



CERTIFICATION TEST REPORT

Report Number. : 12875712-E2V2

Applicant : DISH TECHNOLOGIES LLC
9601 MERIDIAN BLVD
ENGLEWOOD, CO 80112

Model : AIRT V 3

FCC ID : DKN-ATV3

EUT Description : OVER THE AIR TV STREAMING DEVICE

Test Standard(s) : FCC 47 CFR PART 15 SUBPART E

Date Of Issue:
August 27, 2019

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REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions | Revised By |
|------|------------|--|------------|
| V1 | 8/23/2019 | Initial Issue | |
| V2 | 8/27/2019 | Updated Equipment list, antenna names, OFS statement | Tri Pham |

TABLE OF CONTENTS

| | |
|--|-----------|
| REPORT REVISION HISTORY | 2 |
| TABLE OF CONTENTS | 3 |
| 1. ATTESTATION OF TEST RESULTS | 5 |
| 2. TEST METHODOLOGY | 6 |
| 3. FACILITIES AND ACCREDITATION | 6 |
| 4. CALIBRATION AND UNCERTAINTY | 7 |
| 4.1. <i>MEASURING INSTRUMENT CALIBRATION</i> | <i>7</i> |
| 4.2. <i>SAMPLE CALCULATION</i> | <i>7</i> |
| 4.3. <i>MEASUREMENT UNCERTAINTY.....</i> | <i>7</i> |
| 5. EQUIPMENT UNDER TEST | 8 |
| 5.1. <i>EUT DESCRIPTION</i> | <i>8</i> |
| 5.2. <i>MAXIMUM OUTPUT POWER.....</i> | <i>8</i> |
| 5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS</i> | <i>9</i> |
| 5.4. <i>SOFTWARE AND FIRMWARE.....</i> | <i>9</i> |
| 5.5. <i>WORST-CASE CONFIGURATION AND MODE.....</i> | <i>9</i> |
| 5.6. <i>DESCRIPTION OF TEST SETUP.....</i> | <i>10</i> |
| 6. MEASUREMENT METHOD..... | 13 |
| 7. TEST AND MEASUREMENT EQUIPMENT | 14 |
| 8. ANTENNA PORT TEST RESULTS | 15 |
| 8.1. <i>ON TIME AND DUTY CYCLE.....</i> | <i>15</i> |
| 8.2. <i>26 dB BANDWIDTH.....</i> | <i>17</i> |
| 8.2.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND | 18 |
| 8.2.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND | 23 |
| 8.2.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND | 27 |
| 8.2.4. 802.11n HT20 MODE IN THE 5.8 GHz BAND | 30 |
| 8.2.5. 802.11n HT40 MODE IN THE 5.8 GHz BAND | 35 |
| 8.2.6. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND | 39 |
| 8.3. <i>99% BANDWIDTH.....</i> | <i>42</i> |
| 8.3.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND | 43 |
| 8.3.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND | 48 |
| 8.3.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND | 52 |
| 8.3.4. 802.11n HT20 MODE IN THE 5.8 GHz BAND | 55 |
| 8.3.5. 802.11n HT40 MODE IN THE 5.8 GHz BAND | 60 |
| 8.3.6. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND | 64 |

| | |
|---|------------|
| 8.4. 6 dB BANDWIDTH..... | 67 |
| 8.4.1. 802.11n HT20 MODE IN THE 5.8 GHz BAND | 68 |
| 8.4.2. 802.11n HT40 MODE IN THE 5.8 GHz BAND | 72 |
| 8.4.3. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND | 75 |
| 8.5. OUTPUT POWER AND PSD..... | 78 |
| 8.5.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND | 82 |
| 8.5.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND | 90 |
| 8.5.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND | 96 |
| 8.5.4. 802.11n HT20 MODE IN THE 5.8 GHz BAND | 102 |
| 8.5.5. 802.11n HT40 MODE IN THE 5.8 GHz BAND | 109 |
| 8.5.6. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND | 115 |
| 9. RADIATED TEST RESULTS..... | 121 |
| 9.1. TRANSMITTER ABOVE 1 GHz | 123 |
| 9.1.1. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND..... | 123 |
| 9.1.2. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND..... | 135 |
| 9.1.3. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.2 GHz BAND | 145 |
| 9.1.4. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.8 GHz BAND..... | 153 |
| 9.1.5. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.8 GHz BAND..... | 171 |
| 9.1.6. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.8 GHz BAND | 187 |
| 9.2. WORST CASE BELOW 30MHZ | 201 |
| 9.3. WORST CASE BELOW 1 GHZ..... | 203 |
| 9.4. WORST CASE 18-26 GHZ..... | 205 |
| 9.5. WORST CASE 26-40 GHZ..... | 207 |
| 10. AC POWER LINE CONDUCTED EMISSIONS..... | 209 |
| 10.1.1. AC Power Line Norm | 210 |
| 11. SETUP PHOTOS..... | 212 |

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: DISH TECHNOLOGIES LLC
9601 MERIDIAN BLVD
ENGLEWOOD, CO 80112

EUT DESCRIPTION: OVER THE AIR TV STREAMING DEVICE

MODEL: AIRTV 3

SERIAL NUMBER: Conducted: P2-B127
Radiated: P2-B136

DATE TESTED: AUGUST 5, 2019 – AUGUST 19, 2019

| APPLICABLE STANDARDS | | TEST RESULTS |
|--------------------------|--|--------------|
| STANDARD | | |
| CFR 47 Part 15 Subpart E | | Complies |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v02/D03 v01r02/D06 v02, FCC KDB 789033 D02 v02r01, ANSI C63.10-2013, FCC 06-96.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 47173 Benicia Street | 47266 Benicia Street | 47658 Kato Rd |
|---|---|---|
| <input checked="" type="checkbox"/> Chamber A | <input type="checkbox"/> Chamber D | <input checked="" type="checkbox"/> Chamber I |
| <input type="checkbox"/> Chamber B | <input checked="" type="checkbox"/> Chamber E | <input type="checkbox"/> Chamber J |
| <input type="checkbox"/> Chamber C | <input type="checkbox"/> Chamber F | <input type="checkbox"/> Chamber K |
| | <input type="checkbox"/> Chamber G | <input type="checkbox"/> Chamber L |
| | <input type="checkbox"/> Chamber H | <input type="checkbox"/> Chamber M |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

$$36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

$$36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | UNCERTAINTY |
|---|-------------|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz | 3.84 dB |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz | 3.65 dB |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz | 2.52 dB |
| Worst Case Radiated Disturbance, 30 to 1000 MHz | 4.88 dB |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz | 4.24 dB |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.37 dB |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.17 dB |

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is an over the air tv streaming device.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

5.2 GHz BAND (FCC)

| Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|--------------------------|--------------------|--------------------|-------------------|
| 5.2 GHz band, 1TX | | | |
| 5180-5240 | 802.11n HT20 | 12.95 | 19.72 |
| 5190-5230 | 802.11n HT40 | 12.86 | 19.32 |
| 5210 | 802.11ac VHT80 | 10.94 | 12.42 |
| 5.2 GHz band, 2TX | | | |
| 5180-5240 | 802.11n HT20 CDD | 15.67 | 36.90 |
| 5190-5230 | 802.11n HT40 CDD | 15.55 | 35.89 |
| 5210 | 802.11ac VHT80 CDD | 13.81 | 24.04 |

5.8 GHz BAND (FCC)

| Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|--------------------------|--------------------|--------------------|-------------------|
| 5.8 GHz band, 1TX | | | |
| 5745-5825 | 802.11n HT20 | 9.94 | 9.86 |
| 5755-5795 | 802.11n HT40 | 9.76 | 9.46 |
| 5775 | 802.11ac VHT80 | 9.93 | 9.84 |
| 5.8 GHz band, 2TX | | | |
| 5745-5825 | 802.11n HT20 CDD | 12.78 | 18.97 |
| 5755-5795 | 802.11n HT40 CDD | 12.59 | 18.16 |
| 5775 | 802.11ac VHT80 CDD | 12.73 | 18.75 |

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an embedded antenna, with a maximum gain of 3.6 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was WCA 3.0.

The test utility software used during testing was the Marvel Labtool.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

The fundamental of the EUT was tested at normal operation on the Y-axis position.

For 11n HT20, 11n HT40, and 11ac VHT80, radiated harmonics spurious were performed with the EUT set at the 2TX CDD mode with power setting equal or higher than SISO modes as the worst-case scenario. 11a mode covered by 11n HT20 mode since it has the same power as 11n HT20.

Worst-case data rates as provided by the client were:

802.11n HT20 1Tx mode: MCS0
802.11n HT40 1Tx mode: MCS0
802.11ac VHT80 1Tx mode: MCS0
802.11n HT20 2Tx mode: MCS8
802.11n HT40 2Tx mode: MCS8
802.11ac VHT80 2Tx mode: MCS0

5.6. DESCRIPTION OF TEST SETUP

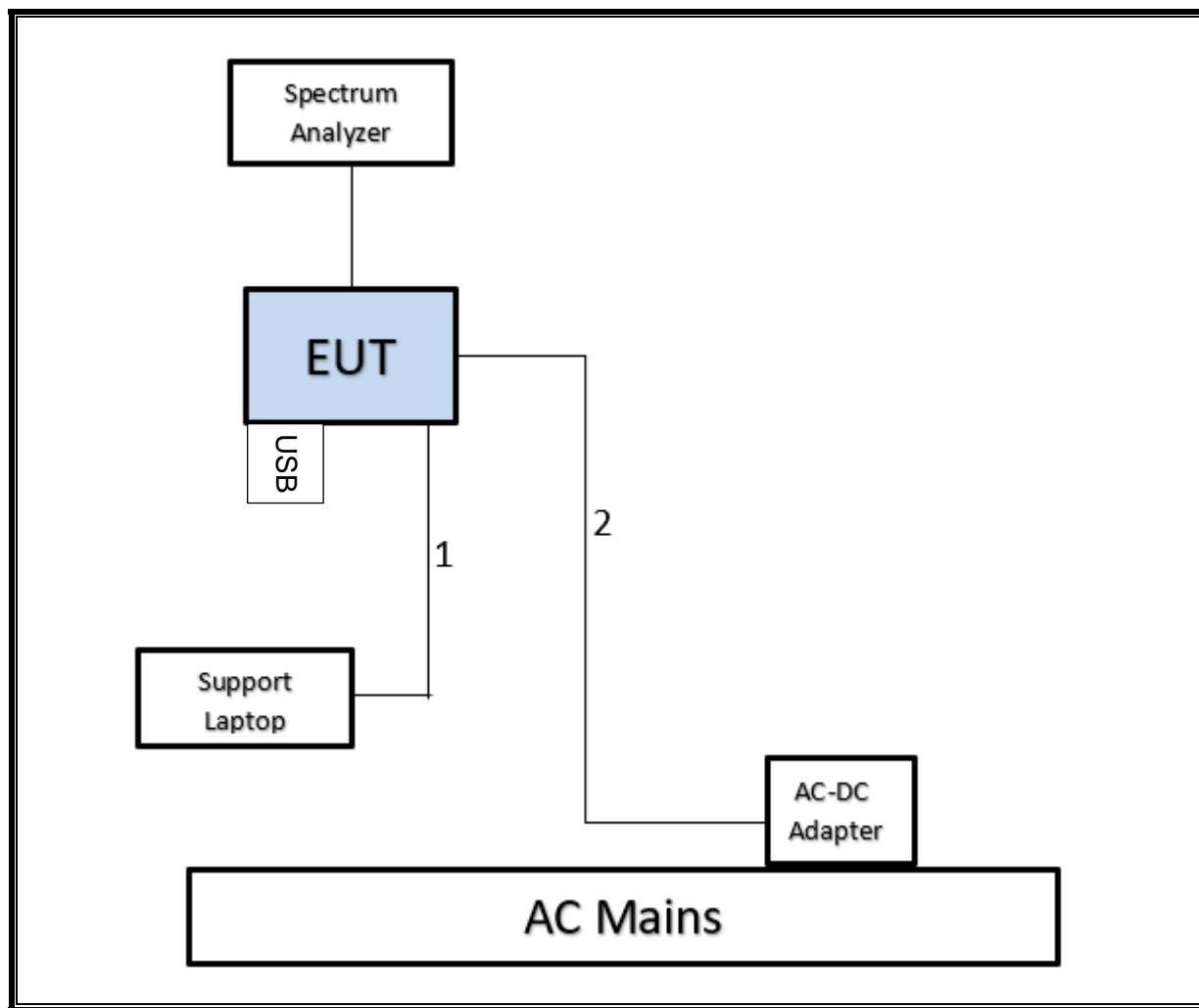
SUPPORT EQUIPMENT

| Support Equipment List | | | | |
|---------------------------|-----------------|-----------------|---------------|--------|
| Description | Manufacturer | Model | Serial Number | FCC ID |
| Laptop | Hewlett-Packard | EliteBook 8470P | CNU342CL9Z | n/a |
| Laptop AC-DC power supply | Hewlett-Packard | PA-1650-32HJ | ETC1806006544 | n/a |
| AC-DC Power supply | LITE-ON | PB-1300-1ES1 | ETC1806006544 | n/a |
| | | | | |
| | | | | |
| | | | | |

I/O CABLES

| I/O Cable List | | | | | | |
|----------------|----------|----------------------|----------------|-------------|------------------|--------------------|
| Cable No | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| 1 | Ethernet | 1 | Ethernet | Un-shielded | 2 | Laptop to EUT |
| 2 | AC | 1 | AC | Un-shielded | 1.5 | |
| 3 | Coaxial | 1 | Coaxial | shielded | 2 | EUT to 50 Ohm load |

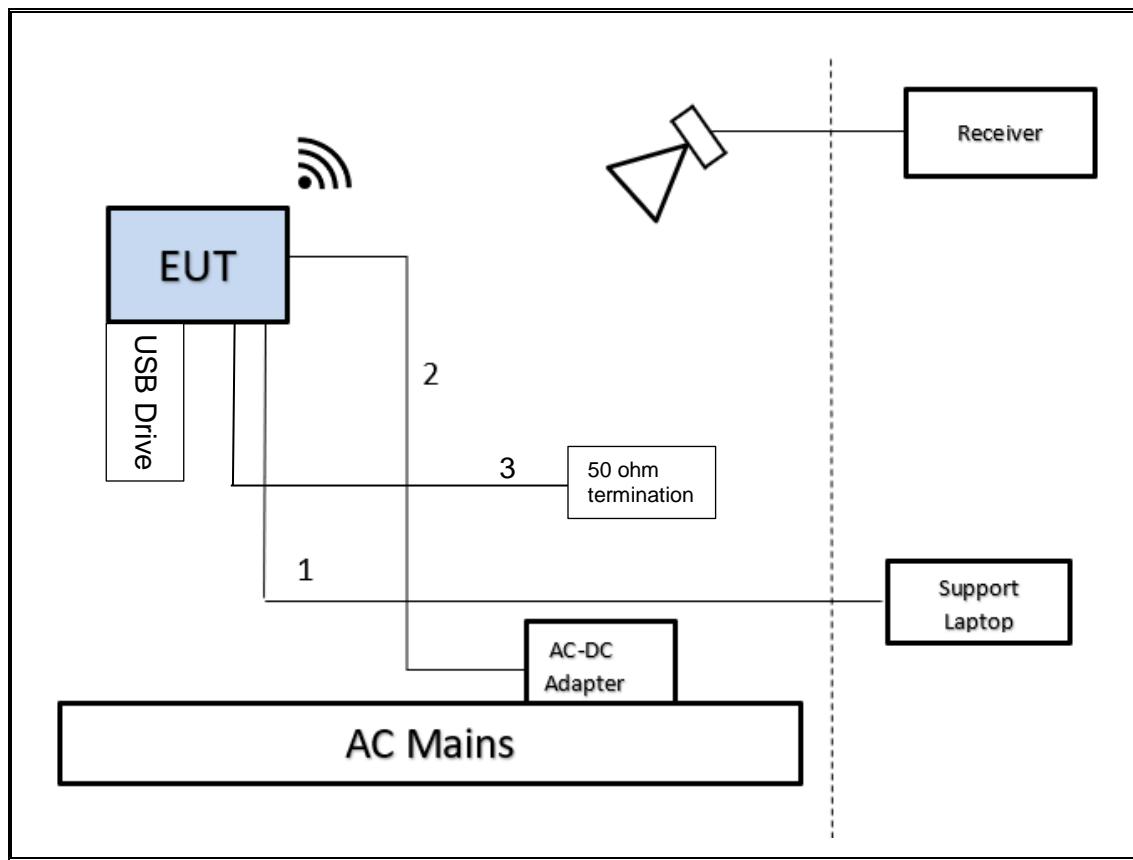
CONDUCTED TEST SETUP DIAGRAM



TEST SETUP

For conducted tests, the EUT was connected to a laptop. The test software exercises the radio.

RADIATED AND AC LINE CONDUCTED EMISSIONS SETUP DIAGRAM



TEST SETUP

For radiated tests: EUT is connected to a laptop. The test software exercises the radio.

6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 789033 D02 v02r01, Section B.

6 dB Emission BW: KDB 789033 D02 v02r01, Section C.2

26 dB Emission BW: KDB 789033 D02 v02r01, Section C.1

99% Occupied BW: KDB 789033 D02 v02r01, Section D.

Conducted Output Power: KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and KDB 789033 D02 v02r01, Section E.2.b (Method SA-1)

Power Spectral Density: KDB 789033 D02 v02r01, Section F

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, and G.5.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4

7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| TEST EQUIPMENT LIST | | | | | |
|---|---------------------------------|------------------------|------------|------------|------------|
| Description | Manufacturer | Model | ID Num | Cal Due | Last Cal |
| 3 Port rf switch | DOW-KEY MICROWAVE | 401-2308 | 172937 | 09/15/2019 | 09/15/2018 |
| 6 Port rf switch | NARDA | SEM163 | 172935 | 09/15/2019 | 09/15/2018 |
| 6 Port rf switch | Pasternack | PE7165 | 172936 | 09/17/2019 | 09/17/2018 |
| Amplifier 1-8GHz 30dB gain | L3 Narda | AMF-4D-01000800-30-29P | 167492 | 05/24/2020 | 06/24/2019 |
| Amplifier, 1 to 18GHz, 35dB | AMPLICAL | AMP1G18-35 | 138301 | 09/15/2019 | 09/15/2018 |
| Amplifier, 1 to 8GHz, 35dB | Miteq Inc. | AMF-4D-01000800-30-29P | T1573 | 12/01/2019 | 12/01/2018 |
| Amplifier, 1 to 8GHz, 35dB | MITEQ | AMF-4D-01000800-30-29P | T1169 | 09/15/2019 | 09/15/2018 |
| Amplifier, 100KHz to 1GHz, 32dB | Agilent (Keysight) Technologies | 8447D | T15 | 10/20/2019 | 10/20/2018 |
| Amplifier, 10KHz to 1GHz, 32dB | SONOMA INSTRUMENT | 310 | T285 | 06/06/2020 | 07/06/2019 |
| Amplifier, 9KHz to 1GHz, 32dB | SONOMA INSTRUMENT | 310 | PRE0180175 | 05/29/2020 | 06/29/2019 |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz | Sunol Sciences Corp. | JB1 | T130 | 08/09/2020 | 08/09/2019 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T119 | 03/22/2020 | 03/22/2019 |
| Antenna, BroadBand Hybrid, 30MHz to 3GHz | Sunol Sciences Corp. | JB3 | PRE0184971 | 11/13/2019 | 11/13/2018 |
| EMI TEST RECEIVER | Rohde & Schwarz | ESW44 | PRE0179376 | 02/14/2020 | 02/14/2019 |
| RF Amplifier, 1-18GHz | MITEQ | AFS42-00101800-25-S-42 | T1165 | 05/24/2020 | 06/24/2019 |
| RF Filter Box | UL (IN HOUSE) | | 172938 | 09/15/2019 | 09/15/2018 |
| RF Filter Box, 1-18GHz | UL (IN HOUSE) | | 168534 | 05/24/2020 | 06/24/2019 |
| RF SWITCH | Pasternack | PE7159 | T1274 | 05/24/2020 | 06/24/2019 |
| RF SWITCH | DOW-KEY MICROWAVE | 401-2308 | T729 | 05/24/2020 | 06/24/2019 |
| Semianechoic Chamber A | TDK RF SOLUTIONS INC. | N/A | T1199 | 01/18/2021 | 01/18/2019 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T908 | 01/24/2020 | 01/24/2019 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1466 | 01/23/2020 | 01/23/2019 |
| Thermometer | Control Company | 14-650-118, 15557603 | T1820 | 02/26/2020 | 02/26/2019 |

| Test Software List | | | |
|-----------------------|--------------|--------|-------------------------|
| Description | Manufacturer | Model | Version |
| Radiated Software | UL | UL EMC | Ver 9.5, June 24, 2015 |
| Conducted Software | UL | UL EMC | Ver 9.5, May 26, 2015 |
| Antenna Port Software | UL | UL RF | Ver 3.9.1, Dec 28, 2015 |

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

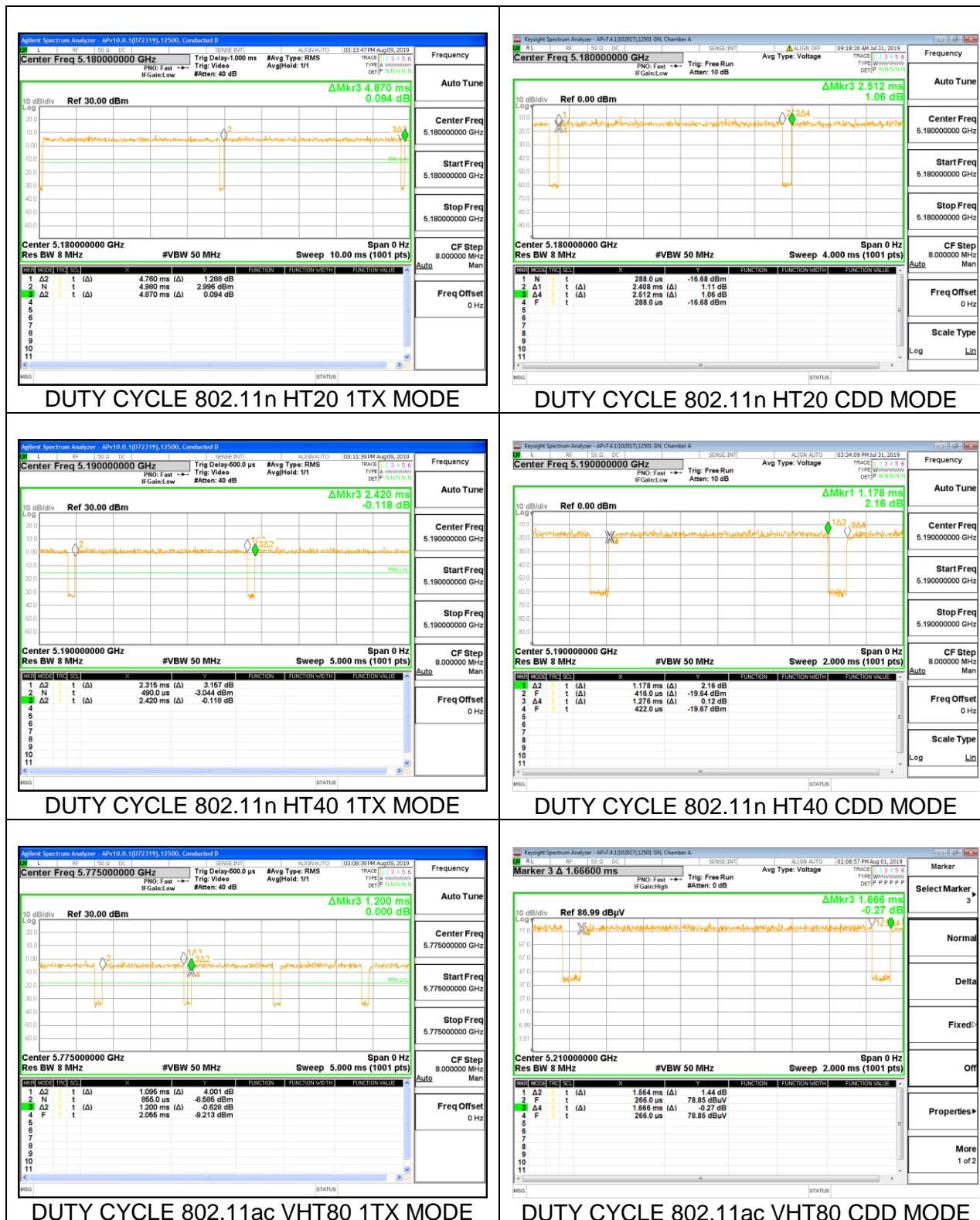
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

| Mode | ON Time B (msec) | Period (msec) | Duty Cycle x (linear) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) | 1/B Minimum VBW (kHz) |
|--------------------|------------------|---------------|-----------------------|----------------|-----------------------------------|-----------------------|
| 802.11n HT20 1TX | 4.760 | 4.870 | 0.977 | 97.74% | 0.10 | 0.210 |
| 802.11n HT20 CDD | 2.408 | 2.512 | 0.959 | 95.86% | 0.18 | 0.415 |
| 802.11n HT40 1TX | 2.315 | 2.420 | 0.957 | 95.66% | 0.19 | 0.432 |
| 802.11n HT40 CDD | 1.1780 | 1.2760 | 0.923 | 92.32% | 0.35 | 0.849 |
| 802.11ac VHT80 1TX | 1.095 | 1.200 | 0.913 | 91.25% | 0.40 | 0.913 |
| 802.11ac VHT80 CDD | 1.564 | 1.666 | 0.939 | 93.88% | 0.27 | 0.639 |

DUTY CYCLE PLOTS



8.2. 26 dB BANDWIDTH

LIMITS

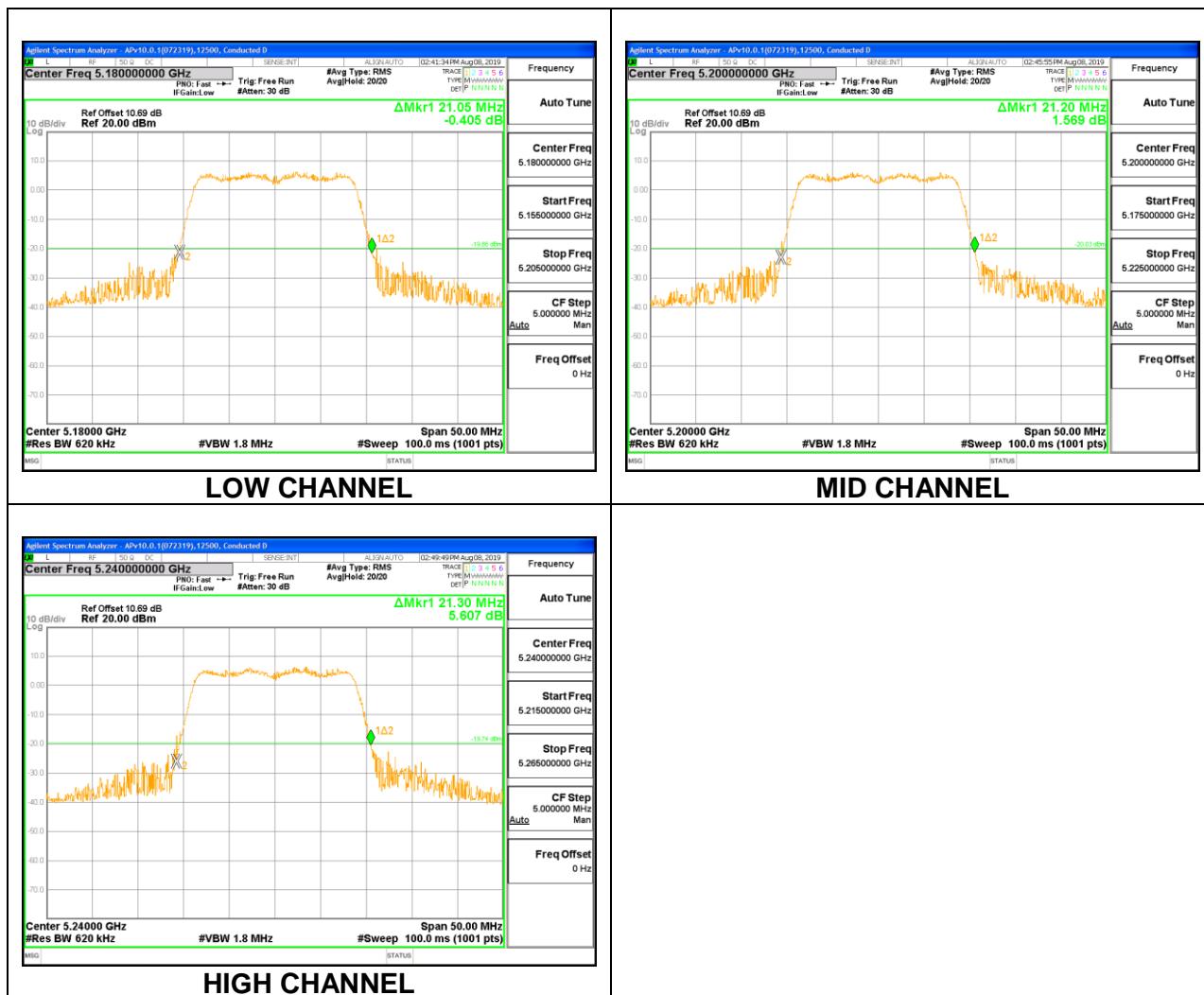
None; for reporting purposes only.

RESULTS

8.2.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

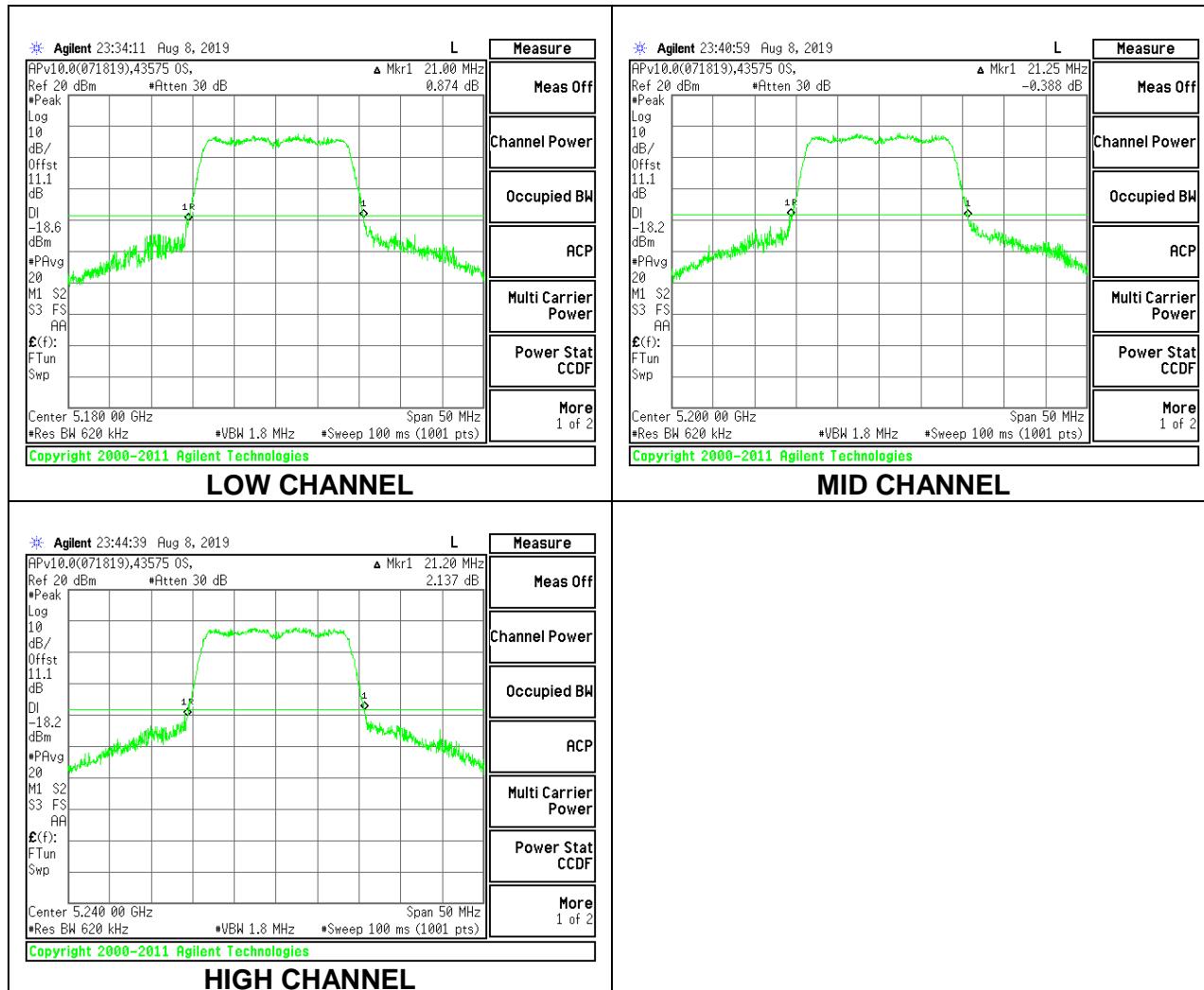
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|--------------------|--------------------------|
| Low | 5180 | 21.05 |
| Mid | 5200 | 21.20 |
| High | 5240 | 21.30 |



1TX Antenna 2 MODE

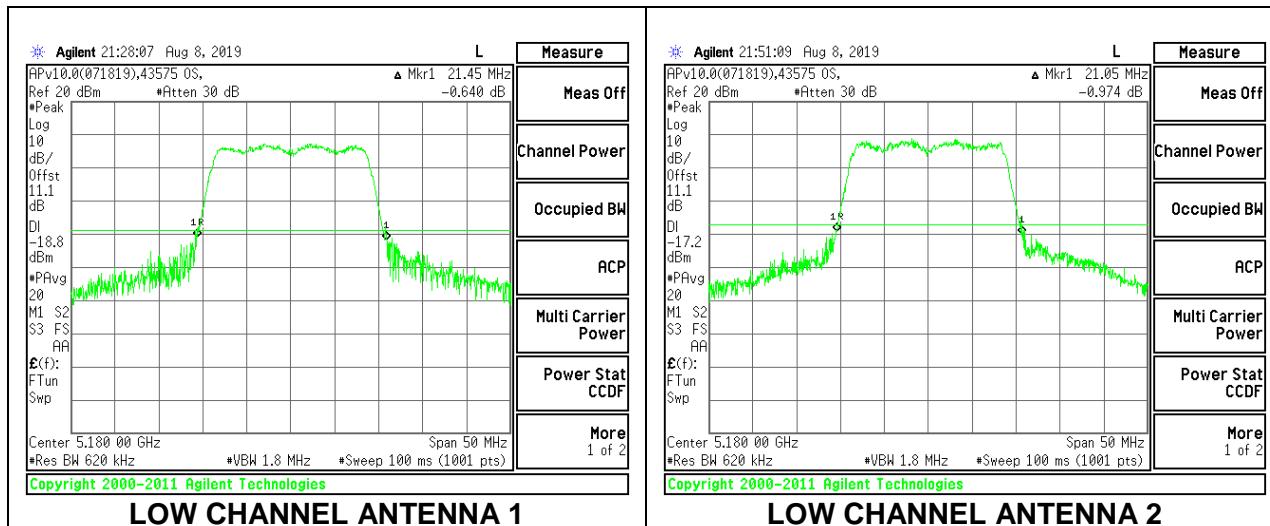
| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|--------------------|--------------------------|
| Low | 5180 | 21.00 |
| Mid | 5200 | 21.25 |
| High | 5240 | 21.20 |



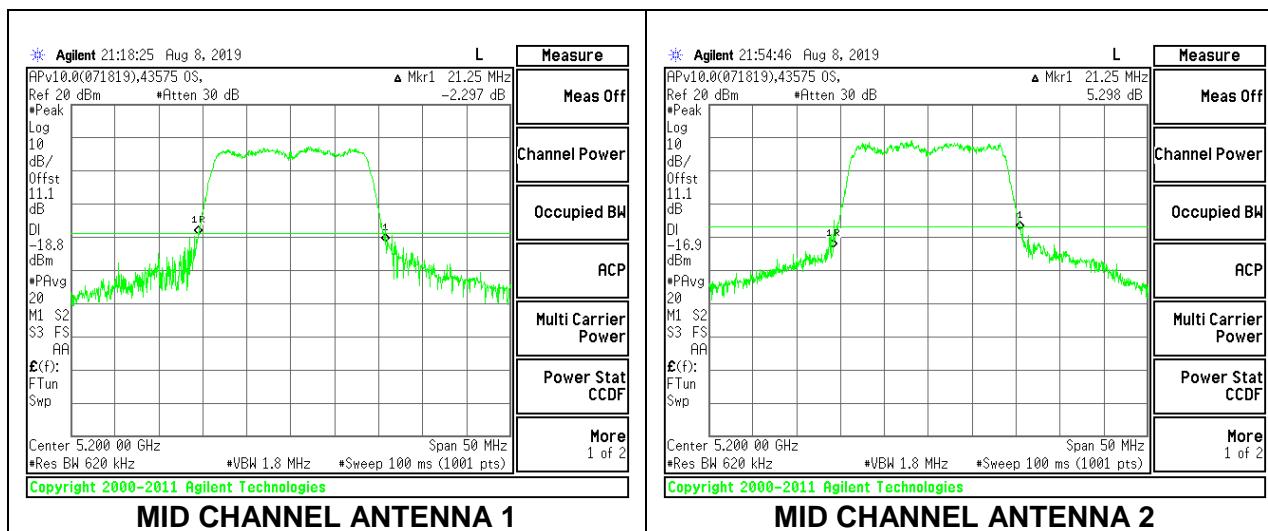
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Low | 5180 | 21.45 | 21.05 |
| Mid | 5200 | 21.25 | 21.25 |
| High | 5240 | 21.05 | 20.95 |

LOW CHANNEL



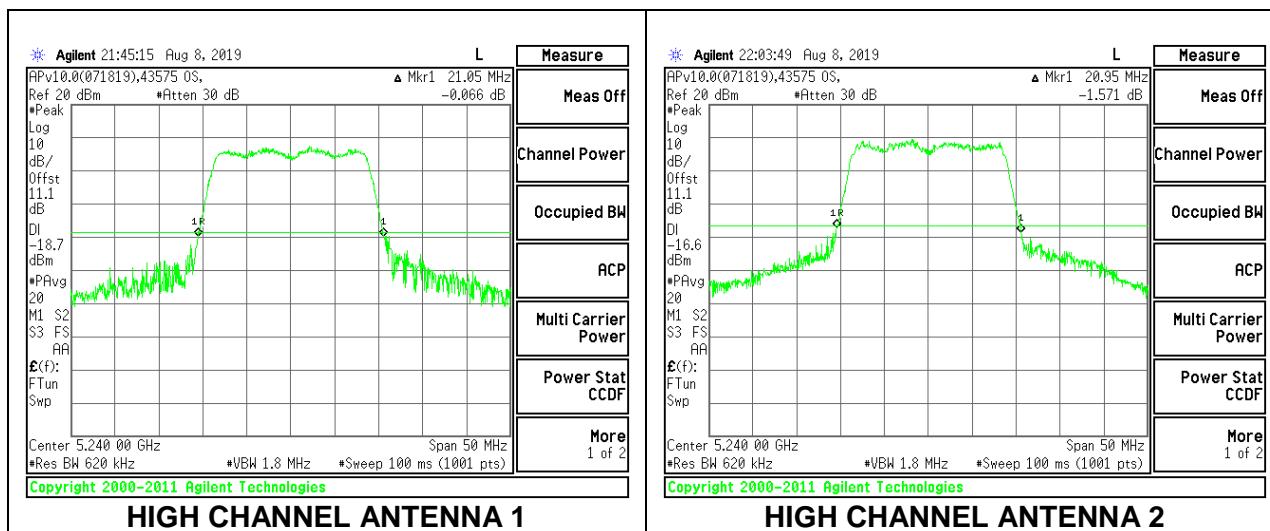
MID CHANNEL



MID CHANNEL ANTENNA 1

MID CHANNEL ANTENNA 2

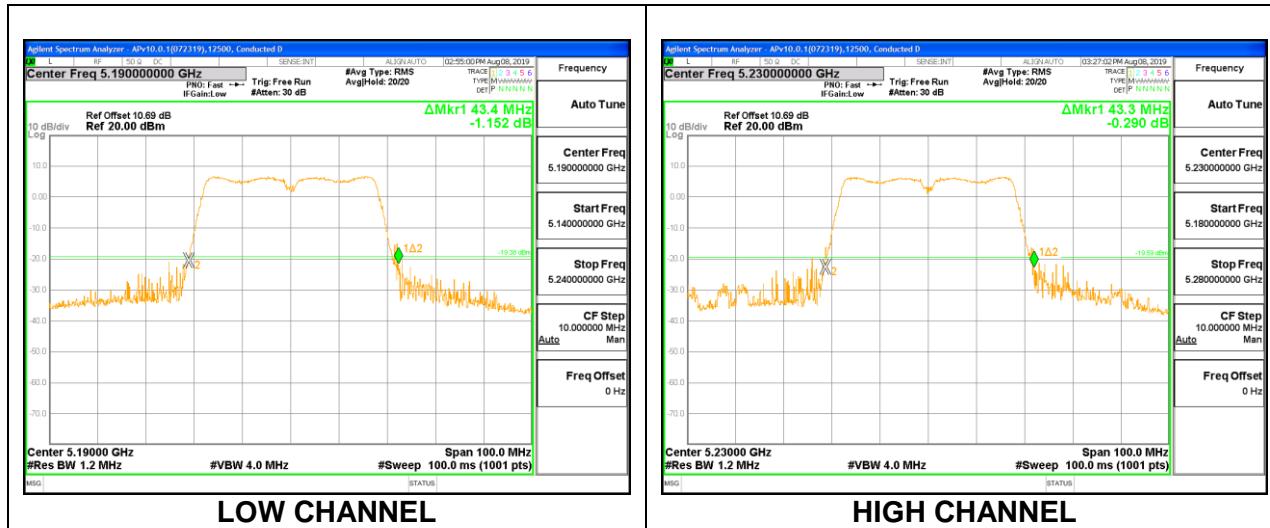
HIGH CHANNEL



8.2.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND

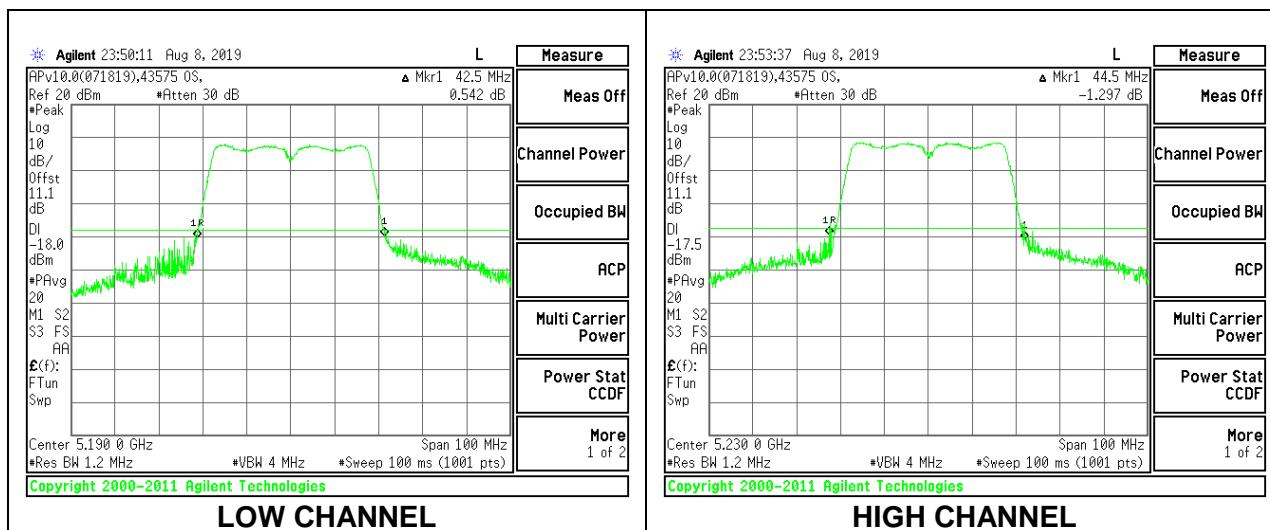
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 26dB Bandwidth (MHz) |
|---------|--------------------|-------------------------|
| Low | 5190 | 43.40 |
| High | 5230 | 43.30 |



1TX Antenna 2 MODE

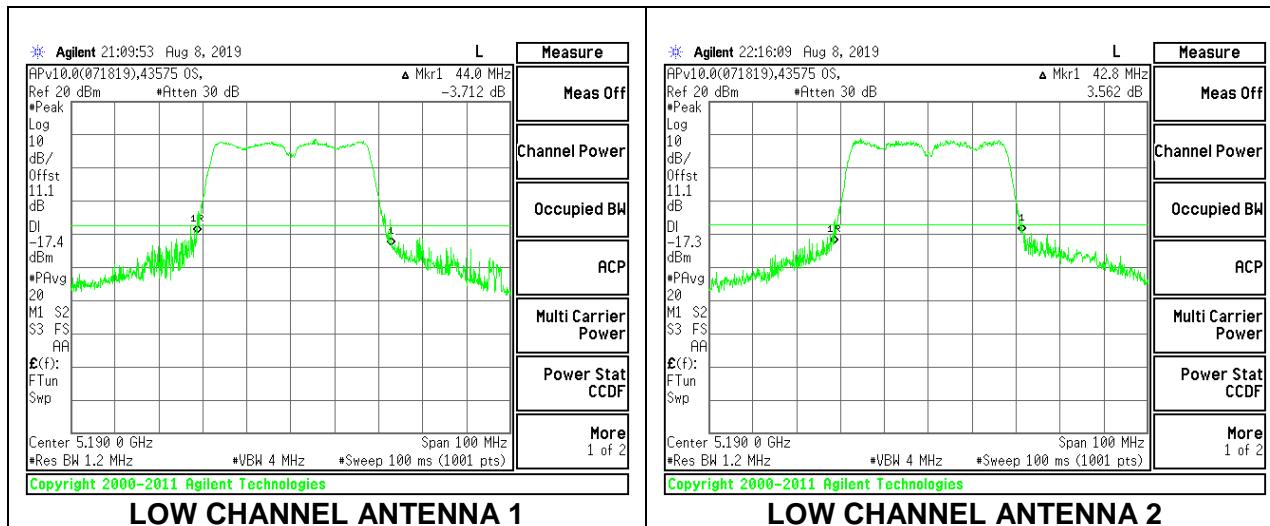
| Channel | Frequency (MHz) | 26dB Bandwidth (MHz) |
|---------|--------------------|-------------------------|
| Low | 5190 | 42.50 |
| High | 5230 | 44.50 |



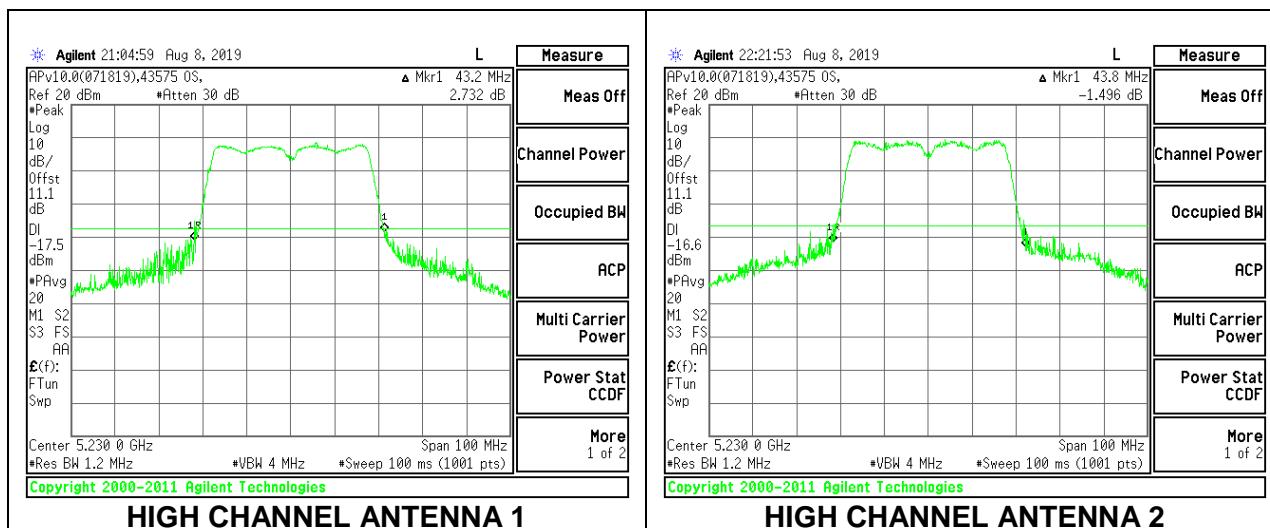
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Low | 5190 | 44.00 | 42.80 |
| High | 5230 | 43.20 | 43.80 |

LOW CHANNEL



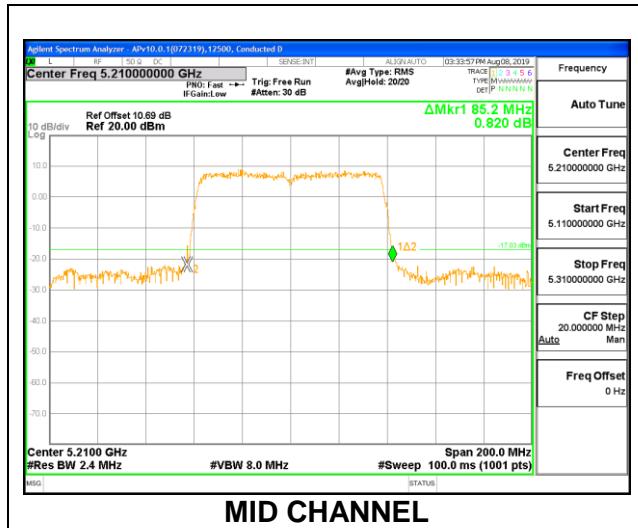
HIGH CHANNEL



8.2.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND

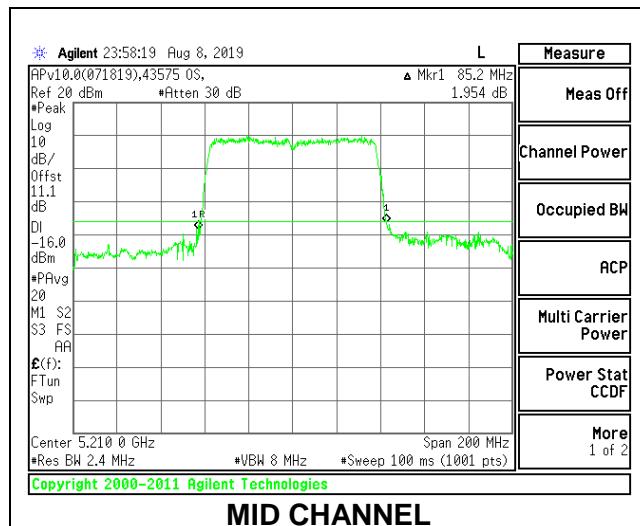
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|--------------------|--------------------------|
| Mid | 5210 | 85.20 |



1TX Antenna 2 MODE

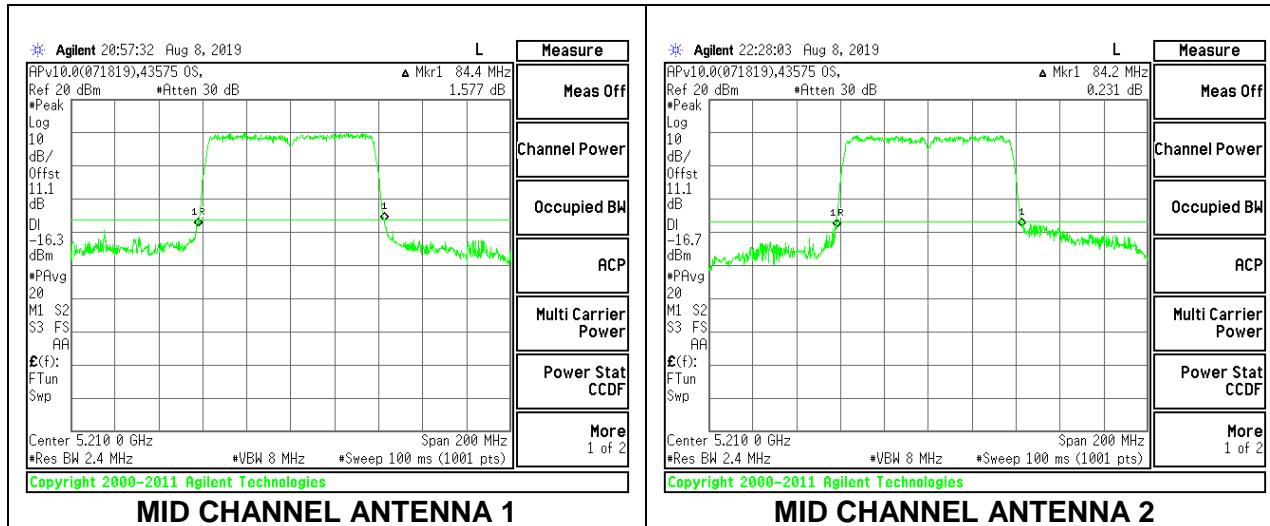
| Channel | Frequency | 26 dB Bandwidth |
|---------|-----------|-----------------|
| | (MHz) | (MHz) |
| Mid | 5210 | 85.20 |



2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Mid | 5210 | 84.40 | 84.20 |

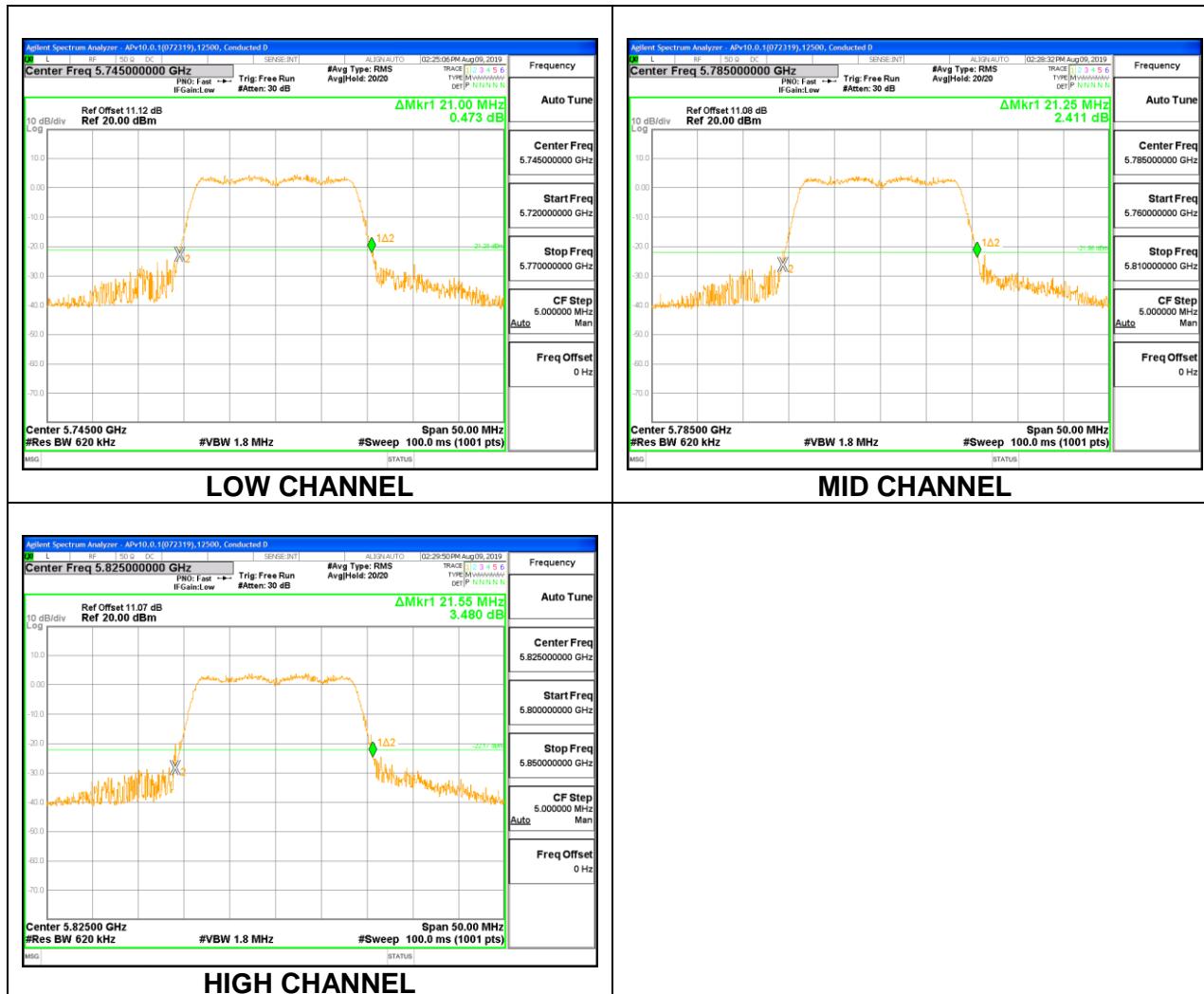
MID CHANNEL



8.2.4. 802.11n HT20 MODE IN THE 5.8 GHz BAND

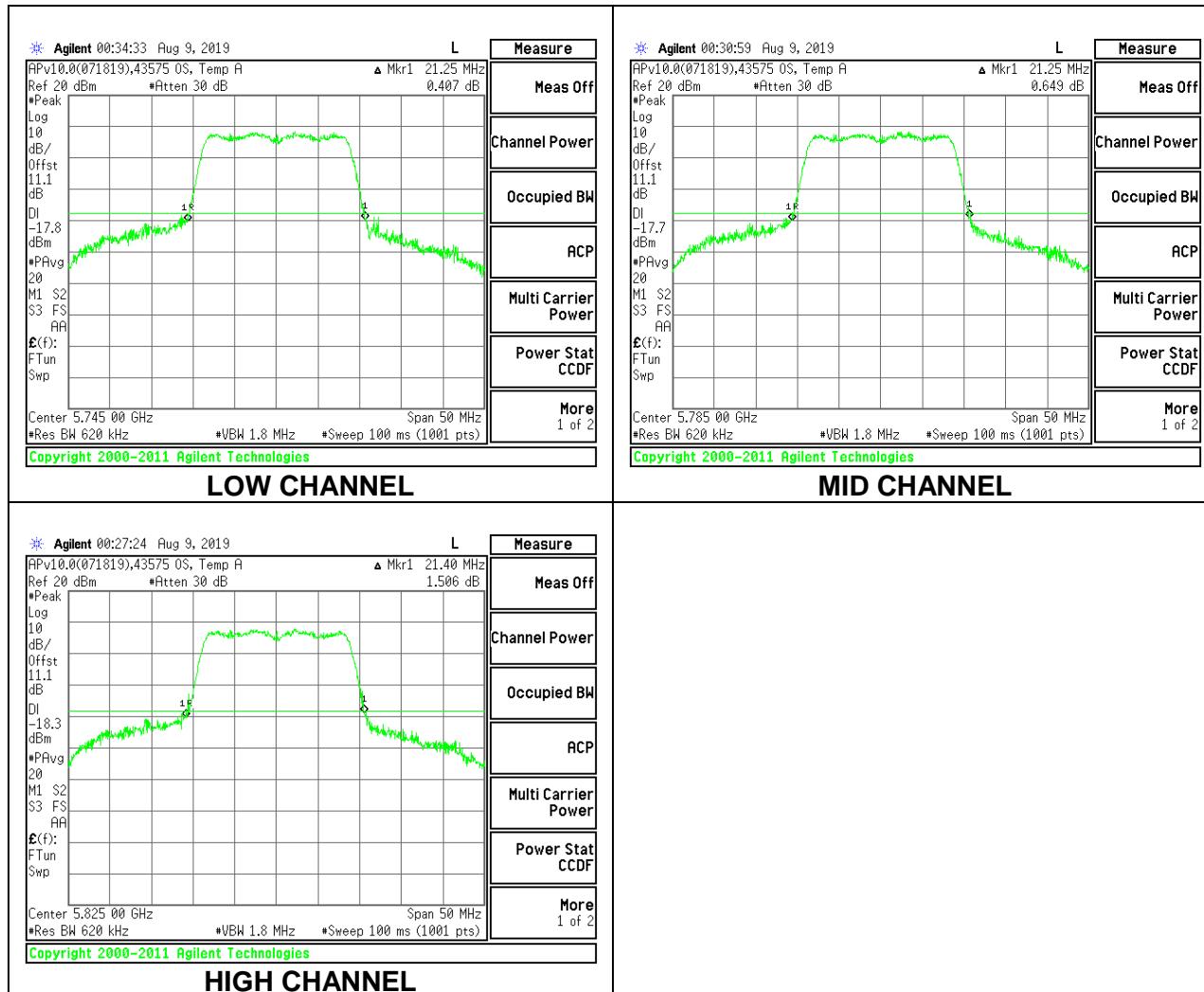
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|-----------------|-----------------------|
| Low | 5745 | 21.00 |
| Mid | 5785 | 21.25 |
| High | 5825 | 21.55 |



1TX Antenna 2 MODE

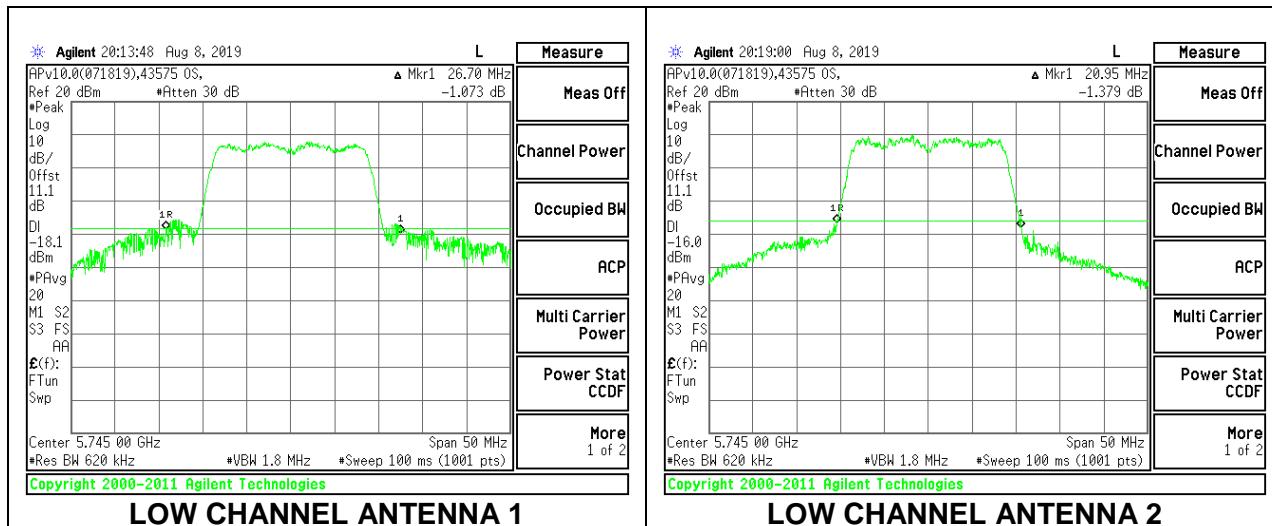
| Channel | Frequency (MHz) | 26 dB Bandwidth (MHz) |
|---------|--------------------|--------------------------|
| Low | 5745 | 21.25 |
| Mid | 5785 | 21.25 |
| High | 5825 | 21.40 |



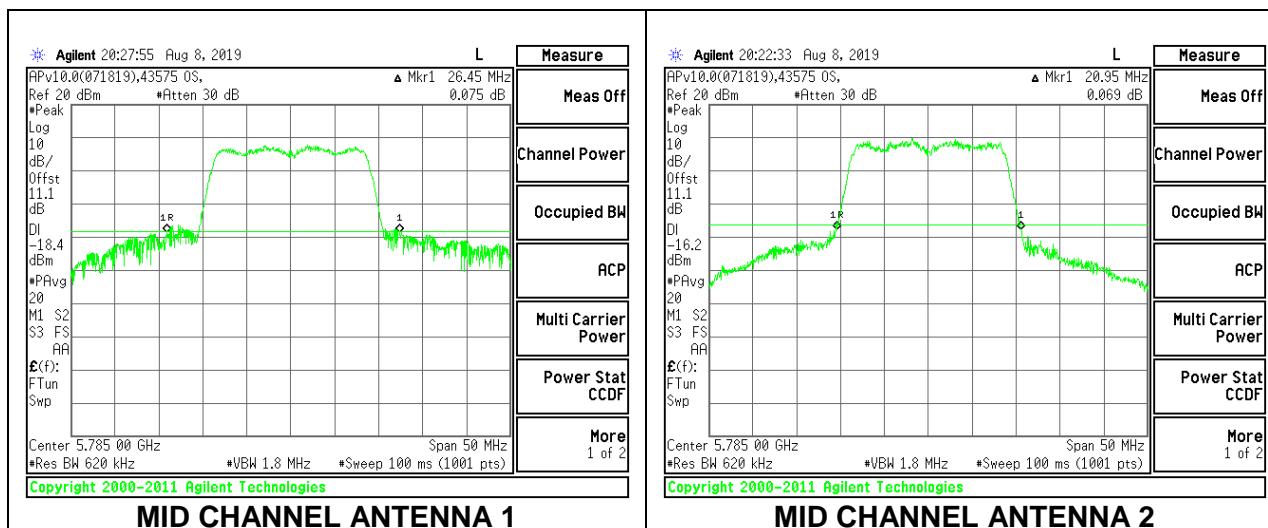
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Low | 5745 | 26.70 | 20.95 |
| Mid | 5785 | 26.45 | 20.95 |
| High | 5825 | 26.50 | 20.90 |

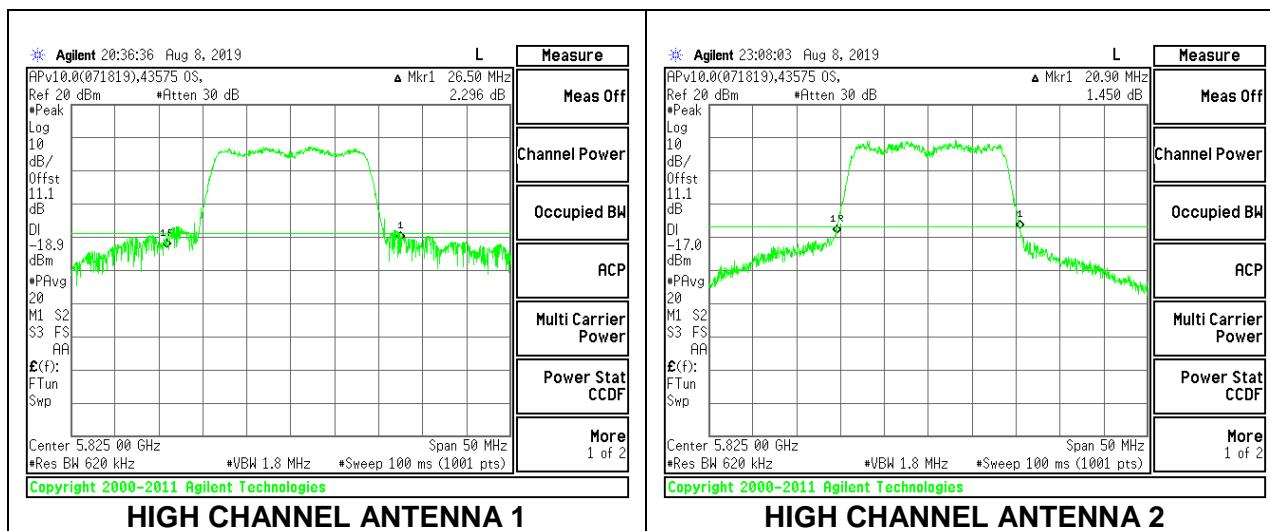
LOW CHANNEL



MID CHANNEL



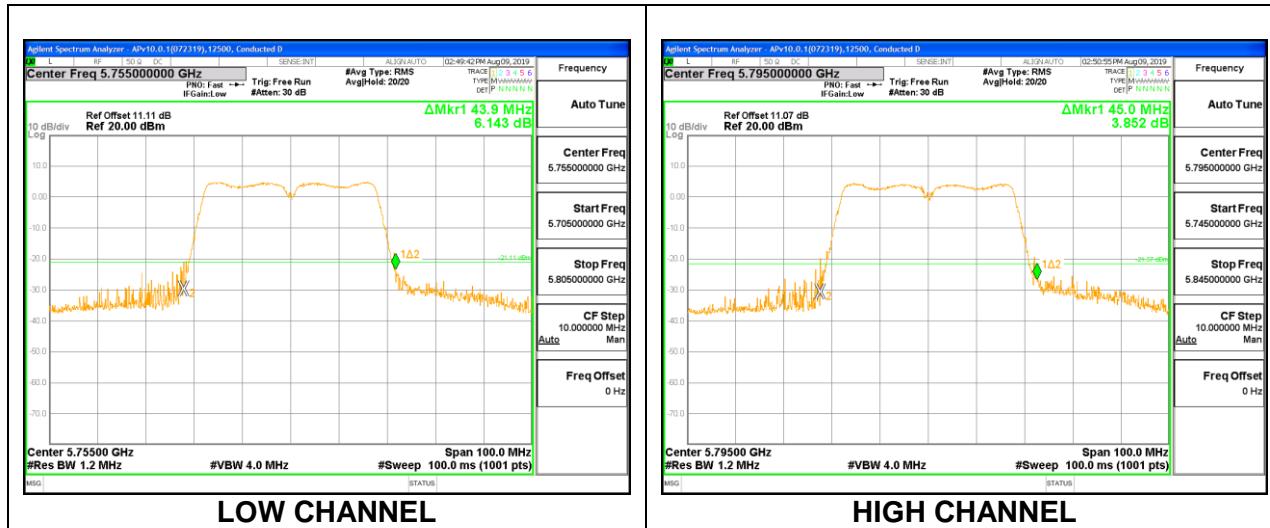
HIGH CHANNEL



8.2.5. 802.11n HT40 MODE IN THE 5.8 GHz BAND

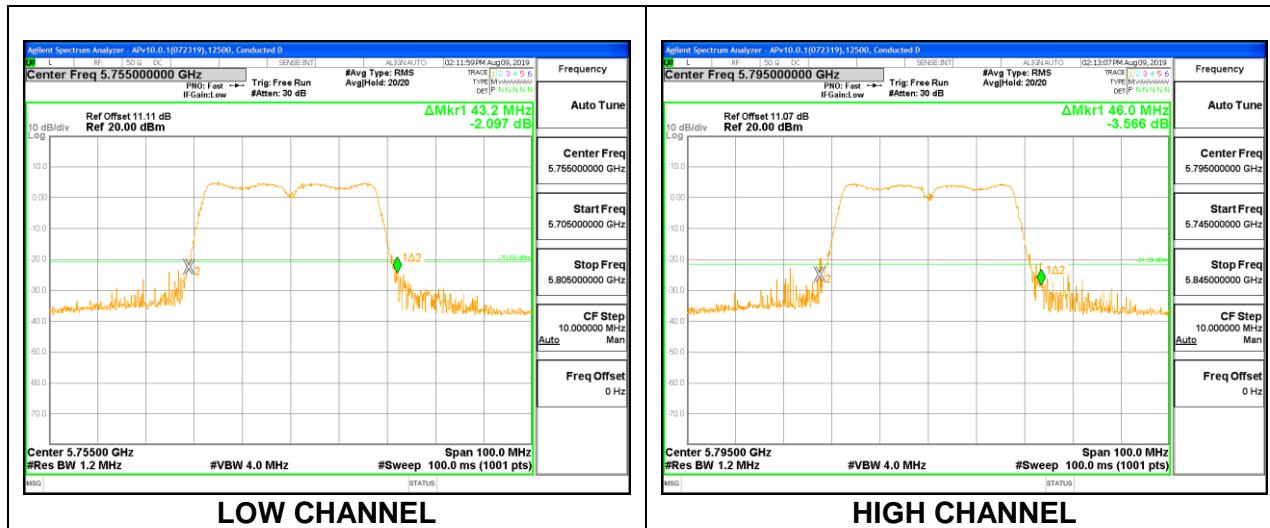
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 26dB Bandwidth (MHz) |
|---------|--------------------|-------------------------|
| Low | 5755 | 43.90 |
| High | 5795 | 45.00 |



1TX Antenna 2 MODE

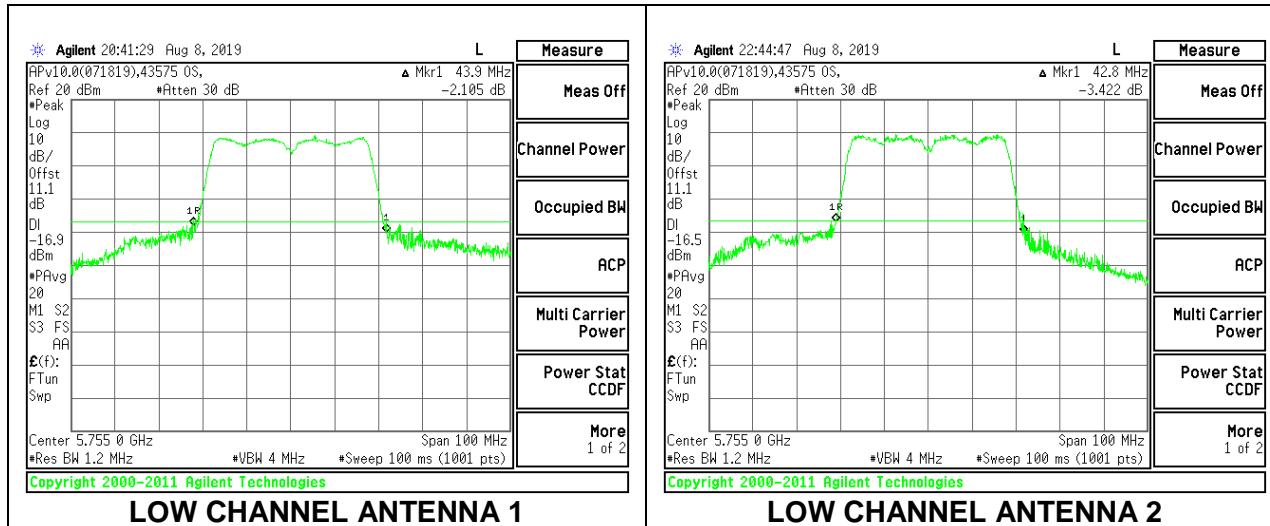
| Channel | Frequency (MHz) | 26dB Bandwidth (MHz) |
|---------|--------------------|-------------------------|
| Low | 5755 | 43.20 |
| High | 5795 | 46.00 |



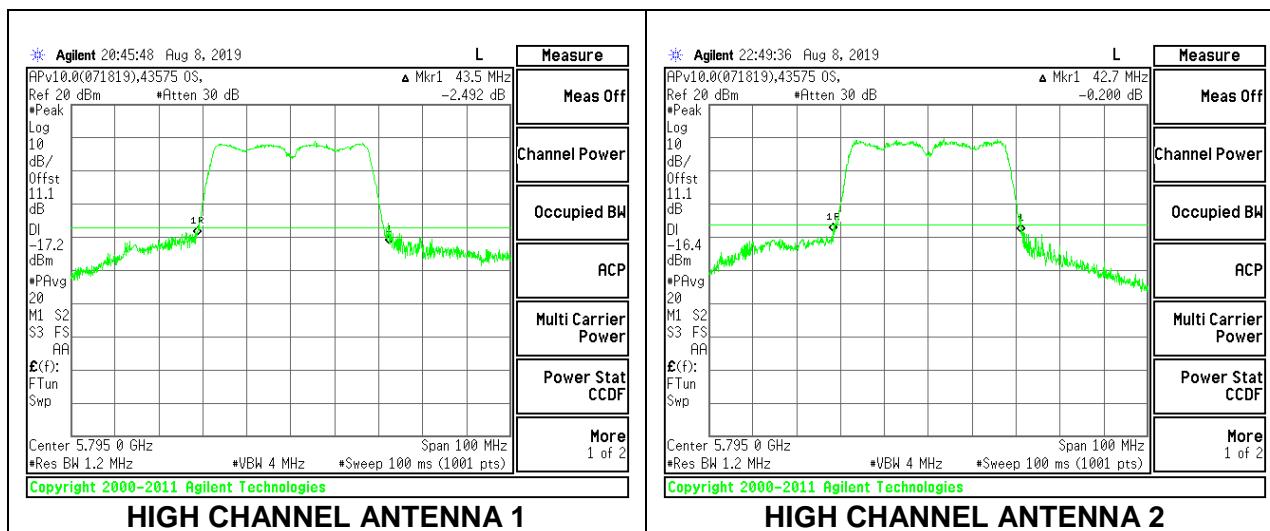
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Low | 5755 | 43.90 | 42.80 |
| High | 5795 | 43.50 | 42.70 |

LOW CHANNEL



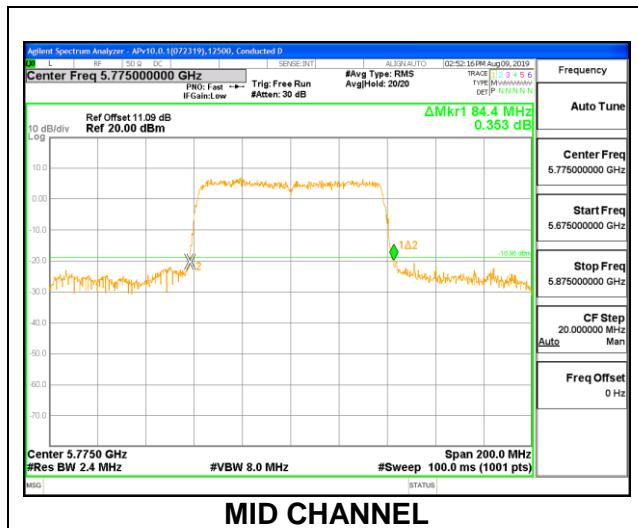
HIGH CHANNEL



8.2.6. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

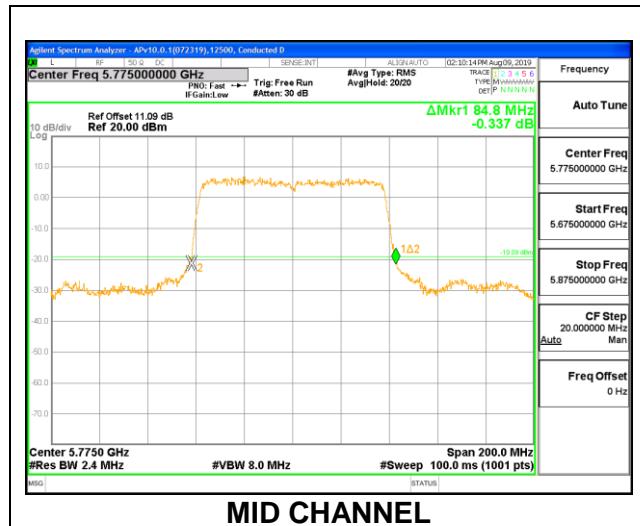
1TX Antenna 1 MODE

| Channel | Frequency | 26 dB Bandwidth |
|---------|-----------|-----------------|
| | (MHz) | (MHz) |
| Mid | 5775 | 84.40 |



1TX Antenna 2 MODE

| Channel | Frequency | 26 dB Bandwidth |
|---------|-----------|-----------------|
| | (MHz) | (MHz) |
| Mid | 5775 | 84.80 |

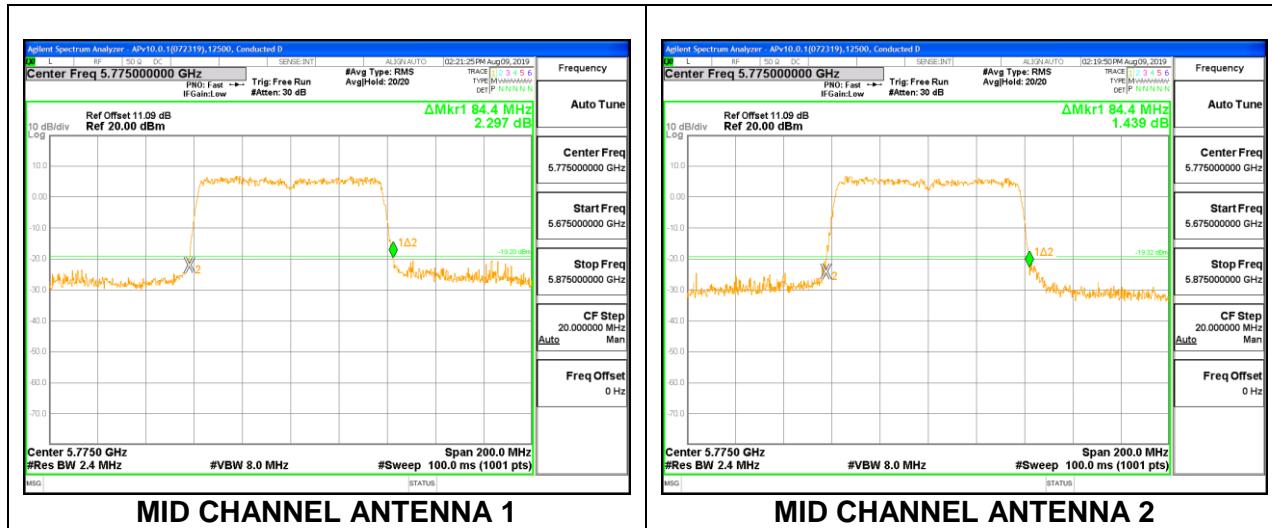


MID CHANNEL

2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 26 dB Bandwidth Antenna 1 (MHz) | 26 dB Bandwidth Antenna 2 (MHz) |
|---------|--------------------|---------------------------------------|---------------------------------------|
| Mid | 5775 | 84.40 | 84.40 |

MID CHANNEL



8.3. 99% BANDWIDTH

LIMITS

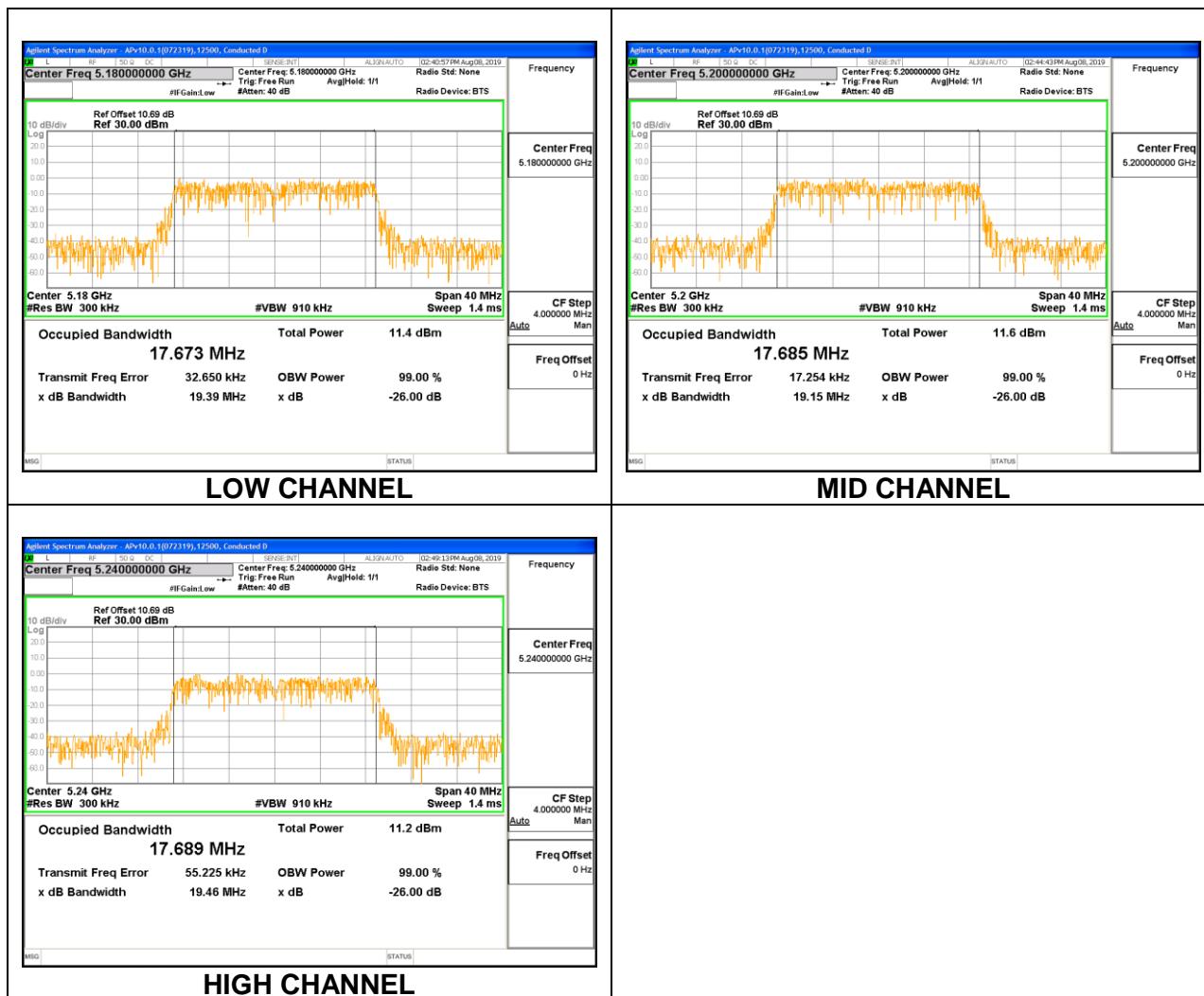
None; for reporting purposes only.

RESULTS

8.3.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

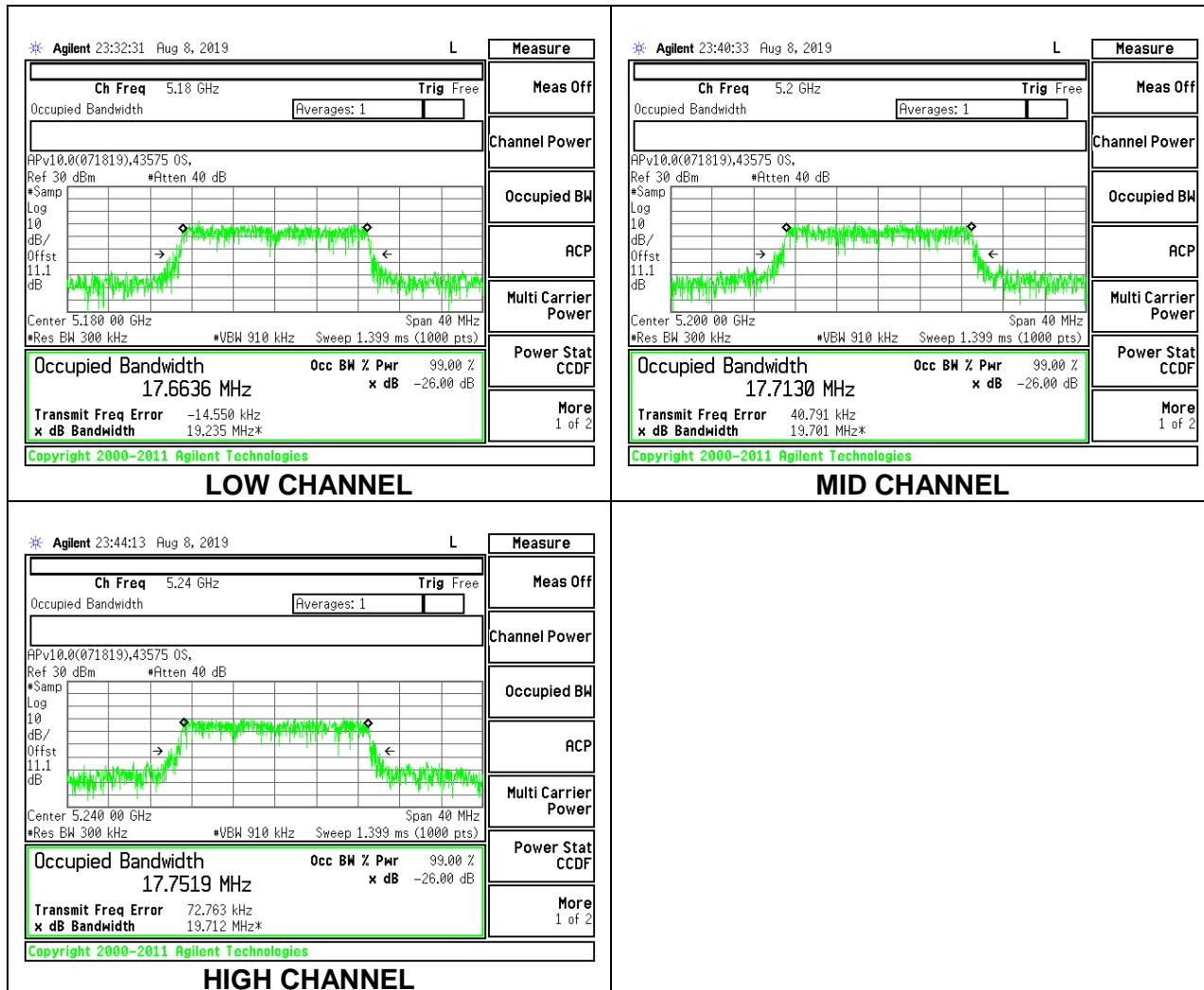
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5180 | 17.6730 |
| Mid | 5200 | 17.6850 |
| High | 5240 | 17.6890 |



1TX Antenna 2 MODE

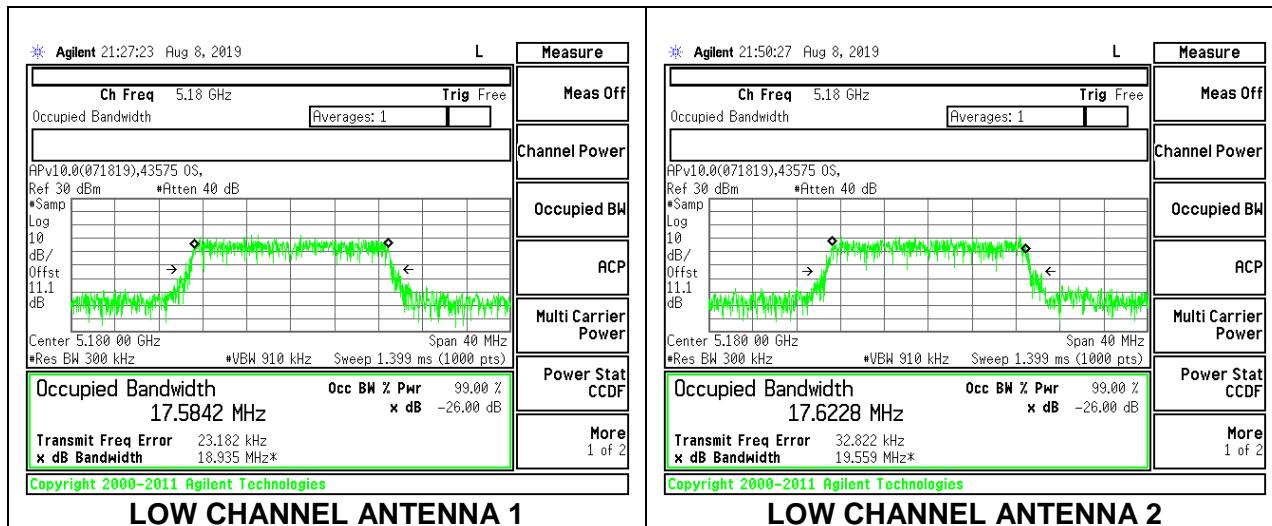
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5180 | 17.6640 |
| Mid | 5200 | 17.7130 |
| High | 5240 | 17.7520 |



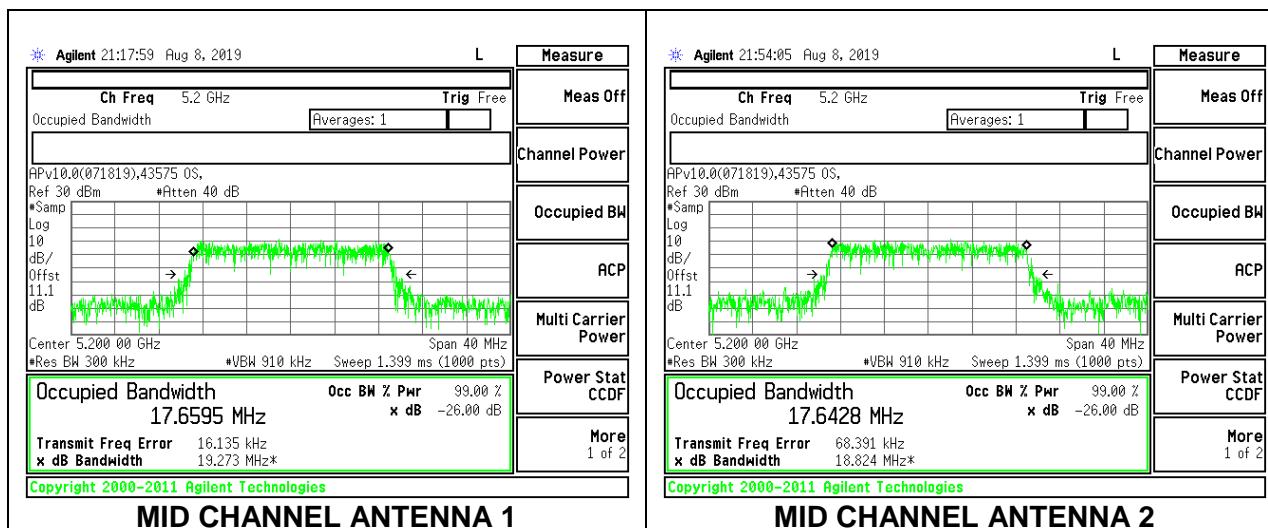
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Low | 5180 | 17.5840 | 17.6230 |
| Mid | 5200 | 17.6600 | 17.6430 |
| High | 5240 | 17.6070 | 17.6200 |

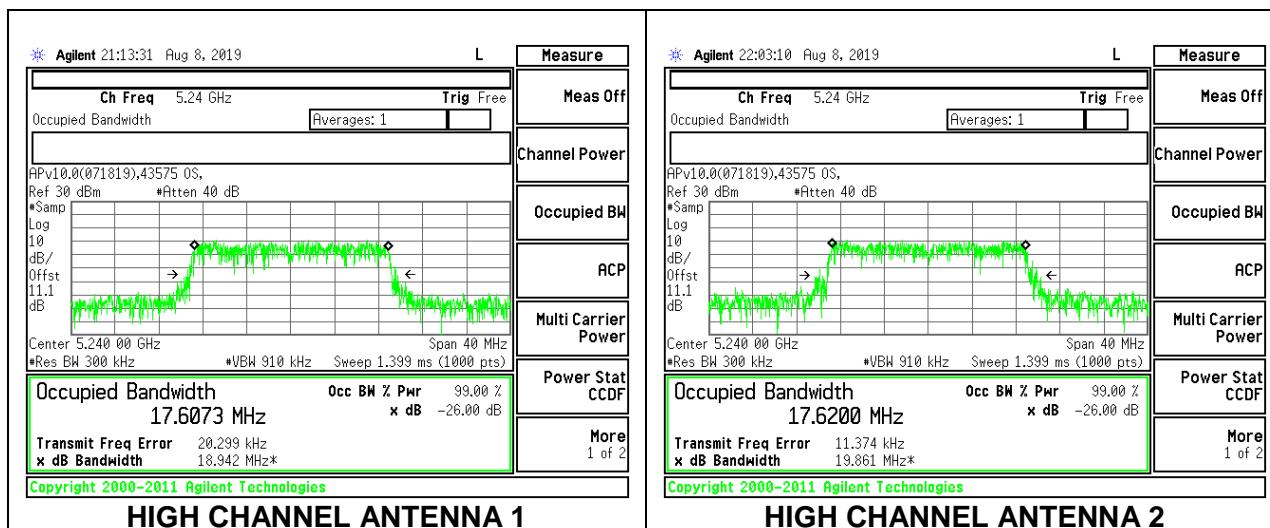
LOW CHANNEL



MID CHANNEL



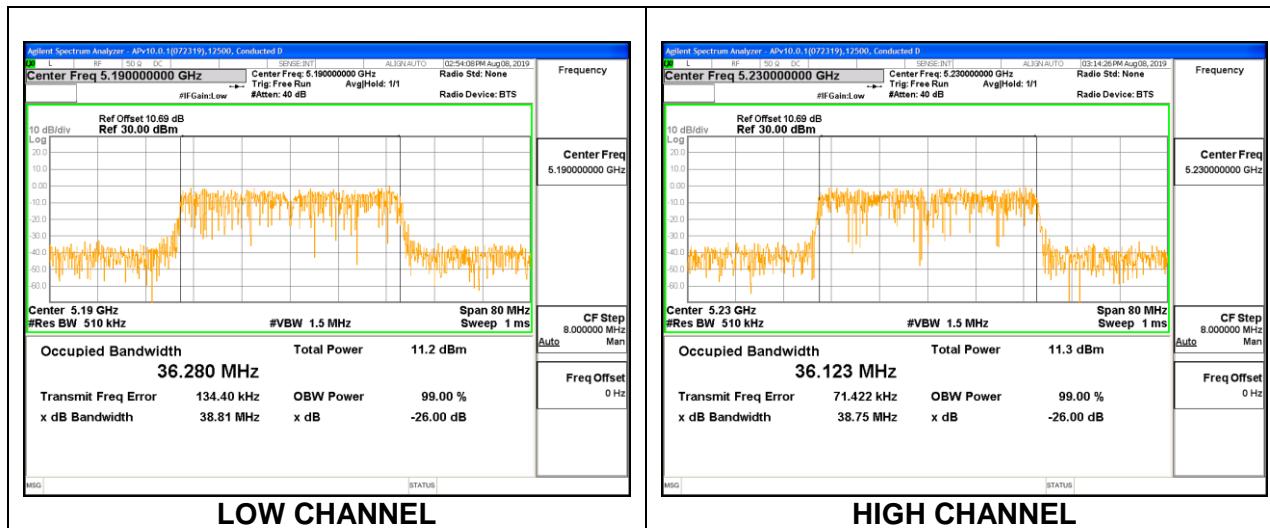
HIGH CHANNEL



8.3.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND

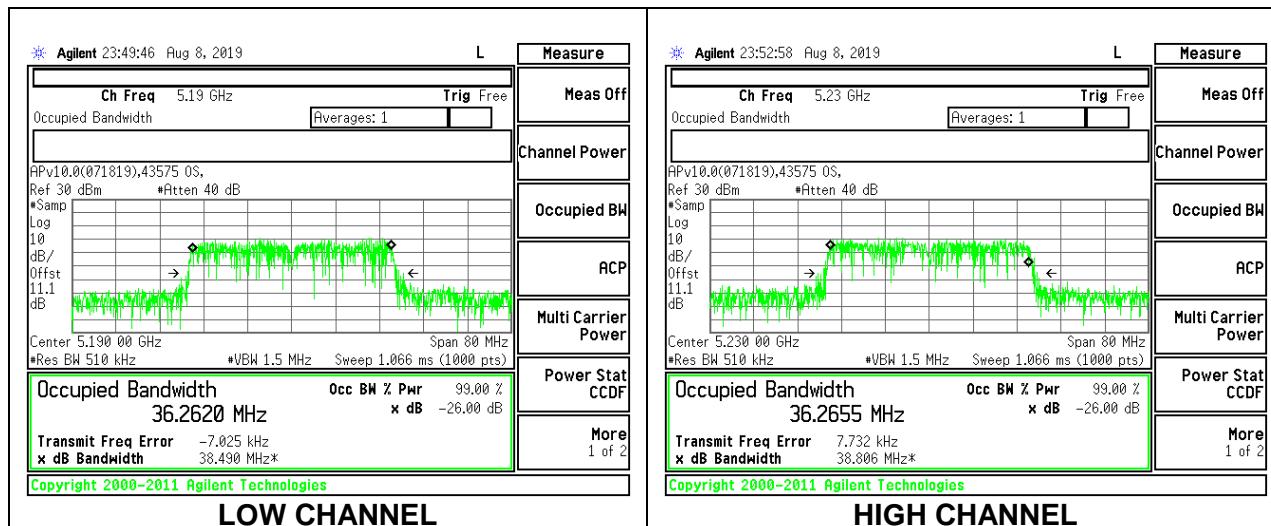
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5190 | 36.2800 |
| High | 5230 | 36.1230 |



1TX Antenna 2 MODE

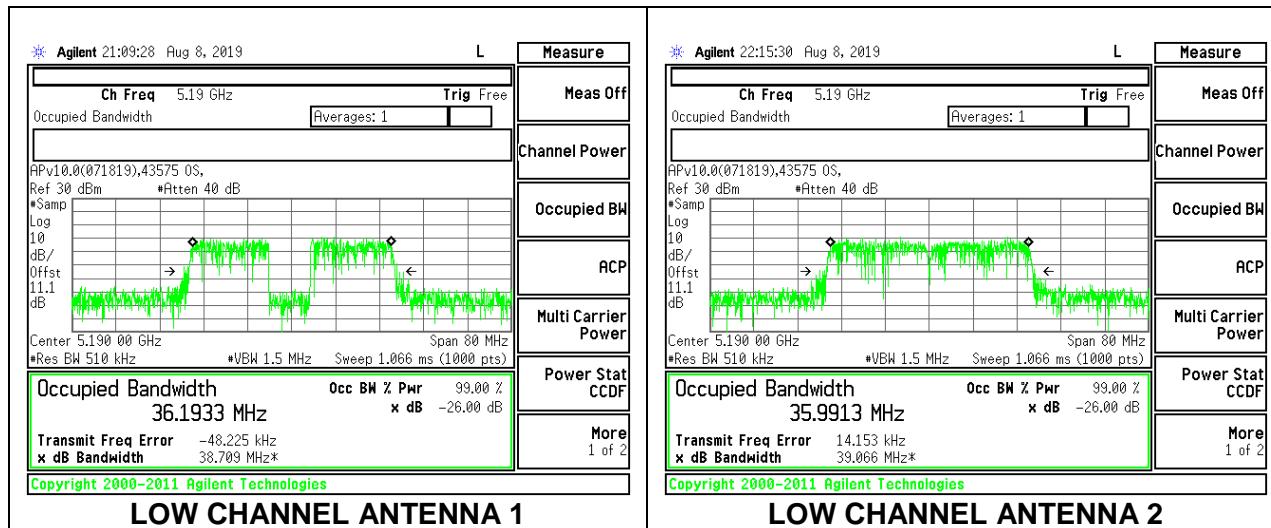
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5190 | 36.2620 |
| High | 5230 | 36.2660 |



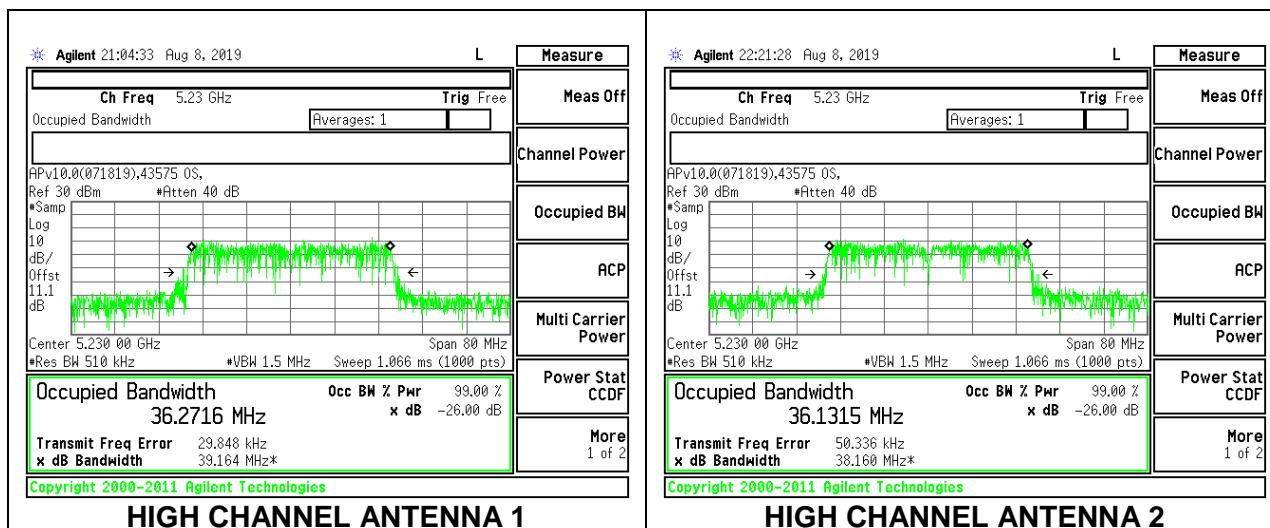
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Low | 5190 | 36.1930 | 35.9910 |
| High | 5230 | 36.2720 | 36.1320 |

LOW CHANNEL



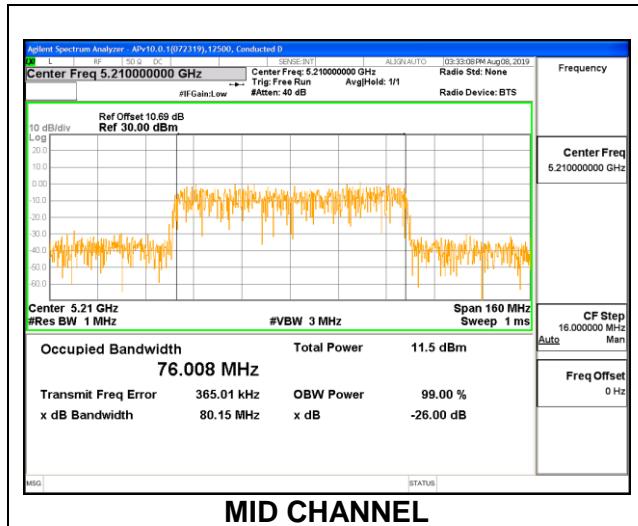
HIGH CHANNEL



8.3.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND

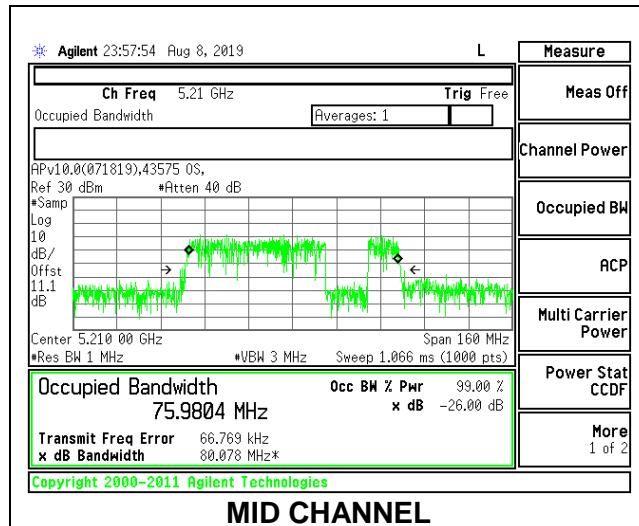
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Mid | 5210 | 76.0080 |



1TX Antenna 2 MODE

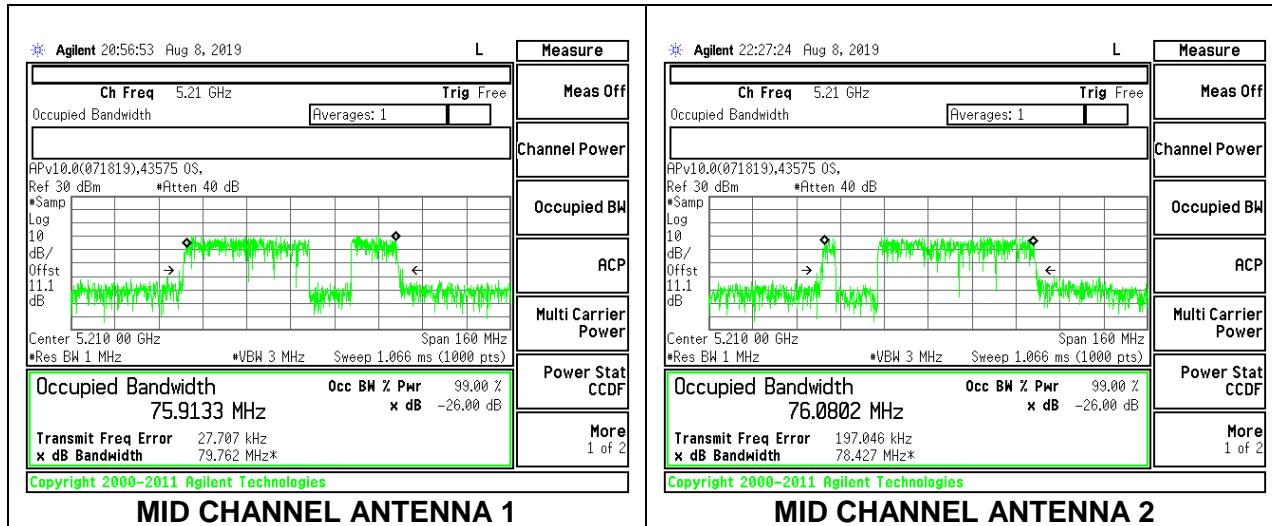
| Channel | Frequency | 99% Bandwidth |
|---------|-----------|---------------|
| | (MHz) | (MHz) |
| Mid | 5210 | 75.9800 |



2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Mid | 5210 | 75.9130 | 76.0800 |

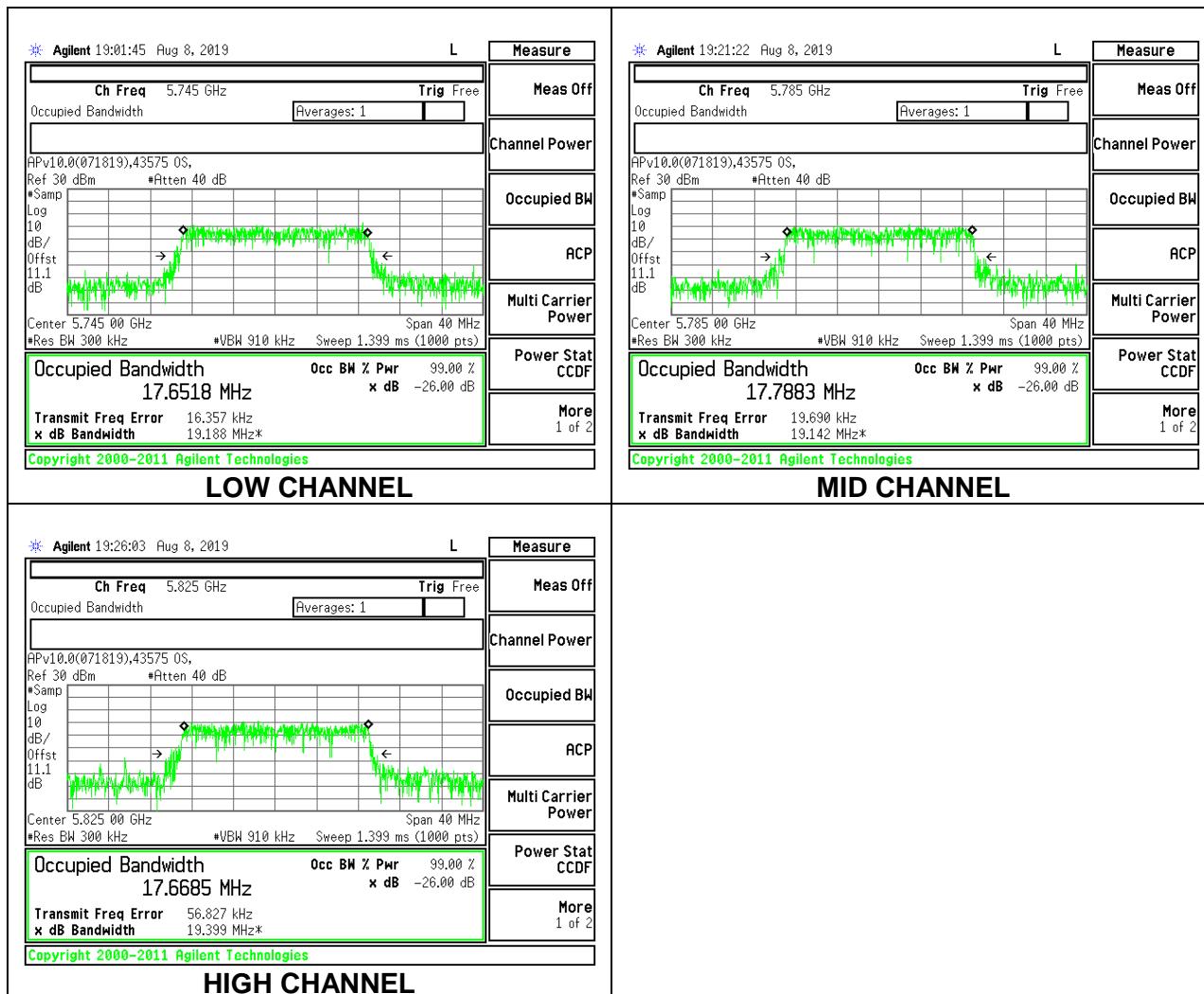
MID CHANNEL



8.3.4. 802.11n HT20 MODE IN THE 5.8 GHz BAND

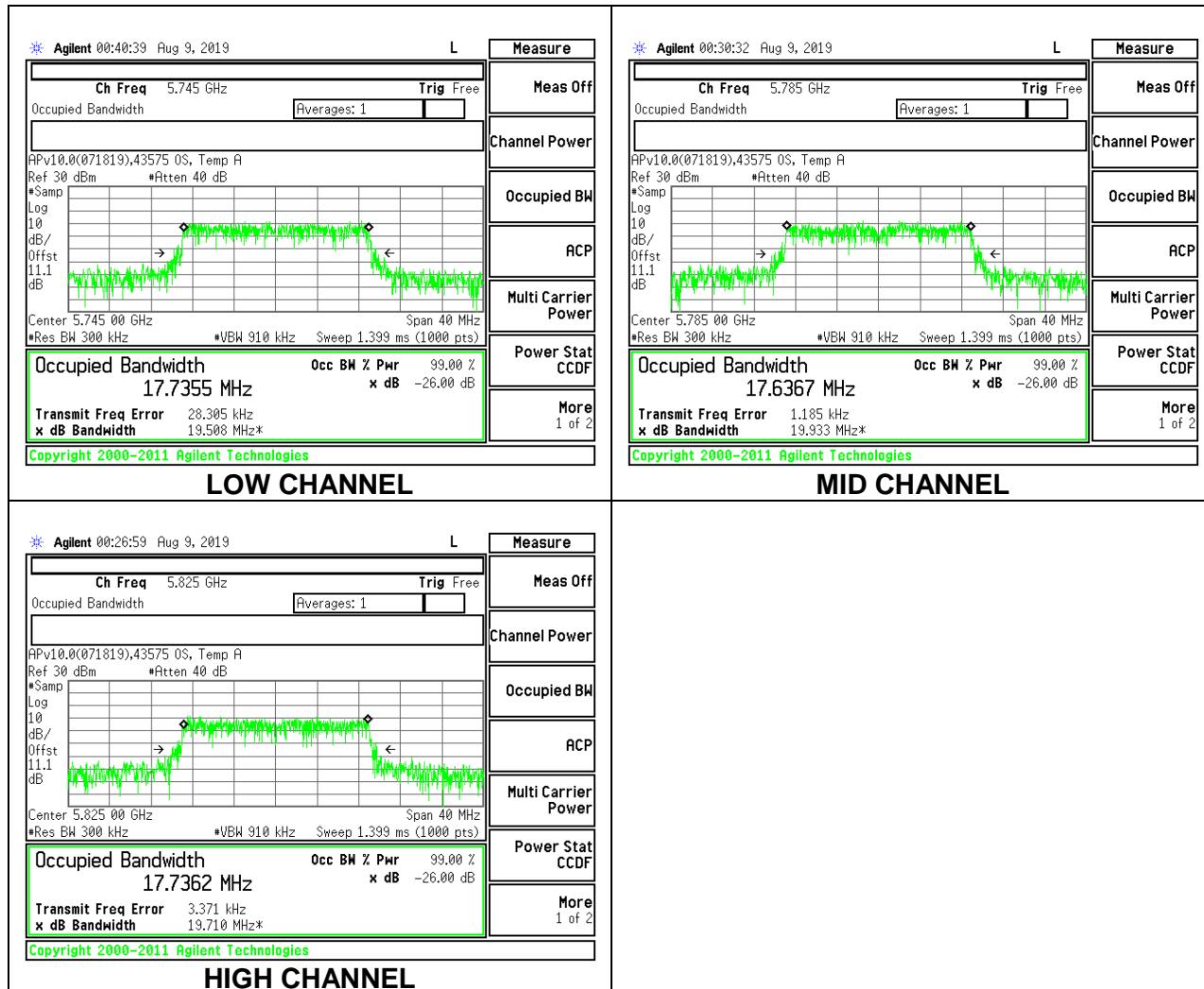
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5745 | 17.6520 |
| Mid | 5785 | 17.7880 |
| High | 5825 | 17.6690 |



1TX Antenna 2 MODE

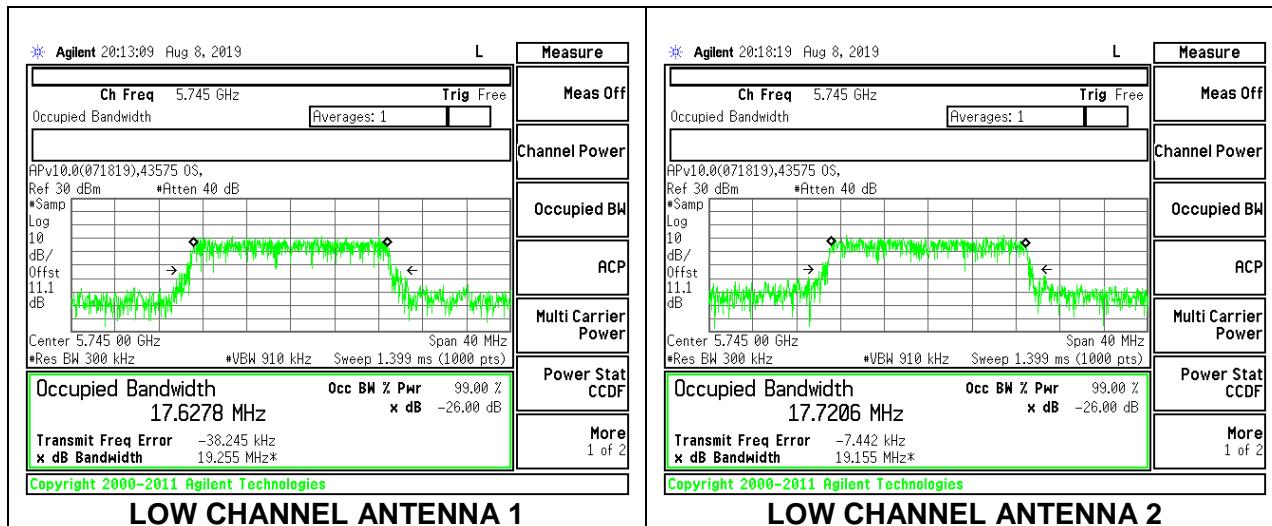
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5745 | 17.7350 |
| Mid | 5785 | 17.6370 |
| High | 5825 | 17.7360 |



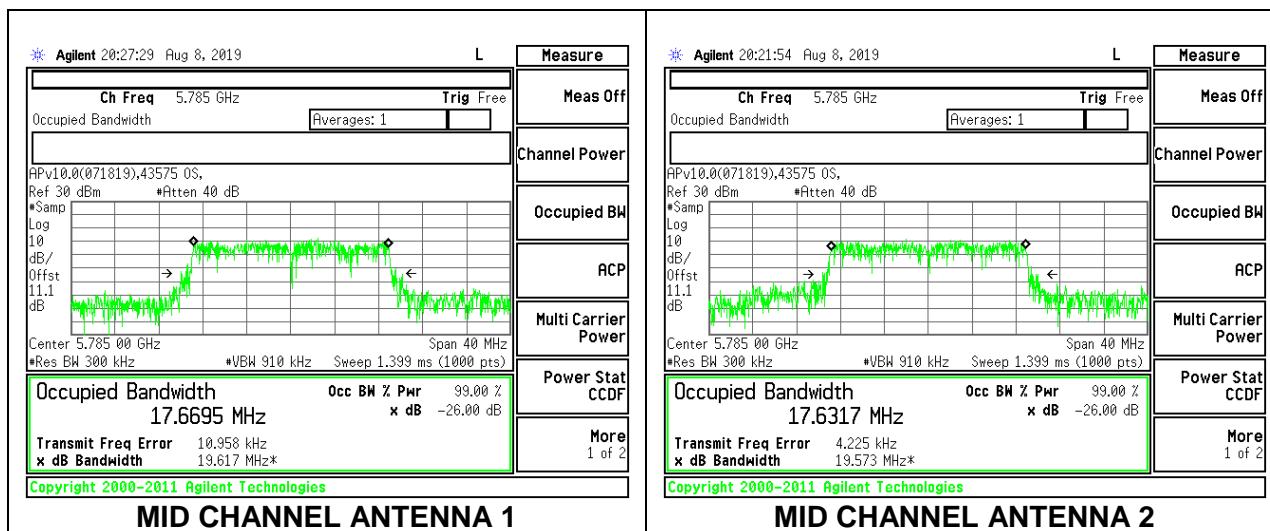
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Low | 5745 | 17.6280 | 17.7210 |
| Mid | 5785 | 17.6690 | 17.6320 |
| High | 5825 | 17.7290 | 17.7230 |

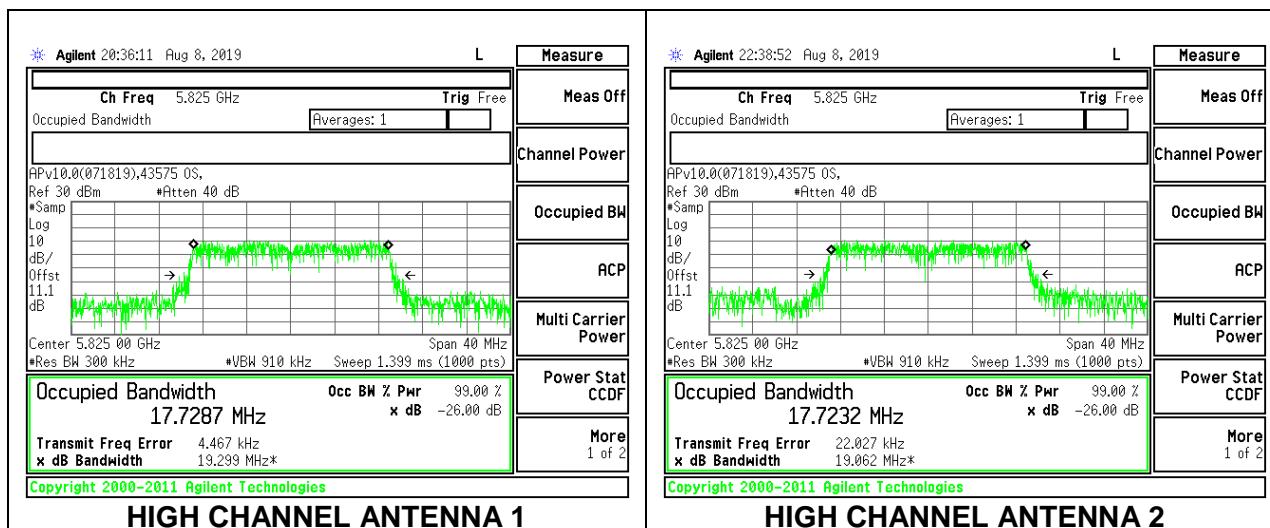
LOW CHANNEL



MID CHANNEL



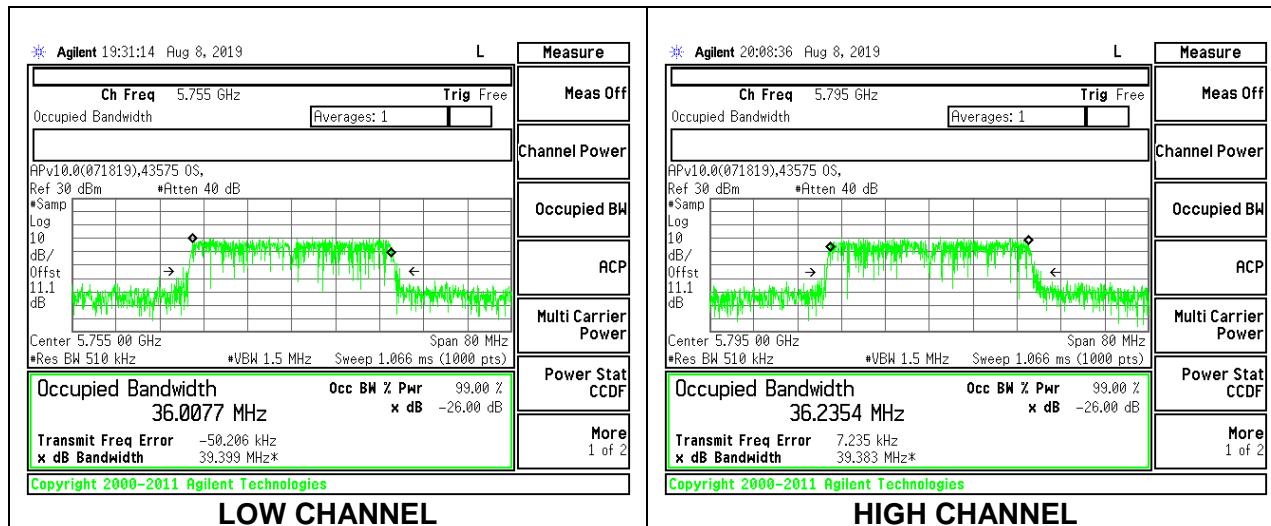
HIGH CHANNEL



8.3.5. 802.11n HT40 MODE IN THE 5.8 GHz BAND

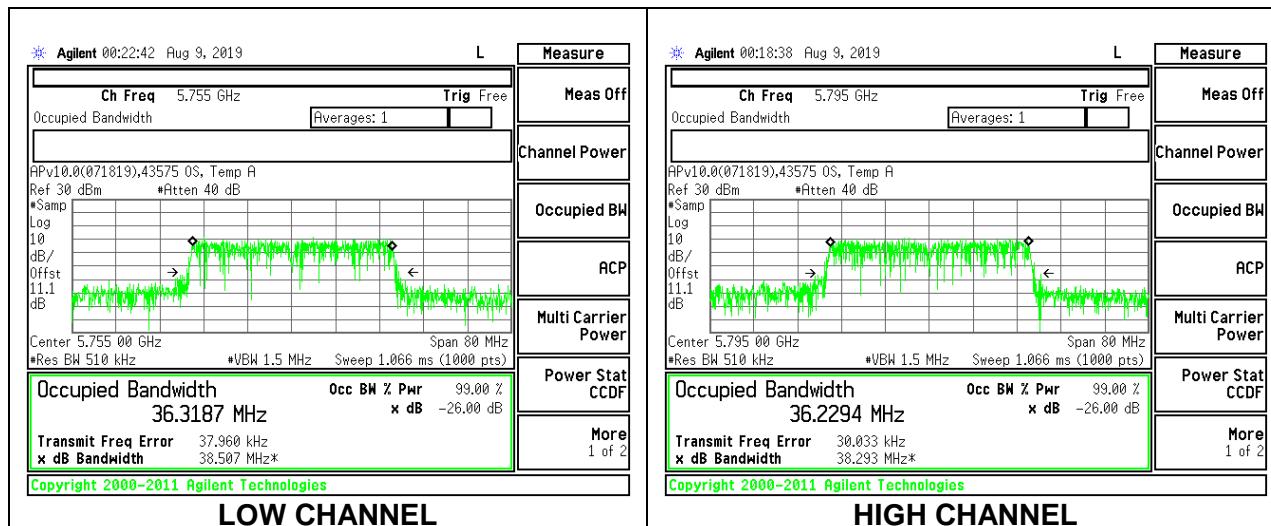
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5755 | 36.0080 |
| High | 5795 | 36.2350 |



1TX Antenna 2 MODE

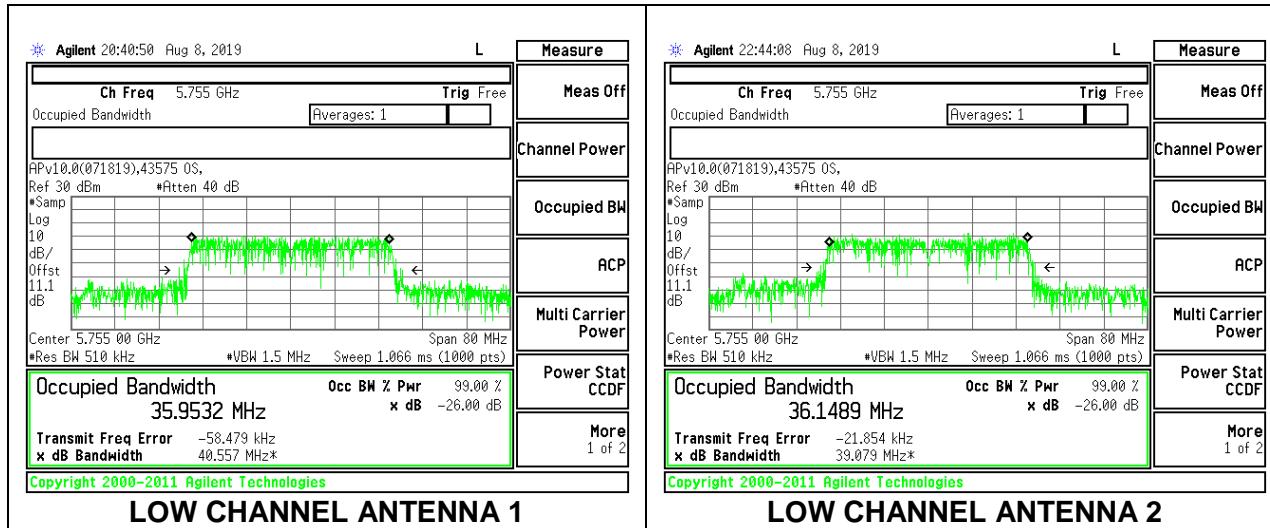
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Low | 5755 | 36.3190 |
| High | 5795 | 36.2290 |



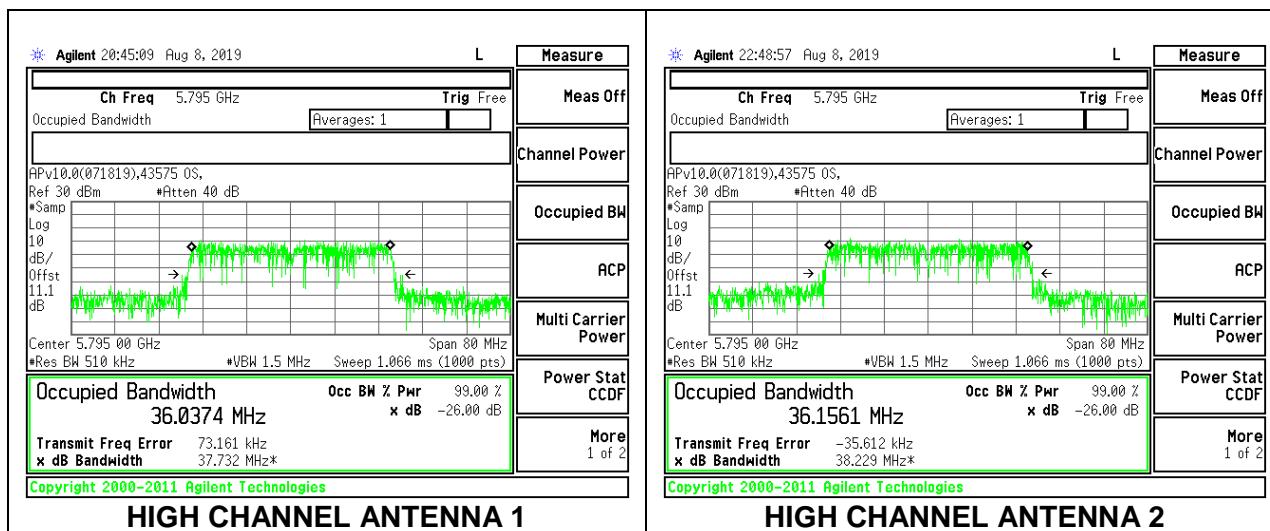
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Low | 5755 | 35.9530 | 36.1490 |
| High | 5795 | 36.0370 | 36.1560 |

LOW CHANNEL



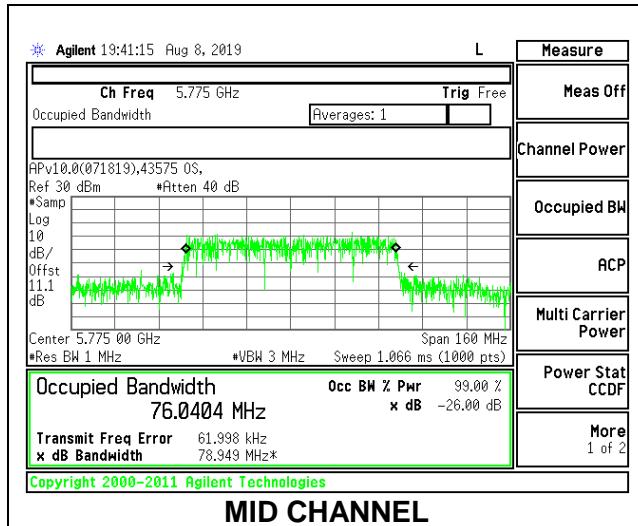
HIGH CHANNEL



8.3.6. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

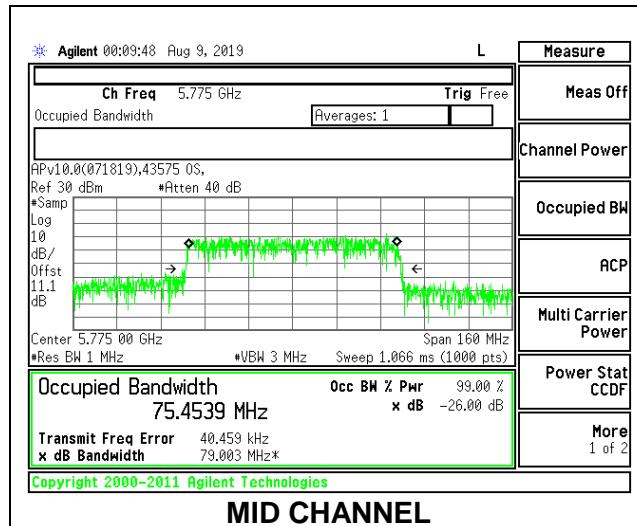
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|--------------------|------------------------|
| Mid | 5775 | 76.0400 |



1TX Antenna 2 MODE

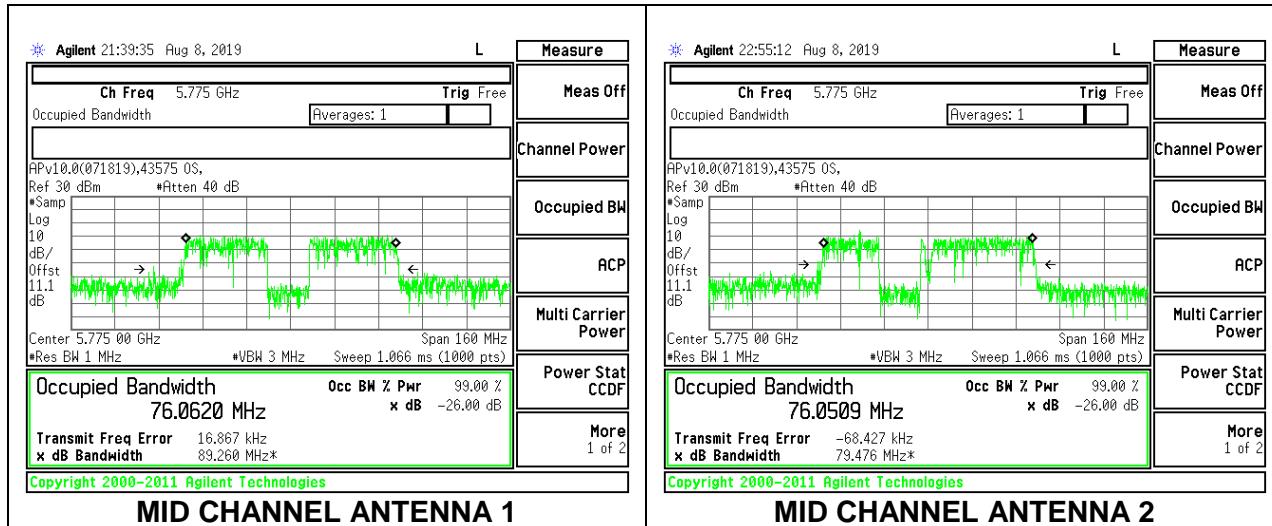
| Channel | Frequency | 99% Bandwidth |
|---------|-----------|---------------|
| | (MHz) | (MHz) |
| Mid | 5775 | 75.4540 |



2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 99% Bandwidth Antenna 1 (MHz) | 99% Bandwidth Antenna 2 (MHz) |
|---------|--------------------|-------------------------------------|-------------------------------------|
| Mid | 5775 | 76.0620 | 76.0510 |

MID CHANNEL



8.4. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

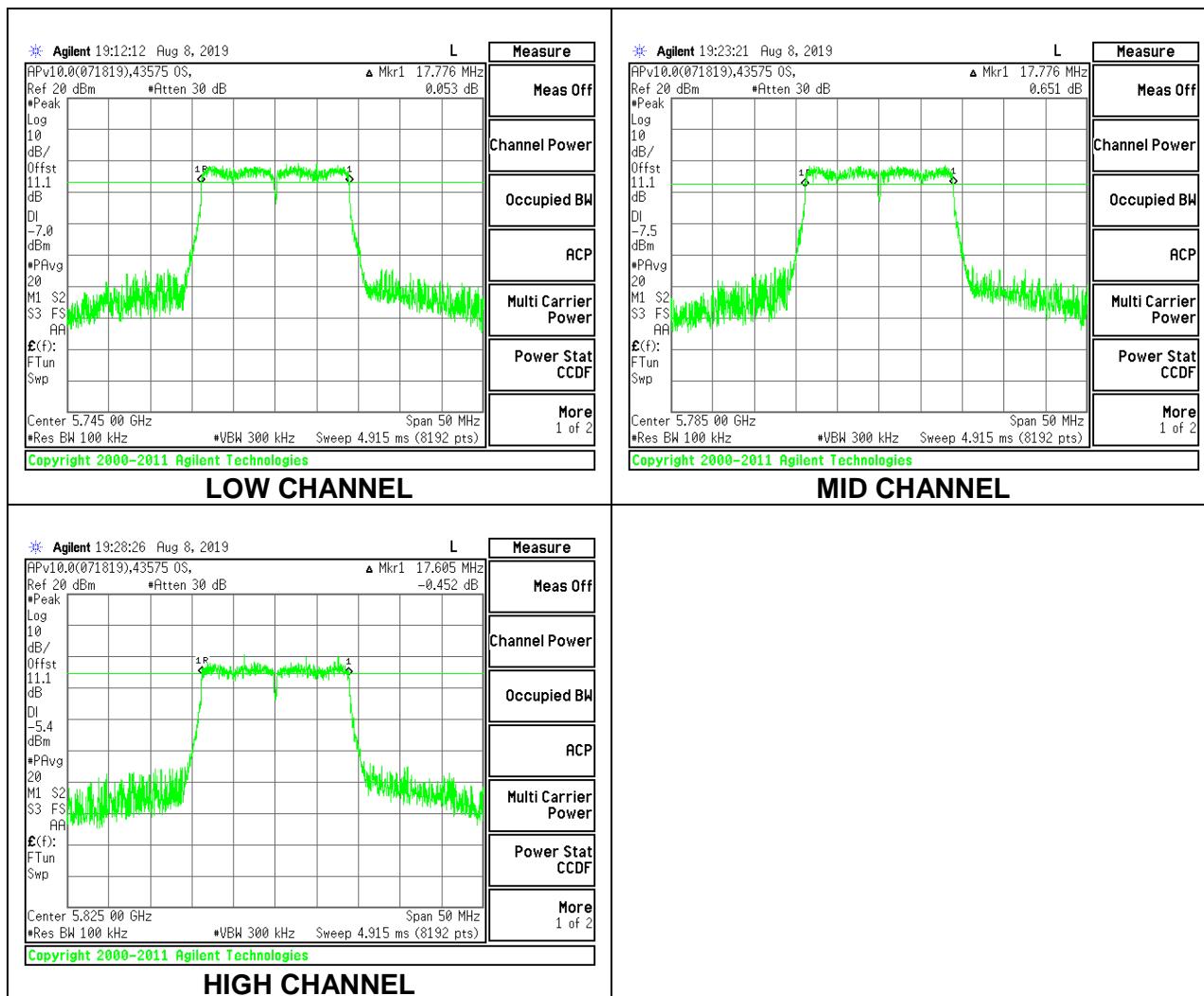
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

8.4.1. 802.11n HT20 MODE IN THE 5.8 GHz BAND

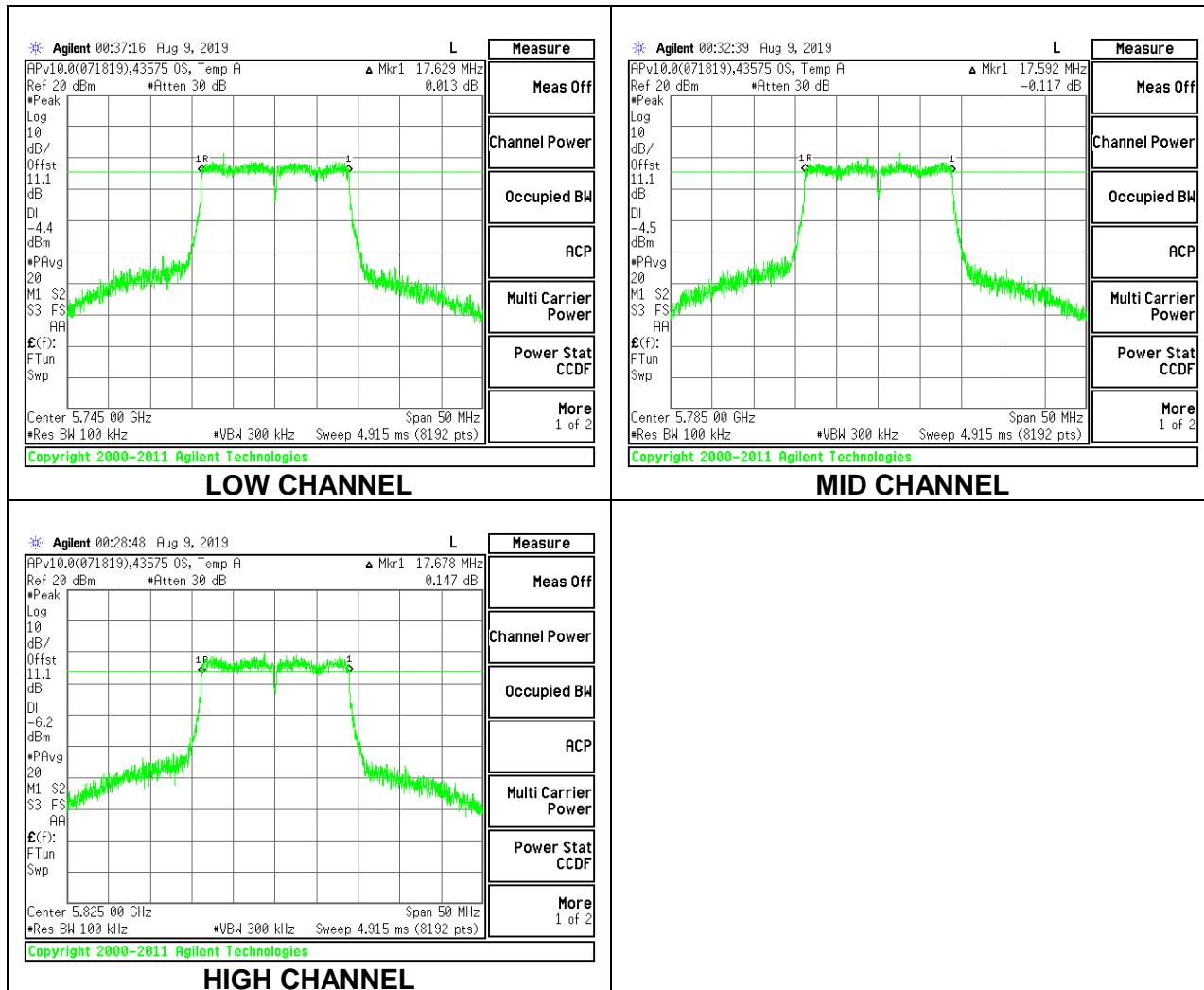
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Low | 5745 | 17.7760 | 0.5 |
| Mid | 5785 | 17.7760 | 0.5 |
| High | 5825 | 17.6050 | 0.5 |



1TX Antenna 2 MODE

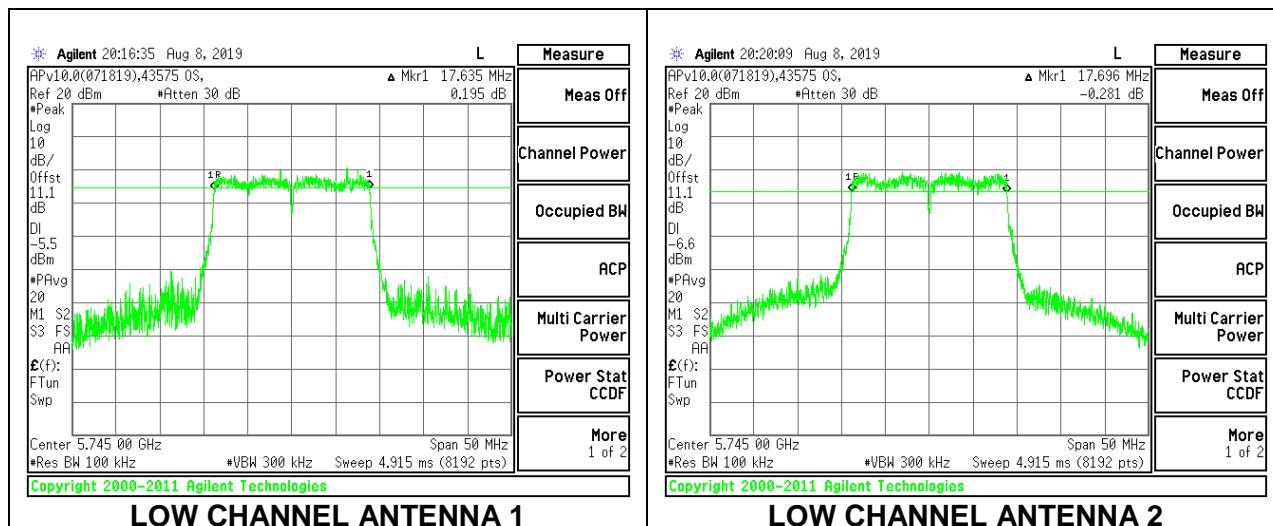
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Low | 5745 | 17.6290 | 0.5 |
| Mid | 5785 | 17.5920 | 0.5 |
| High | 5825 | 17.6780 | 0.5 |



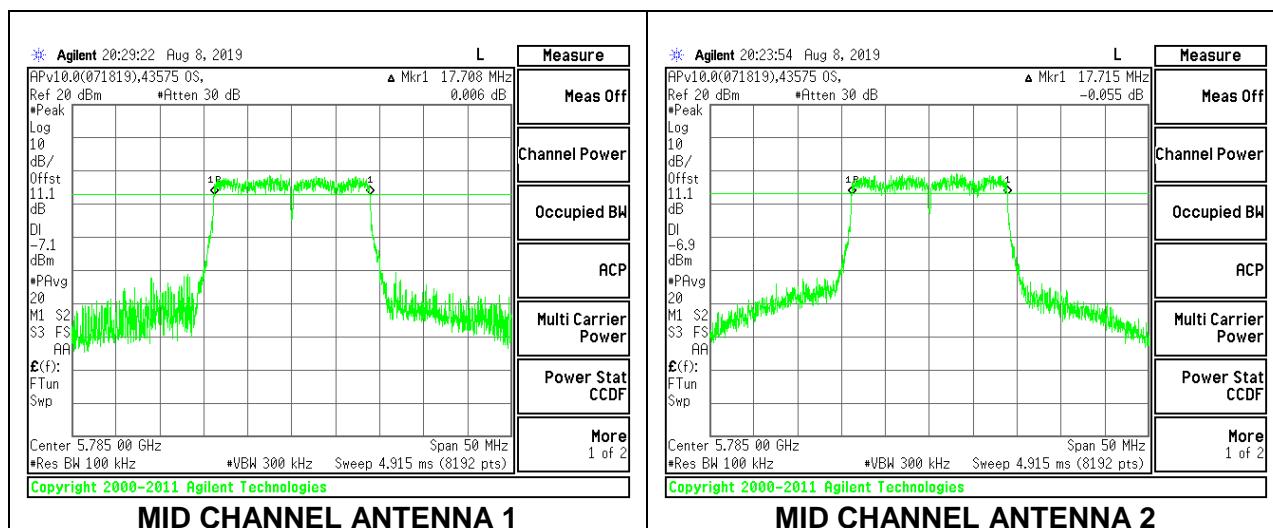
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 6 dB BW Antenna 1 (MHz) | 6 dB BW Antenna 2 (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------------|-------------------------------|---------------------------|
| Low | 5745 | 17.6350 | 17.6960 | 0.5 |
| Mid | 5785 | 17.7080 | 17.7150 | 0.5 |
| High | 5825 | 17.3300 | 17.6110 | 0.5 |

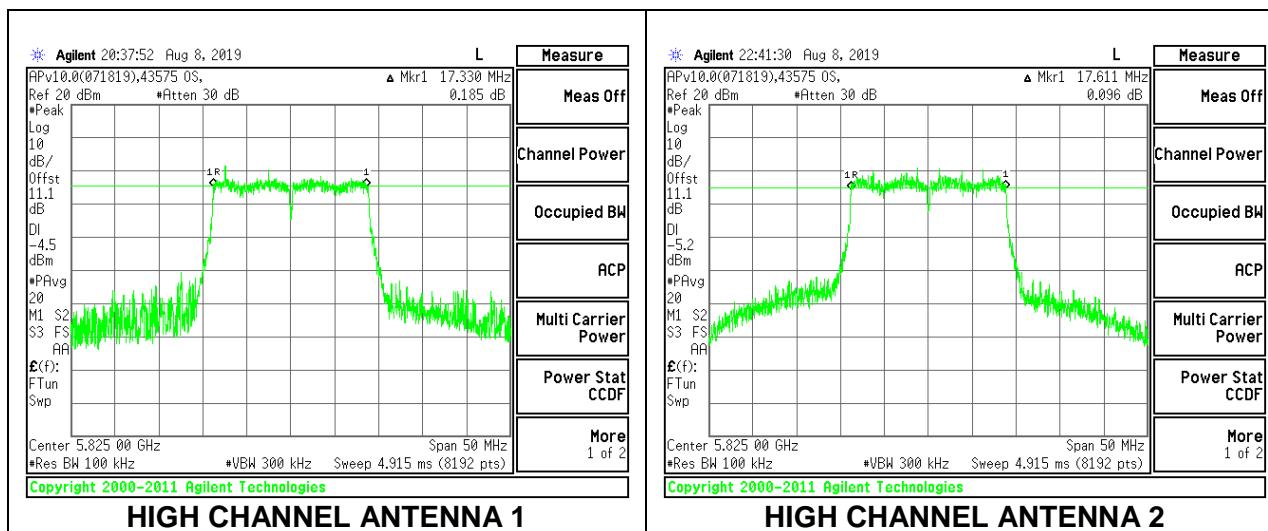
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



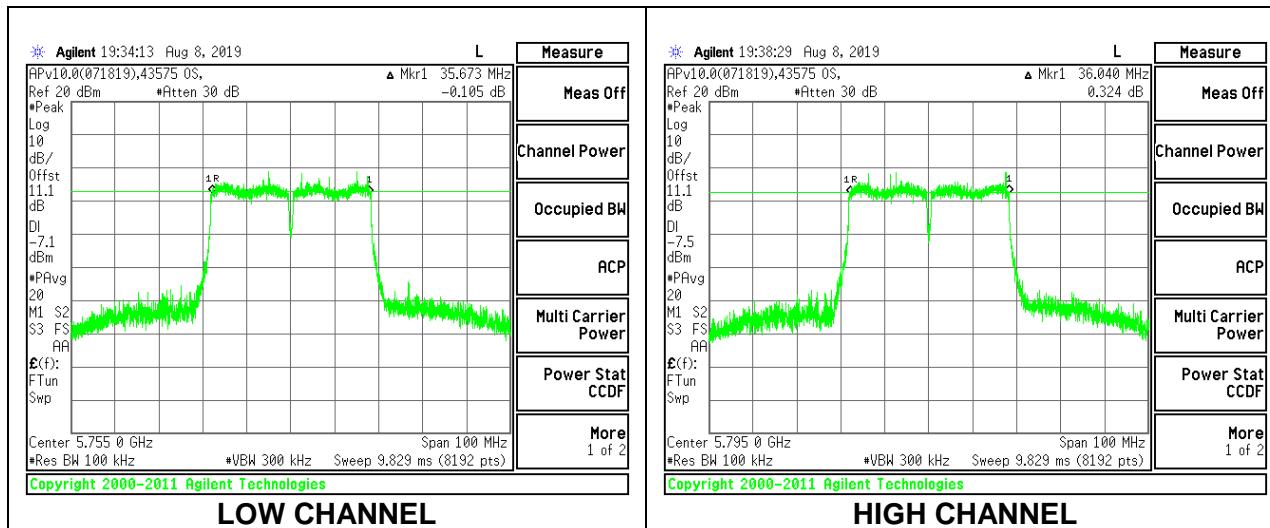
HIGH CHANNEL ANTENNA 1

HIGH CHANNEL ANTENNA 2

8.4.2. 802.11n HT40 MODE IN THE 5.8 GHz BAND

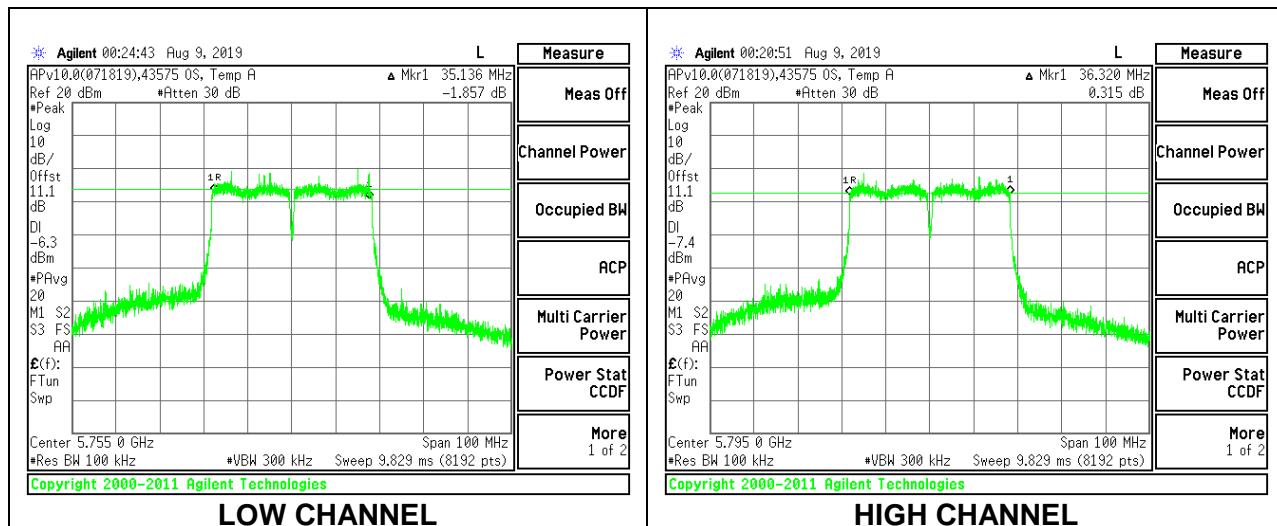
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Low | 5755 | 35.6730 | 0.5 |
| High | 5795 | 36.0400 | 0.5 |



1TX Antenna 2 MODE

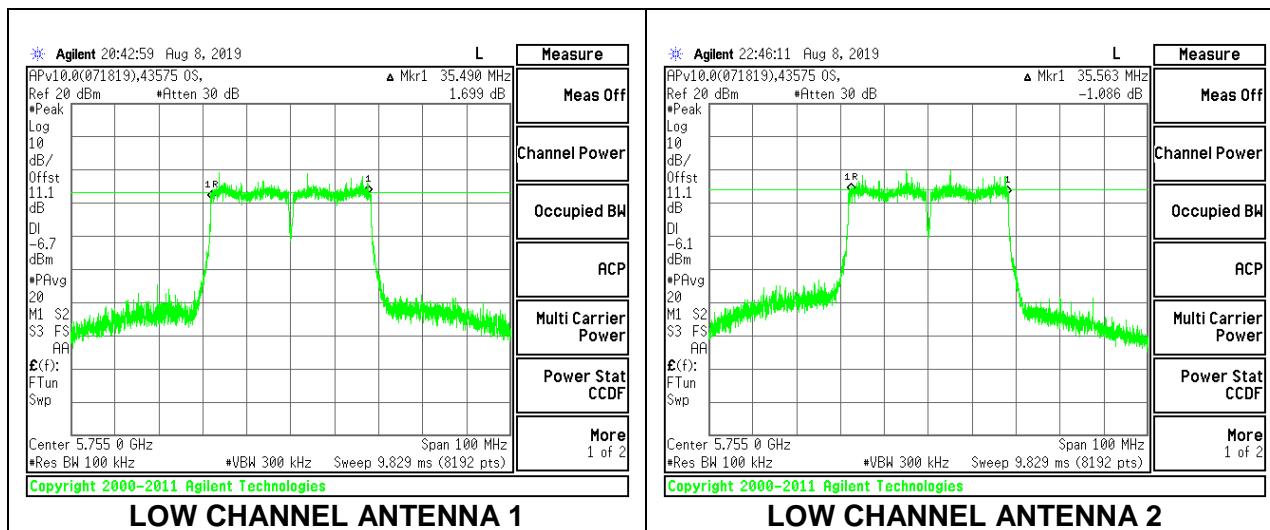
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Low | 5755 | 35.1360 | 0.5 |
| High | 5795 | 36.3200 | 0.5 |



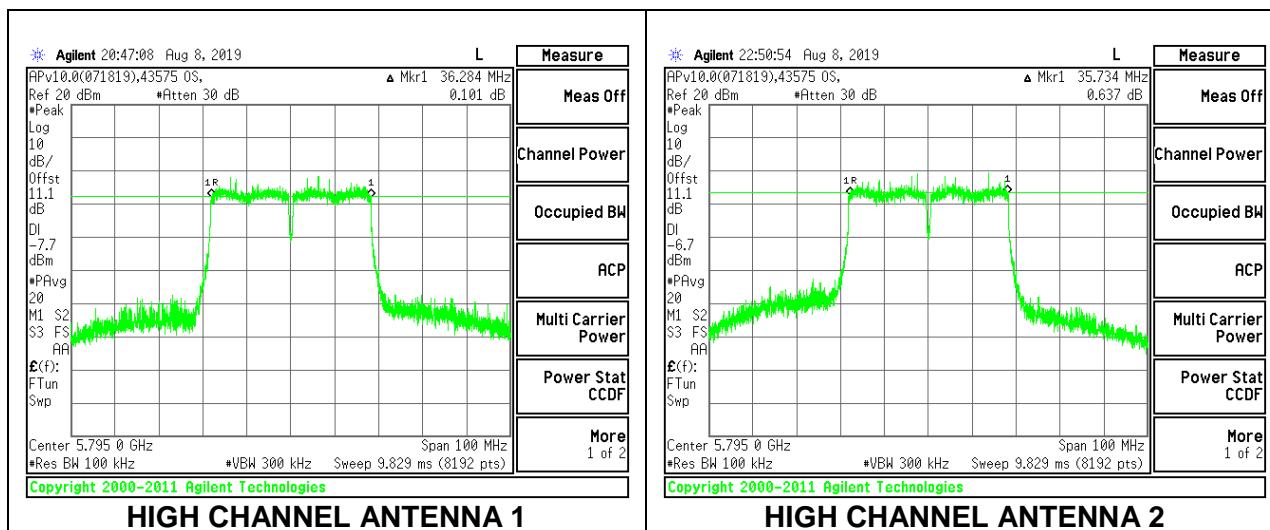
2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency (MHz) | 6 dB BW Antenna 1 (MHz) | 6 dB BW Antenna 2 (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------------|-------------------------------|---------------------------|
| Low | 5755 | 35.4900 | 35.5630 | 0.5 |
| High | 5795 | 36.2840 | 35.7340 | 0.5 |

LOW CHANNEL



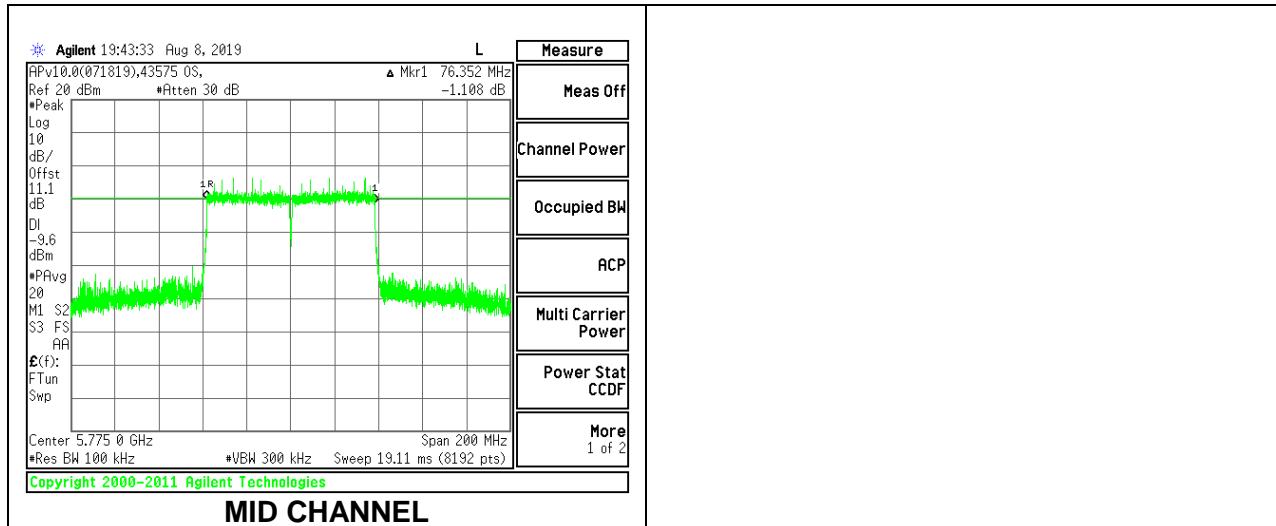
HIGH CHANNEL



8.4.3. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

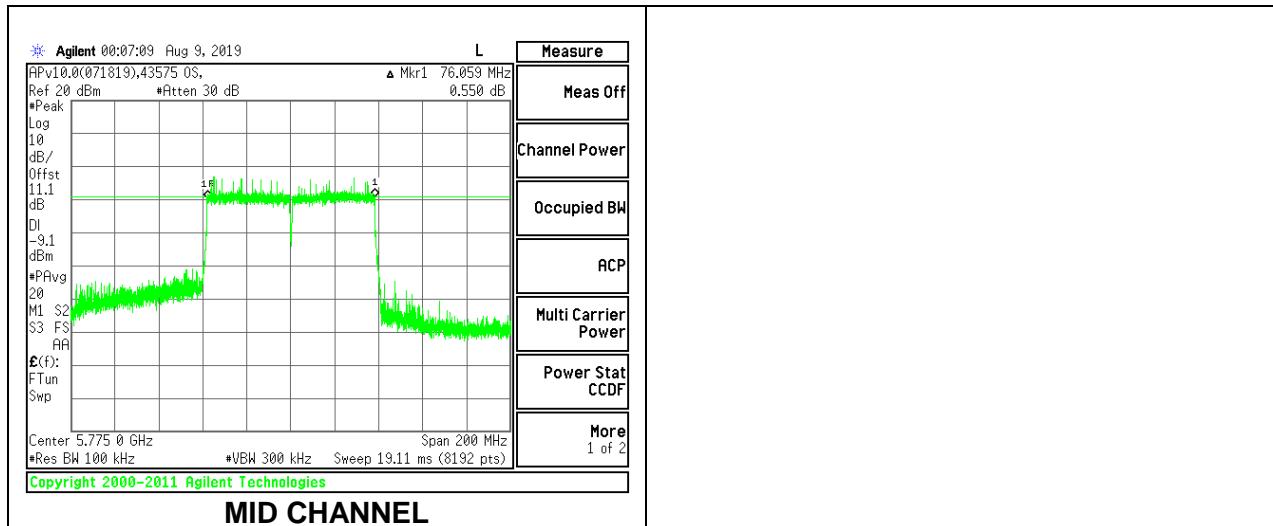
1TX Antenna 1 MODE

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Mid | 5775 | 76.3520 | 0.5 |



1TX Antenna 2 MODE

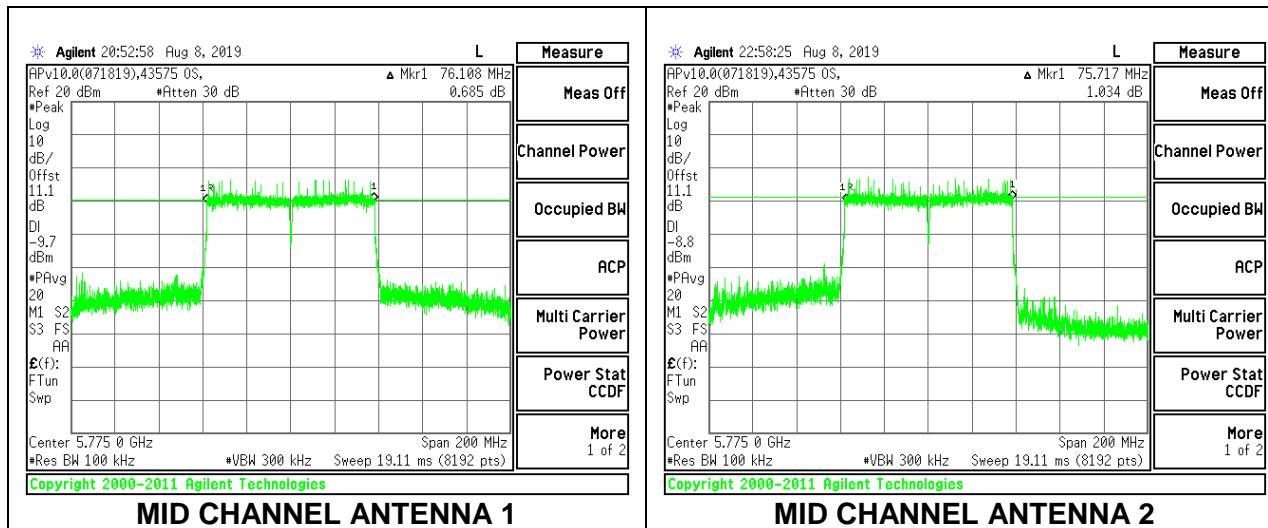
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|--------------------|-------------------------|------------------------|
| Mid | 5775 | 76.0590 | 0.5 |



2TX Antenna 1 + Antenna 2 CDD MODE

| Channel | Frequency | 6 dB BW Antenna 1 | 6 dB BW Antenna 2 | Minimum Limit |
|---------|-----------|----------------------|----------------------|------------------|
| | (MHz) | (MHz) | (MHz) | (MHz) |
| Mid | 5775 | 76.1080 | 75.7170 | 0.5 |

MID CHANNEL



8.5. OUTPUT POWER AND PSD

LIMITS

FCC §15.407

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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. 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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. 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. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. 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.
- (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. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. 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.

Band 5.725-5.85 GHz

The maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. 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.

TEST PROCEDURE

The measurement method used for output power is KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and for straddles channels KDB 789033 D02 v02r01, Section E.2.b (Method SA-1) was used.

The measurement method used for power spectral density is KDB 789033 D02 v02r01, Section F

DIRECTIONAL ANTENNA GAIN

Tx chains are uncorrelated for power and correlated for PSD due to the device supporting CDD in all MIMO modes. The directional gains are as follows:

| Band (GHz) | Antenna 1 Antenna Gain (dBi) | Antenna 2 Antenna Gain (dBi) | Uncorrelated Chains Directional Gain (dBi) | Correlated Chains Directional Gain (dBi) |
|-----------------------|---|---|---|---|
| | 3.60 | 3.60 | 3.60 | 6.61 |
| 5.8 | 2.7 | 2.7 | 2.70 | 5.71 |

RESULTS

8.5.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

1TX Antenna 1 MODE (FCC) MOBILE

Antenna Gain and Limits

| Channel | Frequency (MHz) | Directional Gain (dBi) | Power Limit (dBm) | PSD Limit (dBm/ 1MHz) |
|---------|--------------------|------------------------------|-------------------------|--------------------------------|
| Low | 5180 | 3.60 | 24.00 | 11.00 |
| Mid | 5200 | 3.60 | 24.00 | 11.00 |
| High | 5240 | 3.60 | 24.00 | 11.00 |

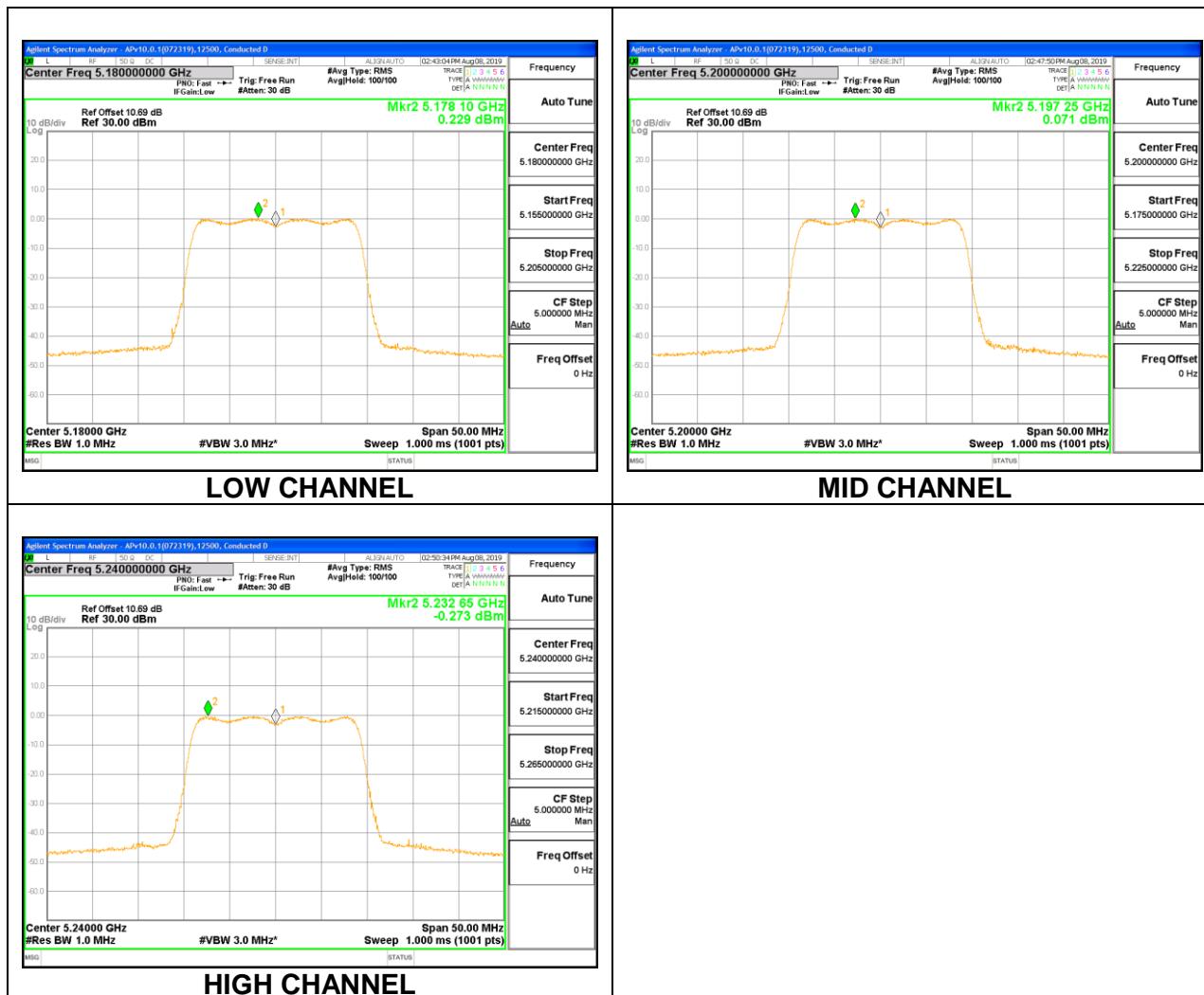
| | | |
|---------------------------|------|---|
| Duty Cycle CF (dB) | 0.10 | Included in Calculations of Corr'd PSD |
|---------------------------|------|---|

Output Power Results

| Channel | Frequency (MHz) | Meas Power (dBm) | Total Corr'd Power (dBm) | Power Limit (dBm) | Power Margin (dB) |
|---------|--------------------|------------------------|-----------------------------------|-------------------------|-------------------------|
| Low | 5180 | 12.57 | 12.57 | 24.00 | -11.43 |
| Mid | 5200 | 11.90 | 11.90 | 24.00 | -12.10 |
| High | 5240 | 11.08 | 11.08 | 24.00 | -12.92 |

PSD Results

| Channel | Frequency (MHz) | Meas PSD (dBm/1MHz) | Total Corr'd PSD (dBm/1MHz) | PSD Limit (dBm/ 1MHz) | PSD Margin (dB) |
|---------|--------------------|---------------------------|--------------------------------------|--------------------------------|-----------------------|
| Low | 5180 | 0.23 | 0.33 | 11.00 | -10.67 |
| Mid | 5200 | 0.07 | 0.17 | 11.00 | -10.83 |
| High | 5240 | -0.27 | -0.17 | 11.00 | -11.17 |



1TX Antenna 2 MODE (FCC) MOBILE

Antenna Gain and Limits

| Channel | Frequency (MHz) | Directional Gain (dBi) | Power Limit (dBm) | PSD Limit (dBm/ 1MHz) |
|---------|--------------------|------------------------------|-------------------------|--------------------------------|
| Low | 5180 | 3.60 | 24.00 | 11.00 |
| Mid | 5200 | 3.60 | 24.00 | 11.00 |
| High | 5240 | 3.60 | 24.00 | 11.00 |

| | | |
|---------------------------|------|---|
| Duty Cycle CF (dB) | 0.10 | Included in Calculations of Corr'd PSD |
|---------------------------|------|---|

Output Power Results

| Channel | Frequency (MHz) | Meas Power (dBm) | Total Corr'd Power (dBm) | Power Limit (dBm) | Power Margin (dB) |
|---------|--------------------|------------------------|-----------------------------------|-------------------------|-------------------------|
| Low | 5180 | 12.64 | 12.64 | 24.00 | -11.36 |
| Mid | 5200 | 12.95 | 12.95 | 24.00 | -11.05 |
| High | 5240 | 12.93 | 12.93 | 24.00 | -11.07 |

PSD Results

| Channel | Frequency (MHz) | Meas PSD (dBm/1MHz) | Total Corr'd PSD (dBm/1MHz) | PSD Limit (dBm/ 1MHz) | PSD Margin (dB) |
|---------|--------------------|---------------------------|--------------------------------------|--------------------------------|-----------------------|
| Low | 5180 | 1.45 | 1.55 | 11.00 | -9.45 |
| Mid | 5200 | 1.64 | 1.74 | 11.00 | -9.26 |
| High | 5240 | 1.94 | 2.04 | 11.00 | -8.96 |

