# TEST REPORT

| | |
|---|---|
| **Product Name:** | Smart Phone |
| **Trade Mark:** | ecom |
| **Model No. / HVIN:** | Smart-Ex 02 |
| **Add. Model No. / HVIN:** | N/A |
| **Report Number:** | 190518039RFC-4 |
| **Test Standards:** | FCC 47 CFR Part 15 Subpart E<br>RSS-247 Issue 2<br>RSS-Gen Issue 5 |
| **FCC ID:** | XAM500079GR01 |
| **IC:** | 8311A-500079GR01 |
| **Test Result:** | PASS |
| **Date of Issue:** | July 20, 2019 |

Prepared for:

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Prepared by:

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| | | | |
|---|---|---|---|
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| Approved by: | Billy Li<br>Technical Director | Date: | July 20, 2019 |

UnionTrust Laboratories UnionTrust Certified

# Version

| Version No. | Date | Description |
|---|---|---|
| V1.0 | July 20, 2019 | Original |

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# 1. GENERAL INFORMATION

## 1.1 CLIENT INFORMATION

| | |
|---|---|
| **Applicant:** | ecom instruments GmbH |
| **Address of Applicant:** | Industriestrasse 2, Assamstadt, 97959, Germany |
| **Manufacturer:** | Pepperl+Fuchs GmbH |
| **Address of Manufacturer:** | Lilienthalstrasse 200, 68307 Mannheim, Germany |

## 1.2 EUT INFORMATION

### 1.2.1 General Description of EUT

| | | | |
|---|---|---|---|
| **Product Name:** | Smart Phone | | |
| **Model No. / HVIN:** | Smart-Ex 02 | | |
| **Add. Model No. / HVIN:** | N/A | | |
| **Trade Mark:** | ecom | | |
| **DUT Stage:** | Identical Prototype | | |
| **EUT Supports Function:** | GSM Bands: | GSM 850/ PCS 1900 | |
| | UTRA Bands: | Band II/ Band IV/ Band V | |
| | E-UTRA Bands: | FDD Band 2/ Band 4/ Band 5/ Band 7/ Band 12/ Band 13/ Band 25/ Band 26/ Band 66/ Band 71 | |
| | | TDD Band 38/ Band 41 | |
| | 2.4 GHz ISM Band: | IEEE 802.11b/g/n | |
| | | Bluetooth V4.2 | |
| | 5 GHz U-NII Bands: | 5 150 MHz to 5 250 MHz | IEEE 802.11a/n/ac |
| | | 5 250 MHz to 5 350 MHz | IEEE 802.11a/n/ac |
| | | 5 470 MHz to 5 725 MHz | IEEE 802.11a/n/ac |
| | | 5 725 MHz to 5 850 MHz | IEEE 802.11a/n/ac |
| | RNSS Bands: | 1559 MHz to 1610 MHz | GPS/ GNSS/ GLONASS/ BDS |
| | NFC: | 13.553 MHz to 13.567 MHz | |
| **Sample Received Date:** | May 20, 2019 | | |
| **Sample Tested Date:** | May 28, 2019 to June 25, 2019 | | |

### 1.2.2 Description of Accessories

| Adapter | |
|---|---|
| **Model No.:** | S008ACM0500200 |
| **Input:** | 100-240 V~50/60 Hz 0.3 A Max |
| **Output:** | 5.0 V ⎓ 2 A |
| **AC Cable:** | N/A |
| **DC Cable:** | N/A |

| Battery (1) | |
|---|---|
| **Model No.:** | EX-BP S02 |
| **Battery Type:** | Lithium-ion Rechargeable Battery |
| **Rated Voltage:** | 3.7 Vdc |
| **Rated Capacity:** | 4400 mAh |

| Battery (2) | |
|---|---|
| **Model No.:** | EX-BP S02C |
| **Battery Type:** | Lithium-ion Rechargeable Battery |
| **Rated Voltage:** | 3.7 Vdc |
| **Rated Capacity:** | 3920 mAh |

| Cable | |
|---|---|
| **Description:** | USB Changing Cable |
| **Cable Type:** | Shielded without ferrite |
| **Length:** | 1.2 Meter |

## 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

| | | |
|---|---|---|
| **Frequency Bands:** | 5150 MHz to 5250 MHz (U-NII-1) | |
| | 5250 MHz to 5350 MHz (U-NII-2A) | |
| | 5470 MHz to 5725 MHz (U-NII-2C) | |
| | 5 725 MHz to 5 850 MHz (U-NII-3) | |
| **Frequency Ranges:** | 5180 MHz to 5240 MHz | |
| | 5260 MHz to 5320 MHz | |
| | 5500 MHz to 5700 MHz | |
| | 5 745 MHz to 5 825 MHz | |
| **Support Standards:** | IEEE 802.11a/n/ac | |
| **TPC Function:** | Not Support | |
| **DFS Operational mode:** | Slave without radar Interference detection function | |
| **Type of Modulation:** | IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK) | |
| | IEEE 802.11n: OFDM(64QAM, 16QAM, QPSK, BPSK) | |
| | IEEE 802.11ac: OFDM(64QAM, 16QAM, QPSK, BPSK) | |
| **Channel Spacing:** | IEEE 802.11a/n-HT20/ac-VHT20: 20 MHz | |
| | IEEE 802.11n-HT40/ac-VHT40: 40 MHz | |
| | IEEE 802.11ac-VHT80: 80 MHz | |
| **Data Rate:** | IEEE 802.11a: Up to 54 Mbps | |
| | IEEE 802.11n-HT20: Up to MCS7 | |
| | IEEE 802.11n-HT40: Up to MCS7 | |
| | IEEE 802.11ac-VHT20: Up to MCS8 | |
| | IEEE 802.11ac-VHT40: Up to MCS9 | |
| | IEEE 802.11ac-VHT80: Up to MCS9 | |
| **Number of Channels:** | 5150 MHz to 5250 MHz:<br>4 for IEEE 802.11a/n-HT20/ac-VHT20<br>2 for IEEE 802.11n-HT40)/ac-VHT40<br>1 for IEEE 802.11acVHT80 | |
| | 5250 MHz to 5350 MHz:<br>4 for IEEE 802.11a/n-HT20/ac-VHT20<br>2 for IEEE 802.11n-HT40)/ac-VHT40<br>1 for IEEE 802.11acVHT80 | |
| | 5470 MHz to 5725 MHz:<br>11 for IEEE 802.11a/n-HT20/ac-VHT20<br>5 for IEEE 802.11n-HT40/ac-VHT40<br>2 for IEEE 802.11ac-VHT80 | |
| | 5725 MHz to 5850 MHz:<br>5 for IEEE 802.11a/n-HT20/ac-VHT20<br>2 for IEEE 802.11n-HT40/ac-VHT40<br>1 for IEEE 802.11ac-VHT80 | |
| **Antenna Type:** | Integral Antenna | |
| **Antenna Gain:** | 5150 MHz to 5250 MHz: -4.04 dBi | |
| | 5250 MHz to 5350 MHz: -3.89 dBi | |
| | 5470 MHz to 5725 MHz: -3.77 dBi | |
| | 5725 MHz to 5850 MHz: -4.09 dBi | |
| **Maximum EIRP (dBm):** | **Chain 0** | **U-NII-1** |
| | IEEE 802.11a: | 12.36 |
| | IEEE 802.11n-HT20: | 12.39 |
| | IEEE 802.11n-HT40: | 12.54 |

| | | | | | |
|---|---|---|---|---|---|
| | IEEE 802.11ac-VHT20: | 12.11 | | | |
| | IEEE 802.11ac-VHT40: | 12.17 | | | |
| | IEEE 802.11ac-VHT80: | 12.03 | | | |
| **Maximum conducted output power (dBm):** | | **U-NII-1** | **U-NII-2A** | **U-NII-2C** | **U-NII-3** |
| | IEEE 802.11a: | 17.15 | 16.74 | 16.12 | 16.13 |
| | IEEE 802.11n-HT20: | 17.28 | 16.79 | 17.32 | 16.17 |
| | IEEE 802.11n-HT40: | 18.06 | 17.69 | 17.14 | 16.81 |
| | IEEE 802.11ac-VHT20 | 16.94 | 16.52 | 17.13 | 15.92 |
| | IEEE 802.11ac-VHT40 | 17.70 | 17.33 | 16.86 | 16.58 |
| | IEEE 802.11ac-VHT80: | 18.71 | 18.59 | 18.46 | 17.85 |
| **Normal Test Voltage:** | 3.7 V Battery | | | | |

## 1.4 OTHER INFORMATION

| **Operation Frequency Each of Channel** | | | | |
|---|---|---|---|---|
| | **U-NII-1** | **U-NII-2A** | **U-NII-2C** | **U-NII-3** |
| **IEEE 802.11a, IEEE 802.11n-HT20, IEEE 802.11ac-VHT20** | **f = 5000 + 5k, k = 32 + 4n** | | | **f = 5000 + 5k, k = 145 + 4n** |
| | **n = 1,…, 4** | **n = 5,…, 8** | **n = 17,…, 27** | **n = 1,…, 5** |
| **IEEE 802.11n-HT40, IEEE 802.11ac-VHT40** | **f = 5000 + 5k, k = 30 + 8n** | | | **f = 5000 + 5k, k = 143 + 8n** |
| | **n = 1, 2** | **n = 1,…, 5** | **n = 9,…, 13** | **n = 1, 2** |
| **IEEE 802.11ac-VHT80** | **f = 5000 + 5k, k = 26 + 16n** | | | **f = 5000 + 5k, k = 155** |
| | **n = 1** | **n = 1, 2** | **n = 5, 6** | |
| Note:<br>**f** is the operating frequency (MHz);<br>**k** is the operating channel. | | | | |

## 1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

| Description | Manufacturer | Model No. | Serial Number | FCC ID | Supplied by |
|---|---|---|---|---|---|
| Notebook | Lenovo | E450 | SL10G10780 | N/A | UnionTrust |
| Wireless Home Router | SAGEMCOM | FAST5280 | N/A | VW3FAST5280 | UnionTrust |

2) Support Cable

| Cable No. | Description | Connector | Length | Supplied by |
|---|---|---|---|---|
| 1 | Antenna Cable | SMA | 0.3 Meter | Applicant |

## 1.6 TEST LOCATION

**Shenzhen UnionTrust Quality and Technology Co., Ltd.**

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

## 1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

**CNAS-Lab Code: L9069**
The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

**A2LA-Lab Certificate No.: 4312.01**
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**ISED Wireless Device Testing Laboratories**
CAB identifier: CN0032

**FCC Accredited Lab.**
Designation Number: CN1194
Test Firm Registration Number: 259480

## 1.8 DEVIATION FROM STANDARDS

None.

## 1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

## 1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

## 1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| No. | Item | Measurement Uncertainty |
|---|---|---|
| 1 | Conducted emission 9KHz-150KHz | ±3.8 dB |
| 2 | Conducted emission 150KHz-30MHz | ±3.4 dB |
| 3 | Radiated emission 9KHz-30MHz | ±4.9 dB |
| 4 | Radiated emission 30MHz-1GHz | ±4.7 dB |
| 5 | Radiated emission 1GHz-18GHz | ±5.1 dB |
| 6 | Radiated emission 18GHz-26GHz | ±5.2 dB |
| 7 | Radiated emission 26GHz-40GHz | ±5.2 dB |

## 2. TEST SUMMARY

| FCC 47 CFR Part 15 Subpart E Test Cases | | | |
|---|---|---|---|
| **Test Item** | **Test Requirement** | **Test Method** | **Result** |
| **Antenna Requirement** | FCC 47 CFR Part 15 Subpart C Section 15.203<br>FCC 47 CFR Part 15 Subpart E Section 15.407(a)(1) (2)<br>RSS-Gen Issue 5, Section 6.8 | N/A | PASS |
| **26 dB emission bandwidth** | FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(2)(5)<br>RSS-247 Issue 2 Section 6.2.1.2 | KDB 789033 D02 v02r01 Section C.1 | PASS |
| **6 dB bandwidth** | FCC 47 CFR Part 15 Subpart E Section 15.407 (e)<br>RSS-247 Issue 2 Section 6.2.4.1 | KDB 789033 D02 v02r01 Section C.2 | PASS |
| **Occupied Bandwidth** | RSS-Gen Issue 5, Section 6.7 | RSS-Gen Issue 5, section 6.7 | PASS |
| **Maximum conducted output power** | FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)<br>RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1 | KDB 789033 D02 v02r01 Section E.3.a (Method PM) | PASS |
| **Peak Power Spectral Density** | FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)<br>RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1 | KDB 789033 D02 v02r01 Section F | PASS |
| **Radiated Emissions and Band Edge Measurement** | FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(1)(2)(3)(4)(6)<br>FCC 47 CFR Part 15 Subpart C Section 15.209/205<br>RSS-247 Issue 2 Section 6.2.1.2/6.2.2.2/6.2.3.2/6.2.4.2 | KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6 | PASS |
| **Dynamic Frequency Selection** | FCC 47 CFR Part 15 Subpart E Section 15.407 (h)<br>RSS-247 Issue 2 Section 6.3 | KDB 905462 D03 Client Without DFS New Rules v01r02 | PASS |
| **AC Power Line Conducted Emission** | FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(6)<br>FCC 47 CFR Part 15 Subpart C Section 15.207<br>RSS-Gen Issue 5, Section 8.8 | ANSI C63.10-2013, Section 6.2. | PASS |
| **Note:**<br>1) N/A: In this whole report not applicable. | | | |

**For Dynamic Frequency Selection**

| Test Case | Result |
|---|---|
| Channel Availability Check Time | N/A[1] |
| U-NII Detection Bandwidth | N/A[1] |
| Channel Closing Transmission Time | PASS |
| Channel Move Time | PASS |
| DFS Detection Threshold | N/A[1] |
| Non- Occupancy Period | N/A[1] |
| **Note:**<br>1) The EUT is slave, NA In this whole report not applicable. | |

# 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | 3M Chamber & Accessory Equipment | ETS-LINDGREN | 3M | N/A | Dec. 03, 2018 | Dec. 03, 2021 |
| ☒ | Receiver | R&S | ESIB26 | 100114 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | Loop Antenna | ETS-LINDGREN | 6502 | 00202525 | Dec. 03, 2018 | Dec. 03, 2019 |
| ☒ | Broadband Antenna | ETS-LINDGREN | 3142E | 00201566 | Dec. 08, 2018 | Dec. 08, 2019 |
| ☒ | 6dB Attenuator | Talent | RA6A5-N-18 | 18103001 | Dec. 08, 2018 | Dec. 08, 2019 |
| ☒ | Preamplifier | HP | 8447F | 2805A02960 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | Horn Antenna (Pre-amplifier) | ETS-LINDGREN | 3117-PA | 00201874 | May 18, 2019 | May 18, 2020 |
| ☒ | Horn Antenna (Pre-amplifier) | ETS-LINDGREN | 3116C-PA | 00202652 | Jan. 05, 2019 | Jan. 05, 2020 |
| ☒ | Multi device Controller | ETS-LINDGREN | 7006-001 | 00160105 | N/A | N/A |
| ☒ | Test Software | Audix | e3 | Software Version: 9.160333 | | |

| Conducted Emission Test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | Receiver | R&S | ESR7 | 1316.3003K07 -101181-K3 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | Pulse Limiter | R&S | ESH3-Z2 | 0357.8810.54 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | LISN | R&S | ESH2-Z5 | 860014/024 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | Test Software | Audix | e3 | Software Version: 9.160323 | | |

| Conducted RF test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | EXA Spectrum Analyzer | KEYSIGHT | N9010A | MY51440197 | Nov. 24, 2018 | Nov. 24, 2019 |
| ☒ | USB Wideband Power Sensor | KEYSIGHT | U2021XA | MY55430035 | Nov. 24, 2018 | Nov. 24, 2019 |

# 4. TEST CONFIGURATION

## 4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

### 4.1.1 Normal or Extreme Test Conditions

| Environment Parameter | Selected Values During Tests | | |
|---|---|---|---|
| Test Condition | Ambient | | |
| | Temperature (°C) | Voltage | Relative Humidity (%) |
| NT/NV | +15 to +35 | 3.7 V Battery | 20 to 75 |
| **Remark:**<br>1) NV: Normal Voltage; NT: Normal Temperature | | | |

### 4.1.2 Record of Normal Environment

| Test Item | Temperature (°C) | Relative Humidity (%) | Pressure (kPa) | Tested by |
|---|---|---|---|---|
| 26 dB emission bandwidth | 25.1 | 49 | 100.1 | Hank Wu |
| 6 dB bandwidth | | | | |
| Occupied Bandwidth | | | | |
| Maximum conducted output power | | | | |
| Peak Power Spectral Density | | | | |
| Radiated Emissions and Band Edge Measurement | 22.4 | 52 | 100.52 | Fire Huo |
| Dynamic Frequency Selection | 25.1 | 49 | 100.1 | Hank Wu |
| AC Power Line Conducted Emission | 25.0 | 41 | 99.8 | Gemini Huang |

## 4.2 TEST CHANNELS

| Mode | Tx/Rx Frequency | Test RF Channel Lists | | |
|---|---|---|---|---|
| | | Lowest(L) | Middle(M) | Highest(H) |
| IEEE 802.11a<br>IEEE 802.11n-HT20<br>IEEE 802.11ac-VHT20 | 5150 MHz to 5250 MHz | Channel 36 | Channel 44 | Channel 48 |
| | | 5180 MHz | 5220 MHz | 5240 MHz |
| | 5250 MHz to 5350 MHz | Channel 52 | Channel 60 | Channel 64 |
| | | 5260 MHz | 5300 MHz | 5320 MHz |
| | 5470 MHz to 5725 MHz | Channel 100 | Channel 116 | Channel 140 |
| | | 5500 MHz | 5580 MHz | 5700 MHz |
| | 5725 MHz to 5850 MHz | Channel 149 | Channel 157 | Channel 165 |
| | | 5745 MHz | 5785 MHz | 5825 MHz |
| IEEE 802.11n-HT40<br>IEEE 802.11ac-VHT40 | 5150 MHz to 5250 MHz | Channel 38 | -- | Channel 46 |
| | | 5190 MHz | -- | 5230 MHz |
| | 5250 MHz to 5350 MHz | Channel 54 | -- | Channel 62 |
| | | 5270 MHz | -- | 5310 MHz |
| | 5470 MHz to 5725 MHz | Channel 102 | Channel 110 | Channel 134 |
| | | 5510 MHz | 5550 MHz | 5670 MHz |
| | 5725 MHz to 5850 MHz | Channel 151 | -- | Channel 159 |
| | | 5755 MHz | -- | 5795 MHz |
| IEEE 802.11ac-VHT80 | 5150 MHz to 5250 MHz | -- | Channel 42 | -- |
| | | -- | 5210 MHz | -- |
| | 5250 MHz to 5350 MHz | -- | Channel 58 | -- |
| | | -- | 5290 MHz | -- |
| | 5470 MHz to 5725 MHz | Channel 106 | -- | -- |
| | | 5530 MHz | -- | -- |
| | 5725 MHz to 5850 MHz | -- | Channel 155 | -- |
| | | -- | 5775 MHz | -- |

## 4.3 EUT TEST STATUS

| Mode | Tx/Rx Function | Description |
|---|---|---|
| IEEE 802.11a/n/ac | 1Tx/1Rx | 1. Keep the EUT in transmitting mode with all kind of modulation and all kind of data rate. |

| Power Setting | | | | |
|---|---|---|---|---|
| | U-NII-1 | U-NII-2A | U-NII-2C | U-NII-3 |
| IEEE 802.11a | 18 | 18 | 18 | 18 |
| IEEE 802.11n-HT20 | 18 | 18 | 19 | 19 |
| IEEE 802.11n-HT40 | 18 | 18 | 18 | 19 |
| IEEE 802.11ac-VHT20 | 18 | 18 | 19 | 19 |
| IEEE 802.11ac-VHT40 | 18 | 18 | 18 | 19 |
| IEEE 802.11ac-VHT80 | 20 | 20 | 20 | 21 |
| Power Setting: not applicable, test used software default power level. | | | | |

| Test Software |
|---|
| Test software name: QRCT ; |

## 4.4 PRE-SCAN

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate. Following data rate was (were) selected for the final test as listed below

| Mode | Worst-case data rates |
|---|---|
| IEEE 802.11a | 54 Mbps |
| IEEE 802.11n-HT20 | MCS7 |
| IEEE 802.11n-HT40 | MCS7 |
| IEEE 802.11ac-VHT20 | MCS8 |
| IEEE 802.11ac-VHT40 | MCS9 |
| IEEE 802.11ac-VHT80 | MCS9 |

## 4.5 TEST SETUP

### 4.5.1 For Radiated Emissions test setup

**Figure 1. Below 30MHz**

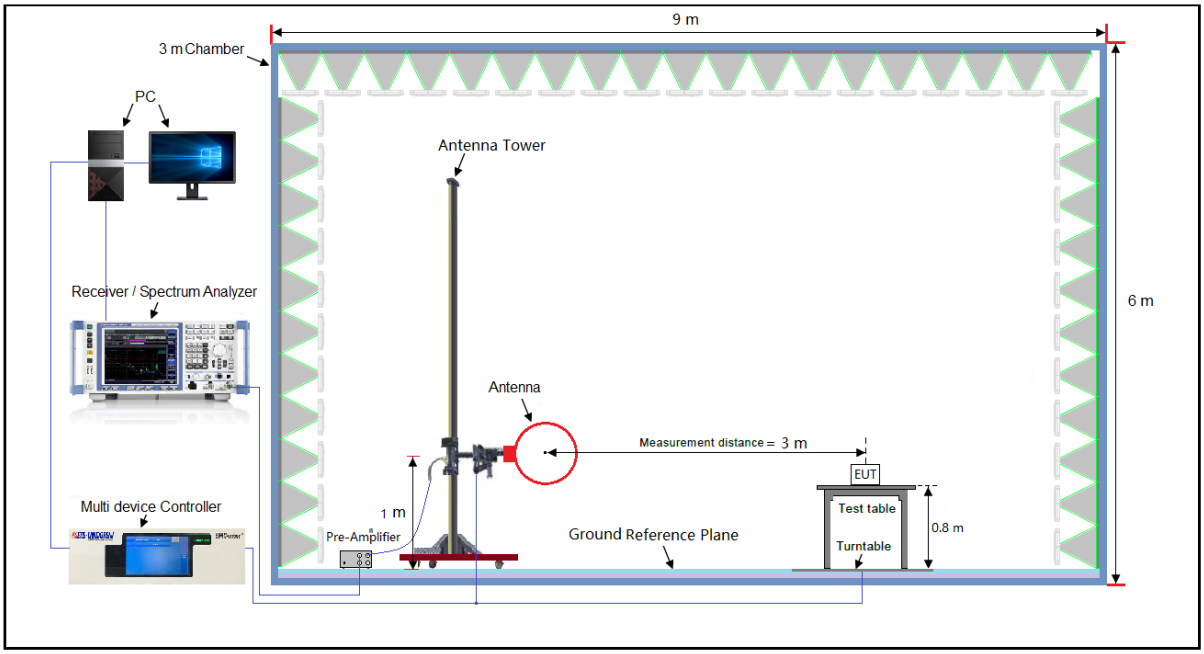



**Figure 2. 30MHz to 1GHz**

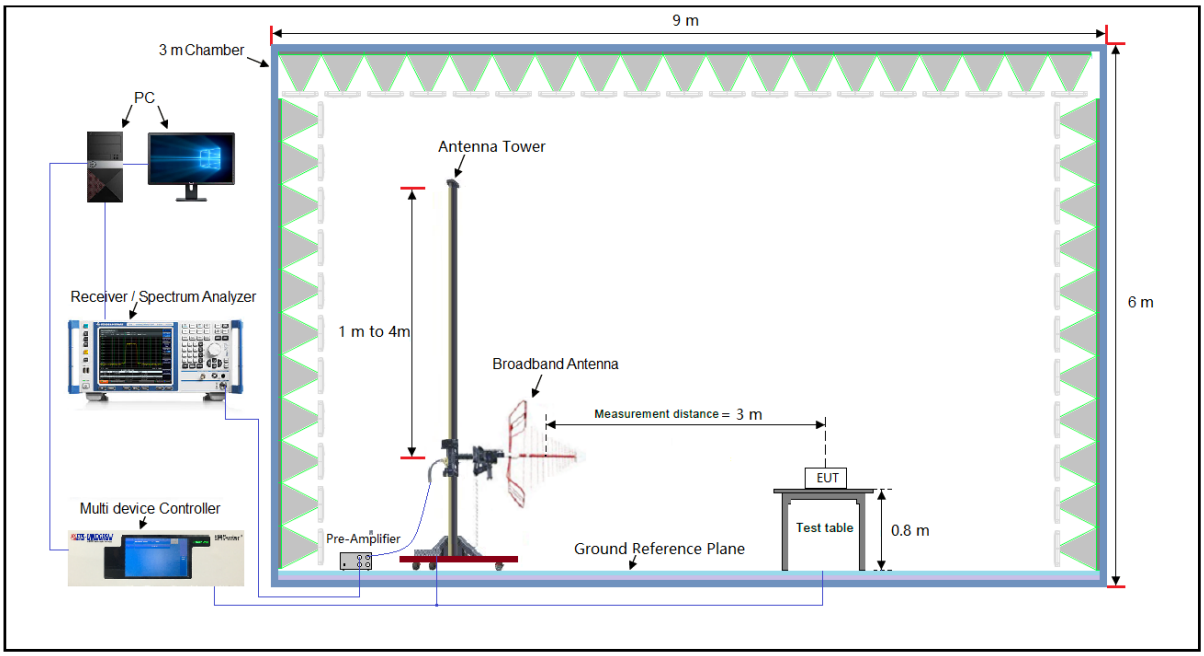
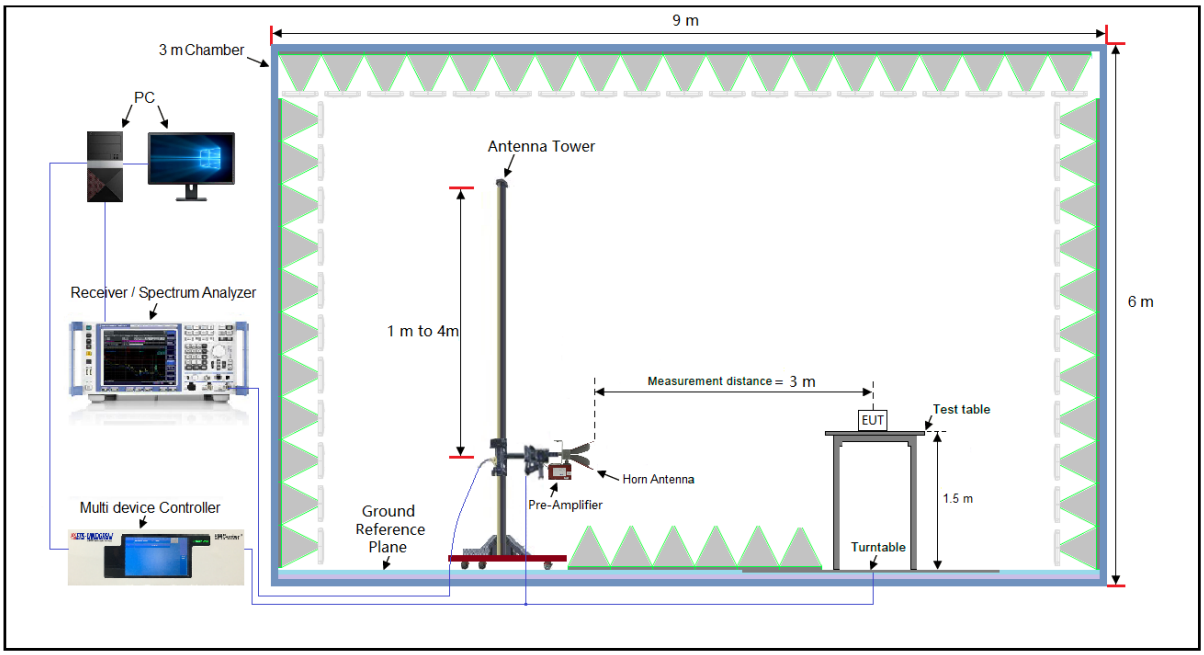
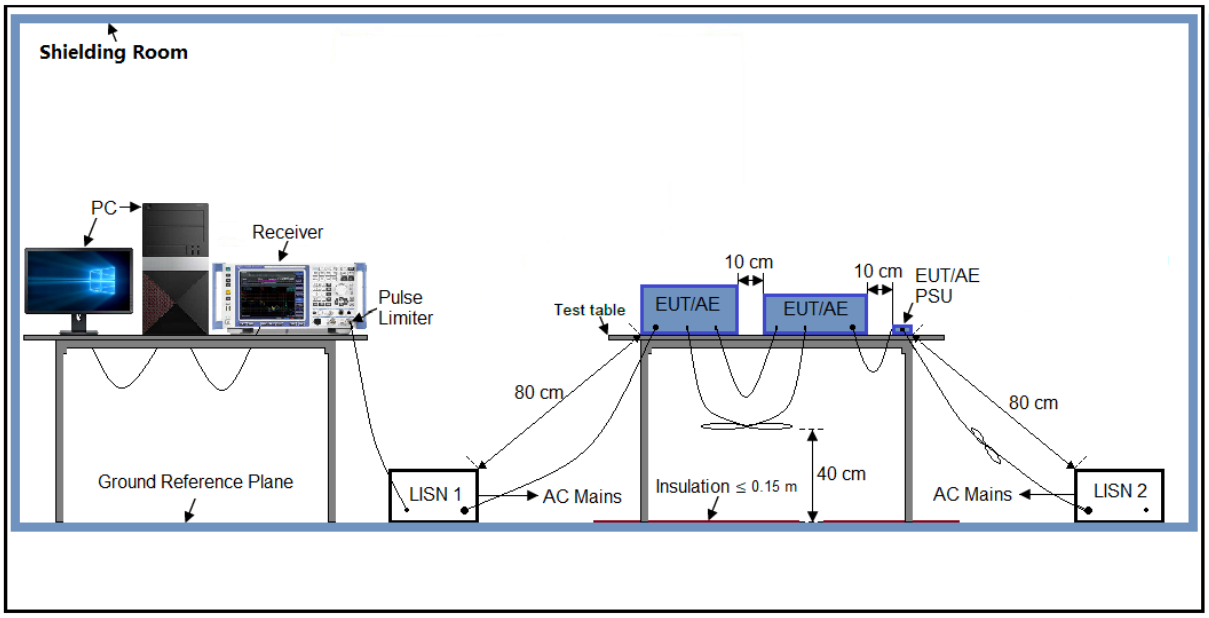


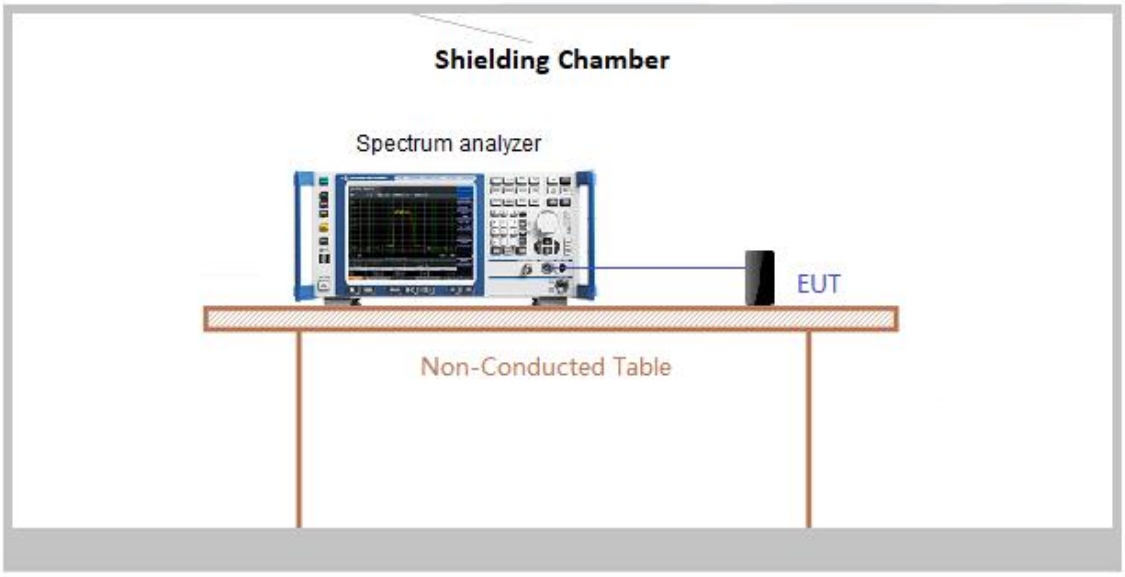
**Figure 3. Above 1GHz**




## 4.5.2 For Conducted Emissions test setup



### 4.5.3 For Conducted RF test setup




Normal Environment

## 4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by 3.7 V Battery. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

## 4.7 DUTY CYCLE

**Test Procedure:** ANSI C63.10-2013 Clause 12.2.

**Test Results**

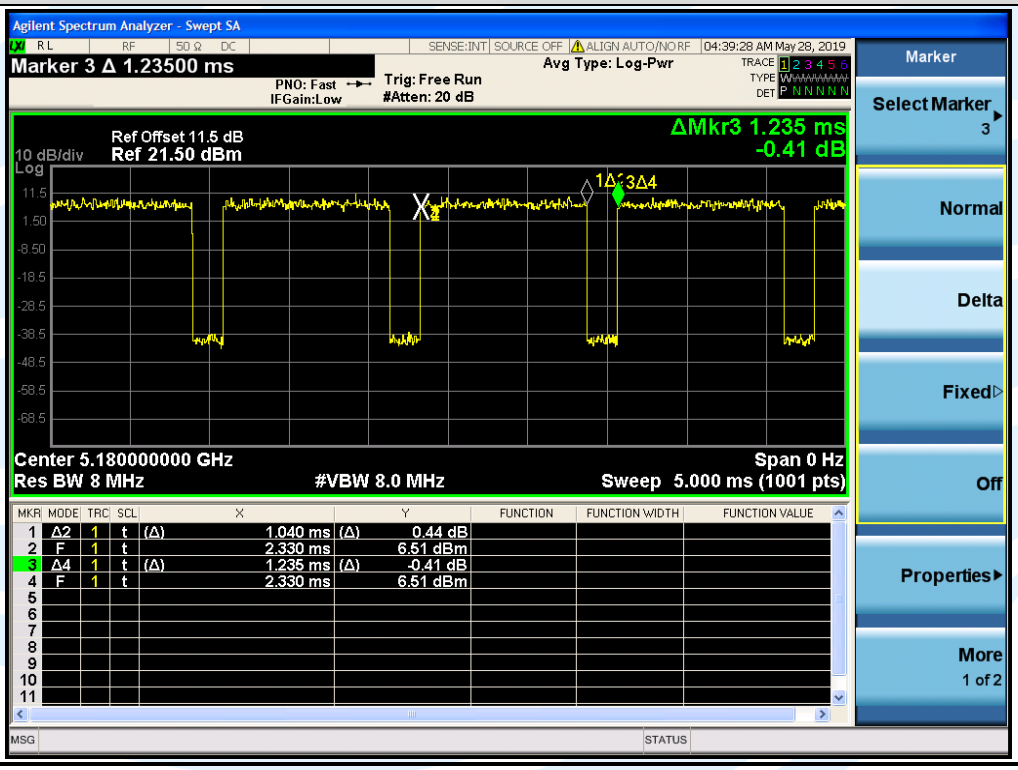
| Mode | Data rates (Mbps) | On Time (msec) | Period (msec) | Duty Cycle (linear) | Duty Cycle (%) | Duty Cycle Factor (dB) | 1/ T Minimum VBW (kHz) | Average Factor (dB) |
|---|---|---|---|---|---|---|---|---|
| IEEE 802.11a | 54 | 1.040 | 1.236 | 0.84 | 84.14 | 0.75 | 0.96 | -1.50 |
| IEEE 802.11n-HT20 | MCS7 | 0.975 | 1.185 | 0.82 | 82.28 | 0.85 | 1.03 | -1.69 |
| IEEE 802.11n-HT40 | MCS7 | 0.489 | 0.687 | 0.71 | 71.18 | 1.48 | 2.04 | -2.95 |
| IEEE 802.11ac-VHT20 | MCS8 | 0.980 | 1.175 | 0.83 | 83.40 | 0.79 | 1.02 | -1.58 |
| IEEE 802.11ac-VHT40 | MCS9 | 0.492 | 0.694 | 0.71 | 70.89 | 1.49 | 2.03 | -2.99 |
| IEEE 802.11ac-VHT80 | MCS9 | 0.244 | 0.448 | 0.54 | 54.46 | 2.64 | 4.10 | -5.28 |

**Remark:**

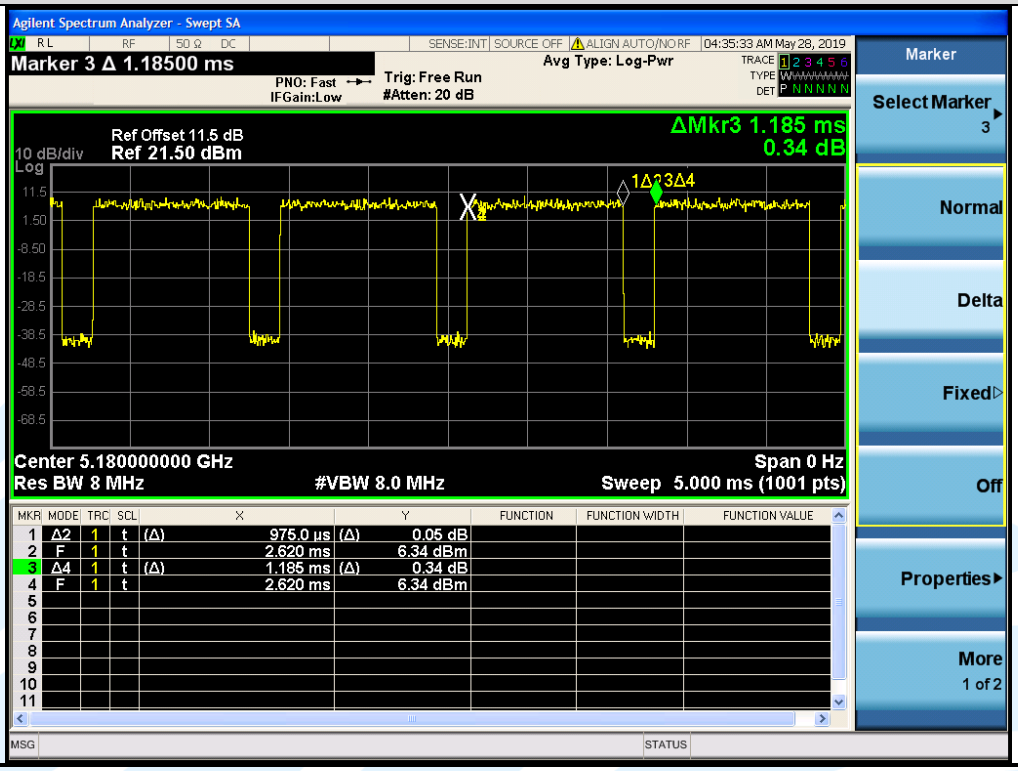
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

**The test plots as follows**

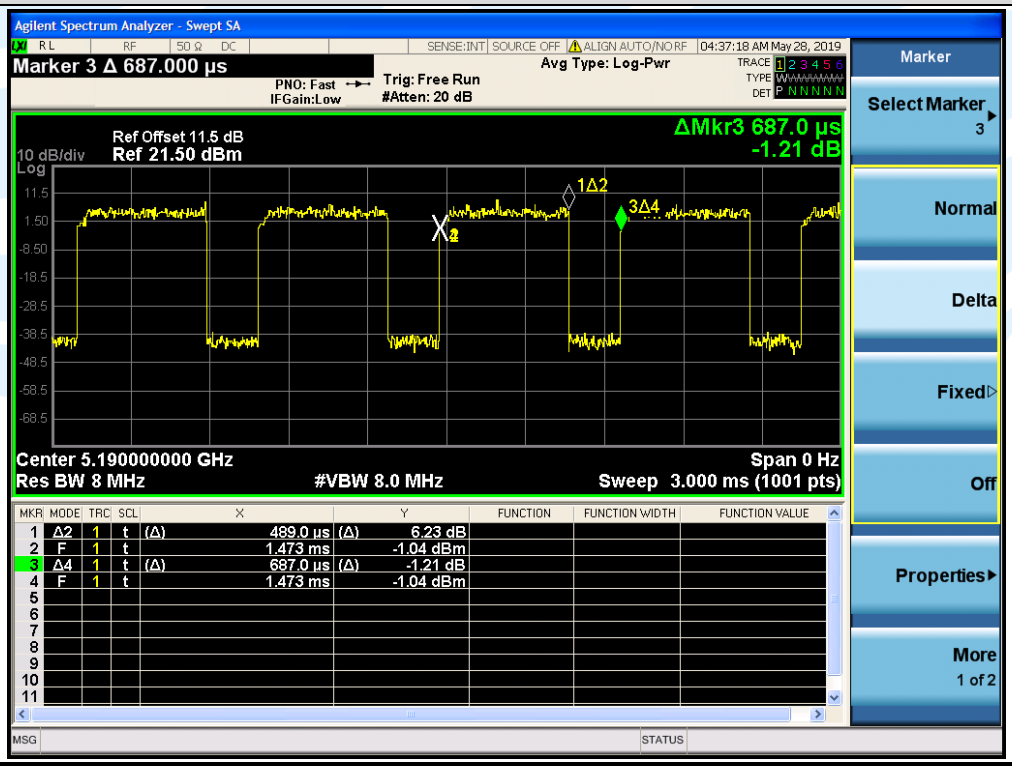
**IEEE 802.11a**



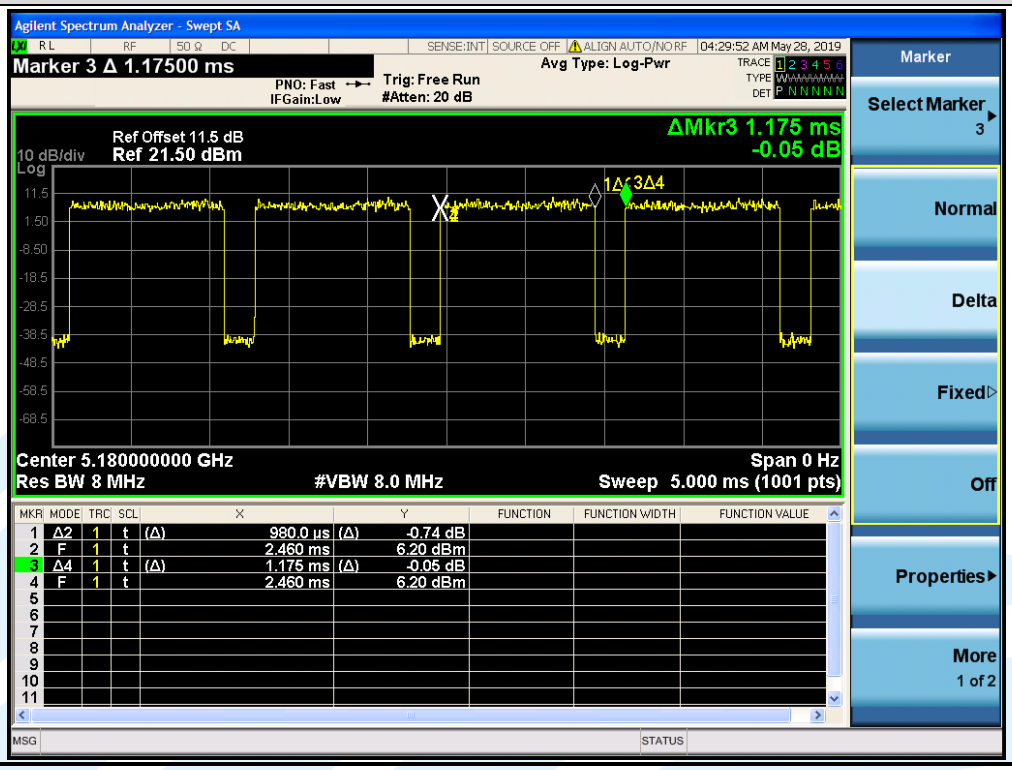
## IEEE 802.11n-HT20



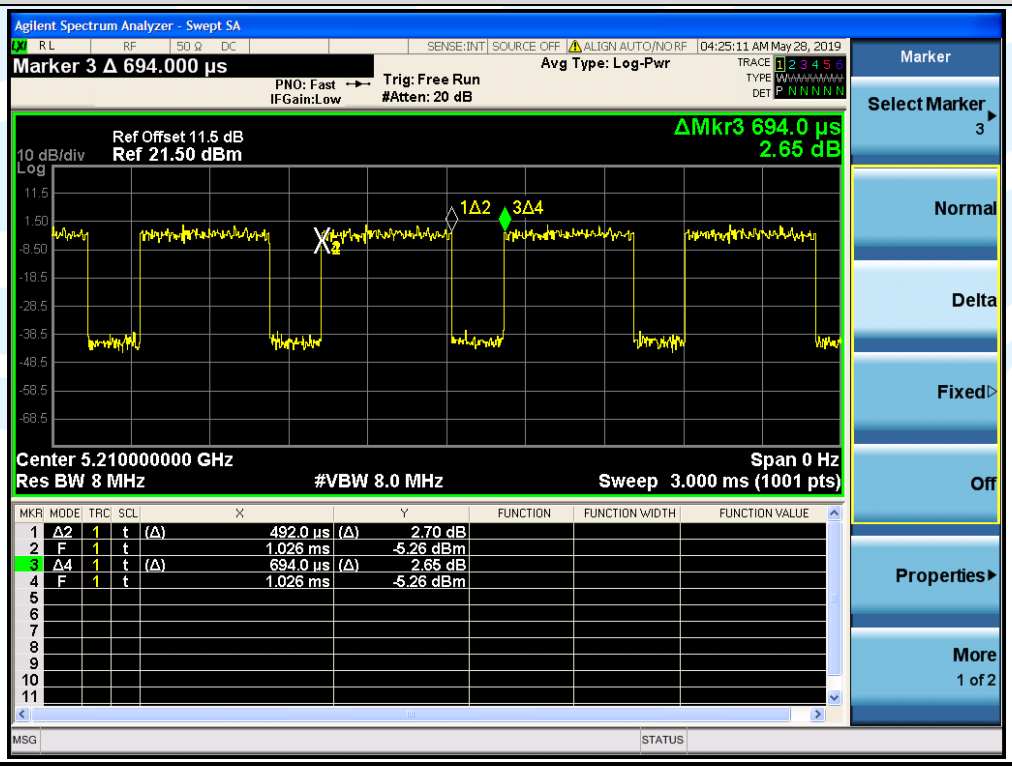

## IEEE 802.11n-HT40



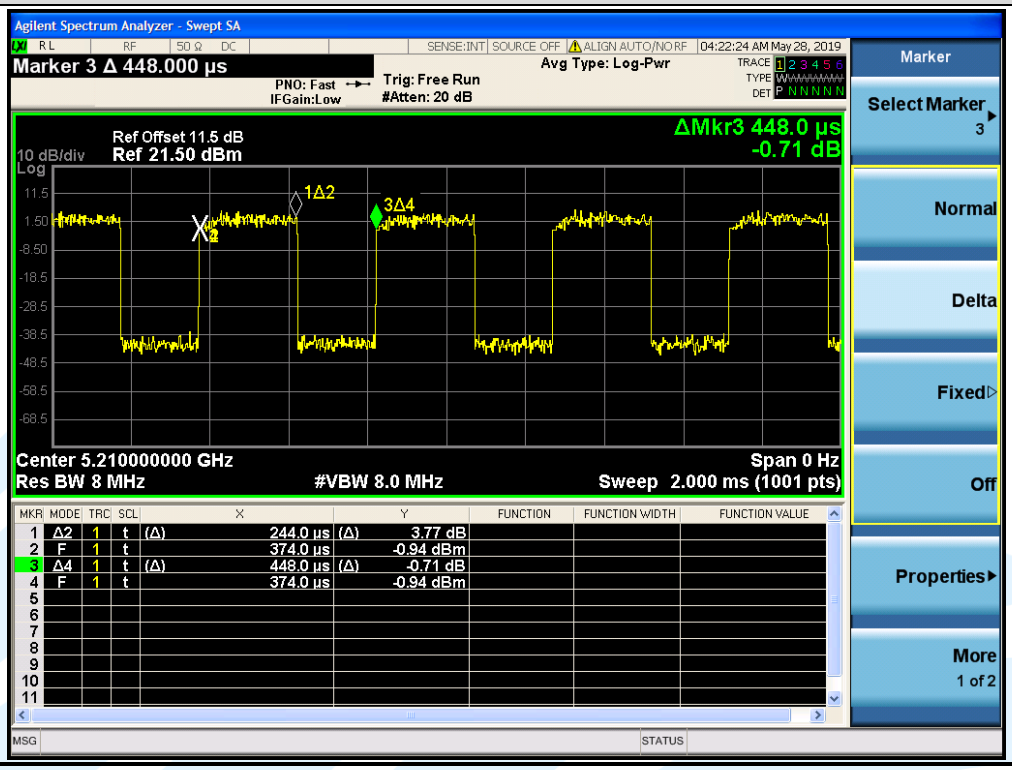
## IEEE 802.11ac-VHT20




## IEEE 802.11ac-VHT40



**IEEE 802.11ac-VHT80**



# 5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

## 5.1 REFERENCE DOCUMENTS FOR TESTING

| No. | Identity | Document Title |
|---|---|---|
| 1 | FCC 47 CFR Part 2 | Frequency allocations and radio treaty matters; general rules and regulations |
| 2 | FCC 47 CFR Part 15 | Radio Frequency Devices |
| 3 | RSS-247 Issue 2 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| 4 | RSS-Gen Issue 5 | General Requirements for Compliance of Radio Apparatus |
| 5 | ANSI C63.10-2013 | American National Standard for Testing Unlicesed Wireless Devices |
| 6 | KDB 789033 D02 General UNII Test Procedures New Rules v02r01 | Guidelines for compliance testing of unlicensed national information infrastructure (U-NII) device part 15, subpart E |
| 7 | KDB 905462 D06 802.11 Channel Plans New Rules v02 | Operation in U-NII bands -802.11 channel PLAN(§15.407) |
| 8 | KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 | Compliance measurement procedures for Unlicensed –National Information Infrastructure devices operates in the frequency bands 5250 MHz to 5350 MHz and 5470 MHz to 5725 MHz bands incorporating dynamic frequency selection |
| 9 | KDB 905462 D03 Client Without DFS New Rules v01r02 | U-NII client devices without radar detection capability |
| 10 | KDB 662911 D01 Multiple Transmitter Output v02r01 | Emissions Testing of Transmitters with Multiple Outputs in the Same Band |

## 5.2 ANTENNA REQUIREMENT

| Standard Requirement |
|---|
| **15.203 requirement:**<br>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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.<br>**15.407(a)(1) (2) requirement:**<br>The conducted output power limit specified in paragraph (a) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (a) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power and the peak power spectral density shall be reduced by the by the amount in dB that the directional gain of the antenna exceeds 6 dBi.<br>**RSS-Gen Issue 5, Section 6.8 requirement:**<br>According to RSS-Gen Issue 5, Section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. |
| **EUT Antenna:** |
| Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is -3.77 dBi |

## 5.3 26 DB BANDWIDTH & OCCUPIED BANDWIDTH

**Test Requirement:** FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(2)(5)
RSS-247 Issue 2 Section 6.2.1.2

**Test Method:** KDB 789033 D02 v02r01 Section C.1

**Limit:** None; for reporting purposes only.

**Test Procedure:**

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum analyzer.

Spectrum analyzer according to the following Settings:
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 %.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

**Test Setup:** Refer to section 4.5.3 for details.

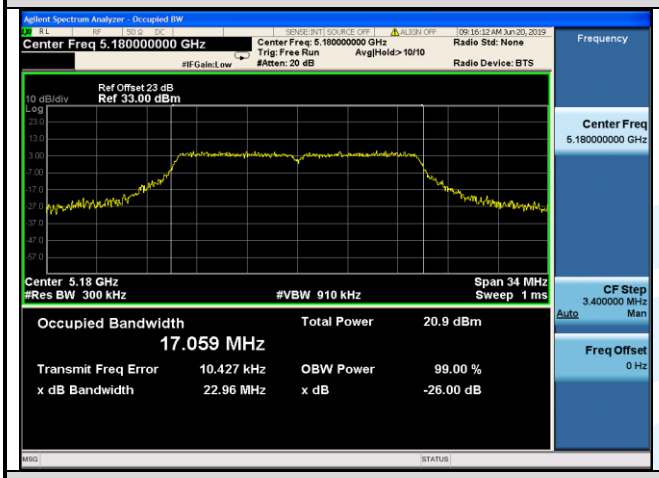
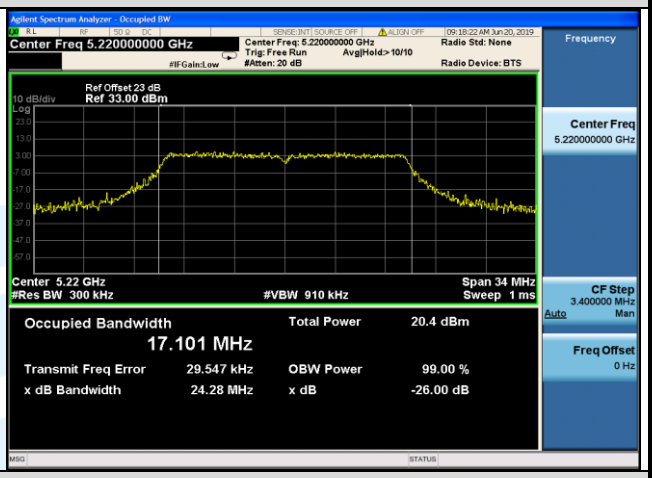
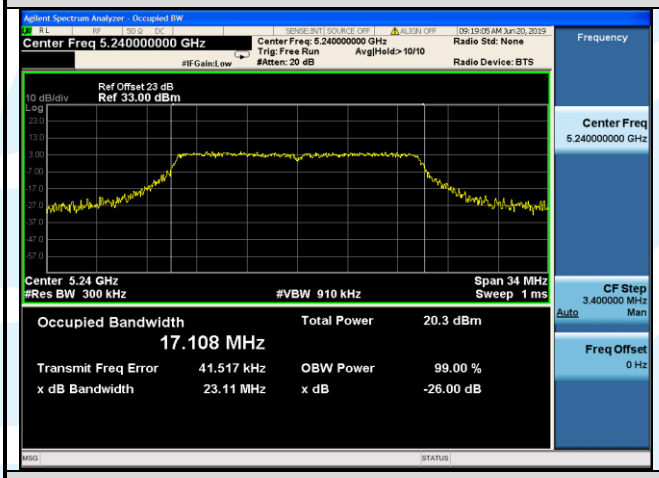
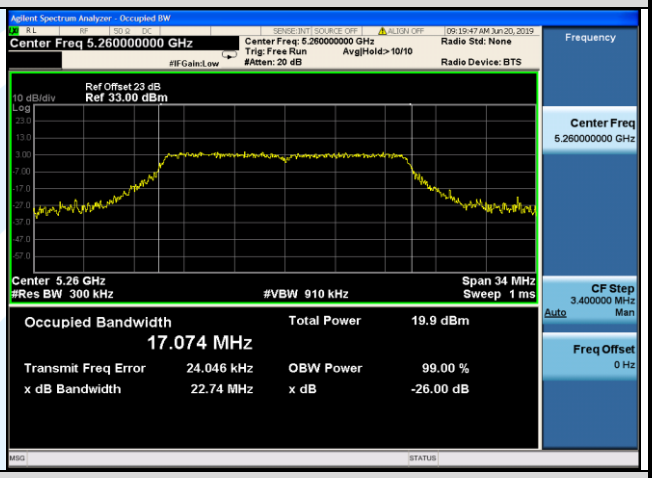
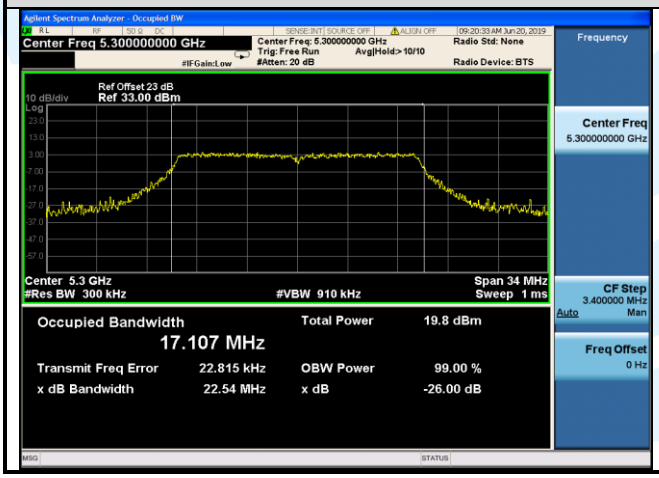
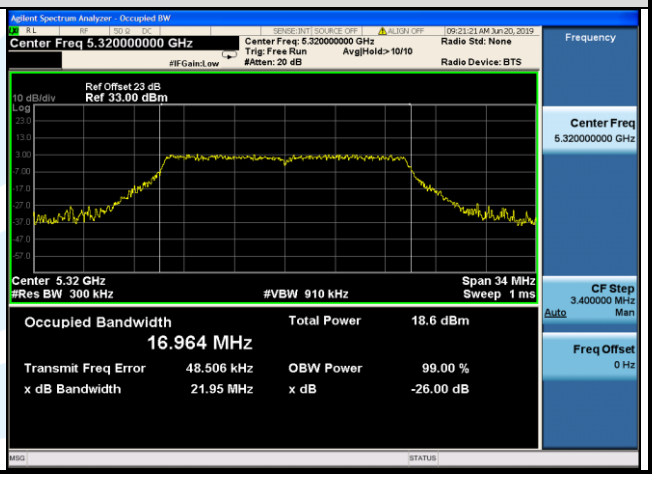
**Instruments Used:** Refer to section 3 for details

**Test Results:** Pass

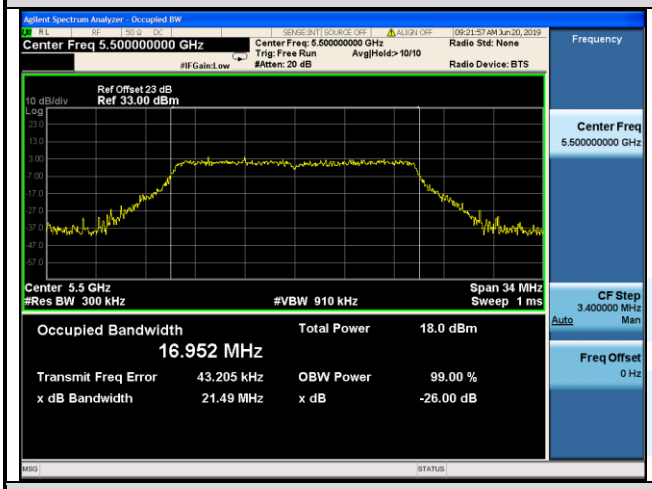
| Mode | Channel | 26 dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---|---|---|---|
| IEEE 802.11a | 36 (5180) | 22.96 | 17.059 |
| | 44 (5220) | 24.28 | 17.101 |
| | 48 (5240) | 23.11 | 17.108 |
| | 52 (5260) | 22.74 | 17.074 |
| | 60 (5300) | 22.54 | 17.107 |
| | 64 (5320) | 21.95 | 16.964 |
| | 100 (5500) | 21.49 | 16.952 |
| | 116 (5580) | 22.08 | 16.993 |
| | 140 (5700) | 21.98 | 16.997 |
| IEEE 802.11n-HT20 | 36 (5180) | 23.39 | 18.044 |
| | 44 (5220) | 22.75 | 17.988 |
| | 48 (5240) | 23.89 | 18.083 |
| | 52 (5260) | 27.15 | 18.175 |
| | 60 (5300) | 27.83 | 18.274 |
| | 64 (5320) | 24.20 | 18.139 |
| | 100 (5500) | 21.83 | 18.008 |
| | 116 (5580) | 22.44 | 18.087 |
| | 140 (5700) | 22.52 | 18.074 |
| IEEE 802.11n-HT40 | 38 (5190) | 60.00 | 36.789 |
| | 46 (5230) | 58.52 | 36.535 |
| | 54 (5270) | 59.70 | 36.449 |
| | 62 (5310) | 54.14 | 36.454 |
| | 102 (5510) | 43.65 | 36.158 |
| | 110 (5550) | 43.47 | 36.271 |
| | 134 (5670) | 42.68 | 36.146 |

| Mode | Channel | 26 dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---|---|---|---|
| IEEE 802.11ac-VHT20 | 36 (5180) | 22.45 | 18.084 |
| | 44 (5220) | 22.53 | 18.060 |
| | 48 (5240) | 21.95 | 18.091 |
| | 52 (5260) | 27.82 | 18.214 |
| | 60 (5300) | 26.67 | 18.131 |
| | 64 (5320) | 24.84 | 18.115 |
| | 100 (5500) | 22.17 | 18.076 |
| | 116 (5580) | 22.48 | 18.041 |
| | 140 (5700) | 22.15 | 18.049 |
| IEEE 802.11ac-VHT40 | 38 (5190) | 59.93 | 36.653 |
| | 46 (5230) | 57.87 | 36.594 |
| | 54 (5270) | 55.30 | 36.517 |
| | 62 (5310) | 54.93 | 36.431 |
| | 102 (5510) | 42.29 | 36.331 |
| | 110 (5550) | 42.27 | 36.185 |
| | 134 (5670) | 42.56 | 36.211 |
| IEEE 802.11ac-VHT80 | 42 (5230) | 85.47 | 74.896 |
| | 58 (5290) | 85.31 | 74.818 |
| | 106 (5530) | 85.85 | 74.789 |

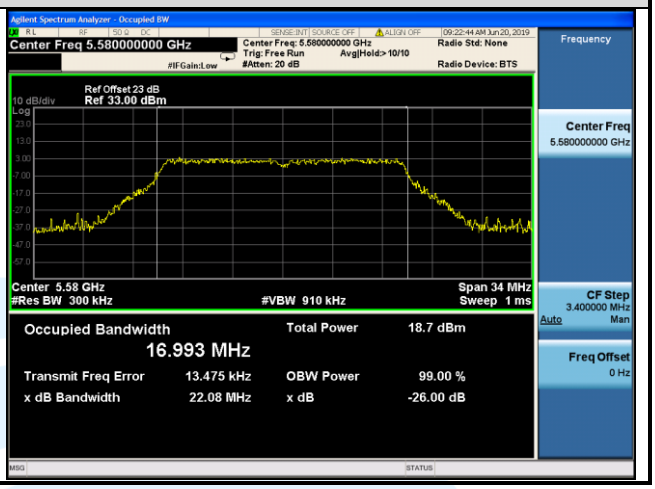
**The test plots as follows:**

| Channel 36 | Channel 44 |
|---|---|
|  |  |
| **Channel 48** | **Channel 52** |
|  |  |
| **Channel 60** | **Channel 64** |
|  |  |

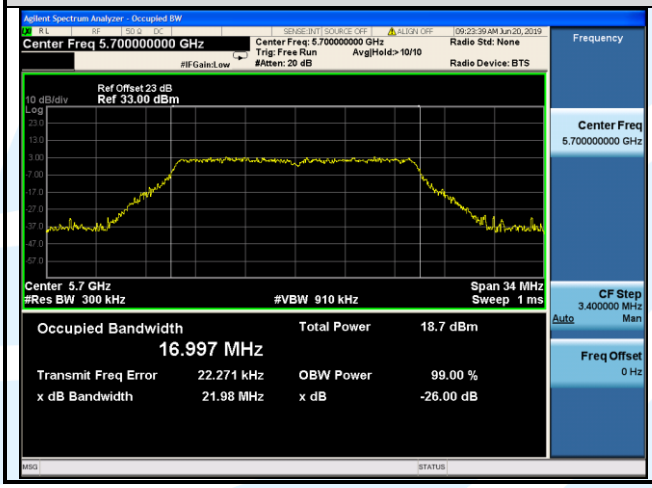
**Channel 100**




**Channel 116**

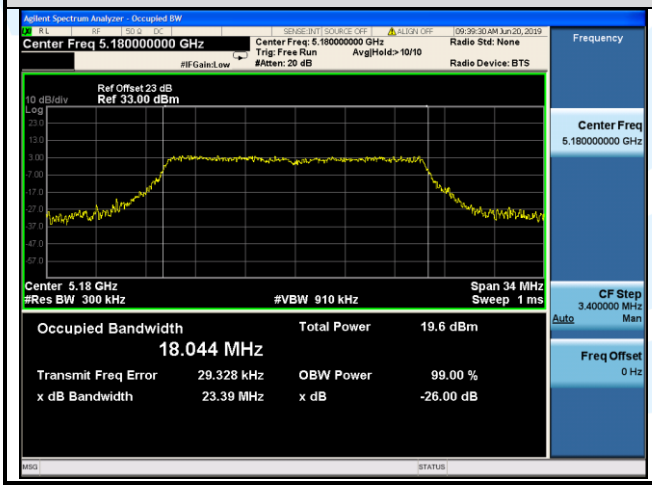



**Channel 140**

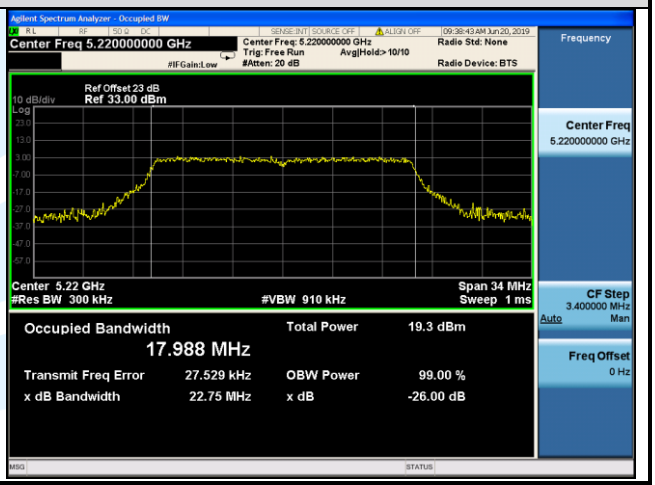



**IEEE 802.11n-HT20**

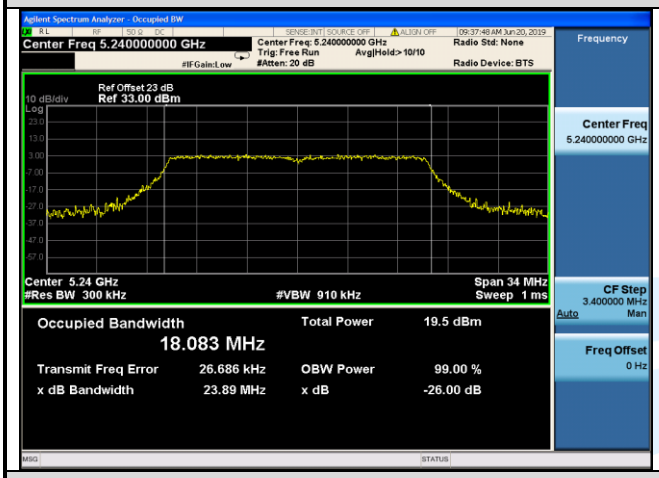
**Channel 36**



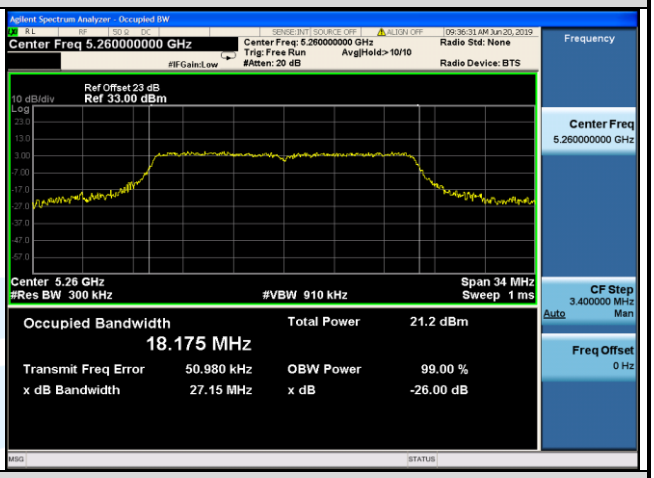

**Channel 44**



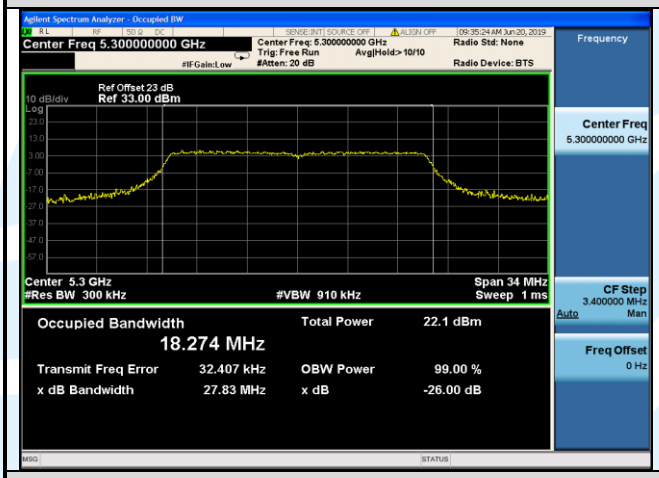
## Channel 48



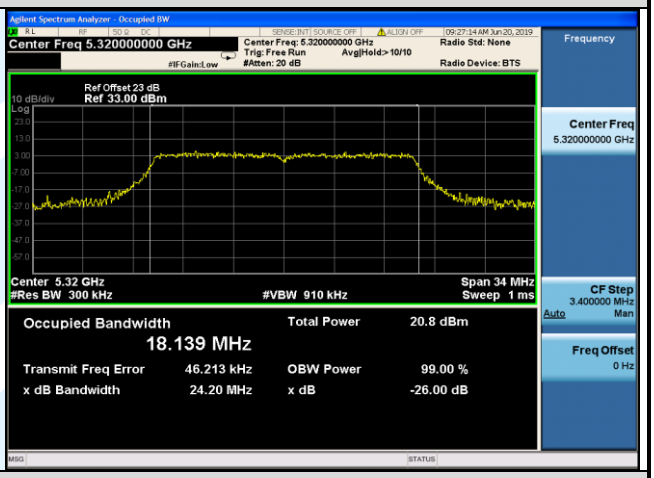

## Channel 52



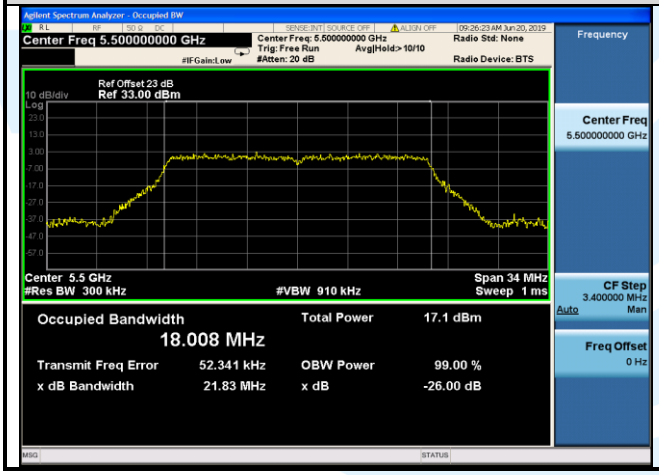

## Channel 60



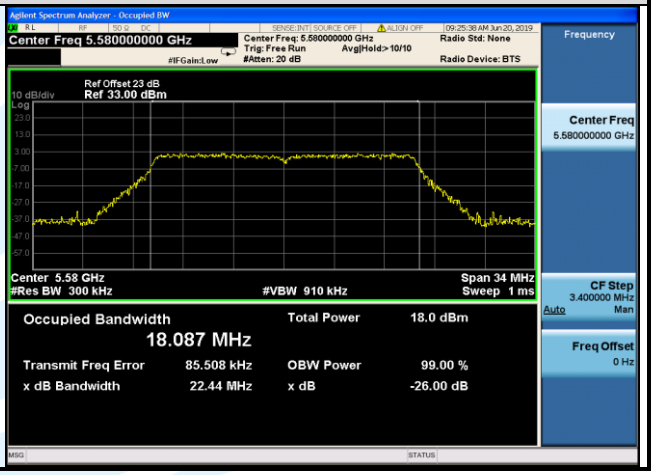

## Channel 64



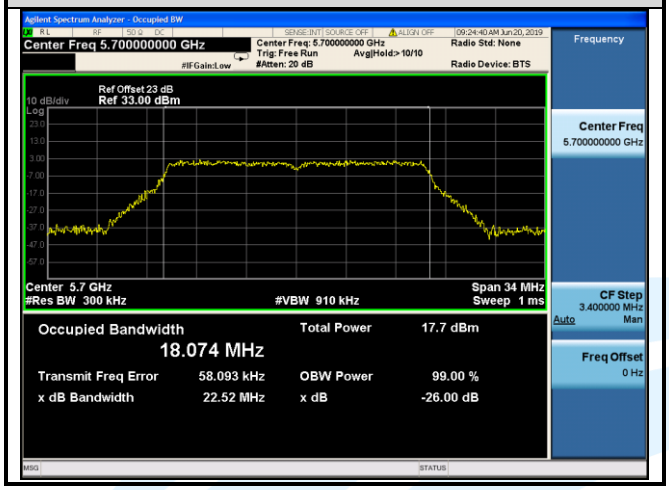

## Channel 100




## Channel 116

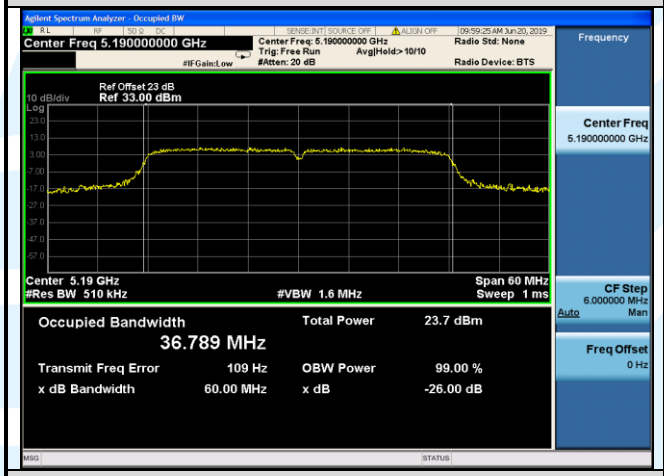


## Channel 140

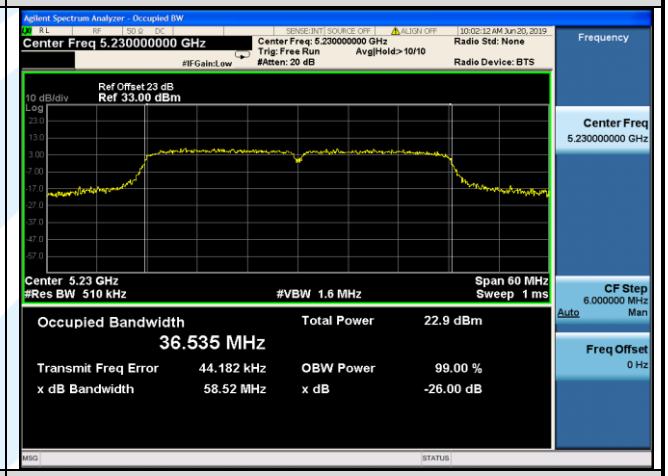



## IEEE 802.11n-HT40

### Channel 38

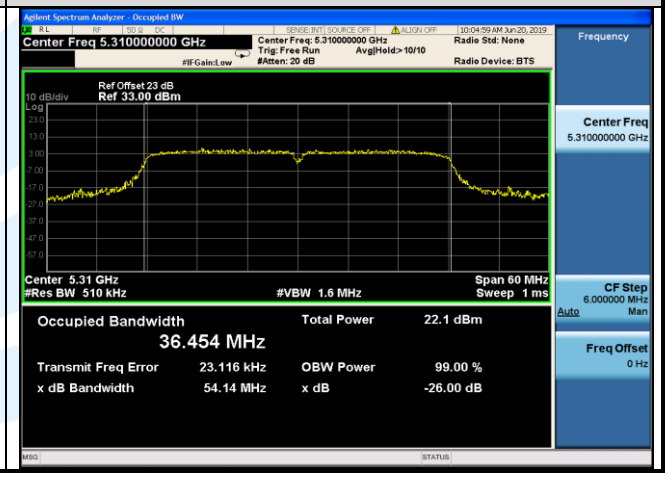



### Channel 46

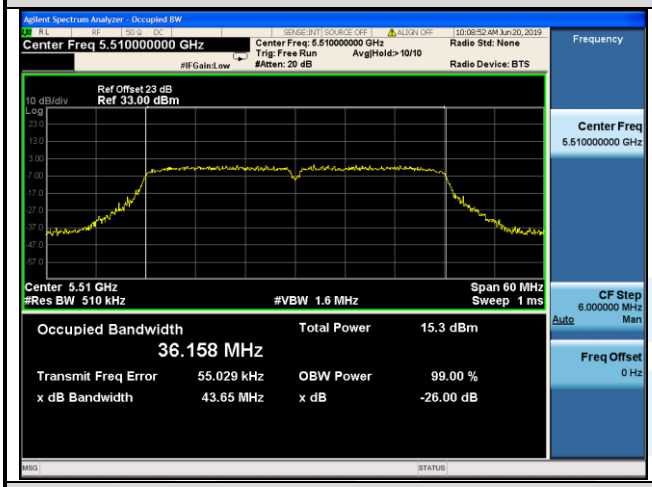



### Channel 54

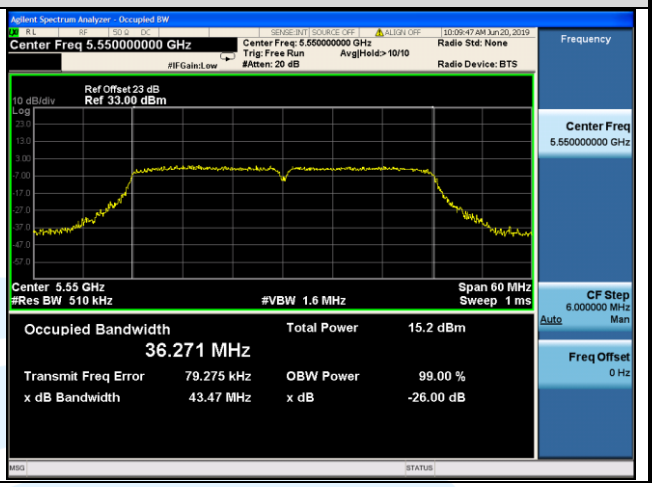
### Channel 62



**Channel 102**



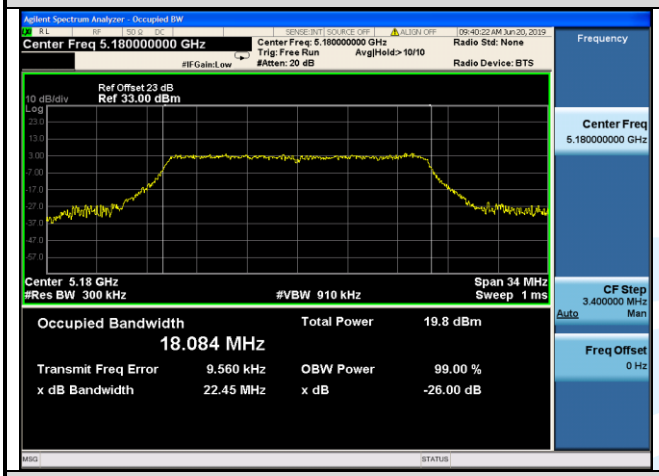

**Channel 110**



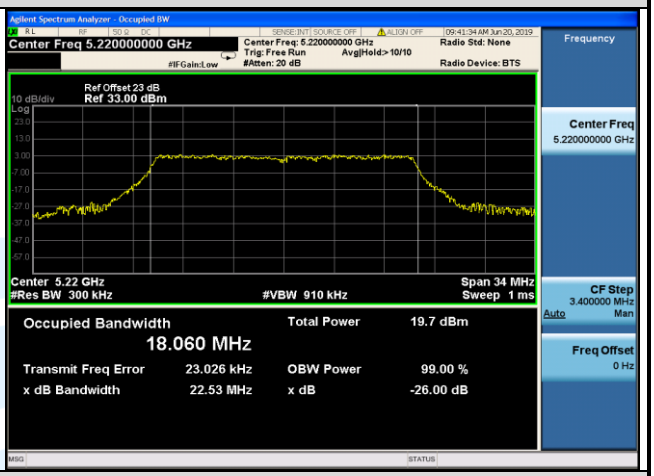

**Channel 134**

## IEEE 802.11ac-VHT20

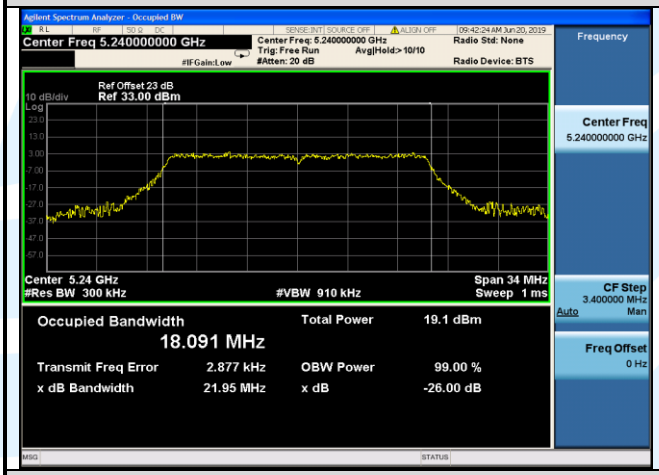
### Channel 36



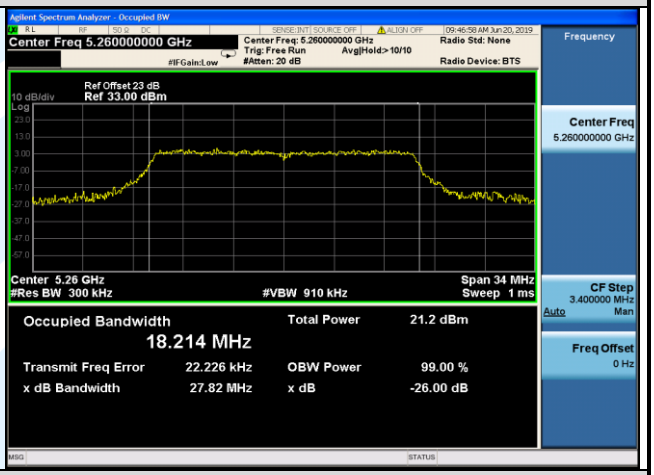

### Channel 44



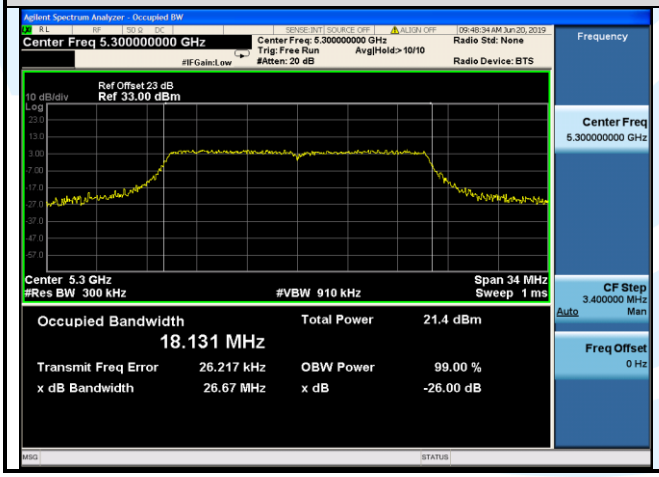

### Channel 48



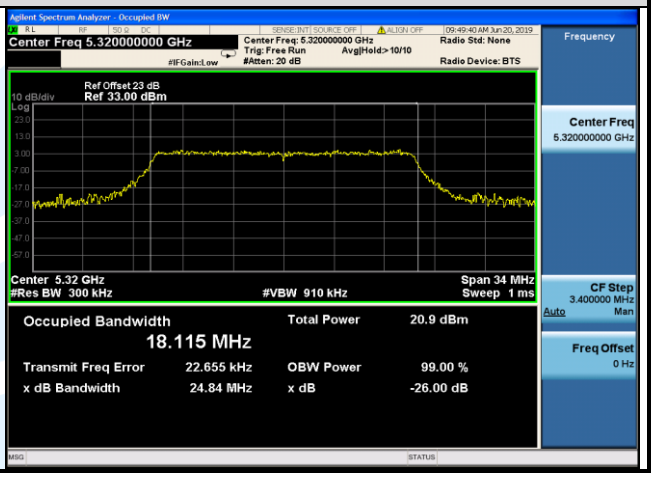

### Channel 52



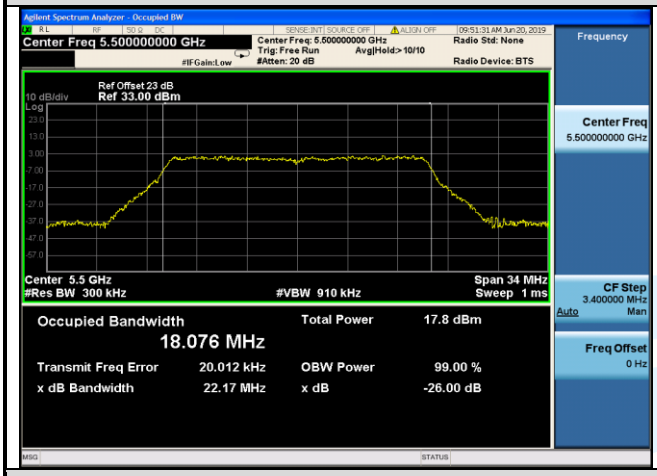

### Channel 60



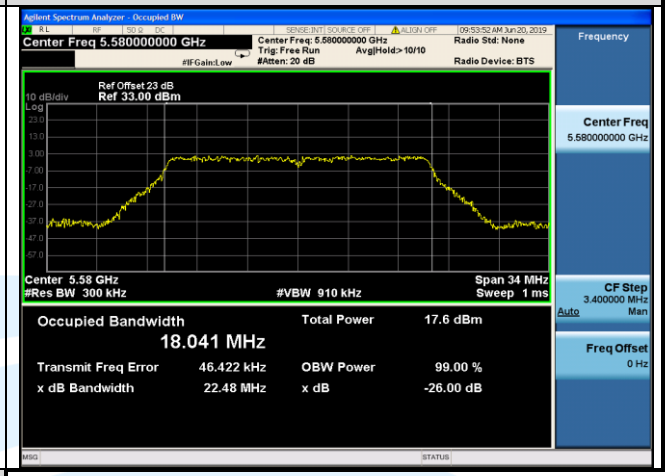

### Channel 64



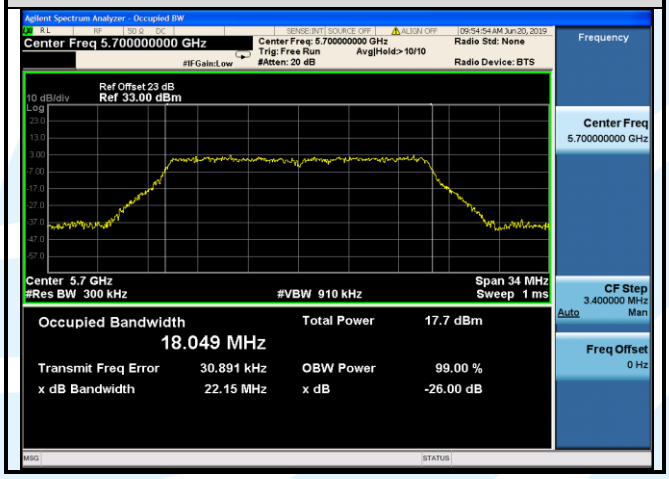
## Channel 100




## Channel 116




## Channel 140

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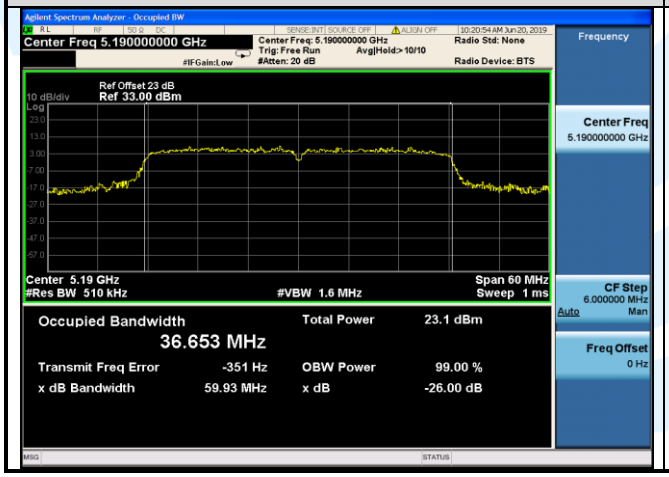
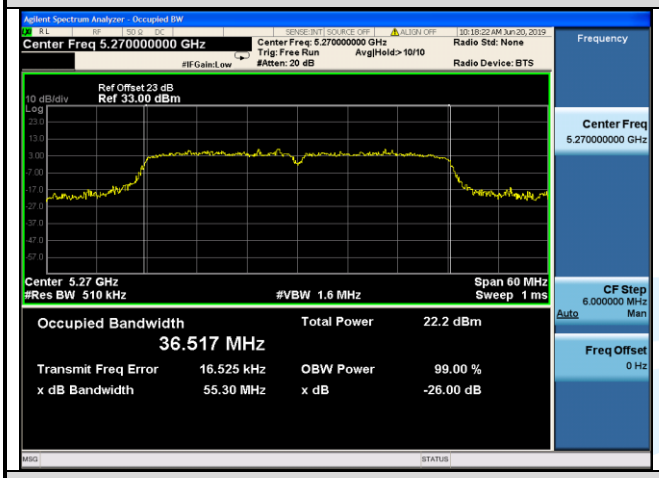
## Channel 38

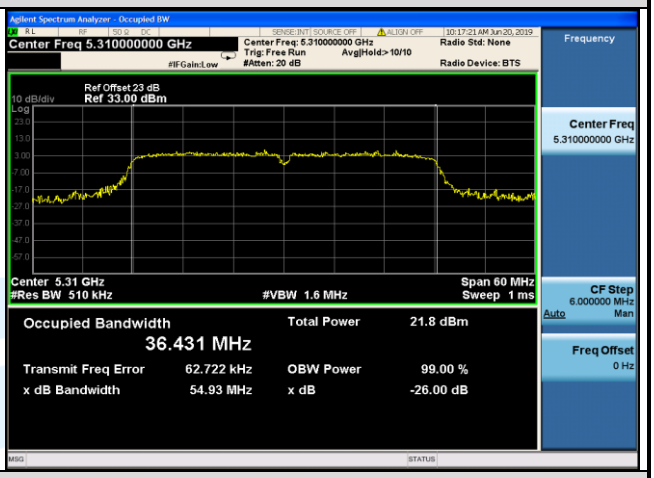



## Channel 46

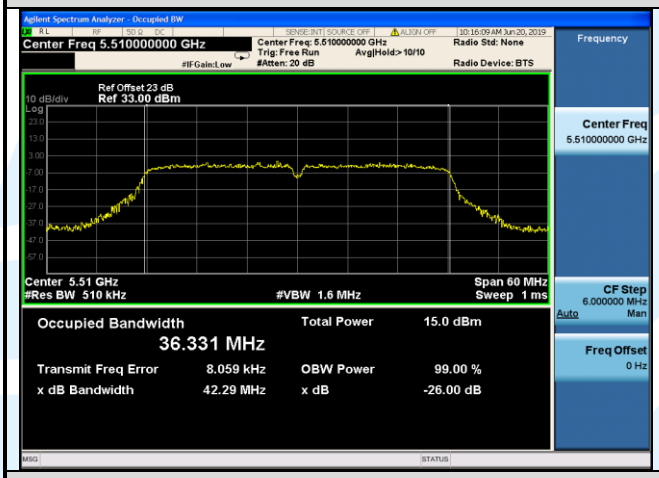
**Channel 54**



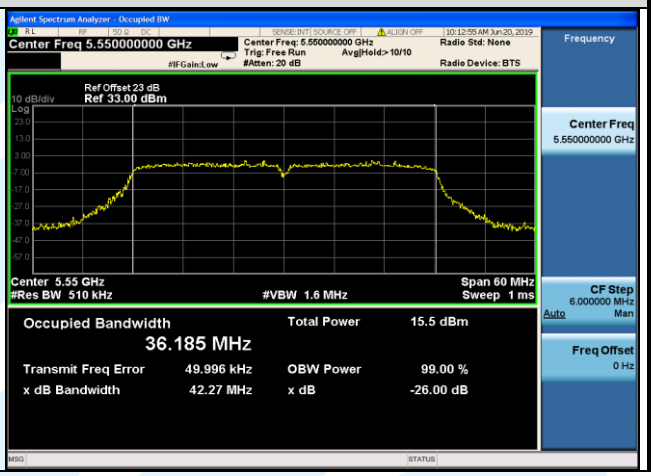

**Channel 62**




**Channel 102**



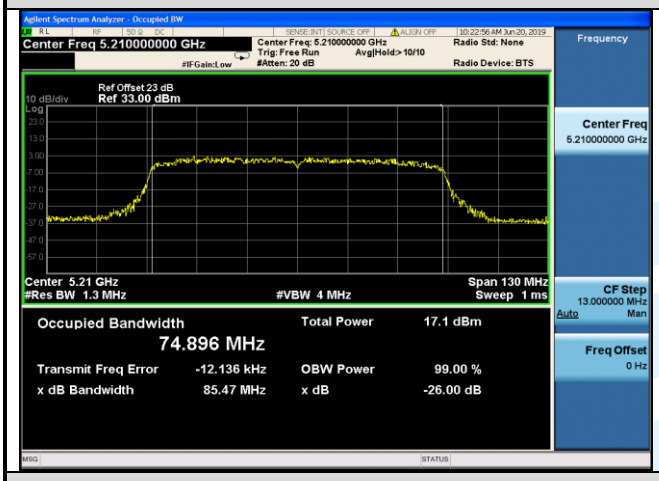

**Channel 110**



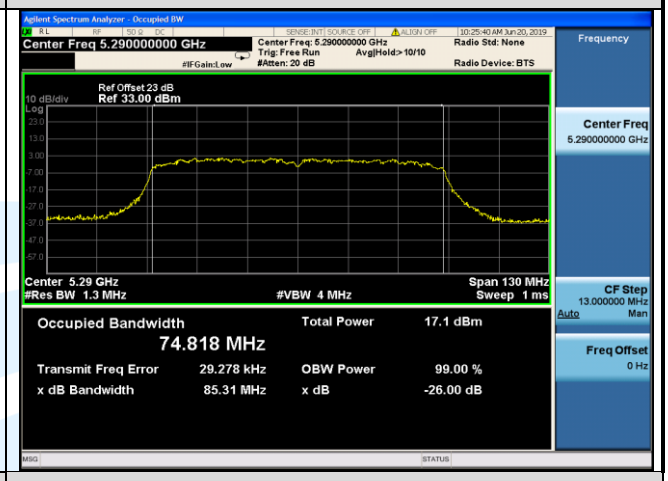

**Channel 134**

## IEEE 802.11ac-VHT80

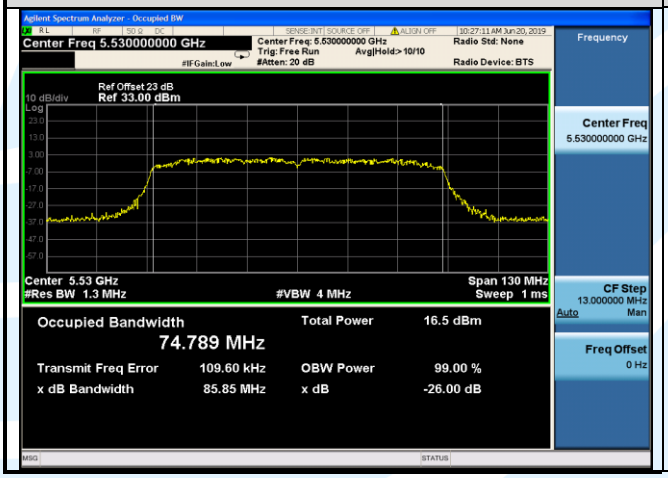
### Channel 42

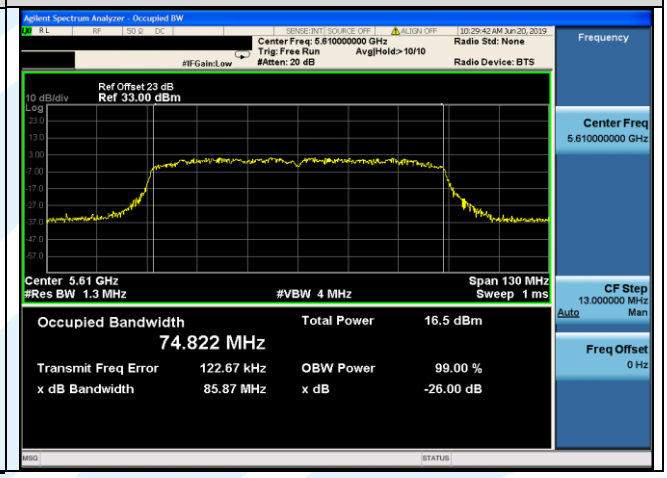



### Channel 58




### Channel 106




### Channel 122