



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

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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 Manufacturer Information

Applicant:	Nanjing Juplink Intelligent Technologies Co., Ltd.
Applicant Address:	No. 757, Dixiu Road, Binjiang Economic Development Zone, Jiangning District, Nanjing China
Manufacturer:	Sichuan Tianyi Comheart Telecom Co., Ltd.
Manufacturer 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:	OFDM
Modulation Mode:	802.11ac(HT20), 802.11ac(HT40),802.11ac(HT80) 802.11a,802.11n(HT20), 802.11n(HT40)
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 5 dBi

Note 1: The U-NII band is applicable to this report, another bands of operation (2.4GHz) is documented in a separate report.

Note 2: The EUT has two antennas and supports a MIMO function. Physically, the EUT provides two completed transmitters and two receivers for 802.11ac and 802.11n modulation mode
Modulation Mode: TX Function

Modulation Mode:	TX Function
802.11a	1TX
802.11n	2TX
802.11ac	2TX

Note 3: According to KDB 662911 D01, the directional gain = $GANT + 10\log(NANT)$ dBi, where GANT is the maximum antenna gain in dBi, NANT is the number of outputs.



Note 4: During test, the duty cycle of the EUT was setting to 100%.

Note 5: For conducted test item Maximum conducted output Power and Peak Power spectral density of each modulation mode, we recorded the test result of two antennas separately, for other conducted test items both of the two antennas were tested separately, we only recorded the worst test result(Ant 0) in this report.

Note 6: All radiation test items for 802.11ac modulation mode operate at MIMO mode during the test.

Note 7: For a more detailed description, please refer to Specification or User’s Manual supplied by the applicant and/or manufacturer.

1.3. Modulation Type and Data Rate of EUT

Modulation technology	Modulation Type	Data Rate (Mbps) <small>Note1</small>
OFDM (802.11ac)	BPSK	6/9
	QPSK	12/18
	16QAM	24/36
	64QAM	48/54
OFDM (802.11n)	BPSK	6.5
	QPSK	13/19.5
	16QAM	26/39
	64QAM	52/58.5/65

Note1: The worst-case mode (black bold) in all data rates has been determined during the pre-scan, only the test data of the worst-case were recorded in this report.



1.4. 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.



1.5. Test Standards and Results

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

No	Identity	Document Title
1	47 CFR Part 15	Radio Frequency Devices

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

No.	Section	Description	Test Date	Test Engineer	Result
1	15.203	Antenna Requirement	N/A	N/A	PASS
2	15.407(a) (e)	Emission Bandwidth	Feb 19, 2020 Feb 20, 2020	Lai Haihuang	PASS
3	15.407(a)	Maximum conducted output Power	Feb 19, 2020 Feb 20, 2020	Lai Haihuang	PASS
4	15.407(a)	Peak Power spectral density	Feb 19, 2020 Feb 20, 2020	Lai Haihuang	PASS
5	15.407(b)	Restricted Frequency Bands	May 19, 2020 May 26, 2020	Yaming Luo	PASS
6	15.407(g)	Frequency Stability	Feb 19, 2020 Feb 20, 2020	Lai Haihuang	PASS
7	15.207	Conducted Emission	May 25, 2020	Yaming Luo	PASS
8	15.407(b)	Radiated Emission	May 19, 2020 May 26, 2020	Yaming Luo	PASS
9	15.407(c)	Automatically discontinue transmission requirement	N/A	N/A	PASS

Note: The tests of Conducted Emission and Radiated Emission were performed according to the method of measurements prescribed in ANSI C63.10 2013 and KDB789033 D02 V02r01.

1.6. 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

According 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 attached 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 irreplaceable attached antenna. Please refer to the EUT internal photos.

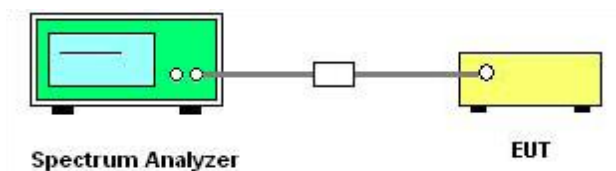
2.2. Emission Bandwidth

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 attached to the EUT antenna terminal is 50Ohm; the path loss as the factor 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) Trace 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) $\geq 3 \times$ RBW.
- c) Detector = Peak.
- d) Trace mode = max hold.



e) Sweep = auto couple.

f) Allow the trace 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

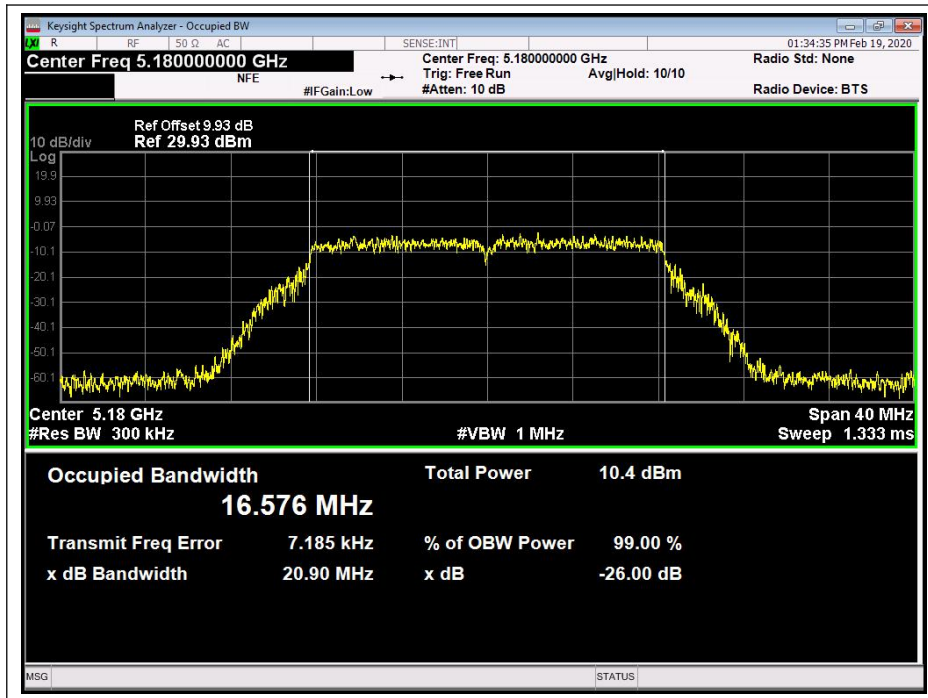
802.11a Test mode

A. Test Verdict:

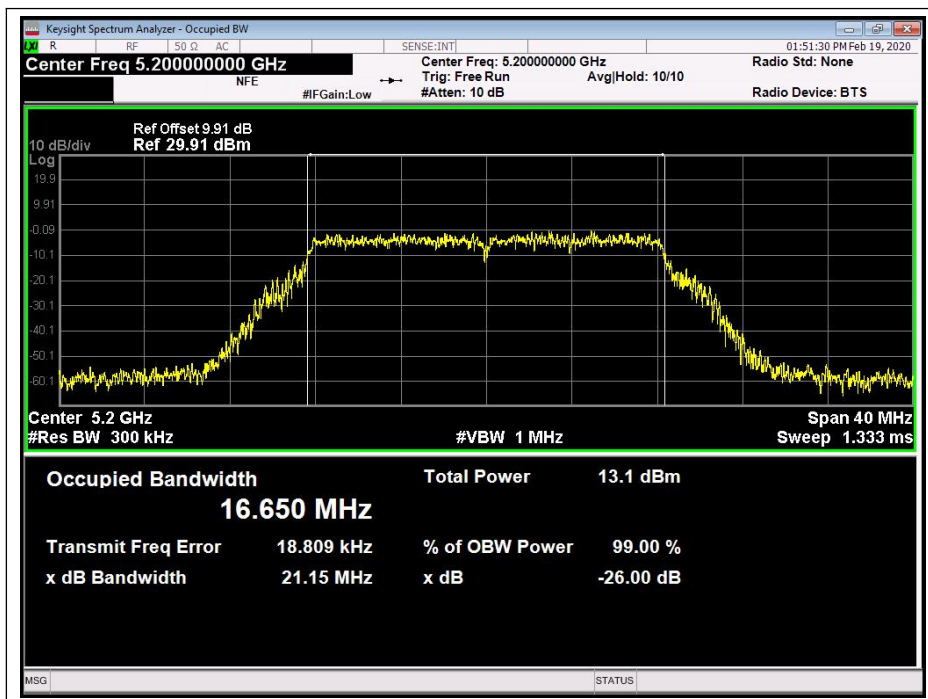
Channel	Frequency (MHz)	ANTO 26 dB Bandwidth (MHz)
36	5180	20.90
40	5200	21.15
48	5240	20.72
Channel	Frequency (MHz)	ANTO 6dB Bandwidth (MHz)
149	5745	17.78
157	5785	16.32
165	5825	16.45



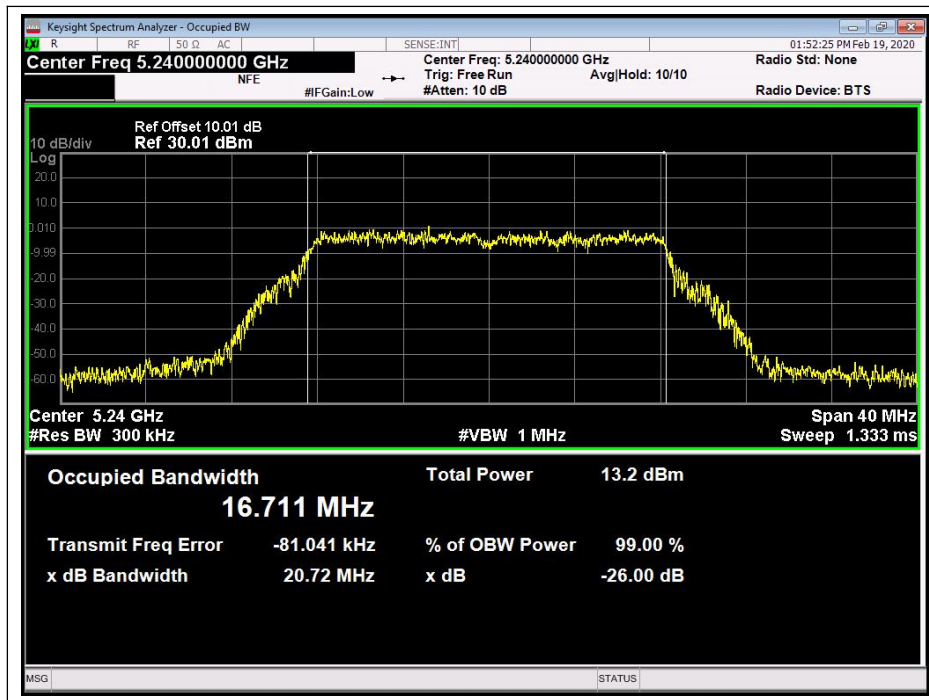
B. Test Plots



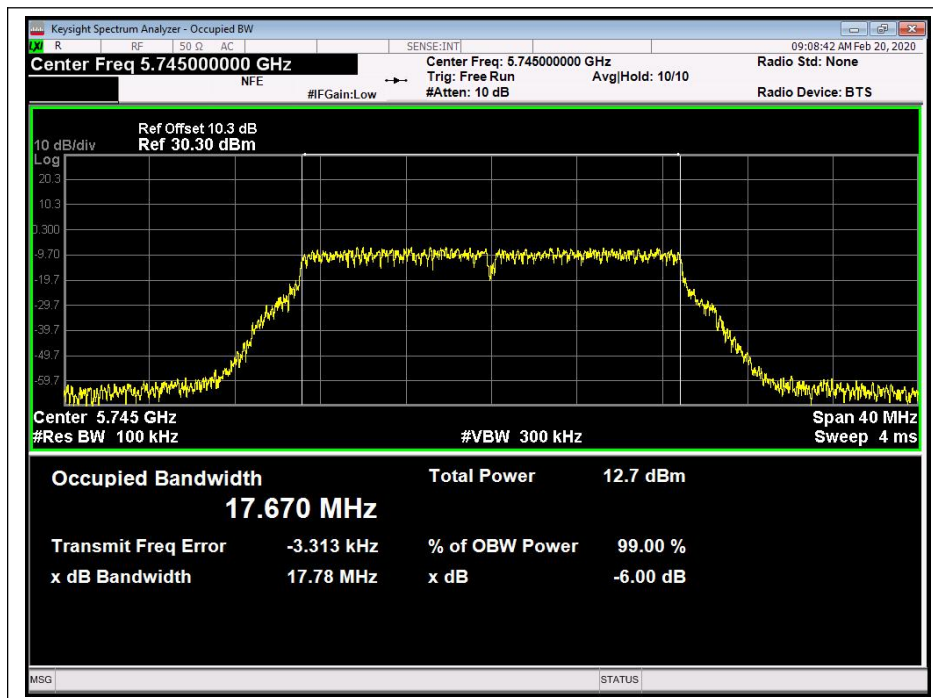
(Channel 36, 5180MHz, 802.11a)



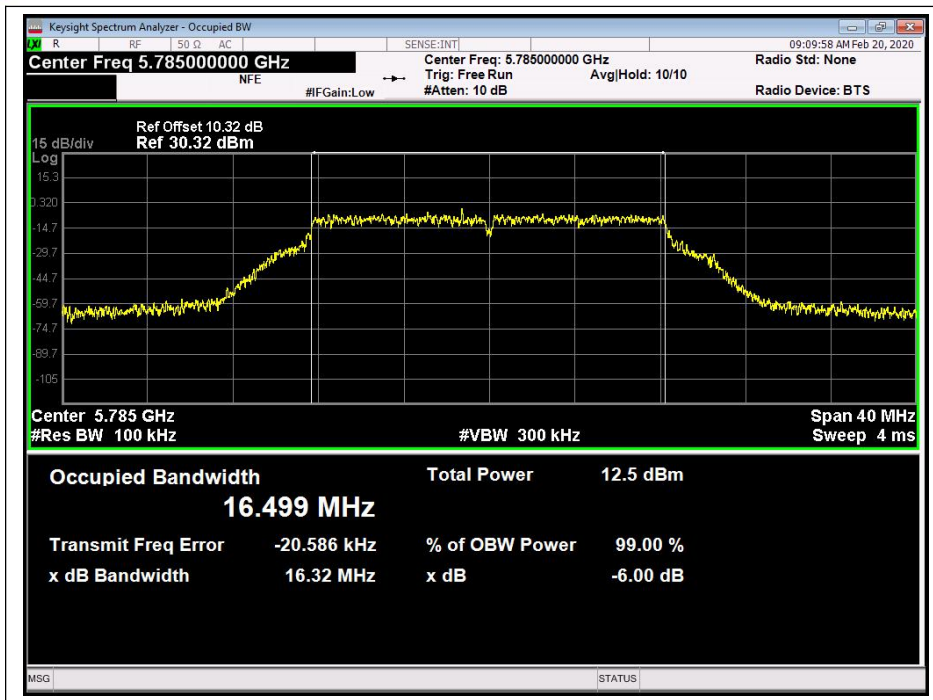
(Channel 40, 5200 MHz, 802.11a)



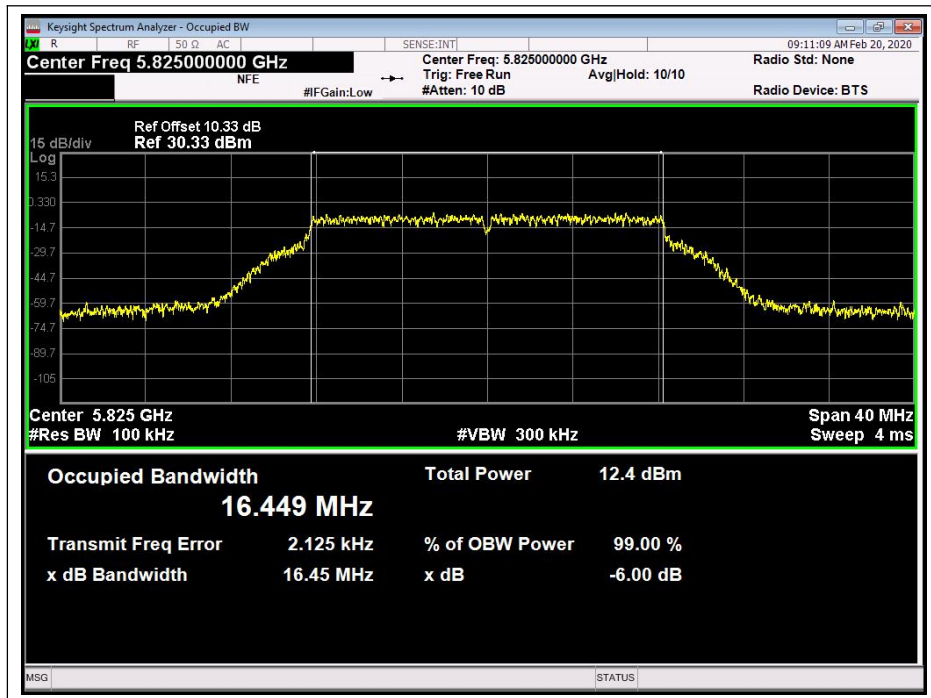
(Channel 48, 5240MHz, 802.11a)



(Channel 149, 5745MHz, 802.11a)



(Channel 157, 5785MHz, 802.11a)



(Channel 165, 5825MHz, 802.11a)

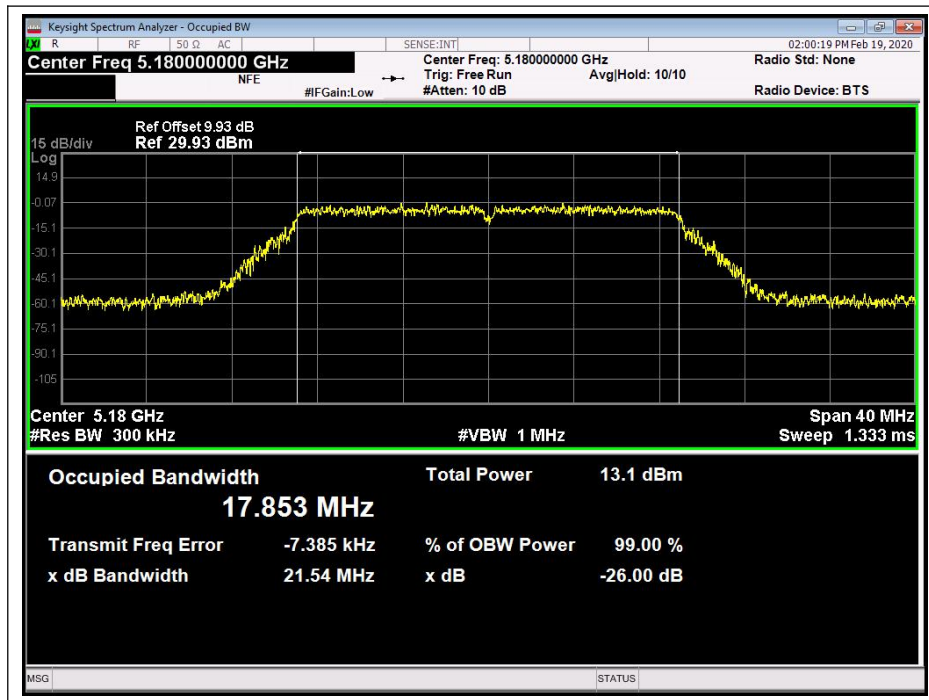


802.11ac20 Test mode

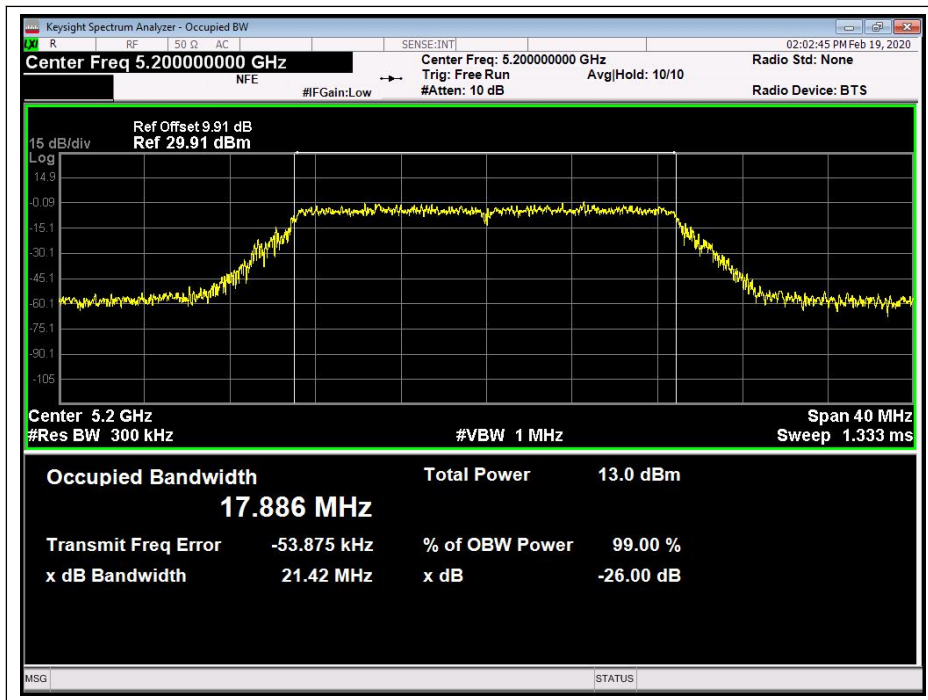
C. Test Verdict:

Channel	Frequency (MHz)	ANTO 26 dB Bandwidth (MHz)
36	5180	21.54
40	5200	21.42
48	5240	21.56
Channel	Frequency (MHz)	ANTO 6dB Bandwidth (MHz)
149	5745	17.50
157	5785	17.74
165	5825	17.60

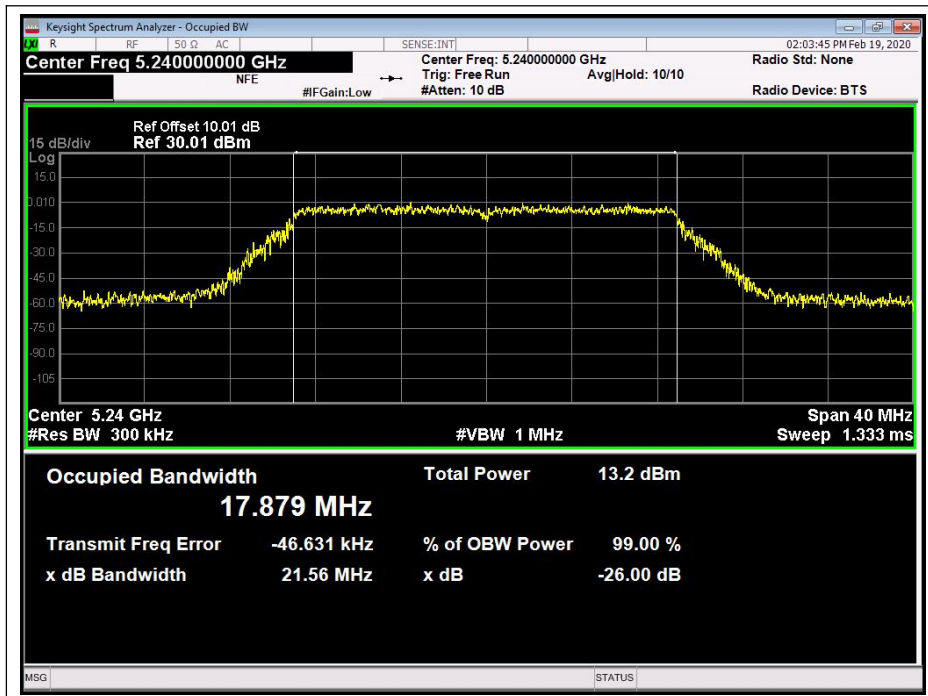
D. Test Plots



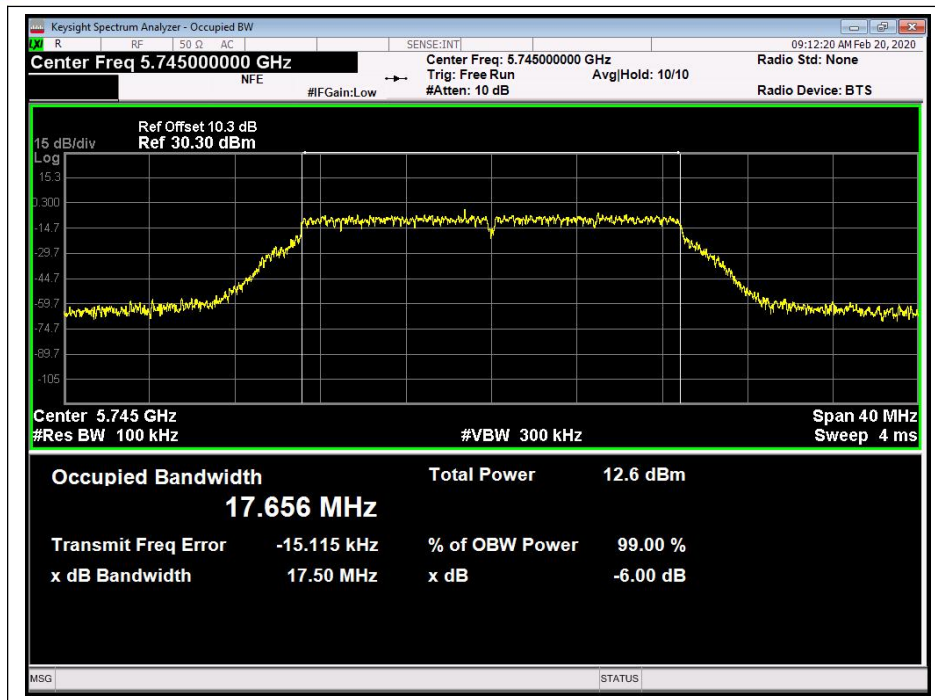
(Channel 36, 5180MHz, 802.11ac)



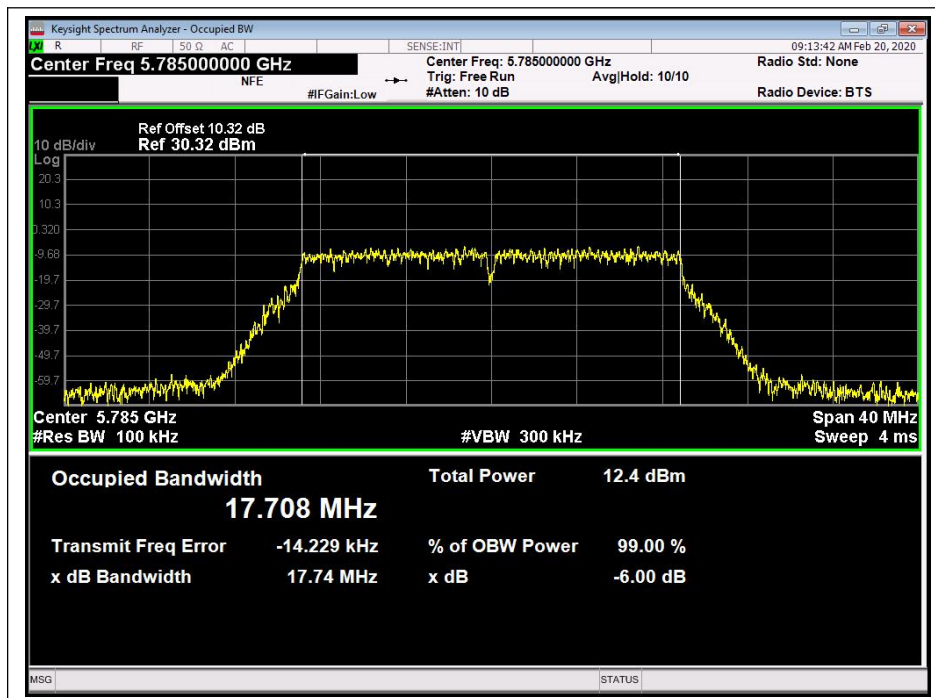
(Channel 40, 5200 MHz, 802.11ac)



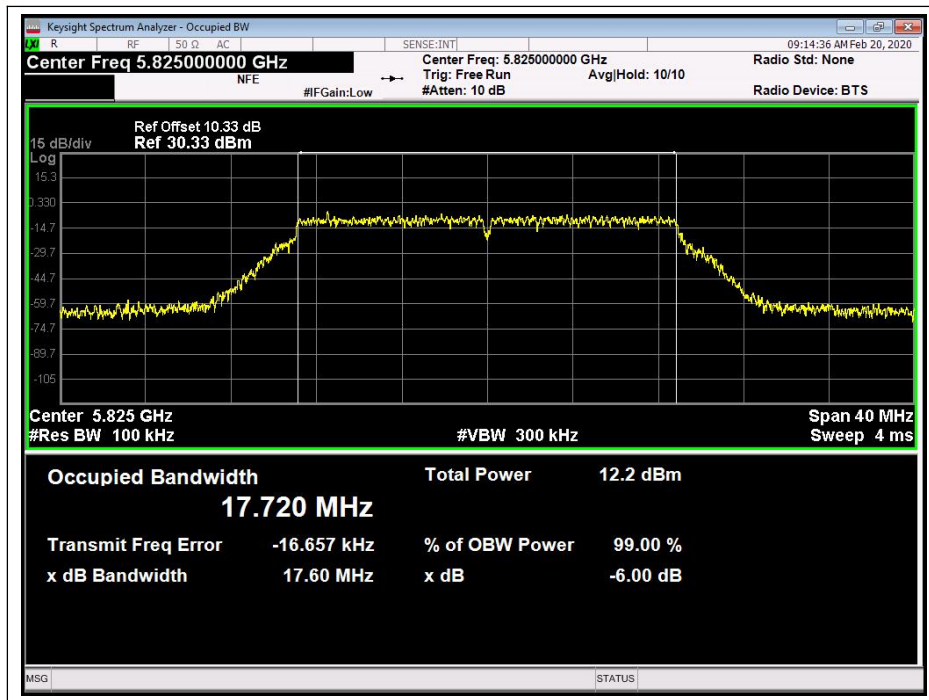
(Channel 48, 5240MHz, 802.11ac)



(Channel 149, 5745MHz, 802.11ac)



(Channel 157, 5785MHz, 802.11ac)



(Channel 165, 5825MHz, 802.11ac)

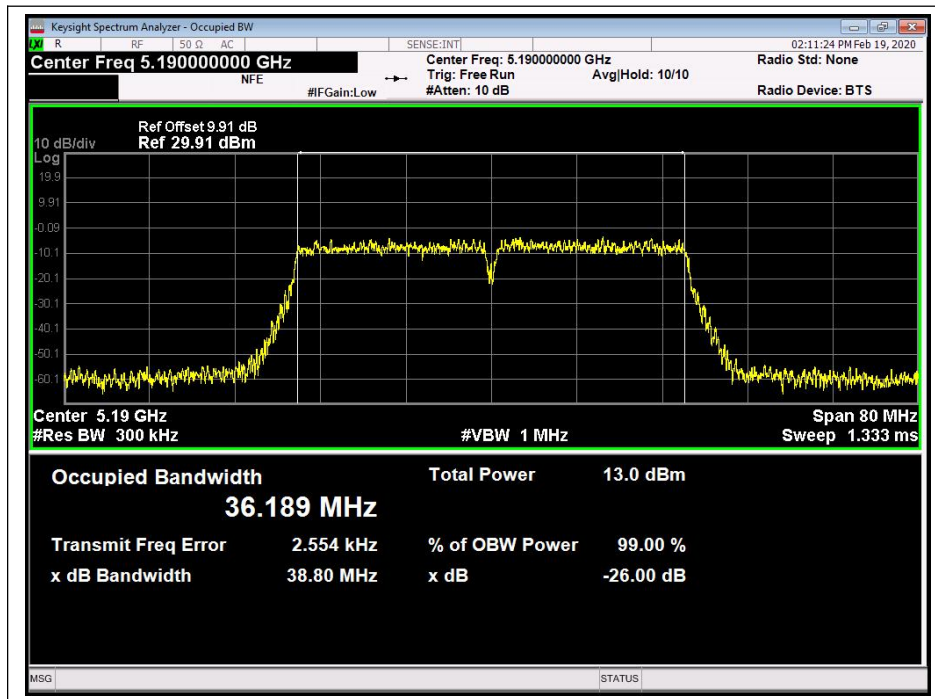


802.11ac (HT40) Test mode

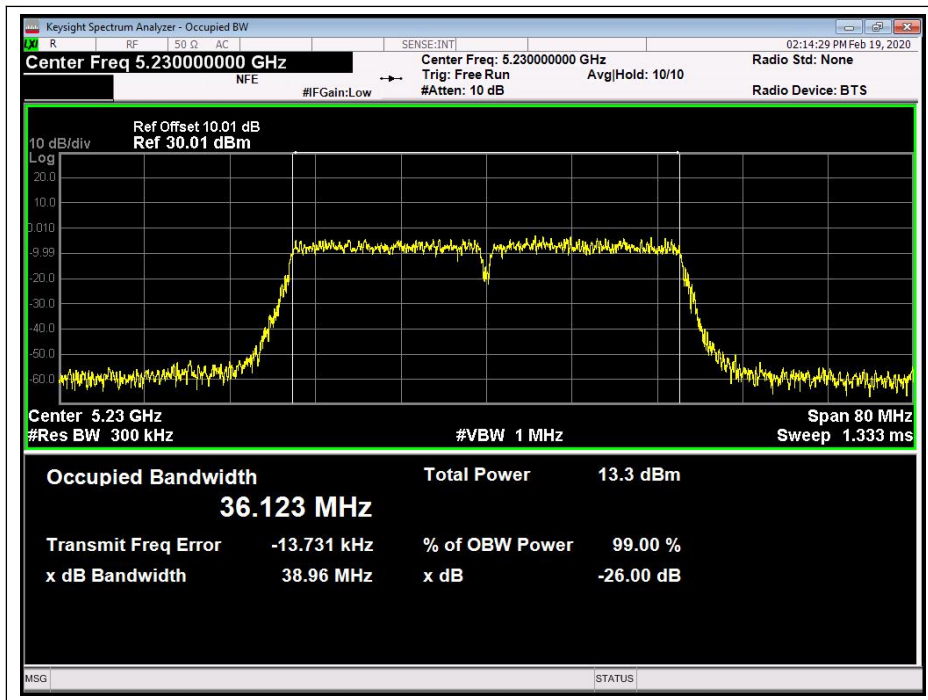
A. Test Verdict:

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
38	5190	38.80
46	5230	38.96
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
151	5755	35.72
159	5795	36.09

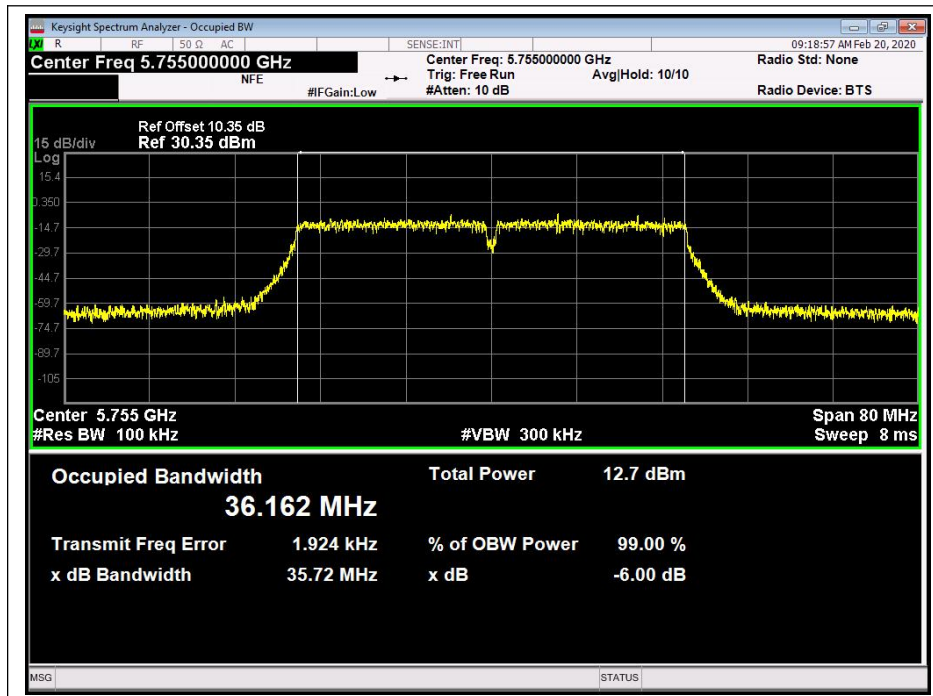
B. Test Plots



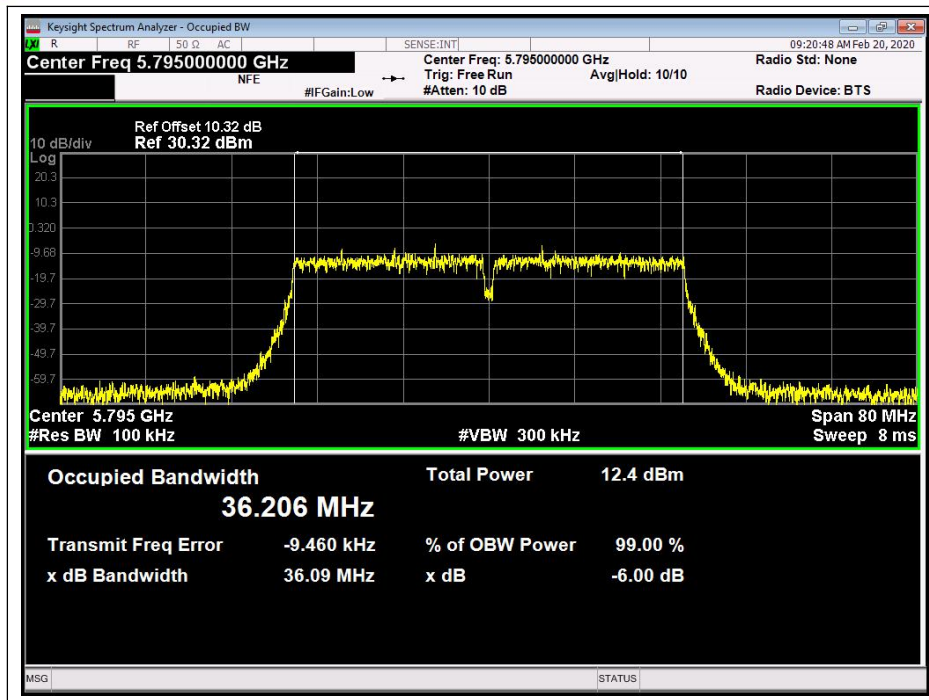
(Channel 38, 5190MHz, 802.11ac (HT40))



(Channel 46, 5230 MHz, 802.11ac (HT40))



(Channel 151, 5755 MHz, 802.11ac (HT40))



(Channel 159, 5795MHz, 802.11ac (HT40))

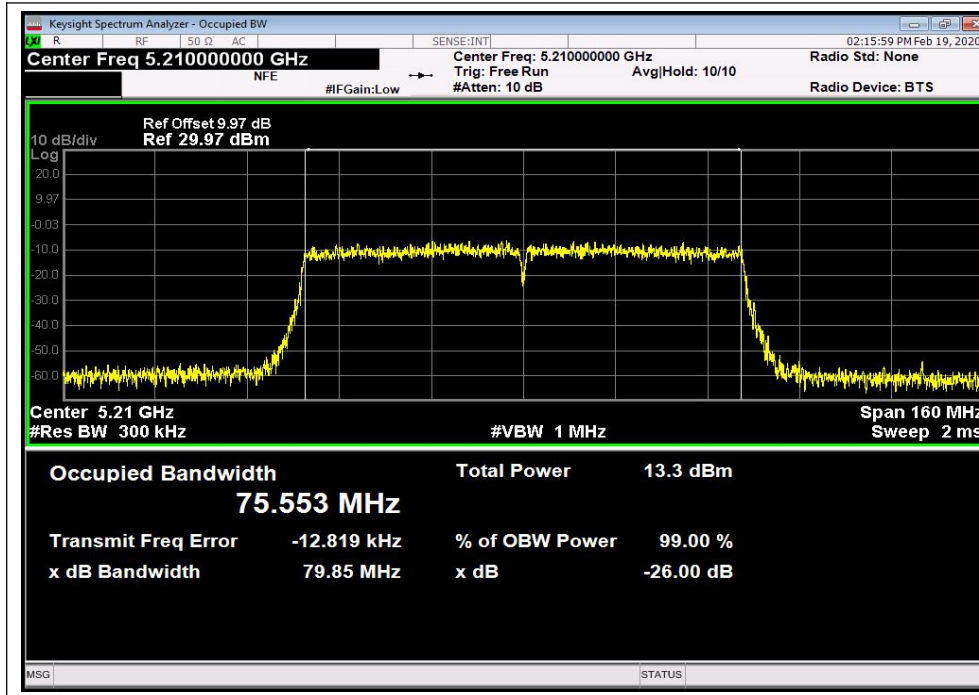


802.11ac (HT80) Test mode

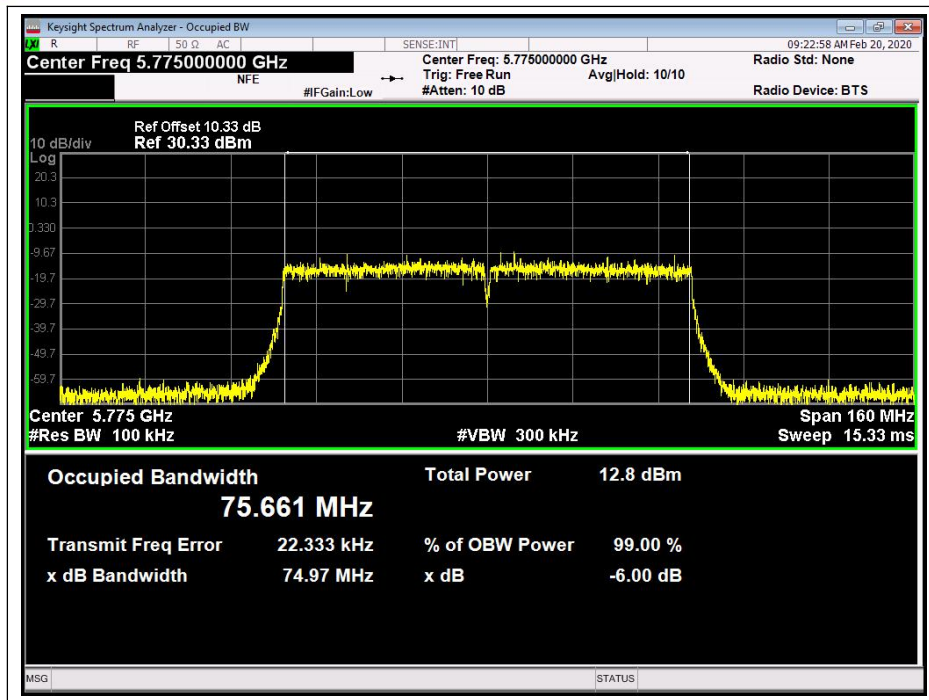
C. Test Verdict:

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
42	5210	79.85
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
155	5775	74.97

D. Test Plots



(Channel 42, 5210MHz, 802.11ac (HT80))



(Channel155, 5775MHz, 802.11ac (HT80))

2.3. Maximum conducted output power

2.3.1. Requirement

(1) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi.

(2) For the 5.25-5.35 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or $11 \text{ dBm} + 10 \log B$, where B is the 26 dB emission bandwidth in megahertz.

(3) For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

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.

(4) According to KDB662911D01 Measure-and-sum technique, the conducted emission level (e.g., transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in units that are directly proportional to power.

(5) According to KDB 662911 D01, the directional gain = $G_{\text{ANT}} + 10 \log(N_{\text{ANT}})$ dBi, where G_{ANT} is the antenna gain in dBi, N_{ANT} is the number of outputs.

2.3.2. Test Description

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 attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading, all test result in USB Wideband Power Sensor.



2.3.3. Test Result

Duty Cycle Factor

ANT0

Mode	Channel	Frequency (MHz)	T _{on} (ms)	T _(on+off) (ms)	Duty Cycle (%)	Duty Cycle Factor
802.11 a	36	5180	100	100	100	0
802.11 ac20	36	5180	100	100	100	0
802.11 ac40	38	5190	100	100	100	0
802.11 ac80	42	5210	100	100	100	0

ANT1

Mode	Channel	Frequency (MHz)	T _{on} (ms)	T _(on+off) (ms)	Duty Cycle (%)	Duty Cycle Factor
802.11 a	36	5180	100	100	100	0
802.11 ac20	36	5180	100	100	100	0
802.11 ac40	38	5190	100	100	100	0
802.11 ac80	42	5210	100	100	100	0

802.11a(HT20) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)		Limit		Verdict
		ANT0	ANT1	(dBm)	11+10*log(EBW) (dBm)	
36	5180	13.59	14.97	24	24.20	PASS
40	5200	13.80	15.11		24.25	
48	5240	14.11	15.21		24.16	
149	5745	13.19	14.35	30		
157	5785	12.97	13.96			
165	5825	13.03	14.51			

Note: Power limit is 24dBm or 11+10*log(EBW)



802.11ac (HT20) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit		Verdict
		ANT0	ANT1	Total	(dBm)	11+10*log(EBW) (dBm)	
36	5180	13.75	15.36	17.84	24	24.33	PASS
40	5200	13.76	15.34	17.83		24.31	
48	5240	13.80	15.31	17.82		24.34	
149	5745	13.22	14.35	17.02	30		
157	5785	12.78	14.10	16.73			
165	5825	12.45	14.46	16.93			

Note: Power limit is 24dBm or 11+10*log(EBW)

802.11ac (HT40) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit		Verdict
		ANT0	ANT1	Total	(dBm)	11+10*log(EBW) (dBm)	
38	5190	13.87	15.26	18.01	24	26.89	PASS
46	5230	14.12	15.44	18.22		26.91	PASS
151	5755	13.21	14.05	16.85	30		PASS
159	5795	12.82	14.05	16.87			PASS

Note: Power limit is 24dBm or 11+10*log(EBW)

802.11ac (HT80) Test mode

Channel	Frequency (MHz)	Average Output Power (dBm)			Limit		Verdict
		ANT0	ANT1	Total	(dBm)	11+10*log(EBW) (dBm)	
42	5210	13.96	15.43	17.92	24	30.02	PASS
149	5745	13.28	14.27	16.96	30		

Note: Power limit is 24dBm or 11+10*log(EBW)

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

2.4. Peak Power spectral density

2.4.1. Requirement

(1) For client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band.

(2) For the 5.25-5.35 GHz bands, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band.

(3) For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500KHz band.

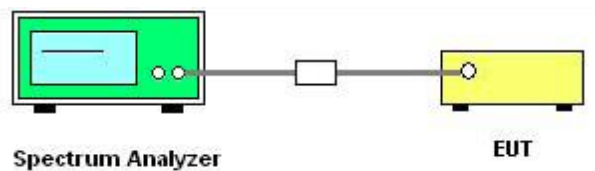
If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(4) According to KDB662911D01 Measure-and-sum technique, the conducted emission level (e.g., transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in units that are directly proportional to power.

(5) According to KDB 662911 D01, the directional gain = $G_{ANT} + 10\log(N_{ANT})$ dBi, where G_{ANT} is the antenna gain in dBi, N_{ANT} is the number of outputs.

2.4.2. Test Description

A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor 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 \geq 3 MHz.
- 3) Number of points in sweep \geq 2 Span / RBW. Sweep time = auto.
- 4) Detector = RMS (i.e., power averaging)
- 5) Trace average at least 100 traces in power averaging (i.e., RMS) mode
- 6) Record the max value



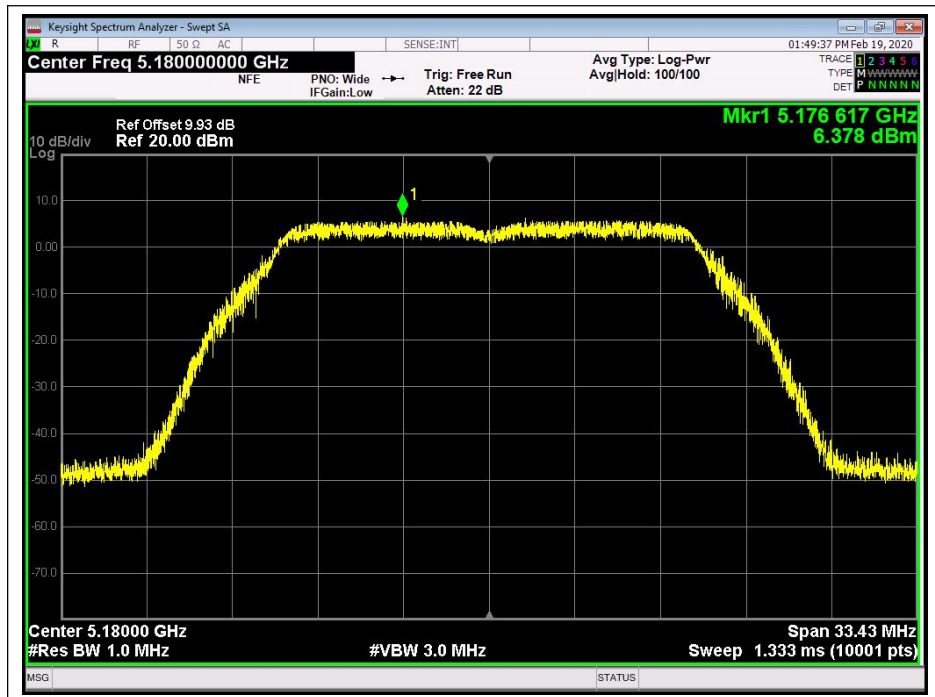
2.4.3. Test Result

802.11a Test mode

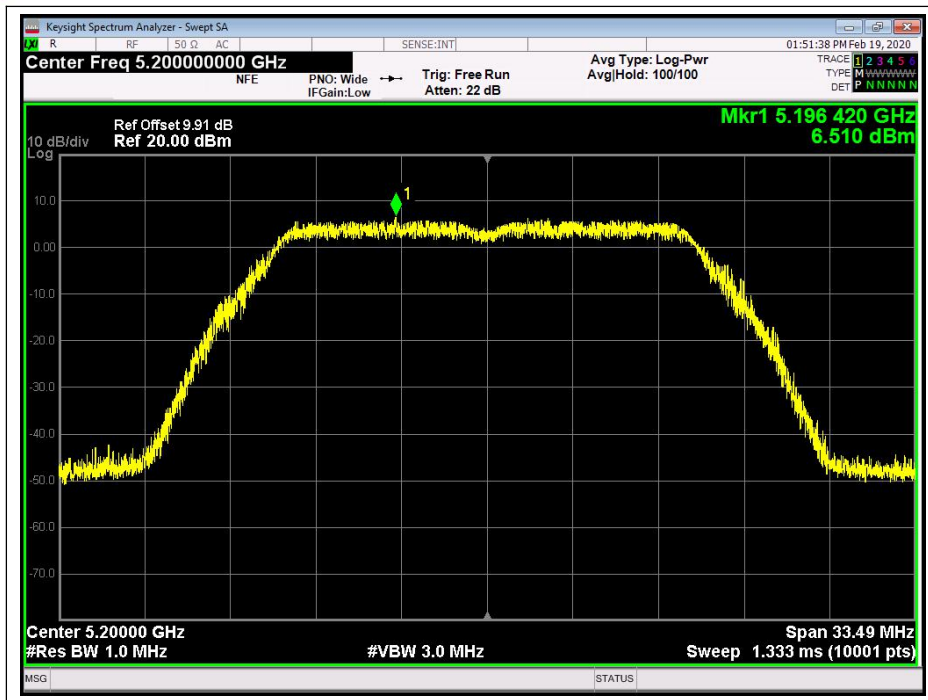
A. Test Verdict:

Channel	Frequency (MHz)	Measured PSD (dBm/MHz)		Limit (dBm/MHz)	Verdict
		ANT0	ANT1		
36	5180	6.318	7.918	11	PASS
40	5200	6.510	8.419		
48	5240	6.839	8.459		
Channel	Frequency (MHz)	Measured PSD (dBm/500KHz)		Limit (dBm/500KHz)	Verdict
		ANT0	ANT1		
149	5745	1.800	4.395	30	PASS
157	5785	2.416	3.658		
165	5825	2.133	3.979		

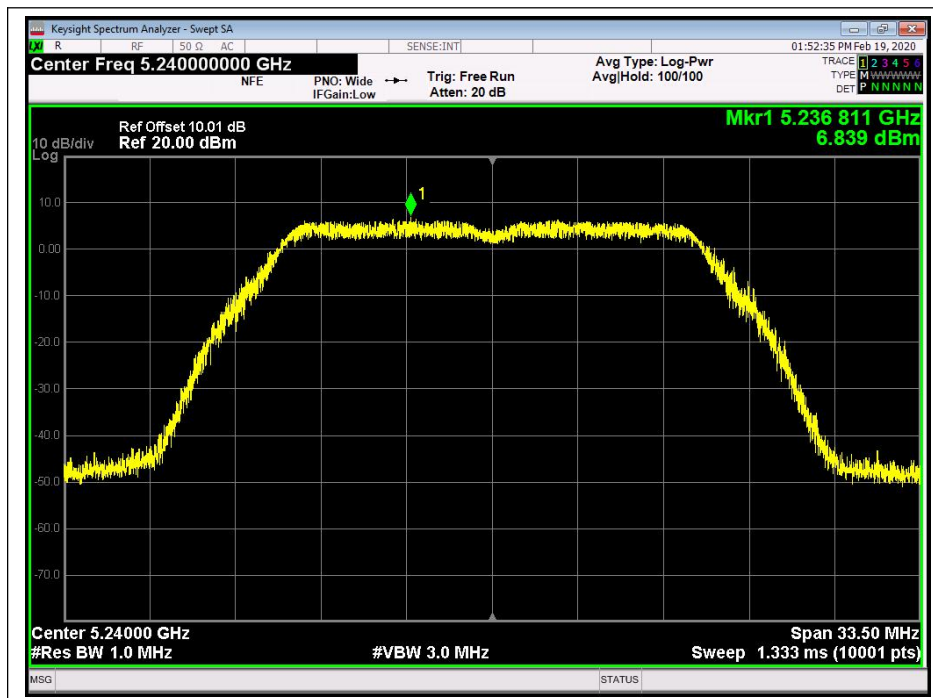
B. Test Plots



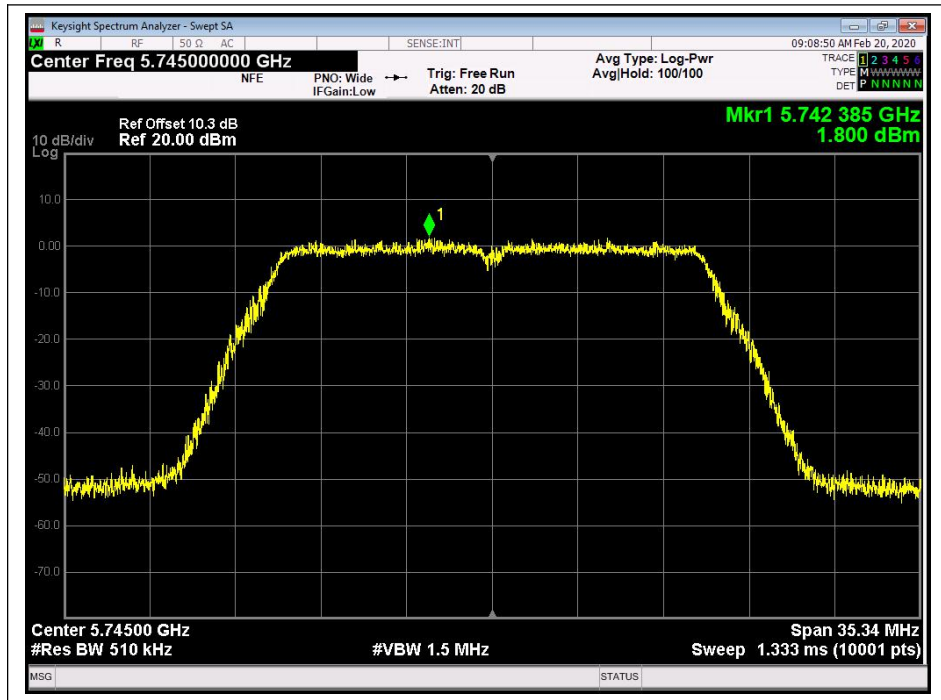
(Channel 36, 5180MHz, 802.11a,ANT0)



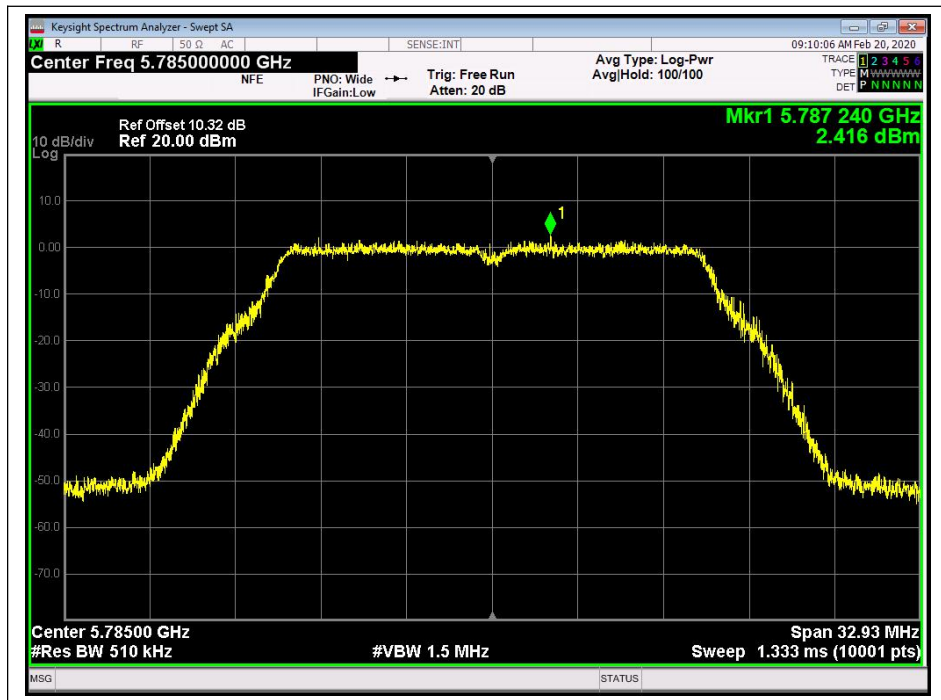
(Channel 40, 5200 MHz, 802.11a,ANT0)



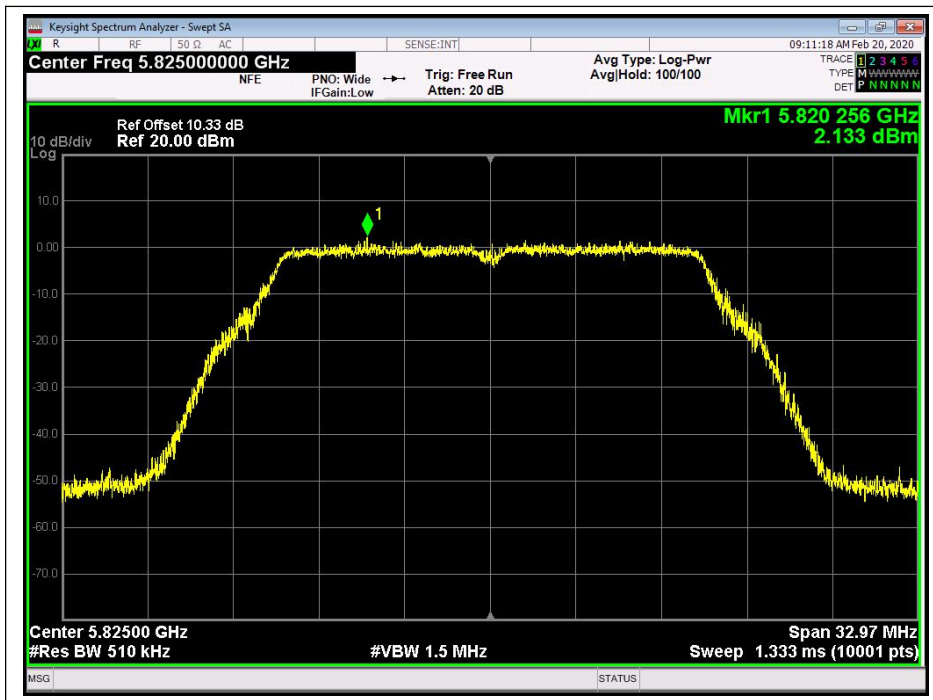
(Channel 48, 5240MHz, 802.11a,ANT0)



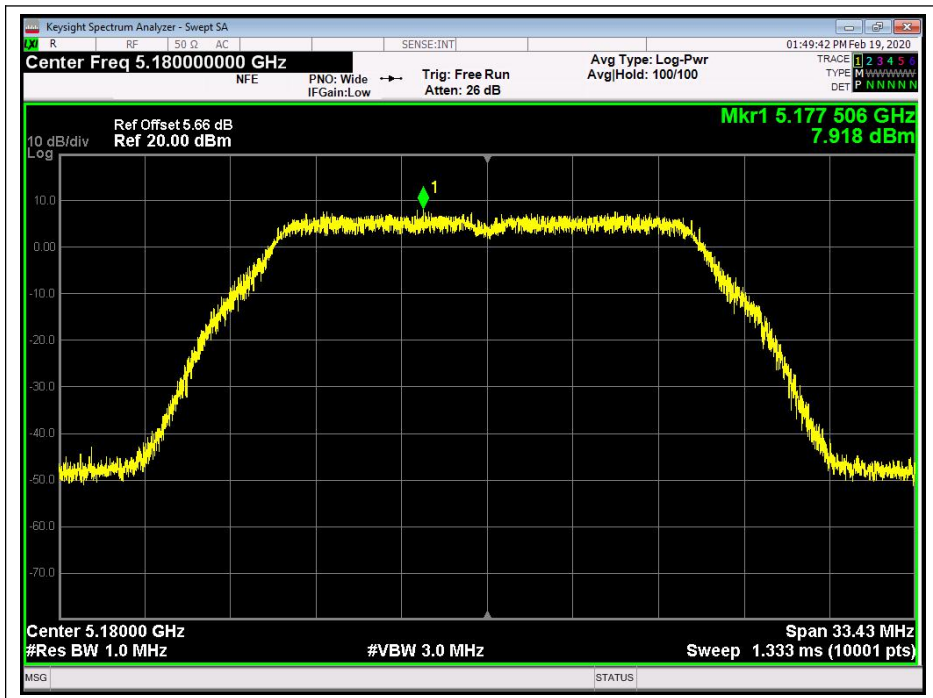
(Channel 149, 5745MHz, 802.11a,ANT0)



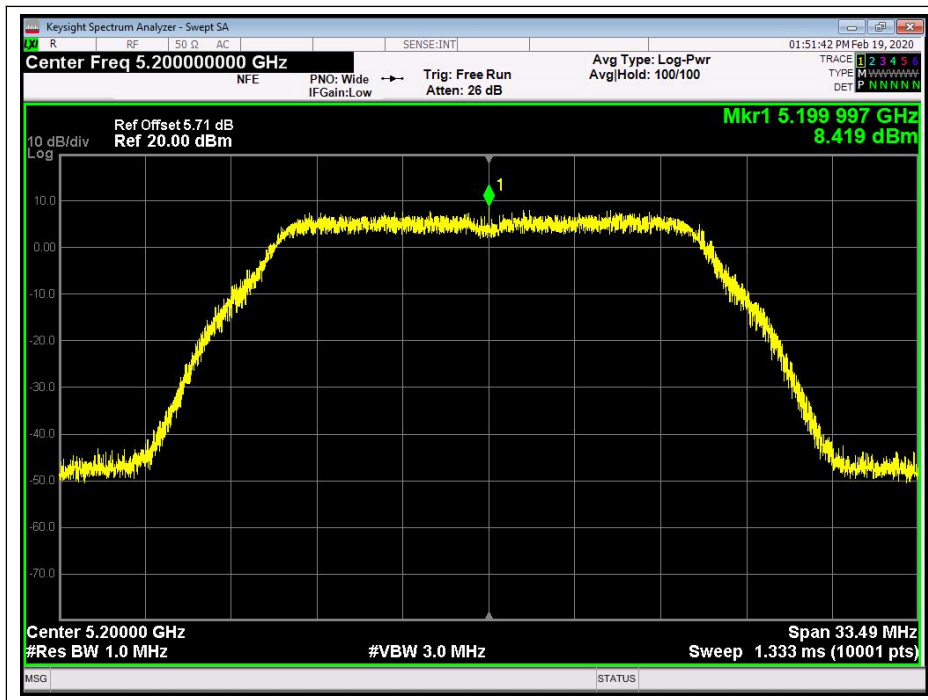
(Channel 157, 5785MHz, 802.11a,ANT0)



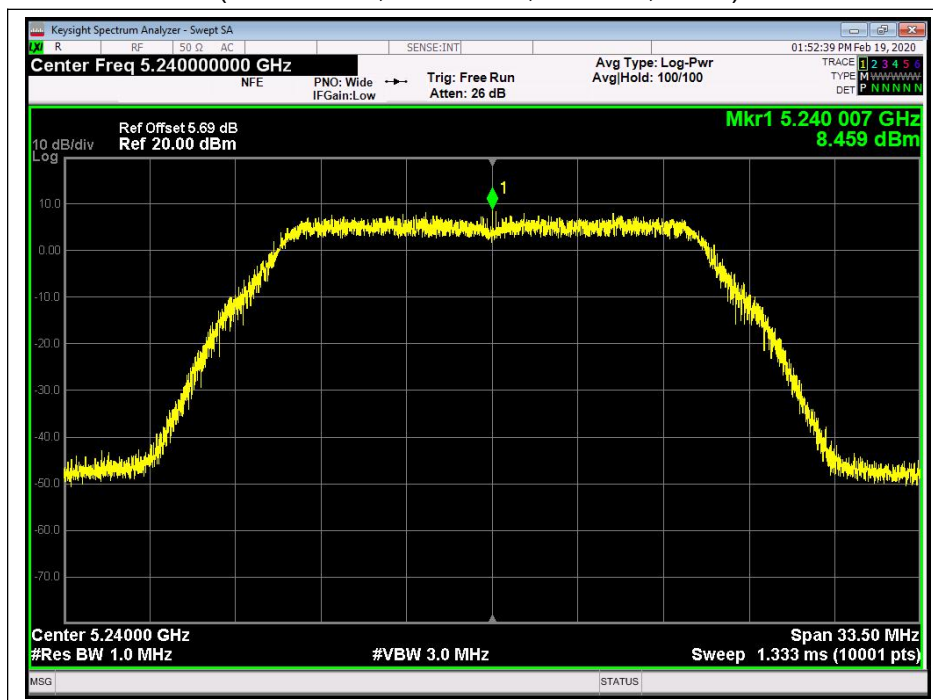
(Channel 165, 5825MHz, 802.11a,ANT0)



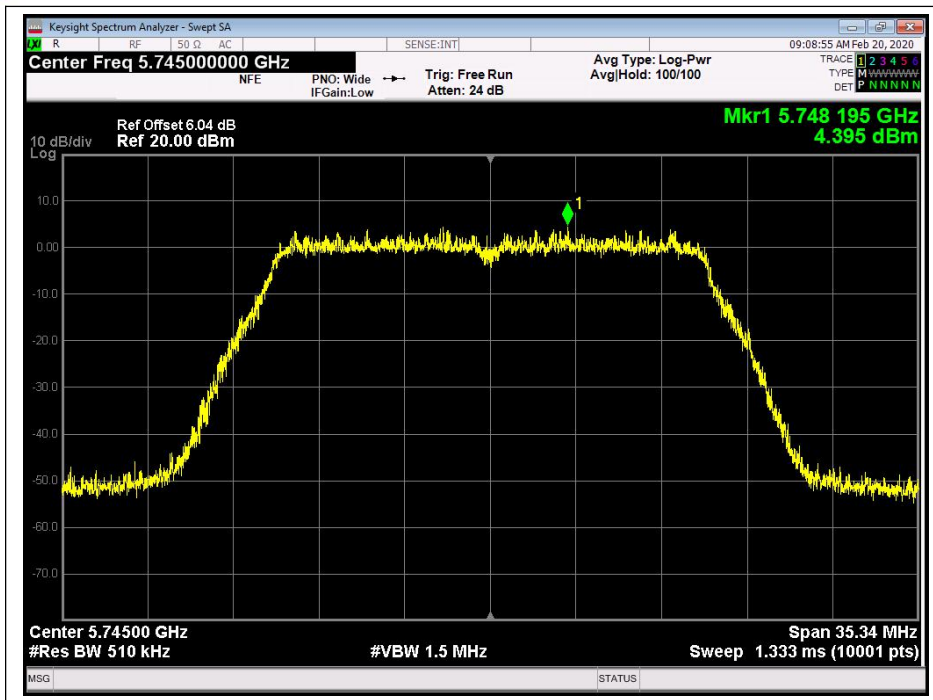
(Channel 36, 5180MHz, 802.11a,ANT1)



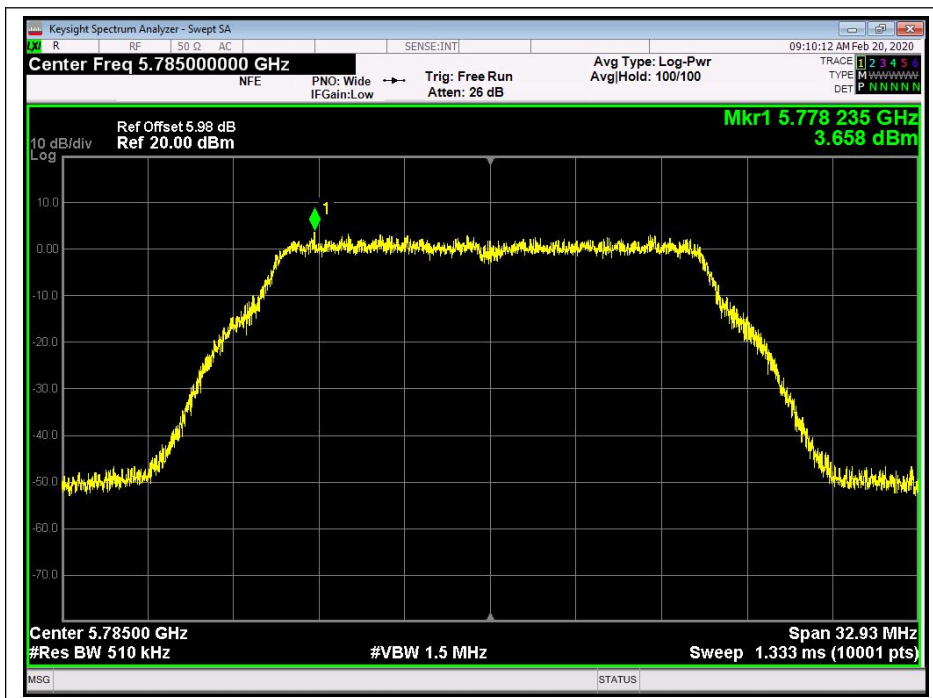
(Channel 40, 5200 MHz, 802.11a,ANT1)



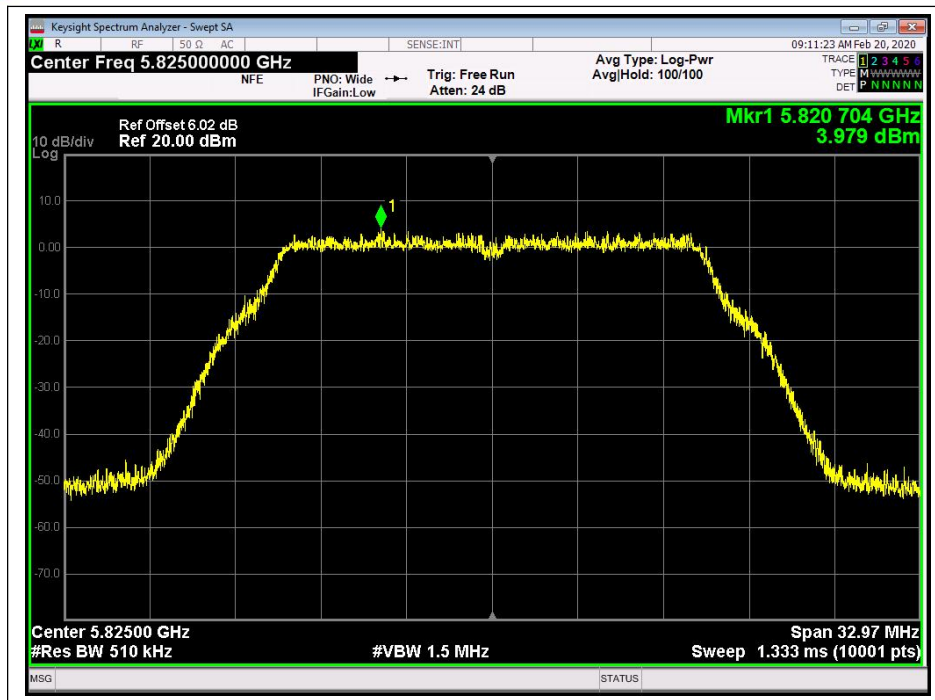
(Channel 48, 5240MHz, 802.11a,ANT1)



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



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



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

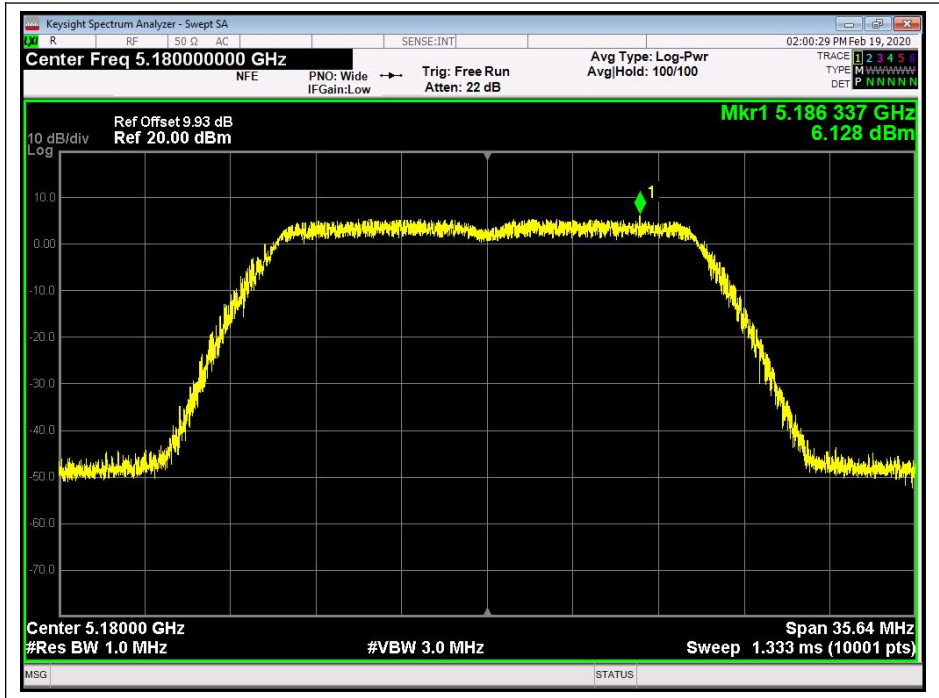
802.11ac20 Test mode

C. Test Verdict:

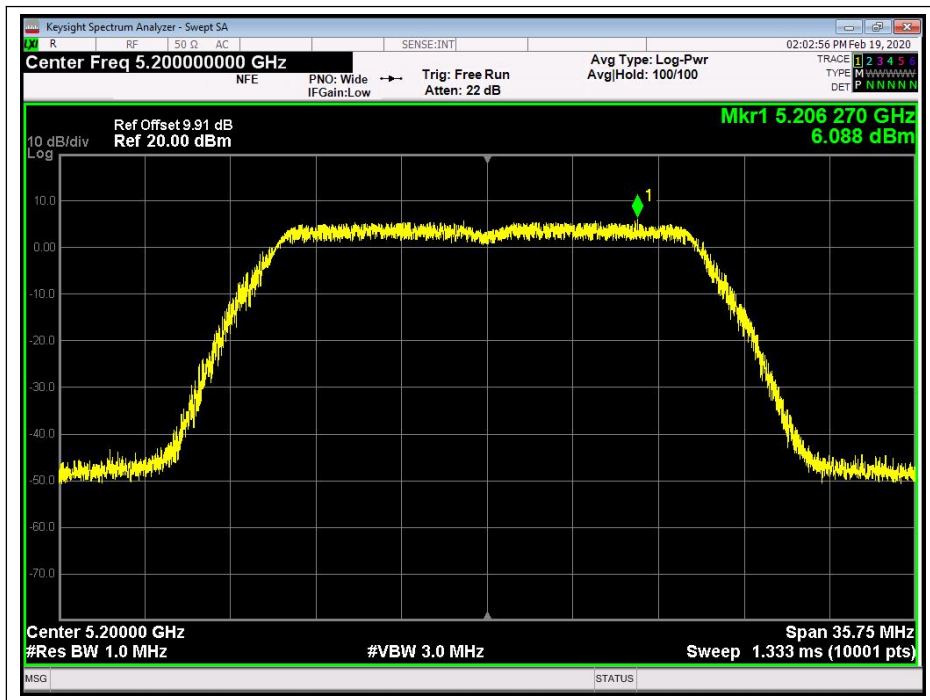
Channel	Frequency (MHz)	Measured PSD (dBm/MHz)			Limit (dBm/MHz)	Verdict
		ANT0	ANT1	Total		
36	5180	6.128	8.156	10.270	11	PASS
40	5200	6.088	8.350	10.375		
48	5240	6.121	7.777	10.038		
Channel	Frequency (MHz)	Measured PSD (dBm/500KHz)			Limit (dBm/500KHz)	Verdict
		ANT0	ANT1	Total		
149	5745	1.466	4.391	6.284	30	PASS
157	5785	1.728	4.115	6.094		
165	5825	1.744	4.847	6.577		



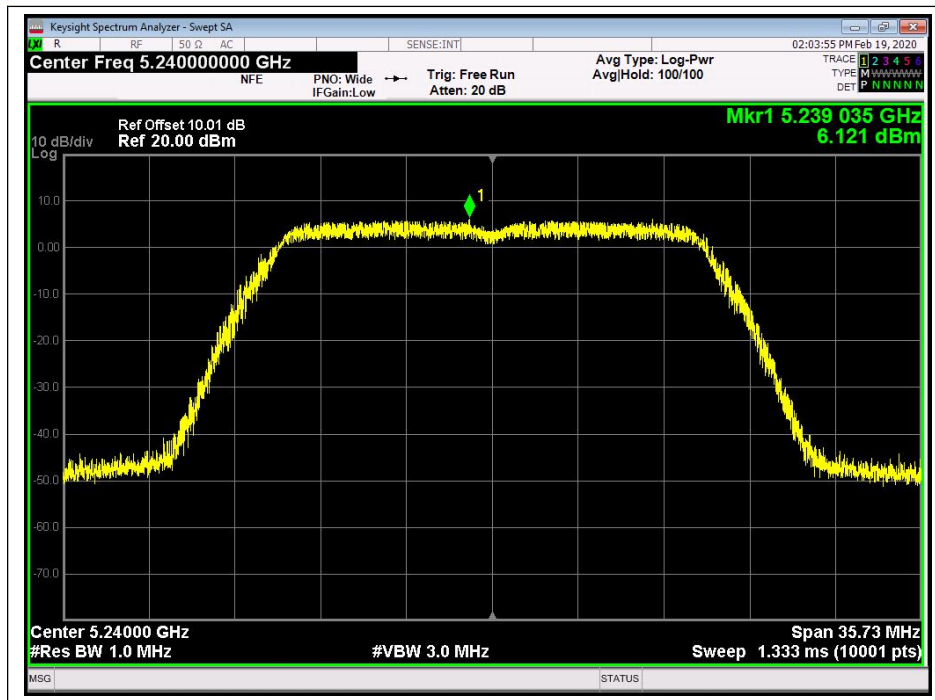
D. Test Plots



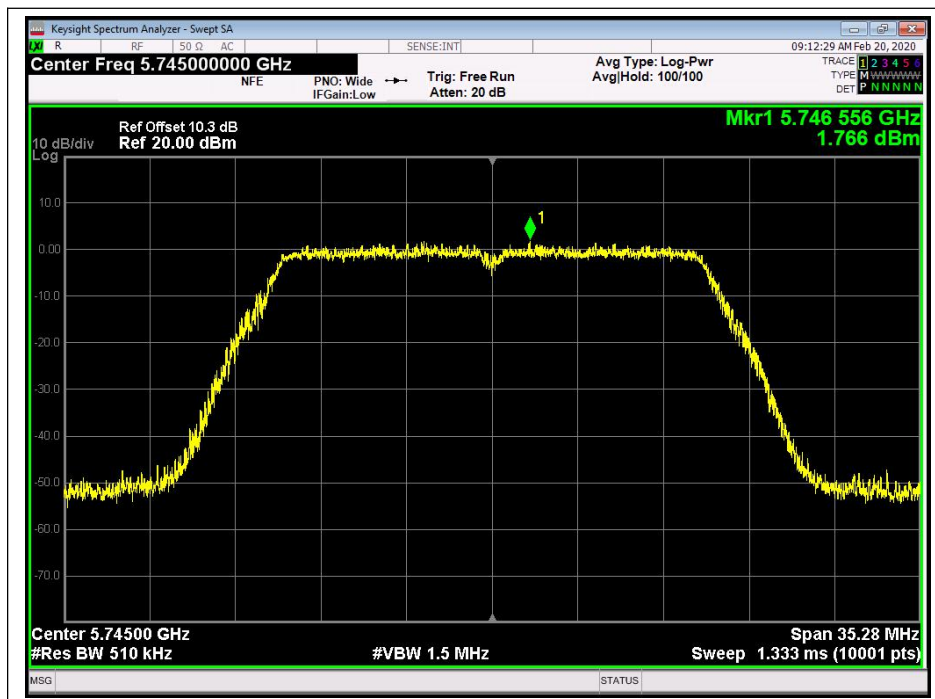
(Channel 36, 5180MHz, 802.11ac,ANT0)



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



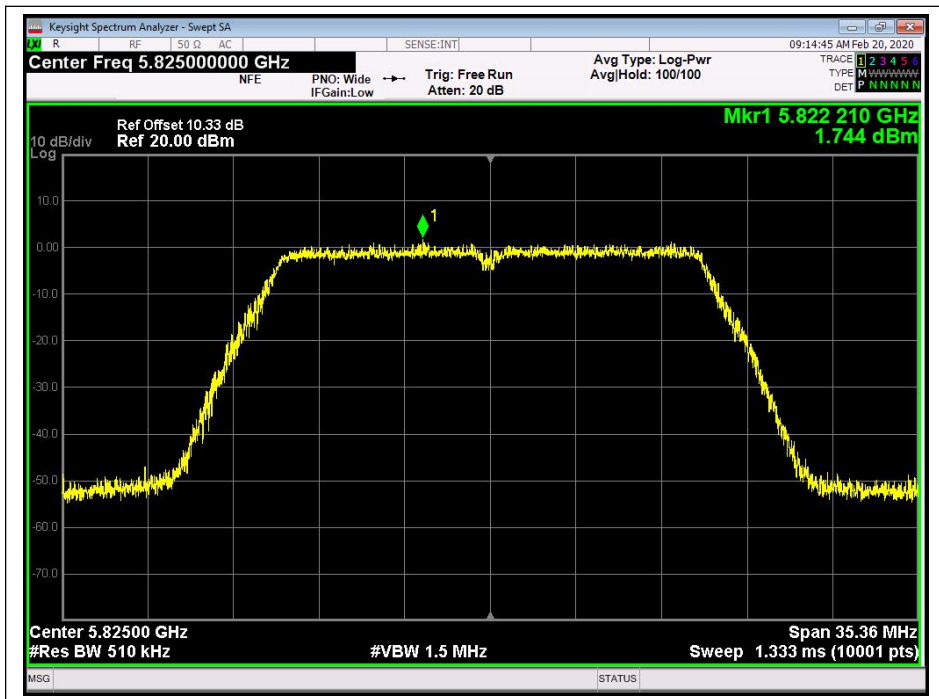
(Channel 48, 5240MHz, 802.11ac,ANT0)



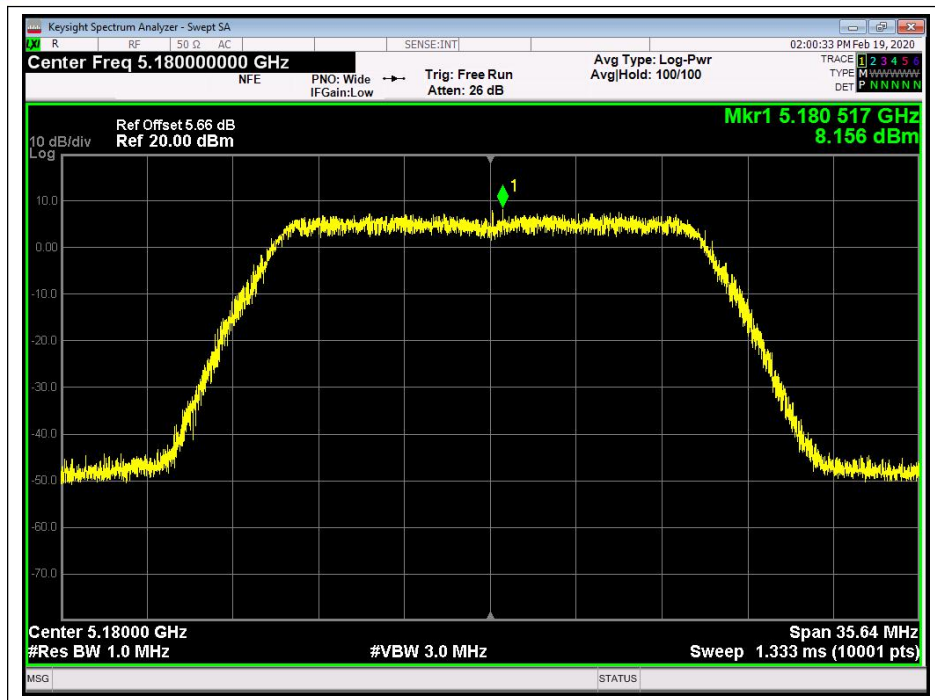
(Channel 149, 5745MHz, 802.11ac,ANT0)



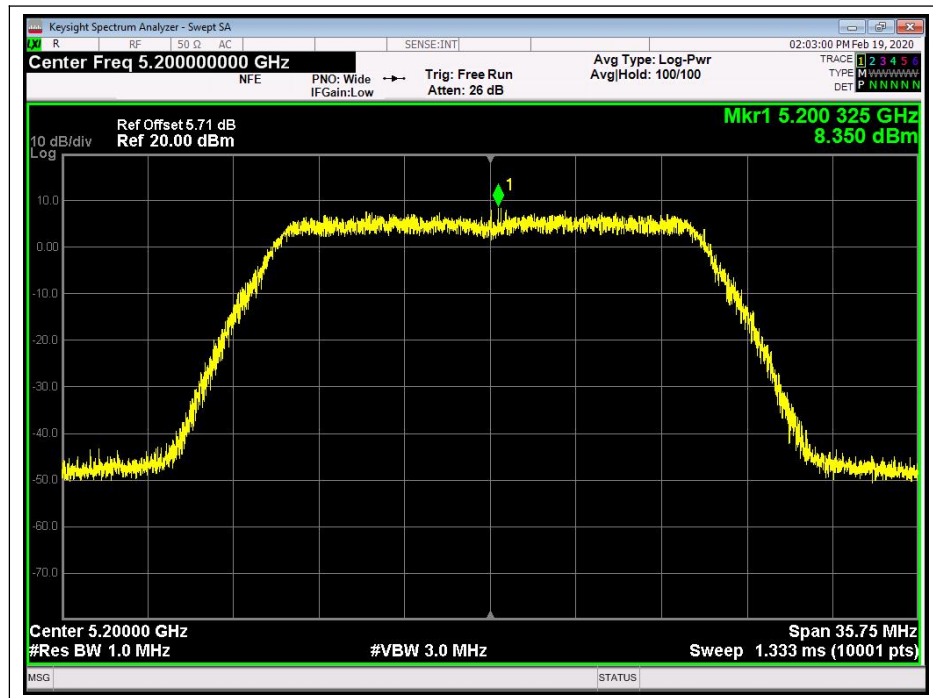
(Channel 157, 5785MHz, 802.11ac,ANT0)



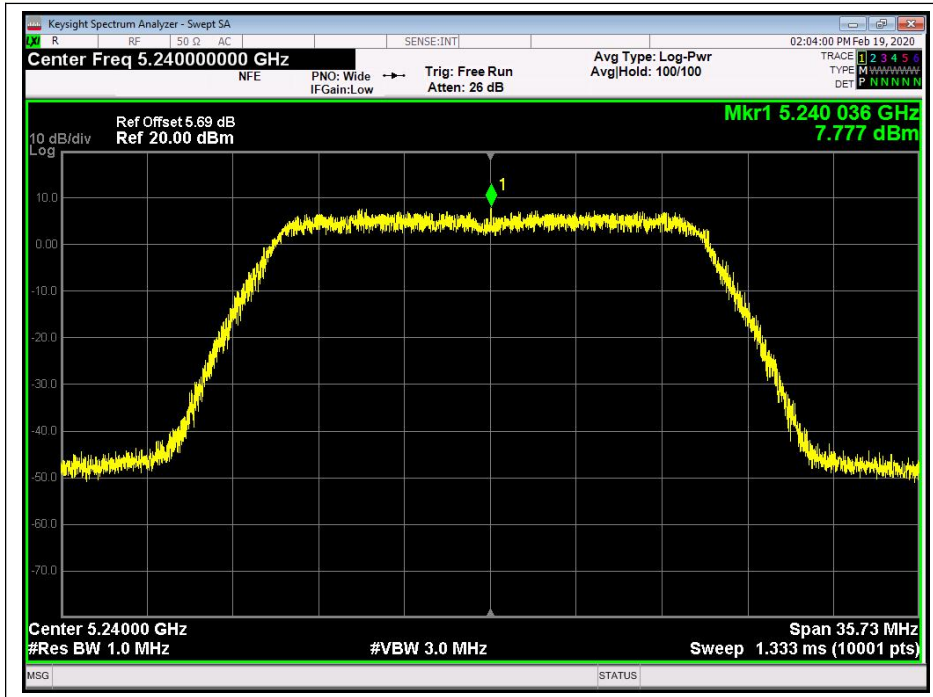
(Channel 165, 5825MHz, 802.11ac,ANT0)



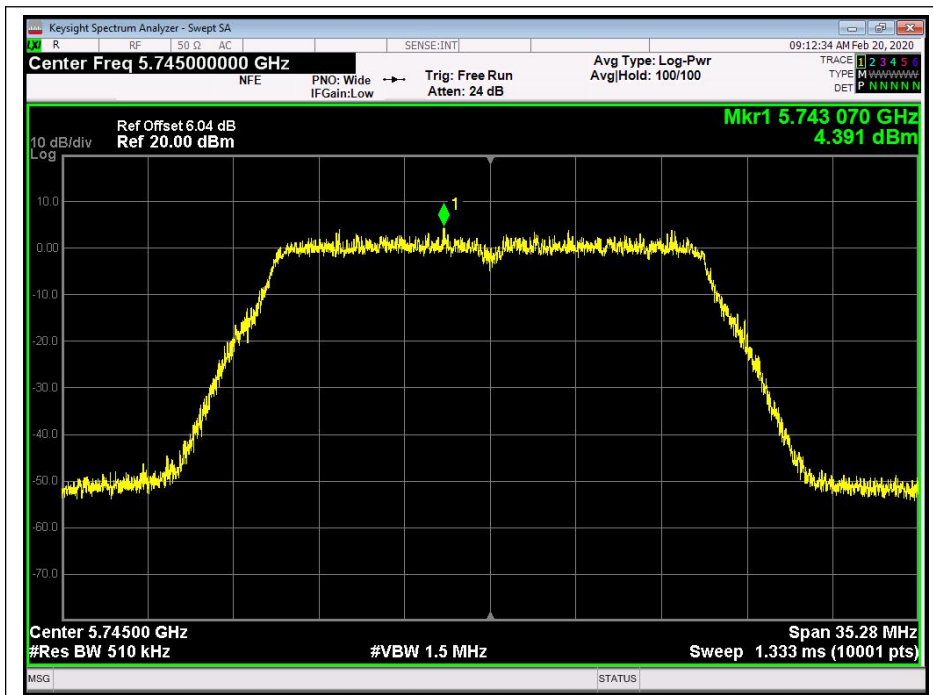
(Channel 36, 5180MHz, 802.11ac,ANT1)



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



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



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