MEASUREMENT REPORT

FCC PART 15 Subpart E WLAN 802.11a/n/ac

FCC ID:	2AD8UFZCWO2CA1
APPLICANT:	Nokia Solutions and Networks, OY
Application Type:	Certification
Product:	AC220 Wi-Fi AP OD directional antenna US AC220 Wi-Fi AP OD external antenna US AC220 Wi-Fi AP OD small omni antenna US
Model No.:	WO2C-AC220
Brand Name:	NOKIA
FCC Classification:	Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s):	Part15 Subpart E (Section 15.407)
Test Procedure(s):	ANSI C63.10-2013, ANSI C63.10-2013, KDB 644545 D03v01, KDB 662911 D01v02r01
Test Date:	June 19 ~ October 10, 2017

Reviewed By : Paddy Chen
(Paddy Chen)

Approved By : Chenz Ker
(Chenz Ker)

Testing Laboratory
3261

The test results relate only to the samples tested.
This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurementreport and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported hereinrelate only to the item(s) tested.
The test report shall not be reproduced except in full without the written approval of MRT Technology (Taiwan) Co., Ltd.

Revision History

Report No.	Version	Description	Issue Date	Note
1707TW0110-U4	Rev. 01	Initial Report	12-02-2017	Valid

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Description Page

§2.1033General Information

Applicant:	Nokia Solutions and Networks, OY
Applicant Address:	1455 W Shure Drive, Arlington Heights, IL 60004
Manufacturer:	Nokia Solutions and Networks, OY
Manufacturer Address:	1455 W Shure Drive, Arlington Heights, IL 60004
Test Site:	MRT Technology (Taiwan) Co., Ltd
Test Site Address:	No. 38, Fuxing Second Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C)
FCC Registration No.:	153292
FCC Rule Part(s):	Part15 Subpart E (Section 15.407)
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Fuxing Rd., Taoyuan, Taiwan (R.O.C)

- **MRT facility is a FCC registered (Reg. No. 153292) test facility with the site description report on file and is designated by the FCC as an Accredited Test Film.**
- **MRT facility is an IC registered (MRT Reg. No. 21723-1) test laboratory with the site description on file at Industry Canada.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (TAF) under the American Association for Laboratory Accreditation Program (TAF Cert. No. 3261) in EMC, Telecommunications and Radio testing for FCC, Industry Taiwan, EU and TELEC Rules.**

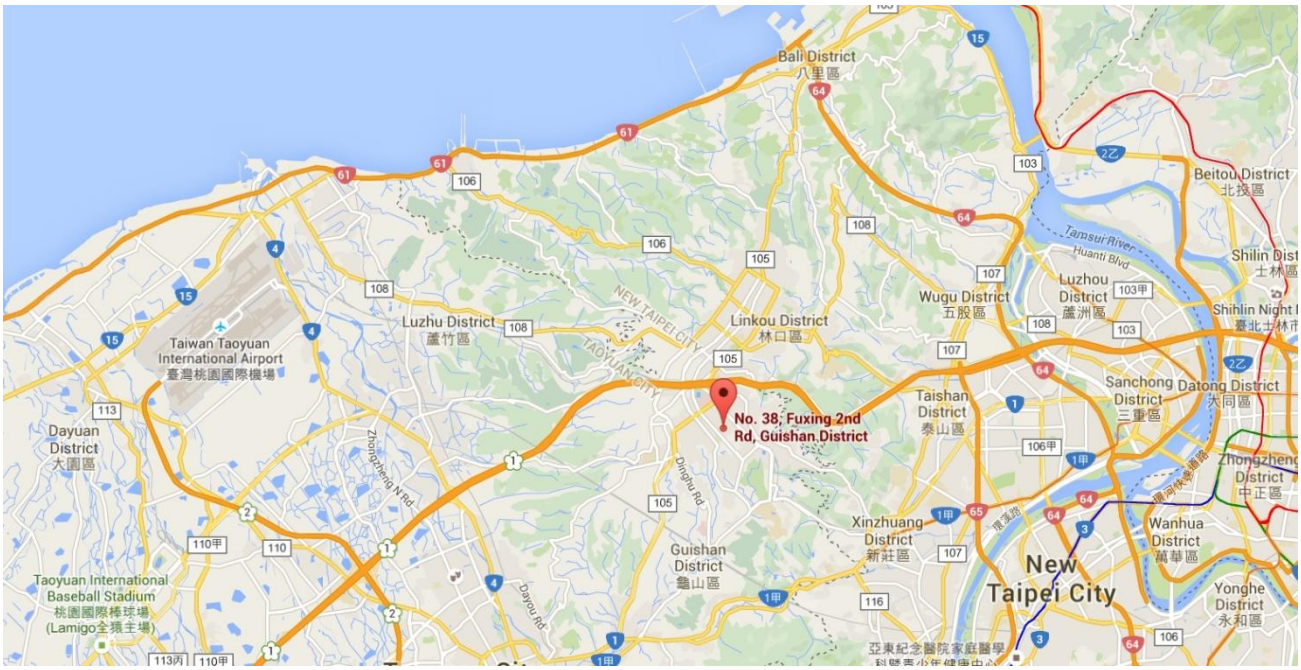
1. INTRODUCTION

1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the FederalCommunications Commission and the Industry Canada Certification and Engineering Bureau.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taoyuan City. These measurement tests were conducted at the MRT Technology (Taiwan) Co., Ltd. Facility located at No.38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 33377, Taiwan (R.O.C).



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name:	AC220 Wi-Fi AP OD directional antenna US AC220 Wi-Fi AP OD external antenna US AC220 Wi-Fi AP OD small omni antenna US
Model No.:	WO2C-AC220
Brand Name:	NOKIA
Wi-Fi Specification:	802.11a/b/g/n/ac
Frequency Range:	**2.4GHz:** For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz **5GHz:** For 802.11a/n-HT20/ac-VHT20:5180~5320MHz, 5500~5720MHz, 5745~5825MHz For 802.11n-HT40/ac-VHT40:5190~5310MHz, 5510~5710MHz, 5755~5795MHz For 802.11ac-VHT80:5210MHz, 5290MHz, 5530MHz, 5610MHz, 5690MHz, 5775MHz
Maximum Output Power:	**CDD Mode:** 802.11a: 21.86dBm, 802.11n-HT20: 21.93dBm, 802.11n-HT40: 22.93dBm, 802.11ac-VHT20: 21.97dBm, 802.11ac-VHT40: 23.10dBm, 802.11ac-VHT80: 23.73dBm **Beam-Forming Mode:** 802.11n-HT20: 20.22dBm, 802.11n-HT40: 21.58dBm, 802.11ac-VHT20: 20.23dBm, 802.11ac-VHT40: 21.62dBm, 802.11ac-VHT80: 21.55dBm
Type of Modulation:	802.11b: DSSS, 802.11a/g/n/ac: OFDM
Modulation Type:	CCK, DQPSK, DBPSK for DSSS 16QAM, 64QAM, 256QAM, QPSK, BPSK for OFDM

Note: The model difference as below:

- when the device has been connected the Galtronics Directional antenna, the product name is “AC220 Wi-Fi AP OD directional antenna US”;
- when the device has been connected the PCTEL antenna, the product name is “AC220 Wi-Fi AP OD external antenna US”;
- when the device has been connected the Galtronics Small Omni antenna, the product name is “AC220 Wi-Fi AP OD small omni antenna US”;

2.2. Working Frequencies for this Report

802.11a/n-HT20/ac-VHT20

Channel	Frequency	Channel	Frequency	Channel	Frequency
36	5180 MHz	40	5200 MHz	44	5220 MHz
48	5240 MHz	52	5260 MHz	56	5280 MHz
60	5300 MHz	64	5320 MHz	100	5500 MHz
104	5520 MHz	108	5540 MHz	112	5560 MHz
116	5580 MHz	120	5600 MHz	124	5620 MHz
128	5640 MHz	132	5660 MHz	136	5680 MHz
140	5700 MHz	144	5720 MHz	149	5745 MHz
153	5765 MHz	157	5785 MHz	161	5805 MHz
165	5825 MHz	--	--	--	--

802.11n-HT40/ac-VHT40

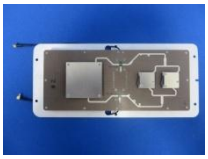
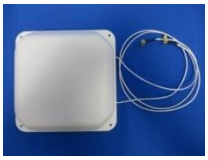
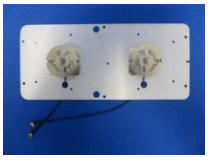
Channel	Frequency	Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz	54	5270 MHz
62	5310 MHz	102	5510 MHz	110	5550 MHz
118	5590 MHz	126	5630 MHz	134	5670 MHz
142	5710 MHz	151	5755 MHz	159	5795 MHz

802.11ac-VHT80

Channel	Frequency	Channel	Frequency	Channel	Frequency
42	5210 MHz	58	5290 MHz	106	5530 MHz
122	5610 MHz	138	5690 MHz	155	5775 MHz

Note: The device can't operate in 5600~5650 MHz band in Canada (The frequency of blue font).

2.3. Description of Available Antennas

Antenna	Manufacturer	Frequency Band (MHz)	Antenna Type	Part Number
	Galtronics	2412 ~ 2472 5150 ~ 5850	Directional Antenna	02078140-06561U2
	PCTEL, Inc.	2412 ~ 2472 5150 ~ 5850	Panel Antenna	FPMI2458-DP2RPSMA
	Galtronics	2412 ~ 2472 5150 ~ 5850	Omni Antenna	02078140-06561U1

Antenna Type	Frequency Band (MHz)	TX Paths	Per Chain Max Antenna Gain (dBi)		Beam Forming Directional Gain (dBi)	CDD Directional Gain (dBi)	
			Ant 1	Ant 2		For Power	For PSD
Directional Antenna	2412 ~ 2462	2	9.00	9.00	12.01	9.00	12.01
	5150 ~ 5250	2	11.00	11.00	14.01	11.00	14.01
	5150 ~ 5250 30° elevation angle	2	3.00	3.00	6.01	3.00	N/A
	5250 ~ 5350	2	11.00	11.00	14.01	11.00	14.01
	5470 ~ 5725	2	10.50	10.50	13.51	10.50	13.51
	5725 ~ 5850	2	10.00	10.00	13.01	10.00	13.01
Panel Antenna	2412 ~ 2462	2	6.00	6.00	9.01	6.00	9.01
	5150 ~ 5250	2	5.00	5.00	8.01	5.00	8.01
	5150 ~ 5250 30° elevation angle	2	2.27	2.27	5.28	2.27	N/A
	5250 ~ 5350	2	5.00	5.00	8.01	5.00	8.01
	5470 ~ 5725	2	5.00	5.00	8.01	5.00	8.01
	5725 ~ 5850	2	5.00	5.00	8.01	5.00	8.01
Small Omni Antenna	2412 ~ 2462	2	5.25	5.25	8.26	5.25	8.26
	5150 ~ 5250	2	6.50	6.50	9.51	6.50	9.51
	5150 ~ 5250 30° elevation angle	2	-1.25	-1.25	1.76	-1.25	N/A
	5250 ~ 5350	2	6.50	6.50	9.51	6.50	9.51
	5470 ~ 5725	2	6.50	6.50	9.51	6.50	9.51
	5725 ~ 5850	2	6.50	6.50	9.51	6.50	9.51

Note:

1. The EUT supports Cyclic Delay Diversity (CDD) mode, and CDD signals are correlated.

   For CDD transmissions, directional gain is calculated as follows, $N_{ANT} = 2$, $N_{SS} = 1$.

   1) If all antennas have the same gain, G_{ANT}, Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

   - For power spectral density (PSD) measurements on all devices,
     Array Gain = 10 log (N_{ANT}/ N_{SS}) dB = 3.01;
   - For power measurements on IEEE 802.11 devices,
     Array Gain = 0 dB for $N_{ANT} \leq 4$;

   2) If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream:

   - Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

- $DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$

  $g_{j,k} = 10^{G_k/20}$ if the kth antenna is being fed by spatial stream j, or zero if it is not;

  G_k is the gain in dBi of the kth antenna.

2. The EUT also supports Beam Forming mode, and the Beam Forming support 802.11n, not include 802.11a/ac.

   Correlated signals include, but are not limited to, signals transmitted in any of the following modes:

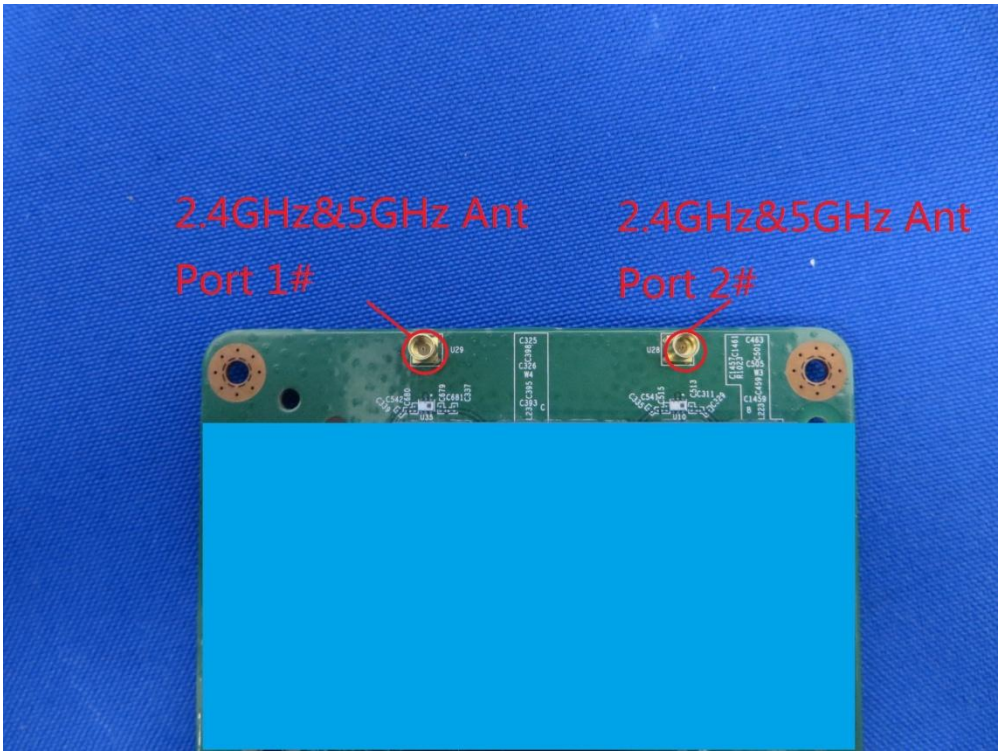
   - Any transmit Beam Forming mode, whether fixed or adaptive (e.g., phased array modes, closed loop MIMO modes, Transmitter Adaptive Antenna modes, Maximum Ratio Transmission (MRT) modes, and Statistical Eigen Beam Forming (EBF) modes).

   Unequal antenna gains, with equal transmit powers. For antenna gains given by G_1, G_2, …, G_N dBi.

   - transmit signals are correlated, then
   - Directional gain = $10*\log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2/N_{ANT}]$ dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

2.4. Description of Antenna RF Port

Antenna RF Port				
--	2.4GHz RF Port		5GHz RF Port	
Software Control Port	Ant 1	Ant 2	Ant 1	Ant 2



2.5. Test Mode

Test Mode	Mode 1: Transmit by 802.11a
	Mode 2: Transmit by 802.11n-HT20
	Mode 3: Transmit by 802.11n-HT40
	Mode 4: Transmit by 802.11ac-VHT20
	Mode 5: Transmit by 802.11ac-VHT40
	Mode 6: Transmit by 802.11ac-VHT80

5GHz Test Mode	Ant 1 + 2	
	CDD	Beam-Forming
802.11a	√	×
802.11n-HT20	√	√
802.11n-HT40	√	√
802.11ac-VHT20	√	√
802.11ac-VHT40	√	√
802.11ac-VHT80	√	√

2.6. Description of Test Software

The test utility software used during testing was“ QCARCT”, and the version was “v3.0.174.0”.

2.7. Device Capabilities

This device contains the following capabilities:

2.4GHz WLAN (DTS) and 5GHzWLAN (NII)

Note: 5GHz (NII) operation is possible in 20MHz, 40MHzand 80MHz channel bandwidths. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = average per the guidance of Section B)2)b) of ANSI C63.10-2013. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Test Mode	Duty Cycle
802.11a	95.80 %
802.11n-HT20	98.07 %
802.11n-HT40	96.60 %
802.11ac-VHT20	98.21 %
802.11ac-VHT40	96.43 %
802.11ac-VHT80	91.40 %

2.8. Test Configuration

The **EUT** were tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

2.9. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

2.10. Labeling Requirements

Per 2.1074 & 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphletsupplied to the user and be readily visible to the purchaser at the time of purchase. However, when the deviceis so small wherein placement of the label with specified statement is not practical, only the FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label andlabel location.

Rsp-100 Issue 10 Section 3

Every unit of Category I radio apparatus certified for marketing and use in Canada shall bear a permanent label on which is indelibly displayed the model number and Industry Canada certification number of the equipment model (transmitter, receiver, or inseparable combination there of. Each model shall be identified by a unique combination of a model number and a certification number, which are assigned as described below in this section.

The label shall be securely affixed to a permanently attached part of the device, in a location where it is visible or easily accessible to the user, and shall not be readily detachable. The label shall be sufficiently durable to remain fully legible and intact on the device in all normal conditions of use throughout the device's expected lifetime. These requirements may be met either by a separate label or nameplate permanently attached to the device or by permanently imprinting or impressing the label directly onto the device.

The label text shall be legible without the aid of magnification, but is not required to be larger than 8-point font size. If the device is too small to meet this condition, the label information may be included in the user manual upon agreement with Industry Canada.

Please see attachment for IC label and label location.

3. DESCRIPTION OF TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in ANSI C63.10-2013 were used in the measurement of the EUT**.**

Deviation from measurement procedure…….....None

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an8'x4'x4' shielded enclosure. A 1m x 2m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50uH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground-plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the receiver and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The receiver was scanned from 150kHz to 30MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying: power lines, the mode of operation or data exchange speed, or support equipment whichever determined the worst-case emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions are used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

An extension cord was used to connect to a single LISN which powered by EUT. The extension cord was calibrated with LISN, the impedance and insertion loss are compliance with the requirements as stated in ANSI C63.10-2013.

3.3. Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. For measurements above 1GHz absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed. A MF Model 210SS turntable is used for radiated measurement. It is a continuously rotatable, remote controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An80cm high PVC support structure is placed on top of the turntable.
For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up for frequencies below 1GHz was placed on top of the 0.8 meter high, 1 x 1.5 meter table; and test set-up for frequencies 1-40GHz was placed on top of the 1.5 meter high, 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated tomaximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, if applicable, turntable azimuth, and receive antenna height was noted for each frequency found.
Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions. According to 3dB Beam-Width of horn antenna, the horn antenna should be always directed to the EUT when rising height.

4. ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antennathat uses a unique coupling to the intentional radiator shall be considered sufficient to comply with theprovisions of this section."

- The antenna of the **AC220 Wi-Fi AP OD directional antenna US, AC220 Wi-Fi AP OD small omni antenna US** is **permanently attached.**
- There are provisions for reverse SMA connector of **AC220 Wi-Fi AP OD external antenna WW**

Conclusion:

The **AC220 Wi-Fi AP OD directional antenna US, AC220 Wi-Fi AP OD external antenna US, AC220 Wi-Fi AP OD small omni antenna US** unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR3	MRTTWA00045	1 year	2018/03/17
Two-Line V-Network	R&S	ENV216	MRTTWA00019	1 year	2018/03/23
Two-Line V-Network	R&S	ENV216	MRTTWA00020	1 year	2018/03/23
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/08

Radiated Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Signal Analyzer	R&S	FSV40	MRTTWA00007	1 year	2018/03/02
EMI Test Receiver	R&S	ESR3	MRTTWA00009	1 year	2018/03/16
Broadband Preamplifier	SCHWARZBECK	BBV 9718	MRTTWA00005	1 year	2018/04/06
Broadband Amplifier	SCHWARZBECK	BBV 9721	MRTTWA00006	1 year	2018/04/06
Acitve Loop Antenna	SCHWARZBECK	FMZB 1519B	MRTTWA00002	1 year	2018/04/06
Broadband TRILOG Antenna	SCHWARZBECK	VULB 9162	MRTTWA00001	1 year	2018/04/06
Broadband Hornantenna	SCHWARZBECK	BBHA 9120D	MRTTWA00003	1 year	2018/04/06
Breitband Hornantenna	SCHWARZBECK	BBHA 9170	MRTTWA00004	1 year	2018/04/06
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/08

Conducted Test Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	KEYSIGHT	N9010A	MRTTWA00012	1 year	2018/07/10
X-Series USB Peak and Average Power Sensor	KEYSIGHT	U2021XA	MRTTWA00014	1 year	2018/03/18
X-Series USB Peak and Average Power Sensor	KEYSIGHT	U2021XA	MRTTWA00015	1 year	2018/03/18
Programmable Temperature & Humidity Chamber	TEN BILLION	TTH-B3UP	MRTTWA00036	1 year	2018/05/11
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/08

Software	**Version**	**Function**
EMI Software	V3	EMI Test Software

6. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT 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.

AC Conducted Emission Measurement - SR2
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 150kHz~30MHz: 3.46dB
Radiated Emission Measurement - AC1
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 9kHz ~ 1GHz: 4.18dB 1GHz ~ 25GHz: 4.76dB

7. TEST RESULT

7.1. Summary

Product Name: **AC220 Wi-Fi AP OD directional antenna US**
AC220 Wi-Fi AP OD external antenna US
AC220 Wi-Fi AP OD small omni antenna US

FCC ID: **2AD8UFZCWO2CA1**

FCC Classification: **Unlicensed National Information Infrastructure (UNII)**

Data Rate / MCS Tested: **6Mbps ~ 54Mbps (a); MCS0 for 802.11n-HT20MHz; MCS0 for 802.11n-HT40MHz; MCS0 for 802.11ac-VHT20MHz; MCS0 for 802.11ac-VHT40MHz; MCS0 for 802.11ac-VHT80MHz**

FCC Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407(a)	26dB Bandwidth	N/A	Conducted	Pass	Section7.2
15.407(e)	6dB Bandwidth	≥ 500kHz		Pass	Section 7.3
15.407(a)(1)(ii), (2), (3)	Maximum Conducted Output Power	Refer to Section 7.4		Pass	Section 7.4
15.407(h)(1)	Transmit Power Control	≤ 24 dBm		N/A	Section 7.5
15.407(a)(1)(ii), (2), (3), (5)	Peak Power Spectral Density	Refer to Section 7.6		Pass	Section 7.6
15.407(g)	Frequency Stability	N/A		Pass	Section 7.8
15.407(b)(1), (2), (3), (4)	Undesirable Emissions	≤ -27dBm/MHz EIRP ≤ -17dBm/MHz EIRP	Radiated	Pass	Section 7.8 & 7.9
15.205, 15.209 15.407(b)(5), (6), (7)	General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in15.209		Pass	
15.207	AC Conducted Emissions 150kHz - 30MHz	< FCC 15.207 limits	Line Conducted	Pass	Section 7.10

Notes:

1) All channels, modes, and modulations/data rates were investigated among all UNII bands. For radiated emission test, every axis (X, Y, Z) was also verified. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer.The correction table was used to account for the losses of the cables and attenuators used as part ofthe system to connect the EUT to the analyzer at all frequencies of interest.

3) Test Items “26dB Bandwidth”, “99% Bandwidth”, “6dB Bandwidth” & “Operation Frequency Rage of 26dB BW” have been assessed single and MIMO transmission, and showed the worst test data in this report.

7.2. 26dB Bandwidth Measurement

7.2.1.Test Limit

N/A

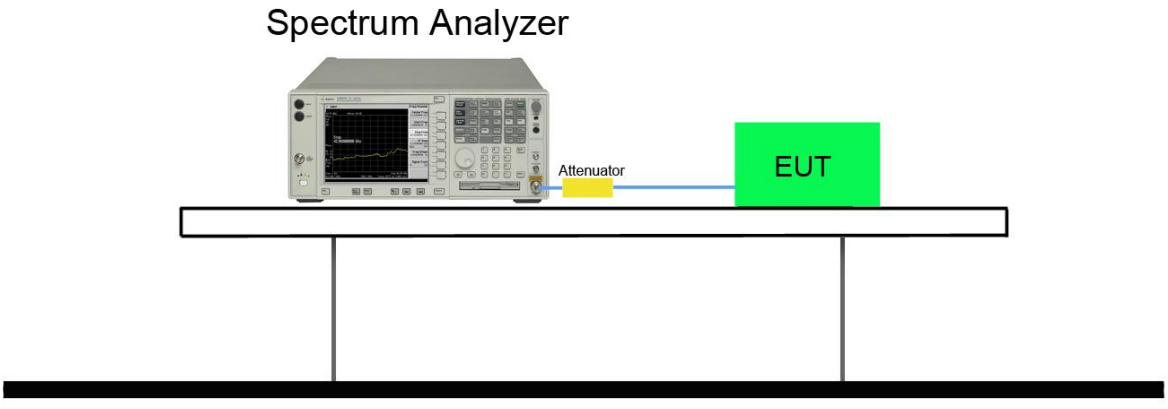
7.2.2.Test Procedure used

ANSI C63.10-2013 - Section C.1

7.2.3.Test Setting

1. The analyzers' automatic bandwidth measurement capability was used to perform the 26dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 26. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediated power nulls in the fundamental emission.
2. RBW = approximately 1% of the emission bandwidth.
3. VBW ≥ 3×RBW.
4. Detector = Peak.
5. Trace mode = max hold.

7.2.4.Test Setup



7.2.5.Test Result

Product	AC220 Wi-Fi AP OD external antenna US	Temperature	24°C
Test Engineer	Kevin Ker	Relative Humidity	59%
Test Site	SR2	Test Date	2017/09/13

Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 1					
802.11a	6Mbps	52	5260	20.00	16.44
802.11a	6Mbps	60	5300	20.46	16.44
802.11a	6Mbps	64	5320	20.37	16.45
802.11a	6Mbps	100	5500	20.51	16.45
802.11a	6Mbps	116	5580	19.37	16.46
802.11a	6Mbps	120	5600	20.03	16.43
802.11a	6Mbps	140	5700	19.61	16.44
802.11a	6Mbps	144	5720	19.57	16.43
802.11n-HT20	MCS0	52	5260	20.12	17.62
802.11n-HT20	MCS0	60	5300	20.13	17.63
802.11n-HT20	MCS0	64	5320	20.06	17.63
802.11n-HT20	MCS0	100	5500	19.95	17.62
802.11n-HT20	MCS0	116	5580	20.02	17.63
802.11n-HT20	MCS0	120	5600	20.29	17.63
802.11n-HT20	MCS0	140	5700	20.49	17.61
802.11n-HT20	MCS0	144	5720	20.37	17.63
802.11n-HT40	MCS0	54	5270	39.80	35.98
802.11n-HT40	MCS0	62	5310	39.05	35.87
802.11n-HT40	MCS0	102	5510	39.06	35.89
802.11n-HT40	MCS0	110	5550	39.69	35.95
802.11n-HT40	MCS0	118	5590	39.28	36.00
802.11n-HT40	MCS0	134	5670	39.33	35.95
802.11n-HT40	MCS0	142	5710	43.75	36.00

Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 1					
802.11ac-VHT20	MCS0	52	5260	20.02	17.63
802.11ac-VHT20	MCS0	60	5300	20.15	17.62
802.11ac-VHT20	MCS0	64	5320	20.17	17.62
802.11ac-VHT20	MCS0	100	5500	20.40	17.63
802.11ac-VHT20	MCS0	116	5580	20.21	17.62
802.11ac-VHT20	MCS0	120	5600	19.84	17.63
802.11ac-VHT20	MCS0	140	5700	19.99	17.63
802.11ac-VHT20	MCS0	144	5720	20.17	17.62
802.11ac-VHT40	MCS0	54	5270	39.28	36.00
802.11ac-VHT40	MCS0	62	5310	39.01	35.91
802.11ac-VHT40	MCS0	102	5510	39.02	35.86
802.11ac-VHT40	MCS0	110	5550	39.48	35.93
802.11ac-VHT40	MCS0	118	5590	43.99	35.99
802.11ac-VHT40	MCS0	134	5670	39.46	35.96
802.11ac-VHT40	MCS0	142	5710	39.80	35.98
802.11ac-VHT80	MCS0	58	5290	83.01	75.78
802.11ac-VHT80	MCS0	106	5530	82.36	75.70
802.11ac-VHT80	MCS0	122	5610	83.25	75.65
802.11ac-VHT80	MCS0	138	5690	83.32	75.68

Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 2					
802.11a	6Mbps	52	5260	19.14	16.40
802.11a	6Mbps	60	5300	19.13	16.41
802.11a	6Mbps	64	5320	19.02	16.40
802.11a	6Mbps	100	5500	19.00	16.39
802.11a	6Mbps	116	5580	18.58	16.41
802.11a	6Mbps	120	5600	18.94	16.39
802.11a	6Mbps	140	5700	19.00	16.41
802.11a	6Mbps	144	5720	18.02	16.41
802.11n-HT20	MCS0	52	5260	20.79	17.68
802.11n-HT20	MCS0	60	5300	22.33	17.68
802.11n-HT20	MCS0	64	5320	22.19	17.66
802.11n-HT20	MCS0	100	5500	20.99	17.67
802.11n-HT20	MCS0	116	5580	20.43	17.63
802.11n-HT20	MCS0	120	5600	20.46	17.66
802.11n-HT20	MCS0	140	5700	20.24	17.65
802.11n-HT20	MCS0	144	5720	20.36	17.64
802.11n-HT40	MCS0	54	5270	59.57	36.24
802.11n-HT40	MCS0	62	5310	39.47	35.97
802.11n-HT40	MCS0	102	5510	39.35	35.91
802.11n-HT40	MCS0	110	5550	50.99	36.06
802.11n-HT40	MCS0	118	5590	45.95	36.05
802.11n-HT40	MCS0	134	5670	46.10	36.05
802.11n-HT40	MCS0	142	5710	50.93	36.08
802.11ac-VHT20	MCS0	52	5260	21.09	17.68
802.11ac-VHT20	MCS0	60	5300	22.36	17.67
802.11ac-VHT20	MCS0	64	5320	21.69	17.66
802.11ac-VHT20	MCS0	100	5500	21.69	17.66
802.11ac-VHT20	MCS0	116	5580	20.39	17.66
802.11ac-VHT20	MCS0	120	5600	20.38	17.64
802.11ac-VHT20	MCS0	140	5700	20.38	17.64
802.11ac-VHT20	MCS0	144	5720	20.49	17.65

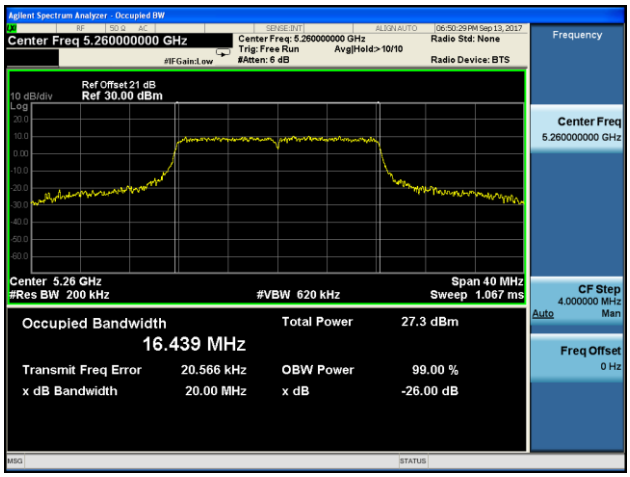
Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 2					
802.11ac-VHT40	MCS0	54	5270	60.93	36.22
802.11ac-VHT40	MCS0	62	5310	50.57	36.00
802.11ac-VHT40	MCS0	102	5510	39.28	35.91
802.11ac-VHT40	MCS0	110	5550	50.81	36.02
802.11ac-VHT40	MCS0	118	5590	39.34	35.99
802.11ac-VHT40	MCS0	134	5670	40.12	36.01
802.11ac-VHT40	MCS0	142	5710	50.78	36.08
802.11ac-VHT80	MCS0	58	5290	82.78	75.82
802.11ac-VHT80	MCS0	106	5530	81.87	75.66
802.11ac-VHT80	MCS0	122	5610	82.63	75.80
802.11ac-VHT80	MCS0	138	5690	83.50	75.83

Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 2 / Ant 1 + 2					
802.11a	6Mbps	52	5260	27.29	16.58
802.11a	6Mbps	60	5300	27.61	16.57
802.11a	6Mbps	64	5320	25.91	16.54
802.11a	6Mbps	100	5500	23.02	16.54
802.11a	6Mbps	116	5580	21.07	16.48
802.11a	6Mbps	120	5600	20.45	16.47
802.11a	6Mbps	140	5700	20.63	16.48
802.11a	6Mbps	144	5720	21.68	16.50
802.11n-HT20	MCS0	52	5260	23.78	17.68
802.11n-HT20	MCS0	60	5300	29.57	17.72
802.11n-HT20	MCS0	64	5320	25.56	17.70
802.11n-HT20	MCS0	100	5500	26.96	17.71
802.11n-HT20	MCS0	116	5580	20.64	17.65
802.11n-HT20	MCS0	120	5600	20.74	17.65
802.11n-HT20	MCS0	140	5700	20.95	17.64
802.11n-HT20	MCS0	144	5720	23.86	17.66
802.11n-HT40	MCS0	54	5270	61.66	36.27
802.11n-HT40	MCS0	62	5310	39.35	35.94
802.11n-HT40	MCS0	102	5510	39.67	35.87
802.11n-HT40	MCS0	110	5550	50.41	36.05
802.11n-HT40	MCS0	118	5590	50.60	36.03
802.11n-HT40	MCS0	134	5670	50.38	36.05
802.11n-HT40	MCS0	142	5710	55.38	36.07
802.11ac-VHT20	MCS0	52	5260	28.06	17.72
802.11ac-VHT20	MCS0	60	5300	29.71	17.73
802.11ac-VHT20	MCS0	64	5320	25.23	17.69
802.11ac-VHT20	MCS0	100	5500	25.21	17.71
802.11ac-VHT20	MCS0	116	5580	20.52	17.66
802.11ac-VHT20	MCS0	120	5600	20.77	17.64
802.11ac-VHT20	MCS0	140	5700	20.88	17.64
802.11ac-VHT20	MCS0	144	5720	21.41	17.67

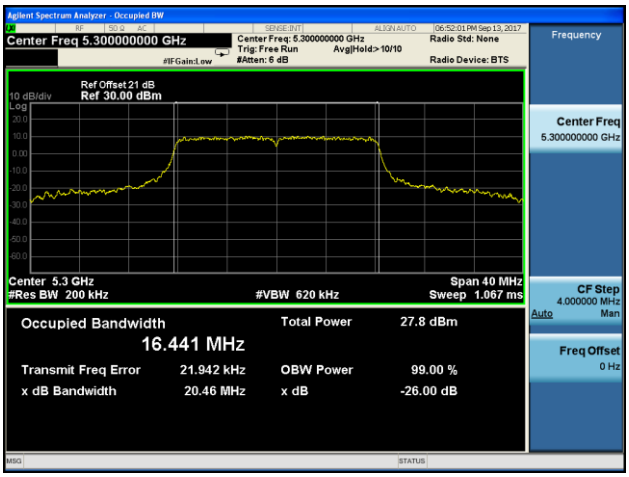
Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 2 / Ant 1 + 2					
802.11ac-VHT40	MCS0	54	5270	62.99	36.30
802.11ac-VHT40	MCS0	62	5310	50.70	35.97
802.11ac-VHT40	MCS0	102	5510	39.20	35.90
802.11ac-VHT40	MCS0	110	5550	50.66	36.03
802.11ac-VHT40	MCS0	118	5590	50.42	36.04
802.11ac-VHT40	MCS0	134	5670	39.76	36.03
802.11ac-VHT40	MCS0	142	5710	51.35	36.09
802.11ac-VHT80	MCS0	58	5290	82.20	75.82
802.11ac-VHT80	MCS0	106	5530	81.75	75.75
802.11ac-VHT80	MCS0	122	5610	82.68	75.84
802.11ac-VHT80	MCS0	138	5690	82.29	75.85

802.11a 26dB Bandwidth & 99% Bandwidth - Ant 1

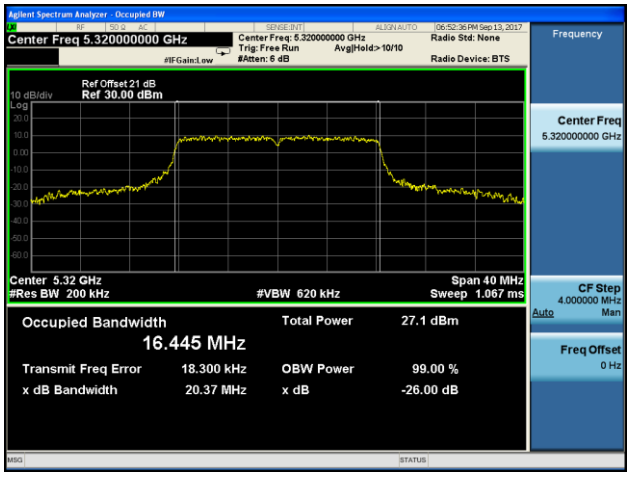
Channel 52 (5260MHz)



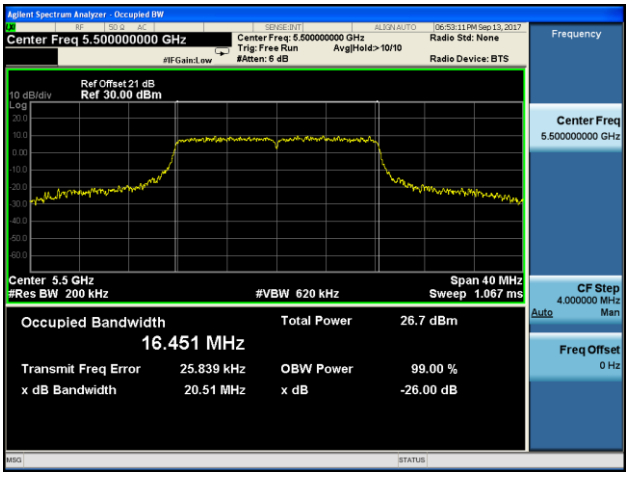
Channel 60 (5300MHz)



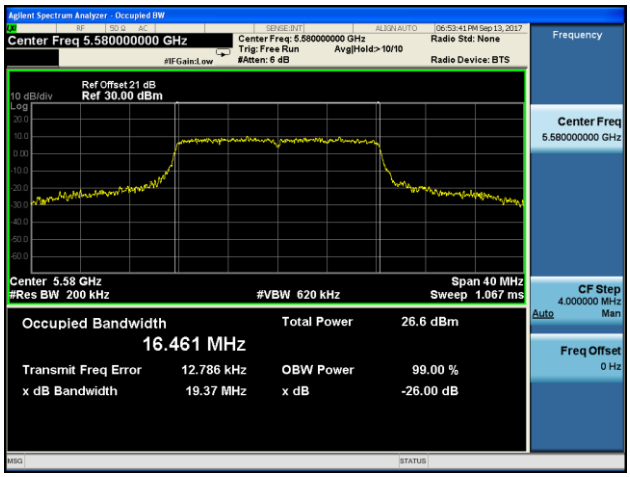
Channel 64 (5320MHz)



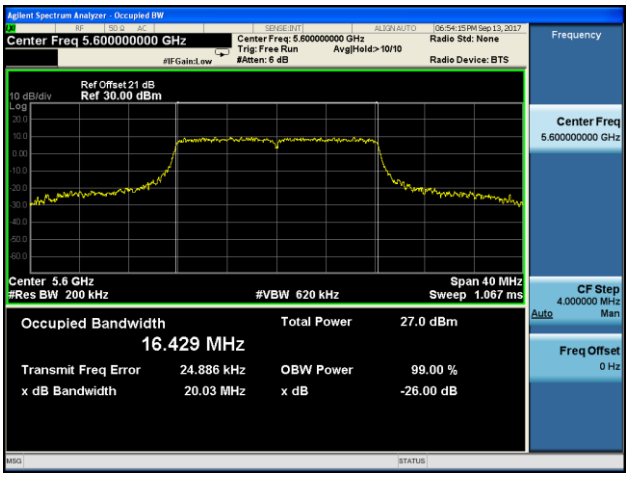
Channel 100 (5500MHz)

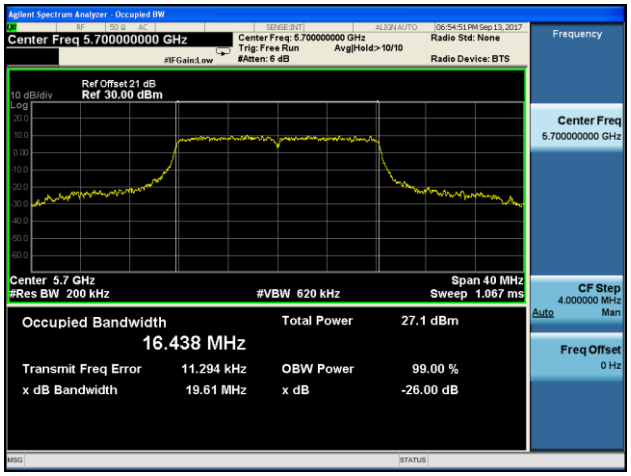
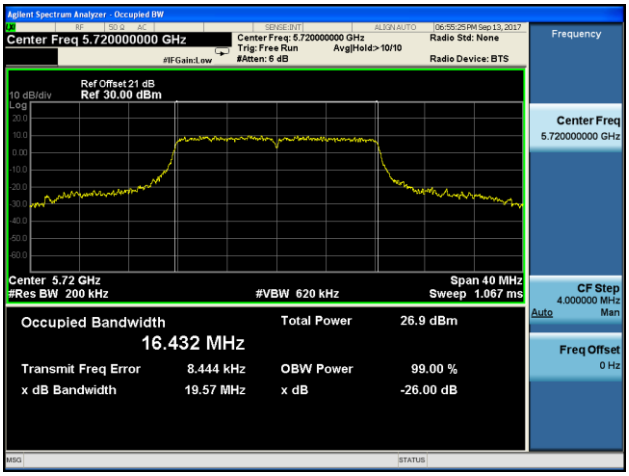


Channel 116 (5580MHz)



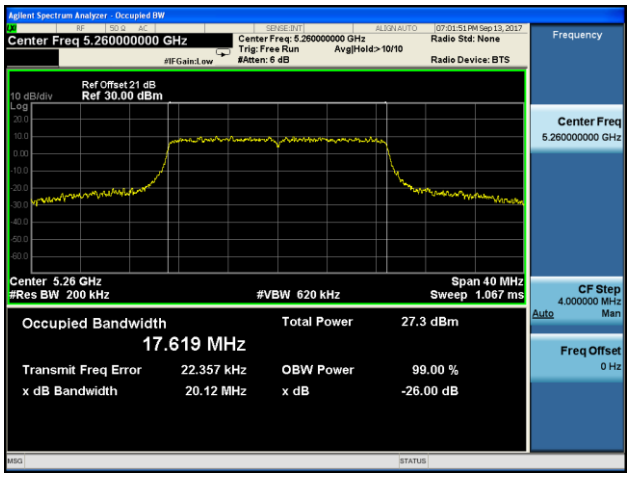
Channel 100 (5600MHz)



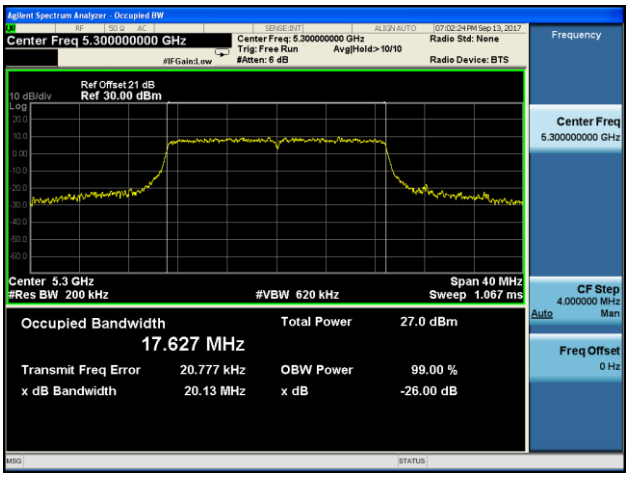
Channel 140 (5700MHz)	Channel 144 (5720MHz)
	

802.11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 1

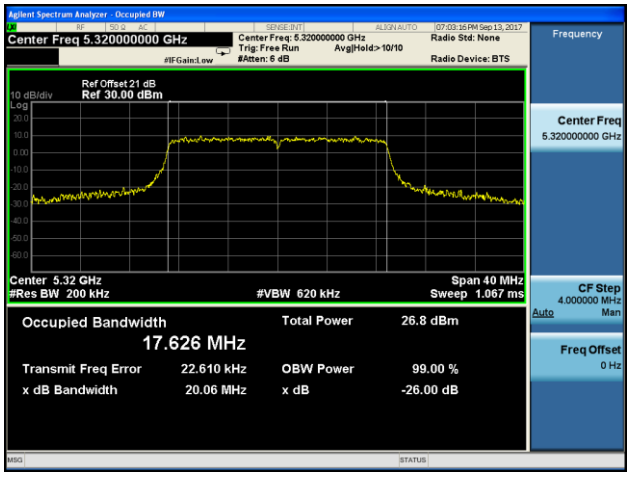
Channel 52 (5260MHz)



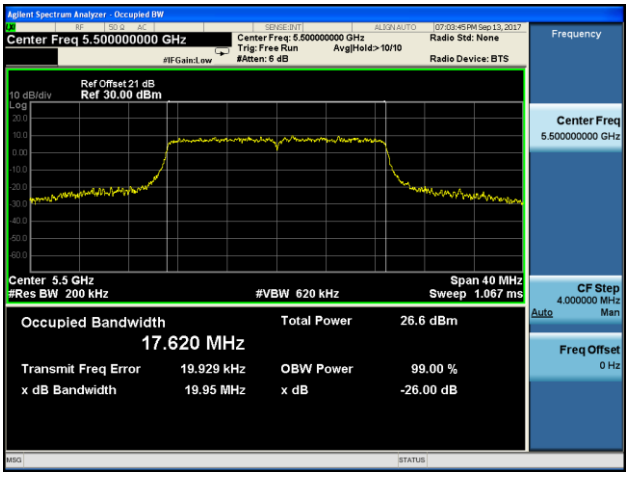
Channel 60 (5300MHz)



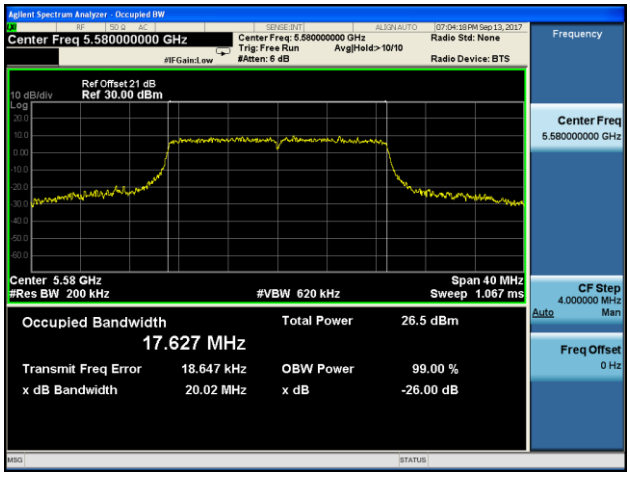
Channel 64 (5320MHz)



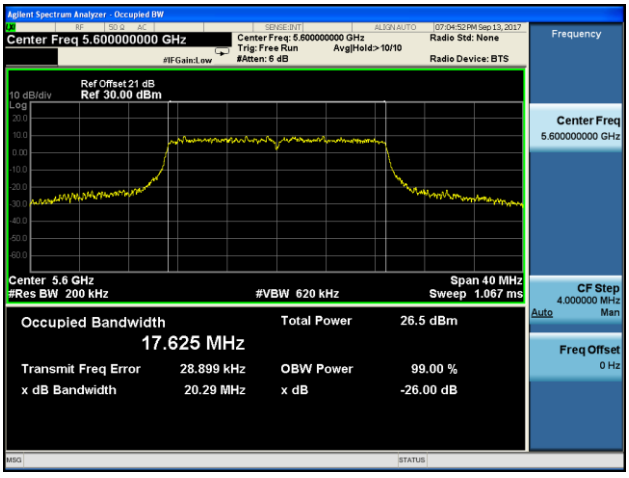
Channel 100 (5500MHz)

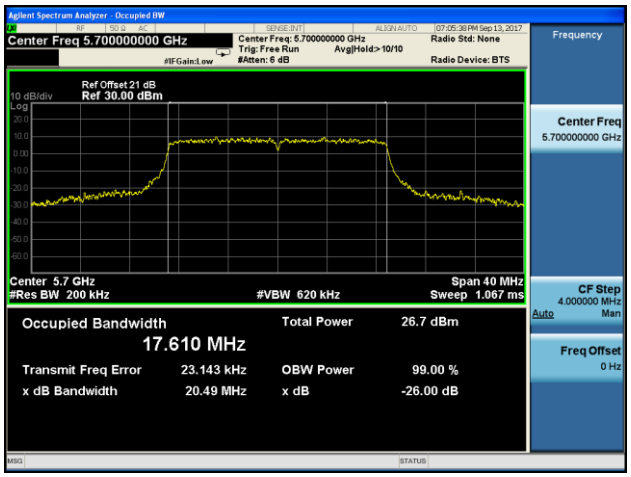
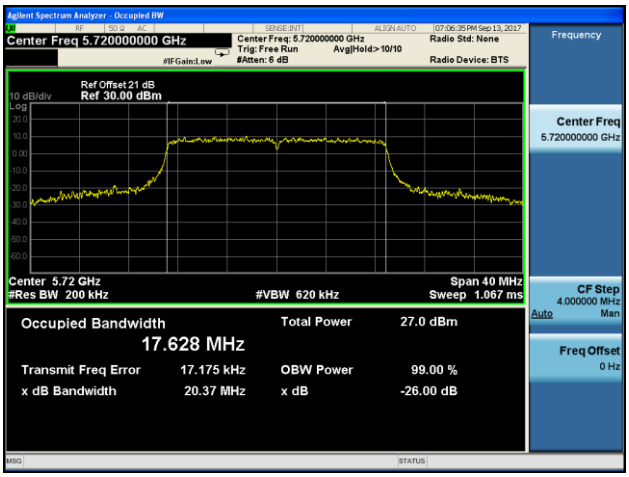


Channel 116 (5580MHz)



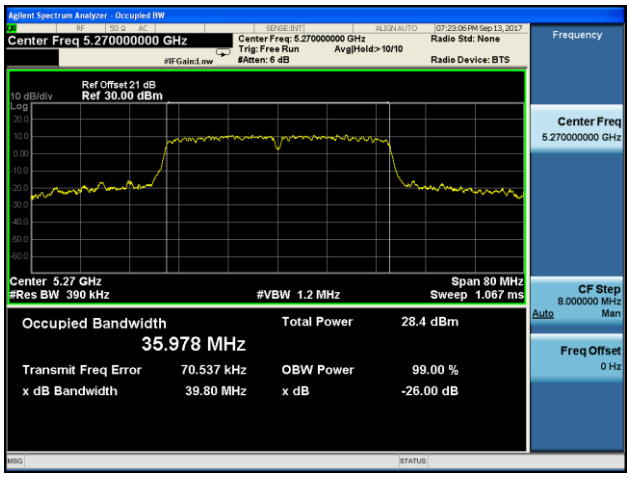
Channel 120 (5600MHz)



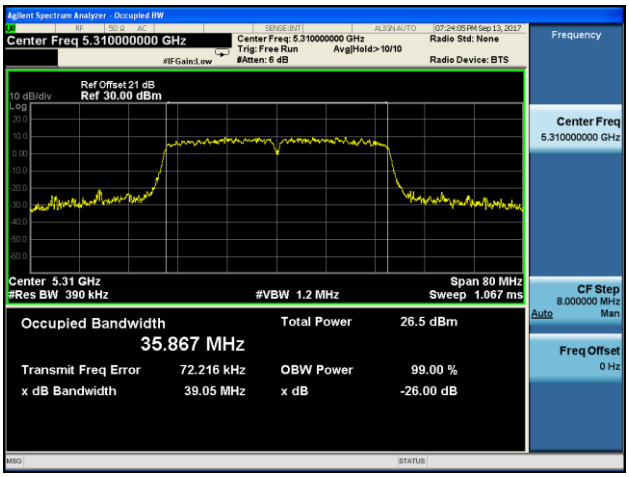
Channel 140 (5700MHz)	Channel 144 (5720MHz)
	

802.11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 1

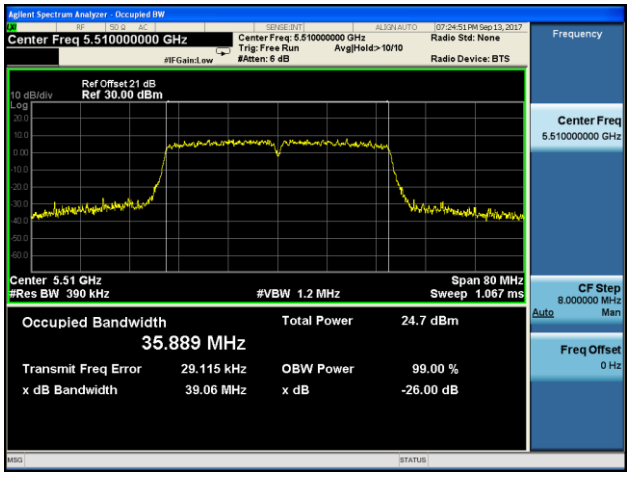
Channel 54 (5270MHz)



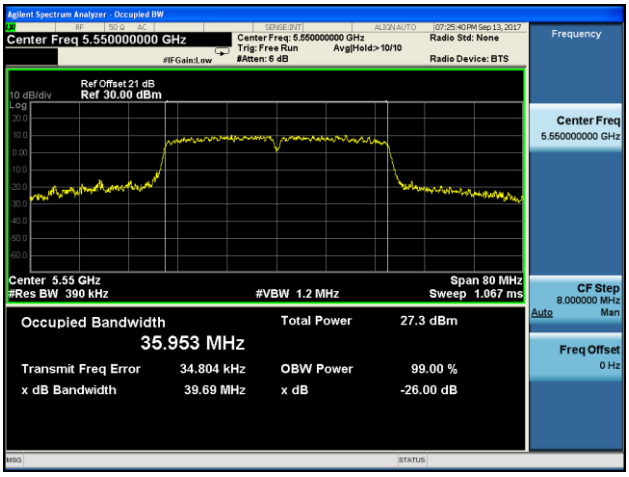
Channel 62 (5310MHz)



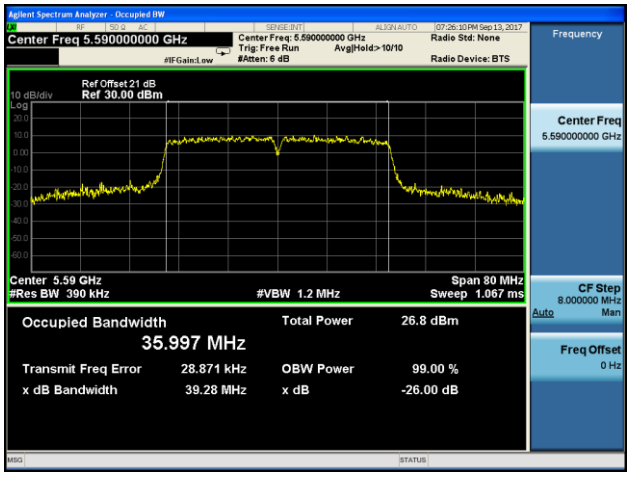
Channel 102 (5510MHz)



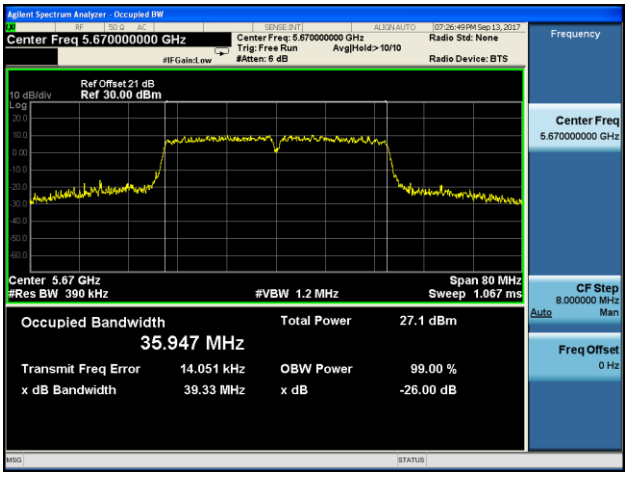
Channel 110 (5550MHz)

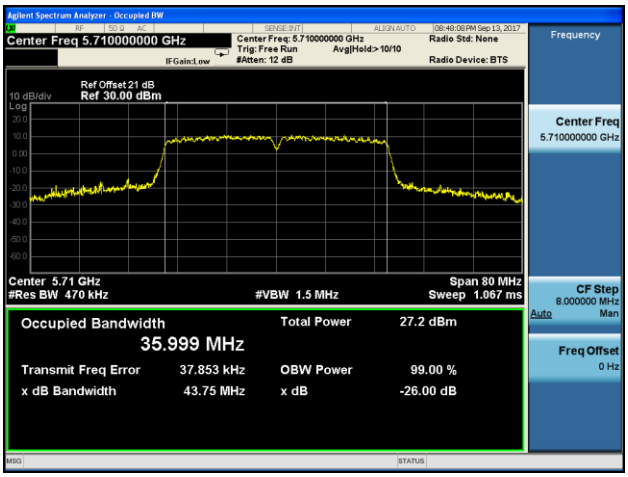


Channel 118 (5590MHz)



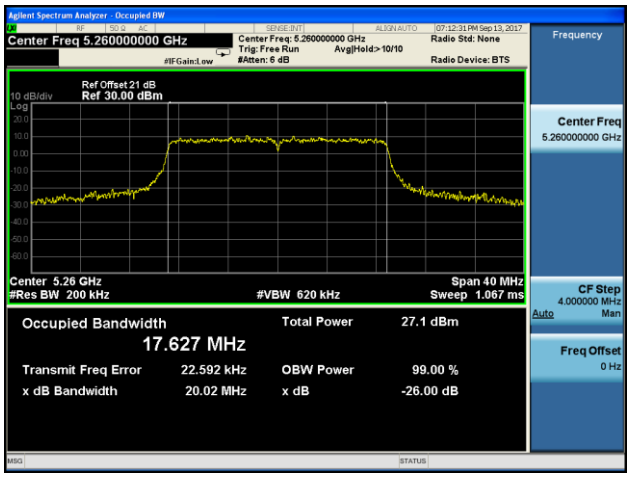
Channel 134 (5670MHz)



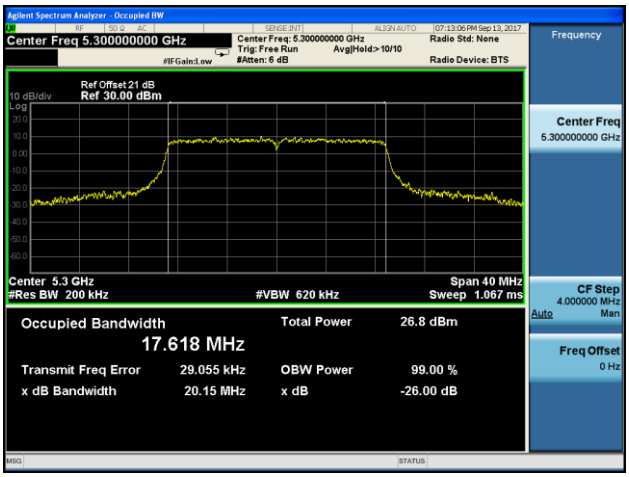
Channel 142 (5710MHz)	
	

802.11ac-VHT20 26dB Bandwidth & 99% Bandwidth - Ant 1

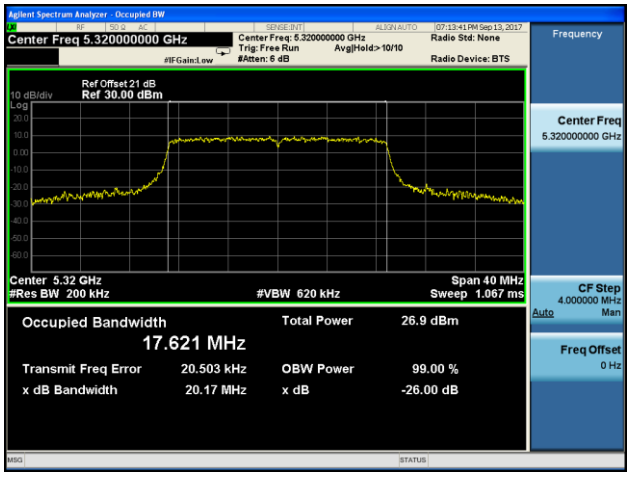
Channel 52 (5260MHz)



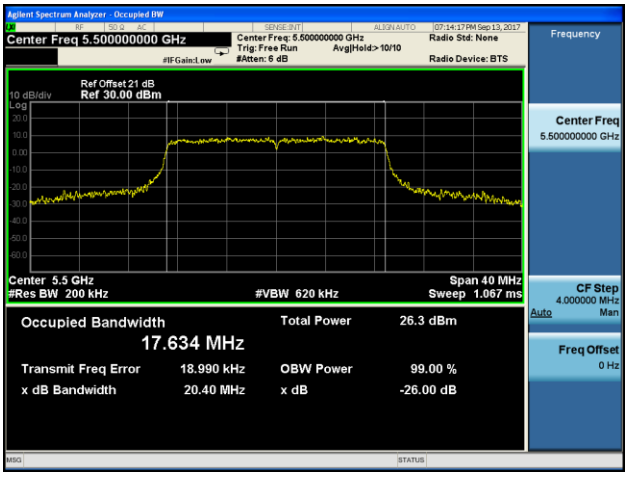
Channel 60 (5300MHz)



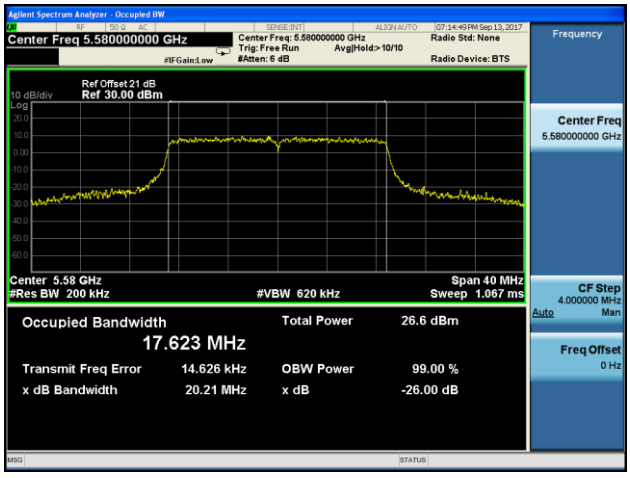
Channel 64 (5320MHz)



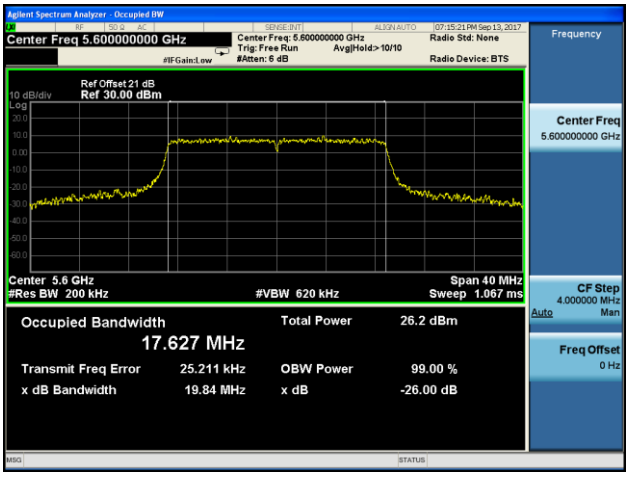
Channel 100 (5500MHz)

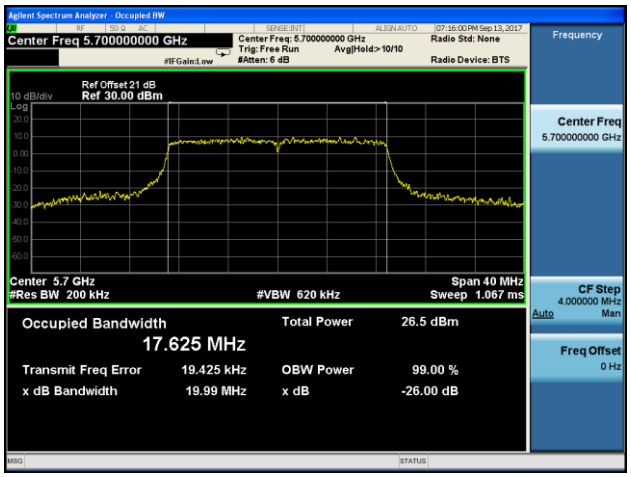
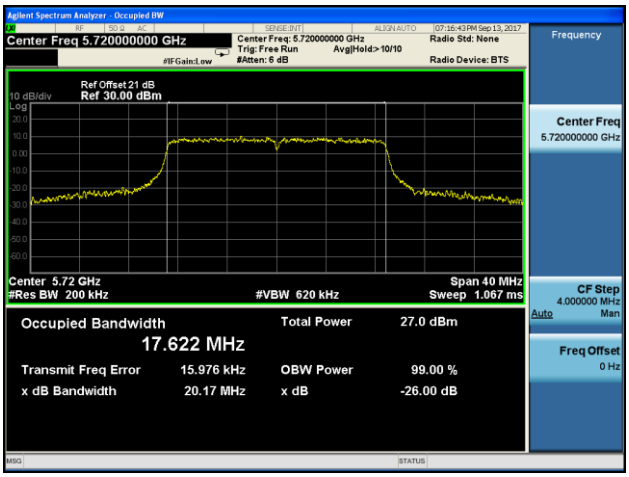


Channel 116 (5580MHz)



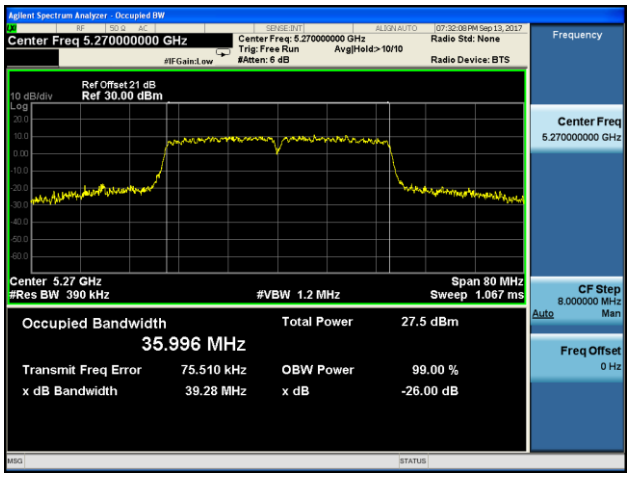
Channel 120 (5600MHz)



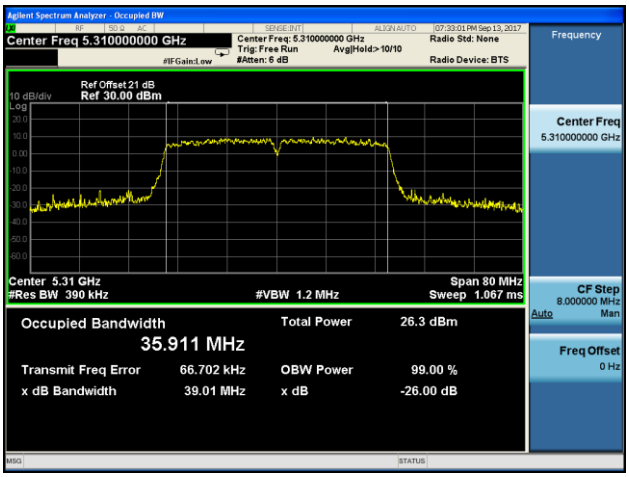
Channel 140 (5700MHz)	Channel 144 (5720MHz)
	

802.11ac-VHT40 26dB Bandwidth & 99% Bandwidth - Ant 1

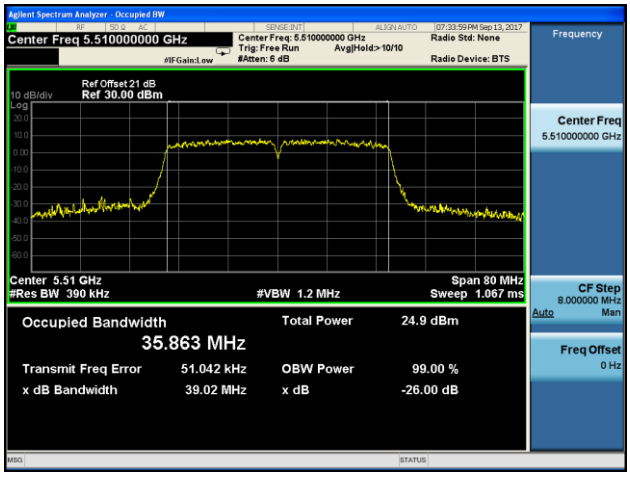
Channel 54 (5270MHz)



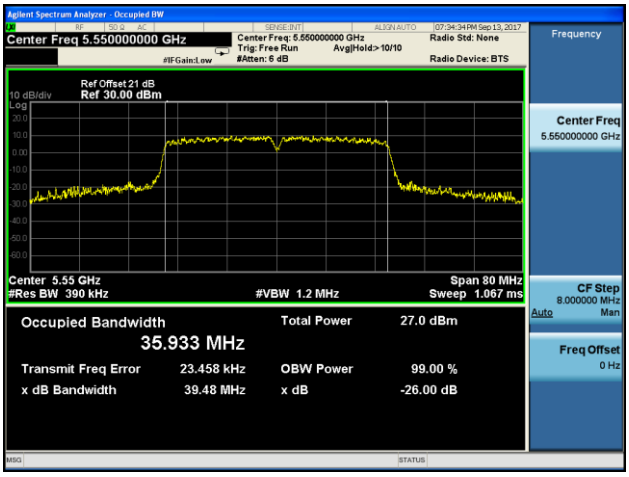
Channel 62 (5310MHz)



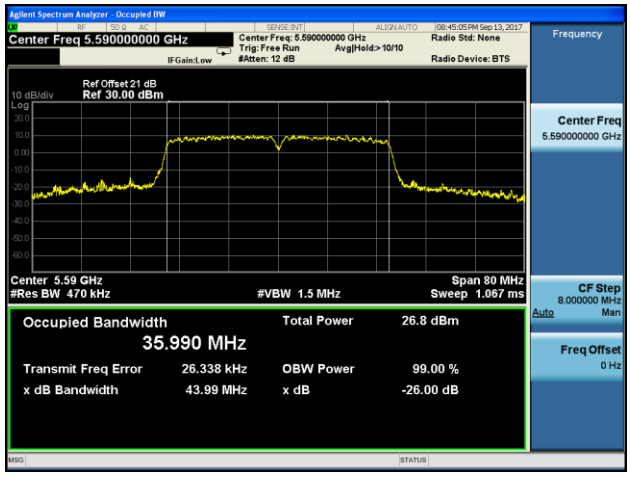
Channel 102 (5510MHz)



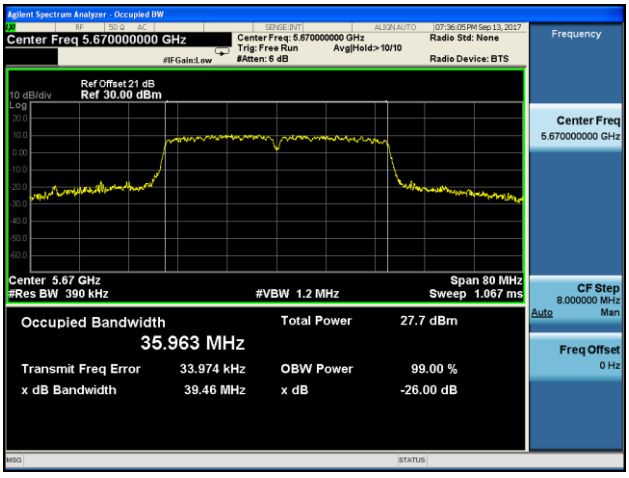
Channel 110 (5550MHz)

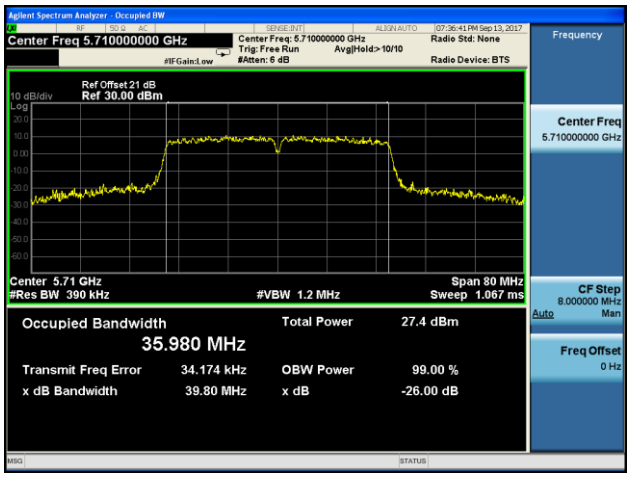


Channel 118 (5590MHz)



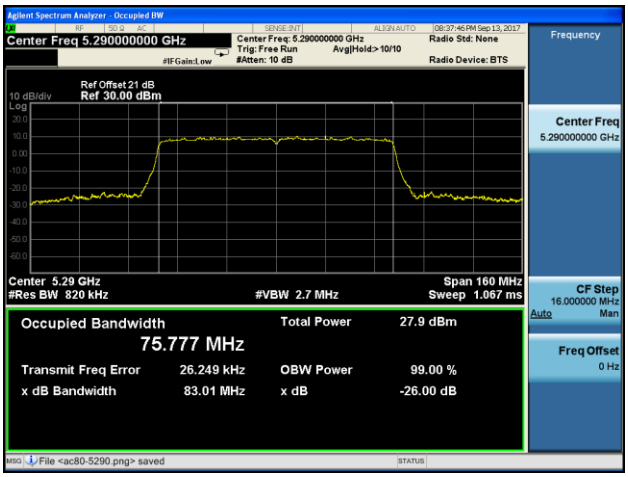
Channel 134 (5670MHz)



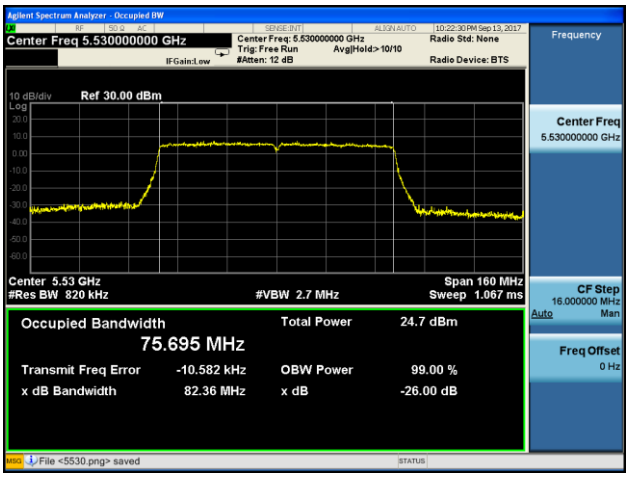
Channel 142 (5710MHz)	
	

802.11ac-VHT80 26dB Bandwidth & 99% Bandwidth - Ant 1

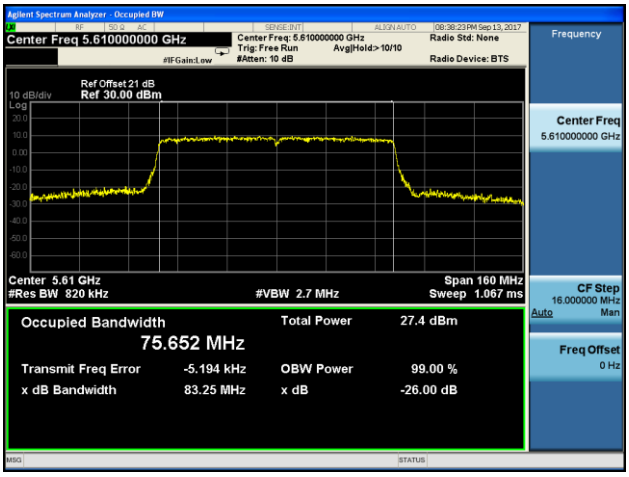
Channel 58 (5290MHz)



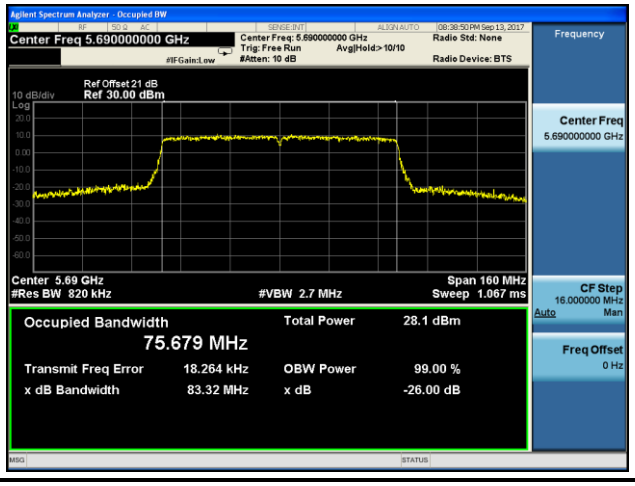
Channel 106 (5530MHz)



Channel 122 (5610MHz)

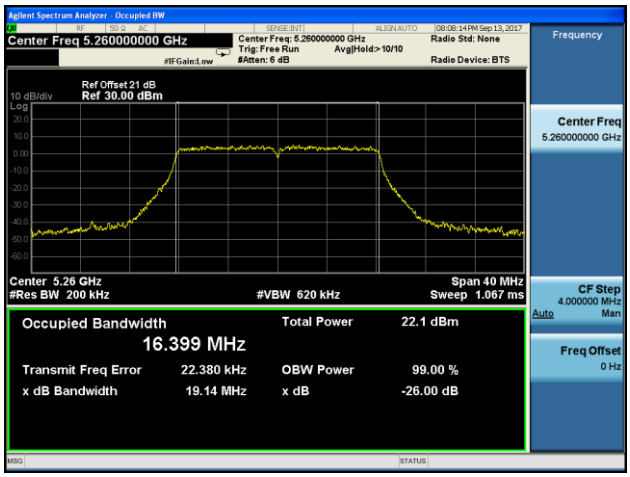


Channel 138 (5690MHz)

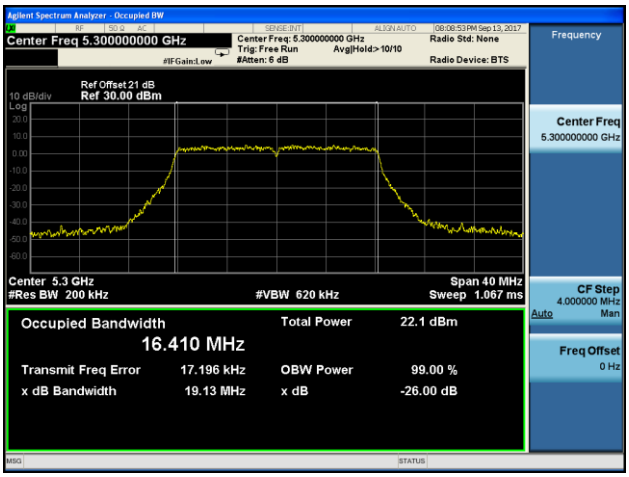


802.11a 26dB Bandwidth & 99% Bandwidth - Ant 2

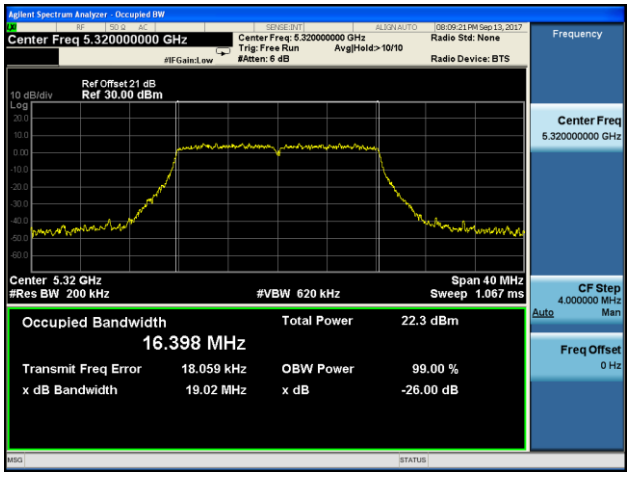
Channel 52 (5260MHz)



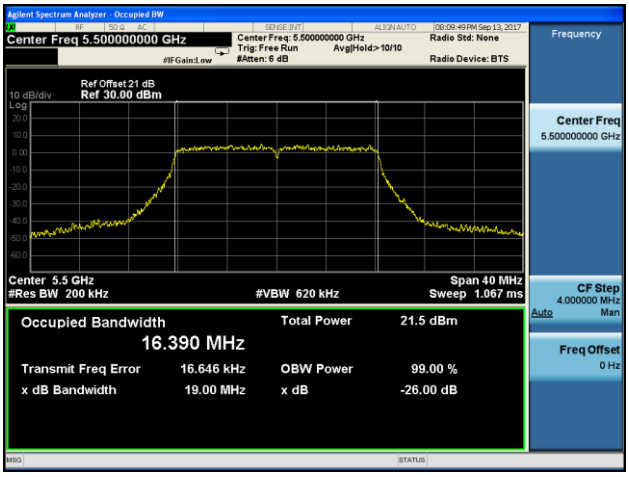
Channel 60 (5300MHz)



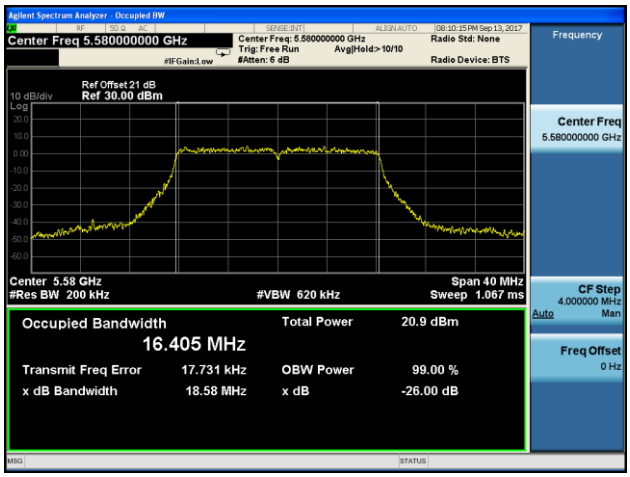
Channel 64 (5320MHz)



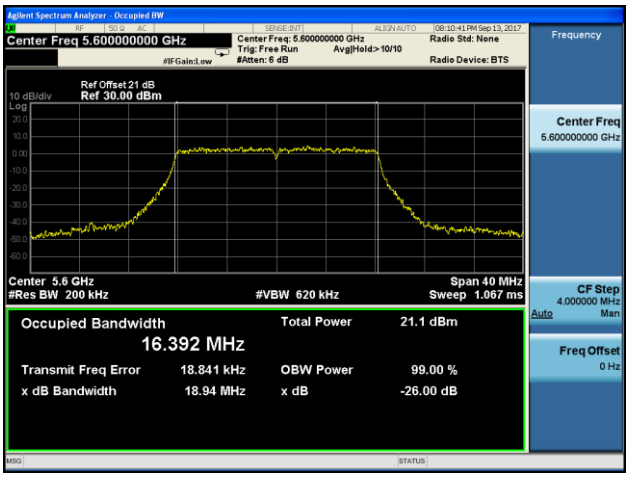
Channel 100 (5500MHz)

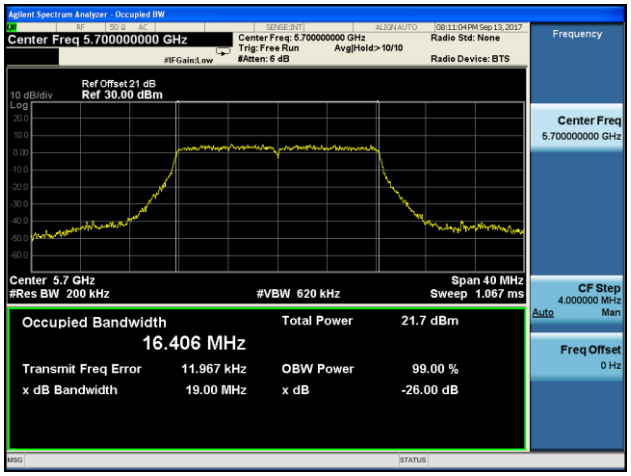
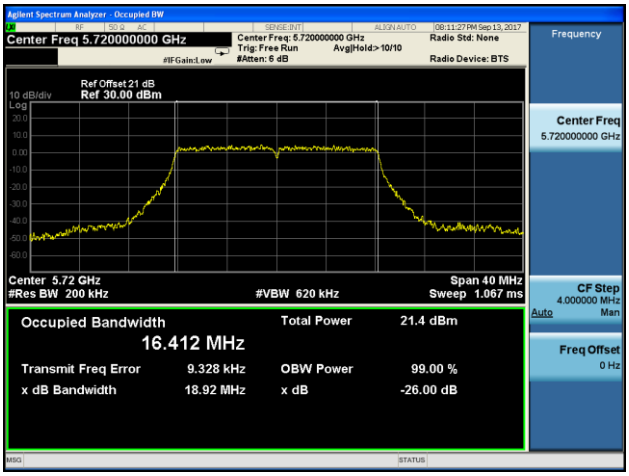


Channel 116 (5580MHz)



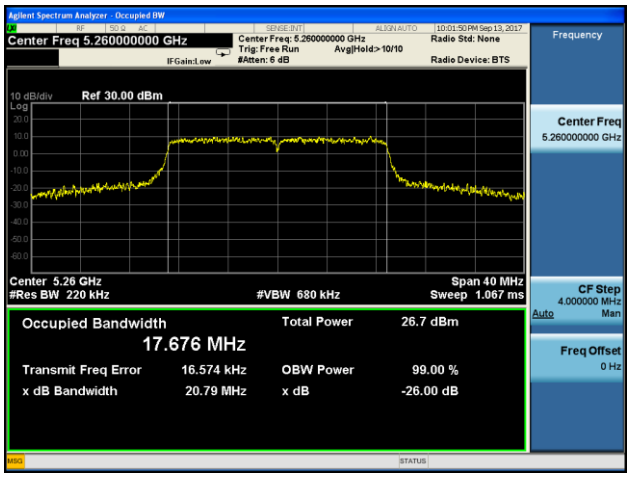
Channel 100 (5600MHz)



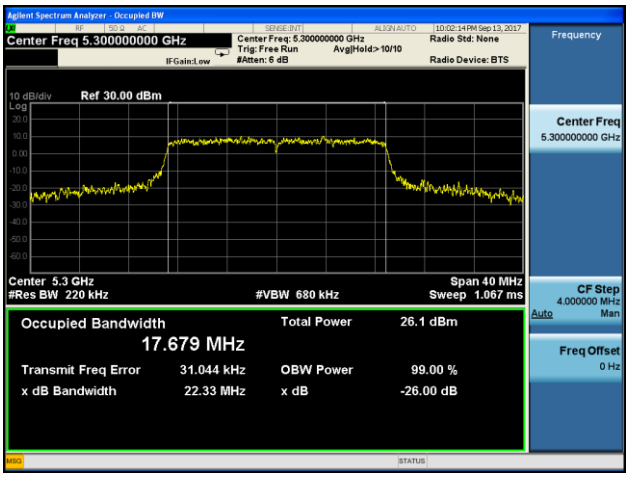
Channel 140 (5700MHz)	Channel 144 (5720MHz)
	

802.11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 2

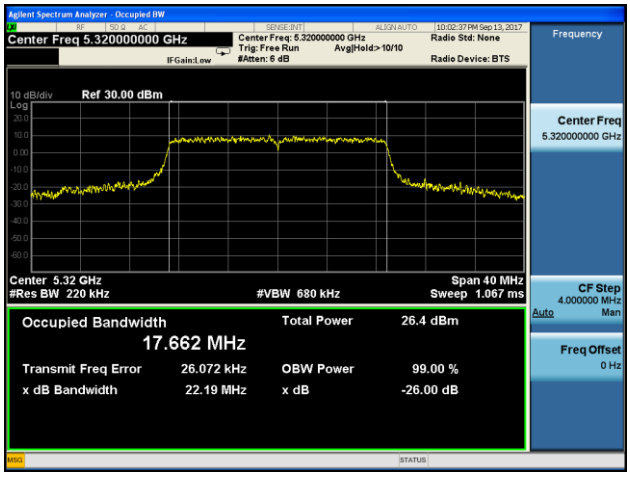
Channel 52 (5260MHz)



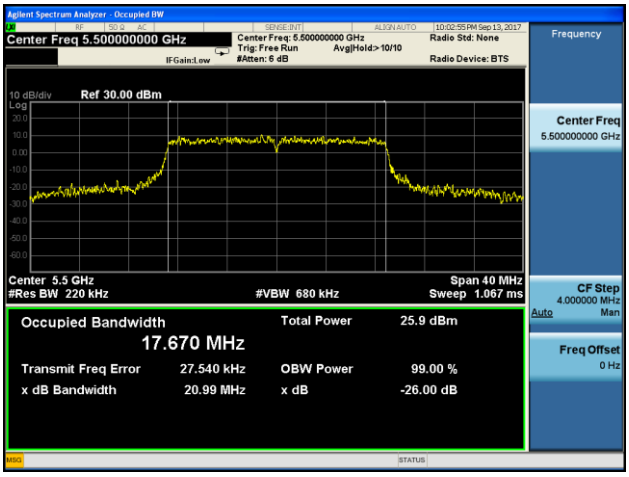
Channel 60 (5300MHz)



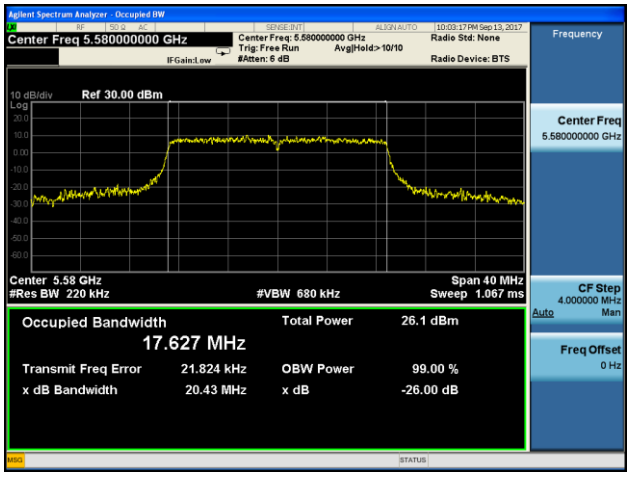
Channel 64 (5320MHz)



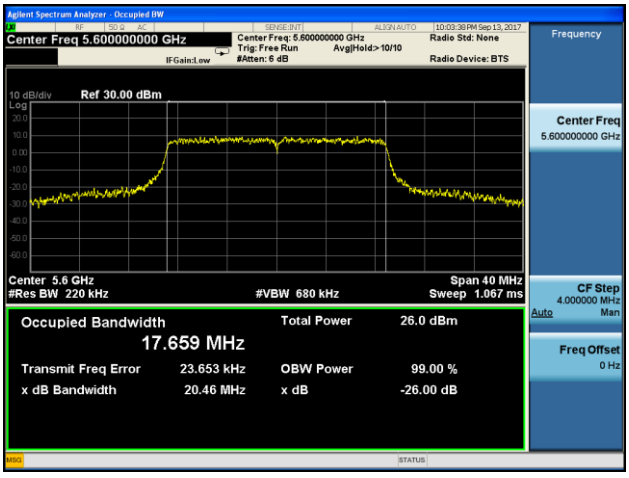
Channel 100 (5500MHz)

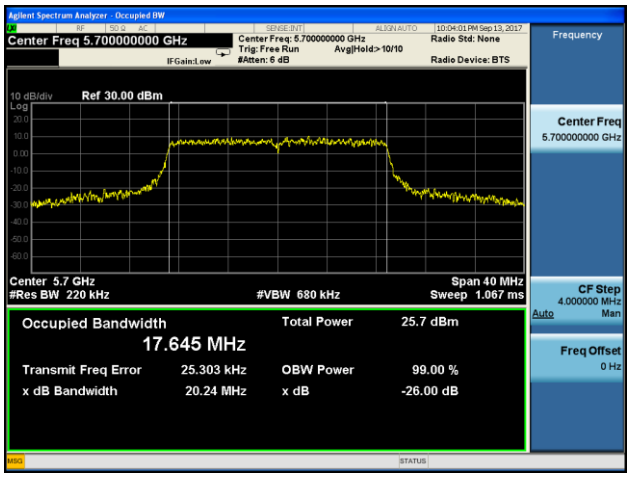
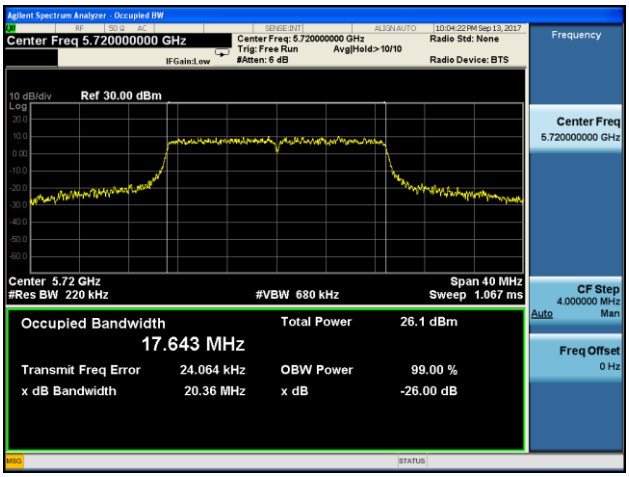


Channel 116 (5580MHz)



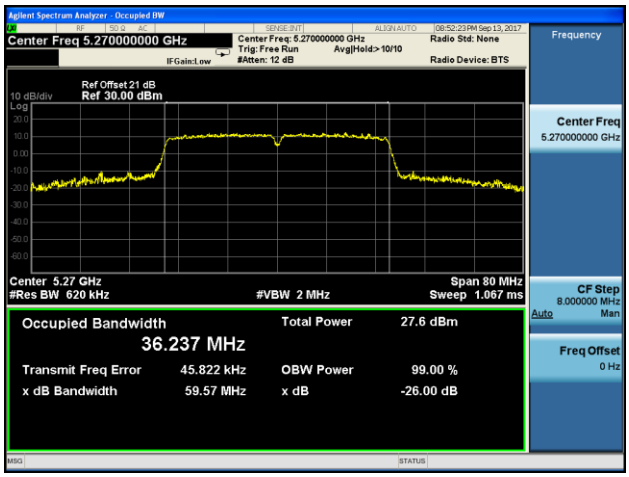
Channel 120 (5600MHz)



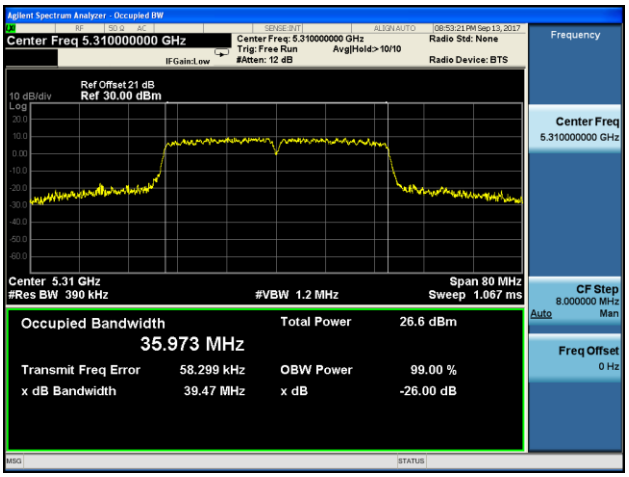
Channel 140 (5700MHz)	Channel 144 (5720MHz)
	

802.11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 2

Channel 54 (5270MHz)

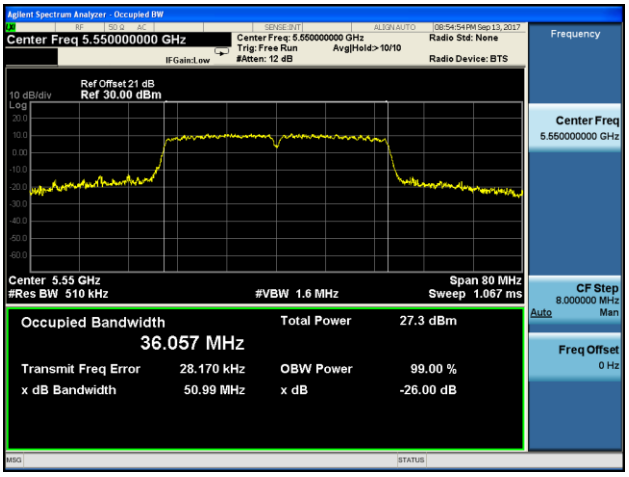


Channel 62 (5310MHz)

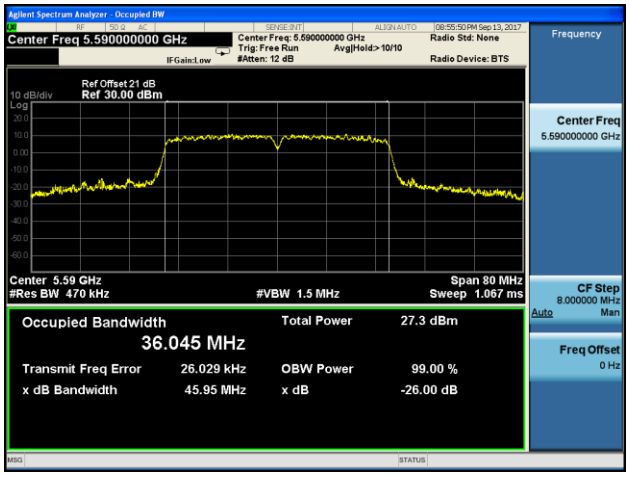


Channel 102 (5510MHz)

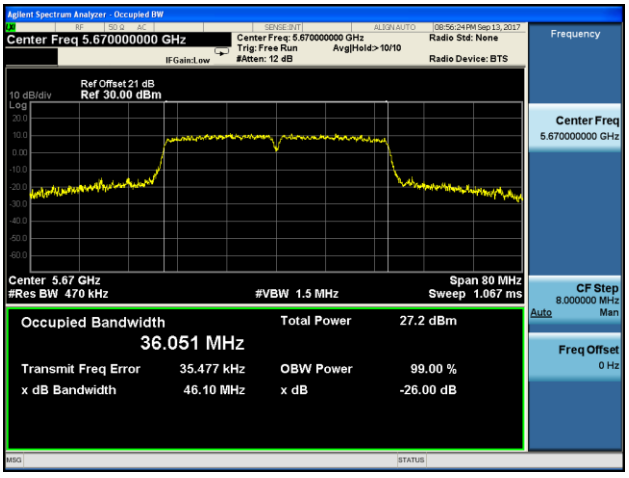
Channel 110 (5550MHz)

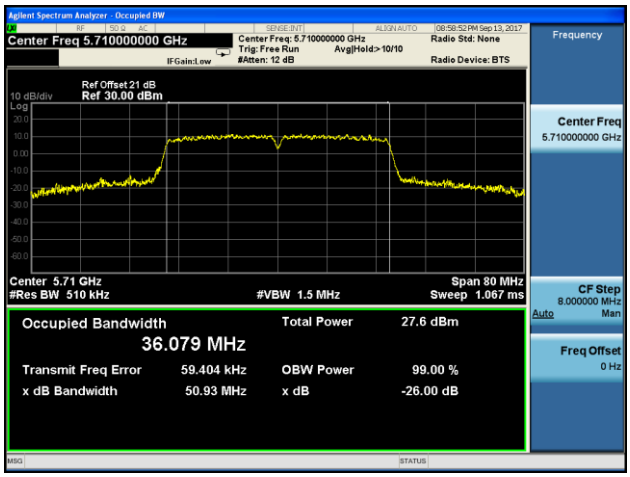


Channel 118 (5590MHz)



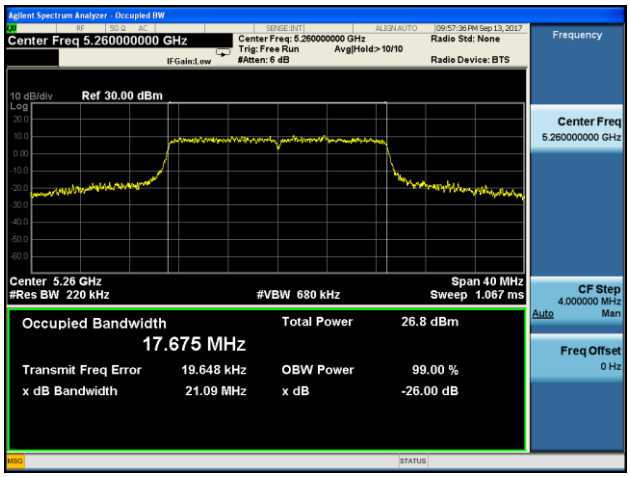
Channel 134 (5670MHz)



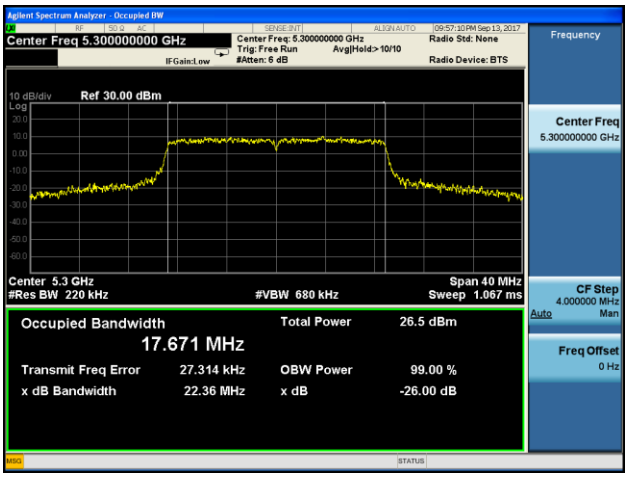
Channel 142 (5710MHz)	
	

802.11ac-VHT20 26dB Bandwidth & 99% Bandwidth - Ant 2

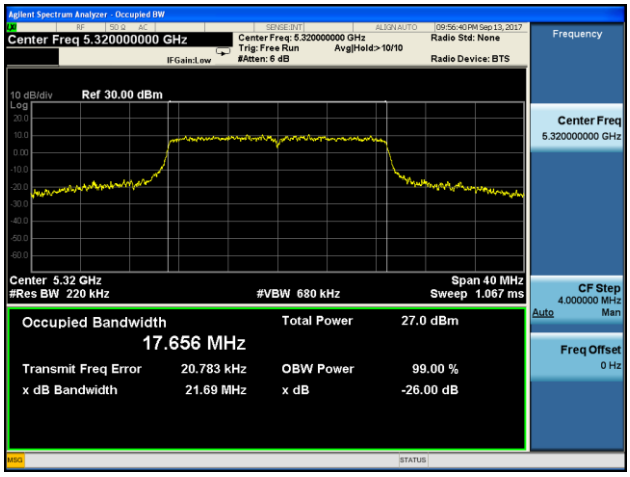
Channel 52 (5260MHz)



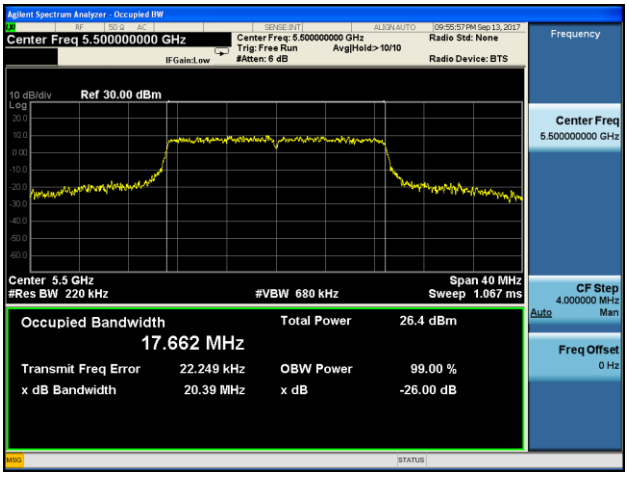
Channel 60 (5300MHz)



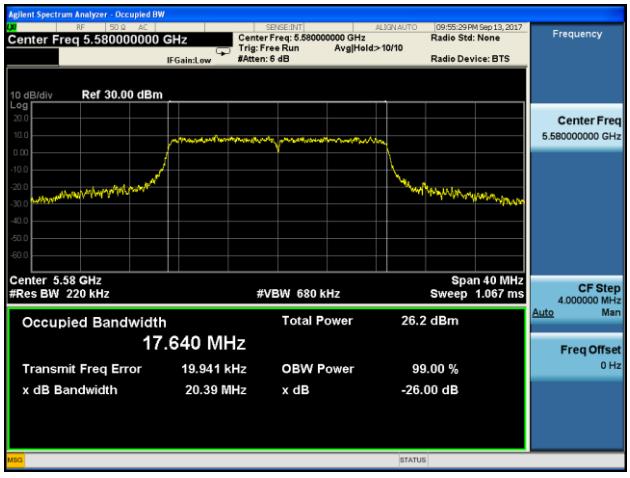
Channel 64 (5320MHz)



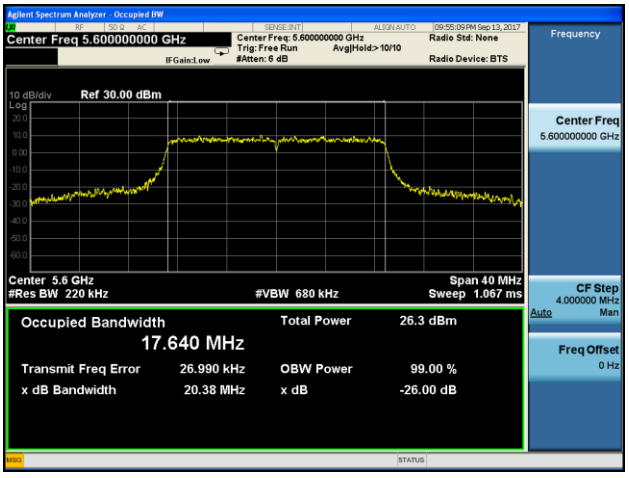
Channel 100 (5500MHz)



Channel 116 (5580MHz)



Channel 120 (5600MHz)



Channel 140 (5700MHz)	Channel 144 (5720MHz)