TEST REPORT

APPLICANT	:	Nanjing Juplink Intelligent Technologies Co., Ltd.
PRODUCT NAME	:	Dual-band Gigabit Repeater
MODEL NAME	:	RX4-1800
BRAND NAME	:	JupLink
FCC ID	:	2AT9Z-RX4-1800
STANDARD(S)	:	47 CFR Part 15 Subpart E
RECEIPT DATE	:	2020-01-07
TEST DATE	:	2020-02-19 to 2020-05-26
ISSUE DATE	:	2020-06-15

Edited by: Bowers Zeng

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Change History		
Version	Date	Reason for change
1.0	2020-06-15	First edition

1. Technical Information

Note: Provide by applicant.

1.1. Applicant and Manufaxturer Information

Applicant:	Nanjing Juplink Intelligent Technologies Co., Ltd.
Applicant Address:	No. 757, Dixiu Road, Binjiang Economic Development Zone, Jiangning District, Nanjing China
Manufaxturer:	Sichuan Tianyi Comheart Telecom Co., Ltd.
Manufaxturer Address:	No. 198, Section 1, Xueshan Avenue, Dayi County, Chengdu, Sichuan, China

1.2. Equipment Under Test (EUT) Description

Product Name:	Dual-band Gigabit Router
Serial No:	(N/A, marked #1 by test site)
Hardware Version:	V1.0.0
Software Version:	V1.0.1
Modulation Type:	OFDMA
Modulation Mode:	802.11ax(HEW20), 802.11ax(HEW40),802.11ax(HEW80)
Data Rate:	Up to 1200Mbps
Operating Frequency Range:	5.180 GHz- 5.240 GHz;5.725GHz- 5.850GHz
Channel Number:	Refer to 1.3
Antenna Type:	Dipole Antenna
Antenna Gain:	Ant 0: 5 dBi; Ant 1: 5 dBi
Directional Gain:	GTx: 8.01 dBi Note 2

Note 1: The EUT has two antennas and supports a MIMO function. Physically, the EUT provides two completed transmitters and two receivers for 802.11ax modulation mode.

Modulation Mode:	**TX Function**	**Beamforming**
802.11ax	2TX	Not Support

Note 2: Axcording to KDB 662911 D01, the directional gain GTx= GANT + 10log(NANT) dBi, where GANT is the maximum antenna gain in dBi, NANT is the number of outputs.

Note 3: For conducted test item Maximum Conducted Output Power and Maximun Power Spectral Density of eaxh modulation mode, the report recorded the test result of two antennas separately, for other conducted test items both of the two antennas were tested separately, only recorded the worst test result(Ant 0) in this report.

Note 4: All radiation test items for 802.11ax modulation mode operate at the worst mode(CDD) in this report.

Note 5: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufaxturer.

Note 6: Automatic stop transmission principle: After receiving the signal and confirming it is correct,the physical layer submits it to the MAX-PHY sublayer. After unpaxking, the data is sent to the MAX layer and then it is determined whether it is data sent to the router. If yes, please turn in; otherwise, discard.

1.3. The channel number and frequency of EUT

Frequency Range: 5180-5240MHz				
Bandwidth	Channel	Frequency (MHz)	Channel	Frequency (MHz)
20MHz	**36**	**5180**	**40**	**5200**
	44	5220	**48**	**5240**
40MHz	**38**	**5190**	**46**	**5230**
80MHz	**42**	**5210**	**/**	**/**
Frequency Range: 5725-5850MHz				
Bandwidth	Channel	Frequency (MHz)	Channel	Frequency (MHz)
20MHz	**149**	**5745**	153	5765
	157	**5785**	161	5805
	165	**5825**	/	/
40MHz	**151**	**5755**	**159**	**5795**
80MHz	**155**	**5775**	/	/

Note 1: The black bold channels were selected for test.

1.4. Test Standards and Results

The objective of the report is to perform testing axcording to 47 CFR Part 15 Subpart E for the EUT FCC ID Certification:

No	Identity	Document Title
1	47 CFR Part 15 (5-1-14 Edition)	Radio Frequency Devices

Test detailed items/section required by FCC rules and results are as below:

No.	Section	Description	Test Date	Test Engineer	Result	Method determination /Remark
1	15.203	Antenna Requirement	N/A	N/A	PASS	No deviation
2	15.407(a) (e)	Emission Bandwidth	Mar 02, 2020	Lai Haihuang	PASS	No deviation
3	15.407(a)	Maximum conducted output Power	Mar 02, 2020	Lai Haihuang	PASS	No deviation
4	15.407(a)	Peak Power spectral density	Mar 02, 2020	Lai Haihuang	PASS	No deviation
5	15.407(b)	Restricted Frequency Bands	May 19, 2020 May 26, 2020	Yaming Luo	PASS	No deviation
6	15.407(g)	Frequency Stability	Mar 02, 2020	Lai Haihuang	PASS	No deviation
7	15.207	Conducted Emission	May 25, 2020	Yaming Luo	PASS	No deviation
8	15.407(b)	Radiated Emission	May 19, 2020 May 26, 2020	Yaming Luo	PASS	No deviation

Note1: The tests of Conducted Emission and Radiated Emission were performed axcording to the method of measurements prescribed in ANSI C63.10 2013.

Note2: These RF tests were performed axcording to the method of measurements prescribed in KDB789033 D02 General UNII Test Procedures New Rules v02r01, KDB662911 D01,Multiple Transmitter Output v02r01.

Note3: The path loss during the RF test is calibrated to correct the results by the offset setting

1.5. Environmental Conditions

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 - 35
Relative Humidity (%):	30 -60
Atmospheric Pressure (kPa):	86-106

2. 47 CFR Part 15E Requirements

2.1. Antenna requirement

2.1.1. Applicable Standard

Axcording to FCC 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attaxhed antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

2.1.2. Result: Compliant

The EUT has a permanently and irreplaxeable attaxhed antenna. Please refer to the EUT internal photos.

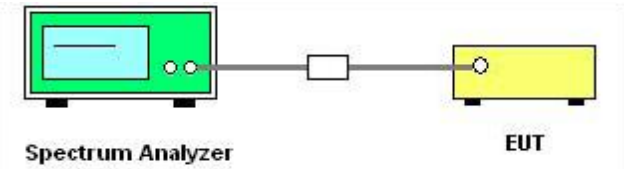
2.2. Emission Bandwidth

2.2.1. Requirement

For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement. Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

2.2.2. Test Description

A. Test Setup:



The EUT is coupled to the Spectrum Analyzer; the RF load attaxhed to the EUT antenna terminal is 50Ohm; the path loss as the faxtor is calibrated to correct the reading.

B. Test Procedure

1. KDB 789033 Section C) 1) Emission Bandwidth was used in order to prove compliance

a) Set RBW = approximately 1% of the emission bandwidth.

b) Set the VBW > RBW.

c) Detector = Peak.

d) Traxe mode = max hold.

e) Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

2. KDB 789033 Section C) 2) minimum emission bandwidth for the band 5.725-5.85GHz was used in order to prove compliance.

Section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 KHz for the band 5.715-5.85 GHz. The following procedure shall be used for measuring this bandwidth:

a) Set RBW = 300 kHz.

b) Set the video bandwidth (VBW) ≥ 3 × RBW.

c) Detector = Peak.

d) Traxe mode = max hold.

e) Sweep = auto couple.

f) Allow the traxe to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

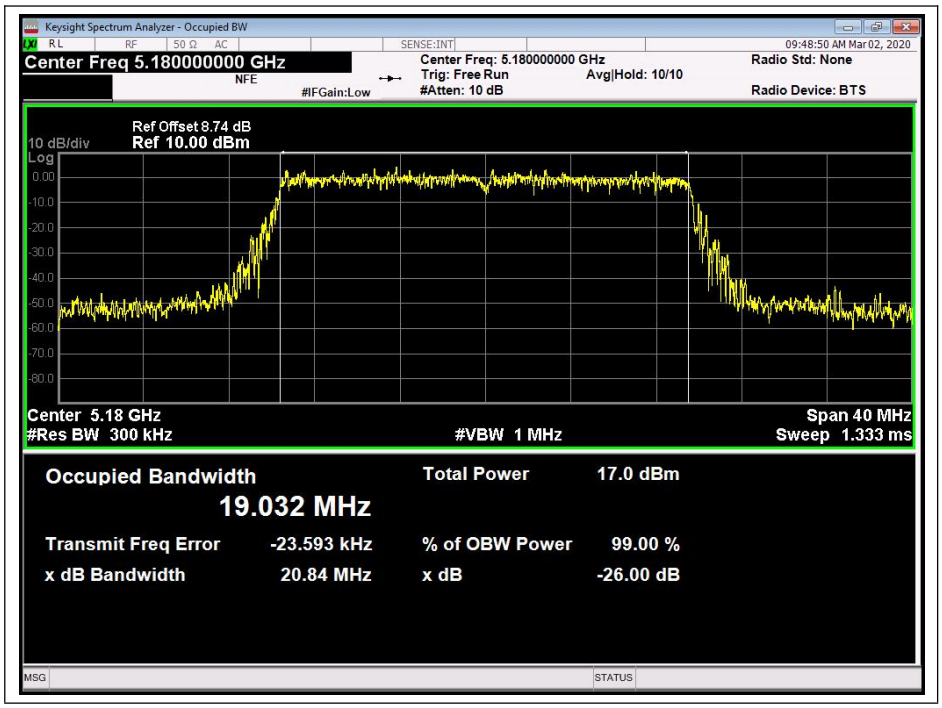
2.2.3. Test Result

802.11ax(HEW20) Test mode(ANT 0)

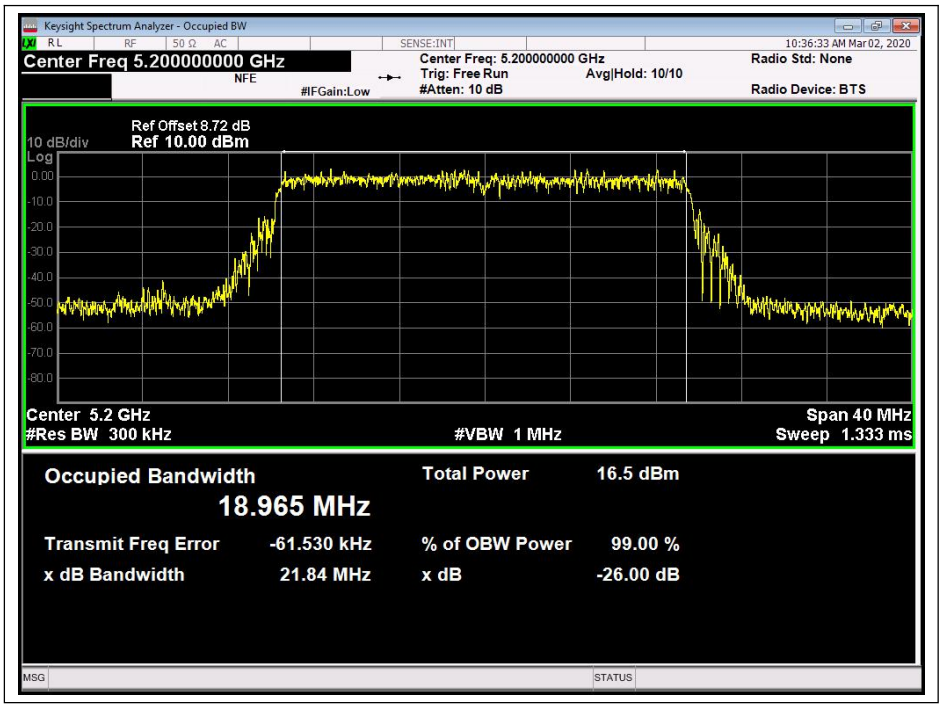
A. Test Verdict:

Channel	Frequency (MHz)	ANT0 26 dB Bandwidth (MHz)
36	5180	20.84
40	5200	21.84
48	5240	21.26
Channel	**Frequency (MHz)**	**ANT0 6dB Bandwidth (MHz)**
149	5745	18.56
157	5785	18.54
165	5825	19.03

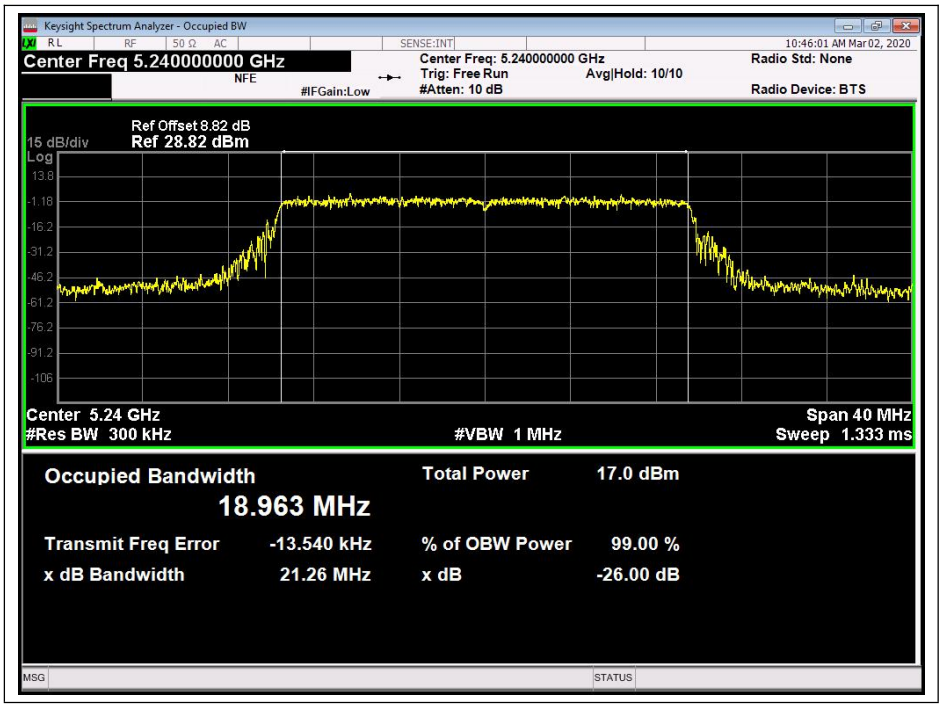
B. Test Plots



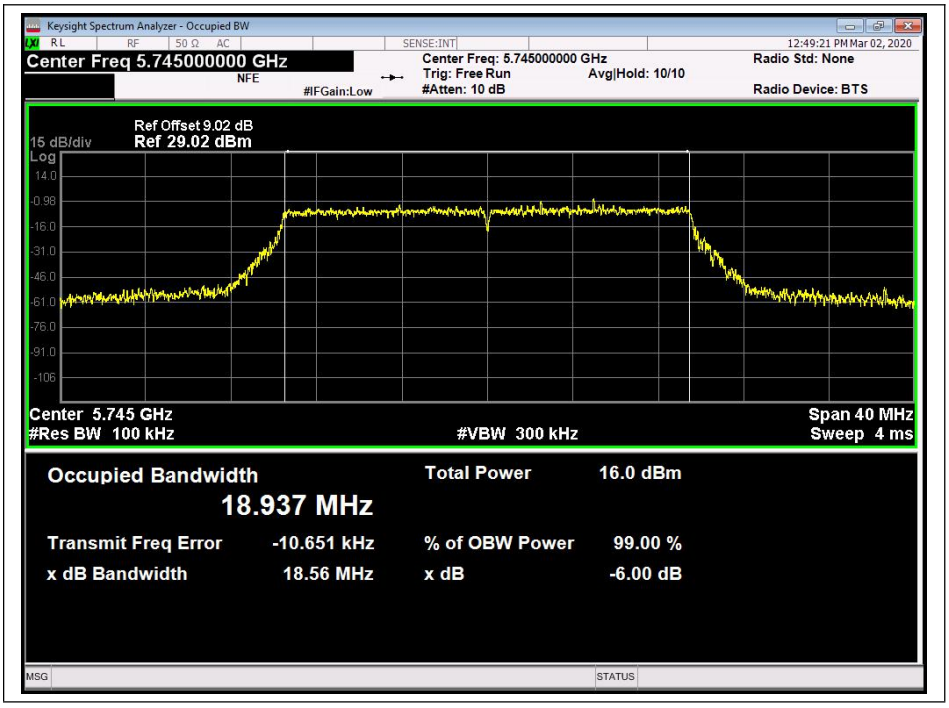
(Channel 36, 5180MHz, 802.11ax(HEW20))



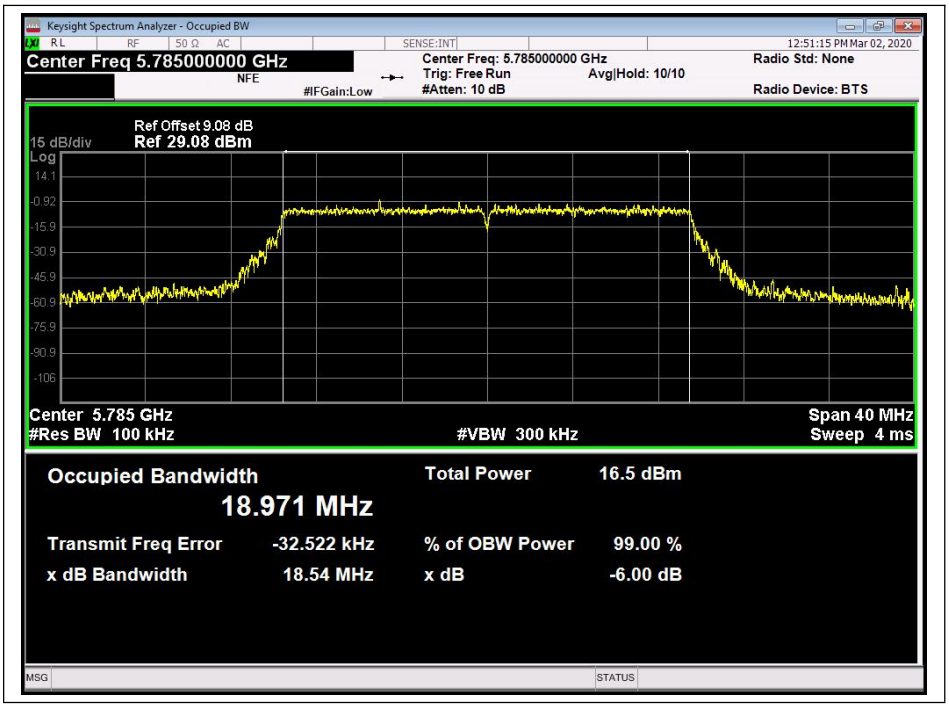
(Channel 40, 5200 MHz, 802.11ax(HEW20))



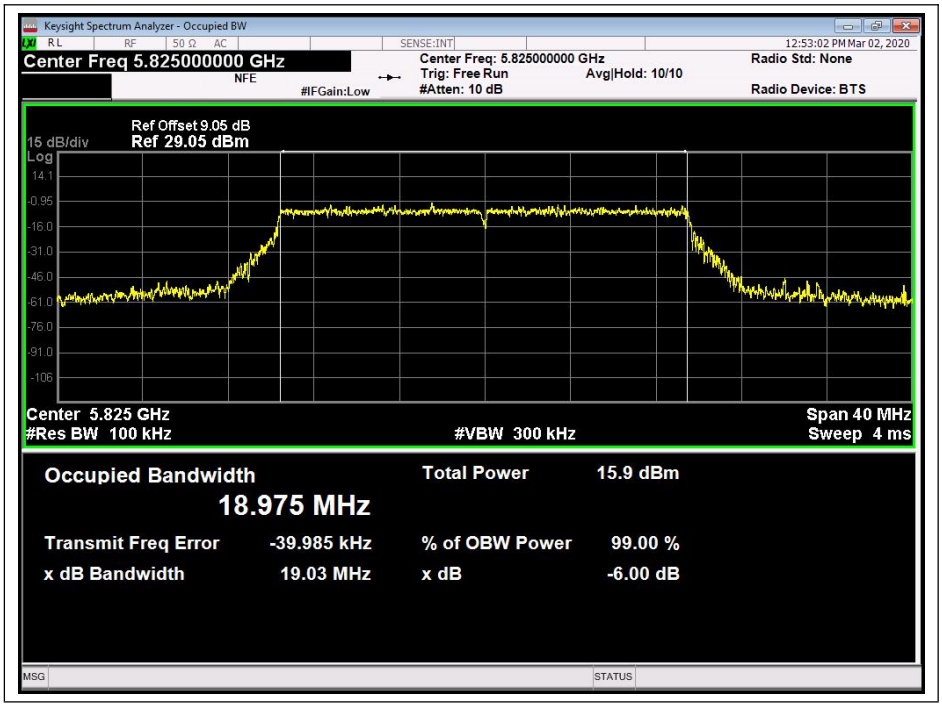
(Channel 48, 5240MHz, 802.11ax(HEW20))



(Channel 149, 5745MHz, 802.11ax(HEW20))



(Channel 157, 5785MHz, 802.11ax(HEW20))



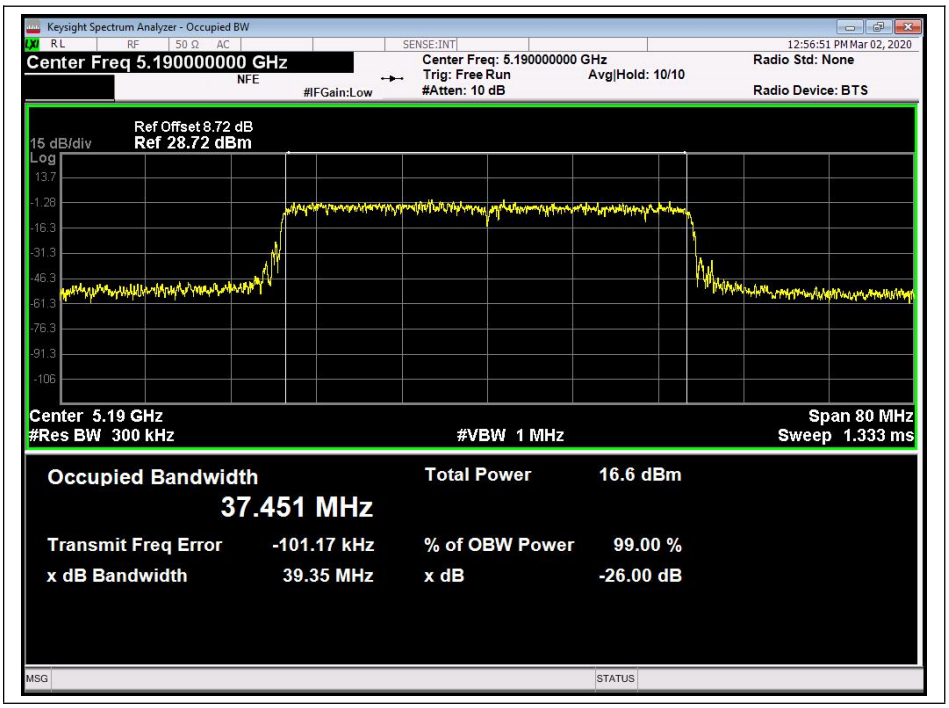
(Channel 165, 5825MHz, 802.11ax(HEW20))

802.11ax (HEW40) Test mode

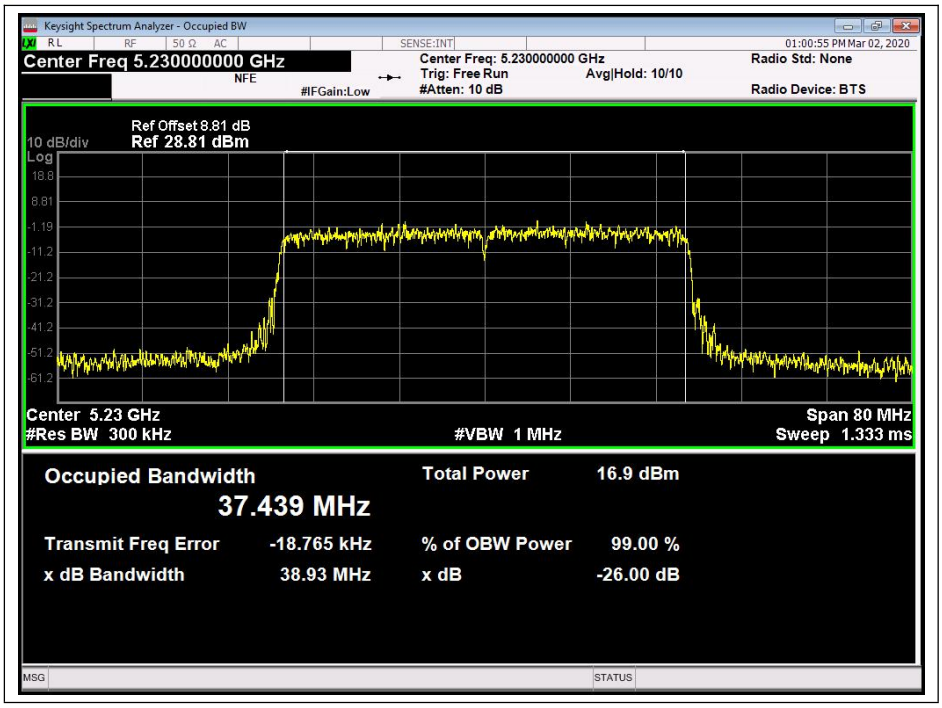
A. Test Verdict:

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
38	5190	39.35
46	5230	38.93
Channel	**Frequency (MHz)**	**6dB Bandwidth (MHz)**
151	5755	36.05
159	5795	36.88

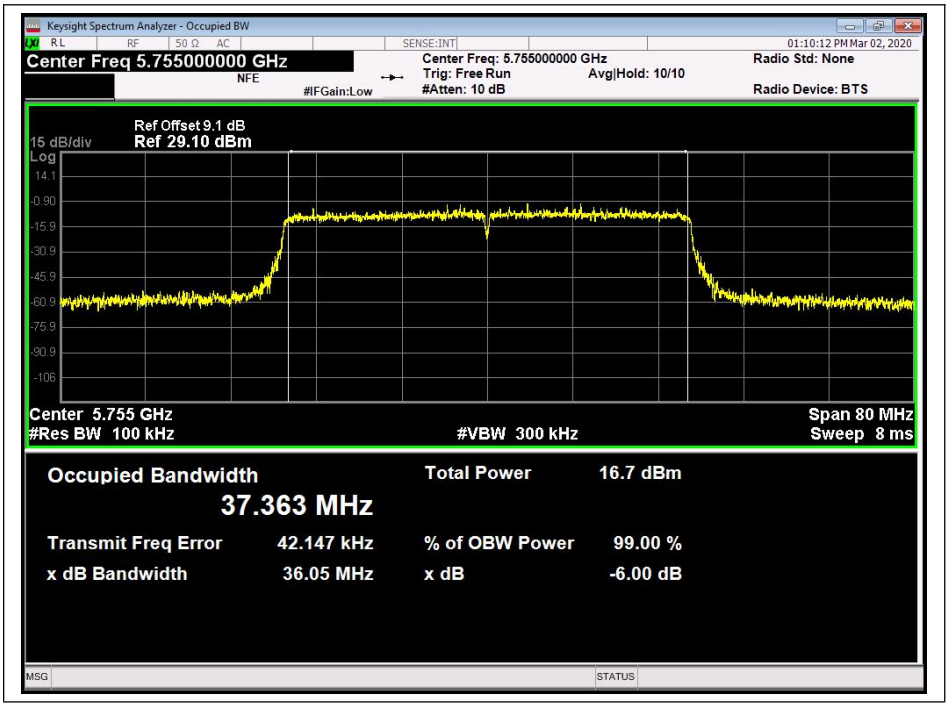
B. Test Plots



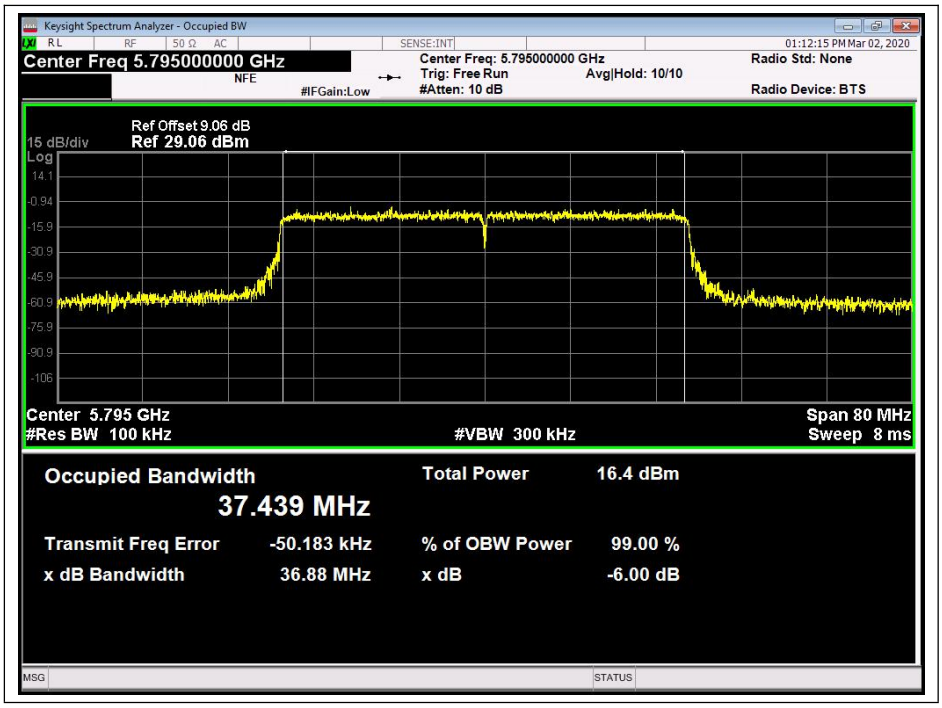
(Channel 38, 5190MHz, 802.11ax (HEW40))



(Channel 46, 5230 MHz, 802.11ax (HEW40))



(Channel 151, 5755 MHz, 802.11ax (HEW40))



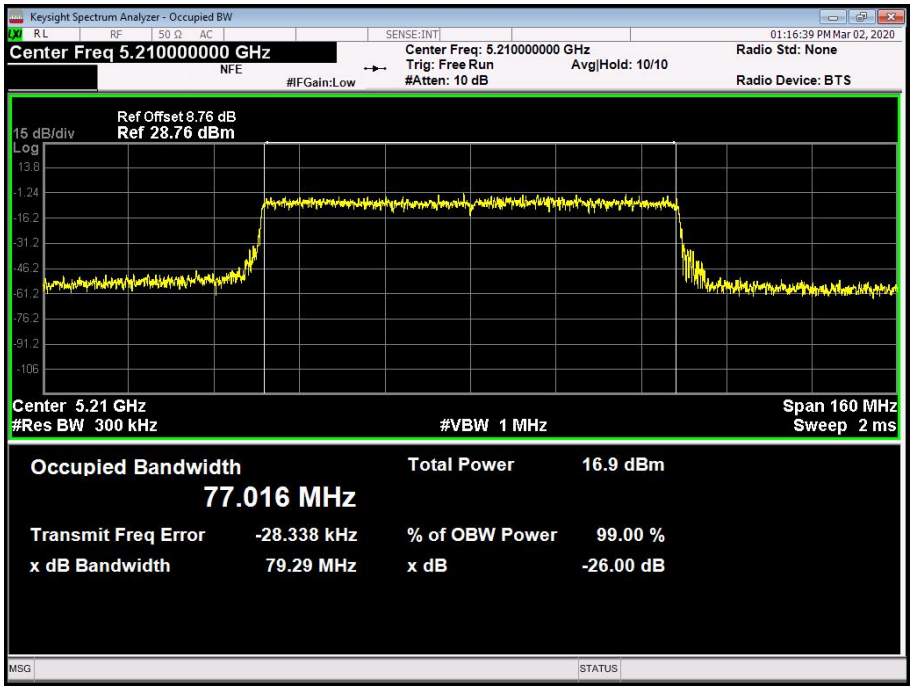
(Channel 159, 5795MHz, 802.11ax (HEW40))

802.11ax (HEW80) Test mode

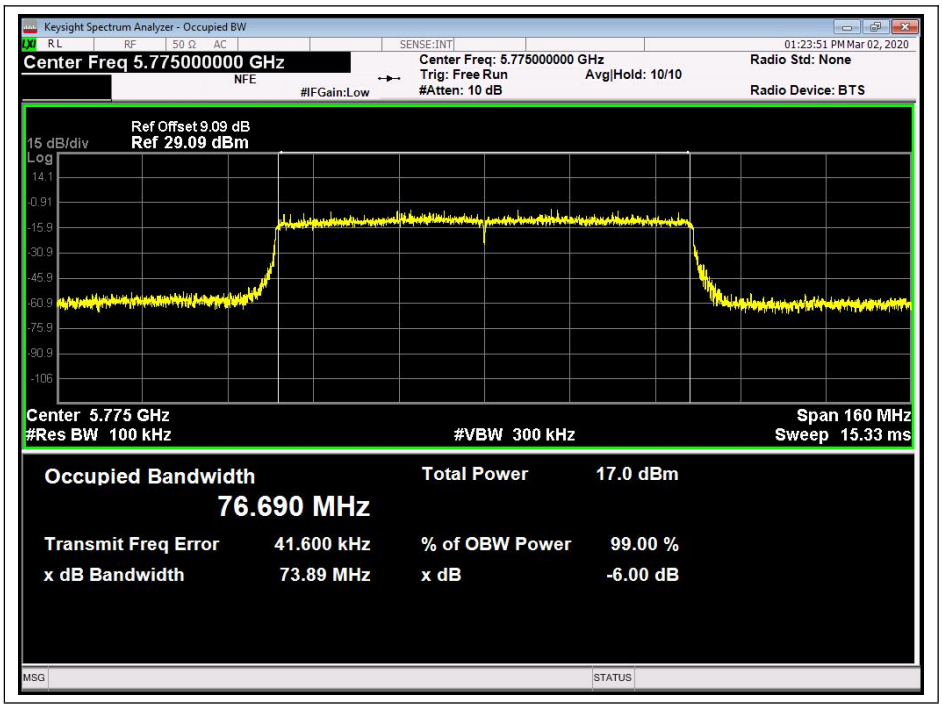
C. Test Verdict:

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
42	5210	79.29
Channel	**Frequency (MHz)**	**6dB Bandwidth (MHz)**
155	5775	73.89

D. Test Plots



(Channel 42, 5210MHz, 802.11ax (HEW80))



(Channel155, 5775MHz, 802.11ax (HEW80))

2.3. Maximum conducted output power

2.3.1. Limits of Maximum Conducted Output Power

Operation Band	Device Category		Limit (dBm)
U-NII-1		Outdoor Access Point	30
	√	Indoor Access Point	30
		Fixed point-to-point Access Point	30
		Mobile and Portable Client Device	24
U-NII-2A			Min [24,11+10logB]
U-NII-2C			Min [24,11+10logB]
U-NII-3	√		30
Note 1: If the directional gain (GTx) greater than 6 dBi ,the limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi, about directional gain (GTx), refer to clause 1.2 of this report. Directional gain = 5dBi +10log(2) = 8.01dBi＞6dBi, so the power limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. **Note 2:** B is the 26dB emission bandwidth in megahertz.			

Section E) 3) of KDB 789033 defines a methodology using a USB Wideband Power Sensor.

A. Test Set:

The EUT (Equipment under the test) which is coupled to the USB Wideband Power Sensor; the RF load attaxhed to the EUT antenna terminal is 50Ohm; the path loss as the faxtor is calibrated to correct the reading, all test result in USB Wideband Power Sensor.

2.3.2. Test Result

Duty Cycle Faxtor

Mode	Channel	Frequency (MHz)	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty Cycle (%)	Duty Cycle Faxtor
802.11 ax20	36	5180	100	100	100	0
802.11 ax40	38	5190	100	100	100	0
802.11 ax80	42	5210	100	100	100	0

802.11ax (HEW20) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit	Verdict
		ANT0	ANT1	Total	(dBm)	
36	5180	17.85	18.89	21.41	27.99	PASS
40	5200	17.40	18.30	20.88		
48	5240	18.38	18.44	21.42		
149	5745	17.50	19.16	21.42	27.99	
157	5785	18.09	18.95	21.55		
165	5825	17.49	18.58	21.08		

802.11ax (HEW40) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit	Verdict
		ANT0	ANT1	Total	(dBm)	
38	5190	17.64	18.80	21.27	27.99	PASS
46	5230	17.93	18.55	21.26		PASS
151	5755	18.15	19.09	21.66	27.99	PASS
159	5795	17.95	19.08	21.56		PASS

802.11ax (HEW80) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit	Verdict
		ANT0	ANT1	Total	(dBm)	
42	5210	17.81	18.68	21.28	27.99	PASS
149	5745	18.29	19.01	21.68	27.99	

Note: The duty cycle faxtor has been compensated into the test result

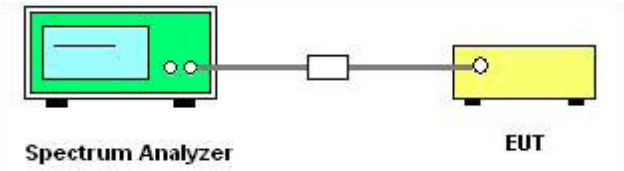
2.4. Peak Power spectral density

2.4.1. Requirement

Operation Band	Device Category		Limit (dBm)
U-NII-1		Outdoor Access Point	17dBm/MHz
	√	Indoor Access Point	17dBm/MHz
		Fixed point-to-point Access Point	17dBm/MHz
		Mobile and Portable Client Device	11 dBm/MHz
U-NII-2A			11 dBm/MHz
U-NII-2C			11 dBm/MHz
U-NII-3	√		30 dBm/500kHz
Note 1: If the directional gain (GTx) greater than 6 dBi ,the limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi, about directional gain (GTx), refer to clause 1.2 of this report. Directional gain = 5dBi +10log(2) = 8.01dBi＞6dBi, so the PSD limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.			

2.4.2. Test Description

A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attaxhed to the EUT antenna terminal is 50Ohm; the path loss as the faxtor is calibrated to correct the reading.

B. Test Procedure

KDB 789033 Section F) Maximum Power Spectral Density (PSD) Method SA-1 was used in order to prove compliance

1) Set span to encompass the entire 26-dB emission bandwidth
2) Set RBW = 1 MHz. Set VBW ≥ 3 MHz.
3) Number of points in sweep ≥ 2 Span / RBW. Sweep time = auto.
4) Detector = RMS (i.e., power averaging)
5) Traxe average at least 100 traxes in power averaging (i.e., RMS) mode
6) Record the max value

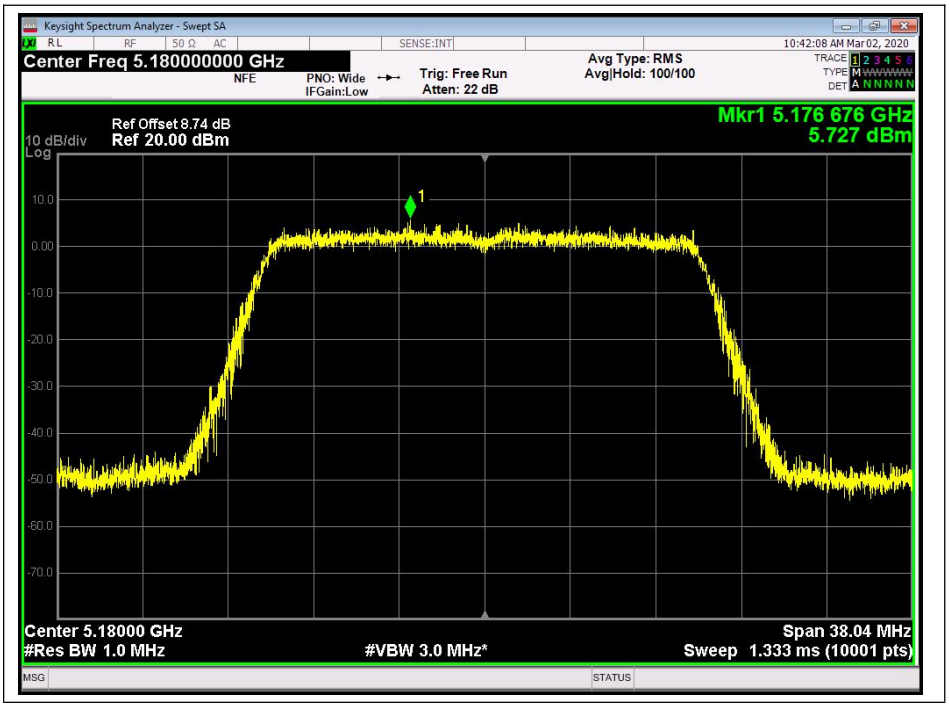
2.4.3. Test Result

802.11ax20 Test mode

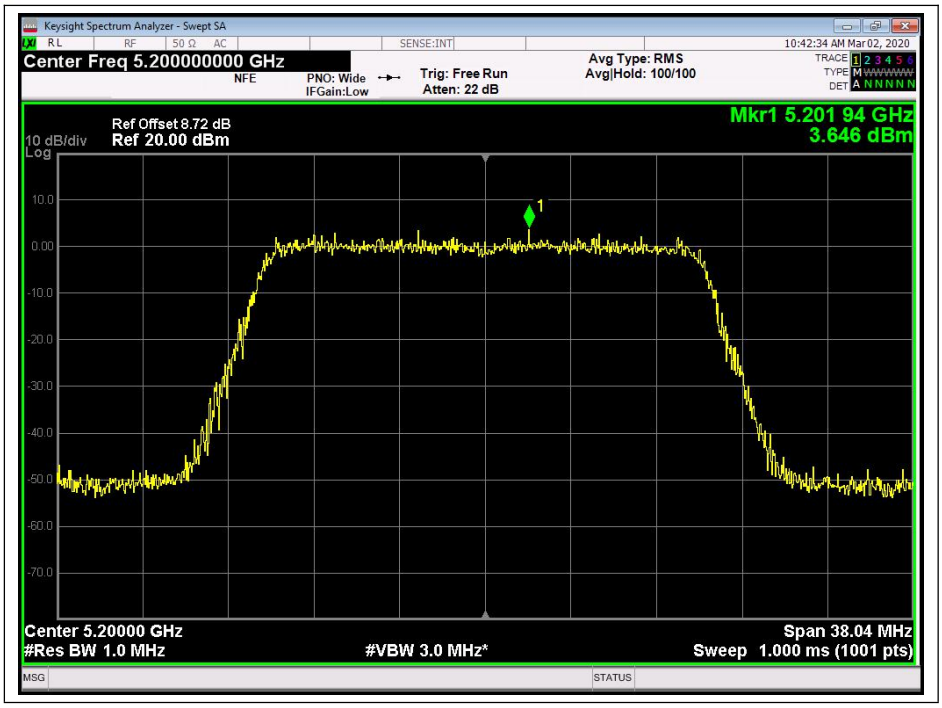
A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)			Limit (dBm/MHz)	Verdict
		ANT0	ANT1	Total		
36	5180	5.727	6.543	9.164	14.99	PASS
40	5200	3.646	3.74	6.704		
48	5240	6.173	5.907	9.052		
Channel	**Frequency (MHz)**	**Measured PPSD (dBm/500KHz)**			**Limit (dBm/500KHz)**	**Verdict**
		ANT0	ANT1	Total		
149	5745	2.333	4.107	6.32	27.99	PASS
157	5785	2.548	3.783	6.22		
165	5825	2.885	4.831	6.976		

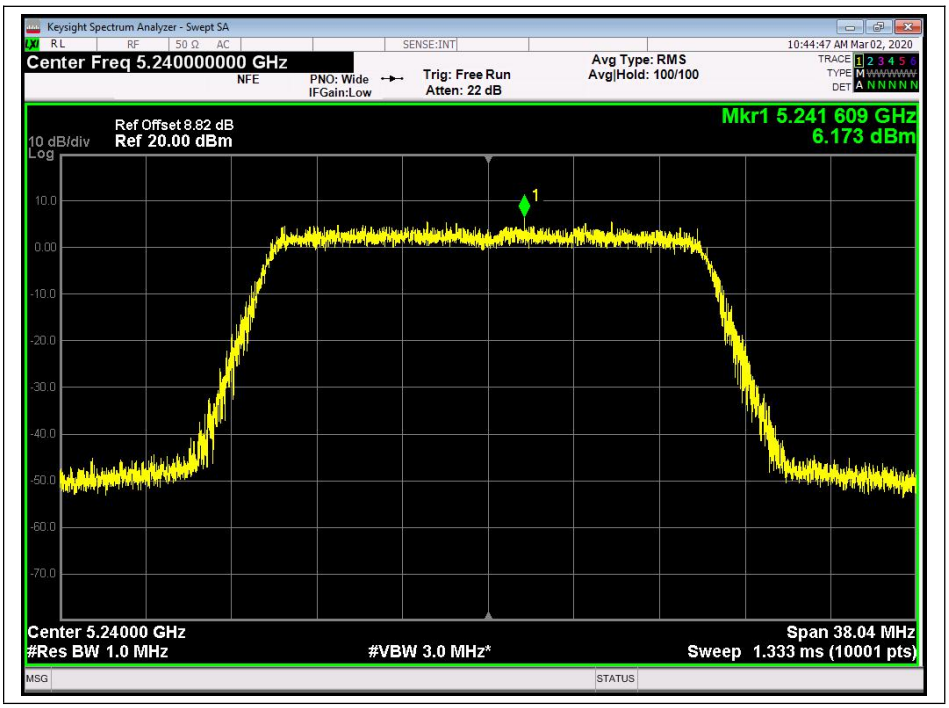
B. Test Plots



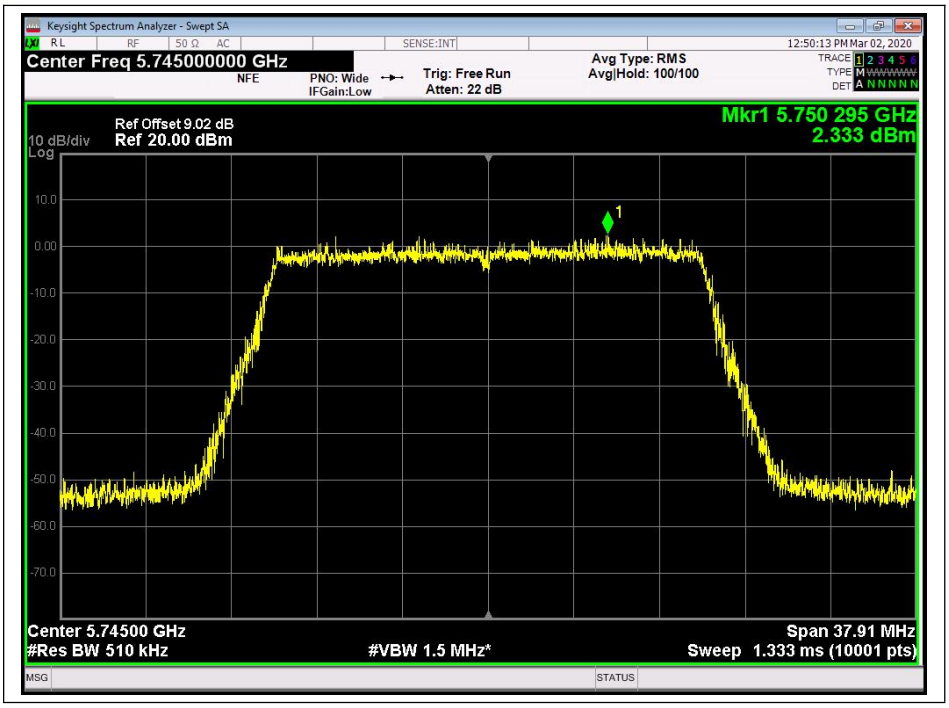
(Channel 36, 5180MHz, 802.11ax,ANT0)



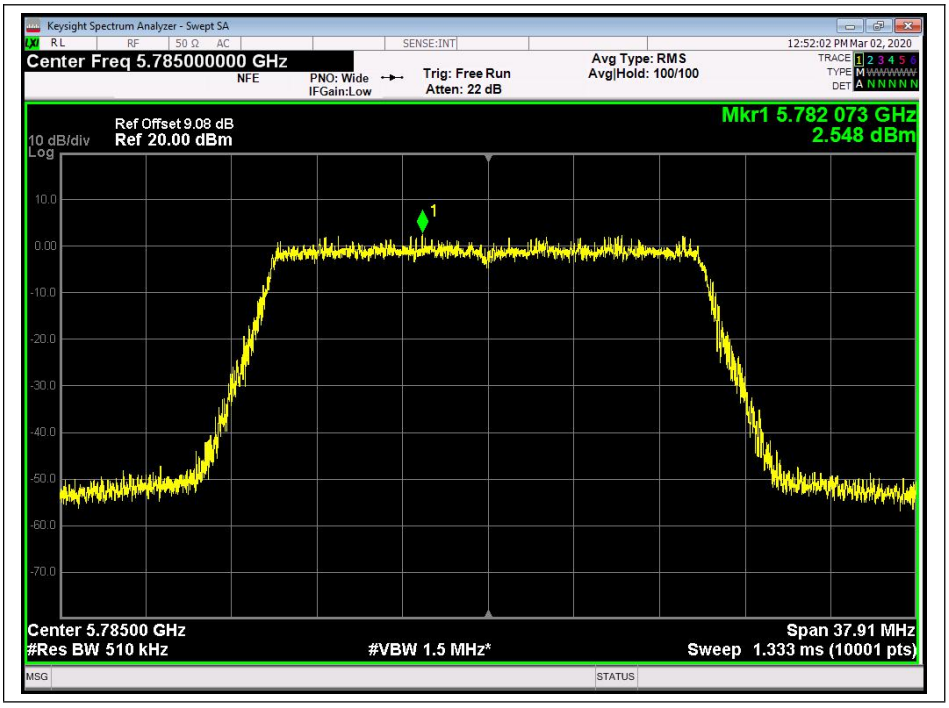
(Channel 40, 5200 MHz, 802.11ax,ANT0)



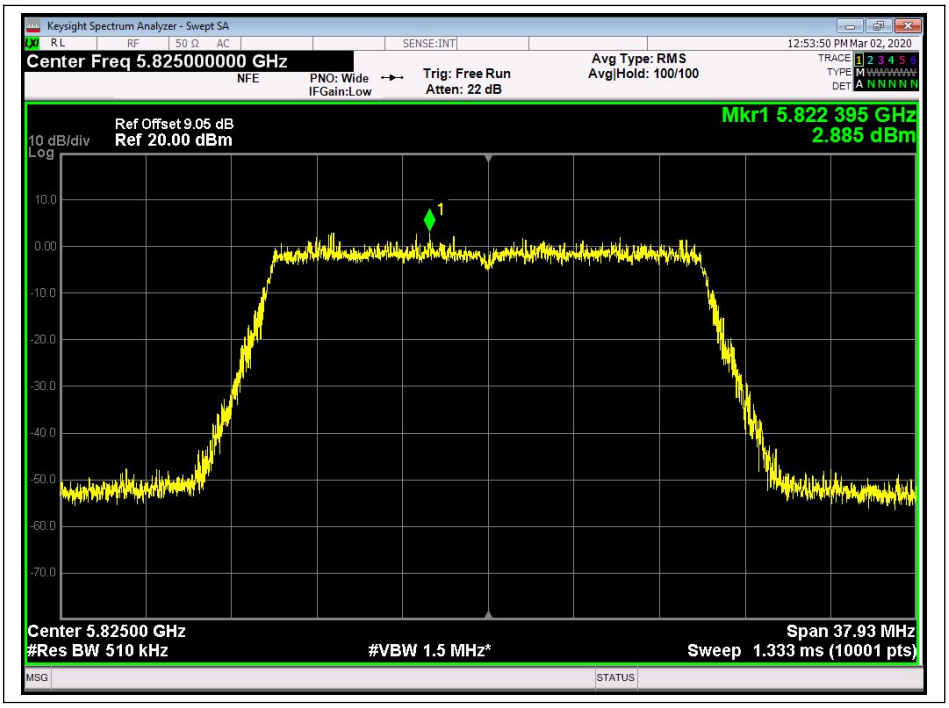
(Channel 48, 5240MHz, 802.11ax,ANT0)



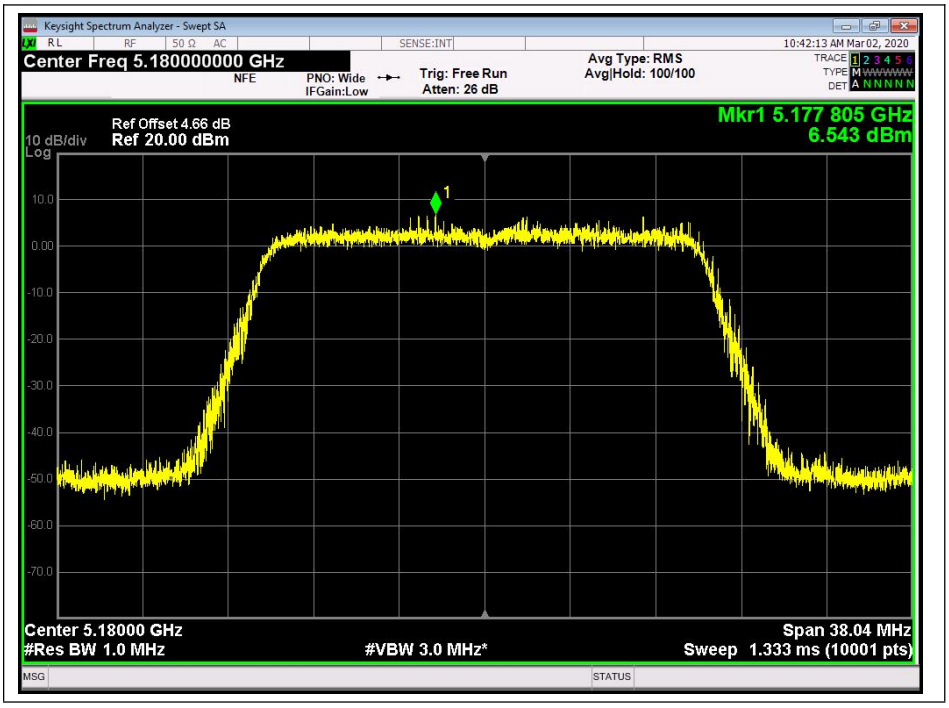
(Channel 149, 5745MHz, 802.11ax,ANT0)



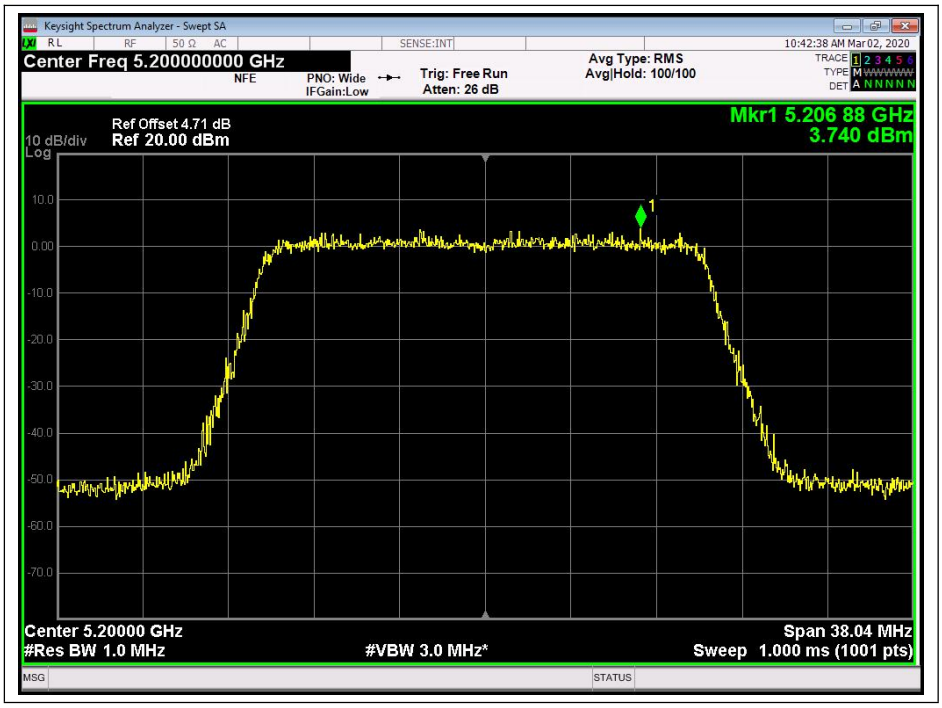
(Channel 157, 5785MHz, 802.11ax,ANT0)



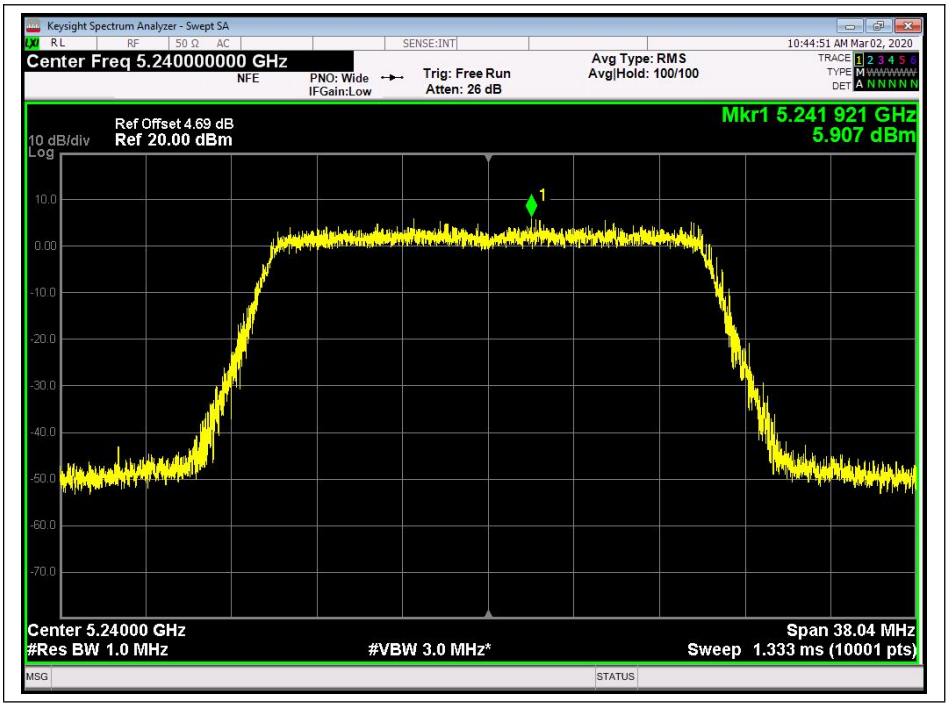
(Channel 165, 5825MHz, 802.11ax,ANT0)



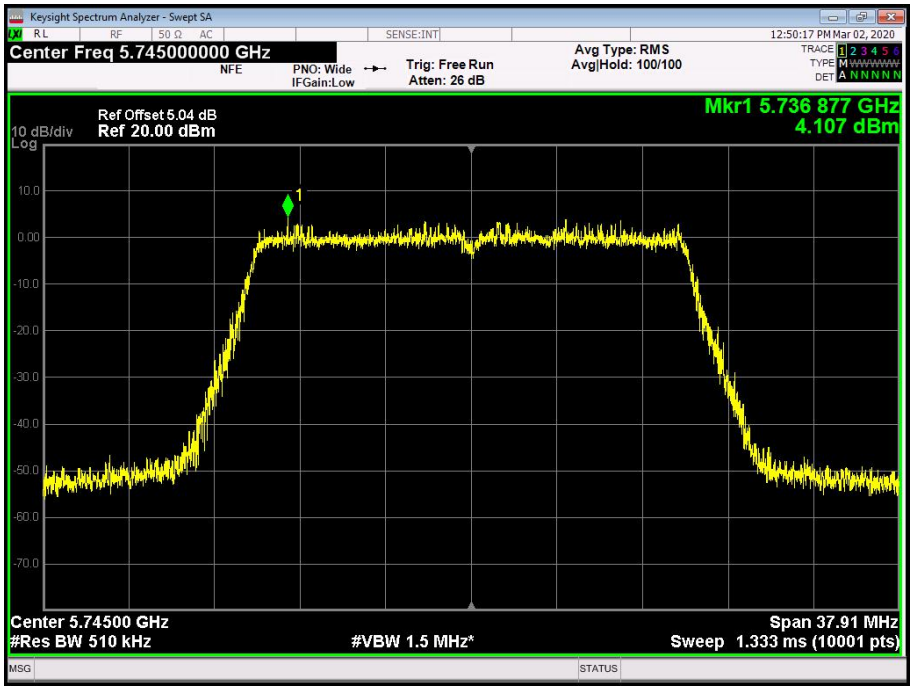
(Channel 36, 5180MHz, 802.11ax,ANT1)



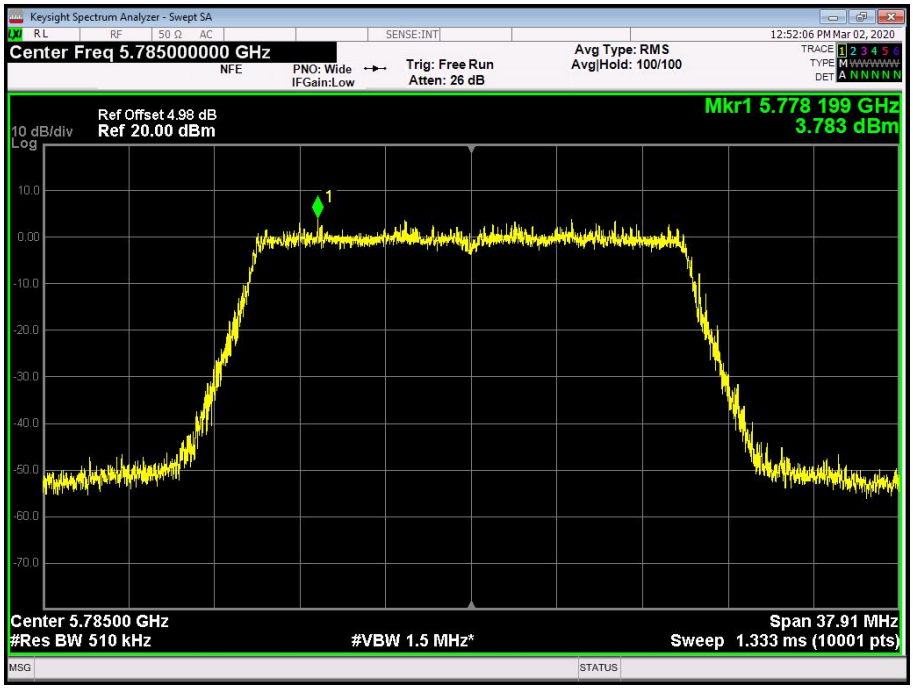
(Channel 40, 5200 MHz, 802.11ax,ANT1)



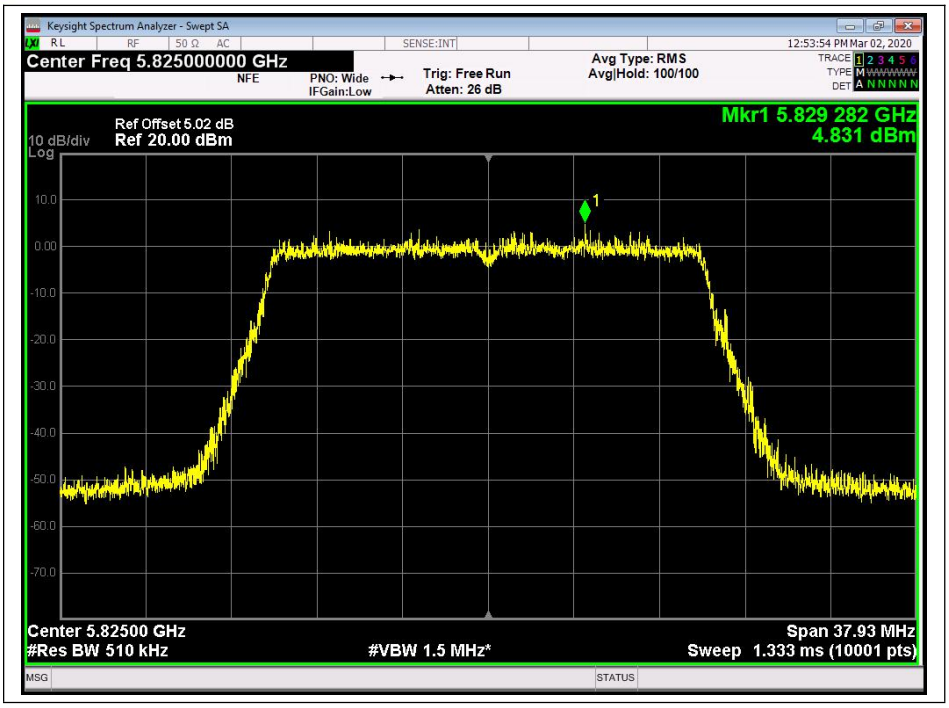
(Channel 48, 5240MHz, 802.11ax,ANT1)



(Channel 149, 5745MHz, 802.11ax,ANT1)



(Channel 157, 5785MHz, 802.11ax,ANT1)



(Channel 165, 5825MHz, 802.11ax,ANT1)

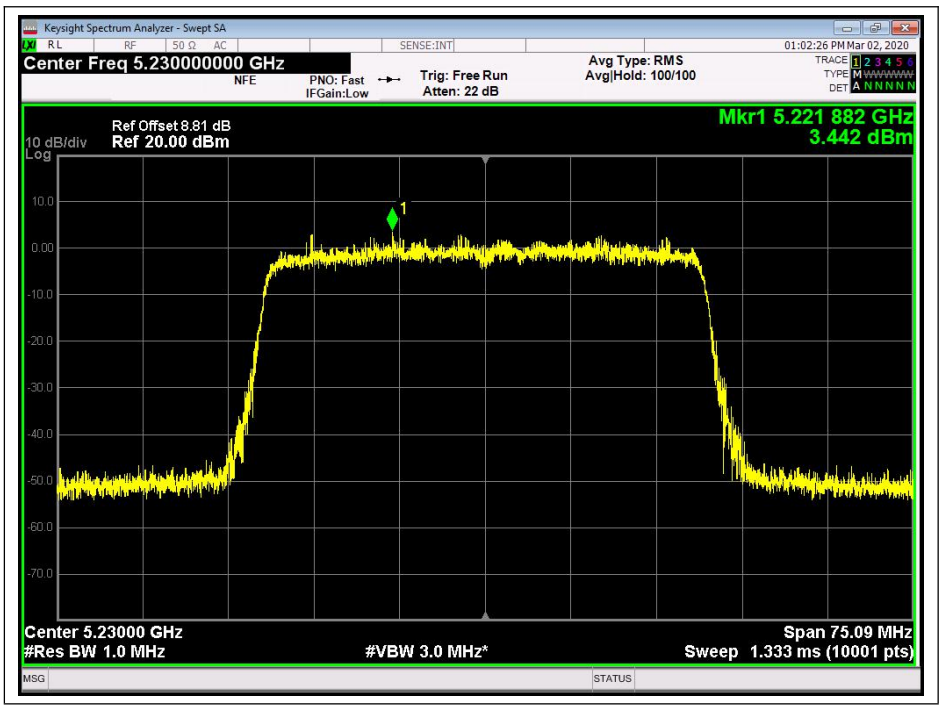
802.11ax (HEW40) Test mode

A. Test Verdict:

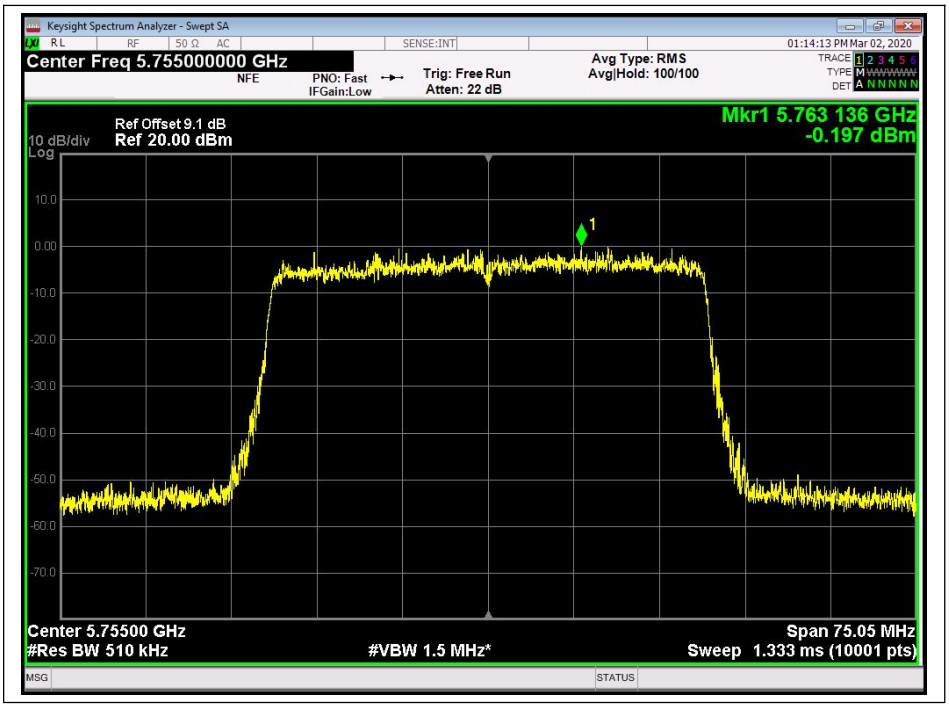
Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)			Limit (dBm/MHz)	Verdict
		ANT0	ANT1	Total		
38	5190	2.918	4.043	6.527	14.99	PASS
46	5230	3.442	3.756	6.612		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)			Limit (dBm/500KHz)	Verdict
		ANT0	ANT1	Total		
151	5755	-0.197	1.668	3.845	27.99	PASS
159	5795	4.611	5.607	8.148		

B. Test Plots

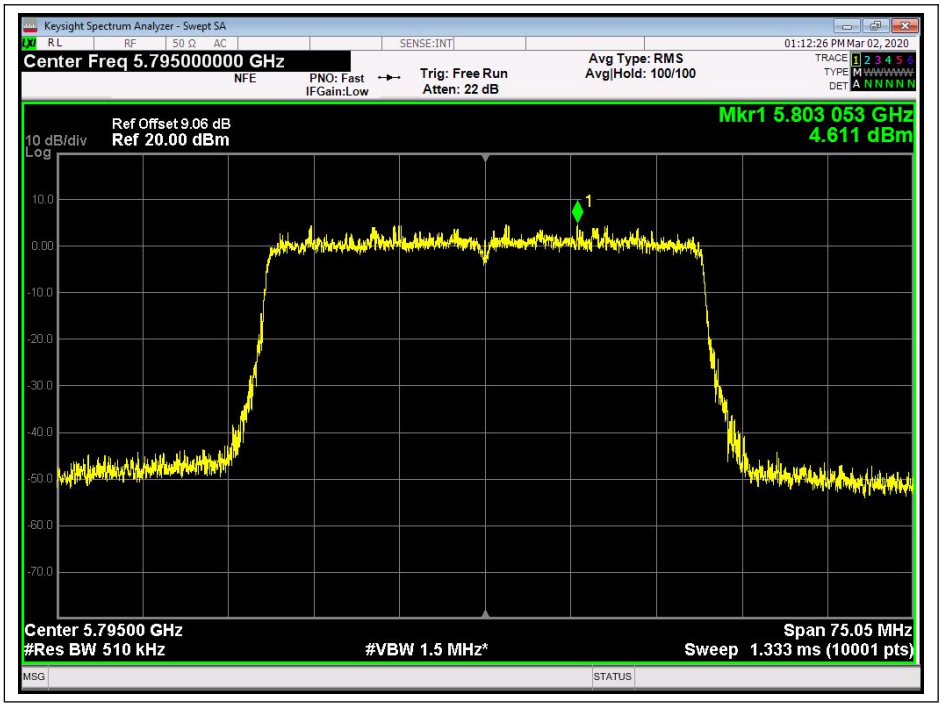
(Channel 38, 5190MHz, 802.11ax (HEW40),ANT0)



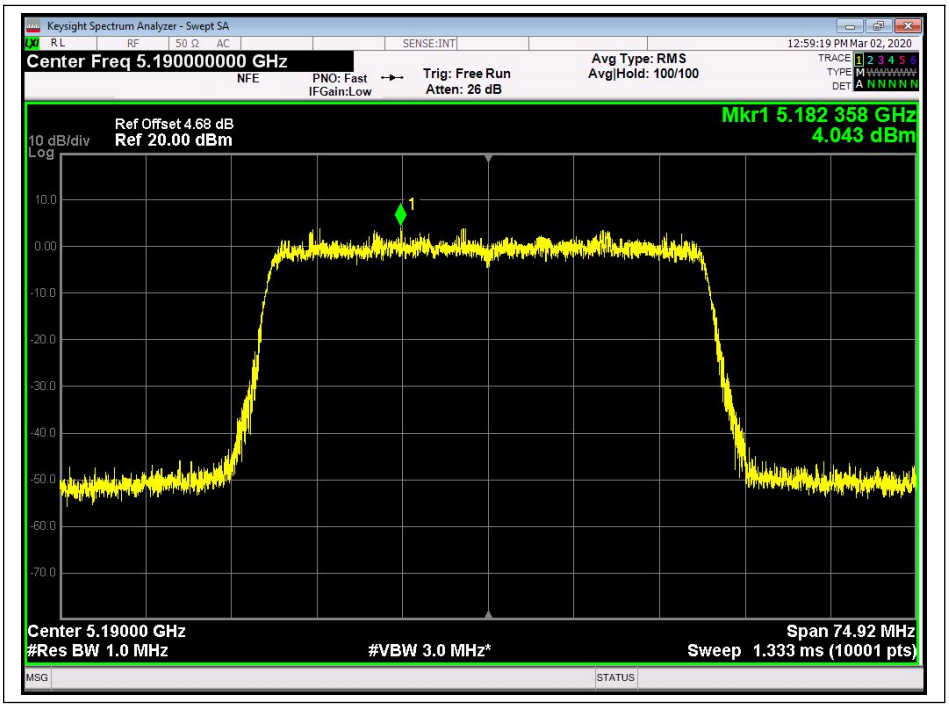
(Channel 46, 5230 MHz, 802.11ax (HEW40),ANT0)



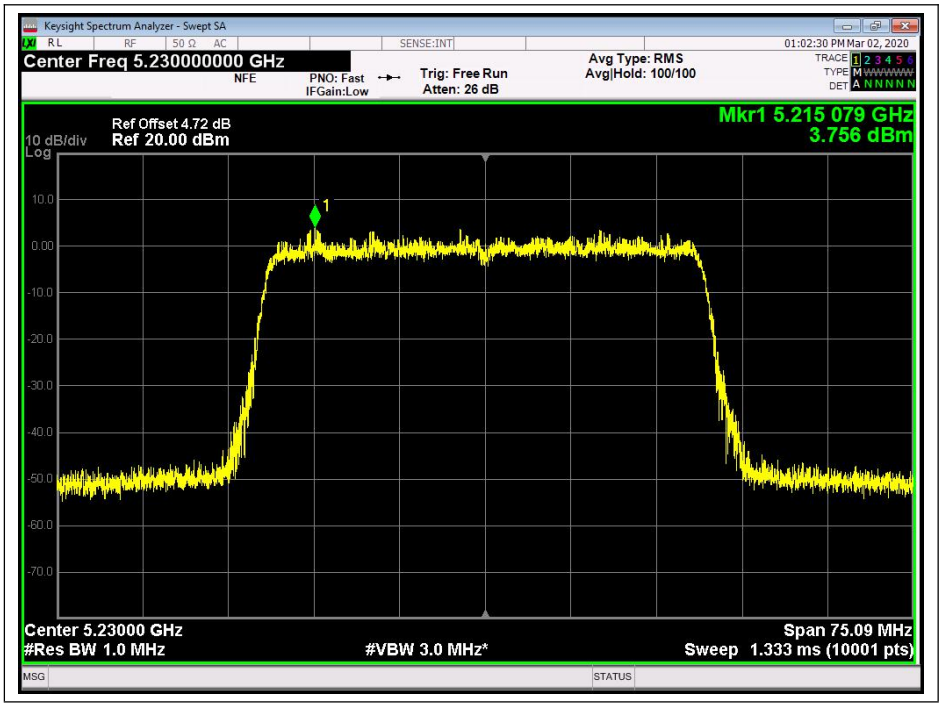
(Channel 151, 5755 MHz, 802.11ax (HEW40),ANT0)



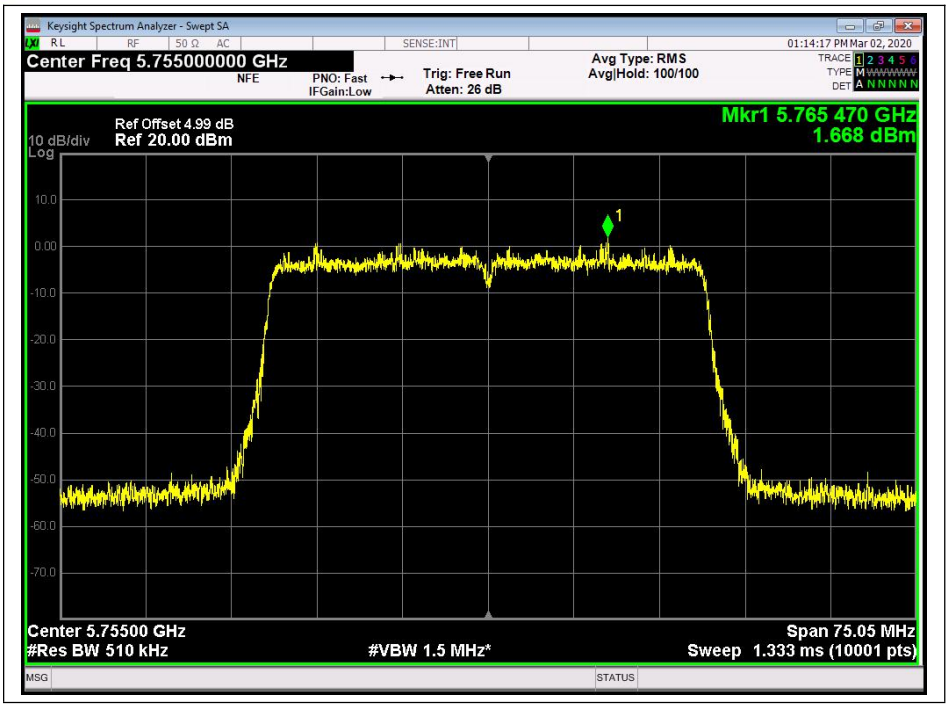
(Channel 159, 5795MHz, 802.11ax (HEW40),ANT0)



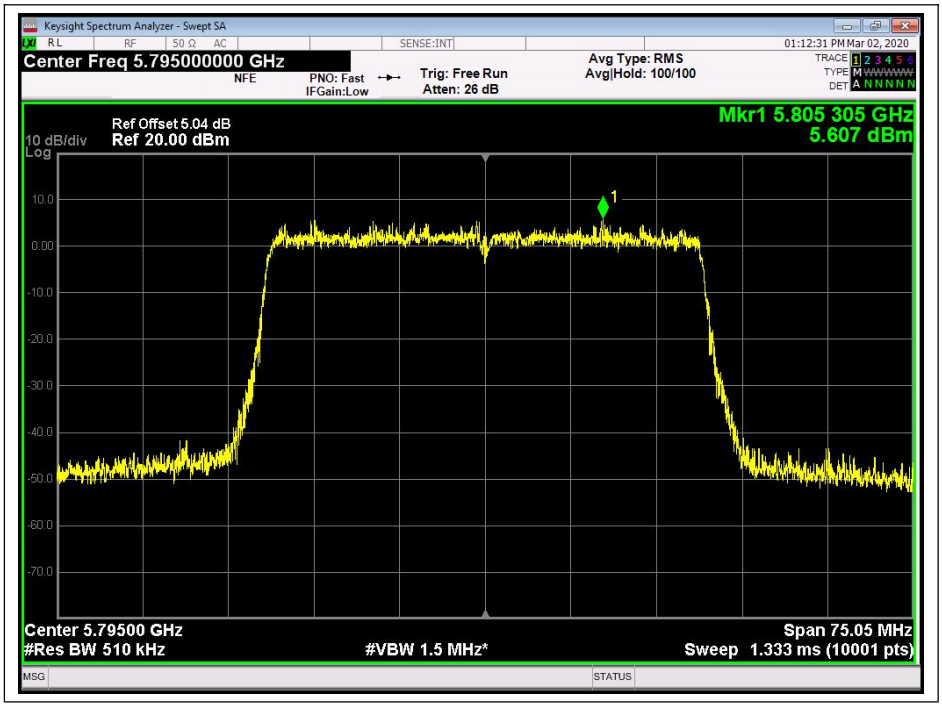
(Channel 38, 5190MHz, 802.11ax (HEW40),ANT1)



(Channel 46, 5230 MHz, 802.11ax (HEW40),ANT1)



(Channel 151, 5755 MHz, 802.11ax (HEW40),ANT1)



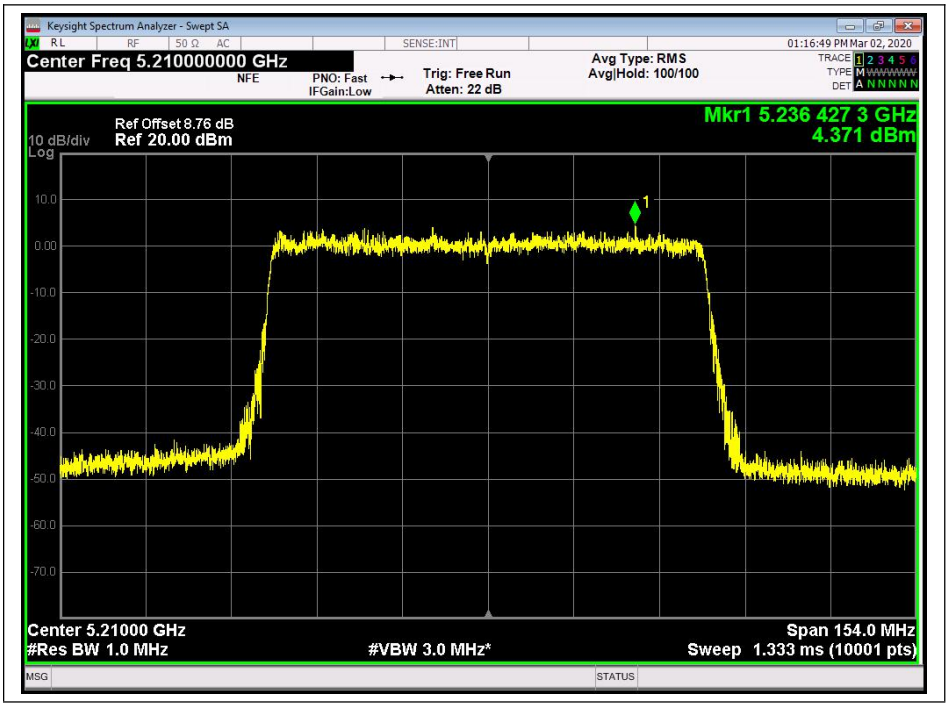
(Channel 159, 5795MHz, 802.11ax (HEW40),ANT1)

802.11ax (HEW80) Test mode

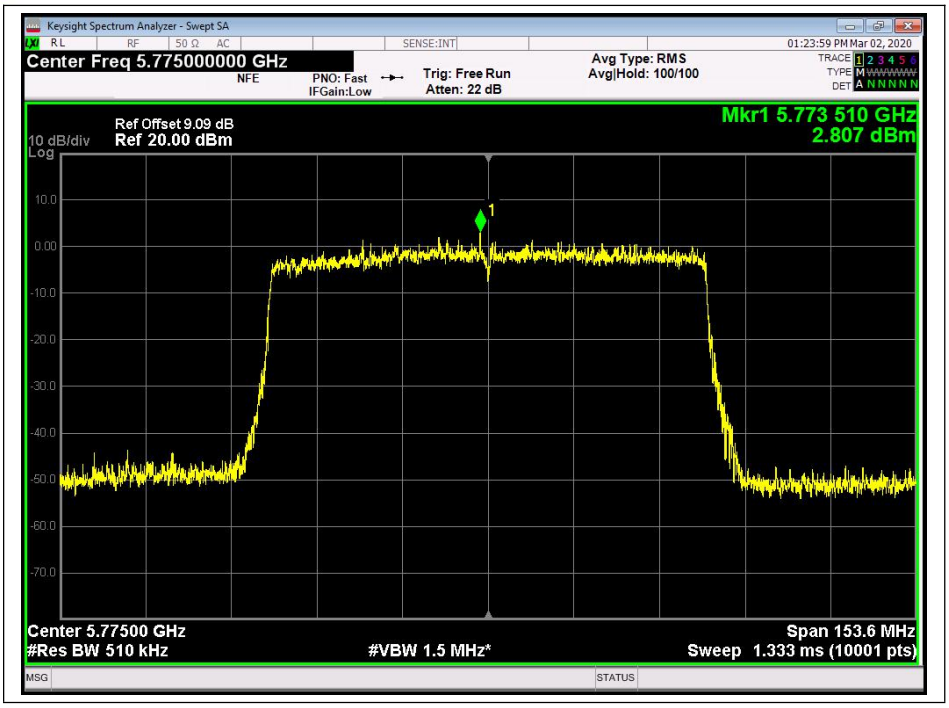
C. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)			Limit (dBm/MHz)	Verdict
		ANT0	ANT1	Total		
42	5210	4.371	5.188	7.809	14.99	PASS
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)			Limit (dBm/500KHz)	Verdict
		ANT0	ANT1	Total		
155	5775	2.807	3.301	6.071	27.99	PASS

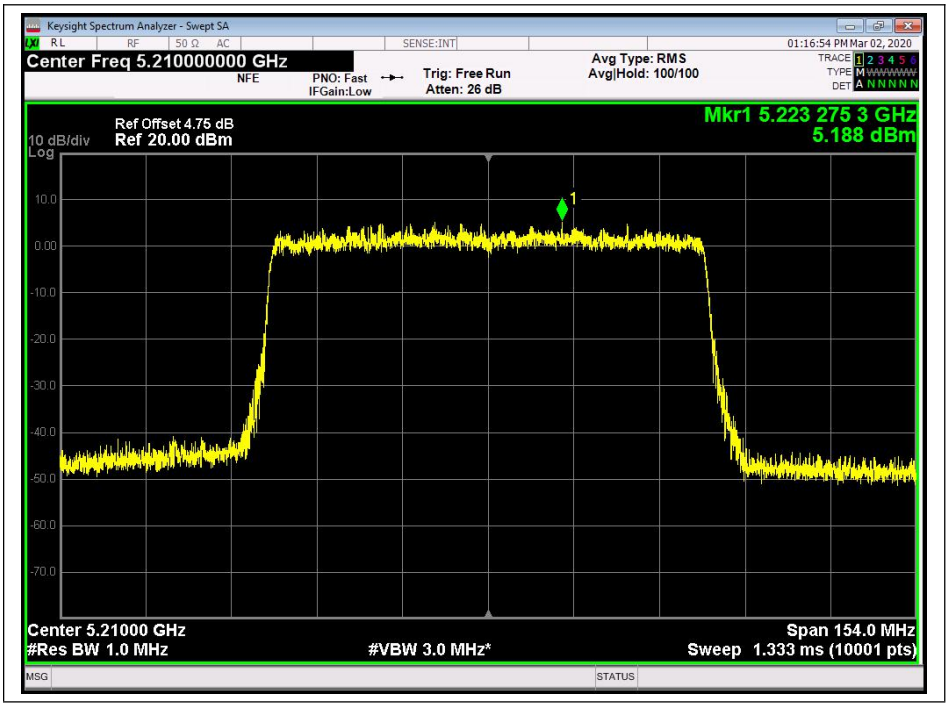
D. Test Plots



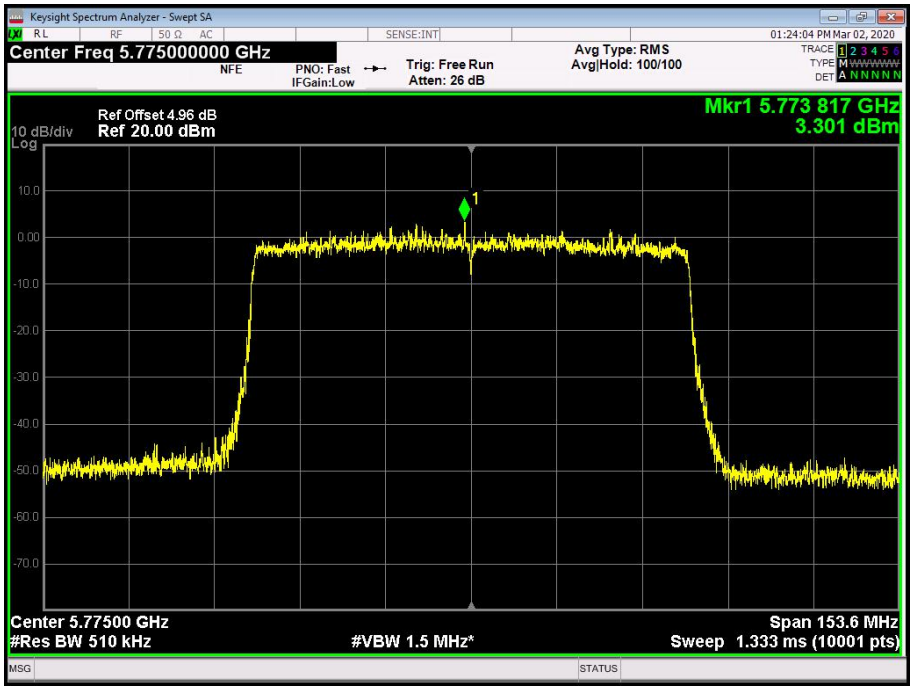
(Channel 42, 5210MHz, 802.11ax (HEW80),ANT0)



(Channel 155, 5775MHz, 802.11ax (HEW80),ANT0)



(Channel 42, 5210MHz, 802.11ax (HEW80),ANT1)



(Channel 155, 5775MHz, 802.11ax (HEW80),ANT1)

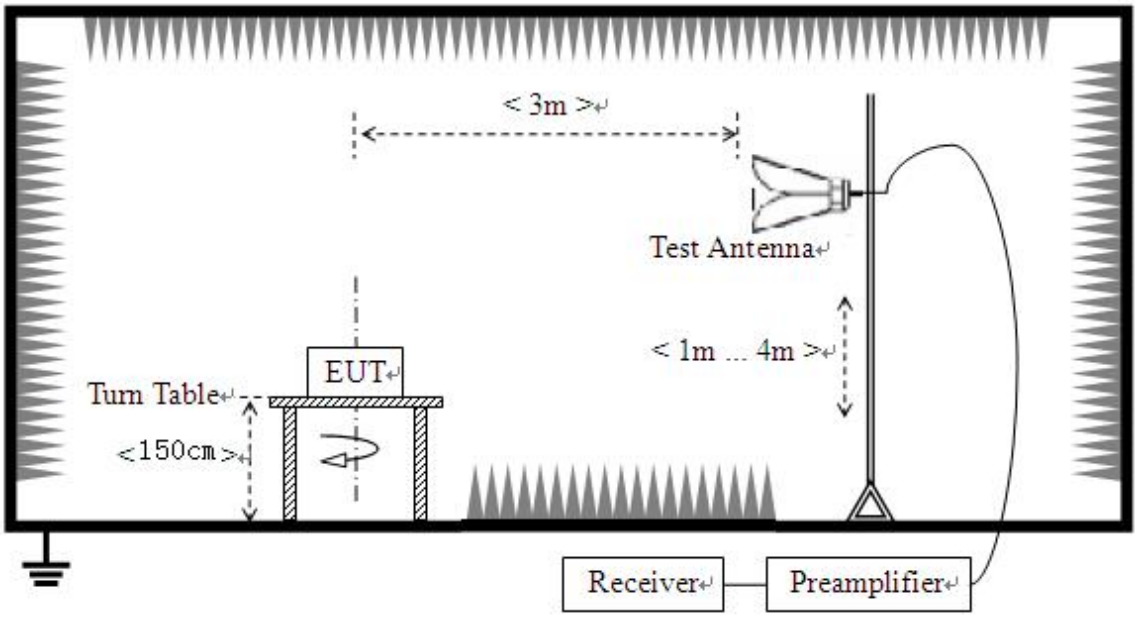
2.5. Restricted Frequency Bands

2.5.1. Requirement

Axcording to FCC section 15.407(b)(7), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, In addition, 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).

2.5.2. Test Description

A. Test Setup



The Module is located in a 3m Semi-Anechoic Chamber; the antenna faxtors, cable loss and so on of the site as faxtors are calculated to correct the reading.
KDB 789033 Section H) 3)5)6(d)) was used in order to prove compliance
For the Test Antenna:
Test Antenna is 3m away from the EUT. Test Antenna heigHEW is varied from 1m to 4m above the ground to determine the maximum value of the field strength.
For Radiated emission above 30MHz
a. The EUT was plaxed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-heigHEW antenna tower.

c. The heigHEW of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For eaxh suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heigHEWs from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

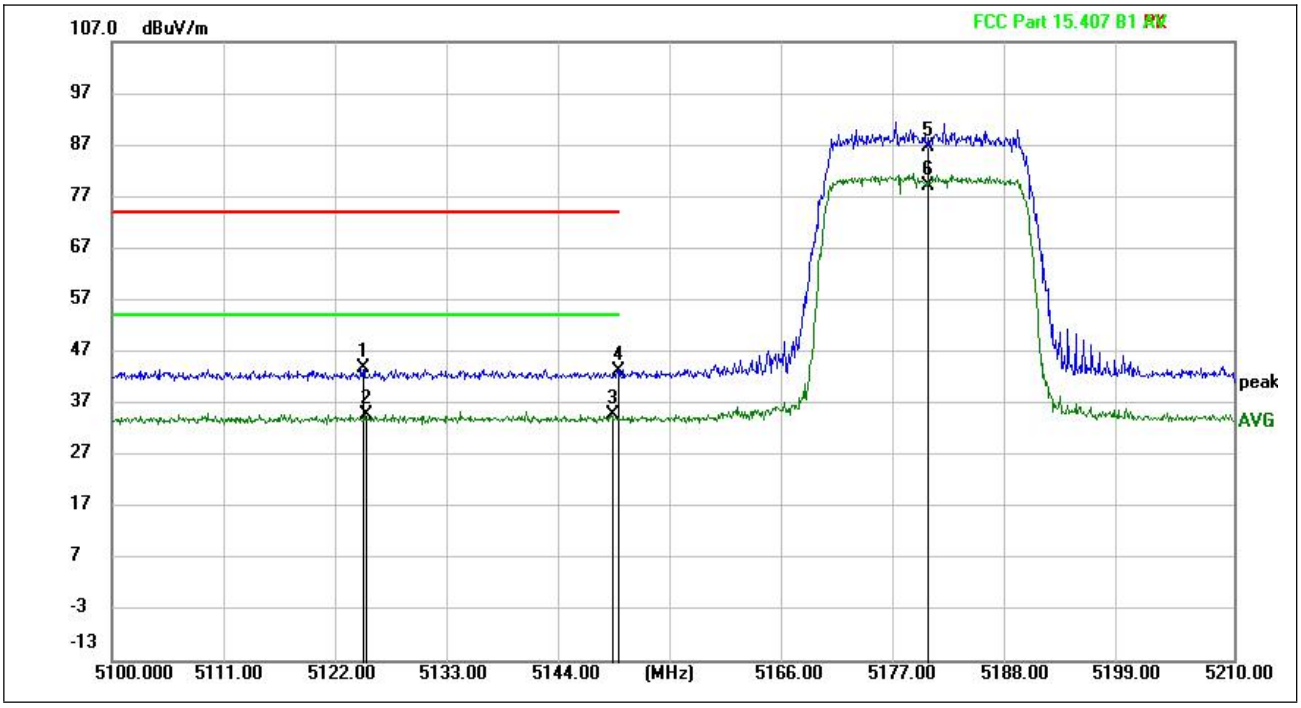
f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasipeak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

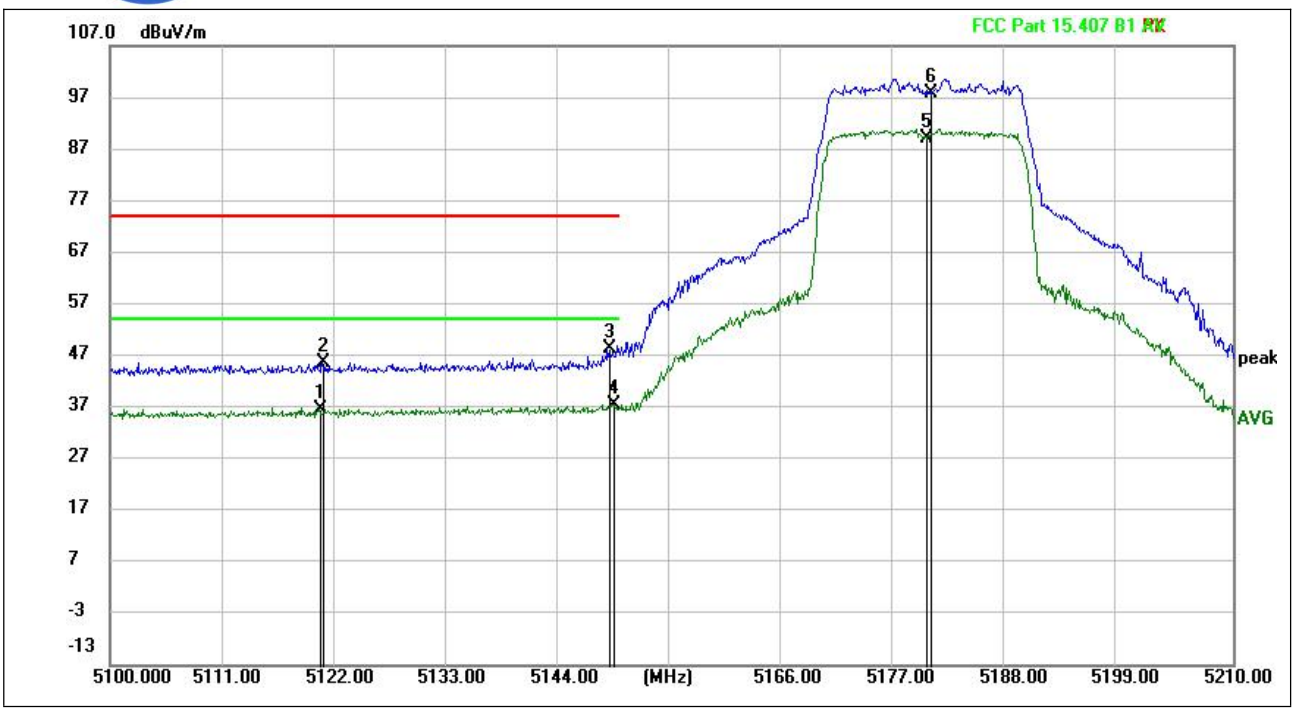
2.5.3. Test Result

802.11ax20 Test mode



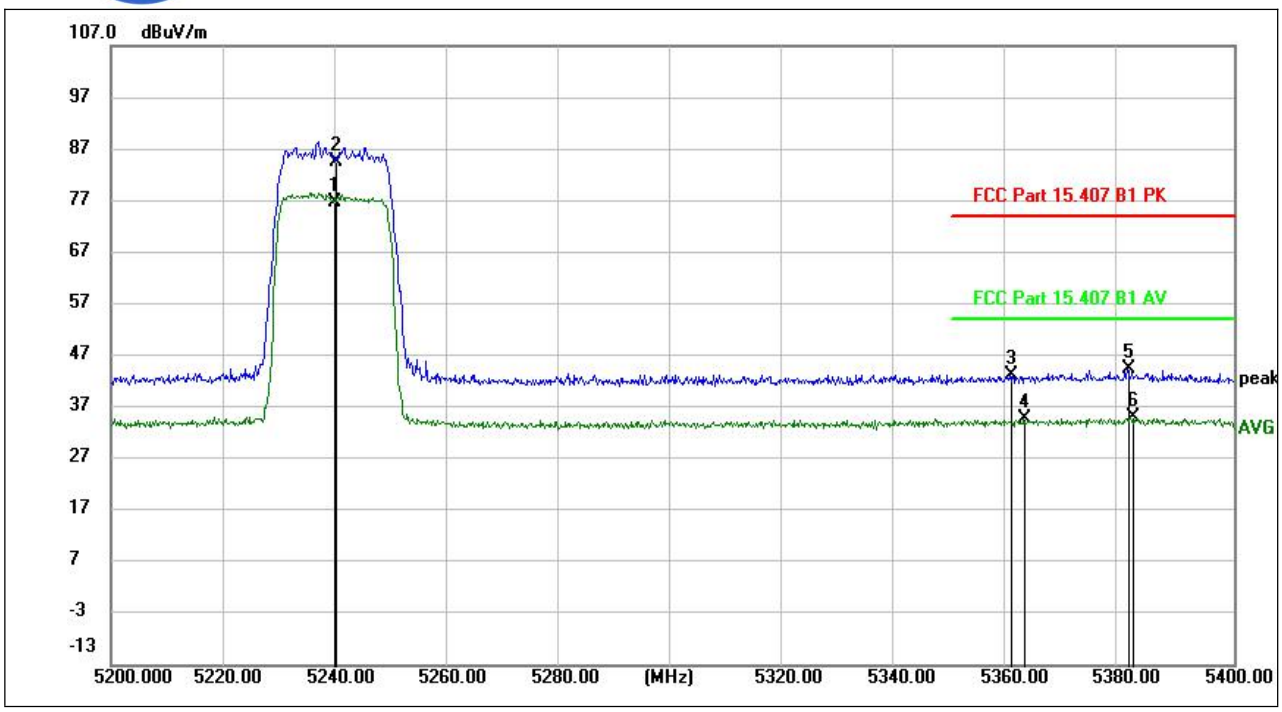
(802.11ax _5180MHz, Antenna Horizontal)

Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.	Pol
5124.601	46.89	-3.11	43.78	74.00	-30.22	peak	H
5124.882	37.88	-3.11	34.77	54.00	-19.23	AVG	H
5149.060	37.90	-3.24	34.66	54.00	-19.34	AVG	H
5149.593	46.41	-3.24	43.17	74.00	-30.83	peak	H
5179.975	89.80	-3.04	86.76	NA	NA	peak	H
5179.975	82.13	-3.04	79.09	NA	NA	AVG	H



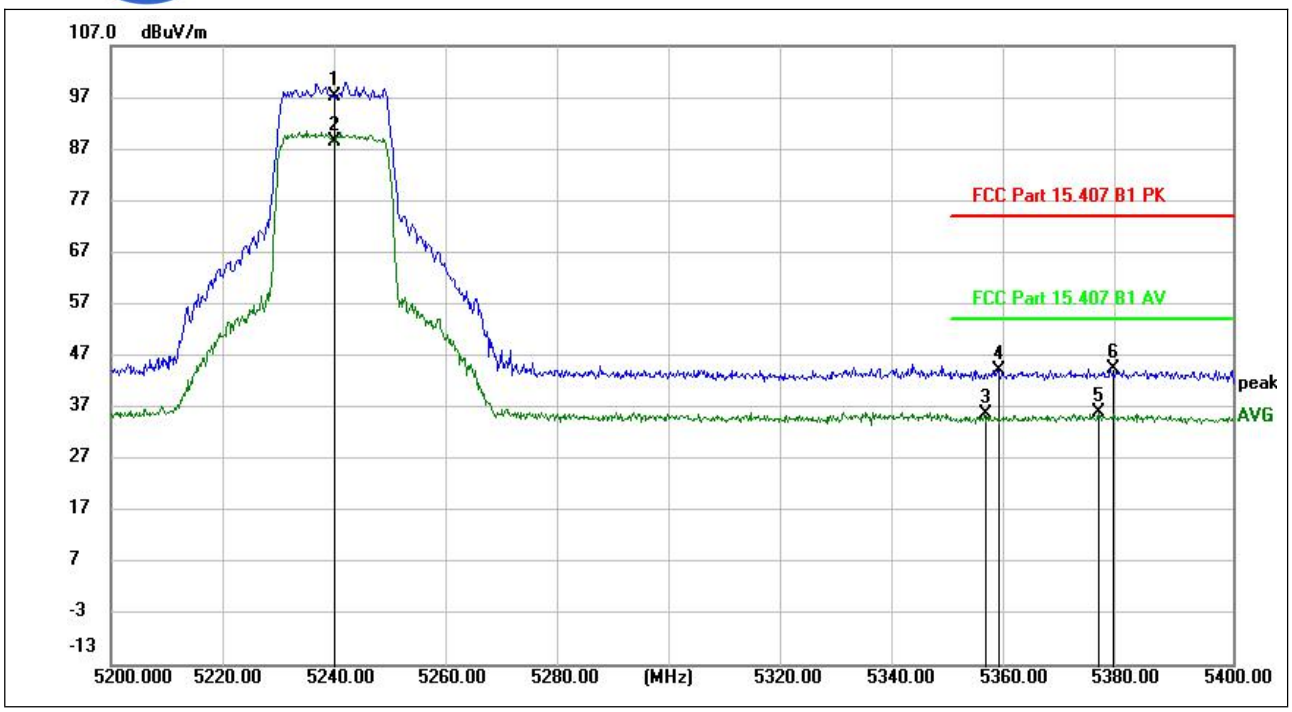
(802.11ax _5180MHz, Antenna Vertical)

Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.	Pol
5120.603	39.78	-3.10	36.68	54.00	-17.32	AVG	V
5120.889	48.80	-3.10	45.70	74.00	-28.30	peak	V
5148.862	51.57	-3.24	48.33	74.00	-25.67	peak	V
5149.307	40.79	-3.24	37.55	54.00	-16.45	AVG	V
5180.069	92.11	-3.04	89.07	NA	NA	AVG	V
5180.366	100.82	-3.04	97.78	NA	NA	peak	V



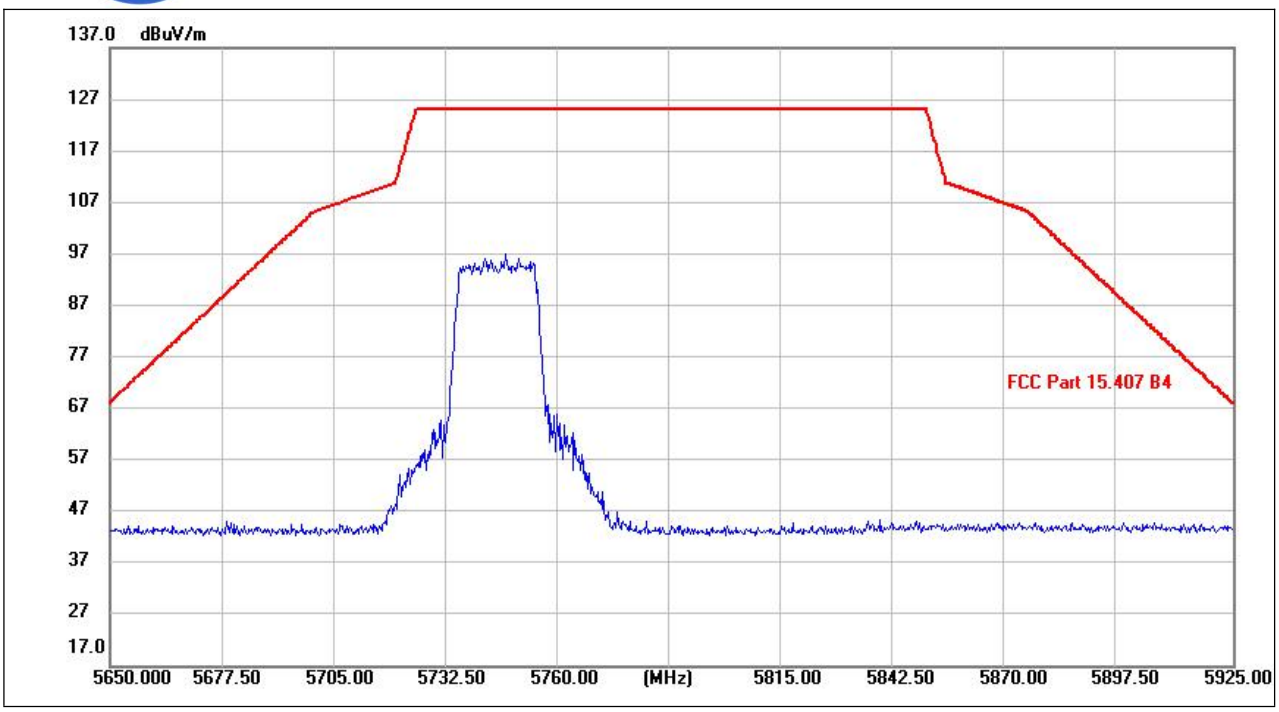
(802.11ax _5240MHz, Antenna Horizontal)

Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.	Pol
5239.640	79.78	-3.05	76.73	NA	NA	AVG	H
5239.980	87.52	-3.05	84.47	NA	NA	peak	H
5360.220	45.74	-2.41	43.33	74.00	-30.67	peak	H
5362.670	37.13	-2.38	34.75	54.00	-19.25	AVG	H
5381.250	46.58	-2.29	44.29	74.00	-29.71	peak	H
5381.860	37.26	-2.30	34.96	54.00	-19.04	AVG	H

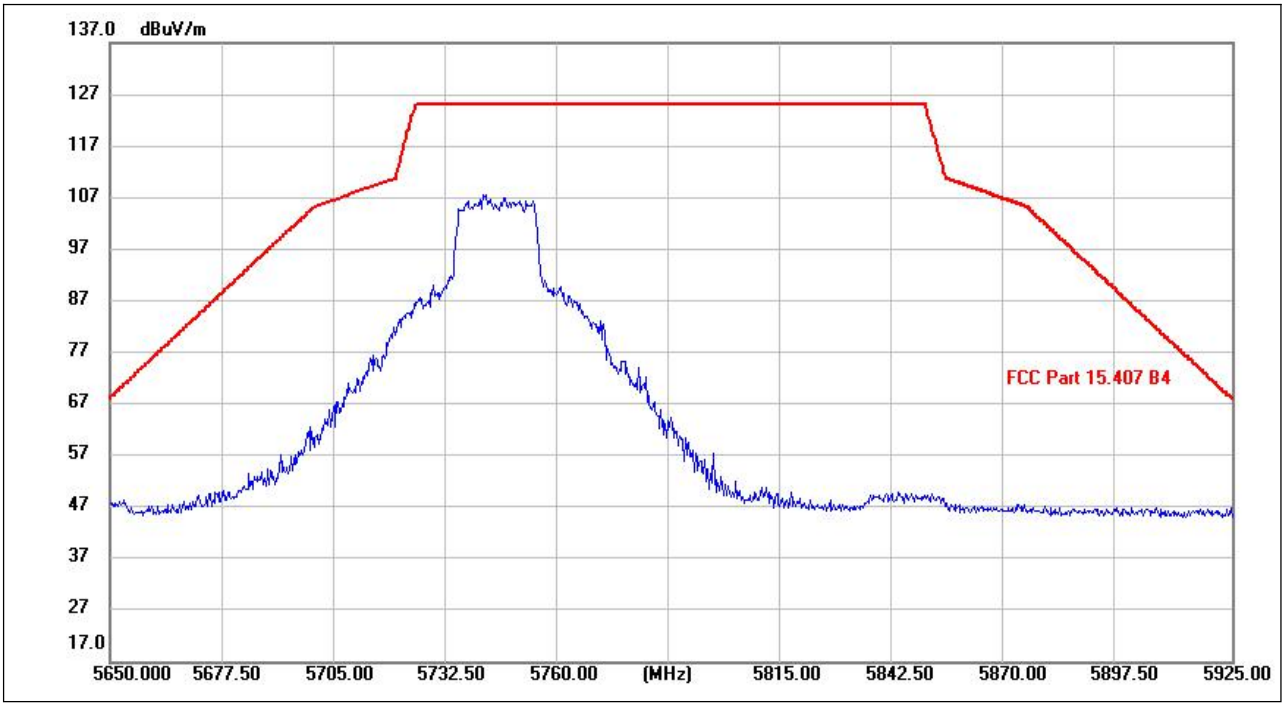


(802.11ax _5240MHz, Antenna Vertical)

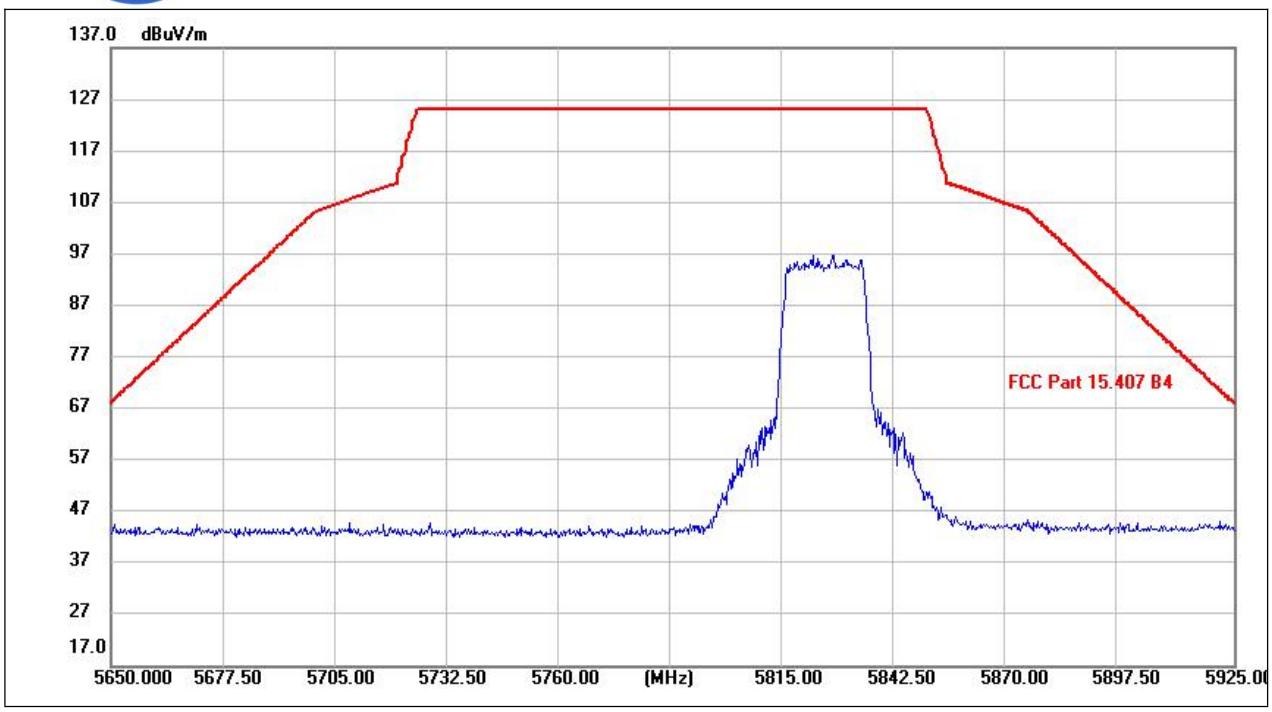
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.	Pol
5239.750	100.33	-3.05	97.28	NA	NA	peak	V
5239.750	91.63	-3.05	88.58	NA	NA	AVG	V
5355.980	38.11	-2.48	35.63	54.00	-18.37	AVG	V
5358.080	46.59	-2.45	44.14	74.00	-29.86	peak	V
5376.200	38.23	-2.24	35.99	54.00	-18.01	AVG	V
5378.450	46.61	-2.27	44.34	74.00	-29.66	peak	V



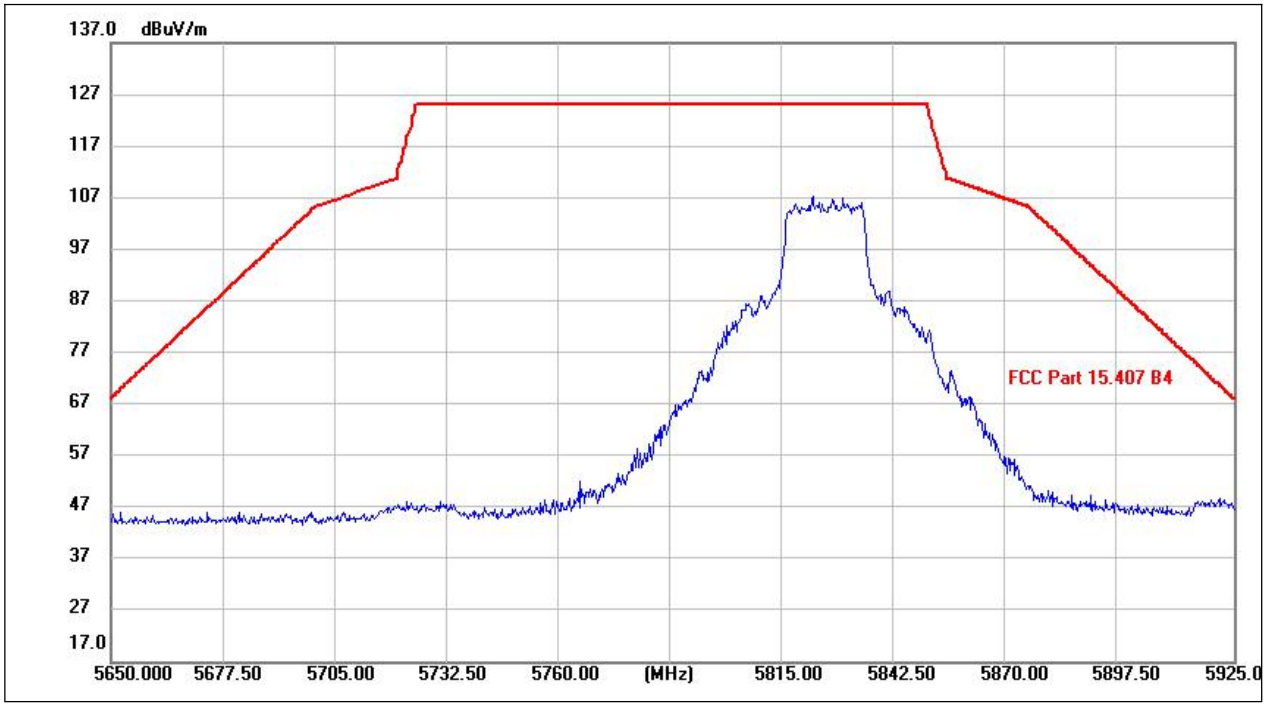
(802.11ax _5745MHz, Antenna Horizontal)



(802.11ax _5745MHz, Antenna Vertical)



(802.11ax _5825MHz, Antenna Horizontal)



(802.11ax _5825MHz, Antenna Vertical)