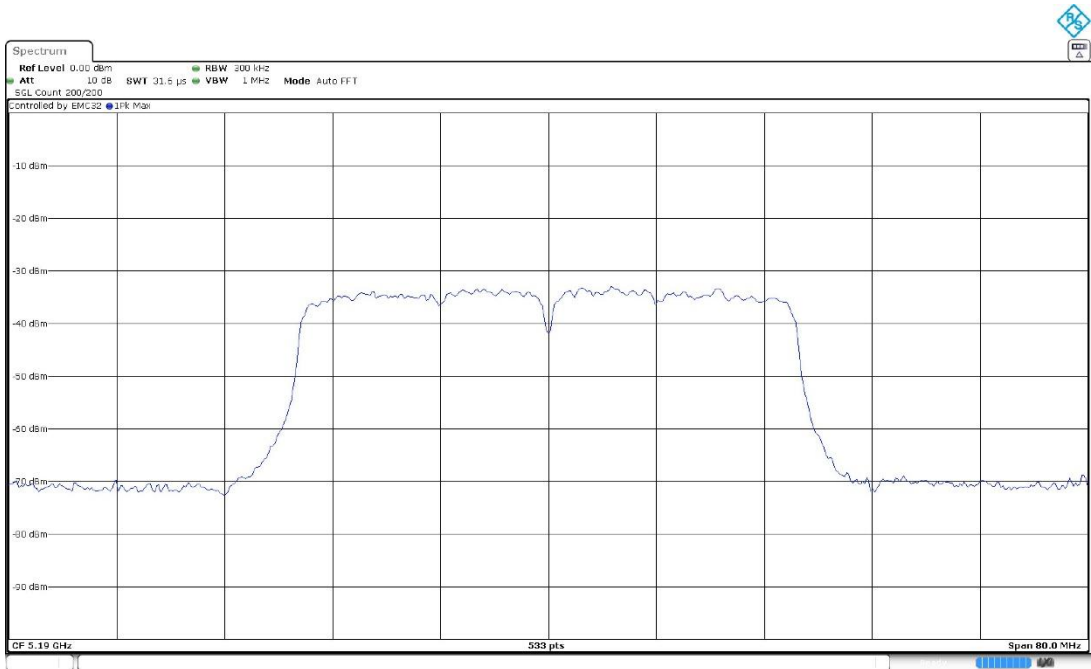
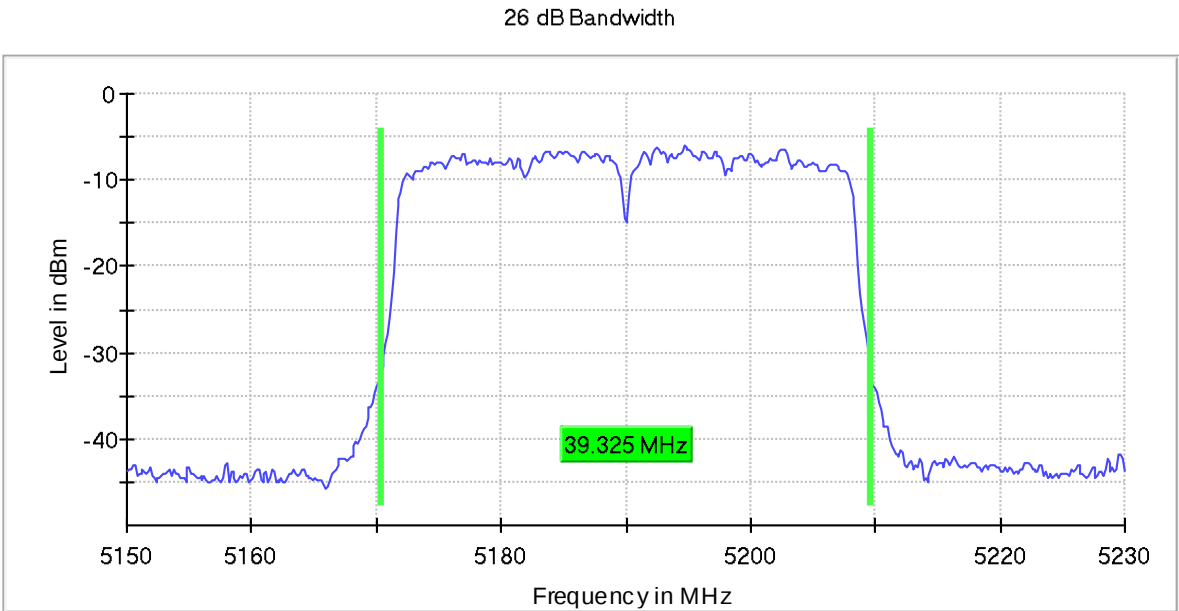


Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

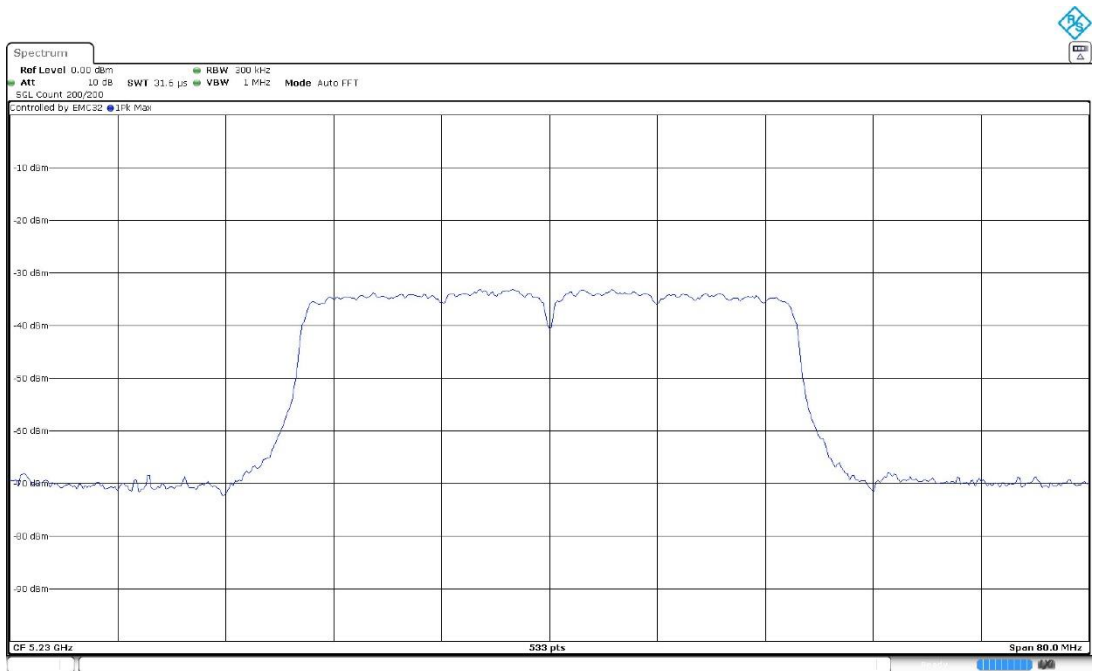
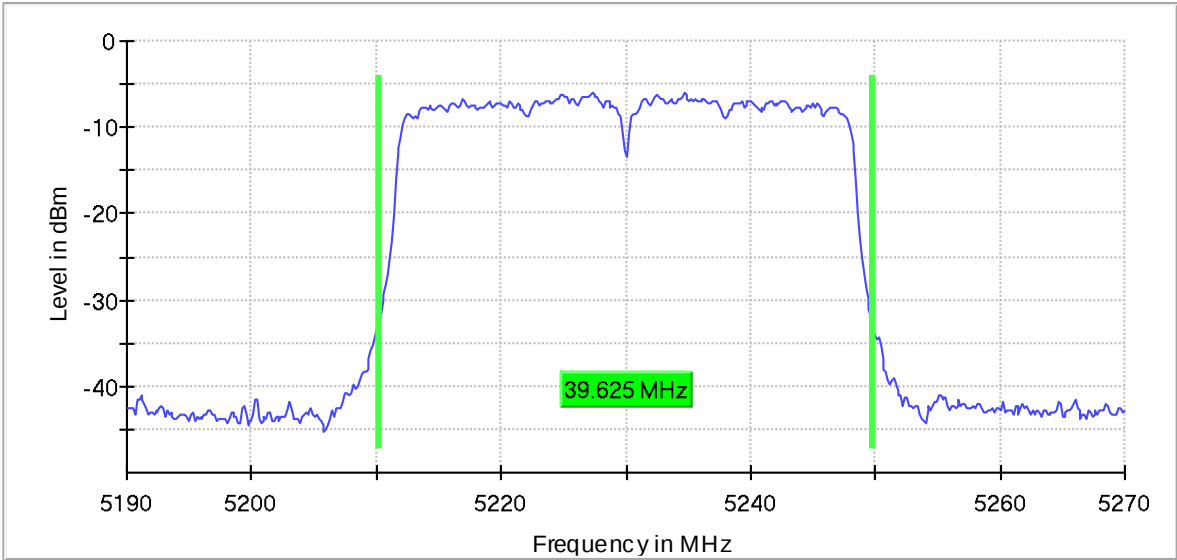
U-NII-1 FCC (5150-5250 MHz)

- Low Channel 36 (5180 MHz):



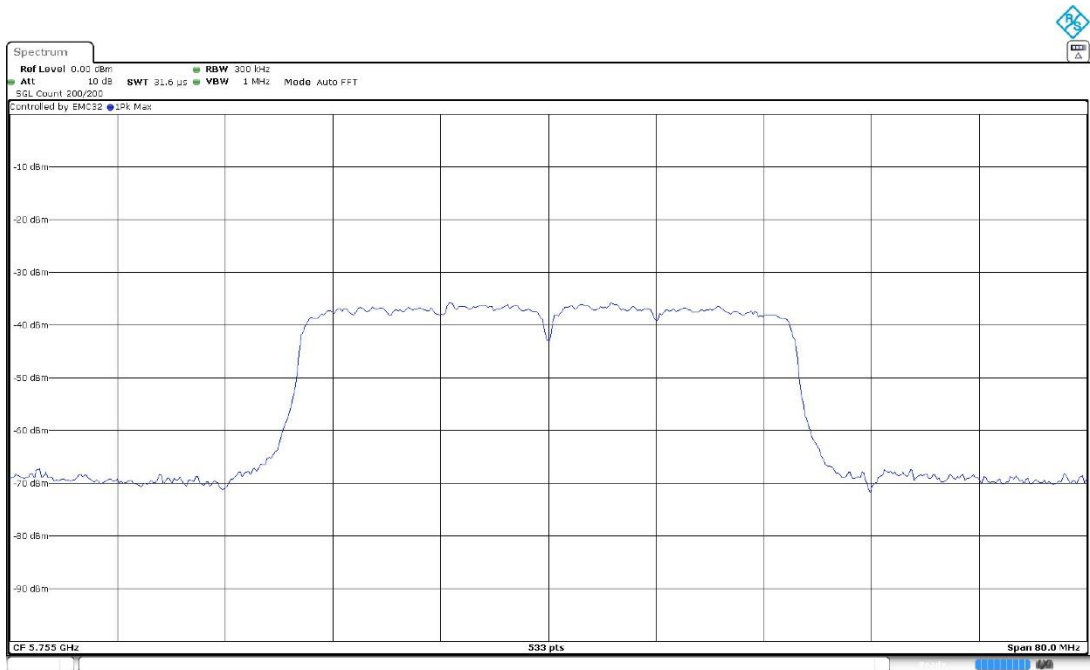
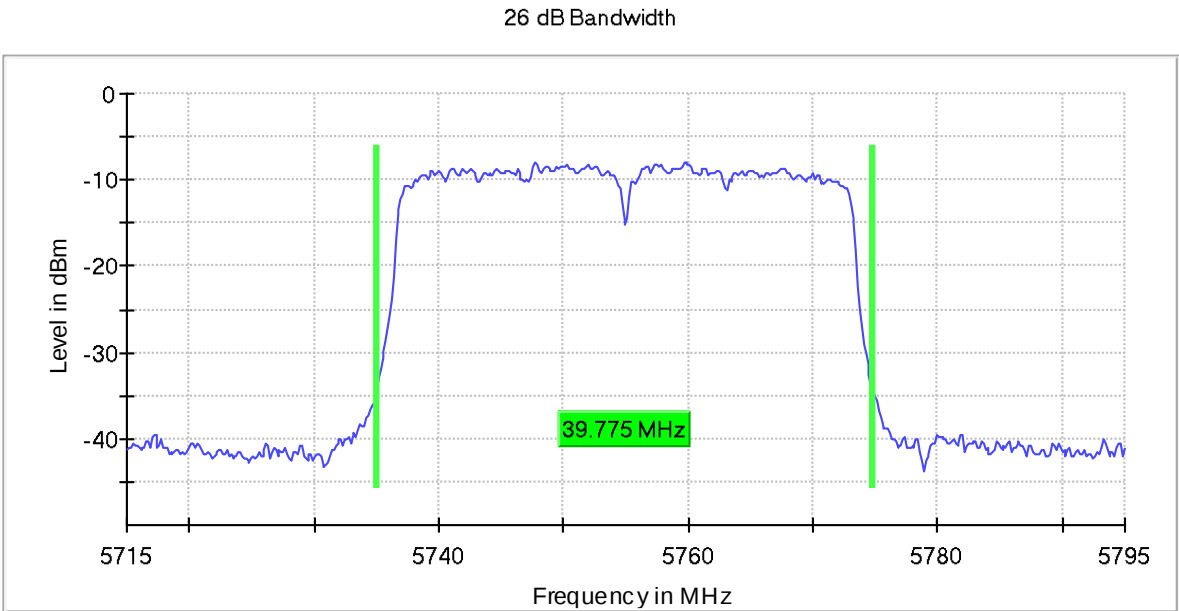
- High Channel 48 (5240 MHz):

26 dB Bandwidth

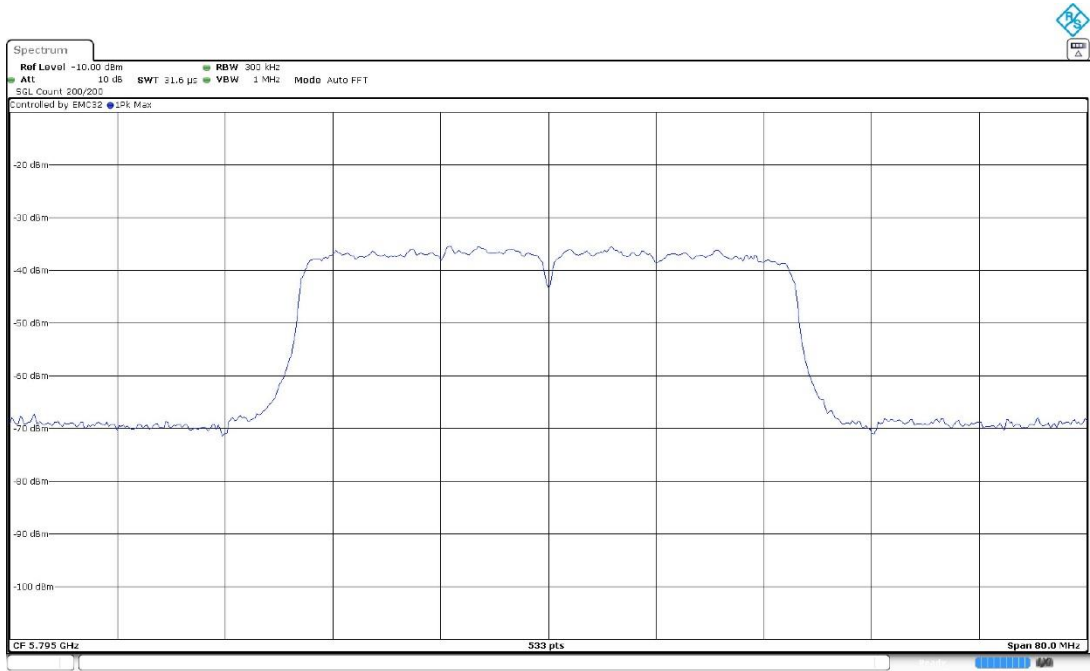
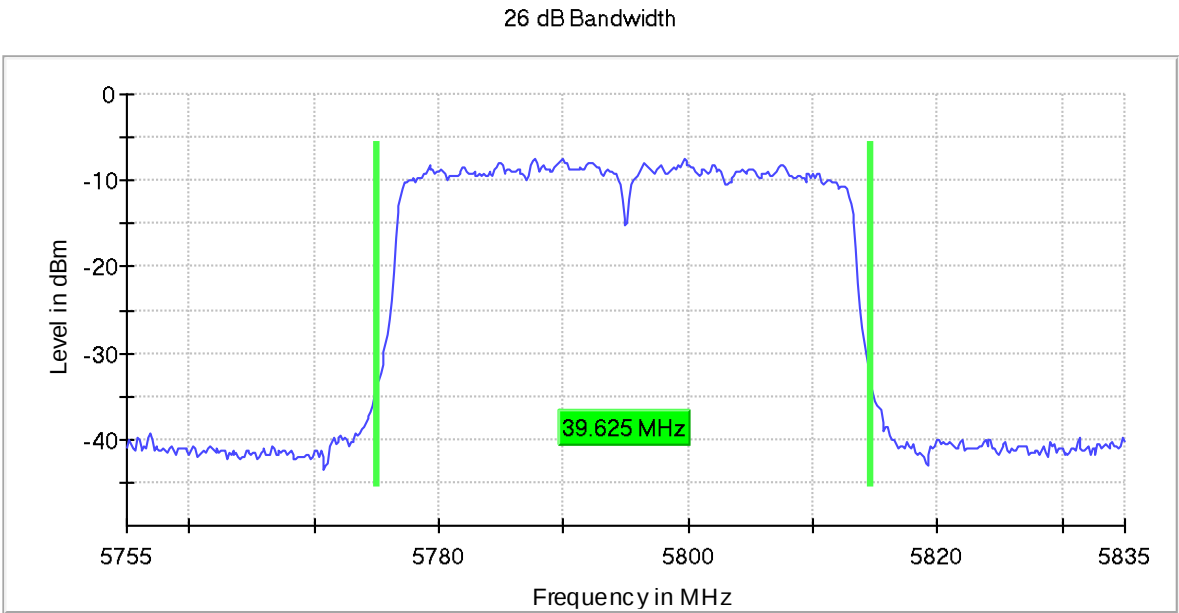


U-NII-3 (5725-5850 MHz)

- Low Channel 149 (5745 MHz):



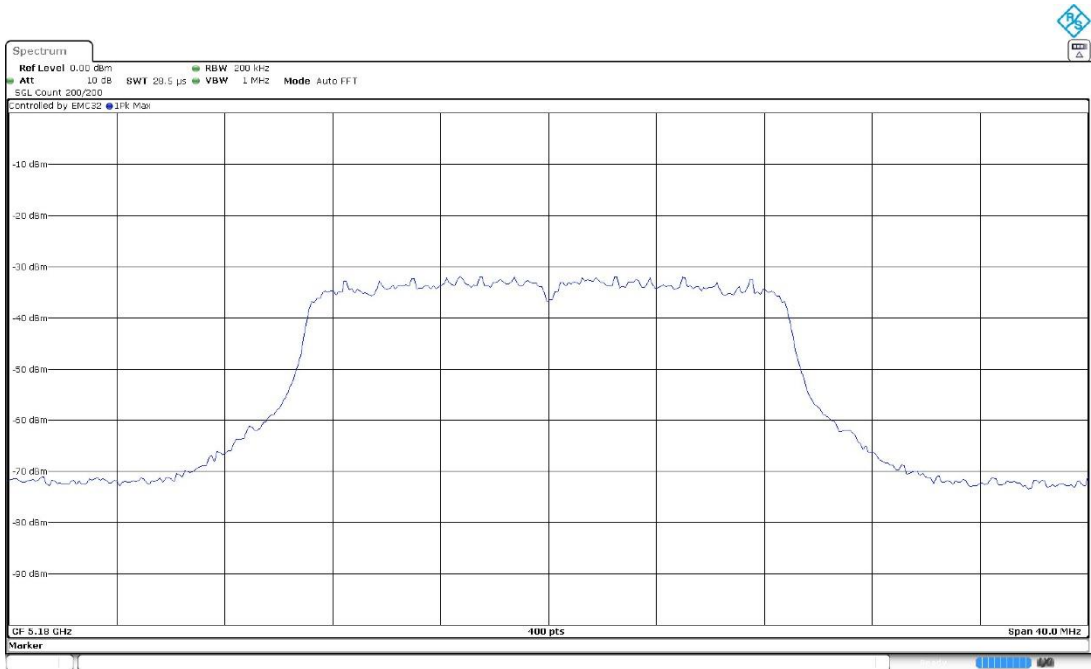
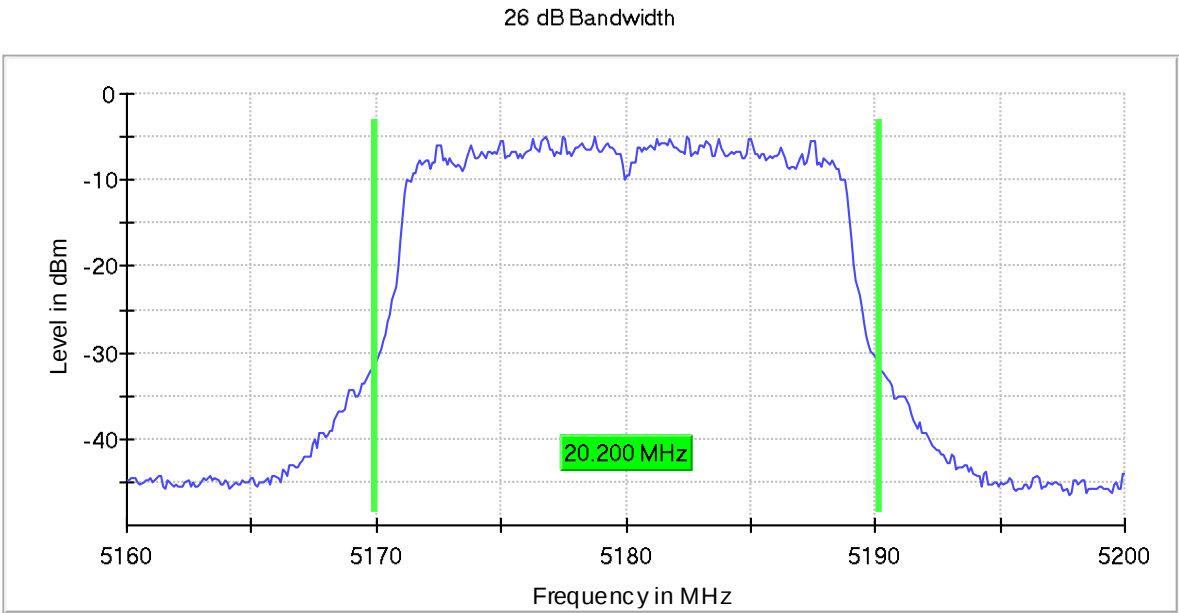
- High Channel 165 (5825 MHz):



Modulation: 802.11ac VHT20 (OFDM MCS0)

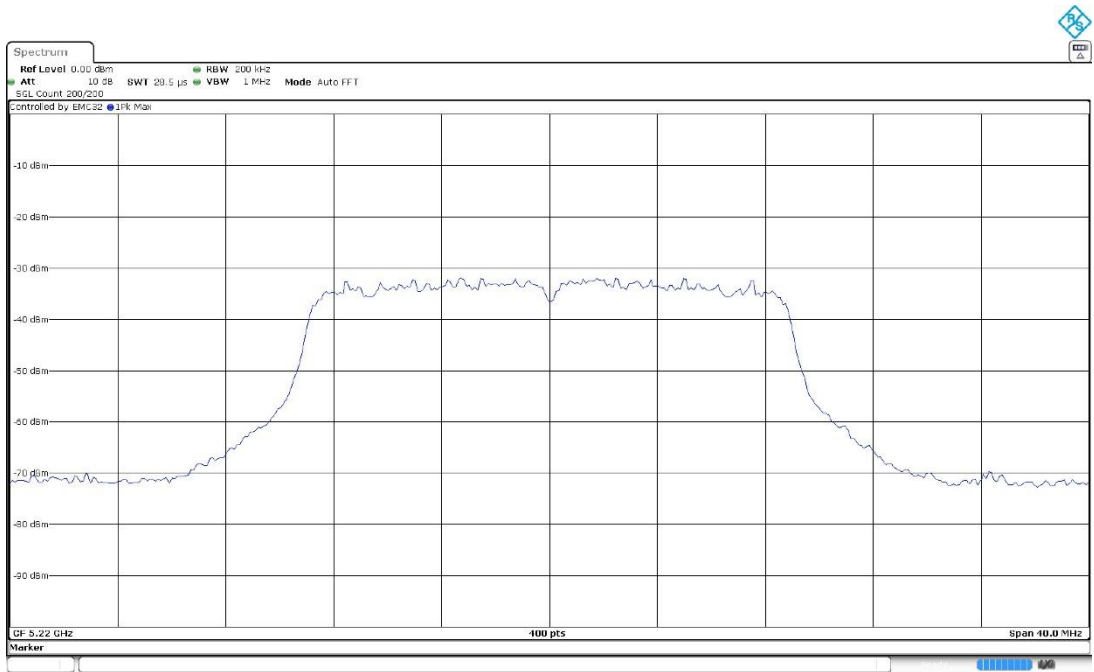
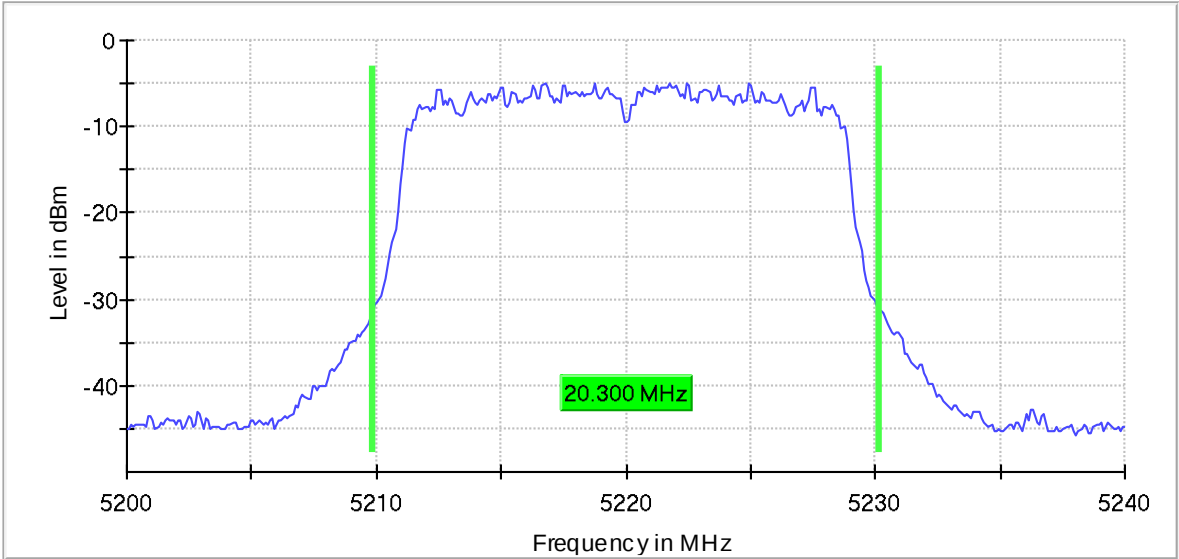
U-NII-1 FCC (5150-5250 MHz)

- Low Channel 36 (5180 MHz):

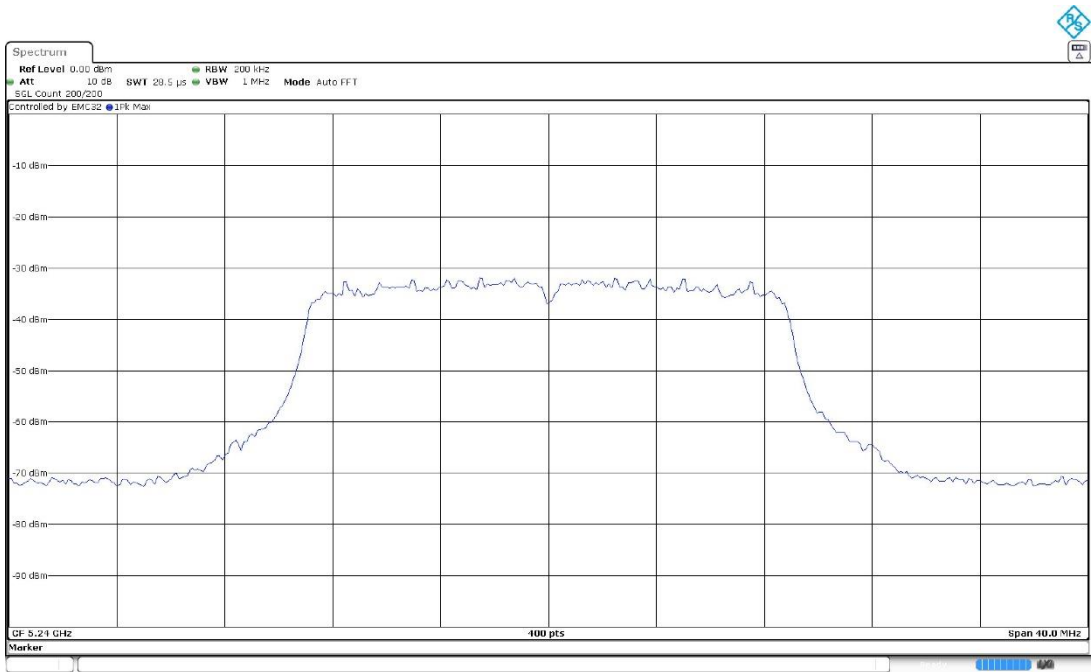
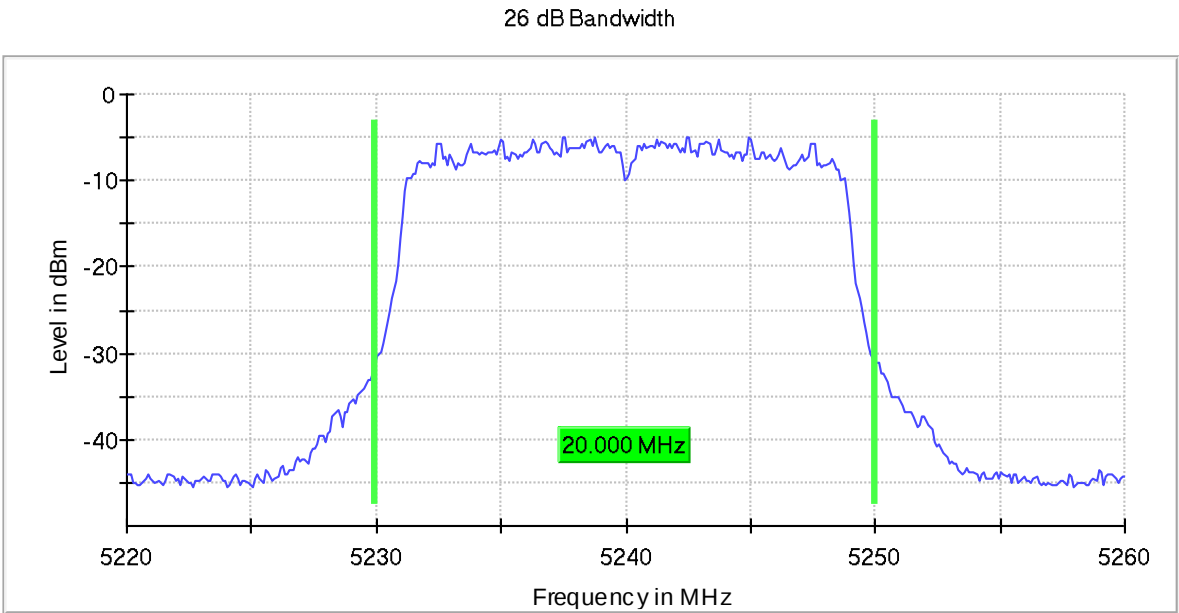


- Middle Channel 44 (5220 MHz):

26 dB Bandwidth

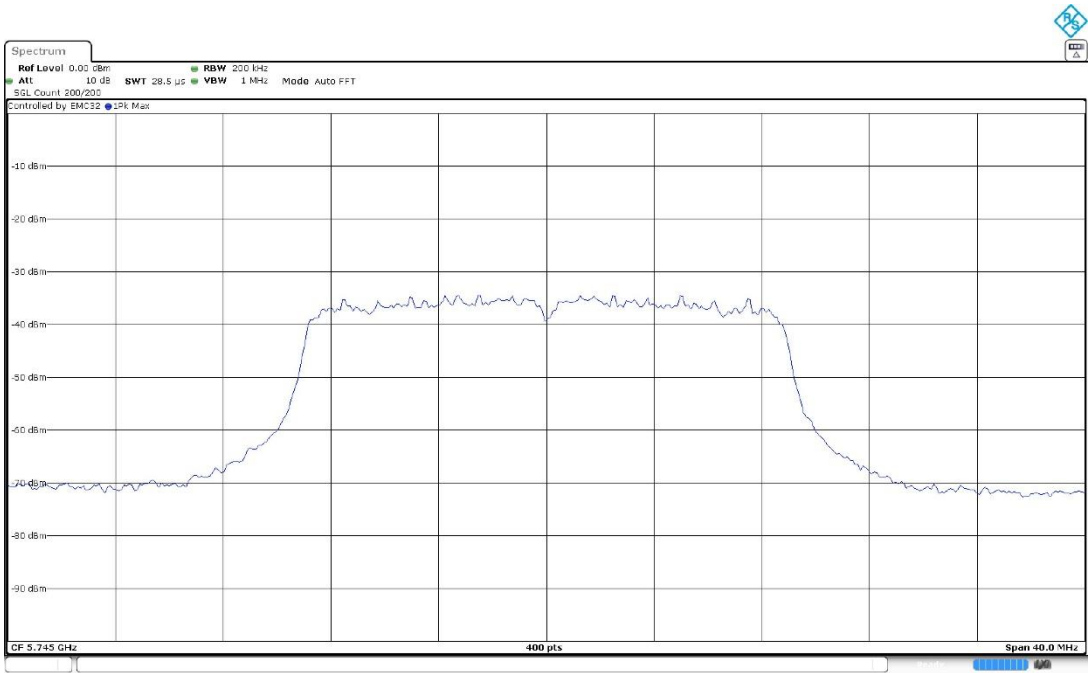
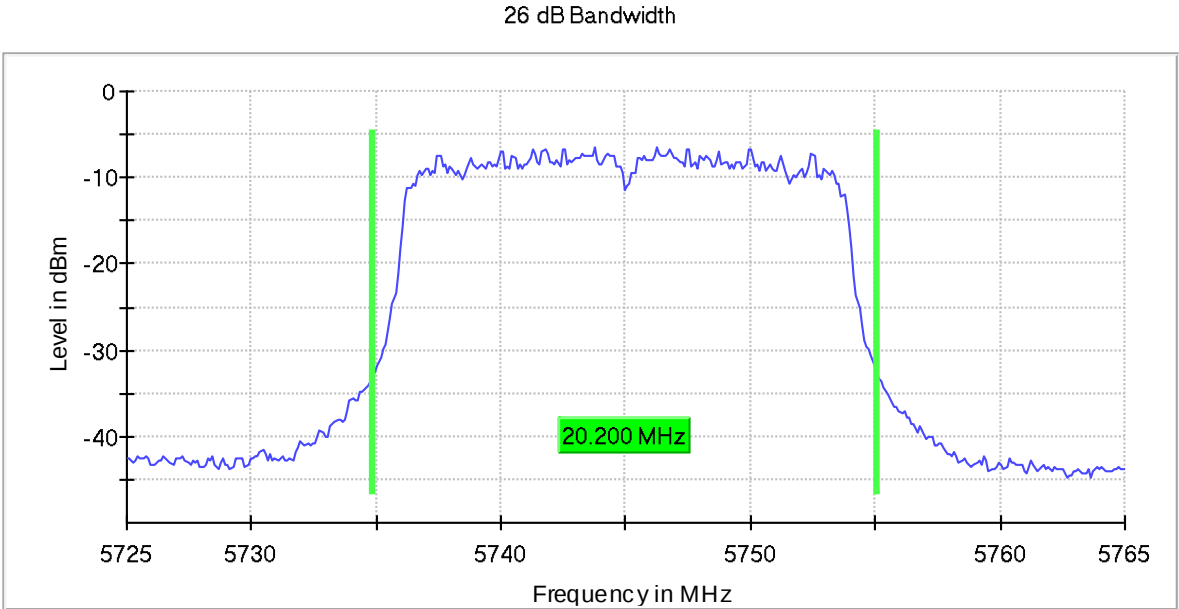


- High Channel 48 (5240 MHz):

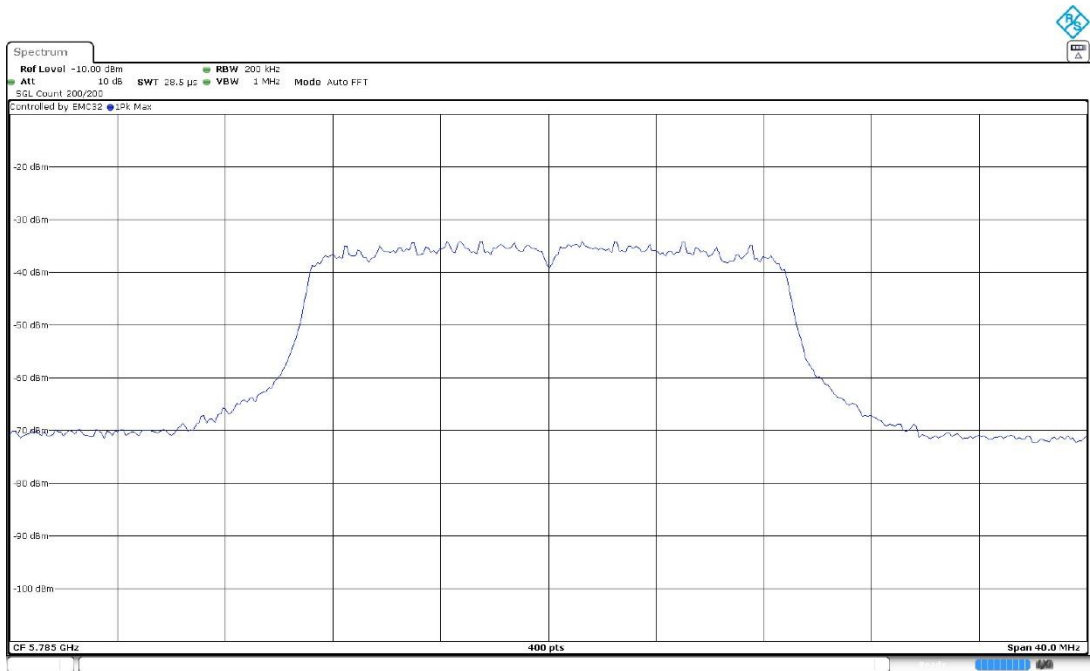
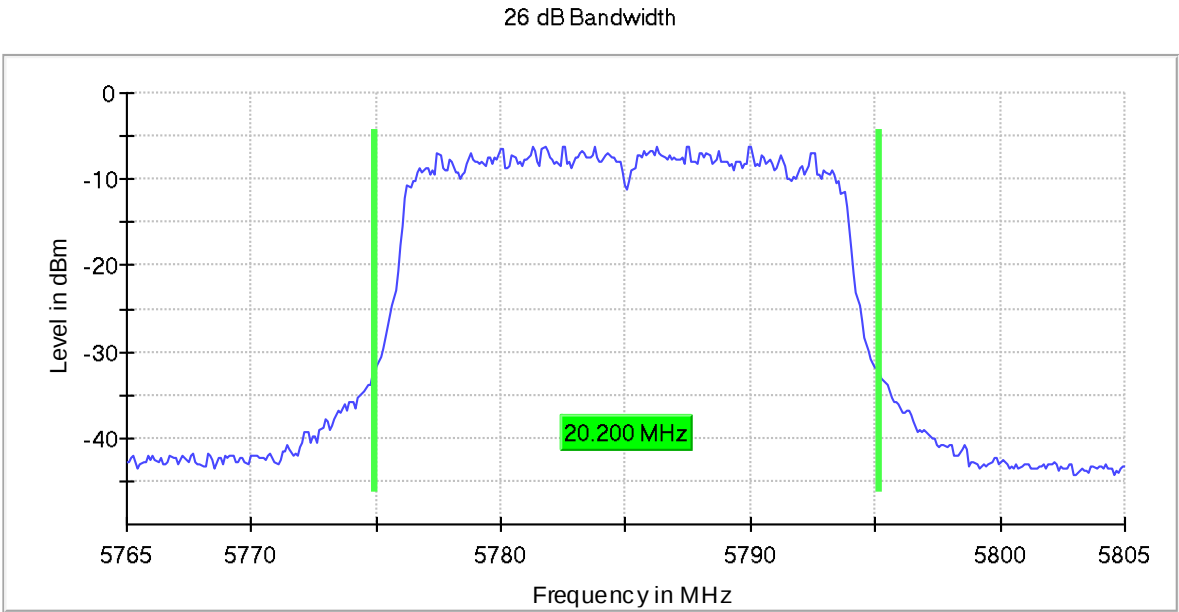


U-NII-3 (5725-5850 MHz)

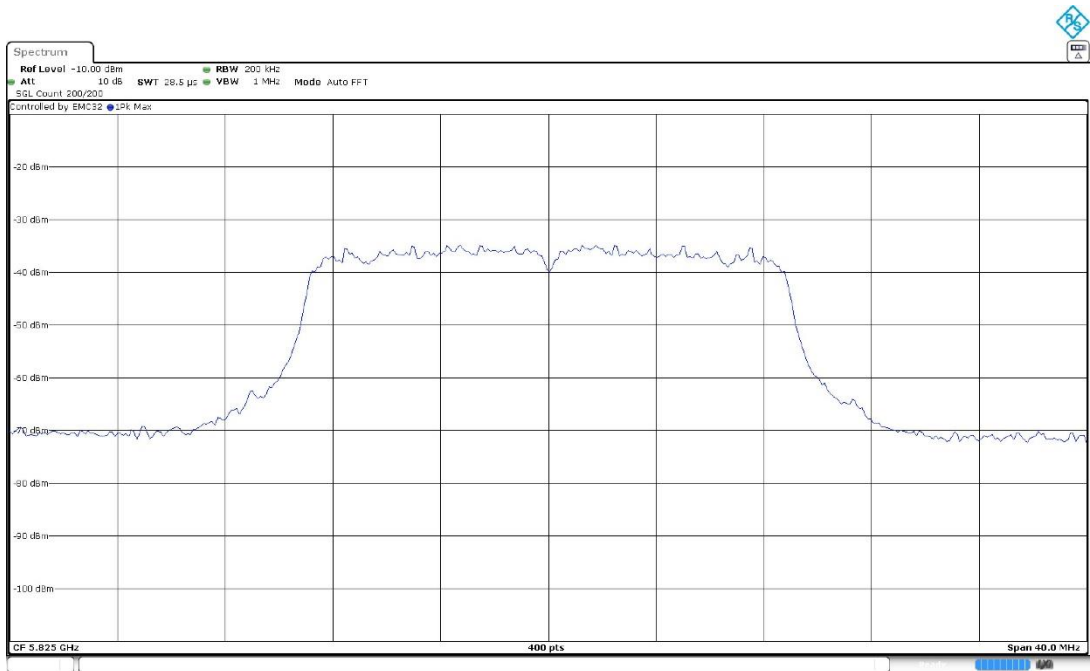
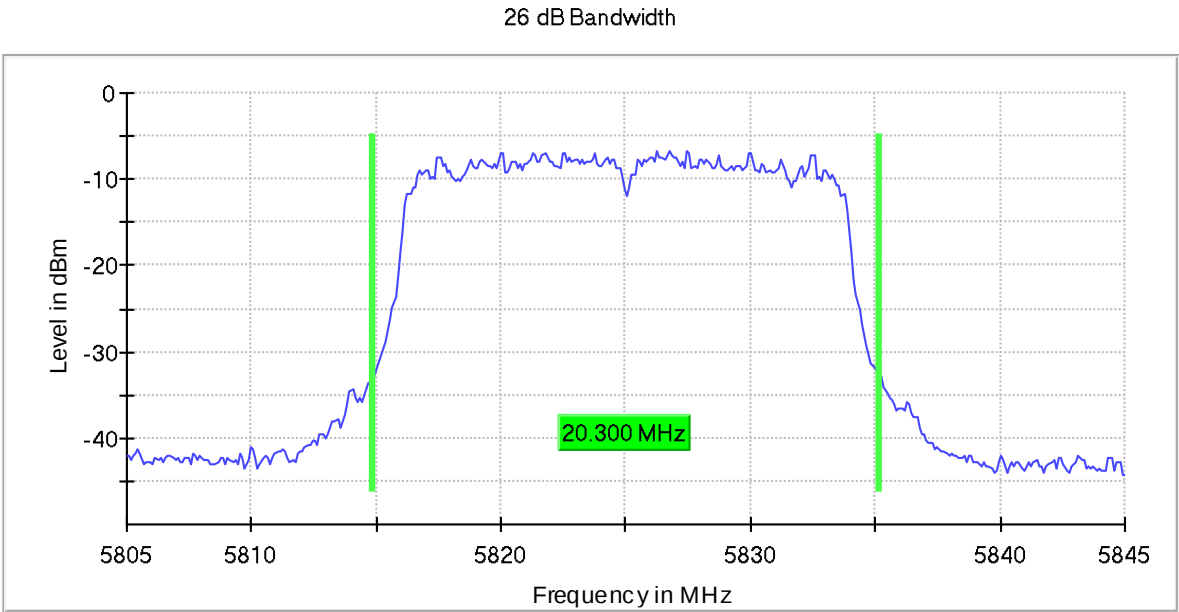
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):



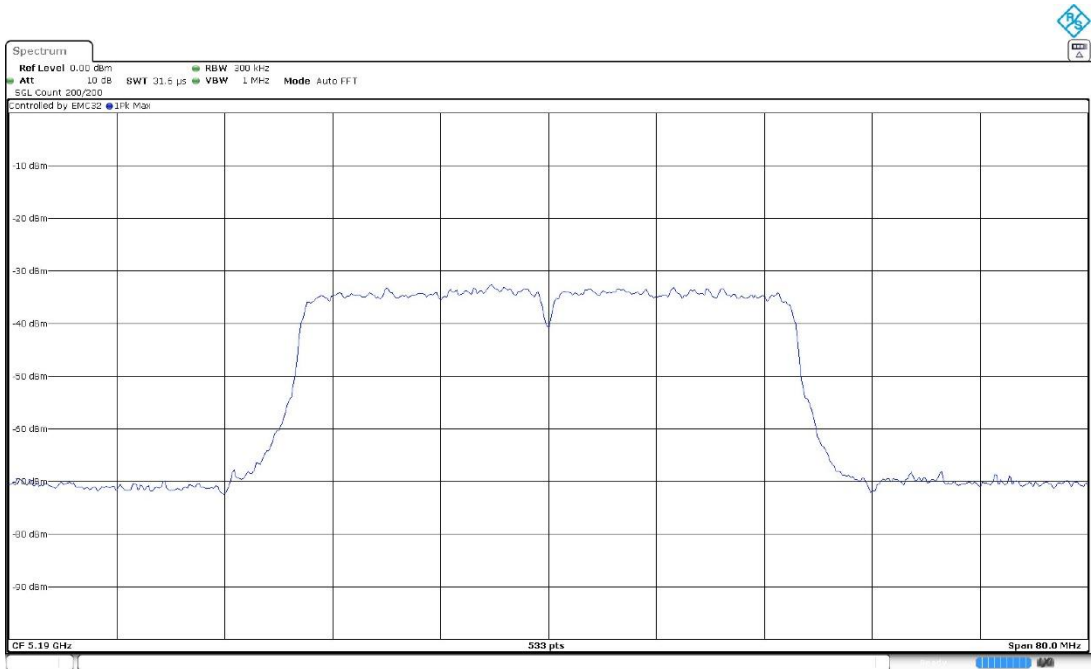
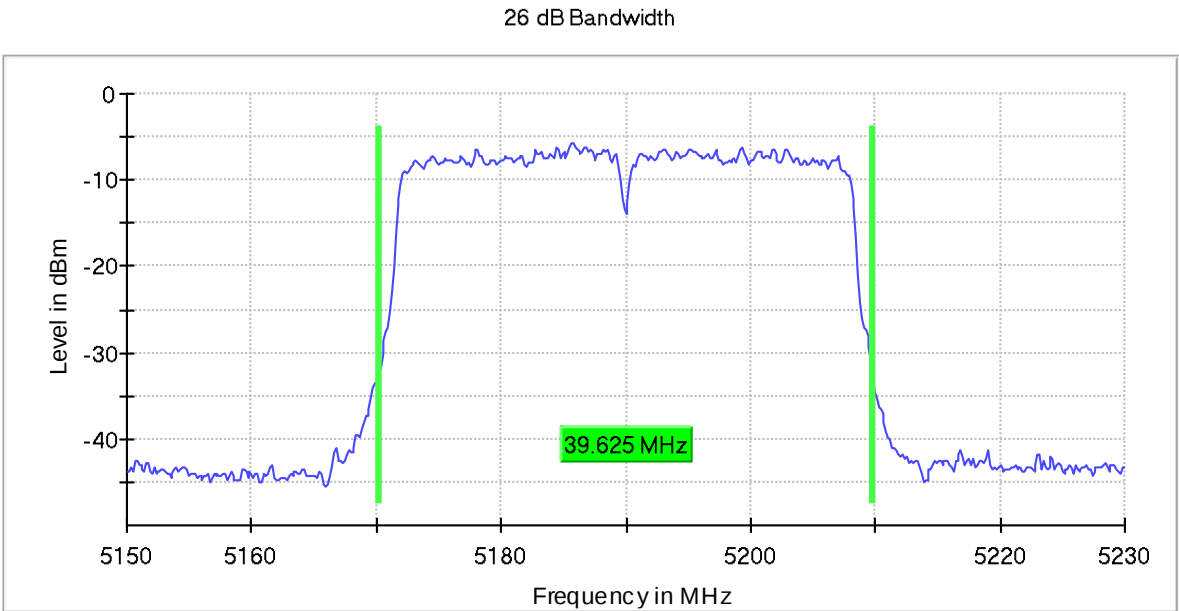
- High Channel 165 (5825 MHz):



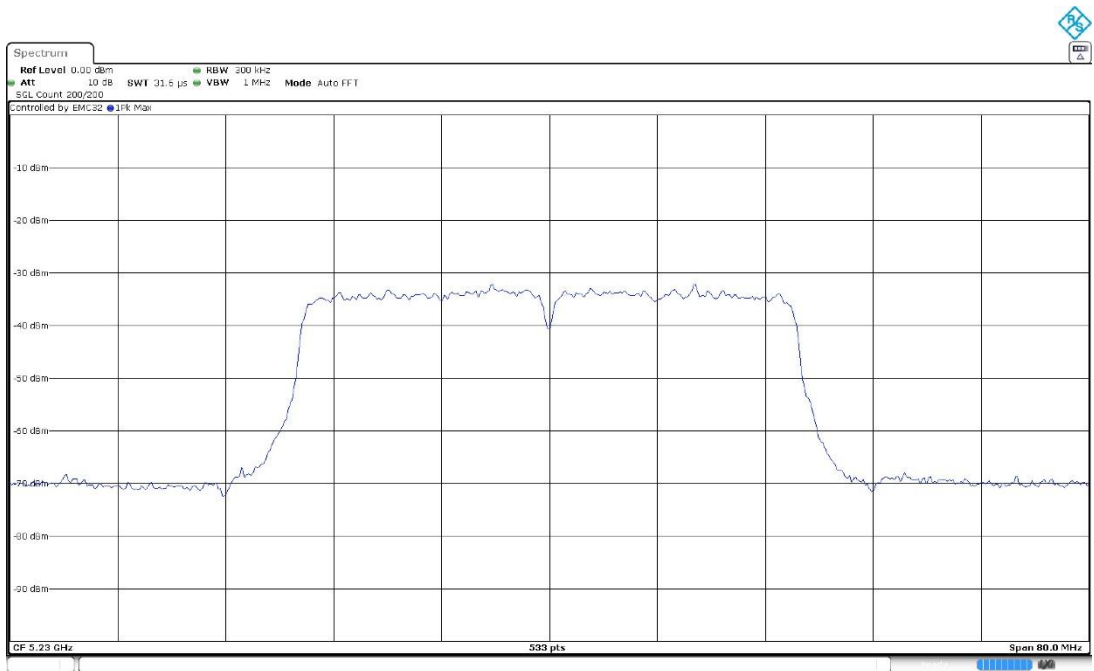
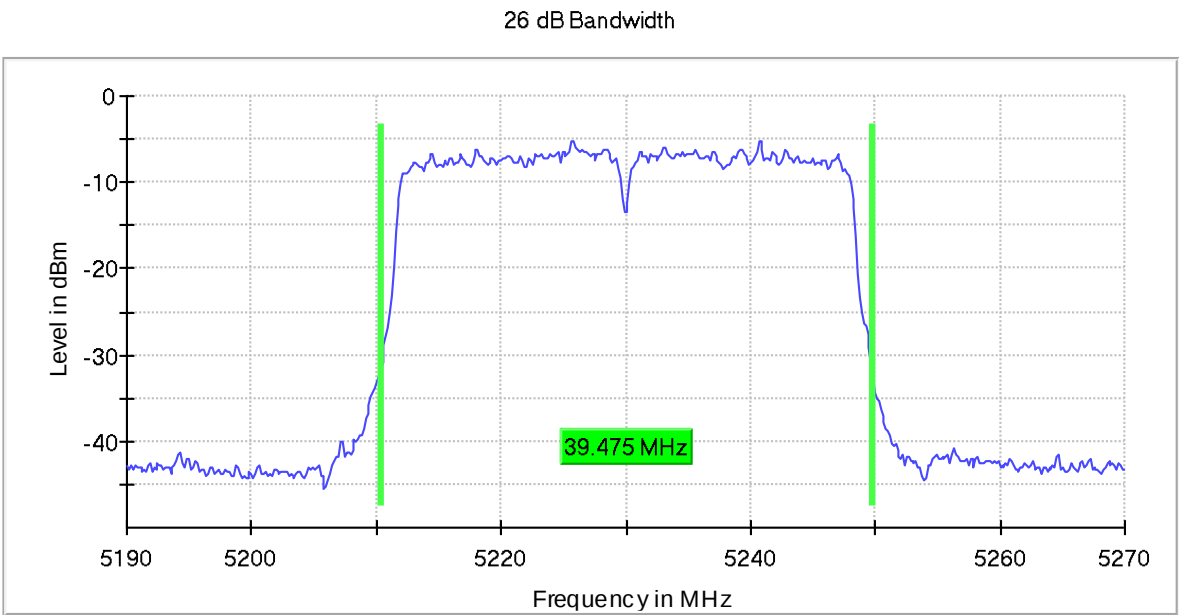
Modulation: 802.11ac VHT40 (OFDM MCS0)

U-NII-1 FCC (5150-5250 MHz)

- Low Channel 38 (5190 MHz):

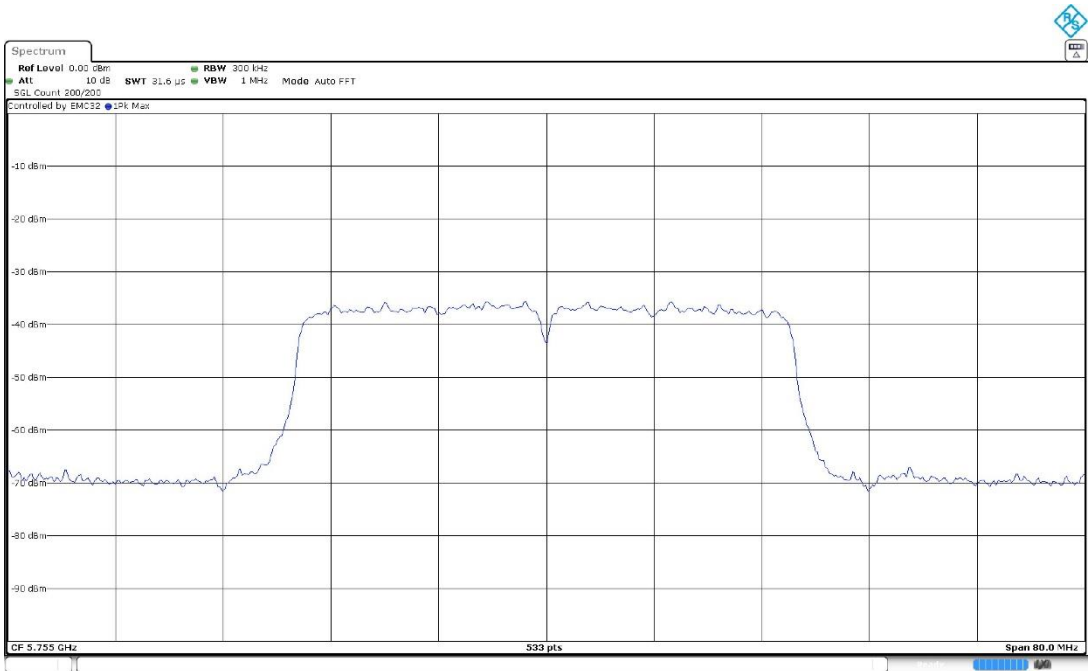
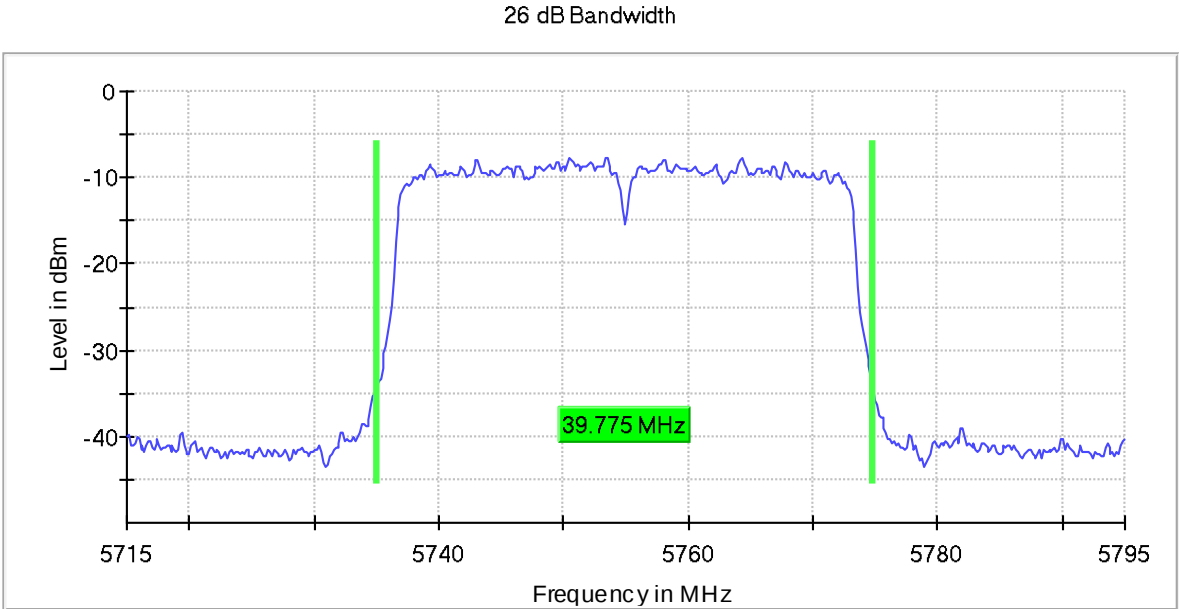


- High Channel 46 (5230 MHz):



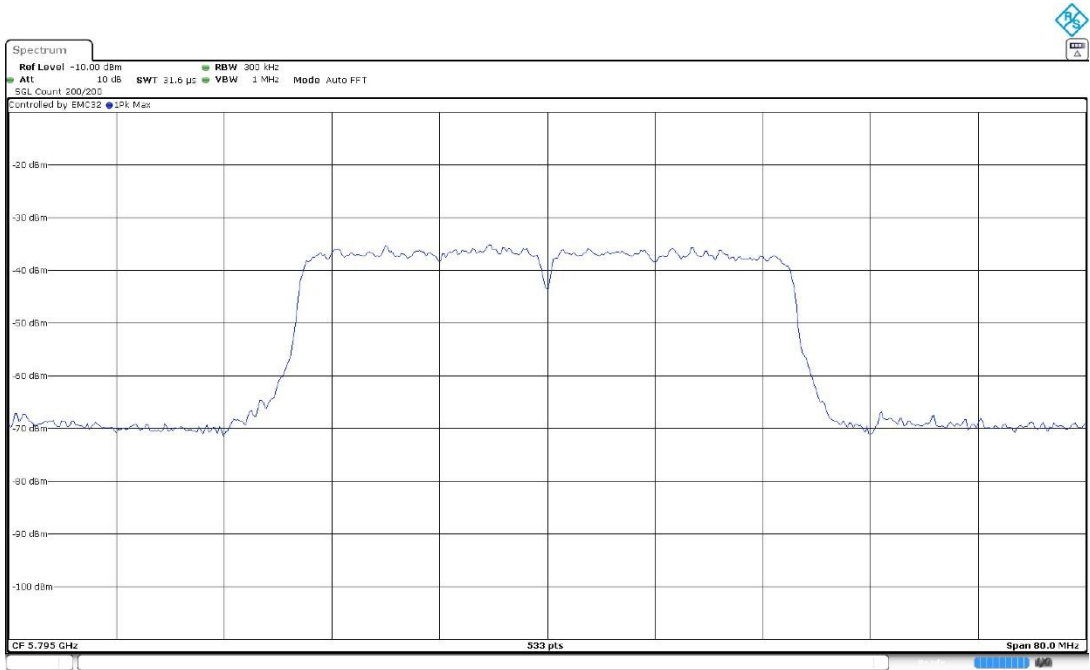
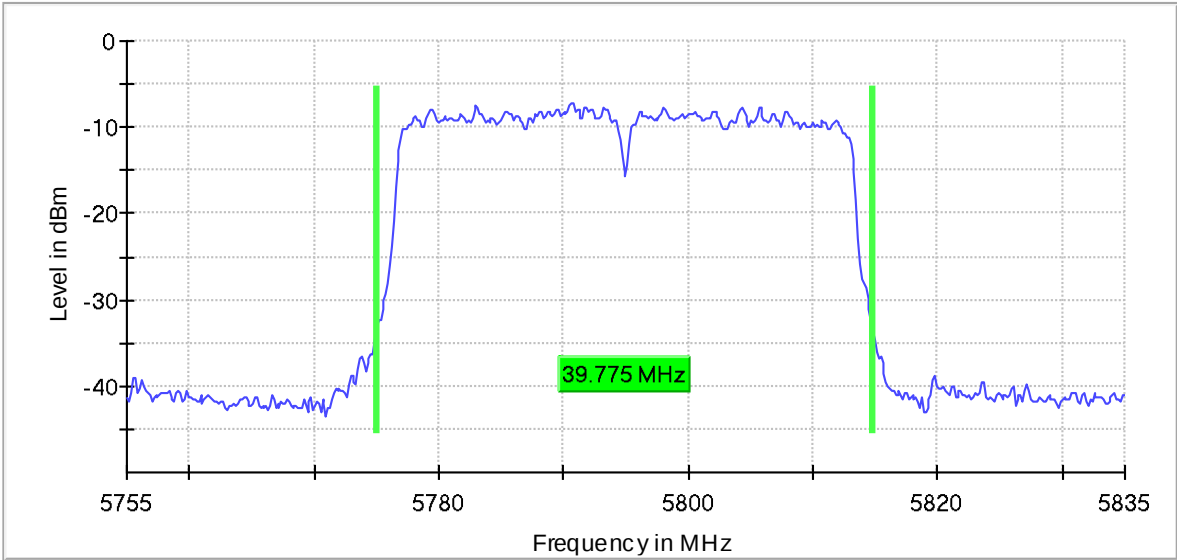
U-NII-3 (5725-5850 MHz)

- Low Channel 151 (5755 MHz):



- High Channel 159 (5795 MHz):

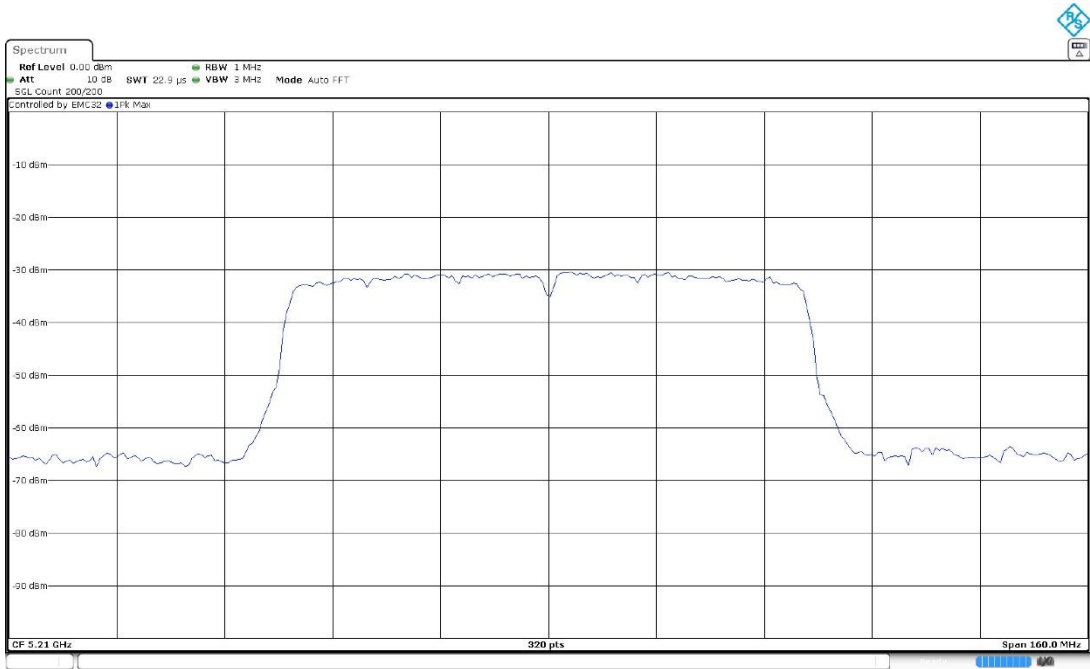
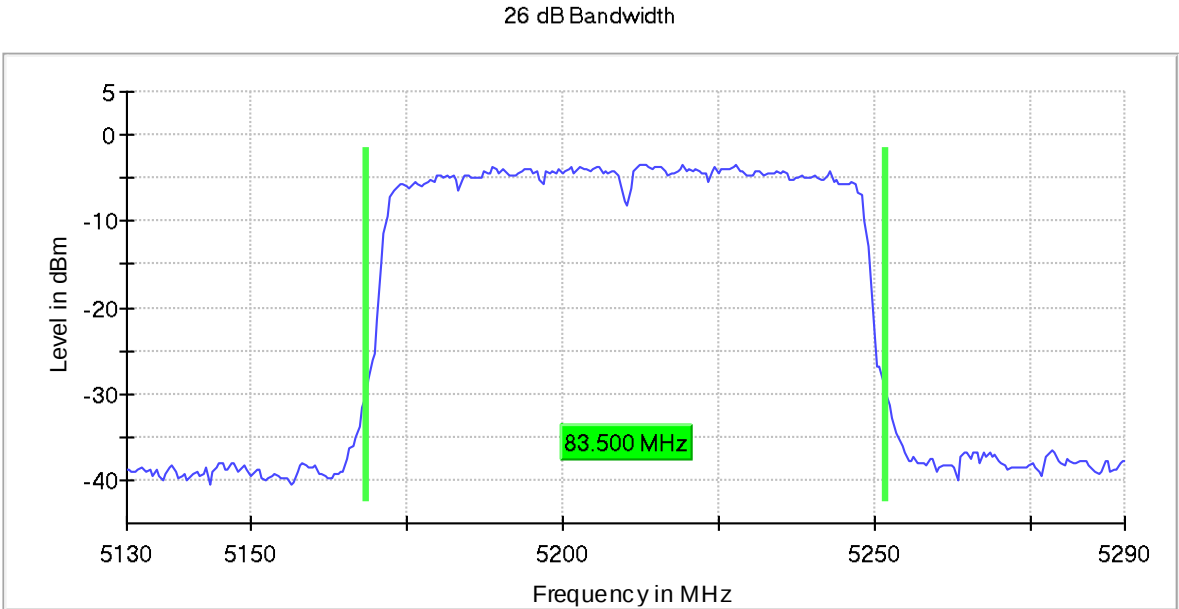
26 dB Bandwidth



Modulation: 802.11ac VHT80 (OFDM MCS0)

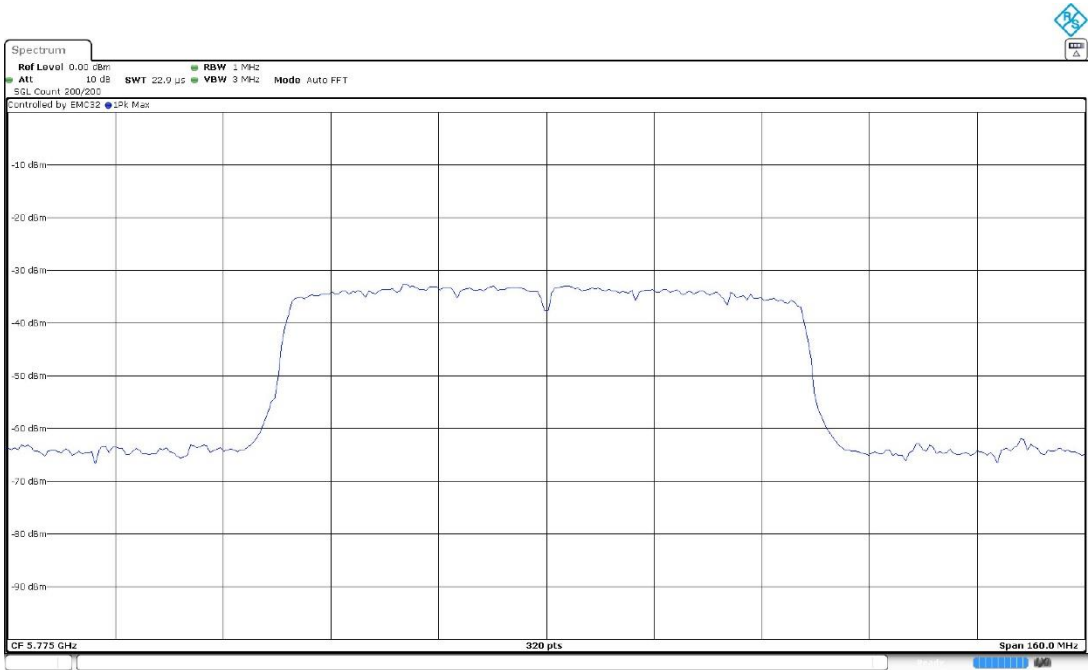
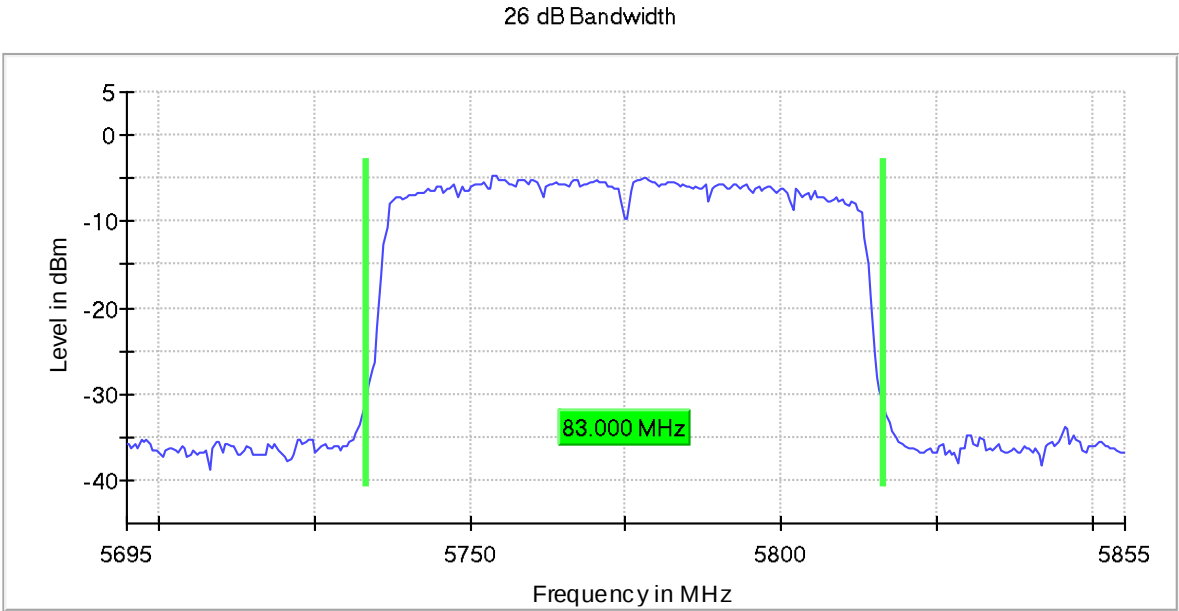
U-NII-1 FCC (5150-5250 MHz)

- Single Channel 42 (5210 MHz):



U-NII-3 (5725-5850 MHz)

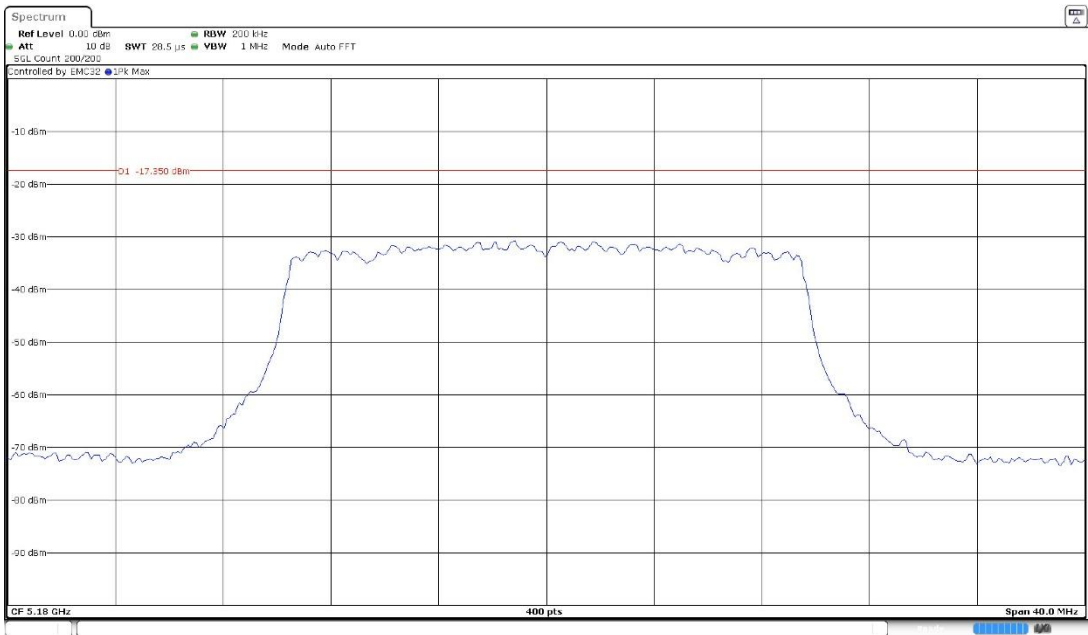
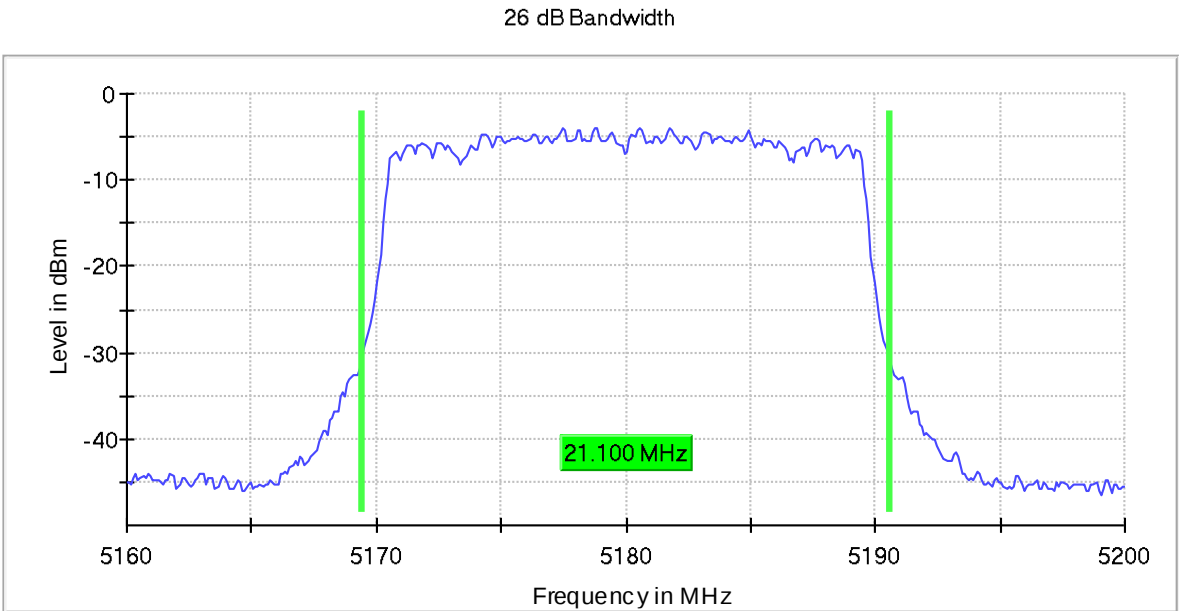
- Single Channel 155 (5775 MHz):



Modulation: 802.11ax HE20 (OFDMA MCS0) – SU

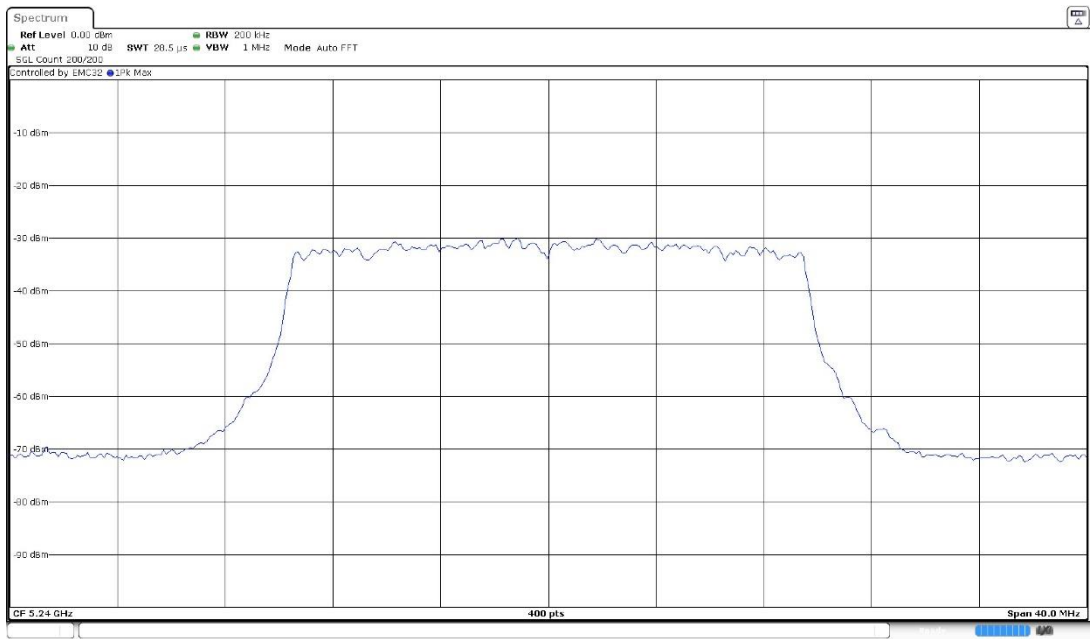
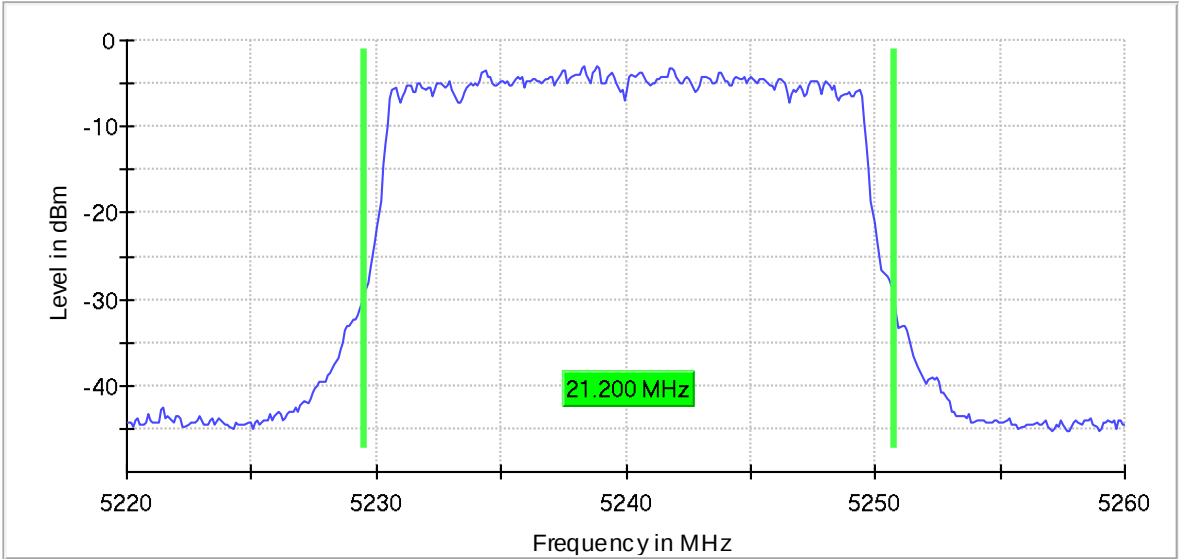
U-NII-1 FCC (5150-5250 MHz)

- Low Channel 36 (5180 MHz):



- High Channel 48 (5240 MHz):

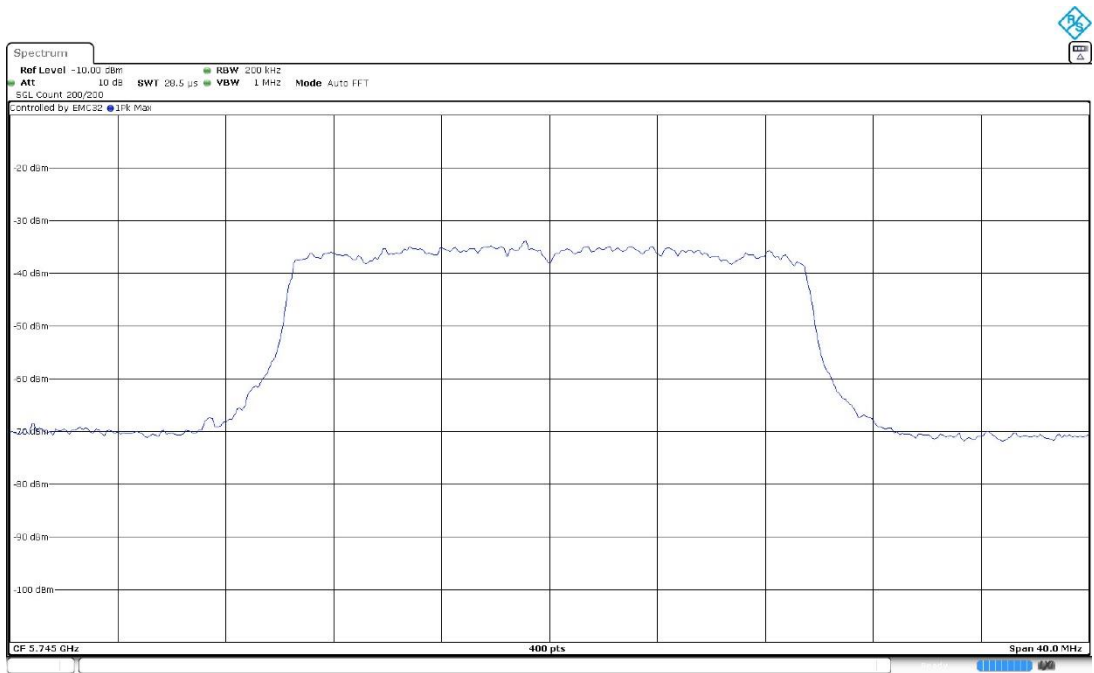
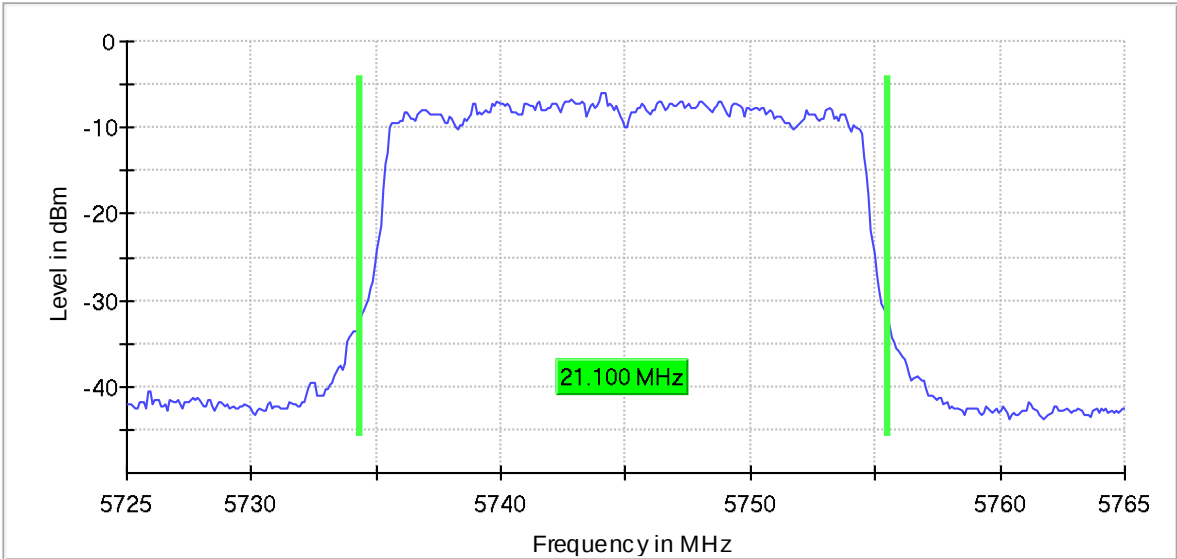
26 dB Bandwidth



U-NII-3 (5725-5850 MHz)

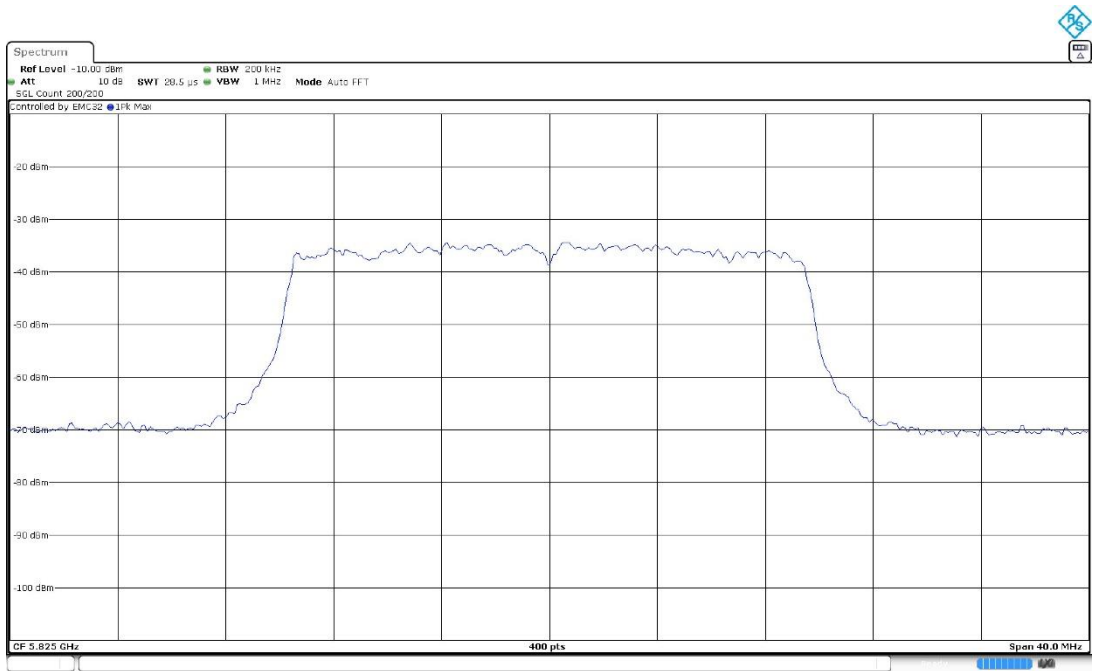
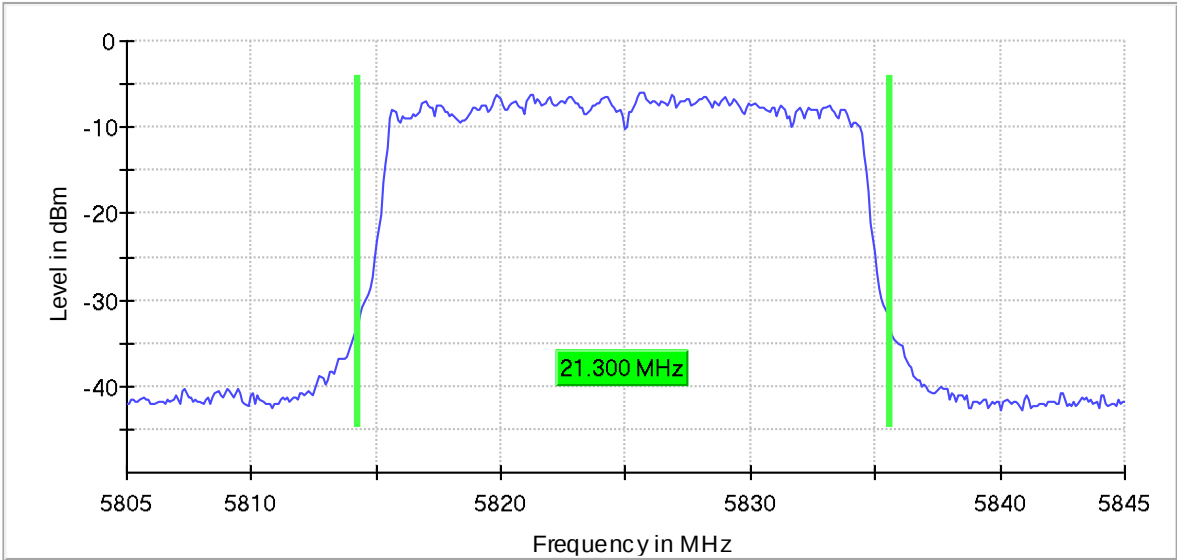
- Low Channel 149 (5745 MHz):

26 dB Bandwidth



- High Channel 165 (5825 MHz):

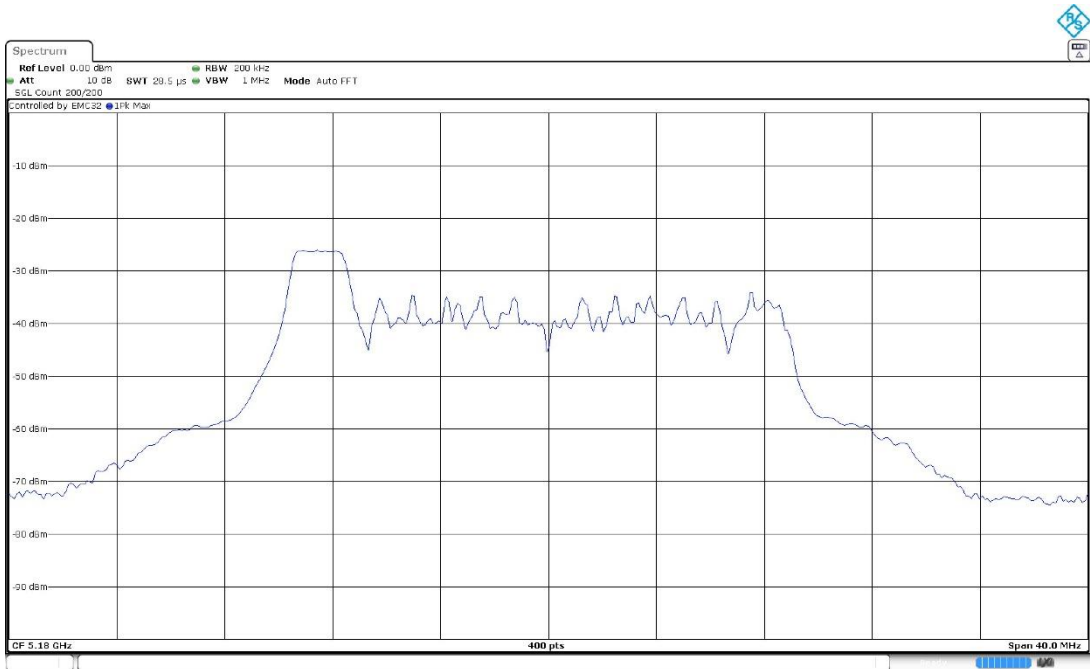
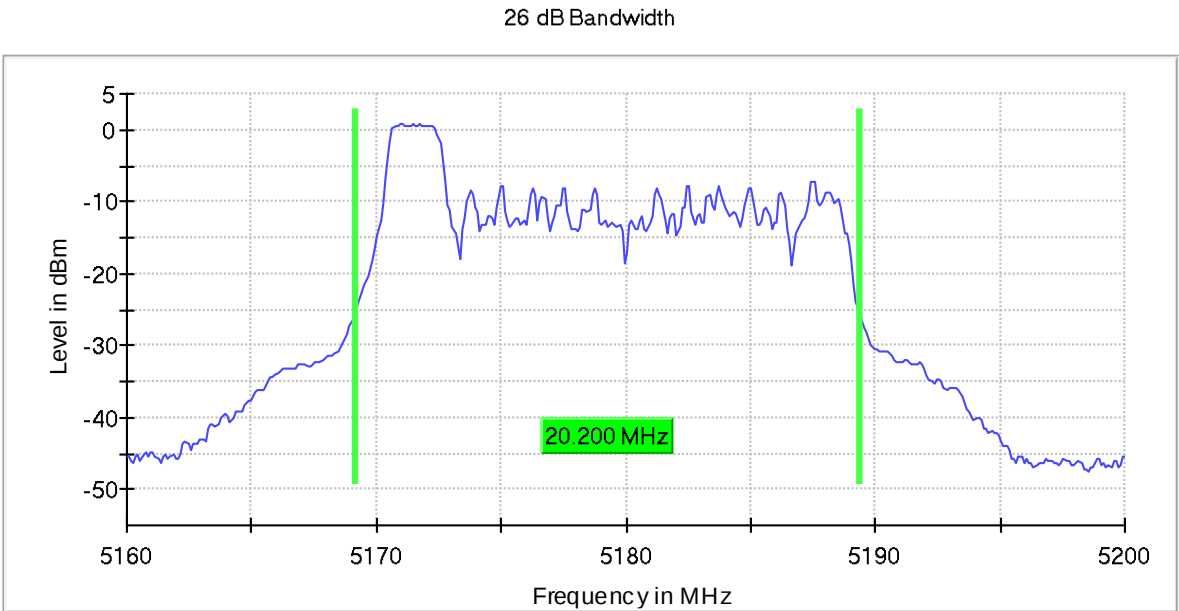
26 dB Bandwidth



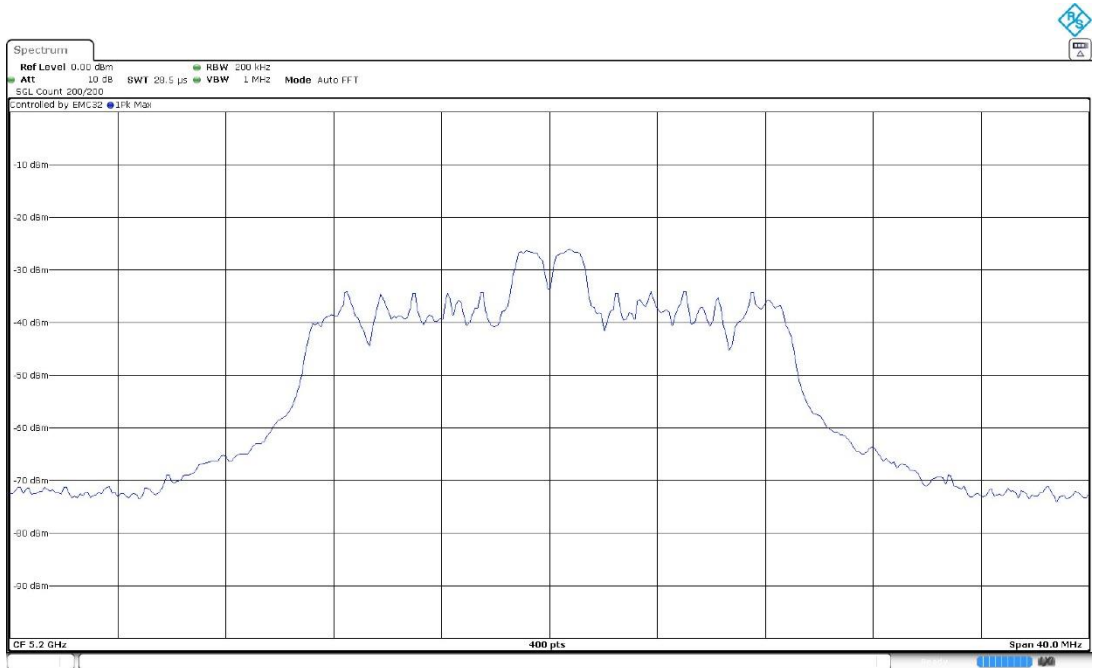
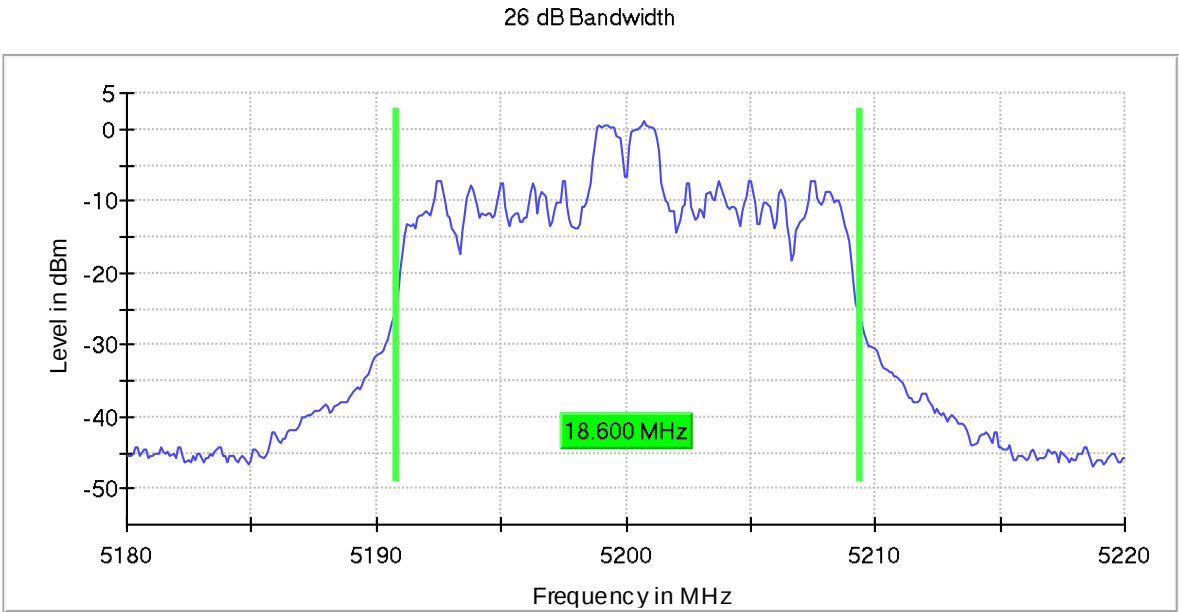
Modulation: 802.11ax HE20 (OFDMA MCS0) – RU

U-NII-1 FCC (5150-5250 MHz)

- Low Channel 36 (5180 MHz):

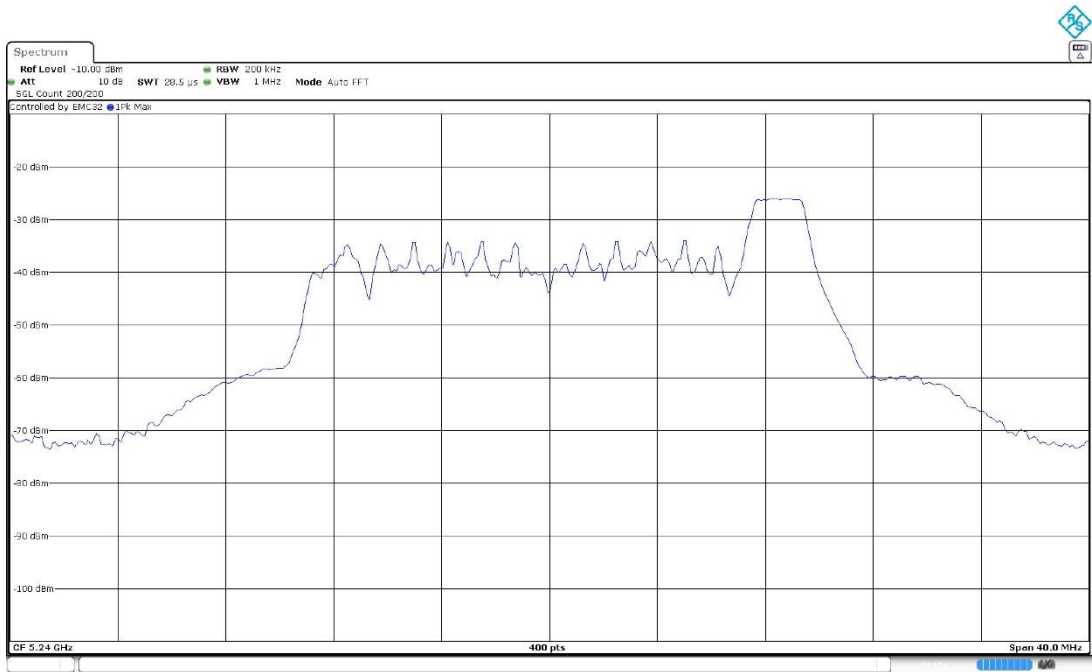
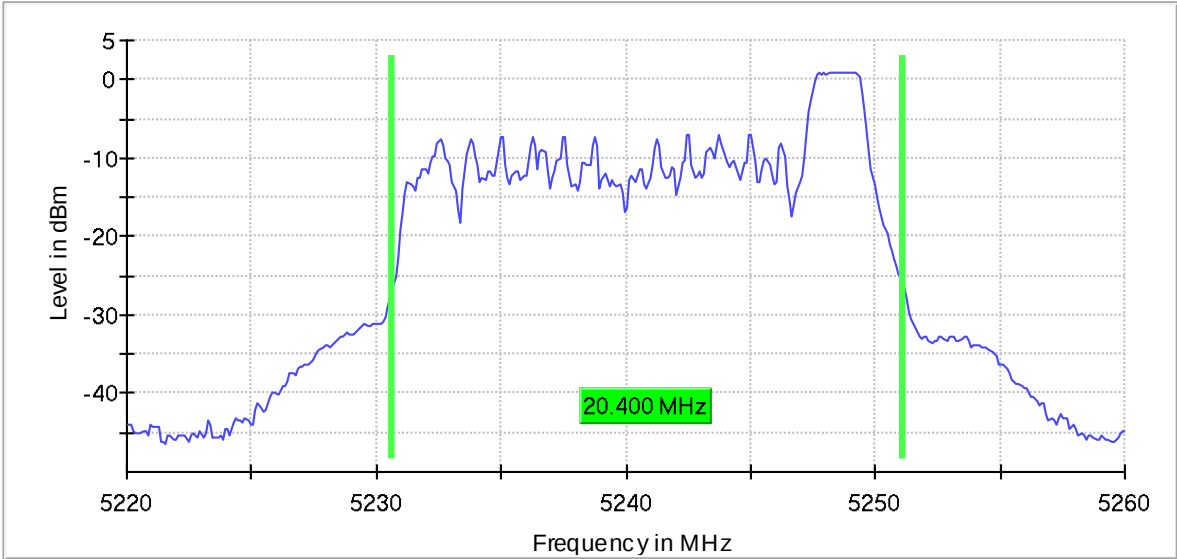


- Middle Channel 36 (5200 MHz):



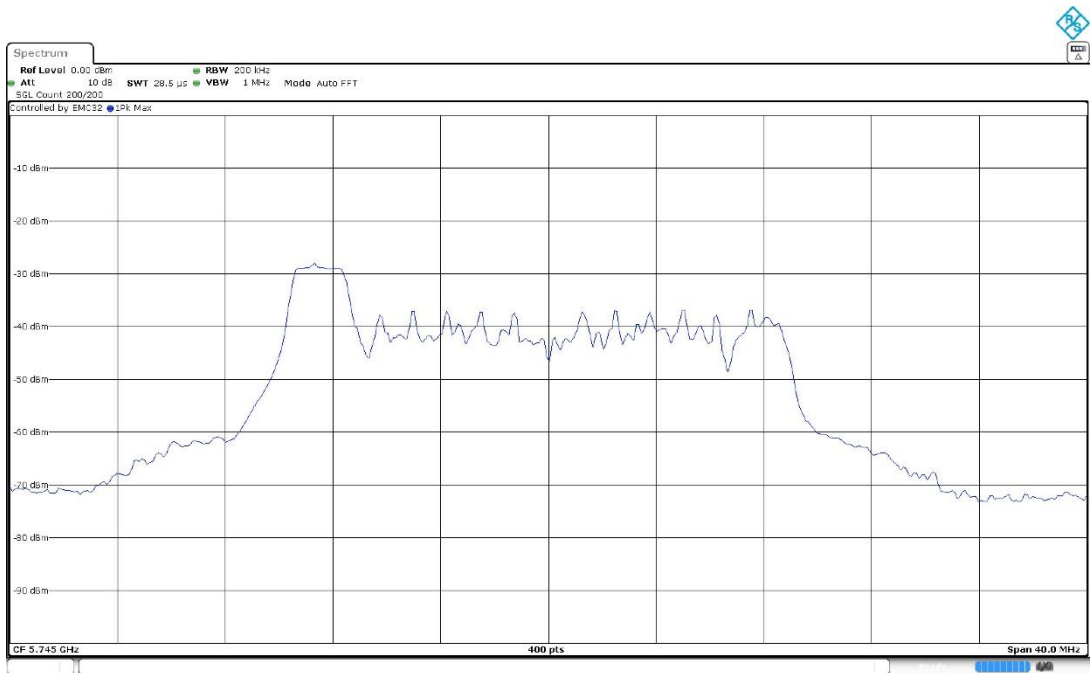
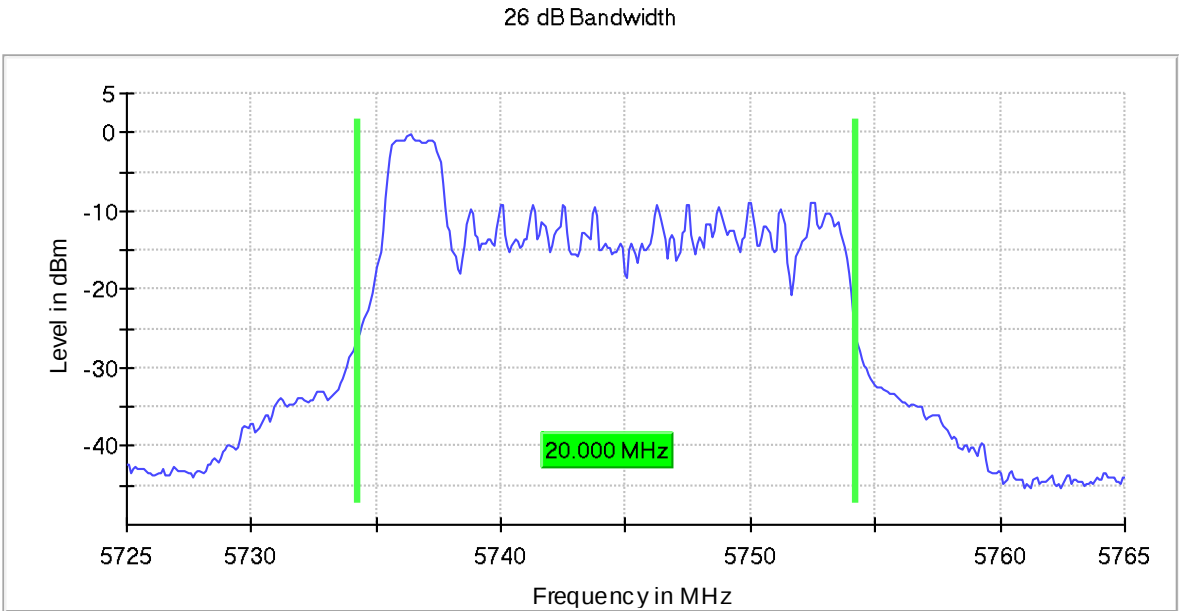
- High Channel 48 (5240 MHz):

26 dB Bandwidth

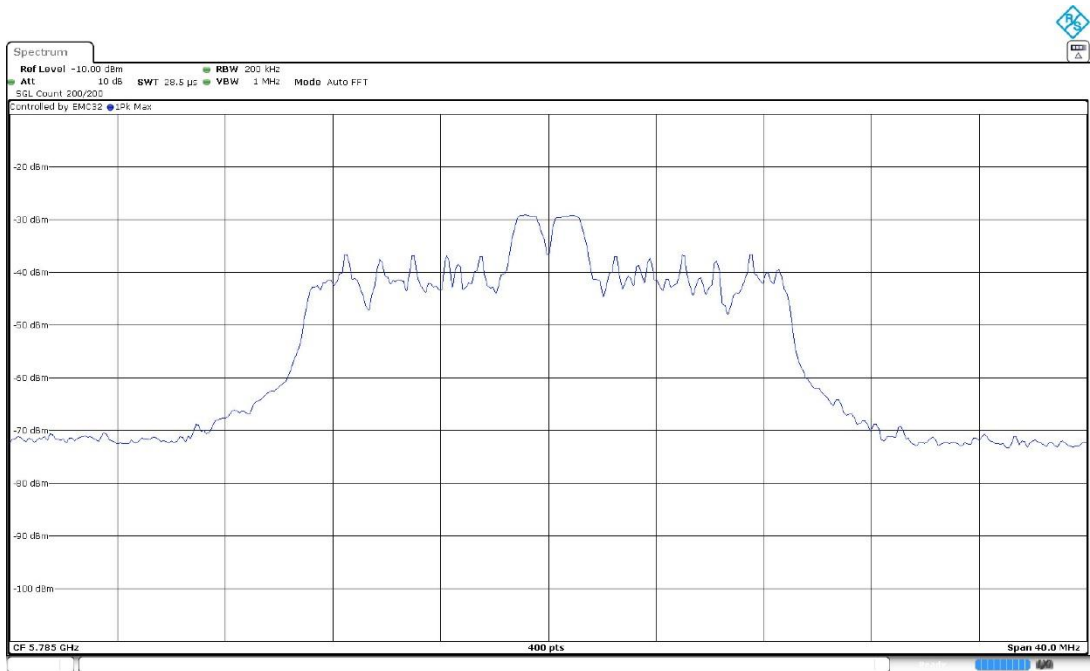
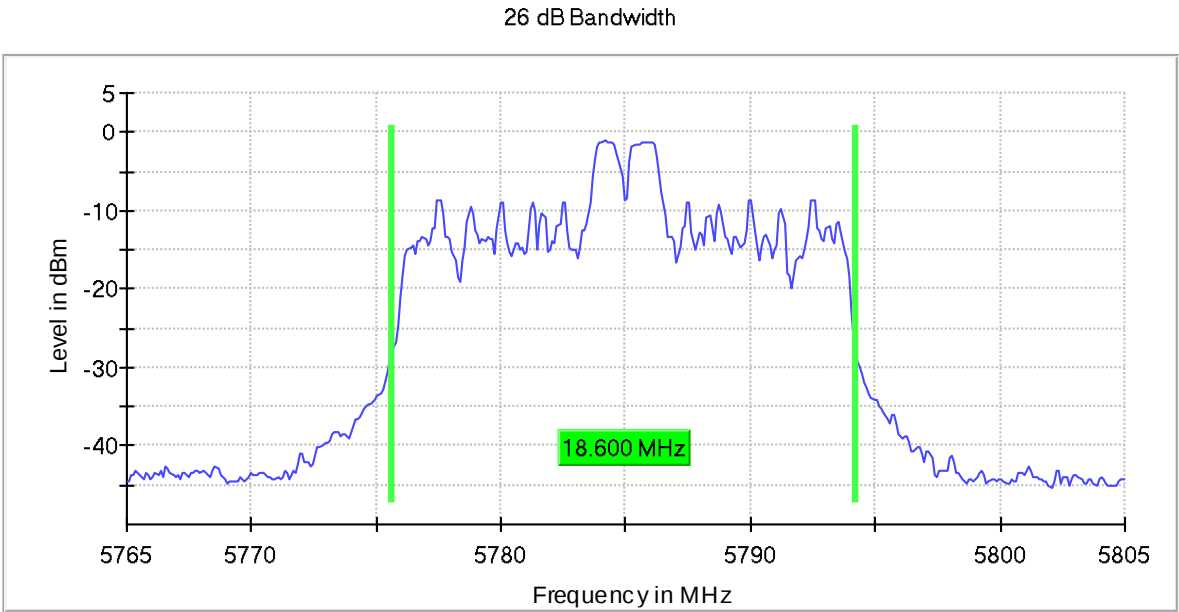


U-NII-3 (5725-5850 MHz)

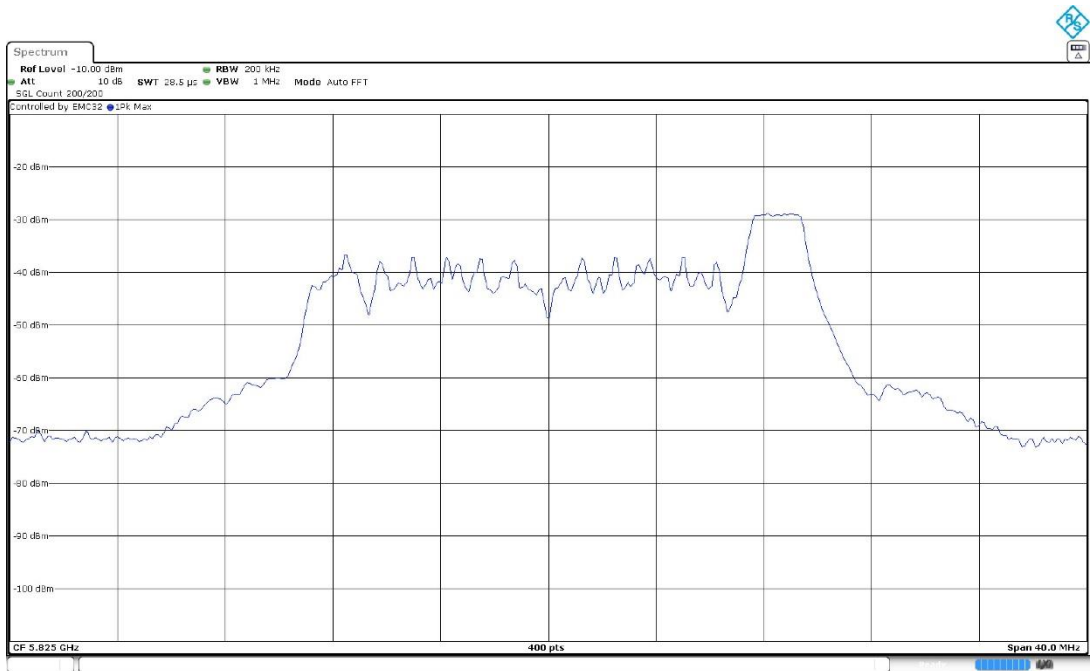
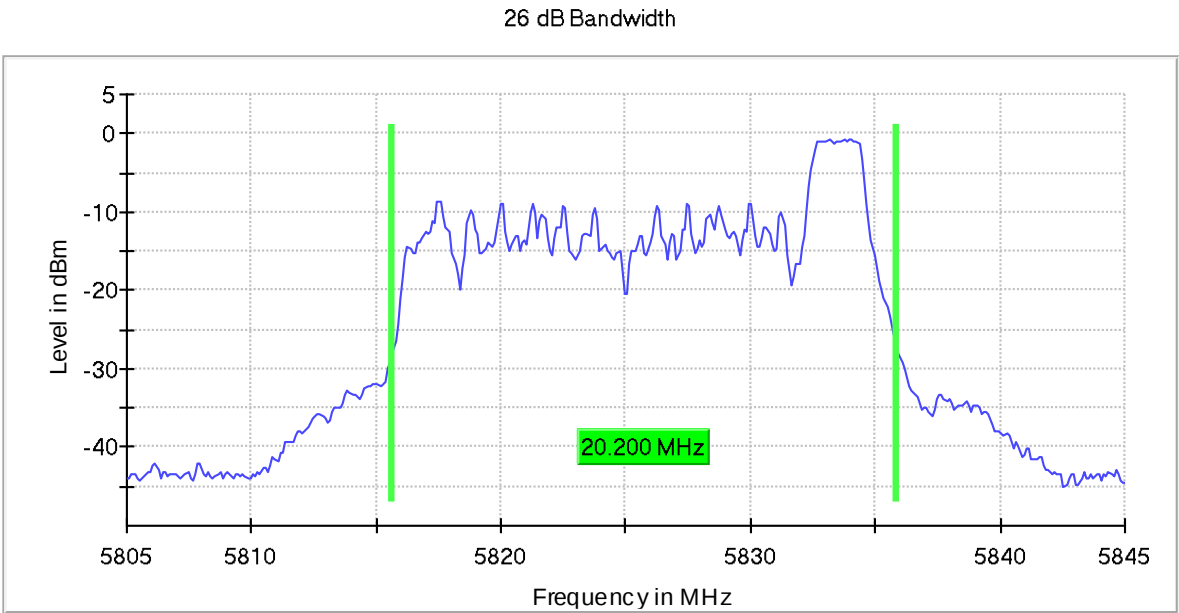
- Low Channel 149 (5745 MHz):



- Middle Channel 165 (5785 MHz):



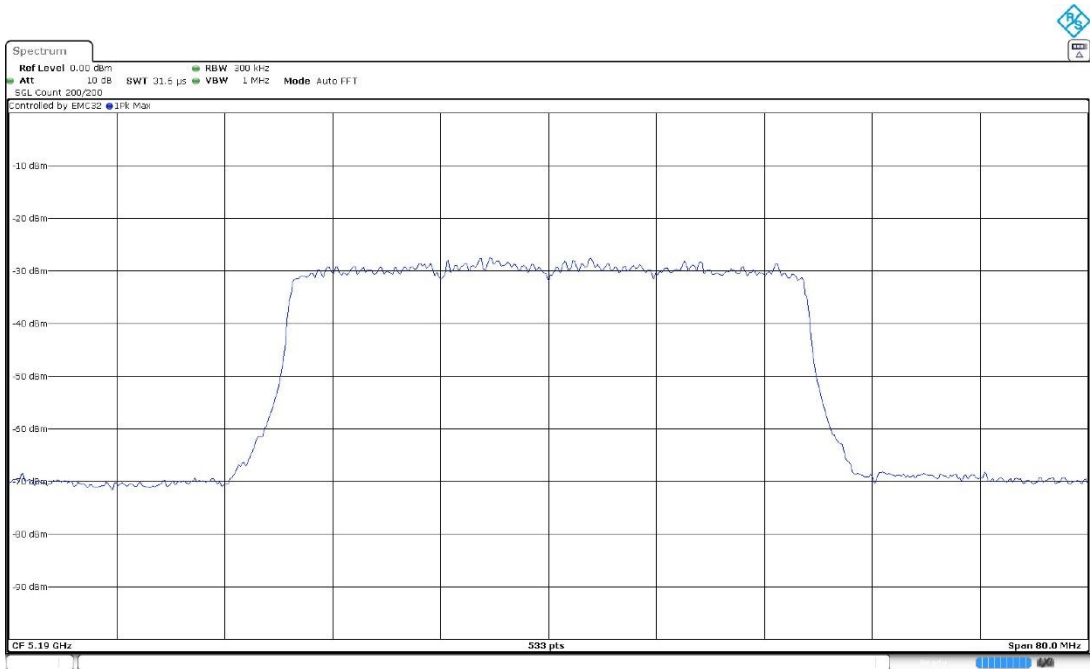
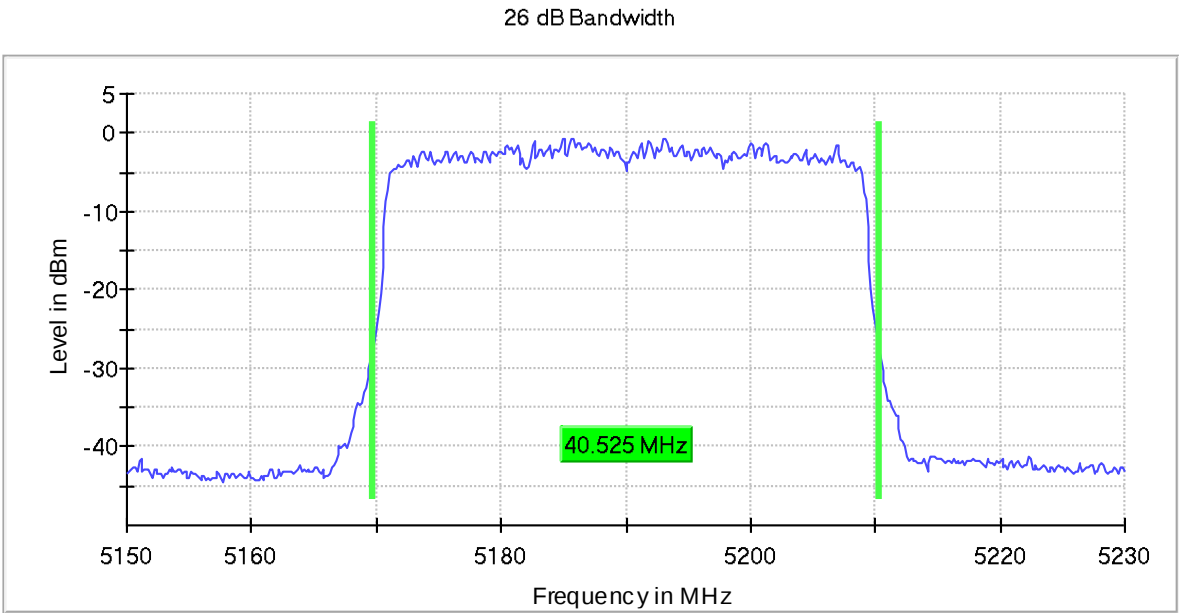
- High Channel 165 (5825 MHz):



Modulation: 802.11ax HE40 (OFDMA MCS0) – SU

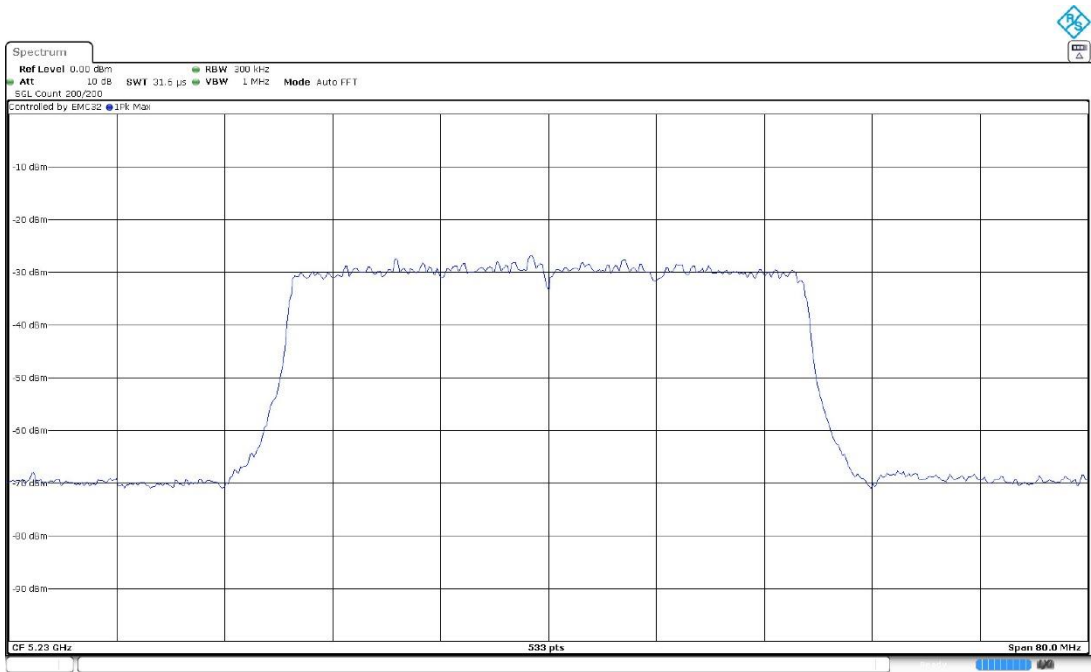
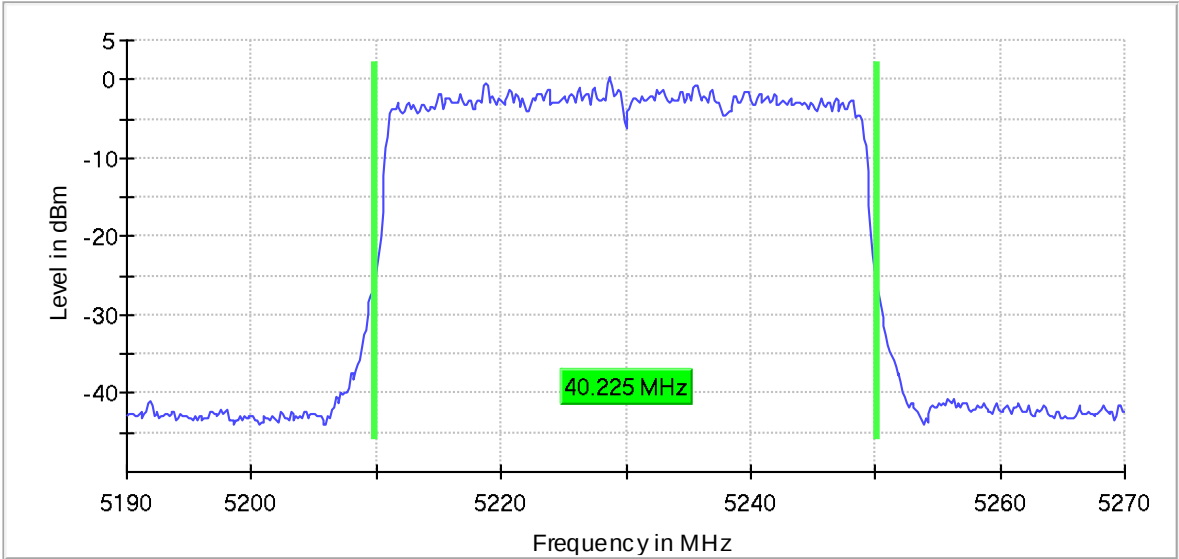
U-NII-1 FCC (5150-5250 MHz)

- Low Channel 38 (5190 MHz):



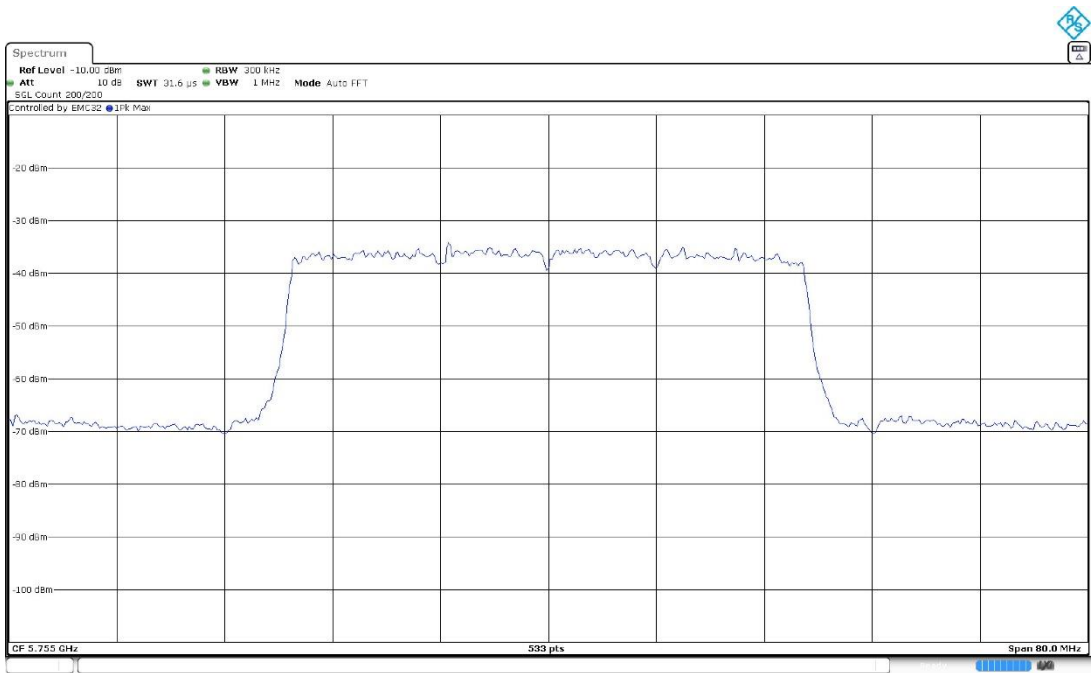
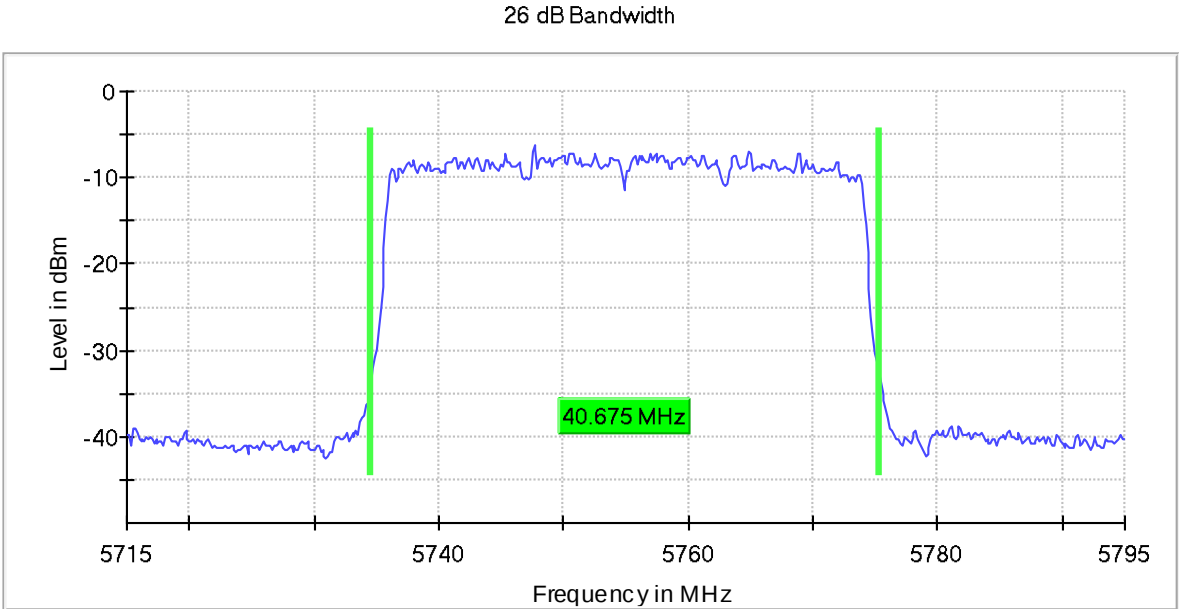
- High Channel 46 (5230 MHz):

26 dB Bandwidth

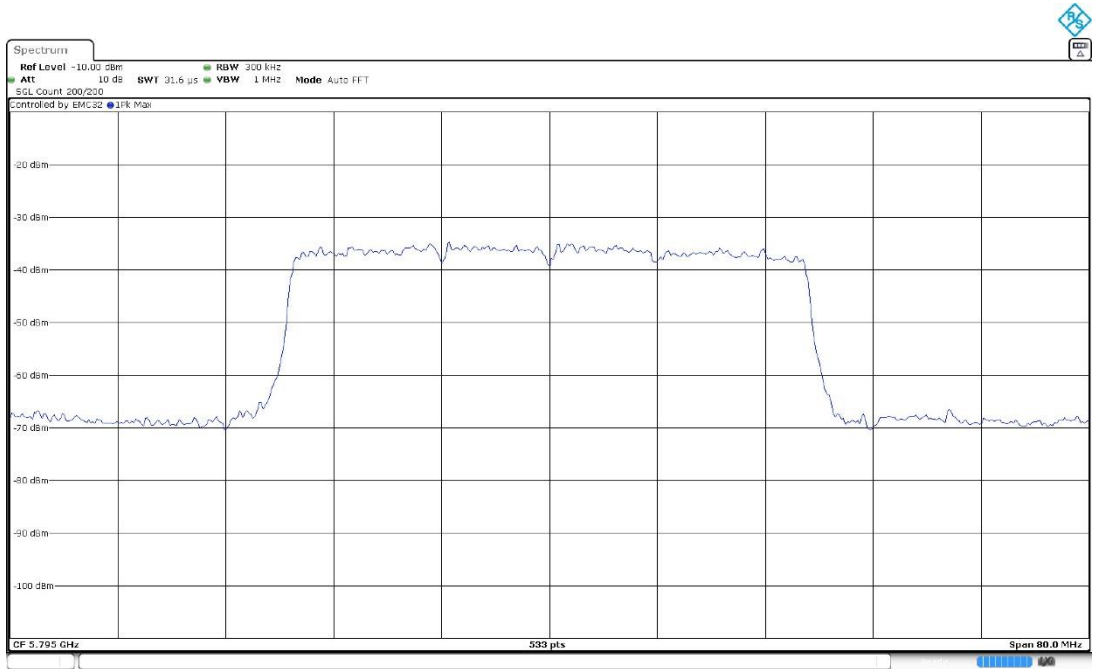
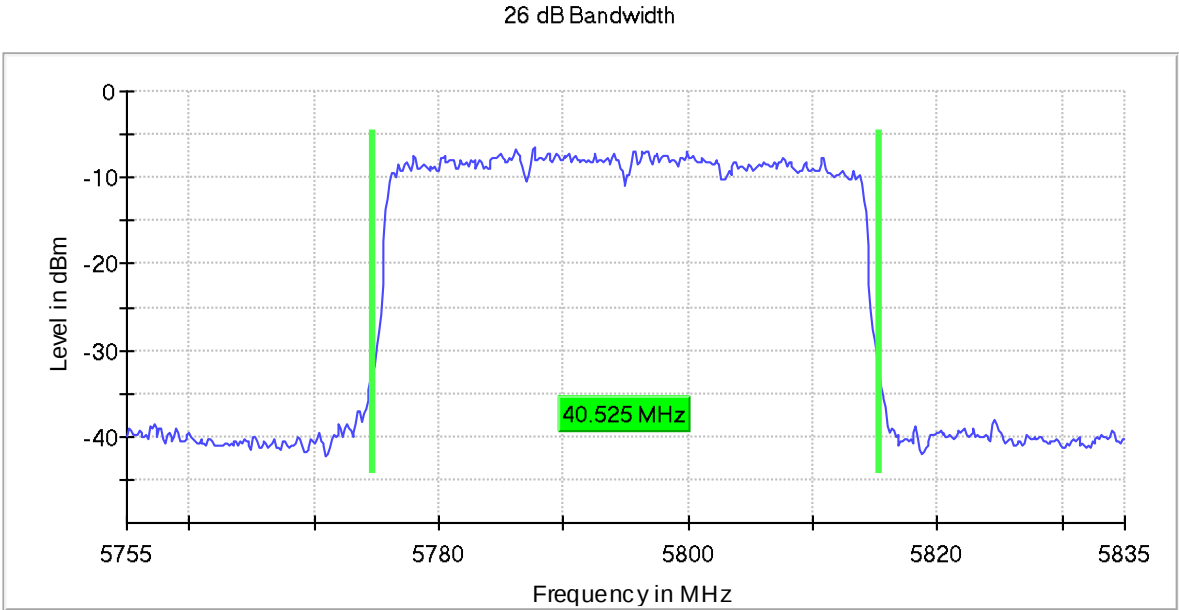


U-NII-3 (5725-5850 MHz)

- Low Channel 151 (5755 MHz):



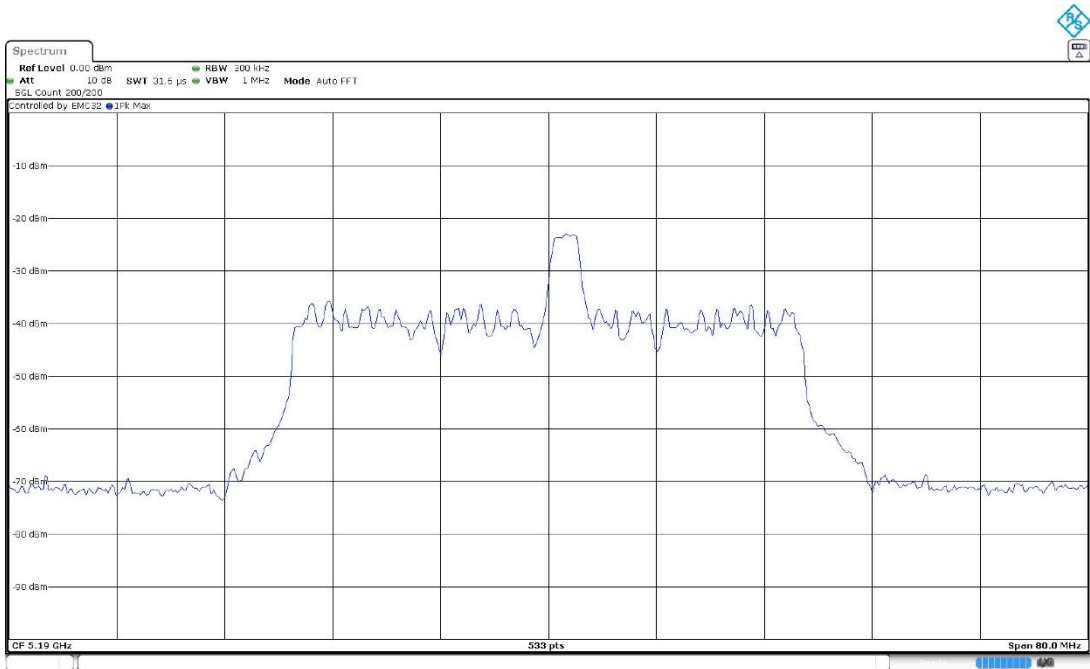
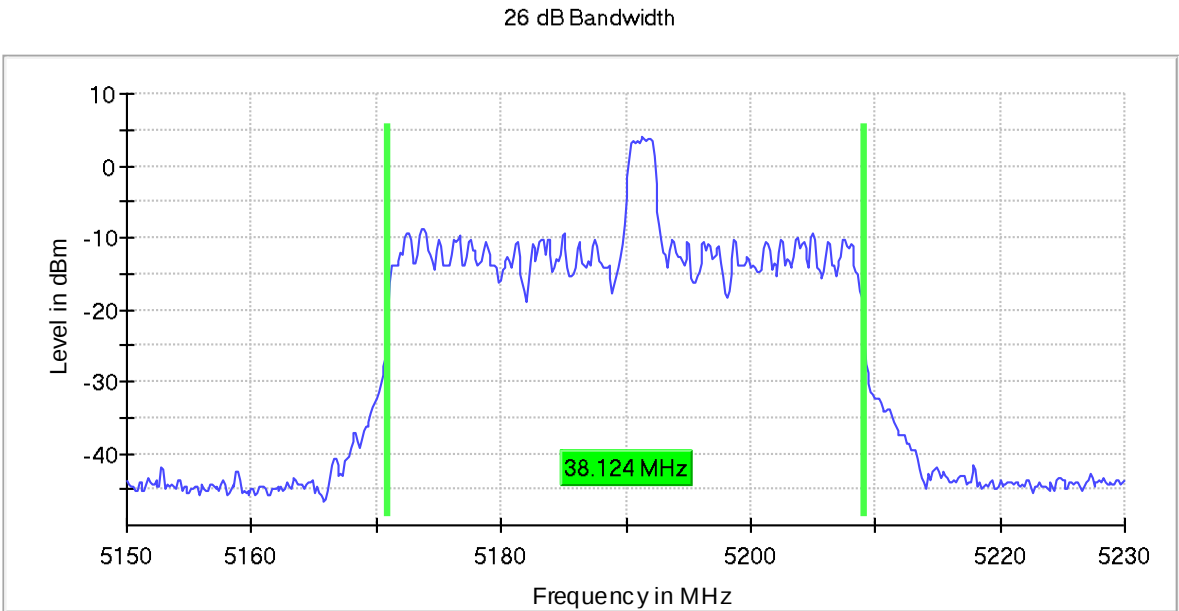
- High Channel 159 (5825 MHz):



Modulation: 802.11ax HE40 (OFDMA MCS0) – RU

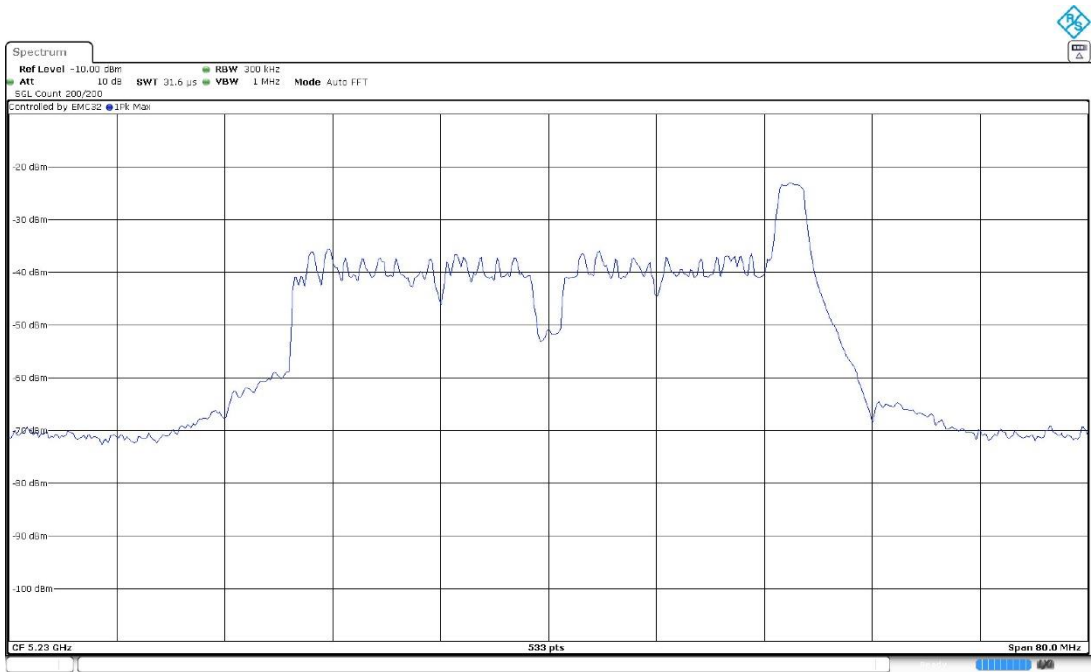
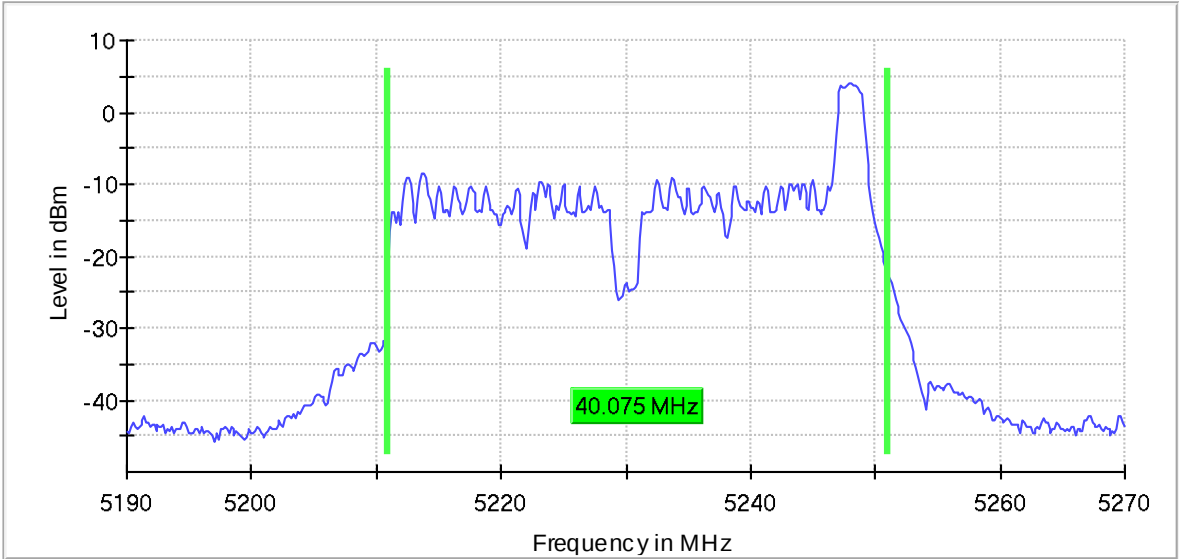
U-NII-1 FCC (5150-5250 MHz)

- Low Channel 38 (5190 MHz):



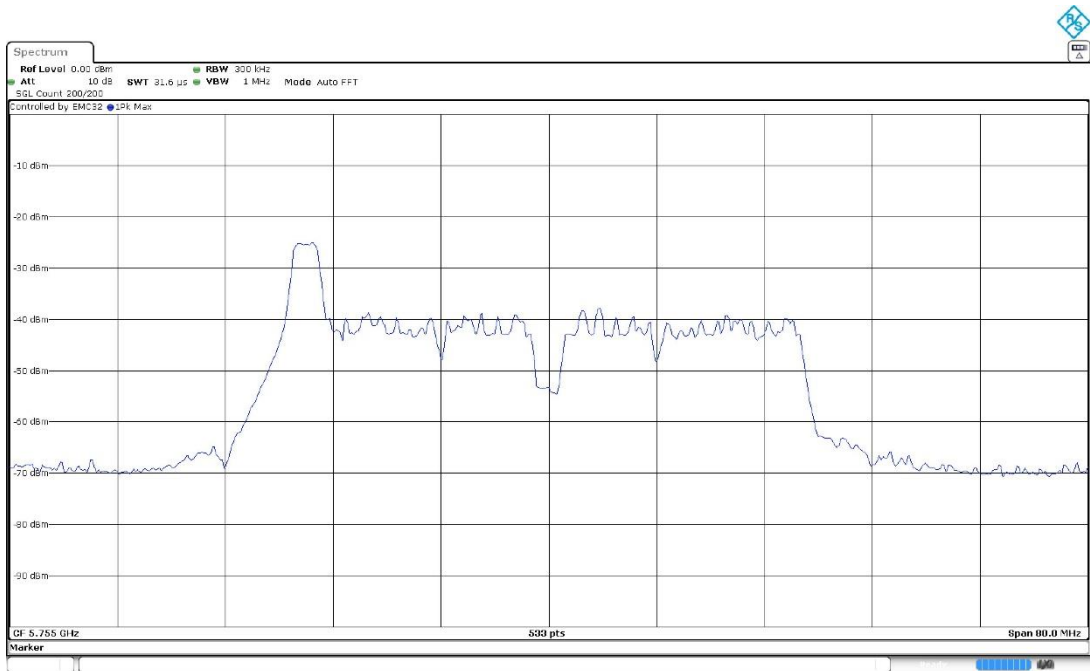
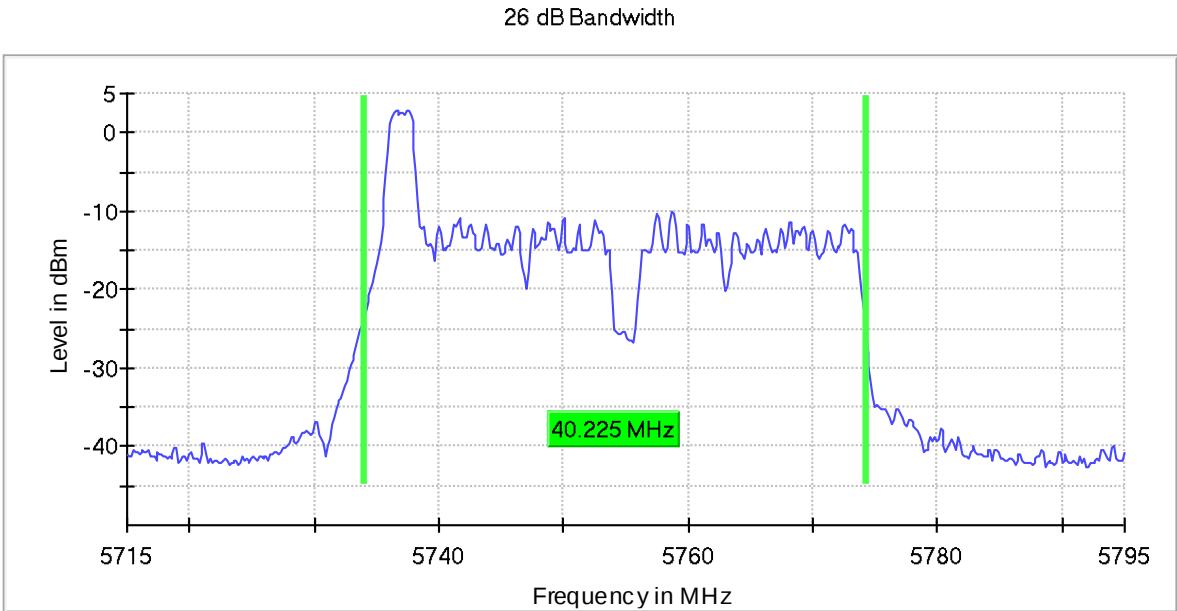
- High Channel 46 (5230 MHz):

26 dB Bandwidth

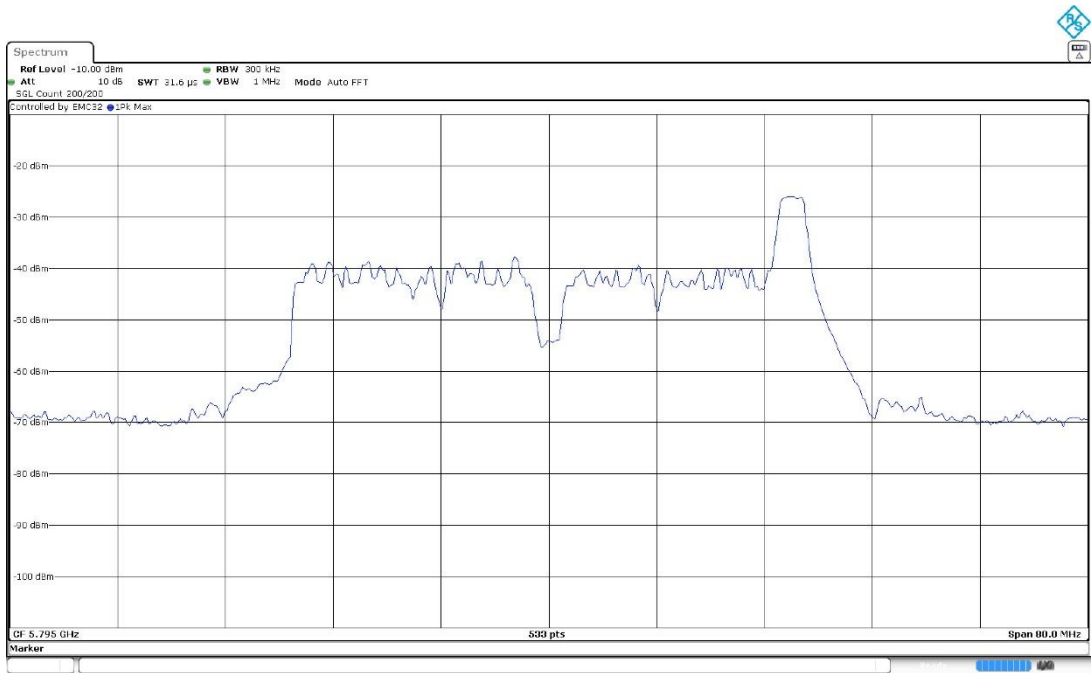
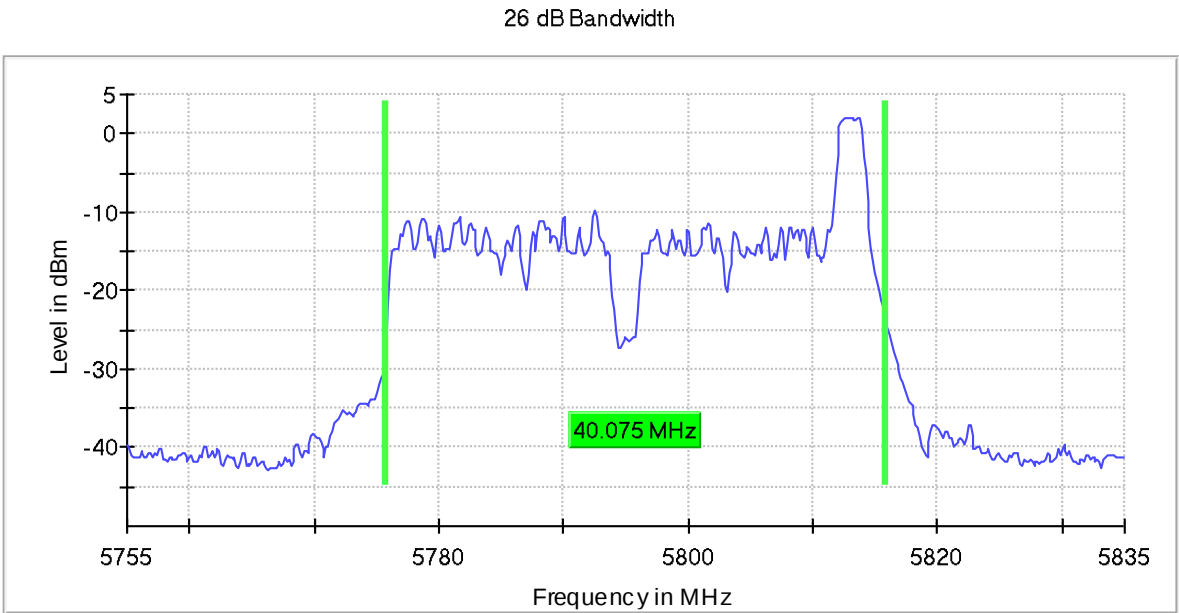


U-NII-3 (5725-5850 MHz)

- Low Channel 151 (5755 MHz):



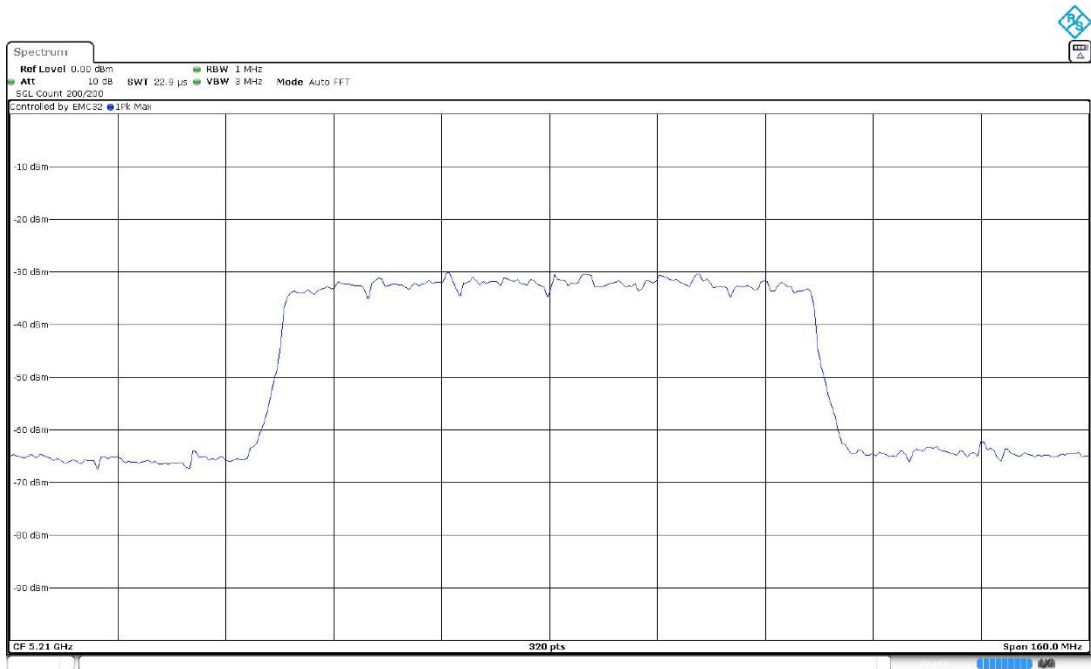
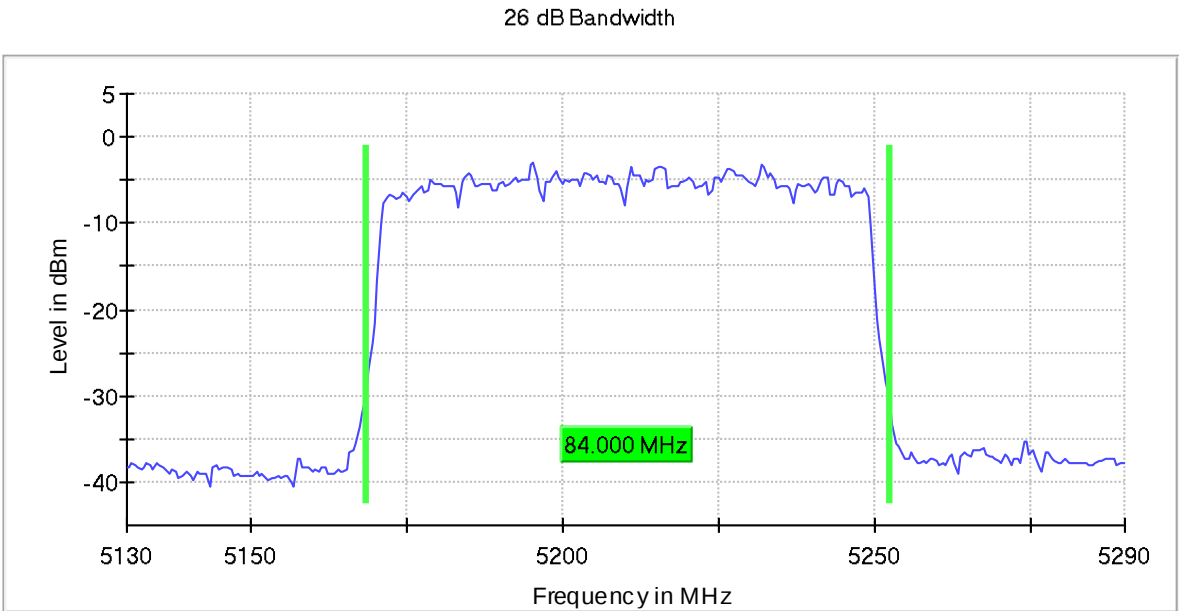
- High Channel 159 (5825 MHz):



Modulation: 802.11ax HE80 (OFDMA MCS0) – SU

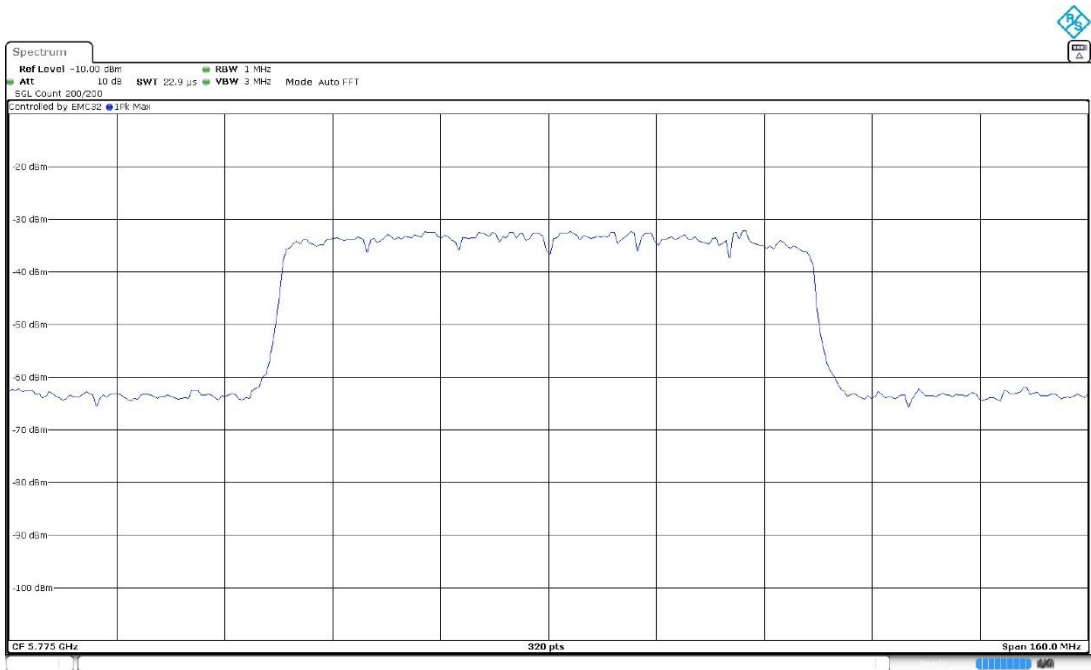
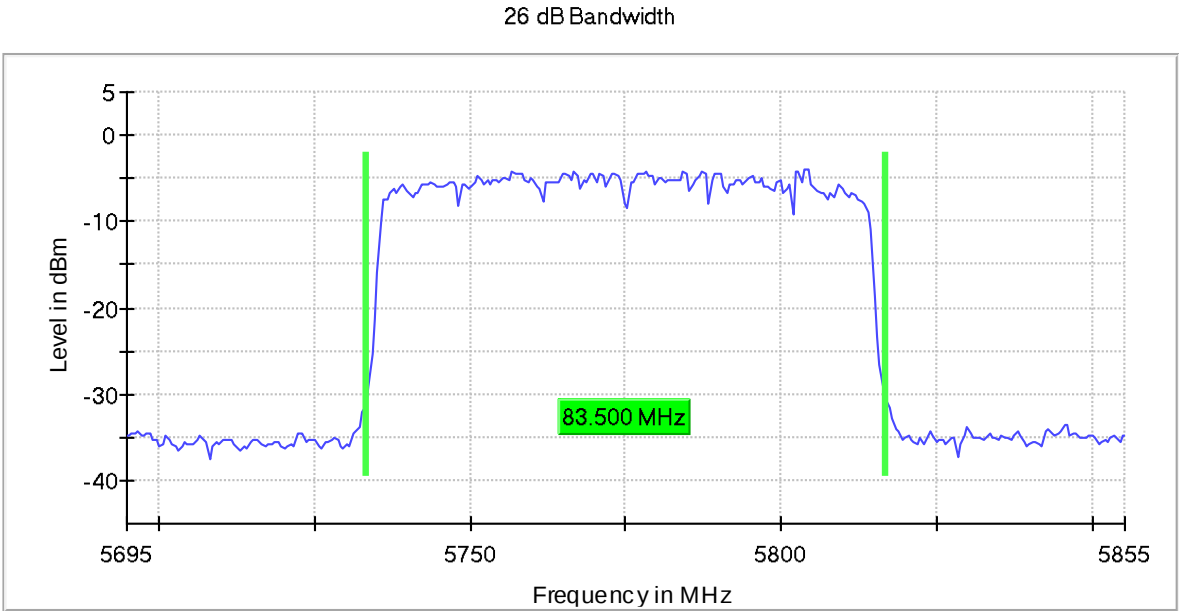
U-NII-1 FCC (5150-5250 MHz)

- Single Channel 42 (5210 MHz):



U-NII-3 (5725-5850 MHz)

- Single Channel 155 (5775 MHz):

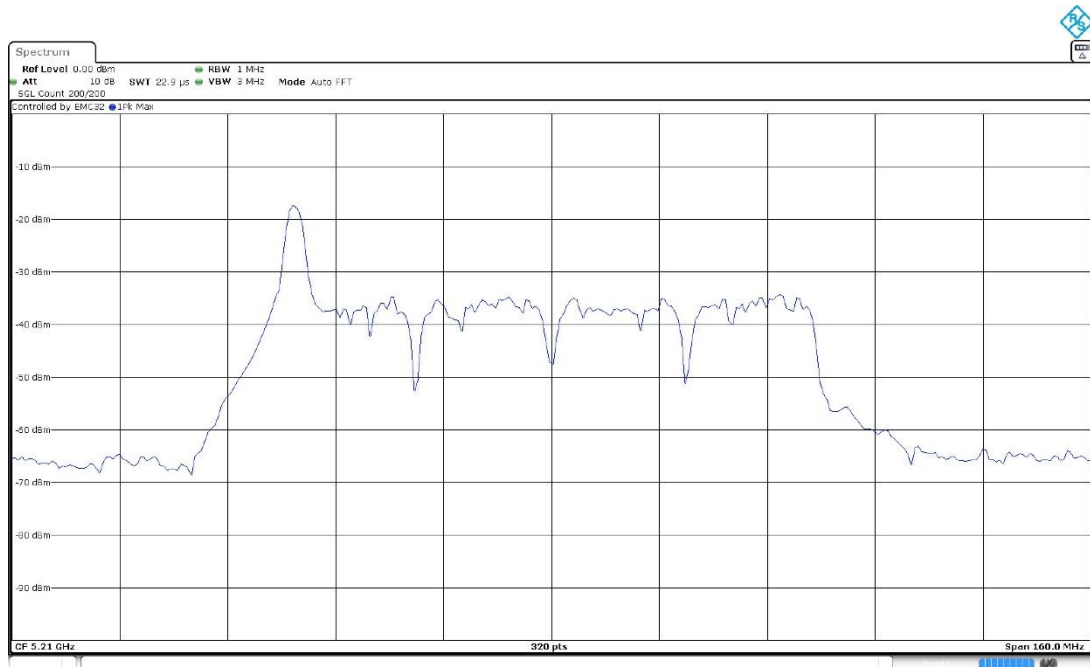


Modulation: 802.11ax HE80 (OFDMA MCS0) – RU

U-NII-1 FCC (5150-5250 MHz)

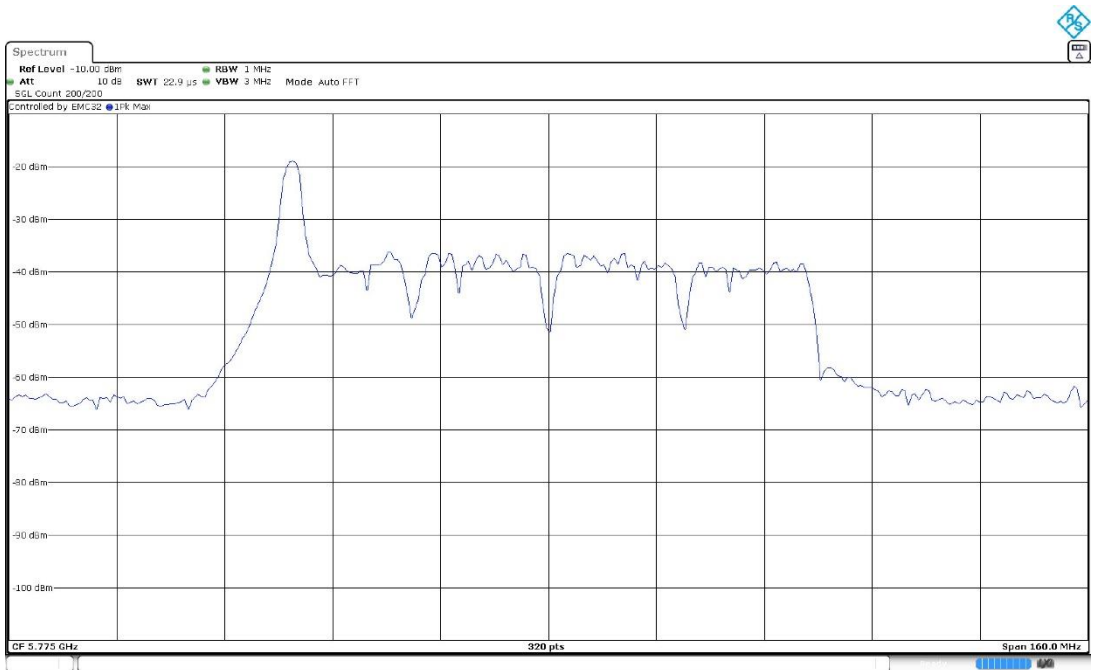
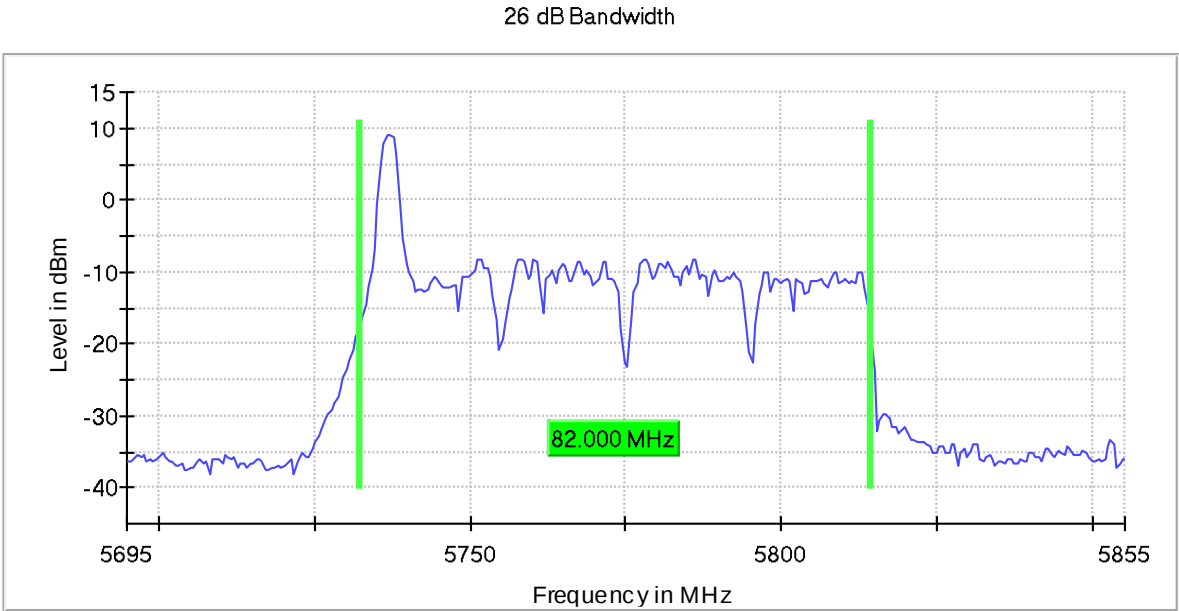
- Single Channel 42 (5210 MHz):

26 dB Bandwidth



U-NII-3 (5725-5850 MHz)

- Single Channel 155 (5775 MHz):



Appendix B: Tests results for the U-NII-1 Band 5.15–5.25 GHz

TEST CONDITIONS	121
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TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	12 Vdc
Type of Power Supply:	Vehicle battery

ANTENNA (*):

Type of Antenna:	External
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Directional Antenna Gain Calculations for CDD MIMO In-Band Measurements:

For 2Tx CDD MIMO modes, in accordance with KDB 662911 D01 v02r01 Section F)2)f)(i), directional gain was calculated as follows:

- For power spectral density (PSD) measurements on all devices:

$$N_{SS} = 1, N_{ANT} = 2, G_{ANT0} = 5.1, G_{ANT1} = 5.1$$

$$Array\ Gain = 10 \log \left[\frac{N_{ANT}}{N_{SS}} \right] = 10 \log \left[\frac{2}{1} \right] = 3.01\ dB$$

$$\textbf{Directional gain} = G_{ANT} + Array\ Gain = 5.1 + 3.01 = \textbf{8.11 dB}$$

- For power measurements on IEEE 802.11 devices:

$$Array\ Gain = 0\ dB\ for\ N_{ANT} \leq 4$$

$$\textbf{Directional gain} = G_{ANT} + Array\ Gain = 5.1 + 0 = \textbf{5.10 dB}$$

POWER ADJUSTMENT (*):	8 dBm
-----------------------	-------

TEST FREQUENCIES (*):

Technology Tested:	WLAN (IEEE 802.11 a,n,ac,ax) 2x2 / U-NII-1	
	802.11 n HT20: MCS0 to MCS23 (MIMO 2x2)	
	802.11 n HT40: MCS0 to MCS23 (MIMO 2x2)	
	802.11 ac VHT20: MCS0 to MCS9 (MIMO 2x2)	
	802.11 ac VHT40: MCS0 to MCS9 (MIMO 2x2)	
	802.11 ac VHT80: MCS0 to MCS9 (MIMO 2x2)	
	802.11 ax HE20: MCS0 to MCS11 (MIMO 2x2) – SU/RU	
	802.11 ax HE40: MCS0 to MCS11 (MIMO 2x2) – SU/RU	
	802.11 ax HE80: MCS0 to MCS11 (MIMO 2x2) – SU/RU	
Setting of cores / ports:	3+4	
Beamforming:	No.	
Frequency Range:	5150 MHz to 5250 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 36	5180
	Middle: 40	5200
	High: 48	5240
Channel Spacing:	40 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 38	5190
	High: 46	5230
Channel Spacing:	80 MHz	
Transmit Channels	Middle: 42	5210

* The EUT does not support the Middle Channel of 802.11ax HE20 (OFDMA MCS0) SU modulation.

The test set-up was made in accordance to 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 in all required channels using the supported data rates/modulations types.

The field strength at the band edges was evaluated for each mode on the lowest and highest channels at the rated power for the channel under test.

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 for output power and spurious levels at the band edges which were selected based on preliminary testing that correspond to next data rates:

- 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
- 802.11 ax HE20: MCS0
- 802.11 ax HE40: MCS0
- 802.11 ax HE80: MCS0

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1.5 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

For radiated emissions in the range 17 GHz-26 GHz that is 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.

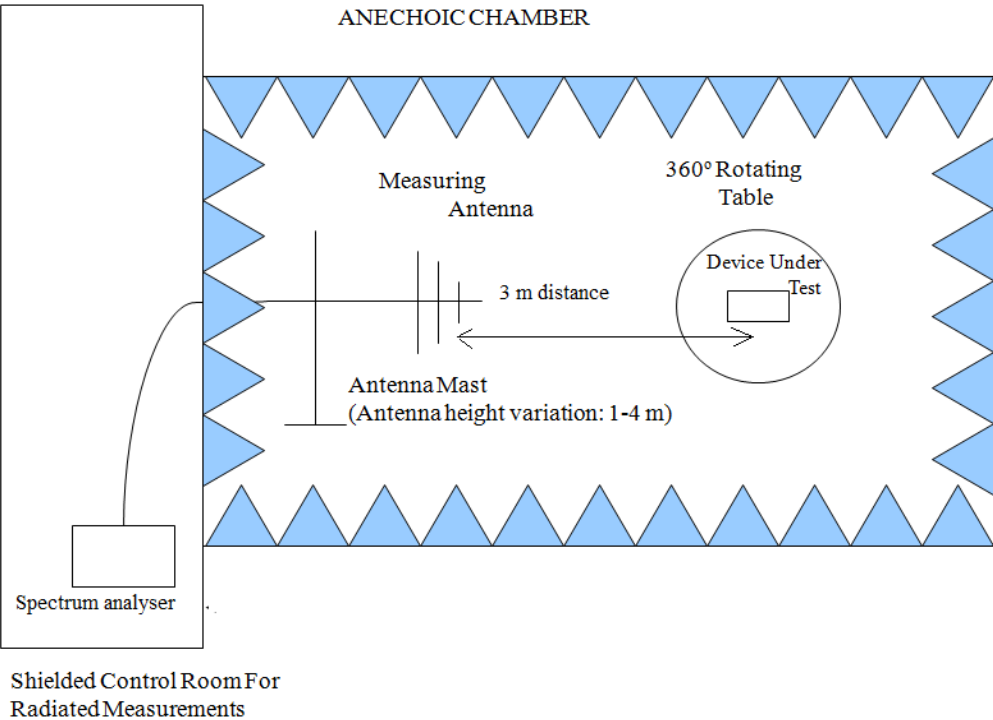
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

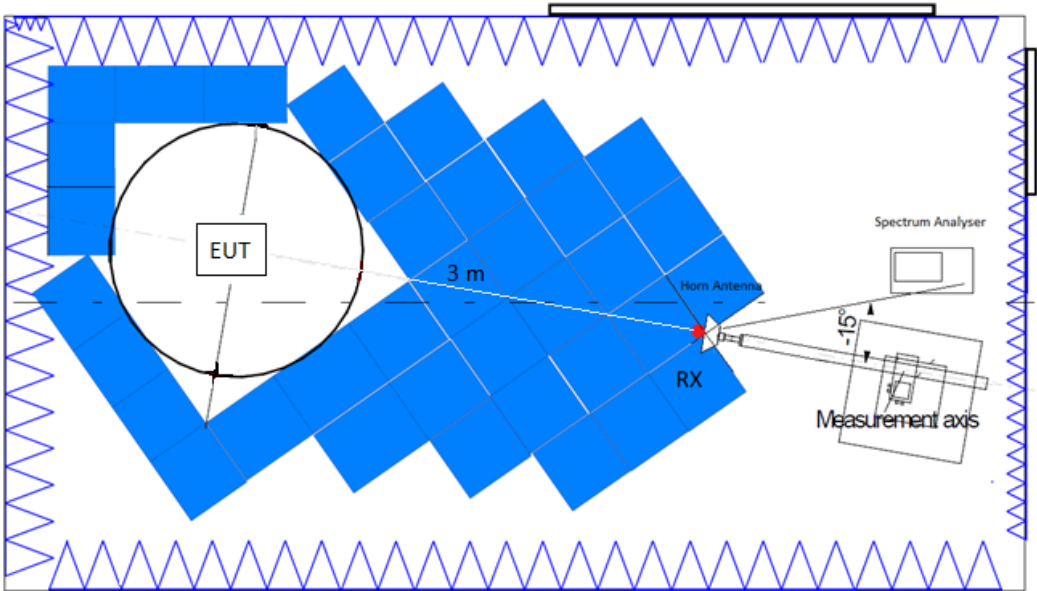
The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

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.

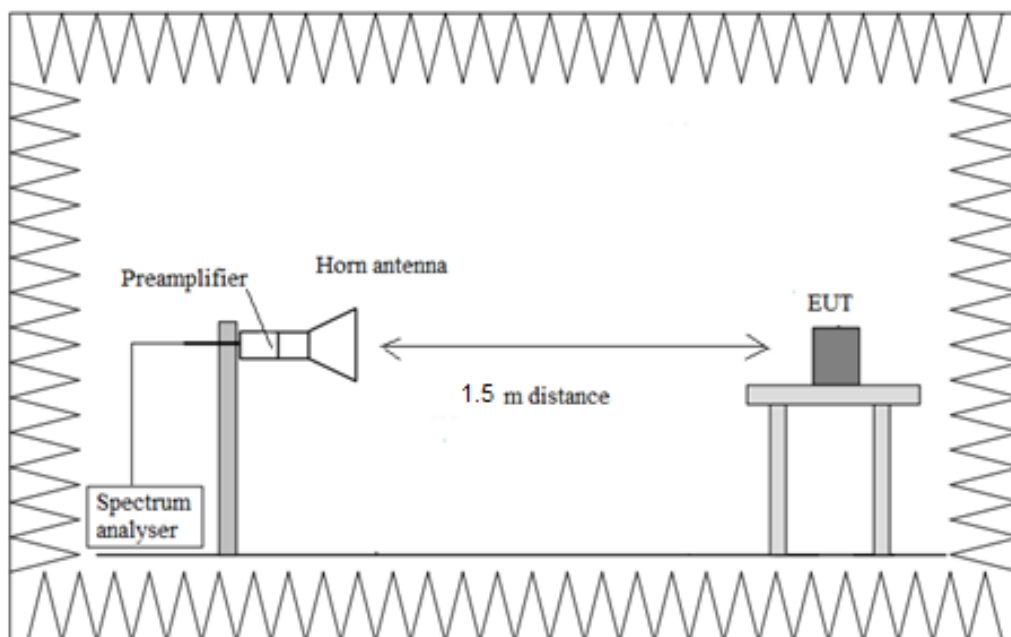
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



TEST CASES DETAILS

FCC 47 CFR Part 15.407

FCC 15.407 (a)(1) Maximum Conducted output power UNII-1

Limits

* FCC 15.407: 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.

Results

Modulation: 802.11n HT20 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5180.00000	No	8.46	13.56
		5220.00000		8.90	14.00
		5240.00000		8.73	13.83

Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5190.00000	No	9.06	14.16
		5230.00000		9.36	14.46

Modulation: 802.11ac VHT20 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5180.00000	No	8.44	13.54
		5220.00000		8.86	13.96
		5240.00000		8.73	13.83

Modulation: 802.11ac VHT40 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5190.00000	No	9.06	14.16
		5230.00000		9.42	14.52

Modulation: 802.11ac VHT80 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5210.00000	No	9.15	14.25

Modulation: 802.11ax HE20 (OFDMA MCS0) – SU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5180.00000	No	6.59	11.69
		5240.00000		7.06	12.16

Modulation: 802.11ax HE20 (OFDMA MCS0) – RU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5180.00000	No	5.57	10.67
		5200.00000		6.45	11.55
		5240.00000		6.82	11.92

Modulation: 802.11ax HE40 (OFDMA MCS0) – SU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5190.00000	No	6.81	11.91
		5230.00000		7.33	12.43

Modulation: 802.11ax HE40 (OFDMA MCS0) – RU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5190.00000	No	6.70	11.80
		5230.00000		6.90	12.00

Modulation: 802.11ax HE80 (OFDMA MCS0) – SU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5210.00000	No	7.04	12.14

Modulation: 802.11ax HE80 (OFDMA MCS0) – RU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5150, 5250]	3+4	5210.00000	No	7.11	12.21

Verdict

Pass

FCC 15.407 (a) (1) Transmitter Maximum Power Spectral Density UNII-1

Limits

FCC 15.407 (a)(1): For the 5.15-5.25 GHz band, 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.

Results

Modulation: 802.11n HT20 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5180.00000	No	5177.227723	-2.785
		5220.00000		5218.217822	-2.498
		5240.00000		5237.425743	-2.460

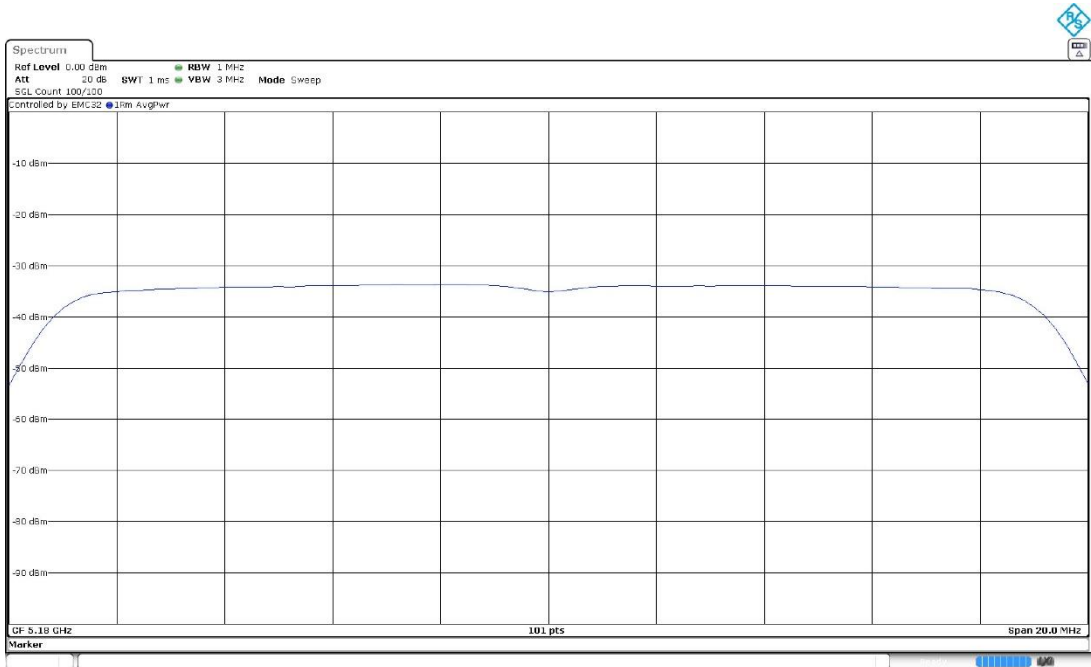
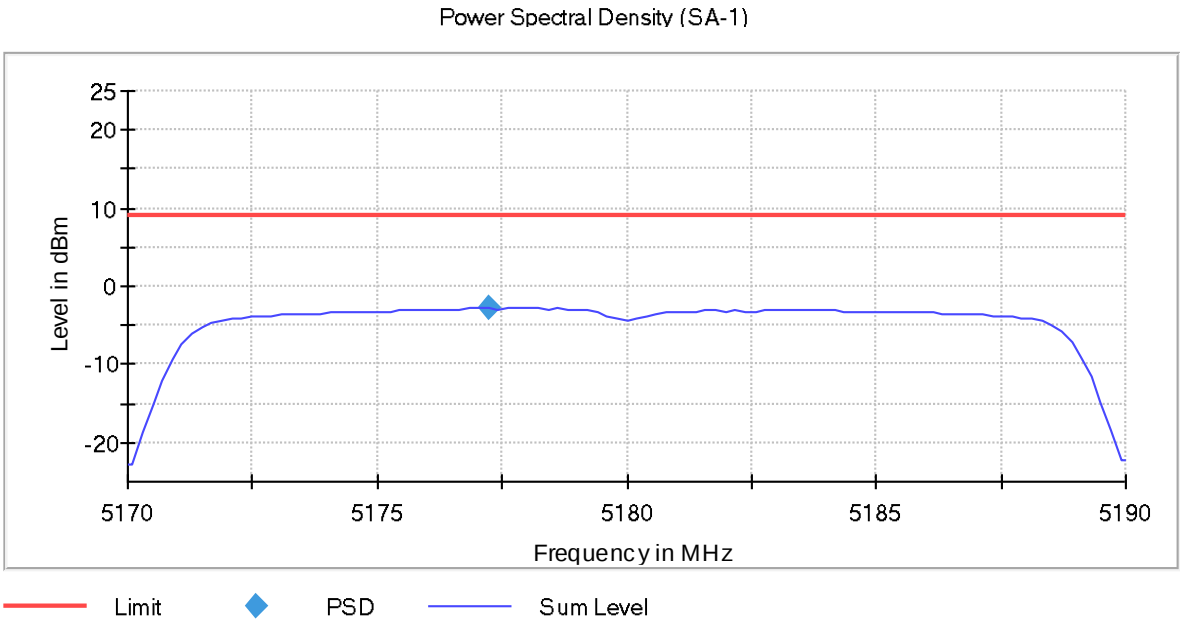
Verdict

Pass

Attachments

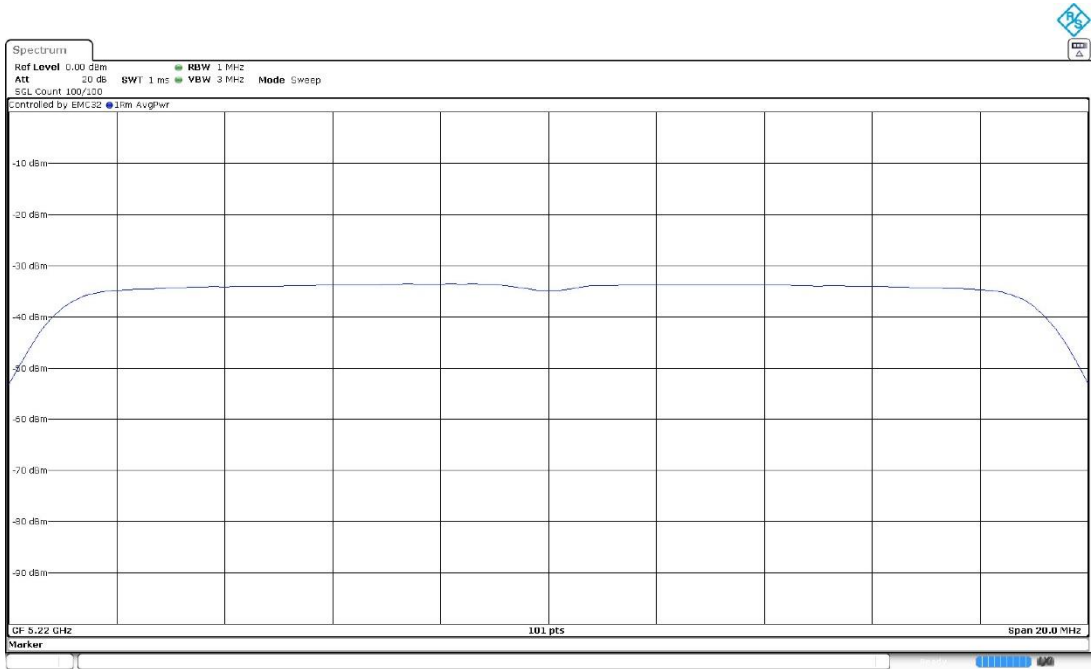
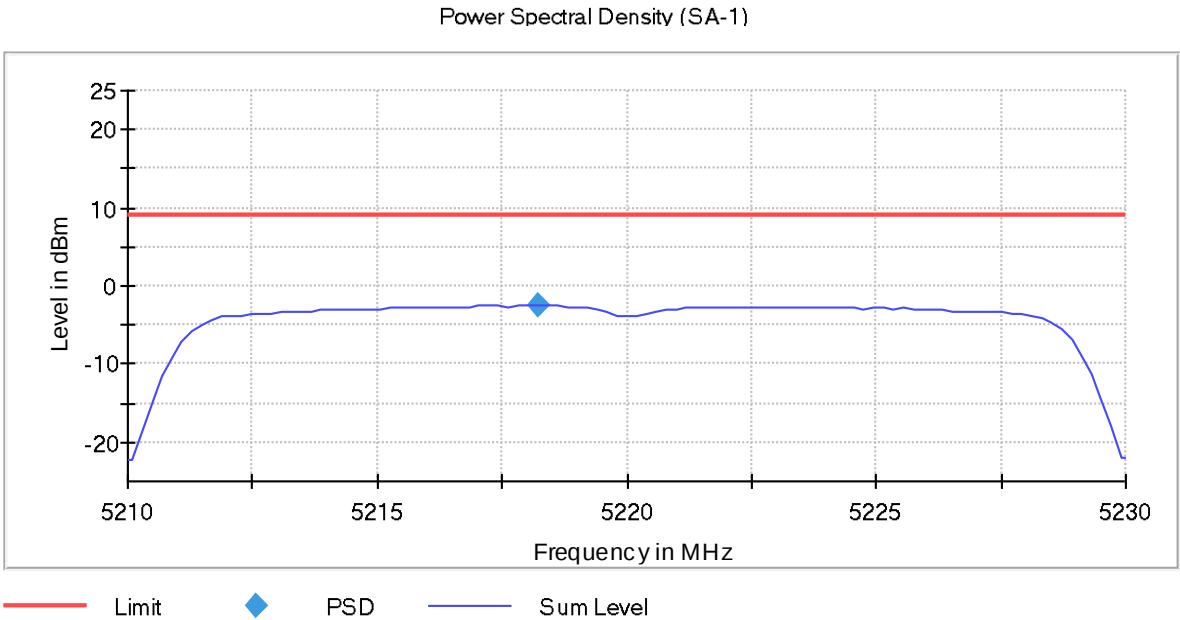
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5180.00000 Modulation = 802.11n HT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



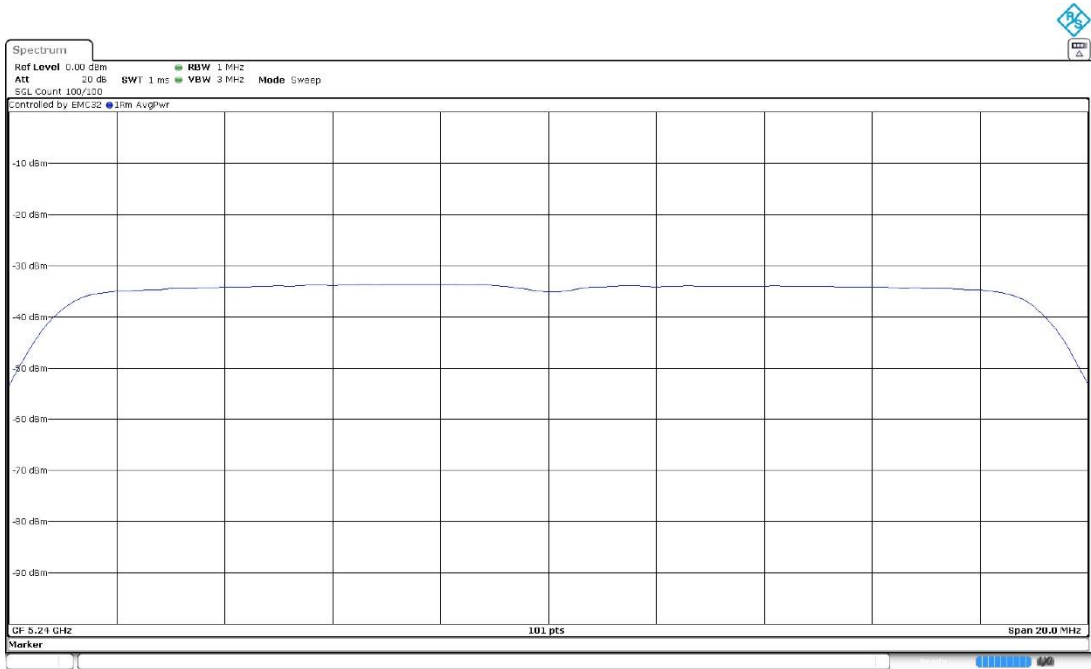
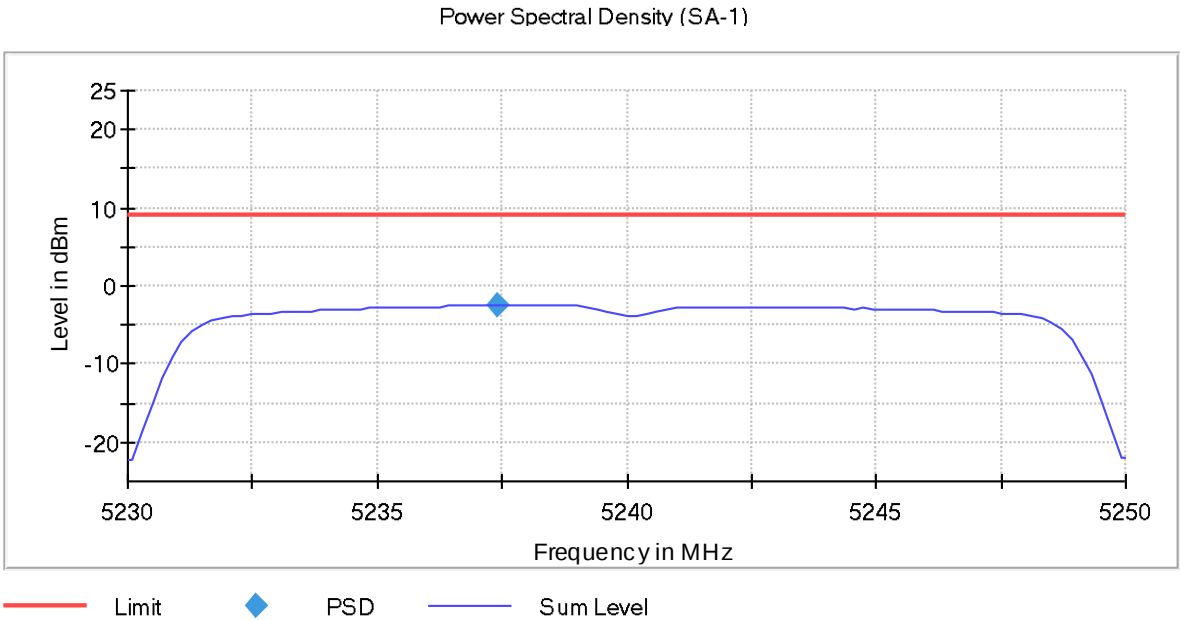
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5220.00000 Modulation = 802.11n HT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5240.00000 Modulation = 802.11n HT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5190.00000	No	5187.227723	-5.889
		5230.00000		5227.623762	-5.507

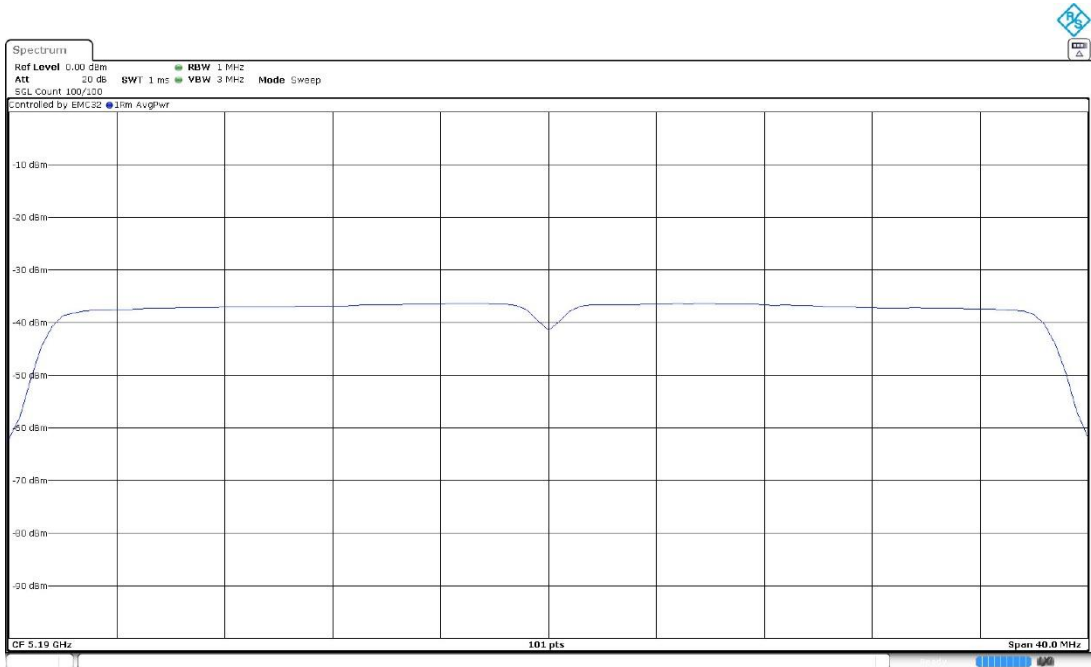
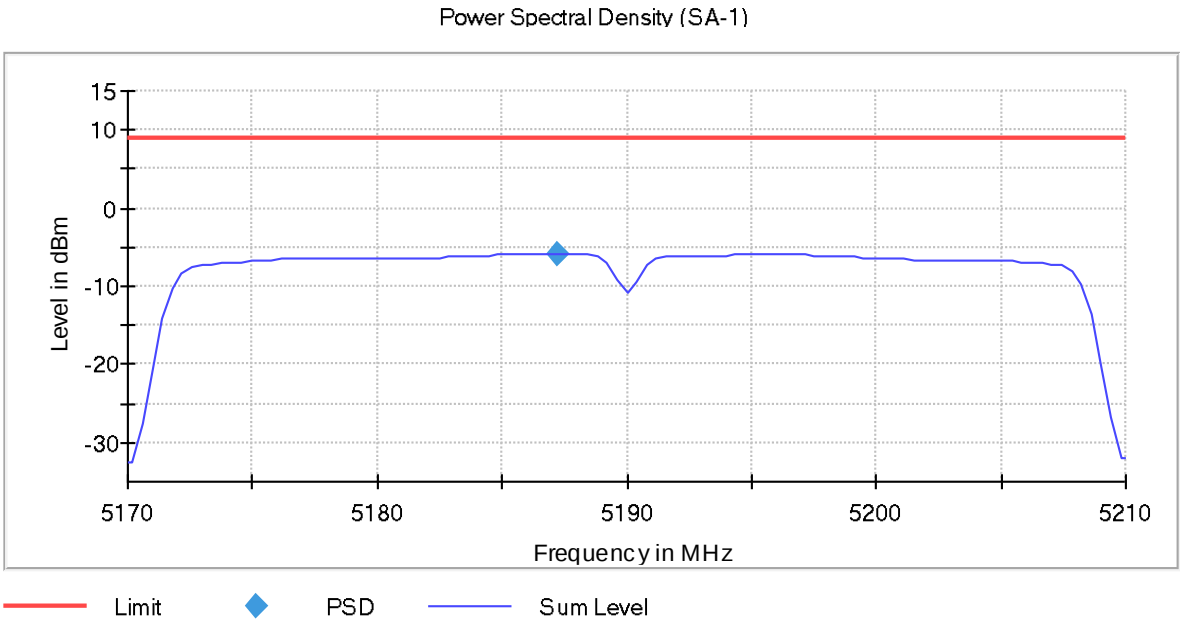
Verdict

Pass

Attachments

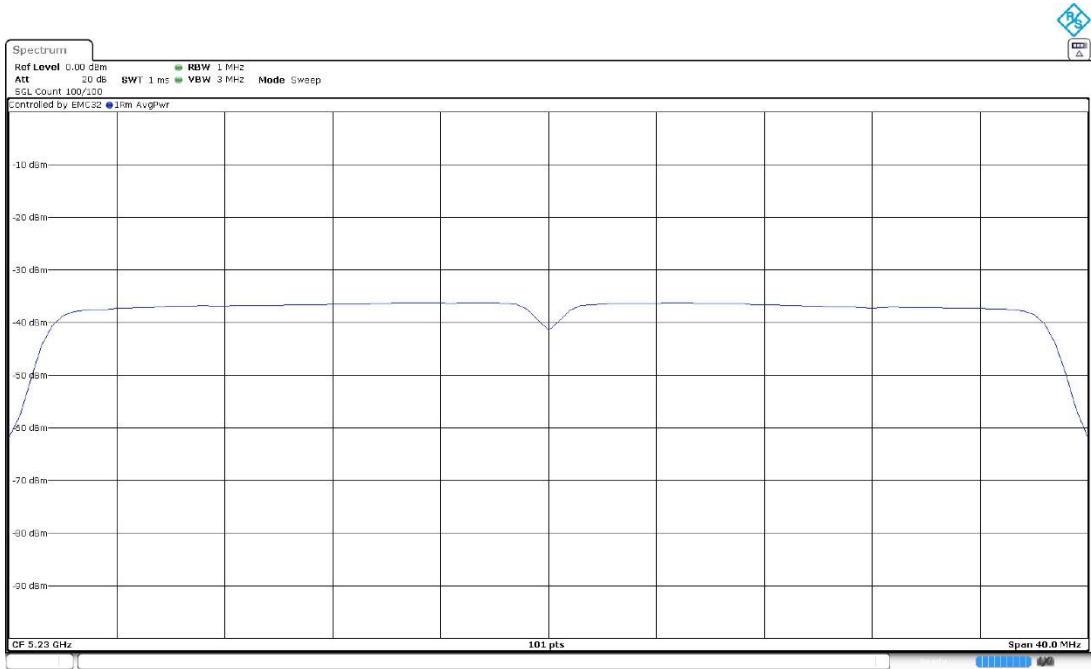
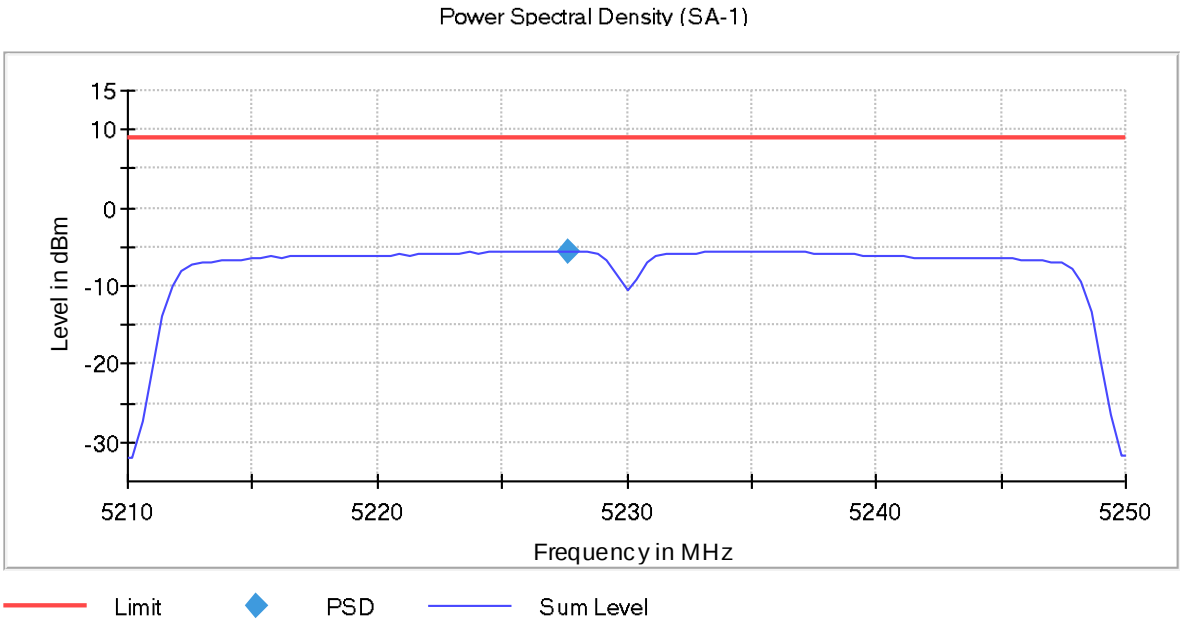
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5190.00000 Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5230.00000 Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11ac VHT20 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5180.00000	No	5181.188119	-2.903
		5220.00000		5221.782178	-2.560
		5240.00000		5241.584158	-2.560

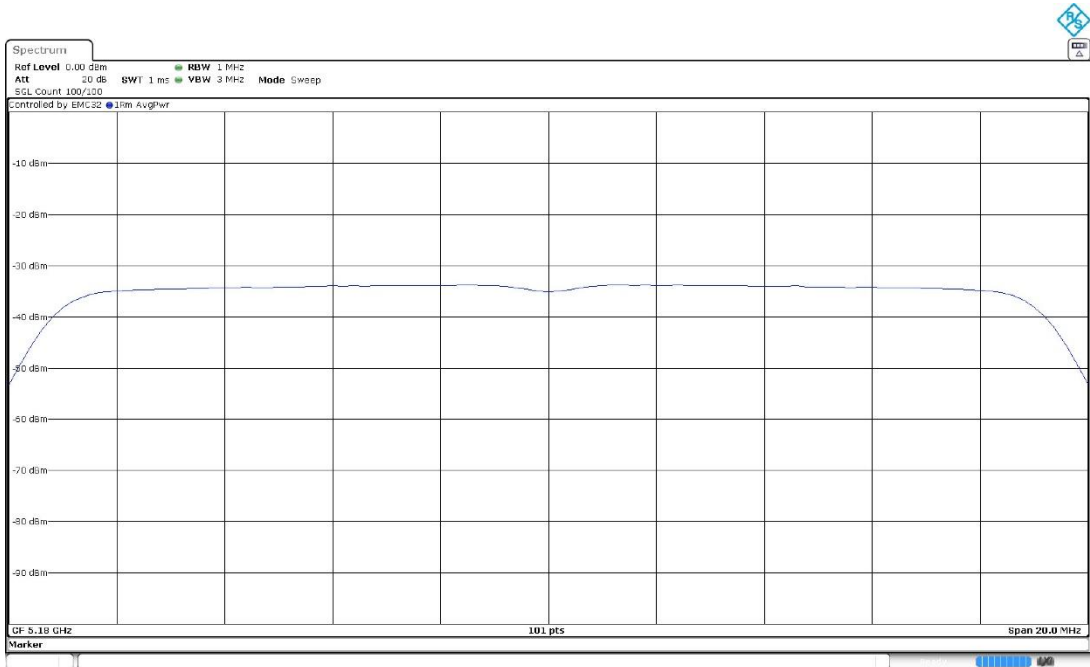
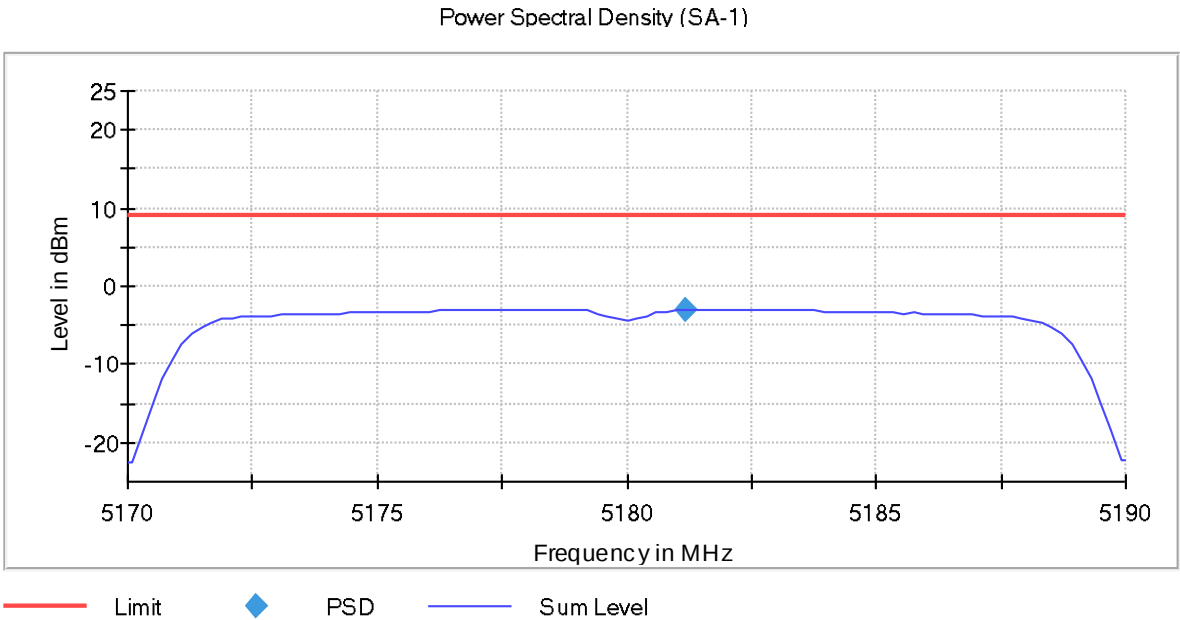
Verdict

Pass

Attachments

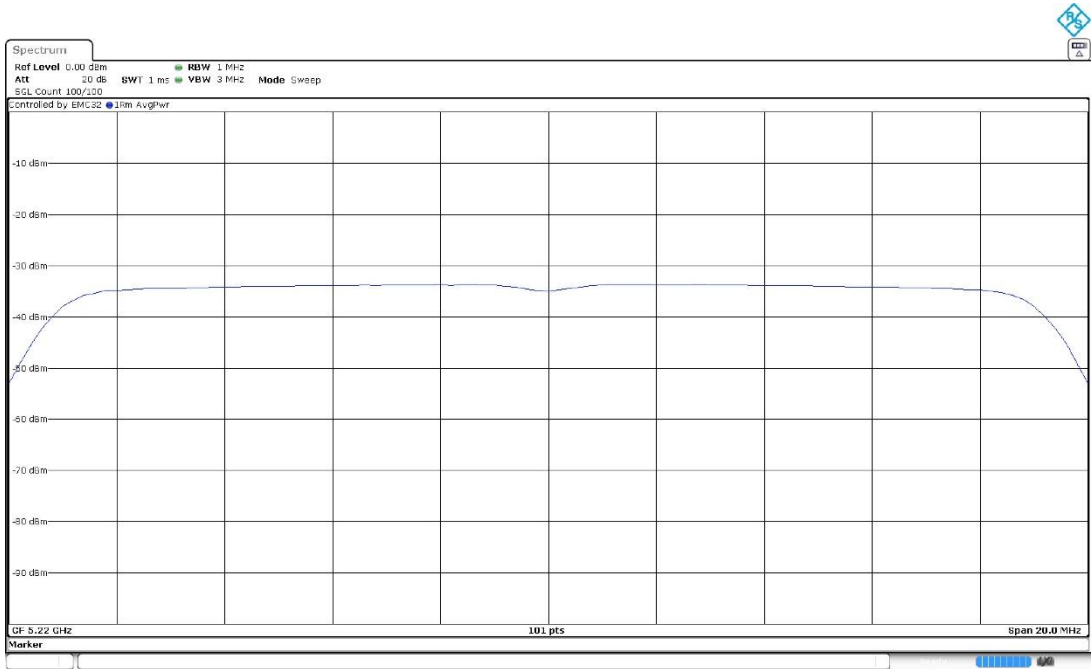
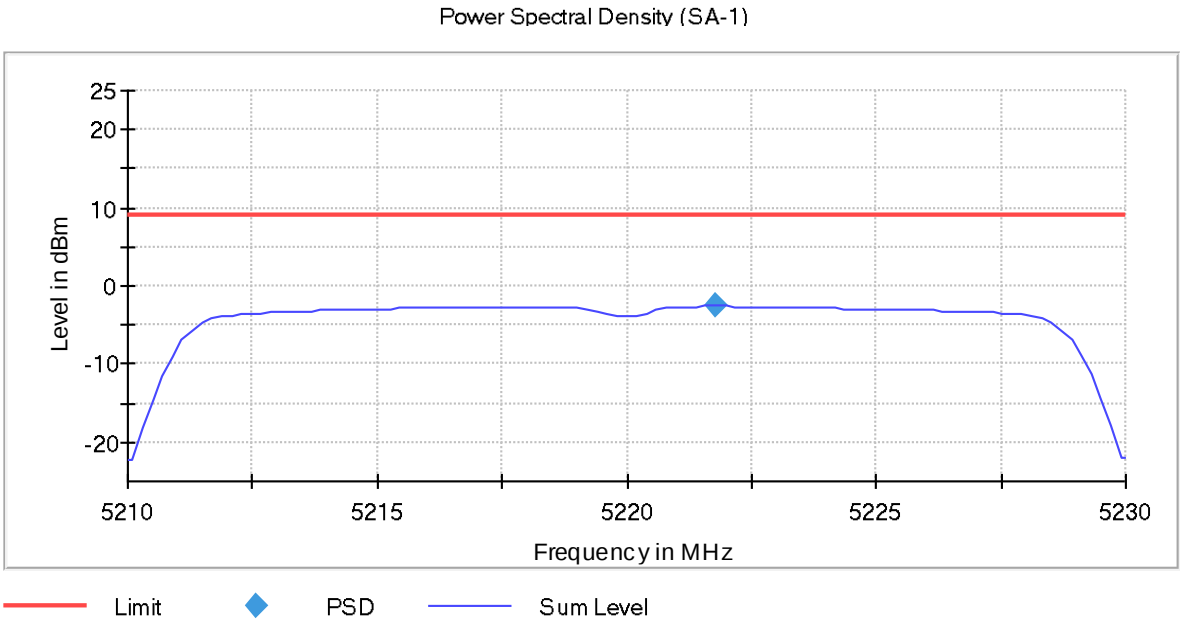
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5180.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



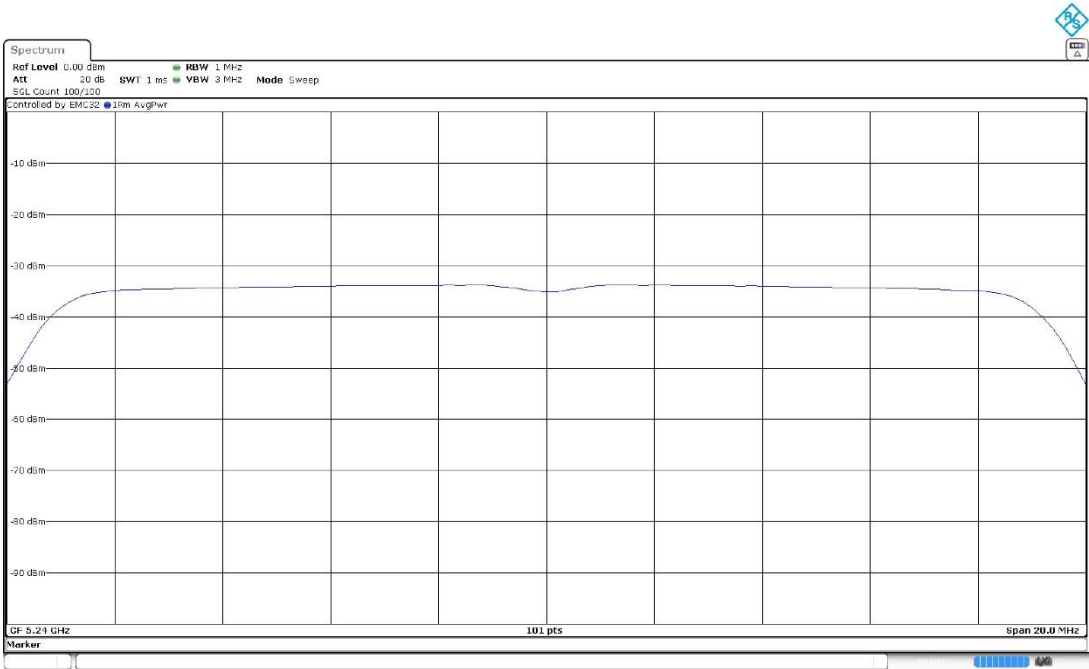
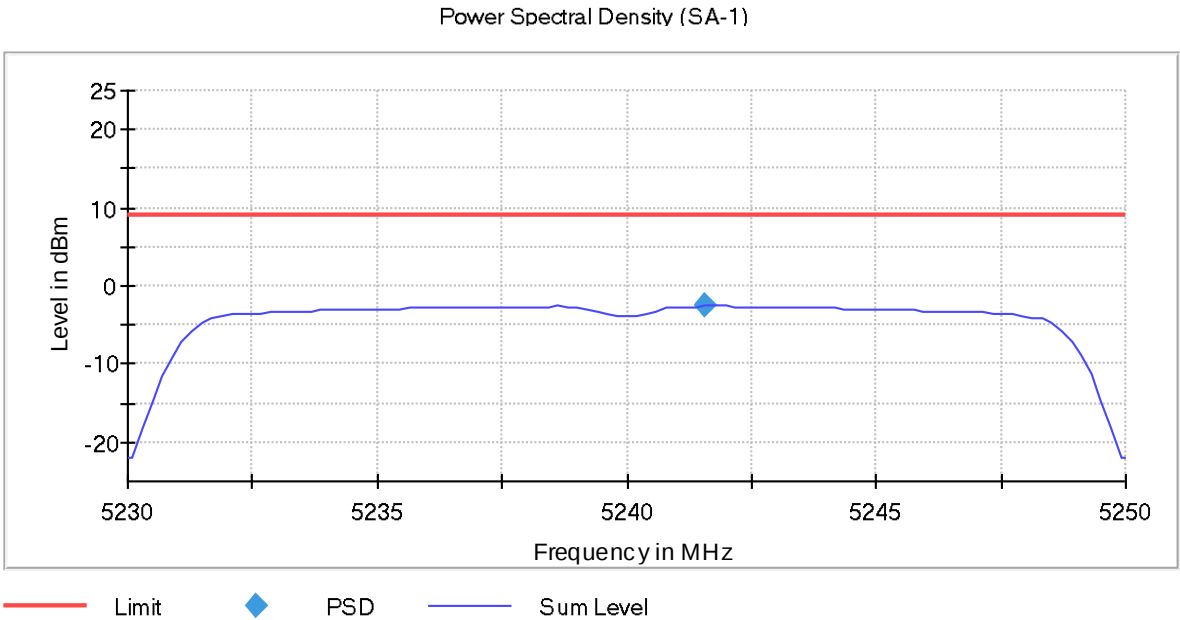
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5220.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5240.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11ac VHT40 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5190.00000	No	5186.831683	-5.927
		5230.00000		5228.019802	-5.548

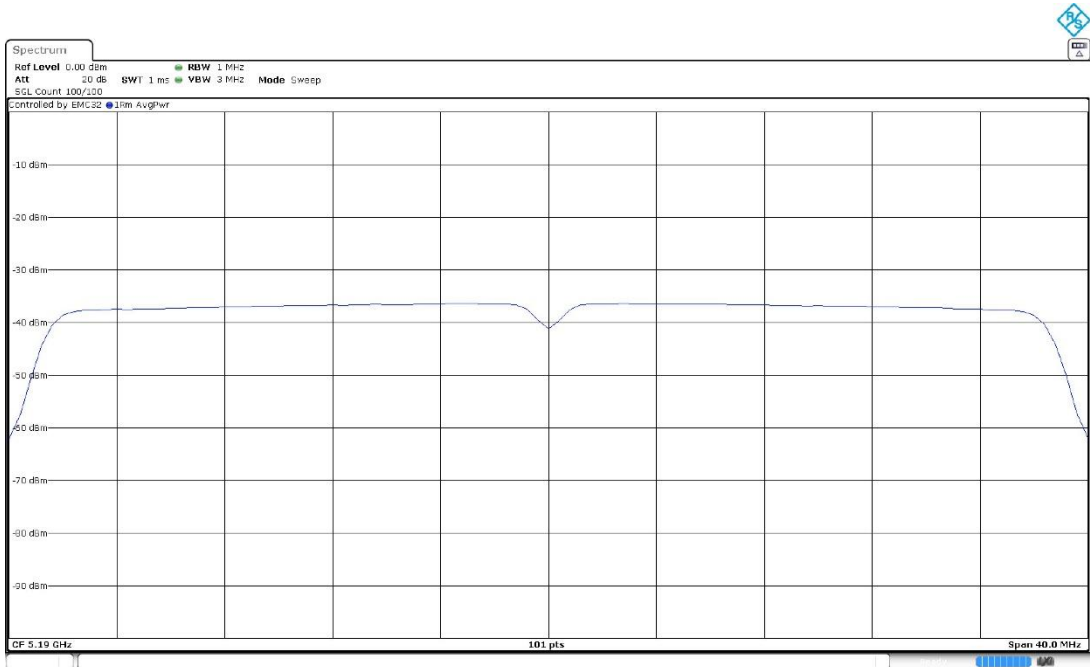
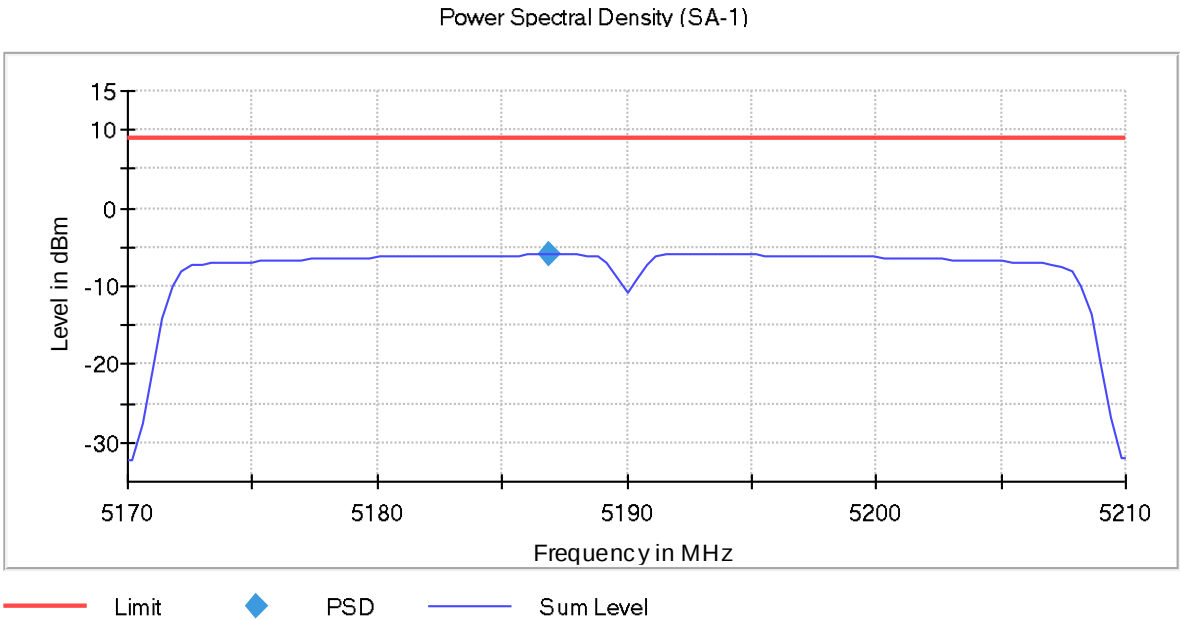
Verdict

Pass

Attachments

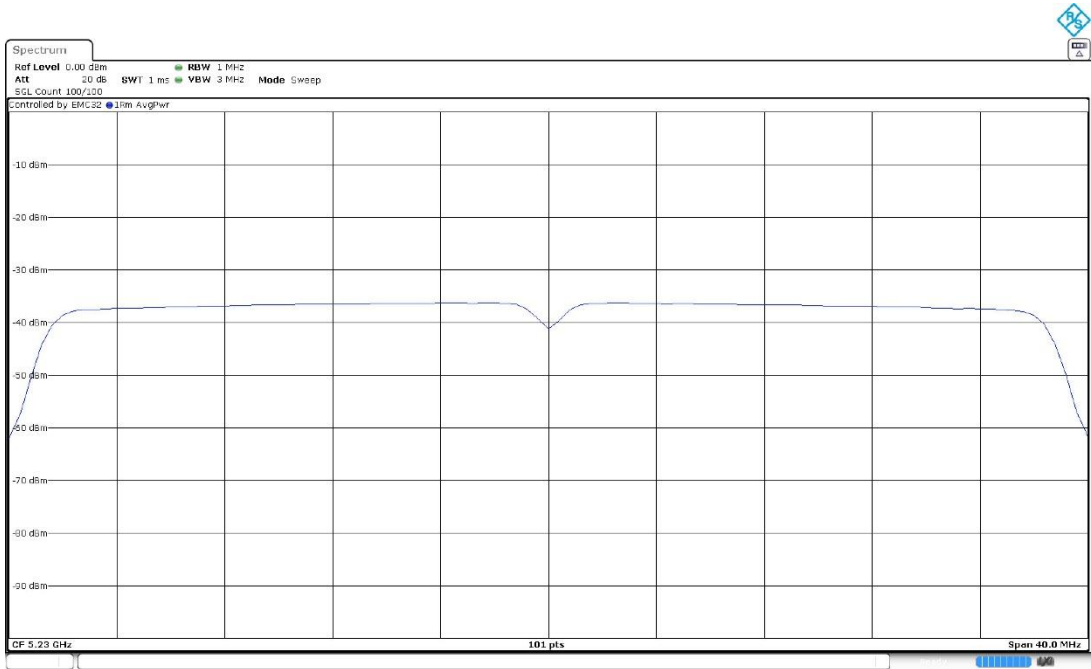
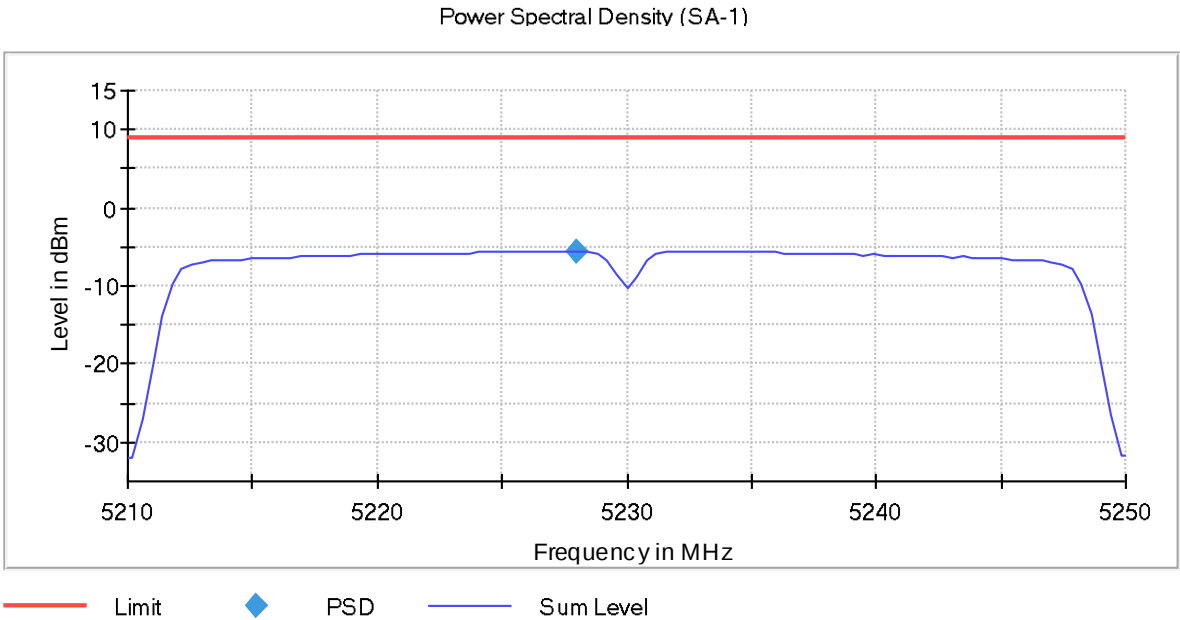
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5190.00000 Modulation = 802.11ac VHT40 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5230.00000 Modulation = 802.11ac VHT40 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11ac VHT80 (OFDM MCS0)

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5210.00000	No	5206.250000	-8.955

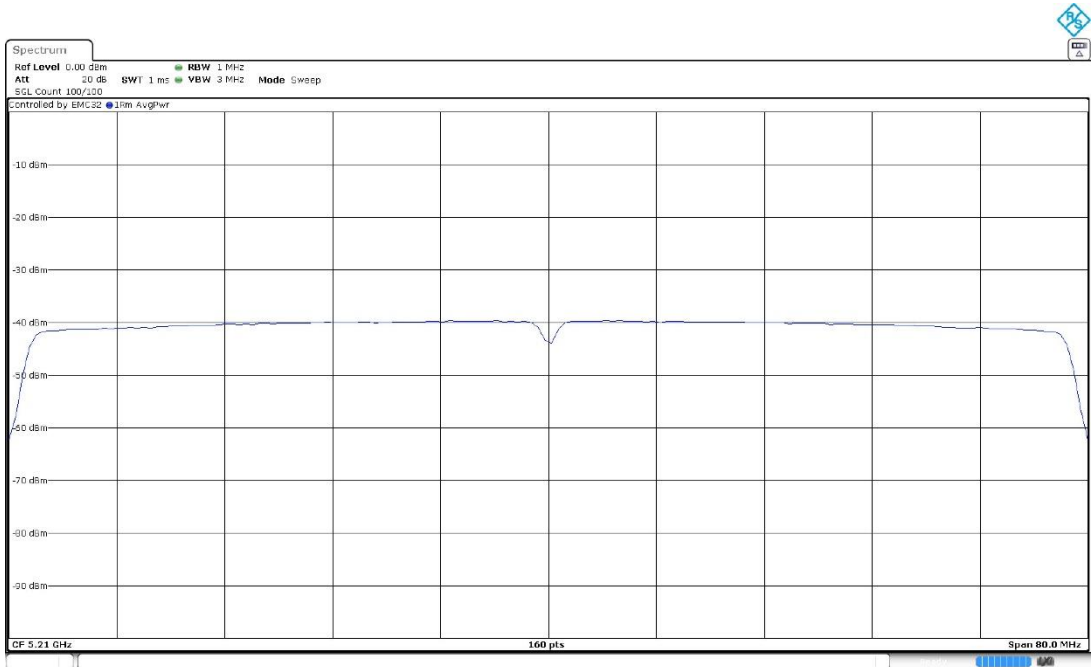
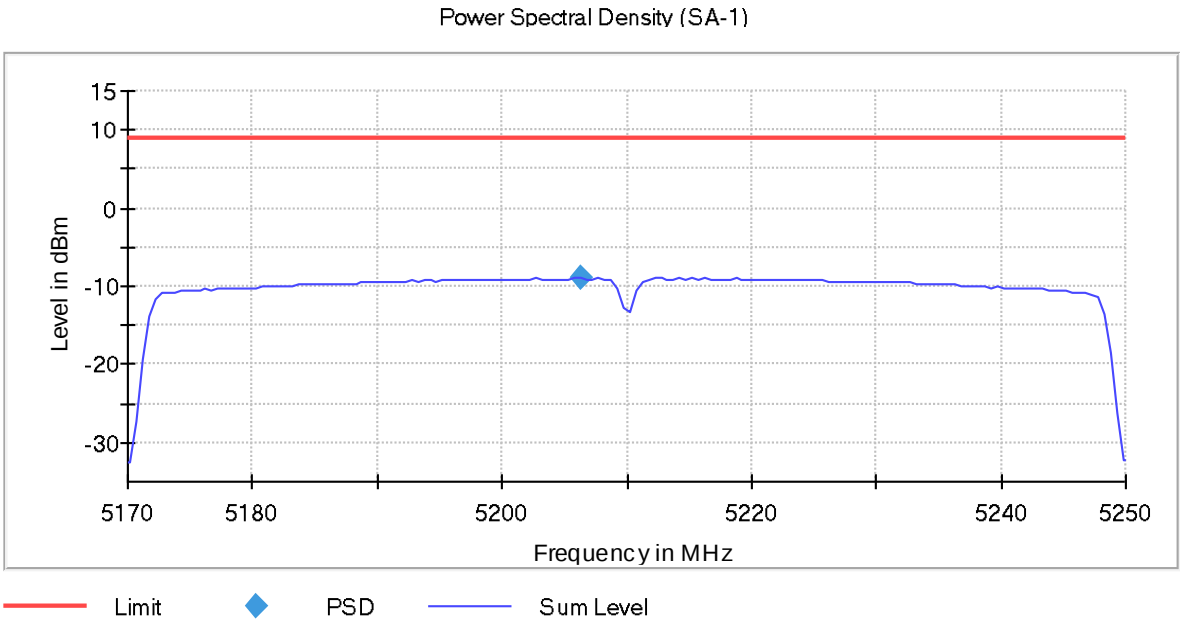
Verdict

Pass

Attachments

Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5210.00000 Modulation = 802.11ac VHT80 (OFDM MCS0)
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11ax HE20 (OFDMA MCS0) – SU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5180.00000	No	5177.821782	-5.587
		5240.00000		5236.633663	-5.118

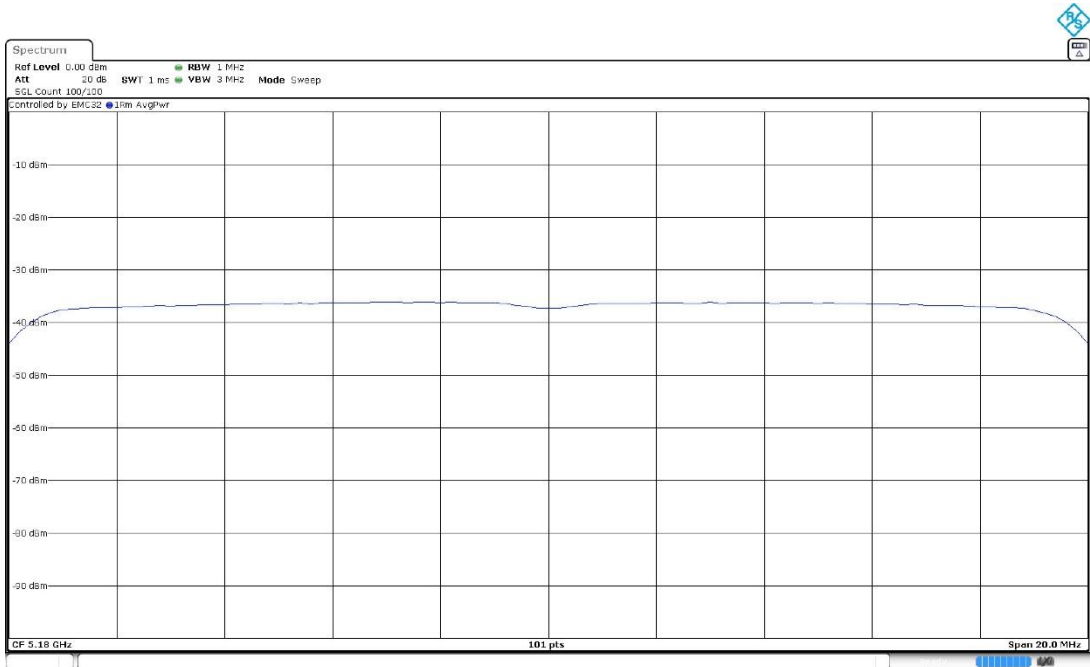
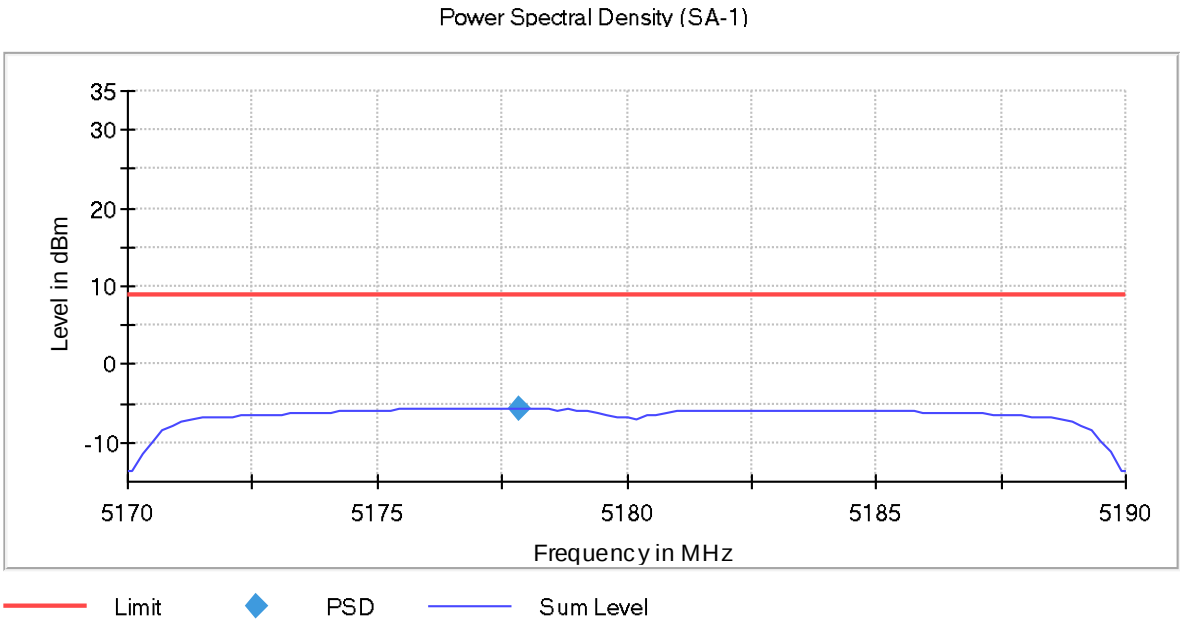
Verdict

Pass

Attachments

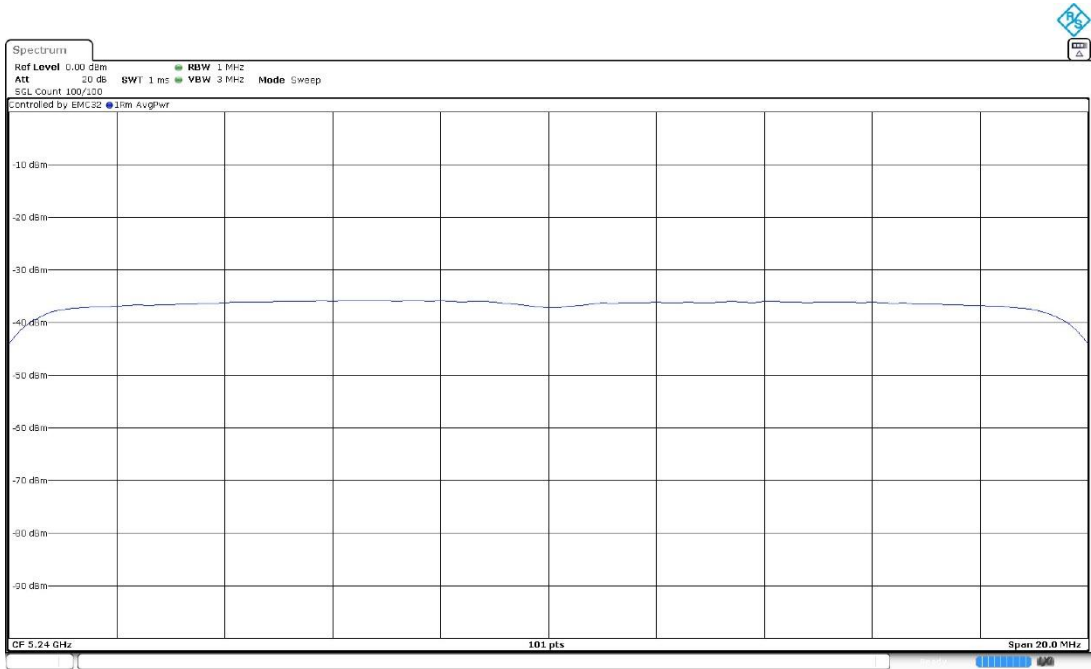
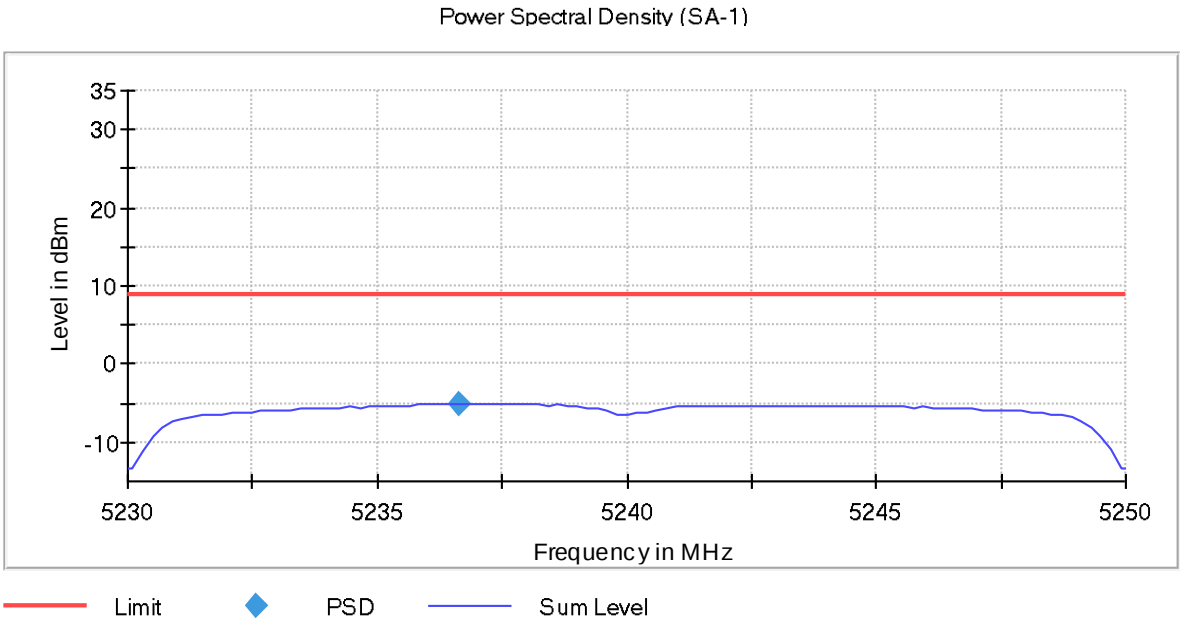
Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5180.00000 Modulation: 802.11ax HE20 (OFDMA MCS0) – SU
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Operation Band MHz = [5150, 5250] Active Port = 3+4
Frequency MHz = 5240.00000 Modulation: 802.11ax HE20 (OFDMA MCS0) – SU
TPC = No MIMO Mode = MIMO CDD Mode 2x2

Images:



Results

Modulation: 802.11ax HE20 (OFDMA MCS0) – RU

MIMO Mode: MIMO CDD Mode 2x2

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5150, 5250]	3+4	5180.00000	No	5200.792079	2.458
		5240.00000		5248.316832	4.189

Verdict

Pass