FCC TEST REPORT

Product Name:	GPON ONT
Trade Mark:	HALNy
Model No.:	HL-4GQV
Report Number:	200704006RFC-2
Test Standards:	FCC 47 CFR Part 15 Subpart E
FCC ID:	2AWIZHL4GQV
Test Result:	PASS
Date of Issue:	October 15, 2020

Prepared for:

FIBRAIN sp.zo.o.
Poland, Zaczernie 190F, 36-062

Prepared by:

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Date: October 15, 2020

UnionTrust Laboratories * Certified *

Version

Version No.	Date	Description
V1.0	October 15, 2020	Original

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	FIBRAIN sp.zo.o.
Address of Applicant:	Poland, Zaczernie 190F, 36-062
Manufacturer:	FIBRAIN sp.zo.o.
Address of Manufacturer:	Poland, Zaczernie 190F, 36-062

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	GPON ONT		
Model No.:	HL-4GQV		
Trade Mark:	HALNy		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
Sample Received Date:	July 4, 2020		
Sample Tested Date:	July 4, 2020 to August 19, 2020		

1.2.2 Description of Accessories

Adapter	
Model No.:	BY-SKY120200U71L
Input:	100-240 V~50/60 Hz 0.7A
Output:	12.0 V ⎓ 2.0A
DC Cable:	1.50 Meter, Unshielded without ferrite
Manufacturer:	SHENZHEN TOPOW ELECTRONICS CO., LTD.

Cable	
Description:	Ethernet Cable
Cable Type:	Unshielded without ferrite
Length:	1.50 Meter, Unshielded without ferrite

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Bands:	5150 MHz to 5250 MHz (U-NII-1)	
	5250 MHz to 5350 MHz (U-NII-2A)	
	5470 MHz to 5725 MHz (U-NII-2C)	
	5 725 MHz to 5 850 MHz (U-NII-3)	
Frequency Ranges:	5180 MHz to 5240 MHz	
	5260 MHz to 5320 MHz	
	5500 MHz to 5700 MHz	
	5 745 MHz to 5 825 MHz	
Support Standards:	IEEE 802.11a/n/ac	
TPC Function:	Not Support	
DFS Operational mode:	Master	
Type of Modulation:	IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK)	
	IEEE 802.11n: OFDM(64QAM, 16QAM, QPSK, BPSK)	
	IEEE 802.11ac: OFDM(256QAM, 64QAM, 16QAM, QPSK, BPSK)	
Channel Spacing:	IEEE 802.11a/n-HT20/ac-VHT20: 20 MHz	
	IEEE 802.11n-HT40/ac-VHT40: 40 MHz	
	IEEE 802.11ac-VHT80: 80 MHz	
Data Rate:	IEEE 802.11a: Up to 54 Mbps	
	IEEE 802.11n-HT20: Up to MCS31	
	IEEE 802.11n-HT40: Up to MCS31	
	IEEE 802.11ac-VHT20: Up to MCS8	
	IEEE 802.11ac-VHT40: Up to MCS9	
	IEEE 802.11ac-VHT80: Up to MCS9	
Number of Channels:	5150 MHz to 5250 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40)/ac-VHT40 1 for IEEE 802.11acVHT80	
	5250 MHz to 5350 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40)/ac-VHT40 1 for IEEE 802.11acVHT80	
	5470 MHz to 5725 MHz: 11 for IEEE 802.11a/n-HT20/ac-VHT20 5 for IEEE 802.11n-HT40/ac-VHT40 2 for IEEE 802.11ac-VHT80	
	5725 MHz to 5850 MHz: 5 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40/ac-VHT40 1 for IEEE 802.11ac-VHT80	
Antenna Type:	Chain 0	External Antenna
	Chain 1	External Antenna
	Chain 2	External Antenna
	Chain 3	External Antenna
Antenna Gain:	Chain 0	5150 MHz to 5250 MHz: 5.0 dBi
		5250 MHz to 5350 MHz: 5.0 dBi
		5470 MHz to 5725 MHz: 5.0 dBi
		5725 MHz to 5850 MHz: 5.0 dBi

	Chain 1	5150 MHz to 5250 MHz: 5.0 dBi
		5250 MHz to 5350 MHz: 5.0 dBi
		5470 MHz to 5725 MHz: 5.0 dBi
		5725 MHz to 5850 MHz: 5.0 dBi
	Chain 2	5150 MHz to 5250 MHz: 5.0 dBi
		5250 MHz to 5350 MHz: 5.0 dBi
		5470 MHz to 5725 MHz: 5.0 dBi
		5725 MHz to 5850 MHz: 5.0 dBi
	Chain 3	5150 MHz to 5250 MHz: 5.0 dBi
		5250 MHz to 5350 MHz: 5.0 dBi
		5470 MHz to 5725 MHz: 5.0 dBi
		5725 MHz to 5850 MHz: 5.0 dBi

Maximum conducted output power (dBm):	**SISO_Chain 0**	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	11.86	11.52	9.82	13.52
	SISO_Chain 1	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	11.39	11.99	10.00	13.65
	SISO_Chain 2	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	6.22	7.49	6.82	7.12
	SISO_Chain 3	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	11.18	11.78	10.63	12.80
	MIMO_Chain 0+1	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11n-HT20:	14.85	15.33	13.74	18.45
	IEEE 802.11n-HT40:	12.60	12.96	12.25	18.04
	IEEE 802.11ac-VHT20:	14.73	15.16	13.61	18.45
	IEEE 802.11ac-VHT40:	12.59	12.96	12.22	17.88
	IEEE 802.11ac-VHT80:	12.46	11.72	10.34	15.65
Normal Test Voltage:	120 Vac				

1.4 OTHER INFORMATION

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

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	FCC ID	Supplied by
Notebook	Lenovo	E450	SL10G10780	UnionTrust	Notebook
Mouse	DELL	MS111	CN-011D3V-738	UnionTrust	Mouse
Phone	MI	MIX 2S	N/A	UnionTrust	Phone

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.3 Meter	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

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

1.7 TEST FACILITY

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

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

A2LA-Lab Certificate No.: 4312.01
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence

in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

ISED Wireless Device Testing Laboratories
CAB identifier: CN0032

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

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

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

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.2 dB
2	Conducted emission 150KHz-30MHz	±2.7 dB
3	Radiated emission 9KHz-30MHz	± 4.7 dB
4	Radiated emission 30MHz-1GHz	± 4.6 dB
5	Radiated emission 1GHz-18GHz	± 4.4 dB
6	Radiated emission 18GHz-26GHz	± 4.6 dB
7	Radiated emission 26GHz-40GHz	± 4.6 dB
8	Conducted spurious emissions	± 2.7 dB
9	RF Power, Conducted	± 0.9 dB
10	Occupied Bandwidth	± 1.86 %
11	Radio Frequency	2.4 GHz: ± 6.5 x 10^{-8}
12	Transmission Time	± 0.19 %

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart E Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203 FCC 47 CFR Part 15 Subpart C Section 15.407(a)(1) (2)	N/A	PASS
26 dB emission bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(2)(5)	KDB 789033 D02 v02r01 Section C.1	PASS
6 dB bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (e)	KDB 789033 D02 v02r01 Section C.2	PASS
Maximum conducted output power	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)	KDB 789033 D02 v02r01 Section E.3.a (Method PM)	PASS
Peak Power Spectral Density	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)	KDB 789033 D02 v02r01 Section F	PASS
Radiated Emissions and Band Edge Measurement	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(1)(2)(3)(4)(6) FCC 47 CFR Part 15 Subpart C Section 15.209/205	KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6	PASS
Dynamic Frequency Selection	FCC 47 CFR Part 15 Subpart E Section 15.407 (h)	KDB 905462 D03 Client Without DFS New Rules v01r02	PASS (See Note 1)
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(6) FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013, Section 6.2.	PASS
Note: 1) Please refer to Report No.: 200704006RFC-3 for DFS Test report.			

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Dec. 03, 2018	Dec. 03, 2021
☒	Receiver	R&S	ESIB26	100114	Nov. 24, 2019	Nov. 23, 2020
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2019	Nov. 23, 2020
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	Nov. 16, 2019	Nov. 15, 2020
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Nov. 16, 2019	Nov. 15, 2020
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	Nov. 16, 2019	Nov. 15, 2020
☒	Preamplifier	HP	8447F	2805A02960	Nov. 24, 2019	Nov. 23, 2020
☐	Broadband Antenna (Pre-amplifier)	ETS-LINDGREN	3142E-PA	00201891	Nov. 24, 2019	Nov. 23, 2020
☐	6dB Attenuator	Talent	RA6A5-N-18	18103002	Nov. 24, 2019	Nov. 23, 2020
☐	Horn Antenna	ETS-LINDGREN	3117	00164202	Nov. 16, 2019	Nov. 15, 2020
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	May 30, 2020	May 29, 2021
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	Jun 19, 2020	Jun 18, 2021
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Nov. 16, 2019	Nov. 15, 2020
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☒	Test Software	Audix	e3	Software Version: 9.160323		

Conducted Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	Receiver	R&S	ESR7	1316.3003K07 -101181-K3	Nov. 24, 2019	Nov. 23, 2020
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 24, 2019	Nov. 23, 2020
☒	LISN	R&S	ESH2-Z5	860014/024	Nov. 24, 2019	Nov. 23, 2020
☒	LISN	ETS-Lindgren	3816/2SH	00201088	Nov. 24, 2019	Nov. 23, 2020
☒	Test Software	Audix	e3	Software Version: 9.160323		

Conducted RF test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2019	Nov. 23, 2020
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 24, 2019	Nov. 23, 2020
☐	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Nov. 24, 2019	Nov. 23, 2020
☒	MXG X-Series RF Vector Signal Generator	KEYSIGHT	N5182B	MY51350267	Nov. 24, 2019	Nov. 23, 2020

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage	Relative Humidity (%)
NT/NV	+15 to +35	120V~60Hz	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment

Test Item	Temperature (°C)	Relative Humidity (%)	Pressure (kPa)	Tested by
AC Power Line Conducted Emission	25.6	60	99.40	Tripp Jiang
26 dB emission bandwidth	25.3	51	99.80	Swift Liu
Maximum conducted output power	25.3	51	99.80	Swift Liu
Peak Power Spectral Density	25.3	51	99.80	Swift Liu
6 dB bandwidth	25.3	51	99.80	Swift Liu
Dynamic Frequency Selection	25.3	51	99.80	Hank Wu
Radiated Emissions and Band Edge Measurement	25.3	53	100.26	Asia Yan

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
IEEE 802.11a IEEE 802.11n-HT20 IEEE 802.11ac-VHT20	5150 MHz to 5250 MHz	Channel 36	Channel 44	Channel 48
		5180 MHz	5220 MHz	5240 MHz
	5250 MHz to 5350 MHz	Channel 52	Channel 60	Channel 64
		5260 MHz	5300 MHz	5320 MHz
	5470 MHz to 5725 MHz	Channel 100	Channel 116	Channel 140
		5500 MHz	5580 MHz	5700 MHz
	5725 MHz to 5850 MHz	Channel 149	Channel 157	Channel 165
		5745 MHz	5785 MHz	5825 MHz
IEEE 802.11n-HT40 IEEE 802.11ac-VHT40	5150 MHz to 5250 MHz	Channel 38	--	Channel 46
		5190 MHz	--	5230 MHz
	5250 MHz to 5350 MHz	Channel 54	--	Channel 62
		5270 MHz	--	5310 MHz
	5470 MHz to 5725 MHz	Channel 102	Channel 110	Channel 134
		5510 MHz	5550 MHz	5670 MHz
	5725 MHz to 5850 MHz	Channel 151	--	Channel 159
		5755 MHz	--	5795 MHz
IEEE 802.11ac-VHT80	5150 MHz to 5250 MHz	--	Channel 42	--
		--	5210 MHz	--
	5250 MHz to 5350 MHz	--	Channel 58	--
		--	5290 MHz	--
	5470 MHz to 5725 MHz	Channel 106	--	Channel 122
		5530 MHz	--	5610 MHz
	5725 MHz to 5850 MHz	--	Channel 155	--
		--	5775 MHz	--

4.3 EUT TEST STATUS

Mode	Tx/Rx Function	Description
IEEE 802.11a/n/ac	1Tx/1Rx or 4Tx/4Rx	1. Keep the EUT in transmitting mode with all kind of modulation and all kind of data rate.

Test Software
Test software name: Engineering mode*#*#3646633#*#*;

Power Setting																
Mode	U-NII-1				U-NII-2A				U-NII-2C				U-NII-3			
	Chain 0	Chain 1	Chain 2	Chain 3	Chain 0	Chain 1	Chain 2	Chain 3	Chain 0	Chain 1	Chain 2	Chain 3	Chain 0	Chain 1	Chain 2	Chain 3
IEEE 802.11a	28	25	2B	28	27	28	2A	28	22	20	24	26	3F	3F	3F	3F
IEEE 802.11n-HT20	1F	1F	1F	1F	1F	1F	1F	1F	1D	1D	1D	1D	3F	3F	3F	3F
IEEE 802.11n-HT40	18	18	18	18	18	18	18	18	18	18	18	18	30	30	30	30
IEEE 802.11ac-VHT20	1F	1F	1F	1F	1F	1F	1F	1F	1D	1D	1D	1D	3F	3F	3F	3F
IEEE 802.11ac-VHT40	18	18	18	18	18	18	18	18	18	18	18	18	30	30	30	30
IEEE 802.11ac-VHT80	18	18	18	18	16	16	16	16	14	14	14	14	23	23	23	23

4.4 PRE-SCAN

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

Mode	Worst-case data rates
IEEE 802.11a	6 Mbps
IEEE 802.11n-HT20	MCS24
IEEE 802.11n-HT40	MCS24
IEEE 802.11ac-VHT20	MCS0
IEEE 802.11ac-VHT40	MCS0
IEEE 802.11ac-VHT80	MCS0

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

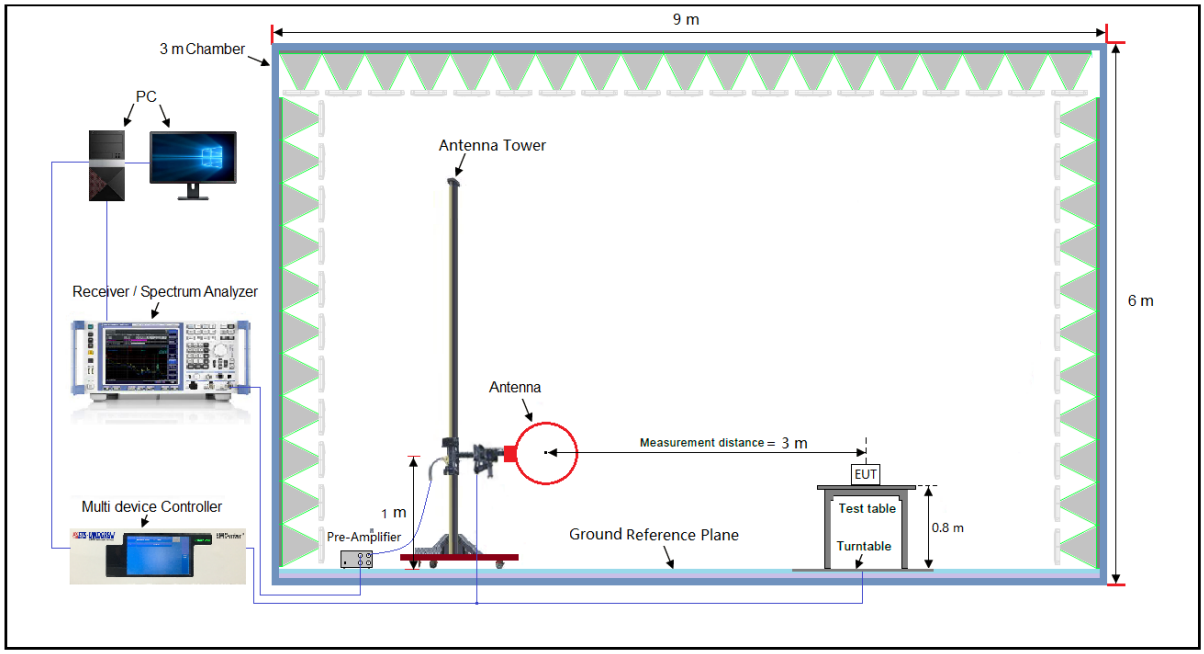


Figure 1. Below 30MHz

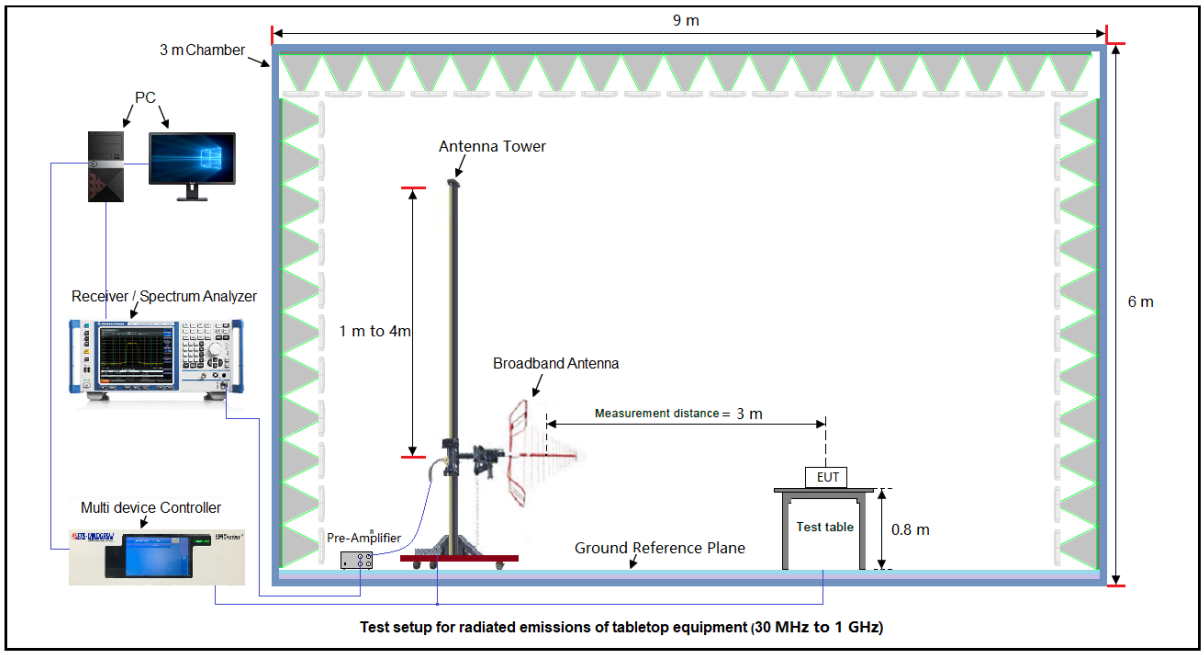


Figure 2. 30MHz to 1GHz

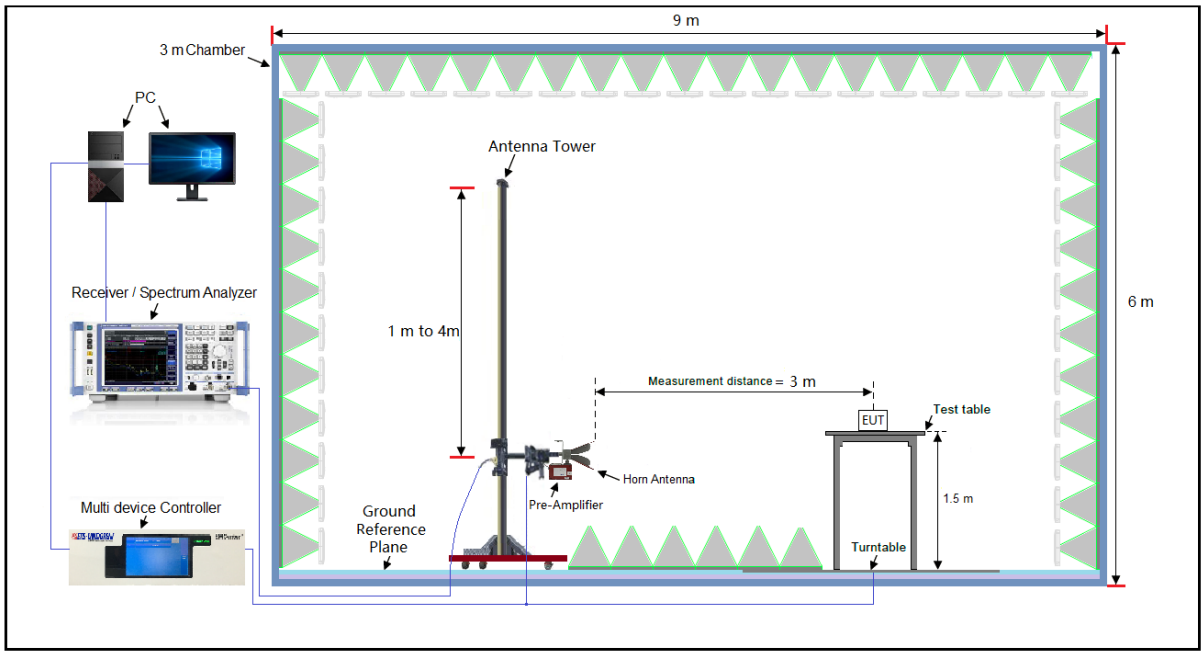
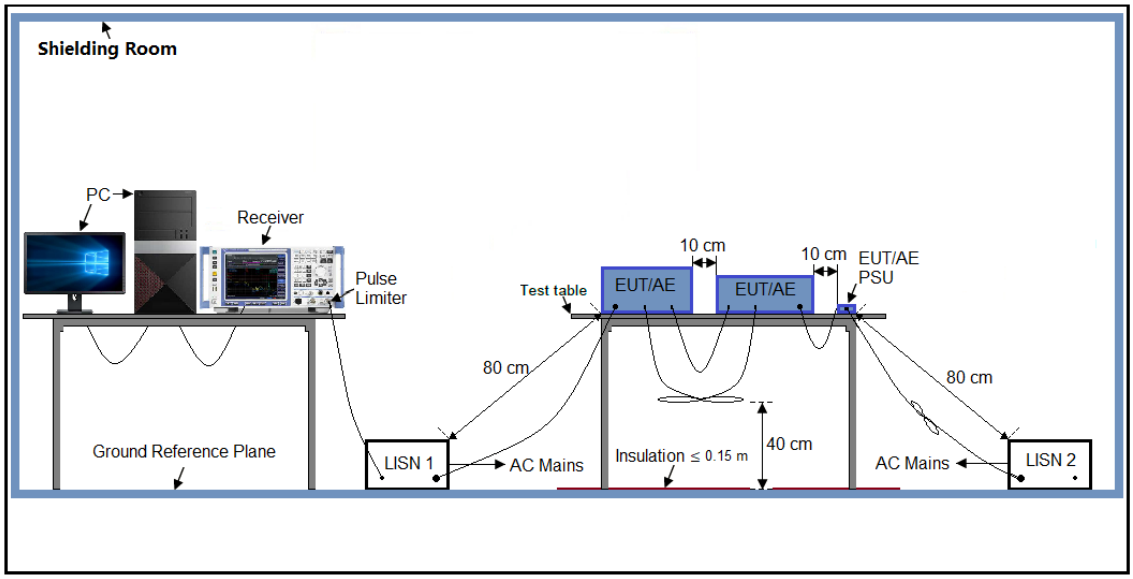
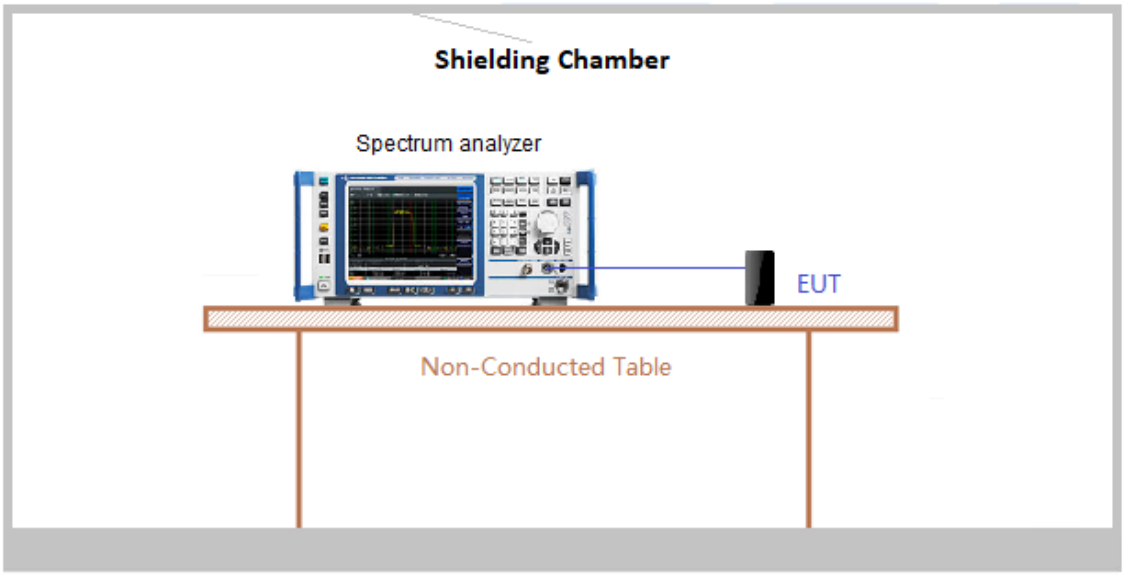


Figure 3. Above 1GHz

4.5.2 For Conducted Emissions test setup



4.5.3 For Conducted RF test setup



Normal Environment

4.6 SYSTEM TEST CONFIGURATION

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

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency	Mode	Antenna Port	Worst-case axis positioning
Above 1GHz	1TX	Chain 0	Y axis
	1TX	Chain 1	Y axis
	1TX	Chain 2	Y axis
	1TX	Chain 3	Y axis
	4TX	Chain 0+1+2+3	Y axis

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

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

4.7 DUTY CYCLE

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

Test Results

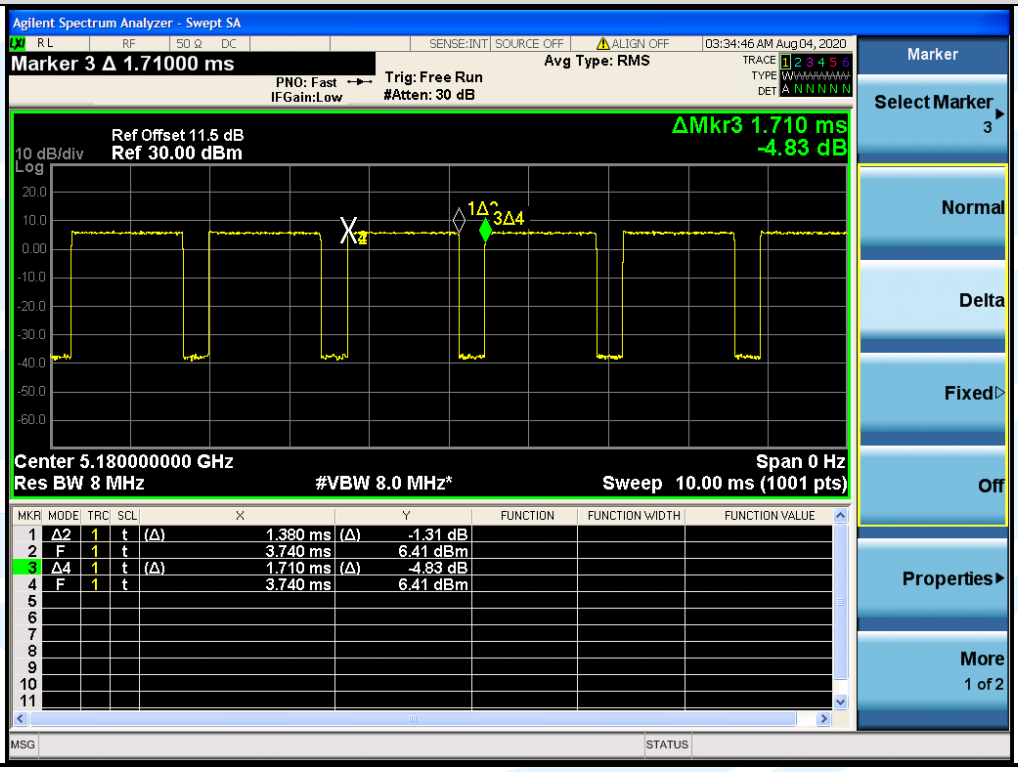
Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11a	6	1.3800	1.7100	0.81	80.70	0.93	0.72	-1.86
IEEE 802.11n-HT20	MCS24	0.3660	0.7080	0.52	51.69	2.87	2.73	-5.73
IEEE 802.11n-HT40	MCS24	0.2040	0.5130	0.40	39.77	4.00	4.90	-8.01
IEEE 802.11ac-VHT20	MCS0	0.3660	0.6990	0.52	52.36	2.81	2.73	-5.62
IEEE 802.11ac-VHT40	MCS0	0.2010	0.5430	0.37	37.02	4.32	4.98	-8.63
IEEE 802.11ac-VHT80	MCS0	0.1200	0.4530	0.26	26.49	5.77	8.33	-11.54

Remark:

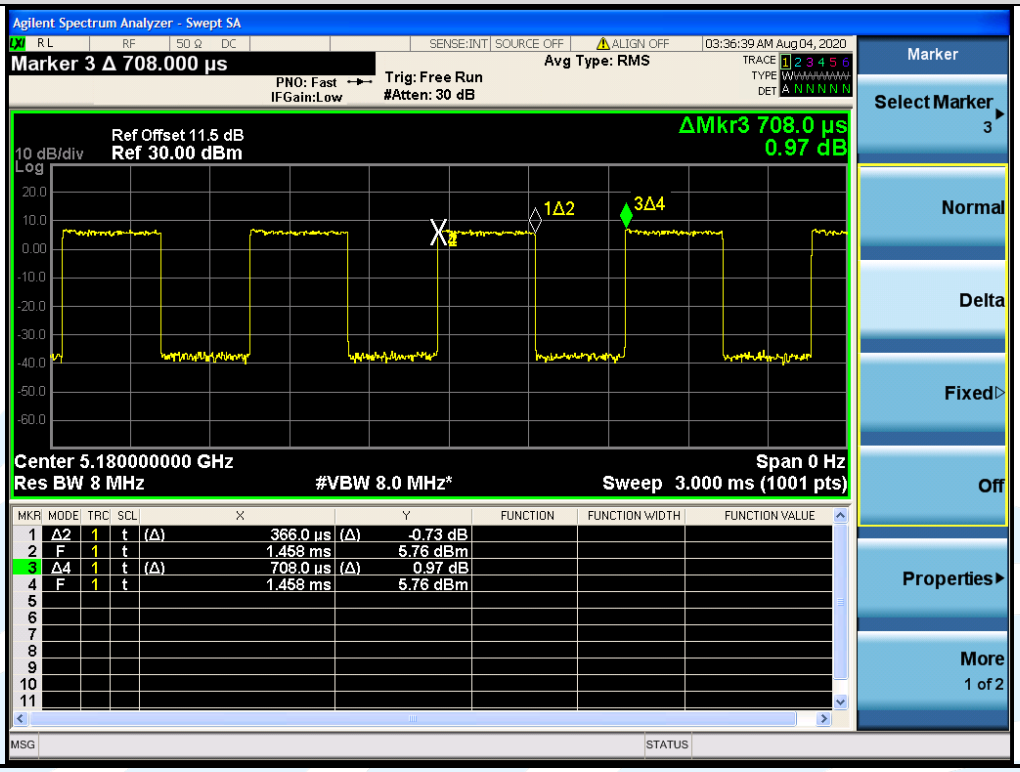
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plots as follows

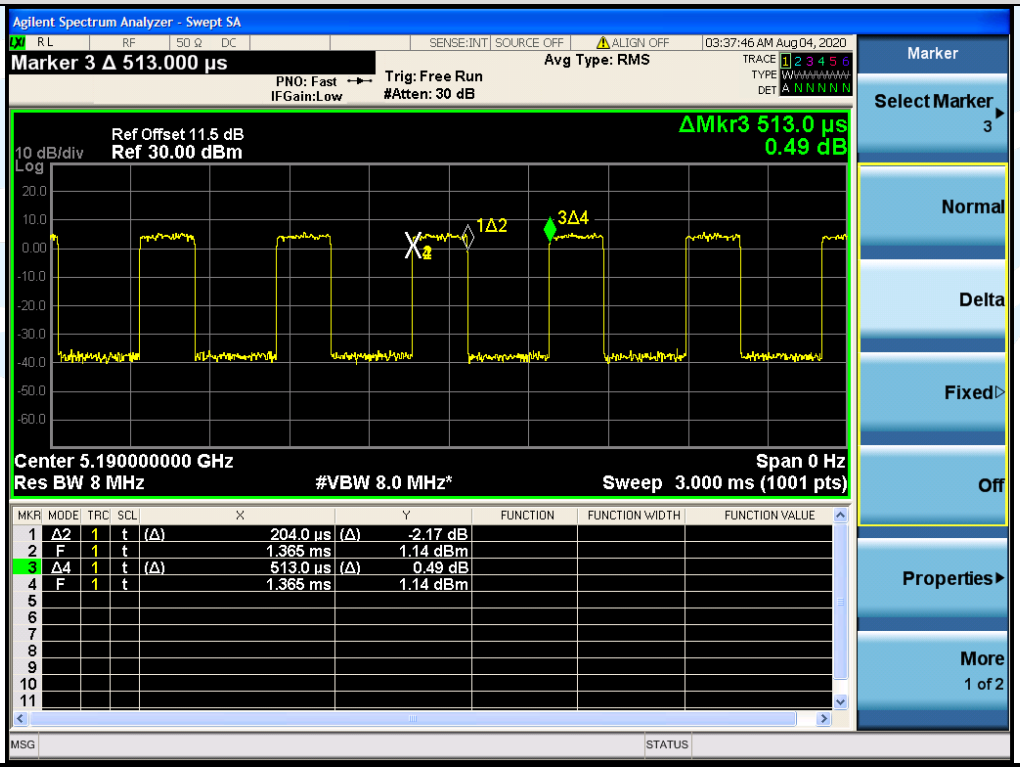
IEEE 802.11a



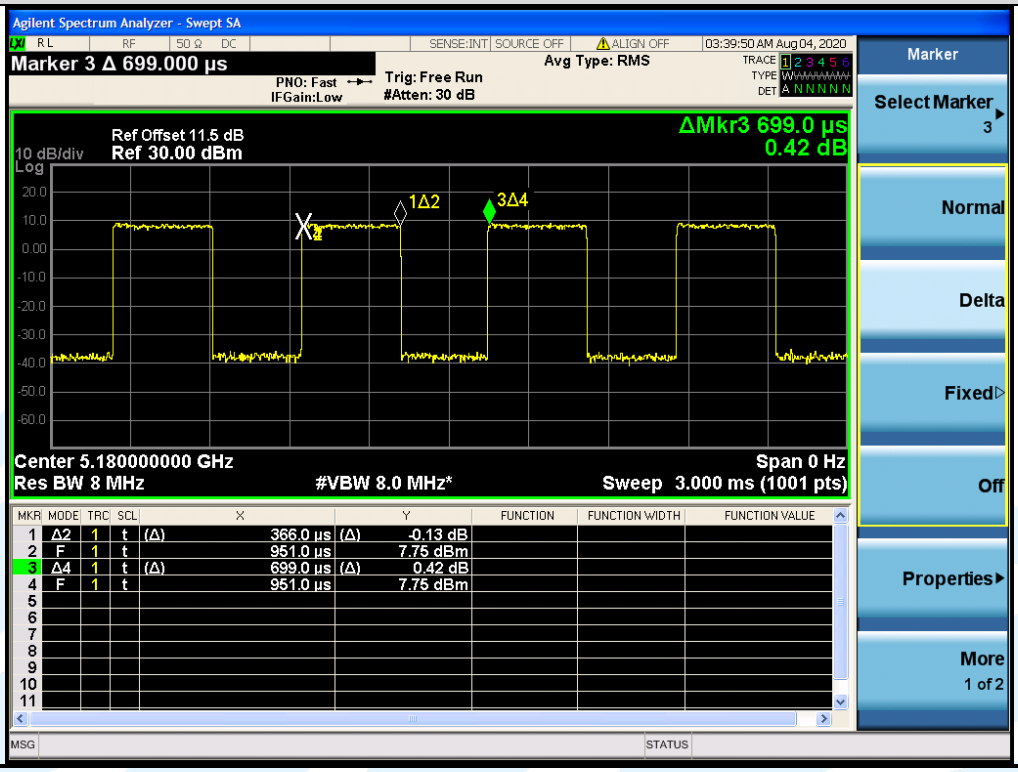
IEEE 802.11n-HT20



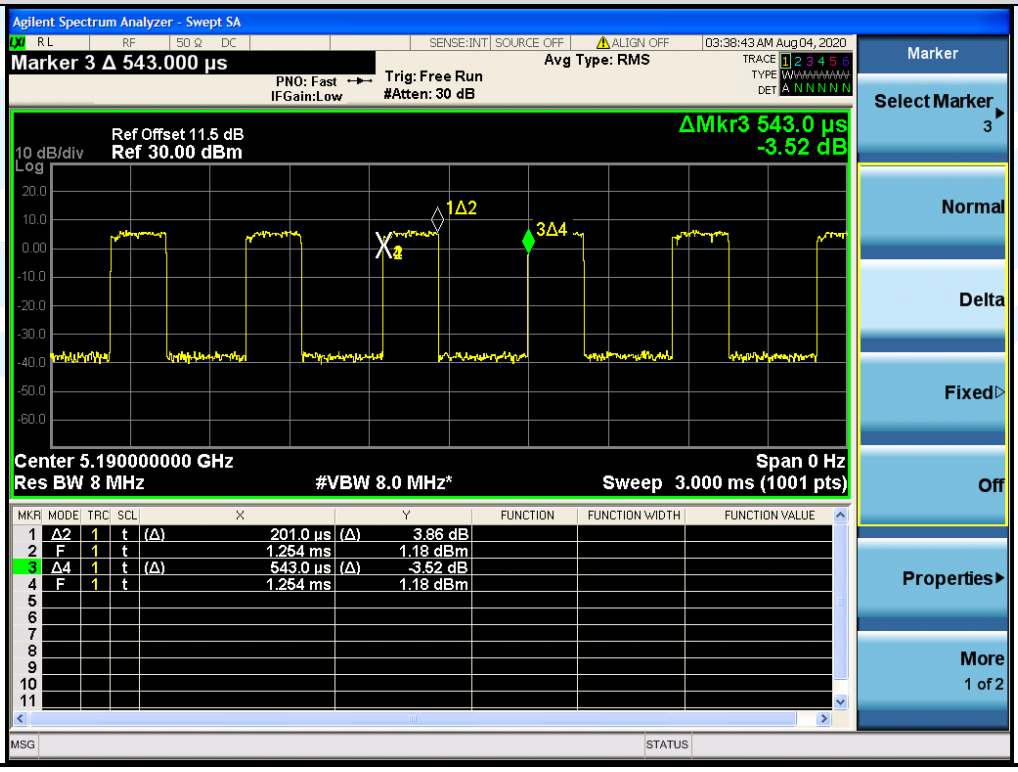
IEEE 802.11n-HT40



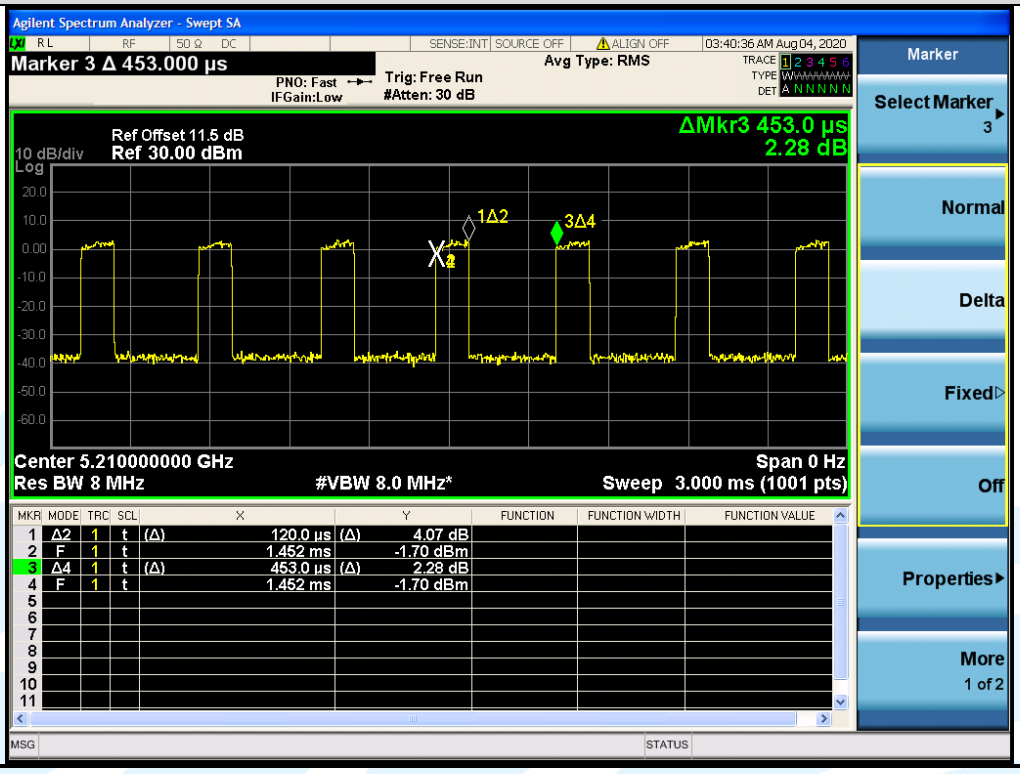
IEEE 802.11ac-VHT20



IEEE 802.11ac-VHT40



IEEE 802.11ac-VHT80



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

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

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. **15.407(a)(1) (2) requirement:** The conducted output power limit specified in paragraph (a) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (a) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power and the peak power spectral density shall be reduced by the by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
EUT Antenna:
The antenna has a special interface and no consideration of replacement. The transmit signals are correlated with each other and the antenna gain of four chains is completely consistent, the best case directional gain of the antenna is 11.02 dBi (See section 5.5).

5.3 26 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a) (2)(5)
Test Method: KDB 789033 D02 v02r01 Section C.1
Limit: None; for reporting purposes only.

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

Spectrum analyzer according to the following Settings:
a) Set RBW = approximately 1 % of the emission bandwidth.
b) Set the VBW > RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1 %.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.
Test Setup: Refer to section 4.5.3 for details.
Instruments Used: Refer to section 3 for details
Test Mode: Transmitter mode
Test Results: Pass

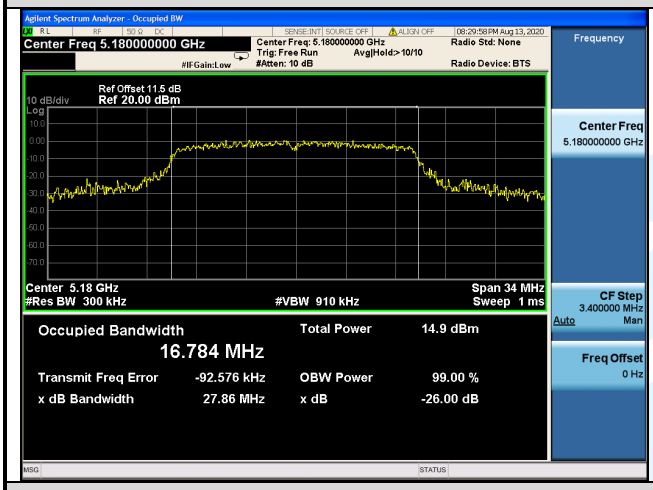
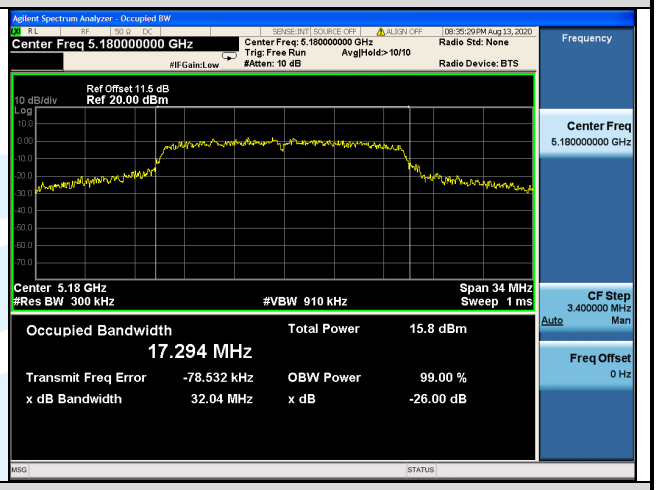
Mode	Channel	26 dB Bandwidth (MHz)		99% Bandwidth (MHz)	
		Chain 0	Chain 1	Chain 0	Chain 1
IEEE 802.11a	36 (5180)	27.86	32.04	16.784	17.294
	44 (5220)	27.59	28.03	16.776	16.918
	48 (5240)	26.17	28.17	16.798	16.863
	52 (5260)	28.05	30.84	16.774	17.271
	60 (5300)	23.38	27.09	16.724	16.816
	64 (5320)	27.65	27.62	16.696	16.808
	100 (5500)	29.69	33.33	16.947	17.338
	116 (5580)	26.85	27.85	16.692	16.884
	140 (5700)	29.47	30.23	17.042	17.585
IEEE 802.11n-HT20	36 (5180)	32.15	33.97	18.002	19.128
	44 (5220)	24.51	30.60	17.821	18.196
	48 (5240)	24.55	28.05	17.751	17.955
	52 (5260)	28.27	31.86	17.784	18.800
	60 (5300)	27.67	31.58	17.815	18.010
	64 (5320)	23.61	30.25	17.693	17.996
	100 (5500)	22.66	22.24	17.678	17.626
	116 (5580)	20.91	19.98	17.698	17.751
	140 (5700)	32.91	29.96	18.048	17.672
IEEE 802.11n-HT40	38 (5190)	40.24	40.68	35.962	36.126
	46 (5230)	40.57	39.56	36.051	36.128
	54 (5270)	40.27	40.49	36.010	36.287
	62 (5310)	40.84	39.60	35.959	36.099
	102 (5510)	40.24	39.84	36.139	36.094
	118 (5590)	40.48	40.30	36.053	36.061
	134 (5670)	41.19	39.97	36.096	36.138

IEEE 802.11ac-VHT20	36 (5180)	28.40	32.03	17.911	18.609
	44 (5220)	25.16	31.38	17.800	18.148
	48 (5240)	25.28	26.53	17.687	17.866
	52 (5260)	28.79	33.11	17.899	19.930
	60 (5300)	26.99	30.25	17.737	17.922
	64 (5320)	21.60	27.33	17.699	17.919
	100 (5500)	22.21	26.94	17.707	17.718
	116 (5580)	22.96	21.73	17.645	17.596
	140 (5700)	31.78	25.76	18.112	17.942
IEEE 802.11ac-VHT40	38 (5190)	40.37	50.61	36.074	36.196
	46 (5230)	39.93	44.79	35.988	35.896
	54 (5270)	40.18	53.62	35.996	36.259
	62 (5310)	40.91	47.19	35.977	36.263
	102 (5510)	40.45	40.44	35.976	36.086
	118 (5590)	40.30	40.00	36.026	36.168
	134 (5670)	39.82	40.60	36.069	35.941
IEEE 802.11ac-VHT80	42 (5230)	81.79	108.5	75.653	75.713
	58 (5290)	80.76	92.49	75.587	75.813
	106 (5530)	80.74	80.39	75.680	75.516
	122 (5610)	80.89	94.85	75.604	75.607

Mode	Channel	26 dB Bandwidth (MHz)		99% Bandwidth (MHz)	
		Chain 2	Chain 3	Chain 2	Chain 3
IEEE 802.11a	36 (5180)	30.04	26.36	17.329	16.630
	44 (5220)	26.46	26.46	16.634	16.583
	48 (5240)	23.67	20.99	16.650	16.563
	52 (5260)	28.84	28.48	16.971	16.682
	60 (5300)	27.08	24.70	16.751	16.584
	64 (5320)	25.87	25.01	16.734	16.621
	100 (5500)	32.72	28.12	17.330	16.712
	116 (5580)	33.70	26.43	17.312	16.700
	140 (5700)	33.17	27.51	18.361	16.756
IEEE 802.11n-HT20	36 (5180)	33.97	29.67	22.677	17.781
	44 (5220)	32.71	26.96	19.269	17.762
	48 (5240)	30.70	22.15	18.114	17.662
	52 (5260)	29.85	24.66	18.179	17.803
	60 (5300)	29.91	24.02	17.861	17.775
	64 (5320)	25.03	24.66	17.778	17.737
	100 (5500)	20.43	20.44	17.700	17.626
	116 (5580)	20.17	24.29	17.709	17.658
	140 (5700)	29.73	20.37	18.009	17.615
IEEE 802.11n-HT40	38 (5190)	48.25	39.58	36.177	36.023
	46 (5230)	40.88	40.22	36.002	35.888
	54 (5270)	40.22	40.07	36.079	35.865
	62 (5310)	39.80	39.46	35.989	35.909
	102 (5510)	40.61	39.80	36.129	36.035

	118 (5590)	40.64	40.25	36.184	35.983
	134 (5670)	40.23	40.59	36.076	36.018
IEEE 802.11ac-VHT20	36 (5180)	33.92	23.51	22.593	17.704
	44 (5220)	33.31	21.64	18.437	17.660
	48 (5240)	31.49	21.85	17.948	17.660
	52 (5260)	28.34	24.90	18.016	17.812
	60 (5300)	28.84	23.29	17.830	17.704
	64 (5320)	24.93	20.46	17.775	17.696
	100 (5500)	19.85	20.35	17.717	17.595
	116 (5580)	20.30	19.96	17.668	17.631
	140 (5700)	29.93	20.21	17.954	17.642
IEEE 802.11ac-VHT40	38 (5190)	52.87	39.59	36.254	35.942
	46 (5230)	50.10	40.31	36.009	35.961
	54 (5270)	40.14	39.82	36.015	35.937
	62 (5310)	39.72	39.96	36.032	35.966
	102 (5510)	52.39	39.96	36.150	35.907
	118 (5590)	40.97	39.99	36.183	35.936
	134 (5670)	47.35	39.38	36.091	36.085
IEEE 802.11ac-VHT80	42 (5230)	109.70	81.40	75.899	75.539
	58 (5290)	80.33	80.06	75.736	75.552
	106 (5530)	103.70	81.12	75.972	75.611
	122 (5610)	100.30	80.64	75.750	75.597

The test plots as follows:

IEEE 802.11a	
Chain 0	**Chain 1**
Channel 36	
	
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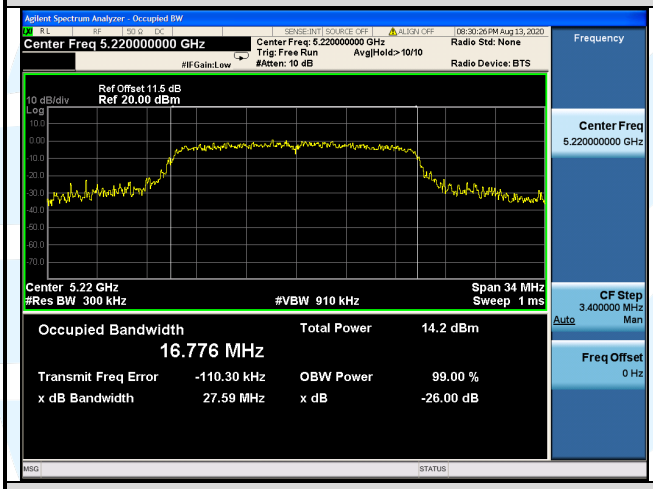	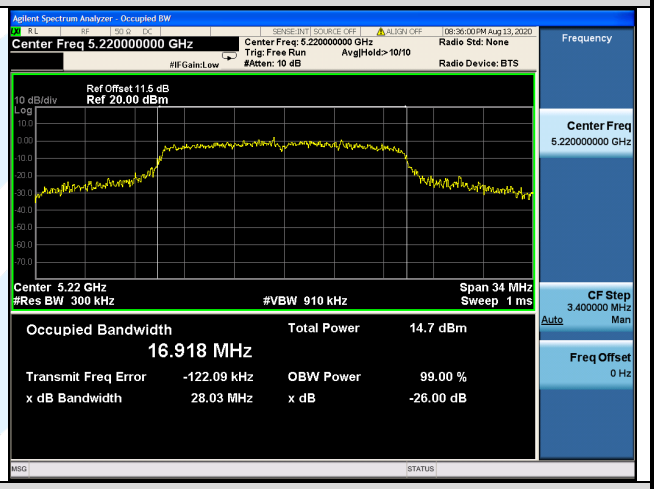
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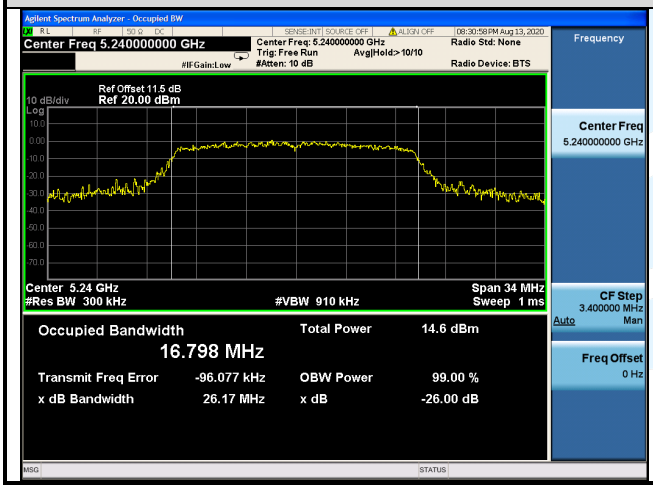
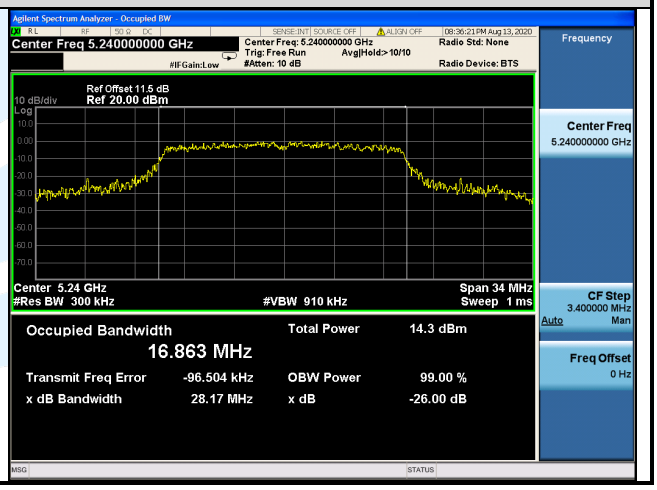
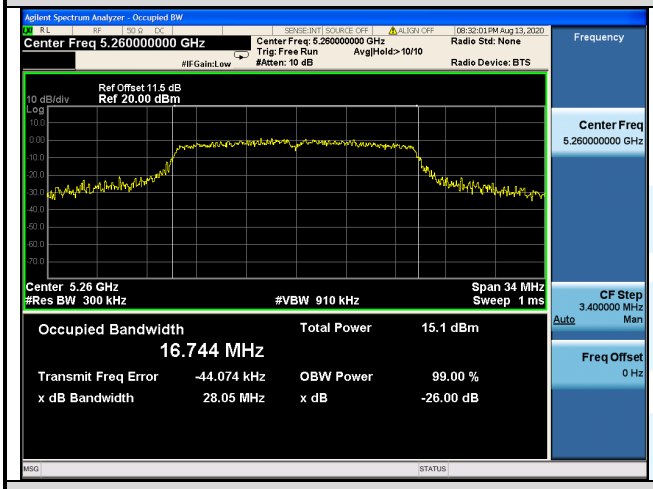
	

IEEE 802.11a

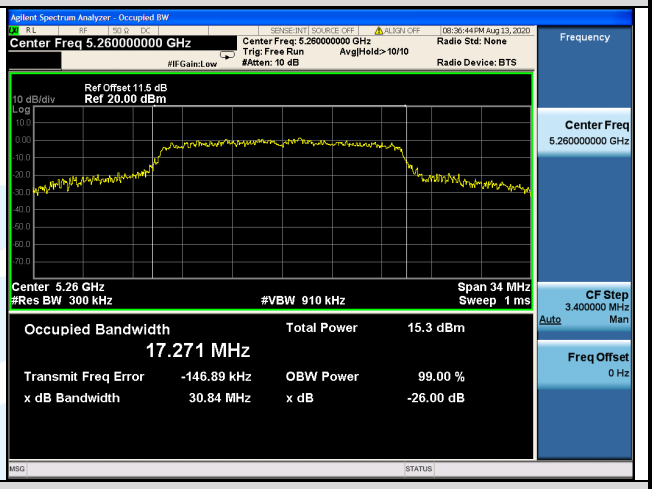
Chain 0

Channel 52



Chain 1

Channel 52



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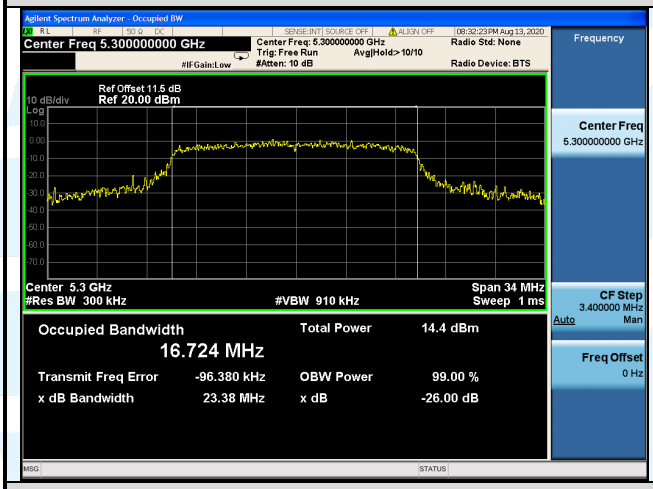

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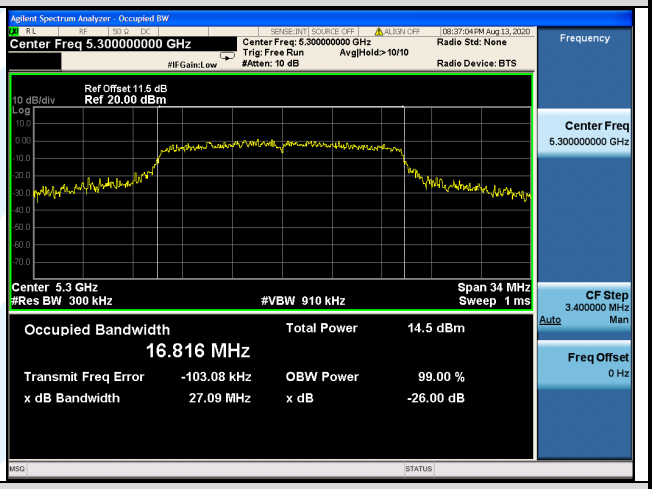
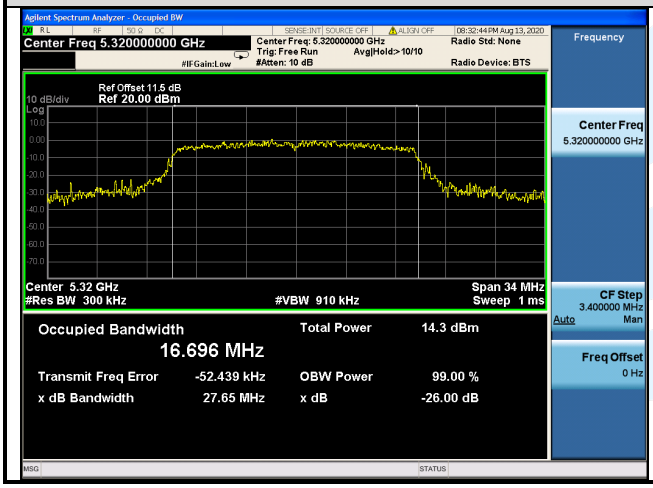
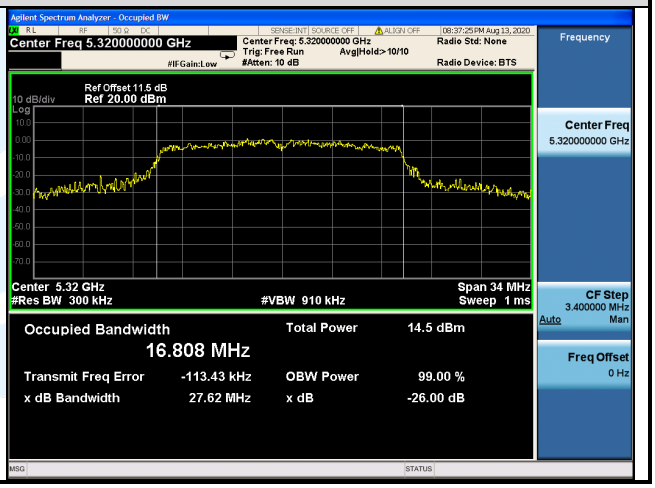


Channel 64



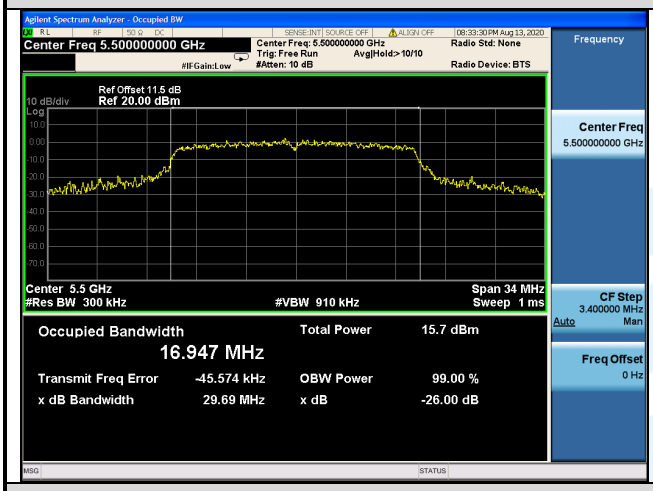
Channel 64



IEEE 802.11a

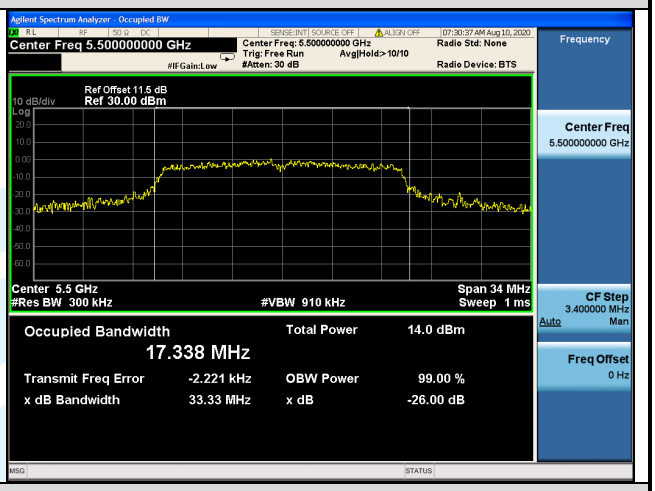
Chain 0

Channel 100

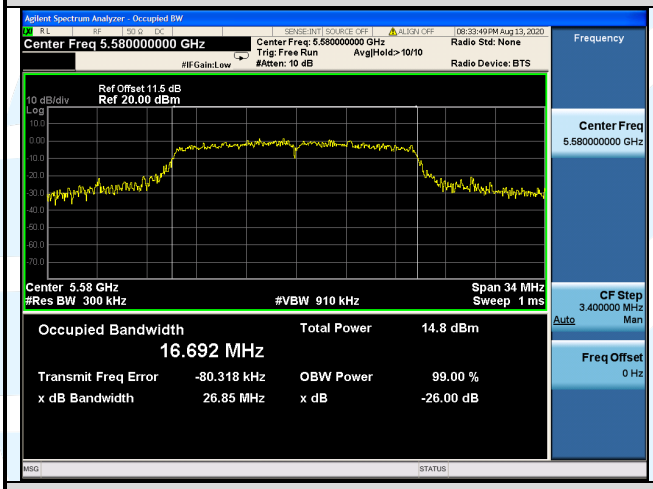


Chain 1

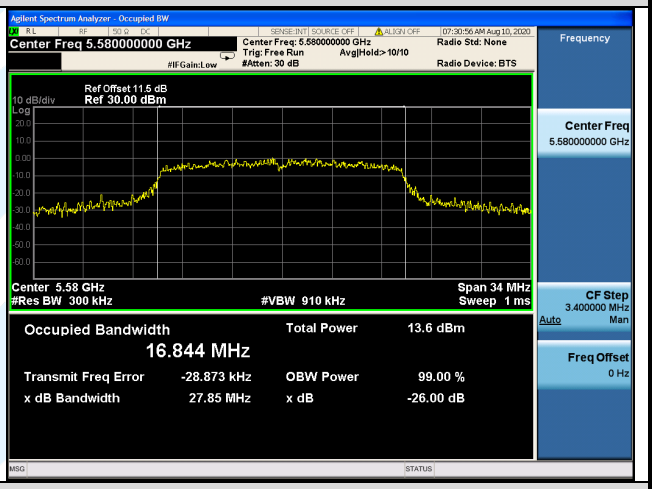
Channel 100



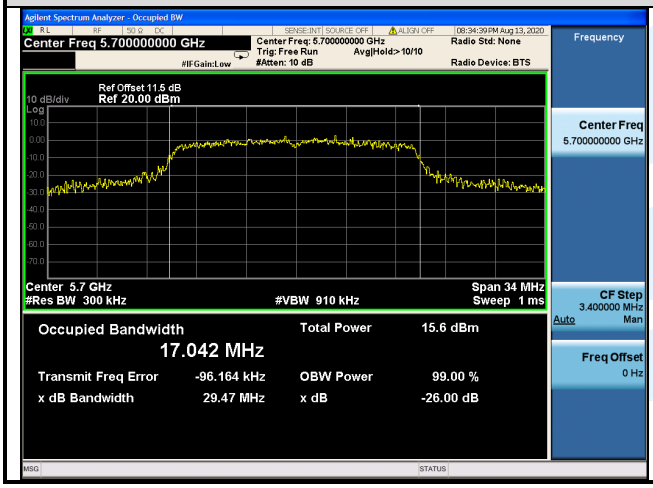
Channel 116



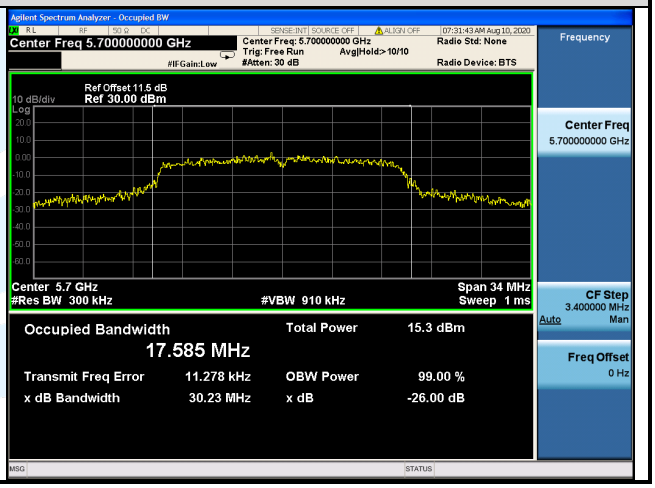
Channel 116



Channel 140



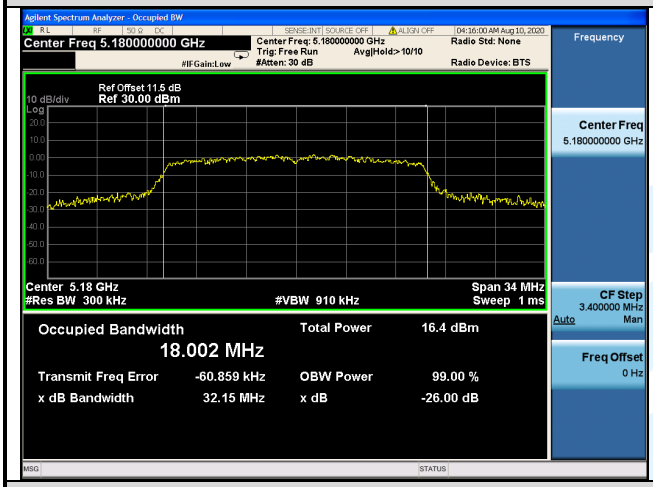
Channel 140



IEEE 802.11n-HT20

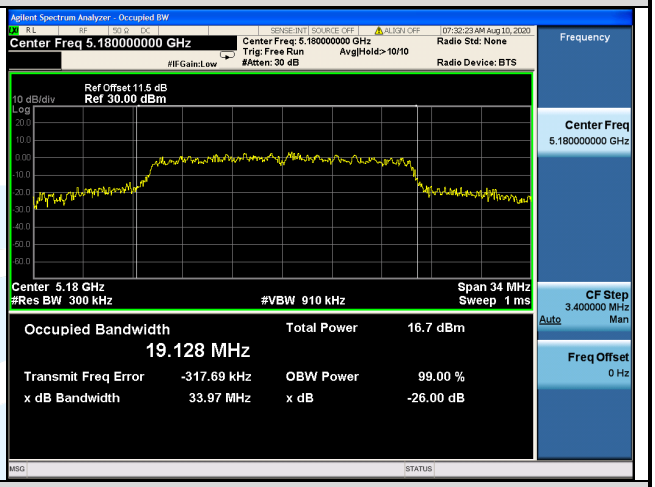
Chain 0

Channel 36

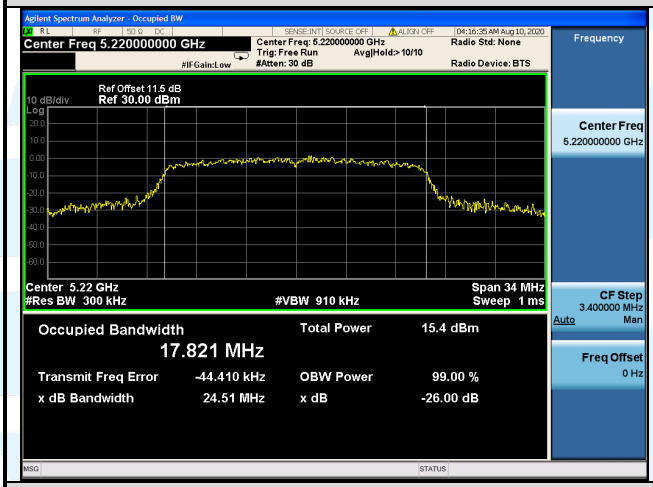


Chain 1

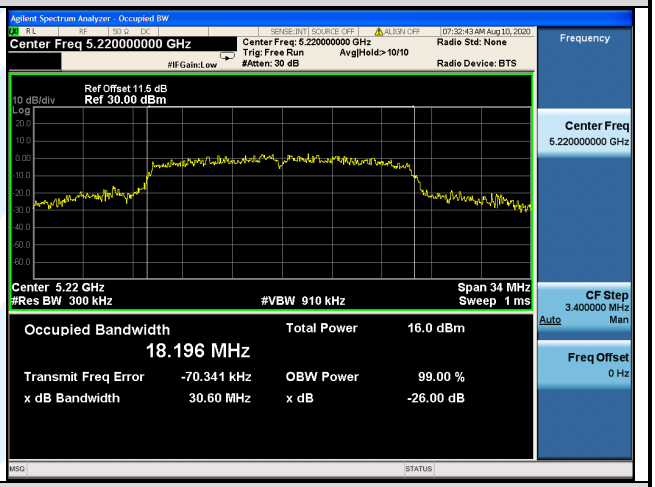
Channel 36



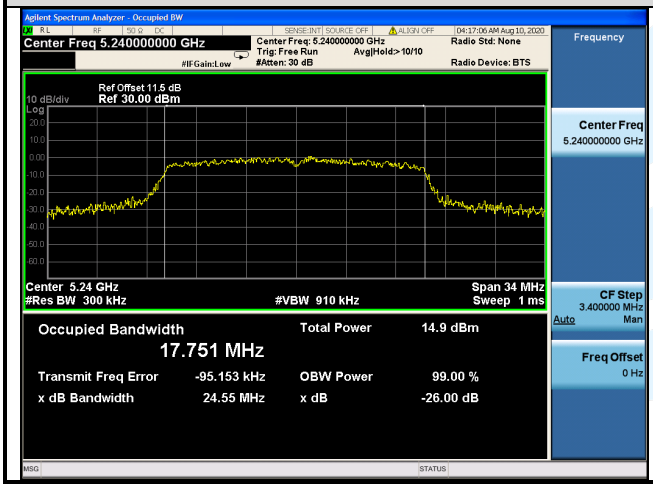
Channel 44



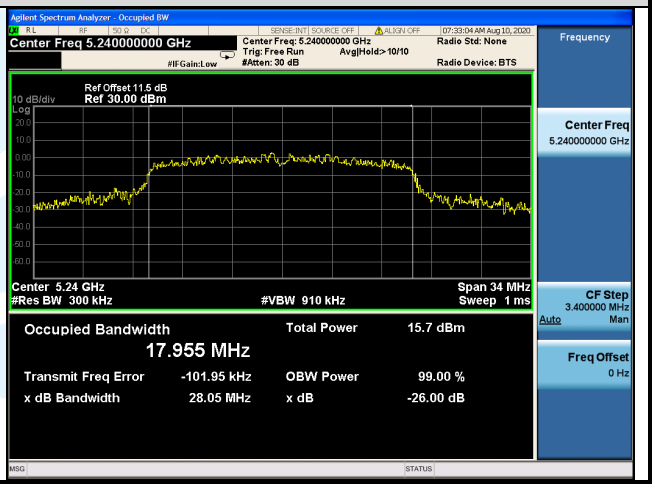
Channel 44



Channel 48



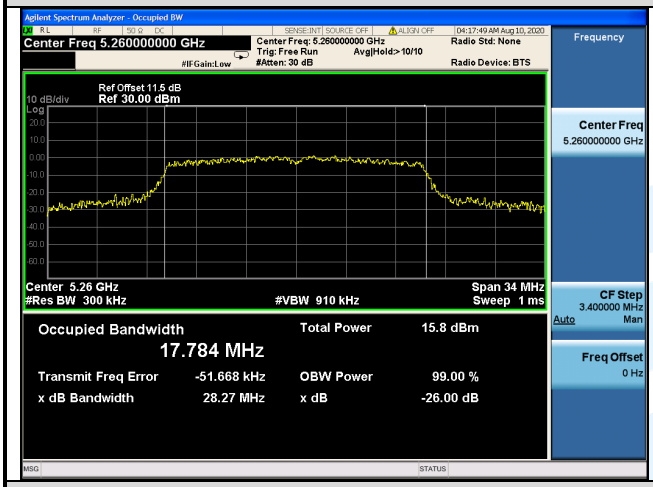
Channel 48

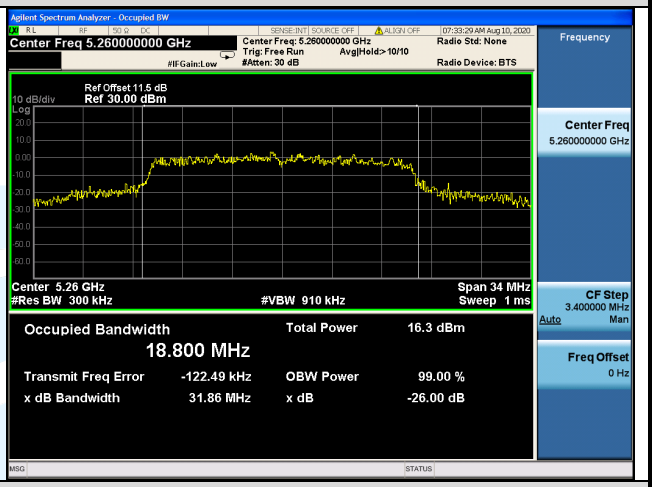


IEEE 802.11n-HT20

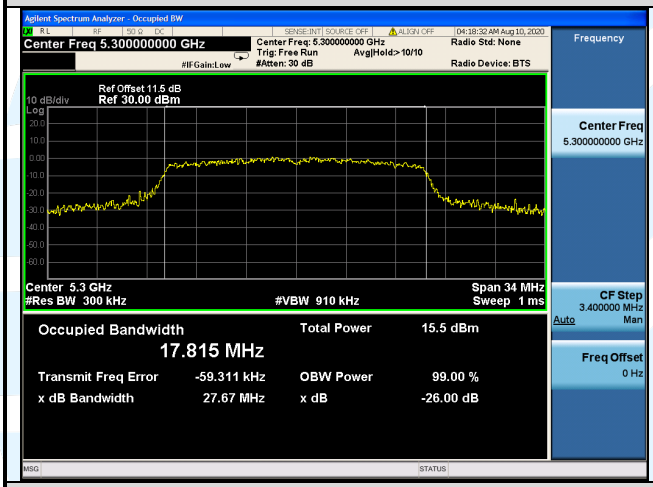
Chain 0	Chain 1

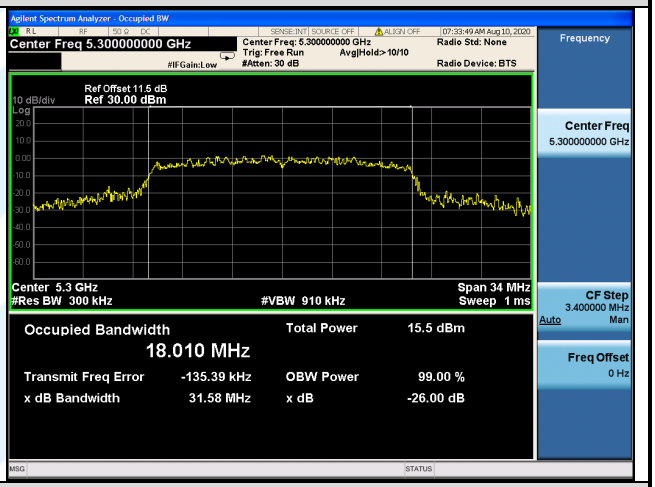
Channel 52



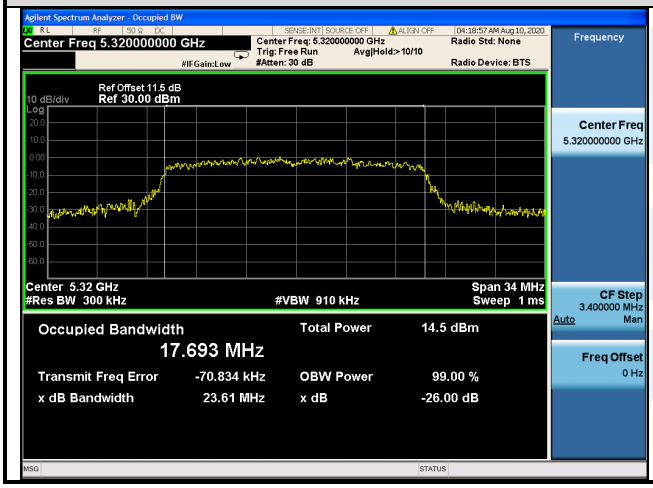


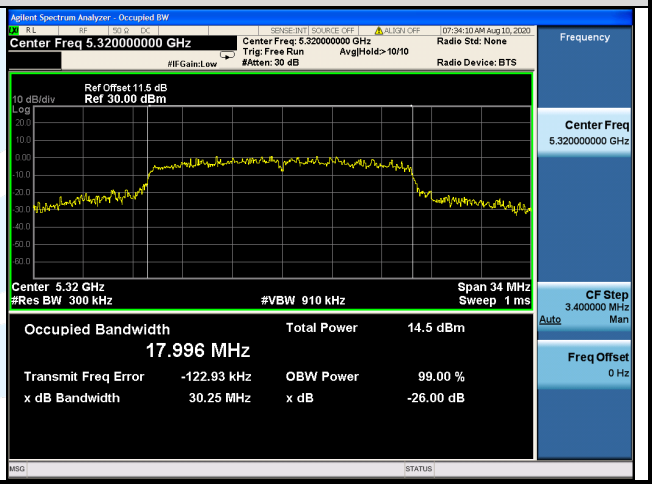
Channel 60





Channel 64

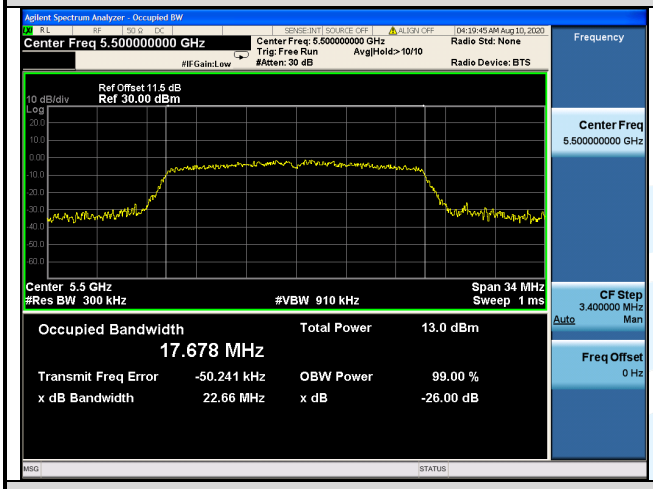




IEEE 802.11n-HT20

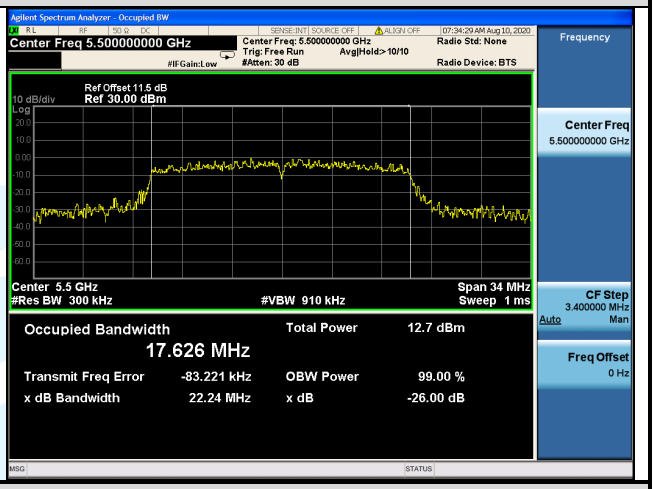
Chain 0

Channel 100

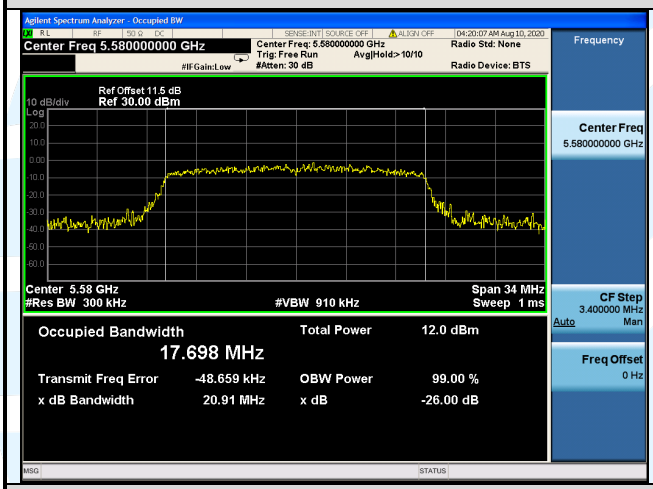


Chain 1

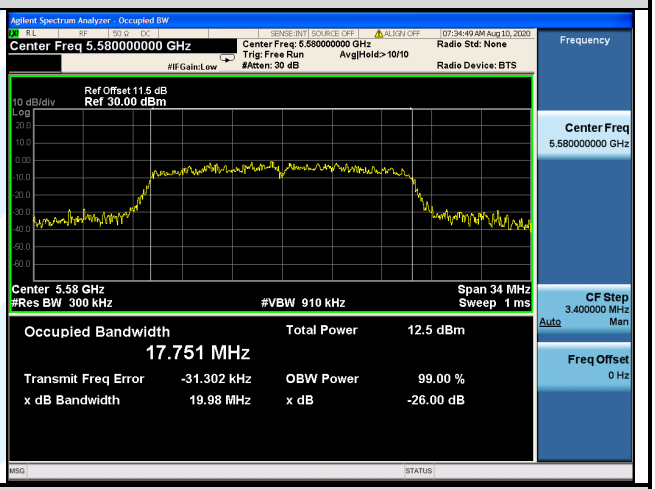
Channel 100



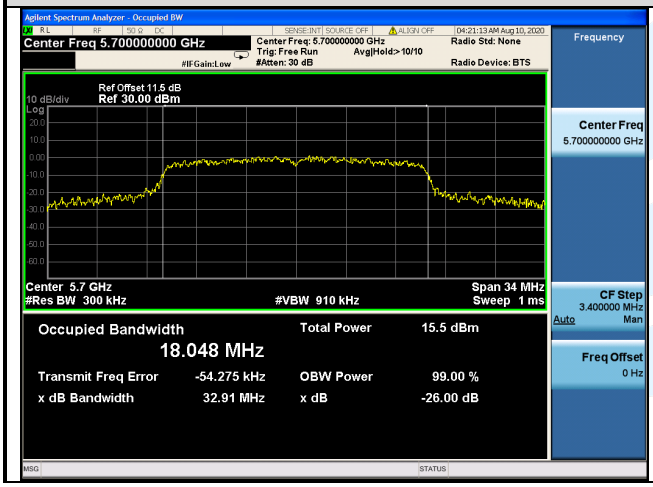
Channel 116



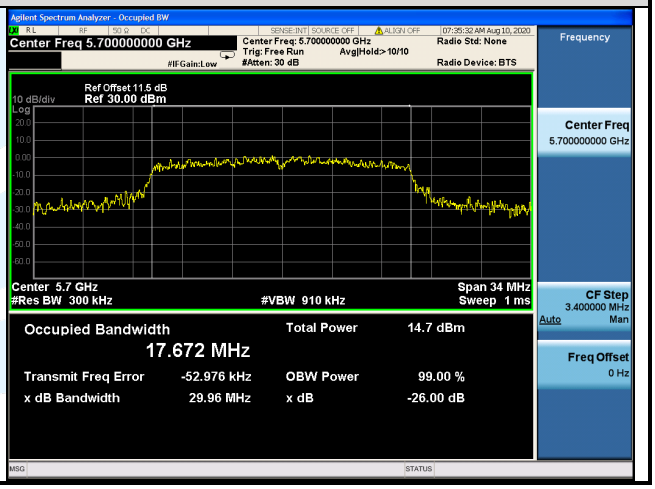
Channel 116



Channel 140



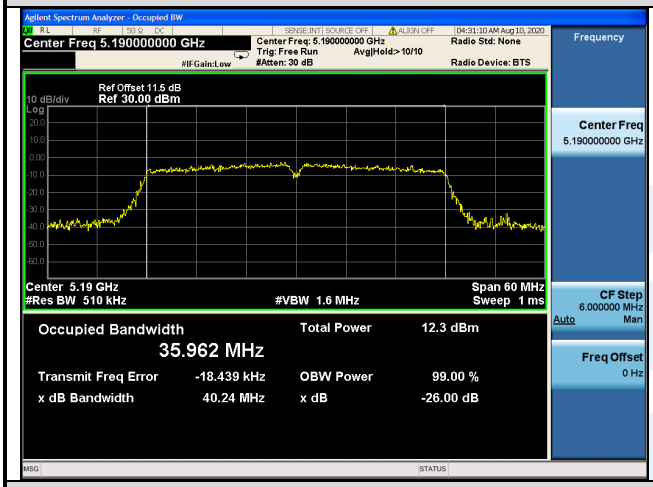
Channel 140



IEEE 802.11n-HT40

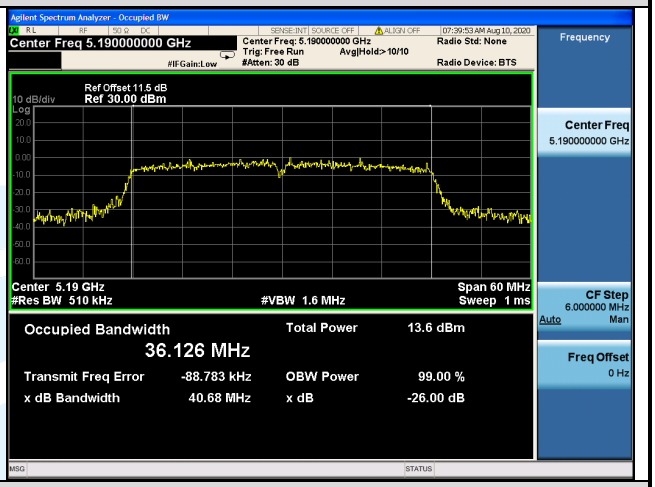
Chain 0

Channel 38

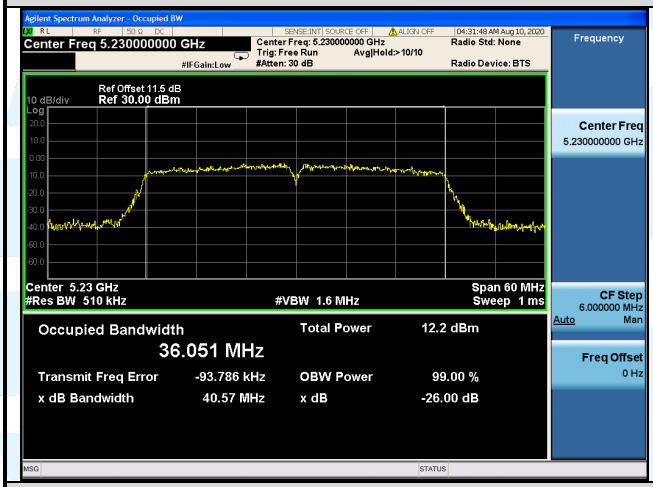


Chain 1

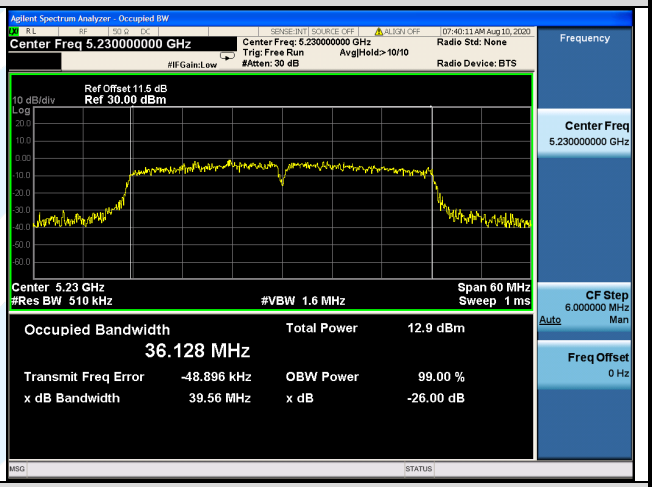
Channel 38



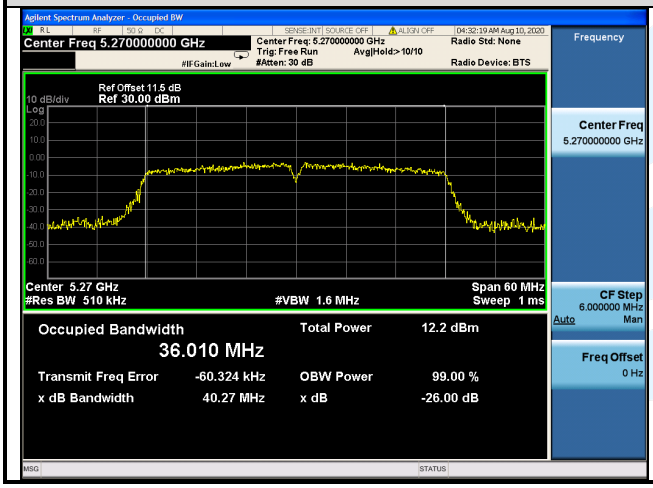
Channel 46



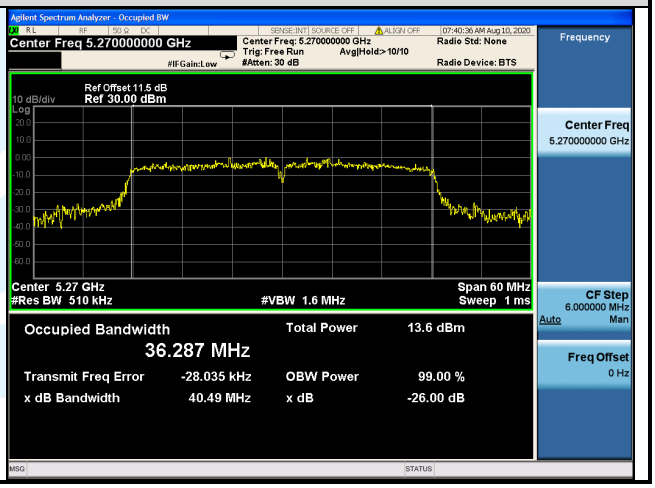
Channel 46



Channel 54



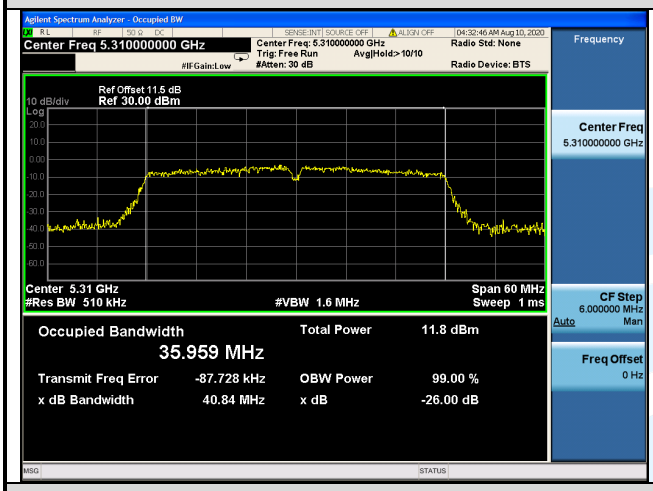
Channel 54



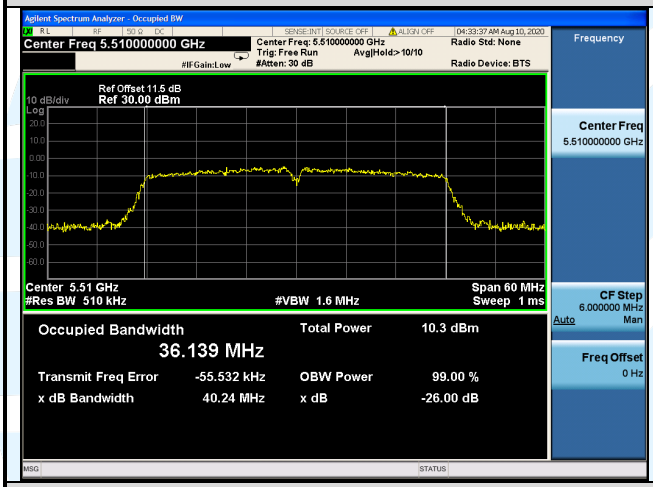
IEEE 802.11n-HT40

Chain 0

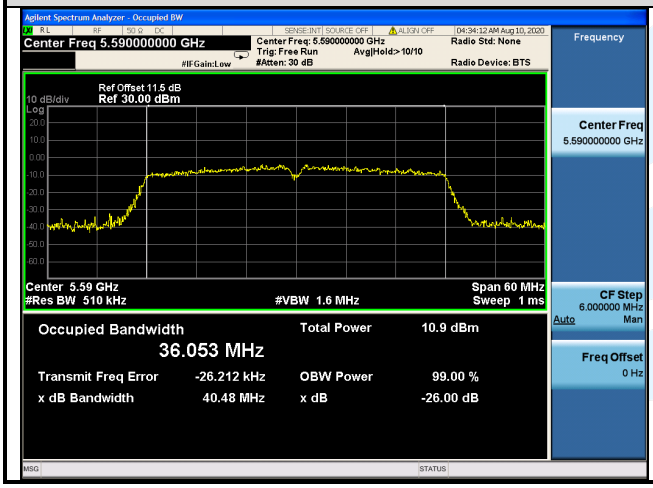
Channel 62



Channel 102

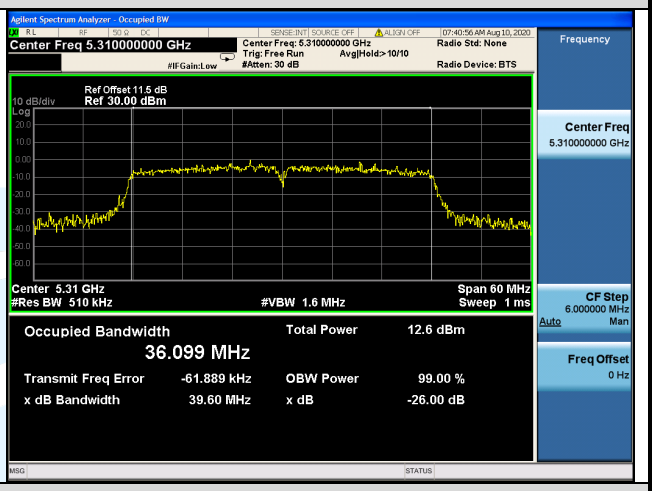


Channel 118

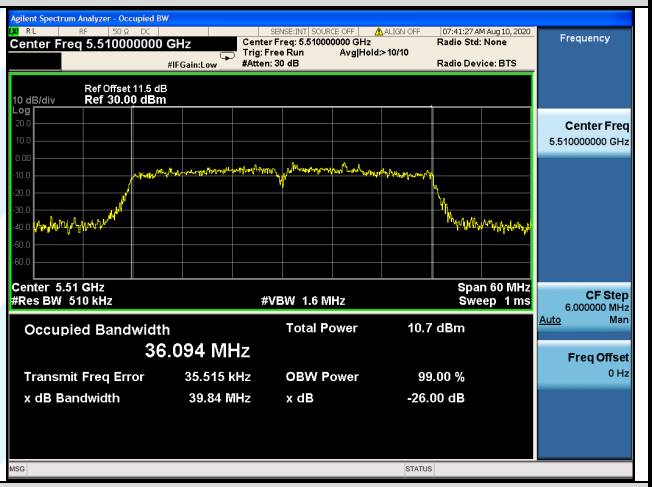


Chain 1

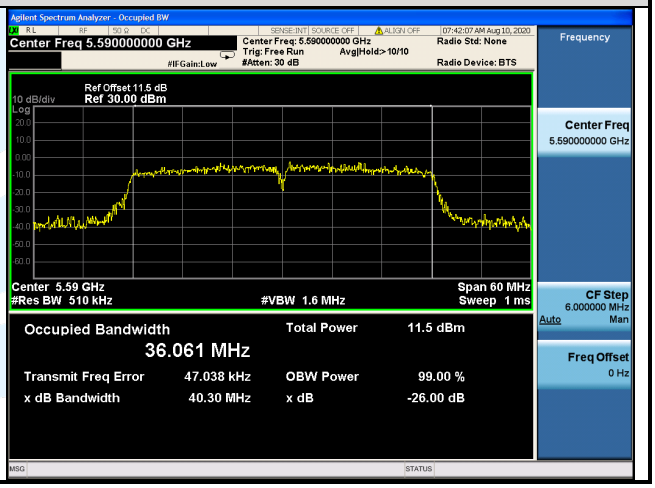
Channel 62



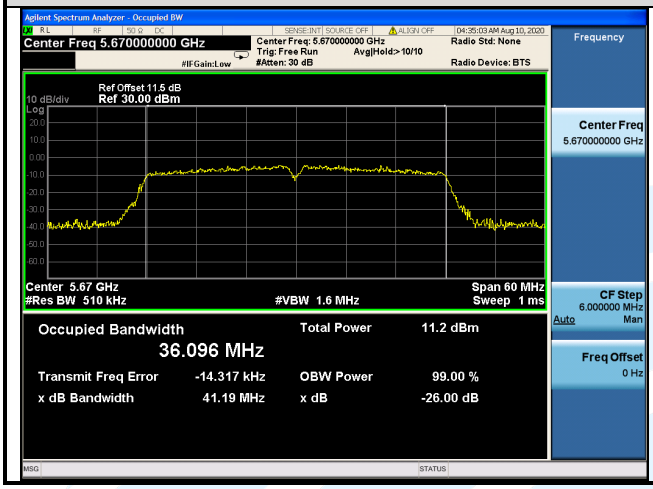
Channel 102

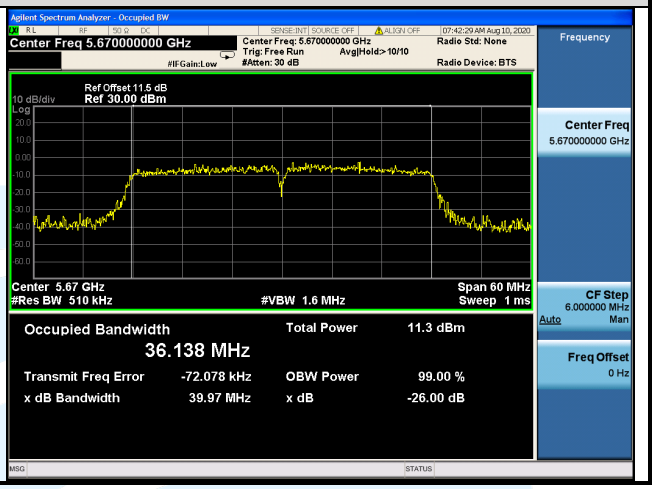


Channel 118



IEEE 802.11n-HT40	
Chain 0	Chain 1
Channel 134	

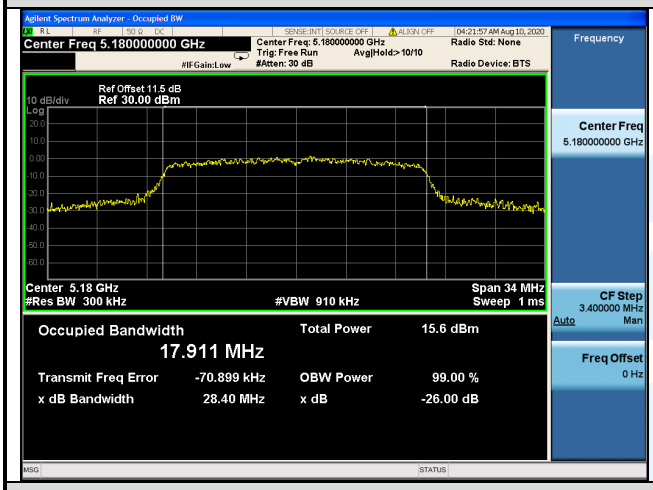




IEEE 802.11ac-VHT20

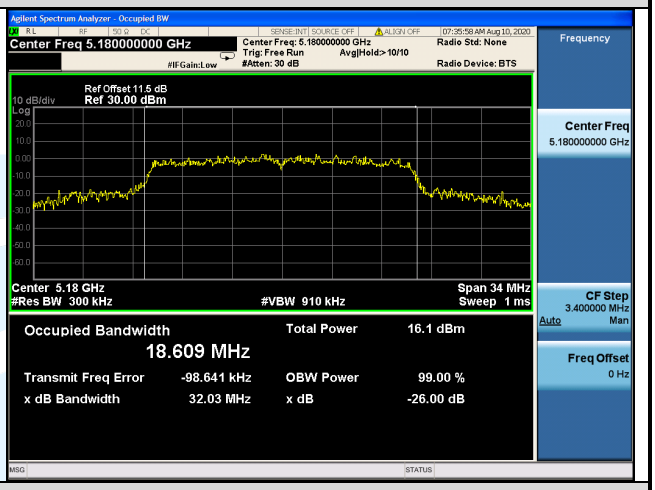
Chain 0

Channel 36

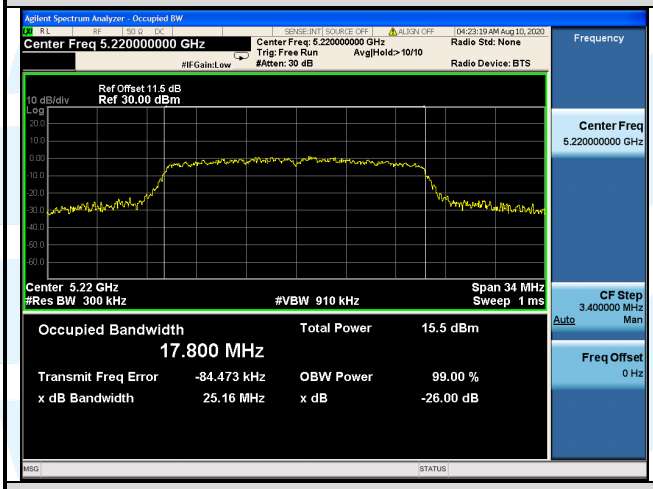


Chain 1

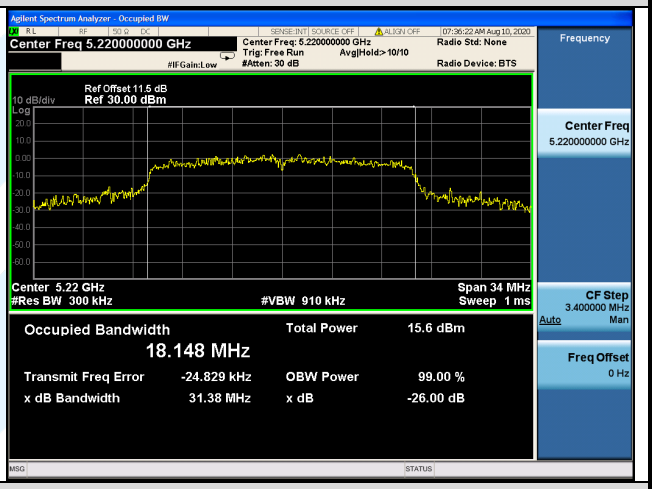
Channel 36



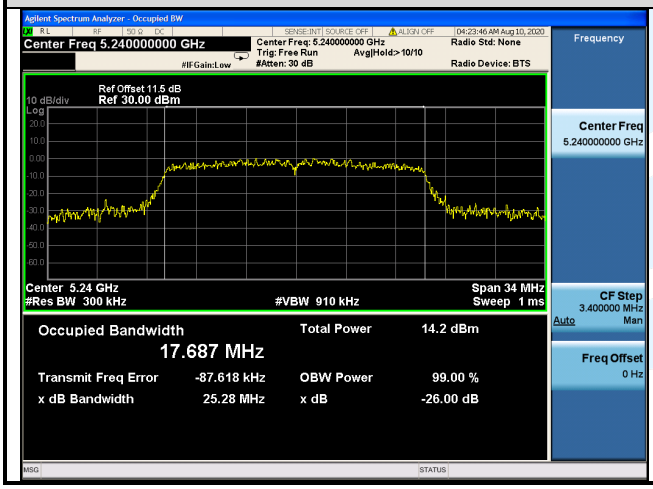
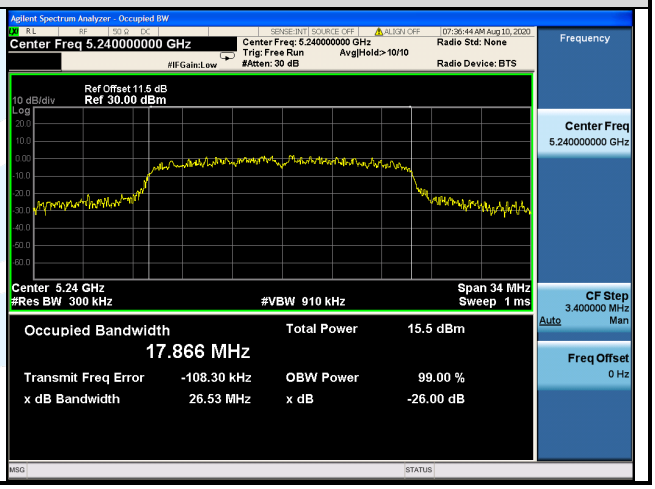
Channel 44



Channel 44



Channel 48



Channel 48