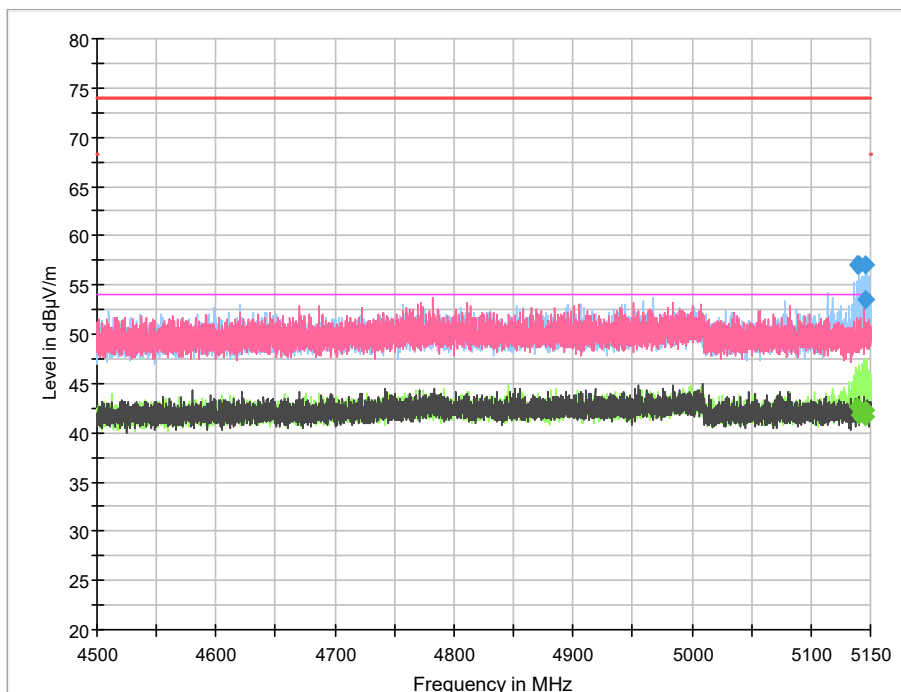
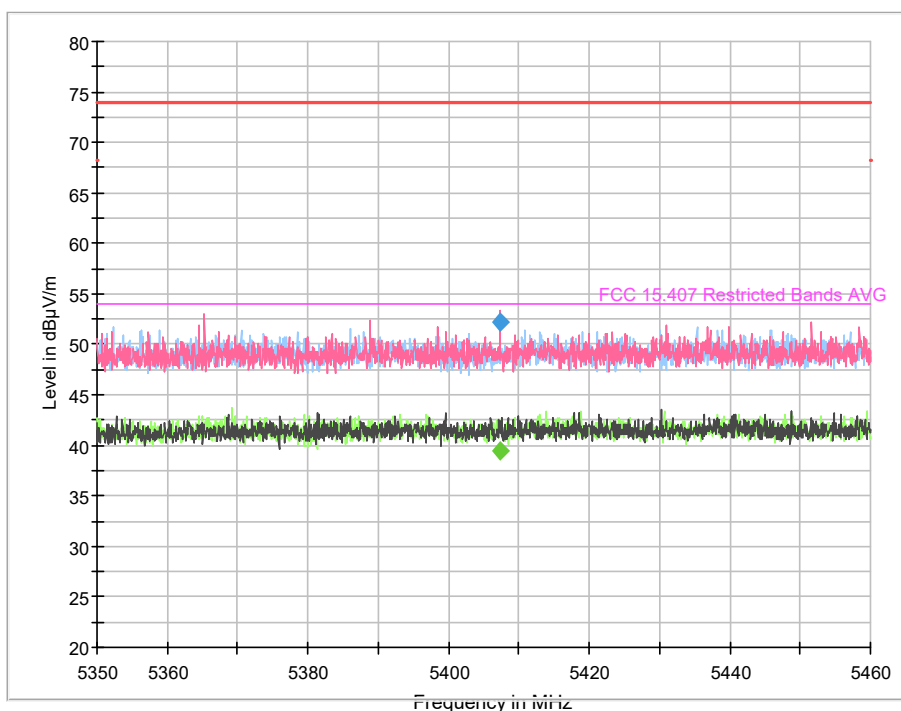


- 802.11 ac80:

- Lower Band Edge Channel 42 (Restricted Band 4.50-5.15 GHz)



- Upper Band Edge Channel 42 (Restricted Band 5.35-5.46 GHz)



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

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TEST CONDITIONS

(*) Data provided by the Applicant

POWER SUPPLY:

Vnominal: 13.2 Vdc.
 Type of Power Supply (*): DC External (Car Battery).

ANTENNA:

Type of Antenna: External.
 Maximum Declared Antenna Gain (*): -2.8 dBi

TEST FREQUENCIES:

Technology Tested:	WLAN (IEEE 802.11 a/n/ac): U-NII-3 band	
Modes:	802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps	
	802.11n HT20: MCS0 to MCS7	
	802.11n HT40: MCS0 to MCS7	
	802.11ac VHT20: MCS0 to MCS8	
	802.11ac VHT40: MCS0 to MCS9	
	802.11ac VHT80: MCS0 to MCS9	
Setting of cores / ports:	One port.	
Beamforming:	No	
Frequency Range:	5725 MHz to 5850 MHz	
Channel Bandwidth:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 149	5745
	Middle: 157	5785
	High: 165	5825
Channel Bandwidth:	40 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 151	5755
	High: 159	5795
Channel Bandwidth:	80 MHz	
Transmit Channels	Middle: 155	5775

The test set-up was made in accordance with the general provisions of FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuously transmitting with a modulated carrier at maximum power on all required channels using the supported data rates/modulations types.

For all modes, the EUT was configured in test mode using a software application. The application was used to enable a continuous transmission and to select the test channels as required. The client supplied instructions to configure the EUT. The customer supplied a document containing the setup instructions.

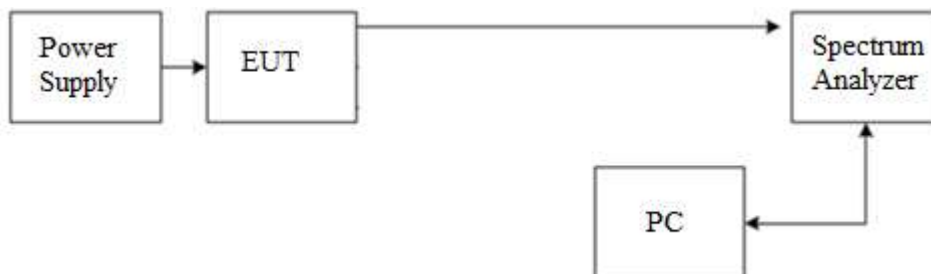
The worst cases for testing were identified based on output power and spurious levels at the band edges. Preliminary testing determined the following data rates as the worst-case modes:

802.11 a20:	6 Mbps
802.11 n HT20:	MCS0
802.11 n HT40:	MCS0
802.11 ac VHT20:	MCS0
802.11 ac VHT40:	MCS0
802.11 ac VHT80:	MCS0

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and connected to a spectrum analyzer using a low-loss RF cable. The reading in the spectrum analyzer is corrected taking into account the internal and external RF cable loss.

For all modes:



The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range from 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and a distance of 1.5m for the frequency range 17 GHz-40 GHz (18 GHz-40 GHz horn antenna).

For radiated emissions in the range 17 GHz-40 GHz performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

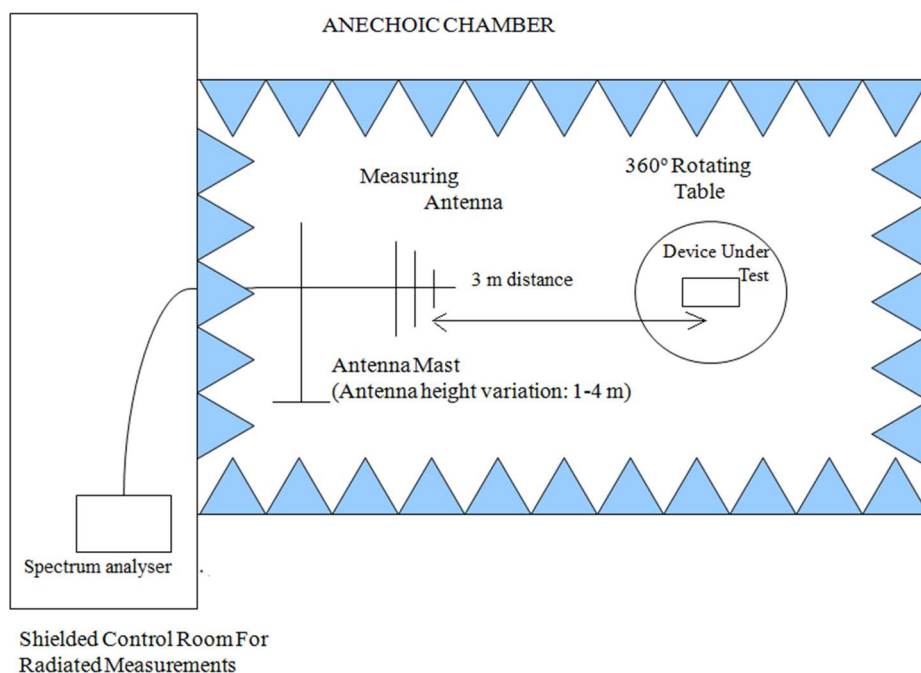
The equipment under test was set up on a non-conductive platform above the ground plane and its situation and orientation were varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

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

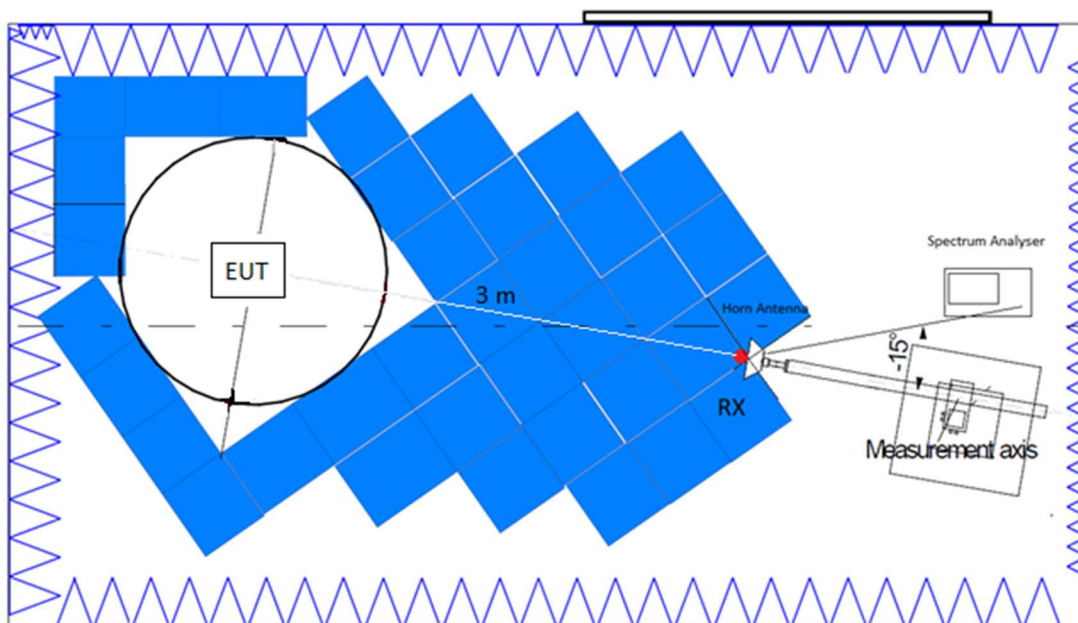
The final measured value, for the given emission, incorporates the calibrated antenna factor and cable loss.

A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

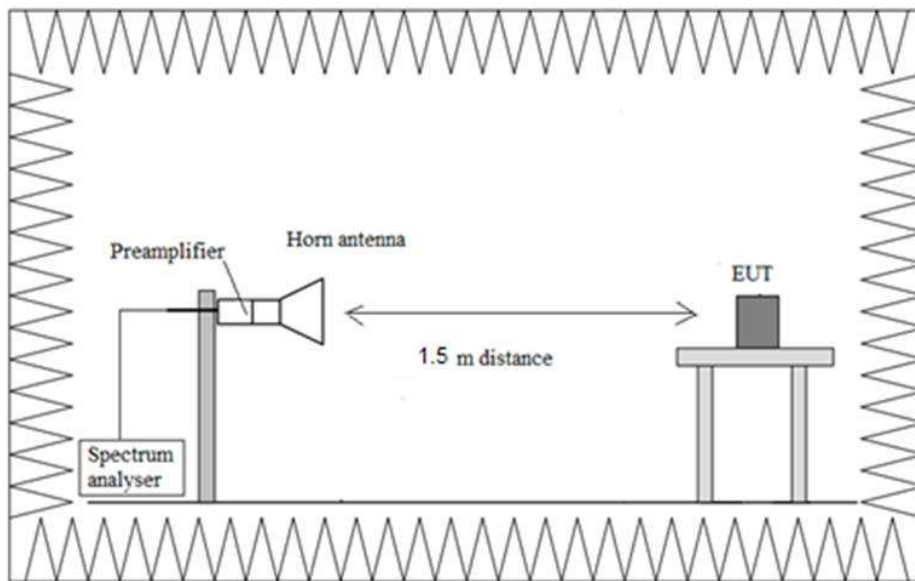
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



FCC 15.247 (e) / RSS-247 6.2.4.1. 6 dB Bandwidth

Limits

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

Results

Mode 802.11 a20:

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	17.15	17.35	17.35

Mode 802.11 n20 (HT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	17.15	17.35	17.35

Mode 802.11 ac20 (VHT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	17.15	17.35	17.35

Mode 802.11 n40 (HT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	35.75	35.75

Mode 802.11 ac40 (VHT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	35.85	35.65

Mode 802.11 ac80 (VHT80):

	Single Channel 155 (5775 MHz)
6 dB bandwidth (MHz)	76.45

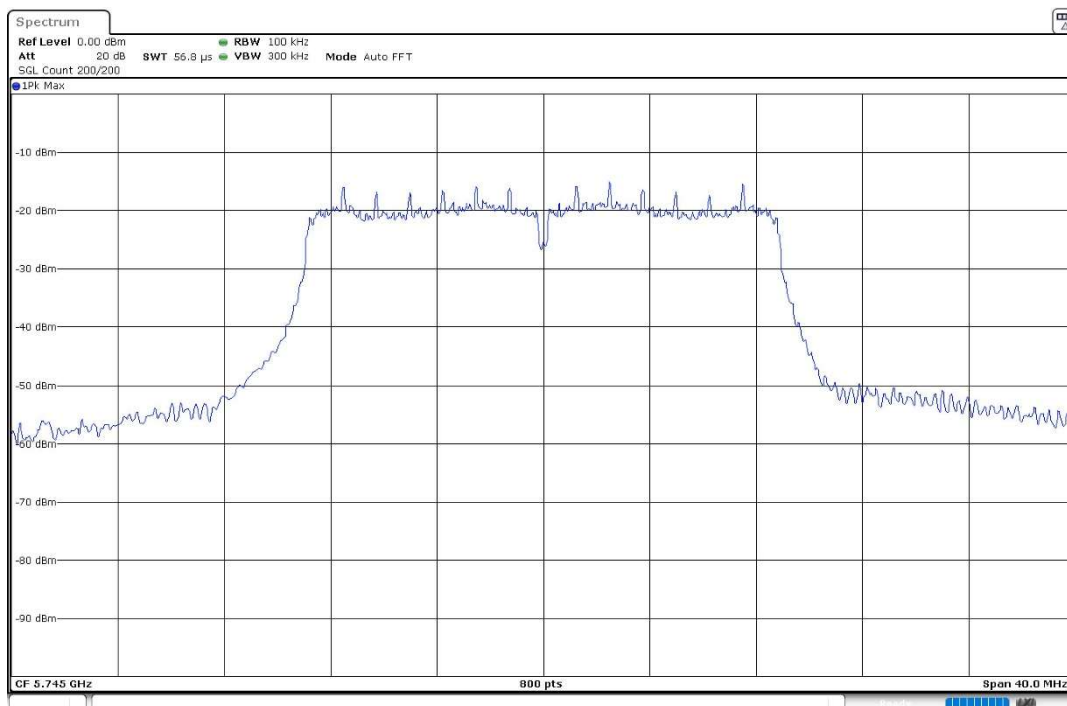
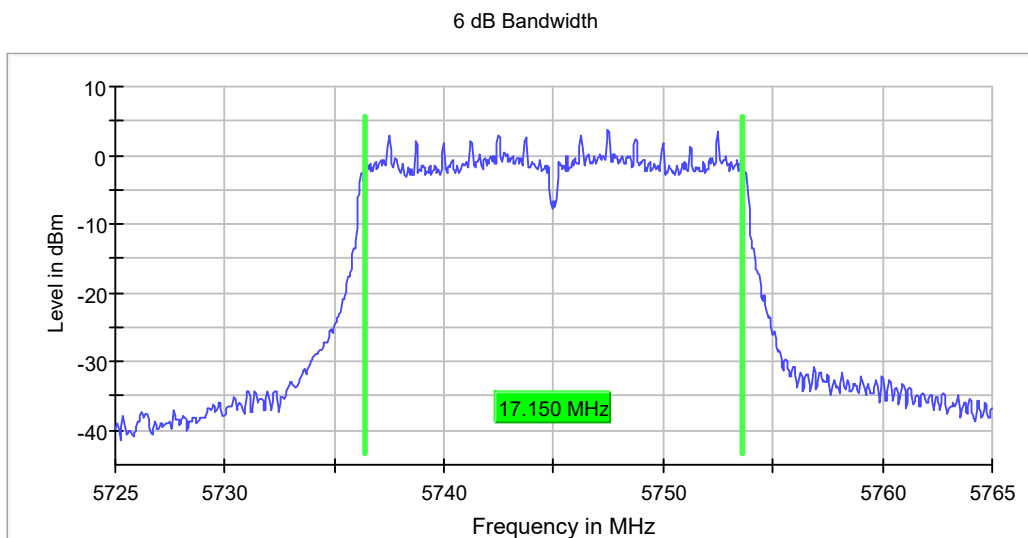
Verdict

Pass

Attachments

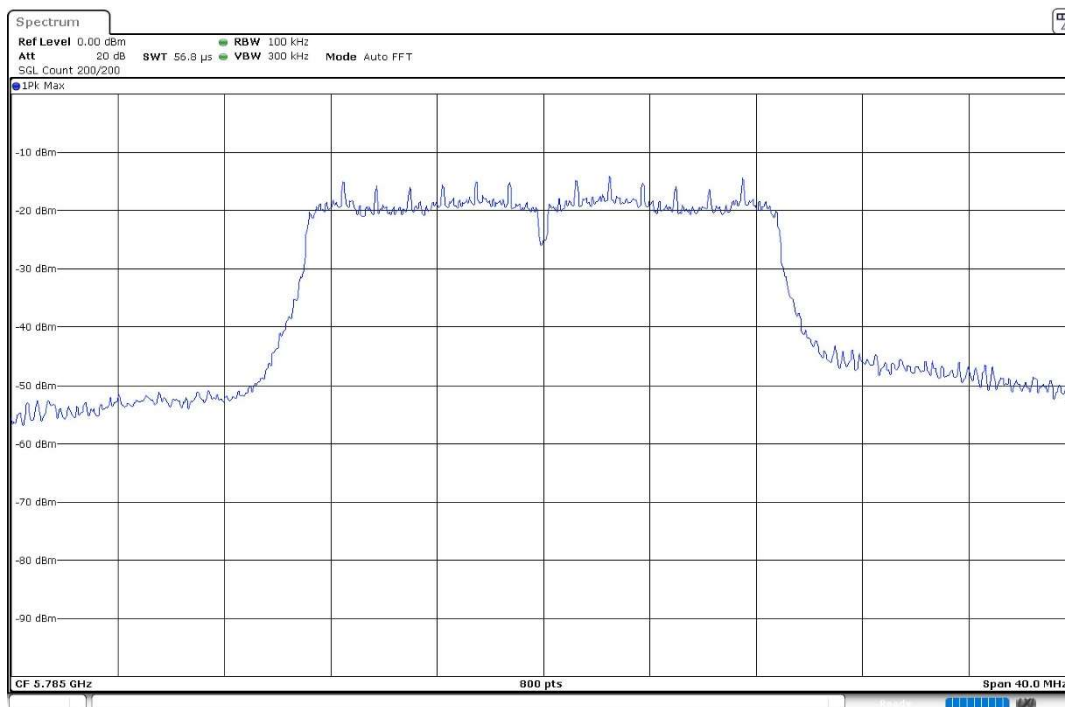
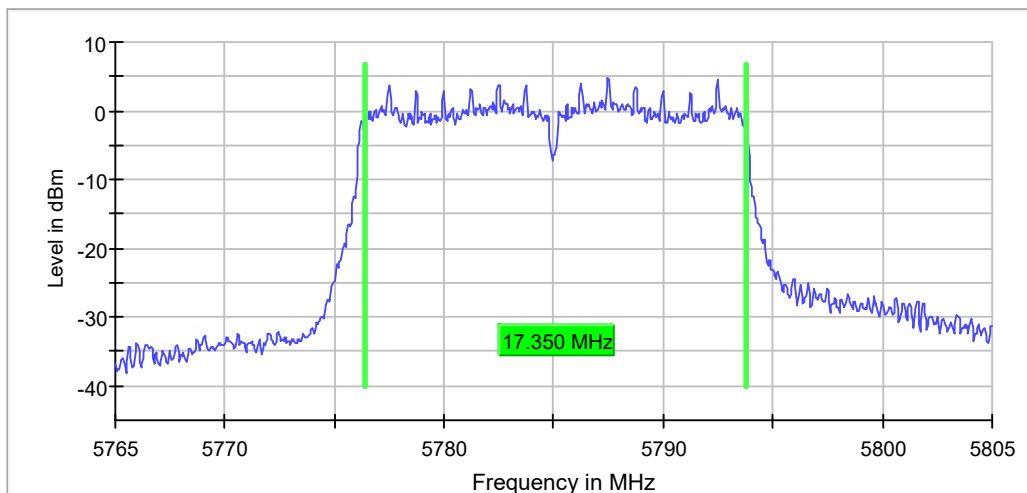
Mode 802.11 a20:

- Low Channel:

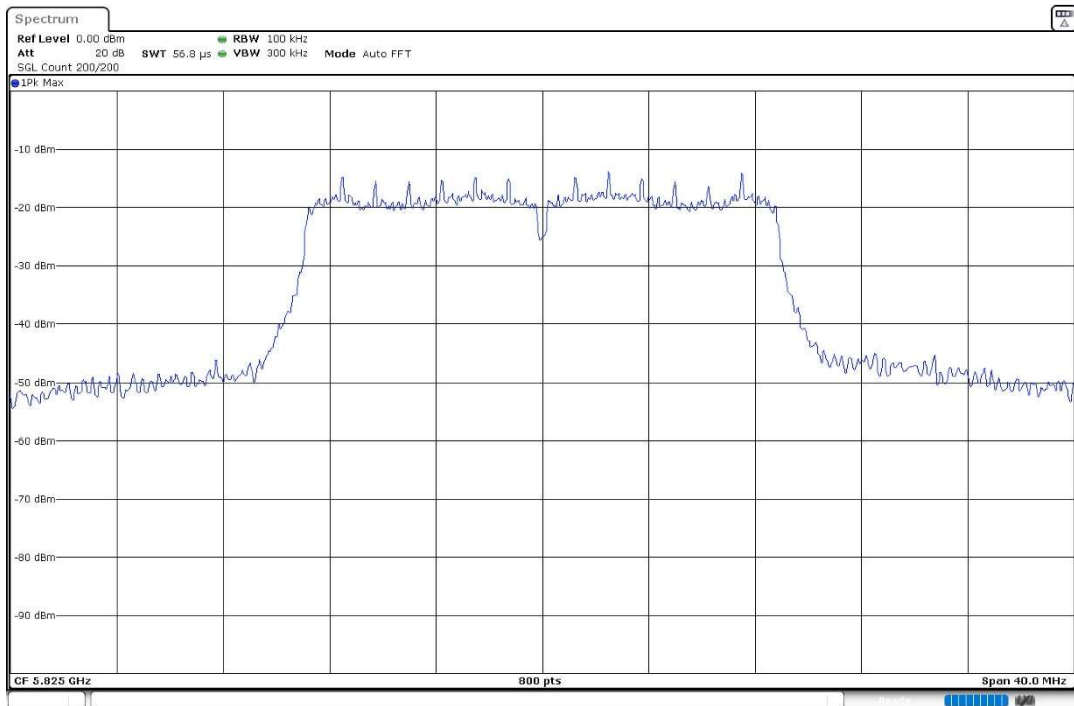
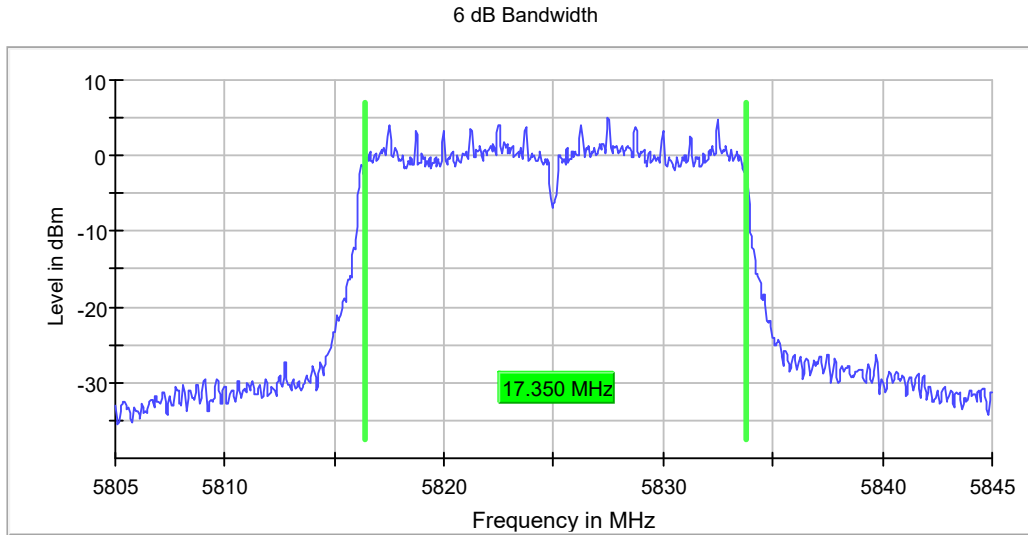


- Middle Channel:

6 dB Bandwidth



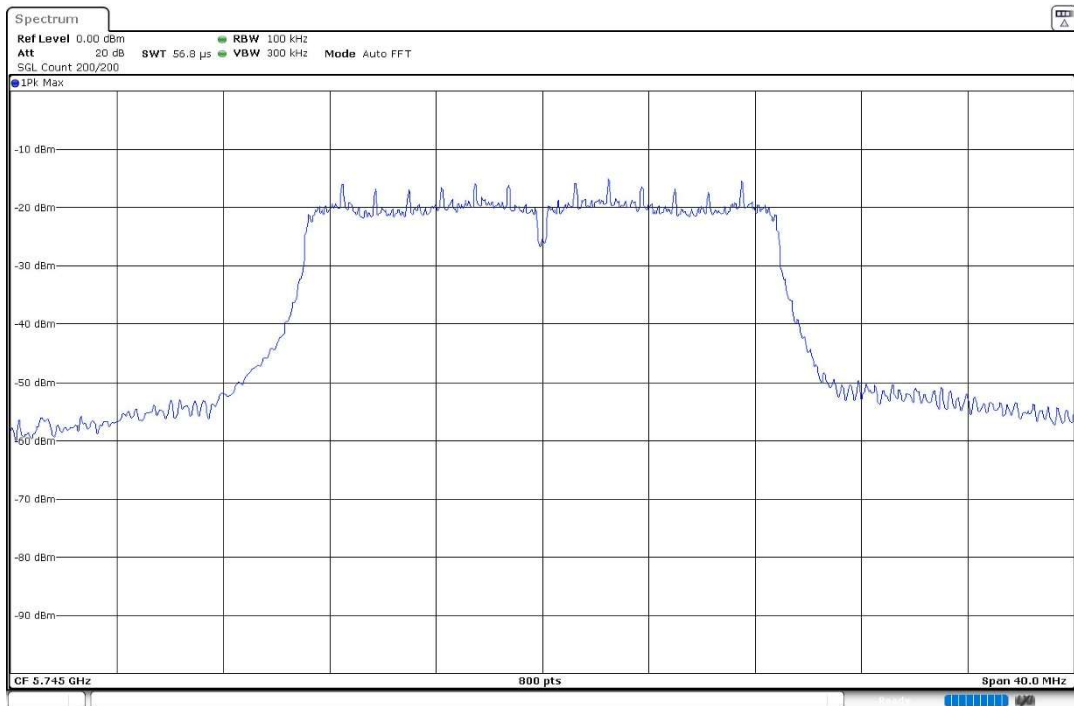
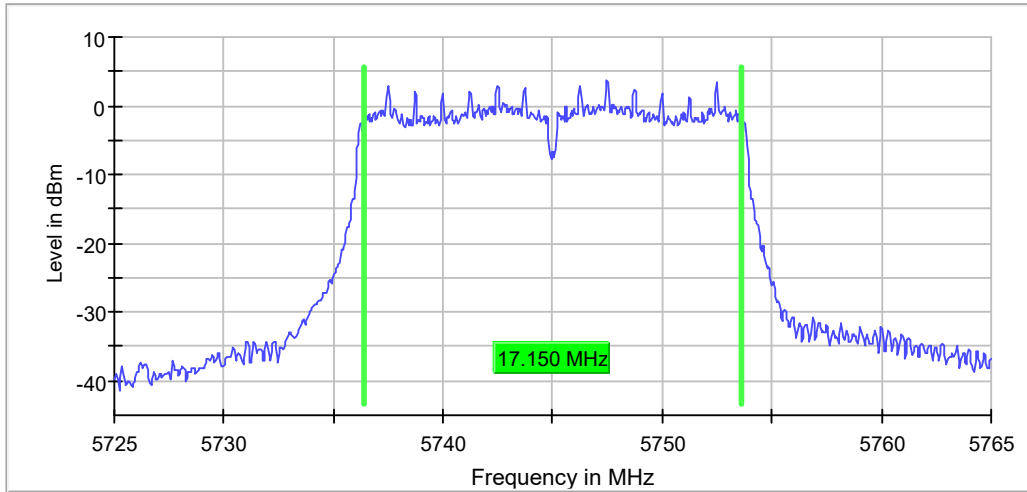
- High Channel:



Mode 802.11 n20 (HT20):

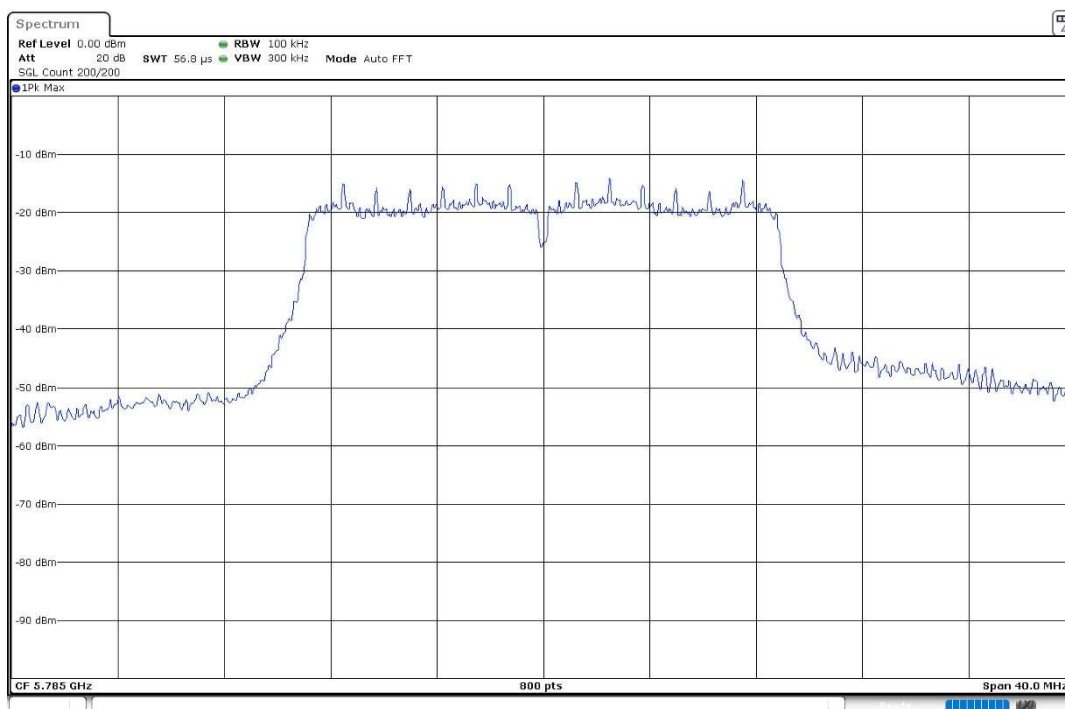
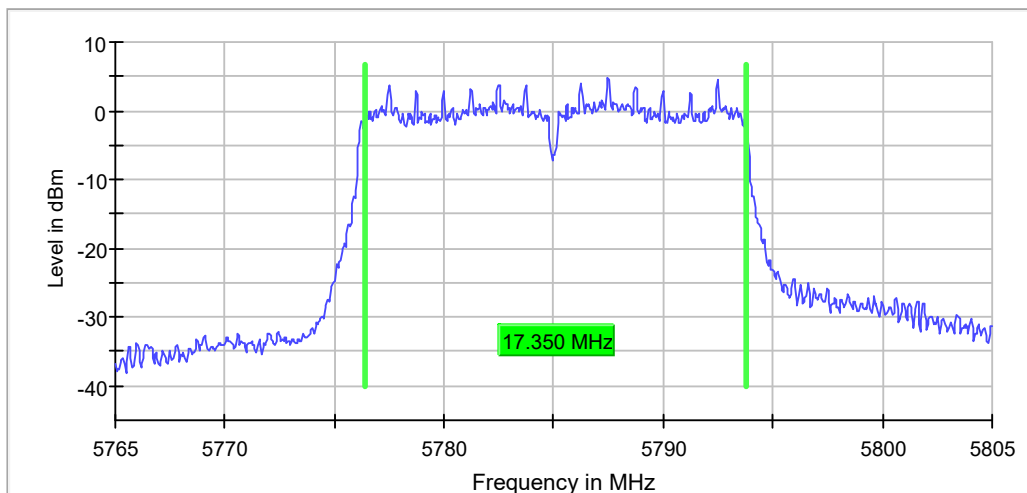
- Low Channel:

6 dB Bandwidth

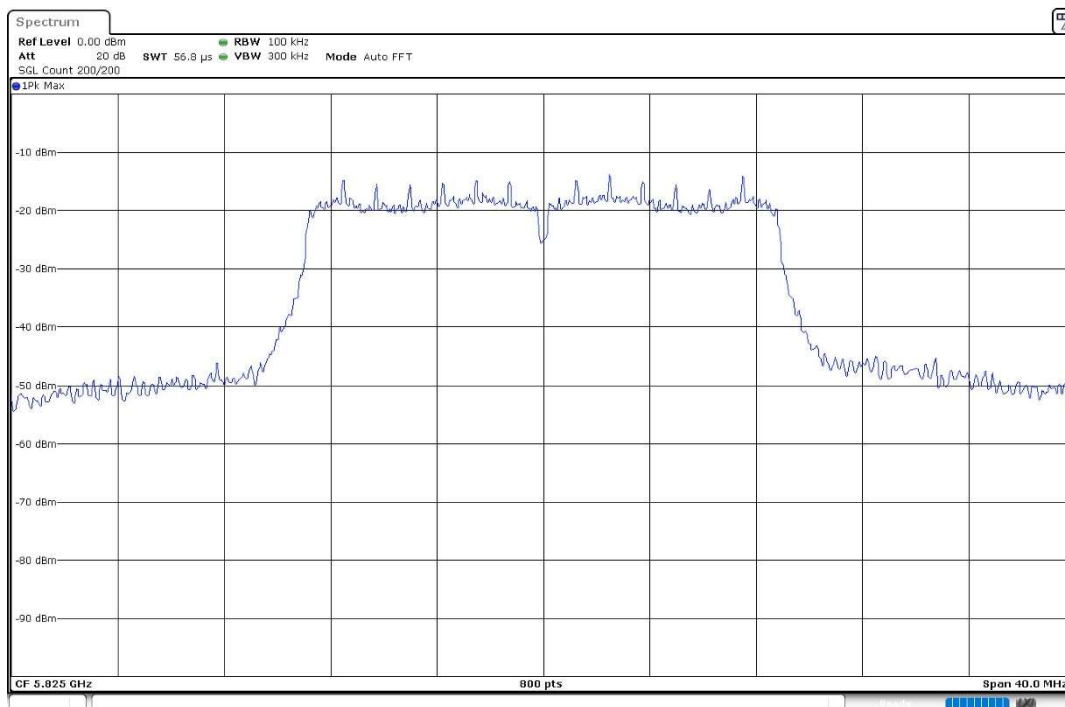
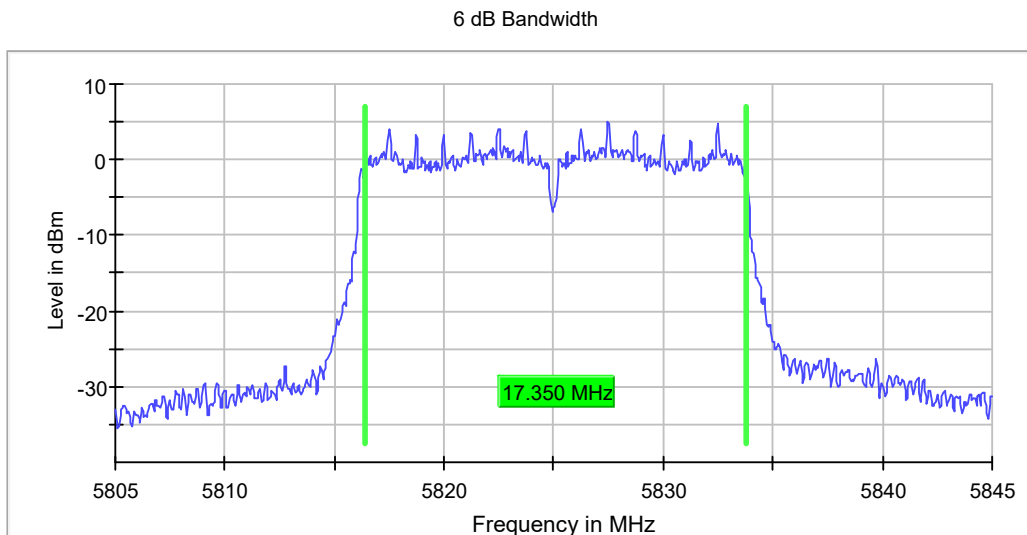


- Middle Channel:

6 dB Bandwidth



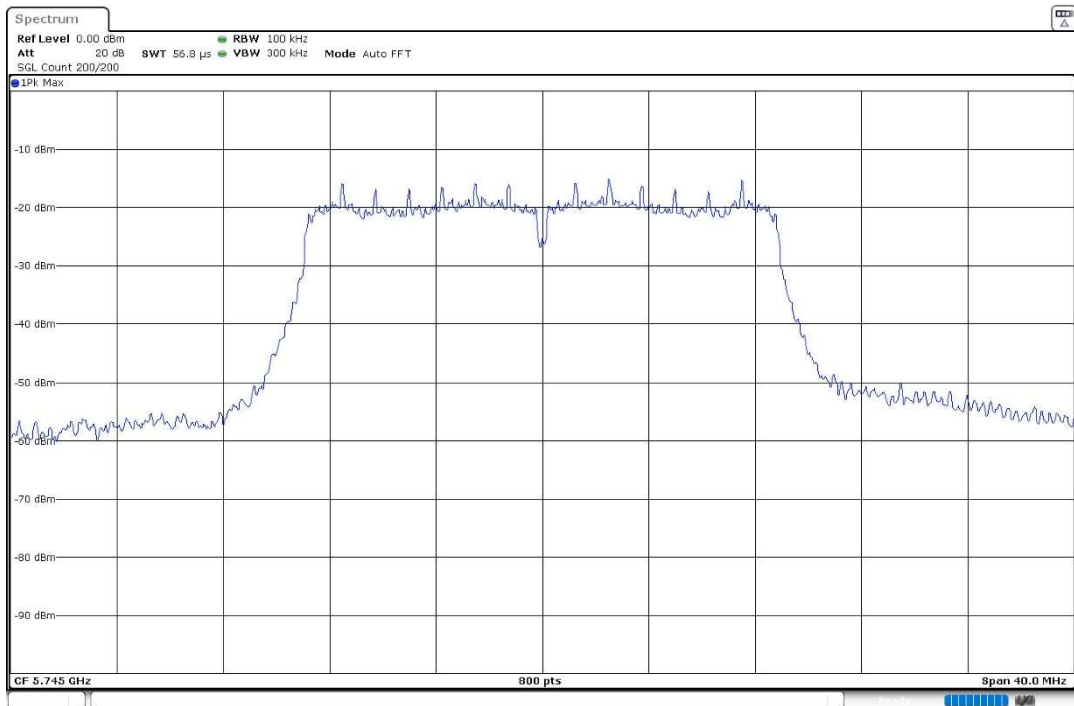
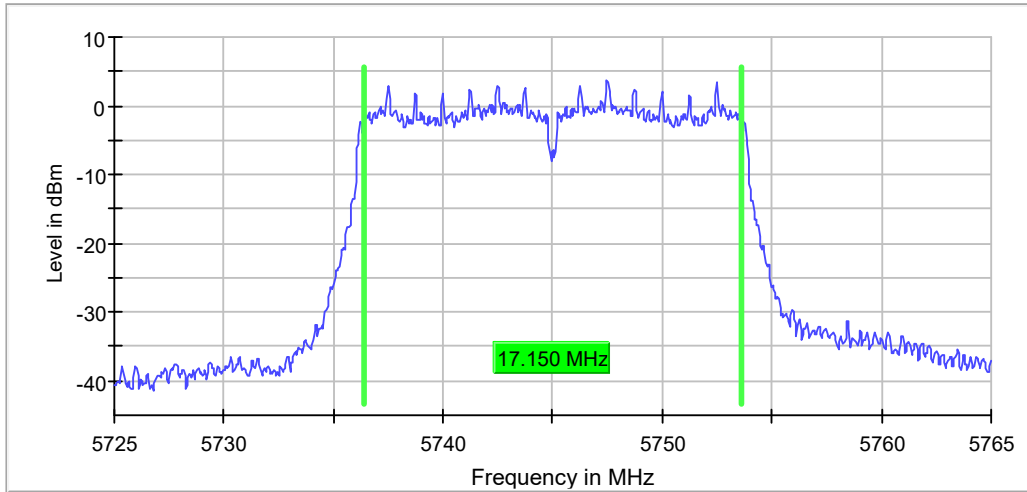
- High Channel:



Mode 802.11 ac20 (VHT20):

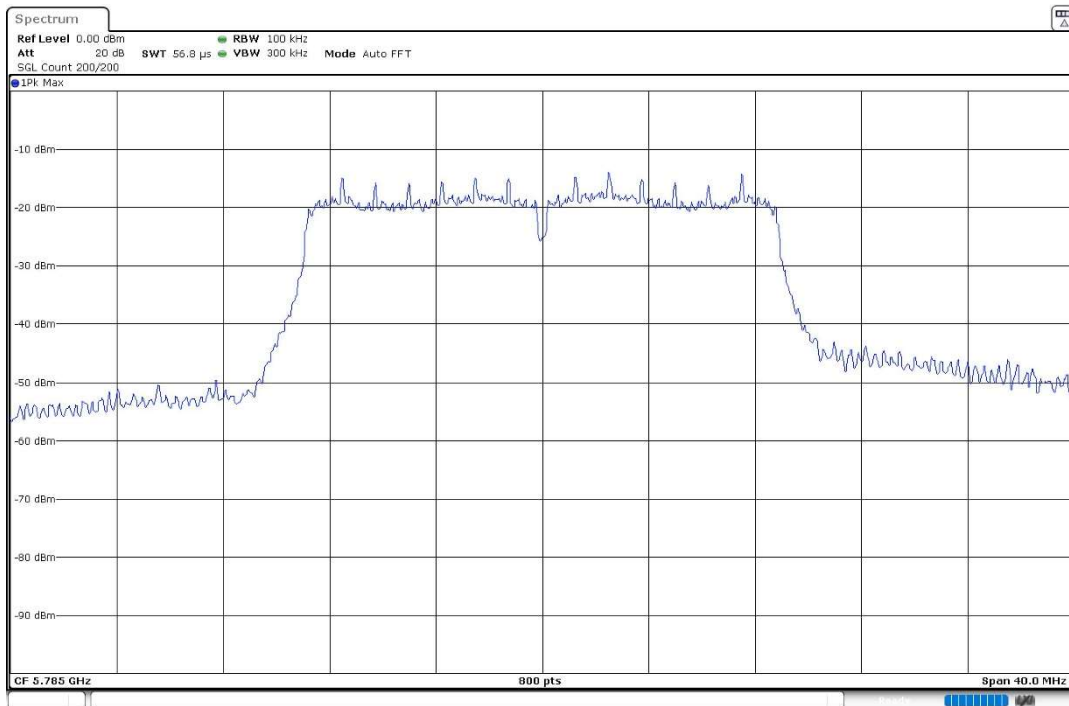
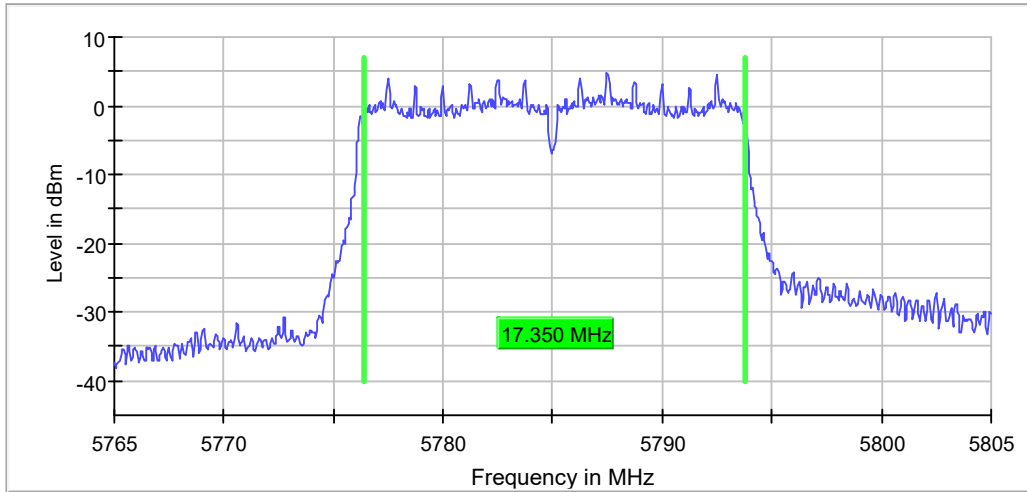
- Low Channel:

6 dB Bandwidth

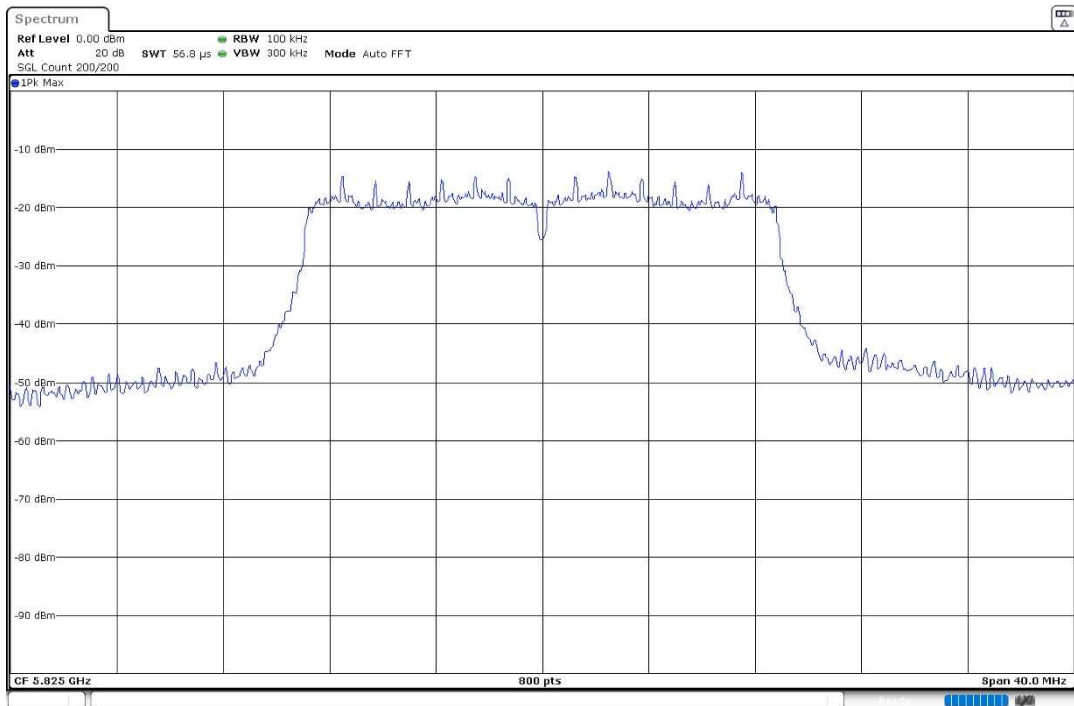
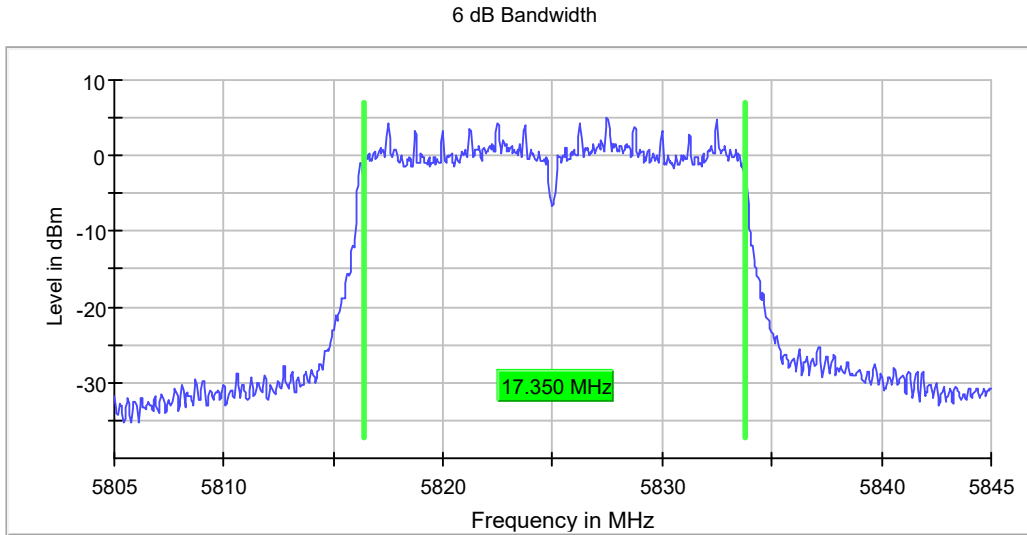


- Middle Channel:

6 dB Bandwidth

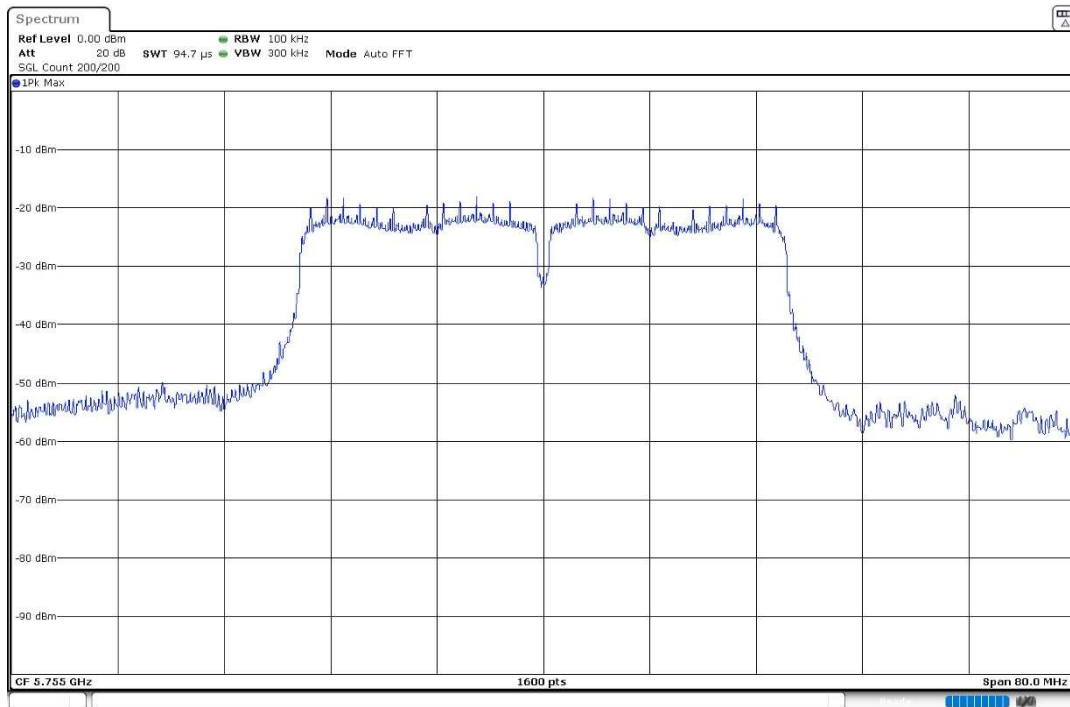
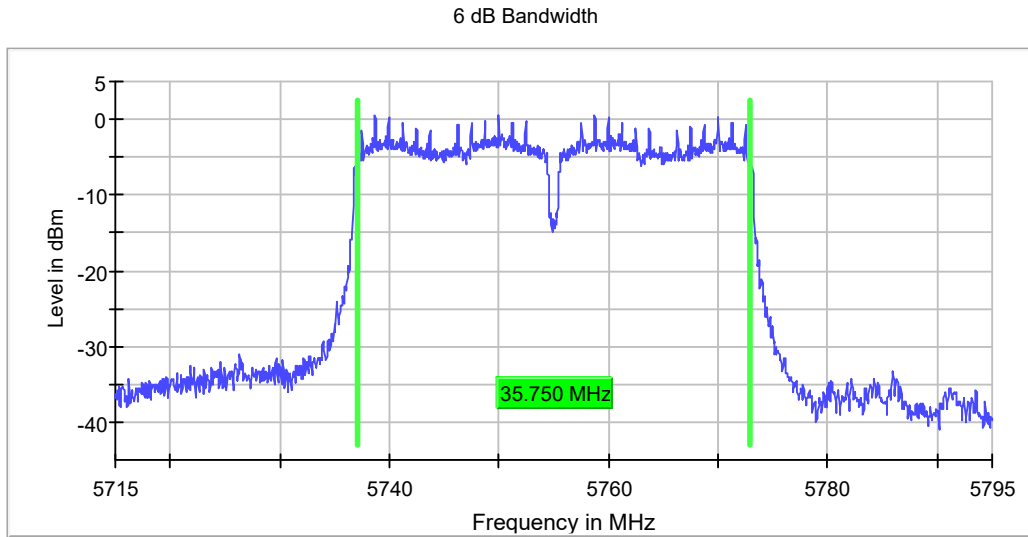


- High Channel:

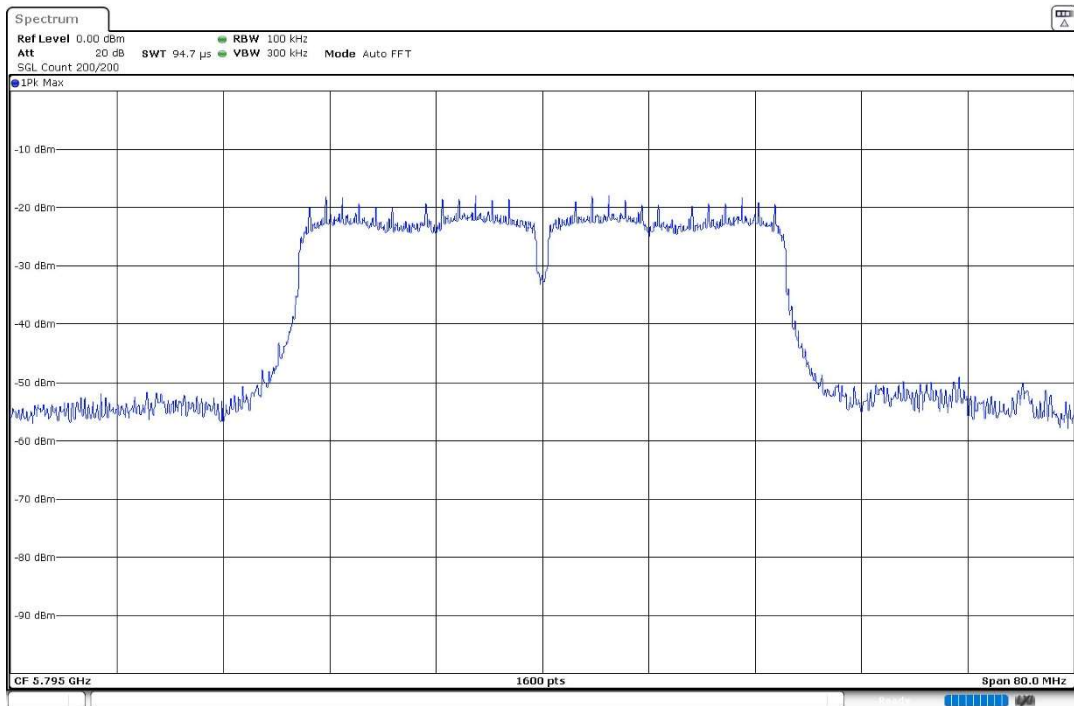
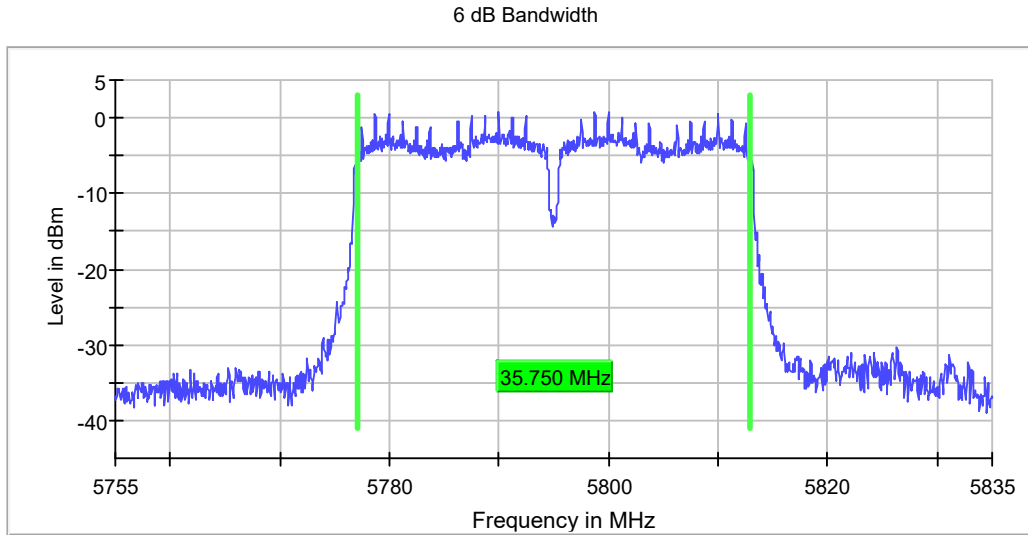


Mode 802.11 n40 (HT40):

- Low Channel:

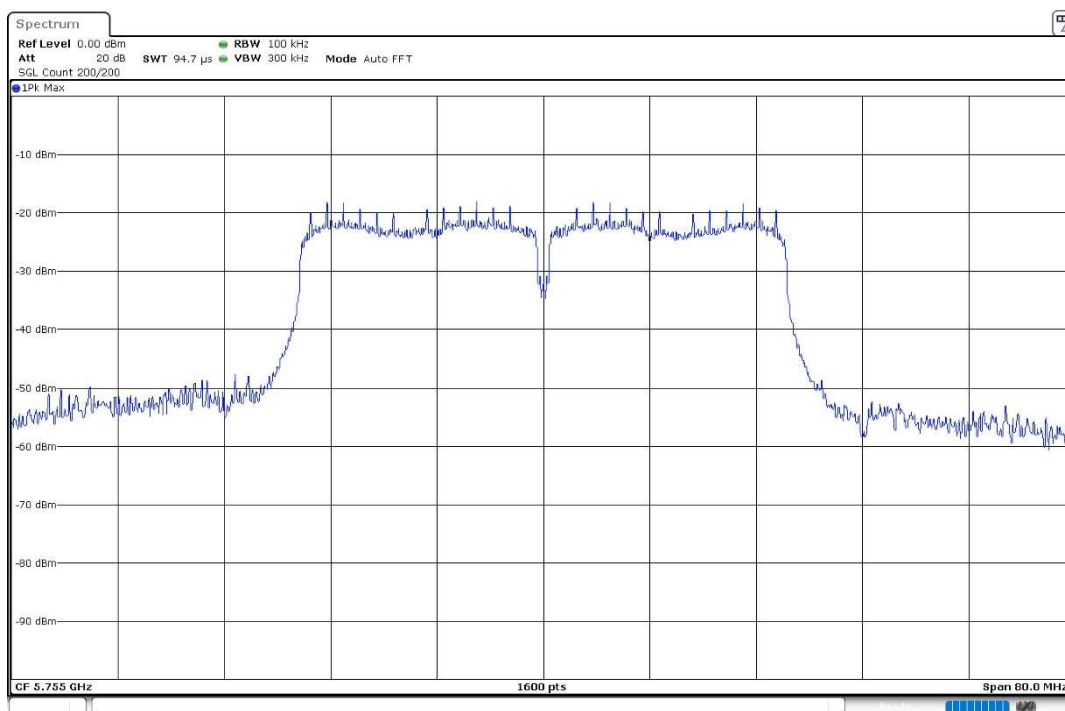
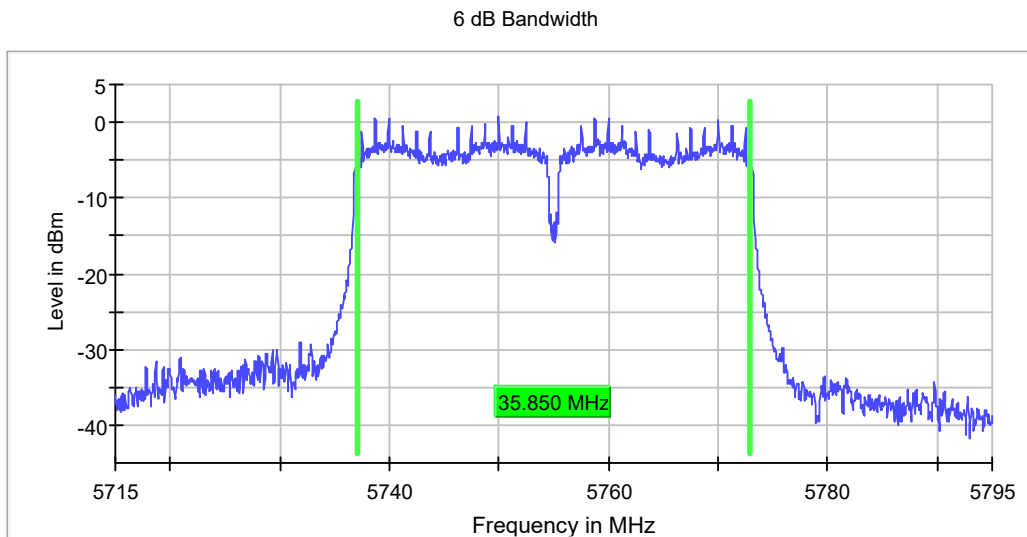


- High Channel:

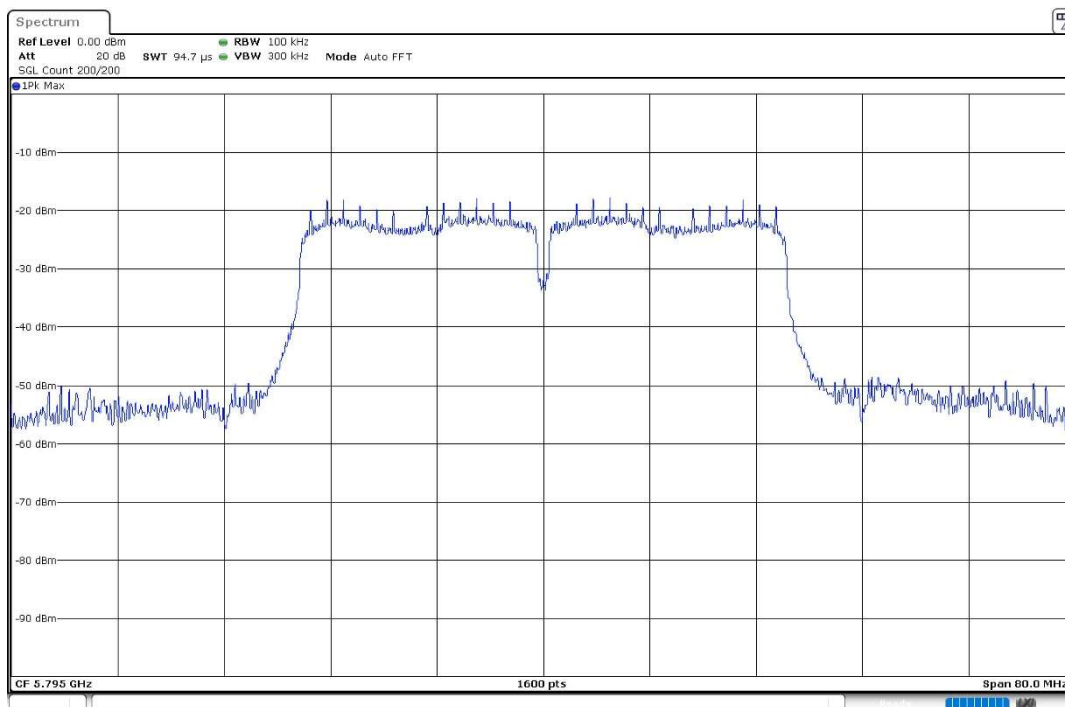
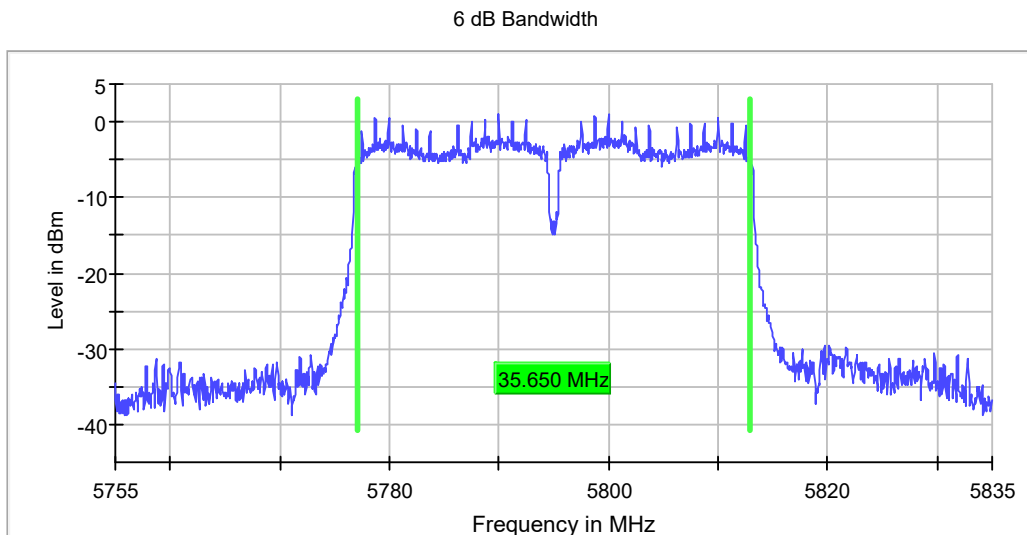


Mode 802.11 ac40 (VHT40):

- Low Channel:

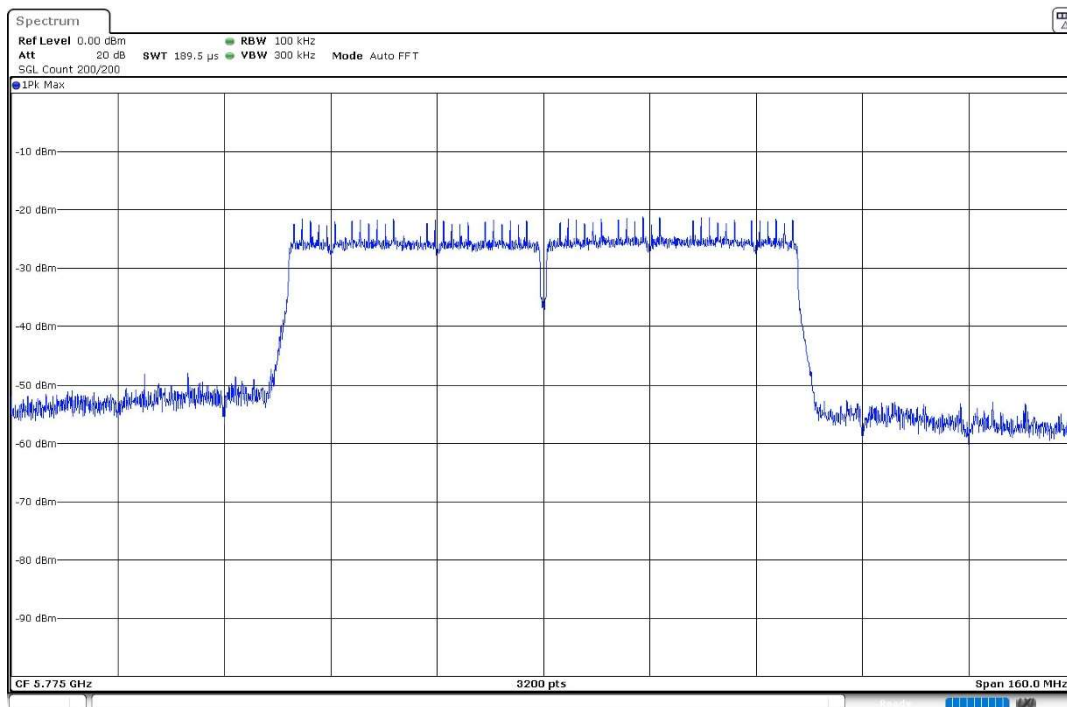
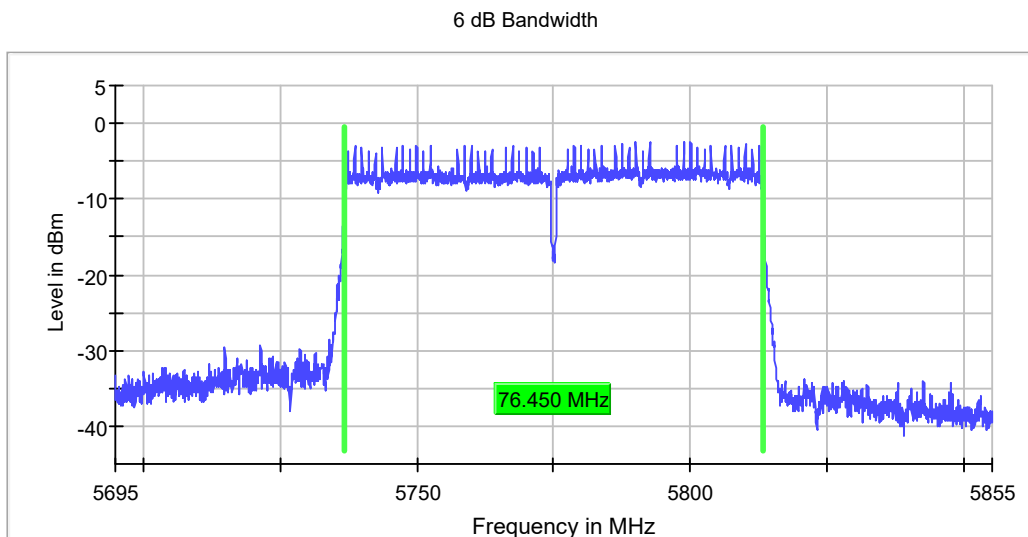


- High Channel:



Mode 802.11 ac80 (VHT80):

- Single Channel:



FCC 15.407 (a)(3) / RSS-247 6.2.4.1. Transmitter Maximum Conducted Output Power

Limits

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1W (30 dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Results

The maximum conducted output power was measured according to ANSI C63.10-2013 clause 11.9.2.3.2 and clause E.3.b) of Guidance 789033 D02 General UNII Test Procedures New Rules v02r01 (Method AVGPM-G). A gated RF average power meter was used; therefore, no duty cycle correction factor is applicable to the measured results.

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 less than 6 dBi.

Maximum Declared Antenna Gain: -2.8 dBi

Mode 802.11 a20:

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Max. Conducted Power (dBm)	14.729	15.451	15.676
Max. Power E.I.R.P (dBm)	11.929	12.651	12.876

Mode 802.11 n20 (HT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Max. Conducted Power (dBm)	14.729	15.451	15.676
Max. Power E.I.R.P (dBm)	11.929	12.651	12.876

Mode 802.11 ac20 (VHT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Max. Conducted Power (dBm)	14.802	15.529	15.803
Max. Power E.I.R.P (dBm)	12.002	12.729	13.003

Mode 802.11 n40 (HT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Max. Conducted Power (dBm)	14.570	14.632
Max. Power E.I.R.P (dBm)	11.770	11.832

Mode 802.11 ac40 (VHT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Max. Conducted Power (dBm)	14.566	14.667
Max. Power E.I.R.P (dBm)	11.766	11.867

Mode 802.11 ac80 (VHT80):

	Single Channel 155 (5775 MHz)
Max. Conducted Power (dBm)	14.670
Max. Power E.I.R.P (dBm)	11.870

Verdict

Pass

FCC 15.407 (a)(3) / RSS-247 6.2.4.1. Transmitter Maximum Power Spectral Density

Limits

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.

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.

An average of 100 traces was performed using rms detector. The maximum PSD is determined by using the peak marker function to find the maximum amplitude level. For the modes with an associated duty cycle < 98 % the applicable duty cycle correction factor is added to the measured PSD value in order to compute the PSD during the actual transmission times.

Both the measured and the corrected PSD values are reported in the tables below.

For all modes of operation, the antenna gain is lower than 6 dBi. Therefore no reduction is applicable to the measured results.

Maximum Declared Antenna Gain: -2.8 dBi

Mode 802.11 a20:

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Average PSD (dBm/500 KHz)	-0.086	0.926	1.205
Duty Cycle Correction Factor (dB)	0.10		
Maximum Average PSD Corrected (dBm/500 KHz)	0.014	1.026	1.305

Mode 802.11 n20 (HT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Average PSD (dBm/500 KHz)	-0.086	0.926	1.205
Duty Cycle Correction Factor (dB)	0.12		
Maximum Average PSD Corrected (dBm/500 KHz)	0.034	1.046	1.325

Mode 802.11 ac20 (VHT20):

	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Average PSD (dBm/500 KHz)	-0.063	1.049	1.312
Duty Cycle Correction Factor (dB)	N/A		
Maximum Average PSD Corrected (dBm/500 KHz)	N/A	N/A	N/A

Mode 802.11 n40 (HT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Average PSD (dBm/500 KHz)	-3.049	-2.798
Duty Cycle Correction Factor (dB)	0.25	
Maximum Average PSD Corrected (dBm/500 KHz)	-2.799	-2.548

Mode 802.11 ac40 (VHT40):

	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Average PSD (dBm/500 KHz)	-3.000	-2.559
Duty Cycle Correction Factor (dB)	0.24	
Maximum Average PSD Corrected (dBm/500 KHz)	-2.760	-2.319

Mode 802.11 ac80 (VHT80):

	Single Channel 42 (5775 MHz)
Maximum Average PSD (dBm/500 KHz)	-6.097
Duty Cycle Correction Factor (dB)	0.21
Maximum Average PSD Corrected (dBm/500 KHz)	-5.887

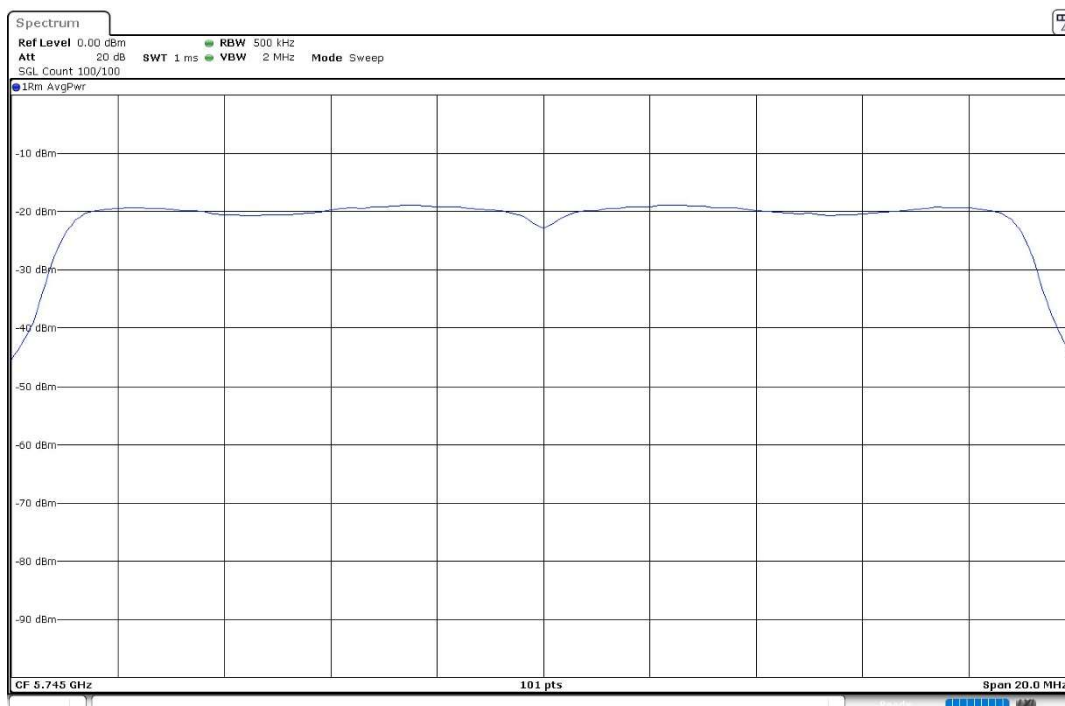
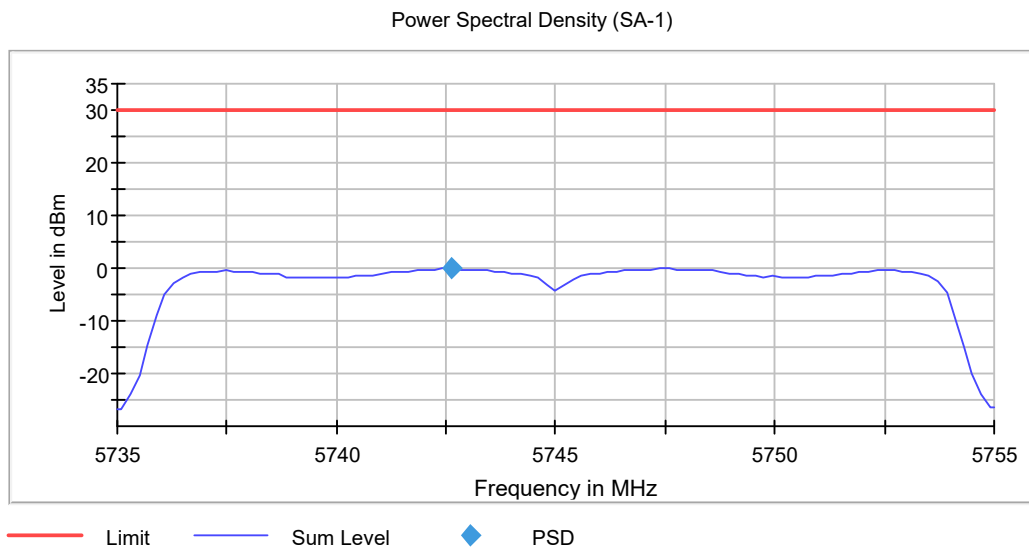
Verdict

Pass

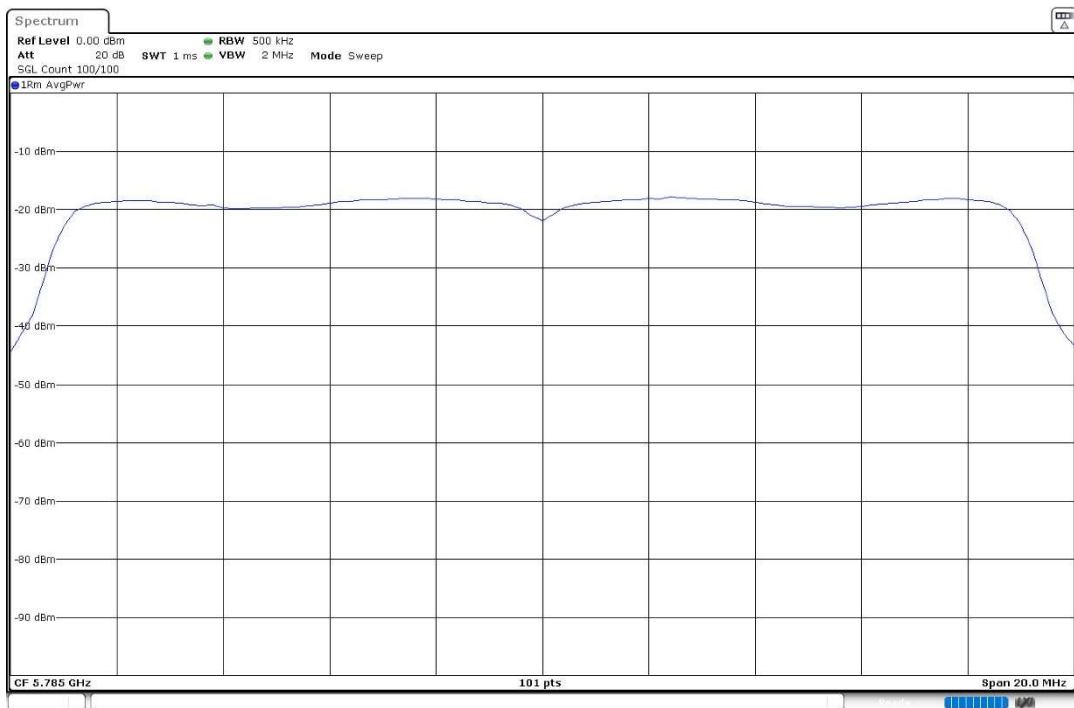
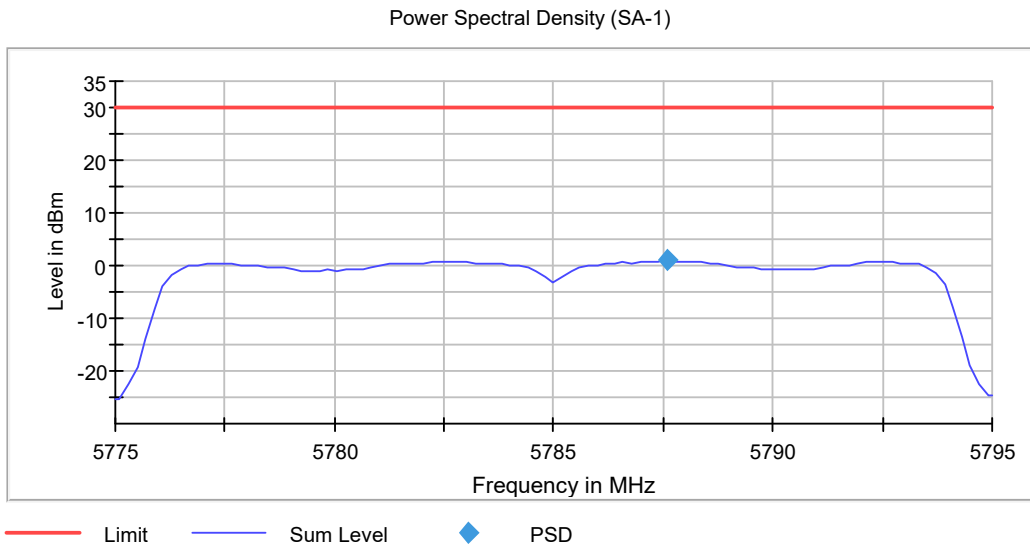
Attachments

Mode 802.11 a20:

- Low Channel:

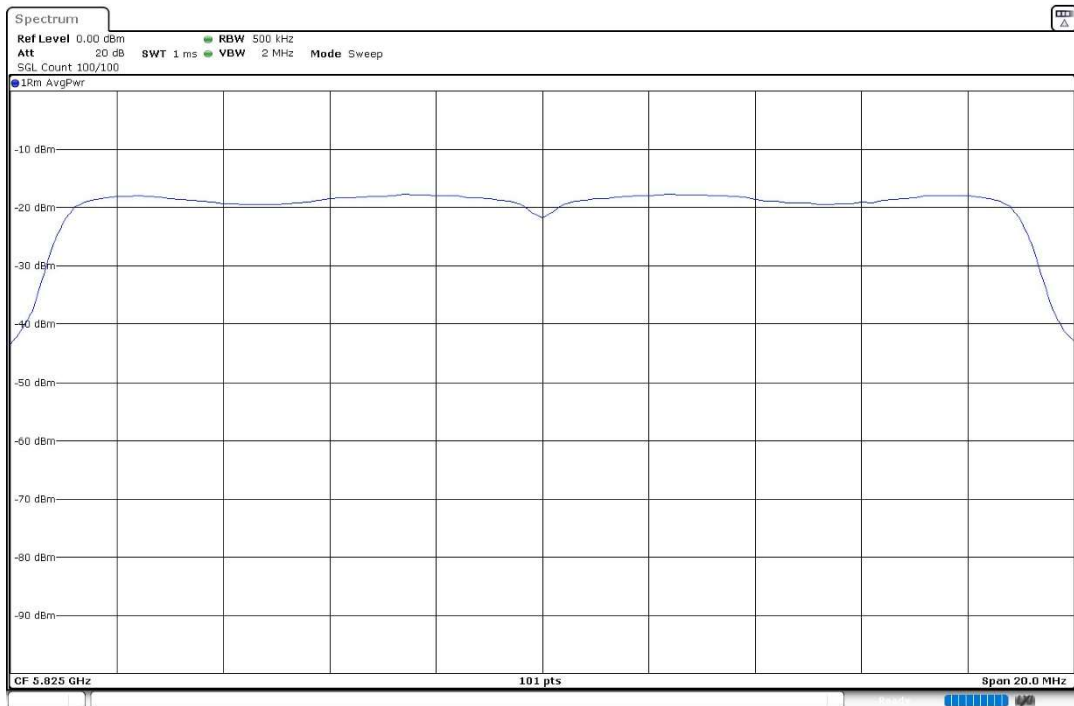
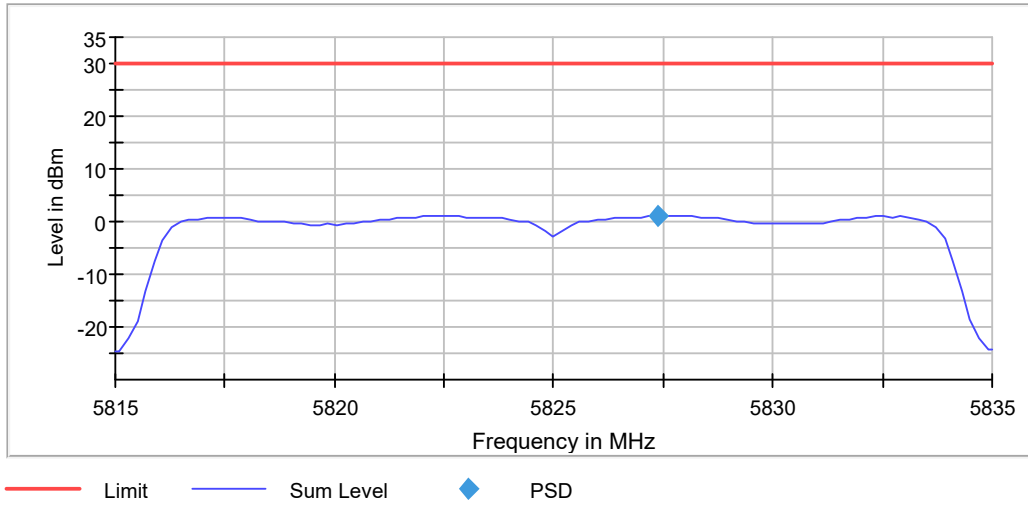


- Middle Channel:



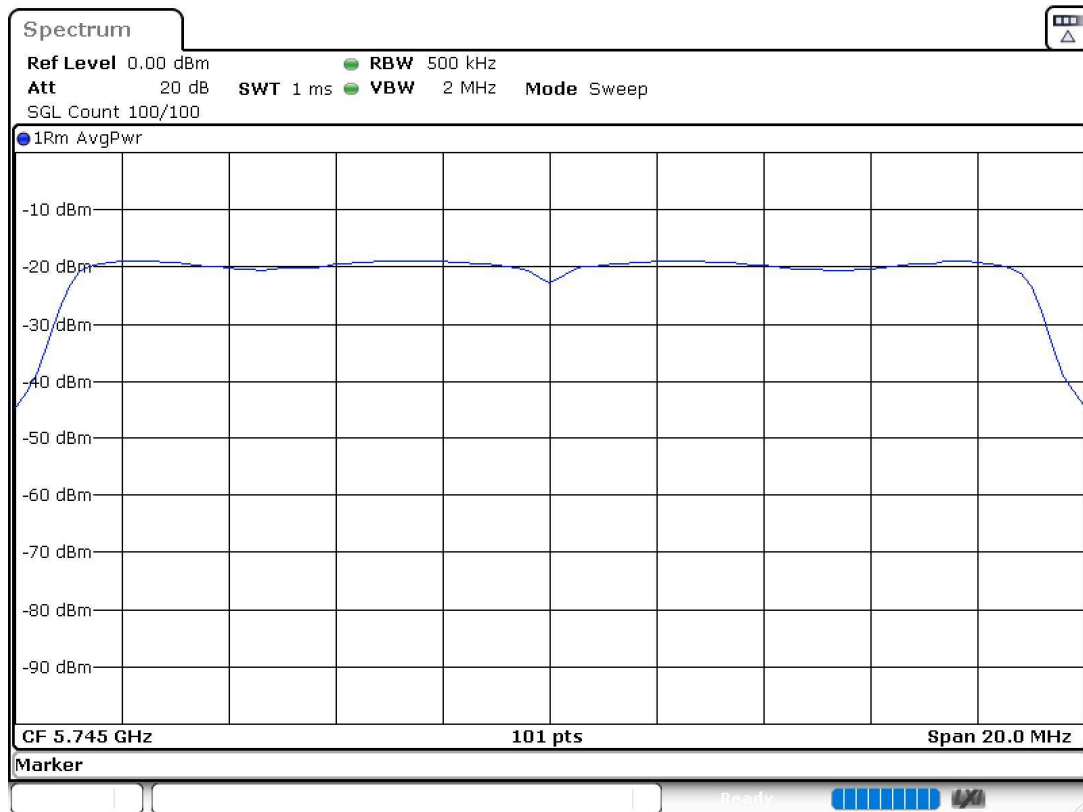
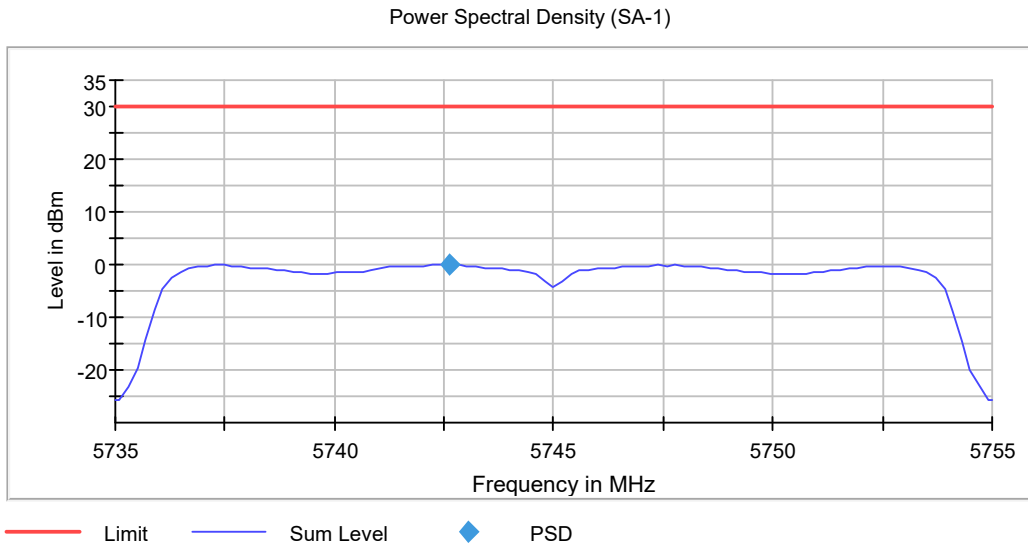
- High Channel:

Power Spectral Density (SA-1)



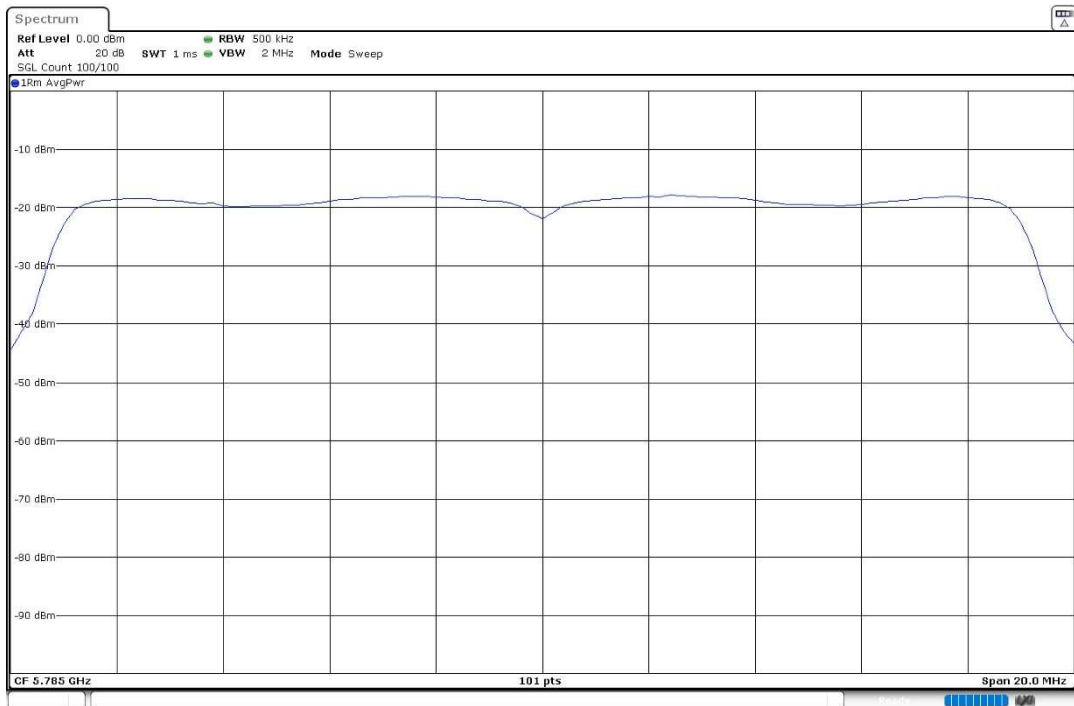
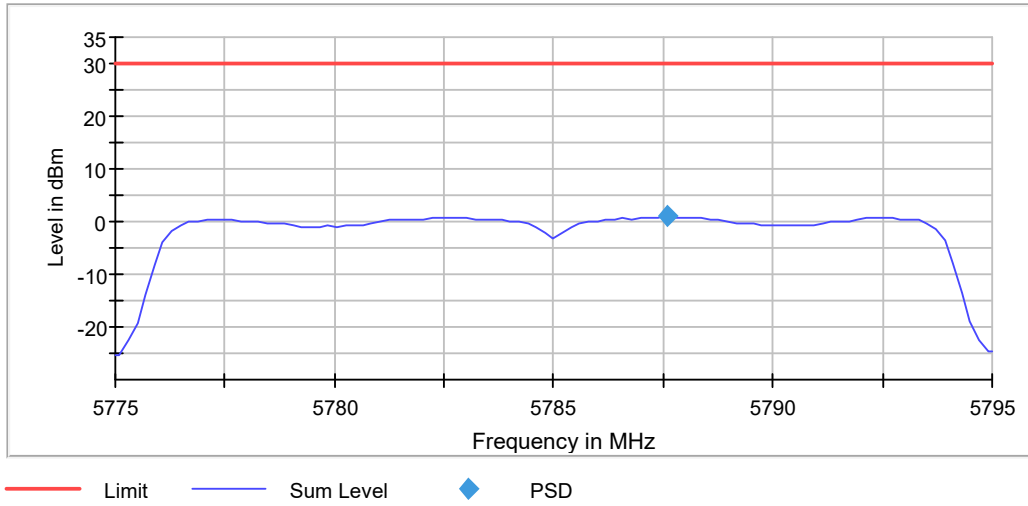
Mode 802.11 n20 (HT20):

- Low Channel:



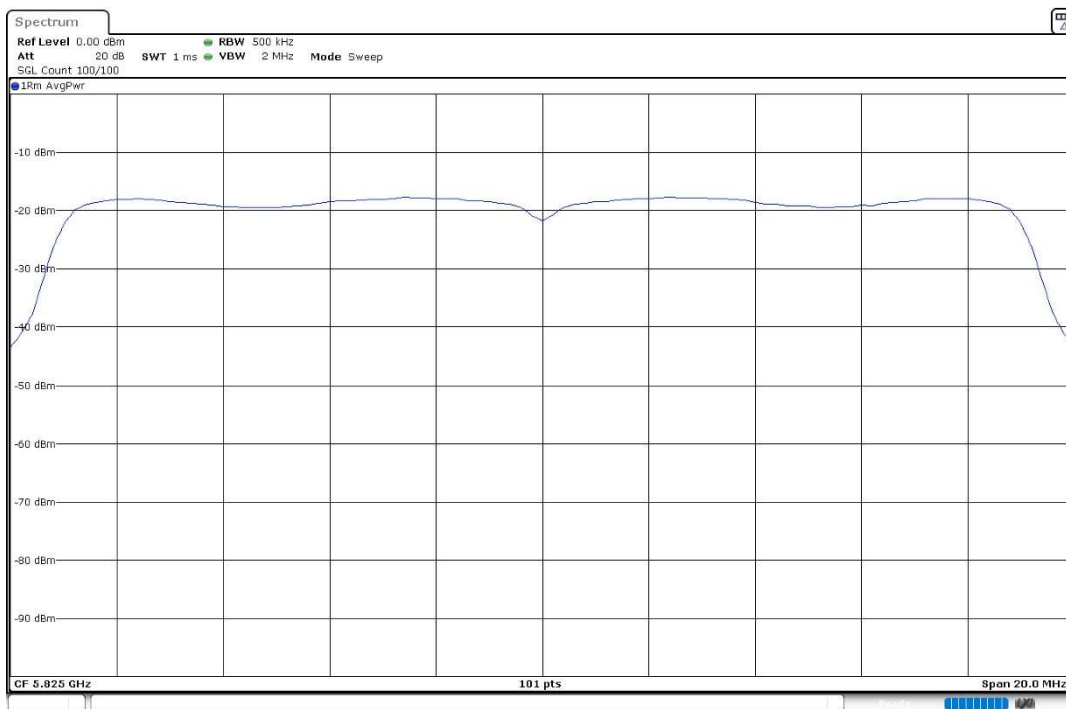
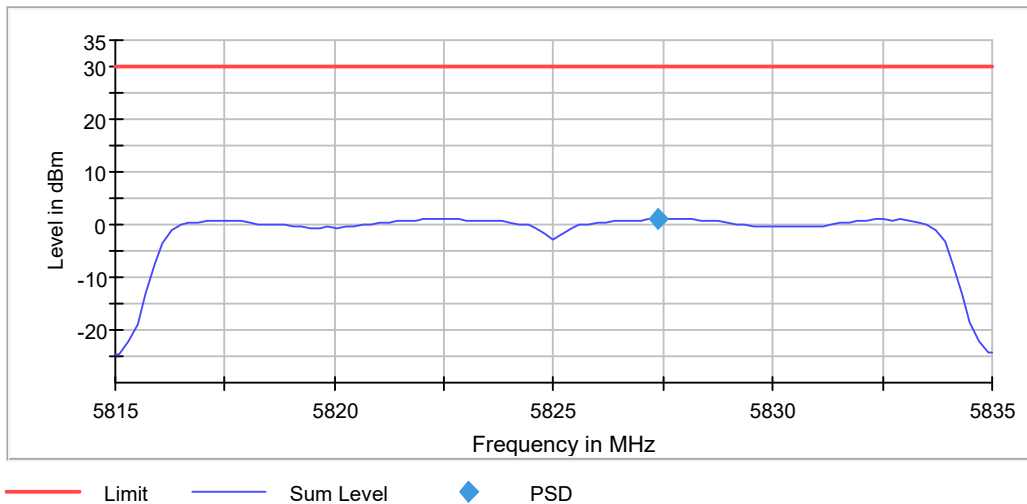
- Middle Channel:

Power Spectral Density (SA-1)



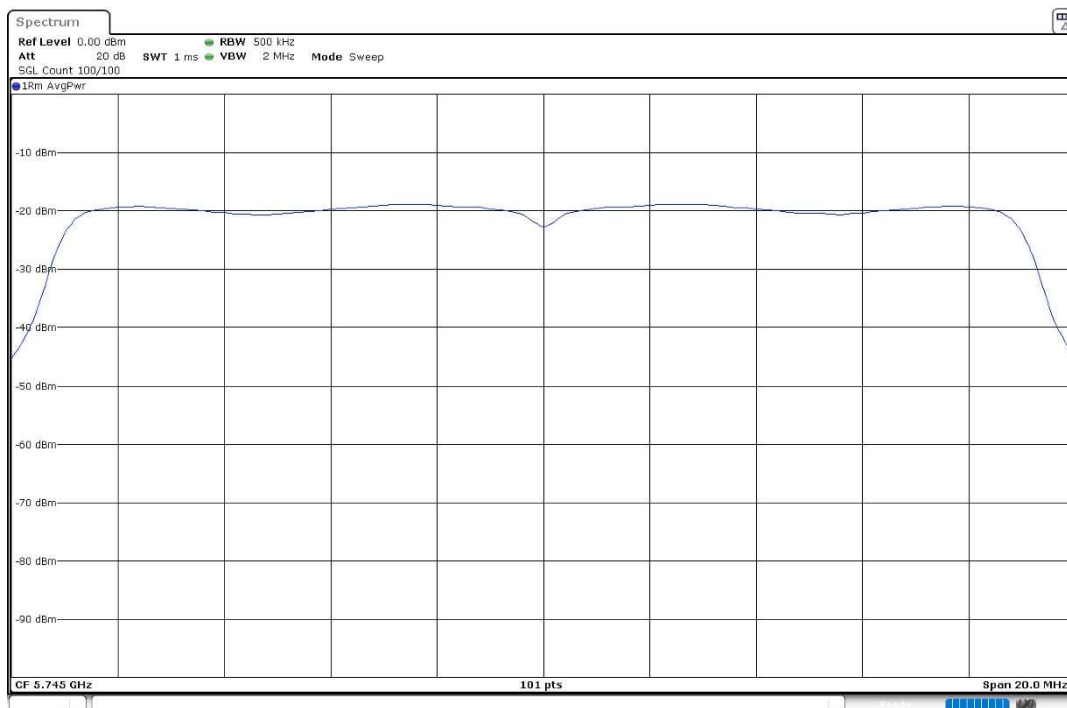
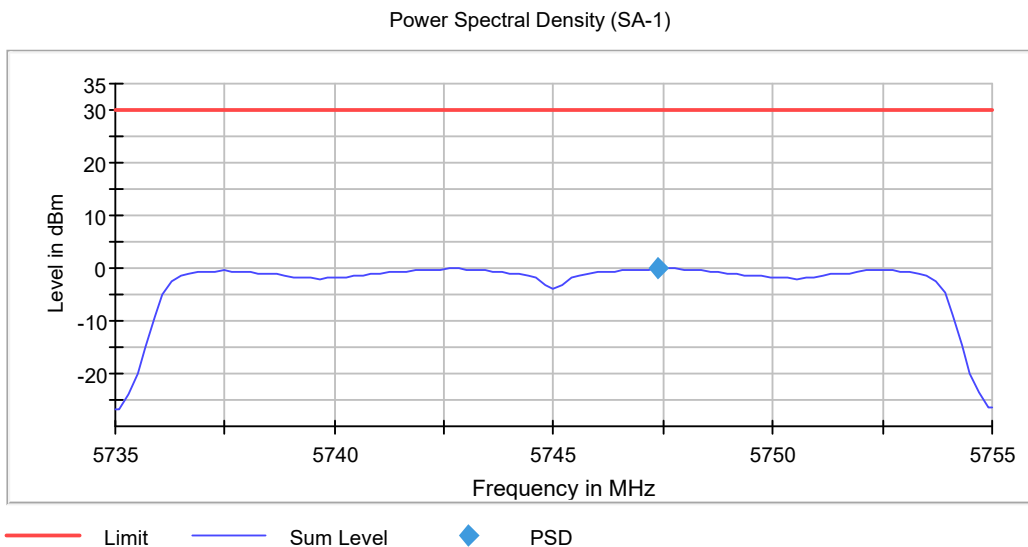
- High Channel:

Power Spectral Density (SA-1)



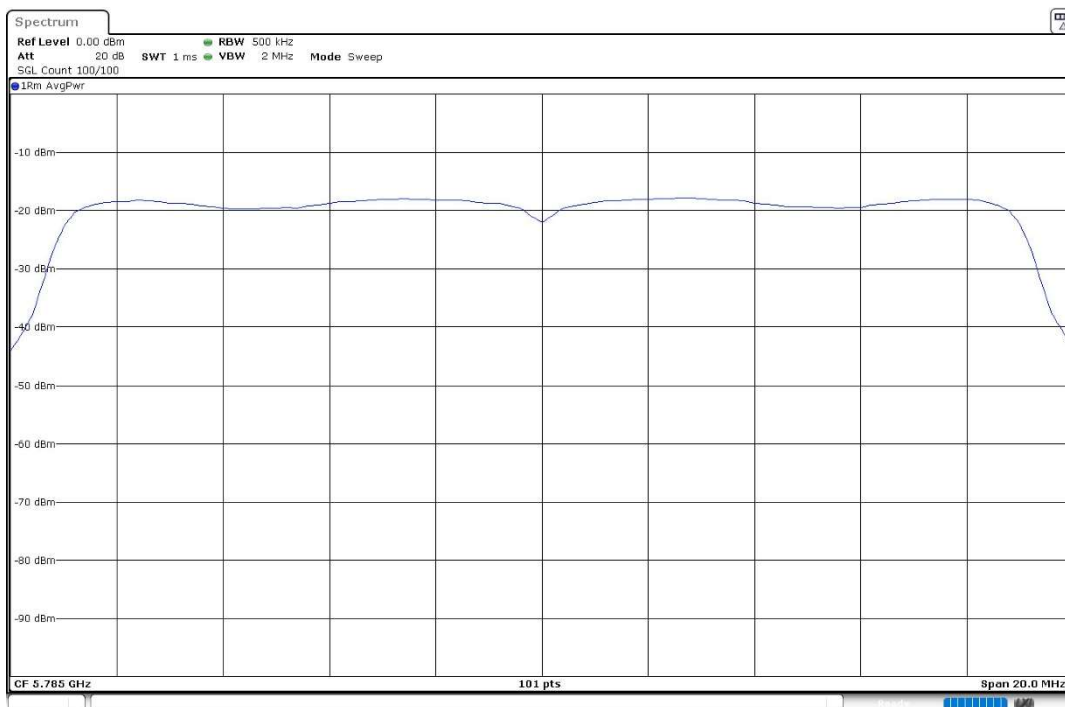
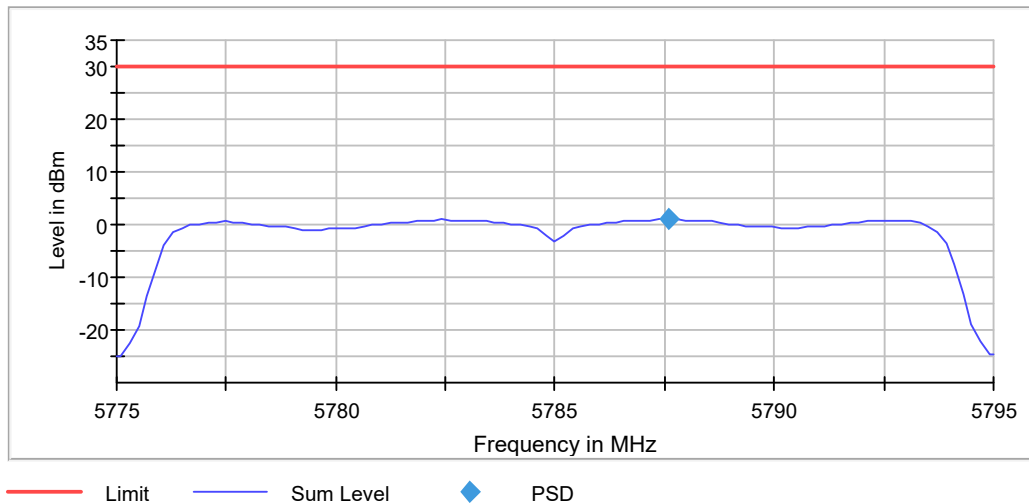
Mode 802.11 ac20 (VHT20):

- Low Channel:



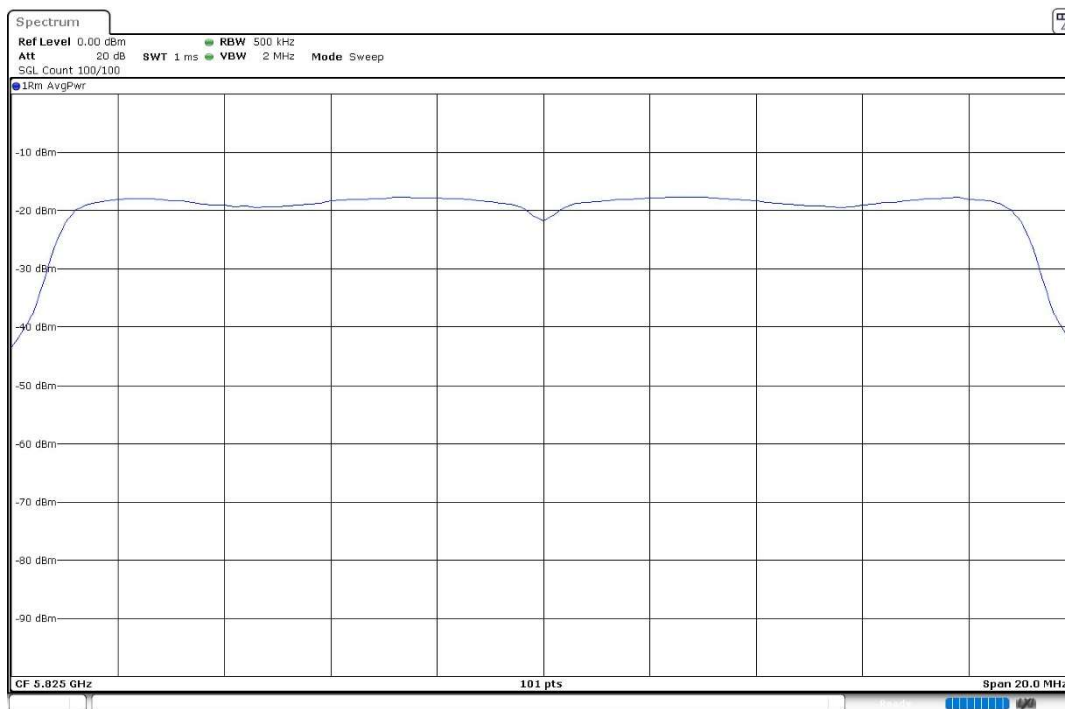
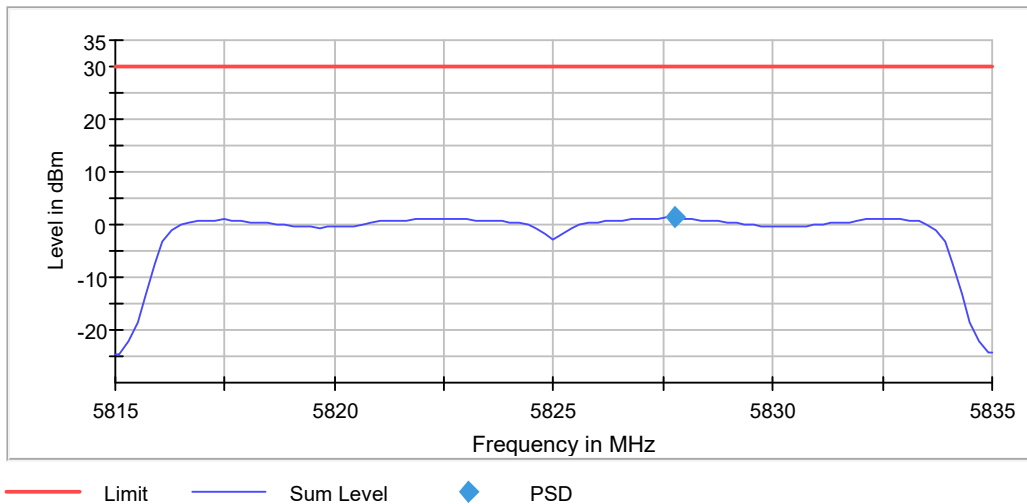
- Middle Channel:

Power Spectral Density (SA-1)



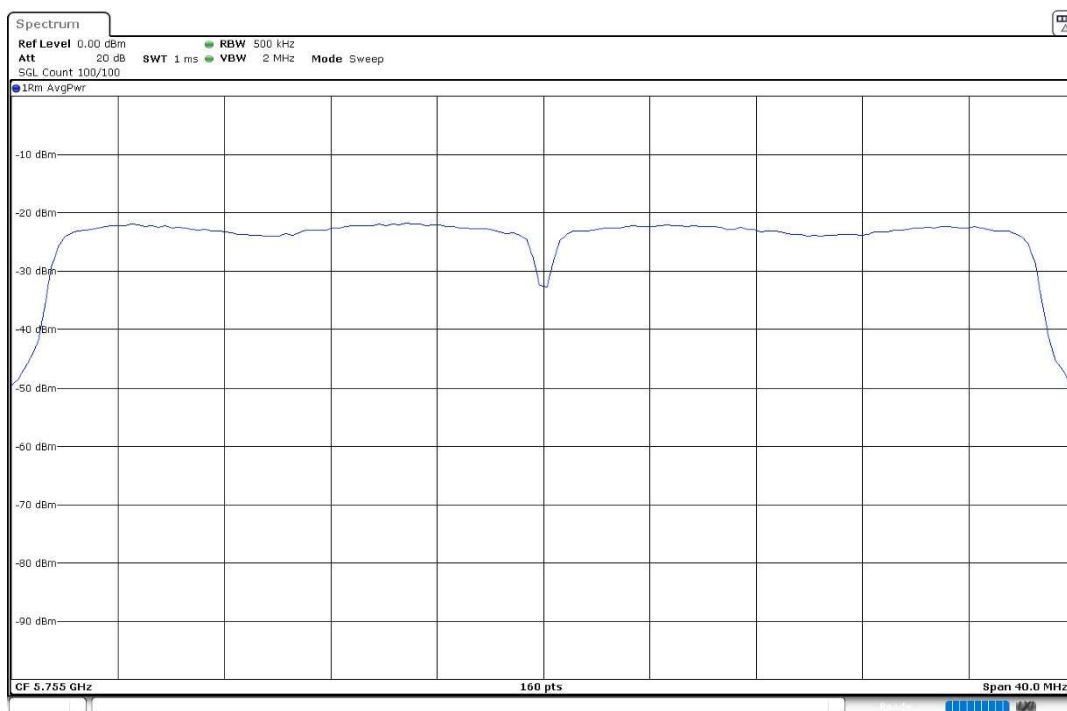
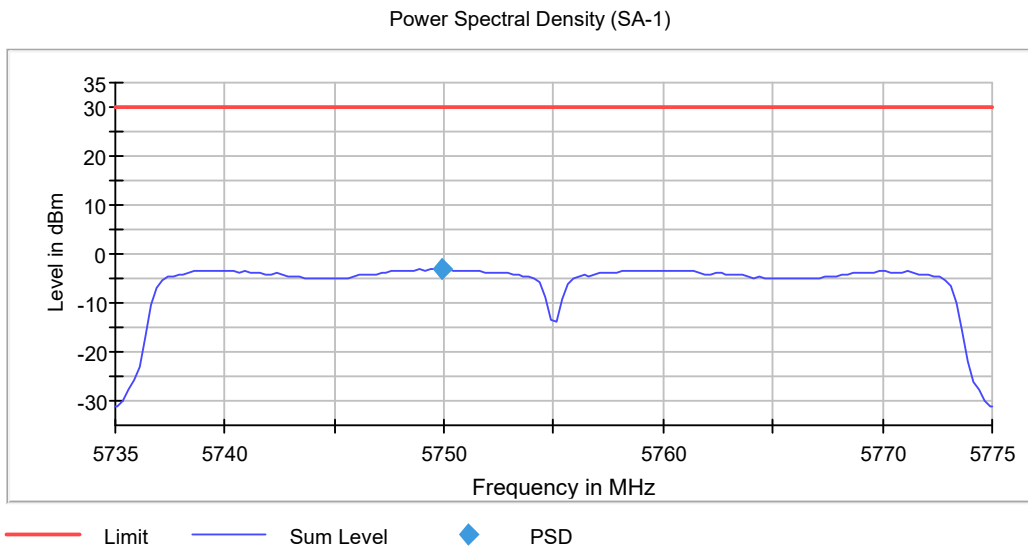
- High Channel:

Power Spectral Density (SA-1)

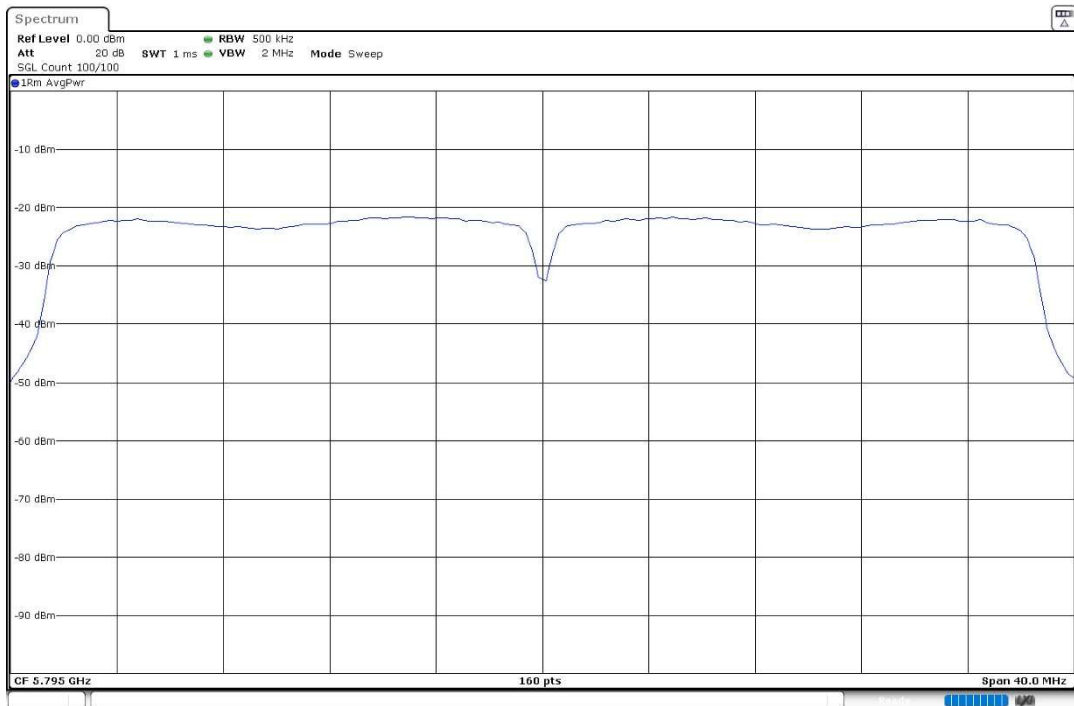
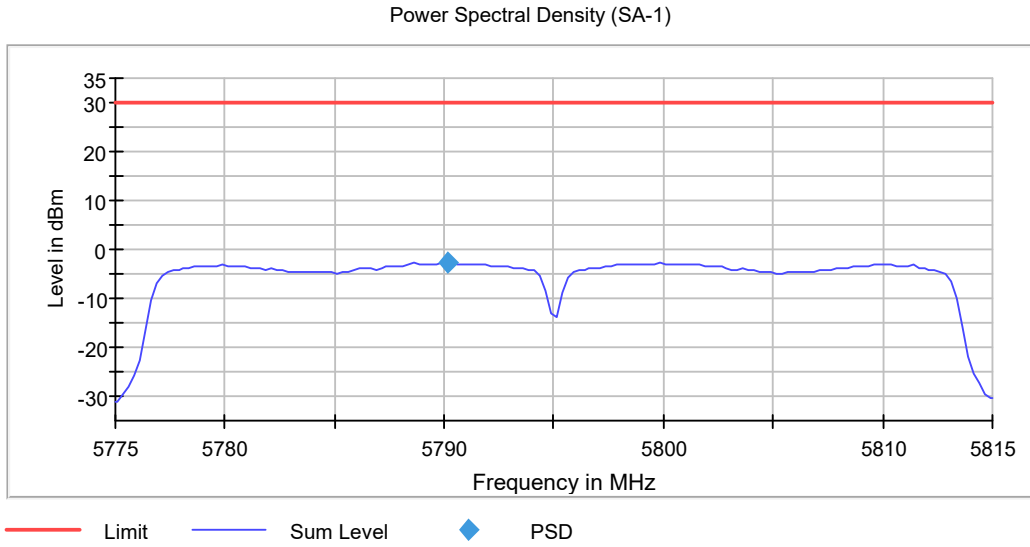


Mode 802.11 n40 (HT40):

- Low Channel:

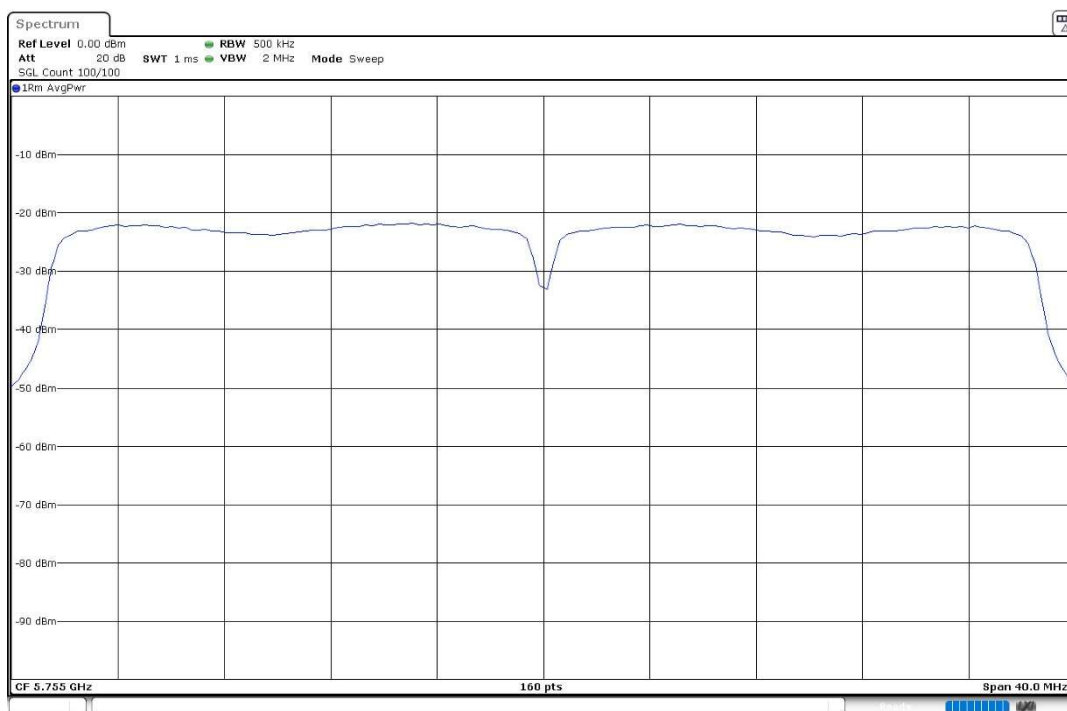
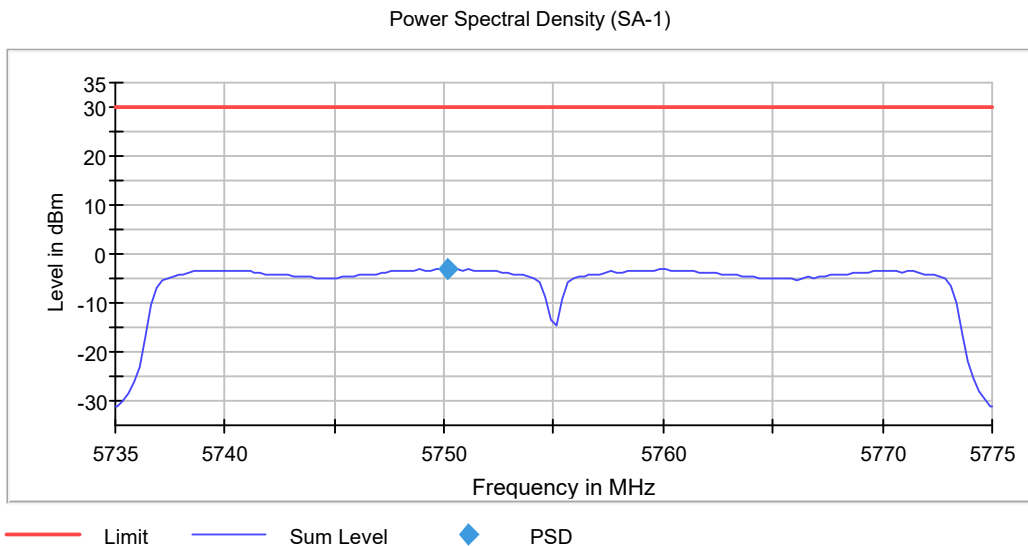


- High Channel:



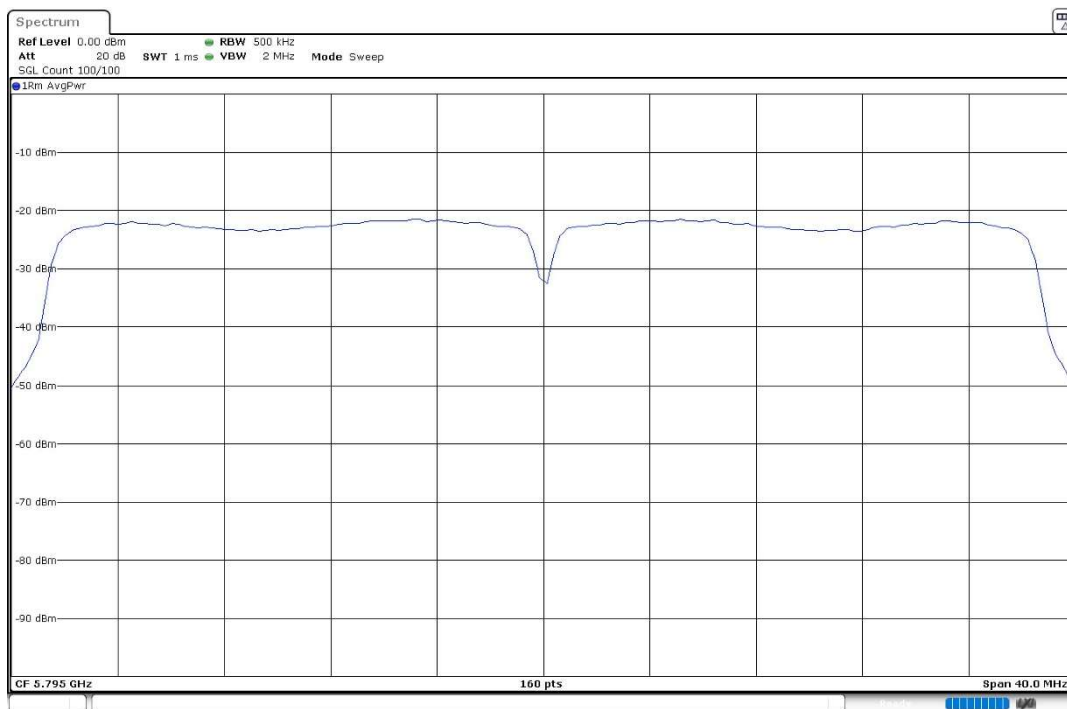
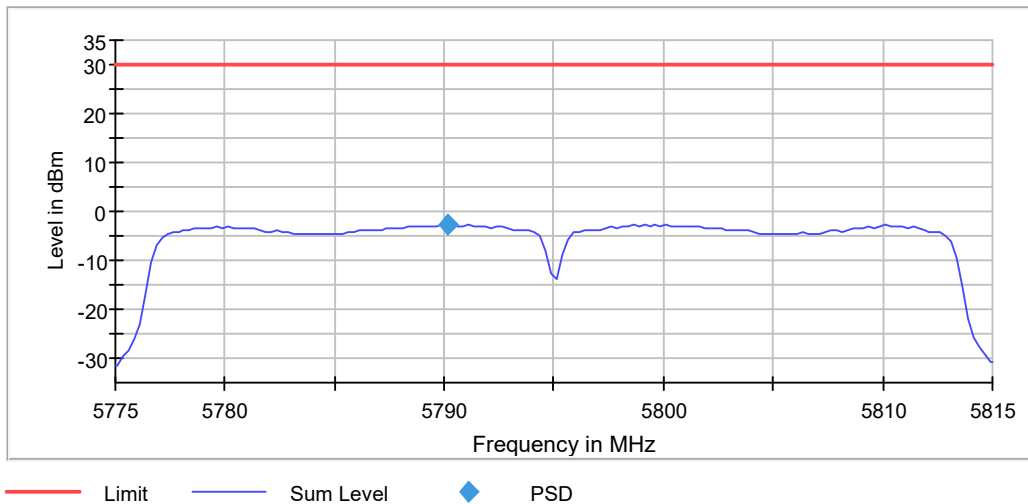
Mode 802.11 ac40 (VHT40):

- Low Channel:



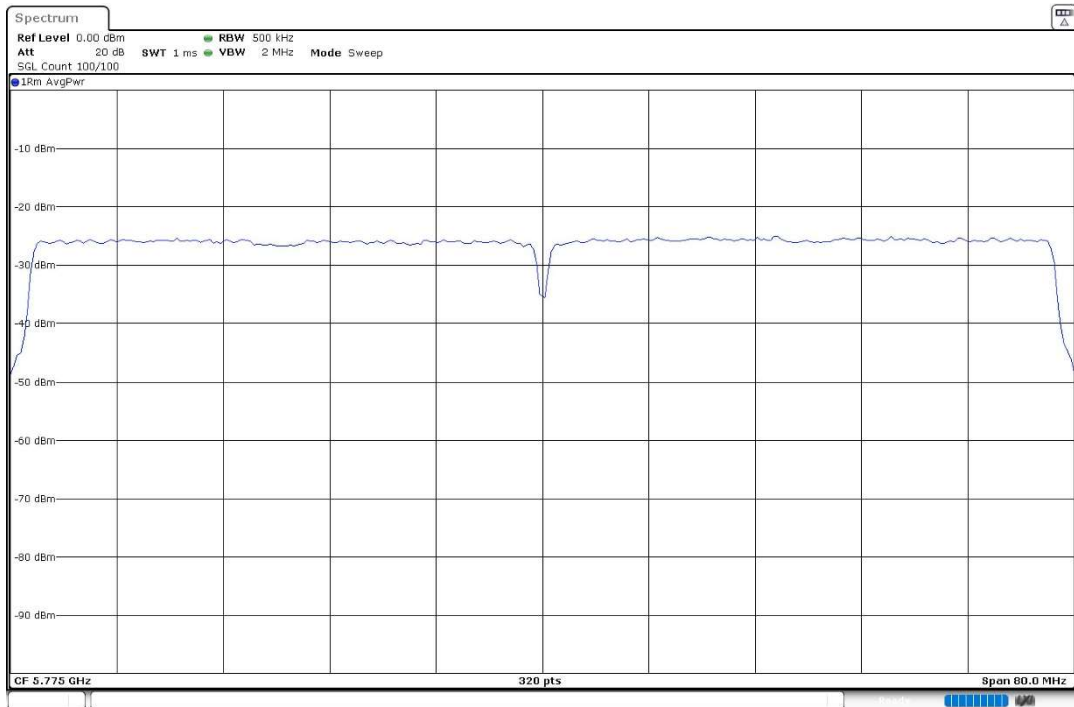
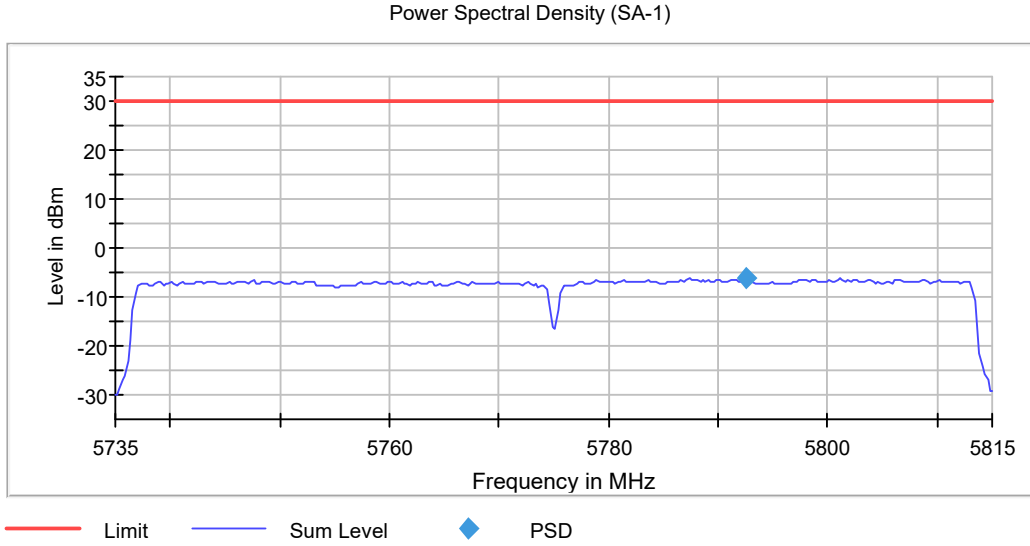
- High Channel:

Power Spectral Density (SA-1)



Mode 802.11 ac80 (VHT80):

- Single Channel:



FCC 15.407 (b)(4) / RSS-247 6.2.4.2. Transmitter Out of Band Radiated Emissions and Transmitter Band Edge Radiated Emissions

Limits

For transmitters operating in the 5.725–5.85 GHz band:

All emissions shall be limited to a level of -27 dBm/MHz (68.23 dBµV/m at 3 m distance) at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

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)	-	30
1.705 – 30.0	30	-	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 – 960	200	46	3
Above 960	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, specified when measuring with peak detector function.

Results

The field strength is calculated by adding a correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain. For measurements above 17 GHz performed at a reduced distance, this factor also includes an inverse proportionality factor of 20 dB per decade to normalize the measured data.

Test performed on the following modulations and data rates:

802.11 a20:	6 Mbps
802.11 n HT20:	MCS0
802.11 n HT40:	MCS0
802.11 ac VHT20:	MCS0
802.11 ac VHT40:	MCS0
802.11 ac VHT80:	MCS0

OUT OF BAND EMISSIONS:

For spurious emissions outside of the U-NII-3 band-edge mask of 5.65-5.925 GHz, the worst-case mode was determined among all modulations after preliminary measurements of the radiated power spectral density.

The Low, Middle and High Channels were tested for the determined worst case.

Worst case: 802.11 n HT20: MCS0

Frequency range 30 MHz - 1 GHz

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

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

Frequency range 1 - 40 GHz

The results below show the maximum measured levels in the 1-40 GHz range except the 5.65-5.725 GHz and 5.85-5.925GHz adjacent bands. The results in the adjacent bands are reported in the next section.

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 average compliance checking.

- LOW CHANNEL 149 (5745 MHz)

No spurious frequencies found.

- MIDDLE CHANNEL 157 (5785 MHz)

No spurious frequencies found.

- HIGH CHANNEL 165 (5825 MHz)

No spurious frequencies found.

Verdict

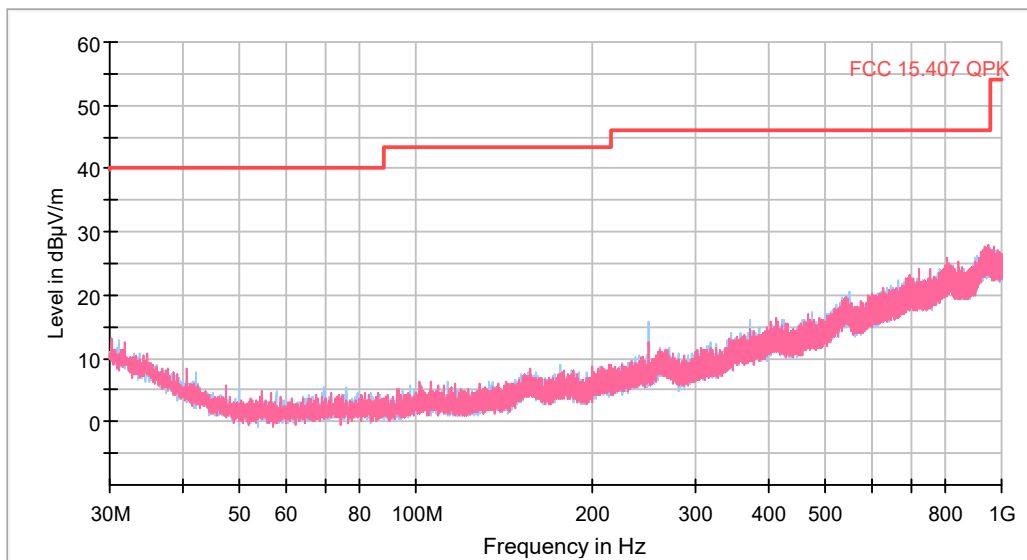
Pass

Attachments

The setting for each range of frequency is indicated in the following tables:

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [ESR 7] 30 MHz - 1 GHz	9,7 kHz	PK+	100 kHz	1 s	0 dB
Receiver: [ESR 7] 1 GHz - 7 GHz	187,5 kHz	PK+ ; AVG	1 MHz	1 s	0 dB
Receiver: [FSW 50] 7 GHz - 17 GHz	100 kHz	PK+ ; AVG	1 MHz	1 s	0 dB
Receiver: [FSW 50] 17 GHz - 40 GHz	230 kHz	PK+ ; AVG	1 MHz	1 s	0 dB

FREQUENCY RANGE 30 MHz - 1 GHz

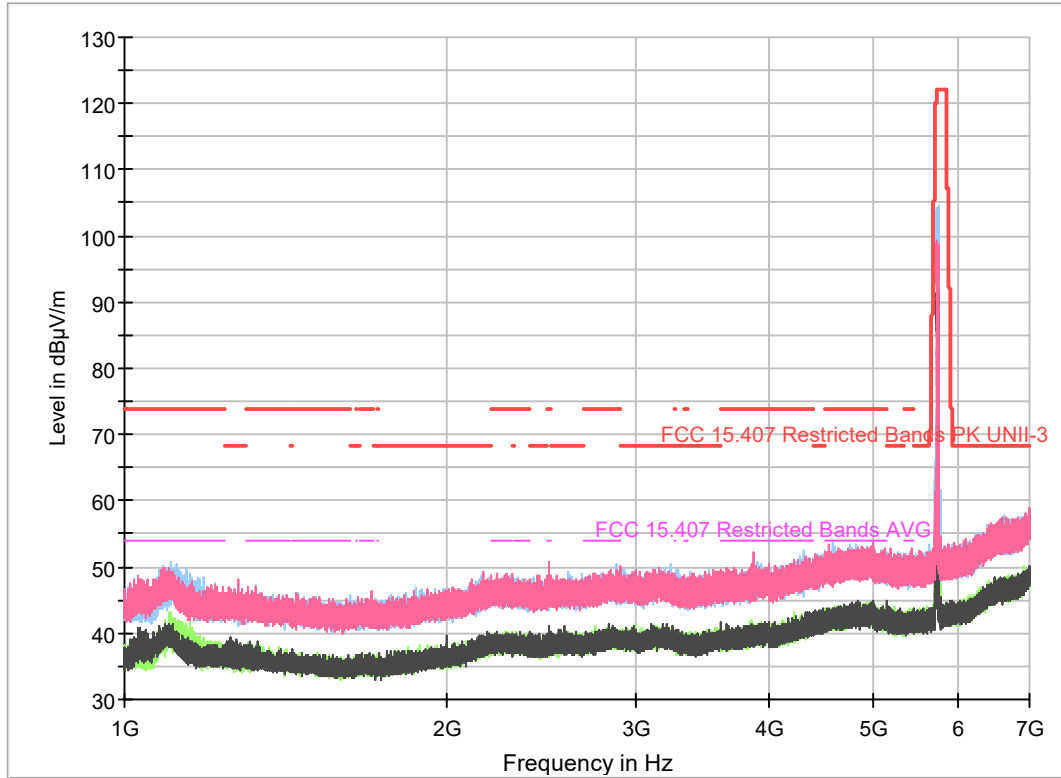


This plot is valid for Low, Middle and High Channels and all modulations.

FREQUENCY RANGE 1 - 7 GHz (802.11 n HT20 MCS0)

- Low Channel:

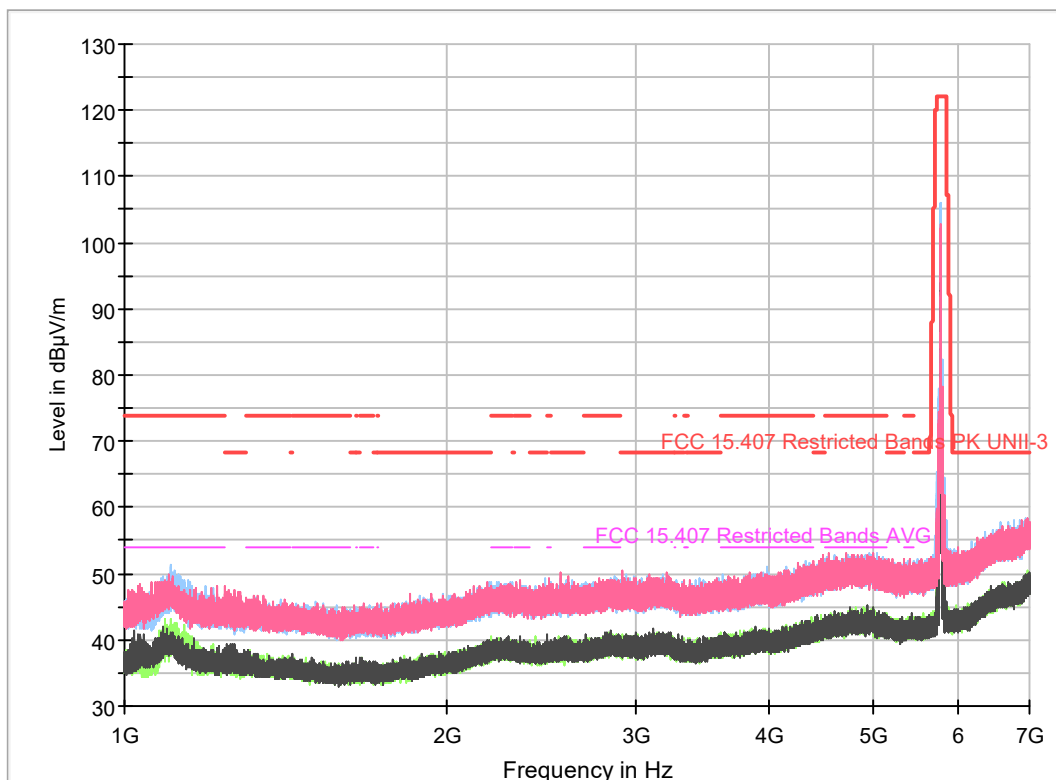
Full Spectrum



The peak above the limit is the carrier frequency.

- Middle Channel:

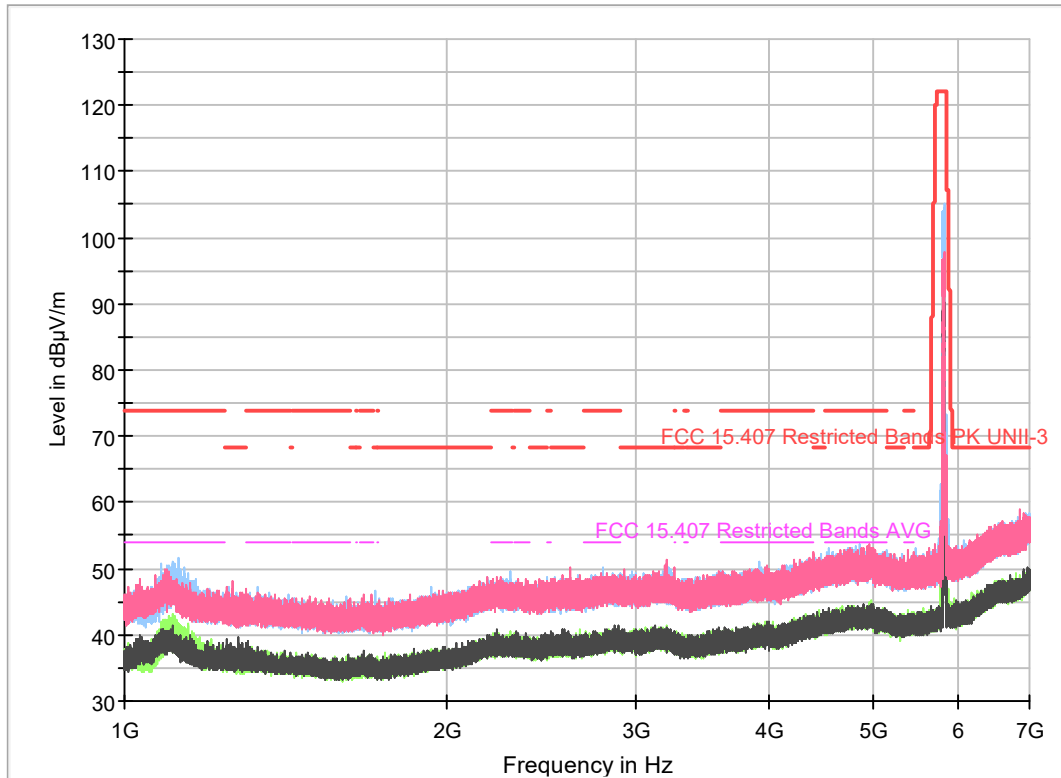
Full Spectrum



The peak above the limit is the carrier frequency.

- High Channel:

Full Spectrum



The peak above the limit is the carrier frequency.