MEASUREMENT REPORT

FCC 15.407 WLAN 802.11a/n/ac

FCC ID:	2ABLK-GS4227E
APPLICANT:	Calix Inc.
Application Type:	CLASS II PERMISSIVE CHANGE
Product:	GigaSpire, GigaSpire BLAST$^{u6.1}$
Model No.:	GS4227E, GS4220E
Brand Name:	Calix
FCC Classification:	Unlicensed National Information Infrastructure (NII)
FCC Rule Part(s):	Part15 Subpart E (Section 15.407)
Test Procedure(s):	ANSI C63.10-2013, KDB 789033 D02v02r01, KDB 662911 D01v02r01
Test Date:	November 22, 2019 ~ January 08, 2020

Reviewed By: (Kevin Guo)

Approved By: (Robin Wu)

ACCREDITED
TESTING LABORATORY
CERTIFICATE #3628.01

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 measurement report and was tested in accordance with the measurement procedures specified in KDB 789033 D02v02r01. Test results reported herein relate only to the item(s) tested.

Revision History

Report No.	Version	Description	Issue Date	Note
1911RSU033-U4	Rev. 01	Initial report	02-02-2020	Valid

CONTENTS

Description Page

§2.1033 General Information

Applicant:	Calix Inc.
Applicant Address:	1035 N. McDowell Blvd Petaluma, CA94954 U.S.A
Manufacturer:	Calix Inc.
Manufacturer Address:	1035 N. McDowell Blvd Petaluma, CA94954 U.S.A
Test Site:	MRT Technology (Suzhou) Co., Ltd
Test Site Address:	D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Tian'edang Rd., Suzhou, China.

- **MRT facility is a FCC registered (MRT Designation No. CN1166) test facility with the site description report on file and has met all the requirements specified in ANSI C63.4-2014.**
- **MRT facility is an IC registered (MRT Reg. No. 11384A-1) test laboratory with the site description on file at Industry Canada.**
- **MRT facility is a VCCI registered (R-4179, G-814, C-4664, T-2206) test laboratory with the site description on file at VCCI Council.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA) under the American Association for Laboratory Accreditation Program (A2LACert. No.3628.01) in EMC, Telecommunications, Radio and SAR testing.**

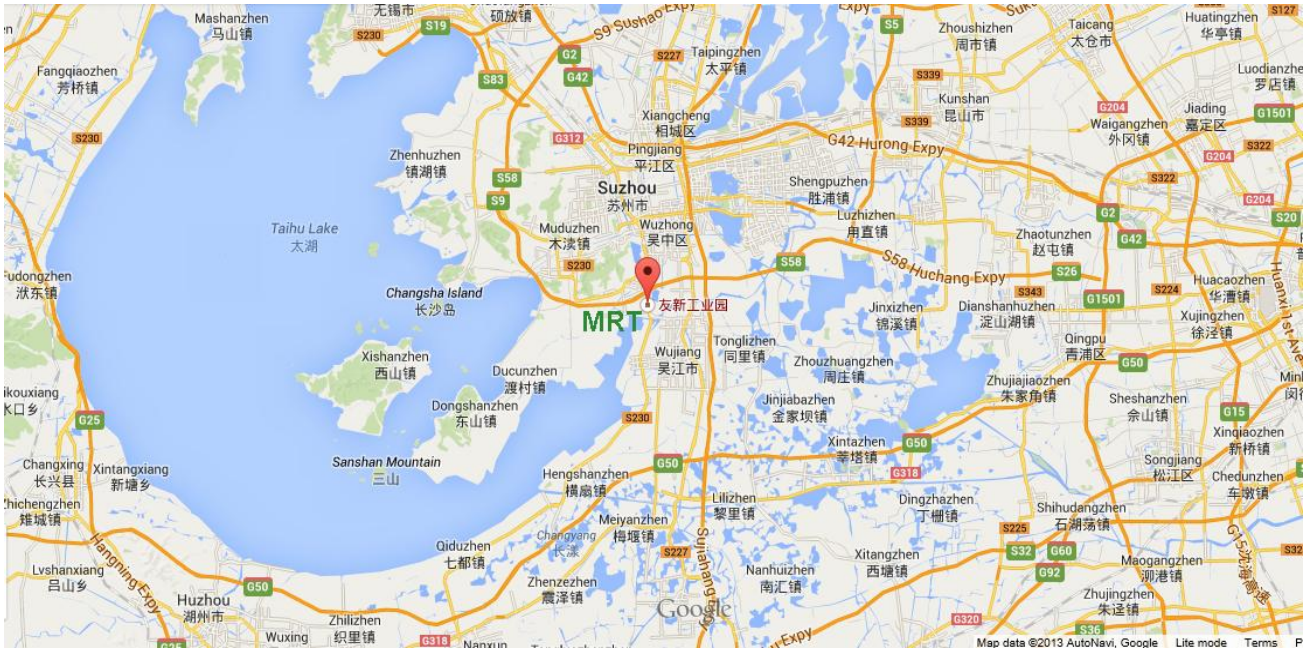
1. INTRODUCTION

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 Federal Communications Commission and the Innovation, Science and Economic Development Canada and Certification and Engineering Bureau.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taihu Lake. These measurement tests were conducted at the MRT Technology (Suzhou) Co., Ltd. Facility located at D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China. The measurement facility compliant with the test site requirements specified in ANSI C63.4-2014.



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name:	GigaSpire, GigaSpire BLAST$^{u6.1}$
Model No.:	GS4227E, GS4220E
Brand Name:	Calix
Wi-Fi Specification:	802.11a/b/g/n/ac/ax

Note 1: There are the same hardware design, PCB layout between product names and models, except the data rate of the white RJ45 port. For this port, GS4227E supports 2.5Gbps, but GS4220E supports 1Gbps only.

Note 2: The difference addressed as above doesn't affect the RF test result, so we selected GS4227E (product name: GigaSpire) for all RF testing.

2.2. Product Specification Subjective to this Report

Frequency Range:	For 802.11a/n-HT20/ac-VHT20/ax-HE20: 5180~5240MHz, 5260~5320MHz, 5500~5720MHz, 5745~5825MHz For 802.11n-HT40/ac-VHT40/ax-HE40: 5190~5230MHz, 5270~5310MHz, 5510~5710MHz, 5755~5795MHz For 802.11ac-VHT80/ax-HE80: 5210MHz, 5290MHz, 5530MHz, 5610 MHz, 5690MHz, 5775MHz For 802.11ac-VHT80+80/ax-HE80+80: 5210+5290MHz, 5530+5610MHz
Type of Modulation:	802.11a/n/ac: OFDM 802.11ax:OFDMA
Data Rate:	802.11a: 6/9/12/18/24/36/48/54Mbps 802.11n: up to 600Mbps 802.11ac: up to 1733.3Mbps 802.11ax: up to 2475Mbps

Note: For other features of this EUT, test report will be issued separately.

2.3. Working Frequencies for this Report

802.11a/n-HT20/ac-VHT20/ax-HE20

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/ax-HE40

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/ax-HE80

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

802.11ac-VHT80+80/ax-HE80+80

Channel	Frequency	Channel	Frequency	Channel	Frequency
42+58	5210+5290MHz	106+122	5530+5610 MHz	--	--

2.4. Description of Available Antennas

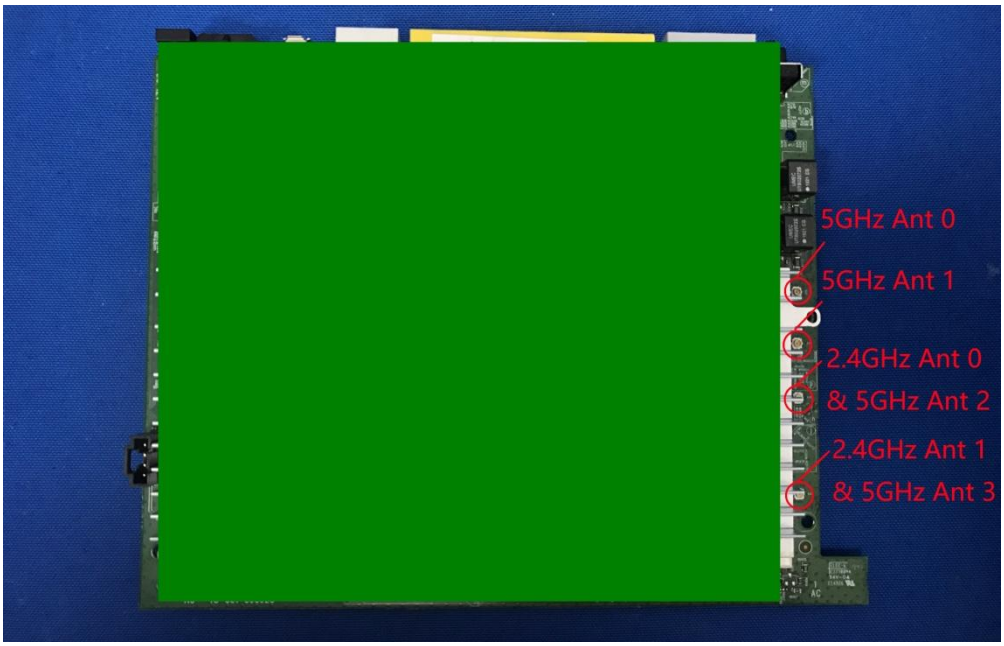
Antenna Type	Frequency Band (MHz)	T_X Paths	Directional Gain (dBi)	
			Non Beam-Forming Mode	Beam-Forming Mode
PCB Antenna	2412 ~ 2462	2	2.62	5.52
	5150 ~ 5250	4	1.89	6.90
	5250 ~ 5350	4	1.89	6.90
	5470 ~ 5725	4	2.03	7.44
	5725 ~ 5850	4	1.20	6.34

Note:

1. The EUT supports Beam Forming technology, and the Beam Forming mode support 802.11ac/ax, not include 802.11a/b/g. Its 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. The EUT also support non Beam-Forming technology, and non Beam-Forming mode support 802.11a/b/g/n/ac/ax, its transmit signals are uncorrelated, then
   Directional gain = 10 log$[(10^{G1/10}+ 10^{G2/10}+ \ldots + 10^{GN/10})/N_{ANT}]$ dBi

2.5. Description of Antenna RF Port

Antenna RF Port						
--	2.4GHz RF Port		5GHz RF Port			
Software Control Port	Ant 0	Ant 1	Ant 0	Ant 1	Ant 2	Ant 3



2.6. Test Mode

Test Mode	Mode 1: Transmit by 802.11a (6Mbps) (Non Beam-Forming Mode)
	Mode 2: Transmit by 802.11n-HT20 (MCS0) (Non Beam-Forming Mode)
	Mode 3: Transmit by 802.11n-HT40 (MCS0) (Non Beam-Forming Mode)
	Mode 4: Transmit by 802.11ac-VHT20 (MCS0) (Non Beam-Forming Mode)
	Mode 5: Transmit by 802.11ac-VHT40 (MCS0) (Non Beam-Forming Mode)
	Mode 6: Transmit by 802.11ac-VHT80 (MCS0) (Non Beam-Forming Mode)
	Mode 7: Transmit by 802.11ac-VHT80+80 (MCS0) (Non Beam-Forming Mode)
	Mode 8: Transmit by 802.11ax-HE20 (MCS0) (Non Beam-Forming Mode)
	Mode 9: Transmit by 802.11 ax-HE40 (MCS0) (Non Beam-Forming Mode)
	Mode 10: Transmit by 802.11ax-HE80 (MCS0) (Non Beam-Forming Mode)
	Mode 11: Transmit by 802.11ax-HE80+80 (MCS0) (Non Beam-Forming Mode)
	Mode 12: Transmit by 802.11ac-VHT20 (MCS0) (Beam-Forming Mode)
	Mode 13: Transmit by 802.11ac-VHT40 (MCS0) (Beam-Forming Mode)
	Mode 14: Transmit by 802.11ac-VHT80 (MCS0) (Beam-Forming Mode)
	Mode 15: Transmit by 802.11ac-VHT80+80 (MCS0) (Beam-Forming Mode)
	Mode 16: Transmit by 802.11ax-HE20 (MCS0) (Beam-Forming Mode)
	Mode 17: Transmit by 802.11 ax-HE40 (MCS0) (Beam-Forming Mode)
	Mode 18: Transmit by 802.11ax-HE80 (MCS0) (Beam-Forming Mode)
	Mode 19: Transmit by 802.11ax-HE80+80MCS0) (Beam-Forming Mode)

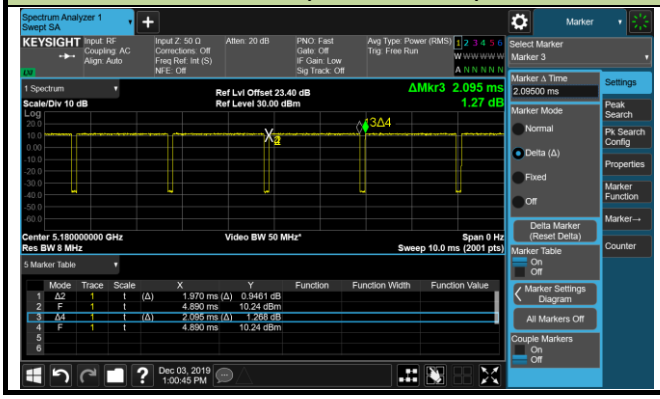
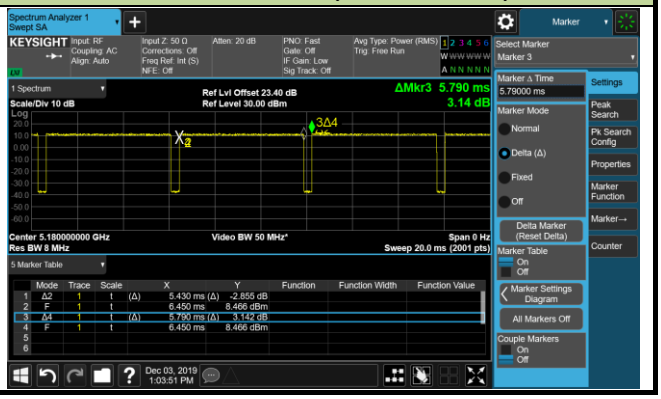
2.7. Description of Test Software

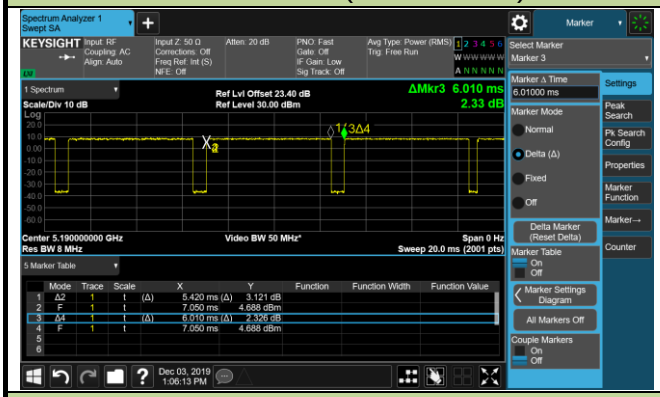
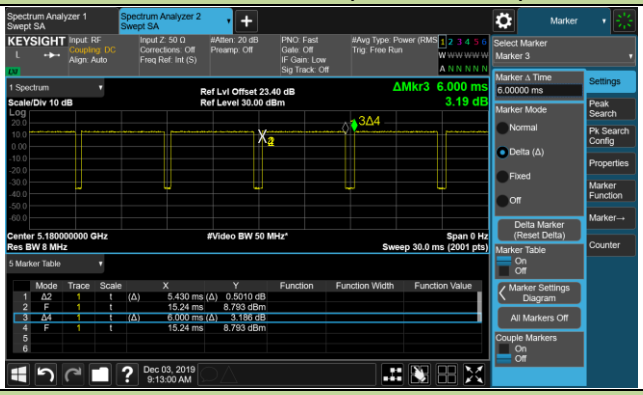
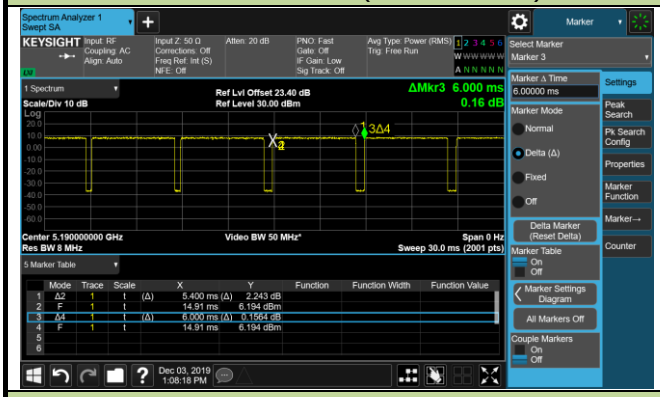
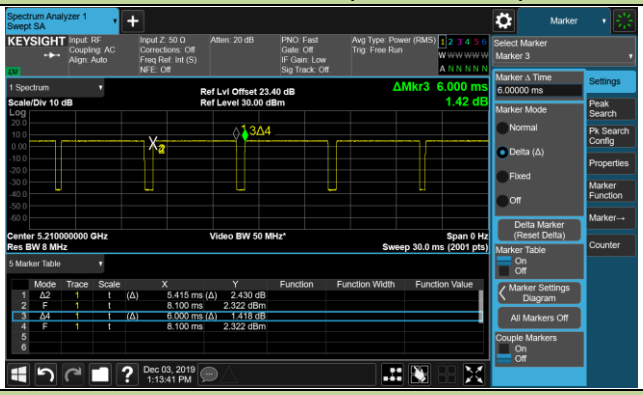
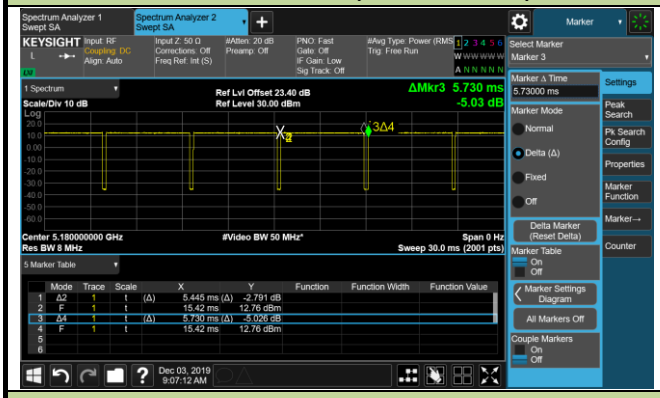
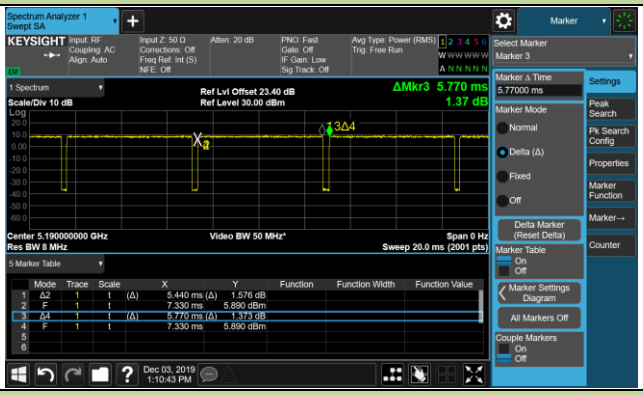
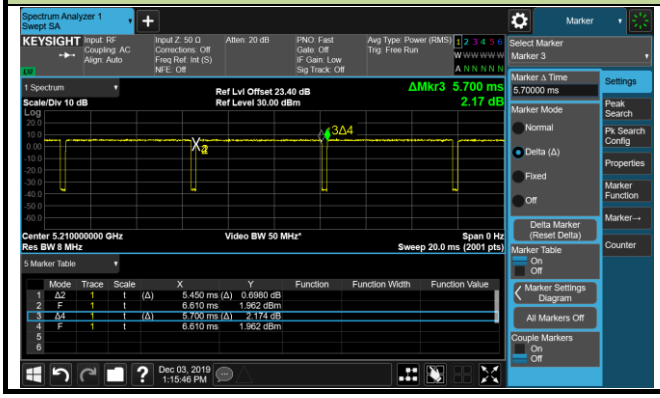
The test utility software used during testing was “Qualcomm Radio Control Tool”, and the version was “4.0.00132.0”.

2.8. Duty Cycle

5GHz (NII) operation is possible in 20MHz, 40MHz, 80MHz and 80+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 per the guidance of Section B)2)b) of KDB 789033 D02v02r01. 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	94.03%
802.11n-HT20	93.78%
802.11n-HT40	90.18%
802.11ac-VHT20	90.50%
802.11ac-VHT40	90.00%
802.11ac-VHT80	90.25%
802.11ax-HE20	95.03%
802.11ax-HE40	94.28%
802.11ax-HE80	95.61%

Duty Cycle (T = Transmission Duration)	
802.11a (T = 1.970ms)	802.11n-HT20 (T = 5.430ms)
	

802.11n-HT40 (T = 5.420ms)	802.11ac-VHT20 (T = 5.430ms)
	
802.11ac-VHT40 (T = 5.400ms)	**802.11ac-VHT80 (T = 5.415ms)**
	
802.11ax-HE20 (T = 5.445ms)	**802.11ax-HE40 (T = 5.440ms)**
	
802.11ax-HE80 (T = 5.450ms)	**--**
	--

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.

3. DESCRIPTION OF TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in KDB 789033 D02v02r01 were used in the measurement**.**

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

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an 8'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. An 80cm 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 to maximize 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 antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antenna of the device is **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions - SR2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR3	MRTSUE06185	1 year	2020/04/15
Two-Line V-Network	R&S	ENV 216	MRTSUE06002	1 year	2020/06/13
Two-Line V-Network	R&S	ENV 216	MRTSUE06003	1 year	2020/06/13
Thermohygrometer	Testo	608-H1	MRTSUE06404	1 year	2020/08/08
Shielding Room	MIX-BEP	Chamber-SR2	MRTSUE06215	N/A	N/A

Radiated Emissions - AC1

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR7	MRTSUE06001	1 year	2020/08/01
PXA Signal Analyzer	Keysight	9030B	MRTSUE06395	1 year	2020/09/03
Loop Antenna	Schwarzbeck	FMZB 1519	MRTSUE06025	1 year	2020/11/13
Bilog Period Antenna	Schwarzbeck	VULB 9168	MRTSUE06172	1 year	2020/03/31
Broad Band Horn Antenna	Schwarzbeck	BBHA 9120D	MRTSUE06023	1 year	2020/10/13
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	MRTSUE06597	1 year	2020/02/24
Microwave System Amplifier	Agilent	83017A	MRTSUE06076	1 year	2020/11/15
Preamplifier	Schwarzbeck	BBV 9721	MRTSUE06121	1 year	2020/06/11
Thermohygrometer	Testo	608-H1	MRTSUE06403	1 year	2020/08/08
Anechoic Chamber	TDK	Chamber-AC1	MRTSUE06212	1 year	2020/04/30

Radiated Emission - AC2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Spectrum Analyzer	Keysight	N9038A	MRTSUE06125	1 year	2020/08/01
Loop Antenna	Schwarzbeck	FMZB 1519	MRTSUE06025	1 year	2020/11/13
Bilog Period Antenna	Schwarzbeck	VULB 9162	MRTSUE06022	1 year	2020/10/13
Horn Antenna	Schwarzbeck	BBHA9120D	MRTSUE06171	1 year	2020/10/27
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	MRTSUE06597	1 year	2020/02/24
Broadband Coaxial Preamplifier	Schwarzbeck	BBV 9718	MRTSUE06176	1 year	2020/11/15
Preamplifier	Schwarzbeck	BBV 9721	MRTSUE06121	1 year	2020/06/11
Temperature/Humidity Meter	Minggao	ETH529	MRTSUE06170	1 year	2020/12/15
Anechoic Chamber	RIKEN	Chamber-AC2	MRTSUE06213	1 year	2020/04/30

Conducted Test Equipment - TR3

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	Agilent	N9020A	MRTSUE06106	1 year	2020/04/15
EXA Signal Analyzer	Keysight	N9010B	MRTSUE06452	1 year	2020/07/11
Signal Analyzer	R&S	FSV40	MRTSUE06218	1 year	2020/04/15
Power Meter	Agilent	U2021XA	MRTSUE06030	1 year	2020/11/18
USB wideband power sensor	Keysight	U2021XA	MRTSUE06446	1 year	2020/06/30
USB wideband power sensor	Keysight	U2021XA	MRTSUE06447	1 year	2020/06/30
Bluetooth Test Set	Anritsu	MT8852B-042	MRTSUE06389	1 year	2020/06/13
Audio Analyzer	Agilent	U8903B	MRTSUE06143	1 year	2020/06/13
Modulation Analyzer	HP	8901A	MRTSUE06098	1 year	2020/10/10
Wideband Radio Communication Tester	R&S	CMW 500	MRTSUE06243	1 year	2020/11/07
DC Power Supply	GWINSTEK	DPS-3303C	MRTSUE06064	N/A	N/A
Temperature & Humidity Chamber	BAOYT	BYH-150CL	MRTSUE06051	1 year	2020/11/07
Thermohygrometer	testo	608-H1	MRTSUE06401	1 year	2020/08/08

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.

Conducted Emission Measurement - SR2
The maximum measurement uncertainty is evaluated as: 9kHz~150kHz: 3.84dB 150kHz~30MHz: 3.46dB
Radiated Emission Measurement - AC1
The maximum measurement uncertainty is evaluated as: Horizontal: 30MHz~300MHz: 4.07dB 300MHz~1GHz: 3.63dB 1GHz~18GHz: 4.16dB Vertical: 30MHz~300MHz: 4.18dB 300MHz~1GHz: 3.60dB 1GHz~18GHz: 4.76dB
Radiated Emission Measurement - AC2
The maximum measurement uncertainty is evaluated as: Horizontal: 30MHz~300MHz: 3.75dB 300MHz~1GHz: 3.53dB 1GHz~18GHz: 4.28dB Vertical: 30MHz~300MHz: 3.86dB 300MHz~1GHz: 3.53dB 1GHz~18GHz: 4.33dB

7. TEST RESULT

7.1. Summary

FCC Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407(a)	26dB Bandwidth	N/A	Conducted	Pass	Section 7.2
15.407(e)	6dB Bandwidth	≥ 500kHz		Pass	Section 7.3
15.407(a)(1)(iii), (2), (3)	Maximum Conducted Output Power	Refer to Section 7.4		Pass	Section 7.4
15.407(h)(1)	Transmit Power Control	≤ 24 dBm		Pass	Section 7.5
15.407(a)(1)(iii), (2), (3), (5)	Peak Power Spectral Density	Refer to Section 7.6		Pass	Section 7.6
15.407(g)	Frequency Stability	± 20 ppm		Pass	Section 7.7
15.407(b)(1), (2), (3), (4)(i)	Undesirable Emissions	Refer to Section 7.8	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 in 15.209		Pass	
15.207	AC Conducted Emissions 150kHz - 30MHz	< FCC 15.207 limits	Line Conducted	Pass	Section 7.10

Notes:

1) 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.
2) 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

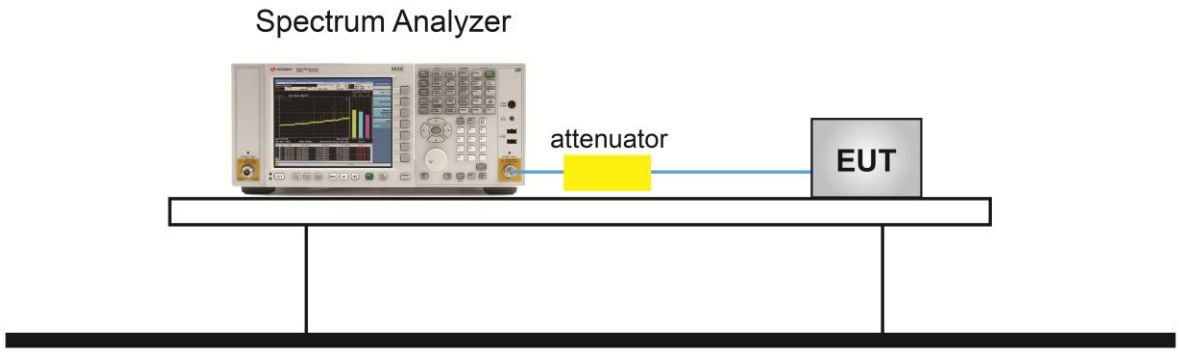
7.2.2.Test Procedure used

KDB 789033 D02v02r01 - 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	GigaSpire	Temperature	22 ~ 25°C
Test Engineer	David Lv	Relative Humidity	46 ~ 59%
Test Site	TR3	Test Date	2019/11/29 ~ 2019/12/07

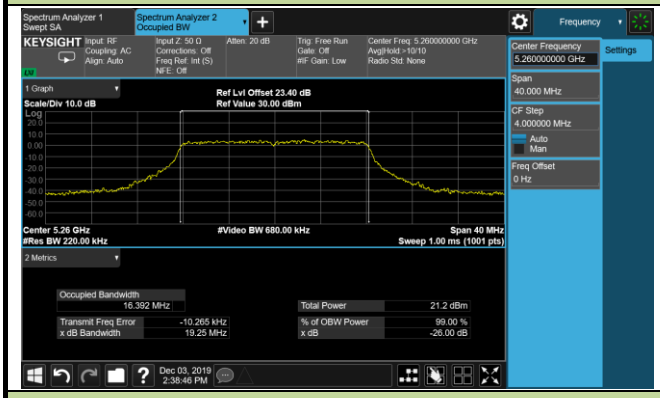
Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 0 / Ant 0 + 1 + 2 + 3					
802.11a	6Mbps	52	5260	19.25	16.39
802.11a	6Mbps	60	5300	19.09	16.37
802.11a	6Mbps	64	5320	19.34	16.39
802.11a	6Mbps	100	5500	20.50	17.57
802.11a	6Mbps	120	5600	19.25	16.38
802.11a	6Mbps	140	5700	19.23	16.38
802.11a	6Mbps	144	5720	19.00	16.38
802.11n-HT20	MCS0	52	5260	20.23	17.61
802.11n-HT20	MCS0	60	5300	20.30	17.59
802.11n-HT20	MCS0	64	5320	20.55	17.60
802.11n-HT20	MCS0	100	5500	19.98	17.60
802.11n-HT20	MCS0	120	5600	20.32	17.59
802.11n-HT20	MCS0	140	5700	19.99	17.61
802.11n-HT20	MCS0	144	5720	20.41	17.60
802.11n-HT40	MCS0	54	5270	39.28	36.02
802.11n-HT40	MCS0	62	5310	39.66	36.07
802.11n-HT40	MCS0	102	5510	39.54	36.07
802.11n-HT40	MCS0	118	5590	40.23	36.11
802.11n-HT40	MCS0	134	5670	39.73	36.08
802.11n-HT40	MCS0	142	5710	39.60	36.07
802.11ac-VHT20	MCS0	52	5260	20.11	17.62
802.11ac-VHT20	MCS0	60	5300	20.14	17.58
802.11ac-VHT20	MCS0	64	5320	20.26	17.58
802.11ac-VHT20	MCS0	100	5500	19.86	17.58
802.11ac-VHT20	MCS0	120	5600	20.14	17.58
802.11ac-VHT20	MCS0	140	5700	20.00	17.60
802.11ac-VHT20	MCS0	144	5720	20.39	17.58

Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 0 / Ant 0 + 1 + 2 + 3					
802.11ac-VHT40	MCS0	54	5270	39.89	36.10
802.11ac-VHT40	MCS0	62	5310	39.32	36.07
802.11ac-VHT40	MCS0	102	5510	39.34	36.10
802.11ac-VHT40	MCS0	118	5590	39.30	36.03
802.11ac-VHT40	MCS0	134	5670	38.96	36.08
802.11ac-VHT40	MCS0	142	5710	39.73	36.10
802.11ac-VHT80	MCS0	58	5290	80.25	75.27
802.11ac-VHT80	MCS0	106	5530	80.23	75.37
802.11ac-VHT80	MCS0	122	5610	81.99	75.38
802.11ac-VHT80	MCS0	138	5690	81.45	75.35
802.11ac-VHT80+80 Contiguous	MCS0	42	5210	170.04	156.10
		58	5290		
802.11ac-VHT80+80 Contiguous	MCS0	106	5530	181.83	156.21
		122	5610		
Note: The detail calculation see page 36.					

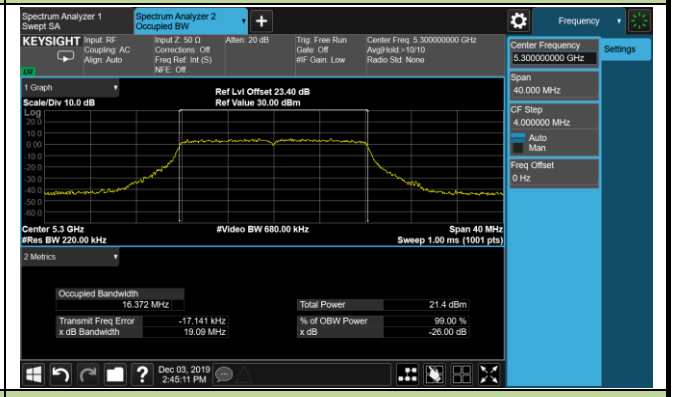
Test Mode	Data Rate/ MCS	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)
Ant 0 / Ant 0 + 1 + 2 + 3					
802.11ax-HE20	MCS0	52	5260	21.13	18.95
802.11ax-HE20	MCS0	60	5300	20.66	18.92
802.11ax-HE20	MCS0	64	5320	21.13	18.92
802.11ax-HE20	MCS0	100	5500	20.96	18.94
802.11ax-HE20	MCS0	120	5600	20.93	18.91
802.11ax-HE20	MCS0	140	5700	20.60	18.94
802.11ax-HE20	MCS0	144	5720	20.71	18.94
802.11ax-HE40	MCS0	54	5270	40.76	37.75
802.11ax-HE40	MCS0	62	5310	40.29	37.75
802.11ax-HE40	MCS0	102	5510	41.01	37.74
802.11ax-HE40	MCS0	118	5590	40.63	37.77
802.11ax-HE40	MCS0	134	5670	40.56	37.77
802.11ax-HE40	MCS0	142	5710	40.64	37.79
802.11ax-HE80	MCS0	58	5290	81.68	77.13
802.11ax-HE80	MCS0	106	5530	81.60	76.96
802.11ax-HE80	MCS0	122	5610	81.40	77.05
802.11ax-HE80	MCS0	138	5690	82.08	77.13
802.11ax-HE80+80 Contiguous	MCS0	42	5210	167.78	157.62
		58	5290		
802.11ax-HE80+80 Contiguous	MCS0	106	5530	179.45	157.68
		122	5610		
Note: The detail calculation see page 41.					

802.11a 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

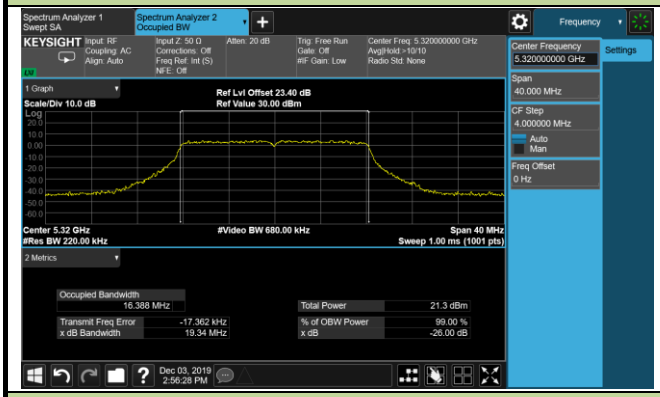
Channel 52 (5260MHz)



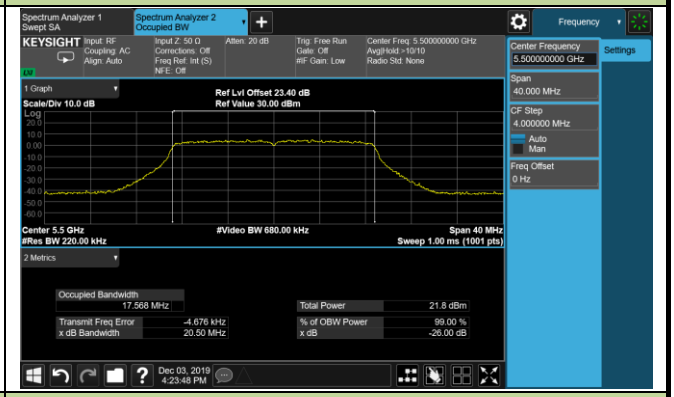
Channel 60 (5300MHz)



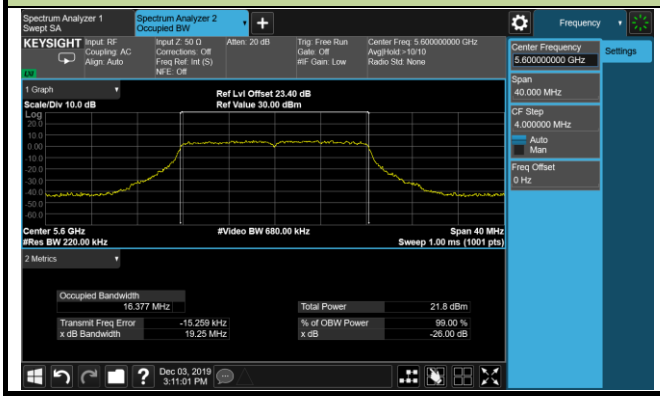
Channel 64 (5320MHz)



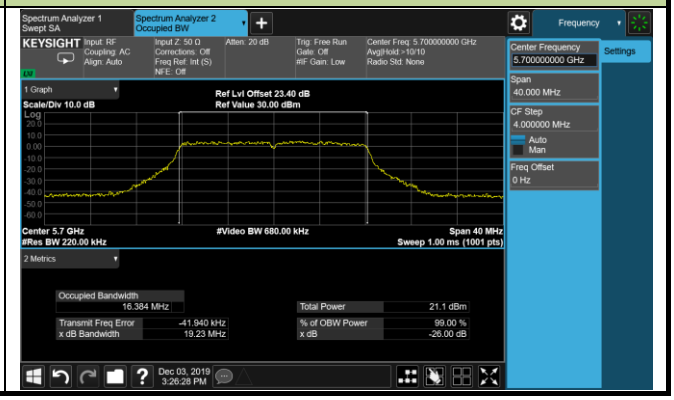
Channel 100 (5500MHz)

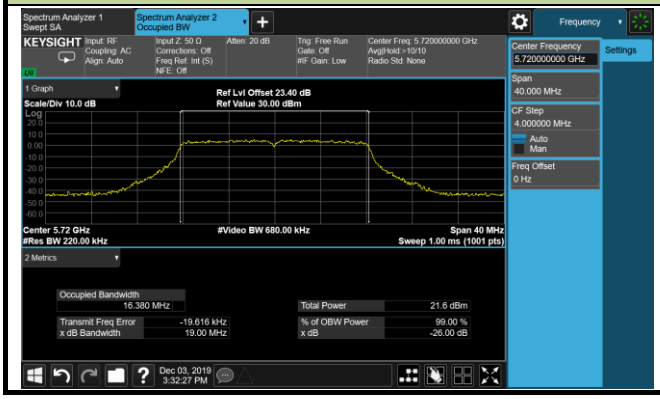


Channel 100 (5600MHz)



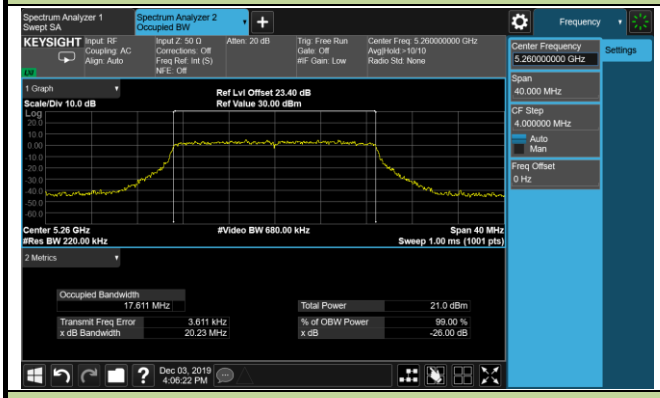
Channel 140 (5700MHz)



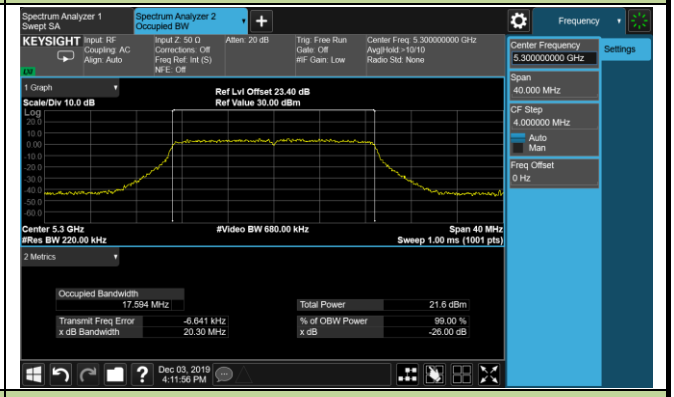
802.11a 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 144 (5720MHz)	
	

802.11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

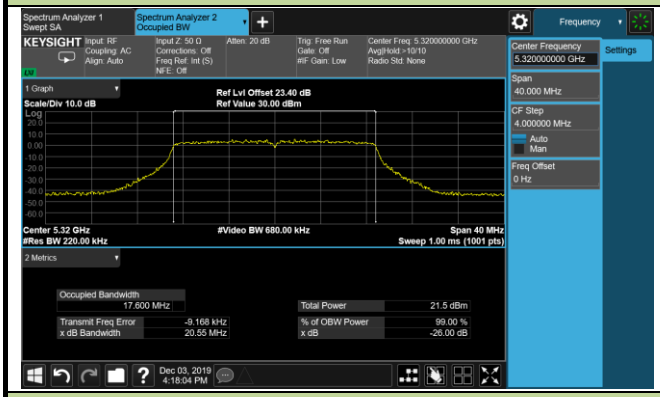
Channel 52 (5260MHz)



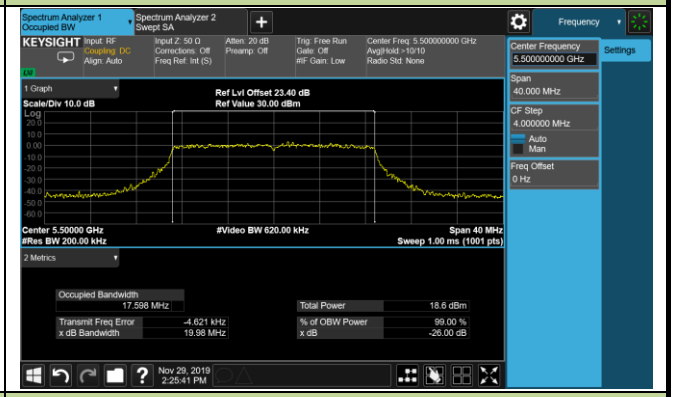
Channel 60 (5300MHz)



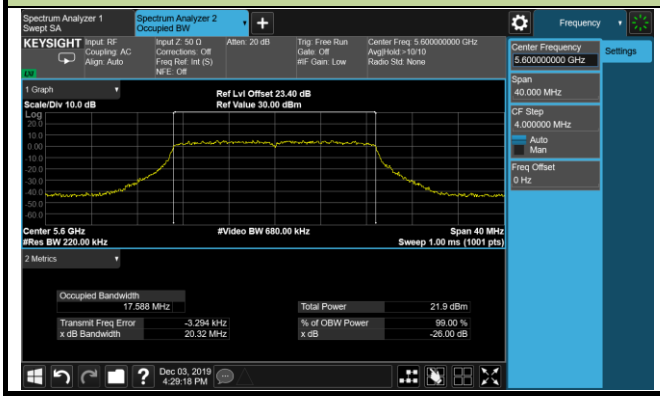
Channel 64 (5320MHz)



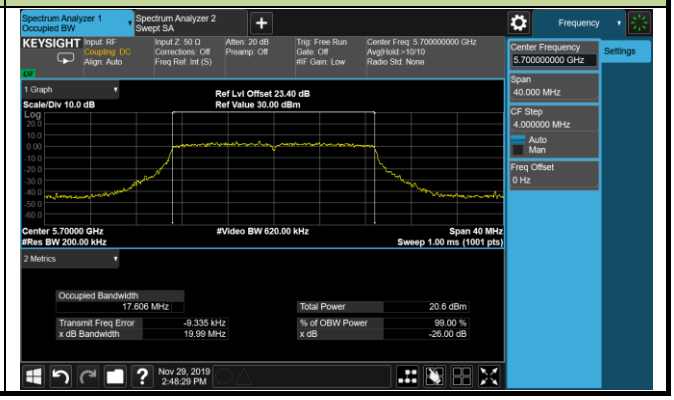
Channel 100 (5500MHz)

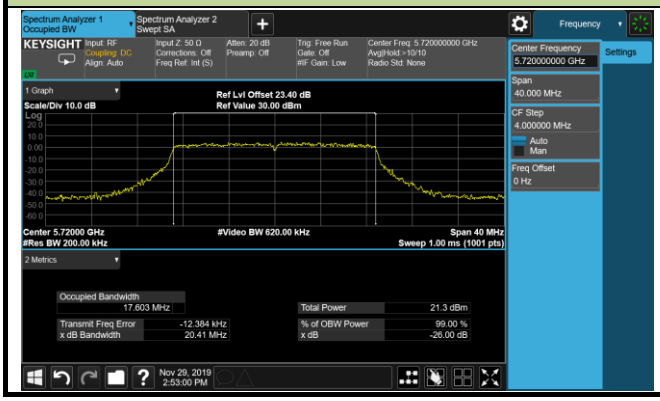


Channel 120 (5600MHz)



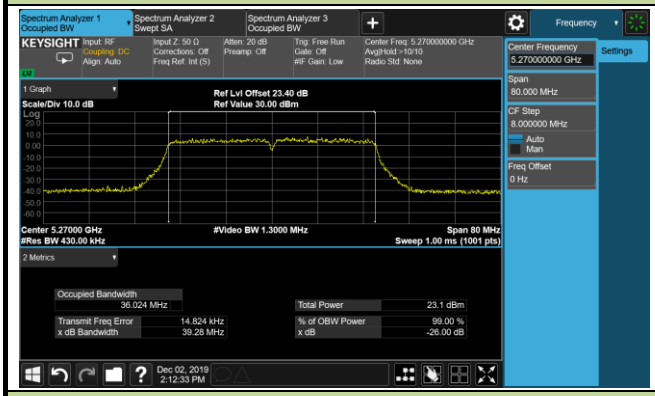
Channel 140 (5700MHz)



802.11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 144 (5720MHz)	
	

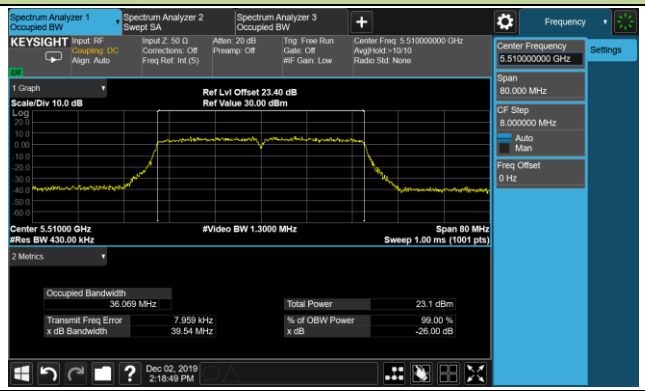
802.11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

Channel 54 (5270MHz)



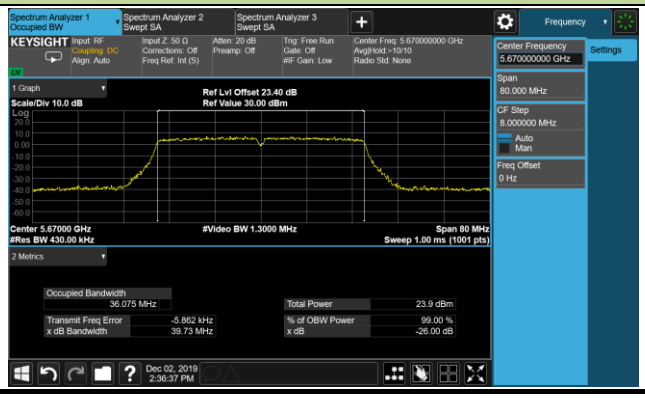
Channel 62 (5310MHz)

Channel 102 (5510MHz)

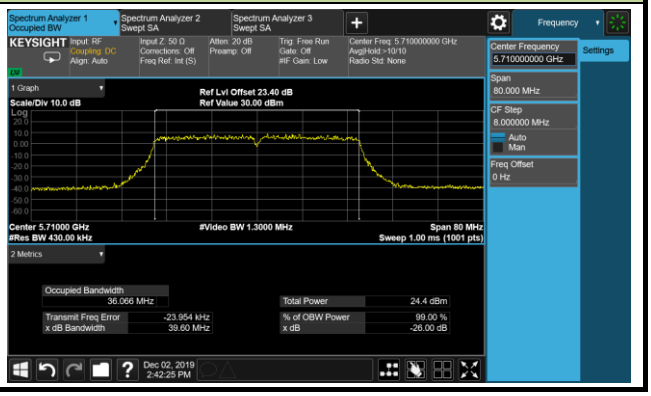


Channel 118 (5590MHz)

Channel 134 (5670MHz)

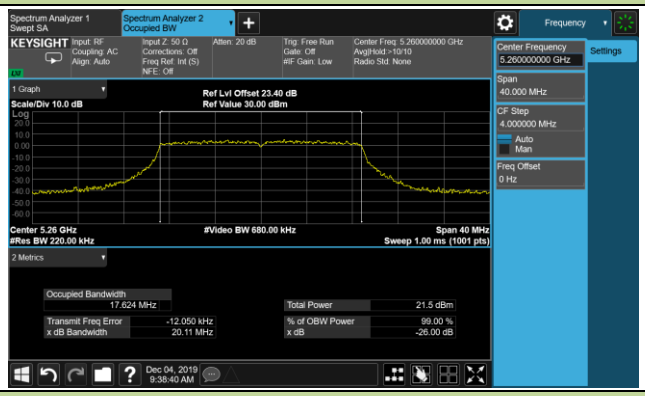


Channel 142 (5710MHz)

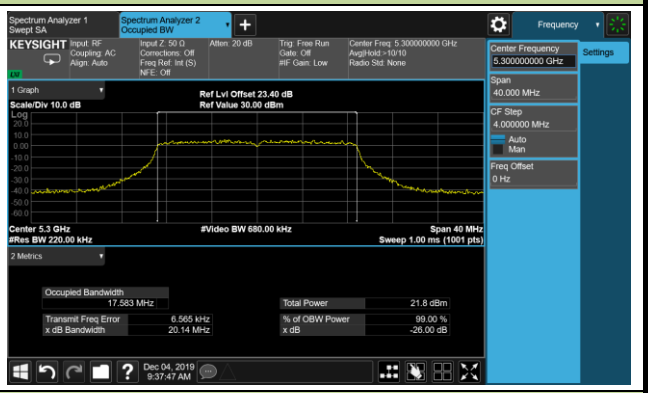


802.11ac-VHT20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

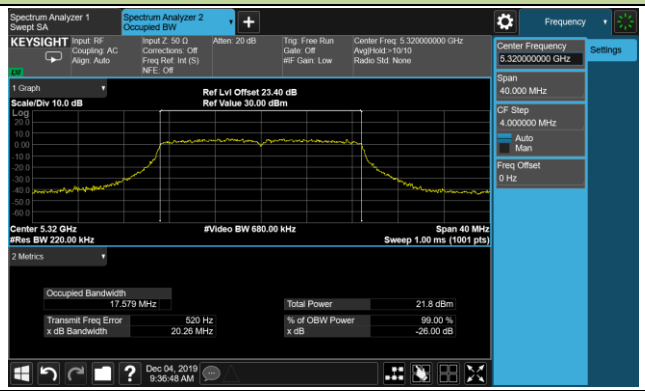
Channel 52 (5260MHz)



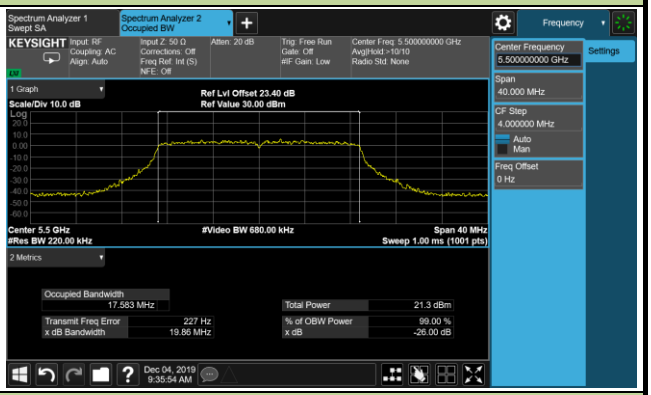
Channel 60 (5300MHz)



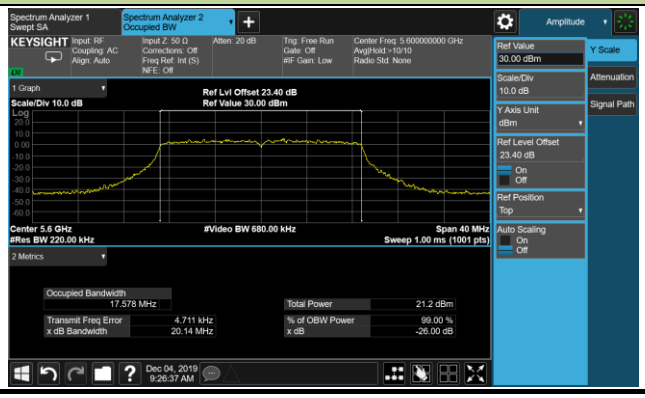
Channel 64 (5320MHz)



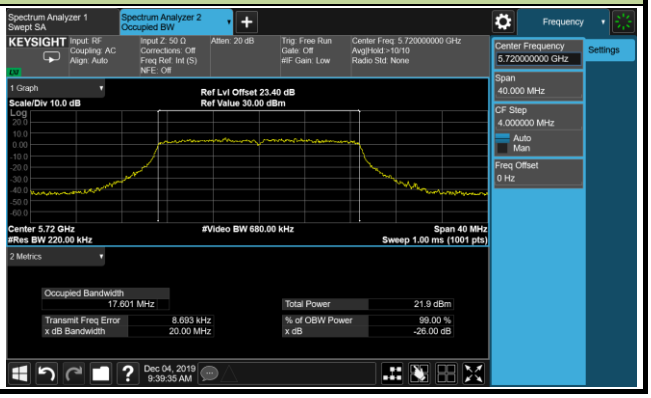
Channel 100 (5500MHz)

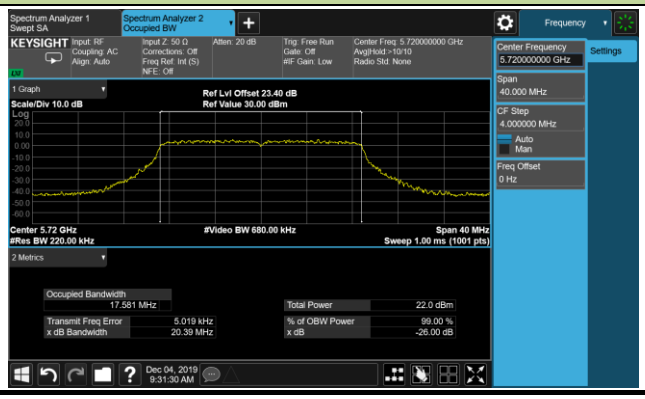


Channel 120 (5600MHz)



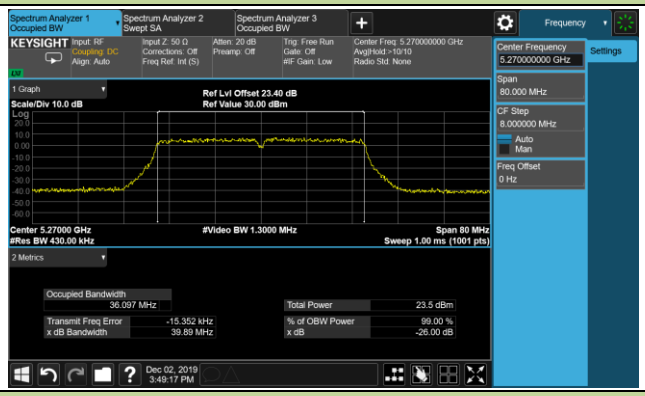
Channel 140 (5700MHz)



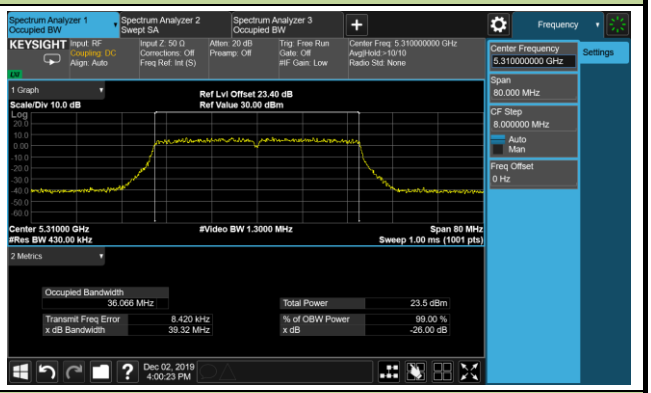
802.11ac-VHT20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 144 (5720MHz)	
	

802.11ac-VHT40 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

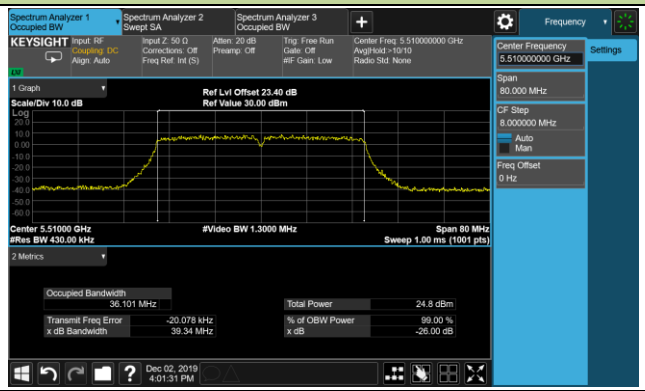
Channel 54 (5270MHz)



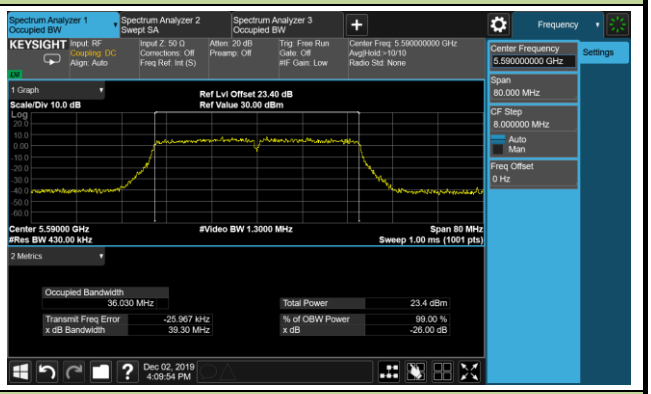
Channel 62 (5310MHz)



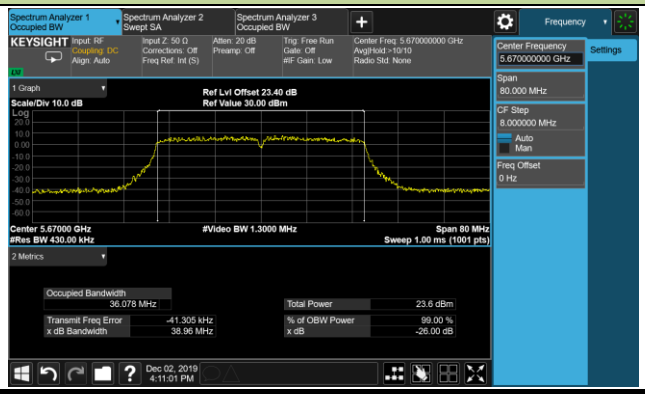
Channel 102 (5510MHz)



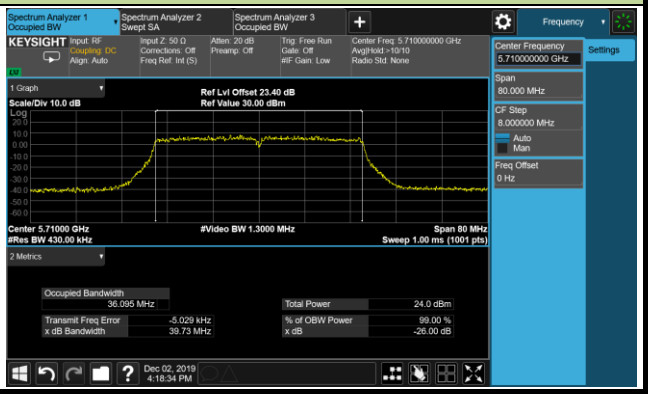
Channel 118 (5590MHz)

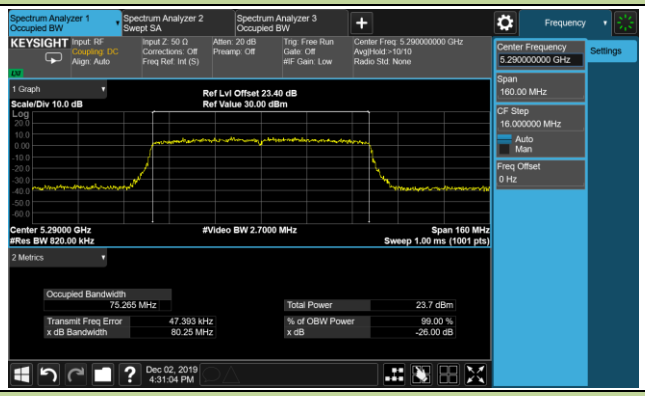
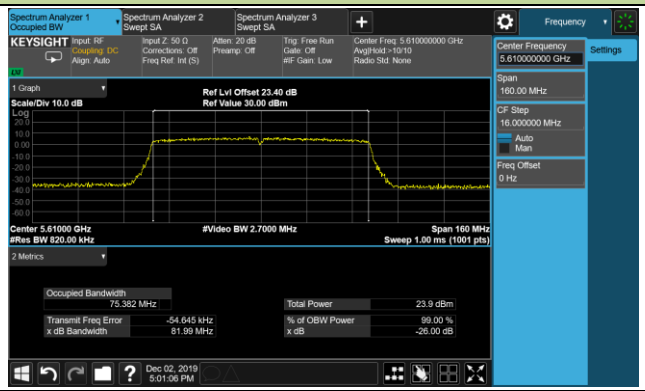
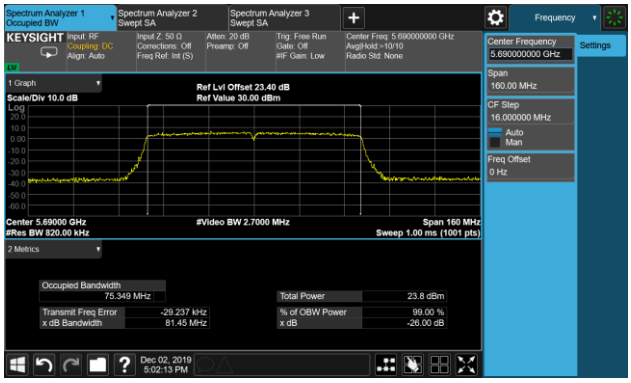


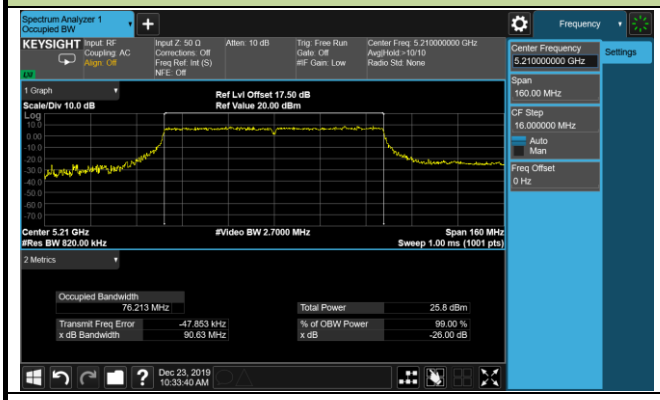
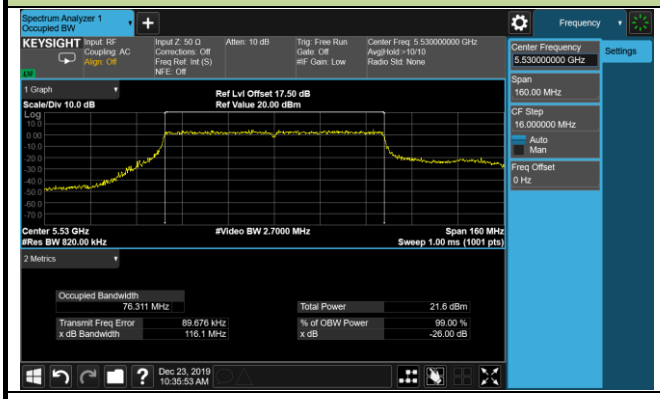
Channel 134 (5670MHz)



Channel 142 (5710MHz)

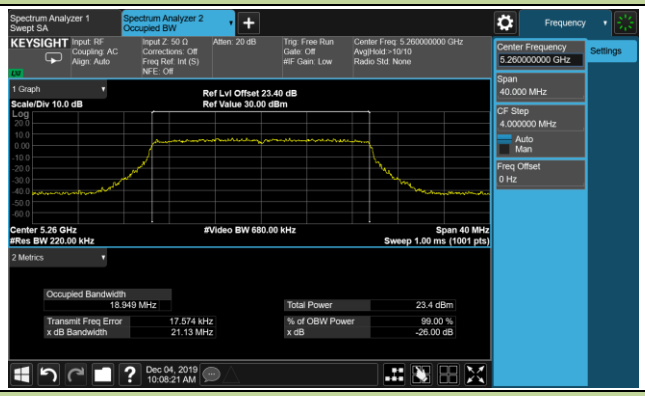


802.11ac-VHT80 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 58 (5290MHz)	**Channel 106 (5530MHz)**
	
Channel 122 (5610MHz)	**Channel 138 (5690MHz)**
	

802.11ac-VHT80+80 Contiguous 26dB Bandwidth & 99% Bandwidth - Ant 0 + 1 + 2 + 3	
Channel 42 (5210MHz)	**Channel 58 (5290MHz)**
	
Note: 26dB OCW = [5290 + (89.45/2)] - [5210 - (90.63/2)] = 170.04 MHz 99% OCW = [5290 + (75.99/2)] - [5210 - (76.21/2)] = 156.10 MHz	
802.11ac-VHT80+80 Contiguous 26dB Bandwidth & 99% Bandwidth - Ant 0 + 1 + 2 + 3	
Channel 106 (5530MHz)	**Channel 122 (5610MHz)**
	
Note: 26dB OCW = [5610 + (87.56/2)] - [5530 - (116.10/2)] = 181.83 MHz 99% OCW = [5610 + (76.11/2)] - [5530 - (76.31/2)] = 156.21 MHz	

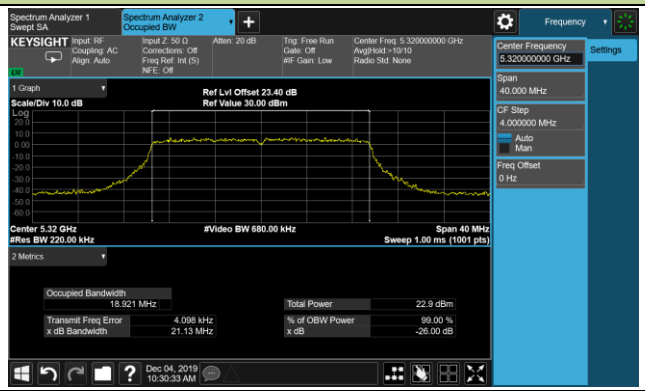
802.11ax-HE20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

Channel 52 (5260MHz)

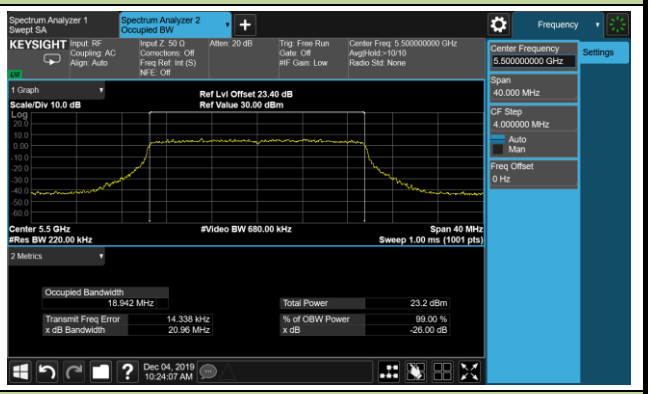


Channel 60 (5300MHz)

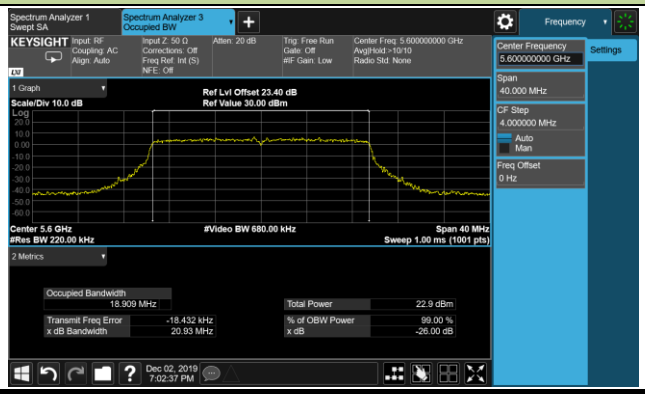
Channel 64 (5320MHz)



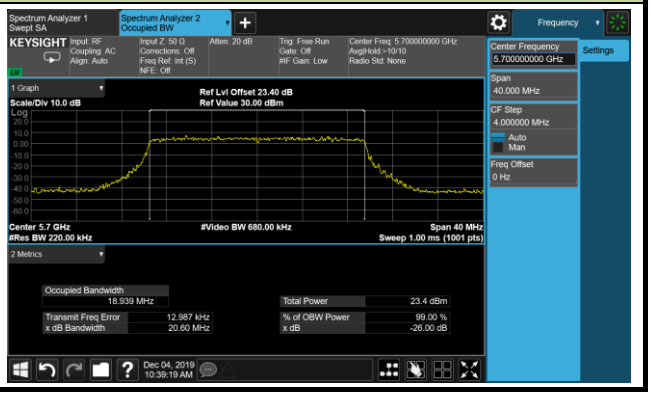
Channel 100 (5500MHz)

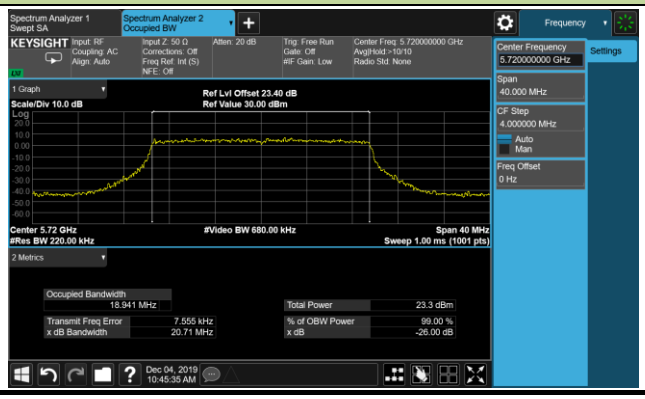


Channel 120 (5600MHz)



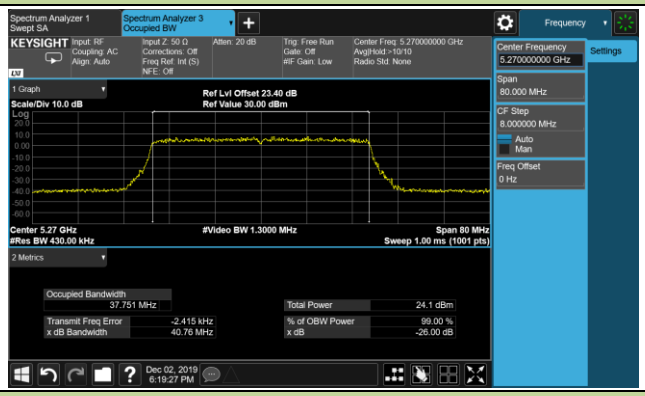
Channel 140 (5700MHz)



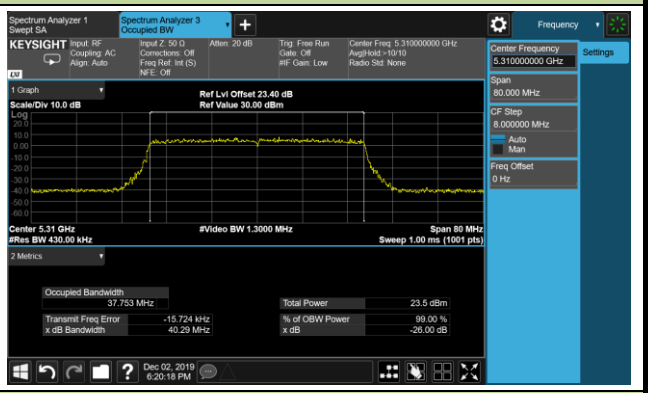
802.11ax-HE20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 144 (5720MHz)	
	

802.11ax-HE40 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1 + 2 + 3

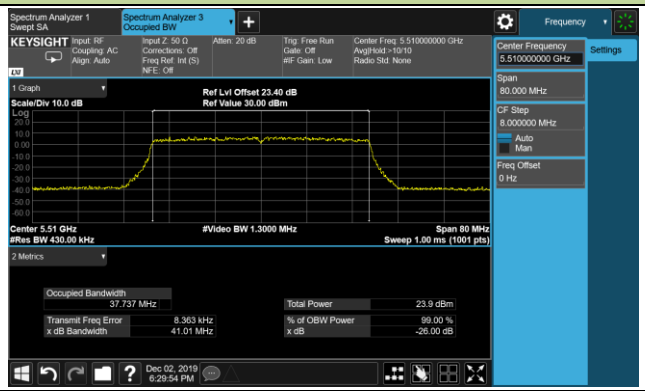
Channel 54 (5270MHz)



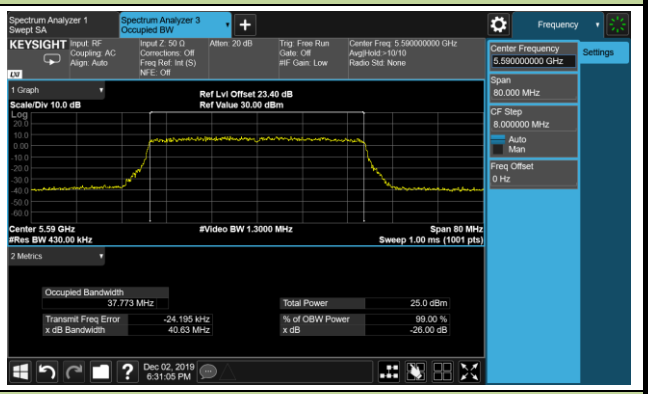
Channel 62 (5310MHz)



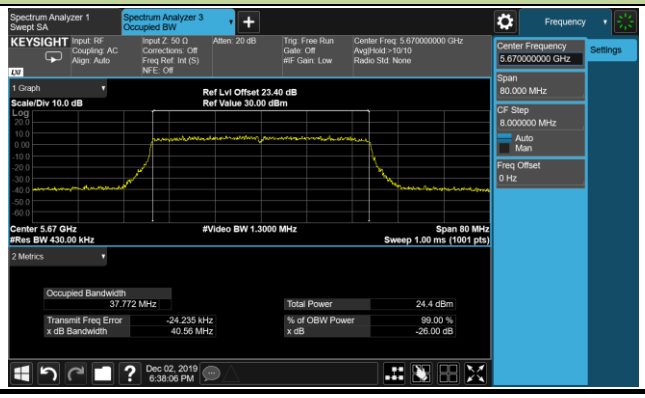
Channel 102 (5510MHz)



Channel 118 (5590MHz)



Channel 134 (5670MHz)



Channel 142 (5710MHz)