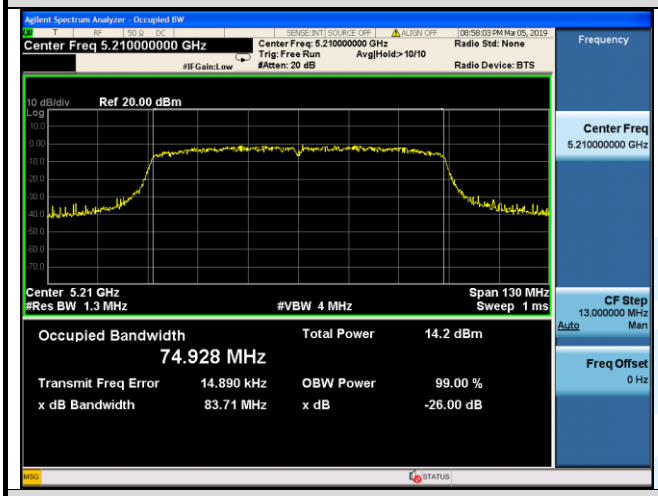
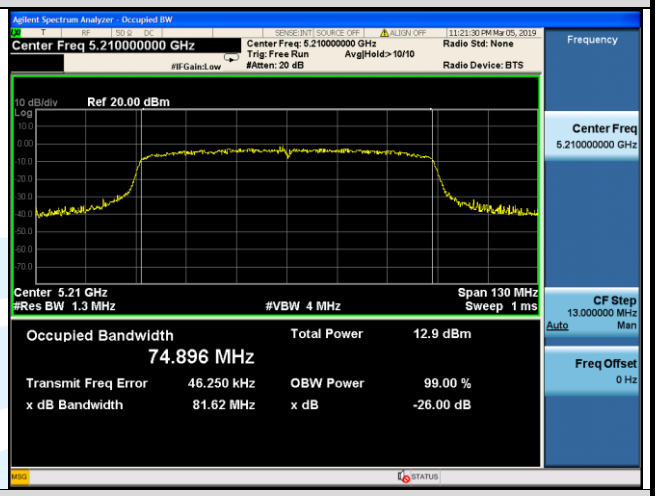
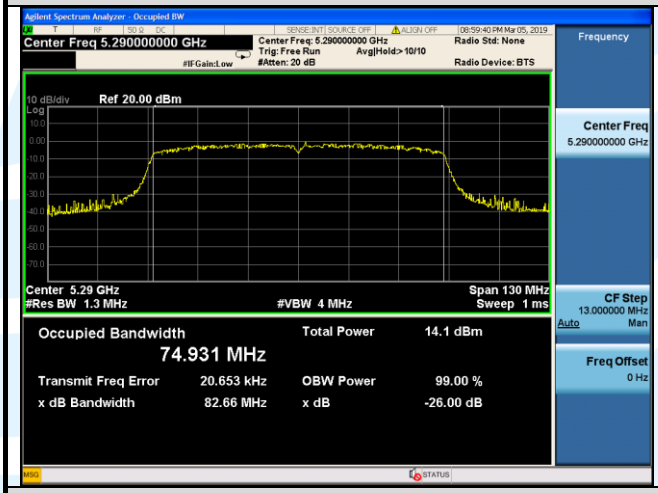
IEEE 802.11ac-VHT80

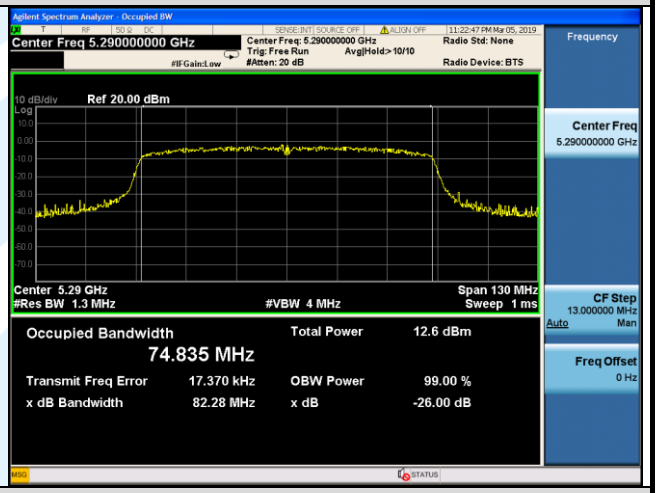
Channel 42



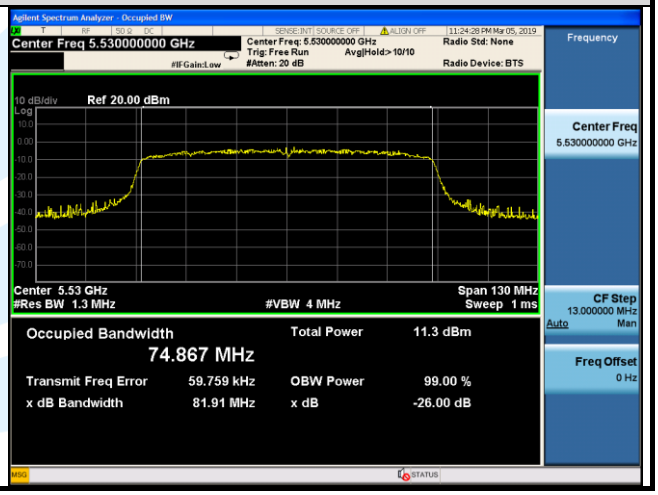


Channel 58





Channel 106



5.46 DB BANDWIDTH & OCCUPIED BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (e)
RSS-247 Issue 2 Section 6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section C.2

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

Test Procedure:

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer.

Spectrum analyzer according to the following Settings:
a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 * RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum 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 6 dB relative to the maximum level measured in the fundamental emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

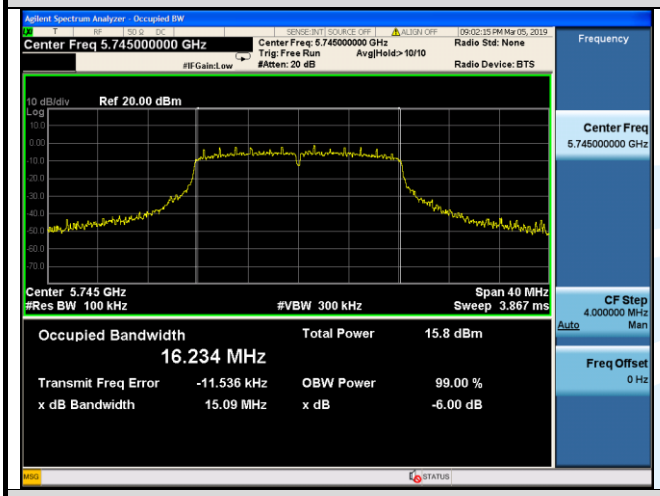
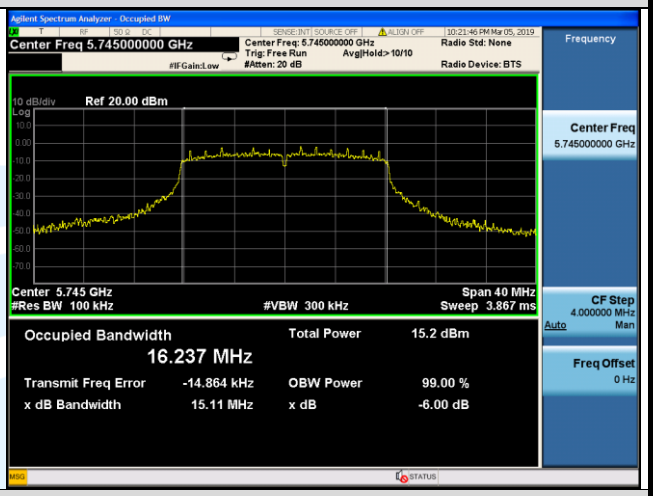
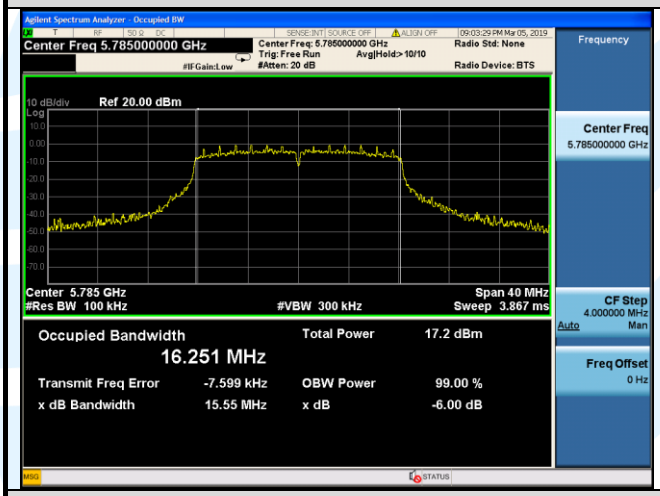
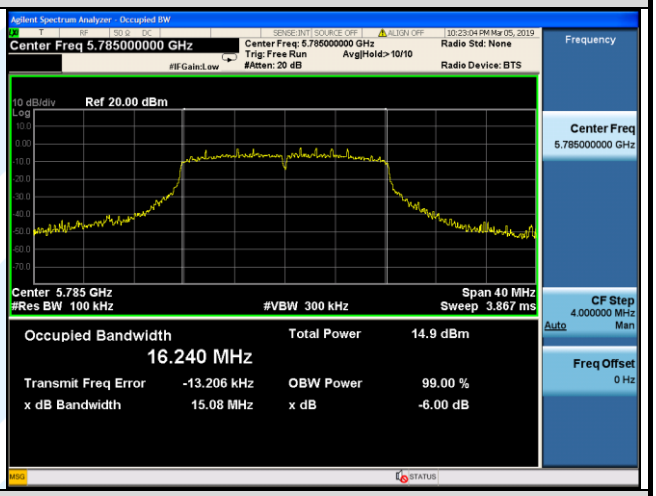
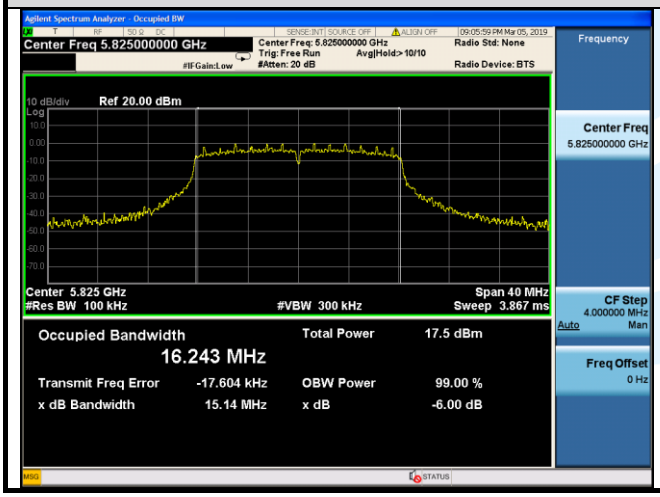
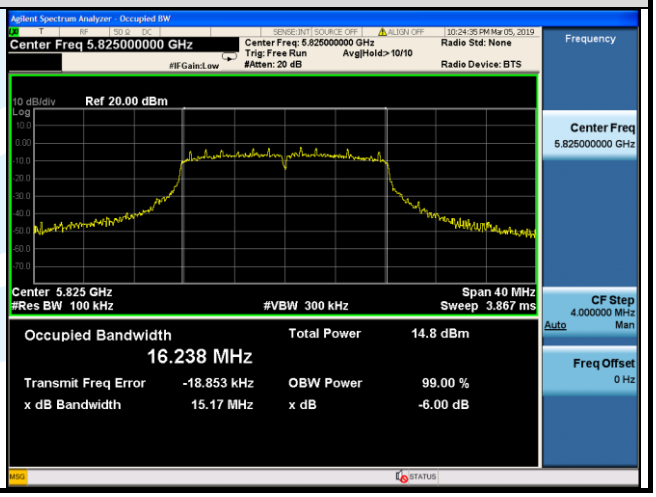
Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)		99% Bandwidth (MHz)		6 dB Bandwidth Limit	Pass / Fail
		Chain 0	Chain 1	Chain 0	Chain 1		
IEEE 802.11a	149 (5745)	15.09	15.11	16.234	16.237	> 500 kHz	Pass
	157 (5785)	15.55	15.08	16.251	16.240	> 500 kHz	Pass
	165 (5825)	15.14	15.17	16.243	16.238	> 500 kHz	Pass
IEEE 802.11n-HT20	149 (5745)	15.18	15.41	17.421	17.412	> 500 kHz	Pass
	157 (5785)	15.10	15.14	17.407	17.400	> 500 kHz	Pass
	165 (5825)	15.17	15.08	17.402	17.388	> 500 kHz	Pass
IEEE 802.11n-HT40	151 (5755)	34.99	35.16	35.694	35.730	> 500 kHz	Pass
	159 (5795)	35.15	33.90	35.666	35.716	> 500 kHz	Pass
IEEE 802.11ac-VHT20	149 (5745)	15.17	15.44	17.406	17.415	> 500 kHz	Pass
	157 (5785)	15.44	15.17	17.423	17.394	> 500 kHz	Pass
	165 (5825)	15.40	15.44	17.398	17.418	> 500 kHz	Pass
IEEE 802.11ac-VHT40	151 (5755)	35.13	35.19	35.696	35.720	> 500 kHz	Pass
	159 (5795)	35.14	35.15	35.676	35.681	> 500 kHz	Pass
IEEE 802.11ac-VHT80	155 (5775)	75.29	75.28	75.062	75.606	> 500 kHz	Pass

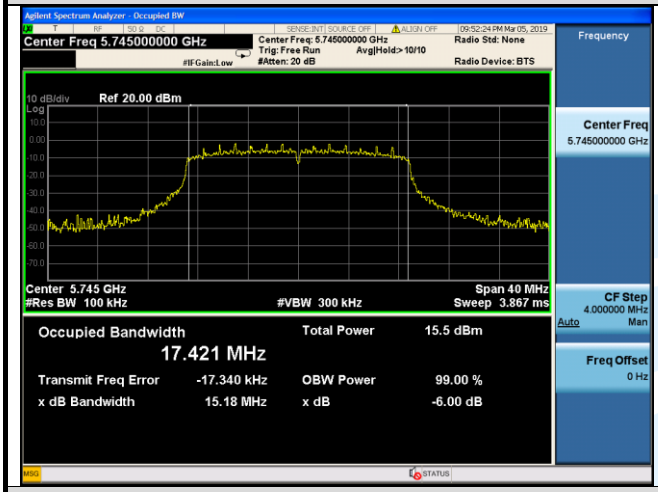
The test plots as follows:

IEEE 802.11a	
Chain 0	**Chain 1**
Channel 149	
	
Channel 157	
	
Channel 165	
	

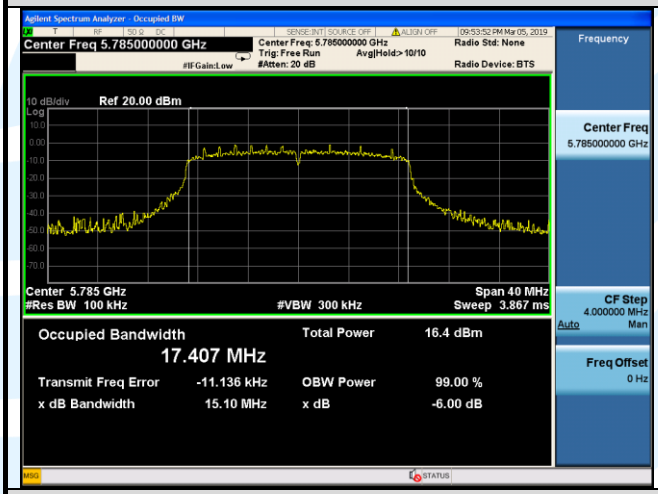
IEEE 802.11n-HT20

Chain 0

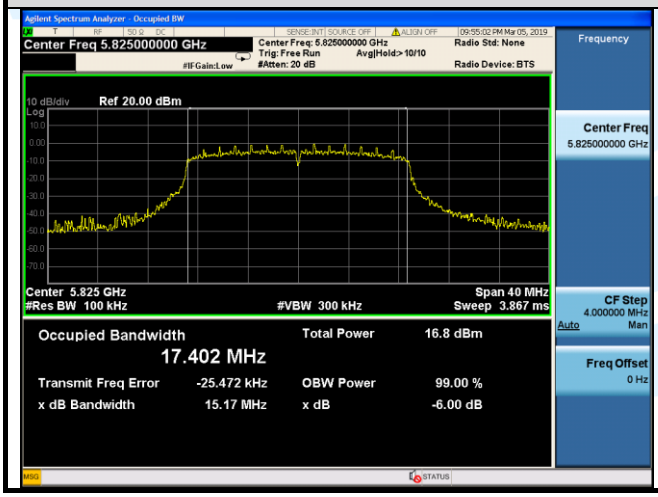
Channel 149



Channel 157

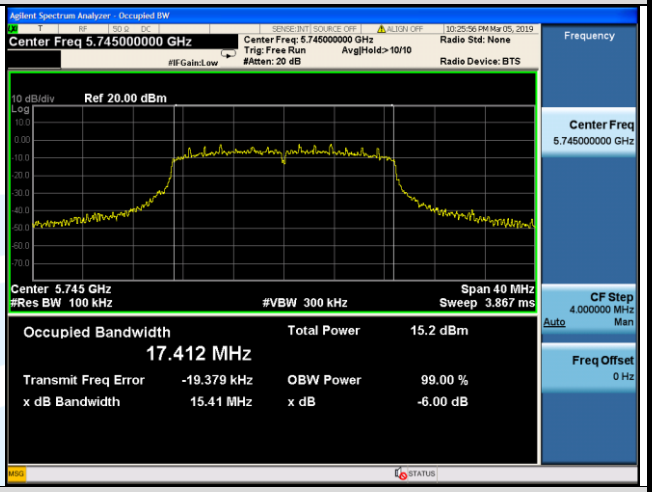


Channel 165

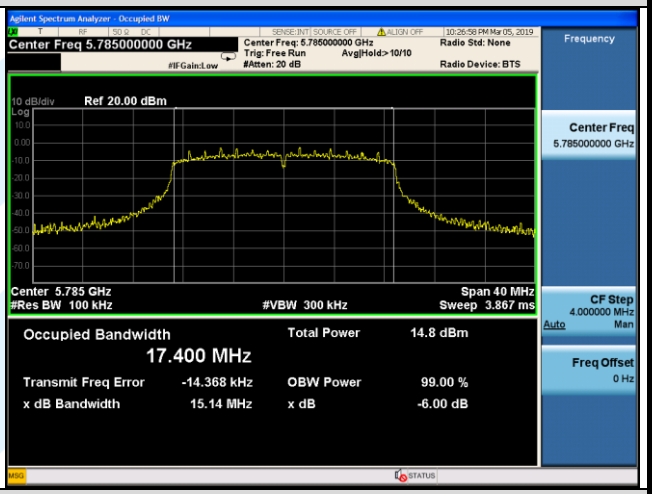


Chain 1

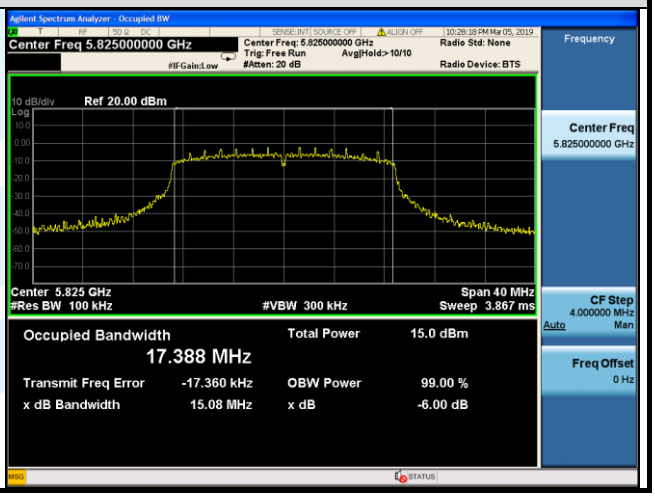
Channel 149

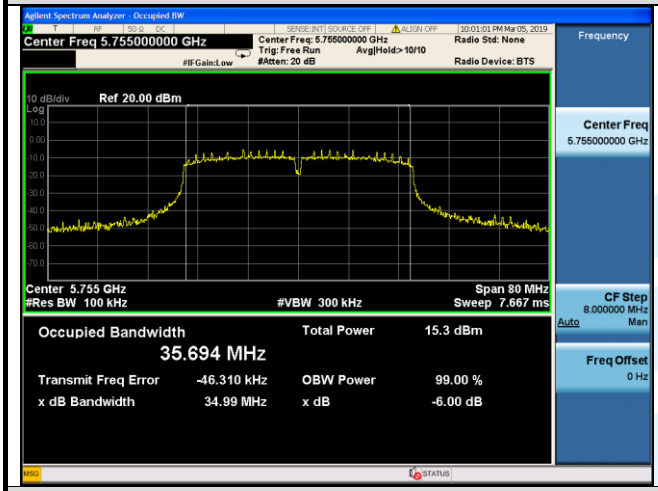
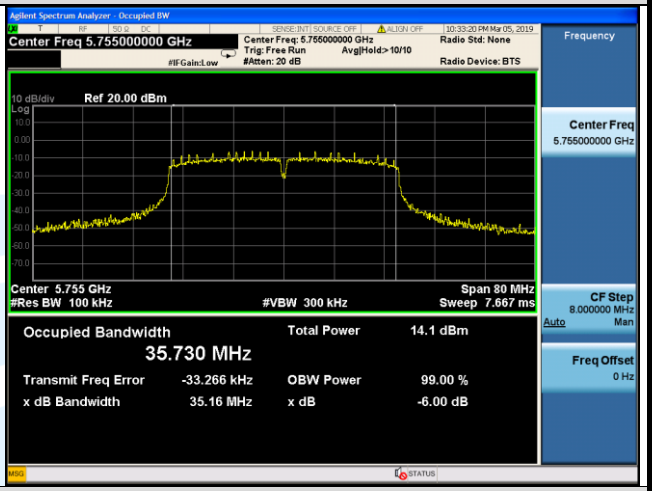
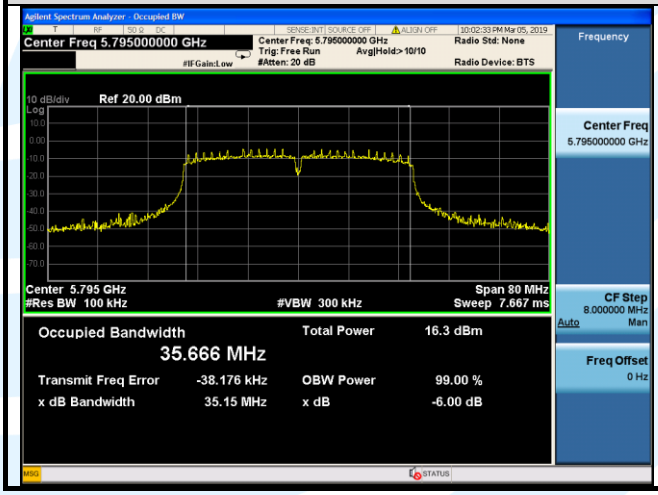
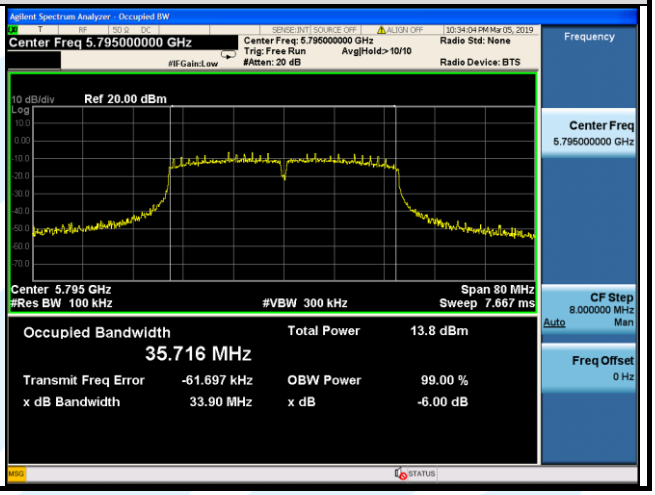


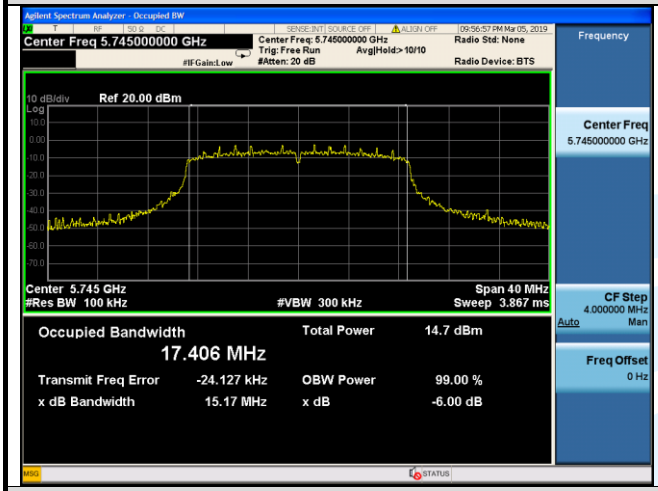
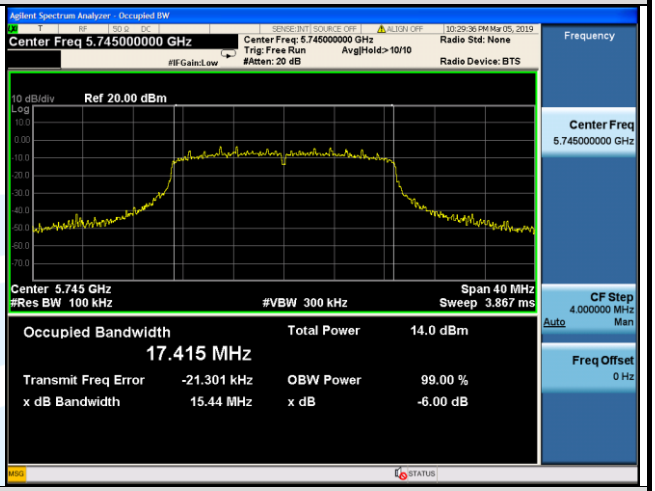
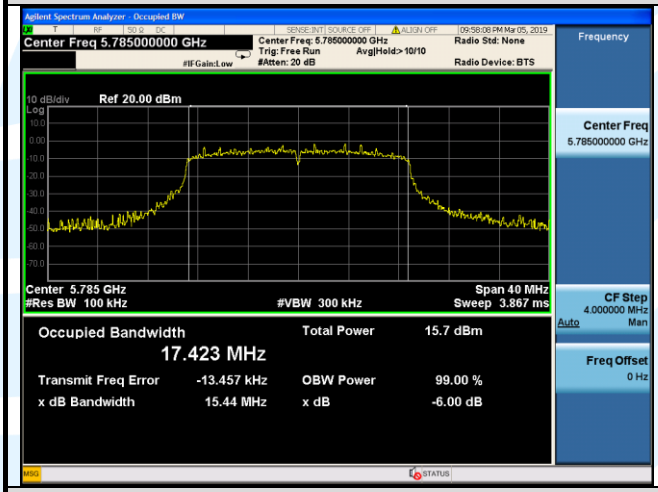
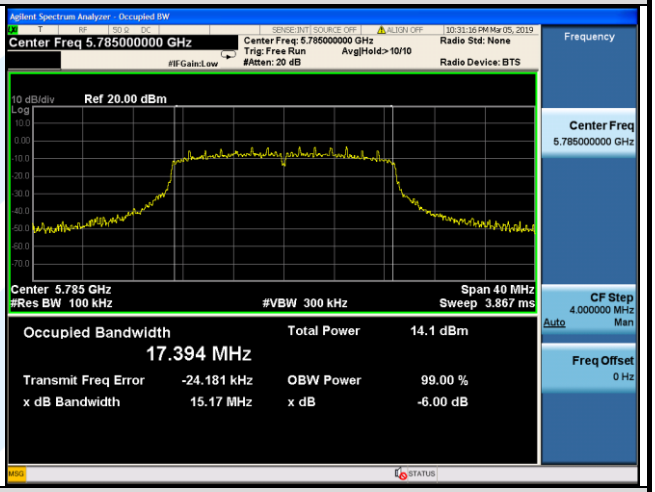
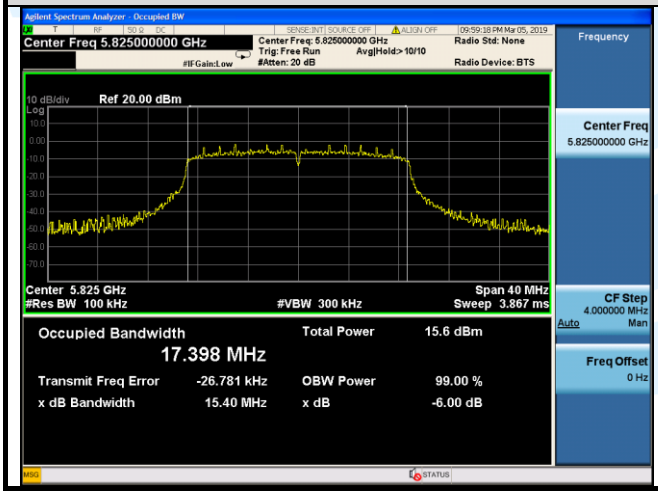
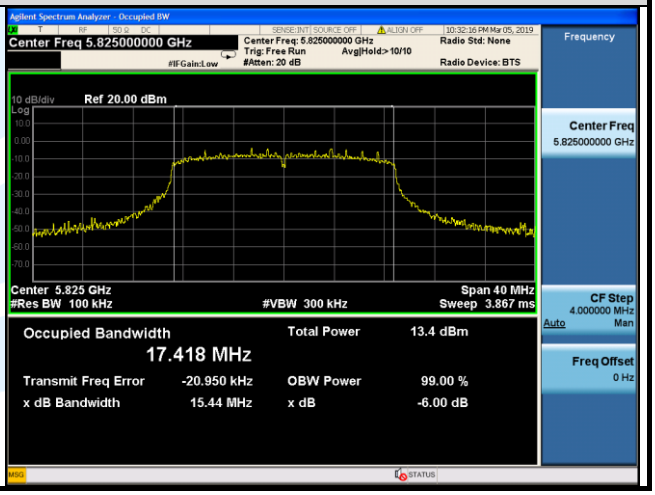
Channel 157



Channel 165



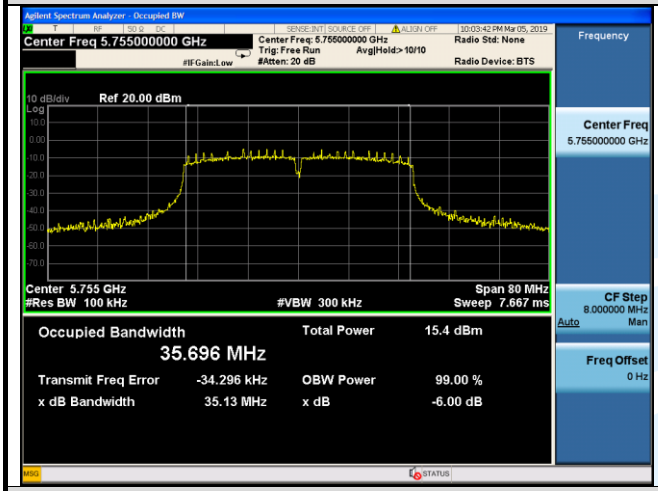
IEEE 802.11n-HT40	
Chain 0	Chain 1
Channel 151	
	
Channel 159	
	

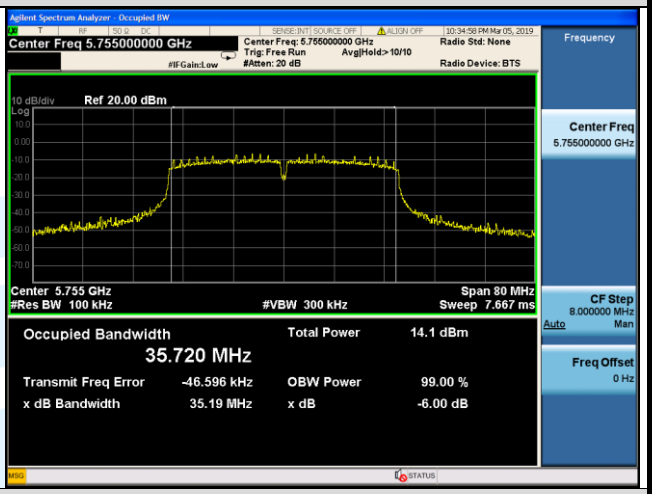
IEEE 802.11ac-VHT20	
Chain 0	Chain 1
Channel 149	
	
Channel 157	
	
Channel 165	
	

IEEE 802.11ac-VHT40

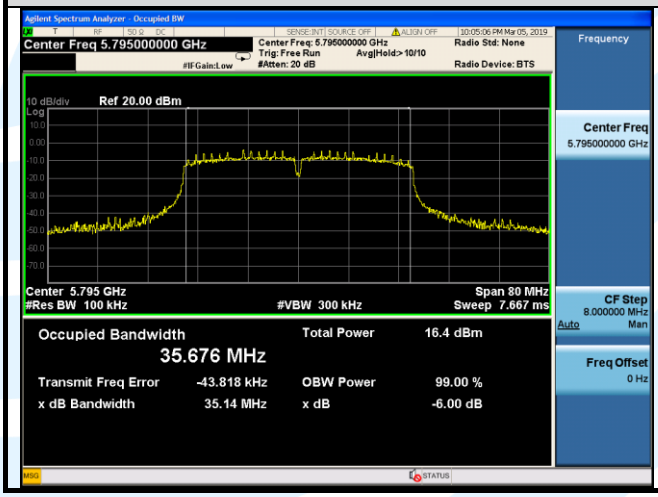
Chain 0	Chain 1

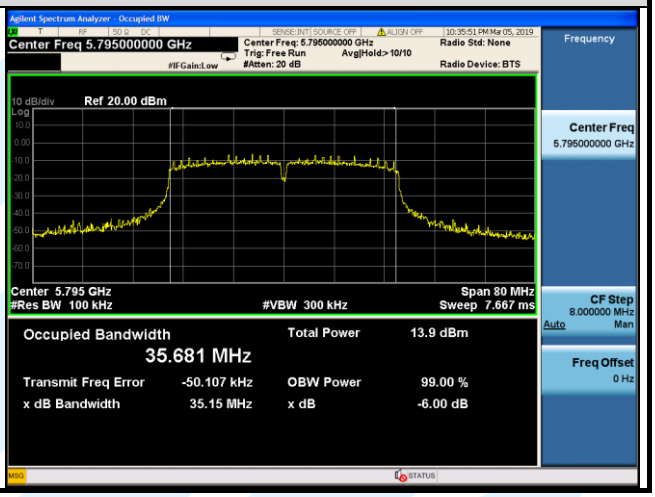
Channel 151





Channel 159

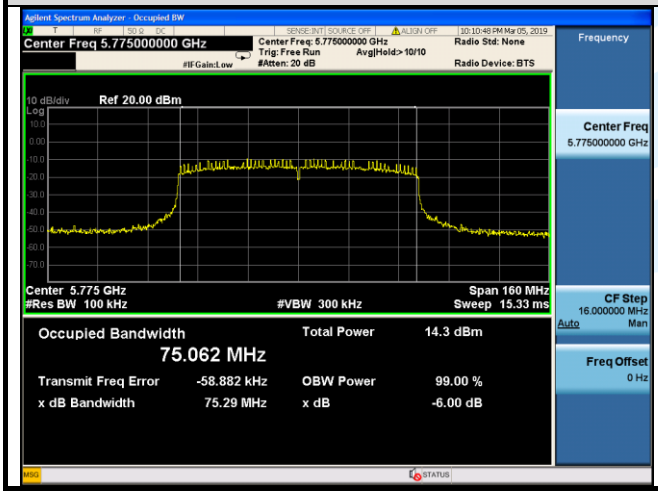


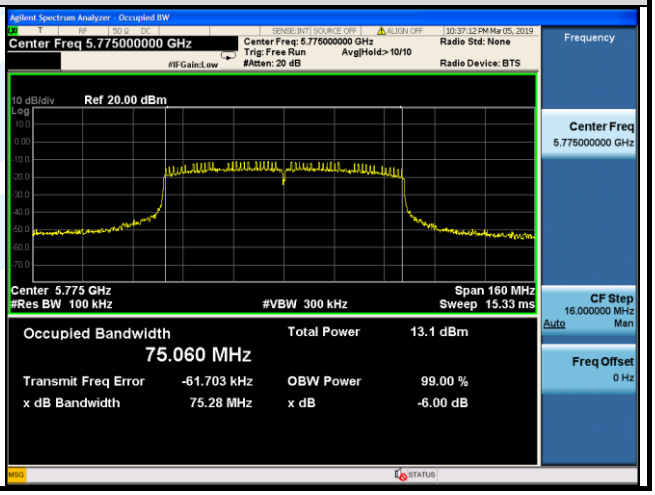


IEEE 802.11ac-VHT80

Chain 0	Chain 1

Channel 151





5.5 MAXIMUM CONDUCTED OUTPUT POWER OR E.I.R.P

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)
RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section E.3.a (Method PM)

Limits: FCC 47 CFR Part 15 Subpart C

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, 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.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

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

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

3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Limits: RSS-247 Issue 2

1. **Frequency band 5150-5250 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For other devices, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 $\log_{10}$B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

2. **Frequency band 5250-5350 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

Devices, other than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band;

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

Additional requirements
In addition to the above requirements, devices shall comply with the following, where applicable:

a) Outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevations, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

i. -13 dBW/MHz for $0^o \leq \theta < 8^o$

ii. -13 − 0.716 (θ-8) dBW/MHz for $8^o \leq \theta < 40^o$

iii. -35.9 − 1.22 (θ-40) dBW/MHz for $40^o \leq \theta \leq 45^o$

iv. -42 dBW/MHz for $\theta > 45^o$

The measurement procedure defined in Annex A of this document shall be used to verify the compliance to the e.i.r.p. at different elevations.

b) Devices, other than outdoor fixed devices, having an e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:

i. devices shall comply with the e.i.r.p. elevation mask in 6.2.2.3(a); or

ii. devices shall implement a method to permanently reduce their e.i.r.p. via a firmwarefeature in the event that the Department requires it. The test report must demonstratehow the device's power table can be updated to meet this firmware requirement. Themanufacturer shall provide this firmware to update all systems automatically incompliance with the directions received from the Department.

3. **Frequency bands 5470-5600 MHz and 5650-5725 MHz**
The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

4. **Frequency band 5725-5850 MHz**
The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any

corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint[3] systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

Test Procedure:

1. Connected the EUT's antenna port to measure device by 10dB attenuator.
2. 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.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Directional gain and the maximum output power limit.
RSS-247 Issue 2

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limits (dBm)
U-NII-1	2.95	4.60	6.82	22.18
U-NII-2A	3.26	4.06	6.68	23.32
U-NII-2C	4.52	4.60	7.57	22.43
U-NII-3	4.56	4.32	7.45	28.55
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = 10 log[(10^G1 /20 + 10^G2 /20 + … + 10^GN /20)^2 /NANT] dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]				

FCC 47 CFR Part 15 Subpart C

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limits (dBm)
U-NII-1	2.95	4.60	6.82	23.18
U-NII-2A	3.26	4.06	6.68	23.32
U-NII-2C	4.52	4.60	7.57	22.43
U-NII-3	4.56	4.32	7.45	28.55
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = 10 log[(10^G1 /20 + 10^G2 /20 + … + 10^GN /20)^2 /NANT] dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]				

Frequency band 5150-5250 MHz
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.272 MHz
10 dBm + $10\log_{10}$ (16.272) = 22.11 dBm < 23 dBm
So the 22.11 dB limit applicable

For IEEE 802.11 n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.383 MHz
10 dBm + $10\log_{10}$ (17.383) = 22.40 dBm > 22.18 dBm
So the 22.18 dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.788 MHz
10 dBm + $10\log_{10}$ (35.788) = 25.53 dBm > 22.18 dBm
So the 22.18 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum e.i.r.p (dBm)		Total e.i.r.p MIMO_ Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		SISO				
		Chain 0	Chain 1			
IEEE 802.11a	36 (5180)	14.48	14.44	N/A	22.11	Pass
	44 (5220)	14.41	14.55	N/A	22.11	Pass
	48 (5240)	14.33	14.79	N/A	22.11	Pass
IEEE 802.11n-HT20	36 (5180)	14.08	12.93	16.56	22.18	Pass
	44 (5220)	14.12	13.59	16.88	22.18	Pass
	48 (5240)	14.32	13.80	17.08	22.18	Pass
IEEE 802.11n-HT40	38 (5190)	14.81	13.95	17.41	22.18	Pass
	46 (5230)	14.65	14.04	17.37	22.18	Pass
IEEE 802.11ac-VHT20	36 (5180)	14.40	13.88	17.16	22.18	Pass
	44 (5220)	14.17	14.06	17.13	22.18	Pass
	48 (5240)	14.69	14.40	17.56	22.18	Pass
IEEE 802.11ac-VHT40	38 (5190)	14.01	13.35	16.70	22.18	Pass
	46 (5230)	14.28	13.65	16.99	22.18	Pass
IEEE 802.11ac-VHT80	42 (5210)	11.63	11.16	14.41	22.18	Pass

Remark:
1. Maximum e.i.r.p = Maximum conducted output power + Antenna Gain
2. Total e.i.r.p (Chain 0+1) = $10*\log[(10^{\text{Chain 0}/10})+(10^{\text{Chain 1}/10})]$

FCC 47 CFR Part 15 Subpart C:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm) SISO		Total Power MIMO_ Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	36 (5180)	11.53	9.84	N/A	24	Pass
	44 (5220)	11.46	9.95	N/A	24	Pass
	48 (5240)	11.38	10.19	N/A	24	Pass
IEEE 802.11n-HT20	36 (5180)	11.13	8.33	12.96	23.18	Pass
	44 (5220)	11.17	8.99	13.23	23.18	Pass
	48 (5240)	11.37	9.20	13.43	23.18	Pass
IEEE 802.11n-HT40	38 (5190)	11.86	9.35	13.80	23.18	Pass
	46 (5230)	11.70	9.44	13.73	23.18	Pass
IEEE 802.11ac-VHT20	36 (5180)	11.45	9.28	13.51	23.18	Pass
	44 (5220)	11.22	9.46	13.44	23.18	Pass
	48 (5240)	11.74	9.80	13.89	23.18	Pass
IEEE 802.11ac-VHT40	38 (5190)	11.06	8.75	13.07	23.18	Pass
	46 (5230)	11.33	9.05	13.35	23.18	Pass
IEEE 802.11ac-VHT80	42 (5210)	8.68	6.56	10.76	23.18	Pass

Remark:

1. Maximum conducted output power = Conducted output power + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain } 0/10})+(10^{\text{Chain } 1/10})]$

Frequency band 5250-5350 MHz
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.277 MHz
10 dBm + $10\log_{10}$ (16.277) = 22.12 dBm < 24 dBm
So the 22.12 dB limit applicable

For IEEE 802.11 n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.394 MHz
10 dBm + $10\log_{10}$ (17.394) = 22.40 dBm < 23.32 dBm
So the 22.40 dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.759 MHz
10 dBm + $10\log_{10}$ (35.759) = 25.53 dBm > 23.32 dBm
So the 23.32 dB limit applicable

FCC 47 CFR Part 15 Subpart C:
For IEEE 802.11 a, the minimum 26 dB emission bandwidth is 18.80 MHz
11 dBm + $10\log_{10}$ (18.80) = 23.74 dBm < 24.00 dBm
So the 23.74 dB limit applicable

For IEEE 802.11 n/ac, the minimum 26 dB emission bandwidth is 19.91 MHz
11 dBm + $10\log_{10}$ (19.91) = 23.99 dBm > 23.32 dBm
So the 23.32 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm) SISO		Total Power MIMO_ Chain 0+1 (dBm)	Limit (dBm)		Pass / Fail
		Chain 0	Chain 1		FCC Part 15E	RSS-247	
IEEE 802.11a	52 (5260)	11.54	9.40	N/A	23.74	22.12	Pass
	60 (5300)	11.57	10.51	N/A	23.74	22.12	Pass
	64 (5320)	11.23	10.49	N/A	23.74	22.12	Pass
IEEE 802.11n-HT20	52 (5260)	11.60	10.38	14.05	23.32	22.40	Pass
	60 (5300)	11.54	10.08	13.88	23.32	22.40	Pass
	64 (5320)	10.93	9.98	13.49	23.32	22.40	Pass
IEEE 802.11n-HT40	54 (5270)	11.55	8.85	13.42	23.32	23.32	Pass
	62 (5310)	12.31	8.75	13.90	23.32	23.32	Pass
IEEE 802.11ac-VHT20	52 (5260)	11.17	8.97	13.22	23.32	22.40	Pass
	60 (5300)	12.03	8.74	13.70	23.32	22.40	Pass
	64 (5320)	12.05	8.43	13.62	23.32	22.40	Pass
IEEE 802.11ac-VHT40	54 (5270)	10.94	7.99	12.72	23.32	23.32	Pass
	62 (5310)	12.01	8.62	13.65	23.32	23.32	Pass
IEEE 802.11ac-VHT80	58 (5290)	8.99	6.57	10.96	23.32	23.32	Pass

Remark:
1. Maximum conducted output power = Conducted output power + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

Frequency bands 5470-5725 MHz (RSS-247 Issue 2 Not including 5600-5650 MHz)
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.276 MHz
10 dBm + $10\log_{10}$ (16.276) = 22.12 dBm < 24 dBm
So the 22.12 dB limit applicable

For IEEE 802.11 n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.385 MHz
10 dBm + $10\log_{10}$ (17.385) = 22.40 dBm < 22.43 dBm
So the 22.40 dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.769 MHz
10 dBm + $10\log_{10}$ (35.769) = 25.54 dBm > 22.43 dBm
So the 22.43 dB limit applicable

FCC 47 CFR Part 15 Subpart C:
For IEEE 802.11 a, the minimum 26 dB emission bandwidth is 18.69 MHz
11 dBm + $10\log_{10}$ (18.69) = 23.72 dBm < 24 dBm
So the 23.72 dB limit applicable

For IEEE 802.11 n/ac, the minimum 26 dB emission bandwidth is 19.92 MHz
11 dBm + $10\log_{10}$ (19.92) = 23.99 dBm > 22.43 dBm
So the 22.43 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm) SISO		Total Power MIMO_ Chain 0+1 (dBm)	Limit (dBm)		Pass / Fail
		Chain 0	Chain 1		FCC Part 15E	RSS-247	
IEEE 802.11a	100 (5500)	9.61	9.09	N/A	23.72	22.12	Pass
	116 (5580)	9.84	9.12	N/A	23.72	22.12	Pass
	140 (5700)	9.79	9.24	N/A	23.72	22.12	Pass
IEEE 802.11n-HT20	100 (5500)	12.74	9.46	14.41	22.43	22.40	Pass
	116 (5580)	12.23	9.88	14.22	22.43	22.40	Pass
	140 (5700)	10.26	9.44	12.88	22.43	22.40	Pass
IEEE 802.11n-HT40	102 (5510)	11.81	9.43	13.79	22.43	22.43	Pass
	110 (5550)	11.78	9.12	13.66	22.43	22.43	Pass
	134 (5670)	12.98	9.40	14.56	22.43	22.43	Pass
IEEE 802.11ac-VHT20	100 (5500)	12.54	9.30	14.23	22.43	22.40	Pass
	116 (5580)	12.18	9.87	14.19	22.43	22.40	Pass
	140 (5700)	10.30	9.36	12.87	22.43	22.40	Pass
IEEE 802.11ac-VHT40	102 (5510)	12.33	9.64	14.20	22.43	22.43	Pass
	110 (5550)	11.95	9.22	13.81	22.43	22.43	Pass
	134 (5670)	10.53	9.62	13.11	22.43	22.43	Pass
IEEE 802.11ac-VHT80	106 (5530)	8.42	7.05	10.80	22.43	22.43	Pass

Remark:
1. Maximum conducted output power = Conducted output power + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

Frequency band 5725-5850 MHz

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm) SISO		Total Power MIMO_ Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	149 (5745)	11.33	10.73	N/A	30	Pass
	157 (5785)	12.55	10.28	N/A	30	Pass
	165 (5825)	12.76	10.56	N/A	30	Pass
IEEE 802.11n-HT20	149 (5745)	12.12	11.14	14.67	28.55	Pass
	157 (5785)	12.40	10.72	14.65	28.55	Pass
	165 (5825)	12.34	10.42	14.50	28.55	Pass
IEEE 802.11n-HT40	151 (5755)	10.91	9.85	13.42	28.55	Pass
	159 (5795)	11.69	9.44	13.72	28.55	Pass
IEEE 802.11ac-VHT20	149 (5745)	11.42	9.76	13.68	28.55	Pass
	157 (5785)	11.88	9.41	13.83	28.55	Pass
	165 (5825)	12.04	9.34	13.91	28.55	Pass
IEEE 802.11ac-VHT40	151 (5755)	11.15	9.99	13.62	28.55	Pass
	159 (5795)	11.91	9.55	13.90	28.55	Pass
IEEE 802.11ac-VHT80	155 (5775)	9.36	7.69	11.62	28.55	Pass

Remark:

1. Maximum conducted output power = Conducted output power + Duty Cycle Factor
2. Total Power(Chain 0+1) = $10*\log[(10^{\text{Chain 0}/10})+(10^{\text{Chain 1}/10})]$

5.6 PEAK POWER SPECTRAL DENSITY

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)
RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section F

Limits: FCC 47 CFR Part 15 Subpart C

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, 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.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

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

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

3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Limits: RSS-247 Issue 2

1. **Frequency band 5150-5250 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For other devices, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 $\log_{10}$B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

2. **Frequency band 5250-5350 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

Devices, other than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band;

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

Additional requirements
In addition to the above requirements, devices shall comply with the following, where applicable:

a) Outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevations, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

i. -13 dBW/MHz for $0^o \leq \theta < 8^o$

ii. -13 − 0.716 (θ-8) dBW/MHz for $8^o \leq \theta < 40^o$

iii. -35.9 − 1.22 (θ-40) dBW/MHz for $40^o \leq \theta \leq 45^o$

iv. -42 dBW/MHz for $\theta > 45^o$

The measurement procedure defined in Annex A of this document shall be used to verify the compliance to the e.i.r.p. at different elevations.

b) Devices, other than outdoor fixed devices, having an e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:

iii. devices shall comply with the e.i.r.p. elevation mask in 6.2.2.3(a); or

iv. devices shall implement a method to permanently reduce their e.i.r.p. via a firmwarefeature in the event that the Department requires it. The test report must demonstratehow the device's power table can be updated to meet this firmware requirement. Themanufacturer shall provide this firmware to update all systems automatically incompliance with the directions received from the Department.

3. **Frequency bands 5470-5600 MHz and 5650-5725 MHz**
The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

4. **Frequency band 5725-5850 MHz**
The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any

corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint[3] systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

Test Procedure:

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer.

Spectrum analyzer according to the following Settings:

1. For U-NII-1, U-NII-2A, U-NII-2C band:

Using method SA-2

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)

2. For U-NII-3 band:

a) Set span to encompass the entire emission bandwidth (EBW) of the signal.
b) Set RBW = 500 kHz, Set VBW ≥ 3 RBW, Detector = RMS
c) Use the peak marker function to determine the maximum power level in any 500 kHz band segment within the fundamental EBW.
d) Sweep time = auto, trigger set to “free run”.
e) Trace average at least 100 traces in power averaging mode.
f) Record the max value and add 10 log (1/duty cycle)

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Directional gain and the maximum output power limit.

RSS-247 Issue 2:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	2.95	4.60	6.82	9.18
U-NII-2A	3.26	4.06	6.68	10.32
U-NII-2C	4.52	4.60	7.57	9.43
U-NII-3	4.56	4.32	7.45	28.55
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = 10 log[(10^G1 /20 + 10^G2 /20 + … + 10^GN /20)^2 /NANT] dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]				

FCC 47 CFR Part 15 Subpart C:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	2.95	4.60	6.82	10.18
U-NII-2A	3.26	4.06	6.68	10.32
U-NII-2C	4.52	4.60	7.57	9.43
U-NII-3	4.56	4.32	7.45	28.55
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = 10 log[(10^G1 /20 + 10^G2 /20 + … + 10^GN /20)^2 /NANT] dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]				

Frequency band 5150-5250 MHz
RSS-247 Issue 2

Mode	Channel/ Frequency (MHz)	e.i.r.p. spectral density (dBm/MHz) SISO		Total e.i.r.p. spectral density MIMO_ Chain 0+1 (dBm/MHz)	Limit (dBm/MHz)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	36 (5180)	0.79	0.87	N/A	10	Pass
	44 (5220)	0.84	0.73	N/A	10	Pass
	48 (5240)	0.91	0.74	N/A	10	Pass
IEEE 802.11n-HT20	36 (5180)	0.04	-0.09	2.99	9.18	Pass
	44 (5220)	0.00	-0.51	2.76	9.18	Pass
	48 (5240)	-0.11	-0.19	2.86	9.18	Pass
IEEE 802.11n-HT40	38 (5190)	-2.20	-2.37	0.73	9.18	Pass
	46 (5230)	-2.28	-2.59	0.58	9.18	Pass
IEEE 802.11ac-VHT20	36 (5180)	1.07	1.04	4.06	9.18	Pass
	44 (5220)	1.04	1.06	4.06	9.18	Pass
	48 (5240)	0.88	0.53	3.72	9.18	Pass
IEEE 802.11ac-VHT40	38 (5190)	-3.28	-3.79	-0.52	9.18	Pass
	46 (5230)	-3.07	-3.38	-0.21	9.18	Pass
IEEE 802.11ac-VHT80	42 (5210)	-8.28	-8.16	-5.21	9.18	Pass

Remark:

1. e.i.r.p. spectral density = Power spectral density + Duty Cycle Factor + Antenna Gain
2. Total e.i.r.p. spectral density (Chain 0+1) = $10*\log[(10^{Chain\ 0/10})+(10^{Chain\ 1/10})]$

FCC 47 CFR Part 15 Subpart C

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz) SISO		Total power spectral density MIMO_ Chain 0+1 (dBm/MHz)	Limit (dBm/MHz)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	36 (5180)	-2.16	-3.73	N/A	11	Pass
	44 (5220)	-2.11	-3.87	N/A	11	Pass
	48 (5240)	-2.04	-3.86	N/A	11	Pass
IEEE 802.11n-HT20	36 (5180)	-2.91	-4.69	-0.70	10.18	Pass
	44 (5220)	-2.95	-5.11	-0.89	10.18	Pass
	48 (5240)	-3.06	-4.79	-0.83	10.18	Pass
IEEE 802.11n-HT40	38 (5190)	-5.15	-6.97	-2.95	10.18	Pass
	46 (5230)	-5.23	-7.19	-3.09	10.18	Pass
IEEE 802.11ac-VHT20	36 (5180)	-1.88	-3.56	0.37	10.18	Pass
	44 (5220)	-1.91	-3.54	0.36	10.18	Pass
	48 (5240)	-2.07	-4.07	0.06	10.18	Pass
IEEE 802.11ac-VHT40	38 (5190)	-6.23	-8.39	-4.17	10.18	Pass
	46 (5230)	-6.02	-7.98	-3.88	10.18	Pass
IEEE 802.11ac-VHT80	42 (5210)	-11.23	-12.76	-8.92	10.18	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

Frequency band 5250-5350 MHz

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz) SISO		Total power spectral density MIMO_ Chain 0+1 (dBm/MHz)	Limit (dBm/MHz)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	52 (5260)	-2.18	-3.85	N/A	11	Pass
	60 (5300)	-2.19	-3.72	N/A	11	Pass
	64 (5320)	-2.19	-4.14	N/A	11	Pass
IEEE 802.11n-HT20	52 (5260)	-2.11	-3.89	0.10	10.32	Pass
	60 (5300)	-2.26	-4.00	-0.03	10.32	Pass
	64 (5320)	-2.78	-4.22	-0.43	10.32	Pass
IEEE 802.11n-HT40	54 (5270)	-6.54	-8.47	-4.39	10.32	Pass
	62 (5310)	-6.91	-8.31	-4.55	10.32	Pass
IEEE 802.11ac-VHT20	52 (5260)	-2.83	-5.27	-0.87	10.32	Pass
	60 (5300)	-3.08	-5.13	-0.97	10.32	Pass
	64 (5320)	-3.73	-5.24	-1.41	10.32	Pass
IEEE 802.11ac-VHT40	54 (5270)	-6.67	-8.99	-4.67	10.32	Pass
	62 (5310)	-7.24	-8.77	-4.93	10.32	Pass
IEEE 802.11ac-VHT80	58 (5290)	-11.44	-12.74	-9.03	10.32	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

Frequency bands 5470-5725 MHz (RSS-247 Issue 2 Not including 5600-5650 MHz)

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz) SISO		Total power spectral density MIMO_ Chain 0+1 (dBm/MHz)	Limit (dBm/MHz)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	100 (5500)	-5.66	-6.92	N/A	11	Pass
	116 (5580)	-5.28	-5.73	N/A	11	Pass
	140 (5700)	-5.35	-5.86	N/A	11	Pass
IEEE 802.11n-HT20	100 (5500)	-4.71	-5.58	-2.11	9.43	Pass
	116 (5580)	-3.46	-4.13	-0.77	9.43	Pass
	140 (5700)	-3.59	-3.93	-0.75	9.43	Pass
IEEE 802.11n-HT40	102 (5510)	-8.48	-9.84	-6.09	9.43	Pass
	110 (5550)	-8.57	-9.38	-5.94	9.43	Pass
	134 (5670)	-8.03	-8.05	-5.03	9.43	Pass
IEEE 802.11ac-VHT20	100 (5500)	-4.38	-5.81	-2.03	9.43	Pass
	116 (5580)	-3.53	-4.35	-0.91	9.43	Pass
	140 (5700)	-3.63	-4.10	-0.85	9.43	Pass
IEEE 802.11ac-VHT40	102 (5510)	-8.66	-9.52	-6.06	9.43	Pass
	110 (5550)	-8.85	-9.45	-6.13	9.43	Pass
	134 (5670)	-7.96	-8.06	-5.00	9.43	Pass
IEEE 802.11ac-VHT80	106 (5530)	-13.49	-14.35	-10.89	9.43	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

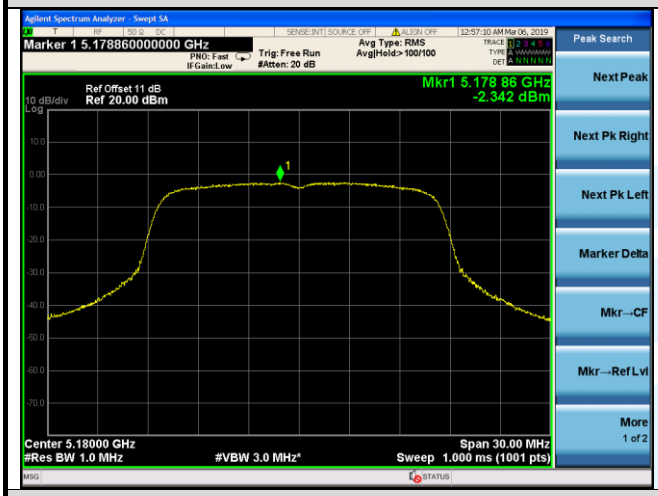
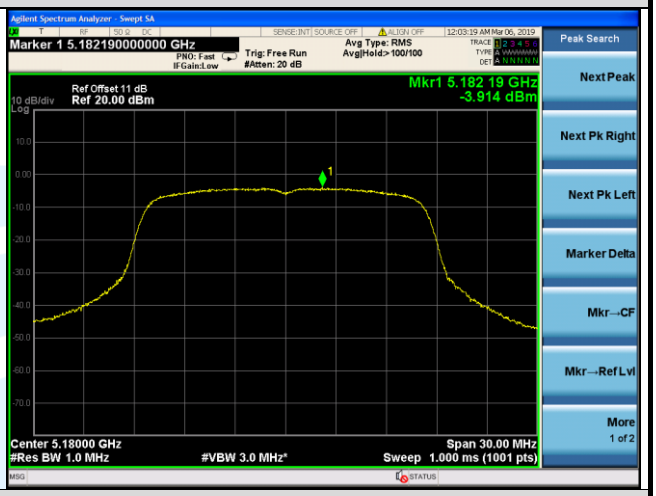
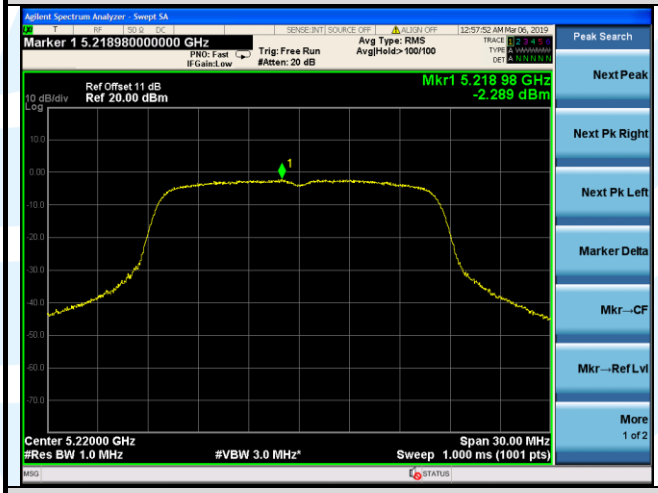
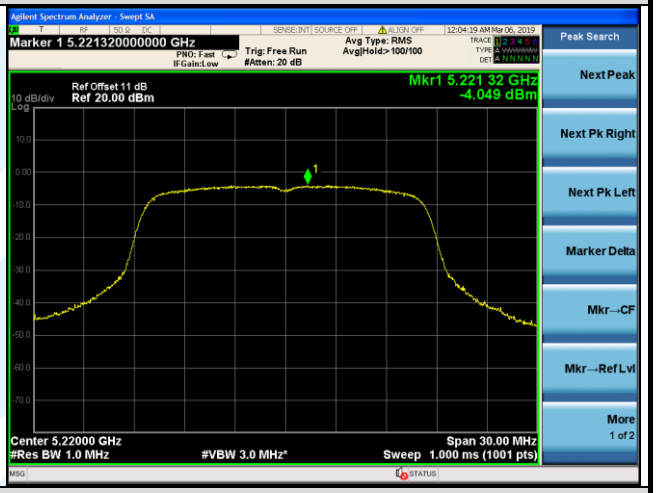
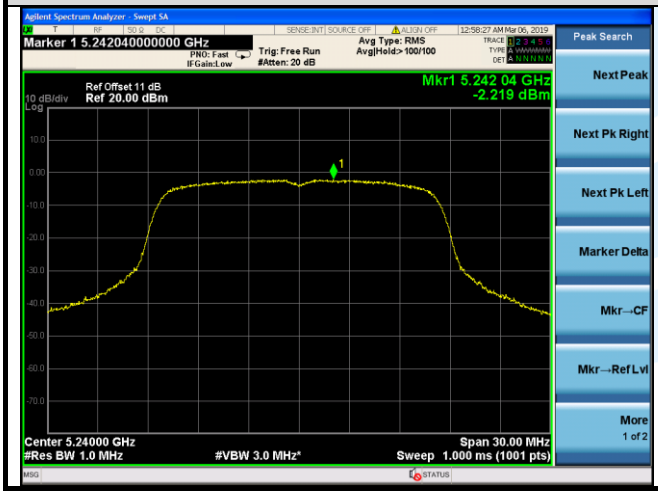
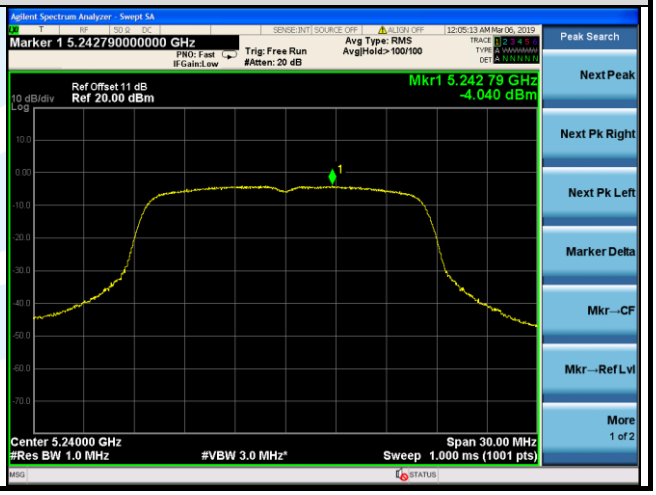
Frequency band 5725-5850 MHz

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz) SISO		Total power spectral density MIMO_ Chain 0+1 (dBm/MHz)	Limit (dBm/500KHz)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a	149 (5745)	-3.68	-4.85	N/A	30	Pass
	157 (5785)	-2.62	-4.99	N/A	30	Pass
	165 (5825)	-2.71	-5.03	N/A	30	Pass
IEEE 802.11n-HT20	149 (5745)	-4.50	-5.16	-1.81	28.55	Pass
	157 (5785)	-3.62	-4.97	-1.24	28.55	Pass
	165 (5825)	-3.09	-5.04	-0.94	28.55	Pass
IEEE 802.11n-HT40	151 (5755)	-8.86	-10.16	-6.45	28.55	Pass
	159 (5795)	-7.89	-10.23	-5.89	28.55	Pass
IEEE 802.11ac-VHT20	149 (5745)	-5.59	-6.18	-2.87	28.55	Pass
	157 (5785)	-4.24	-6.31	-2.14	28.55	Pass
	165 (5825)	-4.12	-6.41	-2.11	28.55	Pass
IEEE 802.11ac-VHT40	151 (5755)	-9.10	-9.71	-6.38	28.55	Pass
	159 (5795)	-7.87	-10.19	-5.86	28.55	Pass
IEEE 802.11ac-VHT80	155 (5775)	-13.35	-14.97	-11.07	28.55	Pass

Remark:

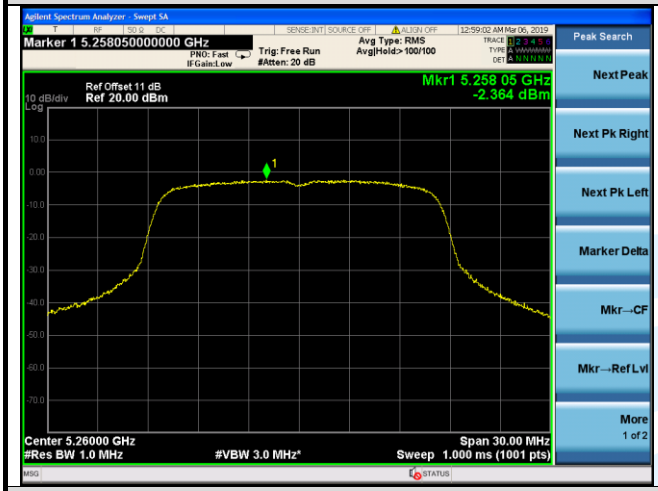
1. Power spectral density = Conducted power spectral density + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

The test plots as follows:

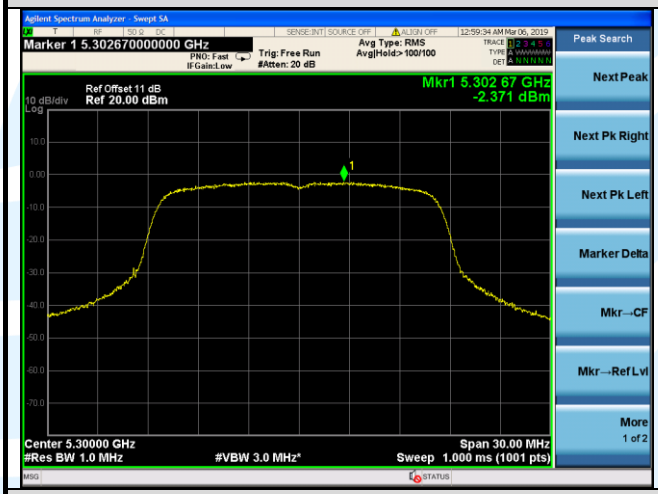
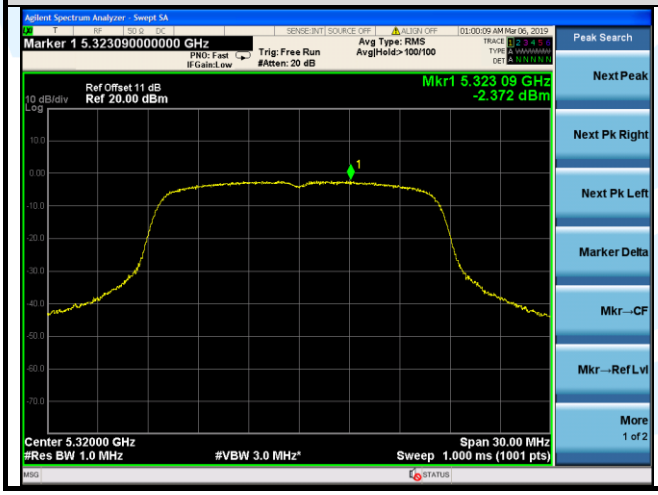
IEEE 802.11a	
Chain 0	**Chain 1**
Channel 36	
	
Channel 44	
	
Channel 48	
	

IEEE 802.11a

Channel 52



Channel 60



Channel 64