

FCC 15.407 (a)(1)(iv). Transmitter Maximum Power Spectral Density / RSS-247

6.2.1.1. Transmitter EIRP Spectral Density

FCC 15.407: 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.

RSS-247: The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

RESULTS:

The maximum power spectral density (PSD) was measured using the method according to point F) referencing E.2.b) (Method SA-1) and E.2.b) (Method SA-2) of Guidance 789033 D02 General UNII Test Procedures New Rules v02r01.

The PSD test uses the same setup as the transmitter maximum conducted output power test. The result of the Peak PSD was measured by colocation a marker on the peak of the signal and the results are in the tables below.

The e.i.r.p. levels are calculated by adding the declared maximum antenna gain (dBi).

For all modes of operation, the antenna gain is < 6 dBi.

Maximum Declared Antenna Gain: -5.4 dBi (antenna gain plus antenna cable loss).

Mode 802.11 a20:

	Low Channel	Middle Channel	High Channel
Maximum Average PSD (dBm/MHz)	0.41	0.88	-1.21
Duty Cycle Correction Factor (dB)	1.047431924		
Maximum Average PSD Corrected (dBm/MHz)	1.457431924	1.927431924	-0.162568076
Maximum EIRP PSD Corrected (dBm/MHz)	-3.942568076	-3.472568076	-5.562568076
Measurement uncertainty (dB)	<±1.20		

Mode 802.11 ac20 (VHT20):

	Low Channel	Middle Channel	High Channel
Maximum Average PSD (dBm/MHz)	-0.23	0.33	-1.46
Duty Cycle Correction Factor (dB)	1.101843955		
Maximum Average PSD Corrected (dBm/MHz)	0.871843955	1.431843955	-0.358156045
Maximum EIRP PSD Corrected (dBm/MHz)	-4.528156045	-3.968156045	-5.758156045
Measurement uncertainty (dB)	<±1.20		

Mode 802.11 n40 (HT40):

	Low Channel	High Channel
Maximum Average PSD (dBm/MHz)	-5.27	-6.37
Duty Cycle Correction Factor (dB)	2.020944858	
Maximum Average PSD Corrected (dBm/MHz)	-3.249055142	-4.349055142
Maximum EIRP PSD Corrected (dBm/MHz)	-8.649055142	-9.749055142
Measurement uncertainty (dB)	<±1.20	

Mode 802.11 ac80 (VHT80):

	Low Channel
Maximum Average PSD (dBm/MHz)	-8.21
Duty Cycle Correction Factor (dB)	3.53587835
Maximum Average PSD Corrected (dBm/MHz)	-4.67412165
Maximum EIRP PSD Corrected (dBm/MHz)	-10.07412165
Measurement uncertainty (dB)	<±1.20

Verdict: PASS

FCC 15.407 (b)(1)(6) / RSS-247 6.2.1.2. Transmitter Out of Band Radiated Emissions

SPECIFICATION:

For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

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

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

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

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 1m for the frequency range 17 GHz-40 GHz and a distance of 3m for frequency range 30MHz-17GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

- Test performed on the following worst case: 802.11 ac20, with an index MCS0.

The worst case was determined by measuring the eirp density (radiated).

Frequency range 30 MHz - 1 GHz:

The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

No spurious frequencies detected at less than 20 dB below the limit.

Measurement Uncertainty (dB): $\leq \pm 5.08$

Frequency range 1 - 40 GHz:

The results in the next tables show the maximum measured levels in the 1-40 GHz frequency range.

The Low, Middle and High Channels were measured for out-of-band emissions for the worst mode.

Spurious frequencies in the restricted bands with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with an average detector for checking compliance with the average limit.

- 802.11 ac20 (worst case):**

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
10.360	65.90	--	65.90	68.23	H	Peak	$\leq \pm 5.13$
	49.66	1.05	50.71	54		Average	$\leq \pm 5.13$
15.537	48.17	--	48.17	74	H	Peak	$\leq \pm 5.13$

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dB μ V/m)	Limit (dB μ V/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.1228	54.54	--	54.54	74	H	Peak	$\leq \pm 5.13$
	40.08	1.05	41.13	54		Average	$\leq \pm 5.13$
5.1456	54.49	--	54.49	74	H	Peak	$\leq \pm 5.13$
	39.13	1.05	40.18	54		Average	$\leq \pm 5.13$
10.4006	66.96	--	66.96	68.23	H	Peak	$\leq \pm 5.13$
	50.48	1.05	51.53	54		Average	$\leq \pm 5.13$
15.5906	51.43	--	51.43	74	H	Peak	$\leq \pm 5.13$

- HIGH CHANNEL. Spurious frequencies closest to the limit:

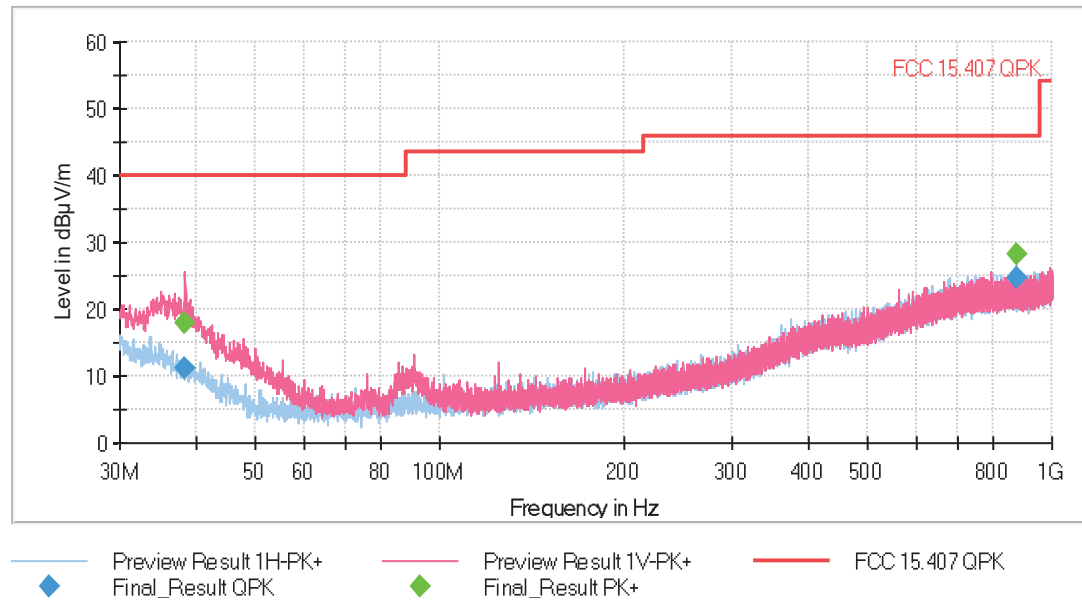
Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
10.479	63.74	--	63.74	68.23	H	Peak	<± 5.13
	46.96	1.05	48.01	54		Average	<± 5.13
15.726	50.89	--	50.89	74	H	Peak	<± 5.13

Measurement Uncertainty (dB): 1 GHz – 17 GHz <± 5.13
 17 GHz – 26.5 GHz <± 5.08
 26.5 GHz – 40 GHz <± 5.33

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst case):

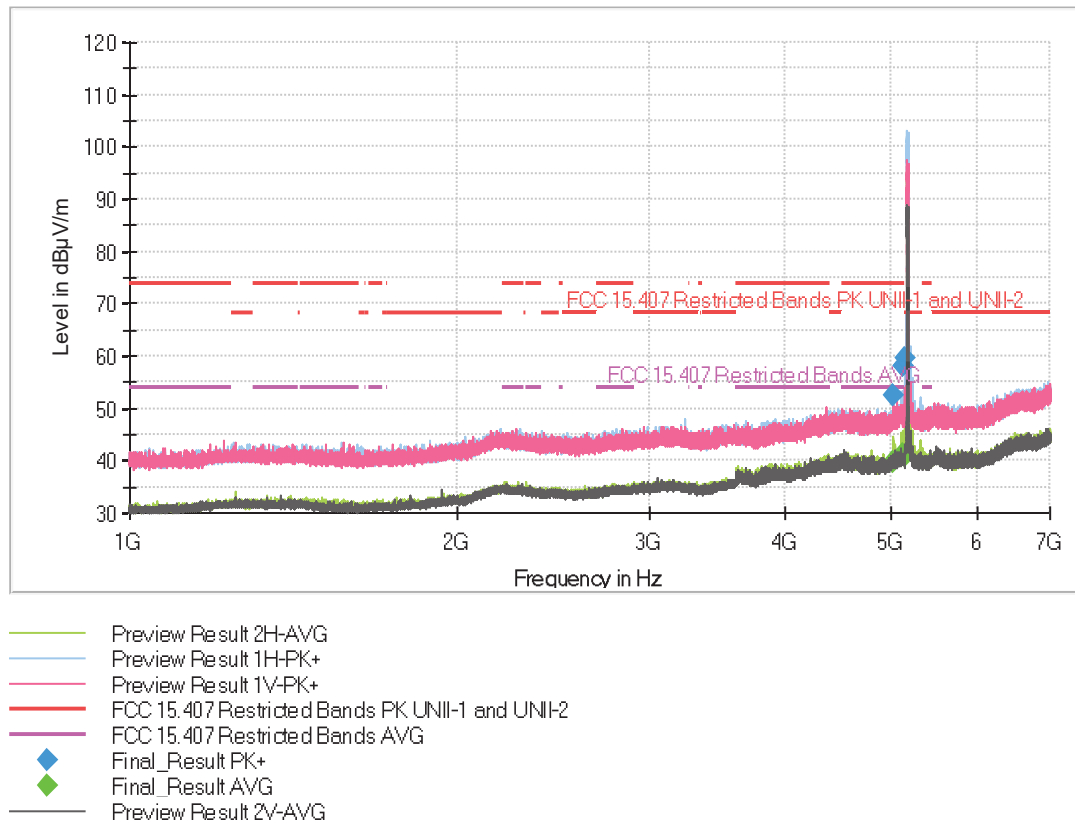
This plot is valid for the Low, Middle and High Channels and all the modulation modes.



FREQUENCY RANGE 1 – 7 GHz (worst case):

- Low Channel:

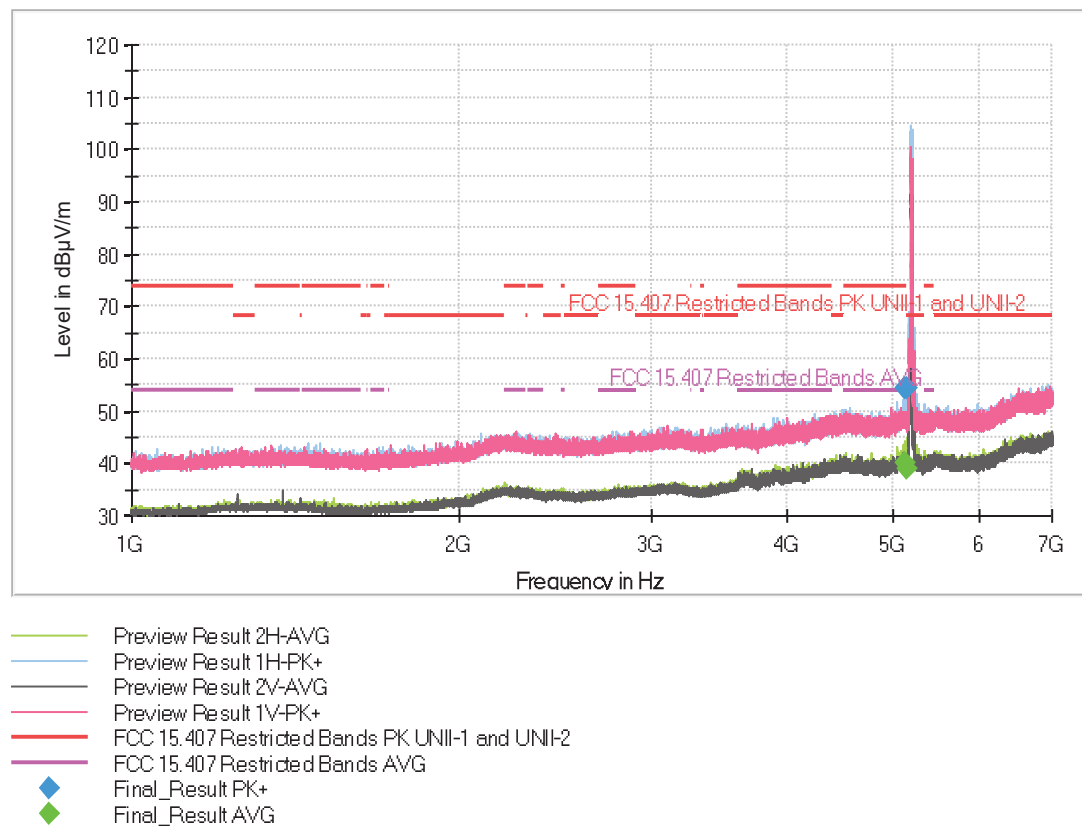
Full Spectrum



The peak shown in the plot above the limit is the carrier frequency.

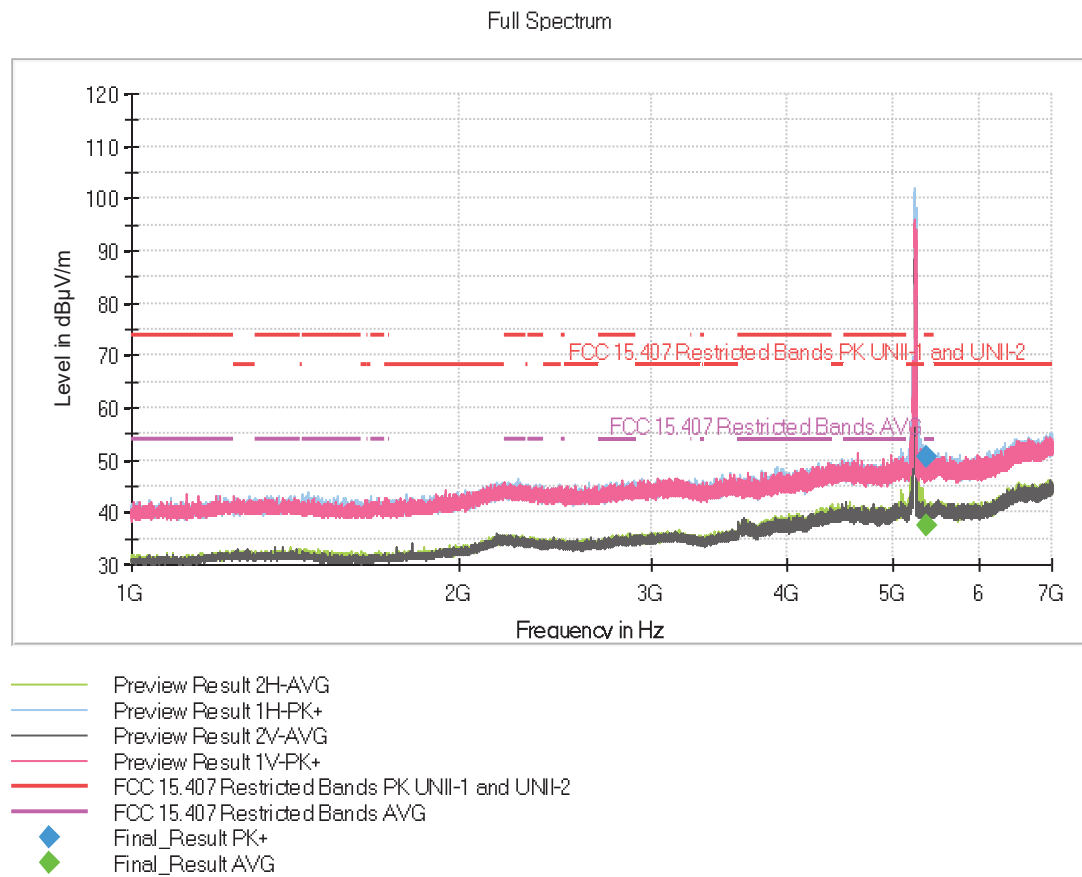
- Middle Channel:

Full Spectrum



The peak shown in the plot above the limit is the carrier frequency.

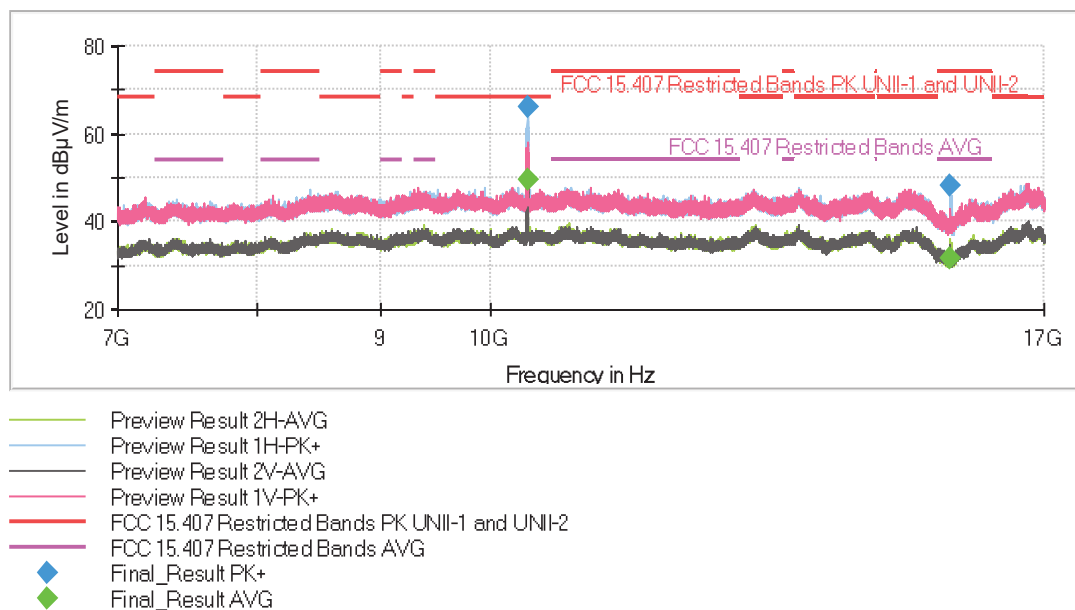
- High Channel:



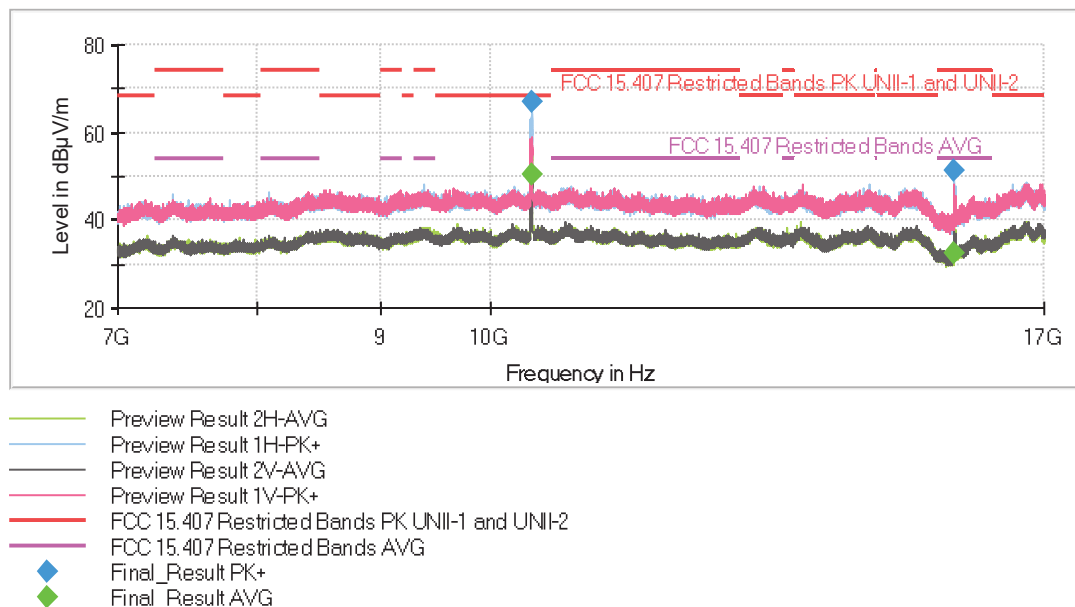
The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 7 - 17 GHz (worst case):

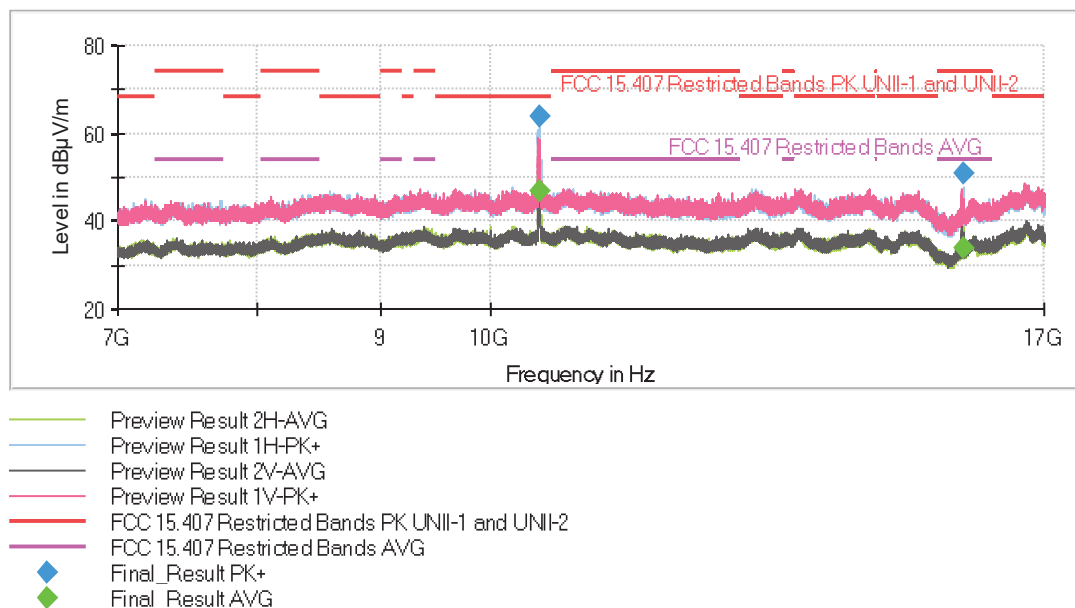
- Low Channel:



- Middle Channel:

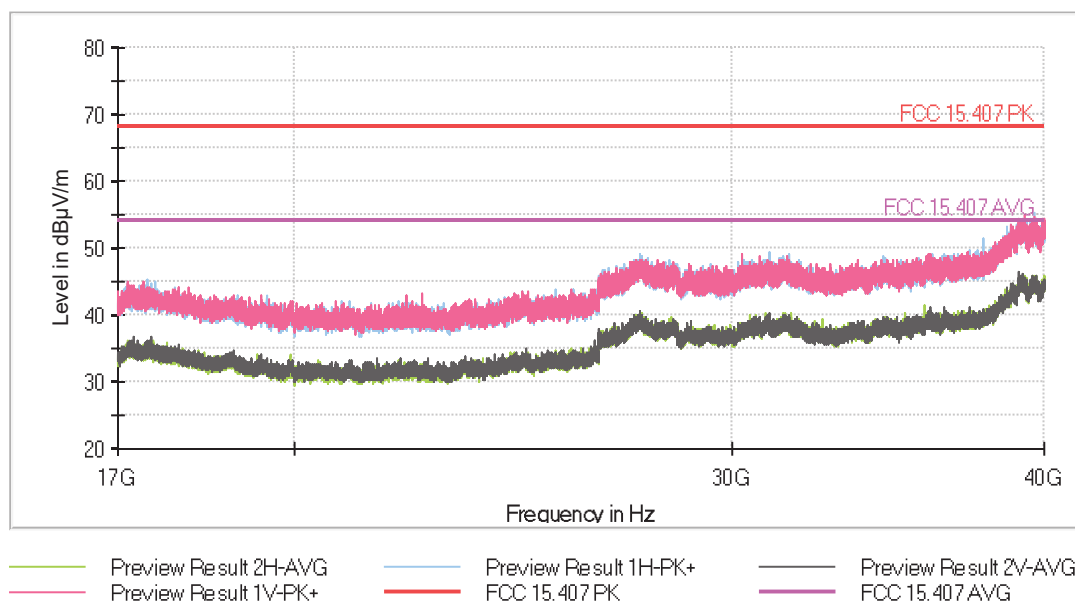


- High Channel:



FREQUENCY RANGE 17 - 40 GHz (worst case):

This plot is valid for the Low, Middle and High Channels and all the modulation modes.



FCC 15.407 (b)(1) / RSS-247 6.2.1.2. Transmitter Band Edge Radiated Emissions

SPECIFICATION:

For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

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

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

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

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

All emissions outside of the 5.15-5.35GHz band shall not exceed an EIRP of -27dBm/MHz. There are restricted bands of operation below band edge at 4.5-5.15 GHz also above the upper band edge at 5.35-5.46GHz therefore the provision of FCC Part 15.205 apply.

Field strength measurements using peak and average detector performed in the restricted bands below 5.15GHz and above 5.35 GHz.

Test performed on the following worst cases modes in all relevant tests channels:

- 802.11a: 6 Mbit/s.
- 802.11n HT20: MCS0.
- 802.11ac VHT20: MCS0.
- 802.11n HT40: MCS0.
- 802.11ac VHT40: MCS0.
- 802.11ac VHT80: MCS0.

• **802.11 a20:**

- Lower Band Edge Channel 36 (5180 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.1194	55.08	--	55.08	74	H	Peak	<± 5.13
	40.10	0.96	41.06	54		Average	<± 5.13
5.1474	56.63	--	56.63	74	H	Peak	<± 5.13
	39.22	0.96	40.18	54		Average	<± 5.13

- Upper Band Edge Channel 48 (5240 MHz): Inside 5.35-5.46 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.3634	50.85	--	50.85	74	H	Peak	<± 5.13
5.3928	53.02	--	53.02	74	H	Peak	<± 5.13

• **802.11 n20:**

- Lower Band Edge Channel 36 (5180 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.106	56.08	--	56.08	74	H	Peak	<± 5.13
	41.26	1.01	42.27	54		Average	<± 5.13
5.1222	56.10	--	56.10	74	H	Peak	<± 5.13
	40.14	1.01	41.15	54		Average	<± 5.13

- Upper Band Edge Channel 48 (5240 MHz): Inside 5.35-5.46 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.3938	52.33	--	52.33	74	H	Peak	<± 5.13

• **802.11 ac20:**

- Lower Band Edge Channel 36 (5180 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.0296	52.66	--	52.66	74	H	Peak	<± 5.13
5.1176	58.06	--	58.06	74	H	Peak	<± 5.13
	41.41	1.05	42.46	54		Average	<± 5.13
5.1392	59.78	--	59.78	74	H	Peak	<± 5.13
	40.98	1.05	42.03	54		Average	<± 5.13

- Upper Band Edge Channel 48 (5240 MHz): Inside 5.35-5.46 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.375	50.76	--	50.76	74	V	Peak	<± 5.13

• **802.11 n40:**

- Lower Band Edge Channel 38 (5190 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.1124	57.51	--	57.51	74	H	Peak	<± 5.13
	40.58	1.86	42.44	54		Average	<± 5.13
5.1494	64.42	--	64.42	74	H	Peak	<± 5.13
	42.21	1.86	44.07	54		Average	<± 5.13

- Upper Band Edge Channel 46 (5230 MHz): Inside 5.35-5.46 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.4594	51.05	--	51.05	74	H	Peak	<± 5.13

• **802.11 ac40:**

- Lower Band Edge Channel 38 (5190 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.1106	56.47	--	56.47	74	H	Peak	<± 5.13
	41.17	1.83	43	54		Average	<± 5.13
5.1496	63.39	--	63.39	74	H	Peak	<± 5.13
	41.93	1.83	43.76	54		Average	<± 5.13

- Upper Band Edge Channel 46 (5230 MHz): Inside 5.35-5.46 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.3644	51.10	--	51.10	74	V	Peak	<± 5.13

• **802.11 ac80:**

- Lower Band Edge Channel 42 (5210 MHz): Inside 4.50-5.15 GHz.

Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.1156	61.49	--	61.49	74	H	Peak	<± 5.13
	41.87	3.21	45.08	54		Average	<± 5.13
5.1412	52.32	--	52.32	74	V	Peak	<± 5.13

- Upper Band Edge Channel 42 (5210 MHz): Inside 5.35-5.46 GHz.

No spurious frequencies at less than 20 dB below the limit.

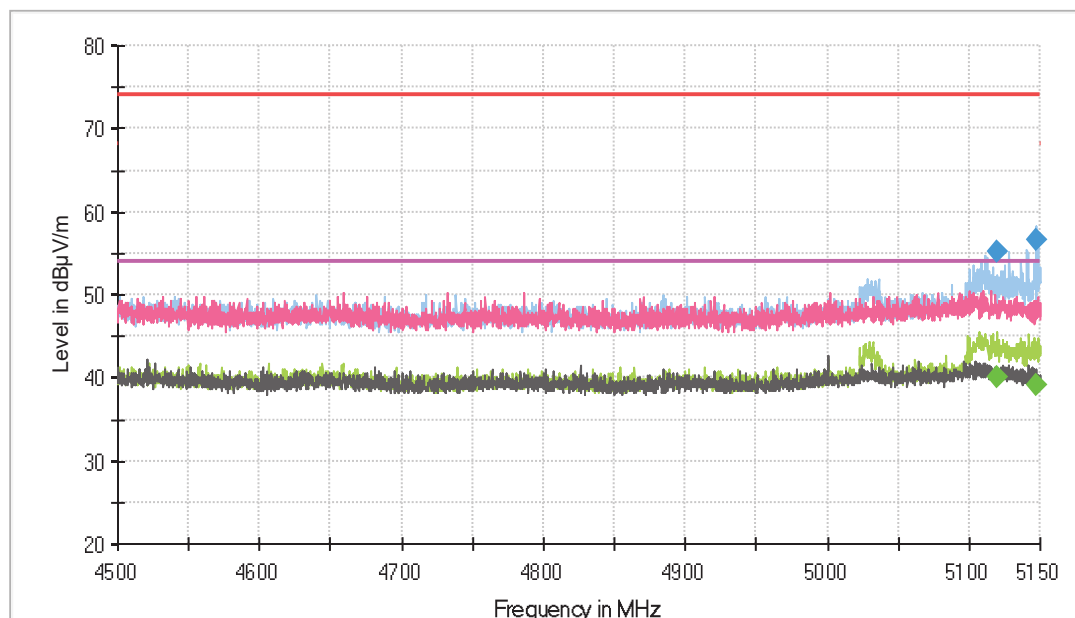
Measurement Uncertainty (dB): <± 5.13

Verdict: PASS

• **802.11 a20:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

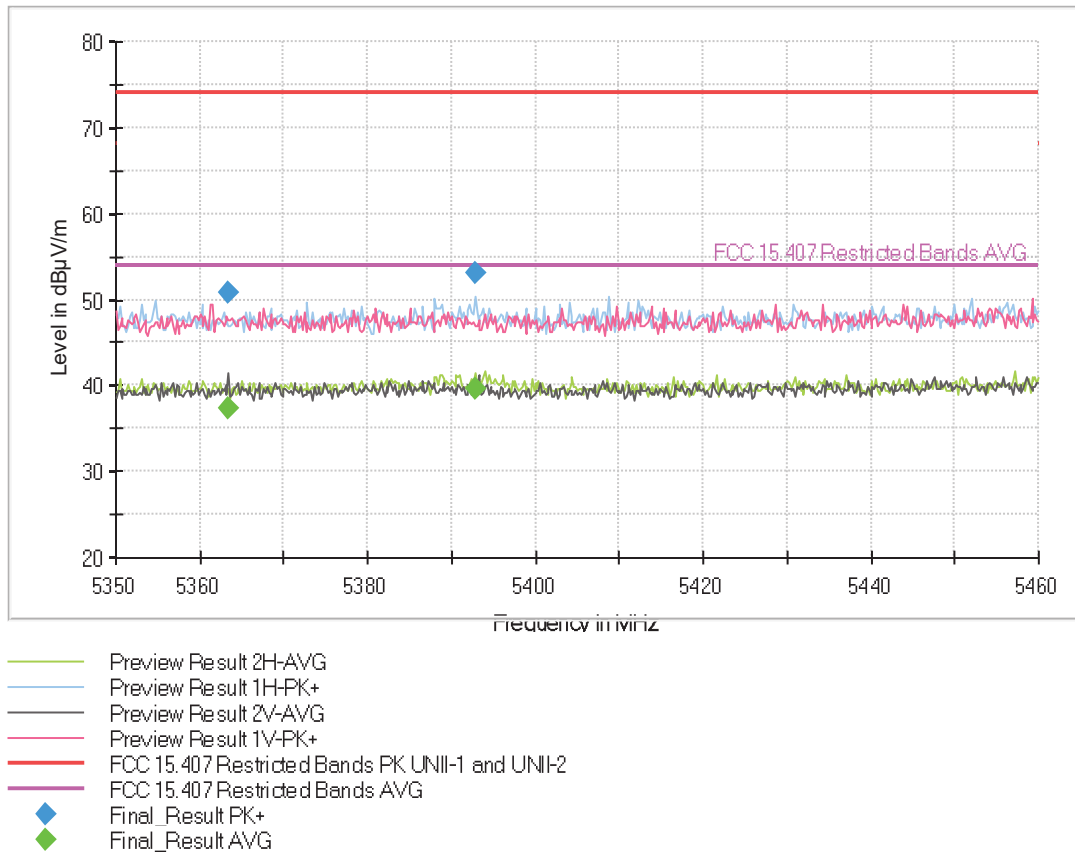
- Lower Band Edge Channel 36 (4500 to 5150 MHz)



- Preview Result 2H-AVG
- Preview Result 1H-PK+
- Preview Result 2V-AVG
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final_Result PK+
- Final_Result AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

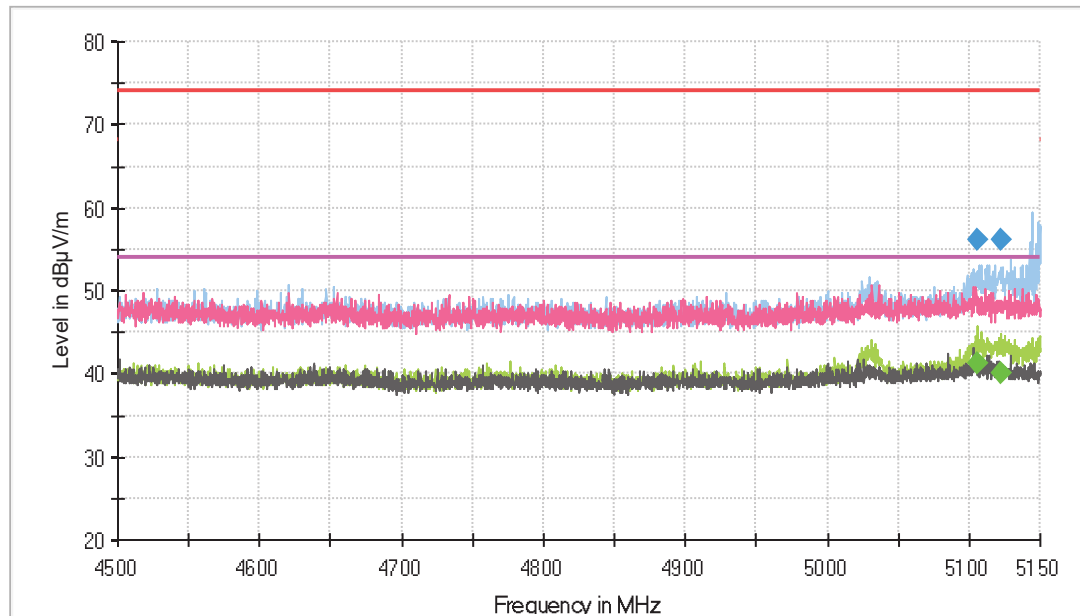
- Upper Band Edge Channel 48 (5350 to 5460 MHz)



• **802.11 n20:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

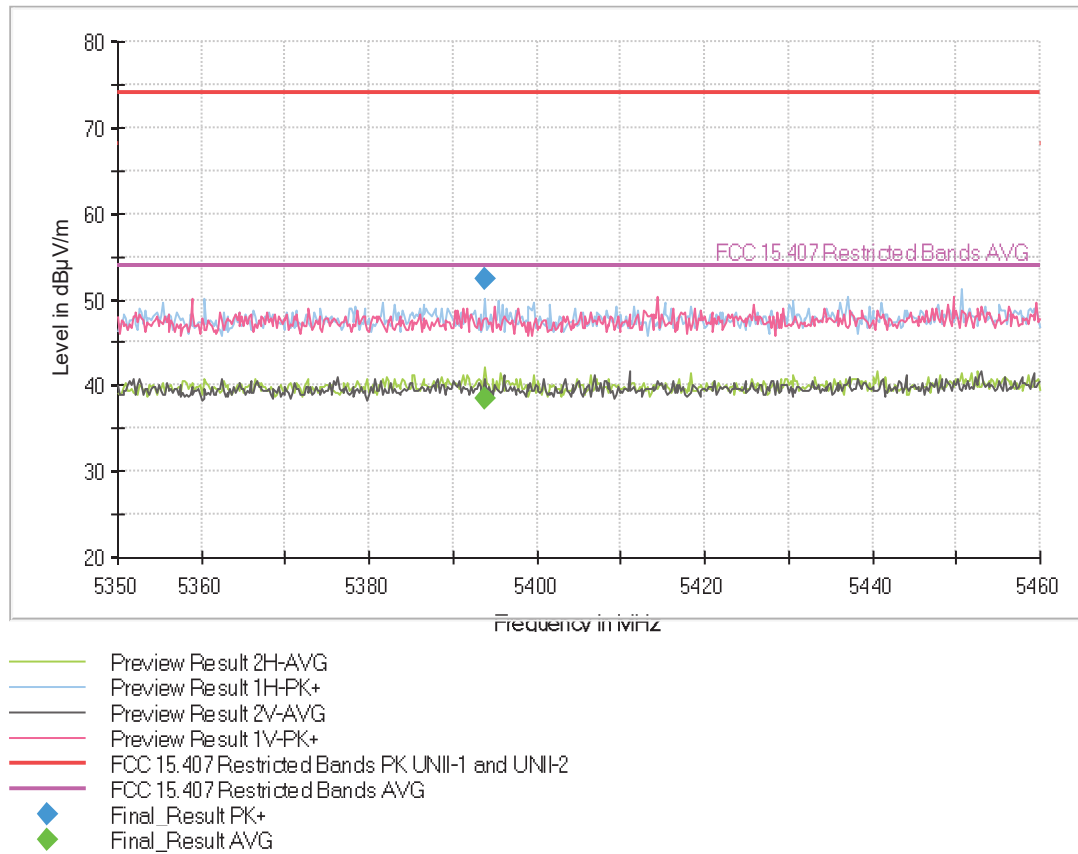
- Lower Band Edge Channel 36 (4500 to 5150 MHz)



- Preview Result 2H-AVG
- Preview Result 1H-PK+
- Preview Result 2V-AVG
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final_Result PK+
- Final_Result AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

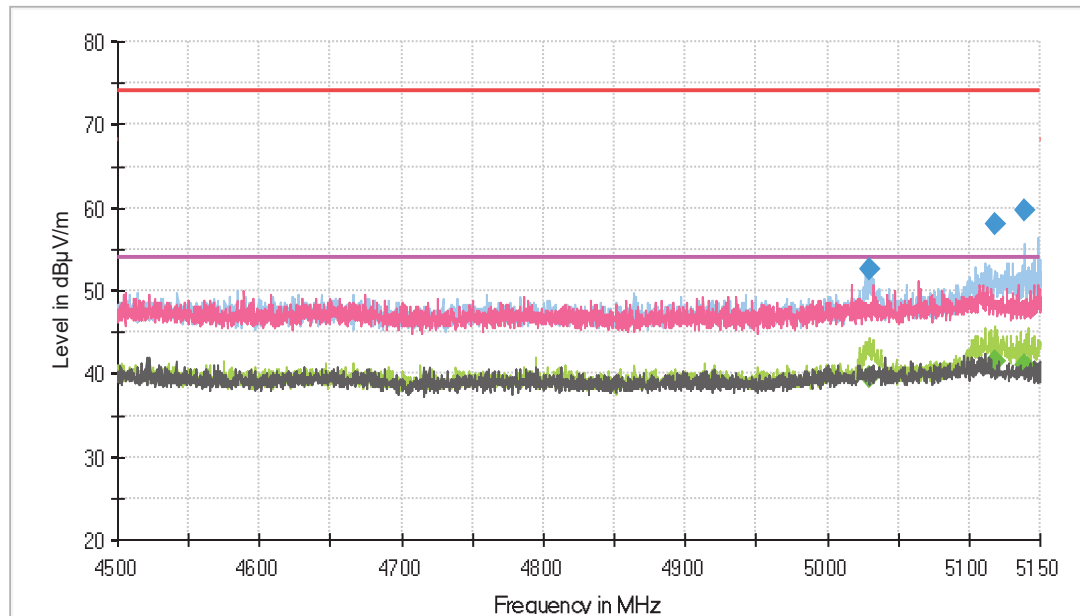
- Upper Band Edge Channel 48 (5350 to 5460 MHz)



• **802.11 ac20:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

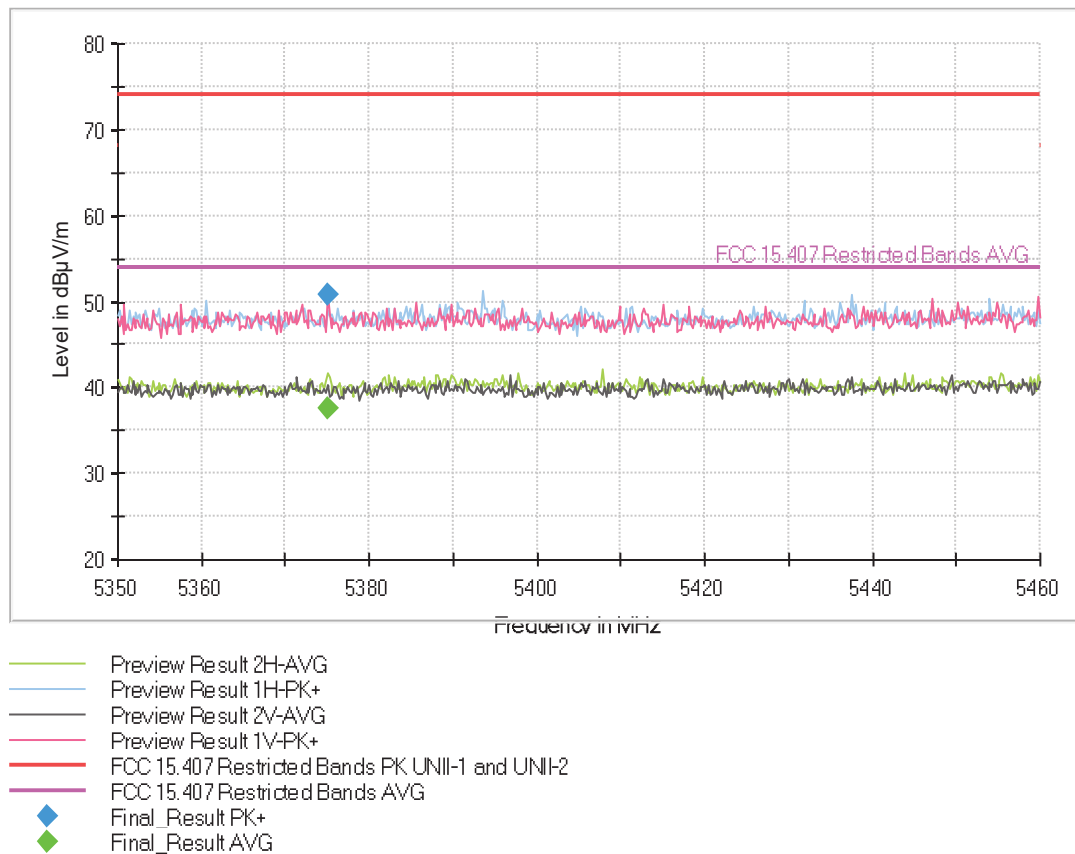
- Lower Band Edge Channel 36 (4500 to 5150 MHz)



- Preview Result 2H-AVG
- Preview Result 1H-PK+
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final_Result PK+
- Final_Result AVG
- Preview Result 2V-AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

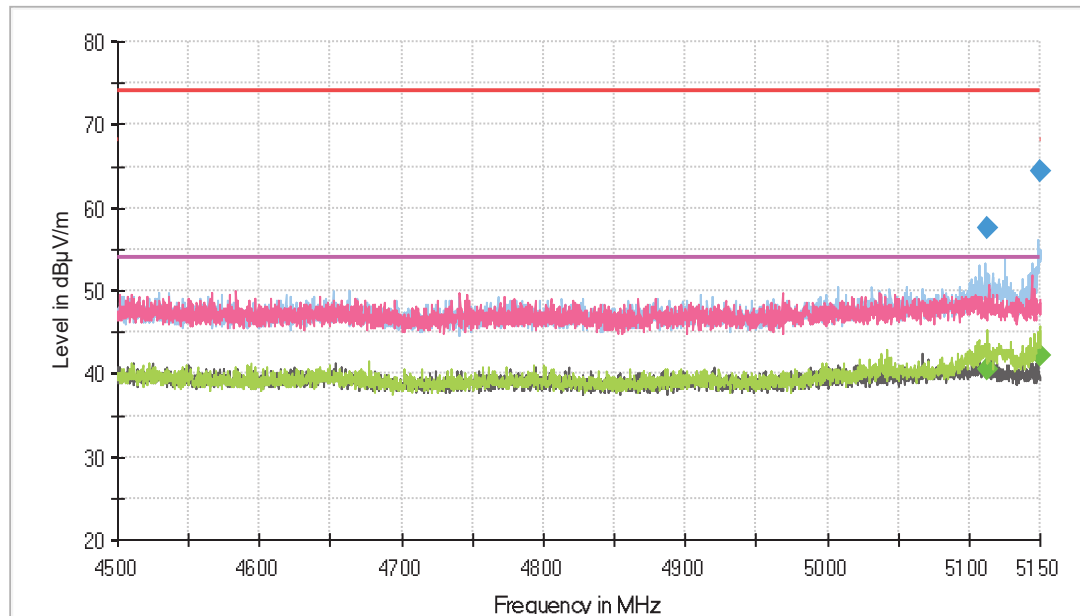
- Upper Band Edge Channel 48 (5350 to 5460 MHz)



• **802.11 n40:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

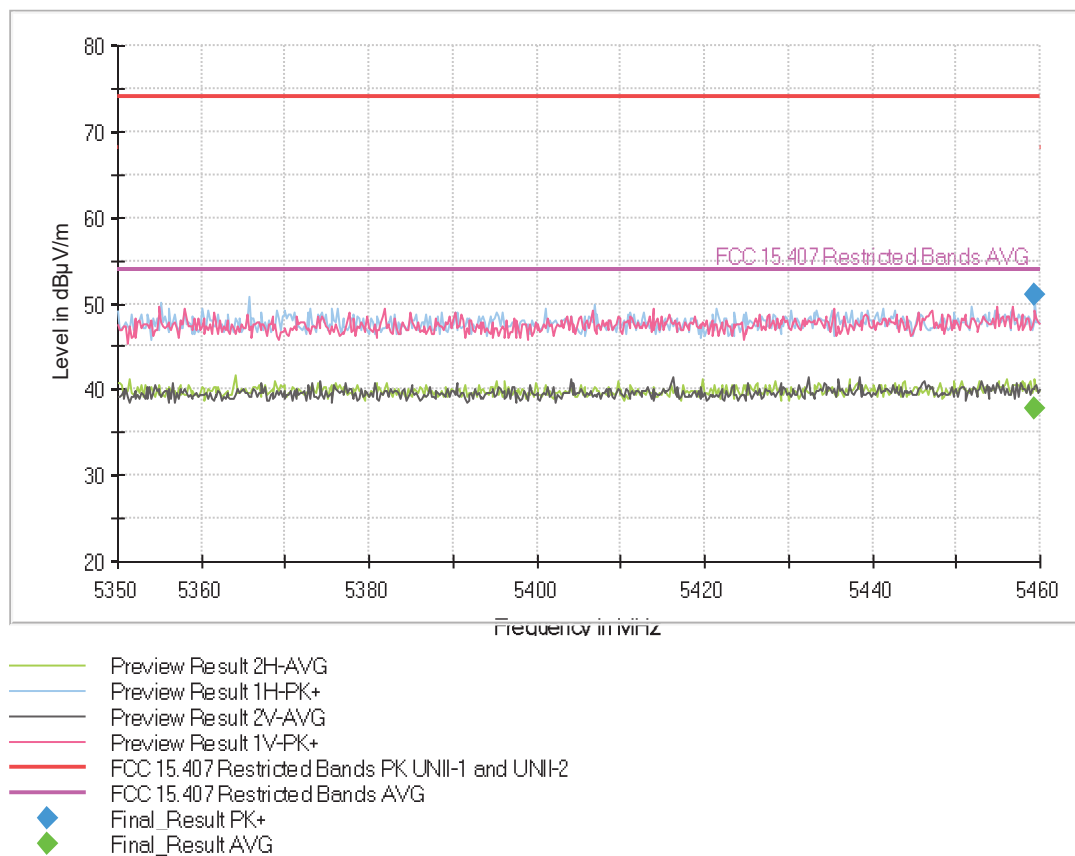
- Lower Band Edge Channel 38 (4500 to 5150 MHz)



- Preview Result 1H-PK+
- Preview Result 2V-AVG
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final_Result PK+
- Final_Result AVG
- Preview Result 2H-AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

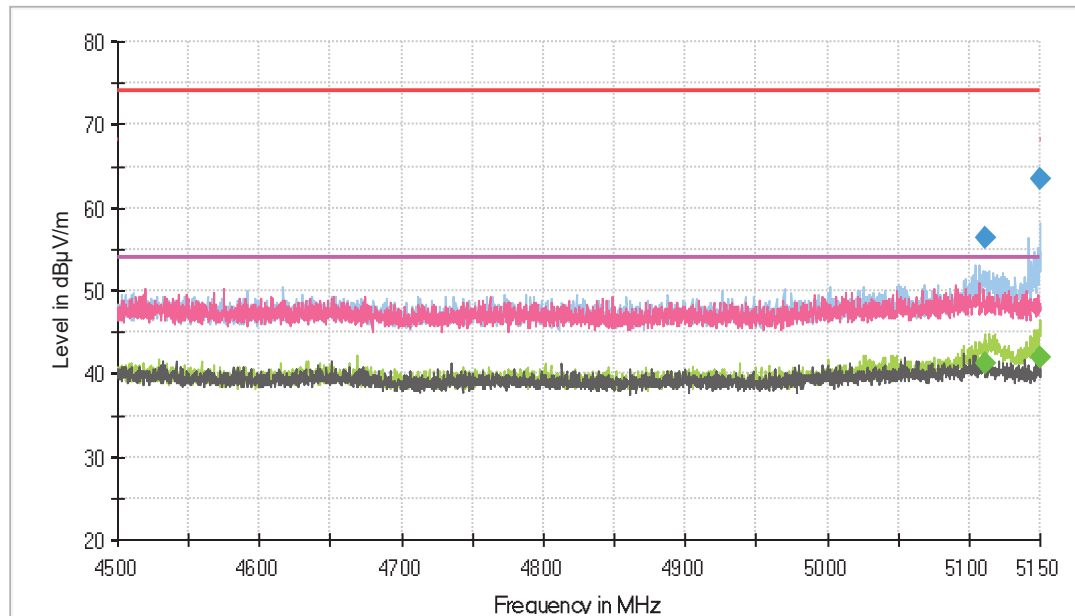
- Upper Band Edge Channel 46 (5350 to 5460 MHz)



• **802.11 ac40:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

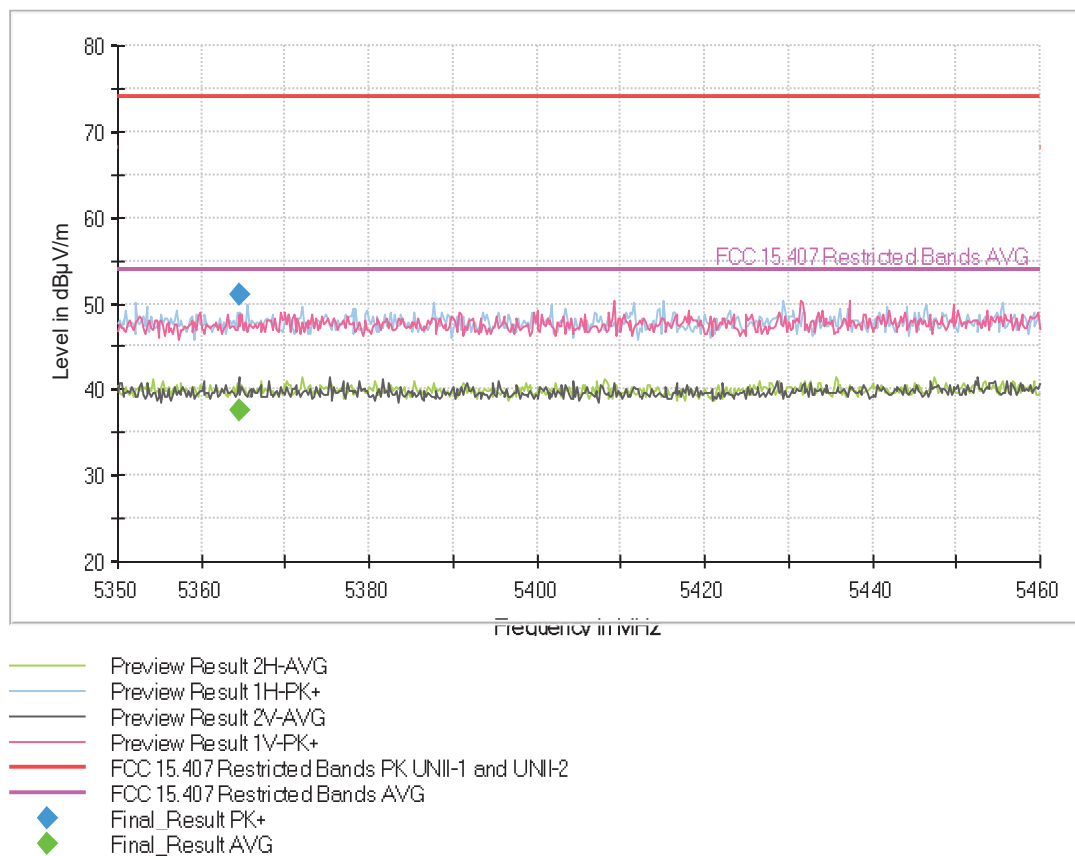
- Lower Band Edge Channel 38 (4500 to 5150 MHz)



- Preview Result 2H-AVG
- Preview Result 1H-PK+
- Preview Result 2V-AVG
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final_Result PK+
- Final_Result AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

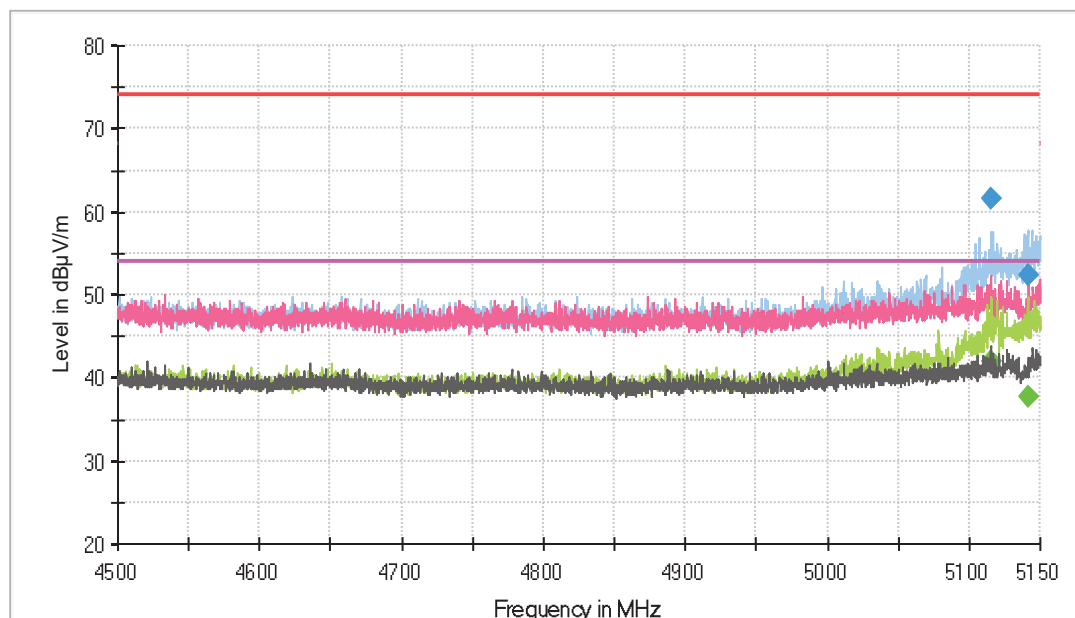
- Upper Band Edge Channel 46 (5350 to 5460 MHz)



• **802.11 ac80:**

Radiated spurious emissions at band-edges and inside adjacent band 4.50 - 5.15 GHz

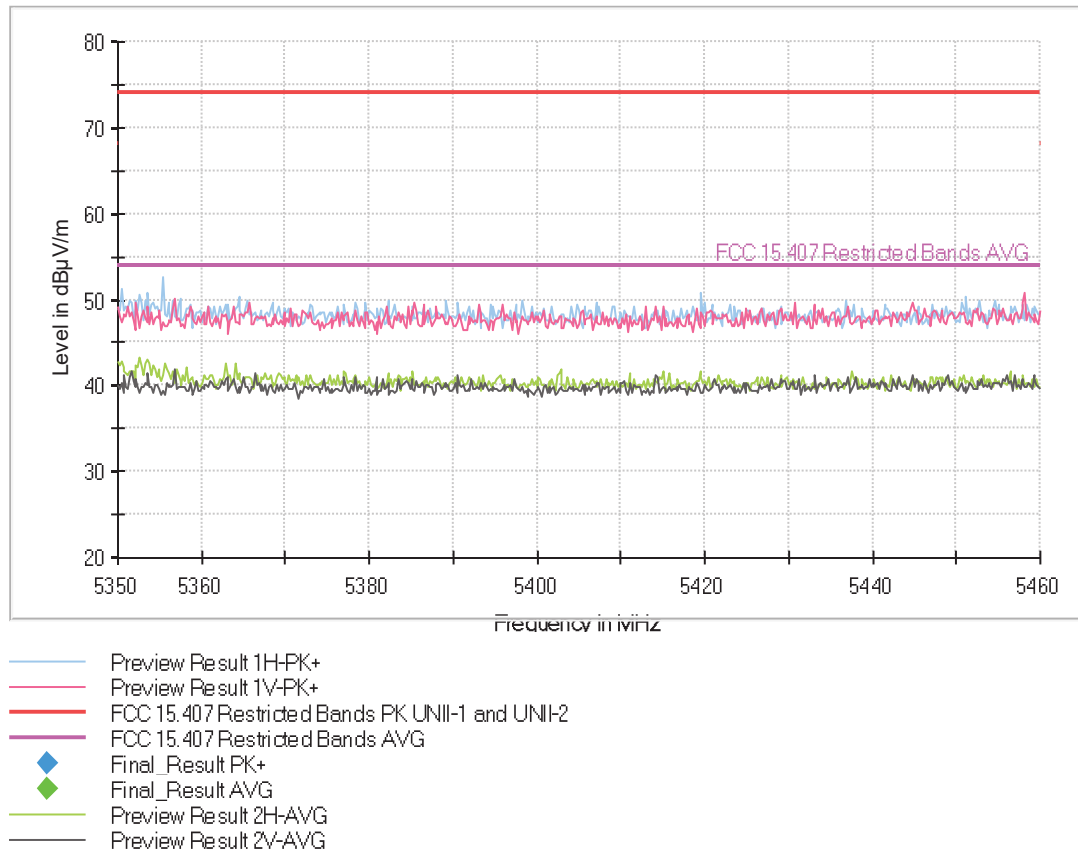
- Lower Band Edge Channel 42 (4500 to 5150 MHz)



- Preview Result 1H-PK+
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final Result PK+
- Final Result AVG
- Preview Result 2H-AVG
- Preview Result 2V-AVG

Radiated spurious emissions at band-edges and inside adjacent band 5.35 - 5.46 GHz

- Upper Band Edge Channel 42 (5350 to 5460 MHz)



Appendix C: Test results for the U-NII-3 Band 5.725 – 5.85 GHz