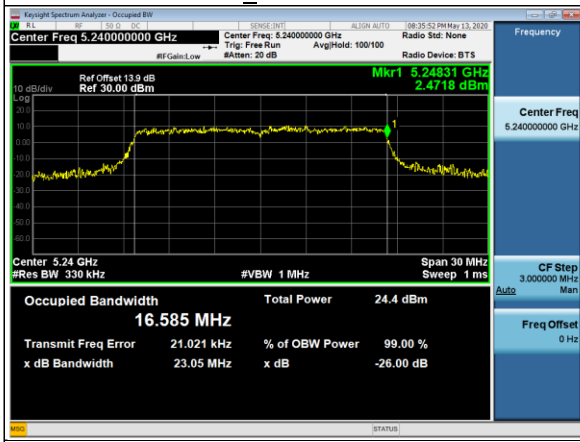
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	35.968	35.93
46	5230	36.216	36.056
151	5755	36.061	36.005
159	5795	35.972	35.918

802.11ac (VHT80)

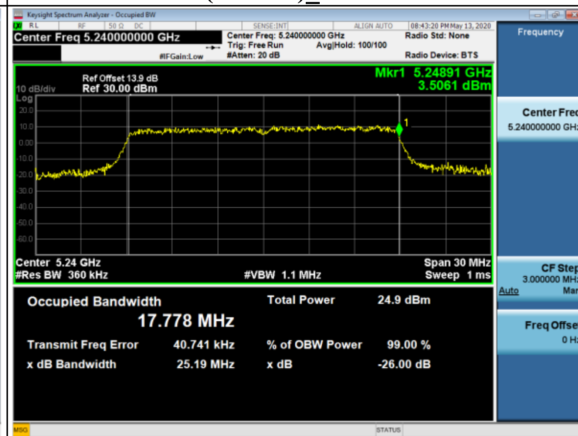
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	76.138	76.008
155	5775	75.977	75.938

Spectrum Plot of Worst Value

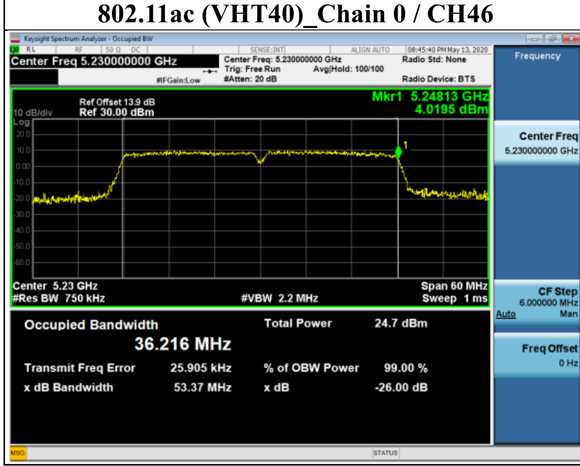
802.11a_Chain 0 / CH48



802.11ac (VHT20)_Chain 0 / CH48



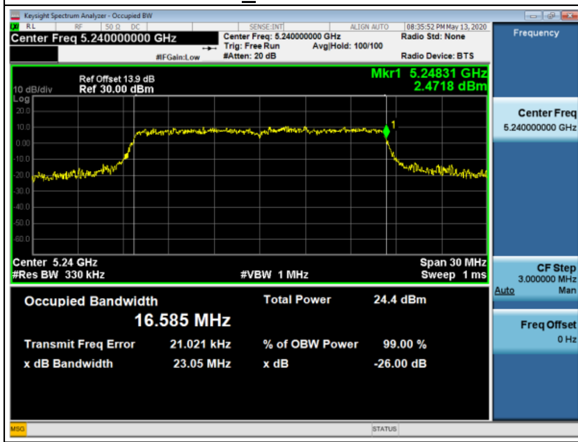
802.11ac (VHT40)_Chain 0 / CH46



802.11ac (VHT80)_Chain 0 / CH42

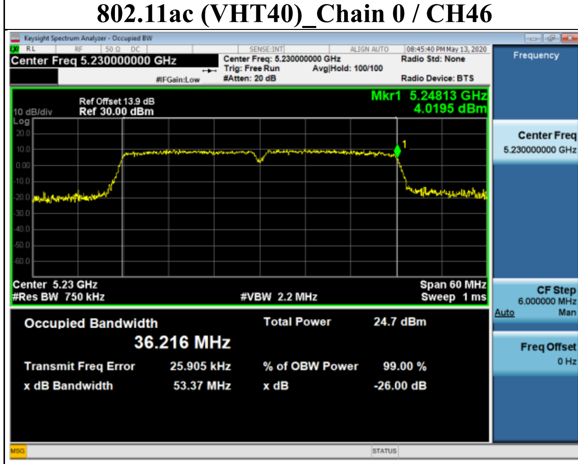
Spectrum Plot for near by DFS band
(DFS is required, if 99% OCP straddle into U-NII-2A band)

802.11a_Chain 0 / CH48



802.11ac (VHT20)_Chain 0 / CH48

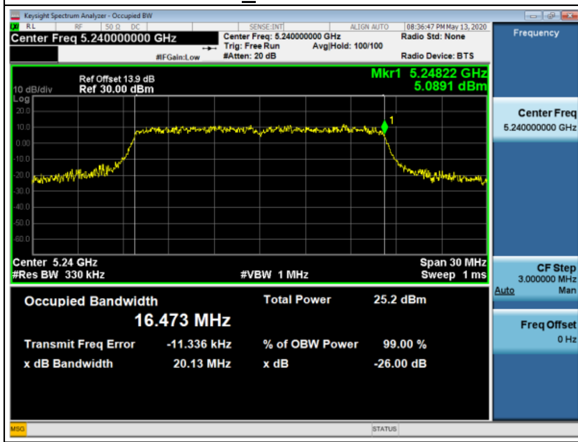
802.11ac (VHT40)_Chain 0 / CH46



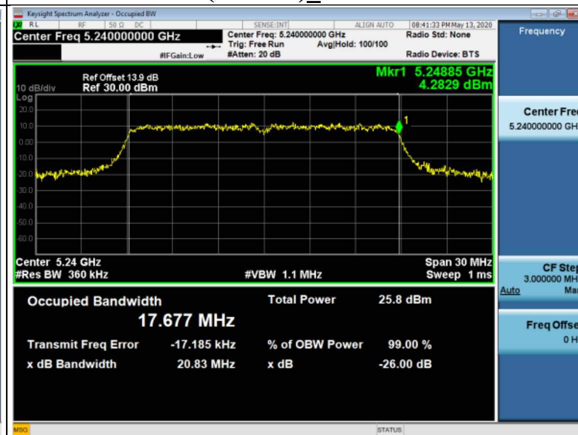
802.11ac (VHT80)_Chain 0 / CH42

Spectrum Plot for near by DFS band
(DFS is required, if 99% OCP straddle into U-NII-2A band)

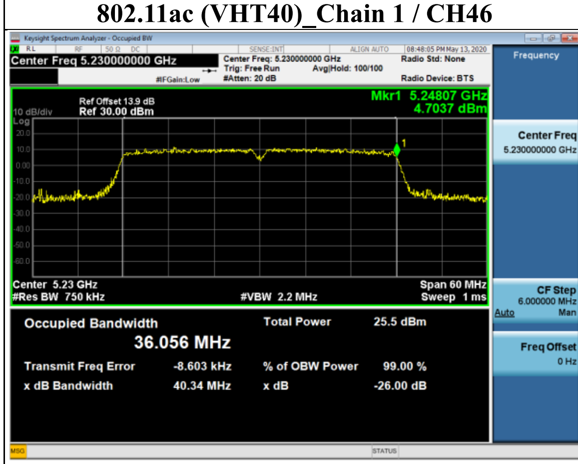
802.11a_Chain 1 / CH48



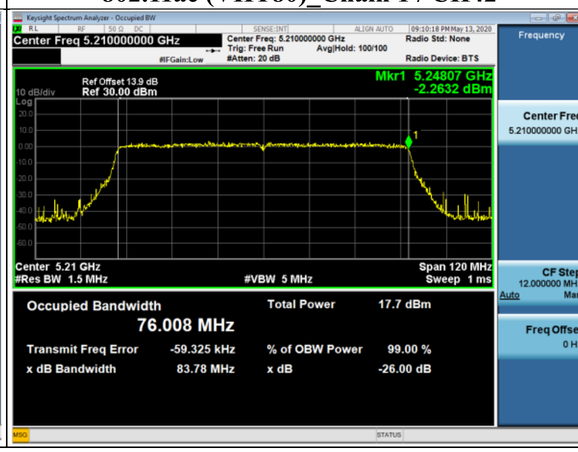
802.11ac (VHT20)_Chain 1 / CH48



802.11ac (VHT40)_Chain 1 / CH46



802.11ac (VHT80)_Chain 1 / CH42



Beamforming Mode

802.11ac (VHT20)

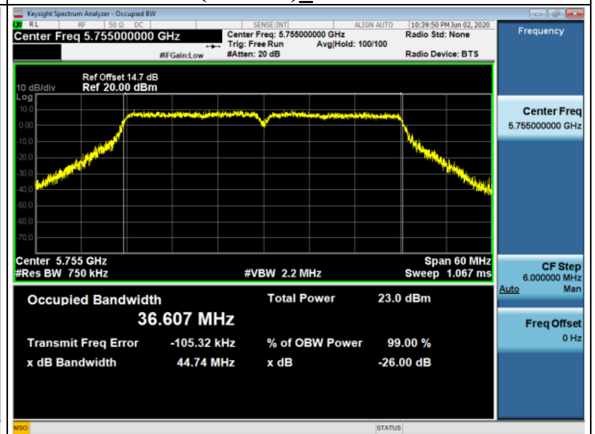
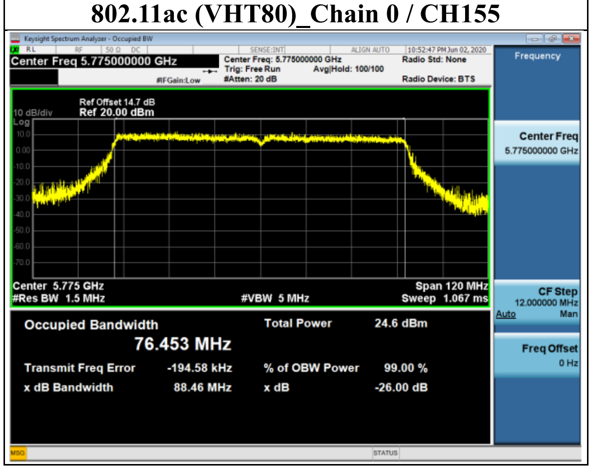
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	17.919	18.002
44	5220	17.725	17.681
48	5240	17.674	17.749
149	5745	18.027	18.066
157	5785	18.039	18.049
165	5825	18.035	18.029

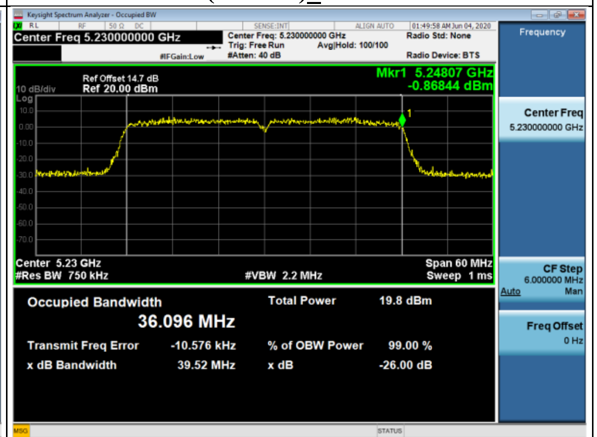
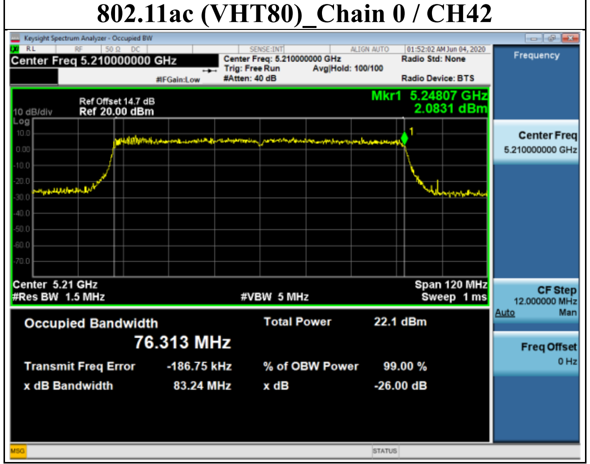
802.11ac (VHT40)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	35.969	35.938
46	5230	36.096	36.177
151	5755	36.607	36.388
159	5795	36.597	36.541

802.11ac (VHT80)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	76.313	76.131
155	5775	76.453	76.304

Spectrum Plot of Worst Value	
802.11ac (VHT20)_Chain 1 / CH149	**802.11ac (VHT40)_Chain 0 / CH151**
	
802.11ac (VHT80)_Chain 0 / CH155	
	

<table>
<tr><th colspan="2">Spectrum Plot for near by DFS band
(DFS is required, if 99% OCP straddle into U-NII-2A band)</th></tr>
<tr><td>802.11ac (VHT20)_Chain 0 / CH48</td><td>802.11ac (VHT40)_Chain 0 / CH46</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>802.11ac (VHT80)_Chain 0 / CH42</td><td></td></tr>
<tr><td>
</td><td></td></tr>
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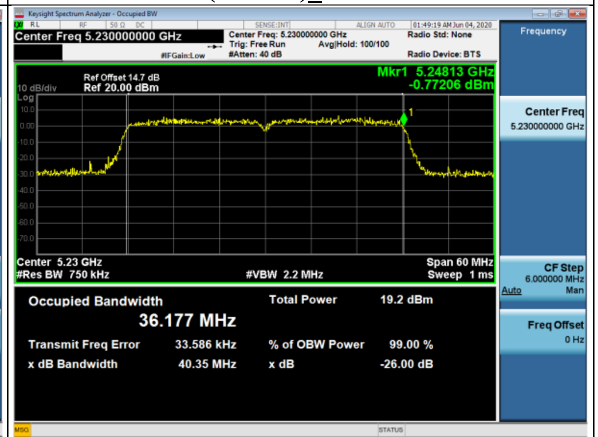
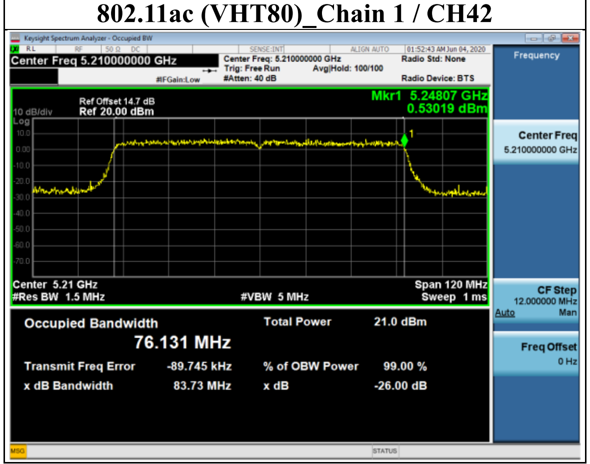
Spectrum Plot for near by DFS band (DFS is required, if 99% OCP straddle into U-NII-2A band)	
802.11ac (VHT20)_Chain 1 / CH48	**802.11ac (VHT40)_Chain 1 / CH46**
	
802.11ac (VHT80)_Chain 1 / CH42	
	

9.4. Conducted output power

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) Max. e.i.r.p ≦ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon If G_{TX} > 6 dBi, then $P_{Out} = 30 – (G_{TX} – 6)$
		Fixed point-to-point Access Point	1 Watt (30 dBm) If G_{TX} > 23 dBi, then $P_{Out} = 30 – (G_{TX} – 23)$
	√	Indoor Access Point	1 Watt (30 dBm) If G_{TX} > 6 dBi, then $P_{Out} = 30 – (G_{TX} – 6)$
		Client device	250mW (24 dBm) If G_{TX} > 6 dBi, then $P_{Out} = 24 – (G_{TX} – 6)$
U-NII-3	---		For Point-to-multipoint systems (P2M): 1 Watt (30 dBm). If G_{TX} > 6 dBi, then $P_{Out} = 30 – (G_{TX} – 6)$ For Point-to-point systems (P2P): 1 Watt (30 dBm)

Note:
1. P_{Out} = maximum conducted output power in dBm,
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = G_{ant} + 10 log (Nant) dBi.

   N*a*nt: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas

4. B is the 26 dB emission bandwidth in megahertz

   Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

   Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
   Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
   Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

   For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

Test Procedure

Test method PM-G

For 802.11a, 802.11ac (VHT20), 802.11ac (VHT40)

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

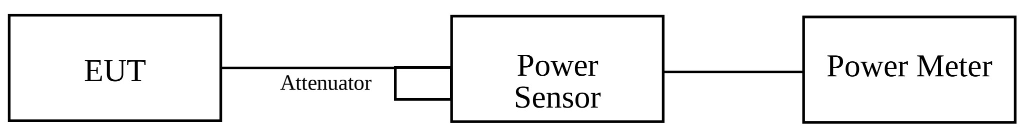
Test method SA-1

For 802.11ac (VHT80)

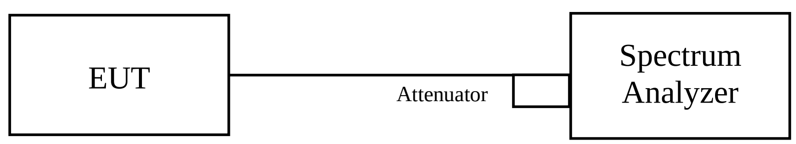
a. Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
b. Set sweep trigger*.
c. Set RBW = 1 MHz.
d. Set VBW ≥ 3 MHz
e. Number of points in sweep ≥ 2 Span / RBW.
f. Sweep time ≤ (number of points in sweep) * T
g. Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
h. Detector = RMS.
i. Trace mode = max hold.
j. Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.

* If transmit duty cycle < 98%, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run."

Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	18.37	18.59	140.984	21.49	30	PASS
44	5220	21.03	22.46	302.963	24.81	30	PASS
48	5240	21.25	21.94	289.667	24.62	30	PASS
149	5745	22.06	21.39	298.415	24.75	30	PASS
157	5785	22.31	21.52	312.122	24.94	30	PASS
165	5825	21.94	21.39	294.036	24.68	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ac (VHT20)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	17.76	18.09	124.121	20.94	30	PASS
44	5220	21.12	22.4	303.2	24.82	30	PASS
48	5240	21.32	22.39	308.899	24.90	30	PASS
149	5745	22.27	21.65	314.873	24.98	30	PASS
157	5785	21.98	21.21	289.891	24.62	30	PASS
165	5825	22.14	21.61	308.559	24.89	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ac (VHT40)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
38	5190	14.42	15.08	59.88	17.77	30	PASS
46	5230	21.21	22.47	308.734	24.90	30	PASS
151	5755	22.19	21.34	301.721	24.80	30	PASS
159	5795	22.22	21.72	315.319	24.99	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ac (VHT80)

CHAN.	CHAN. FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
42	5210	13.42	14.92	53.025	17.24	30	PASS
155	5775	20.02	19.45	188.567	22.75	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

Beamforming Mode

802.11ac (VHT20)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	17.16	16.68	98.559	19.94	29.09	PASS
44	5220	15.67	16.54	81.98	19.14	29.09	PASS
48	5240	15.42	16.19	76.425	18.83	29.09	PASS
149	5745	14.94	14.24	57.735	17.61	29.09	PASS
157	5785	15.72	15.53	73.052	18.64	29.09	PASS
165	5825	16.39	15.46	78.707	18.96	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

802.11ac (VHT40)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
38	5190	16.31	16.49	87.322	19.41	29.09	PASS
46	5230	15.29	15.97	73.343	18.65	29.09	PASS
151	5755	15.58	15.82	74.335	18.71	29.09	PASS
159	5795	17.26	16.34	96.264	19.83	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

802.11ac (VHT80)

CHAN.	CHAN. FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
42	5210	16.57	17.43	100.729	20.03	29.09	PASS
155	5775	15.99	17.38	94.421	19.75	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

9.5. Power Spectral Density

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz If G_{TX} > 6 dBi, then PSD = 17 – (G_{TX} – 6)
		Fixed point-to-point Access Point	17dBm/ MHz If G_{TX} > 23 dBi, then PSD = 17 – (G_{TX} – 23)
	√	Indoor Access Point	17dBm/ MHz If G_{TX} > 6 dBi, then PSD = 17 – (G_{TX} – 6)
		Client device	11dBm/ MHz If G_{TX} > 6 dBi, then PSD = 11 – (G_{TX} – 6)
U-NII-3	---		For Point-to-multipoint systems (P2M): 30dBm/ 500kHz. If G_{TX} > 6 dBi, then PSD = 30 – (G_{TX} – 6) For Point-to-point systems (P2P): 30dBm/ 500kHz

Note:
1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ +...+$10^{Gn/20}$)^2 / Nant] dBi.

   N*a*nt: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas

Test procedure

For U-NII-1 band:

Non-Beamforming Mode

Using method SA-1 Duty cycle >98% (802.11ac (VHT20))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c. Sweep time = auto, trigger set to “free run”.
d. Trace average at least 100 traces in power averaging mode.
e. Record the max value

Using method SA-2_with Duty cycle <98 % (802.11a, 802.11ac (VHT40), 802.11ac (VHT80))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c. Sweep time = auto, trigger set to “free run”.
d. Trace average at least 100 traces in power averaging mode.
e. Record the max value and add 10 log (1/duty cycle)

Beamforming Mode

Using method SA-2_with Duty cycle <98 %

f. Set span to encompass the entire emission bandwidth (EBW) of the signal.
g. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
h. Sweep time = auto, trigger set to “free run”.
i. Trace average at least 100 traces in power averaging mode.
j. Record the max value and add 10 log (1/duty cycle)

For U-NII-3 band:

Non-Beamforming Mode

with Duty cycle >98 % (802.11ac (VHT20))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
c. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
d. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
e. Sweep time = auto, trigger set to "free run".
f. Trace average at least 100 traces in power averaging mode.
g. Record the max value

with Duty cycle <98 % (802.11a, 802.11ac (VHT40), 802.11ac (VHT80))

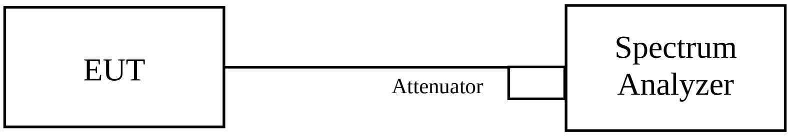
a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
c. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
d. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
e. Sweep time = auto, trigger set to "free run".
f. Trace average at least 100 traces in power averaging mode.
g. Record the max value and add 10 log (1/duty cycle)

Beamforming Mode

with Duty cycle <98 %

h. Set span to encompass the entire emission bandwidth (EBW) of the signal.
i. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
j. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
k. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
l. Sweep time = auto, trigger set to "free run".
m. Trace average at least 100 traces in power averaging mode.
n. Record the max value and add 10 log (1/duty cycle)

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

For U-NII-1 band

Non-Beamforming Mode

802.11a

CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
36	5180	3.11	3.71	6.59	16.09	PASS
44	5220	6.00	5.82	9.08	16.09	PASS
48	5240	6.39	6.08	9.41	16.09	PASS

Note:

1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

802.11ac (VHT20)

CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
36	5180	2.66	3.03	5.86	16.09	PASS
44	5220	6.86	7.33	10.11	16.09	PASS
48	5240	7.02	6.81	9.93	16.09	PASS

Note:

1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

802.11ac (VHT40)

CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
38	5190	-2.50	-2.57	0.62	16.09	PASS
46	5230	3.98	4.41	7.35	16.09	PASS

Note:

1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

802.11ac (VHT80)

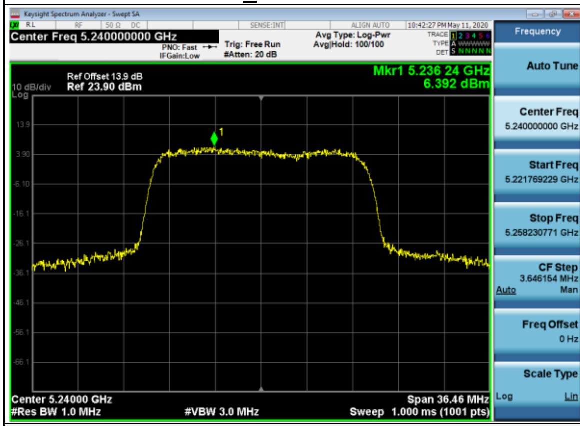
CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
42	5210	-7.97	-7.40	-4.39	16.09	PASS

Note:

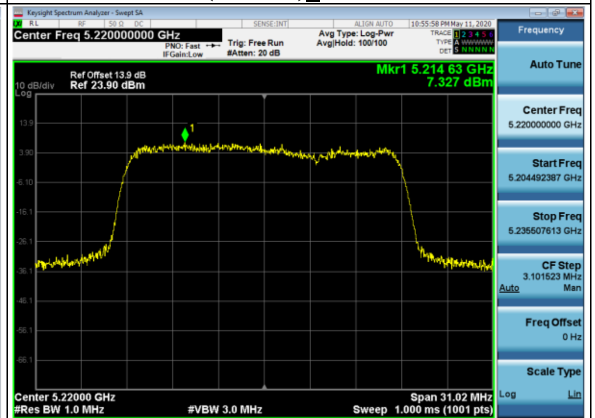
1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

Spectrum Plot of Worst Value

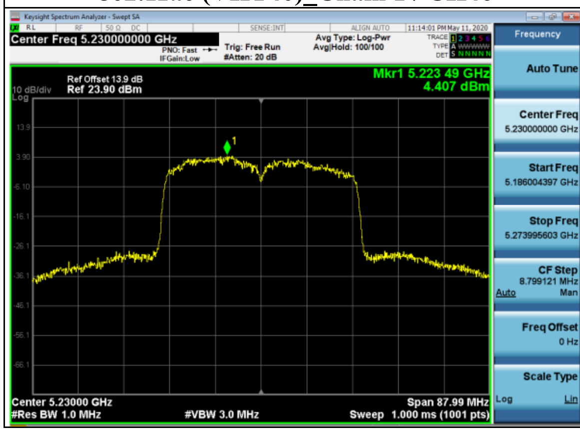
802.11a_Chain 0 / CH48



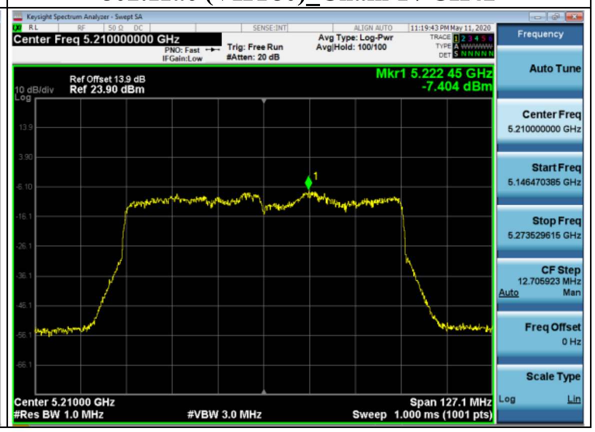
802.11ac (VHT20)_Chain 1 / CH44



802.11ac (VHT40)_Chain 1 / CH46



802.11ac (VHT80)_Chain 1 / CH42



Beamforming Mode

802.11ac (VHT20)

CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
36	5180	1.12	1.21	4.42	16.09	PASS
44	5220	-2.04	-1.01	1.65	16.09	PASS
48	5240	-0.39	-0.53	2.80	16.09	PASS

Note:
1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

802.11ac (VHT40)

CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
38	5190	-3.17	-3.03	0.17	16.09	PASS
46	5230	-5.14	-4.33	-1.45	16.09	PASS

Note:
1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

802.11ac (VHT80)

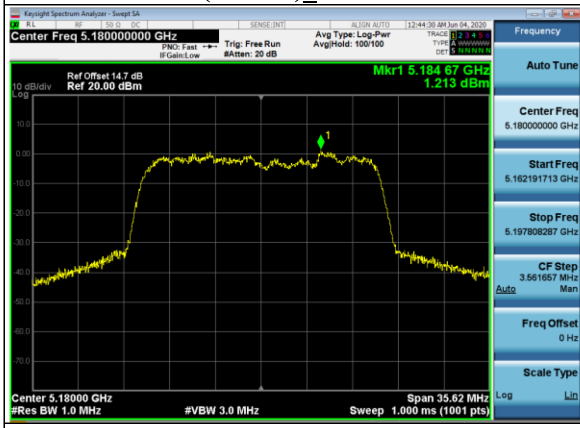
CHAN.	FREQ. (MHz)	PSD (dBm)		TOTAL PSD with duty factor (dBm)	MAX. LIMIT (dBm)	PASS / FAIL
		CHAIN 0	CHAIN 1			
42	5210	-5.23	-5.02	-1.89	16.09	PASS

Note:

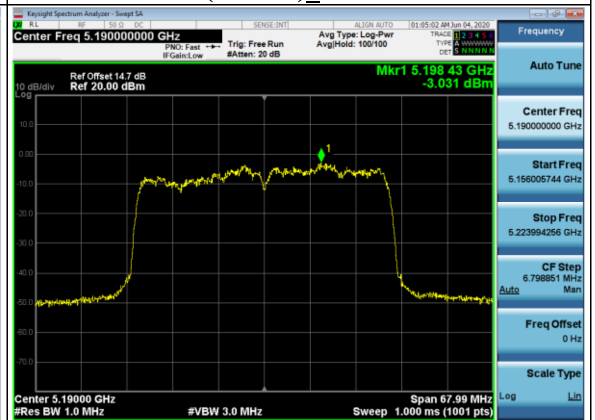
1. Method a) of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
2. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
3. Refer to section 6.6 for duty cycle spectrum plot.

Spectrum Plot of Worst Value

802.11ac (VHT20)_Chain 1 / CH36



802.11ac (VHT40)_Chain 1 / CH38



802.11ac (VHT80)_Chain 1 / CH42

For U-NII-3 Band

Non-Beamforming Mode

802.11a

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	149	5745	2.763	4.98	3.01	8.15	29.09	Pass
	157	5785	2.823	5.04	3.01	8.21	29.09	Pass
	165	5825	1.766	3.99	3.01	7.16	29.09	Pass
1	149	5745	1.84	4.06	3.01	7.23	29.09	Pass
	157	5785	3.126	5.35	3.01	8.52	29.09	Pass
	165	5825	1.109	3.33	3.01	6.5	29.09	Pass

Note:

1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

802.11ac (VHT20)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	149	5745	2.434	4.65	3.01	7.66	29.09	Pass
	157	5785	3.03	5.25	3.01	8.26	29.09	Pass
	165	5825	2.732	4.95	3.01	7.96	29.09	Pass
1	149	5745	2.408	4.63	3.01	7.64	29.09	Pass
	157	5785	1.878	4.10	3.01	7.11	29.09	Pass
	165	5825	2.312	4.53	3.01	7.54	29.09	Pass

Note:

1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

802.11ac (VHT40)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	151	5755	-0.655	1.57	3.01	4.72	29.09	Pass
	159	5795	-0.255	1.97	3.01	5.12	29.09	Pass
1	151	5755	-1.646	0.57	3.01	3.72	29.09	Pass
	159	5795	-0.451	1.77	3.01	4.92	29.09	Pass

Note:

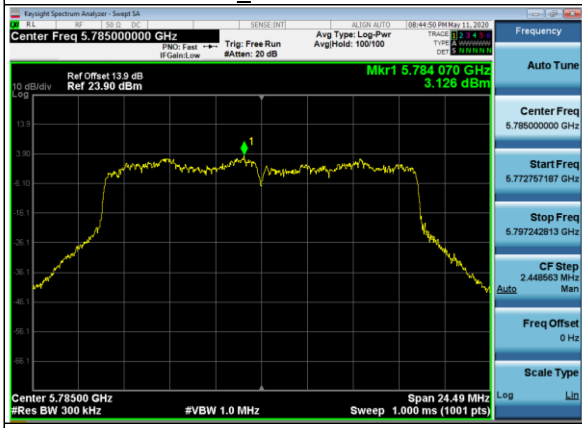
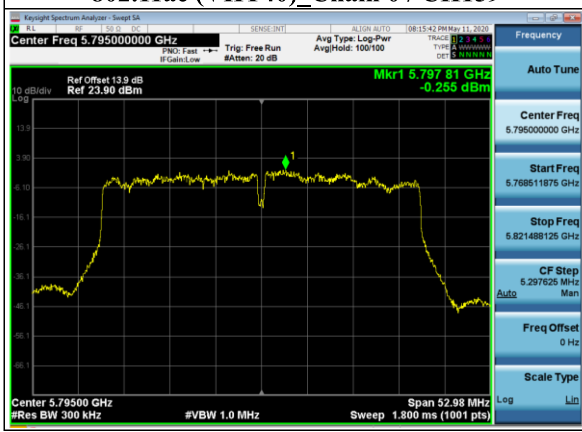
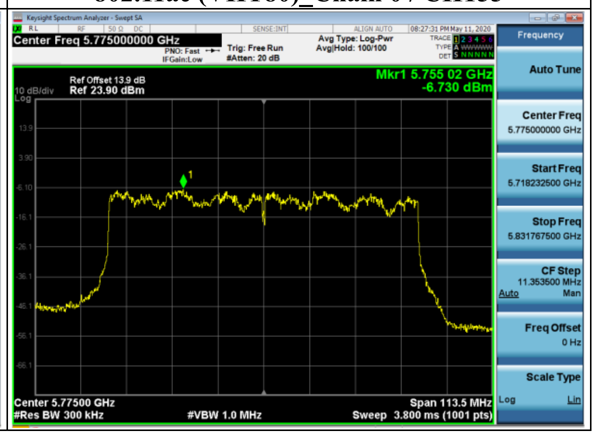
1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

802.11ac (VHT80)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	155	5775	-6.73	-4.51	3.01	-1.22	29.09	Pass
1	155	5775	-6.965	-4.75	3.01	-1.46	29.09	Pass

Note:

1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

<table>
<tr><th colspan="2">Spectrum Plot of Worst Value</th></tr>
<tr><td>802.11a_Chain 1 / CH157</td><td>802.11ac (VHT20)_Chain 0 / CH157</td></tr>
<tr><td></td><td></td></tr>
<tr><td>802.11ac (VHT40)_Chain 0 / CH159</td><td>802.11ac (VHT80)_Chain 0 / CH155</td></tr>
<tr><td></td><td></td></tr>
</table>

Beamforming Mode

802.11ac (VHT20)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	149	5745	-7.299	-5.08	3.01	-1.82	29.09	Pass
	157	5785	-4.683	-2.46	3.01	0.80	29.09	Pass
	165	5825	-5.077	-2.86	3.01	0.40	29.09	Pass
1	149	5745	-6.667	-4.45	3.01	-1.19	29.09	Pass
	157	5785	-4.05	-1.83	3.01	1.43	29.09	Pass
	165	5825	-3.653	-1.43	3.01	1.83	29.09	Pass

Note:

1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

802.11ac (VHT40)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	151	5755	-7.493	-5.27	3.01	-2.01	29.09	Pass
	159	5795	-6.127	-3.91	3.01	-0.65	29.09	Pass
1	151	5755	-6.741	-4.52	3.01	-1.26	29.09	Pass
	159	5795	-7.488	-5.27	3.01	-2.01	29.09	Pass

Note:

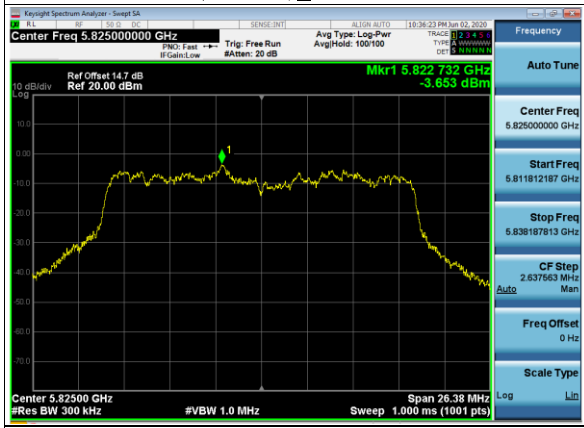
1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

802.11ac (VHT80)

TX Chain	Channel	Frequency (MHz)	PSD w/o BWCF (dBm/300 kHz)	PSD with BWCF (dBm/500 kHz)	10 log (N=2) dB	Total PSD with Duty Factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
0	155	5775	-10.031	-7.81	3.01	-4.58	29.09	Pass
1	155	5775	-8.611	-6.39	3.01	-3.16	29.09	Pass

Note:

1. Directional gain = 6.91 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 1.1 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz).

<table>
<tr><th colspan="2">Spectrum Plot of Worst Value</th></tr>
<tr><td>802.11ac (VHT20)_Chain 1 / CH165</td><td>802.11ac (VHT40)_Chain 0 / CH159</td></tr>
<tr><td>
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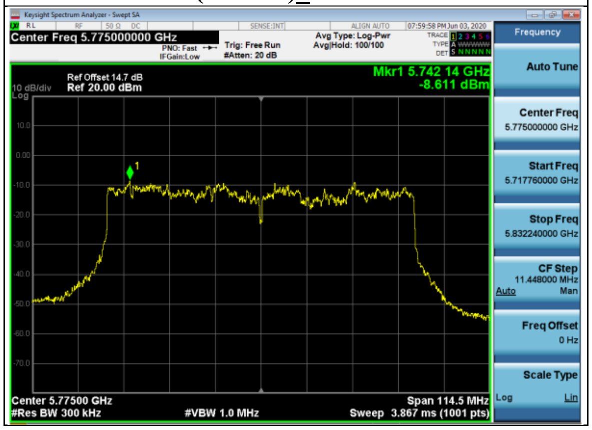
<tr><td>802.11ac (VHT80)_Chain 1 / CH155</td><td></td></tr>
<tr><td>
</td><td></td></tr>
</table>

9.6. Frequency Stability

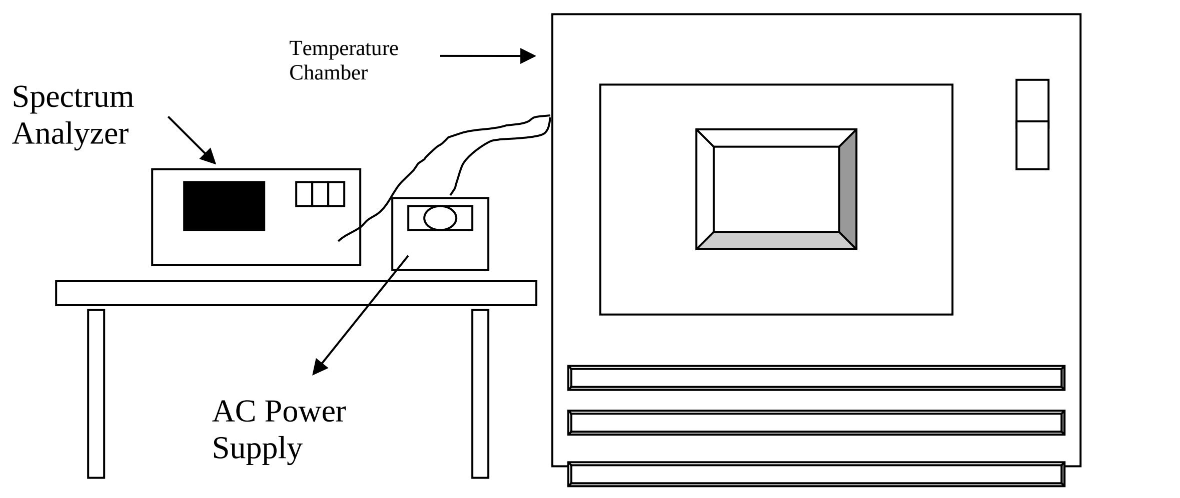
Requirements

The frequency of the carrier signal shall be maintained within band of operation.

Test procedure

a. The EUT was placed inside the environmental test chamber and powered by nominal AC voltage.
b. Turn the EUT on and couple its output to a spectrum analyzer.
c. Turn the EUT off and set the chamber to the highest temperature specified.
d. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
e. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

Test Setup



Test Data

Non-Beamforming Mode

Frequency Stability Versus Temp.									
Operating Frequency: 5180 MHz									
TEMP. (℃)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
50	120	5179.985	-2.90	5180.001	0.19	5179.99	-1.93	5180.02	3.86
40	120	5179.99	-1.93	5179.992	-1.54	5180.004	0.77	5179.995	-0.97
30	120	5180.02	3.86	5180.013	2.51	5179.994	-1.16	5180.01	1.93
20	120	5179.983	-3.28	5179.991	-1.74	5180.012	2.32	5179.989	-2.12
10	120	5180.024	4.63	5179.993	-1.35	5180.009	1.74	5180.006	1.16
0	120	5180.001	0.19	5179.981	-3.67	5179.985	-2.90	5180.019	3.67
-10	120	5180.013	2.51	5180.025	4.83	5180.003	0.58	5179.99	-1.93
-20	120	5180.018	3.47	5180.001	0.19	5180.022	4.25	5179.984	-3.09
-30	120	5179.992	-1.54	5180.025	4.83	5180.014	2.70	5179.993	-1.35
TEMP. (℃)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
20	138	5179.982	-3.47	5179.997	-0.58	5179.981	-3.67	5179.996	-0.77
20	102	5179.98	-3.86	5180.017	3.28	5180.018	3.47	5179.999	-0.19

Beamforming Mode

Frequency Stability Versus Temp.										
Operating Frequency: 5180 MHz										
TEMP. (℃)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute		
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
50	120	5179.975	-4.83	5180.008	1.54	5179.983	-3.28	5180.022	4.25
40	120	5179.996	-0.77	5179.99	-1.93	5180.016	3.09	5179.989	-2.12
30	120	5179.995	-0.97	5179.997	-0.58	5179.995	-0.97	5179.989	-2.12
20	120	5179.983	-3.28	5179.98	-3.86	5180.002	0.39	5179.997	-0.58
10	120	5180.003	0.58	5179.977	-4.44	5180.007	1.35	5179.991	-1.74
0	120	5180.014	2.70	5179.998	-0.39	5180	0.00	5180.013	2.51
-10	120	5179.975	-4.83	5179.977	-4.44	5180.024	4.63	5179.993	-1.35
-20	120	5179.997	-0.58	5180.009	1.74	5179.991	-1.74	5180.023	4.44
-30	120	5179.975	-4.83	5180.019	3.67	5179.996	-0.77	5180.005	0.97
TEMP. (℃)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
20	138	5180.008	1.54	5180.017	3.28	5180.014	2.70	5180.01	1.93
20	102	5179.989	-2.12	5179.991	-1.74	5180.014	2.70	5180.016	3.09

9.7. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

Frequency(MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

Limits of unwanted emission out of the restricted bands

Applicable To		**Limit**	
789033 D02 General UNII Test Procedure New Rules v02r01		Field Strength at 3m	
		PK:74 (dBμV/m)	AV:54 (dBμV/m)
Frequency Band	**Applicable To**	**EIRP Limit**	**Equivalent Field Strength at 3m**
5150~5250 MHz	15.407(b)(1)	PK:-27 (dBm/MHz)	PK:68.2(dBμV/m)
5725~5850 MHz	15.407(b)(4)(i)	PK:-27 (dBm/MHz) *1 PK:10 (dBm/MHz) *2 PK:15.6 (dBm/MHz) *3 PK:27 (dBm/MHz) *4	PK: 68.2(dBμV/m) *1 PK:105.2 (dBμV/m) *2 PK: 110.8(dBμV/m) *3 PK:122.2 (dBμV/m) *4
*1 beyond 75 MHz or more above of the band edge. *2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above. *3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above. *4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.			

Note:
The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

$$E = \frac{1000000\sqrt{30P}}{3}$$ μV/m, where P is the eirp (Watts).

Test Procedures

[For 9 kHz ~ 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:
a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.

Configuration	Non-Beamforming Mode		Beamforming Mode	
	Average		Average	
	RBW	VBW	RBW	VBW
802.11a	1MHz	1 kHz	1MHz	-
802.11ac (VHT20)		10 Hz		1 kHz
802.11ac (VHT40)		1 kHz		1 kHz
802.11ac (VHT80)		1 kHz		1 kHz

Note: Refer to section 6.6 for duty cycle.

d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported.

<u>Test Setup</u>

<Frequency Range 9 kHz ~ 30 MHz>