



REPORT No.: SZ18110110W04

# TEST REPORT

**APPLICANT** : Anker Innovations Limited

**PRODUCT NAME** : Nebula Prizm II Pro

**MODEL NAME** : D2241

**BRAND NAME** : Nebula

**FCC ID** : 2AOKB-D2241

**STANDARD(S)** : 47 CFR Part 15 Subpart E

**RECEIPT DATE** : 2018-11-08

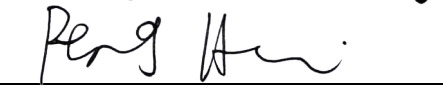
**TEST DATE** : 2018-12-11 to 2018-12-26

**ISSUE DATE** : 2018-12-26

Edited by:

  
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| Change History |            |                   |
|----------------|------------|-------------------|
| Version        | Date       | Reason for change |
| 1.0            | 2018-12-26 | First edition     |
|                |            |                   |



# 1. Technical Information

**Note:** Provide by applicant.

## 1.1. Applicant and Manufacturer Information

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

## 1.2. Equipment Under Test (EUT) Description

|                                   |                                                                                             |                               |
|-----------------------------------|---------------------------------------------------------------------------------------------|-------------------------------|
| <b>Product Name:</b>              | Nebula Prizm II Pro                                                                         |                               |
| <b>Serial No:</b>                 | (N/A, marked #1 by test site)                                                               |                               |
| <b>Hardware Version:</b>          | A231C                                                                                       |                               |
| <b>Software Version:</b>          | 1.23                                                                                        |                               |
| <b>Modulation Type:</b>           | OFDM                                                                                        |                               |
| <b>Modulation Mode:</b>           | 802.11a, 802.11n(HT20), 802.11n(HT40)<br>802.11ac(VHT20), 802.11ac(VHT40), 802.11ac(VHT80), |                               |
| <b>Operating Frequency Range:</b> | 5.180 GHz- 5.240 GHz; 5.745GHz- 5.825GHz                                                    |                               |
| <b>Channel Number:</b>            | Refer to 1.3                                                                                |                               |
| <b>Antenna Type:</b>              | FPC Antenna                                                                                 |                               |
| <b>Antenna Gain:</b>              | 3.04 dBi                                                                                    |                               |
| <b>Accessory Information:</b>     | AC Adapter                                                                                  |                               |
|                                   | Brand Name:                                                                                 | N/A                           |
|                                   | Model No.:                                                                                  | NSA120EC-19063200             |
|                                   | Serial No.:                                                                                 | (N/A, marked #1 by test site) |
|                                   | Rated Input:                                                                                | 100-240V ~ 50/60Hz 2A         |
|                                   | Rated Output:                                                                               | 19V=6.32A                     |

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

**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 | 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  | Dec 11, 2018 | Wang Meng     | PASS   |
| 3   | 15.407(a) (e) | Emission Bandwidth             | Dec 11, 2018 | Wang Meng     | PASS   |
| 4   | 15.407(a)     | Maximum conducted output Power | Dec 11, 2018 | Wang Meng     | PASS   |
| 5   | 15.407(a)     | Peak Power spectral density    | Dec 11, 2018 | Wang Meng     | PASS   |
| 6   | 15.407(g)     | Frequency Stability            | Dec 11, 2018 | Wang Meng     | PASS   |
| 7   | 15.207        | Conducted Emission             | Dec 24, 2018 | Ya Xinhou     | PASS   |
| 8   | 15.407(b)     | Restricted Frequency Bands     | Dec 25, 2018 | Ya Xinhou     | PASS   |
| 3   | 15.407(b)     | Radiated Emission              | Dec 26, 2018 | Ya Xinhou     | PASS   |

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

**Note2:** These RF tests were performed according to the method of measurements prescribed in KDB789033 D02 General UNII Test Procedures New Rules v01r03.

**Note3:** The path loss during the RF test is calibrated to correct the results by the offset setting in the test equipments. The ref offset 11dB contains two parts that cable loss 1.0dB 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 15C 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

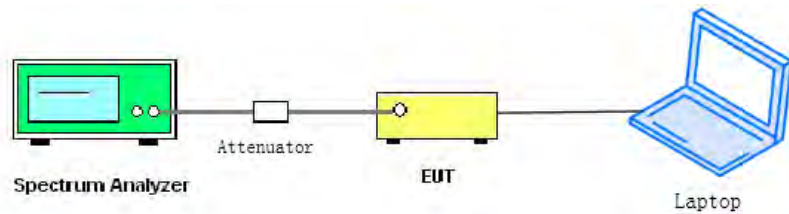
#### 2.2.1. Requirement

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.



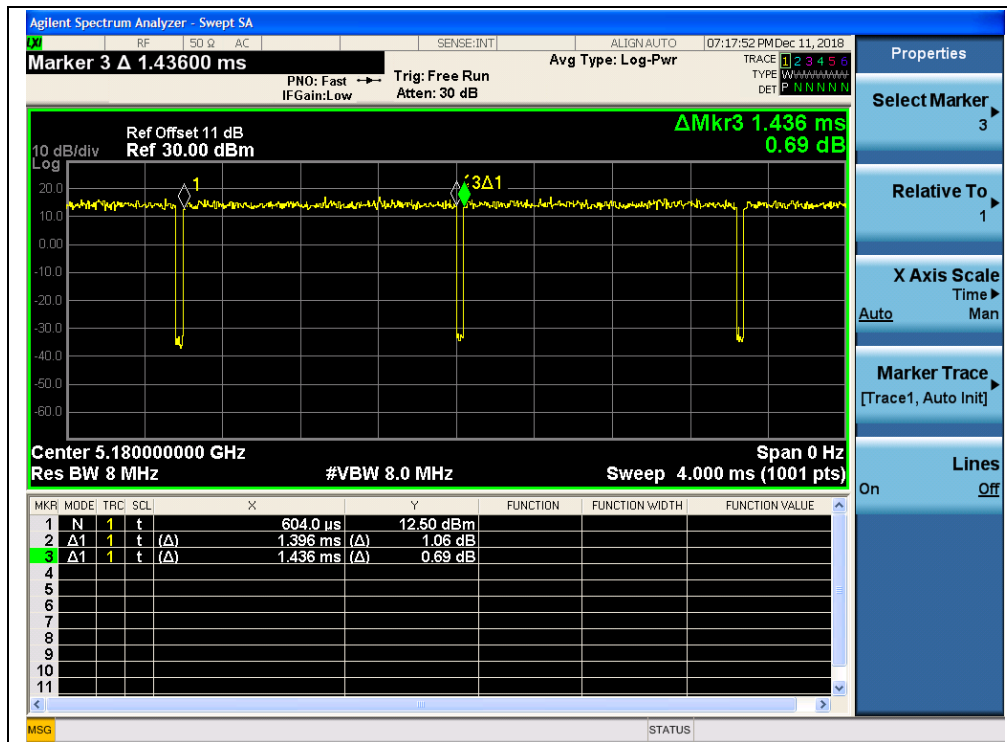


### 2.2.3. Test Result

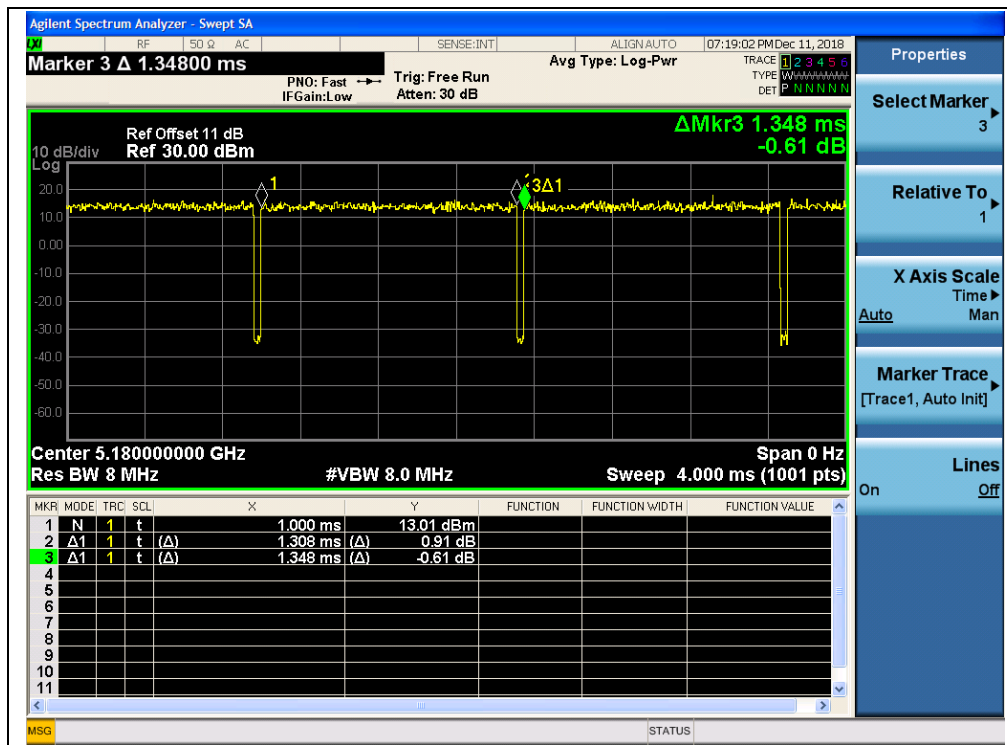
#### A. Test Verdict:

| Test Mode       | Duty Cycle (%)<br>(D) | Duty Factor<br>(10*log[1/D]) |
|-----------------|-----------------------|------------------------------|
| 802.11a         | 97.21                 | 0.12                         |
| 802.11n(HT20)   | 97.03                 | 0.13                         |
| 802.11n(HT40)   | 97.05                 | 0.13                         |
| 802.11ac(VHT20) | 93.62                 | 0.29                         |
| 802.11ac(VHT40) | 93.97                 | 0.27                         |
| 802.11ac(VHT80) | 88.22                 | 0.54                         |

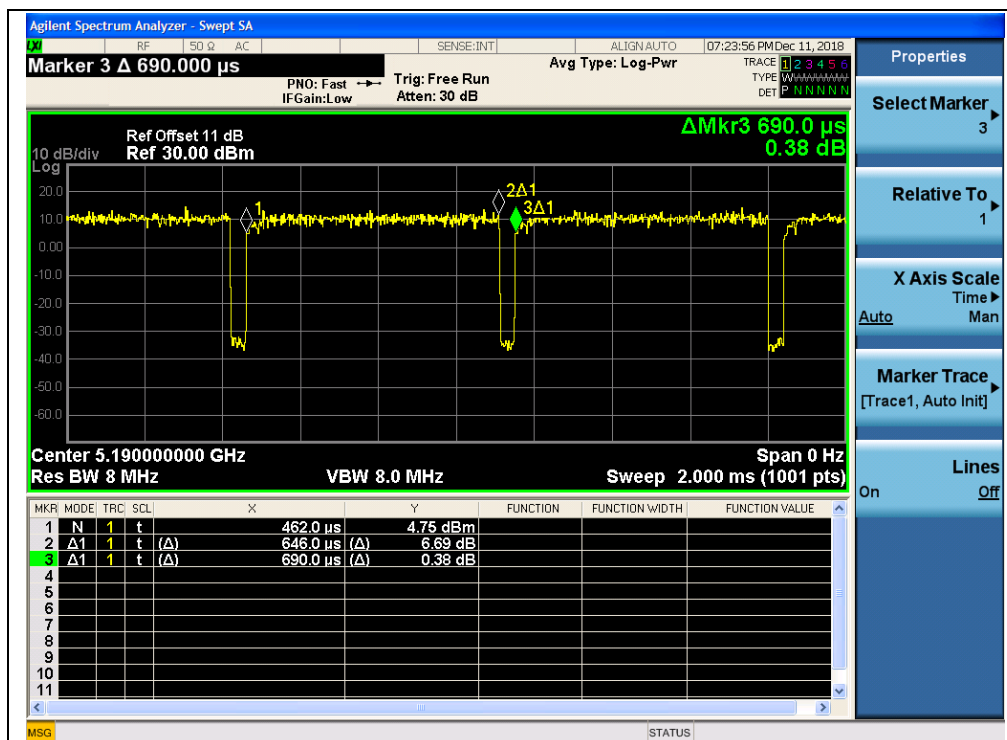
#### B. Test Plots



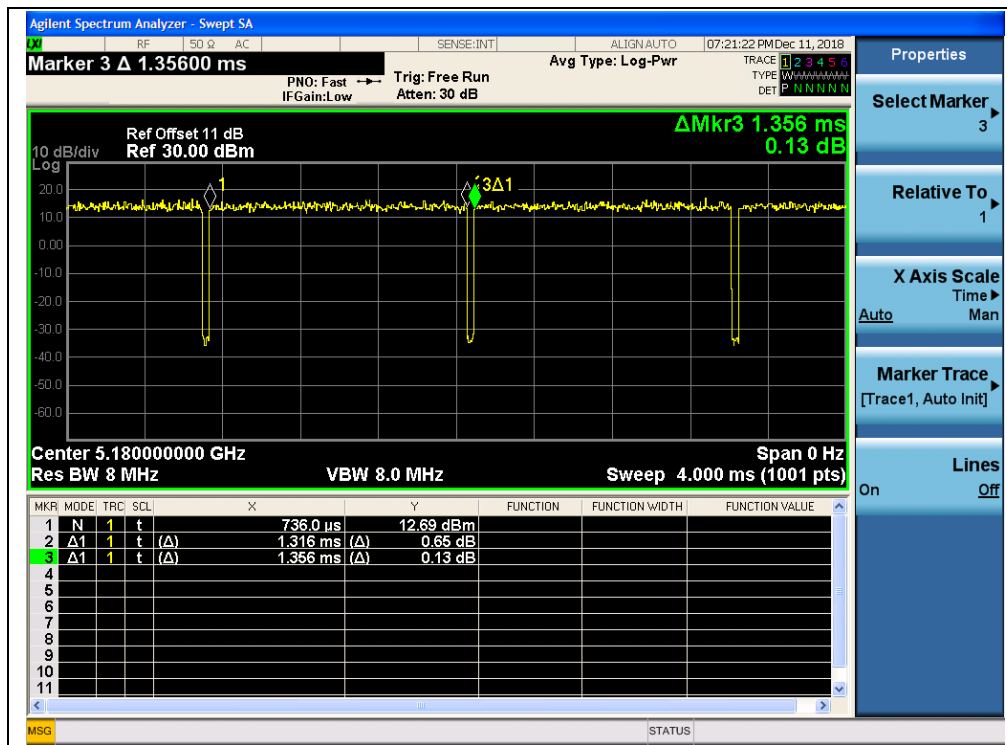
(CH36\_5180MHz\_802.11a)



(CH36\_5180MHz \_802.11n(HT20))



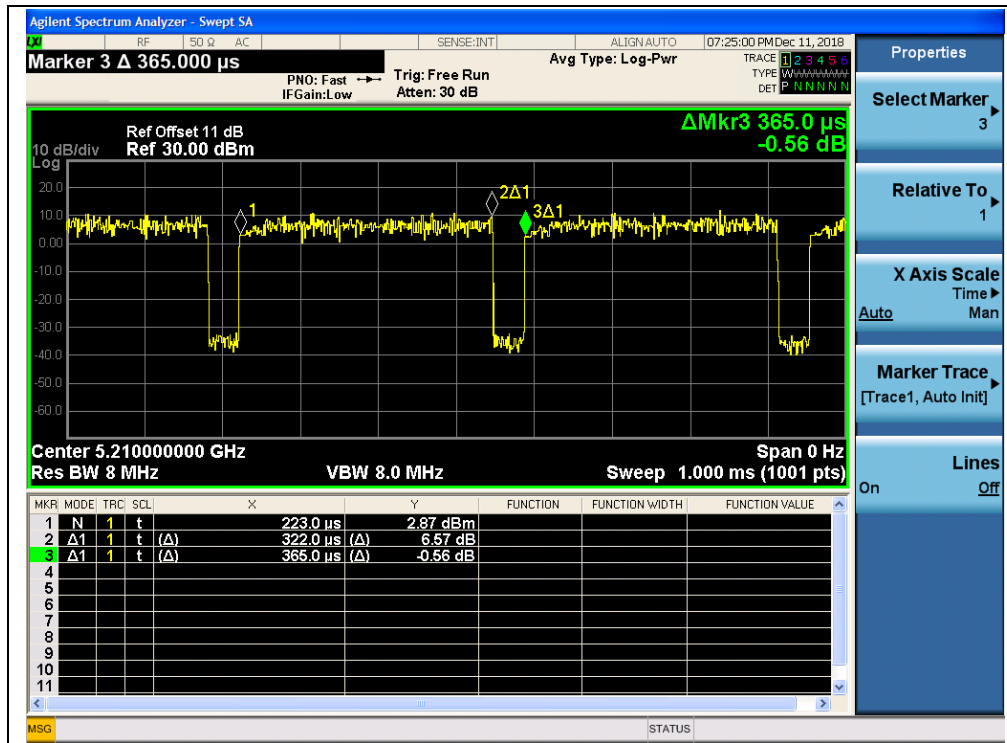
(CH38\_5190MHz \_802.11n(HT40))



(CH36\_5180MHz\_802.11ac(VHT20))



(CH38\_5190MHz\_802.11 ac(VHT40))



(CH42\_5210MHz\_802.11 ac(VHT80))

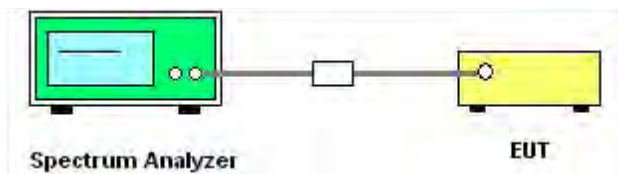
## 2.3. Emission Bandwidth

### 2.3.1. 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.

### 2.3.2. 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

- 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 5.725-5.85 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:

- a) Set RBW = 100 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.

### 2.3.3. Test Result

#### 802.11a Test mode

##### A. Test Verdict:

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|-----------------|-----------------------|
| 36      | 5180            | 30.42                 |
| 44      | 5220            | 31.95                 |
| 48      | 5240            | 31.58 <sub>Note</sub> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)   |
| 149     | 5745            | 16.36                 |
| 157     | 5785            | 16.34                 |
| 165     | 5825            | 16.36                 |

**Note:** The high frequency of the -26dB is 5251.15MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ18110110W05).

##### B. Test Plots



(Channel 36, 5180MHz, 802.11a,)

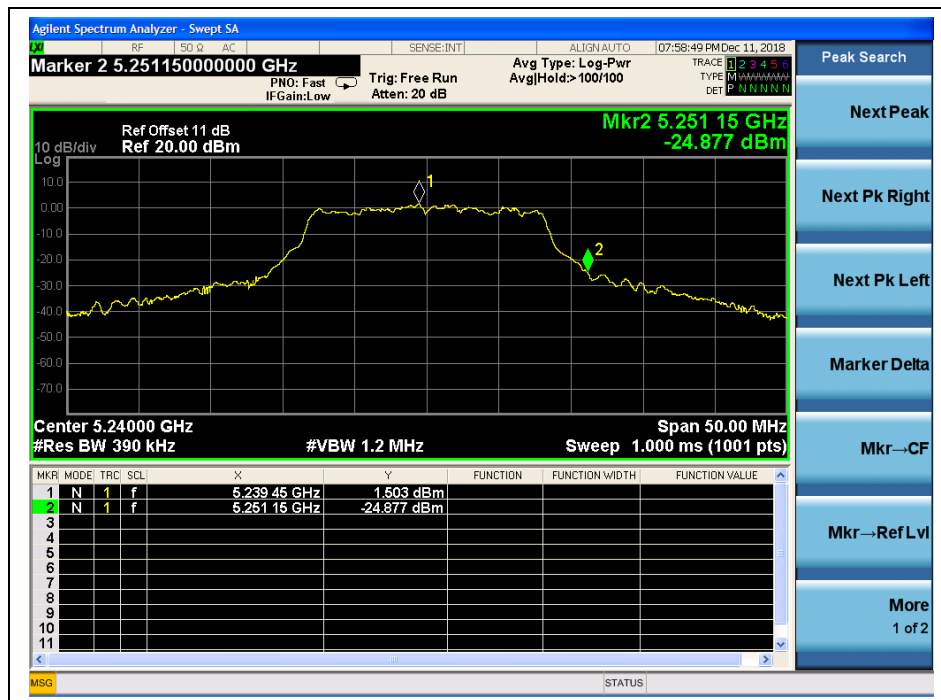




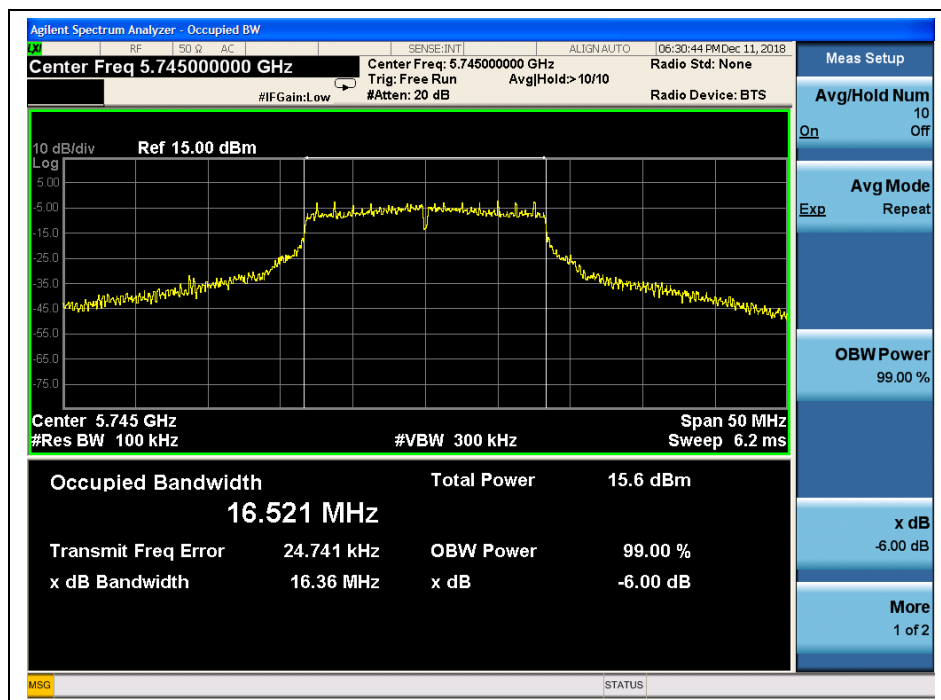
(Channel 44, 5220 MHz, 802.11a,)



(Channel 48, 5240MHz, 802.11a,)



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

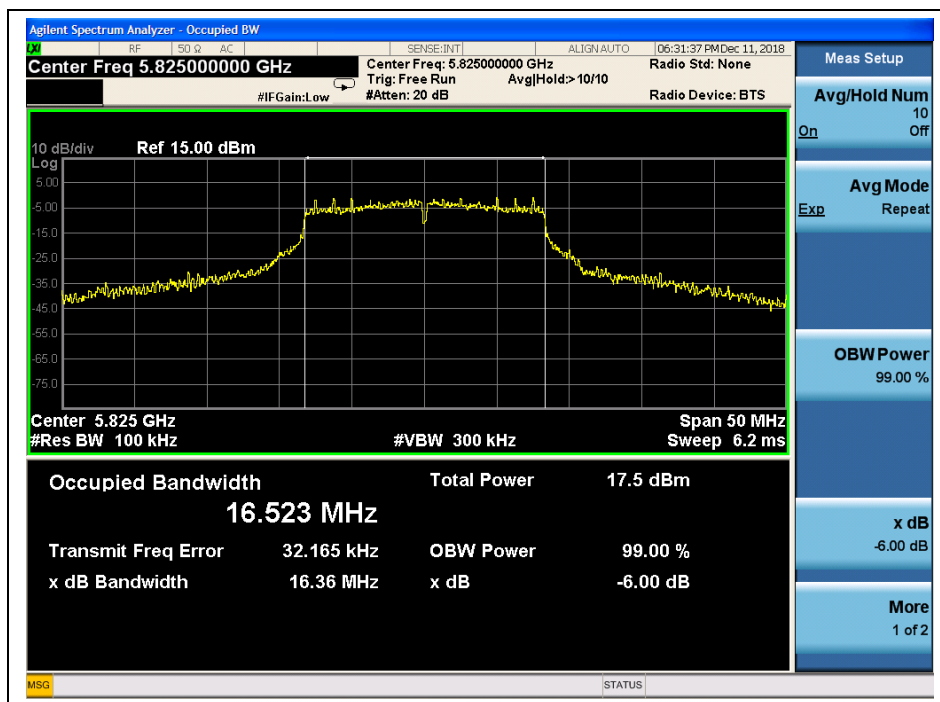


(Channel 149, 5745MHz, 802.11a)





(Channel 157, 5785MHz, 802.11a)

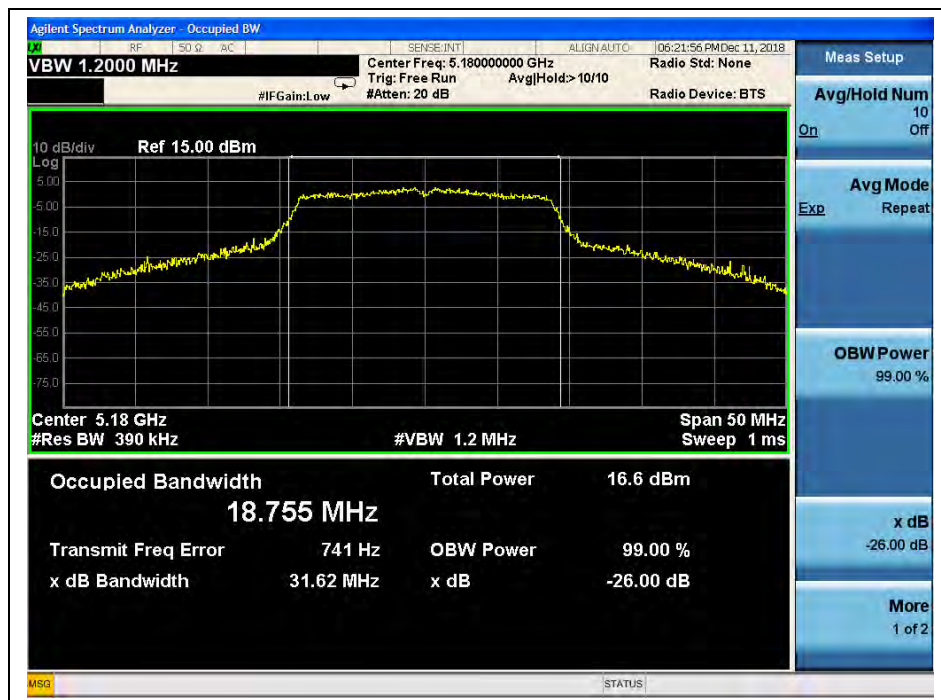


(Channel 165, 5825MHz, 802.11a)

**802.11n (HT20) Test mode****A. Test Verdict:**

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz)     |
|---------|-----------------|---------------------------|
| 36      | 5180            | 31.62                     |
| 44      | 5220            | 32.22                     |
| 48      | 5240            | 30.13 <small>Note</small> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)       |
| 149     | 5745            | 17.58                     |
| 157     | 5785            | 17.53                     |
| 165     | 5825            | 17.57                     |

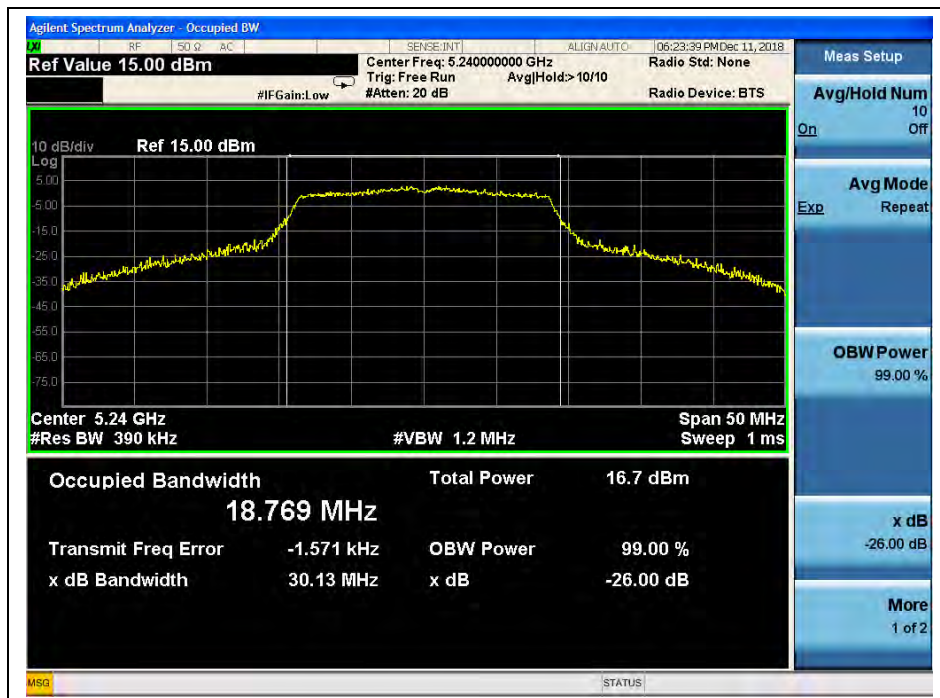
**Note:** The high frequency of the -26dB is 5250.90MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ18110110W05).

**B. Test Plots**

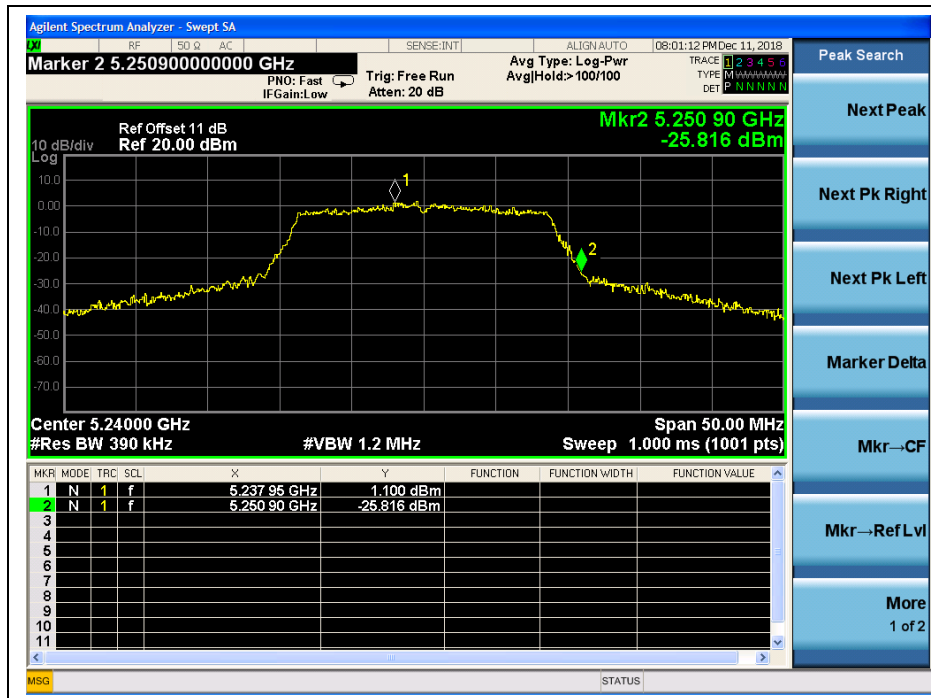
(Channel 36, 5180MHz, 802.11 n (HT20))



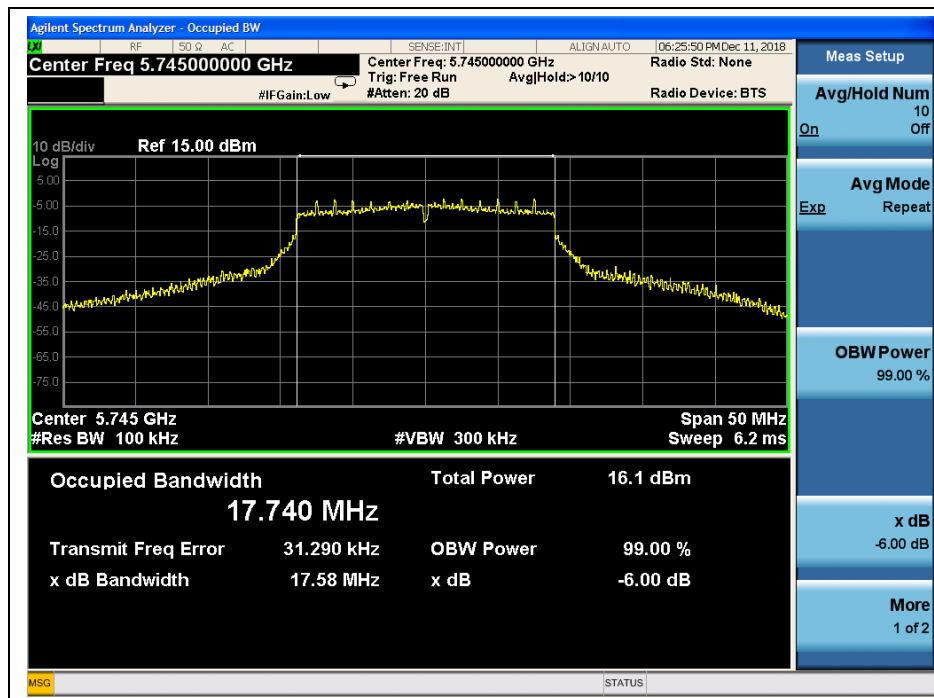
(Channel 44, 5220 MHz, 802.11 n (HT20))



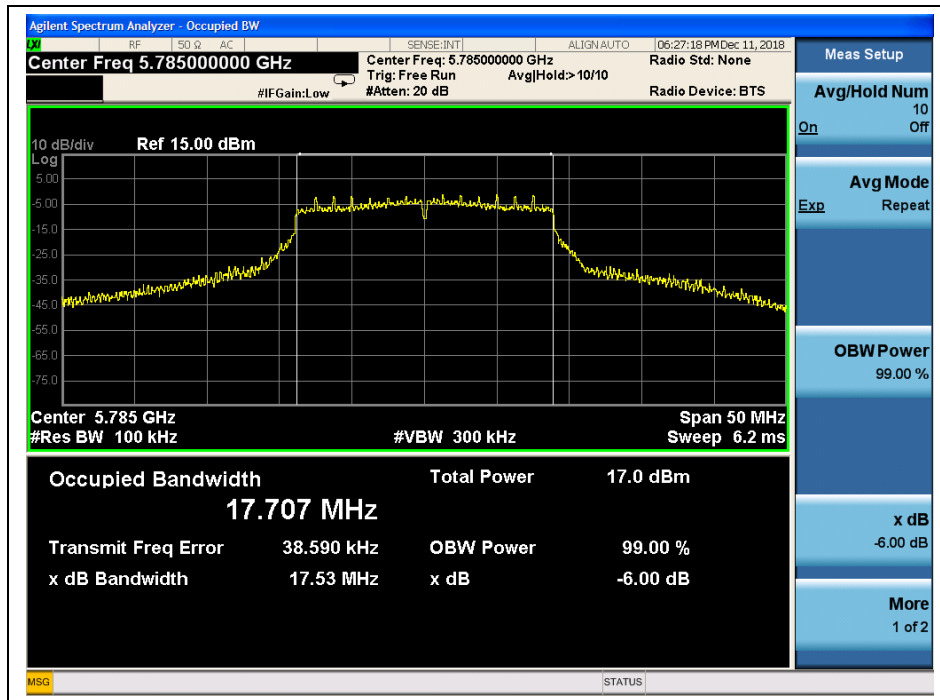
(Channel 48, 5240MHz, 802.11 n (HT20))



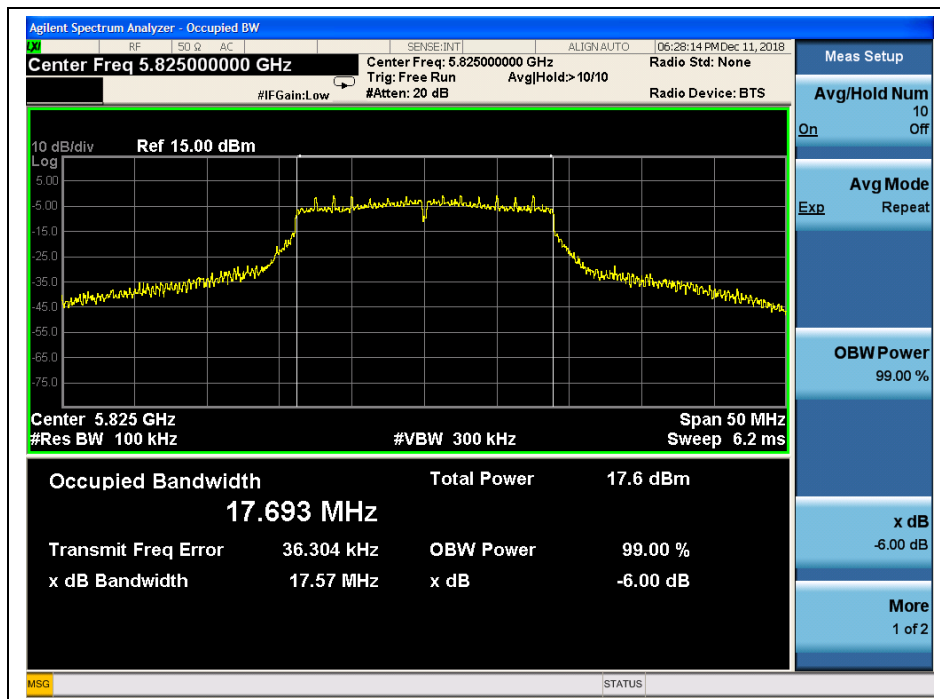
(Channel 48, 5240MHz, fh of -26dB, 802.11 n (HT20))



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



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



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



**802.11n (HT40) Test mode****A. Test Verdict:**

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz)     |
|---------|-----------------|---------------------------|
| 38      | 5190            | 64.45                     |
| 46      | 5230            | 66.07 <small>Note</small> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)       |
| 151     | 5755            | 36.11                     |
| 159     | 5795            | 36.05                     |

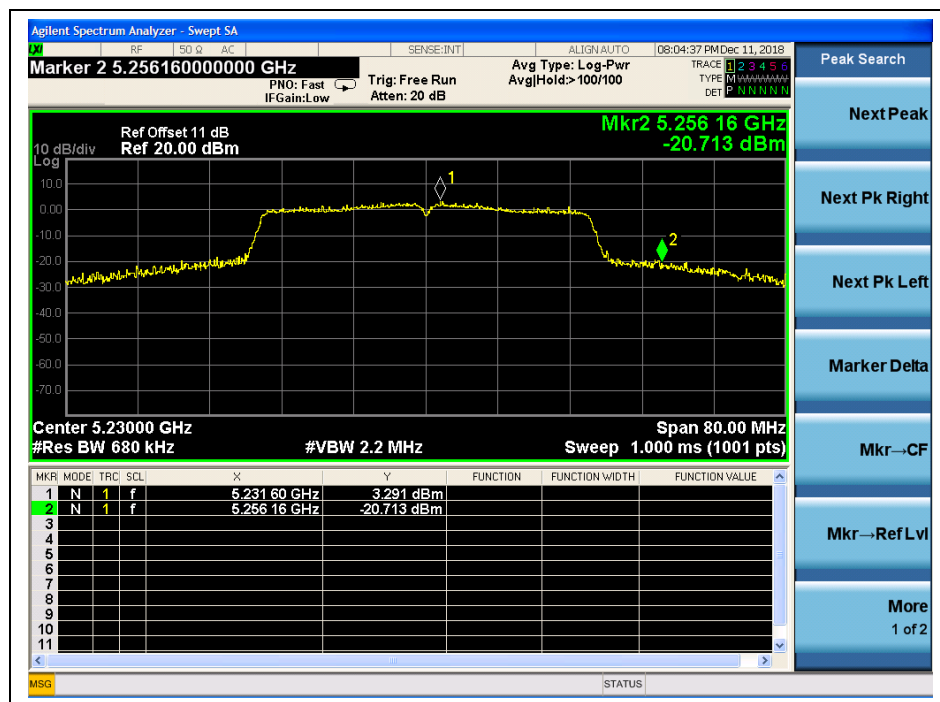
**Note:** The high frequency of the -26dB is 5256.16MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ18110110W05).

**B. Test Plots**

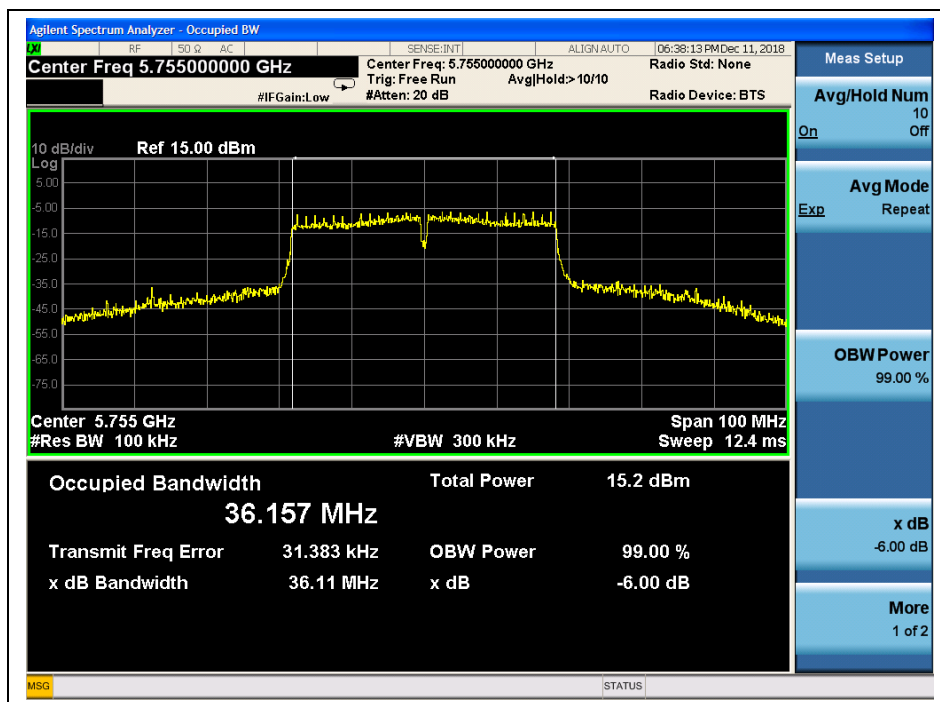
(Channel 38, 5190MHz, 802.11n (HT40))



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



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



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



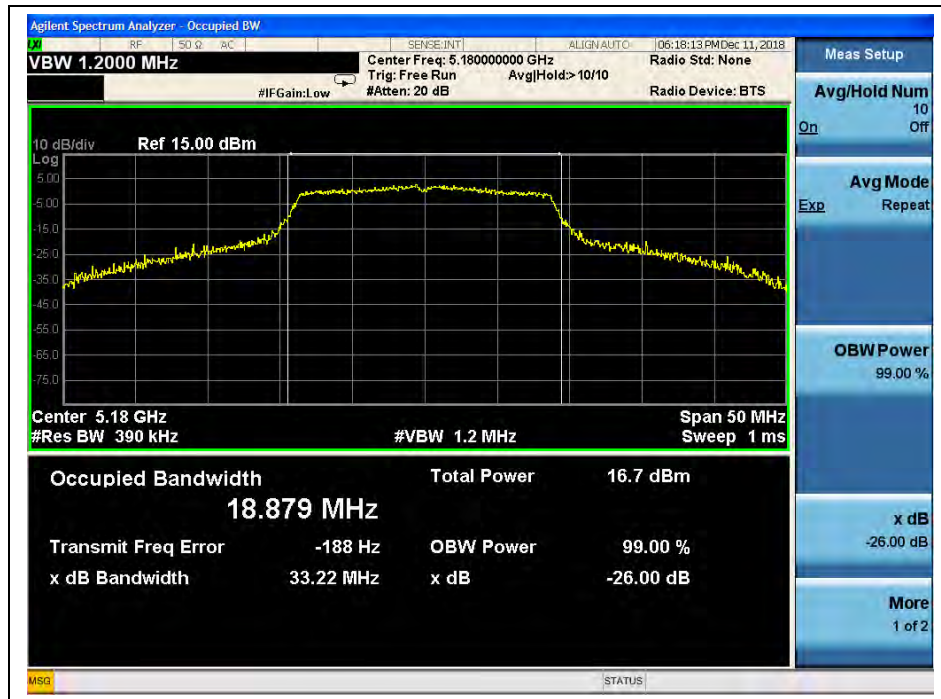
(Channel 159, 5795MHz, 802.11n (HT40))



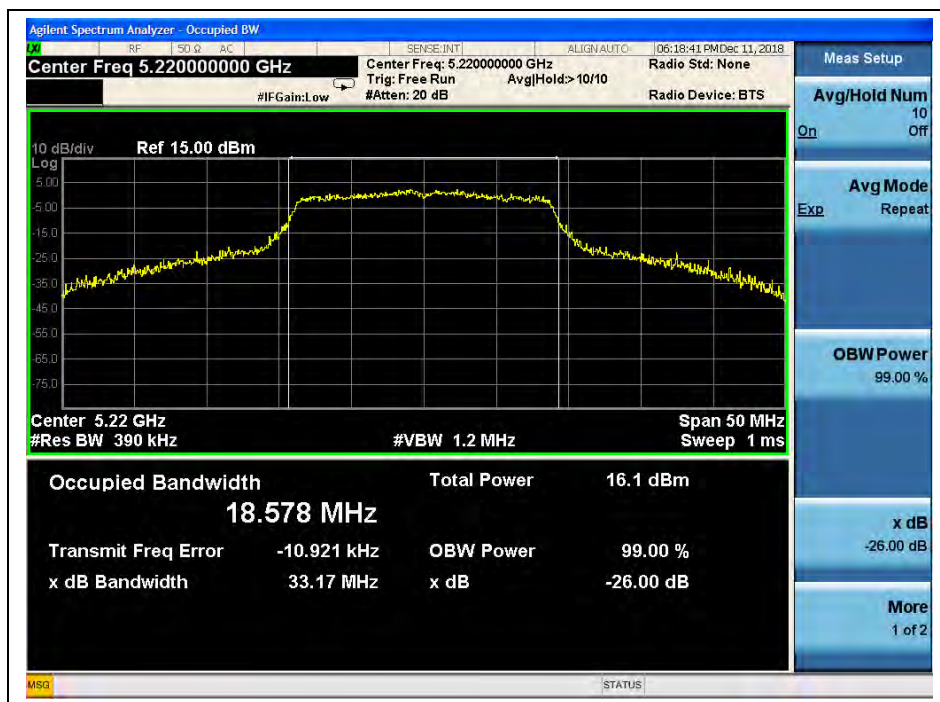
**802.11ac (VHT20) Test mode****A. Test Verdict:**

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz)     |
|---------|-----------------|---------------------------|
| 36      | 5180            | 33.22                     |
| 44      | 5220            | 33.17                     |
| 48      | 5240            | 30.80 <small>Note</small> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)       |
| 149     | 5745            | 17.59                     |
| 157     | 5785            | 17.58                     |
| 165     | 5825            | 17.58                     |

**Note:** The high frequency of the -26dB is 5250.65MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ18110110W05).

**B. Test Plots**

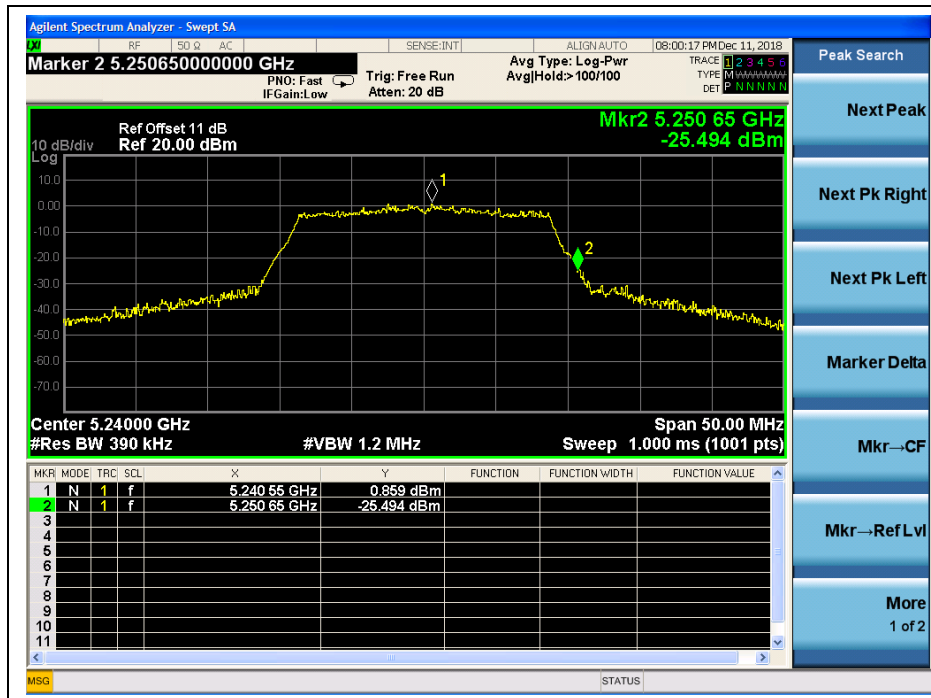
(Channel 36, 5180MHz, 802.11 ac (VHT20))



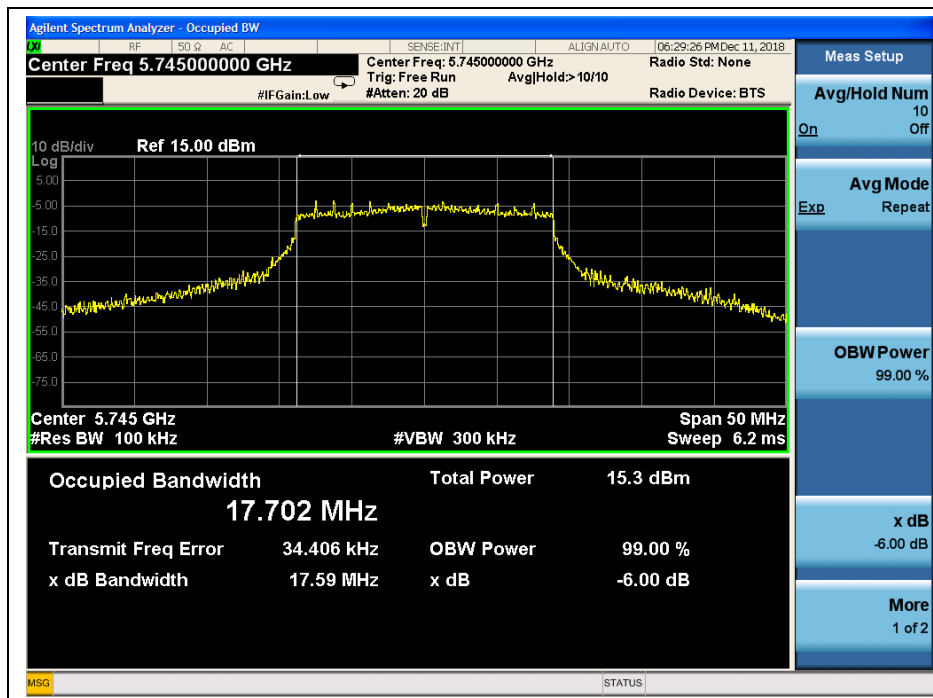
(Channel 44, 5220 MHz, 802.11 ac (VHT20))



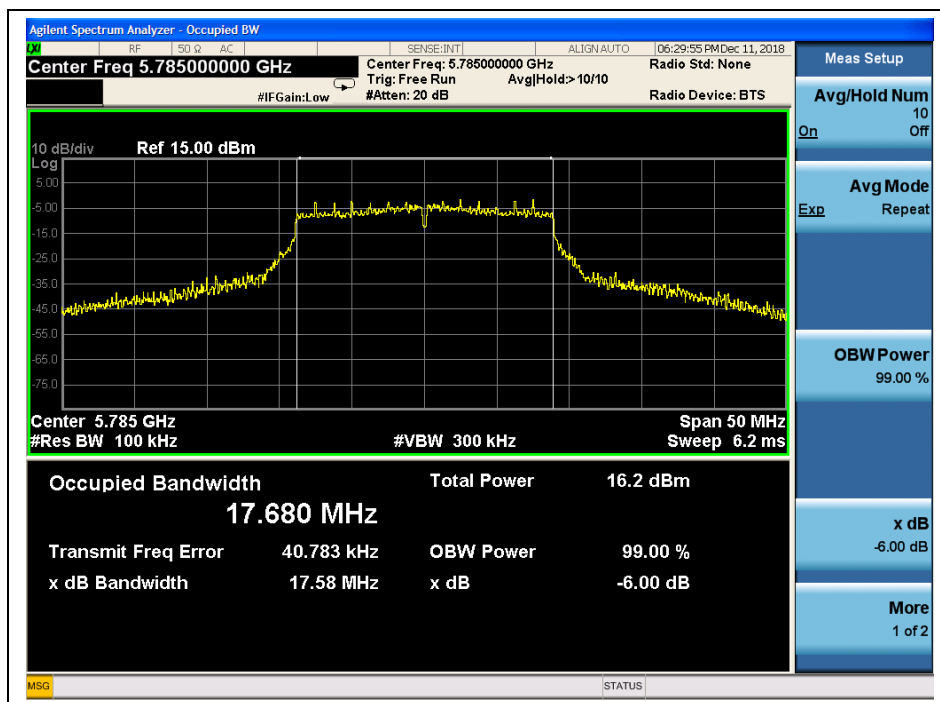
(Channel 48, 5240MHz, 802.11 ac (VHT20))



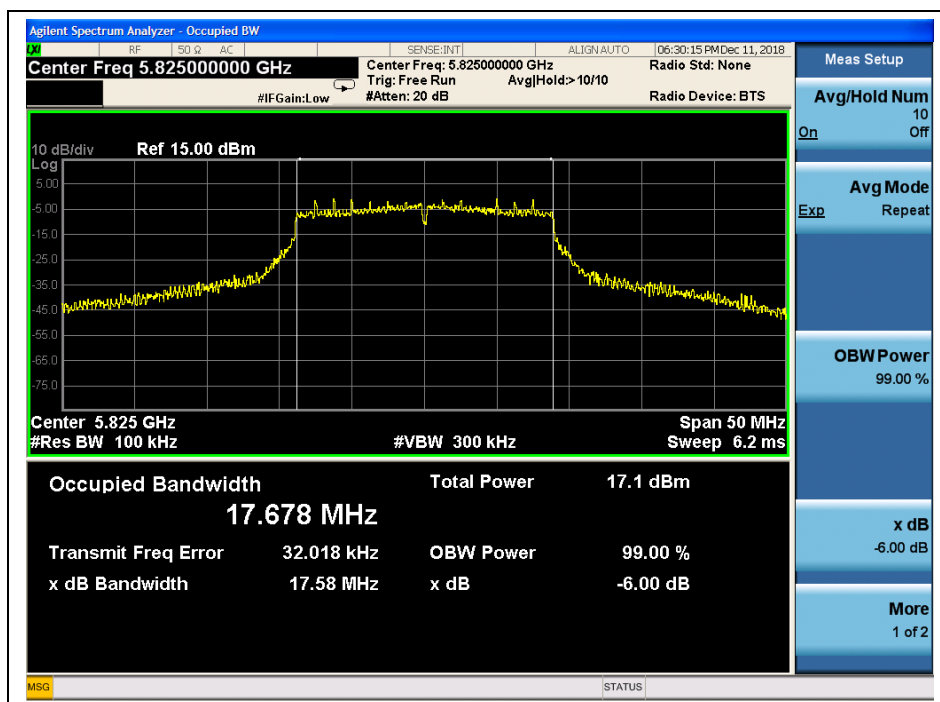
(Channel 48, 5240MHz, fh of -26dB, ac (VHT20))



(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) | 26 dB Bandwidth (MHz) |
|---------|-----------------|-----------------------|
| 38      | 5190            | 65.53                 |
| 46      | 5230            | 63.75 <sub>Note</sub> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)   |
| 151     | 5755            | 36.03                 |
| 159     | 5795            | 35.79                 |

**Note:** The high frequency of the -26dB is 5250.00MHz which is not in the DFS frequency range, so DFS testing is not required.

### B. Test Plots



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

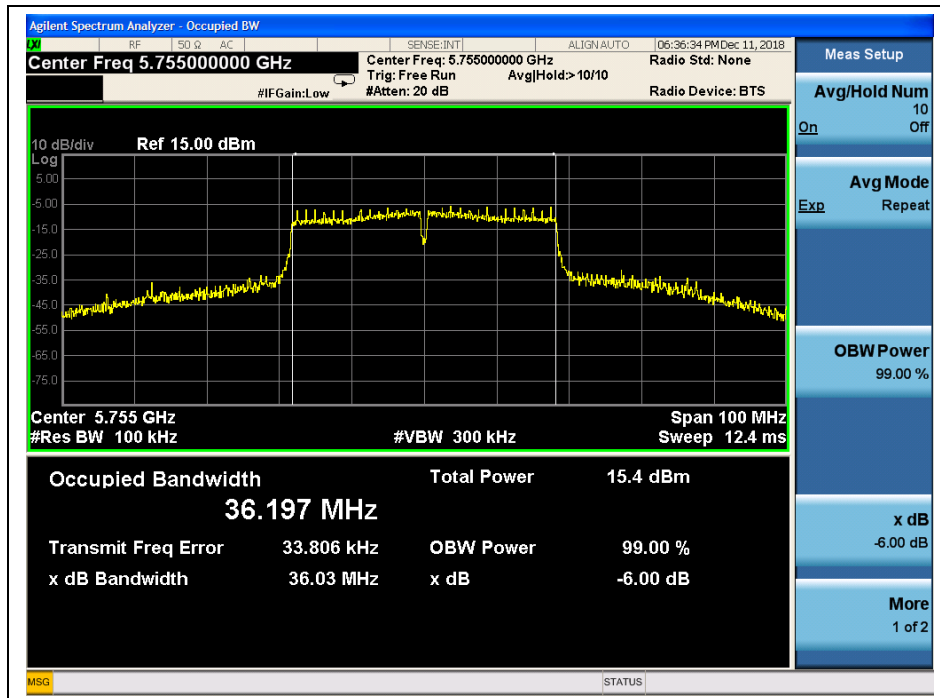




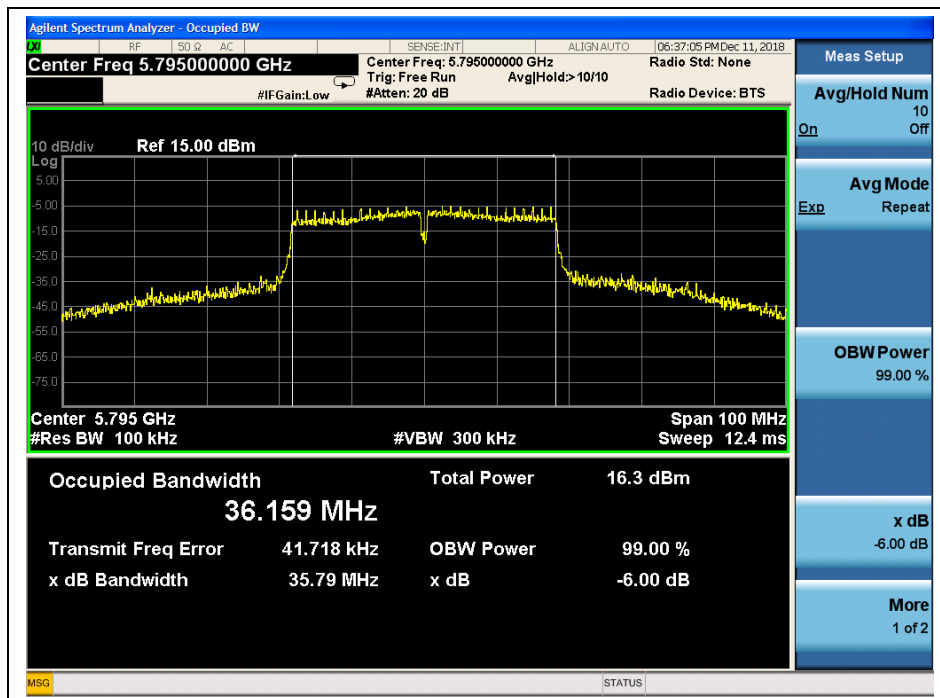
(Channel 46, 5230 MHz, 802.11 ac (VHT40))



(Channel 46, 5230 MHz, fh of -26dB, 802. ac (VHT40))



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



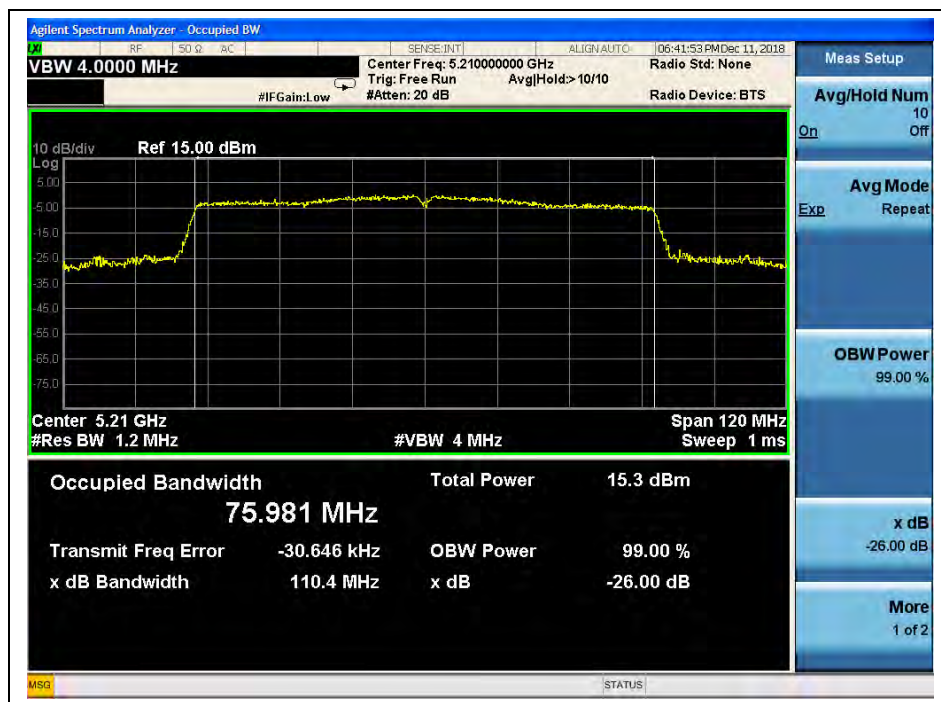
(Channel 159, 5795MHz, 802.11ac (VHT40))



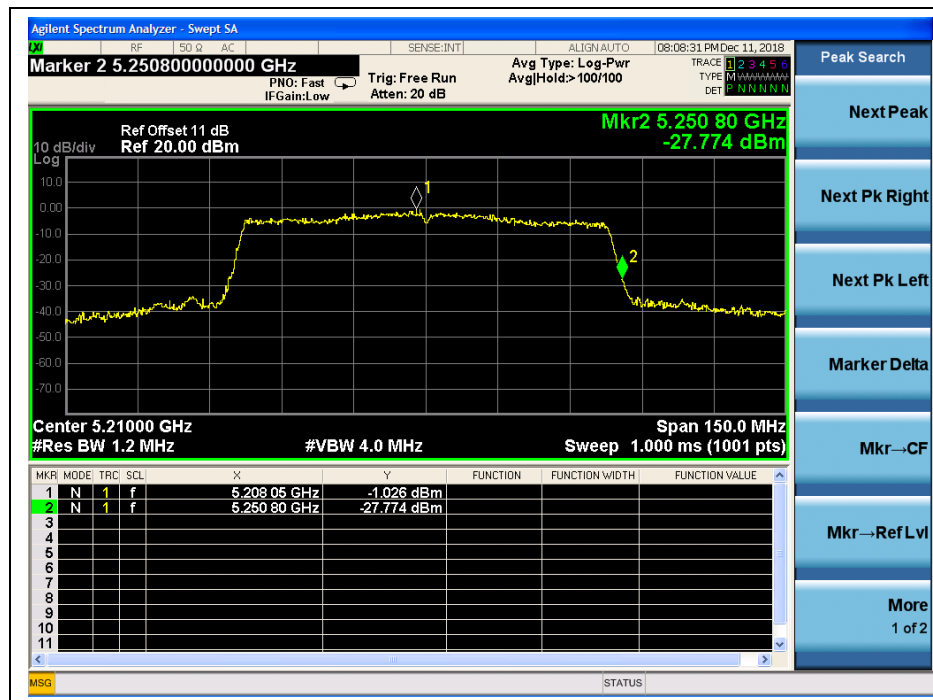
**802.11ac (VHT80) Test mode****A. Test Verdict:**

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz)     |
|---------|-----------------|---------------------------|
| 42      | 5210            | 110.4 <small>Note</small> |
| Channel | Frequency (MHz) | 6dB Bandwidth (MHz)       |
| 155     | 5775            | 75.54                     |

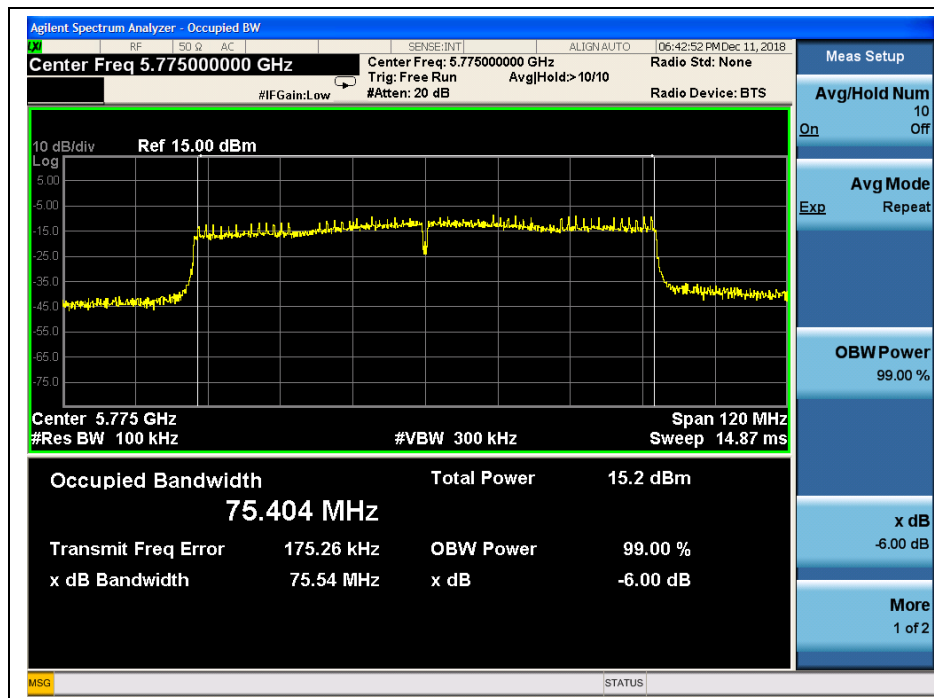
**Note:** The high frequency of the -26dB is 5250.80MHz which is in the DFS frequency range, so DFS testing is required. Please refer to DFS report (Report No.: SZ18110110W05).

**B. Test Plots**

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



(Channel 42, 5210 MHz, fh of -26dB, 802. ac (VHT80))



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

## 2.4. Maximum conducted output power

### 2.4.1. 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.

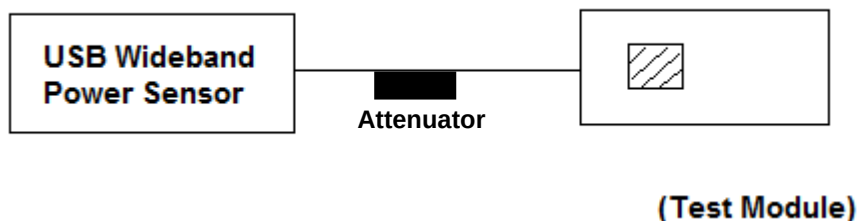
(4) According to KDB662911D01 Measure-and-sum technique, the conducted emission level (e.g., transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the 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  $G_{\text{ANT}}$  is the antenna gain in dBi,  $N_{\text{ANT}}$  is the number of outputs.

### 2.4.2. 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.

**2.4.3. Test Result****802.11a Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 36      | 5180            | 17.84                        | 24          | PASS    |
| 44      | 5220            | 18.02                        |             |         |
| 48      | 5240            | 18.20                        |             |         |
| 149     | 5745            | 18.92                        | 30          |         |
| 157     | 5785            | 19.14                        |             |         |
| 165     | 5825            | 19.72                        |             |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 36      | 5180            | 12.07                        | 24          | PASS    |
| 44      | 5220            | 12.16                        |             |         |
| 48      | 5240            | 12.37                        |             |         |
| 149     | 5745            | 12.83                        | 30          |         |
| 157     | 5785            | 12.95                        |             |         |
| 165     | 5825            | 13.49                        |             |         |

**802.11n (HT20) Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 36      | 5180            | 17.92                        | 24          | PASS    |
| 44      | 5220            | 18.23                        |             |         |
| 48      | 5240            | 18.30                        |             |         |
| 149     | 5745            | 19.05                        | 30          |         |
| 157     | 5785            | 19.28                        |             |         |
| 165     | 5825            | 19.82                        |             |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 36      | 5180            | 11.82                        | 24          | PASS    |
| 44      | 5220            | 12.08                        |             |         |
| 48      | 5240            | 12.15                        |             |         |
| 52      | 5260            | 12.45                        |             |         |
| 149     | 5745            | 12.66                        | 30          |         |
| 157     | 5785            | 13.18                        |             |         |
| 165     | 5825            | 11.82                        |             |         |

**802.11n (HT40) Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 38      | 5190            | 18.17                        | 24          | PASS    |
| 46      | 5230            | 18.32                        |             |         |
| 151     | 5755            | 19.23                        | 30          |         |
| 159     | 5795            | 19.63                        |             |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 38      | 5190            | 11.95                        | 24          | PASS    |
| 46      | 5230            | 11.89                        |             |         |
| 151     | 5755            | 12.58                        | 30          |         |
| 159     | 5795            | 12.90                        |             |         |

**802.11ac (VHT20) Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 36      | 5180            | 18.02                        | 24          | PASS    |
| 44      | 5220            | 18.24                        |             |         |
| 48      | 5240            | 18.42                        |             |         |
| 149     | 5745            | 19.03                        | 30          |         |
| 157     | 5785            | 19.29                        |             |         |
| 165     | 5825            | 19.81                        |             |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 36      | 5180            | 11.92                        | 24          | PASS    |
| 44      | 5220            | 12.08                        |             |         |
| 48      | 5240            | 12.16                        |             |         |
| 149     | 5745            | 12.48                        | 30          |         |
| 157     | 5785            | 12.78                        |             |         |
| 165     | 5825            | 13.14                        |             |         |

**802.11ac (VHT40) Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 38      | 5190            | 18.45                        | 24          | PASS    |
| 46      | 5230            | 18.11                        |             |         |
| 151     | 5755            | 19.29                        | 30          |         |
| 159     | 5795            | 19.54                        |             |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 38      | 5190            | 11.96                        | 24          | PASS    |
| 46      | 5230            | 11.85                        |             |         |
| 151     | 5755            | 12.50                        | 30          |         |
| 159     | 5795            | 12.80                        |             |         |

**802.11ac (VHT80) Test mode**

| Channel | Frequency (MHz) | Measured Peak Power (dBm)    | Limit (dBm) | Verdict |
|---------|-----------------|------------------------------|-------------|---------|
| 42      | 5210            | 18.10                        | 24          | PASS    |
| 155     | 5775            | 19.15                        | 30          |         |
| Channel | Frequency (MHz) | Measured Average Power (dBm) | Limit (dBm) | Verdict |
| 42      | 5210            | 11.53                        | 24          | PASS    |
| 155     | 5775            | 12.11                        | 30          |         |



## 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.

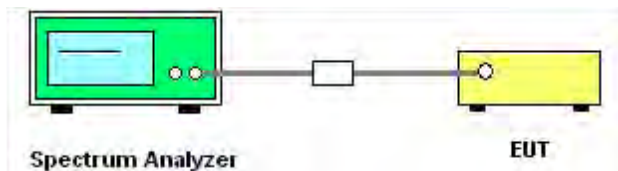
If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(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            | 8.42                       | 11                 | PASS    |
| 44      | 5220            | 7.98                       |                    |         |
| 48      | 5240            | 8.01                       |                    |         |
| Channel | Frequency (MHz) | Measured PPSD (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 149     | 5745            | 4.54                       | 30                 | PASS    |
| 157     | 5785            | 5.77                       |                    |         |
| 165     | 5825            | 6.52                       |                    |         |

##### B. Test Plots



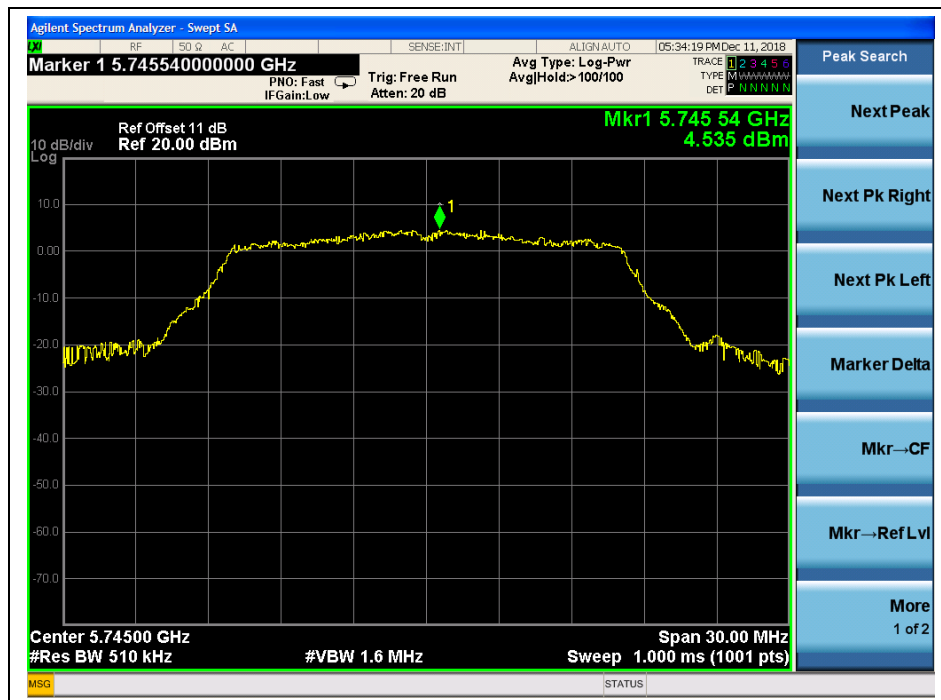
(Channel 36, 5180MHz, 802.11a,)



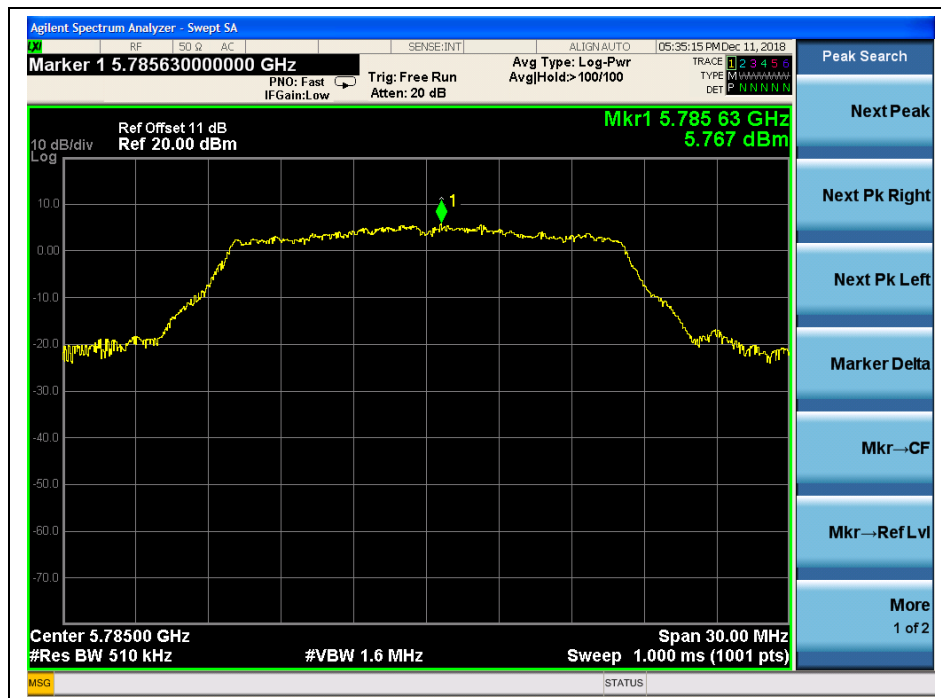
(Channel 44, 5220 MHz, 802.11a,)



(Channel 48, 5240MHz, 802.11a,)



(Channel 149, 5745MHz, 802.11a)



(Channel 157, 5785MHz, 802.11a)



(Channel 165, 5825MHz, 802.11a)

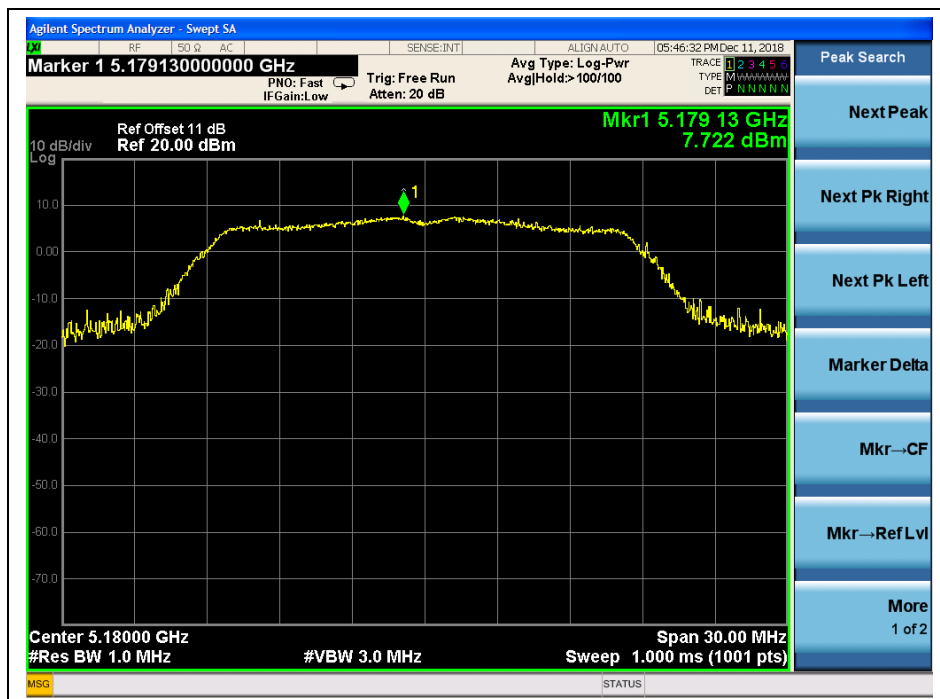
## 802.11n (HT20) Test mode

### A. Test Verdict:

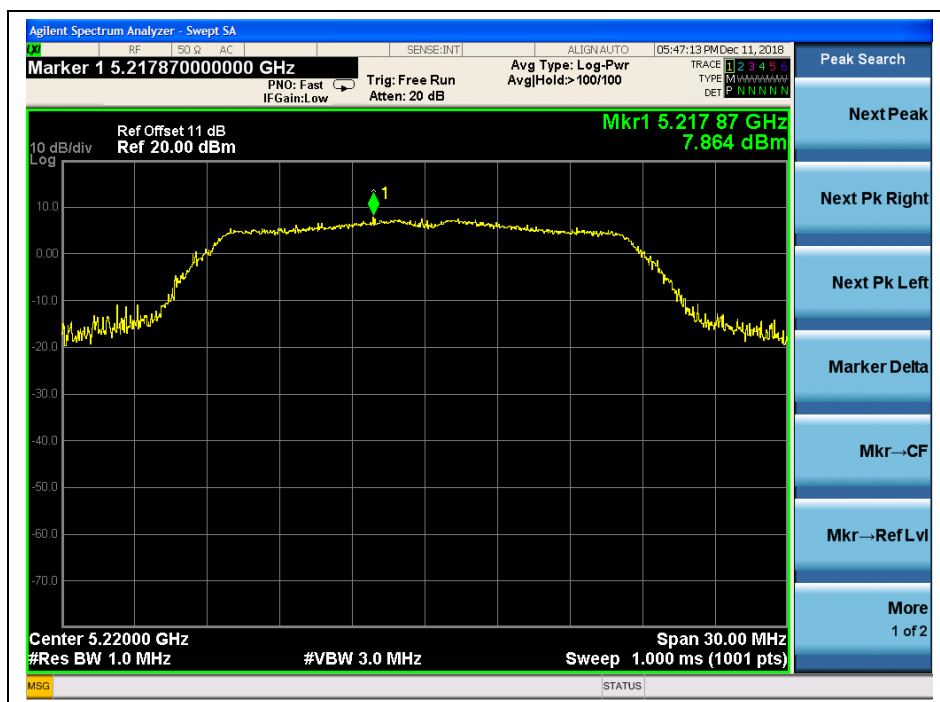
| Channel | Frequency (MHz) | Measured PPSD (dBm/MHz)    | Limit (dBm/MHz)    | Verdict |
|---------|-----------------|----------------------------|--------------------|---------|
| 36      | 5180            | 7.72                       | 11                 | PASS    |
| 44      | 5220            | 7.86                       |                    |         |
| 48      | 5240            | 8.17                       |                    |         |
| Channel | Frequency (MHz) | Measured PPSD (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 149     | 5745            | 4.24                       | 30                 | PASS    |
| 157     | 5785            | 5.68                       |                    |         |
| 165     | 5825            | 7.46                       |                    |         |



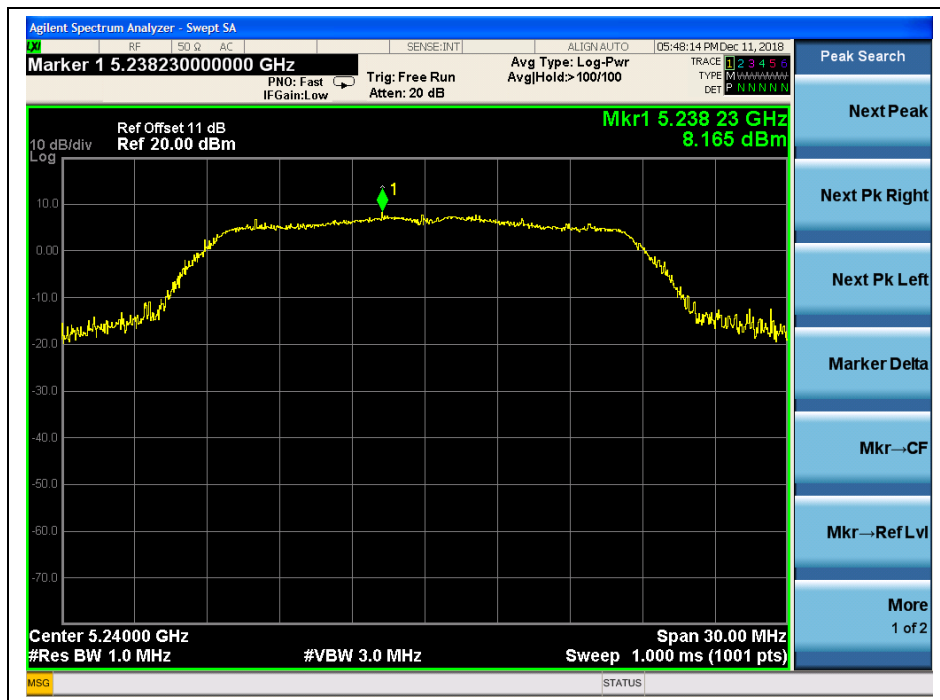
## B. Test Plots



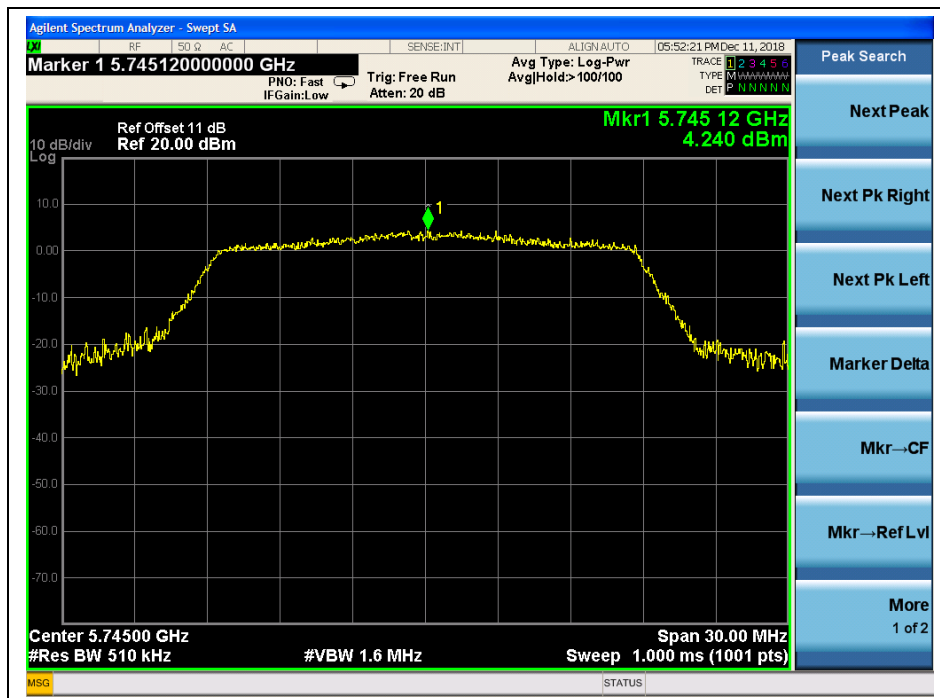
(Channel 36, 5180MHz, 802.11 n (HT20))



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

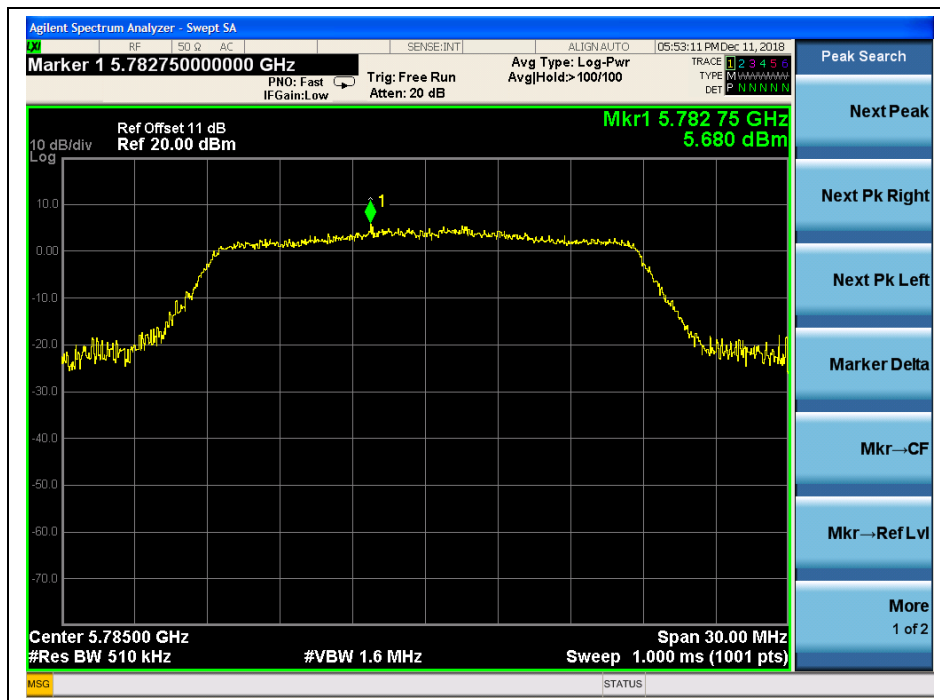


(Channel 48, 5240MHz, 802.11 n (HT20))

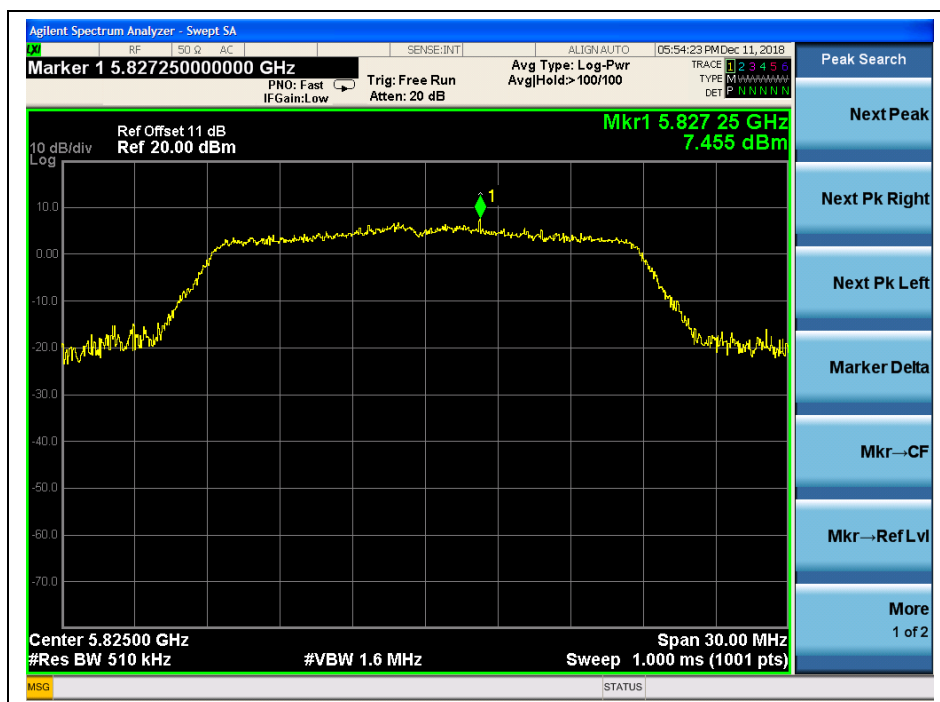


(Channel 149, 5745MHz, 802.11 n (HT20))





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



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

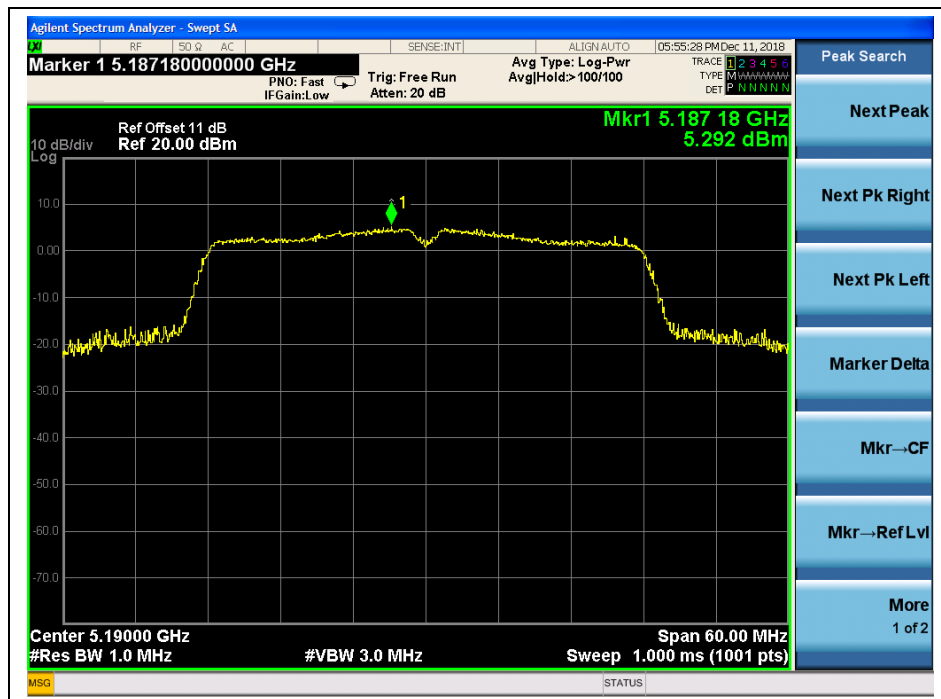


## 802.11n (HT40) Test mode

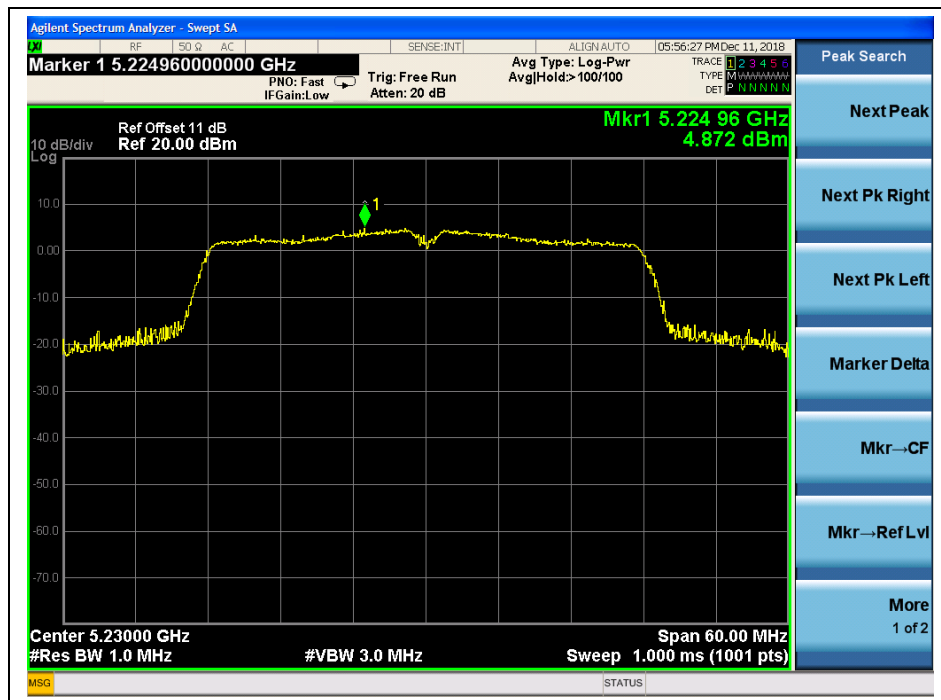
### A. Test Verdict:

| Channel | Frequency (MHz) | Measured PPSD (dBm/MHz)    | Limit (dBm/MHz)    | Verdict |
|---------|-----------------|----------------------------|--------------------|---------|
| 38      | 5190            | 5.29                       | 11                 | PASS    |
| 46      | 5230            | 4.87                       |                    |         |
| Channel | Frequency (MHz) | Measured PPSD (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 151     | 5755            | 2.42                       | 30                 | PASS    |
| 159     | 5795            | 3.35                       |                    |         |

### 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

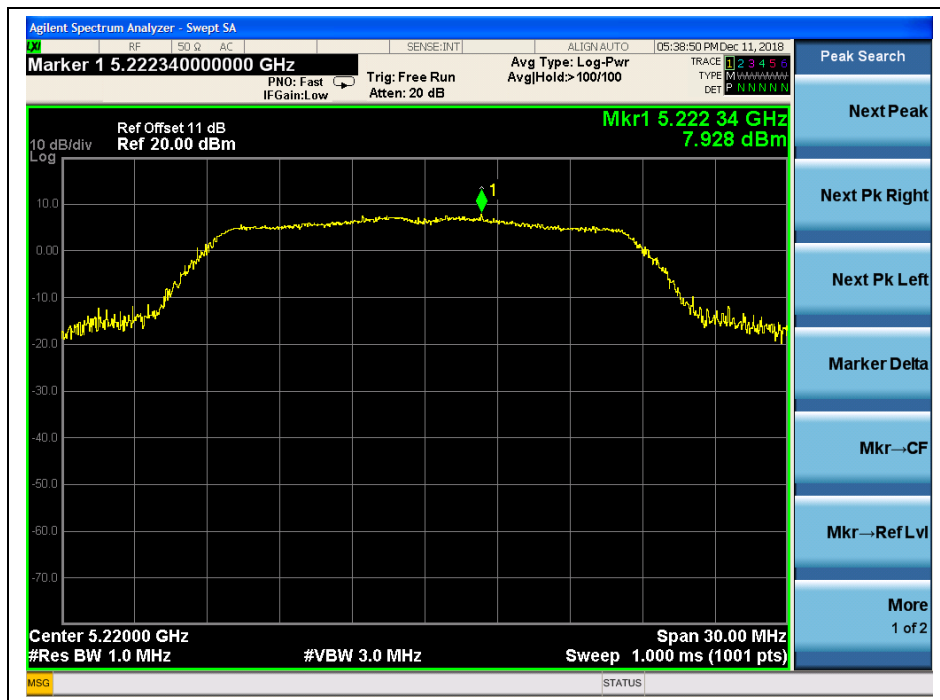
### A. Test Verdict:

| Channel | Frequency (MHz) | Measured PPSD (dBm/MHz)    | Limit (dBm/MHz)    | Verdict |
|---------|-----------------|----------------------------|--------------------|---------|
| 36      | 5180            | 8.06                       | 11                 | PASS    |
| 44      | 5220            | 7.93                       |                    |         |
| 48      | 5240            | 8.07                       |                    |         |
| Channel | Frequency (MHz) | Measured PPSD (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 149     | 5745            | 4.33                       | 30                 | PASS    |
| 157     | 5785            | 5.51                       |                    |         |
| 165     | 5825            | 6.59                       |                    |         |

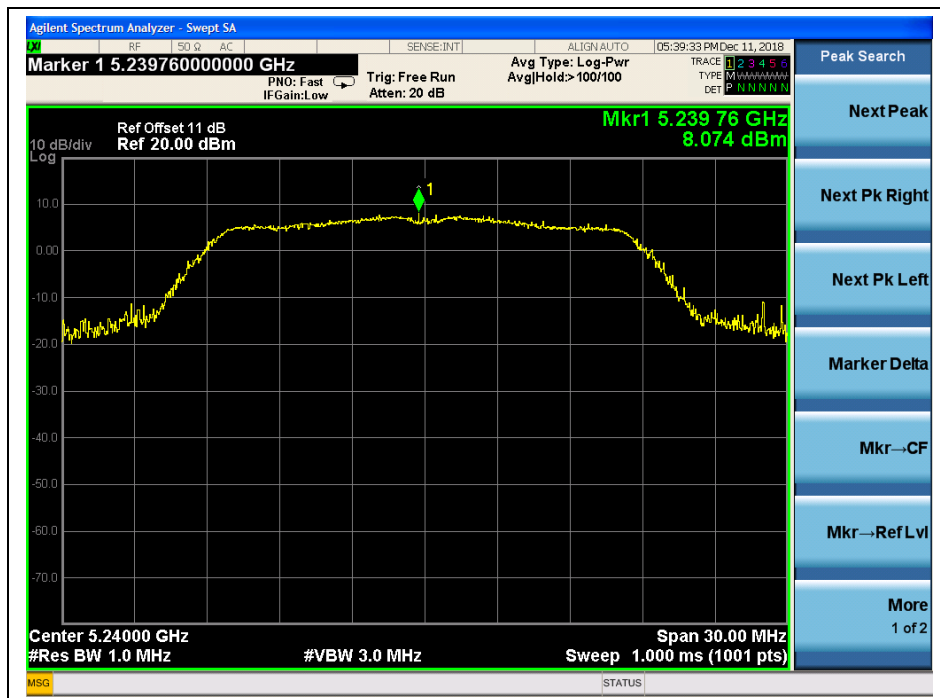
### B. Test Plots



(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:

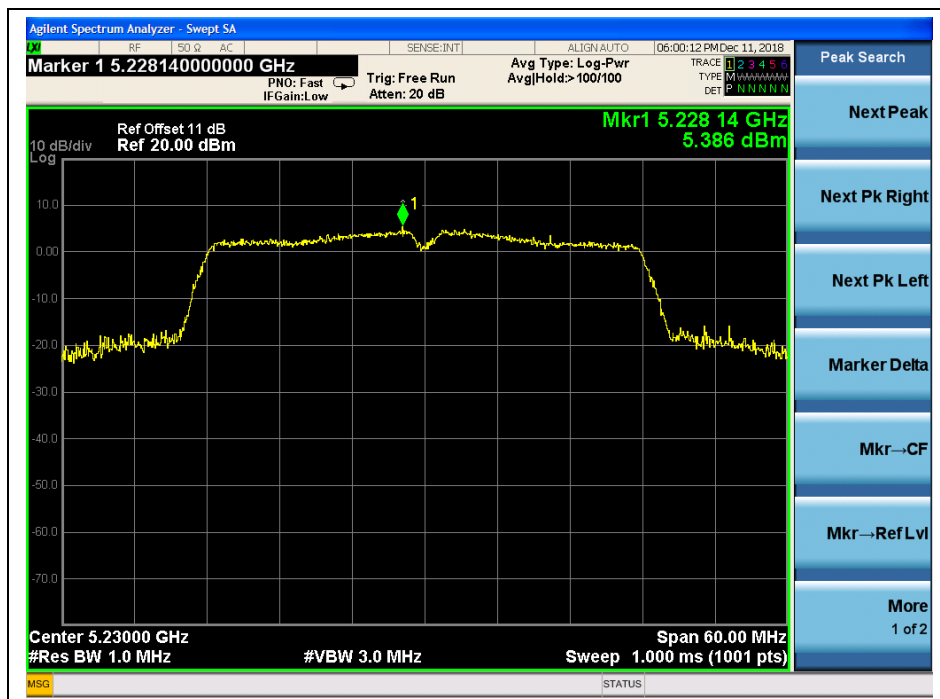
| Channel | Frequency (MHz) | Measured PPSP (dBm/MHz)    | Limit (dBm/MHz)    | Verdict |
|---------|-----------------|----------------------------|--------------------|---------|
| 38      | 5190            | 5.64                       | 11                 | PASS    |
| 46      | 5230            | 5.39                       |                    |         |
| Channel | Frequency (MHz) | Measured PPSP (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 151     | 5755            | 2.42                       | 30                 | PASS    |
| 155     | 5795            | 2.89                       |                    |         |



## B. Test Plots



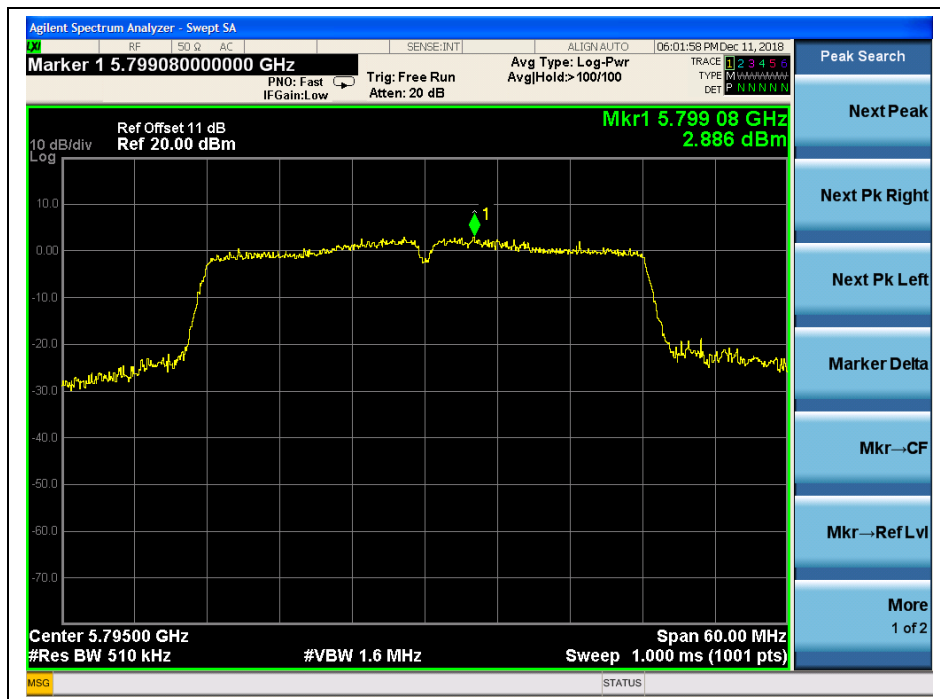
(Channel 38, 5190MHz, 802.11 ac (VHT40))



(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            | 2.85                       | 11                 | PASS    |
| Channel | Frequency (MHz) | Measured PPSP (dBm/500KHz) | Limit (dBm/500KHz) | Verdict |
| 155     | 5775            | -0.01                      | 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)<br>5180MHz |             |           |                |                 |
|-----------------------------|-------------|-----------|----------------|-----------------|
| VOLTAGE (%)                 | POWER (VDC) | TEMP (°C) | Freq Dev. (Hz) | Deviation (ppm) |
| 100%                        | 3.8         | +20(Ref)  | 23             | 0.004           |
| 100%                        |             | -30       | 52             | 0.010           |
| 100%                        |             | -20       | 43             | 0.008           |
| 100%                        |             | -10       | 35             | 0.007           |
| 100%                        |             | 0         | 28             | 0.005           |
| 100%                        |             | +10       | 20             | 0.004           |
| 100%                        |             | +20       | 21             | 0.004           |
| 100%                        |             | +30       | 37             | 0.007           |
| 100%                        |             | +40       | 42             | 0.008           |
| 100%                        |             | +50       | 44             | 0.008           |
| 85%                         | 3.23        | +20       | 50             | 0.010           |
| 115%                        | 4.37        | +20       | 41             | 0.008           |



| U-NII-3 (Ch. 149)<br>5745MHz |             |           |                |                 |
|------------------------------|-------------|-----------|----------------|-----------------|
| VOLTAGE (%)                  | POWER (VDC) | TEMP (°C) | Freq Dev. (Hz) | Deviation (ppm) |
| 100%                         | 3.8         | +20(Ref)  | 16             | 0.003           |
| 100%                         |             | -30       | 49             | 0.009           |
| 100%                         |             | -20       | 36             | 0.006           |
| 100%                         |             | -10       | 25             | 0.004           |
| 100%                         |             | 0         | 18             | 0.003           |
| 100%                         |             | +10       | 16             | 0.003           |
| 100%                         |             | +20       | 21             | 0.004           |
| 100%                         |             | +30       | 25             | 0.004           |
| 100%                         |             | +40       | 33             | 0.006           |
| 100%                         |             | +50       | 42             | 0.007           |
| 85%                          | 3.23        | +20       | 27             | 0.005           |
| 115%                         | 4.37        | +20       | 35             | 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 $\mu$ H/50 $\Omega$  line impedance stabilization network (LISN).

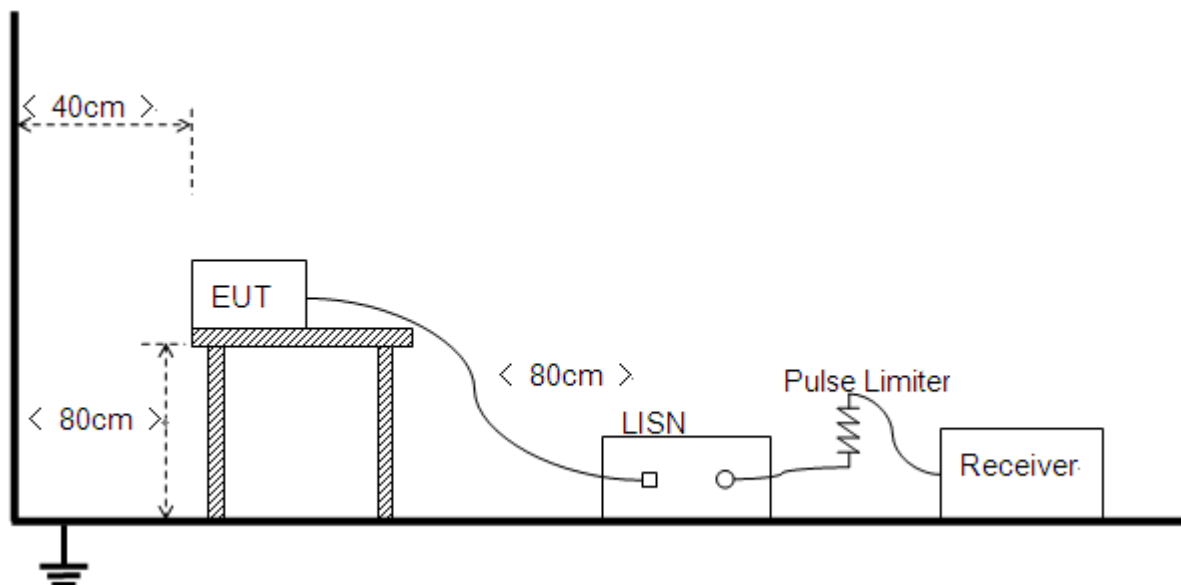
| Frequency range (MHz) | Conducted Limit (dB $\mu$ V) |          |
|-----------------------|------------------------------|----------|
|                       | Quai-peak                    | Average  |
| 0.15 - 0.50           | 66 to 56                     | 56 to 46 |
| 0.50 - 5              | 56                           | 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+ADAPTER+WIFI TX

Test Voltage: AC 120V/60Hz

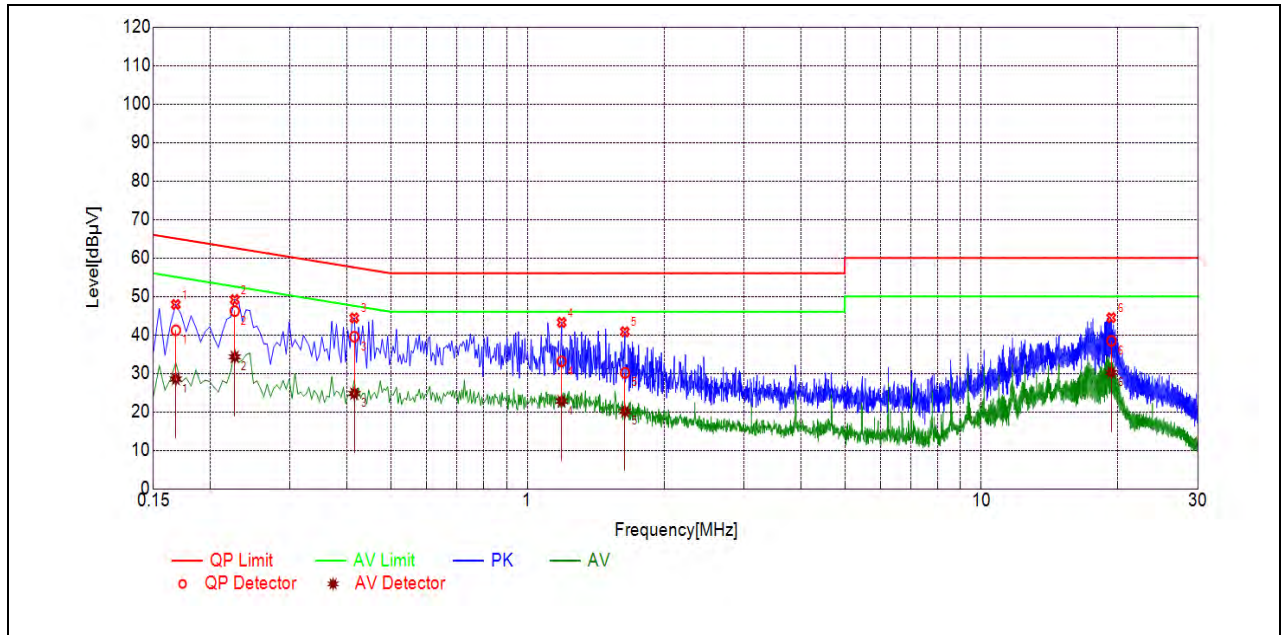
The measurement results are obtained as below:

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

$U_R$ : Receiver Reading

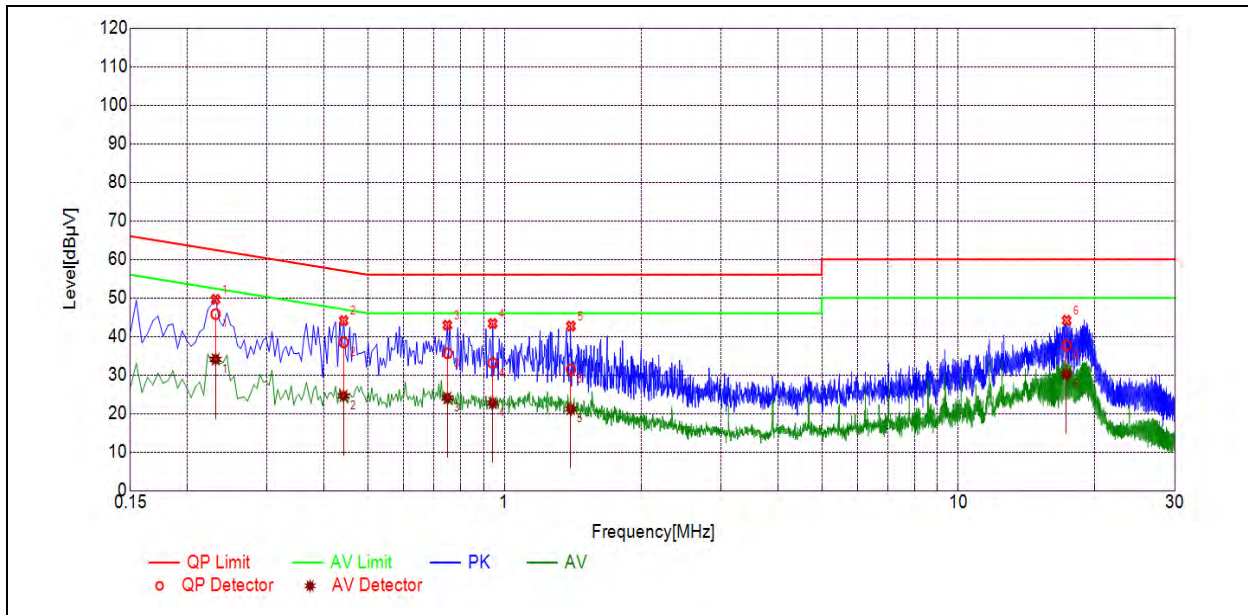
$A_{\text{Factor}}$ : Voltage division factor of LISN

## B. Test Plots:



(L Phase)

| NO. | Fre.<br>(MHz) | Emission Level (dBμV) |         | Limit (dBμV) |         | Power-line | Verdict |
|-----|---------------|-----------------------|---------|--------------|---------|------------|---------|
|     |               | Quai-peak             | Average | Quai-peak    | Average |            |         |
| 1   | 0.1680        | 41.20                 | 28.52   | 65.06        | 55.06   | Line       | PASS    |
| 2   | 0.2265        | 46.20                 | 34.30   | 62.58        | 52.58   |            | PASS    |
| 3   | 0.4154        | 39.55                 | 24.76   | 57.54        | 47.54   |            | PASS    |
| 4   | 1.1885        | 33.12                 | 22.79   | 56.00        | 46.00   |            | PASS    |
| 5   | 1.6402        | 30.14                 | 20.11   | 56.00        | 46.00   |            | PASS    |
| 6   | 19.3374       | 38.47                 | 30.25   | 60.00        | 50.00   |            | PASS    |



(N Phase)

| NO. | Fre.<br>(MHz) | Emission Level (dBμV) |         | Limit (dBμV) |         | Power-line | Verdict |
|-----|---------------|-----------------------|---------|--------------|---------|------------|---------|
|     |               | Quai-peak             | Average | Quai-peak    | Average |            |         |
| 1   | 0.2310        | 45.79                 | 34.07   | 62.41        | 34.07   | Neutral    | PASS    |
| 2   | 0.4421        | 38.45                 | 24.58   | 57.02        | 24.58   |            | PASS    |
| 3   | 0.7489        | 35.63                 | 24.06   | 56.00        | 24.06   |            | PASS    |
| 4   | 0.9416        | 33.11                 | 22.69   | 56.00        | 22.69   |            | PASS    |
| 5   | 1.4003        | 31.43                 | 21.16   | 56.00        | 21.16   |            | PASS    |
| 6   | 17.3066       | 37.73                 | 30.16   | 60.00        | 30.16   |            | PASS    |

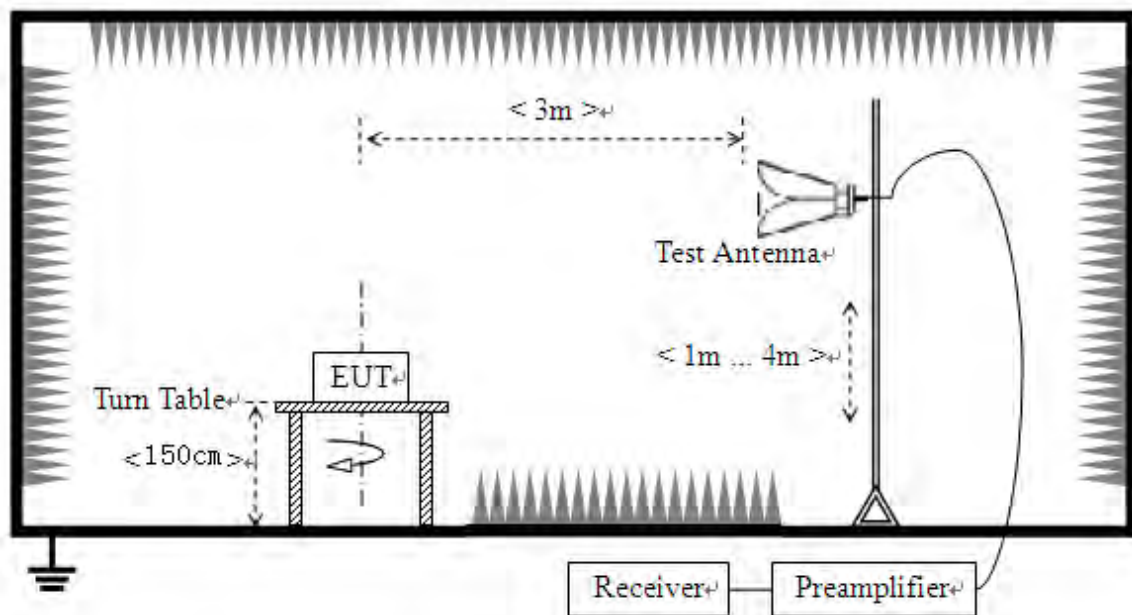
## 2.8. Restricted Frequency Bands

### 2.8.1. Requirement

According 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).

### 2.8.2. Test Description

#### A. Test Setup



The Module is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors 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 height is varied from 1m to 4m above the ground to determine the maximum value of the field strength.



### 2.8.3. Test Result

The lowest and highest channels are tested to verify Restricted Frequency Bands.

The measurement results are obtained as below:

$$E \text{ [dB}\mu\text{V/m]} = U_R + A_T + A_{\text{Factor}} \text{ [dB]}; A_T = L_{\text{Cable loss}} \text{ [dB]} - G_{\text{preamp}} \text{ [dB]}$$

$A_T$ : Total correction Factor except Antenna;  $U_R$ : Receiver Reading

$G_{\text{preamp}}$ : Preamplifier Gain;  $A_{\text{Factor}}$ : Antenna Factor at 3m

**Note:** Restricted Frequency Bands were performed when antenna was at vertical and horizontal polarity, and only the worse test condition (vertical) was recorded in this test report.

### 802.11a Test mode

#### A. Test Verdict:

| Channel | Frequency<br>(MHz) | Detector | Receiver<br>Reading<br>$U_R$<br>(dBuV) | $A_T$<br>(dB) | $A_{\text{Factor}}$<br>(dB@3m) | Max.<br>Emission<br>E<br>(dBμV/m) | Limit<br>(dBμV/m) | Verdict |
|---------|--------------------|----------|----------------------------------------|---------------|--------------------------------|-----------------------------------|-------------------|---------|
|         |                    | PK/ AV   |                                        |               |                                |                                   |                   |         |
| 36      | 5147.36            | PK       | 63.55                                  | -49.53        | 32.20                          | 46.22                             | 74                | PASS    |
| 36      | 5150.00            | AV       | 47.73                                  | -49.53        | 32.20                          | 30.40                             | 54                | PASS    |
| 48      | 5384.52            | PK       | 46.17                                  | -49.53        | 32.20                          | 28.84                             | 74                | PASS    |
| 48      | 5385.62            | AV       | 35.25                                  | -49.53        | 32.20                          | 17.92                             | 54                | PASS    |
| 149     | 5725.00            | PK       | 65.02                                  | -49.53        | 32.20                          | 47.69                             | 122.23            | PASS    |
| 149     | 5725.00            | AV       | 52.74                                  | -49.53        | 32.20                          | 35.41                             | 54                | PASS    |
| 165     | 5850.00            | PK       | 56.72                                  | -49.53        | 32.20                          | 39.39                             | 122.23            | PASS    |
| 165     | 5850.00            | AV       | 46.06                                  | -49.53        | 32.20                          | 28.73                             | 54                | PASS    |





Keysight Spectrum Analyzer - Swept SA

Marker 1 5.147360000000 GHz

PNO: Fast IFGain: Low Trig: Free Run Atten: 10 dB

Avg Type: Voltage Avg/Hold: >100/100

09:08:38 PM Dec 25, 2018

TRACE 1 2 3 4 5 6 TYPE M PNNNN DET PNNNN

10 dB/div Ref 106.00 dBμV

Mkr1 5.14736 GHz 63.546 dBμV

Start 4.5000 GHz Stop 5.1800 GHz

Res BW (CISPR) 1 MHz #VBW 3.0 MHz Sweep 1.400 ms (1001 pts)

| Mkr | MODE | TRC | SCL | X           | Y           | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |
|-----|------|-----|-----|-------------|-------------|----------|----------------|----------------|
| 1   | N    | 1   | f   | 5.14736 GHz | 63.546 dBμV |          |                |                |
| 2   | N    | 1   | f   | 5.15000 GHz | 63.501 dBμV |          |                |                |
| 3   |      |     |     |             |             |          |                |                |
| 4   |      |     |     |             |             |          |                |                |
| 5   |      |     |     |             |             |          |                |                |
| 6   |      |     |     |             |             |          |                |                |
| 7   |      |     |     |             |             |          |                |                |
| 8   |      |     |     |             |             |          |                |                |
| 9   |      |     |     |             |             |          |                |                |
| 10  |      |     |     |             |             |          |                |                |
| 11  |      |     |     |             |             |          |                |                |

Trace/Detector

Select Trace 2

Detector Peak Man

Auto

Preset Detectors

Clear Trace

Clear All Traces

Preset All Traces

More 2 of 3

The screenshot displays the Keysight Spectrum Analyzer - Sweep SA interface. The main plot shows a frequency spectrum with a marker at 5.14668 GHz and 46.492 dBμV. The plot is titled "Mkr1 5.146 68 GHz 46.492 dBμV". The y-axis is labeled "10 dB/div Log" and the x-axis is labeled "Start 4.5000 GHz Res BW (CISPR) 1 MHz Sweep 5.1800 GHz 77.97 s (1001 pts)". The plot shows a flat line at approximately 30 dBμV until about 5.1 GHz, where it rises sharply to the marked value at 5.14668 GHz.

Below the plot, there is a table with columns: MKR, MODE, TRC, SCL, X, Y, FUNCTION, FUNCTION WIDTH, and FUNCTION VALUE. The table contains data for the marker at 5.14668 GHz and 46.492 dBμV.

| MKR | MODE | TRC | SCL | X            | Y           | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |
|-----|------|-----|-----|--------------|-------------|----------|----------------|----------------|
| 1   | N    | 1   | f   | 5.146 68 GHz | 46.492 dBμV |          |                |                |
| 2   | N    | 1   | f   | 5.150 00 GHz | 47.732 dBμV |          |                |                |
| 3   |      |     |     |              |             |          |                |                |
| 4   |      |     |     |              |             |          |                |                |
| 5   |      |     |     |              |             |          |                |                |
| 6   |      |     |     |              |             |          |                |                |
| 7   |      |     |     |              |             |          |                |                |
| 8   |      |     |     |              |             |          |                |                |
| 9   |      |     |     |              |             |          |                |                |
| 10  |      |     |     |              |             |          |                |                |
| 11  |      |     |     |              |             |          |                |                |

On the right side of the interface, there is a "Marker" section with a "Select Marker" dropdown menu showing "1". Below this are buttons for "Normal", "Delta", "Fixed", and "Off". At the bottom right, there is a "Properties" button and a "More" button with "1 of 2" below it.

**MORLAB**

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