



REPORT No.: SZ19060411W04

TEST REPORT

APPLICANT : Anker Innovations Limited

PRODUCT NAME : Nebula Capsule Max

MODEL NAME : D2423

BRAND NAME : NEBULA

FCC ID : 2AOKB-D2423

STANDARD(S) : 47 CFR Part 15 Subpart E

RECEIPT DATE : 2019-06-26

TEST DATE : 2019-07-18 to 2019-07-22

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MORLAB

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REPORT No.: SZ19060411W04

Change History		
Version	Date	Reason for change
1.0	2019-07-25	First edition



1. Technical Information

Note: Provide by applicant.

1.1. Applicant and Manufacturer Information

Applicant:	Anker Innovations Limited
Applicant Address:	Room 1318-19,Hollywood Plaza,610 Nathan Road, Mongkok, Kowloon, Hong Kong
Manufacturer:	Anker Innovations Limited
Manufacturer Address:	Room 1318-19,Hollywood Plaza,610 Nathan Road, Mongkok, Kowloon, Hong Kong

1.2. Equipment Under Test (EUT) Description

Product Name:	Nebula Capsule Max	
Serial No:	(N/A, marked #1 by test site)	
Hardware Version:	V0.3	
Software Version:	V1.1.13	
Modulation Type:	OFDM	
Modulation Mode:	802.11a, 802.11n(HT20), 802.11n(HT40) 802.11ac(VHT20), 802.11ac(VHT40), 802.11ac(VHT80),	
Operating Frequency Range:	5.180 GHz- 5.240 GHz; 5.745GHz- 5.825GHz	
Channel Number:	Refer to 1.3	
Antenna Type:	PIFA Antenna	
Antenna Gain:	0 dBi	
Accessory Information:	Battery	
	Brand Name:	N/A
	Model No.:	BT-H003
	Serial No.:	(N/A, marked #1 by test site)
	Capacity:	3350mAh
	Rated Voltage:	14.52V
	Charge Limit:	16.80 V



Accessory Information:	AC Adapter	
	Brand Name:	N/A
	Model No.:	NSA60ED-190300
	Serial No.:	(N/A, marked #1 by test site)
	Rated Output:	19V=3A
	Rated Input:	100-240V ~ 50/60Hz 1.5A

Note 1: WIFI hotspot does not support U-NII band.

Note 2: During test, the duty cycle of the EUT was setting to 100%.

Note 3: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

1.3.The channel number and frequency of EUT

Frequency Range: 5180MHz-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: 5745-5825MHz				
Bandwidth	Channel	Frequency (MHz)	Channel	Frequency (MHz)
20MHz	149	5745	153	5765
	157	5785	161	5805
	165	5825		
40MHz	151	5775	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 according to 47 CFR Part 15 Subpart E (U-NII band) 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
1	15.203	Antenna Requirement	N/A	N/A	PASS
2	ANSI C63.10	Duty Cycle of the test signal	Jul 09, 2019	Zhou Chuang	PASS
3	15.407(a)	Maximum conducted output Power	Jul 18, 2019	Zhou Chuang	PASS
4	15.407(a) (e)	Emission Bandwidth	Jul 18, 2019	Zhou Chuang	PASS
5	15.407(a)	Peak Power spectral density	Jul 18, 2019	Zhou Chuang	PASS
6	15.407(g)	Frequency Stability	Jul 18, 2019	Zhou Chuang	PASS
7	15.207	Conducted Emission	Jul 19, 2019	Lin Jiayong	PASS
8	15.407(b)	Restricted Frequency Bands	Jul 19, 2019	Li Zihao	PASS
9	15.407(b)	Radiated Emission	Jul 22, 2019	Li Zihao	PASS

Note1: The DFS test report was documented in a separate report(Report No.: SZ19060411W05).

Note2: The tests of Conducted Emission and Radiated Emission were performed according to the method of measurements prescribed in ANSI C63.10 2013.

Note3: These RF tests were performed according to the method of measurements prescribed in KDB789033 D02 General UNII Test Procedures New Rules v01r03.

Note4: The path loss during the RF test is calibrated to correct the results by the offset setting in the test equipments. The ref offset 12dB contains two parts that cable loss 2.0dB and Attenuator 10dB.

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

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. 2.1.2 Result: Compliant

The EUT has a permanently and irreplaceable attached antenna. Please refer to the EUT internal photos.

2.2. Duty Cycle of the test signal

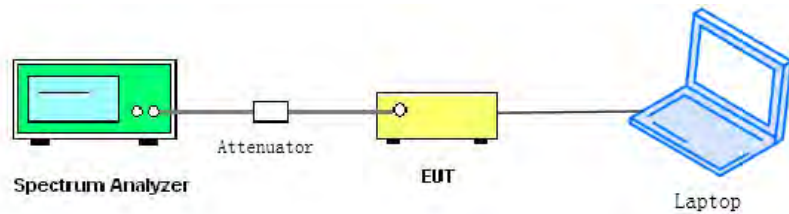
2.2.1. Requirement

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be used to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data are being acquired (i.e., no transmitter OFF-time is to be considered).

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternative procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle (D). Within this subclause, the duty cycle refers to the fraction of time over which the transmitter is ON and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than $\pm 2\%$; otherwise, the duty cycle is considered to be nonconstant.

2.2.2. 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 B was used in order to prove compliance.

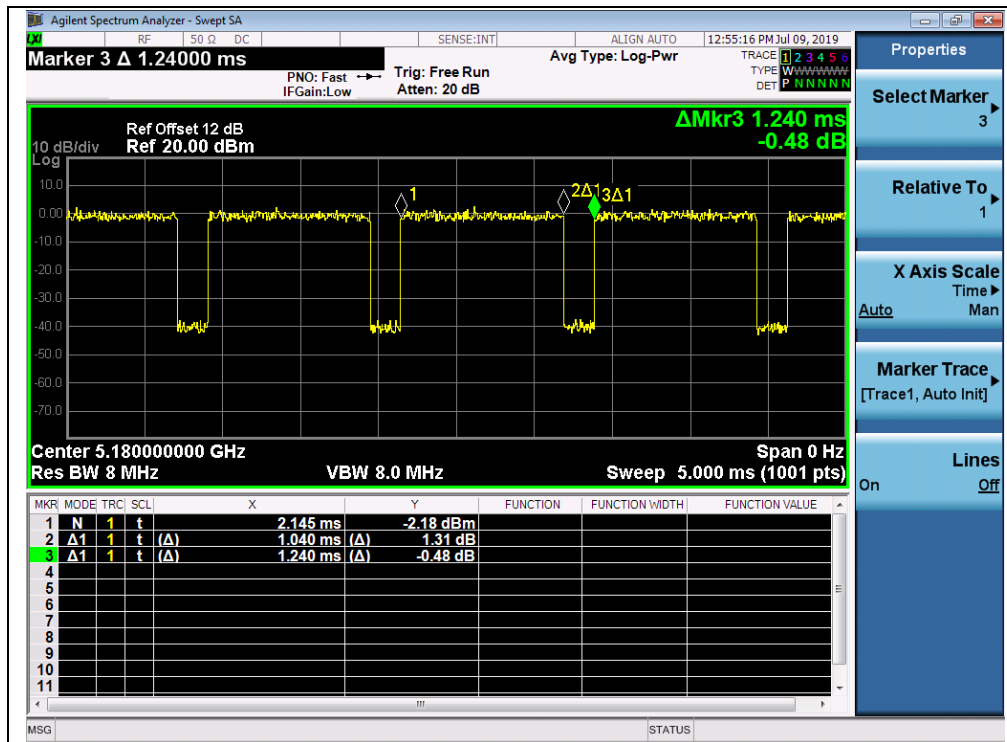


2.2.3. Test Result

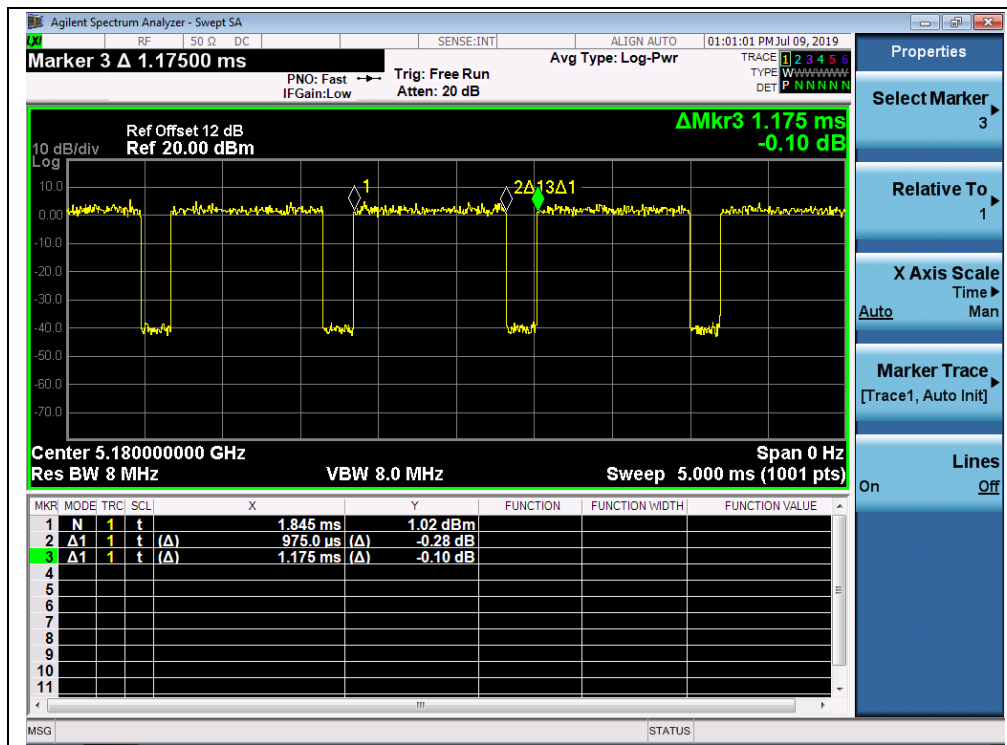
A. Test Verdict:

Test Mode	Duty Cycle (%) (D)	Duty Factor (10*log[1/D])
802.11a	83.87	0.76
802.11n(HT20)	82.98	0.81
802.11n(HT40)	83.40	0.79
802.11ac(VHT20)	70.87	1.50
802.11ac(VHT40)	71.00	1.49
802.11ac(VHT80)	55.36	2.57

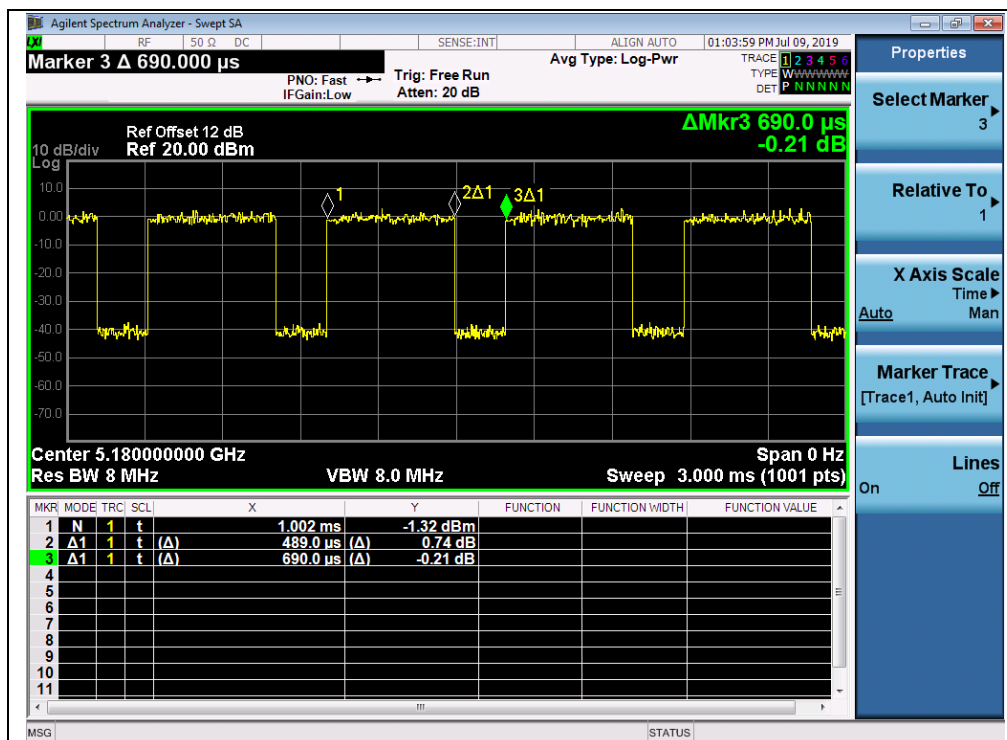
B. Test Plots



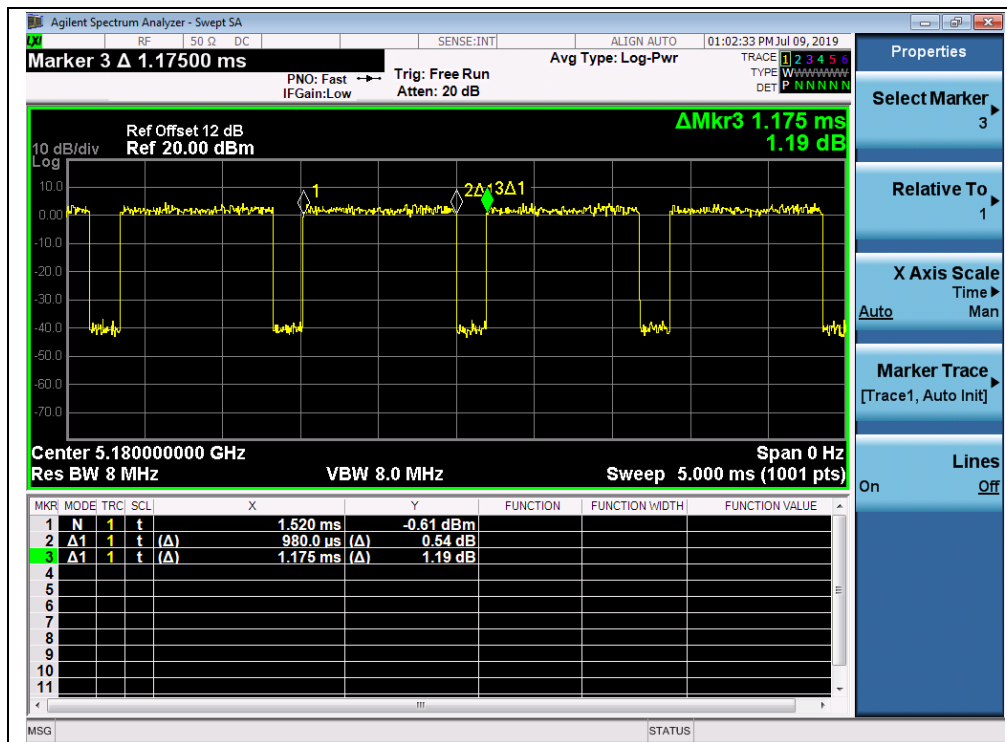
(CH36_5180MHz_802.11a)



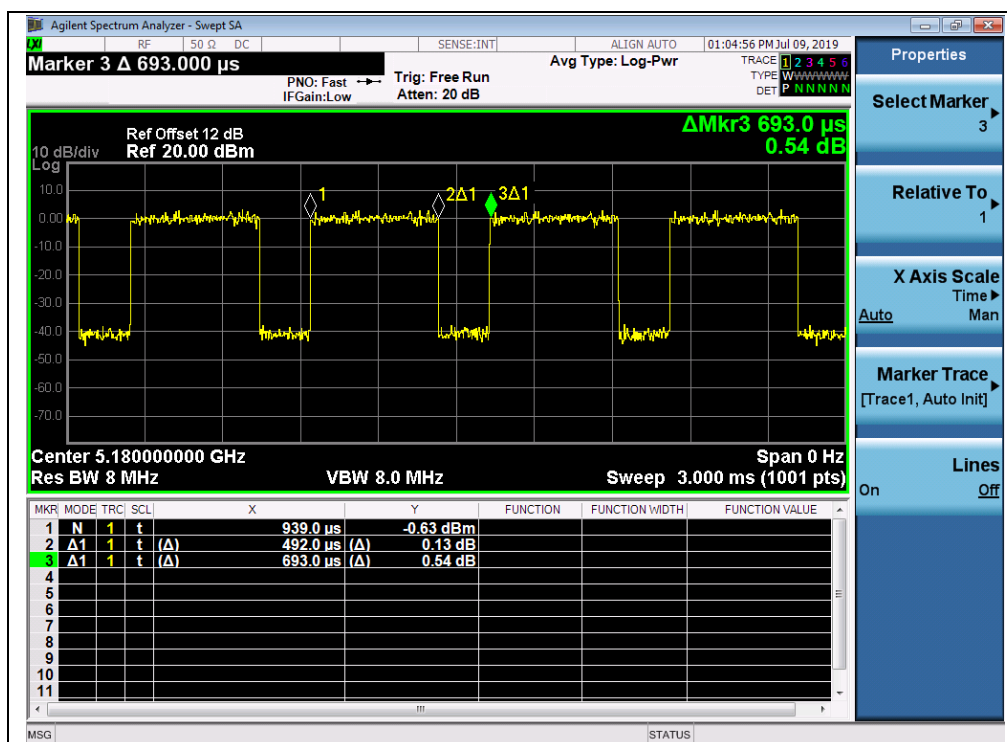
(CH36_5180MHz_802.11n(HT20))



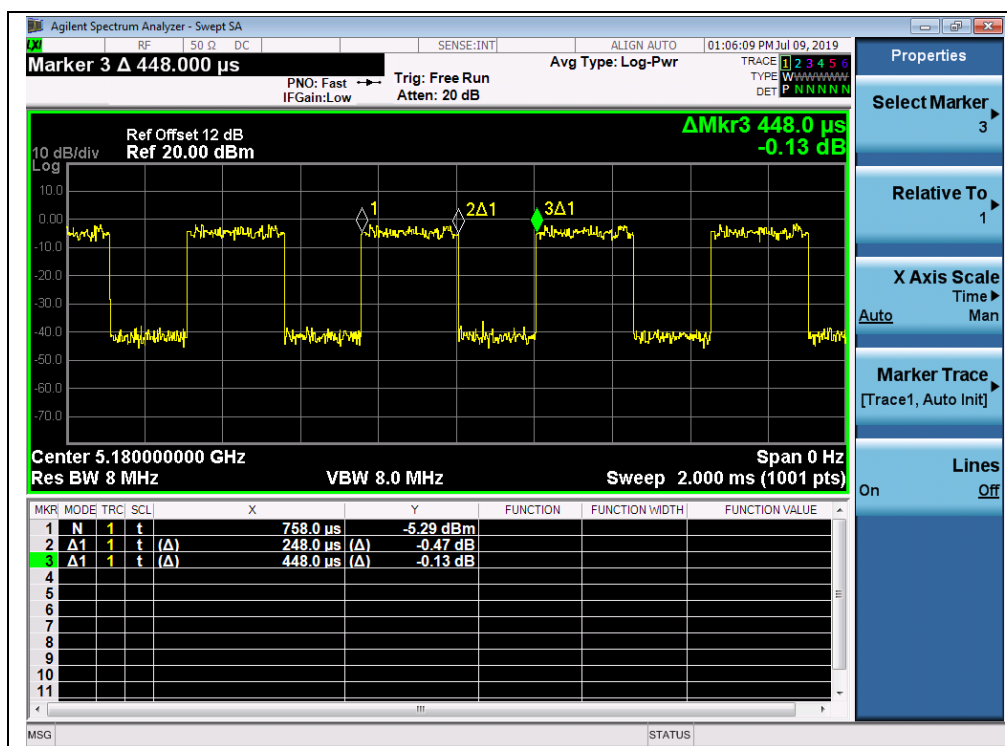
(CH38_5190MHz_802.11n(HT40))



(CH36_5180MHz_802.11ac(VHT20))



(CH38_5190MHz_802.11 ac(VHT40))



(CH42_5210MHz_802.11 ac(VHT80))

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 and 5.47-5.725 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.

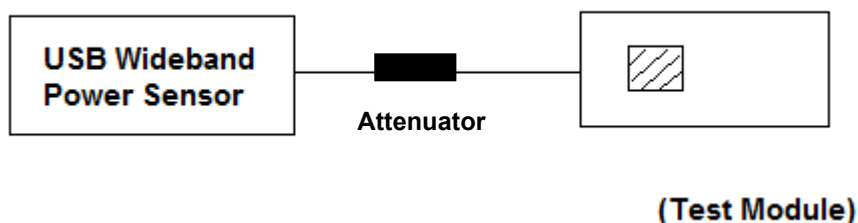
(4) According to KDB662911D01 Measure-and-sum technique, the conducted emission level (e.g., transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the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

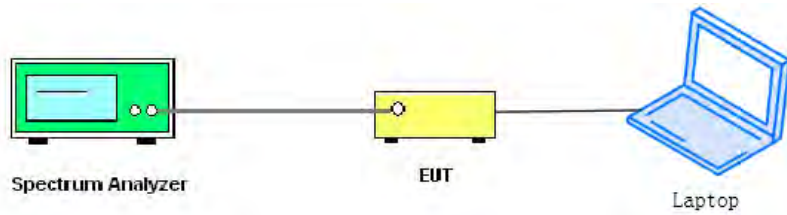
Section E) 3) of KDB 789033 defines a methodology using a USB Wideband Power Sensor.

A. Test Setup:



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.

For ac (VHT80) mode power



The EUT (Equipment under the test) 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, all test result in Spectrum analyzer.

2.3.3. Test Result

802.11a Test mode

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
36	5180	19.64	0.092		24	0.25	PASS
44	5220	19.18	0.083				
48	5240	19.66	0.092				
149	5745	16.27	0.042		30	1	
157	5785	15.25	0.033				
165	5825	14.47	0.028				
Channel	Frequency (MHz)	Average Power (dBm)			Limit (dBm)		Verdict
		Measured	Duty factor Calculated		dBm		
		dBm	dBm	W	dBm	W	
36	5180	11.93	12.69	0.019	24	0.25	PASS
44	5220	11.50	12.26	0.017			
48	5240	12.15	12.91	0.020			
149	5745	9.05	9.81	0.010	30	1	
157	5785	8.03	8.79	0.008			
165	5825	7.31	8.07	0.006			

**802.11n (HT20) Test mode**

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
36	5180	19.47	0.089		24	0.25	PASS
44	5220	19.00	0.079				
48	5240	20.08	0.102				
149	5745	16.14	0.041		30	1	
157	5785	15.32	0.034				
165	5825	14.43	0.028				
Channel	Frequency (MHz)	Average Power (dBm)			Limit (dBm)		Verdict
		Measured	Duty factor Calculated		dBm		
		dBm	dBm	W			
36	5180	12.26	13.07	0.020	24	0.25	PASS
44	5220	11.80	12.61	0.018			
48	5240	12.72	13.53	0.023			
149	5745	8.82	9.63	0.009	30	1	
157	5785	7.65	8.46	0.007			
165	5825	7.20	8.01	0.006			

802.11n (HT40) Test mode

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
38	5190	18.66	0.073		24	0.25	PASS
46	5230	18.92	0.078				
151	5755	14.93	0.031		30	1	
159	5795	13.89	0.024				
Channel	Frequency (MHz)	Average Power			Limit (dBm)		Verdict
		Measured	Duty factor Calculated		dBm W		
		dBm	dBm	W			
38	5190	10.80	12.30	0.017	24	0.25	PASS
46	5230	11.20	12.70	0.019			
151	5755	7.26	8.76	0.008	30	1	
159	5795	6.20	7.70	0.006			

802.11ac (VHT20) Test mode

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
36	5180	19.85	0.097		24	0.25	PASS
44	5220	19.40	0.087				
48	5240	19.86	0.097				
149	5745	16.33	0.043		30	1	
157	5785	15.59	0.036				
165	5825	14.67	0.029				
Channel	Frequency (MHz)	Average Power (dBm)			Limit (dBm)		Verdict
		Measured	Duty factor Calculated		dBm W		
		dBm	dBm	W			
36	5180	12.24	13.03	0.020	24	0.25	PASS
44	5220	11.63	12.42	0.017			
48	5240	11.96	12.75	0.019			
149	5745	8.54	9.33	0.009	30	1	
157	5785	7.82	8.61	0.007			
165	5825	7.11	7.90	0.006			

802.11ac (VHT40) Test mode

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
38	5190	18.46	0.070		24	0.25	PASS
46	5230	18.71	0.074				
151	5755	14.56	0.029		30	1	
159	5795	13.72	0.024				
Channel	Frequency (MHz)	Average Power			Limit (dBm)		Verdict
		Measured	Duty factor Calculated				
		dBm	dBm	W	dBm	W	
38	5190	11.13	12.62	0.018	24	0.25	PASS
46	5230	11.22	12.71	0.019			
151	5755	7.12	8.61	0.007	30	1	
159	5795	6.47	7.96	0.006			

**802.11ac (VHT80) Test mode**

Channel	Frequency (MHz)	Measured Peak Power			Limit (dBm)		Verdict
		dBm	W		dBm	W	
42	5210	17.56	0.057		24	0.25	PASS
155	5775	13.83	0.024		30	1	
Channel	Frequency (MHz)	Average Power			Limit (dBm)		Verdict
		Measured	Duty factor Calculated				
		dBm	dBm	W	dBm	W	
42	5210	9.32	11.89	0.015	24	0.25	PASS
155	5775	5.83	8.398	0.007	30	1	

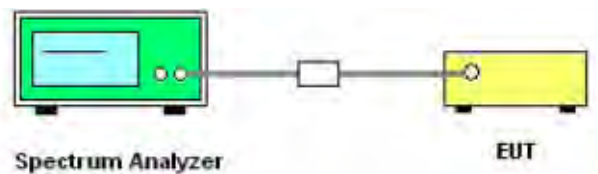
2.4. Emission Bandwidth

2.4.1. 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.

2.4.2. Test Description

A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50 Ohm; 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

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- 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 5.725-5.85 GHz 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:

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- 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.

2.4.3. Test Result

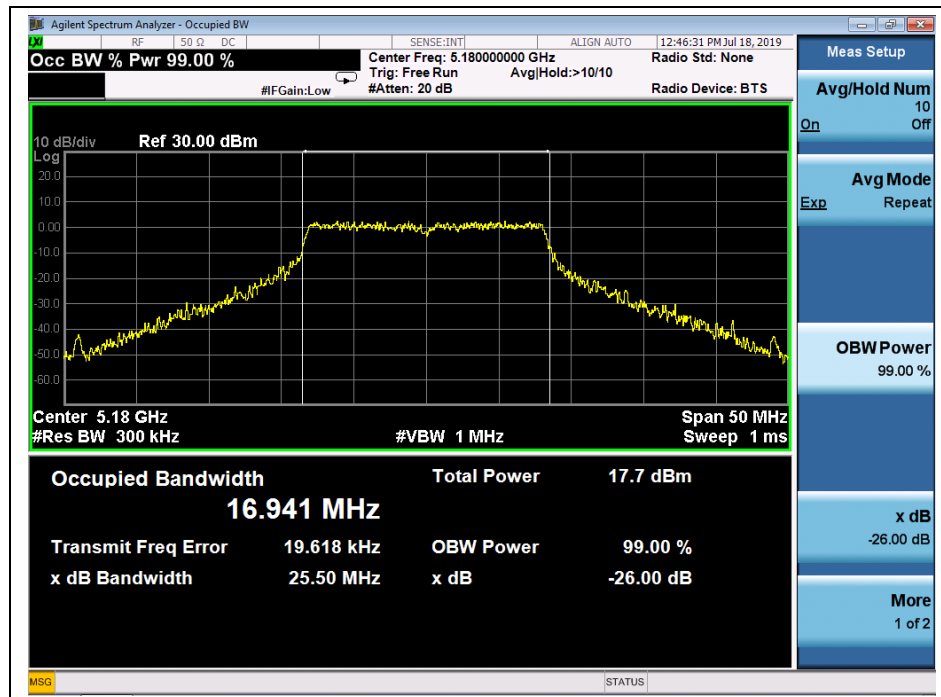
802.11a Test mode

A. Test Verdict:

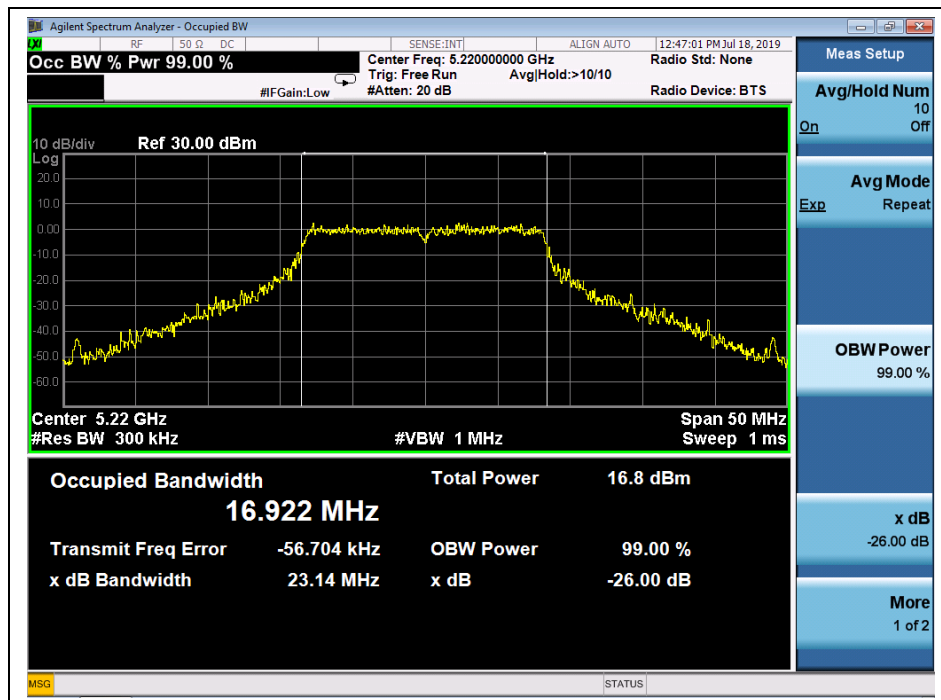
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
36	5180	25.50
44	5220	23.14
48	5240	24.13 _{Note}
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
149	5745	16.43
157	5785	16.38
165	5825	16.39

Note: The high frequency of the -26dB bandwidth is 5251.82MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

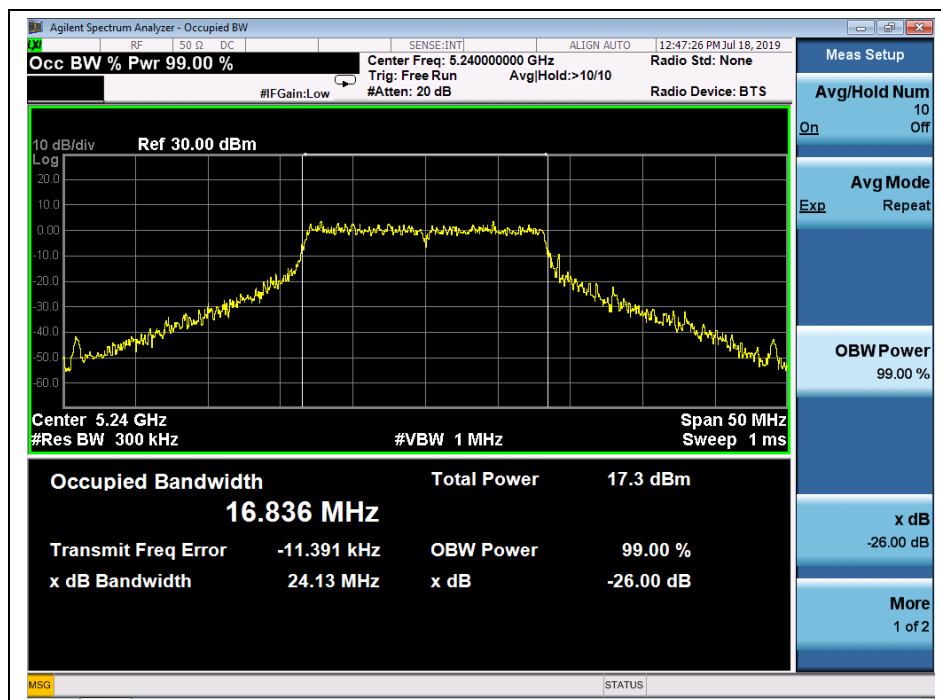
B. Test Plots



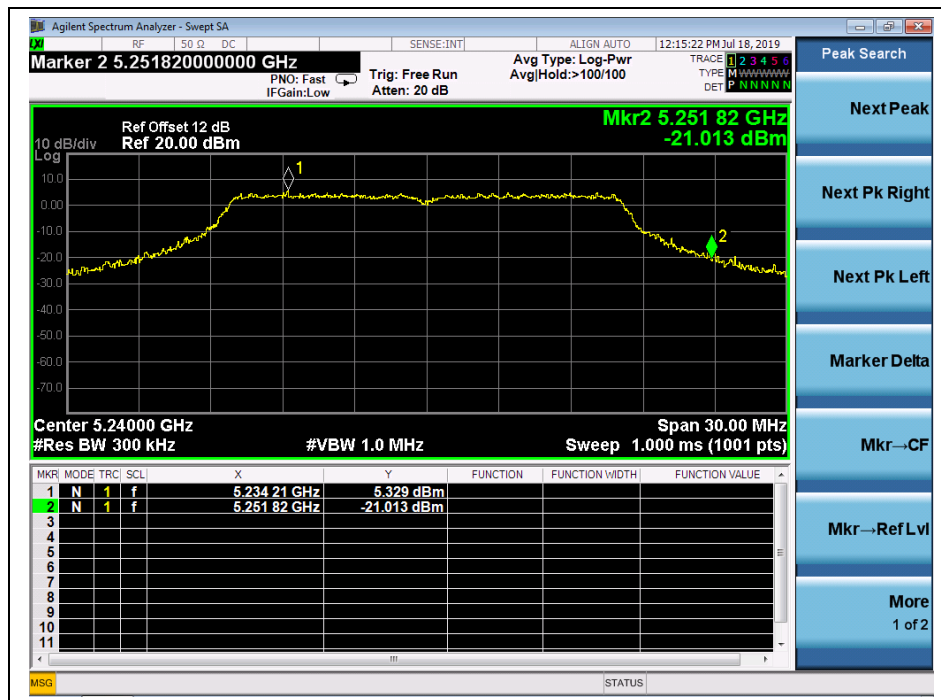
(Channel 36, 5180MHz, 802.11a,)



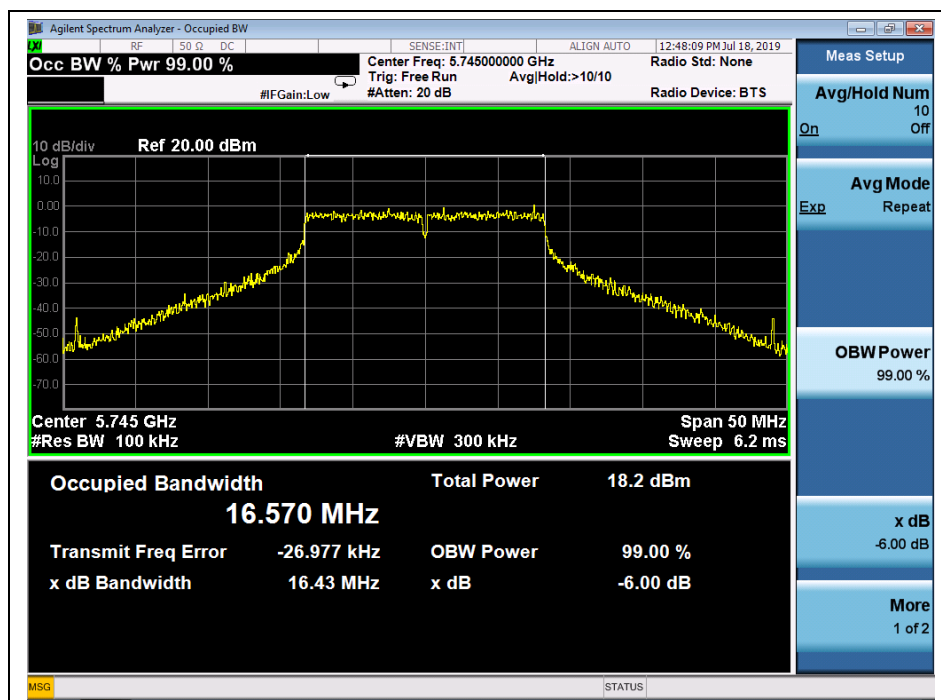
(Channel 44, 5220 MHz, 802.11a,)



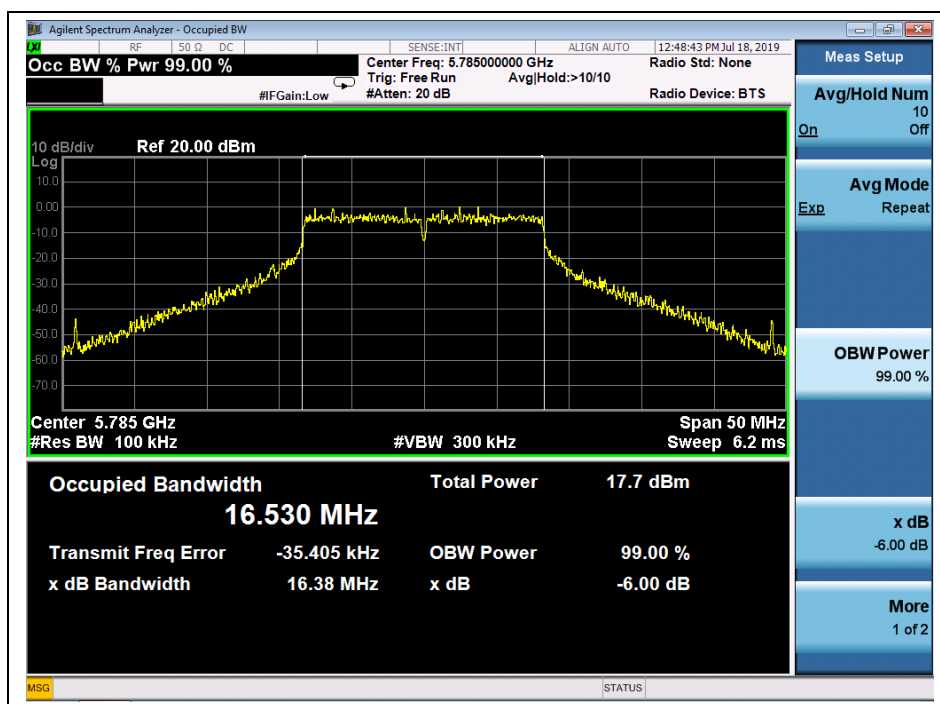
(Channel 48, 5240MHz, 802.11a,)



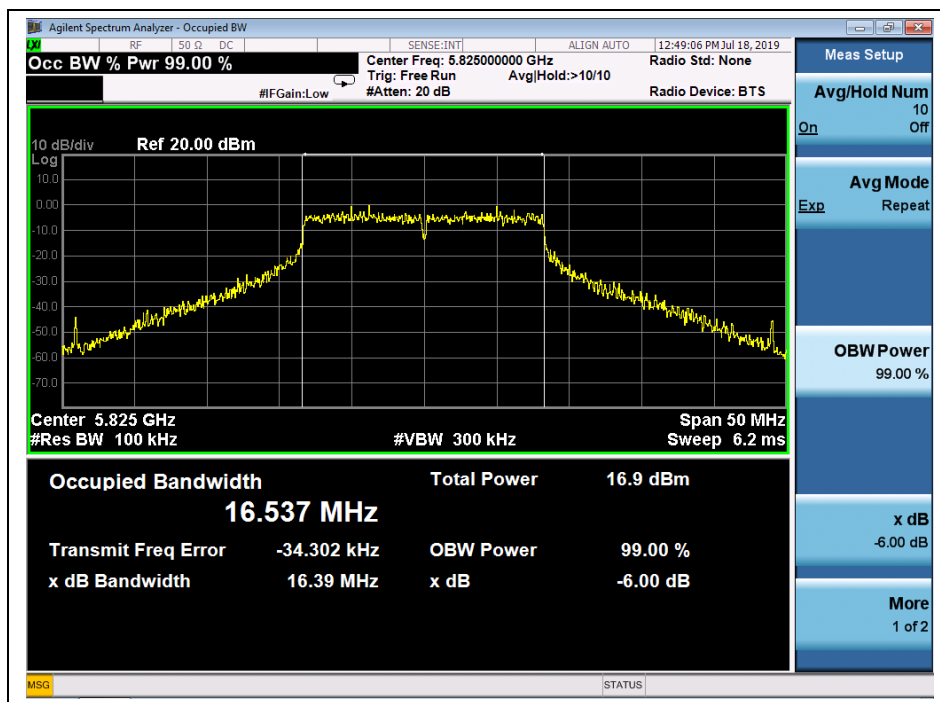
(Channel 48, 5240MHz, fh of -26dB, 802.11a,)



(Channel 149, 5745MHz, 802.11a)



(Channel 157, 5785MHz, 802.11a)



(Channel 165, 5825MHz, 802.11a)



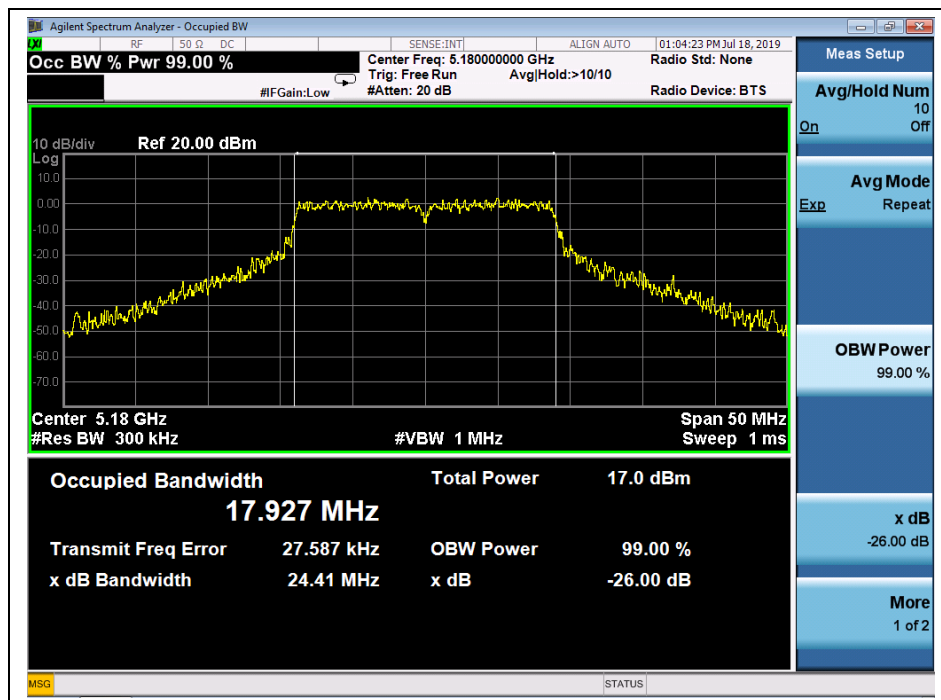
802.11n (HT20) Test mode

A. Test Verdict:

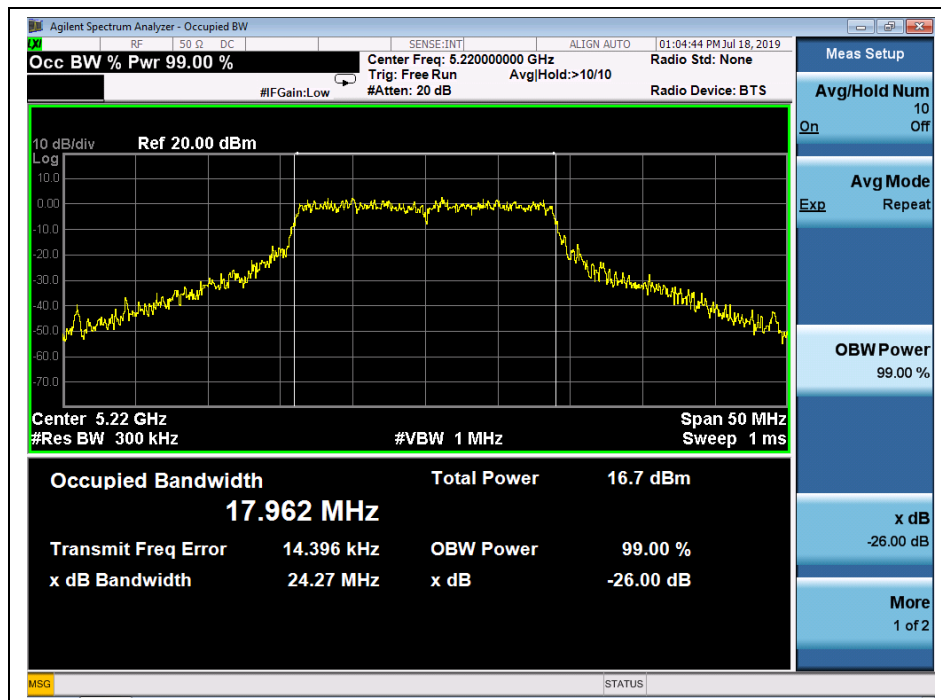
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
36	5180	24.41
44	5220	24.27
48	5240	23.78 _{Note}
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
149	5745	17.60
157	5785	17.59
165	5825	17.60

Note: The high frequency of the -26dB bandwidth is 5251.79MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

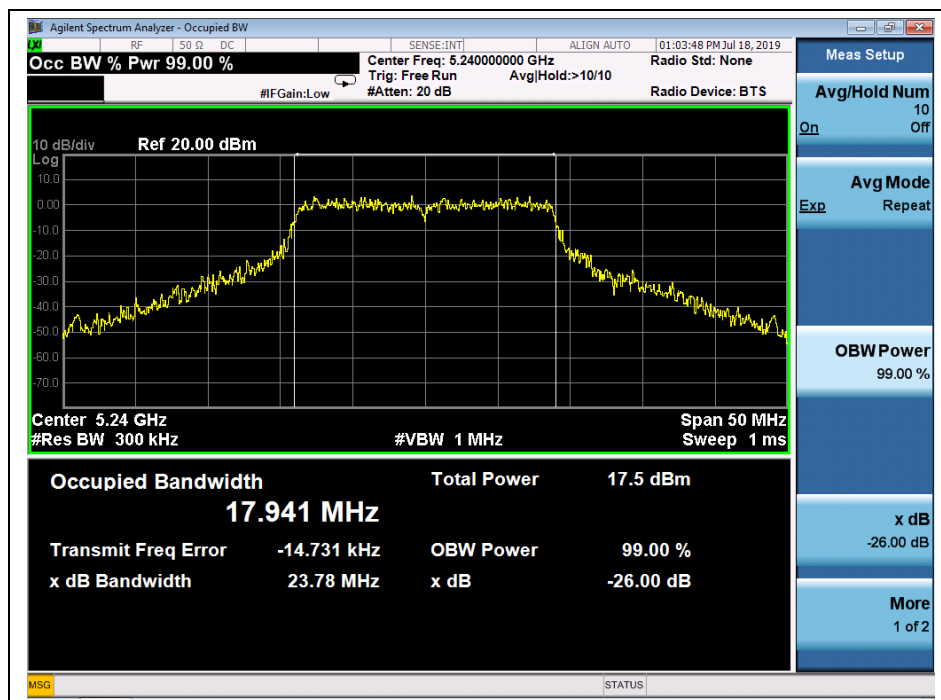
B. Test Plots



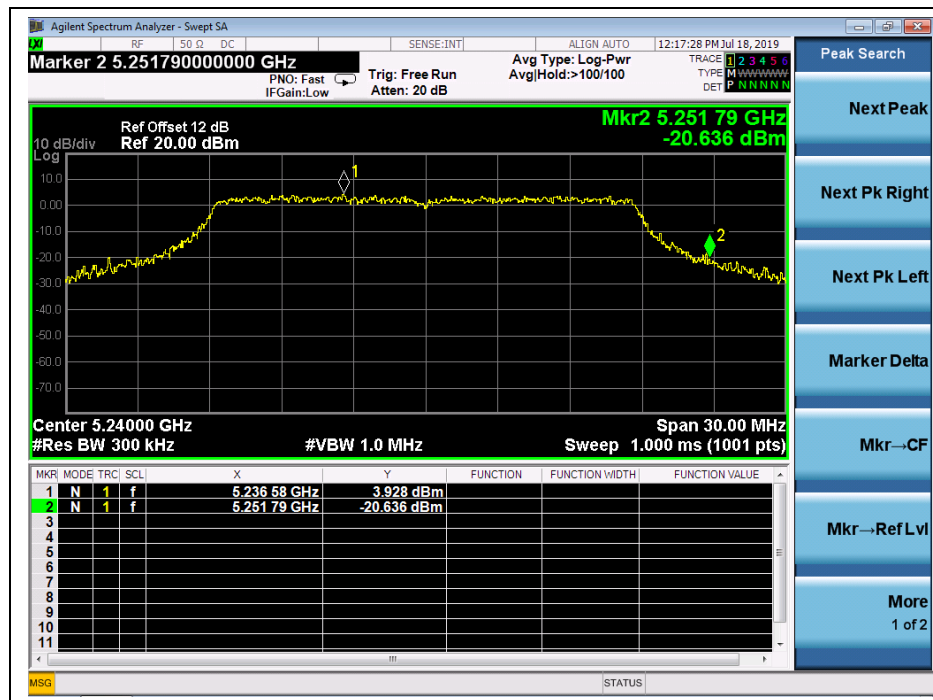
(Channel 36, 5180MHz, 802.11 n (HT20))



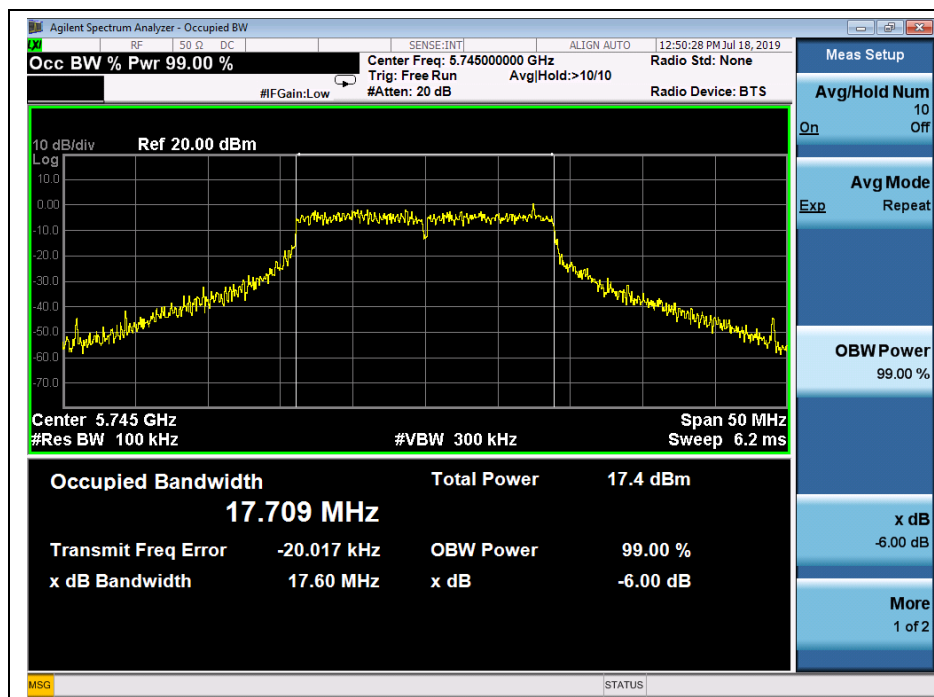
(Channel 44, 5220 MHz, 802.11 n (HT20))



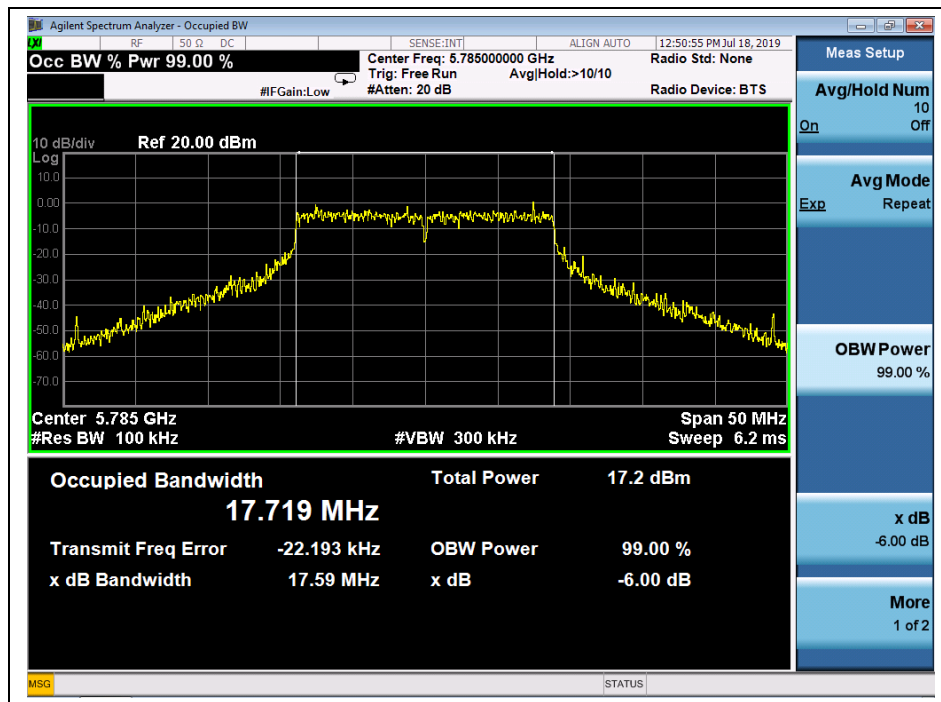
(Channel 48, 5240MHz, 802.11 n (HT20))



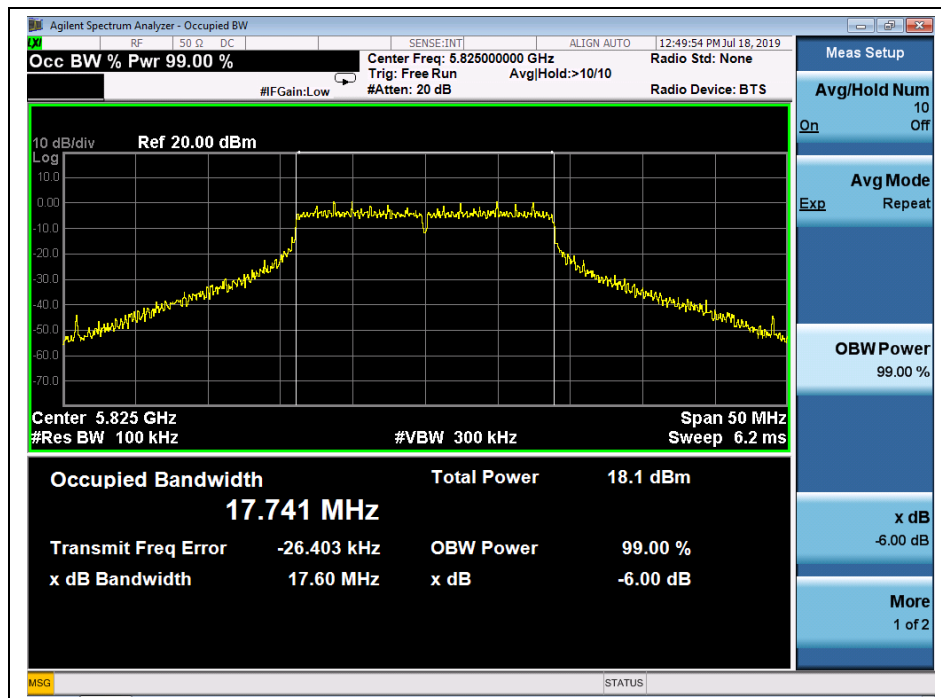
(Channel 48, 5240MHz, fh of -26dB, 802.11 n (HT20))



(Channel 149, 5745MHz, 802.11 n (HT20))



(Channel 157, 5785MHz, 802.11 n (HT20))



(Channel 165, 5825MHz, 802.11 n (HT20))



A. Test Verdict:

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
38	5190	48.52
46	5230	51.33 Note
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
151	5755	35.47
159	5795	35.21

Note: The high frequency of the -26dB bandwidth is 5253.10MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

Agilent Spectrum Analyzer - Occupied BW

RF 1.50 GHz DC SENSE:INT ALIGN AUTO 12:56:33 PM Jul 18, 2019

Occ BW % Pwr 99.00 % Center Freq: 5.190000000 GHz Radio Std: None
 Trig: Free Run AvgHld:>10/10 Radio Device: BTS
 #IFGain:Low #Atten: 20 dB

10 dB/div Ref 20.00 dBm

Center 5.19 GHz Span 100 MHz
 #Res BW 510 kHz #VBW 1.6 MHz Sweep 1 ms

Occupied Bandwidth		Total Power	
36.215 MHz		17.9 dBm	
Transmit Freq Error	20.729 kHz	OBW Power	99.00 %
x dB Bandwidth	48.52 MHz	x dB	-26.00 dB

MSG STATUS

Meas Setup

Avg/Hold Num 10 On
 Off

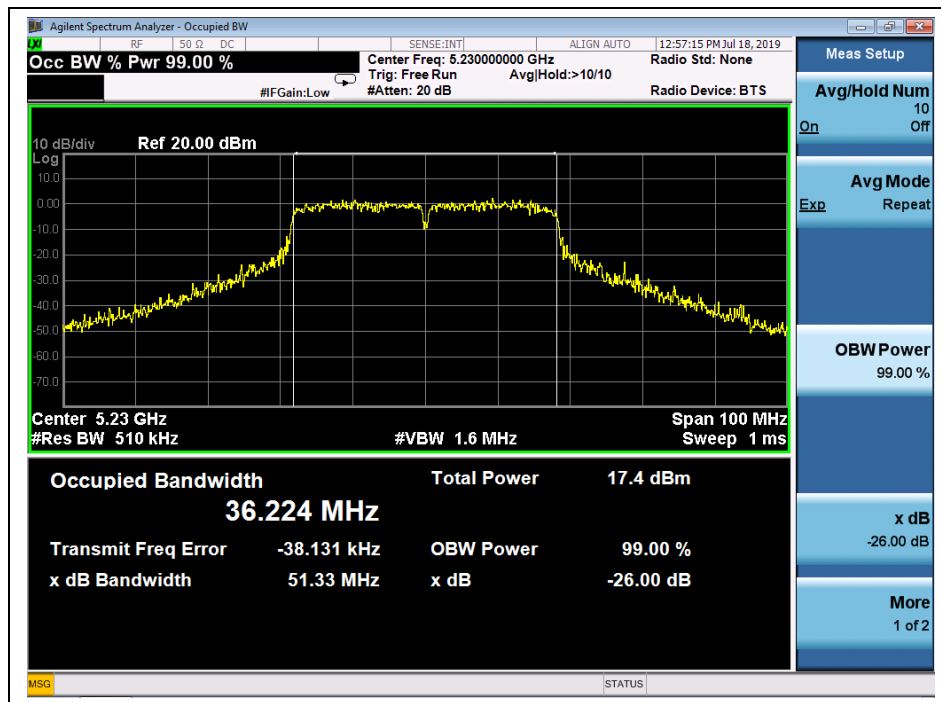
Avg Mode Exp Repeat

OBW Power 99.00 %

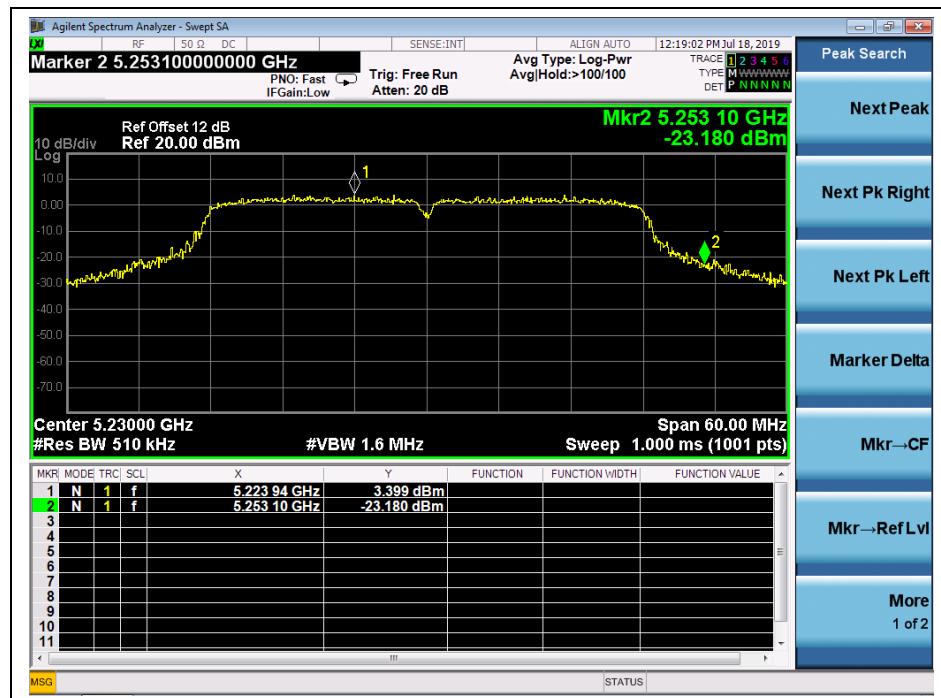
x dB -26.00 dB

More 1 of 2

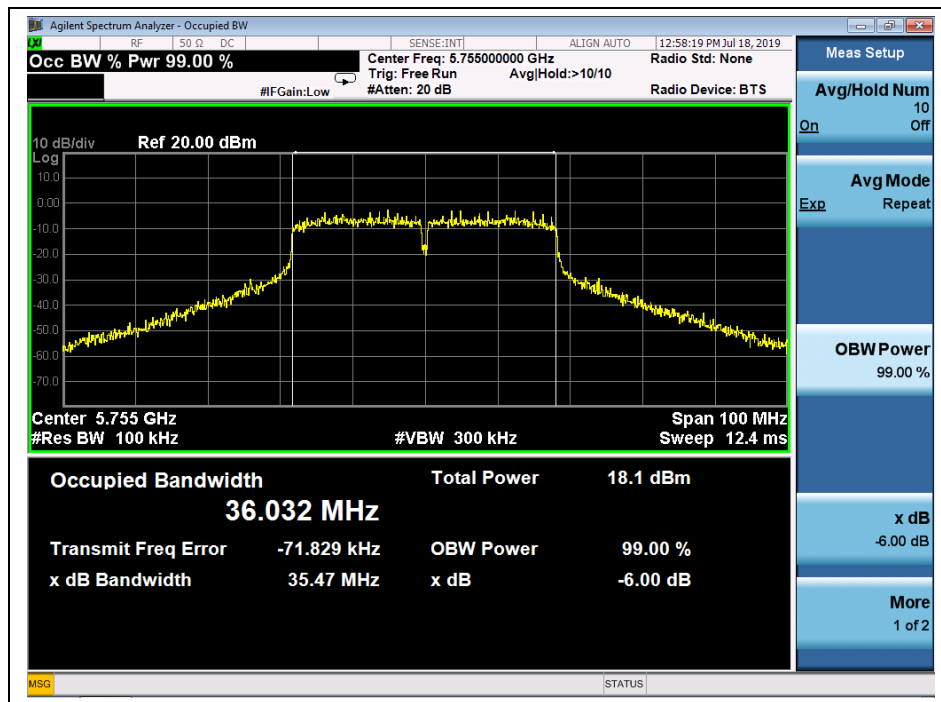
(Channel 38, 5190MHz, 802.11n (HT40))



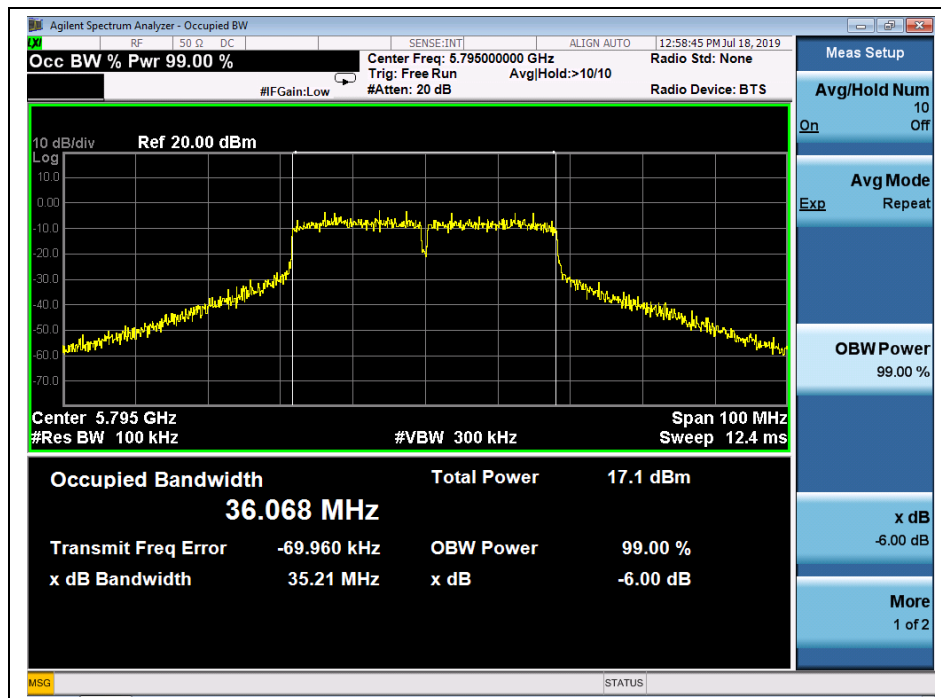
(Channel 46, 5230 MHz, 802.11n (HT40))



(Channel 46, 5230 MHz, fh of -26dB, 802.11n (HT40))



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



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



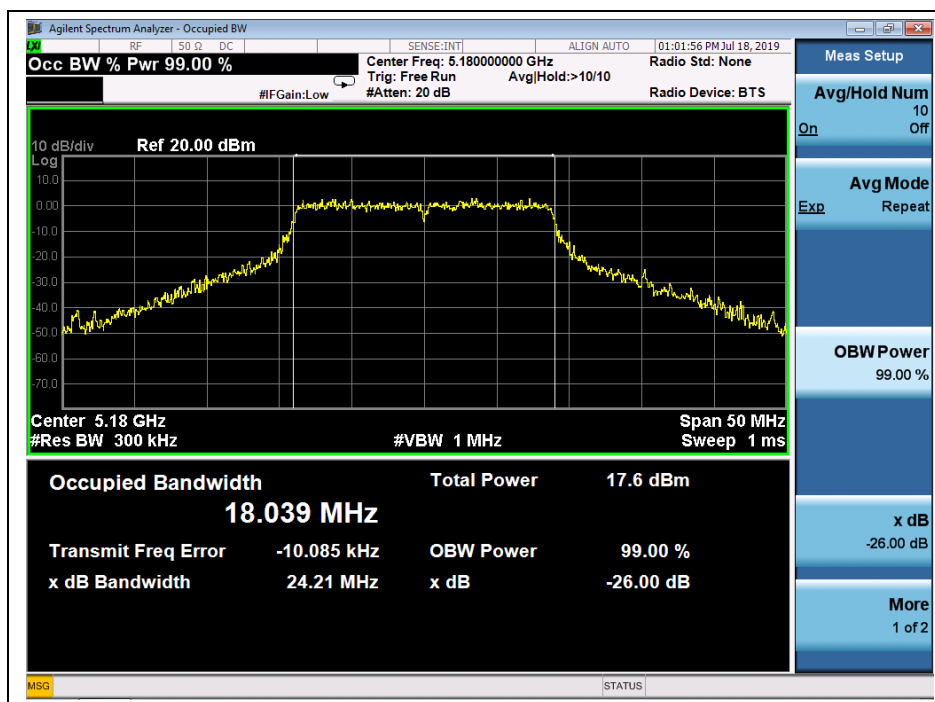
802.11ac (VHT20) Test mode

A. Test Verdict:

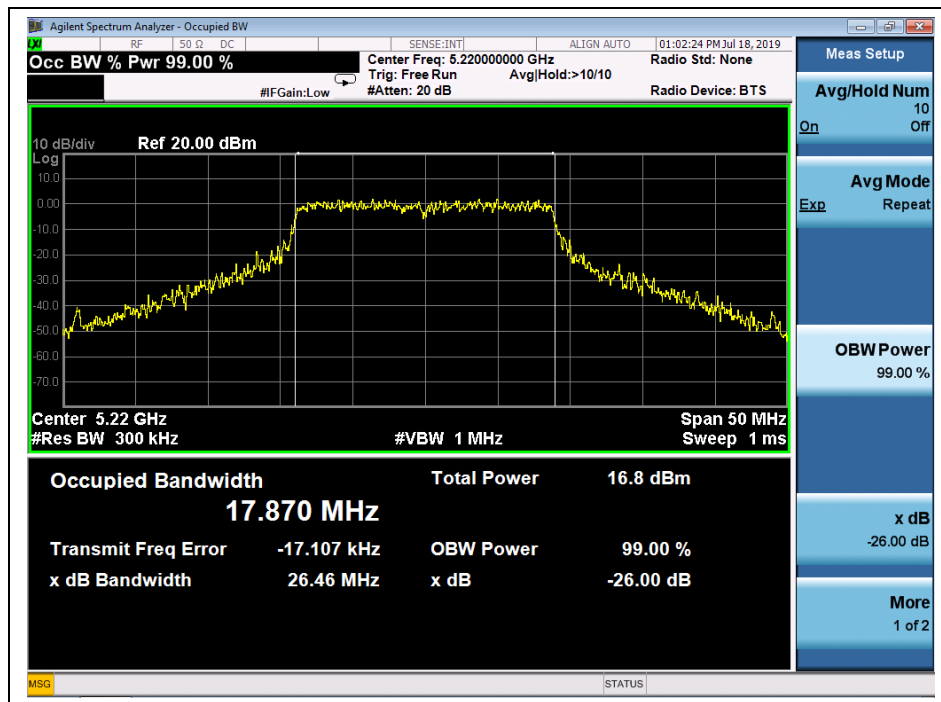
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
36	5180	24.21
44	5220	26.46
48	5240	23.23 _{Note}
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
149	5745	17.59
157	5785	17.62
165	5825	17.61

Note: The high frequency of the -26dB bandwidth is 5251.91MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

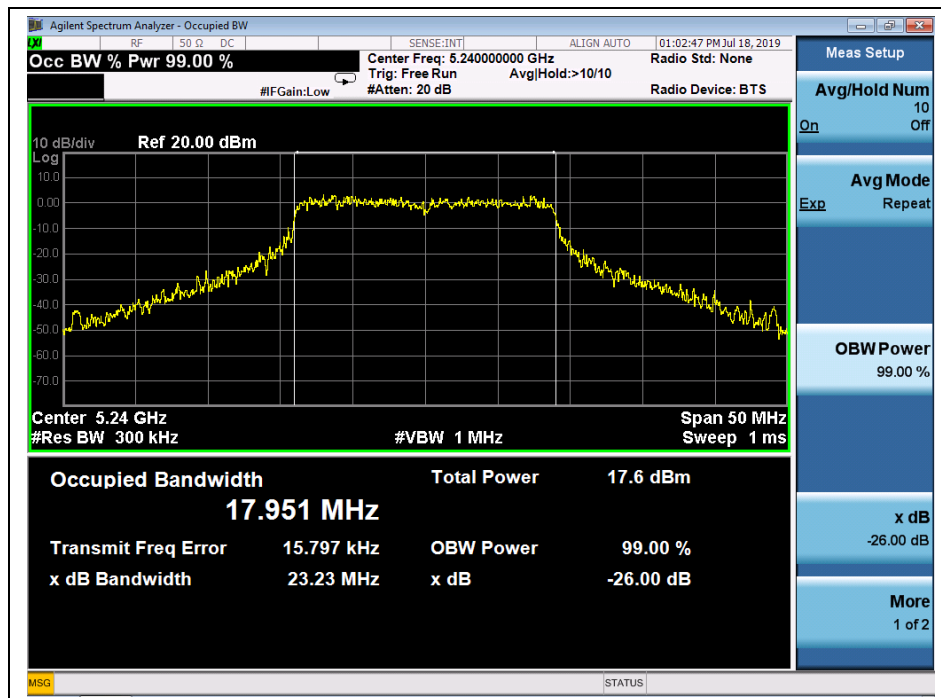
B. Test Plots



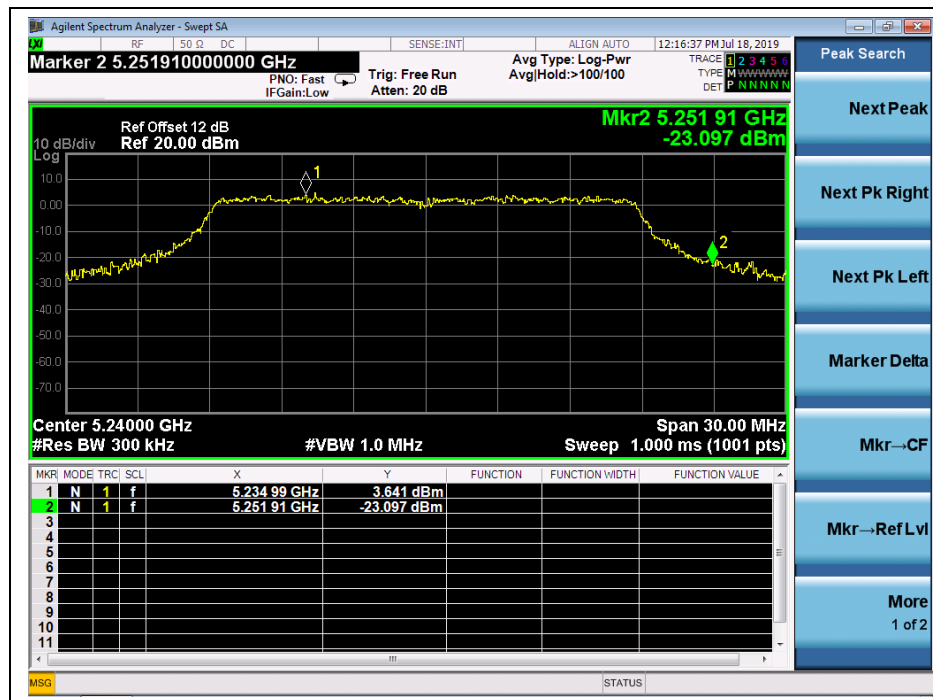
(Channel 36, 5180MHz, 802.11 ac (VHT20))



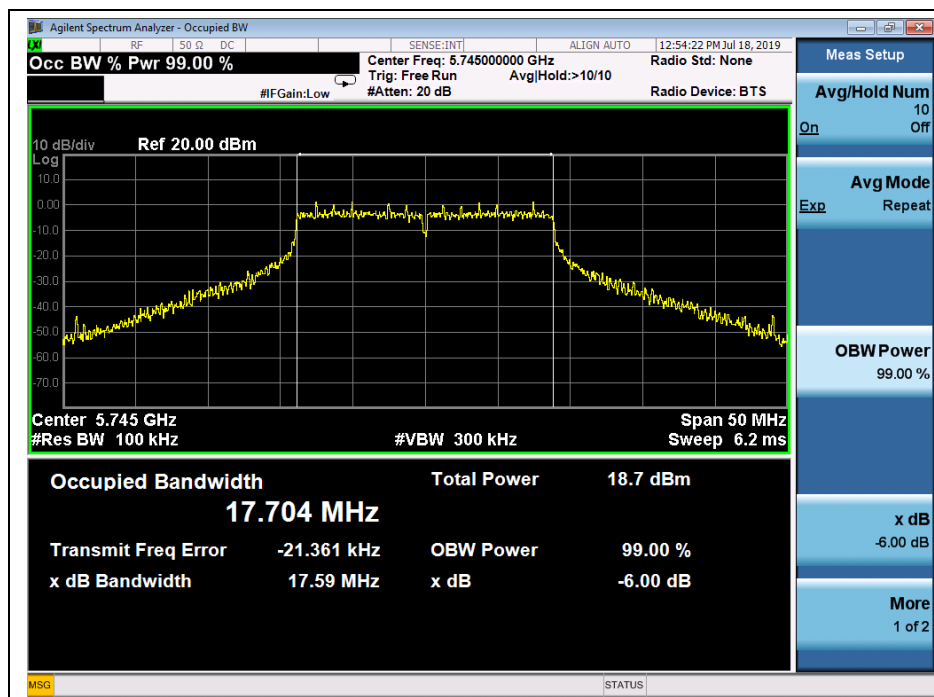
(Channel 44, 5220 MHz, 802.11 ac (VHT20))



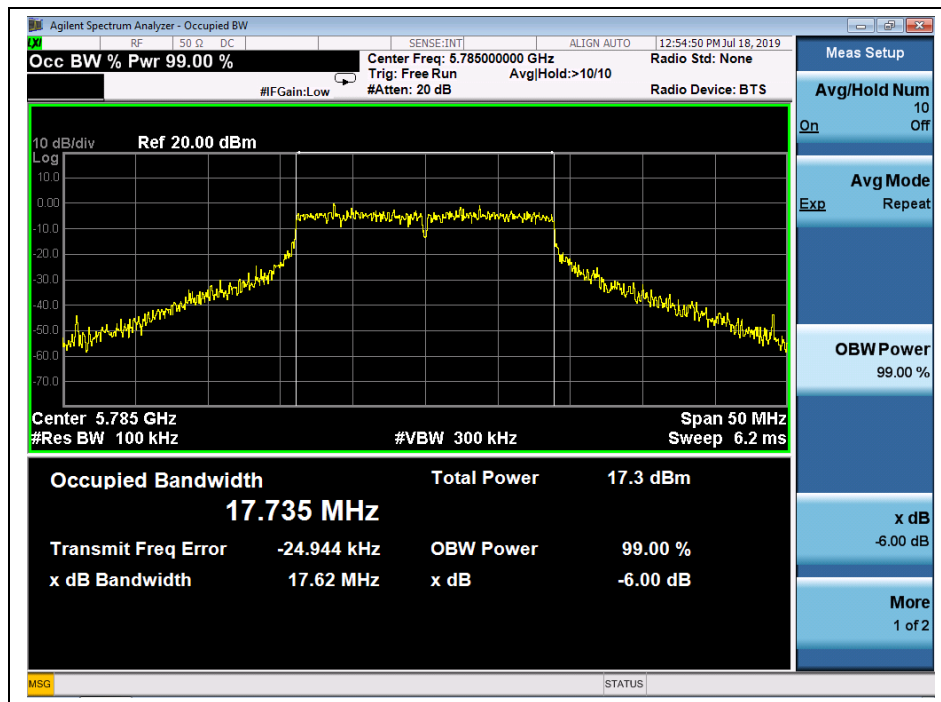
(Channel 48, 5240MHz, 802.11 ac (VHT20))



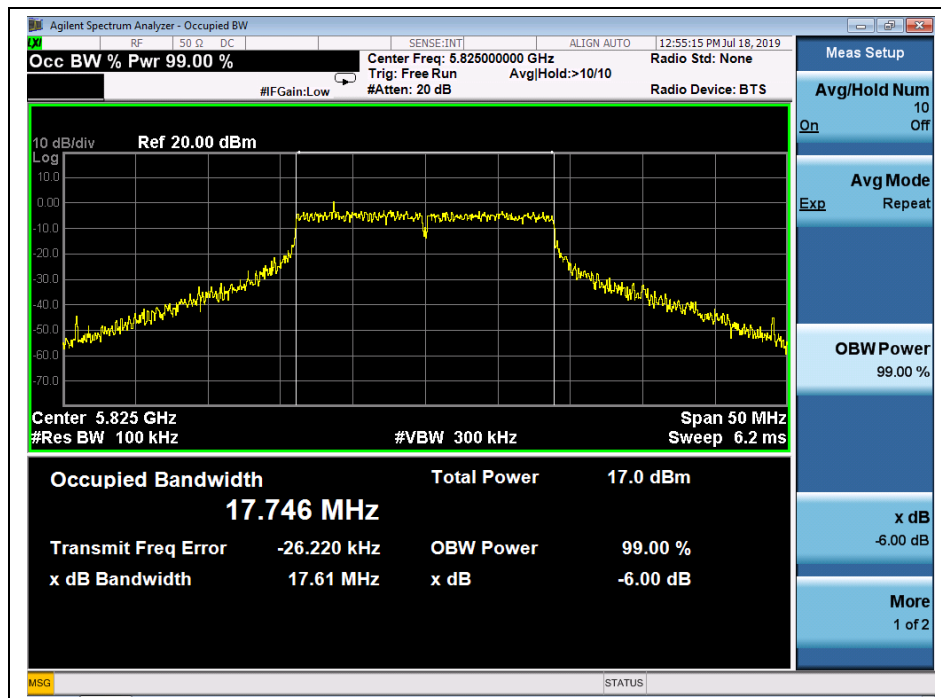
(Channel 48, 5240MHz, fh of -26dB, 802.11 ac (VHT20))



(Channel 149, 5745MHz, 802.11 ac (VHT20))



(Channel 157, 5785MHz, 802.11 ac (VHT20))

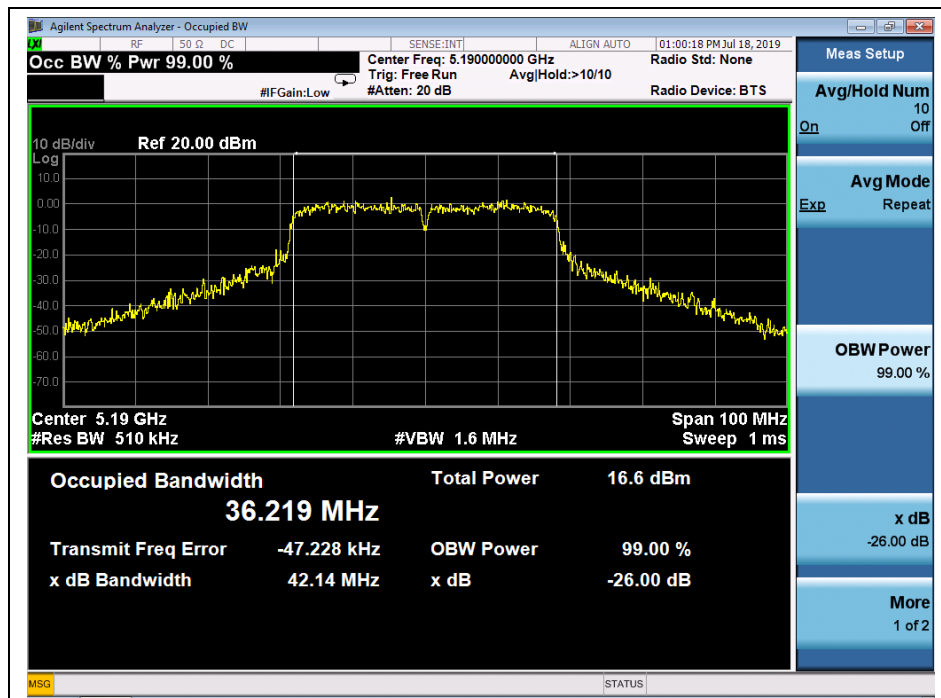


(Channel 165, 5825MHz, 802.11 ac (VHT20))

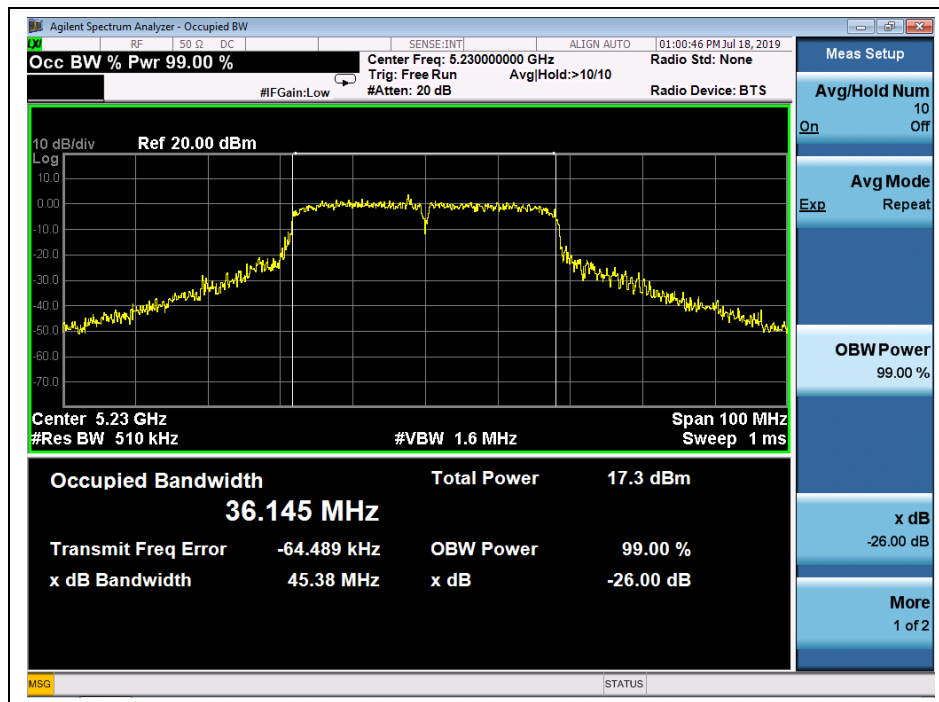
**802.11 ac (VHT40) Test mode****A. Test Verdict:**

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
38	5190	42.14
46	5230	45.38 _{Note}
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
151	5755	35.44
159	5795	35.47

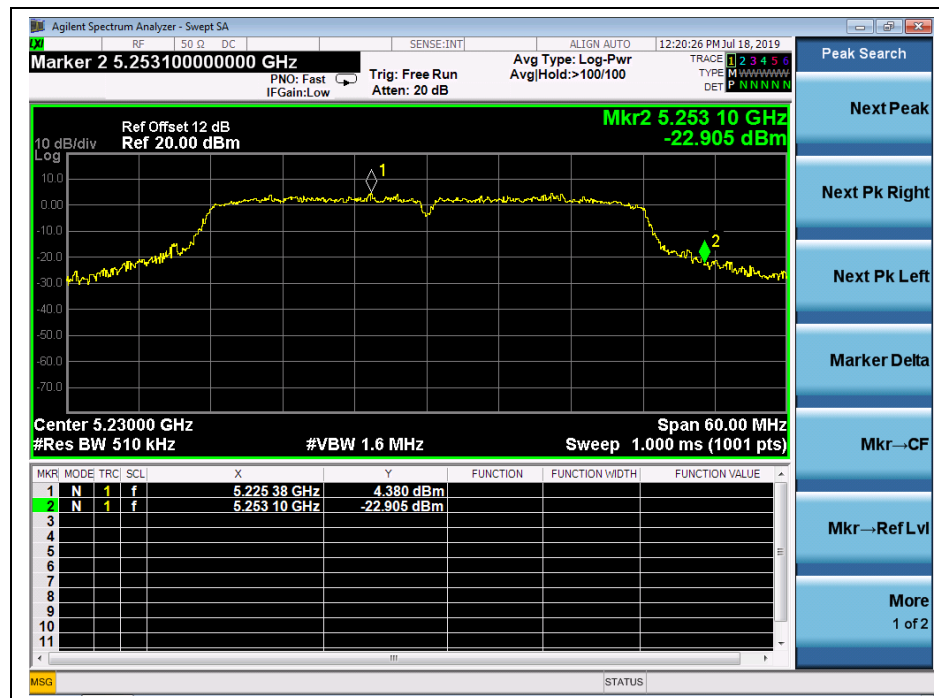
Note: The high frequency of the -26dB bandwidth is 5253.10MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

B. Test Plots

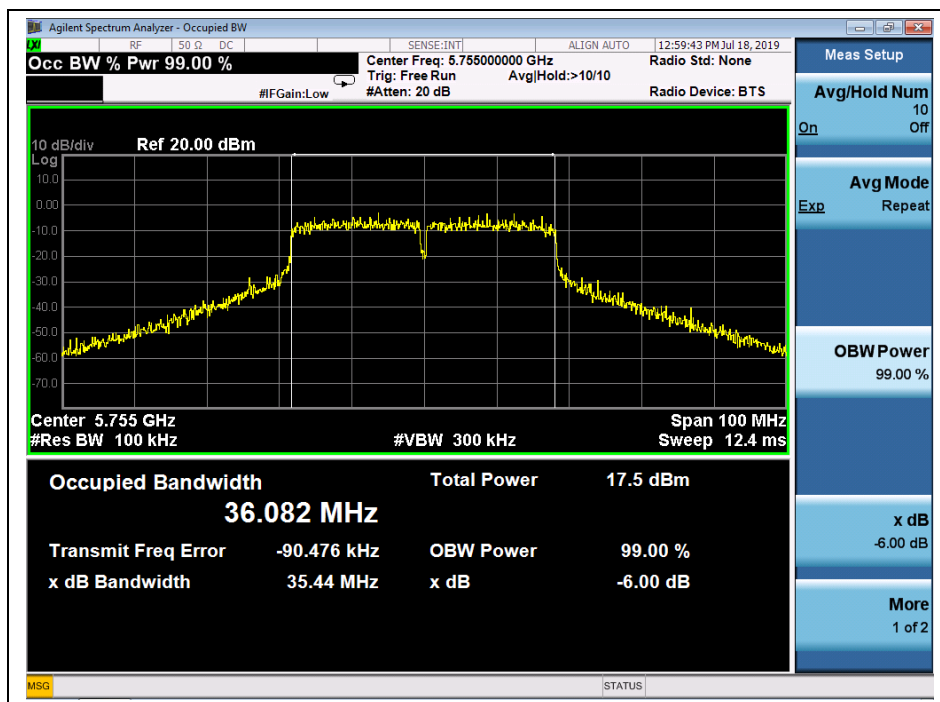
(Channel 38, 5190MHz, 802.11 ac (VHT40))



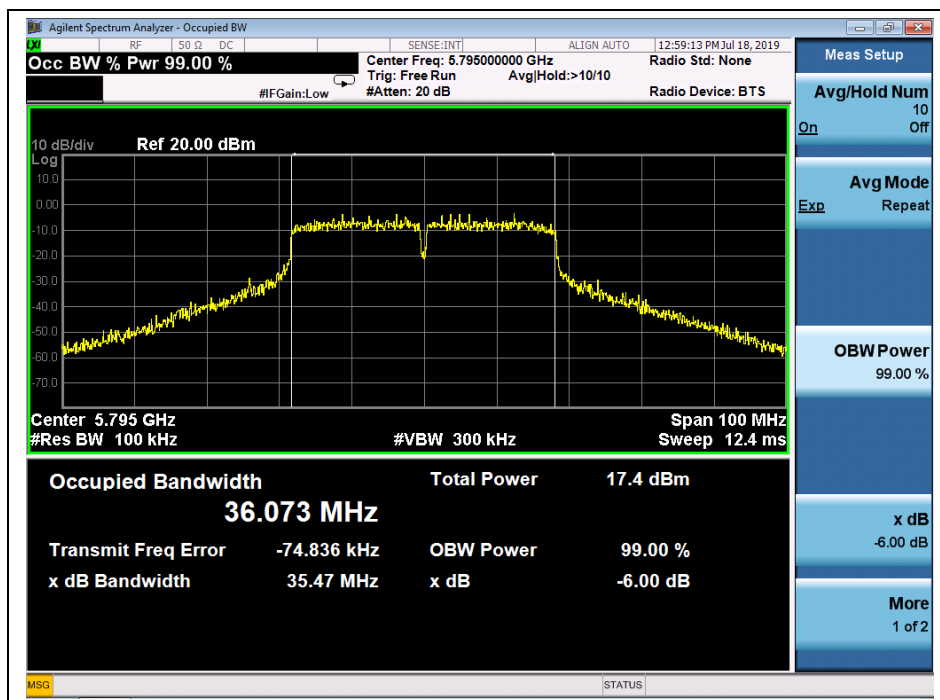
(Channel 46, 5230 MHz, 802.11 ac (VHT40))



(Channel 46, 5230 MHz, fh of -26dB, 802.11 ac (VHT40))



(Channel 151, 5755 MHz, 802.11 ac (VHT40))

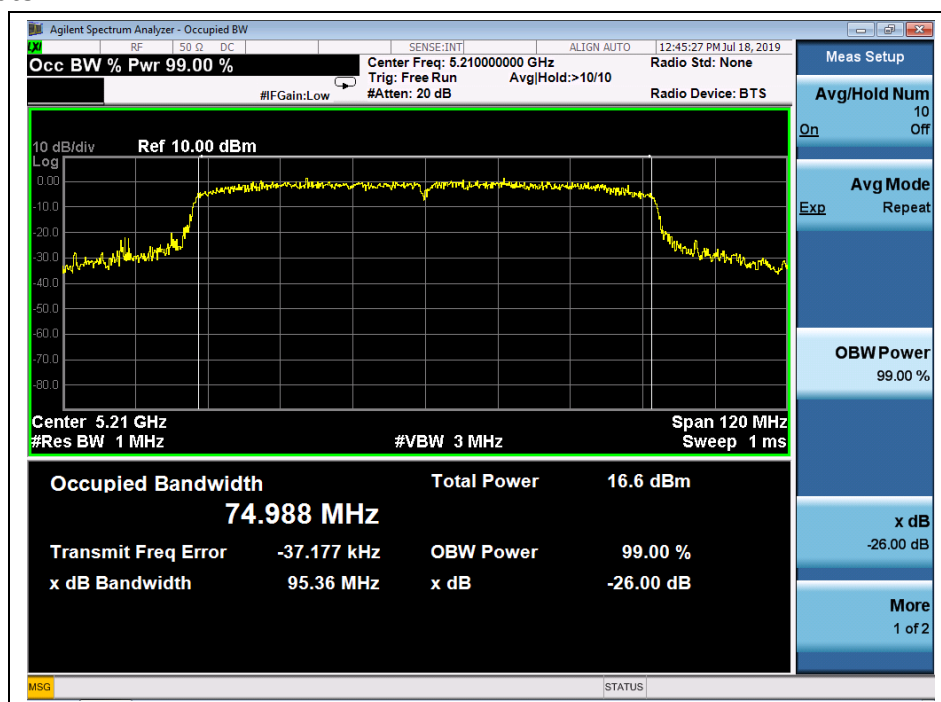


(Channel 159, 5795MHz, 802.11 ac (VHT40))

**802.11 ac (VHT80) Test mode****A. Test Verdict:**

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
42	5210	95.36 Note
Channel	Frequency (MHz)	6dB Bandwidth (MHz)
155	5775	75.06

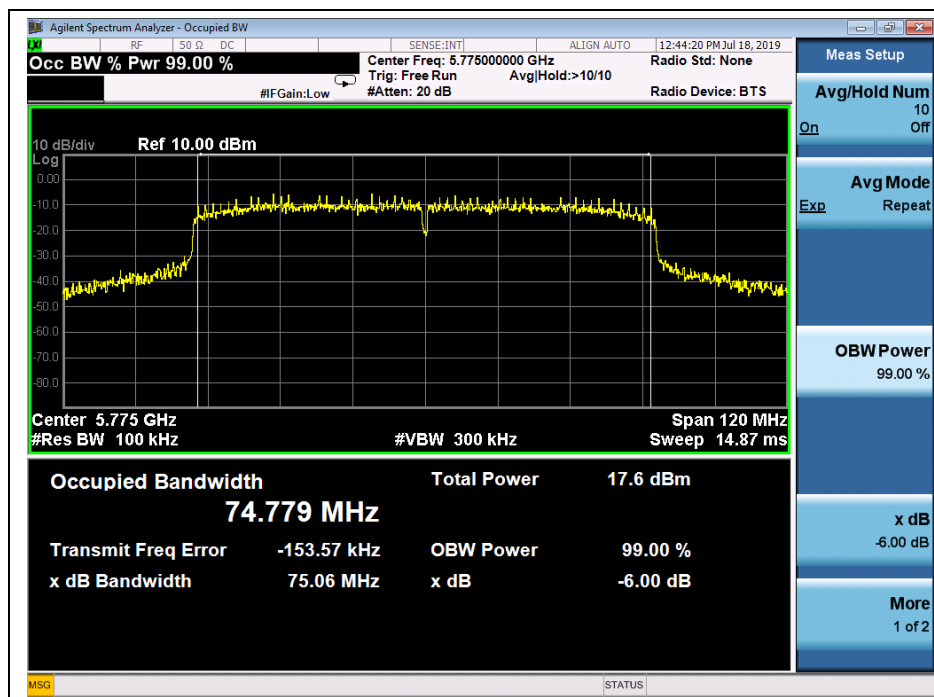
Note: The high frequency of the -26dB bandwidth is 5251.64MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ19060411W05).

B. Test Plots

(Channel 42, 5210MHz, 802.11 ac (VHT80))



(Channel 42, 5210 MHz, fh of -26dB, 802.11 ac (VHT80))



(Channel 155, 5775 MHz, 802.11 ac (VHT80))

2.5. Peak Power spectral density

2.5.1. 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 and 5.47-5.725 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.

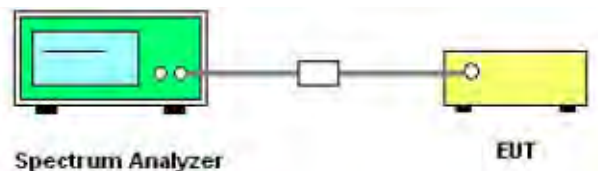
If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(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.

2.5.2. 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 = Peak
- 5) Trace mode=Max hold
- 6) Record the max value



2.5.3. Test Result

802.11a Test mode

A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
36	5180	9.71	11	PASS
44	5220	9.37		
48	5240	10.07		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
149	5745	7.12	30	PASS
157	5785	6.78		
165	5825	6.25		

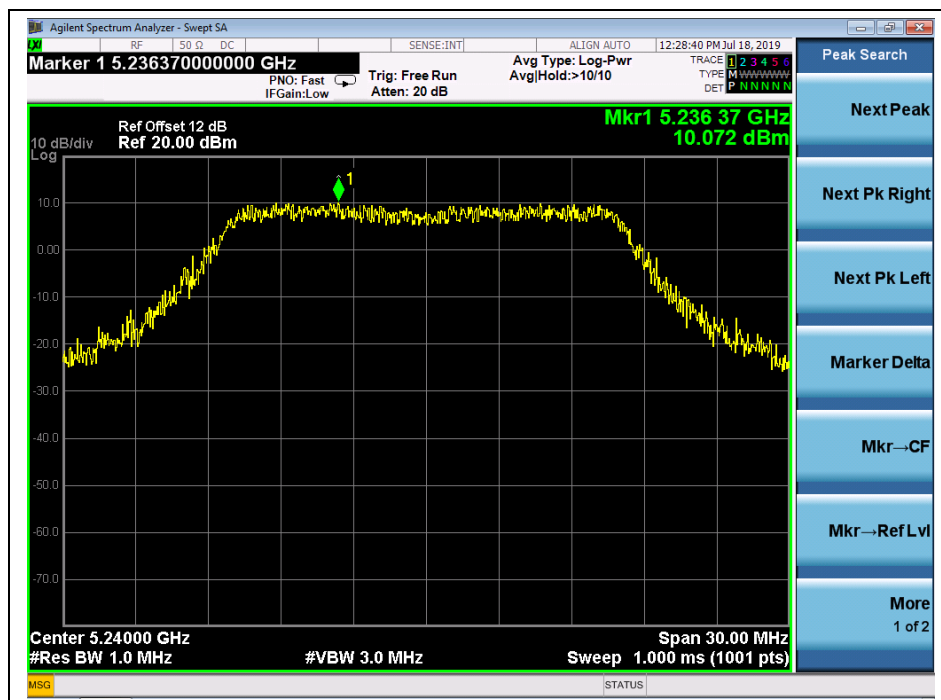
B. Test Plots



(Channel 36, 5180MHz, 802.11a,)



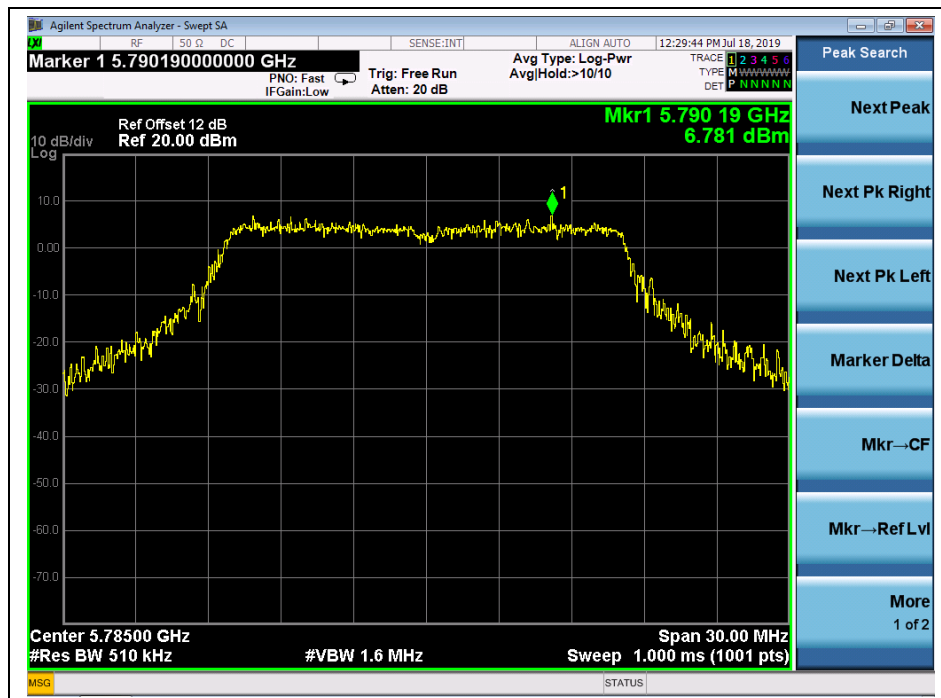
(Channel 44, 5220 MHz, 802.11a,)



(Channel 48, 5240MHz, 802.11a,)



(Channel 149, 5745MHz, 802.11a)



(Channel 157, 5785MHz, 802.11a)



(Channel 165, 5825MHz, 802.11a)



802.11n (HT20) Test mode

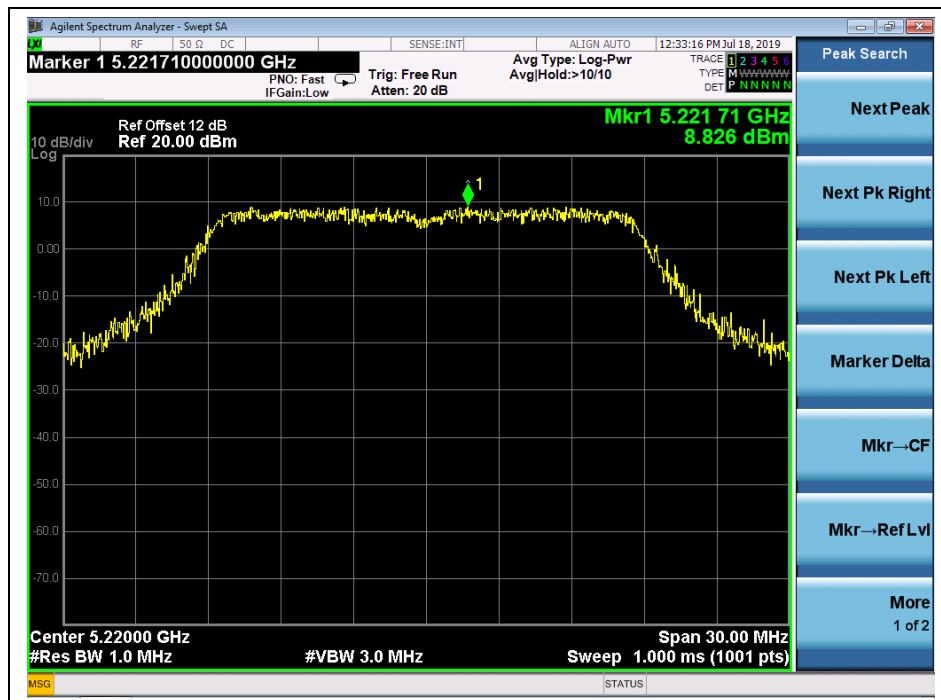
A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
36	5180	9.15	11	PASS
44	5220	8.83		
48	5240	9.50		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
149	5745	6.54	30	PASS
157	5785	6.62		
165	5825	5.96		

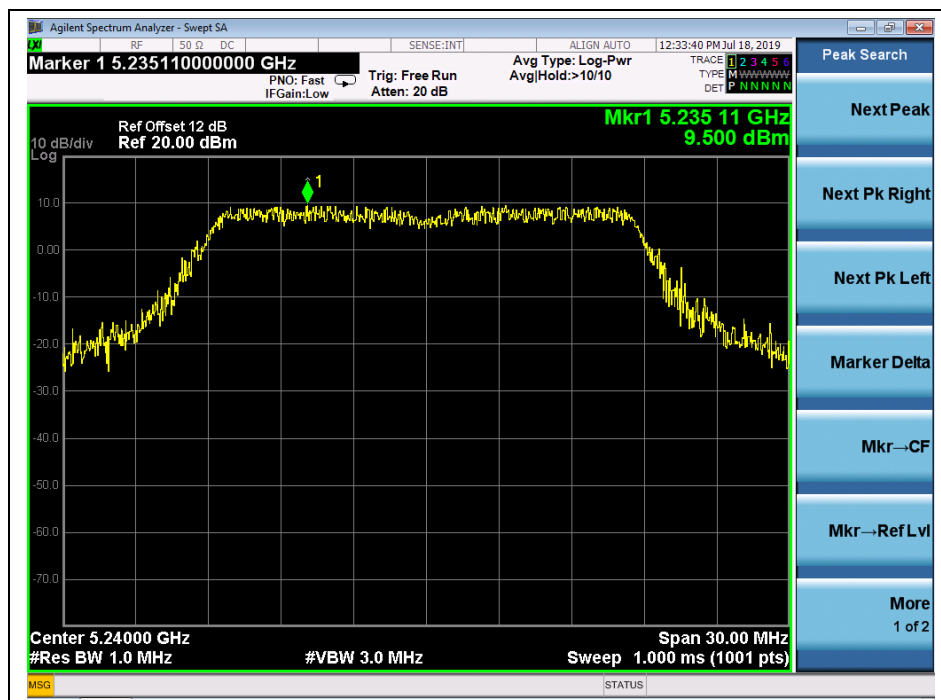
B. Test Plots



(Channel 36, 5180MHz, 802.11 n (HT20))



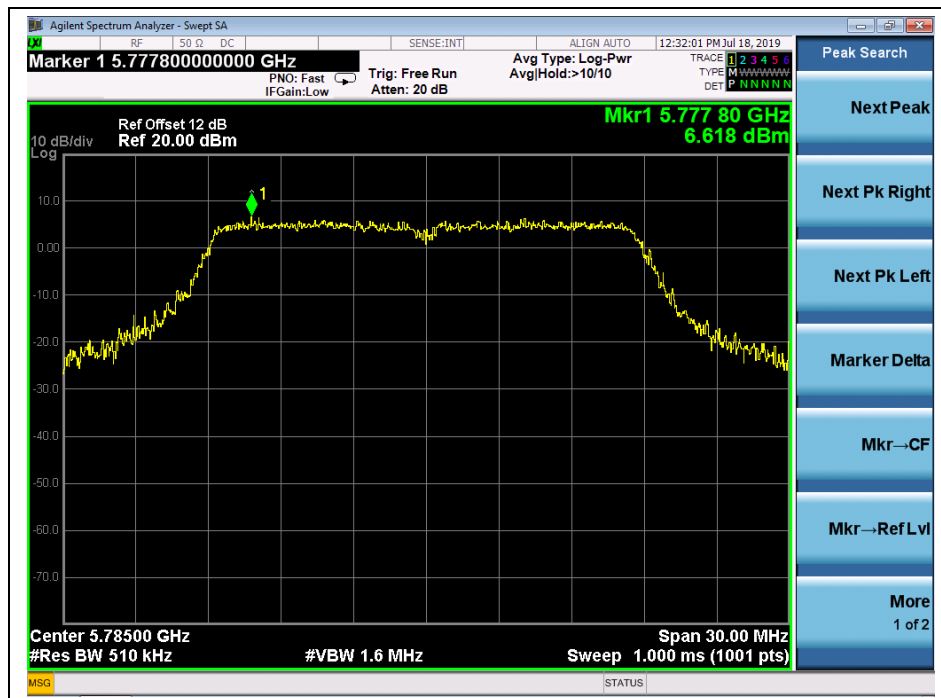
(Channel 44, 5220 MHz, 802.11 n (HT20))



(Channel 48, 5240MHz, 802.11 n (HT20))



(Channel 149, 5745MHz, 802.11 n (HT20))



(Channel 157, 5785MHz, 802.11 n (HT20))



(Channel 165, 5825MHz, 802.11 n (HT20))

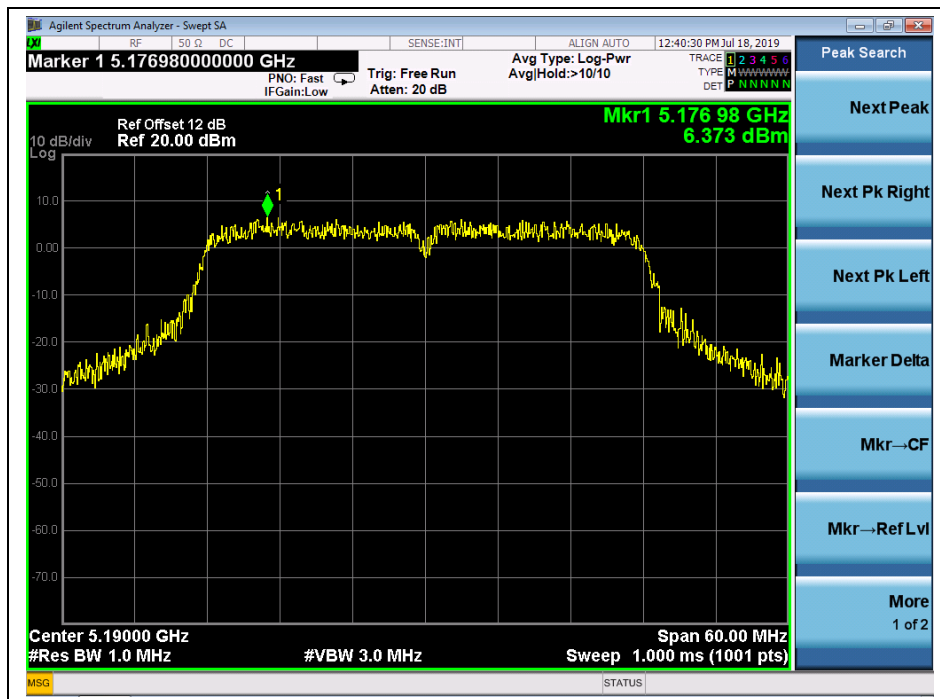


802.11n (HT40) Test mode

A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
38	5190	6.37	11	PASS
46	5230	7.16		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
151	5755	3.63	30	PASS
159	5795	3.08		

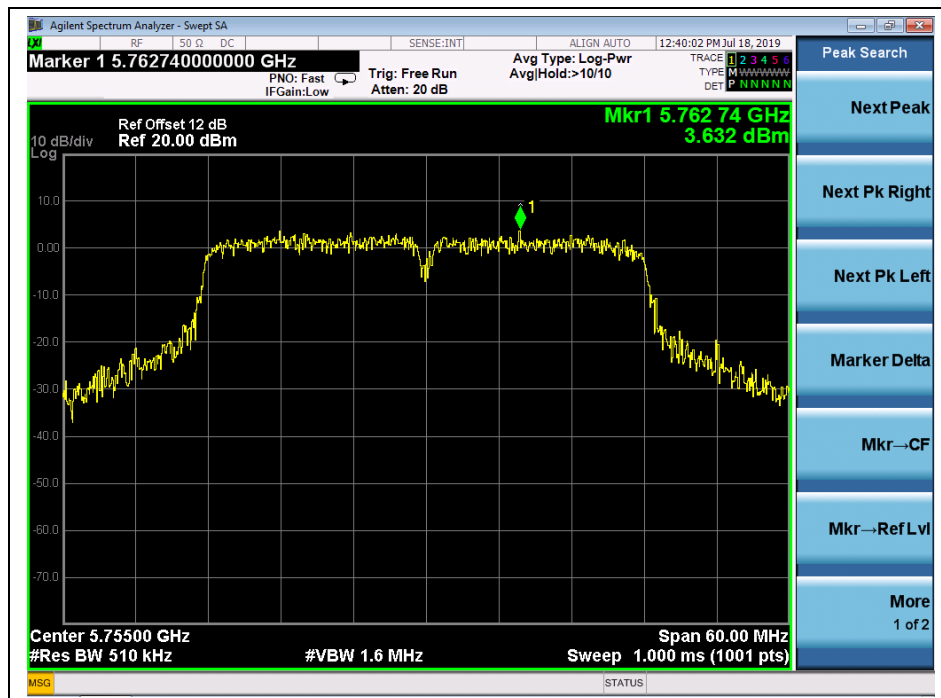
B. Test Plots



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



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



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



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

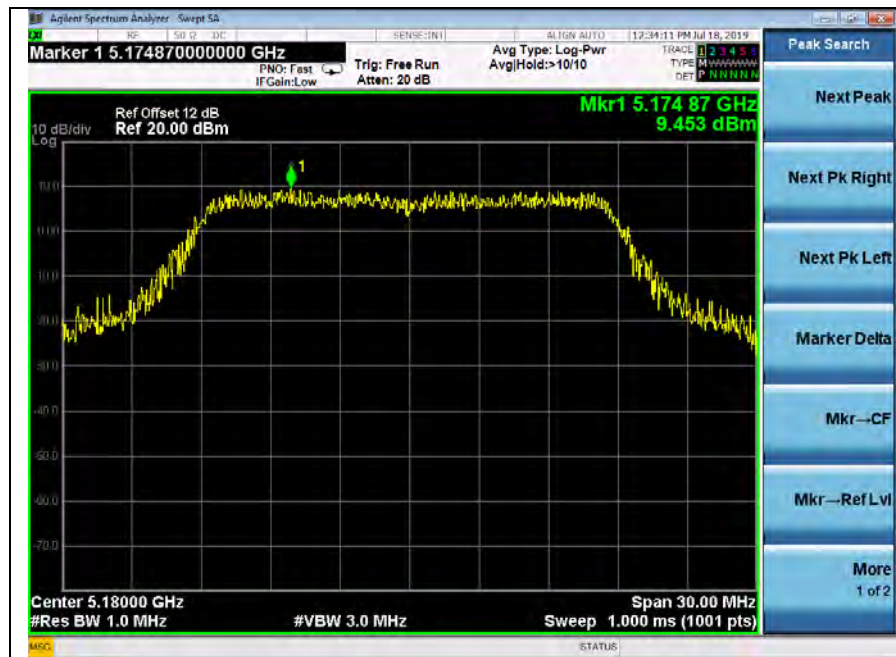


802.11ac (VHT20) Test mode

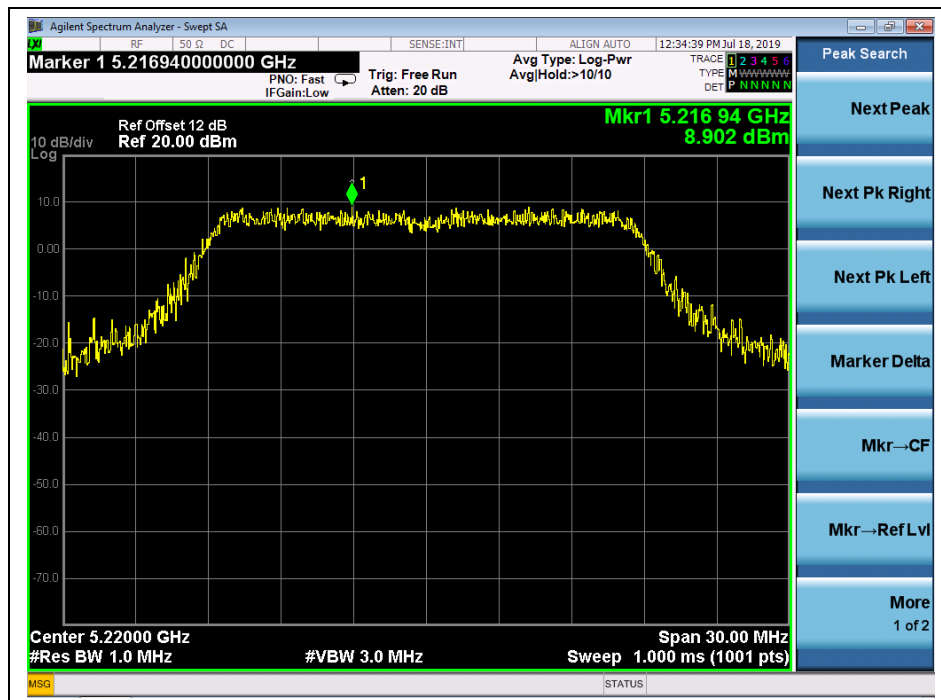
A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
36	5180	9.45	11	PASS
44	5220	8.90		
48	5240	9.62		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
149	5745	5.63	30	PASS
157	5785	6.85		
165	5825	5.90		

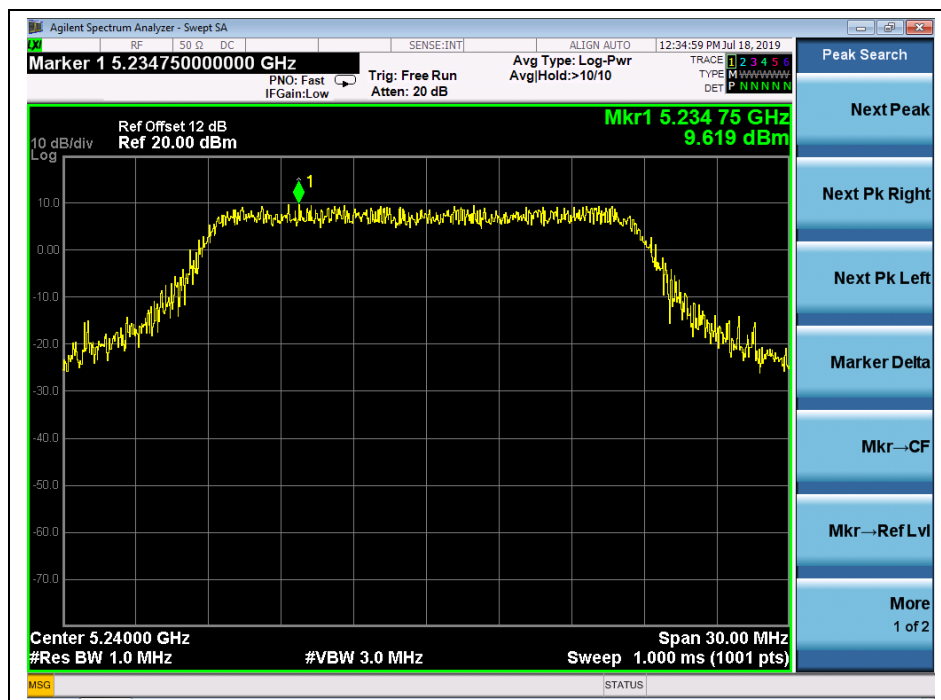
B. Test Plots



(Channel 36, 5180MHz, 802.11ac (VHT20))



(Channel 44, 5220 MHz, 802.11 ac (VHT20))



(Channel 48, 5240MHz, 802.11 ac (VHT20))



(Channel 149, 5745MHz, 802.11 ac (VHT20))



(Channel 157, 5785MHz, 802.11 ac (VHT20))



(Channel 165, 5825MHz, 802.11 ac (VHT20))



802.11ac (VHT40) Test mode

A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSD (dBm/MHz)	Limit (dBm/MHz)	Verdict
38	5190	8.70	11	PASS
46	5230	6.80		
Channel	Frequency (MHz)	Measured PPSD (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
151	5755	4.66	30	PASS
155	5795	3.54		

B. Test Plots



(Channel 38, 5190MHz, 802.11 ac (VHT40))



(Channel 46, 5230 MHz, 802.11 ac (VHT40))



(Channel 151, 5755MHz, 802.11 ac (VHT40))



(Channel 159, 5795MHz, 802.11 ac (VHT40))



802.11ac (VHT80) Test mode

A. Test Verdict:

Channel	Frequency (MHz)	Measured PPSP (dBm/MHz)	Limit (dBm/MHz)	Verdict
42	5210	4.29	11	PASS
Channel	Frequency (MHz)	Measured PPSP (dBm/500KHz)	Limit (dBm/500KHz)	Verdict
155	5775	1.17	30	PASS

B. Test Plots



(Channel 42, 5210MHz, 802.11ac (VHT80))



(Channel 155, 5775MHz, 802.11 ac (VHT80))



2.6. Frequency Stability

2.6.1. Requirement

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

2.6.2. Test Procedure

The EUT was placed inside of an environmental chamber as the temperature in the chamber was varied between 5°C to 40°C. The temperature was incremented by 10° intervals and the unit was allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded. Data for the worst case channel is shown below.

2.6.3. Test Result

U-NII-1 (Ch. 36) 5180MHz				
VOLTAGE (%)	POWER (VDC)	TEMP (°C)	Freq Dev. (Hz)	Deviation (ppm)
100%	7.26	+20(Ref)	45	0.009
100%		-30	20	0.004
100%		-20	39	0.008
100%		-10	49	0.009
100%		0	24	0.005
100%		+10	18	0.003
100%		+20	20	0.004
100%		+30	37	0.007
100%		+40	40	0.008
100%		+50	43	0.008
85%	6.17	+20	47	0.009
115%	8.35	+20	41	0.008



U-NII-3 (Ch. 149) 5745MHz				
VOLTAGE (%)	POWER (VDC)	TEMP (°C)	Freq Dev. (Hz)	Deviation (ppm)
100%	7.26	+20(Ref)	22	0.004
100%		-30	31	0.005
100%		-20	24	0.004
100%		-10	19	0.003
100%		0	33	0.006
100%		+10	42	0.007
100%		+20	22	0.004
100%		+30	50	0.009
100%		+40	51	0.009
100%		+50	26	0.005
85%	6.17	+20	42	0.007
115%	8.35	+20	36	0.006

2.7. Conducted Emission

2.7.1. Requirement

According to FCC section 15.207, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

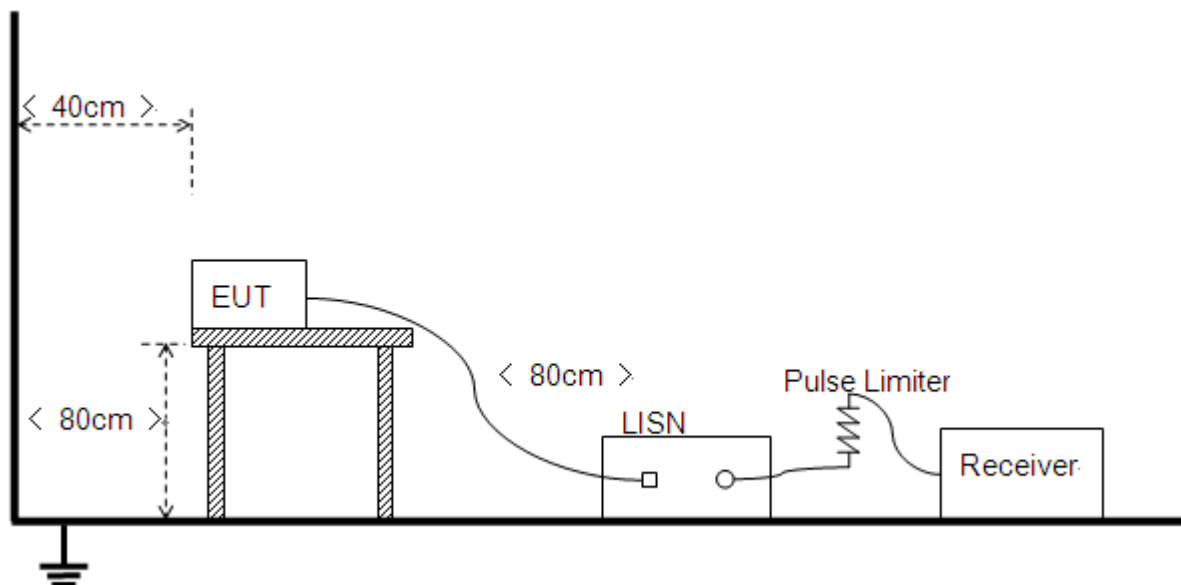
Frequency range (MHz)	Conducted Limit (dB μ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

NOTE:

- The lower limit shall apply at the band edges.
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50MHz.

2.7.2. Test Description

A. Test Setup:



The Table-top EUT was placed upon a non-metallic table 0.8m above the horizontal metal reference ground plane. EUT was connected to LISN and LISN was connected to reference Ground Plane. EUT was 80cm from LISN. The set-up and test methods were according to ANSI C63.10: 2013.



2.7.3. Test Result

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

Note: Both of the test voltage AC 120V/60Hz and AC 230V/50Hz were considered and tested respectively, only the results of the worst case AC 120V/60Hz were recorded in this report.

A. Test setup:

Test Mode: EUT+ ADAPTOR + WIFI TX

Test Voltage: AC 120V/60Hz

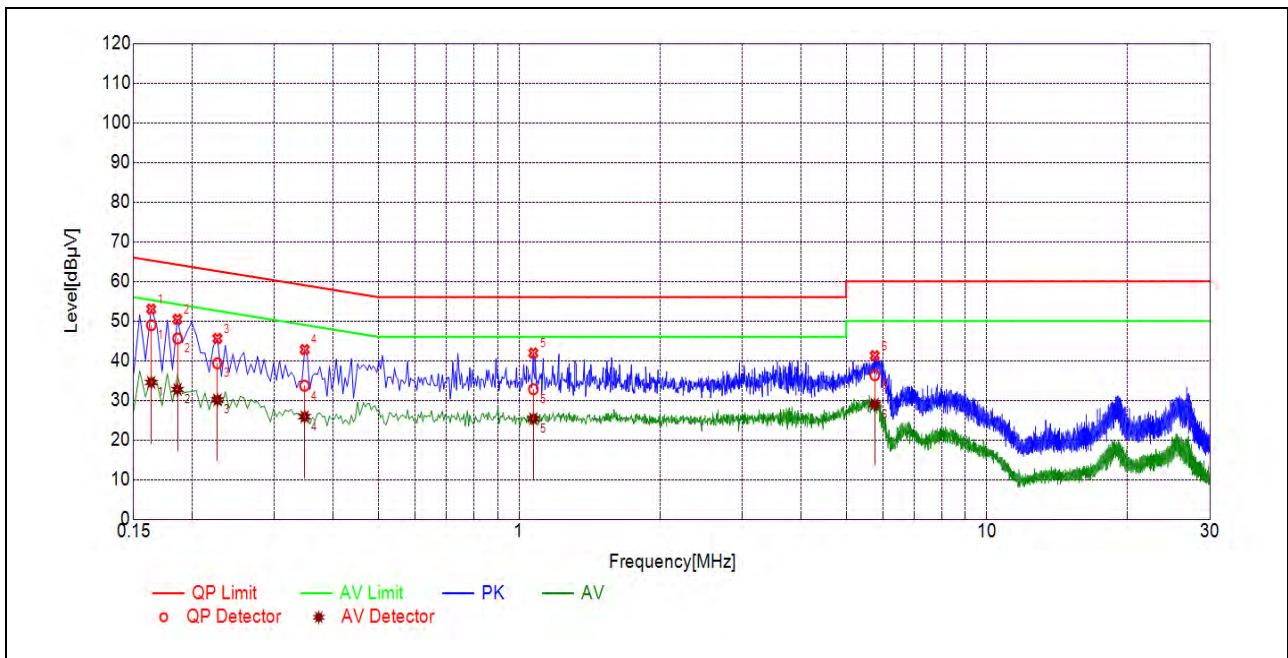
The measurement results are obtained as below:

$$E \text{ [dB}\mu\text{V]} = U_R + L_{\text{Cable loss}} \text{ [dB]} + A_{\text{Factor}}$$

U_R : Receiver Reading

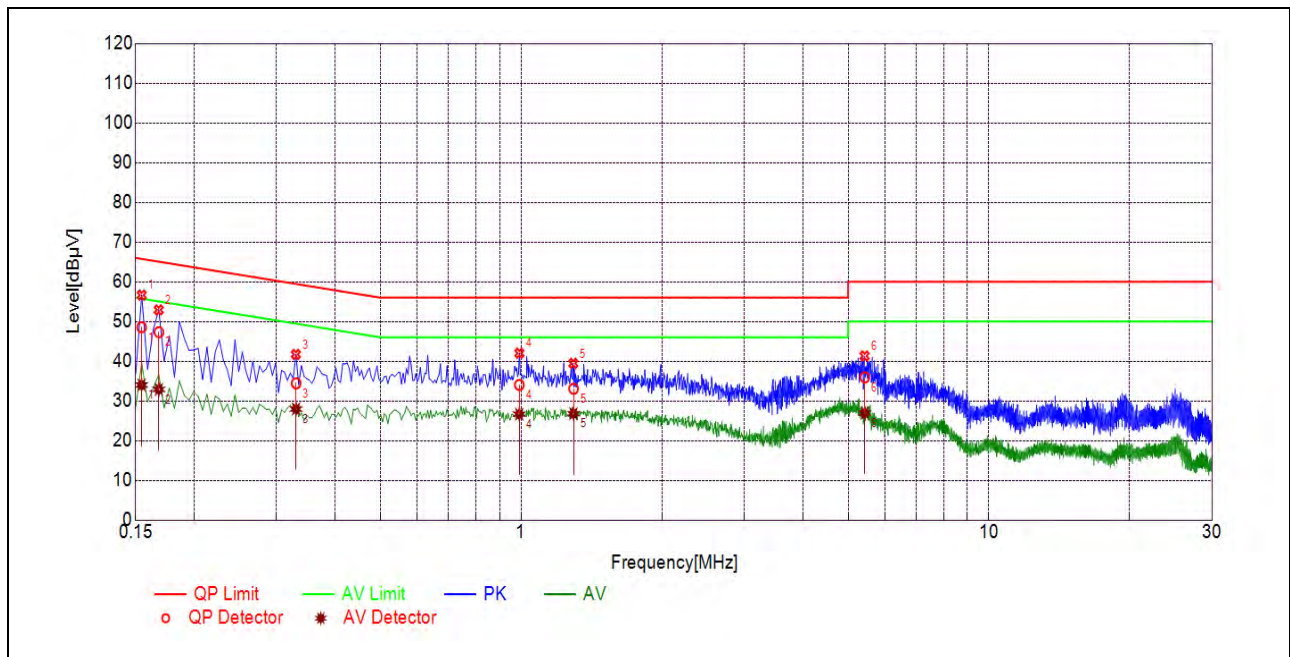
A_{Factor} : Voltage division factor of LISN

B. Test Plots:



(L Phase)

NO.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1635	48.95	34.53	65.29	55.29	Line	PASS
2	0.1861	45.60	32.74	64.21	54.21		PASS
3	0.2265	39.33	30.10	62.58	52.58		PASS
4	0.3478	33.67	25.87	59.02	49.02		PASS
5	1.0726	32.80	25.34	56.00	46.00		PASS
6	5.7574	36.35	29.01	60.00	50.00		PASS



(N Phase)

NO.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1544	48.55	34.01	65.76	55.76	Neutral	PASS
2	0.1681	47.30	32.90	65.05	55.05		PASS
3	0.3303	34.42	27.98	59.44	49.44		PASS
4	0.9909	34.03	26.68	56.00	46.00		PASS
5	1.2943	33.06	26.80	56.00	46.00		PASS
6	5.4276	35.92	26.94	60.00	50.00		PASS