# TEST REPORT

DT&C Co., Ltd.
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1611-0154
2. Customer
   - Name : HYUNDAI MOBIS CO., LTD
   - Address : 203 Teheran-ro, Gangnam-gu, Seoul, Korea, 135-977
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : DIGITAL CAR AVN SYSTEM / AVC40D5AN
   FCC ID : TQ8-AVC40D5AN
5. Test Method Used : FCC Part 15.407 Subpart E
6. Date of Test : 2016-11-18 ~ 2016-11-25
7. Testing Environment : See appended test report
8. Test Result : Refer to the attached Test Result

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name : Chulmin Kim (Signature) | Technical Manager<br>Name : Geunki Son (Signature) |



**2016 . 11 . 25 .**

**DT&C Co., Ltd.**

**If this report is required to confirmation of authenticity, please contact to report@dtnc.net**

# Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| DRTFCC1611-0154 | Nov, 25. 2016 | Initial issue |
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# CONTENTS

# 1. EUT DESCRIPTION

| | |
|---|---|
| **FCC Equipment Class** | Unlicensed National Information Infrastructure (UNII) |
| **Product** | DIGITAL CAR AVN SYSTEM |
| **Model Name** | AVC40D5AN |
| **Add Model Name** | N/A |
| **Power Supply** | DC 14.4 V |
| **Hardware version** | 1.0 |
| **Software version** | 1.0 |
| **Frequency Range** | **U-NII 1(5150 ~ 5250 MHz)**<br>▪ 802.11a/n(HT20)/ac(VHT20): 5180 ~ 5240 MHz<br>▪ 802.11n(HT40)/ac(VHT40): 5190 ~ 5230 MHz<br>▪ 802.11ac(VHT80): 5210 MHz<br>**U-NII 2A(5250 ~ 5350 MHz)**<br>▪ 802.11a/n(HT20)/ac(VHT20): 5260 ~ 5320 MHz<br>▪ 802.11n(HT40)/ac(VHT40): 5270 ~ 5310 MHz<br>▪ 802.11ac(VHT80): 5290 MHz<br>**U-NII 2C(5470 ~ 5725 MHz)**<br>▪ 802.11a/n(HT20)/ac(VHT20): 5500 ~ 5720 MHz<br>▪ 802.11n(HT40)/ac(VHT40): 5510 ~ 5710 MHz<br>▪ 802.11ac(VHT80): 5530, 5690 MHz<br>**U-NII 3(5725 ~ 5850MHz)**<br>▪ 802.11a/n(HT20)/ac(VHT20): 5745 ~ 5825 MHz<br>▪ 802.11n(HT40)/ac(VHT40): 5755 ~ 5795 MHz<br>▪ 802.11ac(VHT80): 5775 MHz |
| **Modulation type** | OFDM |
| **Antenna Specification** | **Antenna type**: Internal Antenna<br>**Antenna gain**<br>▪ U-NII-1: 1.420 dBi<br>▪ U-NII 2A: 1.420 dBi<br>▪ U-NII 2C: -0.850 dBi<br>▪ U-NII-3: -2.390 dBi |

# 2. Information about test items

## 2.1 Test mode / Channel Information

| 5GHz Band | Mode | Data Rate |
|---|---|---|
| | | Multiple transmitting |
| U-NII 1 | 802.11a | 6Mbps |
| | 802.11n(HT20) | MCS 0 |
| | 802.11n(HT40) | MCS 0 |
| | 802.11ac(VHT80) | NSS2 MCS 0 |
| U-NII 2A | 802.11a | 6Mbps |
| | 802.11n(HT20) | MCS 0 |
| | 802.11n(HT40) | MCS 0 |
| | 802.11ac(VHT80) | NSS2 MCS 0 |
| U-NII 2C | 802.11a | 6Mbps |
| | 802.11n(HT20) | MCS 0 |
| | 802.11n(HT40) | MCS 0 |
| | 802.11ac(VHT80) | NSS2 MCS 0 |
| U-NII 3 | 802.11a | 6Mbps |
| | 802.11n(HT20) | MCS 0 |
| | 802.11n(HT40) | MCS 0 |
| | 802.11ac(VHT80) | NSS2 MCS 0 |

The worst case data rate for each modulation is determined as above table. And all tests conducted in this report were made at the worst case data rate of each modulation.

## 2.2 Tested Channel Information

| 5GHz Band | 802.11a/n(HT20) | | 802.11n(HT40) | | 802.11ac(VHT80) | |
|---|---|---|---|---|---|---|
| | Channel | Frequency [MHz] | Channel | Frequency [MHz] | Channel | Frequency [MHz] |
| U-NII 1 | 36 | 5180 | 38 | 5190 | - | - |
| | 40 | 5200 | - | - | 42 | 5210 |
| | 48 | 5240 | 46 | 5230 | - | - |
| U-NII 2A | 52 | 5260 | 54 | 5270 | - | - |
| | 60 | 5300 | - | - | 58 | 5290 |
| | 64 | 5320 | 62 | 5310 | - | - |
| U-NII 2C | 100 | 5500 | 102 | 5510 | 106 | 5530 |
| | 120 | 5600 | 118 | 5590 | 122 | 5610 |
| | 144 | 5720 | 142 | 5710 | 138 | 5690 |
| U-NII 3 | 149 | 5745 | 151 | 5755 | - | - |
| | 157 | 5785 | - | - | 155 | 5775 |
| | 165 | 5825 | 159 | 5795 | - | - |

## 2.3 Auxiliary equipment

| Equipment | Model No. | Serial No. | Manufacturer | Note |
|---|---|---|---|---|
| - | - | - | - | - |

## 2.4 Tested environment

| | | |
|---|---|---|
| **Temperature** | : | 22 ºC ~ 25 ºC |
| **Relative humidity content** | : | 40 % ~ 44 % R.H. |
| **Details of power supply** | : | DC 14.4 V |

## 2.5 EMI Suppression Device(s)/Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

# 3. SUMMARY OF TESTS

| FCC Part Section(s) | RSS Section(s) | Parameter | Limit | Test Condition | Status Note 1 |
|---|---|---|---|---|---|
| **I. Transmitter Mode (TX)** | | | | | |
| 15.407(a) | N/A | Emission Bandwidth (26 dB Bandwidth) | N/A | Conducted | C |
| 15.407(e) | RSS-210 [A8.2] | Minimum Emission Bandwidth (6 dB Bandwidth) | > 500 kHz (5725-5850) | | C |
| 15.407(a) | RSS-210 [A9.2] | Maximum Conducted Output Power | 5150 ~ 5250MHz : < 30 dBm or < 23.97 dBm<br>5250 ~ 5350MHz & 5470 ~ 5725MHz : 250mW or <11 + 10log$_{10}$(B) dBm, whichever power is less.<br>5725 ~ 5850MHz : < 30 dBm | | C Note 3 |
| 15.407(a) | RSS-210 [A9.2] | Peak Power Spectral Density | 5150 ~ 5250MHz : 11dBm/MHz or 17dBm/MHz<br>5250 ~ 5350MHz & 5470 ~ 5725MHz: 11dBm/MHz<br>5725 ~ 5850MHz: 30dBm/500kHz | | C Note 4 |
| 15.407(g) | RSS Gen [6.11] | Frequency Stability | N/A | | C |
| RSS Gen[6.6] | RSS Gen [6.6] | Occupied Bandwidth (99%) | RSS Gen [6.6] | | NA |
| 15.407(b) | RSS-210 [A9.2] | Undesirable Emissions | 5150 ~ 5725MHz: < -27 dBm/MHz EIRP<br>5725 ~ 5850MHz: < -17 dBm/MHz EIRP or< -27 dBm/MHz EIRP | Radiated | C Note 5 |
| 15.205<br>15.209<br>15.407(b) | RSS-Gen [8.9&8.10] | General Field Strength Limits(Restricted Bands and Radiated Emission Limits) | Emissions in restricted bands must meet the radiated limits detailed in 15.209 | | C Note 6 |
| 15.407(h) | RSS-210 [A9.3] | Dynamic Frequency Selection | FCC 15.407(h) | Conducted | C Note 7 |
| 15.207 | RSS-Gen [8.8] | AC Conducted Emissions | FCC 15.207 | AC Line Conducted | NA Note 8 |
| 15.203 | RSS-Gen [6.7] | Antenna Requirements | FCC 15.203 | - | C |

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: The test items were performed according to the KDB789033 D02 V01 and ANSI C63.10-2013.

Note 3: (i) For access point operating in the band 5.15-5.25 GHz: < 30 dBm

(ii) For mobile and portable client devices in the 5.15-5.25 GHz band: < 23.97 dBm

Note 4: (i) For access point operating in the band 5.15-5.25 GHz: < 17 dBm/MHz

(ii) For mobile and portable client devices in the 5.15-5.25 GHz band: < 11 dBm/MHz

Note 5: For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of −17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of −27 dBm/MHz

Note 6: These test items were performed in each axis and the worst case data was reported.

Note 7: For DFS testing, please refer to DFS test report.

Note 8: This device is installed in a car. Therefore the power source is a battery of car.

# 4. TEST METHODOLOGY

Generally the tests were performed according to the KDB789033 D02 v01r02. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing

## 4.1 EUT configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

## 4.2 EUT exercise

The EUT was operated in the test mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart C.

## 4.3 General test procedures

### Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB789033 D02. So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10-2013.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector.

### Radiated Emissions

Basically the radiated tests were performed with KDB789033 D02. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10-2013 as stated on KDB789033 D02.

The EUT is placed on a non-conductive table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 1 or 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the highest emission, the relative positions of the EUT were rotated through three orthogonal axis.

## 4.4 Description of test modes

A test program is used to control the EUT for staying in continuous transmitting mode with maximum fixed duty cycle.

## 4.5 Measurement Uncertainty

| Test items | Measurement uncertainty |
|---|---|
| Transmitter Output Power | 0.71 dB (The confidence level is about 95 %, k = 2) |
| Conducted spurious emission | 0.93 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (1 GHz Below) | 5.1 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (1 GHz ~ 18 GHz) | 5.4 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (18 GHz Above) | 5.3 dB (The confidence level is about 95 %, k = 2) |

# 5. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.

# 6. FACILITIES AND ACCREDITATIONS

## 6.1 Facilities

The open area test site(OATS) or semi anechoic chamber and conducted measurement facility used to collect the radiated and conducted test data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935. The site is constructed in conformance with the requirements.

**- Semi anechoic chamber registration Number: 165783 (FCC)**

## 6.2 Equipment

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, loop, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

# 7. ANTENNA REQUIREMENTS

## 7.1 According to FCC 47 CFR §15.203:

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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.

**The internal antenna was Permanently attached. (Refer to Internal Photo file.)**
**Therefore this DIGITAL CAR AVN SYSTEM complies with the requirement of §15.203**

# 8. TEST RESULT

## 8.1 Emission Bandwidth (26 dB Bandwidth)

### ▣ Test Requirements

The bandwidth at 26 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.
The 26 dB bandwidth is used to determine the conducted output power limit.

### ▣ Test Configuration

Refer to the APPENDIX I.

### ▣ Test Procedure

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB789033 D02**.
1. Set resolution bandwidth (RBW) = approximately **1 %** of the EBW.
2. Set the video bandwidth **(VBW) > RBW**.
3. Detector = **Peak**.
4. 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%.

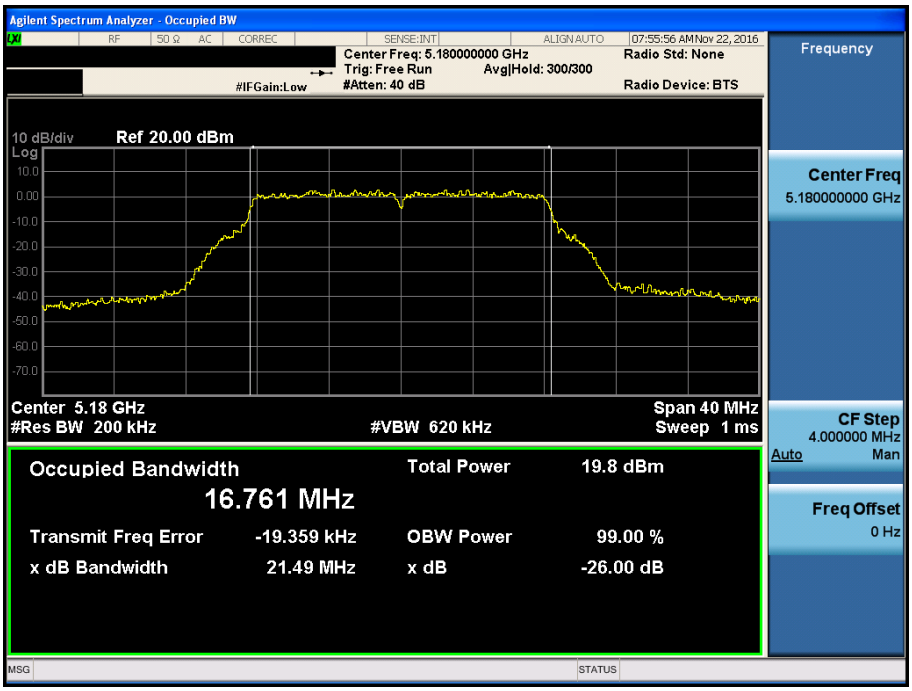
▣ **TEST RESULTS: Comply**

| Mode | Band | Channel | Frequency [MHz] | Test Result [MHz] |
|---|---|---|---|---|
| 802.11a | U-NII 1 | 36 | 5180 | 21.490 |
| | | 40 | 5200 | 21.470 |
| | | 48 | 5240 | 21.500 |
| | U-NII 2A | 52 | 5260 | 21.270 |
| | | 60 | 5300 | 21.360 |
| | | 64 | 5320 | 21.500 |
| | U-NII 2C | 100 | 5500 | 21.370 |
| | | 120 | 5600 | 21.420 |
| | | 144 | 5720 | 15.825 |
| 802.11n (HT20) | U-NII 1 | 36 | 5180 | 21.650 |
| | | 40 | 5200 | 21.660 |
| | | 48 | 5240 | 21.450 |
| | U-NII 2A | 52 | 5260 | 21.630 |
| | | 60 | 5300 | 21.860 |
| | | 64 | 5320 | 21.620 |
| | U-NII 2C | 100 | 5500 | 21.760 |
| | | 120 | 5600 | 21.600 |
| | | 144 | 5720 | 15.930 |
| 802.11n (HT40) | U-NII 1 | 38 | 5190 | 39.960 |
| | | 46 | 5230 | 39.980 |
| | U-NII 2A | 54 | 5270 | 39.940 |
| | | 62 | 5310 | 40.030 |
| | U-NII 2C | 102 | 5510 | 40.060 |
| | | 118 | 5590 | 40.110 |
| | | 142 | 5710 | 35.040 |
| 802.11ac (VHT80) | U-NII 1 | 42 | 5210 | 81.550 |
| | | - | - | - |
| | U-NII 2A | 58 | 5290 | 81.390 |
| | | - | - | - |
| | U-NII 2C | 106 | 5530 | 82.560 |
| | | 122 | 5610 | 81.830 |
| | | 138 | 5690 | 76.600 |

## ▣ Result Plots

### 26 dB Bandwidth

Test Mode: 802.11a & Ch.36

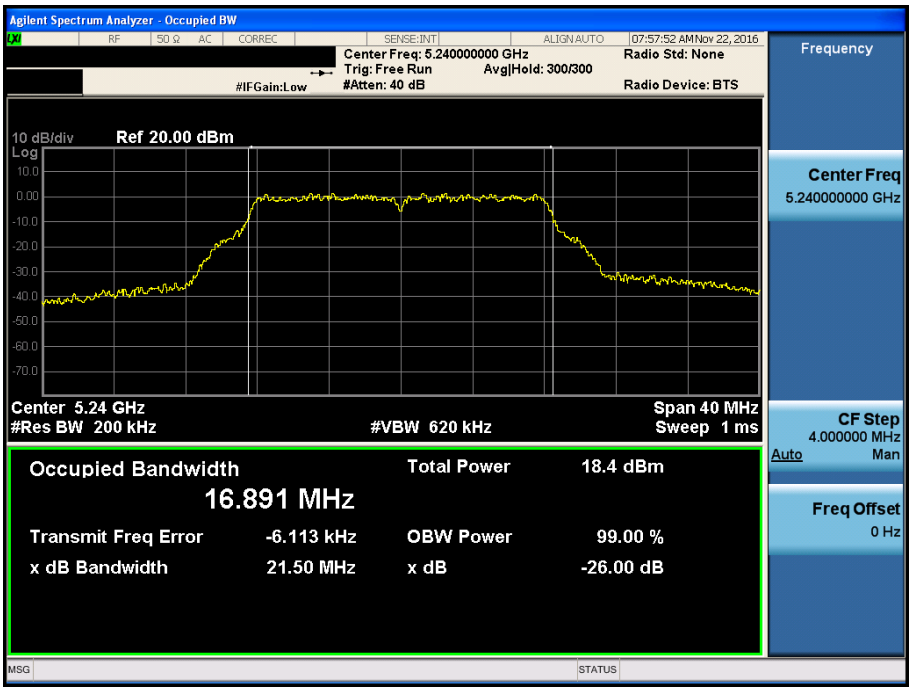



### 26 dB Bandwidth

Test Mode: 802.11a & Ch.40

## 26 dB Bandwidth

Test Mode: 802.11a & Ch.48



## 26 dB Bandwidth

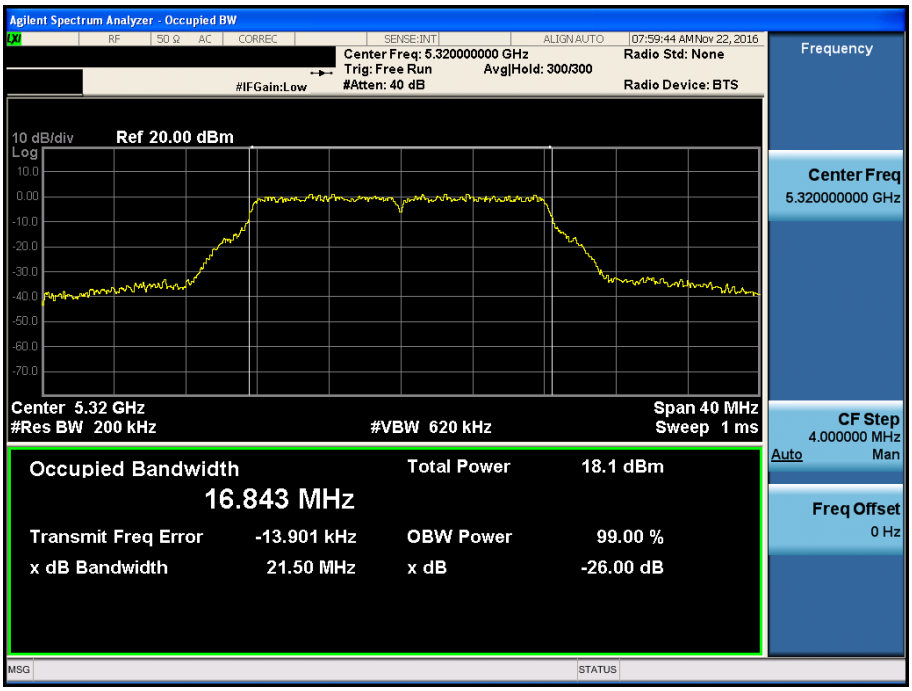
Test Mode: 802.11a & Ch.52


## 26 dB Bandwidth

Test Mode: 802.11a & Ch.60

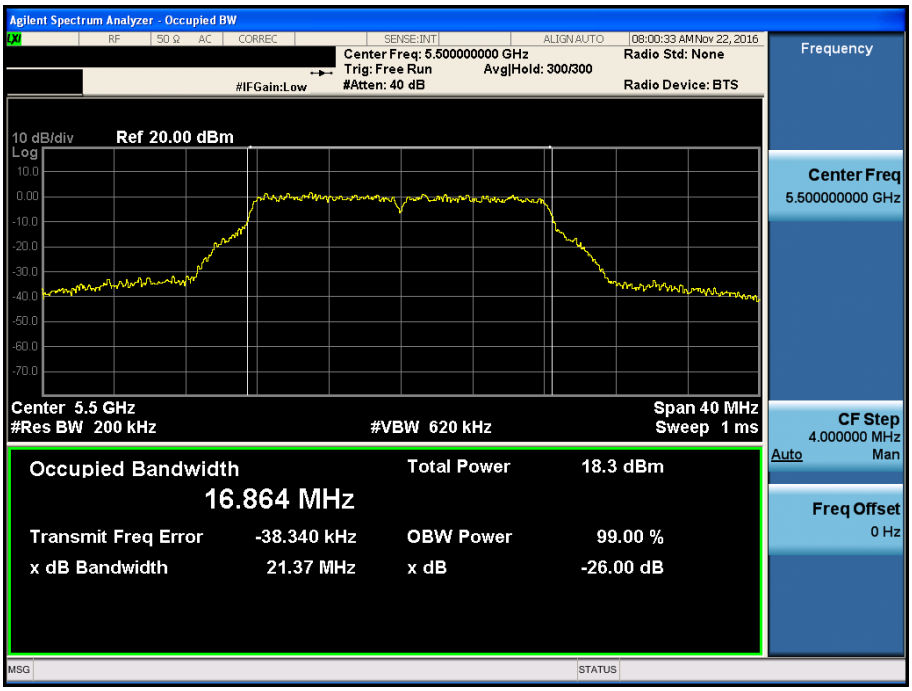
## 26 dB Bandwidth

Test Mode: 802.11a & Ch.64



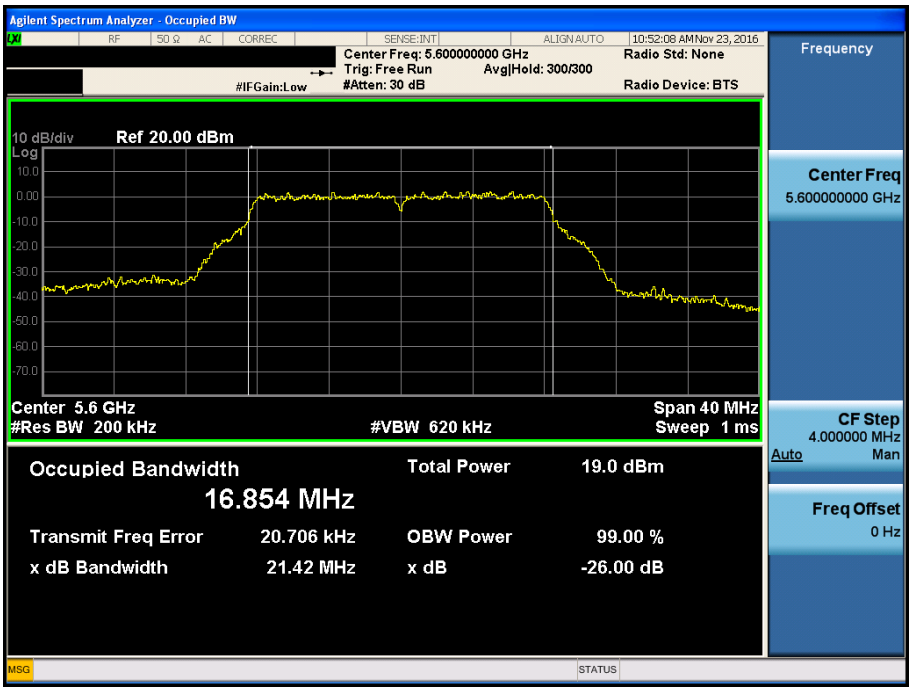
## 26 dB Bandwidth

Test Mode: 802.11a & Ch.100




## 26 dB Bandwidth

Test Mode: 802.11a & Ch.120

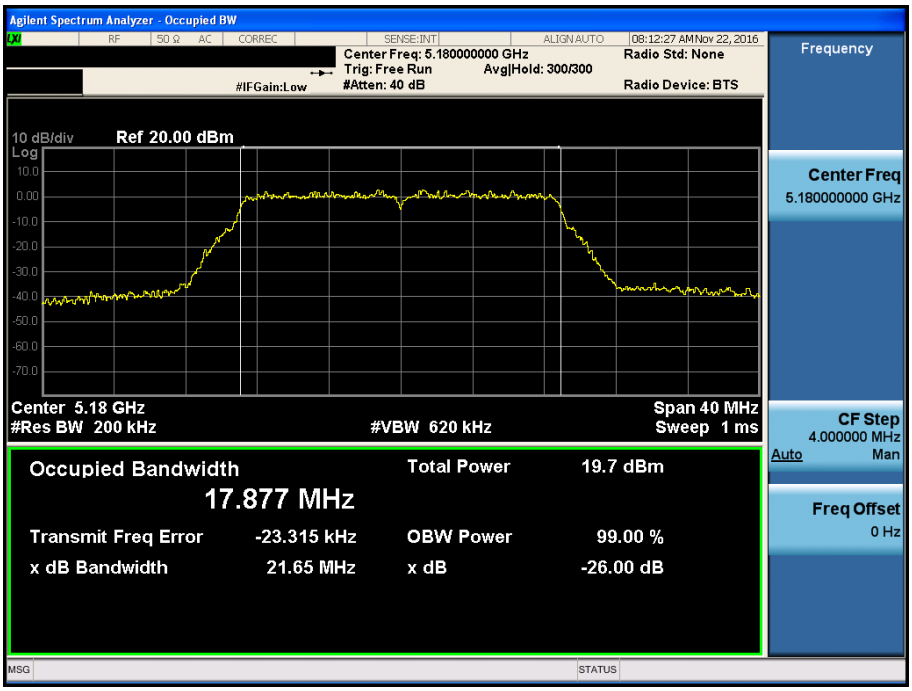


## 26 dB Bandwidth

Test Mode: 802.11a & Ch.144

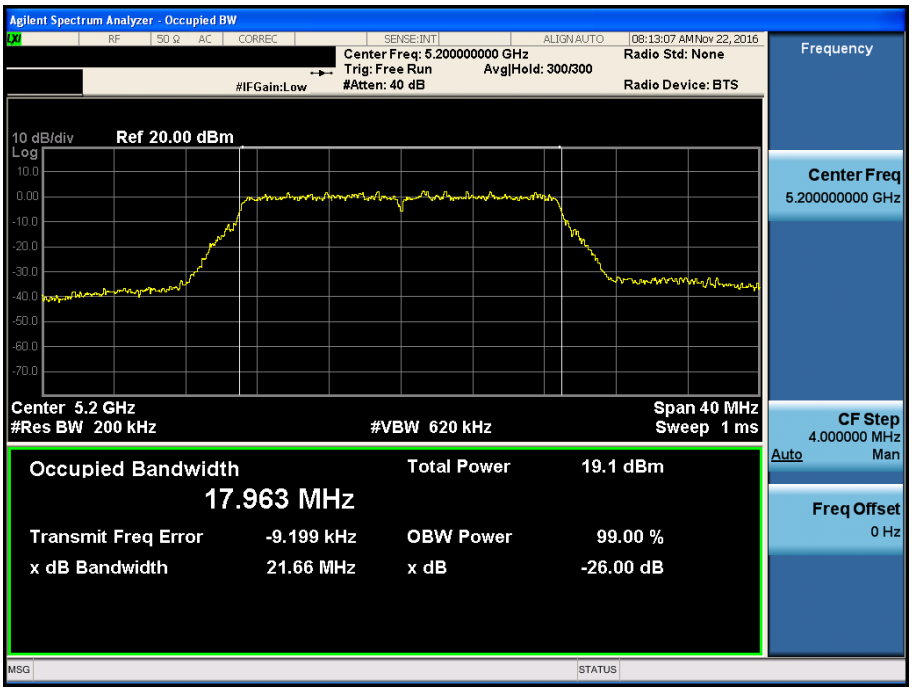
## 26 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.36



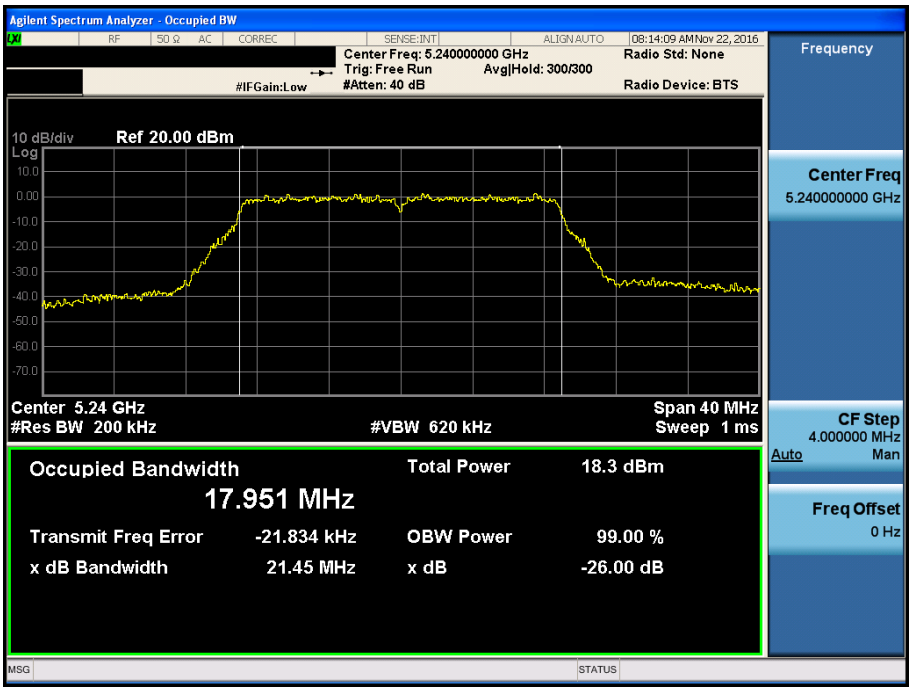

## 26 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.40



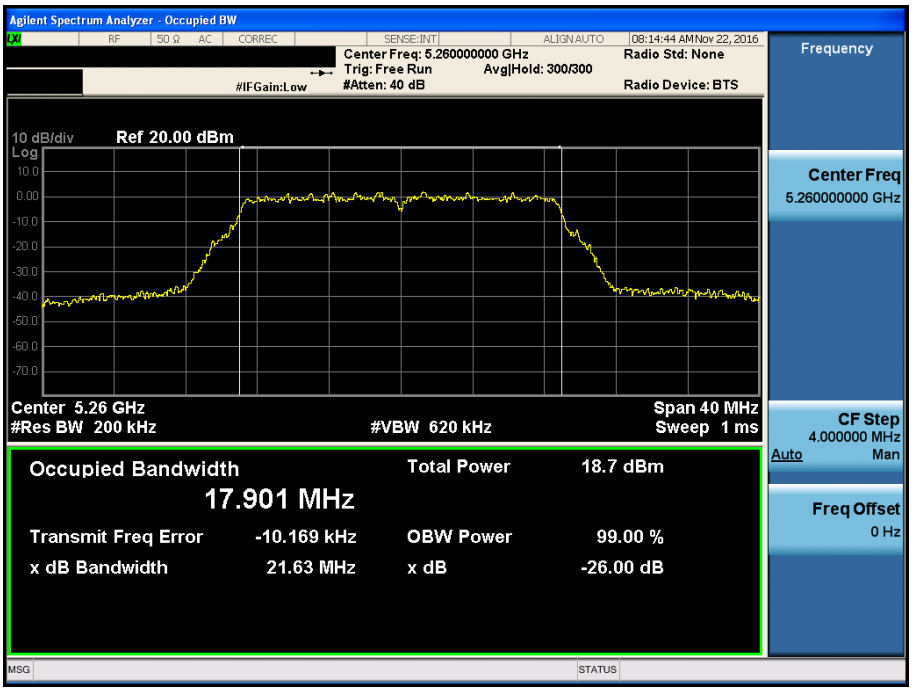
## 26 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.48



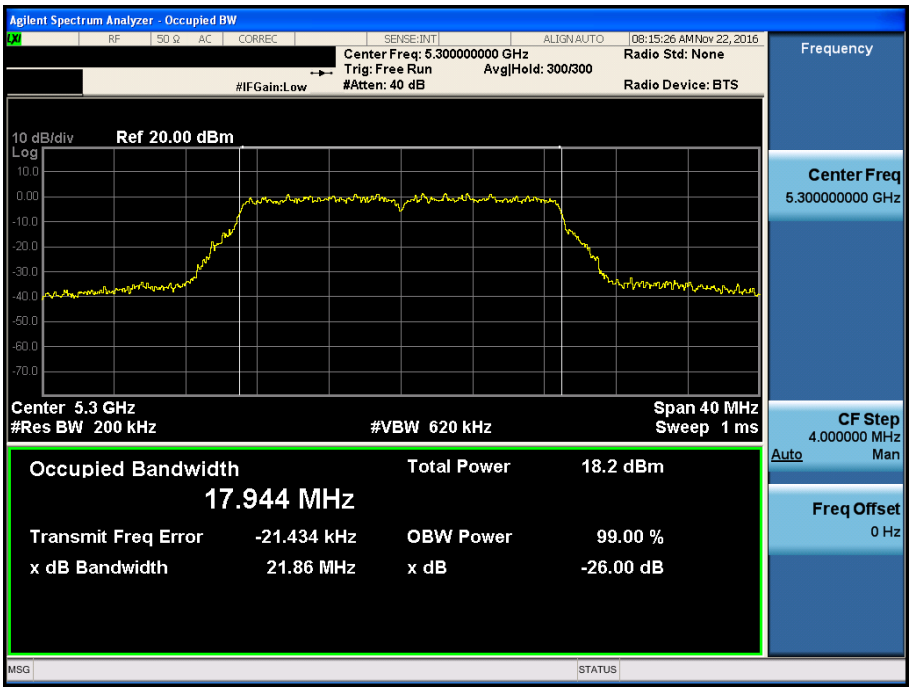
## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.52



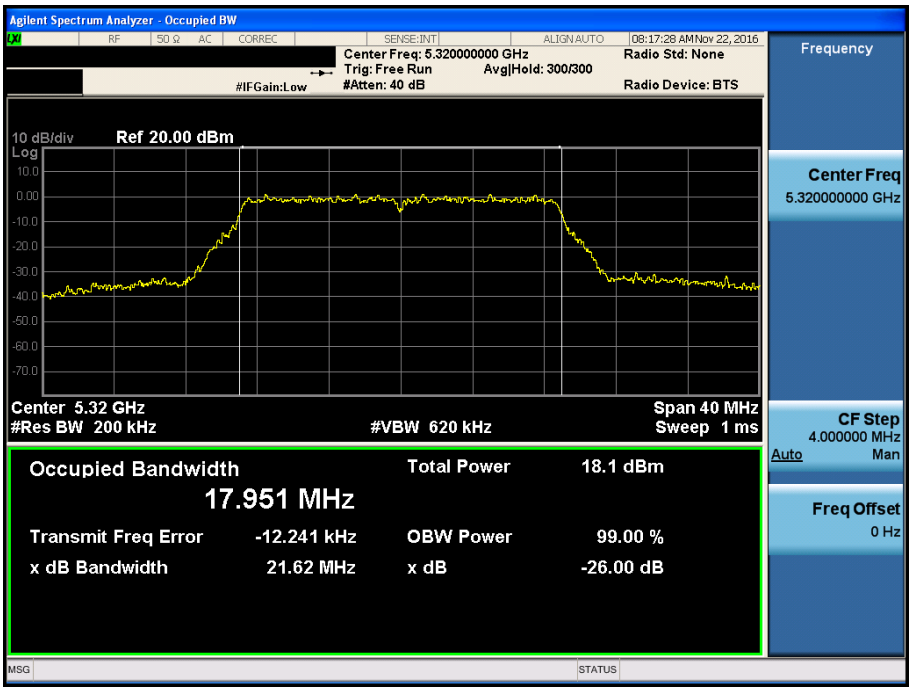

## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.60



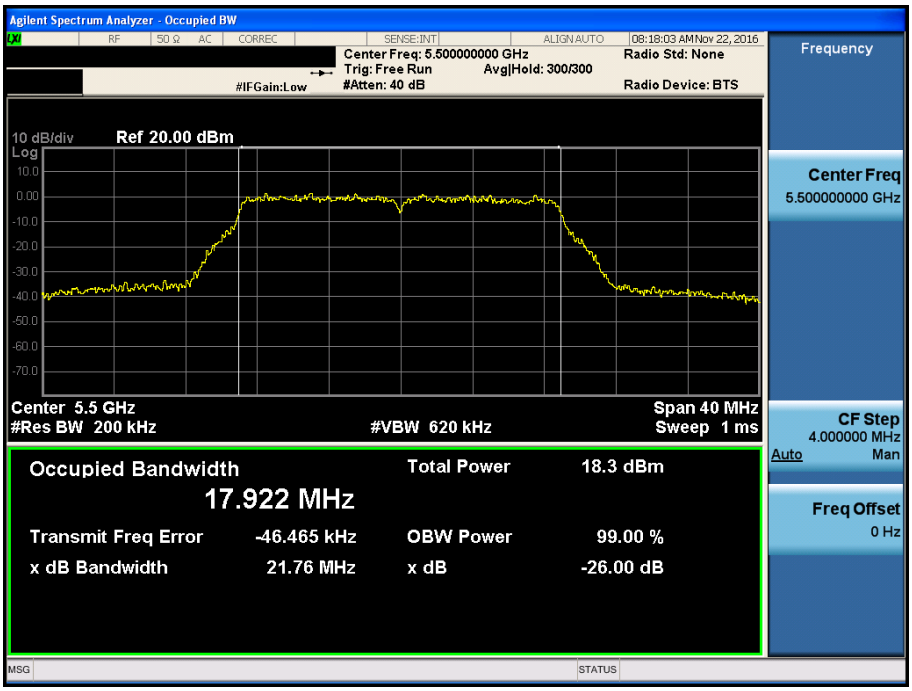
## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.64



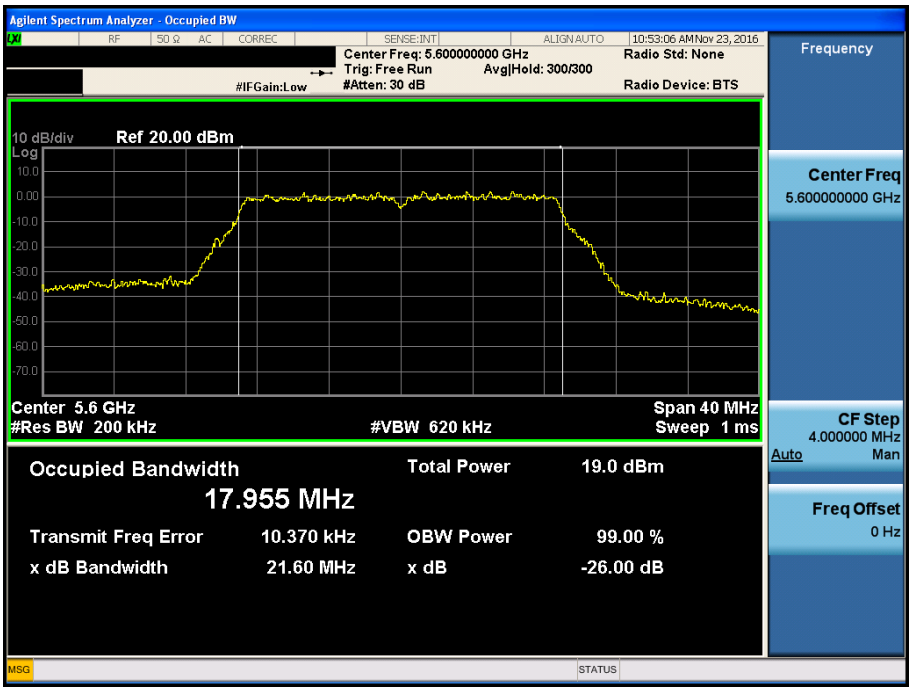
## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.100




## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.120

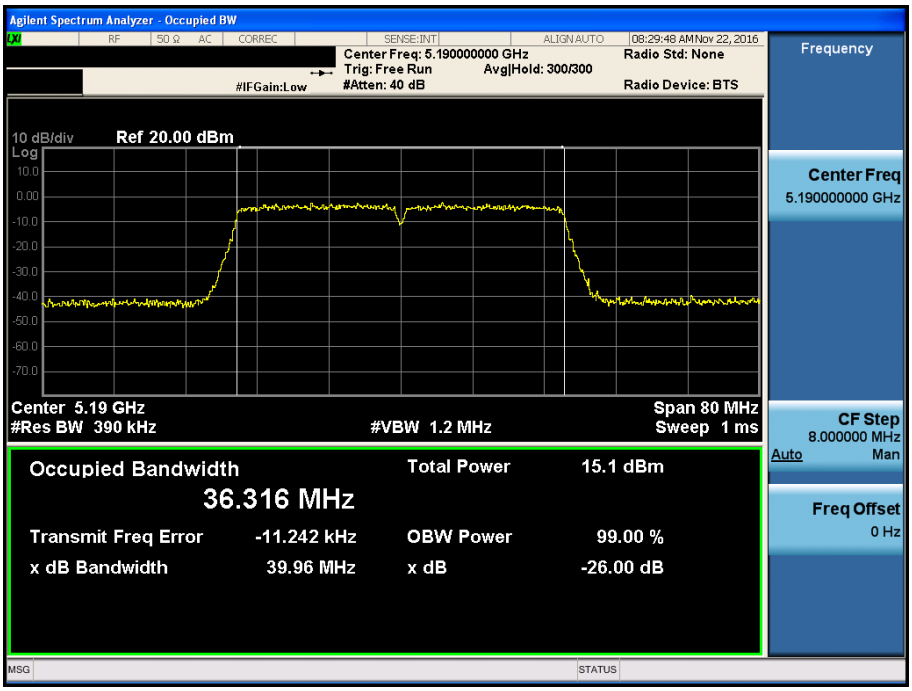


## 26 dB Bandwidth

Test Mode: 802.11n HT20 & Ch.144

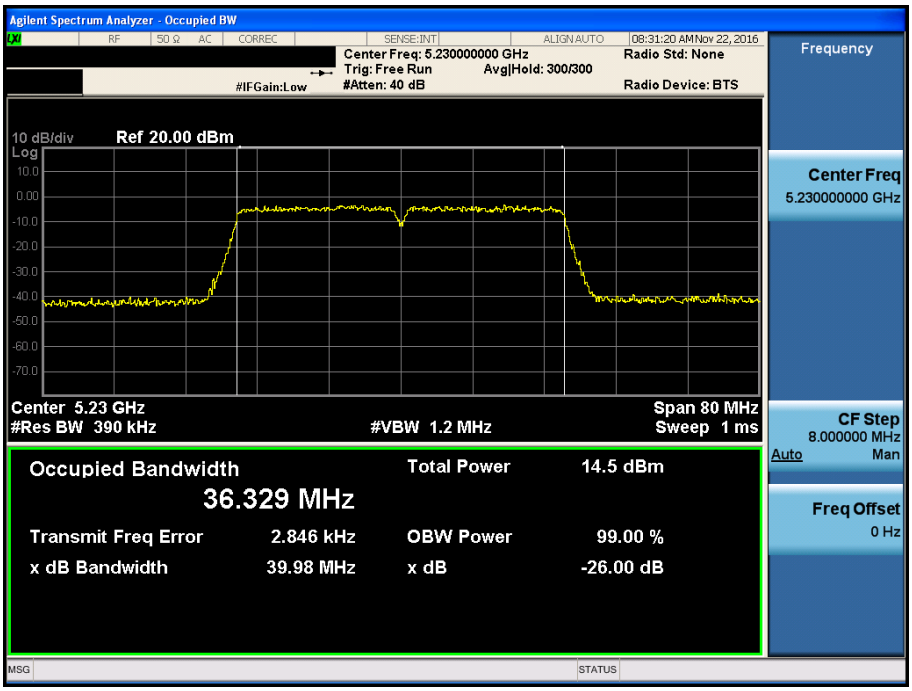
## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.38



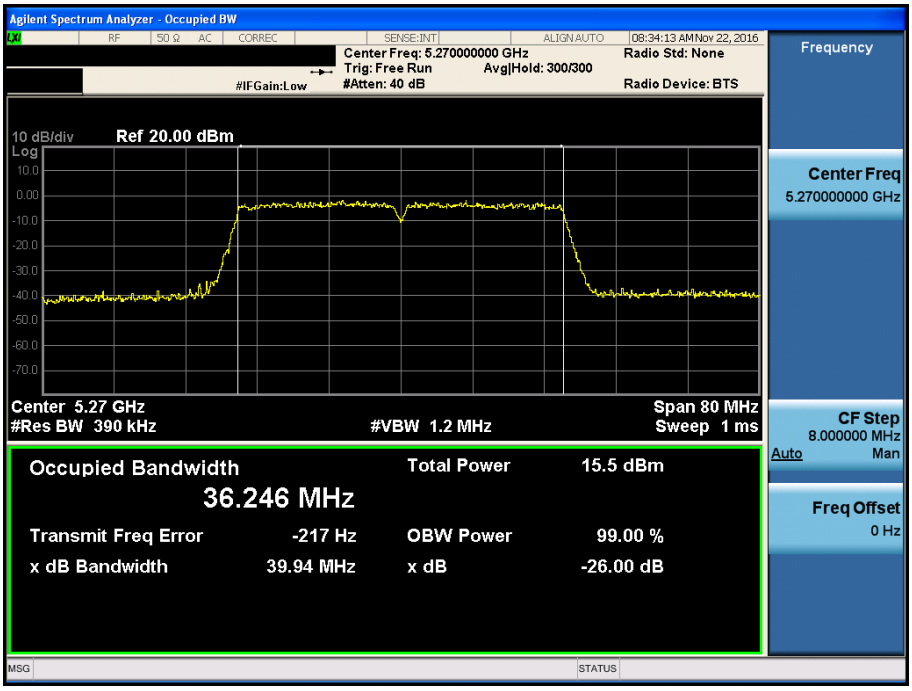

## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.46



## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.54




## 26 dB Bandwidth

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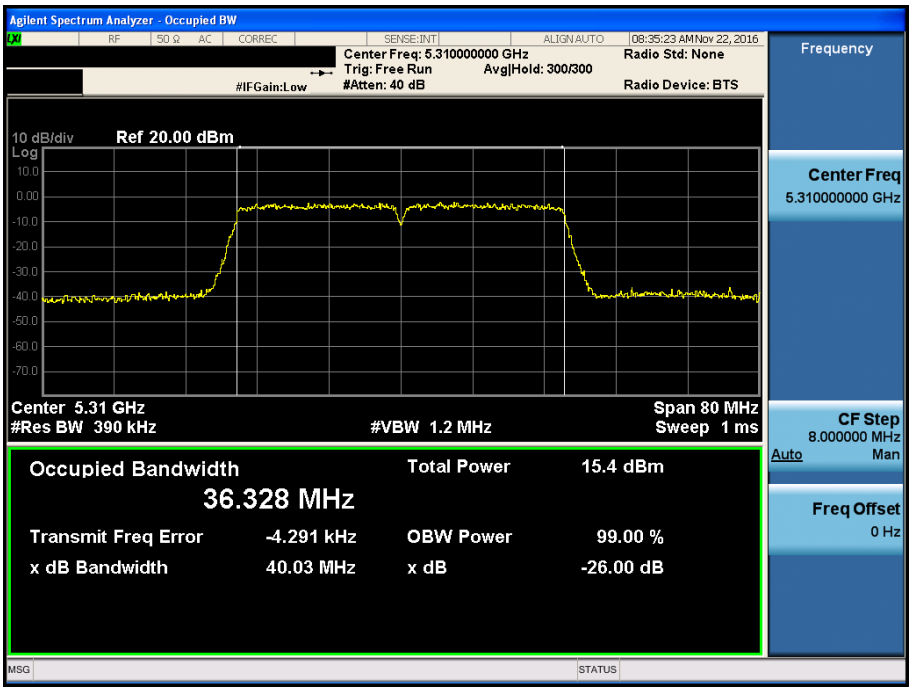
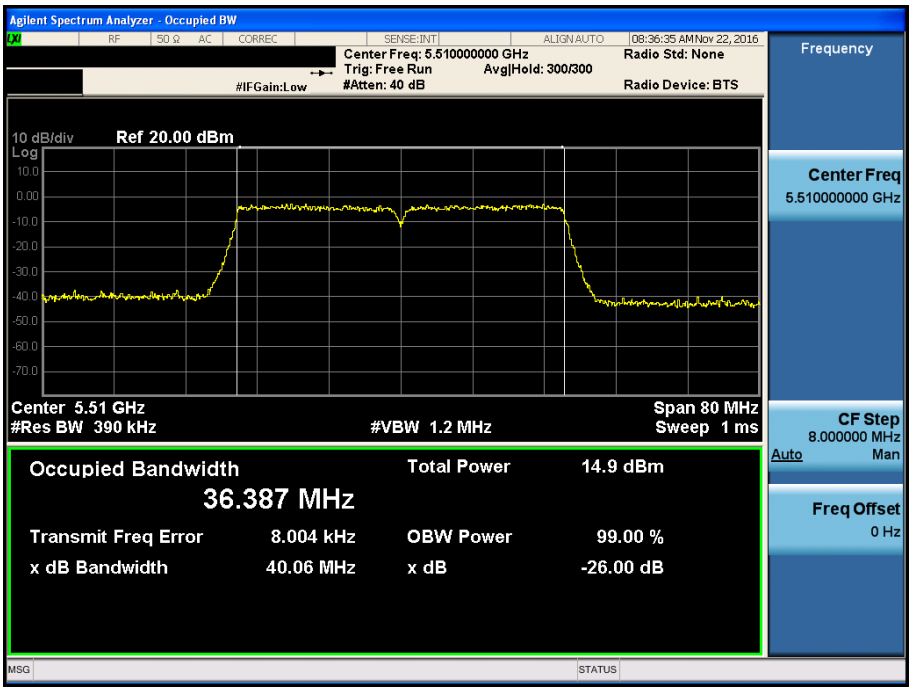


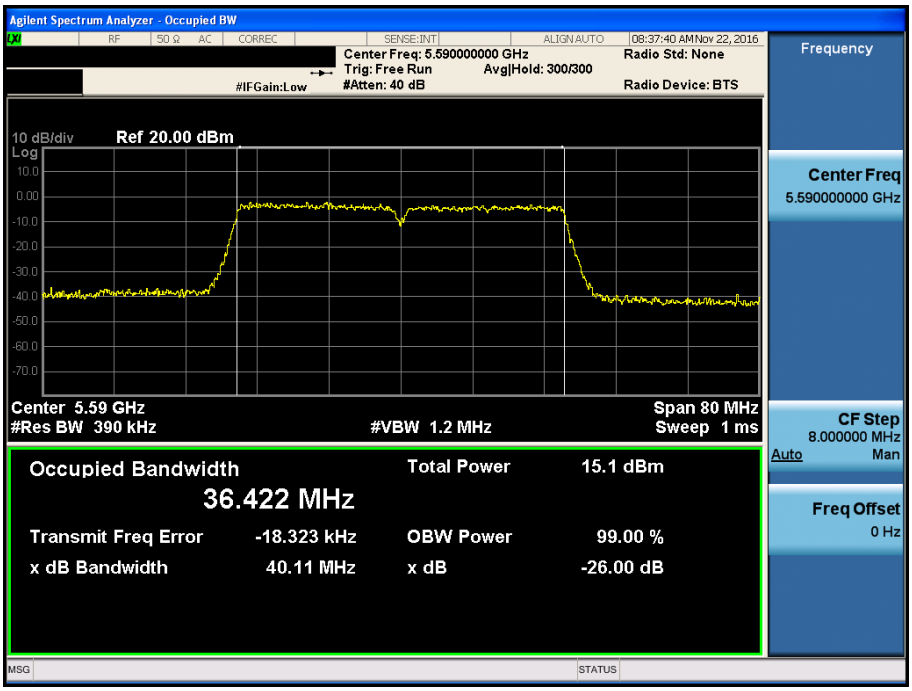
## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.102




## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.118

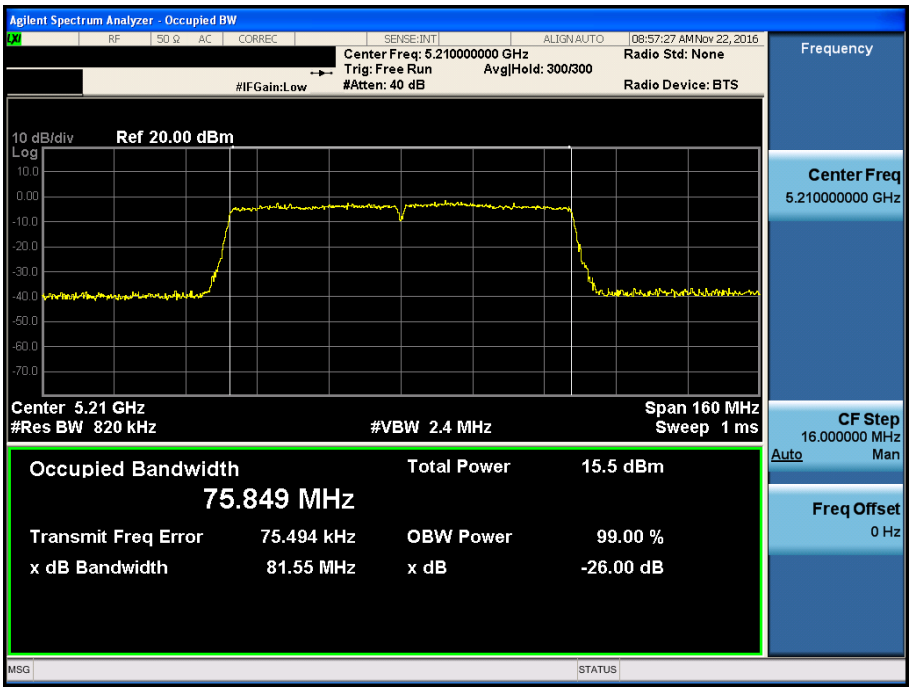


## 26 dB Bandwidth

Test Mode: 802.11n HT40 & Ch.142

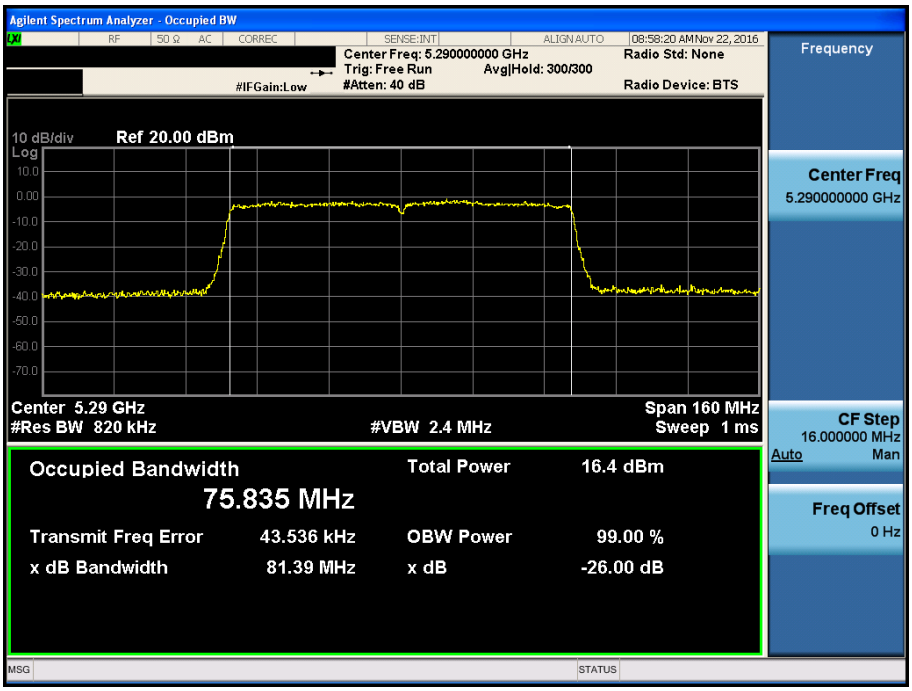
## 26 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.42



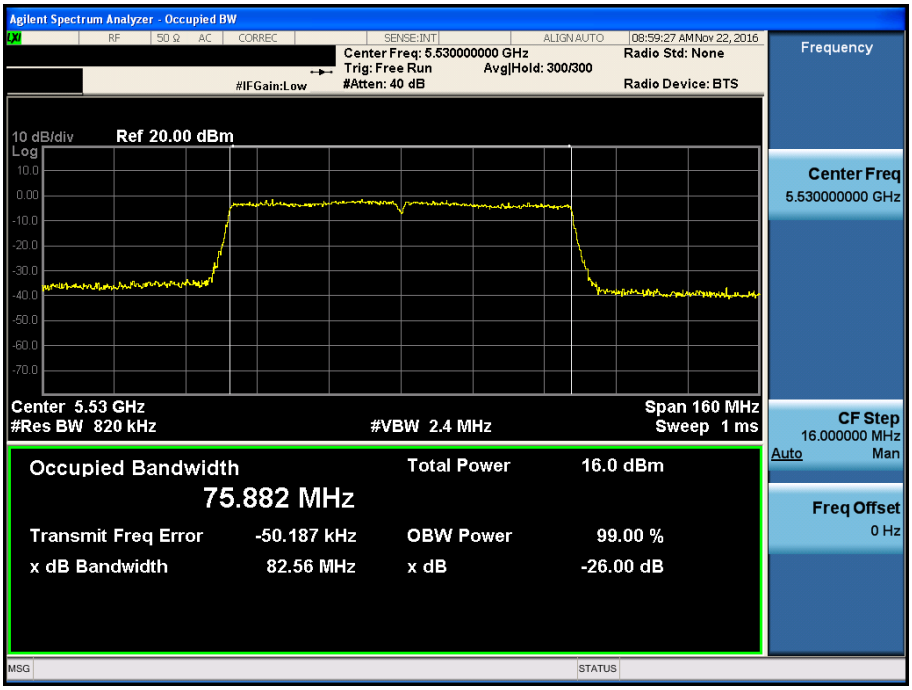

## 26 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.58



## 26 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.106




## 26 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.122

## 26 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.138

## 8.2 Minimum Emission Bandwidth (6 dB Bandwidth)

### ▣ Test Requirements

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

### ▣ Test Configuration

Refer to the APPENDIX I.

### ▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB789033 D02**.

1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth **≥ 3 x RBW**.
3. Detector = **Peak**.
4. Trace mode = **max hold**.
   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.

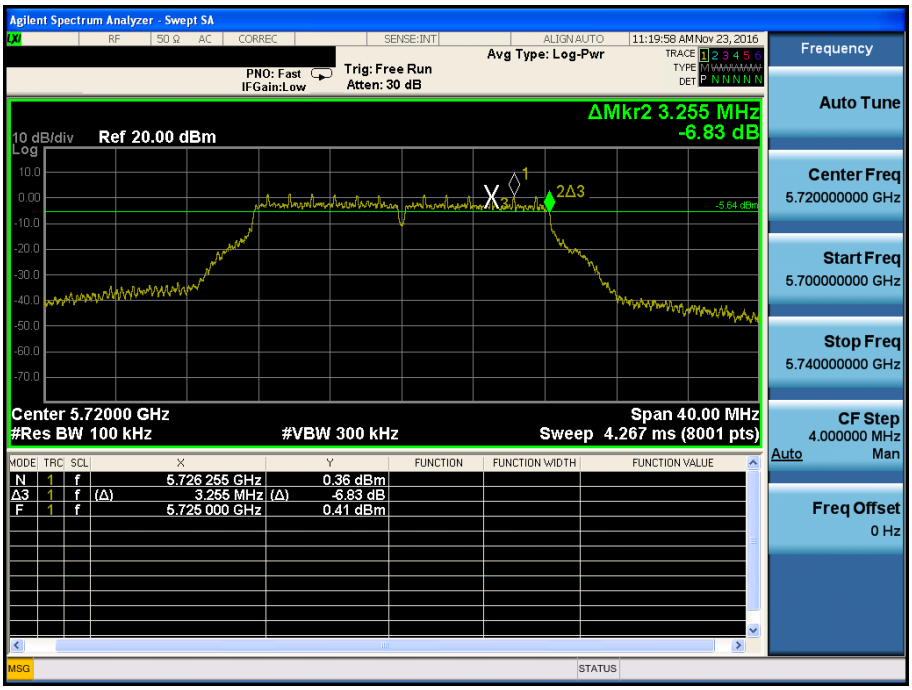
### ▣ TEST RESULTS: Comply

| Mode | Band | Channel | Frequency [MHz] | Test Result [MHz] |
|---|---|---|---|---|
| **802.11a** | U-NII 3 | 144 | 5720 | 3.255 |
| | | 149 | 5745 | 16.360 |
| | | 157 | 5785 | 16.380 |
| | | 165 | 5825 | 16.350 |
| **802.11n (HT20)** | U-NII 3 | 144 | 5720 | 3.805 |
| | | 149 | 5745 | 17.570 |
| | | 157 | 5785 | 17.330 |
| | | 165 | 5825 | 17.580 |
| **802.11n (HT40)** | U-NII 3 | 142 | 5710 | 3.150 |
| | | 151 | 5755 | 35.740 |
| | | 159 | 5795 | 36.110 |
| **802.11ac (VHT80)** | U-NII 3 | 138 | 5690 | 3.100 |
| | | 155 | 5775 | 75.480 |

## ▣ RESULT PLOTS

### 6 dB Bandwidth

Test Mode: 802.11a & Ch.144




### 6 dB Bandwidth

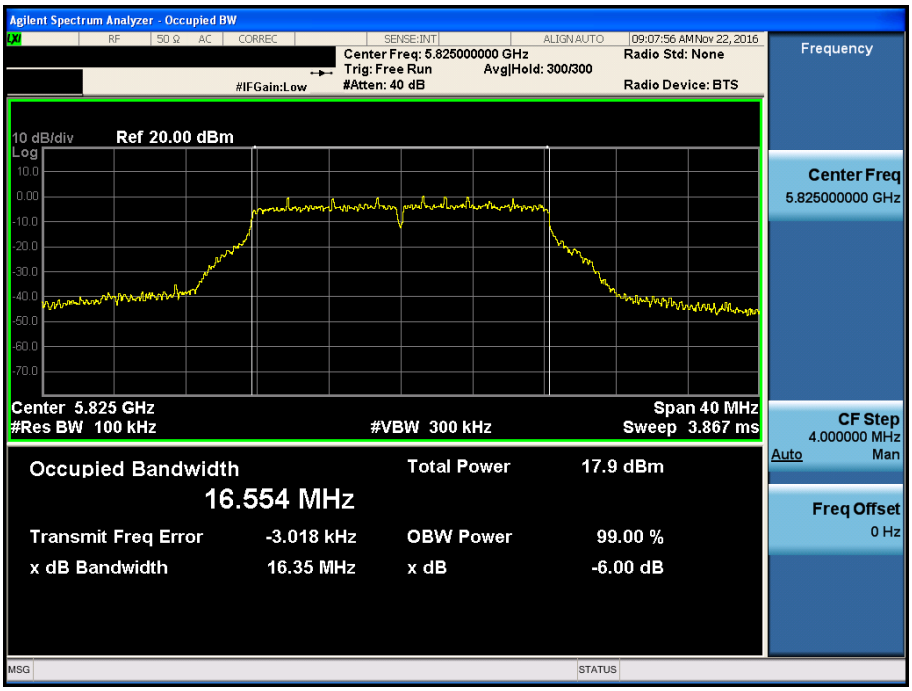
Test Mode: 802.11a & Ch.149

## 6 dB Bandwidth

Test Mode: 802.11a & Ch.157

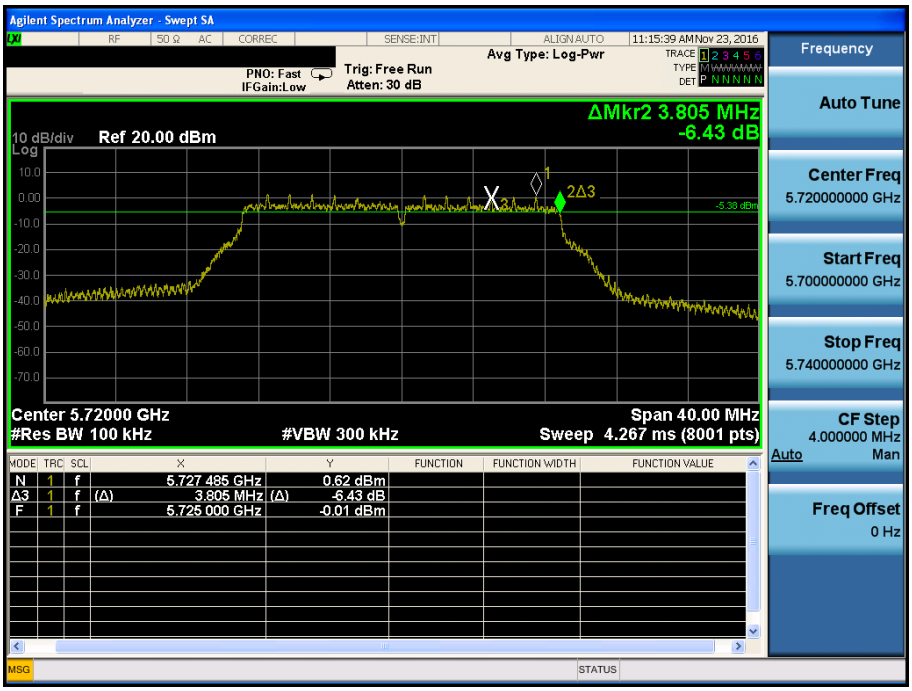

## 6 dB Bandwidth

Test Mode: 802.11a & Ch.165



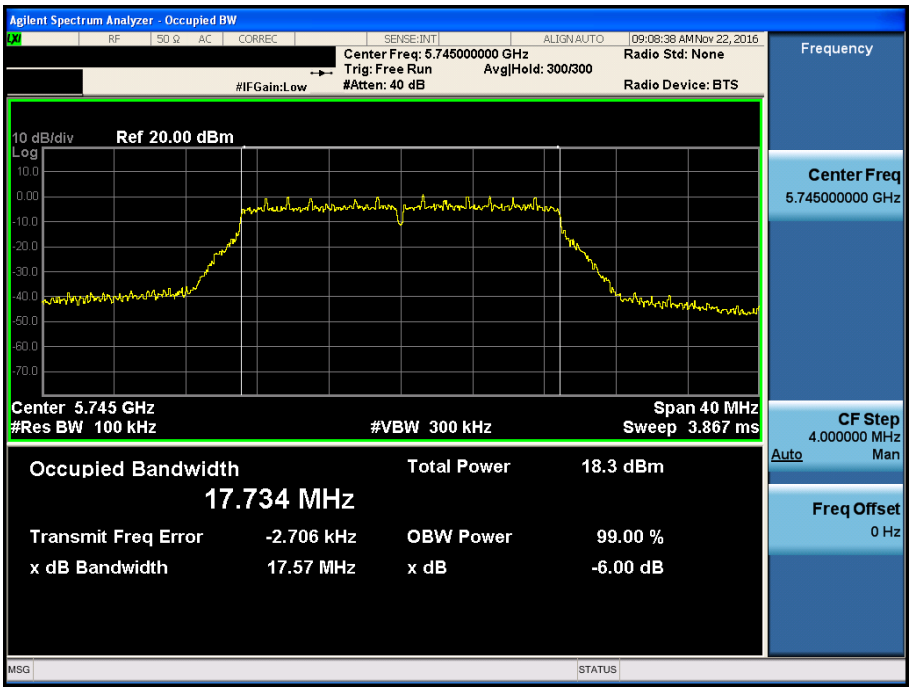
## 6 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.144




## 6 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.149

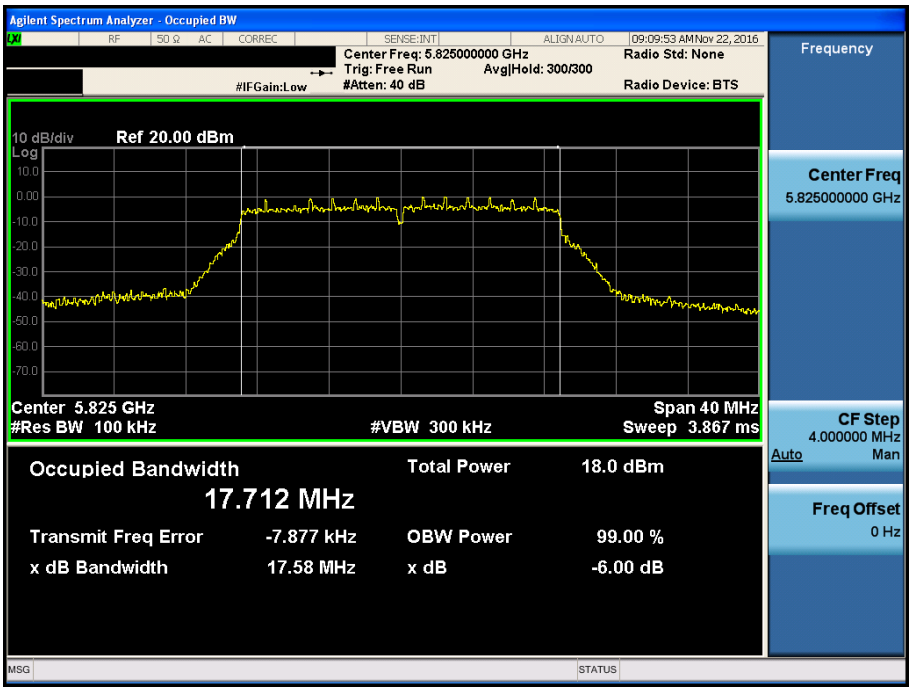


## 6 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.157

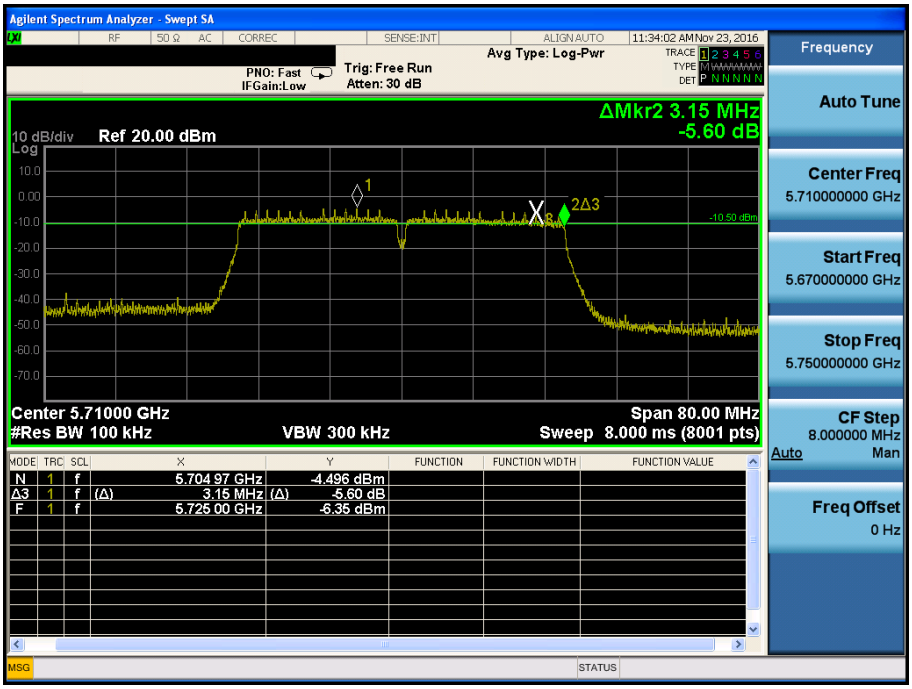

## 6 dB Bandwidth

Test Mode: 802.11n(HT20) & Ch.165



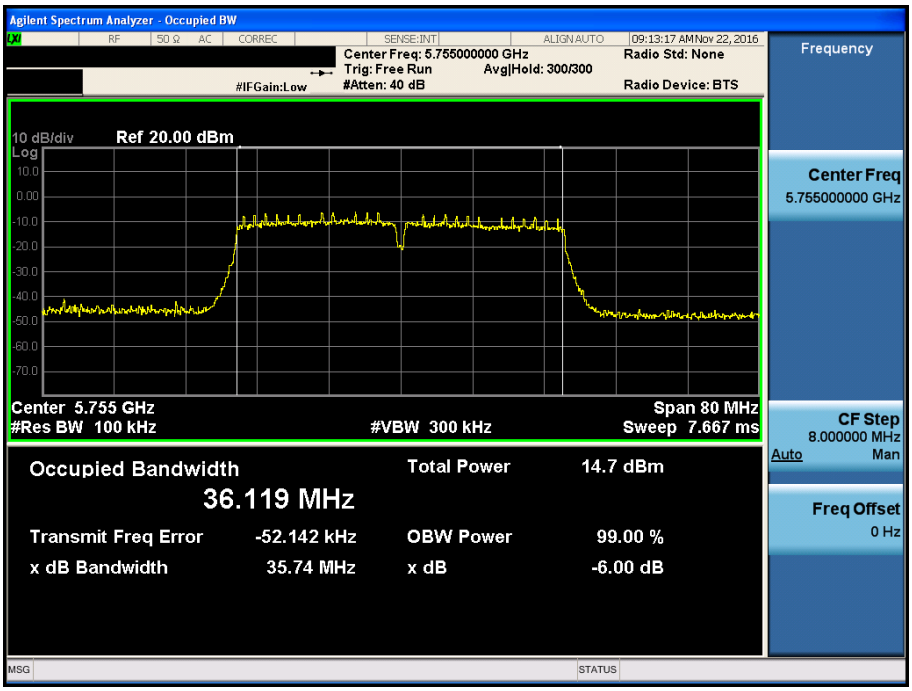
## 6 dB Bandwidth

Test Mode: 802.11n(HT40) & Ch.142



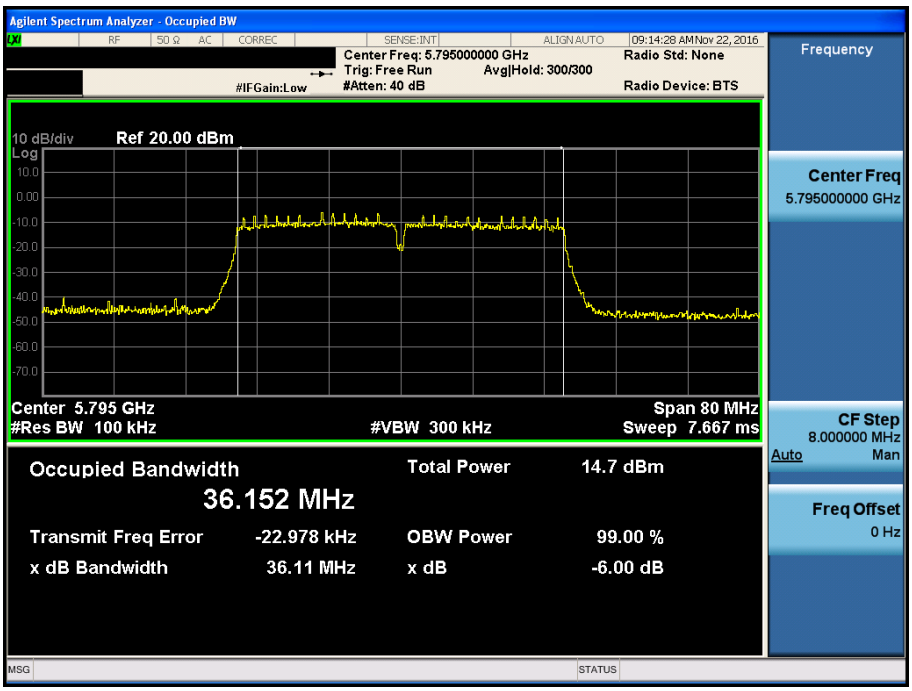

## 6 dB Bandwidth

Test Mode: 802.11n(HT40) & Ch.151



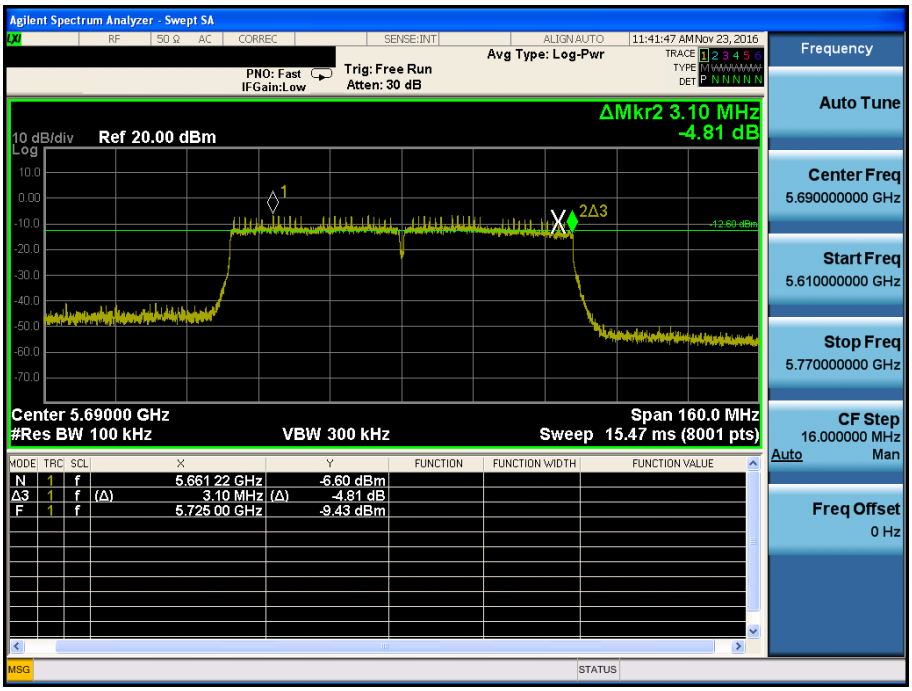
## 6 dB Bandwidth

Test Mode: 802.11n(HT40) & Ch.159



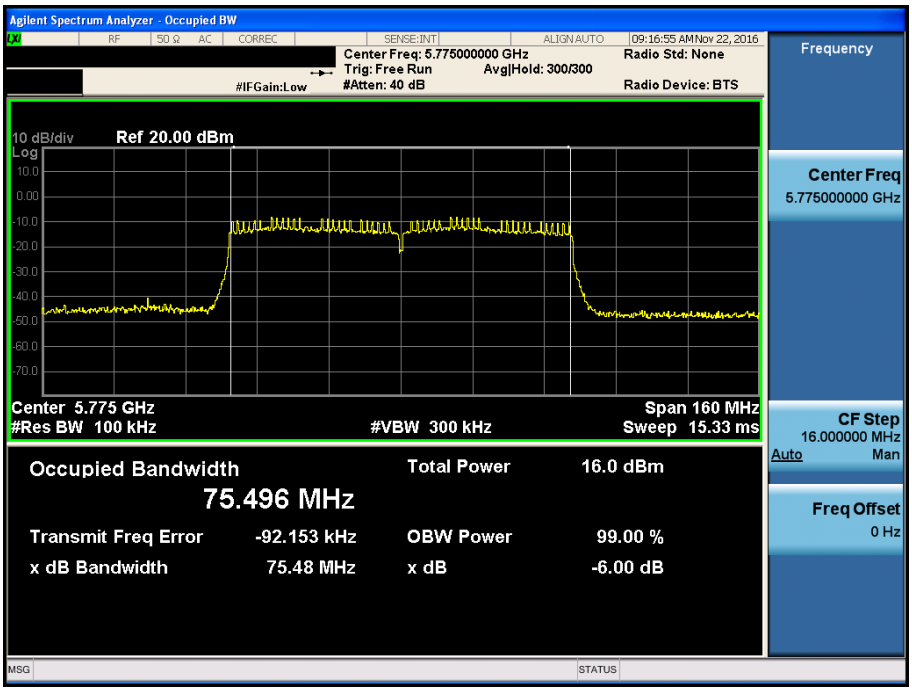
## 6 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.138




## 6 dB Bandwidth

Test Mode: 802.11ac(VHT80) & Ch.155



## 8.3 Maximum Conducted Output Power

### ▣ Test Requirements

**Part. 15.407(a)**

**(1) For the band 5.15 - 5.25 GHz.**

(i) For an outdoor access point operating in the band 5.15 - 5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15 - 5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15 - 5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

**(iv) For mobile and portable 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. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.**

**(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 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.**

**(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, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.**

**- Output power Limit Calculation(FCC)**

| Bands | Mode | Power Limit [mW] | Calculated Limit [dBm] | Antenna Gain (Worst case) | Determined Limit [dBm] |
|---|---|---|---|---|---|
| U-NII 1 | 802.11a | 250 | 23.97 | 1.420 | 23.97 |
| | 802.11n(HT20)/ 802.1ac(VHT20) | | | | |
| | 802.11n(HT40) / 802.1ac(VHT40) | | | | |
| | 802.11ac(VHT80) | | | | |

| Bands | Mode | Power Limit [mW] / Least 26 dBc BW [MHz] | Calculated Limit [dBm] | Antenna Gain (Worst case) | Determined Limit [dBm] |
|---|---|---|---|---|---|
| U-NII 2A | 802.11a | 250 | 23.97 | 1.420 | 23.97 |
| | | 21.27 | 24.27 | | |
| | 802.11n(HT20)/ 802.1ac(VHT20) | 250 | 23.97 | | |
| | | 21.62 | 24.34 | | |
| | 802.11n(HT20)/ 802.1ac(VHT20) | 250 | 23.97 | | |
| | | 39.94 | 27.01 | | |
| | 802.11ac(VHT80) | 250 | 23.97 | | |
| | | 81.39 | 30.10 | | |

| Bands | Mode | Power Limit [mW] / Least 26 dBc BW [MHz] | Calculated Limit [dBm] | Antenna Gain (Worst case) | Determined Limit [dBm] |
|---|---|---|---|---|---|
| U-NII 2C | 802.11a | 250 | 23.97 | -0.850 | 22.99 |
| | | 15.83 | 22.99 | | |
| | 802.11n(HT20)/ 802.1ac(VHT20) | 250 | 23.97 | | 23.02 |
| | | 15.93 | 23.02 | | |
| | 802.11n(HT20)/ 802.1ac(VHT20) | 250 | 23.97 | | 23.97 |
| | | 35.04 | 26.44 | | |
| | 802.11ac(VHT80) | 250 | 23.97 | | 23.97 |
| | | 76.60 | 29.84 | | |

| Bands | Mode | Power Limit [mW] | Calculated Limit [dBm] | Antenna Gain (Worst case) | Determined Limit [dBm] |
|---|---|---|---|---|---|
| U-NII 3 | 802.11a | 1000 | 30.00 | -2.390 | 30.00 |
| | 802.11n(HT20)/ 802.1ac(VHT20) | | | | |
| | 802.11n(HT40) / 802.1ac(VHT40) | | | | |
| | 802.11ac(VHT80) | | | | |

▣ **Test Results: Comply**

| Mode | Bands | Channel | Frequency [MHz] | Test Result [dBm] |
|---|---|---|---|---|
| 802.11a | U-NII 1 | 36 | 5180 | 11.690 |
| | | 40 | 5200 | 11.210 |
| | | 48 | 5240 | 10.510 |
| | U-NII 2A | 52 | 5260 | 9.770 |
| | | 60 | 5300 | 9.120 |
| | | 64 | 5320 | 9.100 |
| | U-NII 2C | 100 | 5500 | 11.340 |
| | | 120 | 5600 | 11.280 |
| | | 144 | 5720 | 9.660 |
| | U-NII 3 | 149 | 5745 | 8.310 |
| | | 157 | 5785 | 8.380 |
| | | 165 | 5825 | 8.630 |
| 802.11n HT20 | U-NII 1 | 36 | 5180 | 11.510 |
| | | 40 | 5200 | 11.010 |
| | | 48 | 5240 | 10.060 |
| | U-NII 2A | 52 | 5260 | 9.650 |
| | | 60 | 5300 | 9.030 |
| | | 64 | 5320 | 8.960 |
| | U-NII 2C | 100 | 5500 | 11.150 |
| | | 120 | 5600 | 11.470 |
| | | 144 | 5720 | 9.570 |
| | U-NII 3 | 149 | 5745 | 8.130 |
| | | 157 | 5785 | 8.290 |
| | | 165 | 5825 | 8.730 |
| 802.11n HT40 | U-NII 1 | 38 | 5190 | 7.150 |
| | | 46 | 5230 | 6.050 |
| | U-NII 2A | 54 | 5270 | 6.410 |
| | | 62 | 5310 | 6.340 |
| | U-NII 2C | 102 | 5510 | 7.920 |
| | | 118 | 5590 | 8.140 |
| | | 142 | 5710 | 6.190 |
| | U-NII 3 | 151 | 5755 | 4.710 |
| | | 159 | 5795 | 4.950 |

▣ **Test Results: Comply**

| Mode | Bands | Channel | Frequency [MHz] | Test Result [dBm] |
|---|---|---|---|---|
| 802.11ac VHT20 | U-NII 1 | 36 | 5180 | 11.490 |
| | | 40 | 5200 | 10.870 |
| | | 48 | 5240 | 10.030 |
| | U-NII 2A | 52 | 5260 | 9.420 |
| | | 60 | 5300 | 8.950 |
| | | 64 | 5320 | 8.850 |
| | U-NII 2C | 100 | 5500 | 11.350 |
| | | 120 | 5600 | 11.410 |
| | | 144 | 5720 | 9.520 |
| | U-NII 3 | 149 | 5745 | 8.070 |
| | | 157 | 5785 | 8.140 |
| | | 165 | 5825 | 8.560 |
| 802.11ac VHT40 | U-NII 1 | 38 | 5190 | 7.130 |
| | | 46 | 5230 | 6.020 |
| | U-NII 2A | 54 | 5270 | 6.360 |
| | | 62 | 5310 | 6.160 |
| | U-NII 2C | 102 | 5510 | 7.730 |
| | | 118 | 5590 | 8.020 |
| | | 142 | 5710 | 6.150 |
| | U-NII 3 | 151 | 5755 | 4.580 |
| | | 159 | 5795 | 4.880 |
| 802.11ac VHT80 | U-NII 1 | 42 | 5210 | 6.340 |
| | | - | - | - |
| | U-NII 2A | 58 | 5290 | 6.230 |
| | | - | - | - |
| | U-NII 2C | 106 | 5530 | 8.550 |
| | | 122 | 5610 | 8.230 |
| | | 138 | 5690 | 7.140 |
| | U-NII 3 | 155 | 5755 | 5.490 |
| | | - | - | - |

## 8.4 Maximum Power Spectral Density

▣ **Test requirements**

**(1) For the band 5.15-5.25 GHz.**

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1MHz band. note1

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1MHz band. note1

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi.

**(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1MHz band.** note1

**(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the peak power spectral density shall not exceed 11 dBm in any 1 MHz band.** note1

**(3) For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.** note1,note2

**Note1**: If transmitting antennas of directional gain greater than 6 dBi are used, the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Note2**: fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information.

**- Peak Power Spectral Density Limit Calculation**

| Band | Limit [dBm] | Antenna Gain (Worst case) | Determined Limit [dBm] |
|---|---|---|---|
| U-NII 1 | 11 | 1.420 | 11 |
| U-NII 2A | 11 | 1.420 | 11 |
| U-NII 2C | 11 | -0.850 | 11 |
| U-NII 3 | 30 | -2.390 | 30 |

▣ **Test configuration**

Refer to the APPENDIX I.

▣ **Test procedure**

Maximum Power Spectral Density is measured using Measurement Procedure **of KDB789033 D02 V01**

1) Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, “Compute power…”. (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)

2) Use the peak search function on the instrument to find the peak of the spectrum and record its value.

3) Make the following adjustments to the peak value of the spectrum, if applicable:
**a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.**
b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.

4) The result is the Maximum PSD over 1 MHz reference bandwidth.

5) For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in §15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, “provided that the measured power is integrated over the full reference bandwidth” to show the total power over the specified measurement bandwidth (i.e., 1 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:

a) Set RBW ≥ 1/T, where T is defined in section II.B.1.a). (Refer to Appendix II)

b) Set VBW ≥ 3 RBW.

c) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add 10log(500kHz/RBW) to the measured result, whereas RBW (< 500 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.

d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10log(1MHz/RBW) to the measured result, whereas RBW (< 1 MHz) is the reduced resolution bandwidth of spectrum analyzer set during measurement.

e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

**Note: As a practical matter, it is recommended to use reduced RBW of 100 kHz for the sections 5.c) and 5.d) above, since RBW=100 kHz is available on nearly all spectrum analyzers.**

▣ **Test result: Comply**

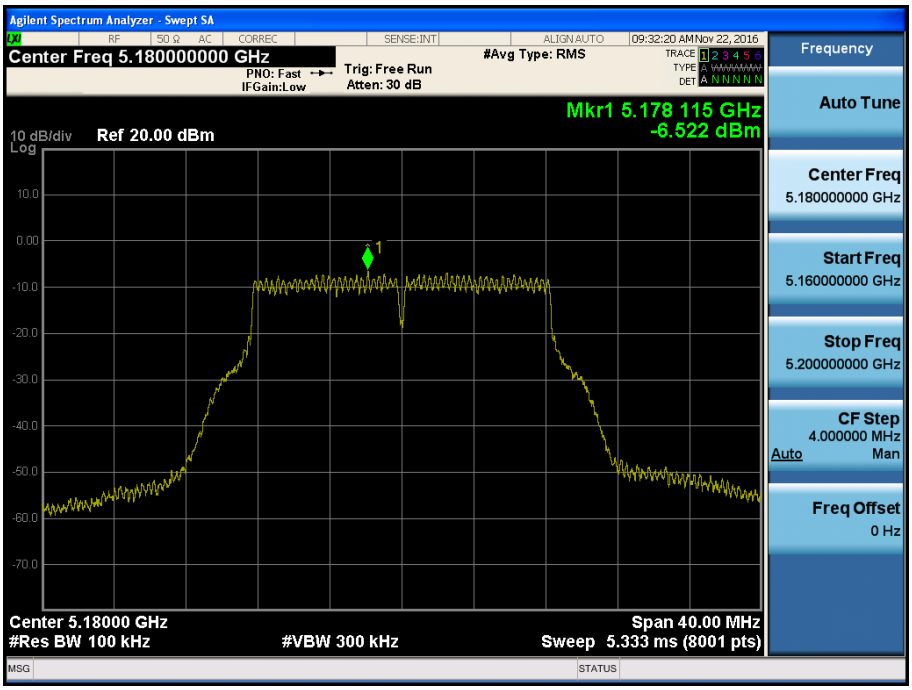
| Mode | Channel | Frequency [MHz] | Reading [dBm] | T.F [dB] Note 1 | Test Result [dBm] |
|---|---|---|---|---|---|
| 802.11a | 36 | 5180 | -6.522 | 10.310 | 3.788 |
| | 40 | 5200 | -7.417 | | 2.893 |
| | 48 | 5240 | -8.464 | | 1.846 |
| | 52 | 5260 | -7.788 | | 2.522 |
| | 60 | 5300 | -8.485 | | 1.825 |
| | 64 | 5320 | -8.337 | | 1.973 |
| | 100 | 5500 | -8.487 | | 1.823 |
| | 120 | 5600 | -7.837 | | 2.473 |
| | 144 | 5720 | -7.583 | | 2.727 |
| | 149 | 5745 | -8.452 | 7.300 | -1.152 |
| | 157 | 5785 | -8.671 | | -1.371 |
| | 165 | 5825 | -8.241 | | -0.941 |
| 802.11n HT20 | 36 | 5180 | -7.329 | 10.320 | 2.991 |
| | 40 | 5200 | -8.166 | | 2.154 |
| | 48 | 5240 | -8.527 | | 1.793 |
| | 52 | 5260 | -8.501 | | 1.819 |
| | 60 | 5300 | -8.945 | | 1.375 |
| | 64 | 5320 | -9.148 | | 1.172 |
| | 100 | 5500 | -8.862 | | 1.458 |
| | 120 | 5600 | -8.494 | | 1.826 |
| | 144 | 5720 | -8.089 | | 2.231 |
| | 149 | 5745 | -8.955 | 7.310 | -1.645 |
| | 157 | 5785 | -8.939 | | -1.629 |
| | 165 | 5825 | -9.184 | | -1.874 |
| 802.11n HT40 | 38 | 5190 | -14.968 | 10.630 | -4.338 |
| | 46 | 5230 | -15.174 | | -4.544 |
| | 54 | 5270 | -14.589 | | -3.959 |
| | 62 | 5310 | -14.600 | | -3.970 |
| | 102 | 5510 | -15.198 | | -4.568 |
| | 118 | 5590 | -14.635 | | -4.005 |
| | 142 | 5710 | -14.383 | | -3.753 |
| | 151 | 5755 | -15.411 | 7.620 | -7.791 |
| | 159 | 5795 | -15.986 | | -8.366 |
| 802.11ac VHT80 | 42 | 5210 | -17.913 | 11.170 | -6.743 |
| | - | - | - | | - |
| | 58 | 5290 | -17.729 | | -6.559 |
| | - | - | - | | - |
| | 106 | 5530 | -17.280 | | -6.110 |
| | 122 | 5610 | -16.637 | | -5.467 |
| | 138 | 5690 | -16.873 | | -5.703 |
| | 155 | 5775 | -17.952 | 8.160 | -9.792 |
| | - | - | - | | - |

Note 1: "Band 1, 2, 3 [T.F] = D.C.F"
"Band 4 [T.F] = 10*LOG(500/100) + D.C.F"
For D.C.F., please refer to appendix II.
Note 2: Test Result = Measurement Data + T.F

## ▣ RESULT PLOTS

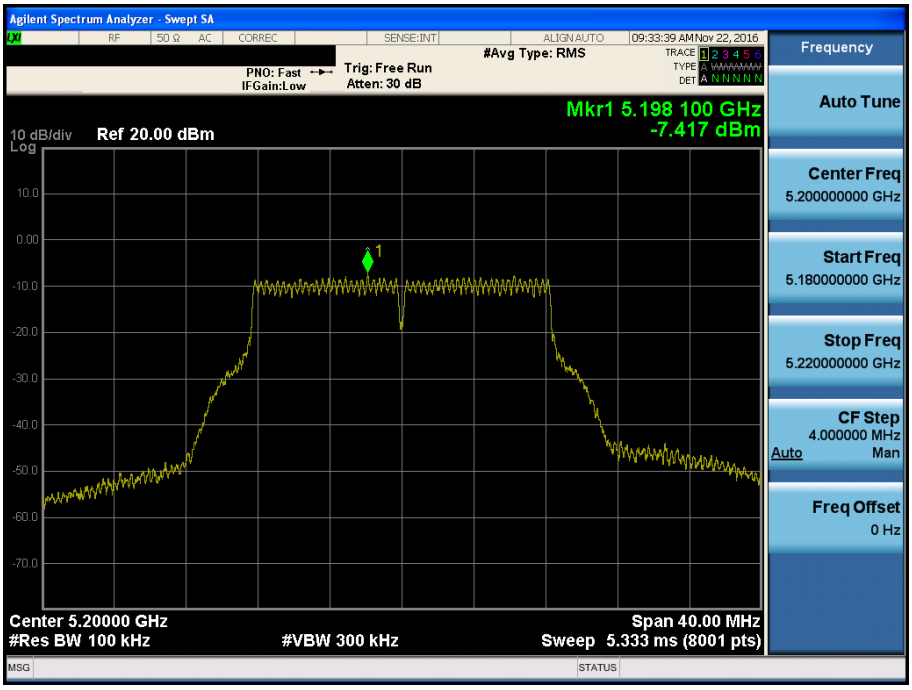
### Maximum Power Spectral Density

Test Mode: 802.11a & Ch.36

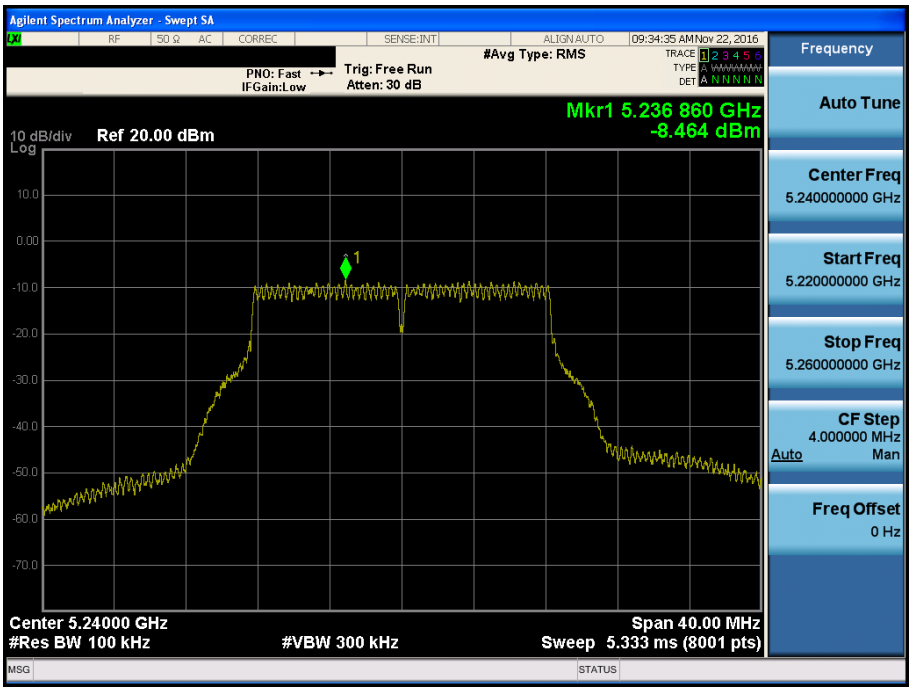



### Maximum Power Spectral Density

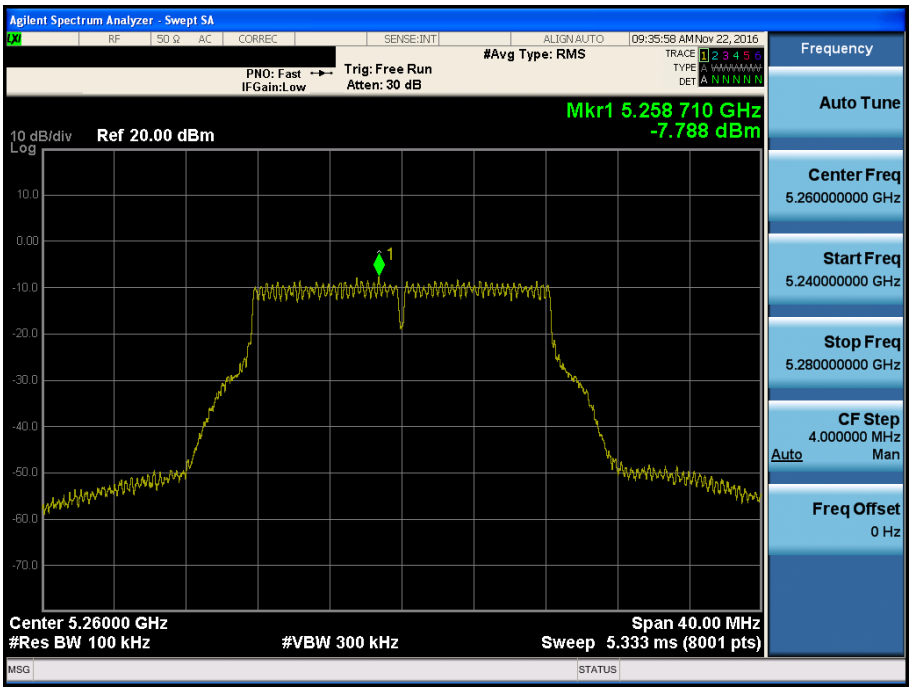
Test Mode: 802.11a & Ch.40



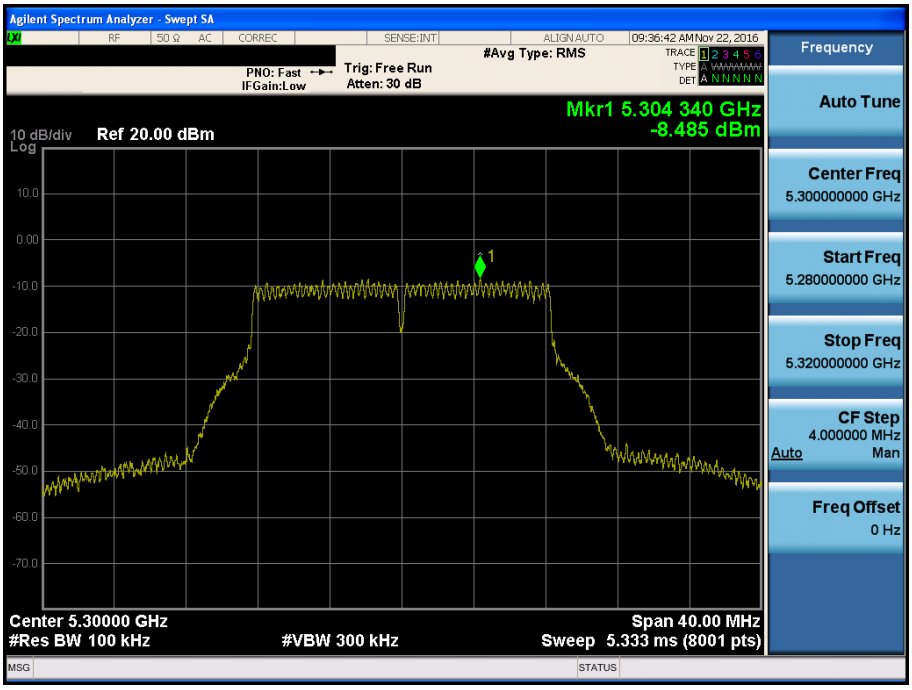
**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.48



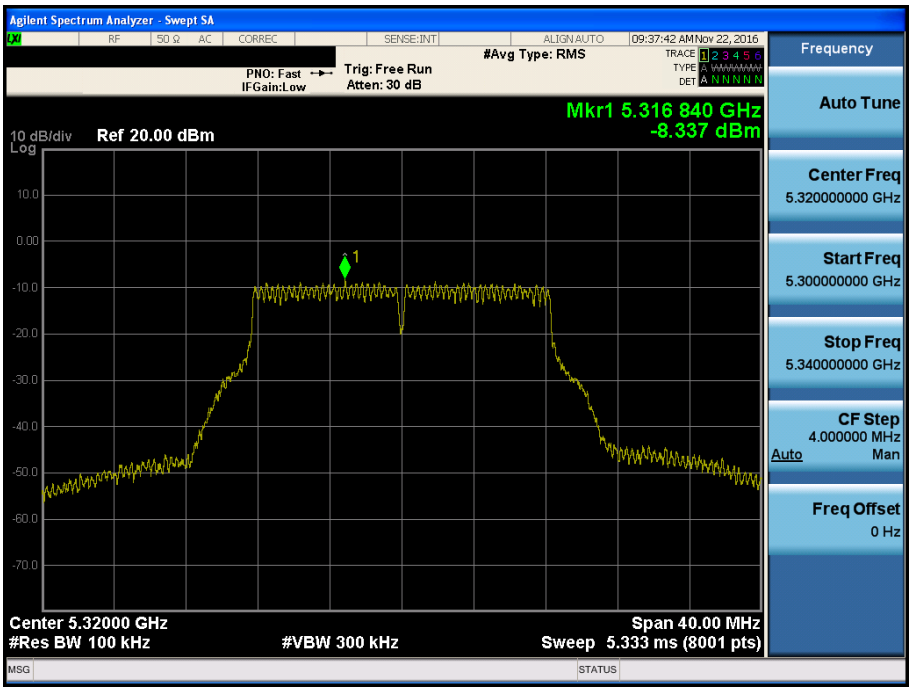
**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.52




**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.60

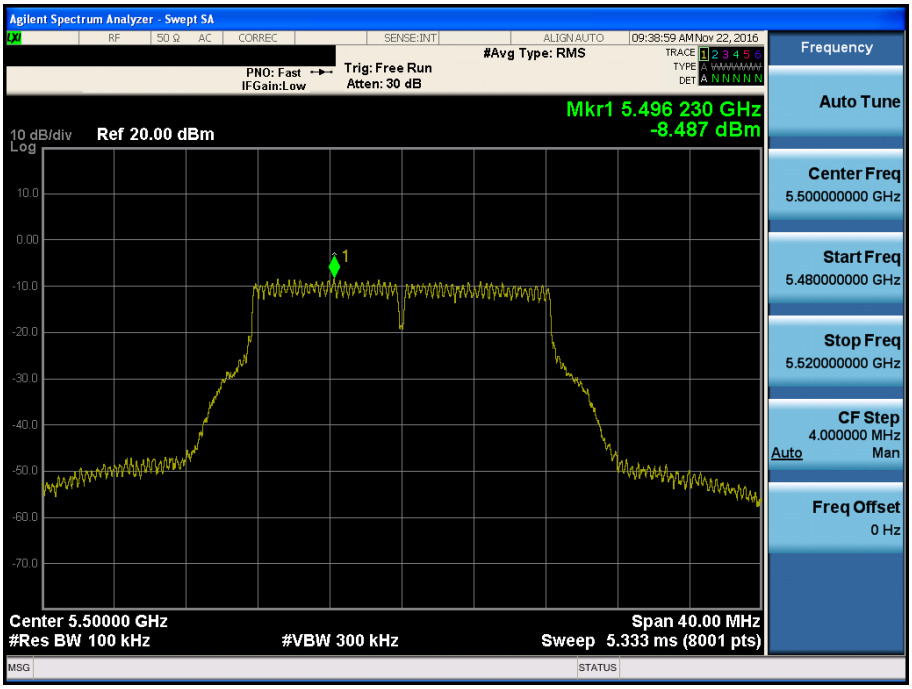


**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.64



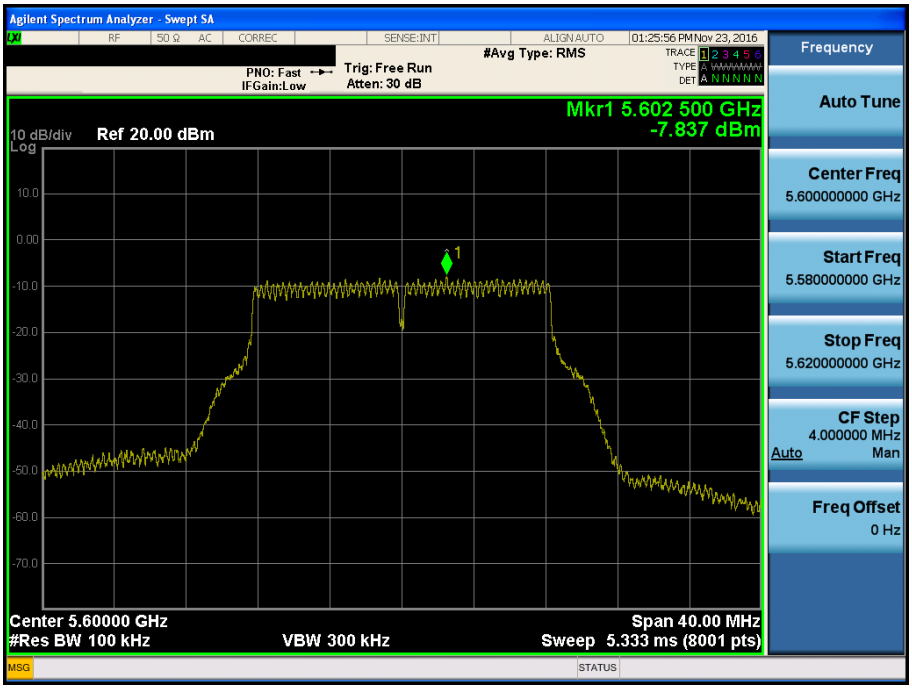
## Maximum Power Spectral Density

Test Mode: 802.11a & Ch.100

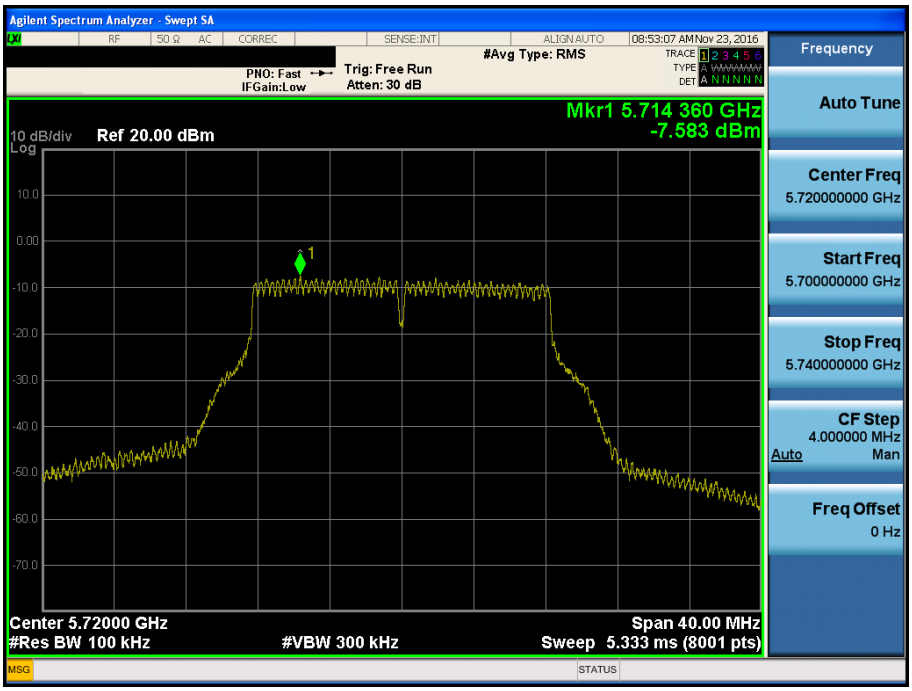



## Maximum Power Spectral Density

Test Mode: 802.11a & Ch.120

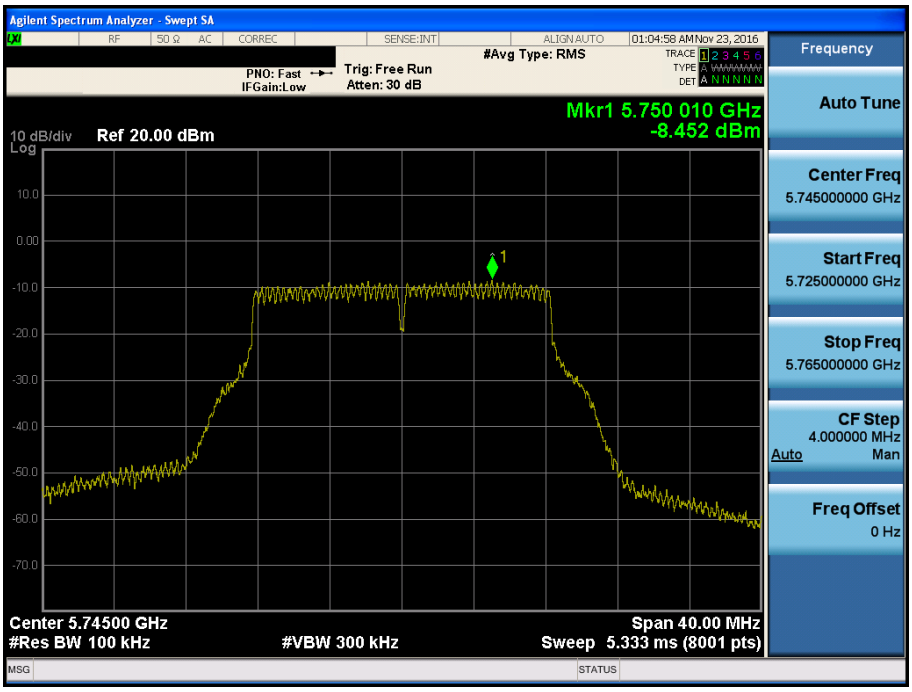


**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.144



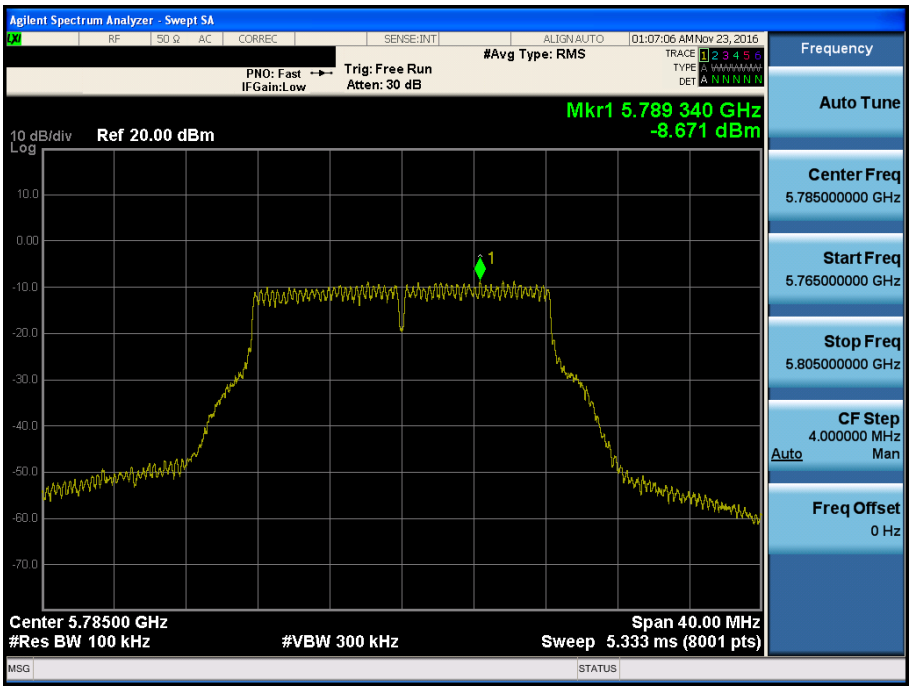
## Maximum Power Spectral Density

Test Mode: 802.11a & Ch.149

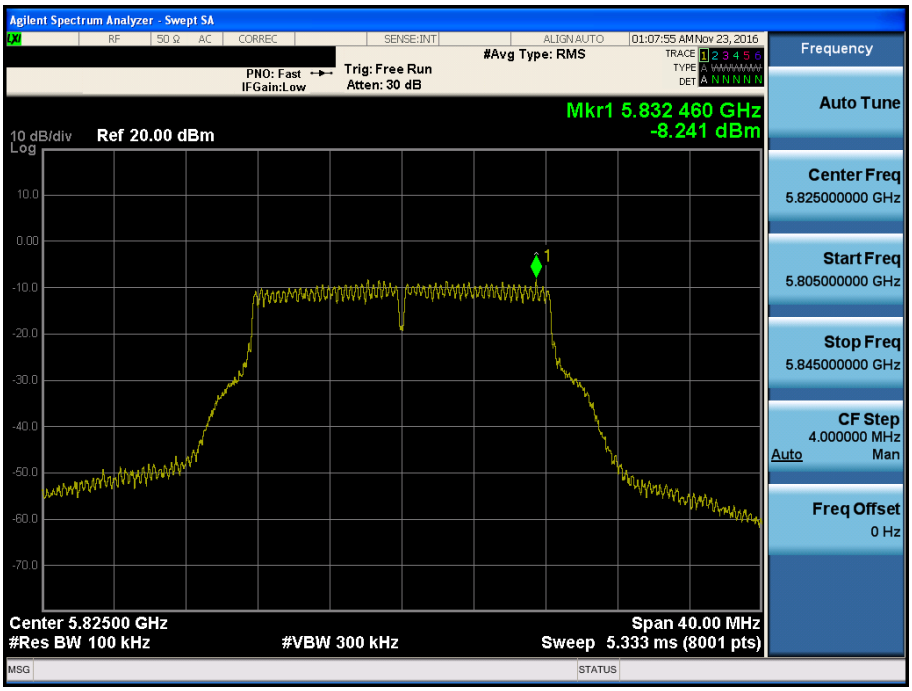



## Maximum Power Spectral Density

Test Mode: 802.11a & Ch.157

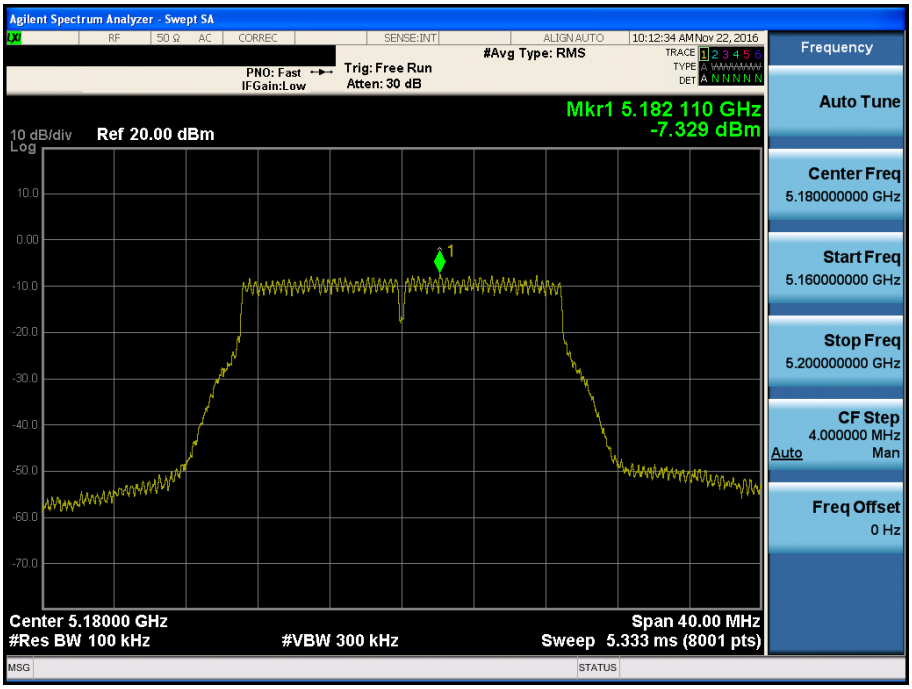


**Maximum Power Spectral Density** Test Mode: 802.11a & Ch.165



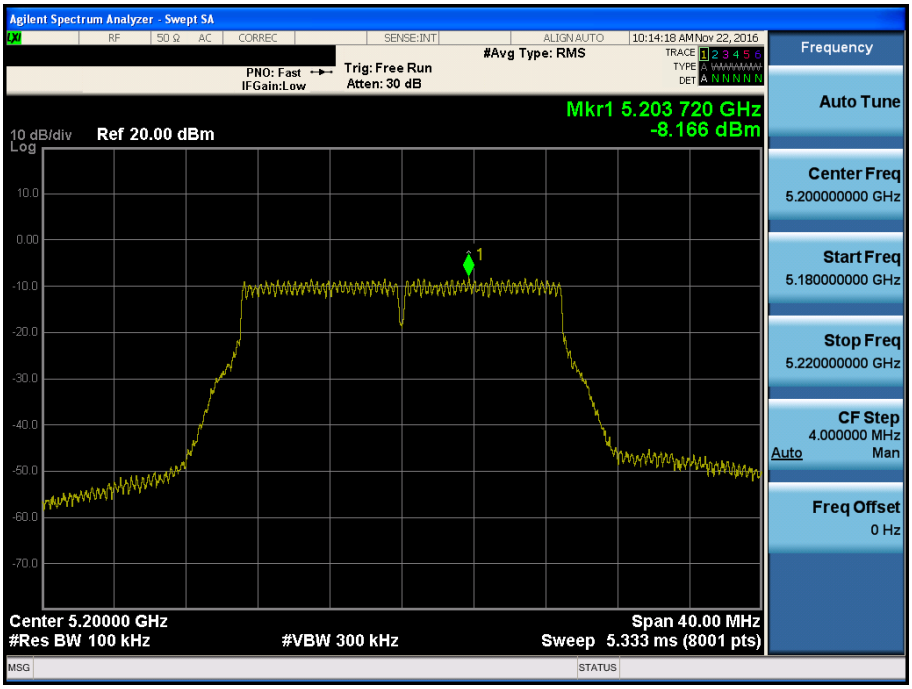
## Maximum Power Spectral Density

Test Mode: 802.11n(HT20) & Ch.36

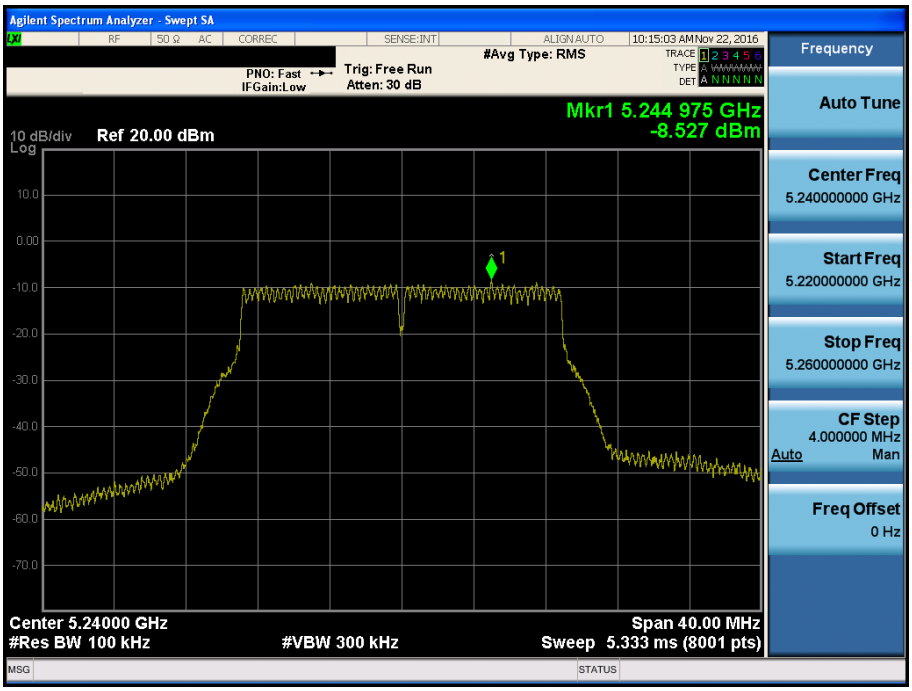



## Maximum Power Spectral Density

Test Mode: 802.11n(HT20) & Ch.40

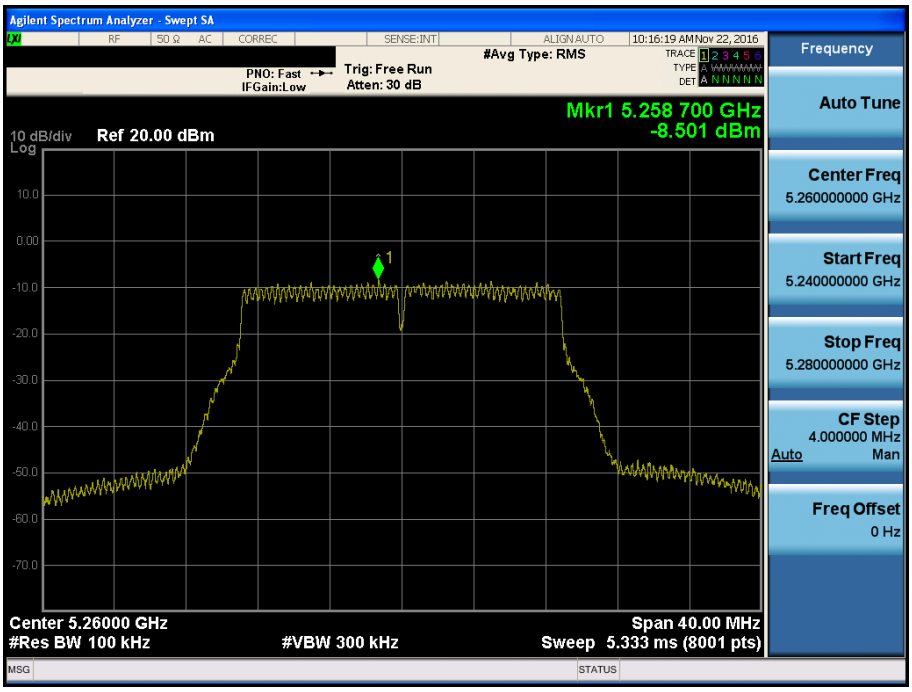


**Maximum Power Spectral Density** Test Mode: 802.11n(HT20) & Ch.48



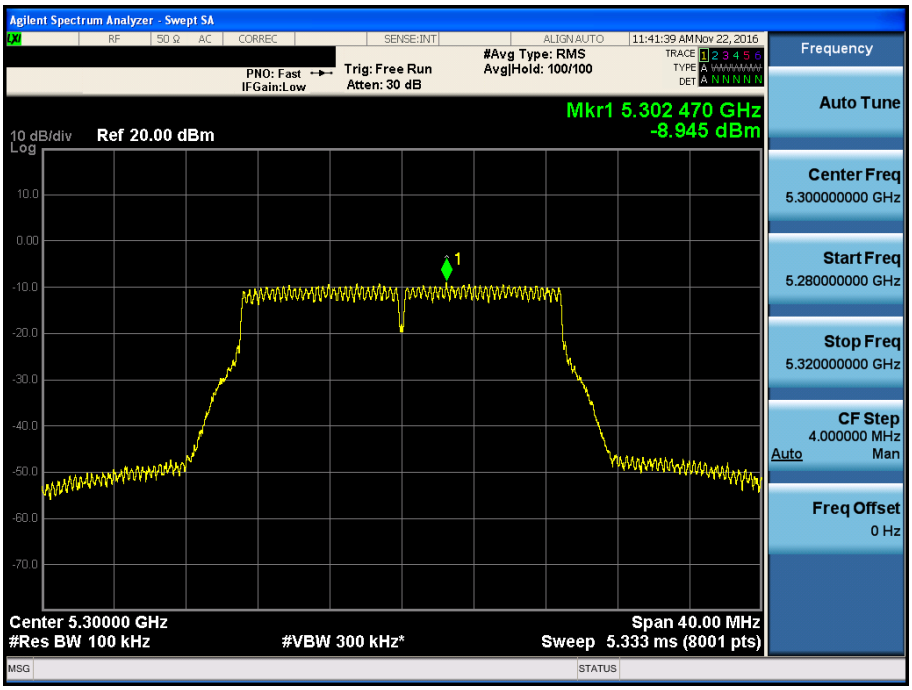
## Maximum Power Spectral Density

Test Mode: 802.11n HT20 & Ch.52

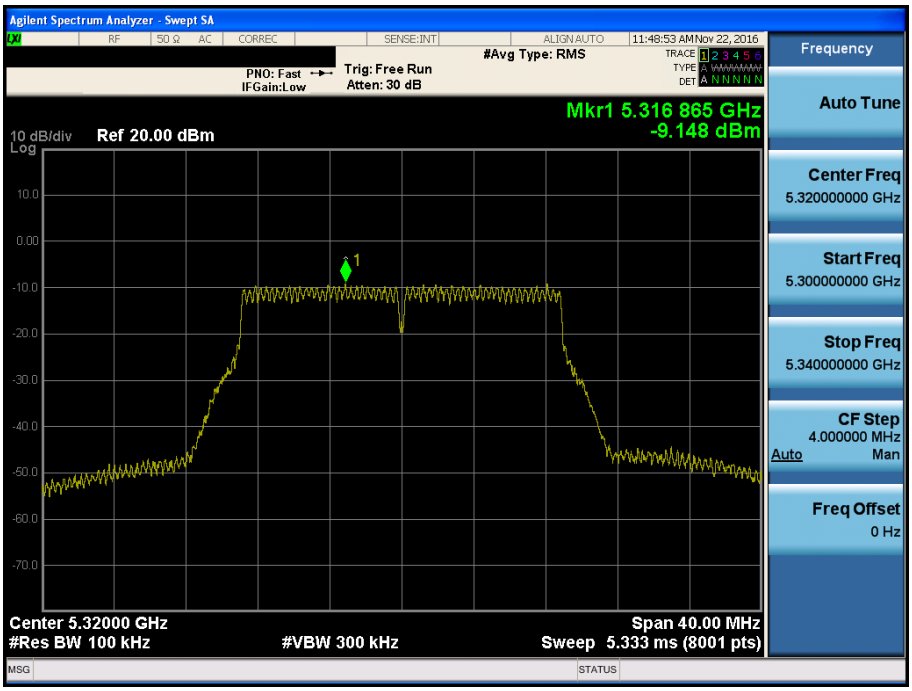



## Maximum Power Spectral Density

Test Mode: 802.11n HT20 & Ch.60

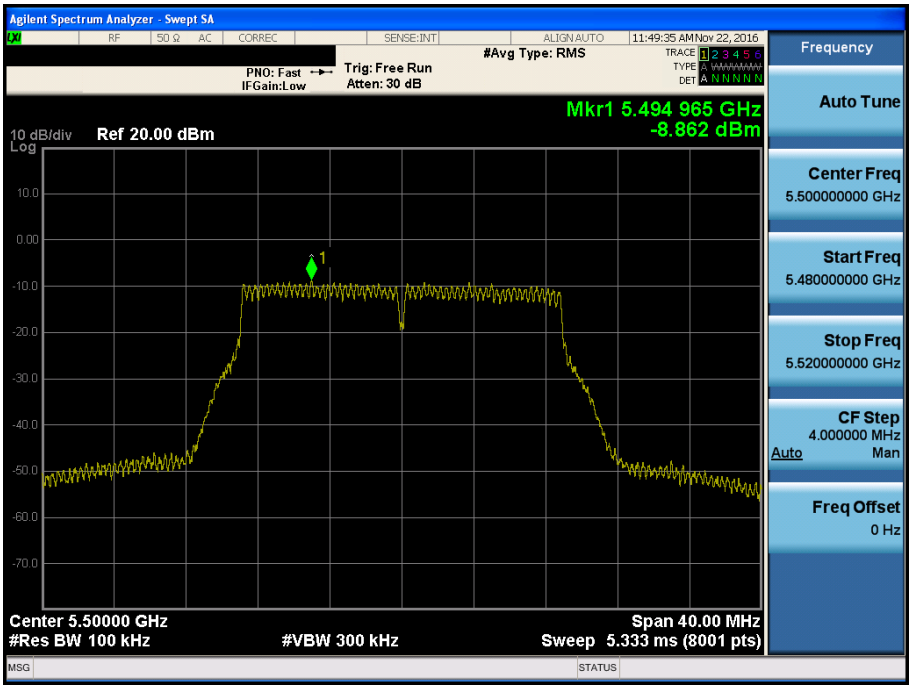


**Maximum Power Spectral Density** Test Mode: 802.11n HT20 & Ch.64



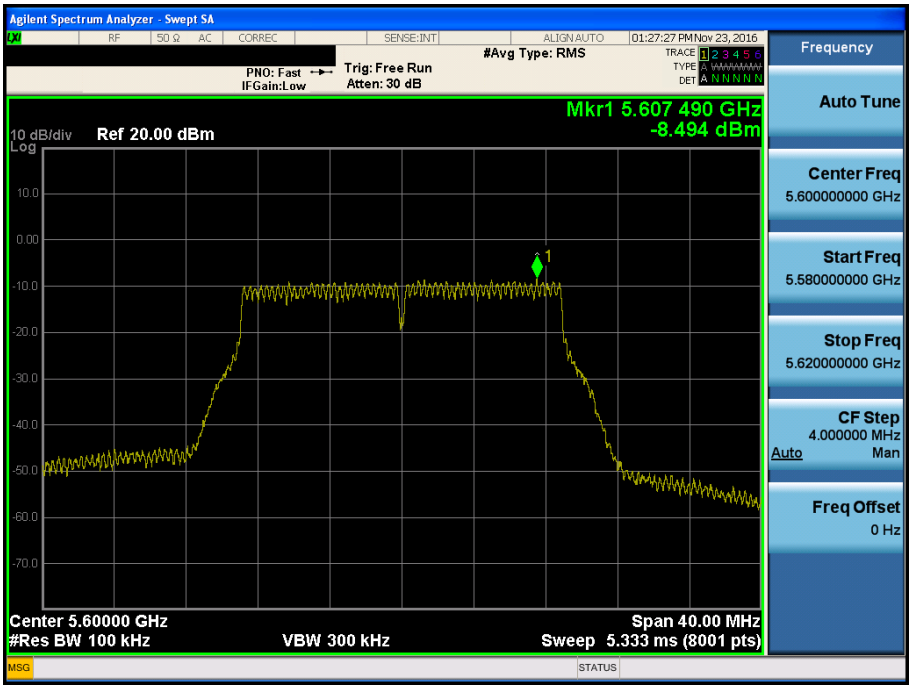
## Maximum Power Spectral Density

Test Mode: 802.11n HT20 & Ch.100

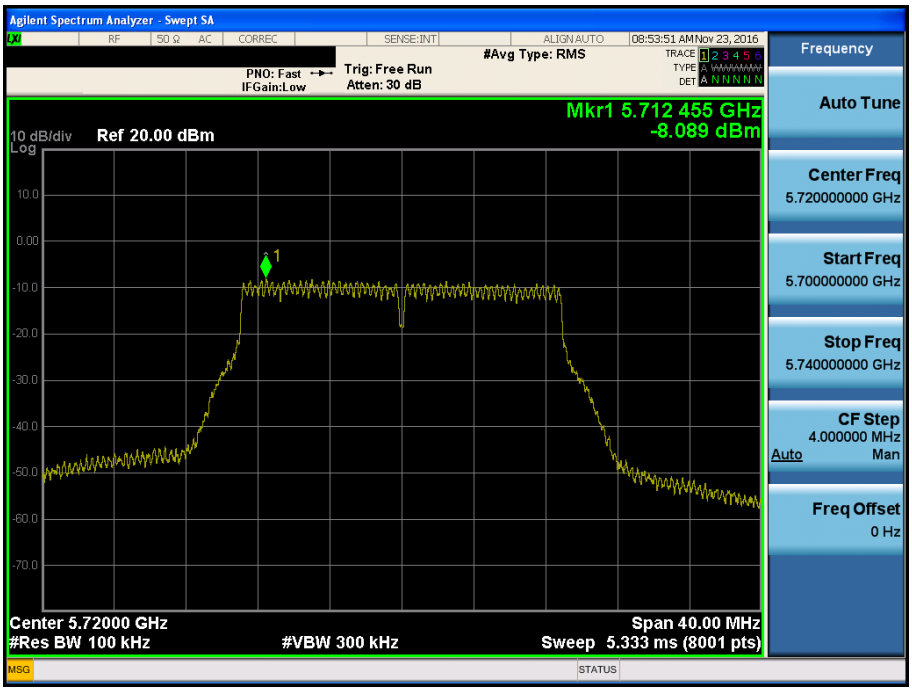



## Maximum Power Spectral Density

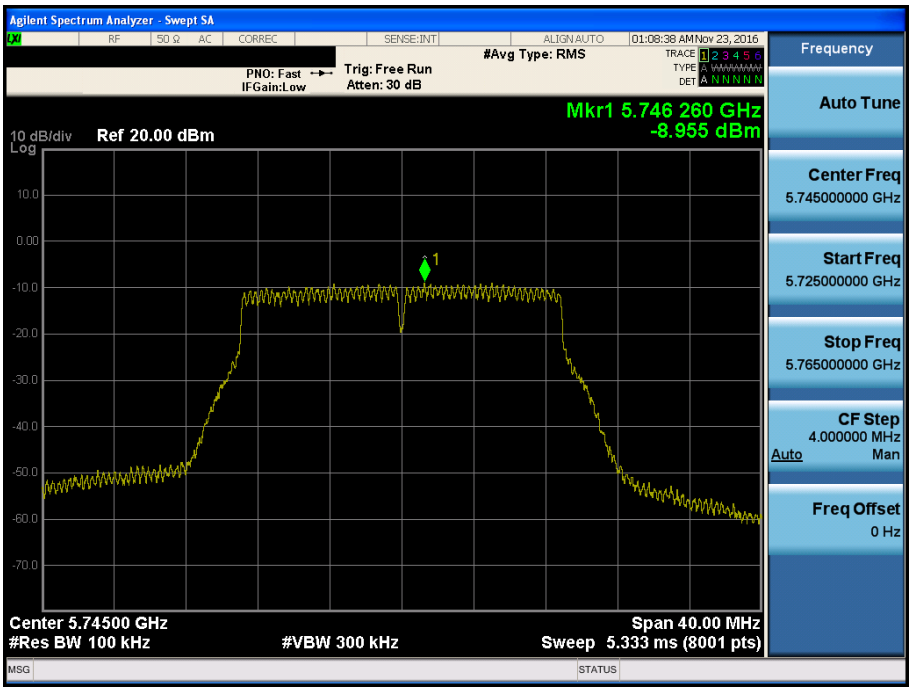
Test Mode: 802.11n HT20 & Ch.120



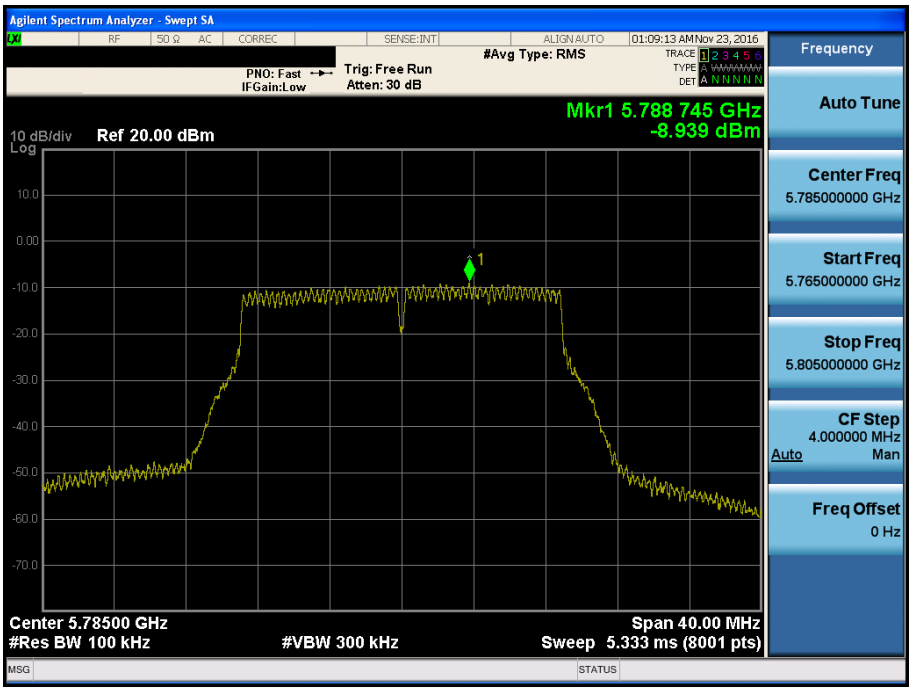
**Maximum Power Spectral Density** Test Mode: 802.11n HT20 & Ch.144



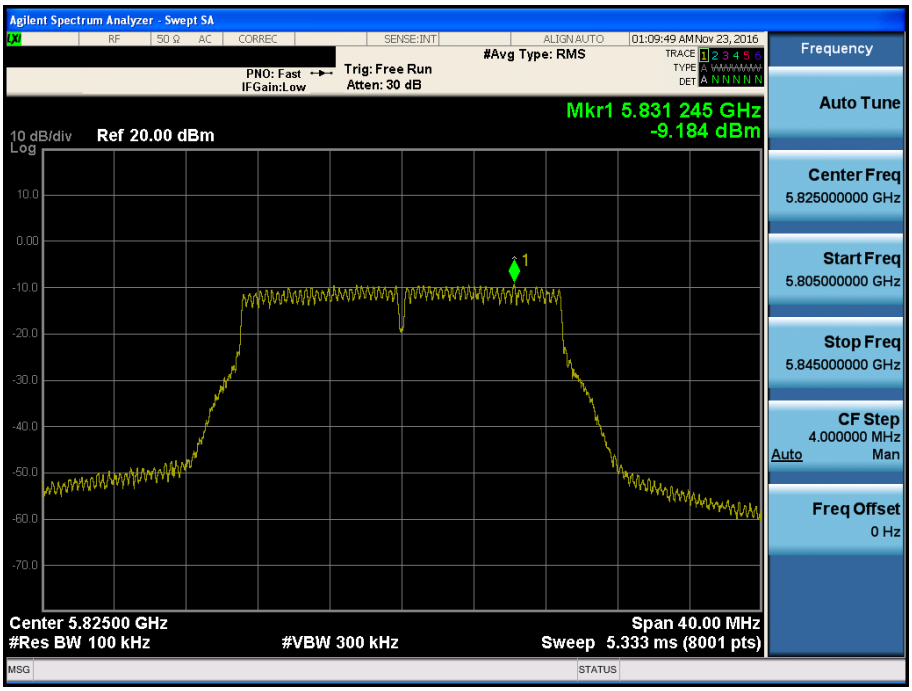
**Maximum Power Spectral Density** Test Mode: 802.11n(HT20) & Ch.149




**Maximum Power Spectral Density** Test Mode: 802.11n(HT20) & Ch.157

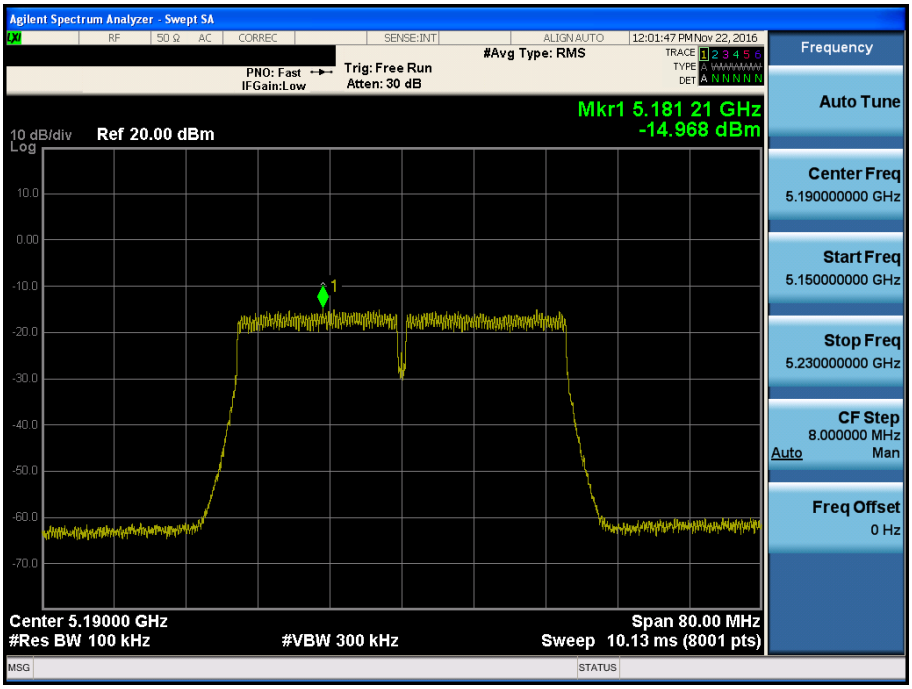


**Maximum Power Spectral Density** Test Mode: 802.11n(HT20) & Ch.165



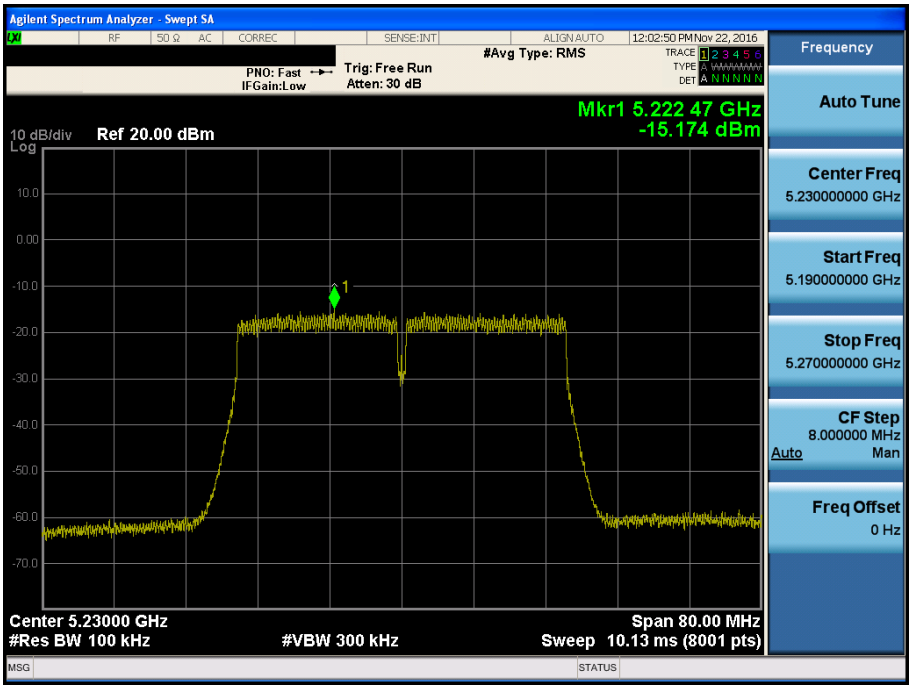
## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.38



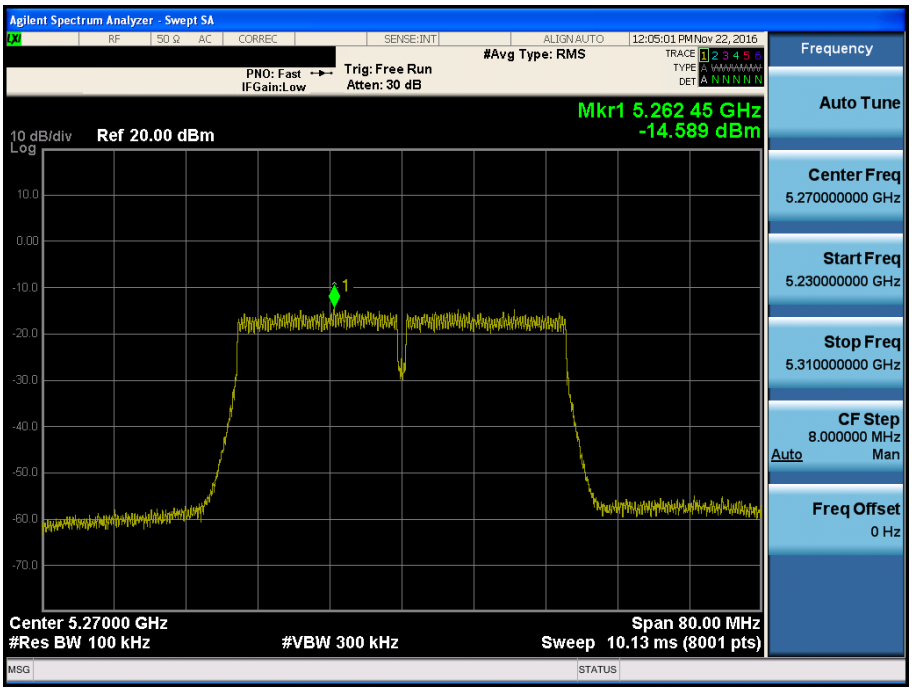

## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.46



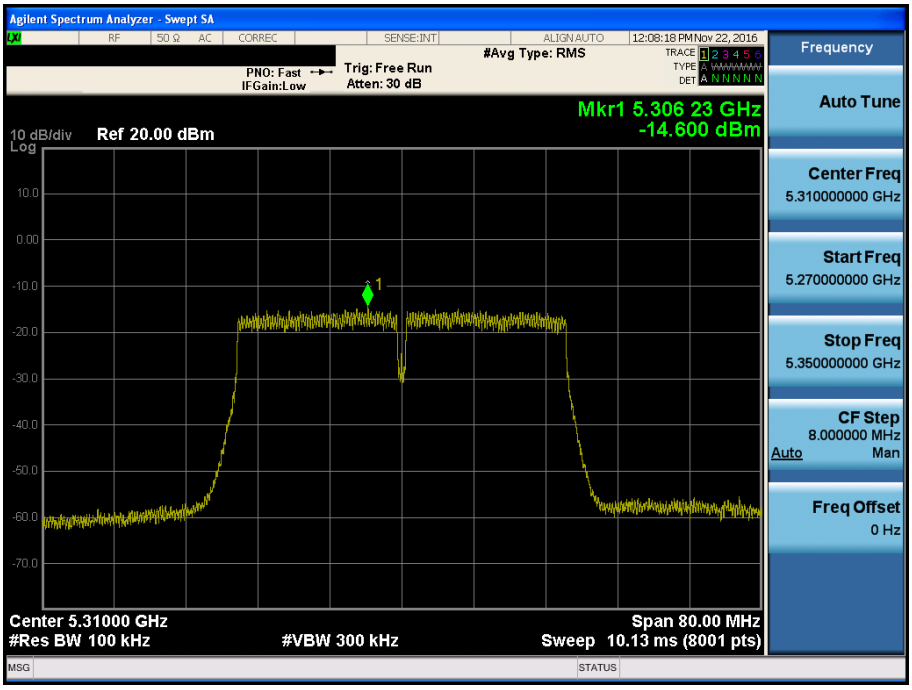
## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.54



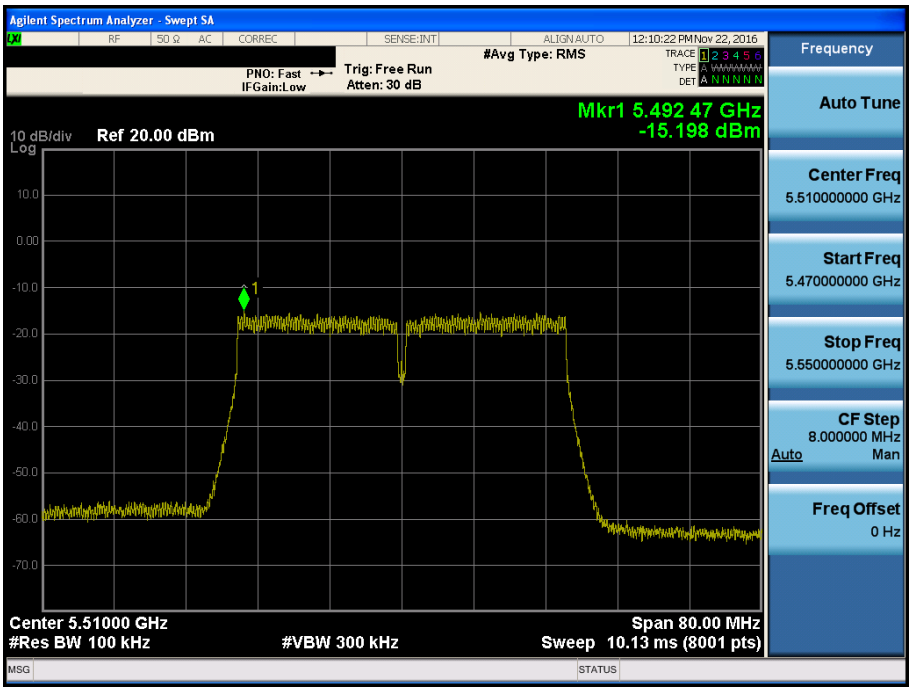

## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.62



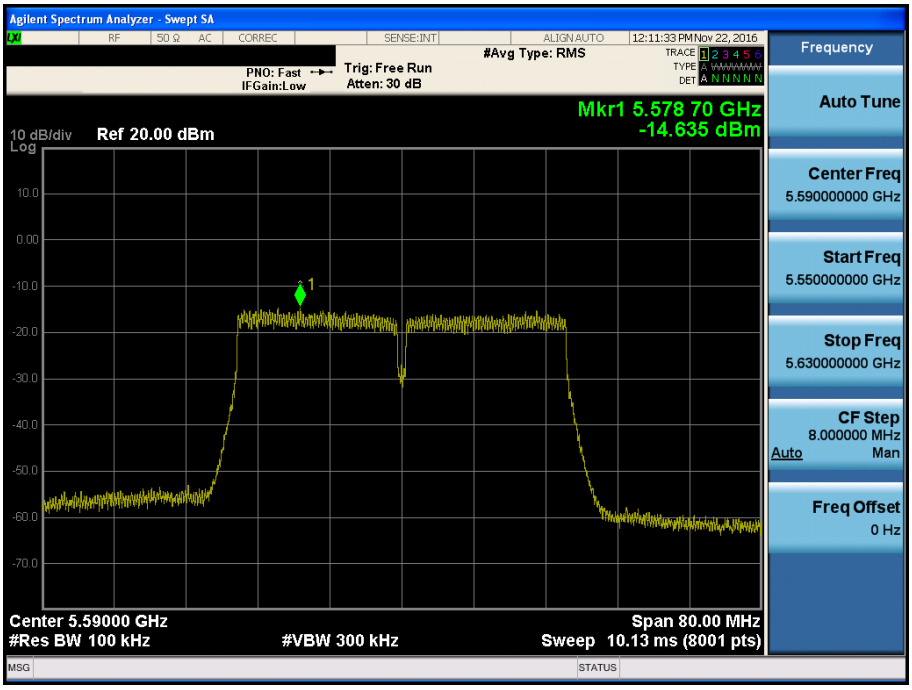
## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.102

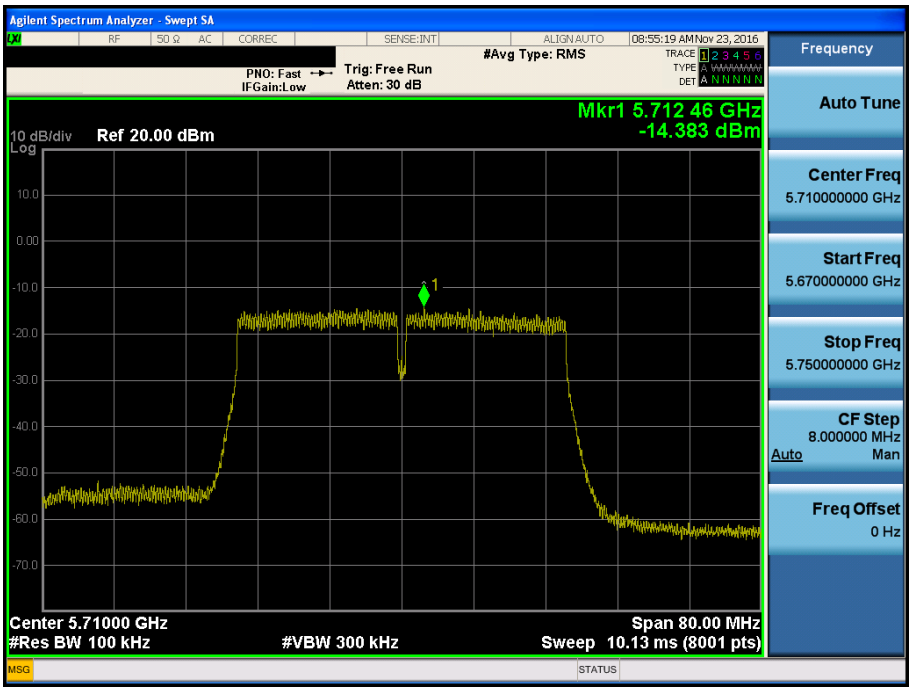



## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.118

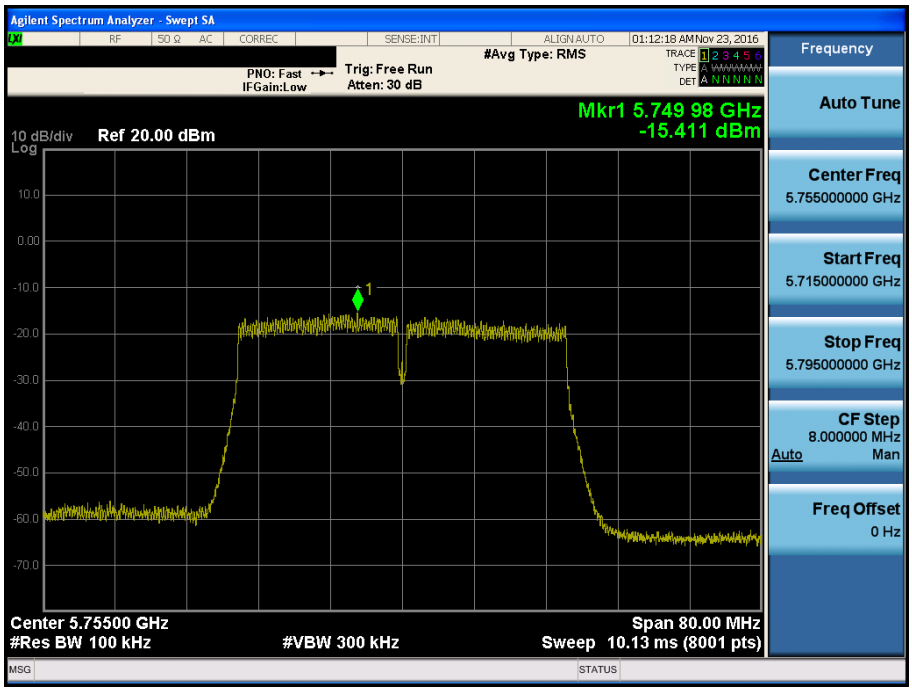


**Maximum Power Spectral Density** Test Mode: 802.11n HT40 & Ch.142



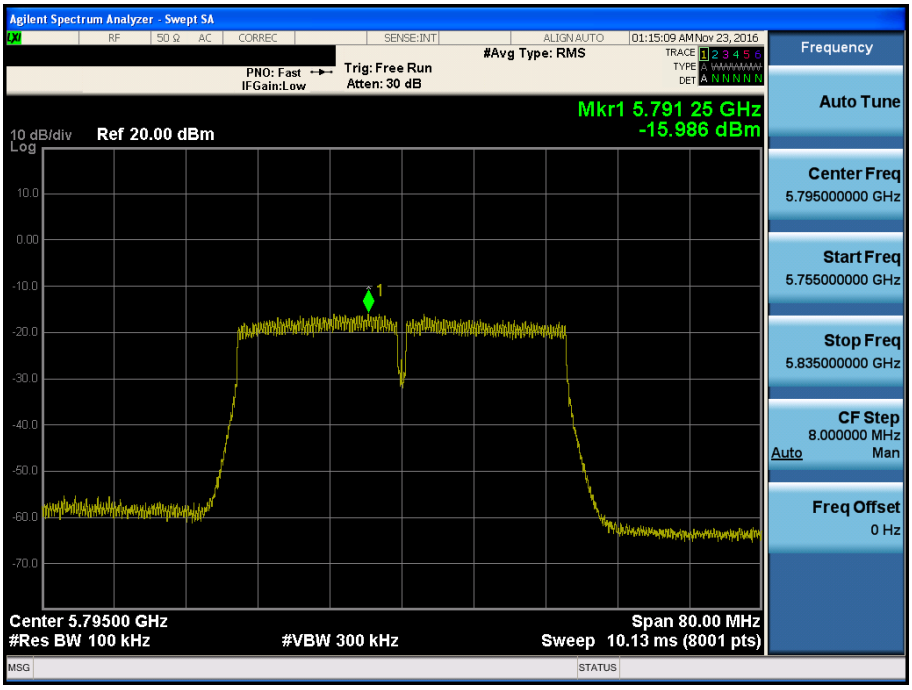
## Maximum Power Spectral Density

Test Mode: 802.11n HT40 & Ch.151

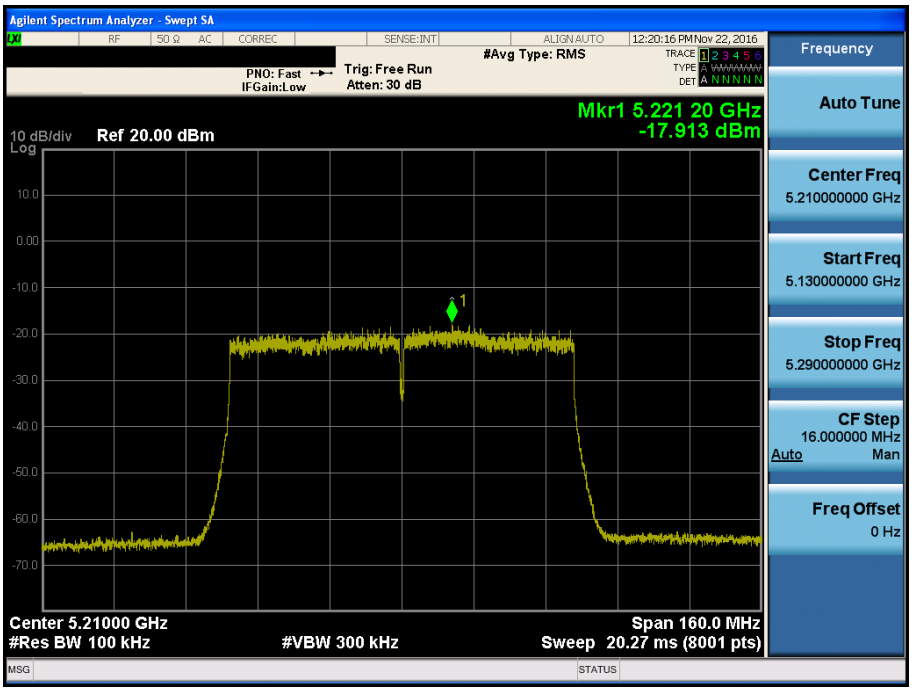



## Maximum Power Spectral Density

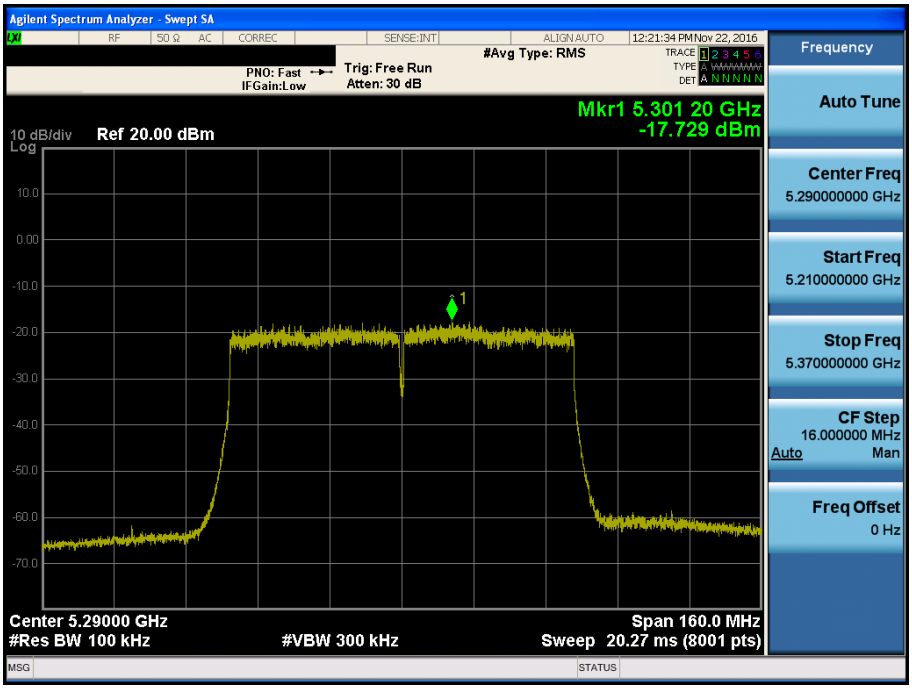
Test Mode: 802.11n HT40 & Ch.159



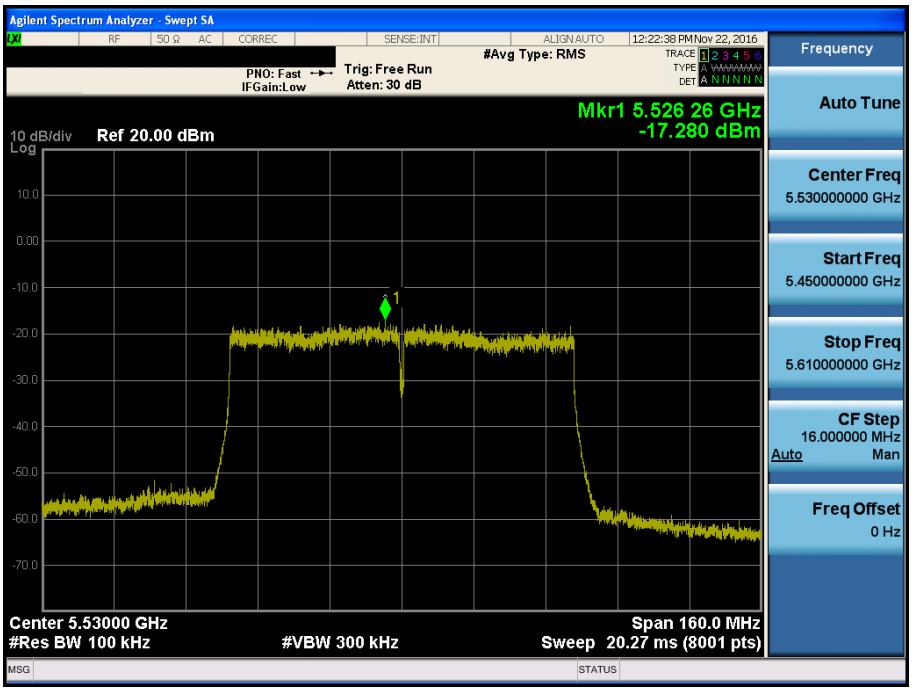
**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.42



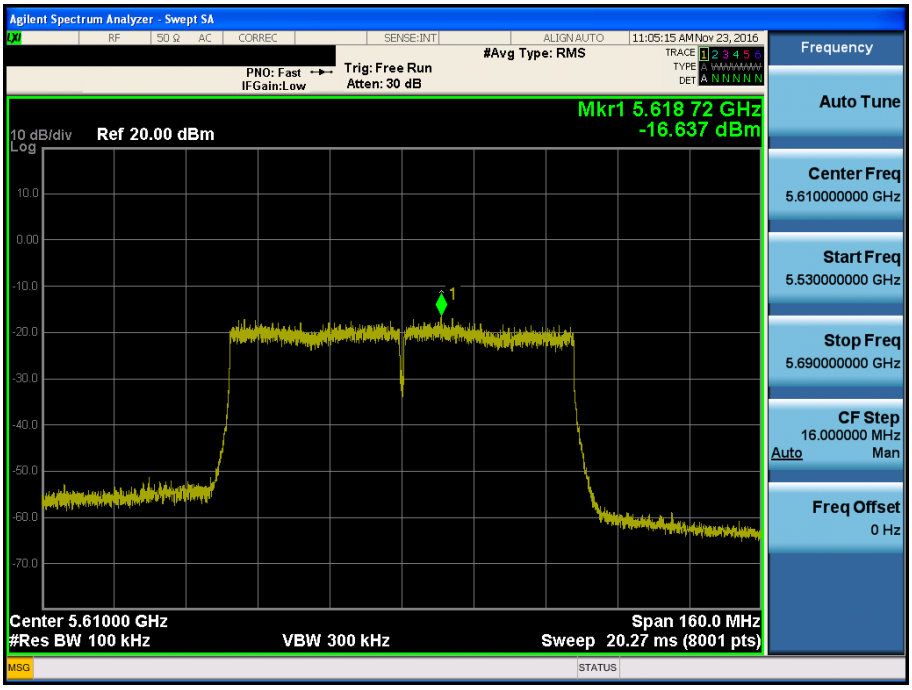

**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.58



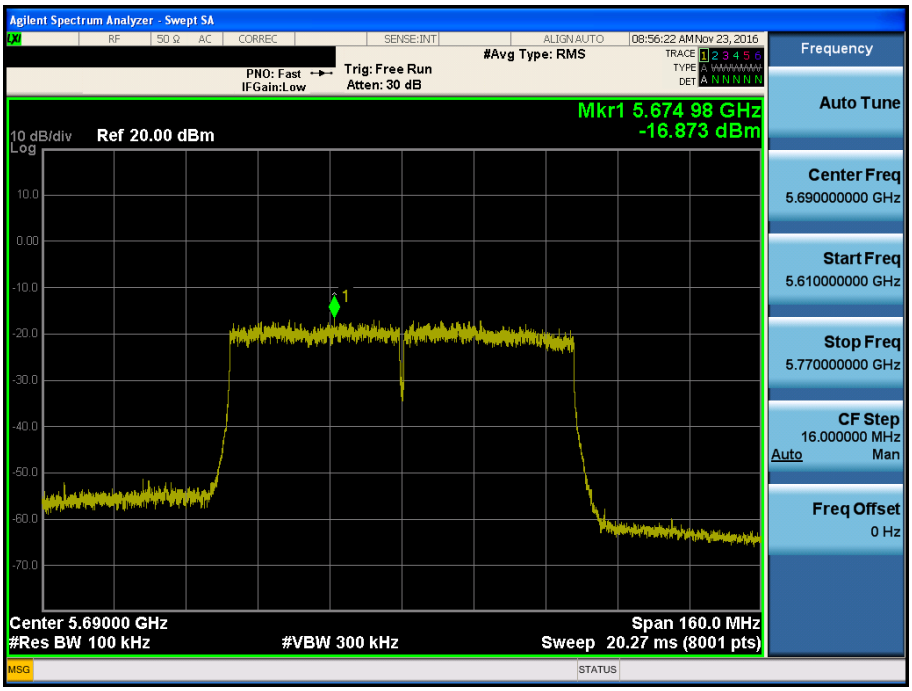
**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.106




**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.122



**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.138



**Maximum Power Spectral Density** Test Mode: 802.11ac VHT80 & Ch.155