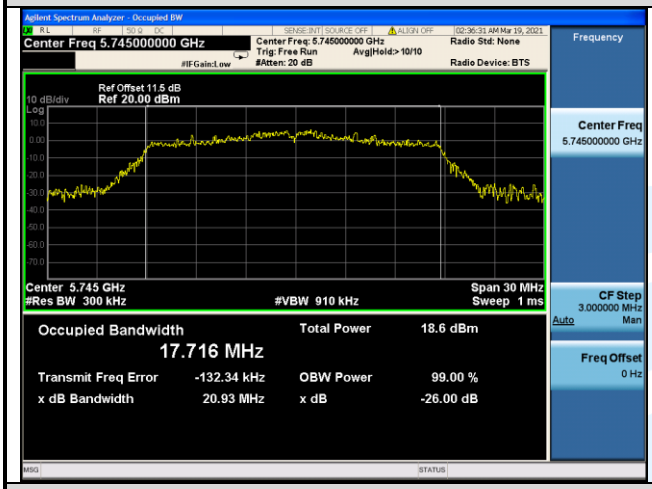
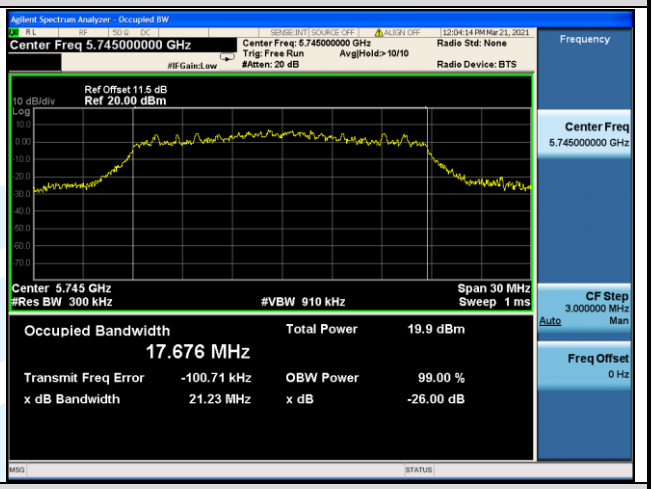
IEEE 802.11n-HT20

Chain 0	Chain 1
Channel 149	
	
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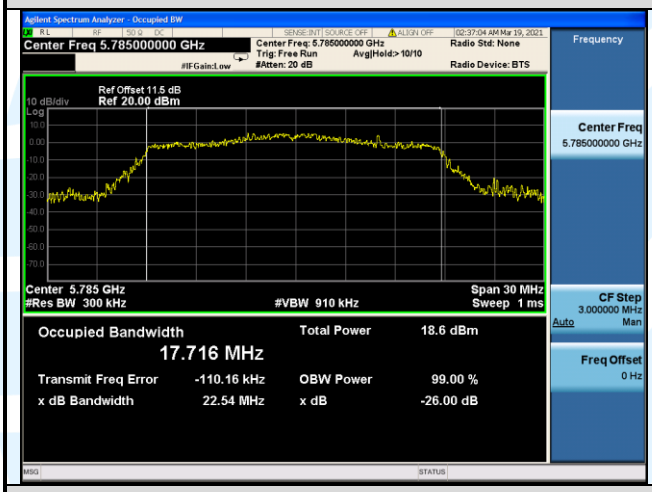	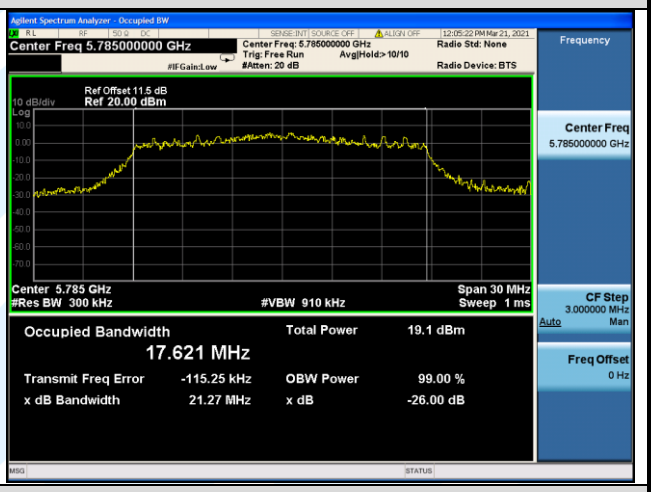
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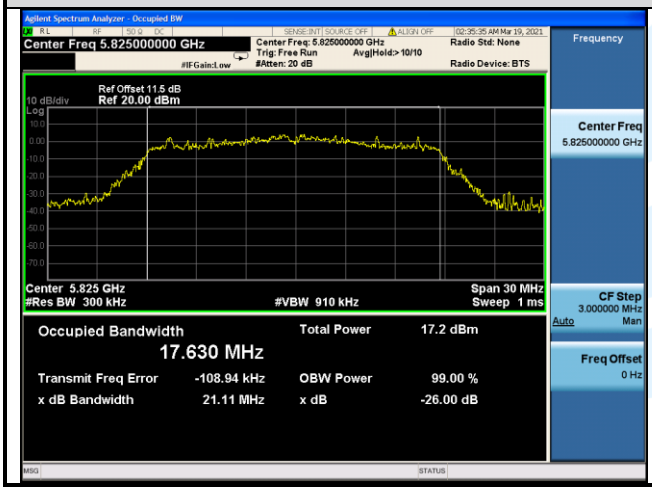	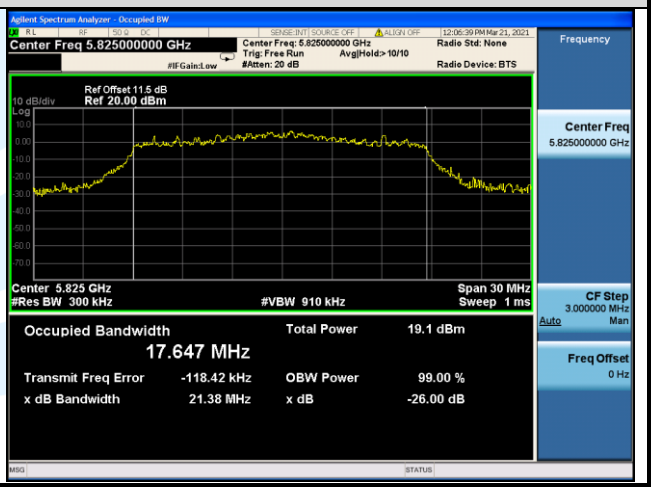

IEEE 802.11n-HT40	
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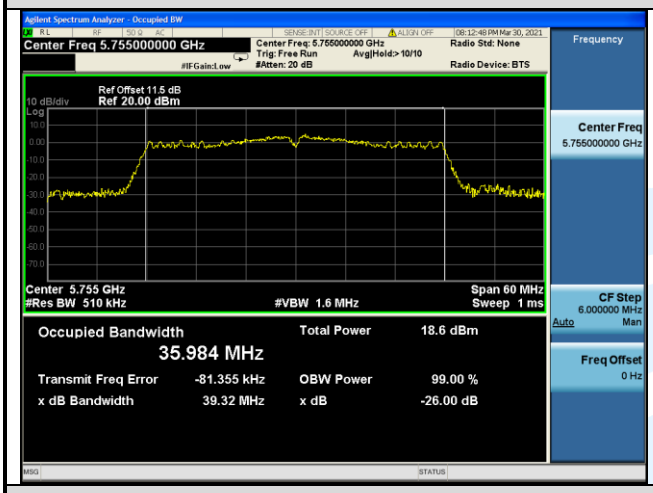	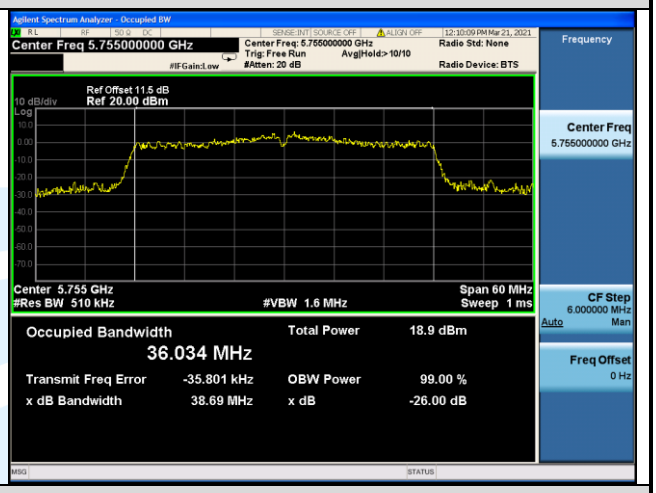
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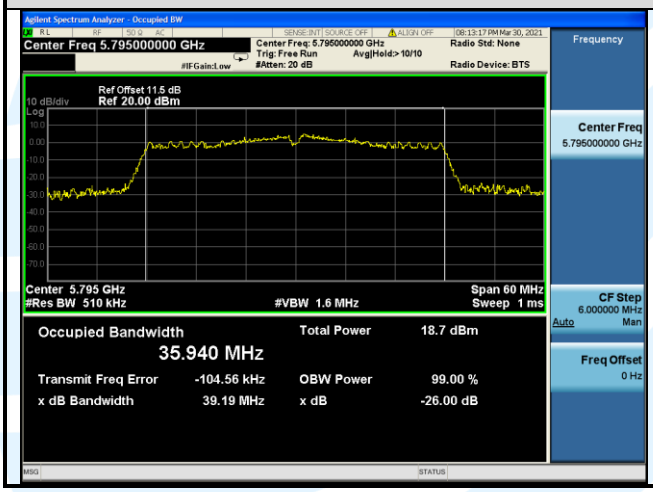	

IEEE 802.11ac-VHT20	
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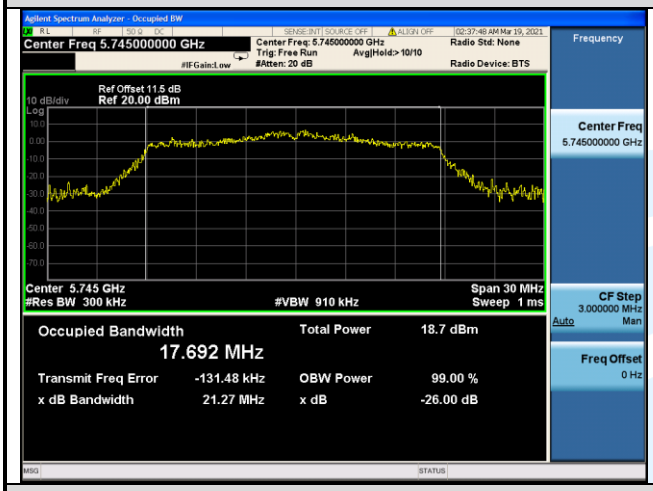	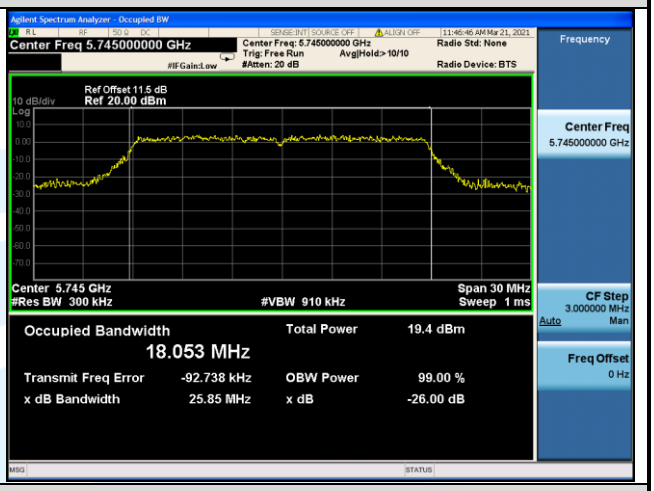
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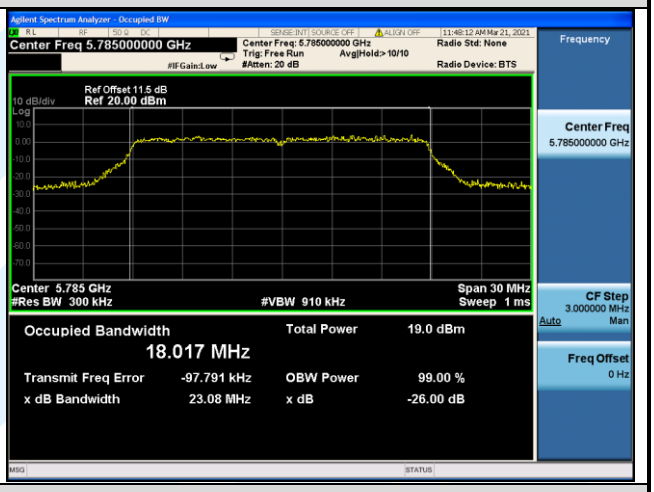
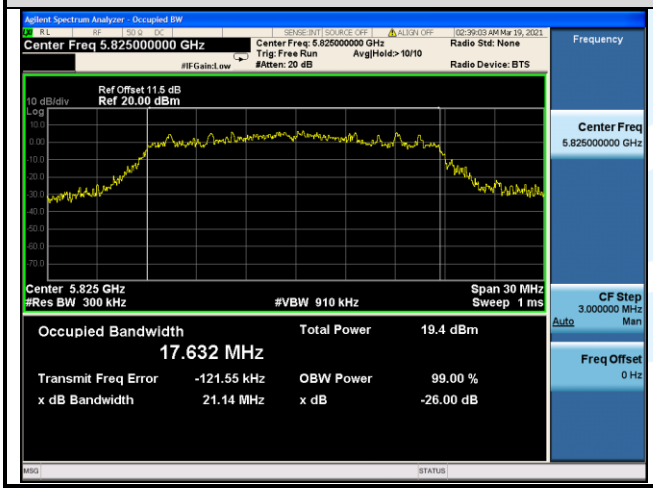
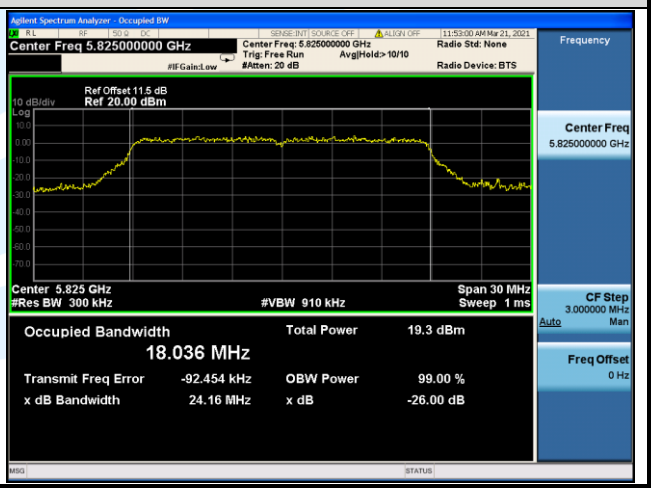
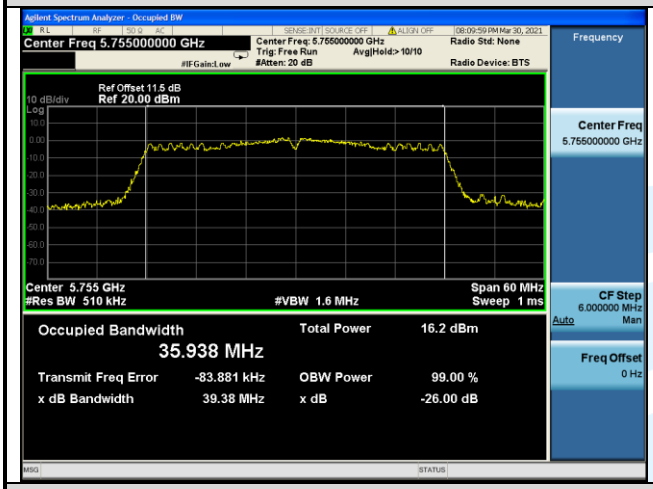
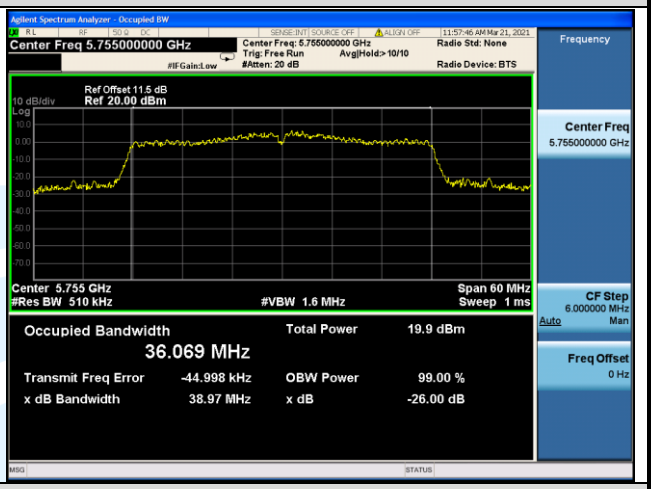
	
Channel 165	
	

IEEE 802.11ac-VHT40

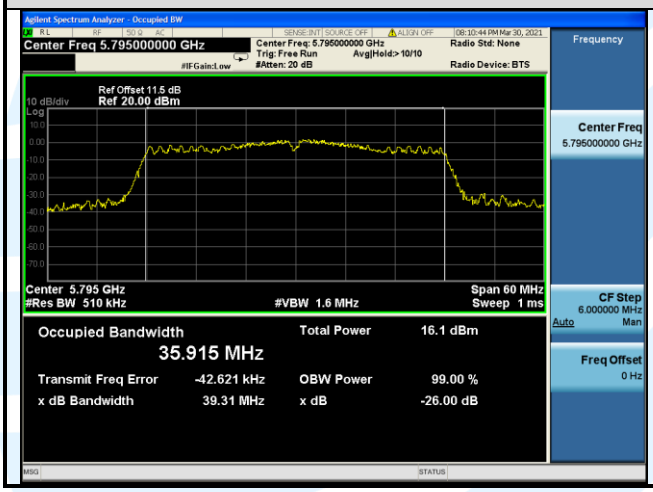
Chain 0	Chain 1

Channel 151





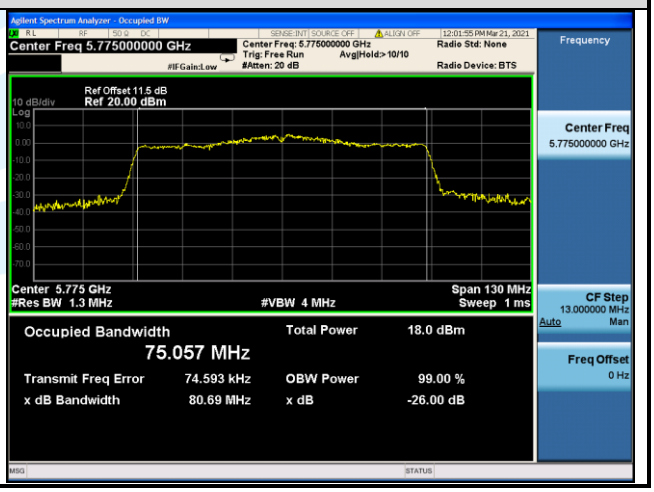
Channel 159



IEEE 802.11ac-VHT80

Chain 0	Chain 1

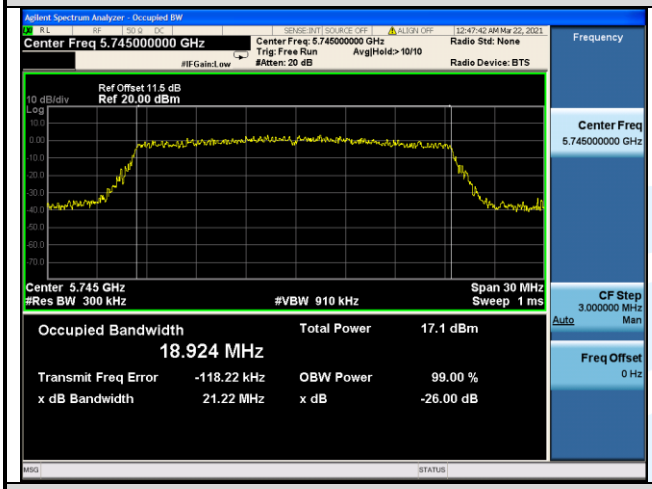
Channel 151



IEEE 802.11ax20

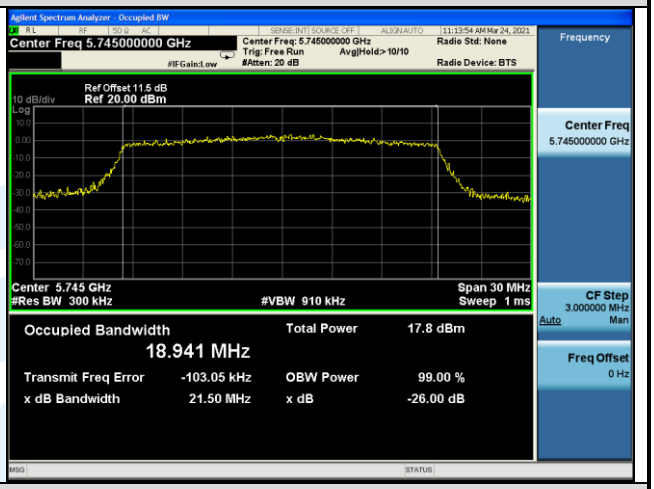
Chain 0

Channel 149

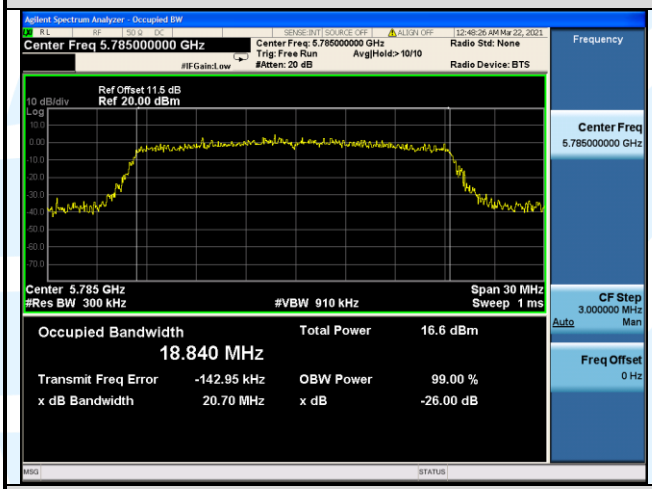


Chain 1

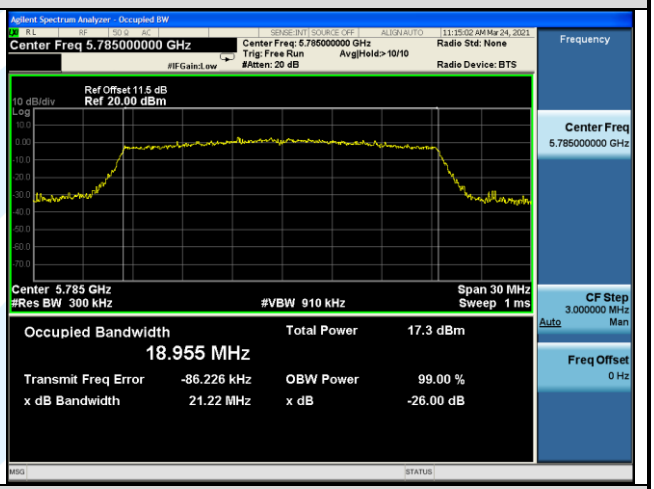
Channel 149



Channel 157

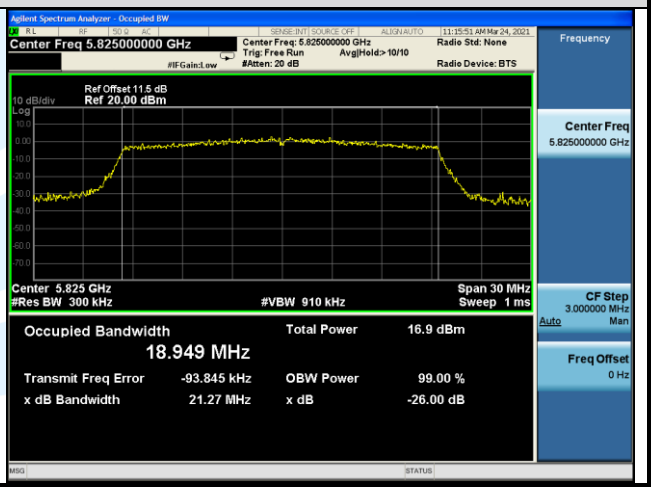


Channel 157



Channel 165

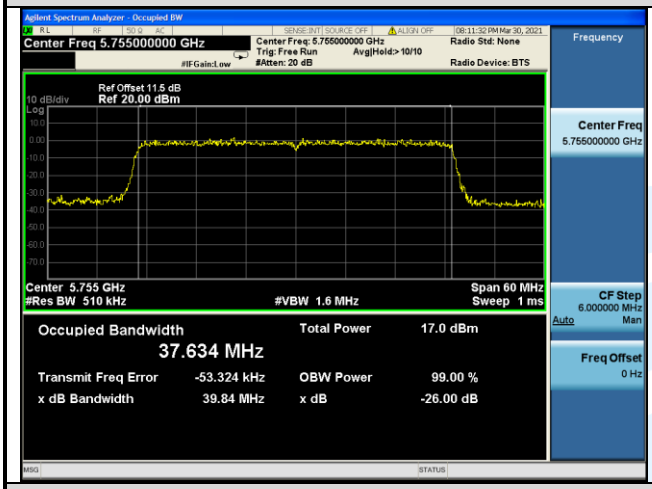
Channel 165



IEEE 802.11ax40

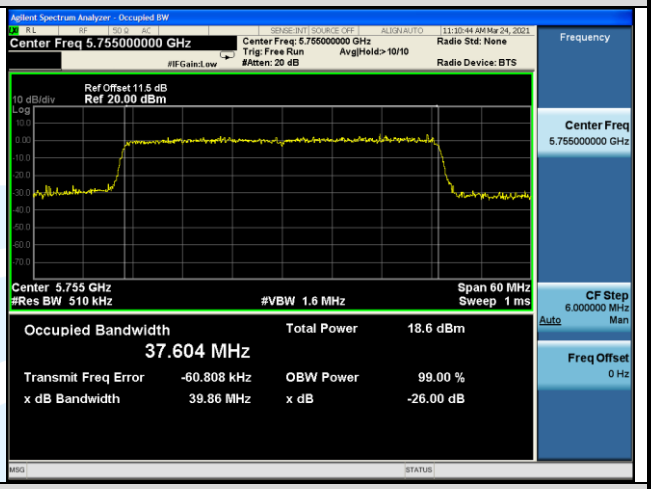
Chain 0

Channel 151

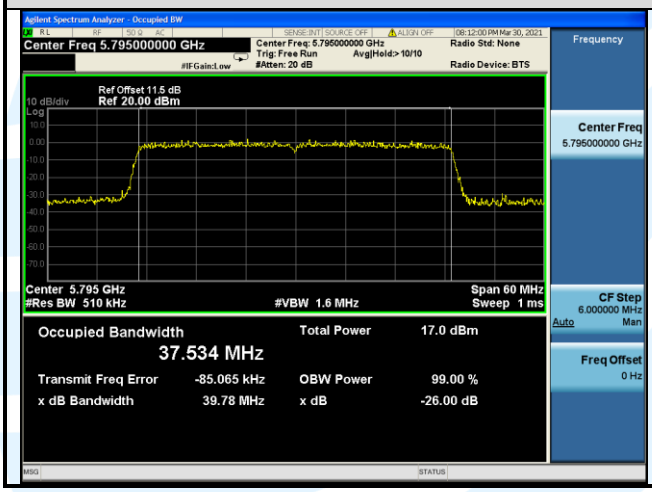


Chain 1

Channel 151



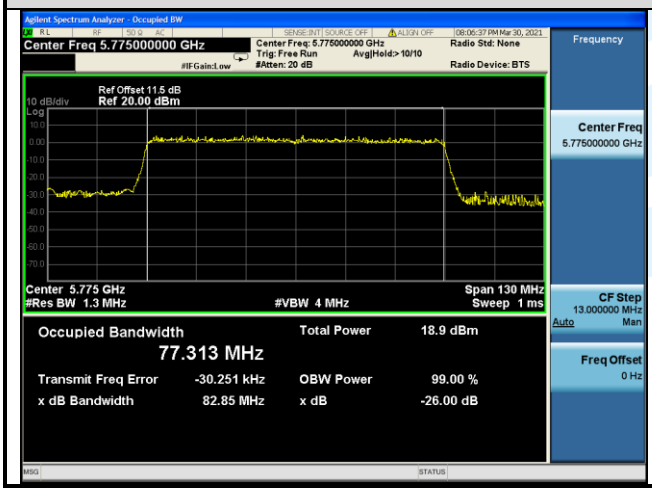
Channel 159



IEEE 802.11ax80

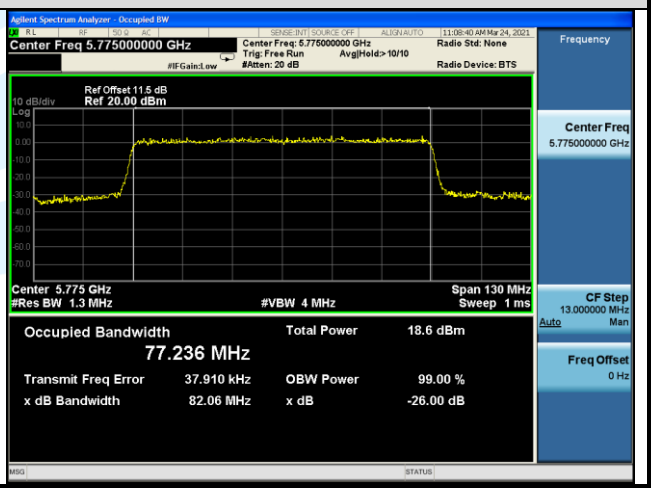
Chain 0

Channel 151



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 E

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	1.67	1.67	4.68	23.00
U-NII-2A	1.75	1.75	4.76	24.00
U-NII-2C	2.95	2.95	5.96	24.00
U-NII-3	1.55	1.55	4.56	30.00

Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:

If *any* transmit signals are *correlated* with each other,

Directional gain = $G_{ANT} + 10 \log(N_{ANT})$ dBi

FCC 47 CFR Part 15 Subpart E

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limits (dBm)
U-NII-1	1.67	1.67	4.68	24.00
U-NII-2A	1.75	1.75	4.76	24.00
U-NII-2C	2.95	2.95	5.96	24.00
U-NII-3	1.55	1.55	4.56	30.00

Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:

If *any* transmit signals are *correlated* with each other,

Directional gain = $G_{ANT} + 10 \log(N_{ANT})$ dBi

Frequency band 5150-5250 MHz
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.570 MHz
10 dBm + $10\log_{10}$ (16.570) = 22.19 dBm < 23 dBm
So the 22.19 dB limit applicable

For IEEE 802.11 n-HT20/ac-VHT20/ax20, the minimum 99% emission bandwidth is 17.605 MHz
10 dBm + $10\log_{10}$ (17.605) = 22.46 dBm < 23 dBm
So the 22.46 dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80/ax40/ax80, the minimum 99% emission bandwidth is 35.935 MHz
10 dBm + $10\log_{10}$ (35.935) = 25.56 dBm > 23 dBm
So the 23 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)	13.73	14.75	N/A	22.19	Pass
	44 (5220)	14.02	14.54	N/A	22.19	Pass
	48 (5240)	14.10	14.60	N/A	22.19	Pass
IEEE 802.11n-HT20	36 (5180)	15.40	17.13	19.36	22.46	Pass
	44 (5220)	15.64	16.95	19.35	22.46	Pass
	48 (5240)	15.49	17.08	19.37	22.46	Pass
IEEE 802.11n-HT40	38 (5190)	12.23	14.16	16.31	23	Pass
	46 (5230)	12.31	14.24	16.39	23	Pass
IEEE 802.11ac-VHT20	36 (5180)	13.50	15.40	17.56	22.46	Pass
	44 (5220)	13.76	15.10	17.49	22.46	Pass
	48 (5240)	13.54	15.23	17.48	22.46	Pass
IEEE 802.11ac-VHT40	38 (5190)	11.72	12.04	14.89	23	Pass
	46 (5230)	11.87	11.80	14.85	23	Pass
IEEE 802.11ac-VHT80	42 (5210)	11.00	11.53	14.28	23	Pass
IEEE 802.11ax20	36 (5180)	10.71	12.91	14.96	22.46	Pass
	44 (5220)	10.78	12.96	15.02	22.46	Pass
	48 (5240)	10.76	12.98	15.02	22.46	Pass
IEEE 802.11ax40	38 (5190)	10.07	10.91	13.52	23	Pass
	46 (5230)	10.10	10.83	13.49	23	Pass
IEEE 802.11ax80	42 (5210)	11.18	13.51	15.51	23	Pass

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

FCC 47 CFR Part 15 Subpart E:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Total Power MIMO_ Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		SISO				
		Chain 0	Chain 1			
IEEE 802.11a	36 (5180)	12.06	13.08	N/A	24	Pass
	44 (5220)	12.35	12.87	N/A	24	Pass
	48 (5240)	12.43	12.93	N/A	24	Pass
IEEE 802.11n-HT20	36 (5180)	13.73	15.46	17.69	24	Pass
	44 (5220)	13.97	15.28	17.68	24	Pass
	48 (5240)	13.82	15.41	17.70	24	Pass
IEEE 802.11n-HT40	38 (5190)	10.56	12.49	14.64	24	Pass
	46 (5230)	10.64	12.57	14.72	24	Pass
IEEE 802.11ac-VHT20	36 (5180)	11.83	13.73	15.89	24	Pass
	44 (5220)	12.09	13.43	15.82	24	Pass
	48 (5240)	11.87	13.56	15.81	24	Pass
IEEE 802.11ac-VHT40	38 (5190)	10.05	10.37	13.22	24	Pass
	46 (5230)	10.20	10.13	13.18	24	Pass
IEEE 802.11ac-VHT80	42 (5210)	9.33	9.86	12.61	24	Pass
IEEE 802.11ax20	36 (5180)	9.04	11.24	13.29	24	Pass
	44 (5220)	9.11	11.29	13.35	24	Pass
	48 (5240)	9.09	11.31	13.35	24	Pass
IEEE 802.11ax40	38 (5190)	8.40	9.24	11.85	24	Pass
	46 (5230)	8.43	9.16	11.82	24	Pass
IEEE 802.11ax80	42 (5210)	9.51	11.84	13.84	24	Pass

Remark:

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

Frequency band 5250-5350 MHz
RSS-247 Issue 2:
For IEEE 802.11 a/ n-HT20/ac-VHT20/ax20,, the minimum 99% emission bandwidth is 16.545 MHz
11 dBm + $10\log_{10}$ (16.545) = 23.19 dBm < 24dBm
So the 23.19 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT80/ax40/ax80, the minimum 99% emission bandwidth is 35.935 MHz
11 dBm + $10\log_{10}$ (35.935) = 26.56 dBm > 24 dBm (250mW)
So the 24 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac/ax, the minimum 26 dB emission bandwidth is 20.68 MHz
11 dBm + $10\log_{10}$ (19.36) = 24.15 dBm > 24 dBm (250mW)
So the 24 dBm 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)	12.16	12.81	N/A	24	23.19	Pass
	60 (5300)	12.36	13.07	N/A	24	23.19	Pass
	64 (5320)	12.27	13.25	N/A	24	23.19	Pass
IEEE 802.11n-HT20	52 (5260)	13.83	14.69	17.29	24	23.19	Pass
	60 (5300)	12.95	14.27	16.67	24	23.19	Pass
	64 (5320)	12.11	14.07	16.21	24	23.19	Pass
IEEE 802.11n-HT40	54 (5270)	10.34	12.36	14.48	24	24	Pass
	62 (5310)	10.23	12.49	14.52	24	24	Pass
IEEE 802.11ac-VHT20	52 (5260)	11.73	13.28	15.58	24	24	Pass
	60 (5300)	11.77	13.11	15.50	24	24	Pass
	64 (5320)	11.66	12.97	15.37	24	24	Pass
IEEE 802.11ac-VHT40	54 (5270)	9.79	11.39	13.67	24	24	Pass
	62 (5310)	9.71	11.44	13.67	24	24	Pass
IEEE 802.11ac-VHT80	58 (5290)	8.83	9.77	12.34	24	24	Pass
IEEE 802.11ax20	52 (5260)	8.75	10.75	12.87	24	23.19	Pass
	60 (5300)	8.90	10.82	12.98	24	23.19	Pass
	64 (5320)	8.84	10.86	12.98	24	23.19	Pass
IEEE 802.11ax40	54 (5270)	8.25	8.57	11.42	24	24	Pass
	62 (5310)	8.27	9.06	11.69	24	24	Pass
IEEE 802.11ax80	58 (5290)	9.13	11.45	13.45	24	24	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/n-HT20/ax20, the minimum 99% emission bandwidth is 16.520 MHz
11 dBm + $10\log_{10}$ (16.520) = 23.18 dBm < 24 dBm
So the 23.18 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT80/ax40/ax80, the minimum 99% emission bandwidth is 35.877 MHz
11 dBm + $10\log_{10}$ (35.877) = 26.55 dBm > 24 dBm
So the 24 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac/ax, the minimum 26 dB emission bandwidth is 20.75 MHz
11 dBm + $10\log_{10}$ (20.75) = 24.17 dBm >24 dBm
So the 24 dBm 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)	11.97	12.52	N/A	24	23.18	Pass
	116 (5580)	11.17	11.36	N/A	24	23.18	Pass
	140 (5700)	10.68	9.24	N/A	24	23.18	Pass
IEEE 802.11n-HT20	100 (5500)	13.73	15.46	17.69	24	23.18	Pass
	116 (5580)	13.97	15.28	17.68	24	23.18	Pass
	140 (5700)	13.82	15.41	17.70	24	23.18	Pass
IEEE 802.11n-HT40	102 (5510)	9.33	12.44	14.17	24	24	Pass
	110 (5550)	9.51	11.53	13.65	24	24	Pass
	134 (5670)	8.59	9.55	12.11	24	24	Pass
IEEE 802.11ac-VHT20	100 (5500)	11.83	13.73	15.89	24	23.18	Pass
	116 (5580)	12.09	13.43	15.82	24	23.18	Pass
	140 (5700)	11.87	13.56	15.81	24	23.18	Pass
IEEE 802.11ac-VHT40	102 (5510)	8.63	11.21	13.12	24	24	Pass
	110 (5550)	9.00	10.83	13.02	24	24	Pass
	134 (5670)	7.77	8.62	11.23	24	24	Pass
IEEE 802.11ac-VHT80	106 (5530)	8.38	9.93	12.23	24	24	Pass
IEEE 802.11ax20	100 (5500)	9.03	11.49	13.44	24	23.18	Pass
	116 (5580)	8.34	10.41	12.51	24	23.18	Pass
	140 (5700)	8.31	8.73	11.54	24	23.18	Pass
IEEE 802.11ax40	102 (5510)	8.11	10.13	12.25	24	24	Pass
	110 (5550)	7.39	8.89	11.21	24	24	Pass
	134 (5670)	7.16	7.57	10.38	24	24	Pass
IEEE 802.11ax80	106 (5530)	9.18	11.78	13.68	24	24	Pass

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

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)	12.24	13.03	N/A	30	Pass
	157 (5785)	12.41	12.12	N/A	30	Pass
	165 (5825)	12.53	12.24	N/A	30	Pass
IEEE 802.11n-HT20	149 (5745)	13.09	12.32	15.73	30	Pass
	157 (5785)	13.25	11.73	15.57	30	Pass
	165 (5825)	13.52	11.29	15.56	30	Pass
IEEE 802.11n-HT40	151 (5755)	10.97	11.58	14.30	30	Pass
	159 (5795)	11.26	11.37	14.33	30	Pass
IEEE 802.11ac-VHT20	149 (5745)	9.63	9.38	12.52	30	Pass
	157 (5785)	9.58	8.77	12.20	30	Pass
	165 (5825)	9.74	8.79	12.30	30	Pass
IEEE 802.11ac-VHT40	151 (5755)	10.53	10.95	13.76	30	Pass
	159 (5795)	10.69	10.44	13.58	30	Pass
IEEE 802.11ac-VHT80	155 (5775)	8.40	7.71	11.08	30	Pass
IEEE 802.11ax20	149 (5745)	8.32	9.11	11.74	30	Pass
	157 (5785)	8.47	8.66	11.58	30	Pass
	165 (5825)	8.82	8.56	11.70	30	Pass
IEEE 802.11ax40	151 (5755)	8.51	7.06	10.86	30	Pass
	159 (5795)	8.61	8.29	11.46	30	Pass
IEEE 802.11ax80	155 (5775)	8.84	8.44	11.65	30	Pass

Remark:

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

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 E

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	1.67	1.67	4.68	10.00
U-NII-2A	1.75	1.75	4.76	11.00
U-NII-2C	2.95	2.95	5.96	11.00
U-NII-3	1.55	1.55	4.56	30.00
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:				
If *any* transmit signals are *correlated* with each other,				
Directional gain = G_{ANT} + 10 log(N_{ANT}) dBi				

FCC 47 CFR Part 15 Subpart E:

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	1.67	1.67	4.68	11.00
U-NII-2A	1.75	1.75	4.76	11.00
U-NII-2C	2.95	2.95	5.96	11.00
U-NII-3	1.55	1.55	4.56	30.00
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:				
If *any* transmit signals are *correlated* with each other,				
Directional gain = $G_{ANT} + 10 \log(N_{ANT})$ dBi				

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)	5.26	6.69	N/A	10	Pass
	44 (5220)	5.44	6.69	N/A	10	Pass
	48 (5240)	5.46	6.59	N/A	10	Pass
IEEE 802.11n-HT20	36 (5180)	5.04	7.89	9.71	10	Pass
	44 (5220)	4.77	7.56	9.40	10	Pass
	48 (5240)	4.95	7.40	9.36	10	Pass
IEEE 802.11n-HT40	38 (5190)	1.15	3.65	8.59	10	Pass
	46 (5230)	1.35	3.71	8.71	10	Pass
IEEE 802.11ac-VHT20	36 (5180)	3.47	7.25	8.77	10	Pass
	44 (5220)	3.77	7.24	8.85	10	Pass
	48 (5240)	3.40	7.29	8.78	10	Pass
IEEE 802.11ac-VHT40	38 (5190)	0.69	2.70	7.83	10	Pass
	46 (5230)	0.47	2.92	7.89	10	Pass
IEEE 802.11ac-VHT80	42 (5210)	-2.71	0.49	5.20	10	Pass
IEEE 802.11ax20	36 (5180)	0.71	3.47	8.32	10	Pass
	44 (5220)	0.71	2.95	8.00	10	Pass
	48 (5240)	0.82	3.36	8.29	10	Pass
IEEE 802.11ax40	38 (5190)	-3.87	-1.05	3.78	10	Pass
	46 (5230)	-3.77	-1.40	3.60	10	Pass
IEEE 802.11ax80	42 (5210)	-5.88	-3.22	1.67	10	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) = $10*\log[(10^{Chain\ 0/10})+(10^{Chain\ 1/10})]$ + Directional gain

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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)	3.594	5.015	N/A	11	Pass
	44 (5220)	3.769	5.015	N/A	11	Pass
	48 (5240)	3.794	4.916	N/A	11	Pass
IEEE 802.11n-HT20	36 (5180)	3.370	6.218	8.03	11	Pass
	44 (5220)	3.099	5.889	7.72	11	Pass
	48 (5240)	3.276	5.728	7.68	11	Pass
IEEE 802.11n-HT40	38 (5190)	-0.521	1.976	3.91	11	Pass
	46 (5230)	-0.318	2.040	4.03	11	Pass
IEEE 802.11ac-VHT20	36 (5180)	1.801	5.583	7.10	11	Pass
	44 (5220)	2.097	5.571	7.18	11	Pass
	48 (5240)	1.733	5.620	7.11	11	Pass
IEEE 802.11ac-VHT40	38 (5190)	-0.979	1.031	3.15	11	Pass
	46 (5230)	-1.198	1.253	3.21	11	Pass
IEEE 802.11ac-VHT80	42 (5210)	-4.376	-1.182	0.52	11	Pass
IEEE 802.11ax20	36 (5180)	-0.961	1.799	3.64	11	Pass
	44 (5220)	-0.956	1.281	3.32	11	Pass
	48 (5240)	-0.854	1.686	3.61	11	Pass
IEEE 802.11ax40	38 (5190)	-5.542	-2.723	-0.90	11	Pass
	46 (5230)	-5.436	-3.068	-1.08	11	Pass
IEEE 802.11ax80	42 (5210)	-7.552	-4.886	-3.01	11	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)	3.54	4.432	N/A	11	Pass
	60 (5300)	3.257	4.633	N/A	11	Pass
	64 (5320)	3.433	4.859	N/A	11	Pass
IEEE 802.11n-HT20	52 (5260)	3.220	5.674	7.63	11	Pass
	60 (5300)	3.305	4.225	6.80	11	Pass
	64 (5320)	3.358	4.036	6.72	11	Pass
IEEE 802.11n-HT40	54 (5270)	-1.003	1.303	3.31	11	Pass
	62 (5310)	-0.969	1.207	3.26	11	Pass
IEEE 802.11ac-VHT20	52 (5260)	1.685	5.140	6.76	11	Pass
	60 (5300)	1.877	4.662	6.50	11	Pass
	64 (5320)	1.877	3.876	6.00	11	Pass
IEEE 802.11ac-VHT40	54 (5270)	-1.099	1.292	3.27	11	Pass
	62 (5310)	-1.854	0.665	2.60	11	Pass
IEEE 802.11ac-VHT80	58 (5290)	-5.115	-2.447	-0.57	11	Pass
IEEE 802.11ax20	52 (5260)	-0.894	1.0202	3.18	11	Pass
	60 (5300)	-1.242	0.777	2.89	11	Pass
	64 (5320)	-1.439	0.575	2.69	11	Pass
IEEE 802.11ax40	54 (5270)	-5.967	-3.685	-1.67	11	Pass
	62 (5310)	-5.839	-4.265	-1.97	11	Pass
IEEE 802.11ax80	58 (5290)	-8.563	-5.691	-3.88	11	Pass

Remark:

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

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)	2.988	4.170	N/A	11	Pass
	116 (5580)	2.746	3.916	N/A	11	Pass
	140 (5700)	2.929	2.203	N/A	11	Pass
IEEE 802.11n-HT20	100 (5500)	1.693	4.774	6.51	11	Pass
	116 (5580)	1.838	3.781	5.93	11	Pass
	140 (5700)	2.004	2.530	5.29	11	Pass
IEEE 802.11n-HT40	102 (5510)	-2.708	-0.477	1.56	11	Pass
	110 (5550)	-2.727	-0.365	1.62	11	Pass
	134 (5670)	-3.108	-1.568	0.74	11	Pass
IEEE 802.11ac-VHT20	100 (5500)	0.463	4.134	5.69	11	Pass
	116 (5580)	0.284	3.829	5.42	11	Pass
	140 (5700)	0.430	2.382	4.53	11	Pass
IEEE	102 (5510)	-3.54	-1.001	0.92	11	Pass

802.11ac-VHT40	110 (5550)	-3.550	-1.132	0.84	11	Pass
	134 (5670)	-3.486	-3.336	-0.40	11	Pass
IEEE 802.11ac-VHT80	106 (5530)	-6.026	-3.568	-1.62	11	Pass
IEEE 802.11ax20	100 (5500)	-1.108	1.722	3.54	11	Pass
	116 (5580)	-1.763	0.551	2.56	11	Pass
	140 (5700)	-1.102	-0.796	2.06	11	Pass
IEEE 802.11ax40	102 (5510)	-5.933	-2.885	-1.14	11	Pass
	110 (5550)	-5.657	-3.499	-1.44	11	Pass
	134 (5670)	-6.429	-4.908	-2.59	11	Pass
IEEE 802.11ax80	106 (5530)	-8.662	-6.156	-4.22	11	Pass

Remark:

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

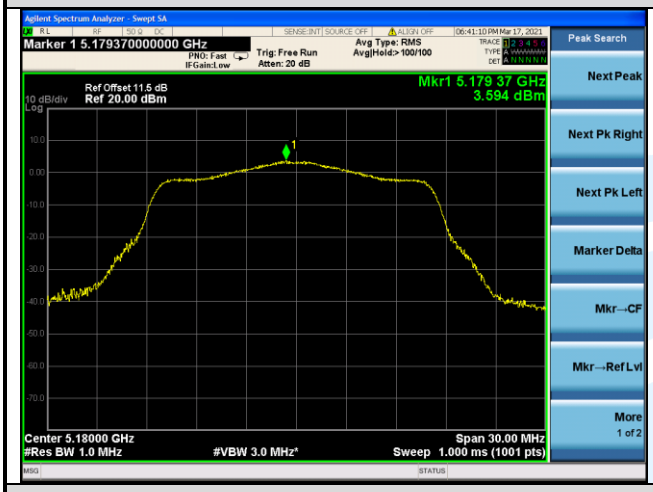
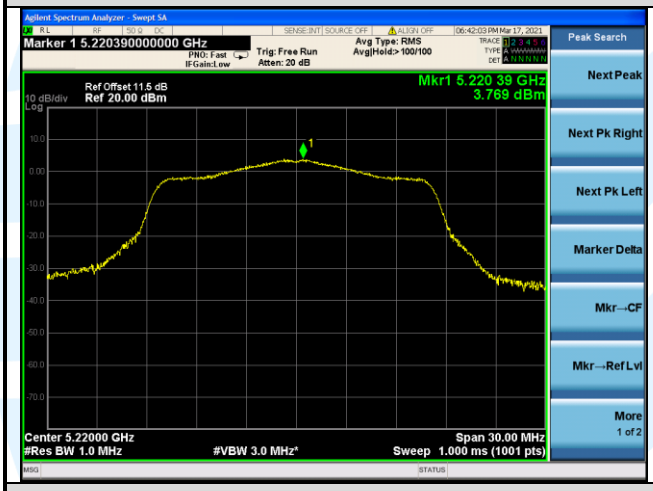
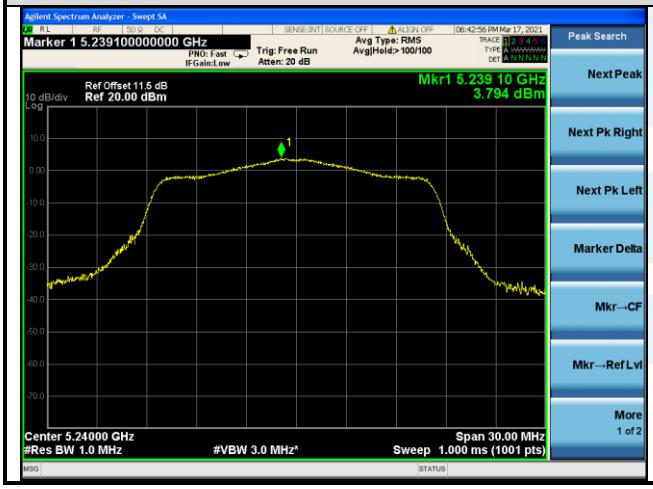
Frequency band 5725-5850 MHz

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)	2.529	4743	N/A	30	Pass
	157 (5785)	2.437	4.017	N/A	30	Pass
	165 (5825)	2.614	3.363	N/A	30	Pass
IEEE 802.11n-HT20	149 (5745)	2.304	4.538	6.57	30	Pass
	157 (5785)	1.272	3.641	5.63	30	Pass
	165 (5825)	2.938	3.121	6.04	30	Pass
IEEE 802.11n-HT40	151 (5755)	-2.056	0.653	2.52	30	Pass
	159 (5795)	-1.414	0.606	2.72	30	Pass
IEEE 802.11ac-VHT20	149 (5745)	2.241	4.498	6.52	30	Pass
	157 (5785)	1.272	3.553	5.57	30	Pass
	165 (5825)	2.203	3.374	5.84	30	Pass
IEEE 802.11ac-VHT40	151 (5755)	-2.374	-0.394	1.74	30	Pass
	159 (5795)	-2.112	0.022	2.10	30	Pass
IEEE 802.11ac-VHT80	155 (5775)	-7.266	-4.506	-2.66	30	Pass
IEEE 802.11ax20	149 (5745)	0.374	-0.182	3.12	30	Pass
	157 (5785)	-0.075	-0.518	2.72	30	Pass
	165 (5825)	0.437	-1.145	2.73	30	Pass
IEEE 802.11ax40	151 (5755)	-5.299	-5.210	-2.24	30	Pass
	159 (5795)	-4.927	-5.201	-2.05	30	Pass
IEEE 802.11ax80	155 (5775)	-8.097	-8.814	-5.43	30	Pass

Remark:

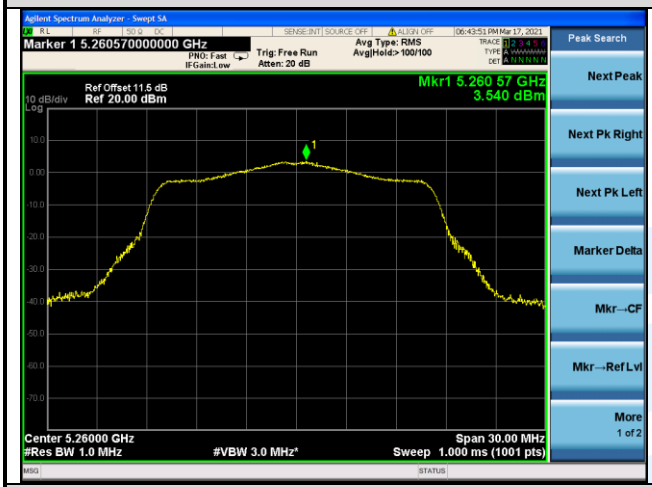
1. Power spectral density = Conducted power spectral density + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$

The test plots as follows:

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

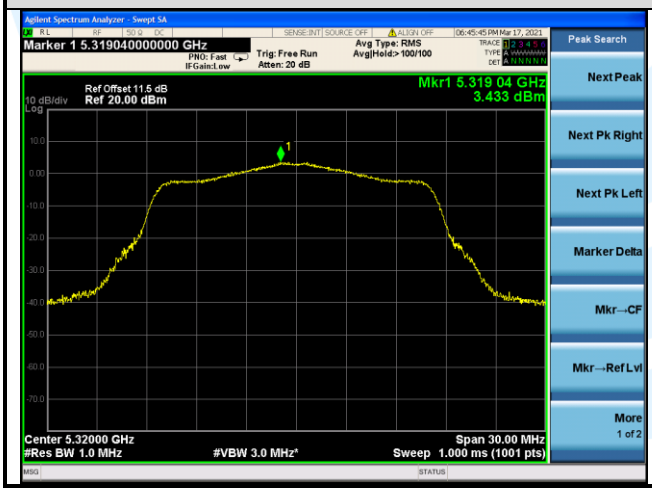
IEEE 802.11a

Channel 52



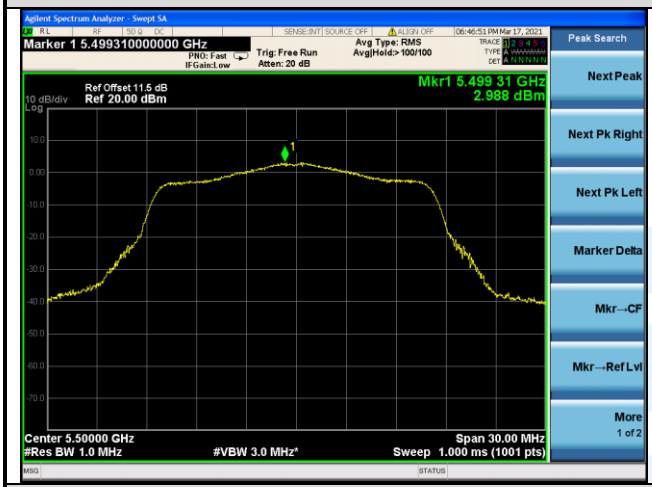
Channel 60

Channel 64

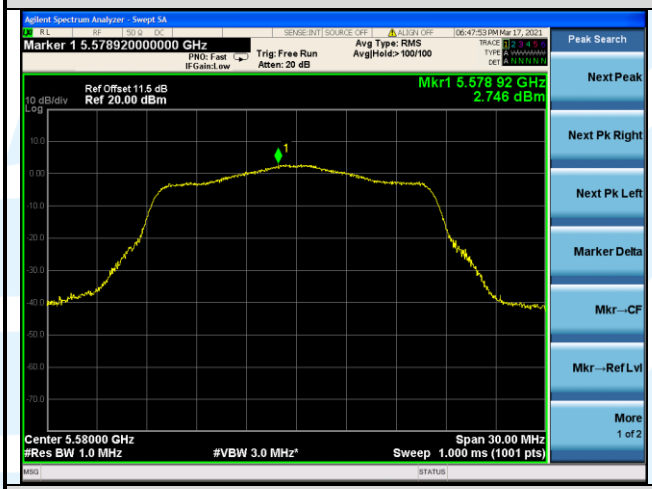


IEEE 802.11a

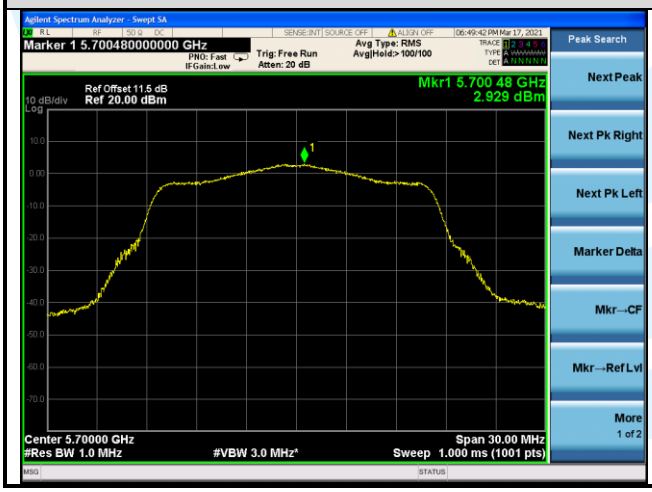
Channel 100



Channel 116

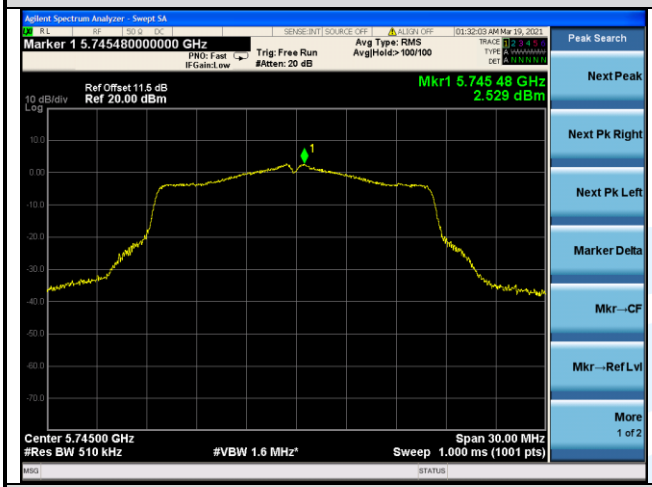


Channel 140

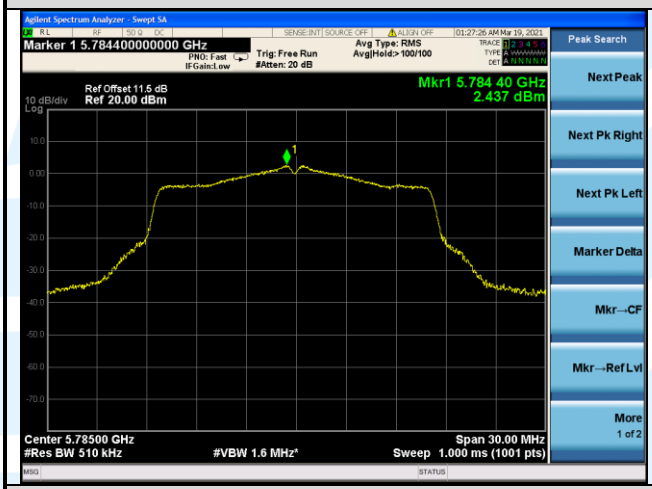
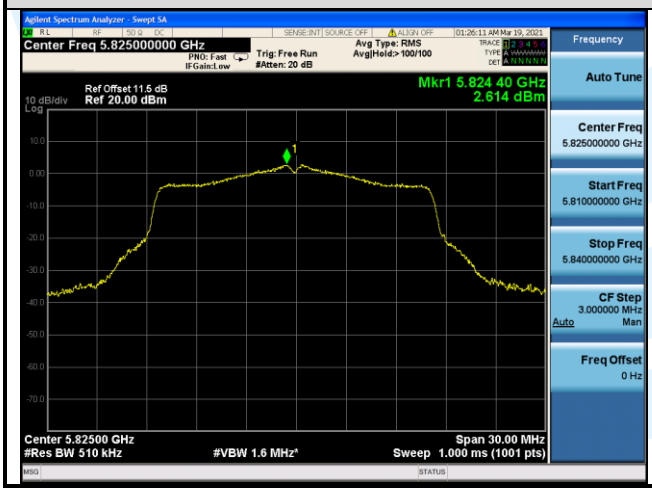


IEEE 802.11a

Channel 149



Channel 157



Channel 165