TEST REPORT

Product Name:	Vision MARK-1
Trade Mark:	N/A
Model No. / HVIN:	Vision MARK-1
Report Number:	210125061RFC-3
Test Standards:	FCC 47 CFR Part 15 Subpart E RSS-247 Issue 2 RSS-Gen Issue 5
FCC ID:	2AYS7-MARK1
IC:	27077-MARK1
Test Result:	PASS
Date of Issue:	May 7, 2021

Prepared for:

Insituware LLC
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Prepared by:

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Date: May 7, 2021

UnionTrust Laboratories UnionTrust *Certified*

Version

Version No.	Date	Description
V1.0	May 7, 2021	Original

CONTENTS

1. GENERAL INFORMATION 4
   1.1 CLIENT INFORMATION 4
   1.2 EUT INFORMATION 4
      1.2.1 GENERAL DESCRIPTION OF EUT 4
      1.2.2 DESCRIPTION OF ACCESSORIES 4
   1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD 5
   1.4 OTHER INFORMATION 6
   1.5 DESCRIPTION OF SUPPORT UNITS 6
   1.6 TEST LOCATION 7
   1.7 TEST FACILITY 7
   1.8 DEVIATION FROM STANDARDS 7
   1.9 ABNORMALITIES FROM STANDARD CONDITIONS 7
   1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER 7
   1.11 MEASUREMENT UNCERTAINTY 8
2. TEST SUMMARY 9
3. EQUIPMENT LIST 10
4. TEST CONFIGURATION 11
   4.1 ENVIRONMENTAL CONDITIONS FOR TESTING 11
      4.1.1 NORMAL OR EXTREME TEST CONDITIONS 11
      4.1.2 RECORD OF NORMAL ENVIRONMENT 11
   4.2 TEST CHANNELS 12
   4.3 EUT TEST STATUS 12
   4.4 PRE-SCAN 13
   4.5 TEST SETUP 13
      4.5.1 FOR RADIATED EMISSIONS TEST SETUP 13
      4.5.2 FOR CONDUCTED EMISSIONS TEST SETUP 15
      4.5.3 FOR CONDUCTED RF TEST SETUP 15
   4.6 SYSTEM TEST CONFIGURATION 16
   4.7 DUTY CYCLE 17
5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION 21
   5.1 REFERENCE DOCUMENTS FOR TESTING 21
   5.2 ANTENNA REQUIREMENT 21
   5.3 26 DB BANDWIDTH & OCCUPIED BANDWIDTH 22
   5.4 6 DB BANDWIDTH & OCCUPIED BANDWIDTH 33
   5.5 MAXIMUM CONDUCTED OUTPUT POWER OR E.I.R.P 40
   5.6 PEAK POWER SPECTRAL DENSITY 48
   5.7 RADIATED EMISSIONS AND BAND EDGE MEASUREMENT 65
   5.8 DYNAMIC FREQUENCY SELECTION 105
   5.9 AC POWER LINE CONDUCTED EMISSION 115

APPENDIX 1 PHOTOS OF TEST SETUP 118
APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS 118

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Insituware LLC
Address of Applicant:	107 Gilbreth Pkwy, Suite #202, Mullica Hill, NJ 08062
Manufacturer:	Insituware LLC
Address of Manufacturer:	107 Gilbreth Pkwy, Suite #202, Mullica Hill, NJ 08062

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	Vision MARK-1		
Model No. / HVIN:	Vision MARK-1		
Trade Mark:	N/A		
DUT Stage:	Production Unit		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
		Bluetooth V4.2	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
Sample Received Date:	January 26, 2021		
Sample Tested Date:	January 26, 2021 to April 2, 2021		

1.2.2 Description of Accessories

Adapter	
Model No.:	GTM96180-1807-2.0
Input:	100-240 V~50/60 Hz 0.6 A
Output:	5.0 V ⎓ 3.6 A 18W
DC Cable:	1.20 Meter, Unshielded without ferrite
Manufacturer:	GlobTek Inc

Battery	
Model No.:	PR-CU-R295-V1
Battery Type:	Lithium-ion Polymer Battery
Rated Voltage:	3.7 Vdc
Limited Charge Voltage:	4.2 Vdc
Rated Capacity:	5000 mAh
Manufacturer:	AA Portable Power Corp (Battery Space)

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Bands:	5150 MHz to 5250 MHz (U-NII-1)	
	5250 MHz to 5350 MHz (U-NII-2A)	
	5470 MHz to 5725 MHz (U-NII-2C)	
	5 725 MHz to 5 850 MHz (U-NII-3)	
Frequency Ranges:	5180 MHz to 5240 MHz	
	5260 MHz to 5320 MHz	
	5500 MHz to 5700 MHz	
	5 745 MHz to 5 825 MHz	
Support Standards:	IEEE 802.11a/n/ac	
TPC Function:	Not Support	
DFS Operational mode:	Slave without radar Interference detection function	
Type of Modulation:	IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK)	
	IEEE 802.11n: OFDM(64QAM, 16QAM, QPSK, BPSK)	
	IEEE 802.11ac: OFDM(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 MCS7	
	IEEE 802.11n-HT40: Up to MCS7	
	IEEE 802.11ac-VHT20: Up to MCS8	
	IEEE 802.11ac-VHT40: Up to MCS9	
	IEEE 802.11ac-VHT80: Up to MCS9	
Number of Channels:	5150 MHz to 5250 MHz: 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:	PCB Trace Antenna	
Antenna Gain:	5150 MHz to 5250 MHz: 6.5 dBi	
	5250 MHz to 5350 MHz: 6.5 dBi	
	5470 MHz to 5725 MHz: 6.5 dBi	
	5725 MHz to 5850 MHz: 6.5 dBi	
Maximum EIRP (dBm):	**Chain 0**	**U-NII-1**
	IEEE 802.11a:	15.58
	IEEE 802.11n-HT20:	14.96

	IEEE 802.11n-HT40:	16.22			
	IEEE 802.11ac-VHT20:	14.95			
	IEEE 802.11ac-VHT40:	16.15			
	IEEE 802.11ac-VHT80:	14.45			
Maximum conducted output power (dBm):		**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	9.08	8.96	6.48	6.67
	IEEE 802.11n-HT20:	8.46	8.52	6.06	6.29
	IEEE 802.11n-HT40:	9.72	9.30	7.15	7.73
	IEEE 802.11ac-VHT20	8.45	8.47	6.00	6.25
	IEEE 802.11ac-VHT40	9.65	9.22	7.14	7.67
	IEEE 802.11ac-VHT80:	7.95	7.61	5.65	6.07
Normal Test Voltage:	3.7 Vdc				

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

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.20 Meter	Applicant
2	USB Cable	Type C	0.50 Meter	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China
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	± 4.9 dB
5	Radiated emission 1GHz-18GHz	± 4.8 dB
6	Radiated emission 18GHz-26GHz	± 5.1 dB
7	Radiated emission 26GHz-40GHz	± 5.1 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 E Section 15.407(a)(1) (2) RSS-Gen Issue 5, Section 6.8	N/A	PASS
26 dB emission bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(2)(5) RSS-247 Issue 2 Section 6.2.1.2	KDB 789033 D02 v02r01 Section C.1	PASS
6 dB bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (e) RSS-247 Issue 2 Section 6.2.4.1	KDB 789033 D02 v02r01 Section C.2	PASS
Occupied Bandwidth	RSS-Gen Issue 5, Section 6.7	RSS-Gen Issue 5, section 6.7	PASS
Maximum conducted output power	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3) RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1	KDB 789033 D02 v02r01 Section E.3.a (Method PM)	PASS
Peak Power Spectral Density	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3) RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1	KDB 789033 D02 v02r01 Section F	PASS
Radiated Emissions and Band Edge Measurement	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(1)(2)(3)(4)(6) FCC 47 CFR Part 15 Subpart C Section 15.209/205 RSS-247 Issue 2 Section 6.2.1.2/6.2.2.2/6.2.3.2/6.2.4.2	KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6	PASS
Dynamic Frequency Selection	FCC 47 CFR Part 15 Subpart E Section 15.407 (h) RSS-247 Issue 2 Section 6.3	KDB 905462 D03 Client Without DFS New Rules v01r02	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(6) FCC 47 CFR Part 15 Subpart C Section 15.207 RSS-Gen Issue 5, Section 8.8	ANSI C63.10-2013, Section 6.2.	PASS
Note: 1) N/A: In this whole report not applicable.			

For Dynamic Frequency Selection

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

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Jan. 22, 2021	Jan. 21, 2024
☒	Receiver	R&S	ESIB26	100114	Nov. 18, 2020	Nov. 17, 2021
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 10, 2020	Nov. 09, 2021
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	Nov. 14, 2020	Nov. 13, 2021
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Nov. 14, 2020	Nov. 13, 2021
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	Nov. 10, 2020	Nov. 9, 2021
☒	Preamplifier	HP	8447F	2805A02960	May. 30, 2020	May. 9, 2021
☐	Broadband Antenna (Pre-amplifier)	ETS-LINDGREN	3142E-PA	00201891	Nov. 18, 2020	Nov. 17, 2021
☐	6dB Attenuator	Talent	RA6A5-N-18	18103002	Nov. 14, 2020	Nov. 13, 2021
☐	Horn Antenna	ETS-LINDGREN	3117	00164202	May. 30, 2020	May. 29, 2021
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	Dec. 03, 2018	Dec. 03, 2021
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	Jun. 19, 2020	Jun. 18, 2021
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Nov. 14, 2020	Nov. 13, 2021
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☐	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	Nov. 16, 2020	Nov. 15, 2021
☒	Band Rejection Filter (5150MHz~5880MHz)	Micro-Tronics	BRM50716	G1868	Nov. 16, 2020	Nov. 15, 2021
☒	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. 18, 2020	Nov. 17, 2021
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 18, 2020	Nov. 17, 2021
☒	LISN	R&S	ESH2-Z5	860014/024	Nov. 18, 2020	Nov. 17, 2021
☐	LISN	ETS-Lindgren	3816/2SH	00201088	Nov. 18, 2020	Nov. 17, 2021
☒	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. 10, 2020	Nov. 09, 2021
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 10, 2020	Nov. 09, 2021
☐	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Nov. 10, 2020	Nov. 09, 2021
☒	MXG X-Series RF Vector Signal Generator	KEYSIGHT	N5182B	MY51350267	Nov. 10, 2020	Nov. 09, 2021

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 (V)	Relative Humidity (%)
NT/NV	+15 to +35	3.7	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
26 dB emission bandwidth	24.3	48	99.80	Leo Li
6 dB bandwidth				
Occupied Bandwidth				
Maximum conducted output power				
Peak Power Spectral Density				
Radiated Emissions and Band Edge Measurement	25.9	54	100.34	Andy Lin
Dynamic Frequency Selection	24.3	48	99.80	Leo Li
AC Power Line Conducted Emission	24.5	51	100.03	Tripp Jiang

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	--	--
		5530 MHz	--	--
	5725 MHz to 5850 MHz	--	Channel 155	--
		--	5775 MHz	--

4.3 EUT TEST STATUS

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

Power Setting
Power Setting: not applicable, test used software default power level.

Test Software
Test software name: Testing_Commands_Insituware_Rev1;

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	MCS0
IEEE 802.11n-HT40	MCS0
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

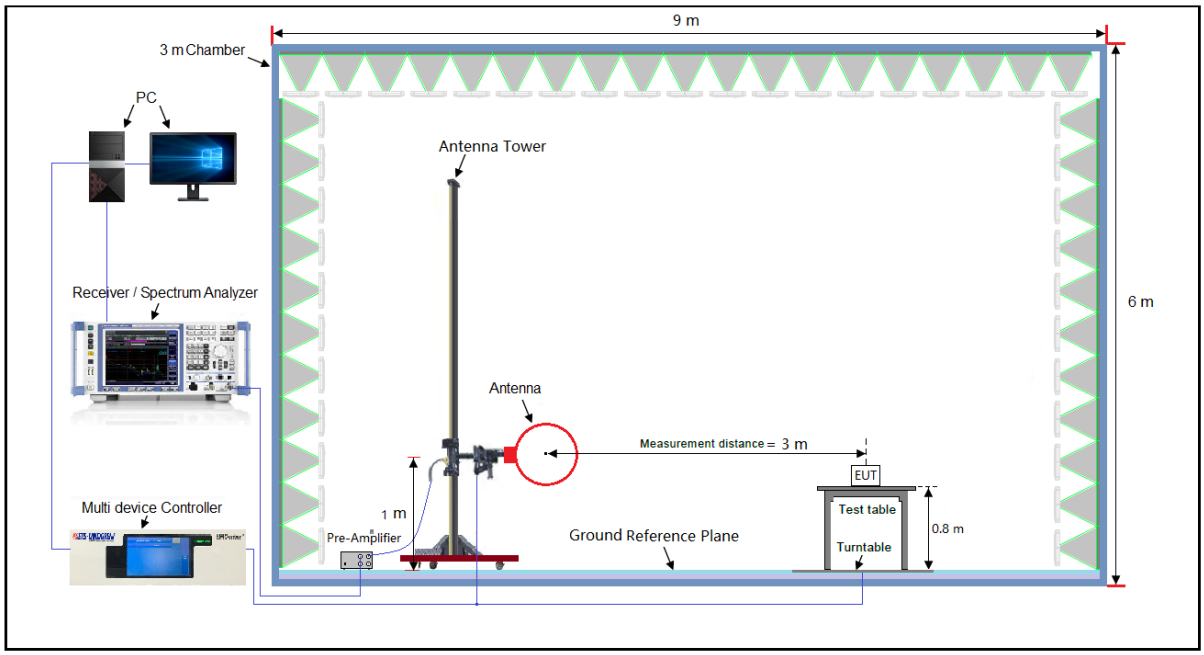


Figure 2. 30MHz to 1GHz

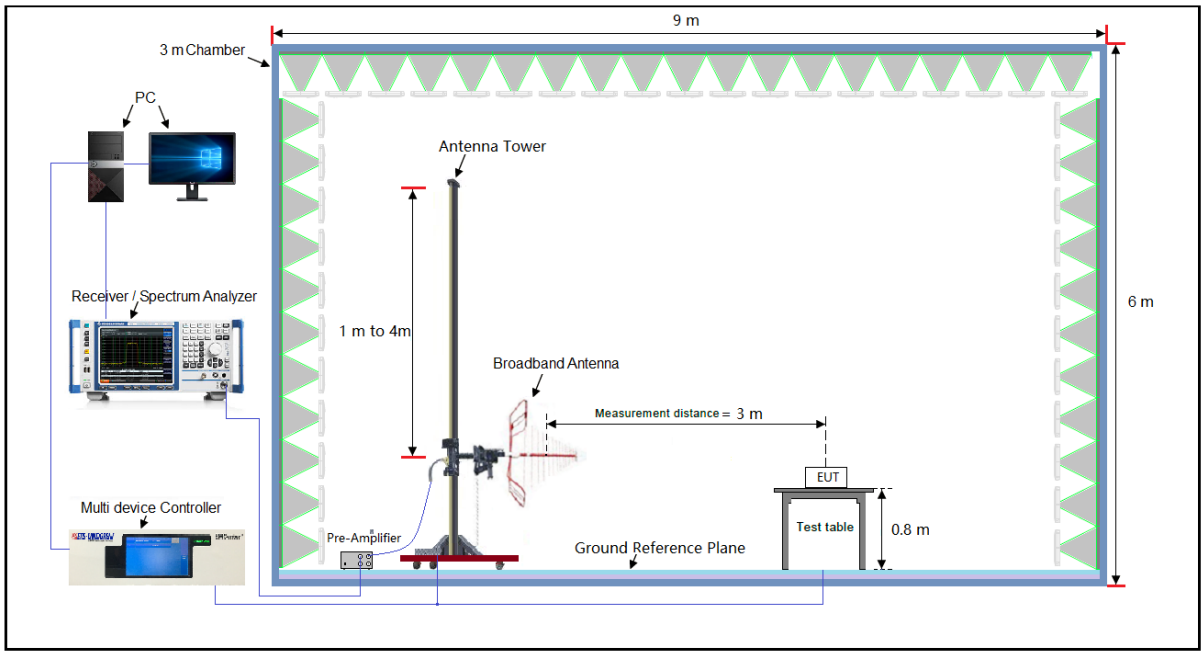
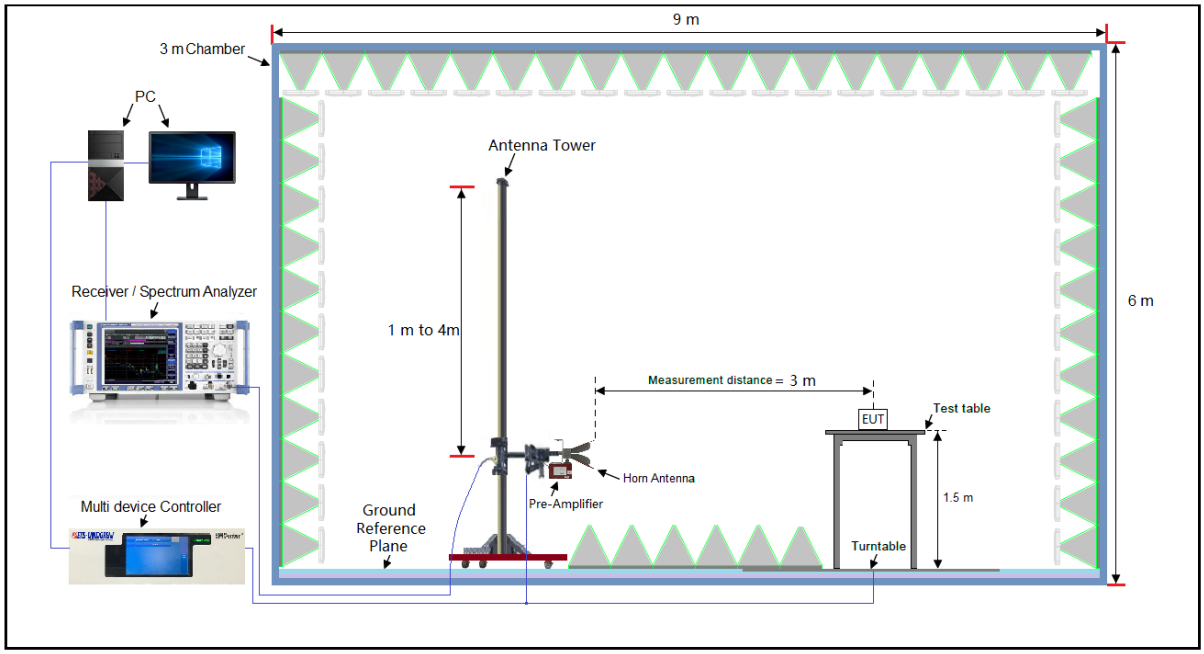
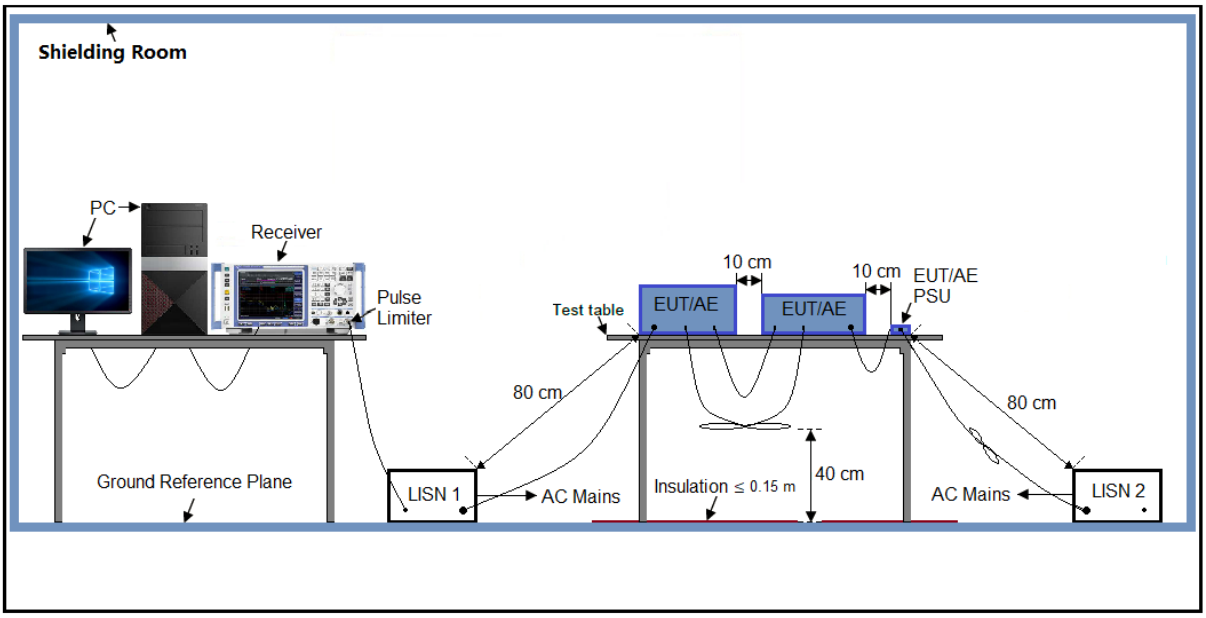


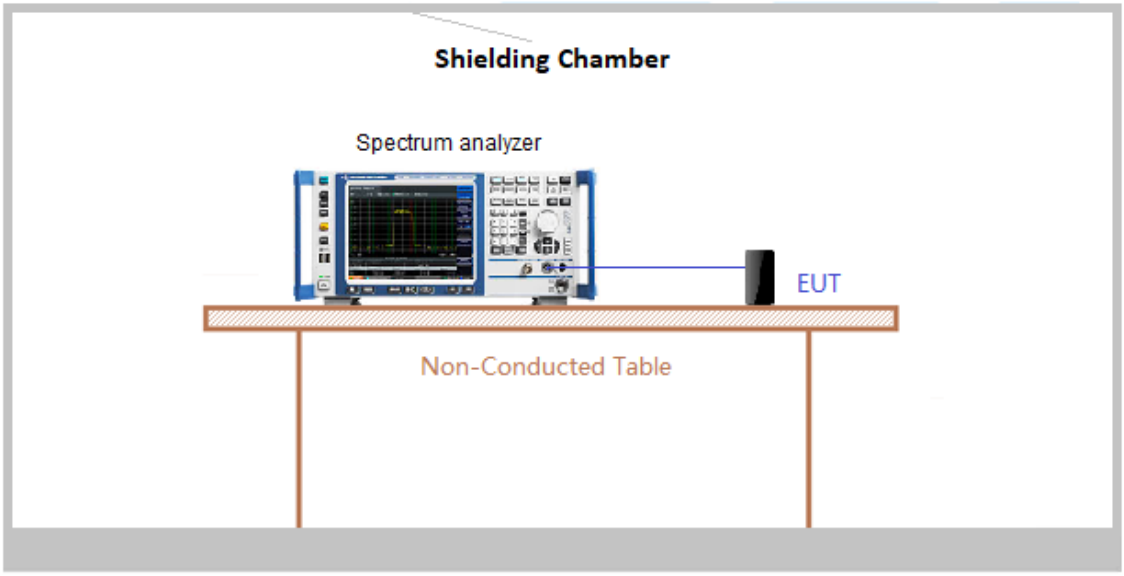
Figure 3. Above 1GHz



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. It was powered by 3.7. Only the worst case data were recorded in this test report.

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

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

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

4.7 DUTY CYCLE

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

Test Results

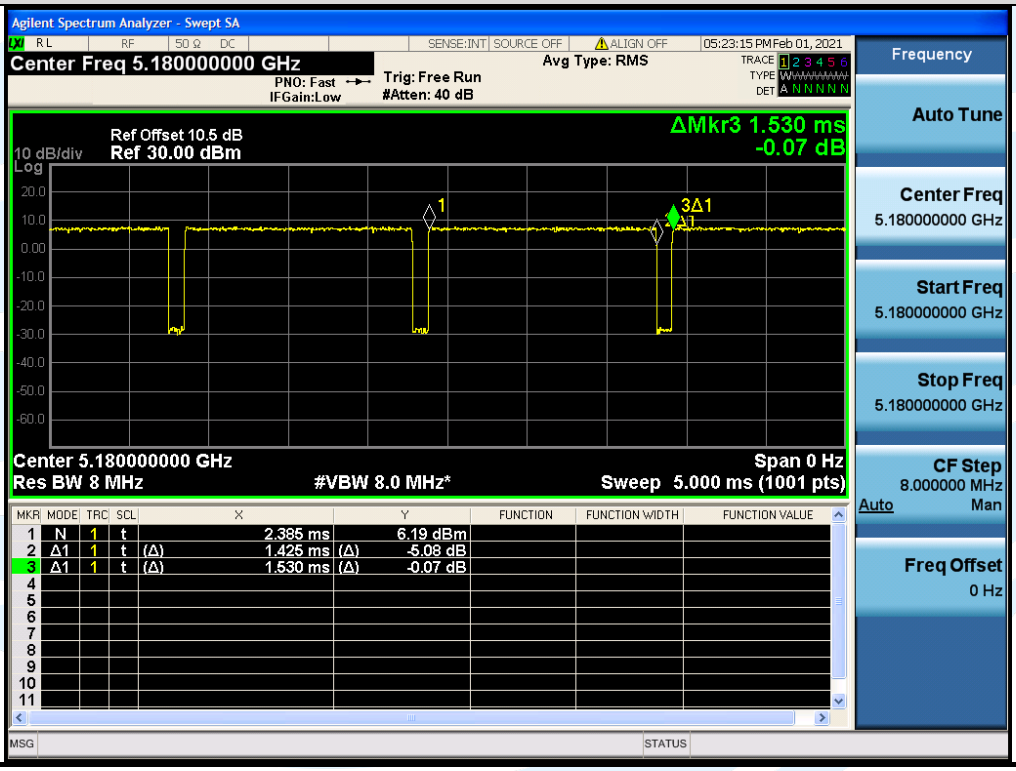
Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11a	6	1.4250	1.5300	0.93	93.14	0.31	0.70	-0.62
IEEE 802.11n-HT20	MCS0	1.3350	1.4350	0.93	93.03	0.31	0.75	-0.63
IEEE 802.11n-HT40	MCS0	0.6600	0.7650	0.86	86.27	0.64	1.52	-1.28
IEEE 802.11ac-VHT20	MCS0	1.3400	1.4400	0.93	93.06	0.31	0.75	-0.63
IEEE 802.11ac-VHT40	MCS0	0.6600	0.7650	0.86	86.27	0.64	1.52	-1.28
IEEE 802.11ac-VHT80	MCS0	1.3400	1.4500	0.92	92.41	0.34	0.75	-0.69

Remark:

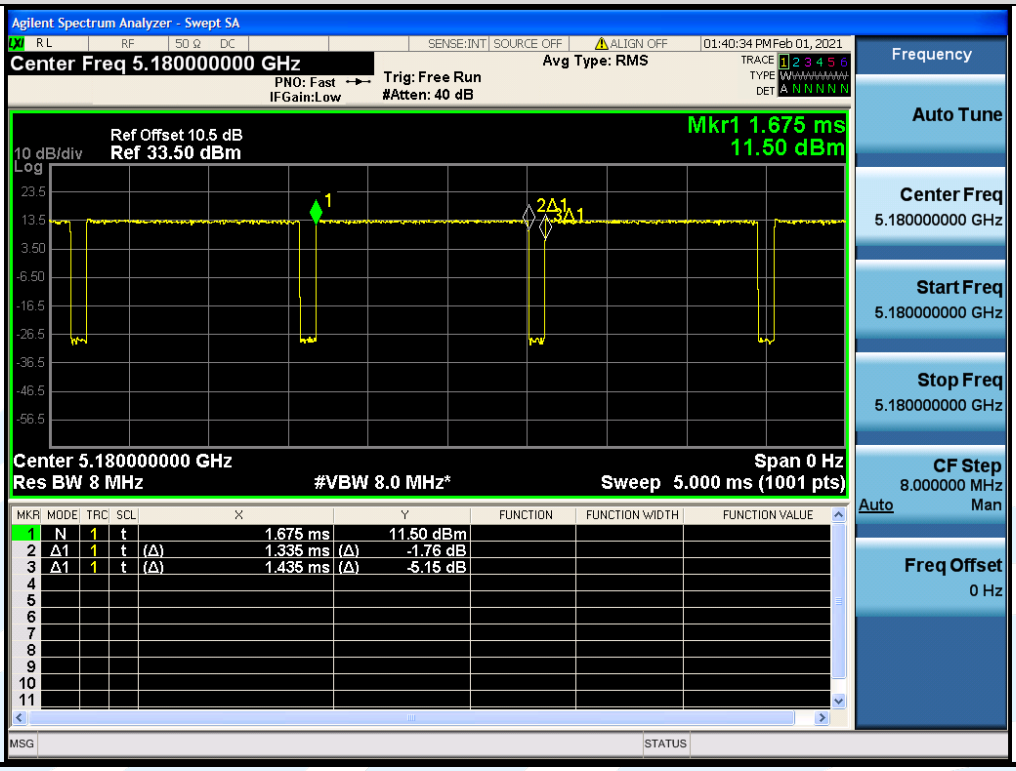
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plots as follows

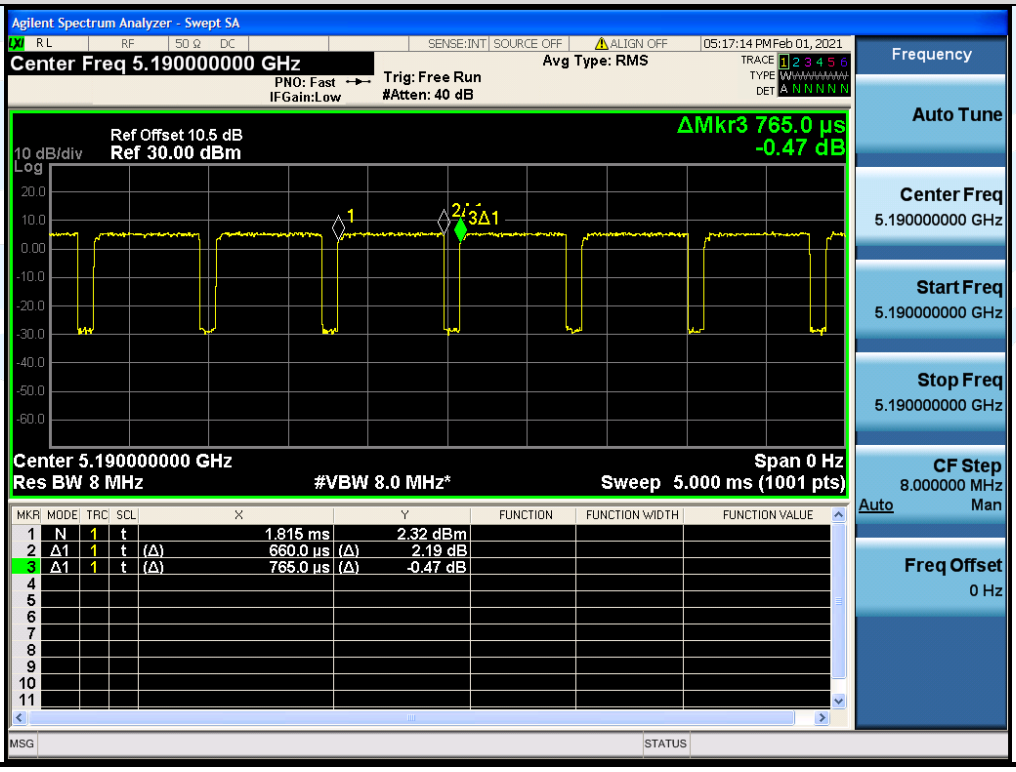
IEEE 802.11a



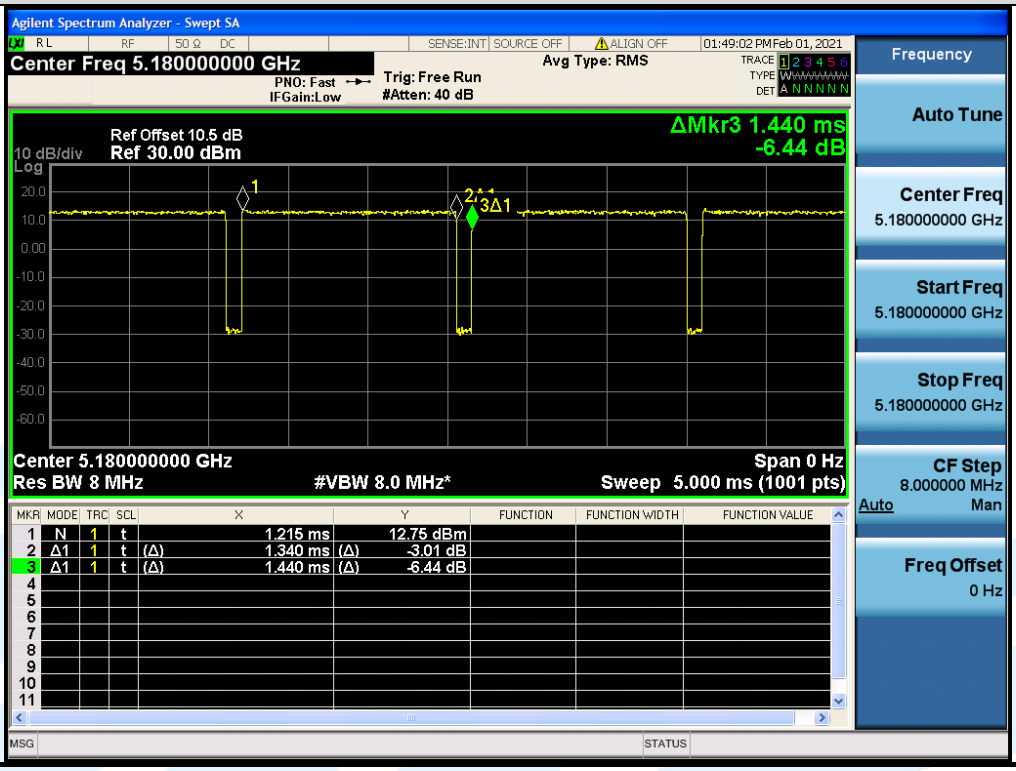
IEEE 802.11n-HT20



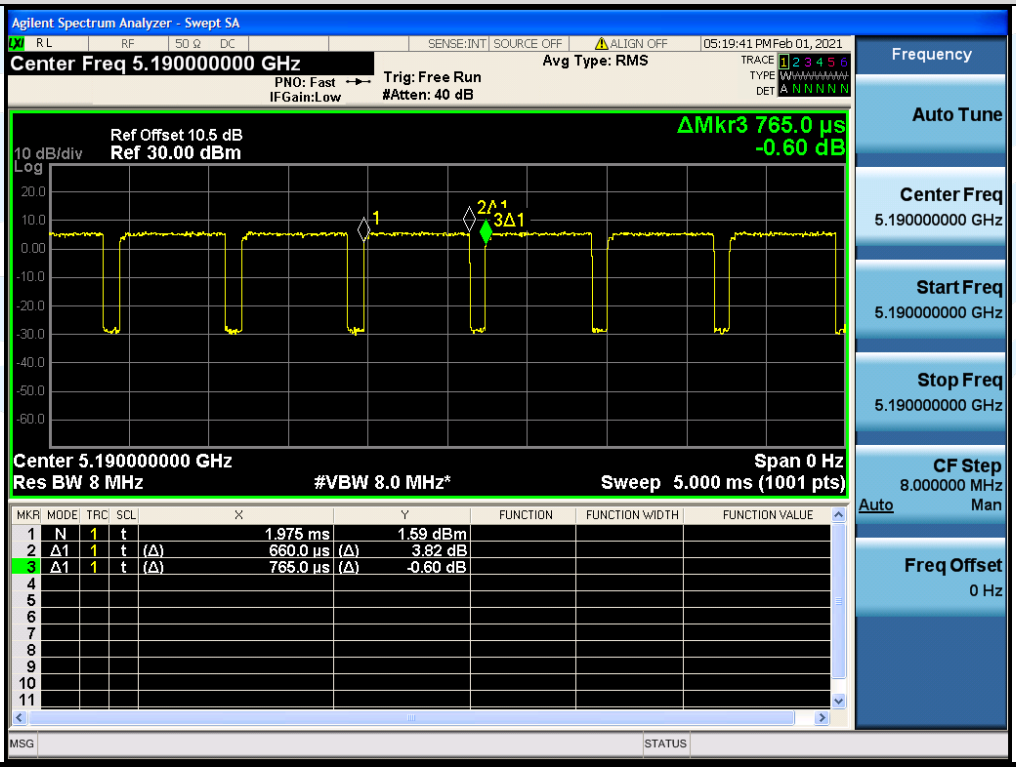
IEEE 802.11n-HT40



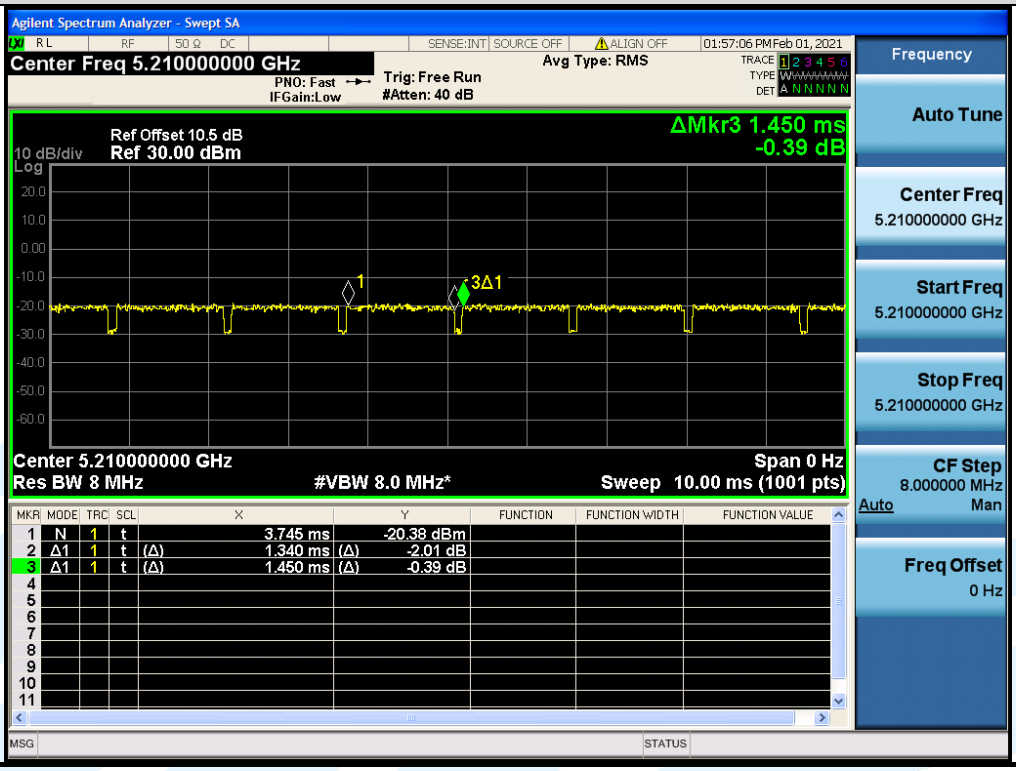
IEEE 802.11ac-VHT20



IEEE 802.11ac-VHT40



IEEE 802.11ac-VHT80



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

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

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. **RSS-Gen Issue 5, Section 6.8 requirement:** According to RSS-Gen Issue 5, Section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.
EUT Antenna:
Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is 6.5 dBi.

5.3 26 DB BANDWIDTH & OCCUPIED BANDWIDTH

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

Test Method: KDB 789033 D02 v02r01 Section C.1

Limit: None; for reporting purposes only.

Test Procedure:

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

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

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

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results: Pass

Mode	Channel	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
IEEE 802.11a	36 (5180)	21.21	16.955
	44 (5220)	21.27	17.025
	48 (5240)	21.28	16.882
	52 (5260)	21.23	16.903
	60 (5300)	20.91	16.935
	64 (5320)	21.05	16.884
	100 (5500)	21.39	16.945
	116 (5580)	21.10	16.900
	140 (5700)	21.12	16.937
IEEE 802.11n-HT20	36 (5180)	21.74	18.104
	44 (5220)	21.22	17.952
	48 (5240)	21.39	17.923
	52 (5260)	21.11	17.906
	60 (5300)	21.15	17.930
	64 (5320)	21.35	17.922
	100 (5500)	21.36	17.989
	116 (5580)	21.49	17.981
	140 (5700)	21.22	17.958
IEEE 802.11n-HT40	38 (5190)	40.58	36.378
	46 (5230)	40.14	36.332
	54 (5270)	40.02	36.319
	62 (5310)	40.13	36.335
	102 (5510)	40.89	36.362
	110 (5550)	40.42	36.440
	134 (5670)	40.00	36.299

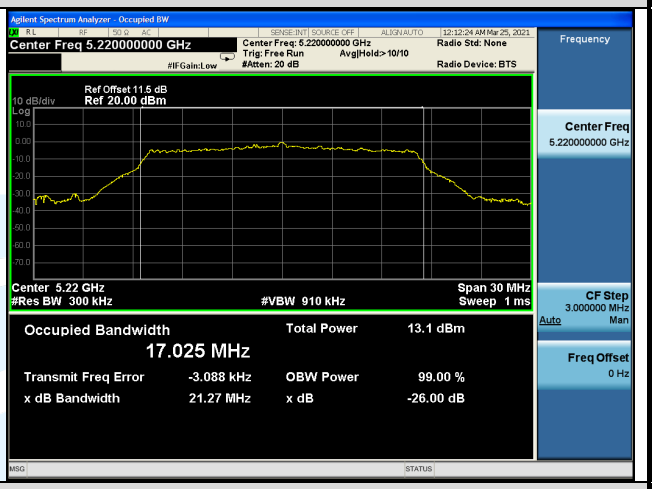
Mode	Channel	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
IEEE 802.11ac-VHT20	36 (5180)	21.48	18.061
	44 (5220)	21.16	17.963
	48 (5240)	21.29	17.986
	52 (5260)	21.13	19.925
	60 (5300)	21.51	17.970
	64 (5320)	21.28	17.991
	100 (5500)	21.54	18.002
	116 (5580)	21.24	17.981
	140 (5700)	21.29	17.926
IEEE 802.11ac-VHT40	38 (5190)	40.03	36.328
	46 (5230)	40.52	36.337
	54 (5270)	39.94	36.268
	62 (5310)	39.72	36.283
	102 (5510)	40.54	36.430
	110 (5550)	40.34	36.397
	134 (5670)	39.83	36.276
IEEE 802.11ac-VHT80	42 (5210)	81.63	75.663
	58 (5290)	80.77	75.350
	106 (5530)	81.56	75.746

The test plots as follows:

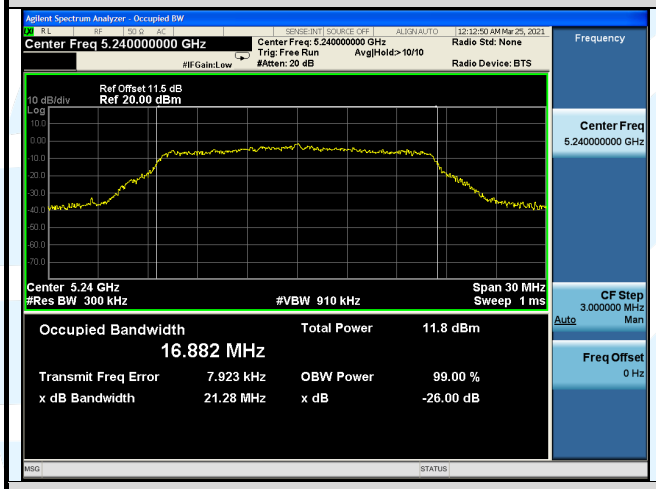
IEEE 802.11a

Channel 36

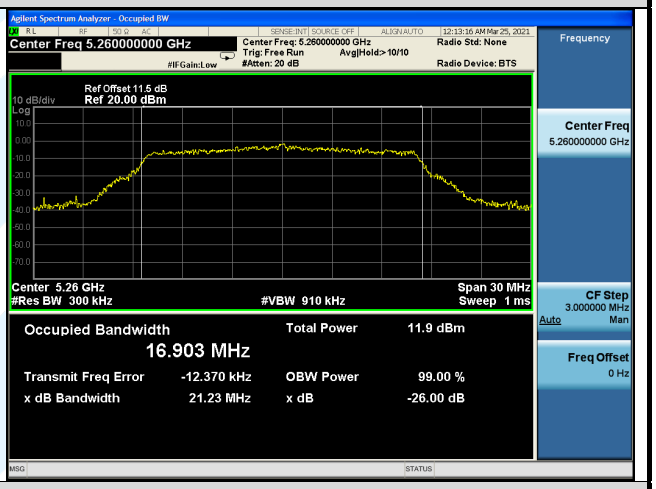
Channel 44



Channel 48



Channel 52



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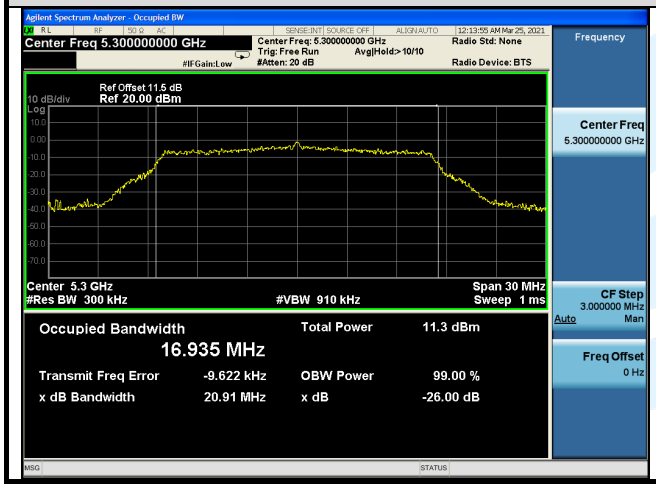

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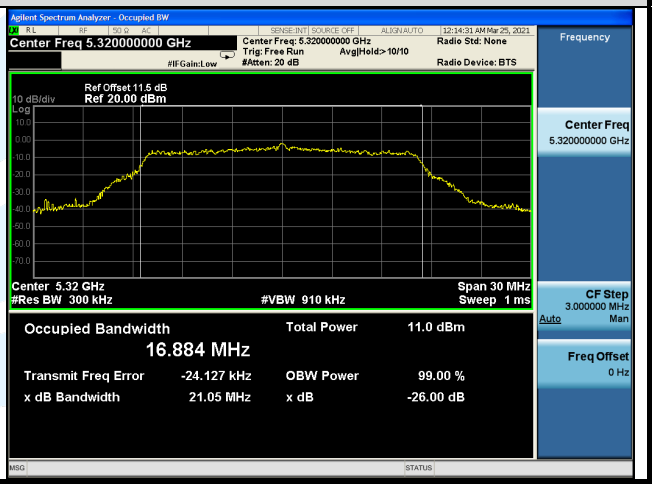
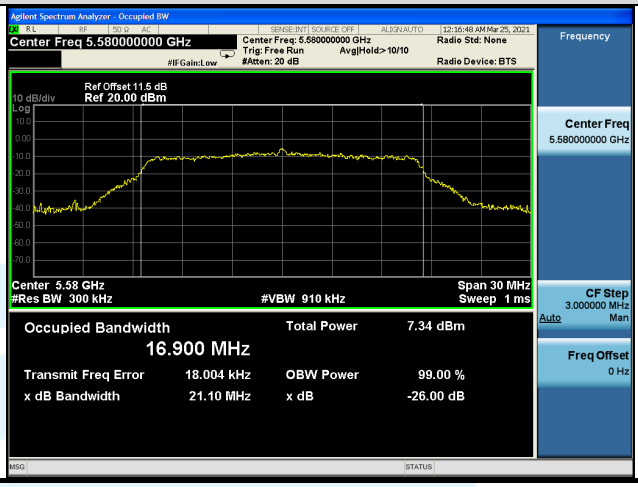
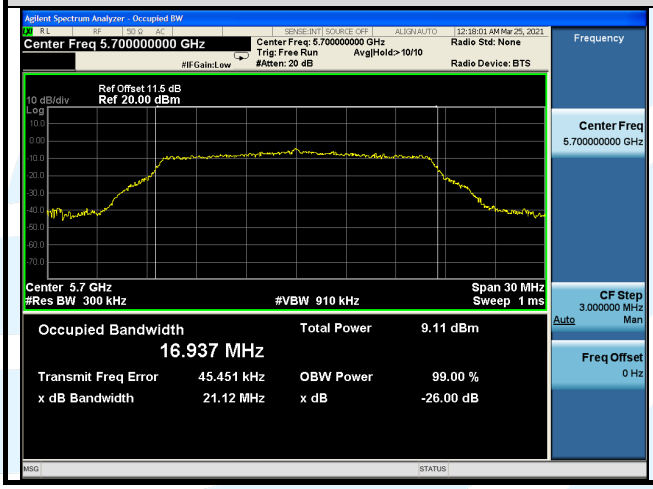


Channel 100

Channel 116

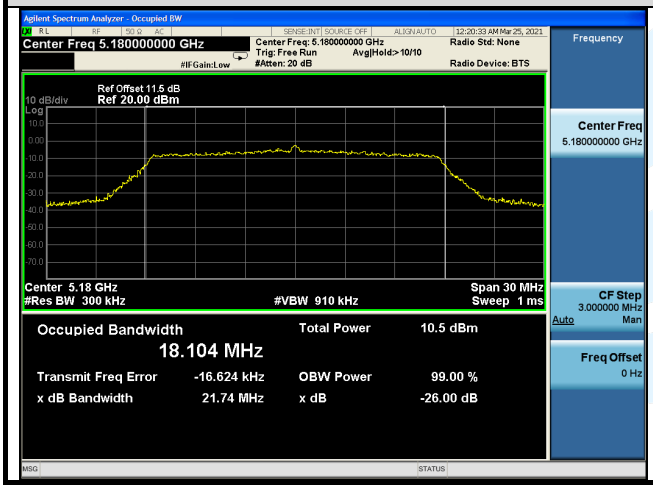


Channel 140



IEEE 802.11n-HT20

Channel 36



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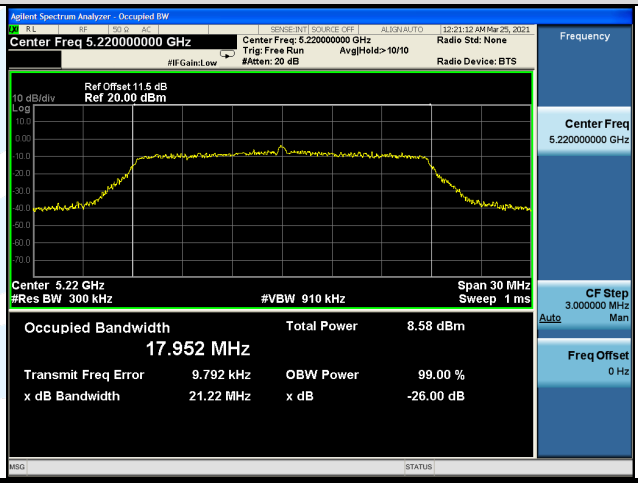

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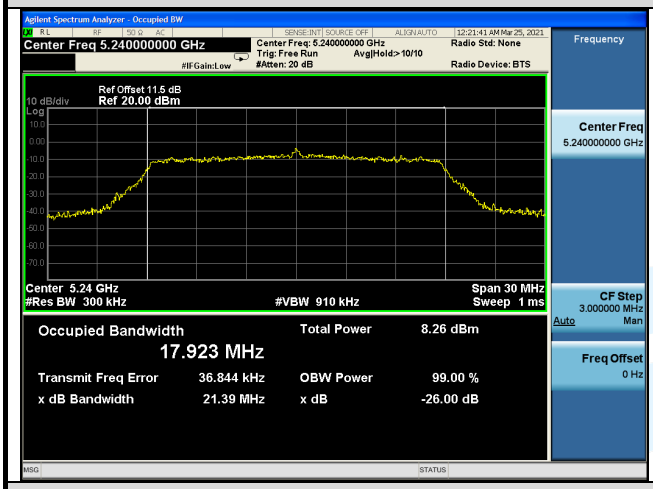
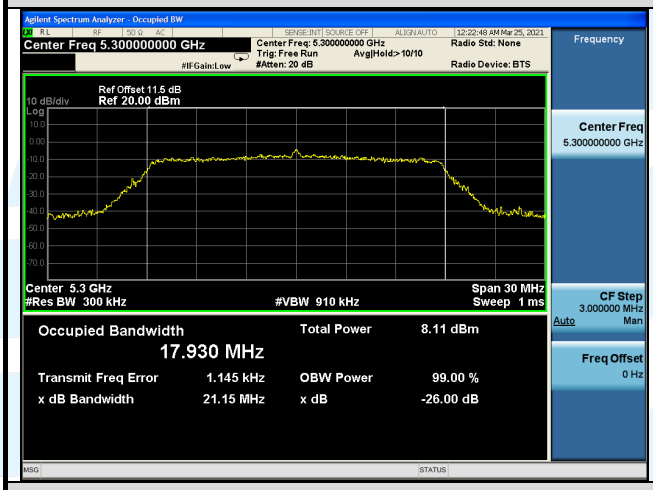


Channel 52

Channel 60



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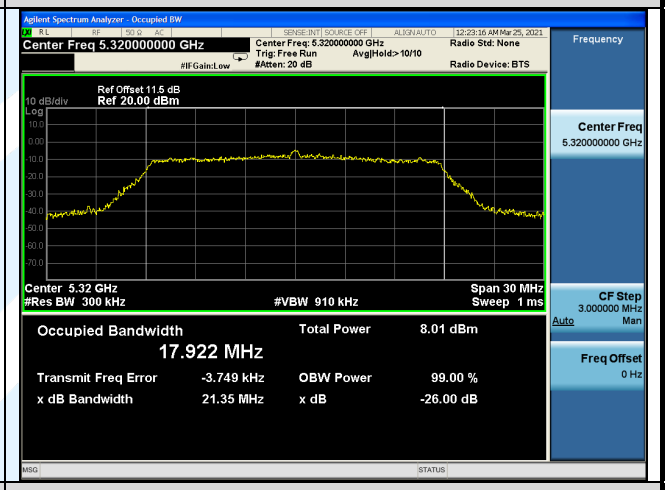


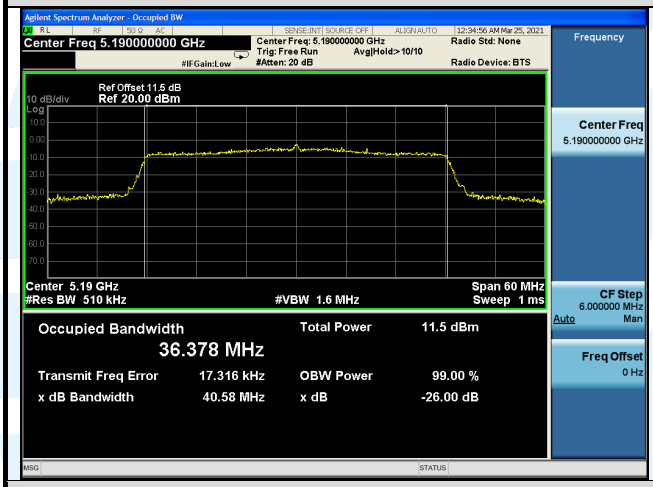
Channel 100

Channel 116

Channel 140

IEEE 802.11n-HT40

Channel 38



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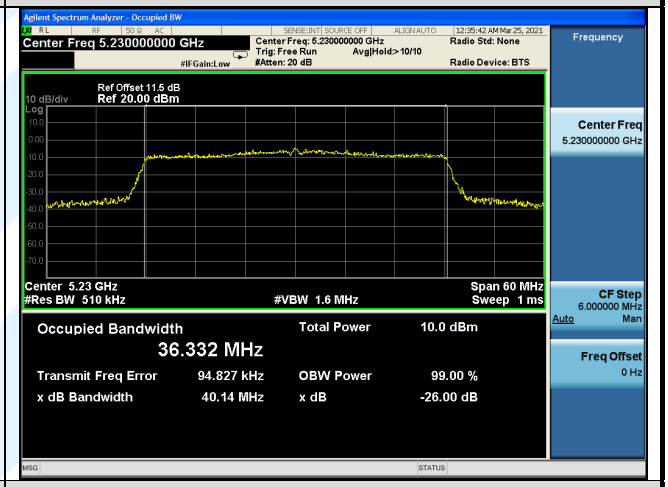
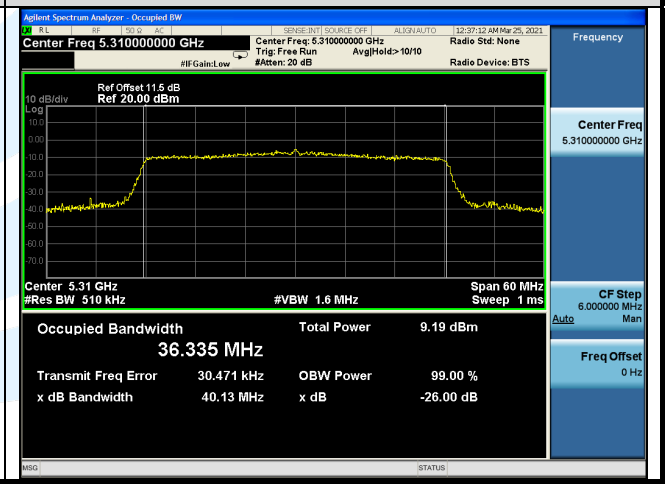


Channel 54

Channel 62



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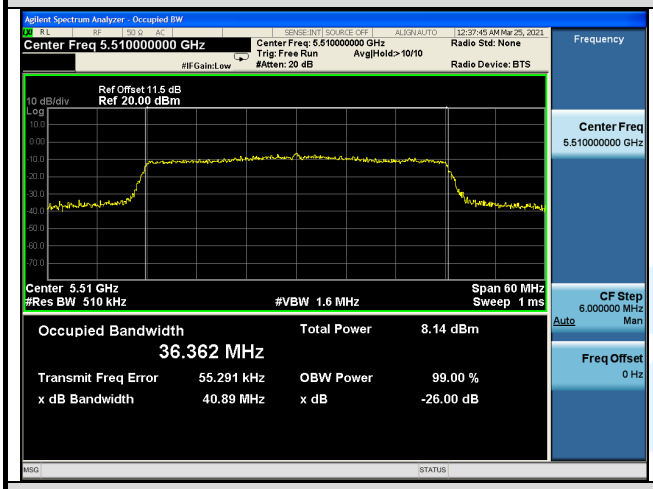
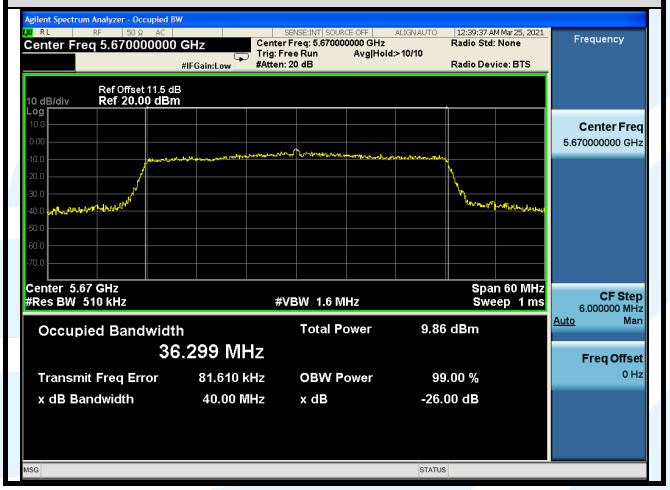


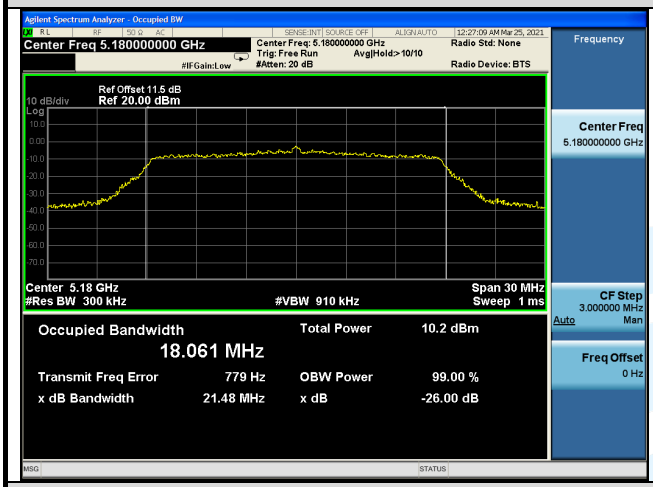
Channel 110

Channel 134

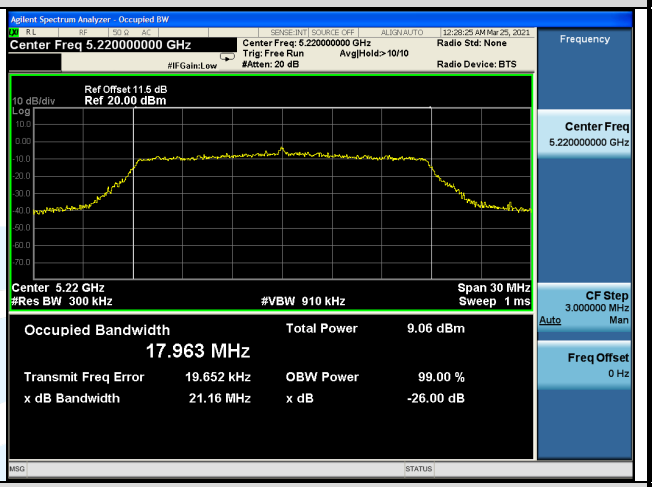


IEEE 802.11ac-VHT20

Channel 36



Channel 44



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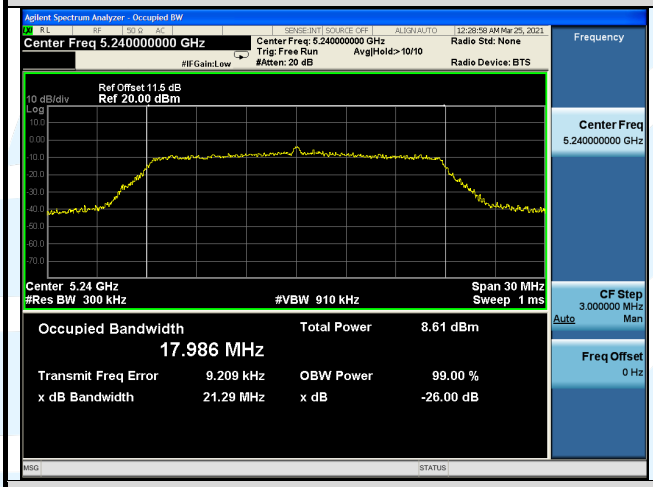
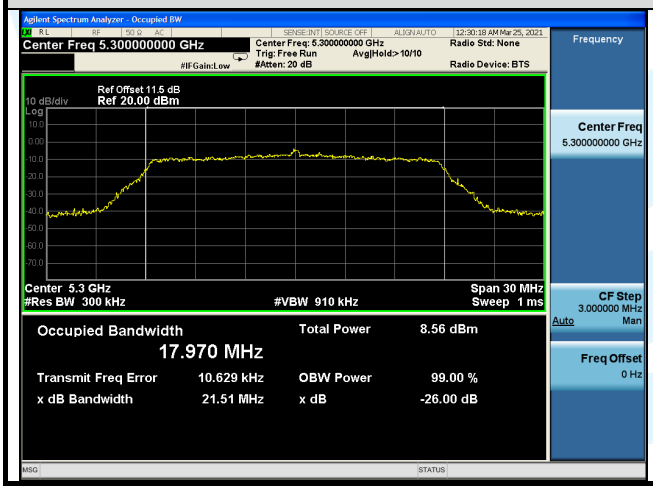
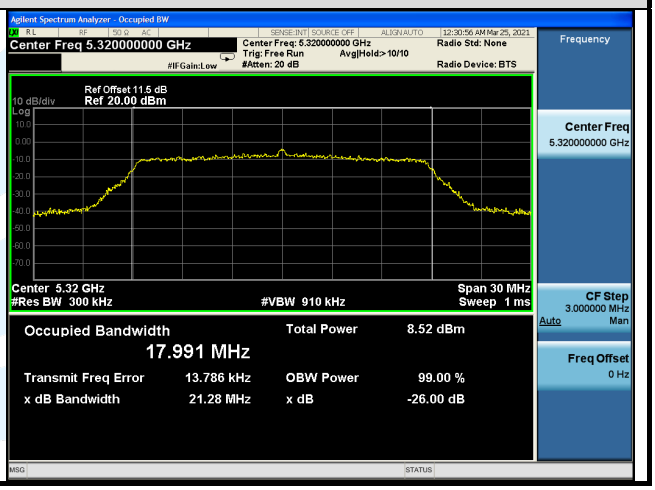


Channel 52

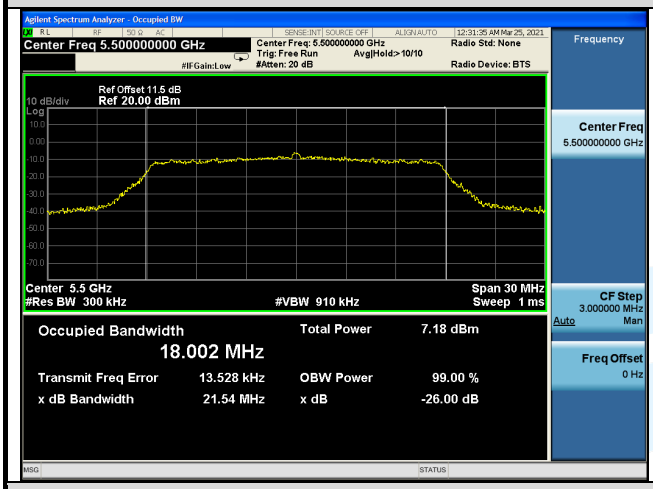
Channel 60



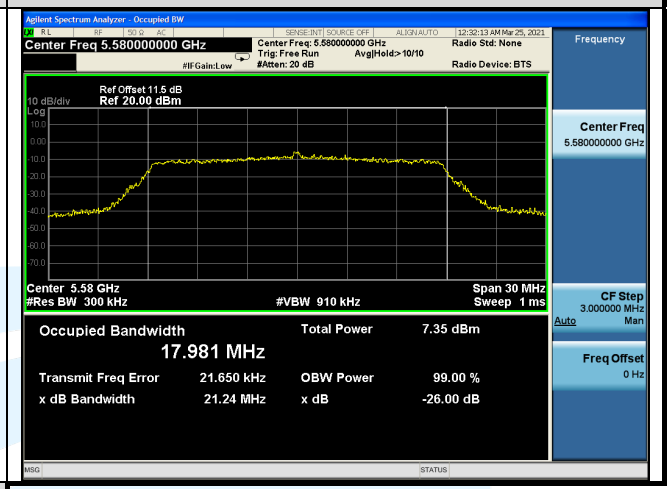
Channel 64



Channel 100



Channel 116



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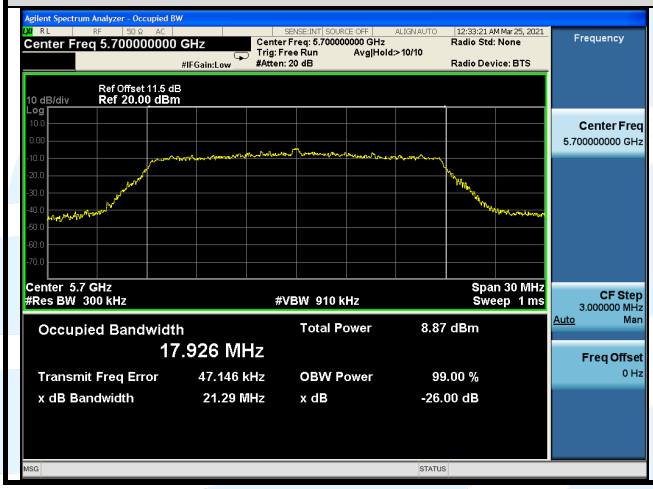

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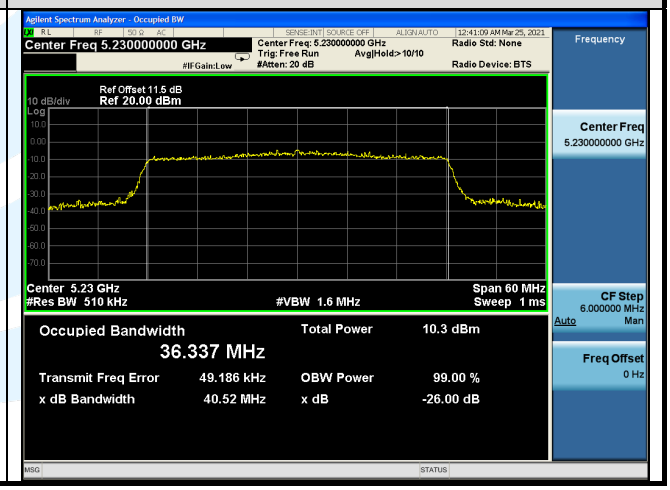
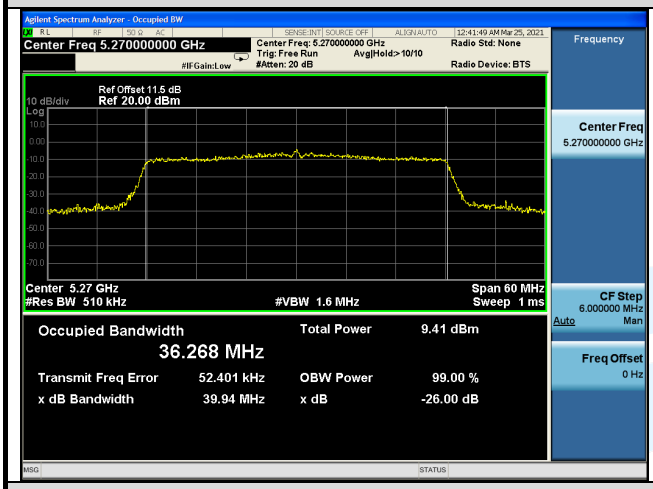
IEEE 802.11ac-VHT40

Channel 38

Channel 46



Channel 54



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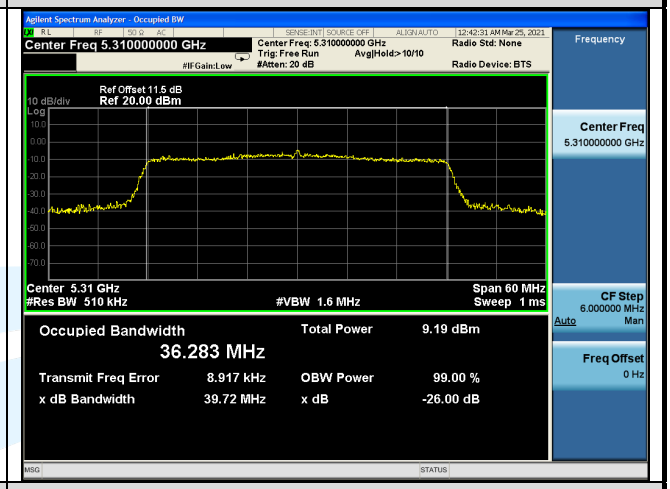
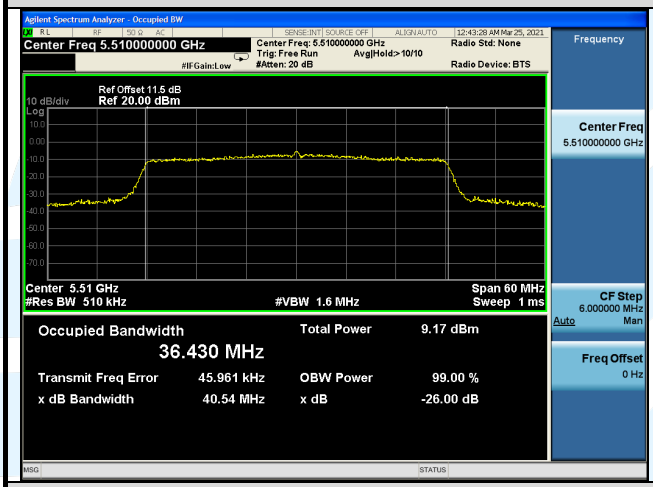
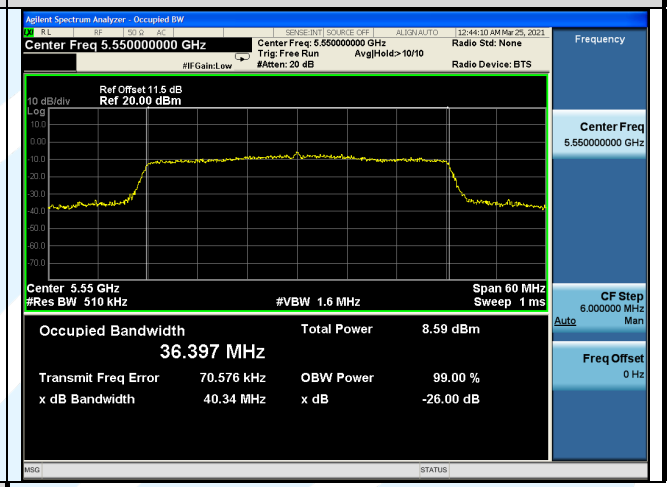


Channel 102



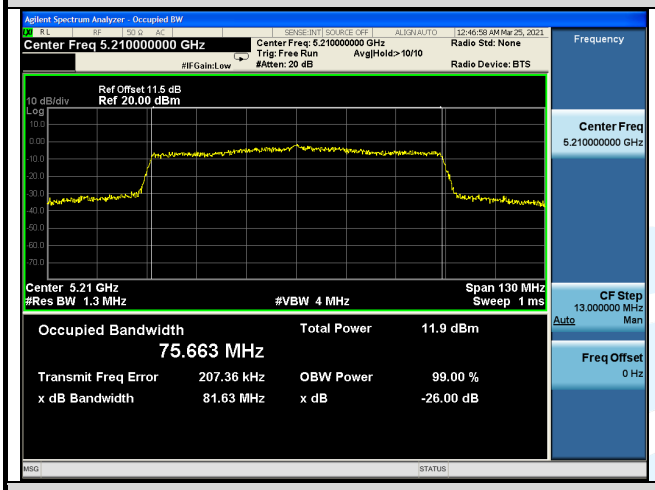
Channel 110



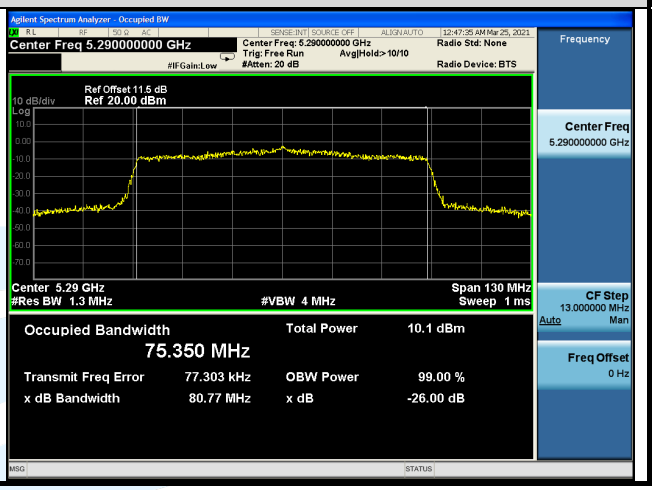
Channel 134

IEEE 802.11ac-VHT80

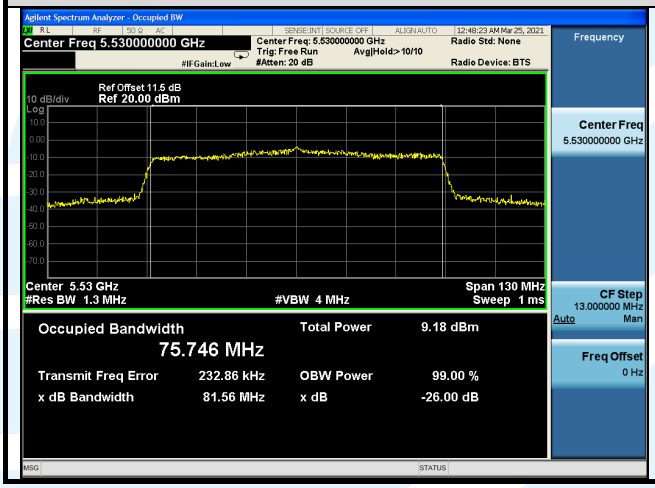
Channel 42



Channel 58



Channel 106



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5.46 DB BANDWIDTH & OCCUPIED BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (e)
RSS-247 Issue 2 Section 6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section C.2

Limit: Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

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 = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 * RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

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

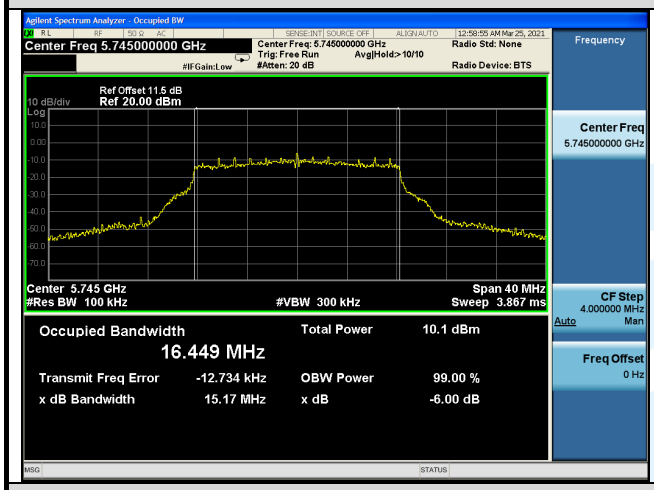
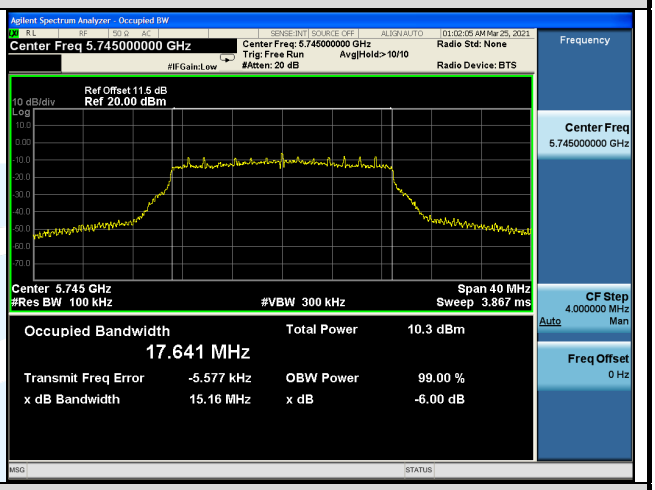
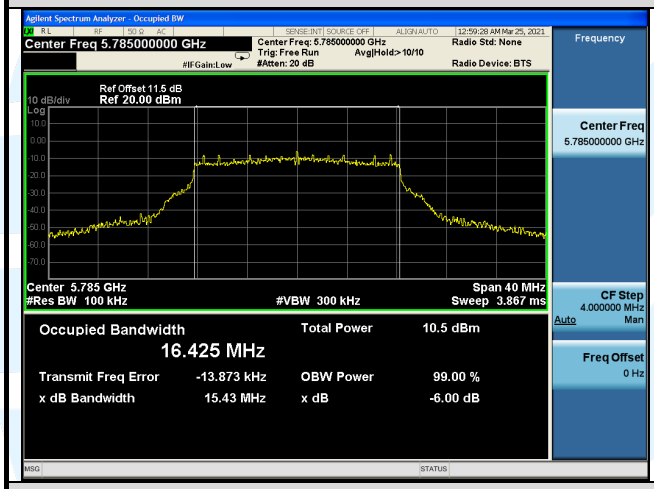
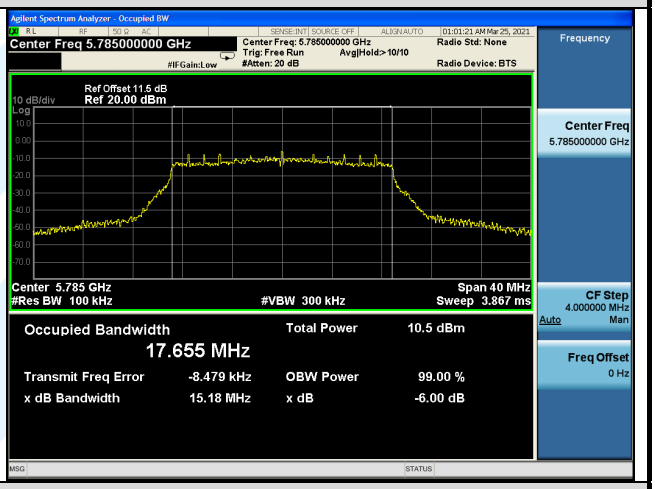
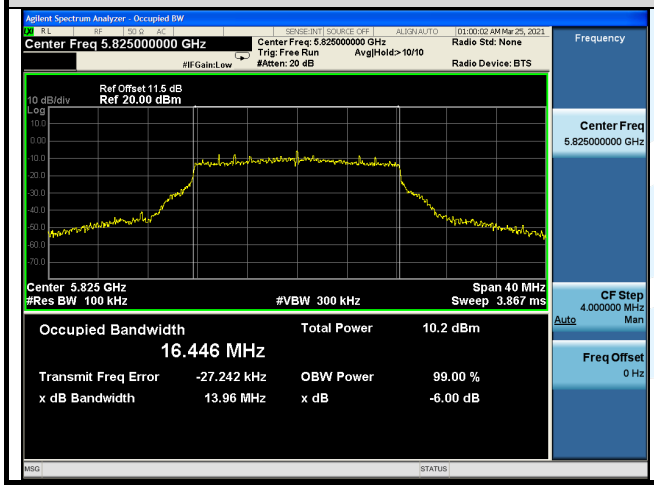
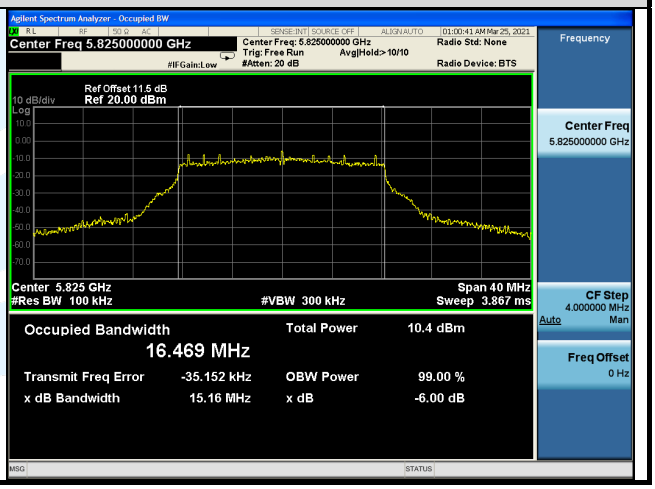
Test Results: Pass

Test Data:

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
IEEE 802.11a	149 (5745)	15.17	17.969	> 500 kHz	Pass
	157 (5785)	15.43	16.843	> 500 kHz	Pass
	165 (5825)	13.96	16.901	> 500 kHz	Pass
IEEE 802.11n-HT20	149 (5745)	15.16	17.893	> 500 kHz	Pass
	157 (5785)	15.18	17.895	> 500 kHz	Pass
	165 (5825)	15.16	17.963	> 500 kHz	Pass
IEEE 802.11n-HT40	151 (5755)	35.07	36.325	> 500 kHz	Pass
	159 (5795)	35.11	36.276	> 500 kHz	Pass
IEEE 802.11ac-VHT20	149 (5745)	15.18	17.946	> 500 kHz	Pass
	157 (5785)	15.06	17.951	> 500 kHz	Pass
	165 (5825)	12.62	17.961	> 500 kHz	Pass
IEEE 802.11ac-VHT40	151 (5755)	33.86	36.265	> 500 kHz	Pass
	159 (5795)	35.12	36.294	> 500 kHz	Pass
IEEE 802.11ac-VHT80	155 (5775)	74.72	75.491	> 500 kHz	Pass

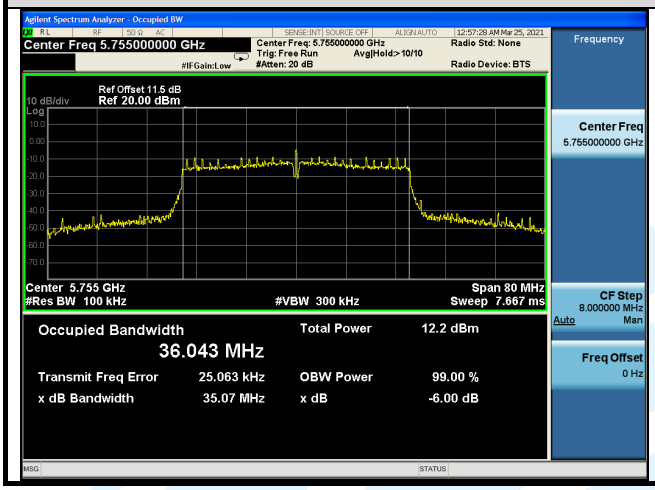
The test plots as follows:

6 dB Bandwidth

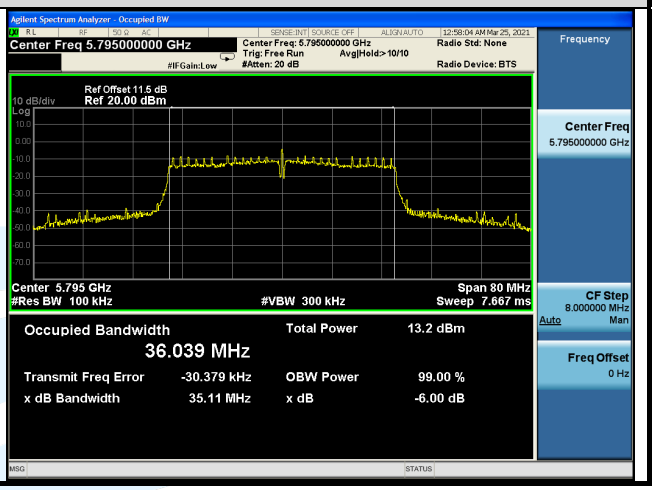
IEEE 802.11a	IEEE 802.11n-HT20
Channel 149	
	
Channel 157	
	
Channel 165	
	

IEEE 802.11n-HT40

Channel 151

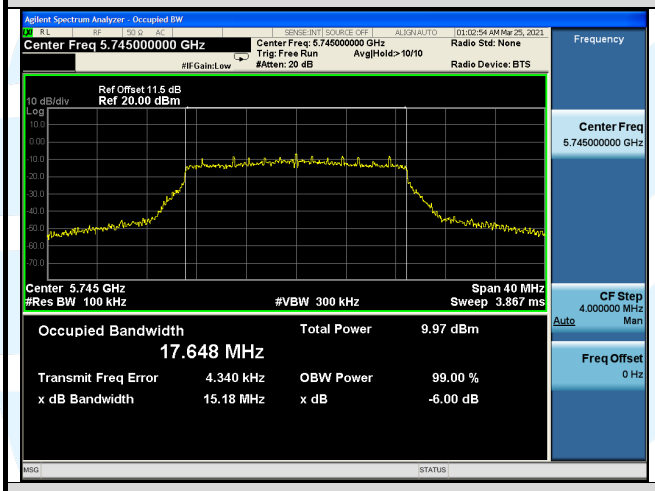


Channel 159

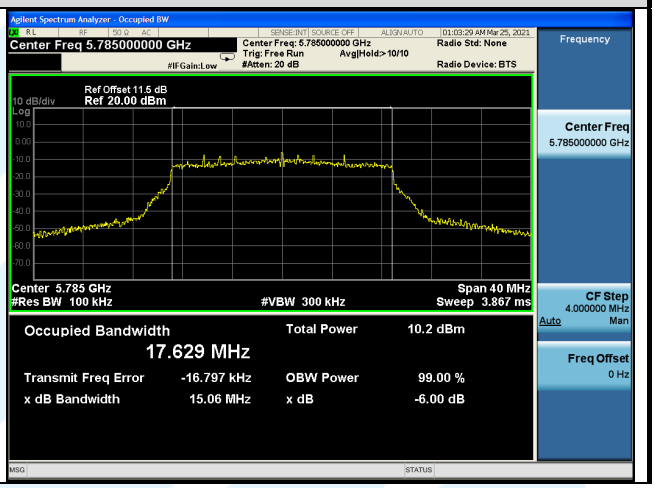


IEEE 802.11ac-VHT20

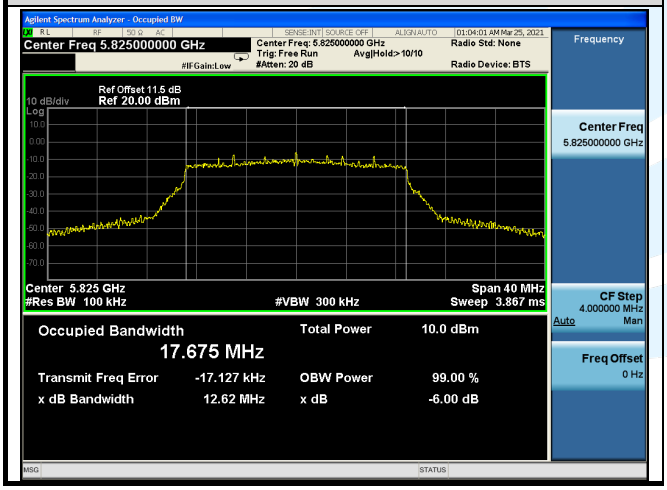
Channel 149



Channel 157

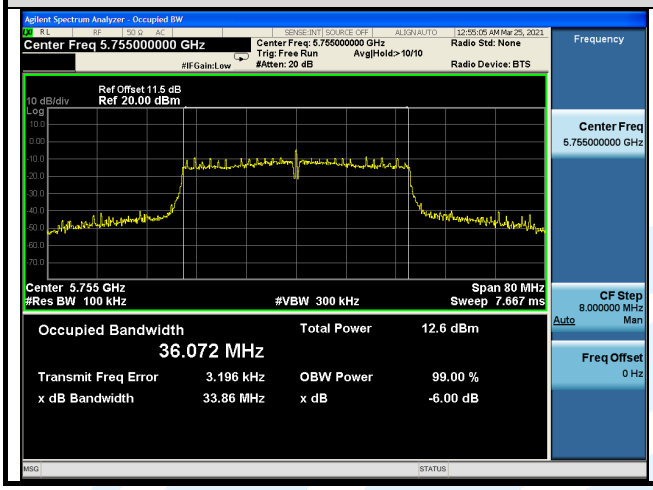


Channel 165

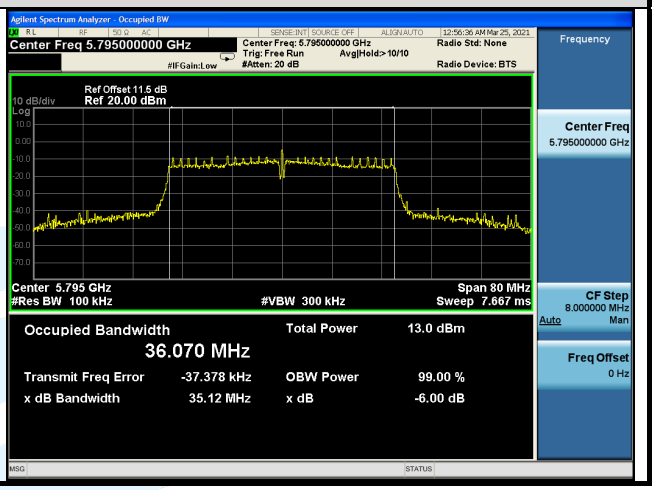


IEEE 802.11 ac-VHT40

Channel 151

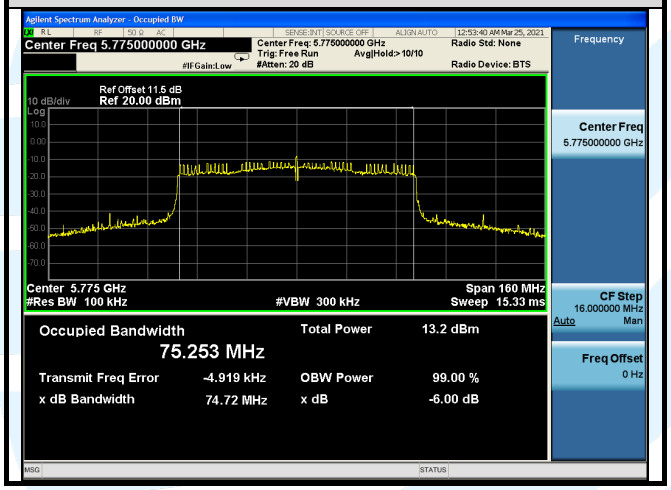


Channel 159

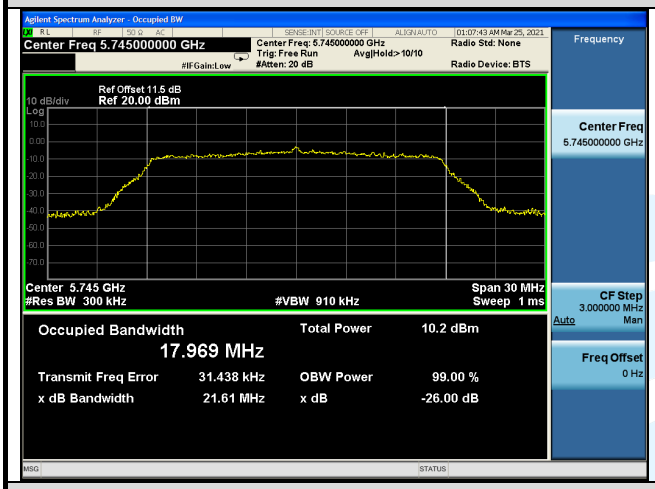
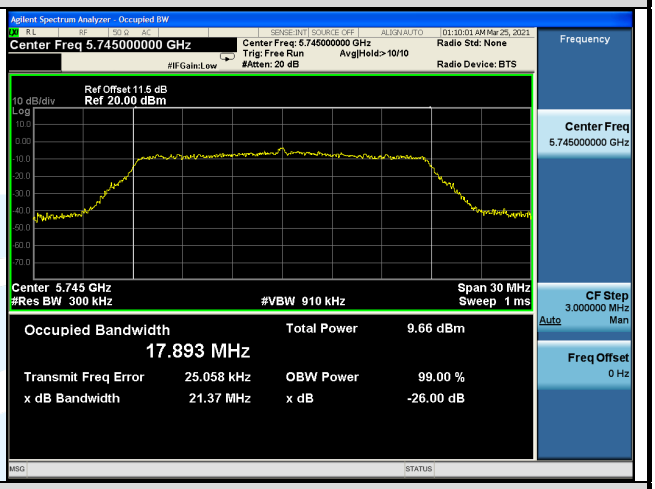
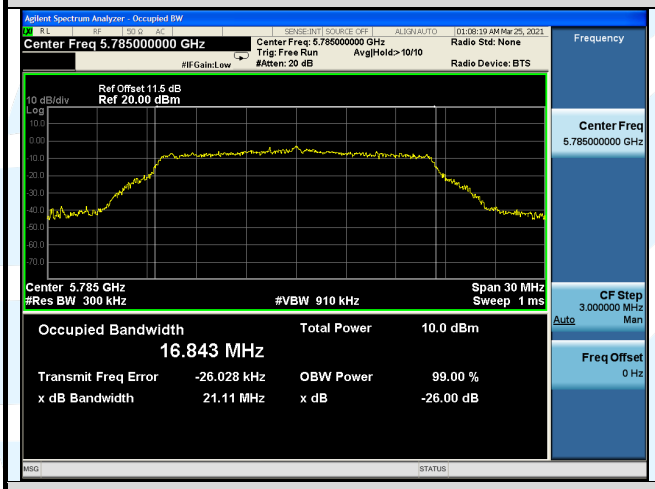
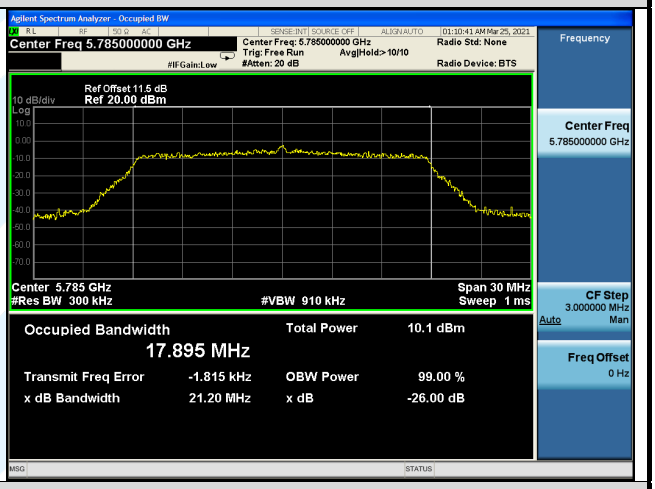
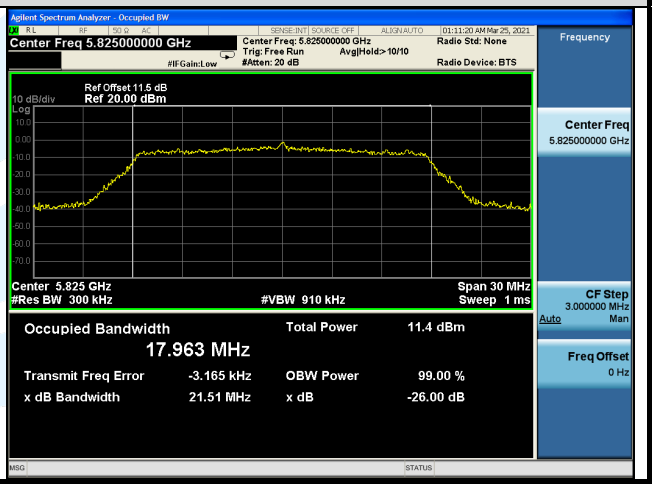


IEEE 802.11ac-VHT80

Channel 155

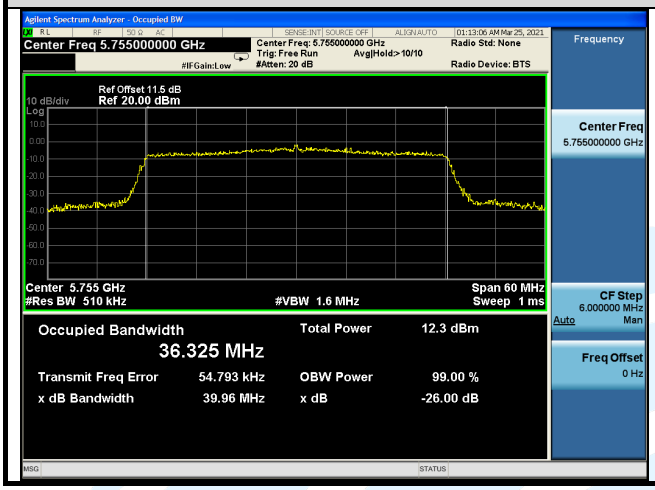


Occupied Bandwidth

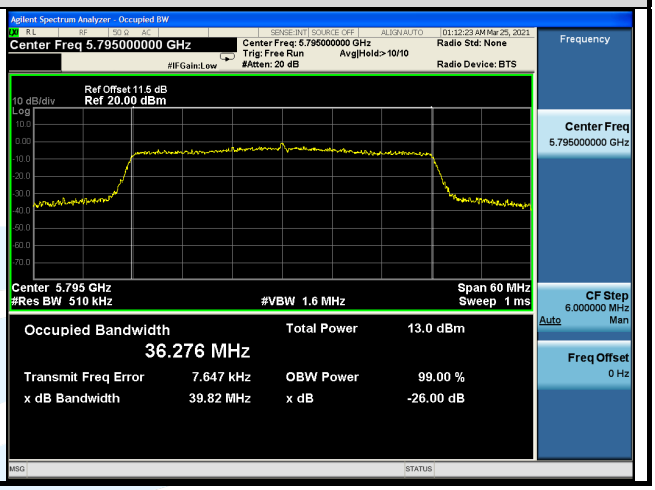
IEEE 802.11a	IEEE 802.11n-HT20
Channel 149	
	
Channel 157	
	
Channel 165	
	

IEEE 802.11n-HT40

Channel 151

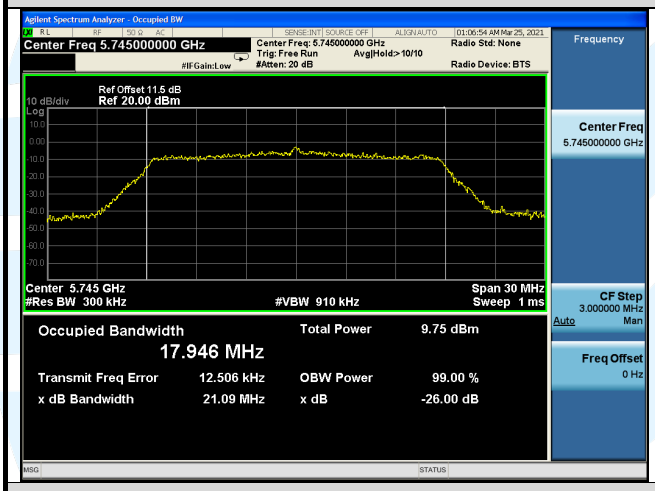


Channel 159

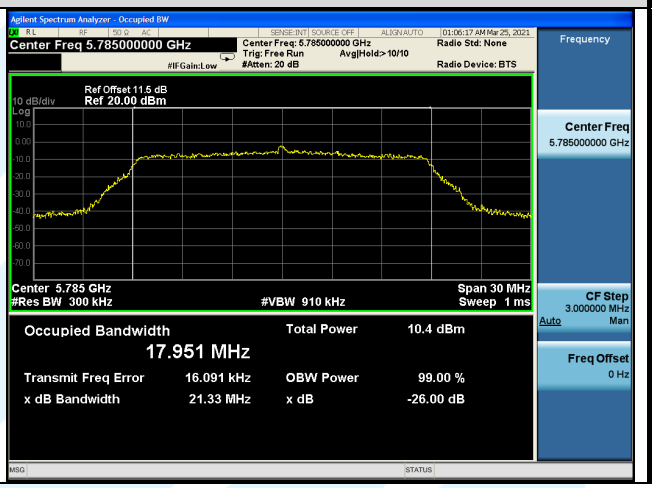


IEEE 802.11ac-VHT20

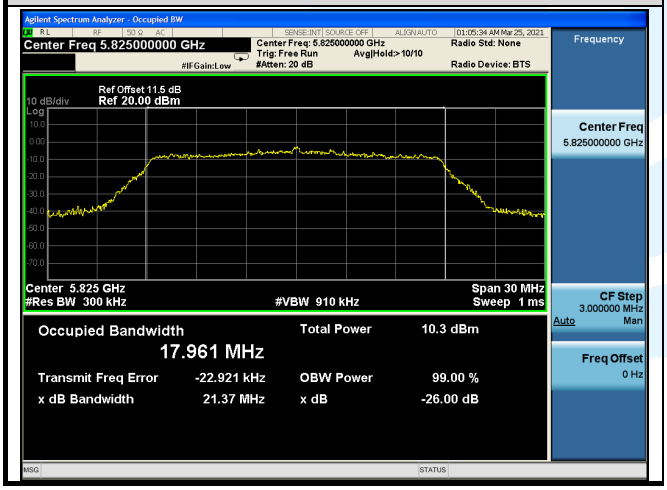
Channel 149



Channel 157



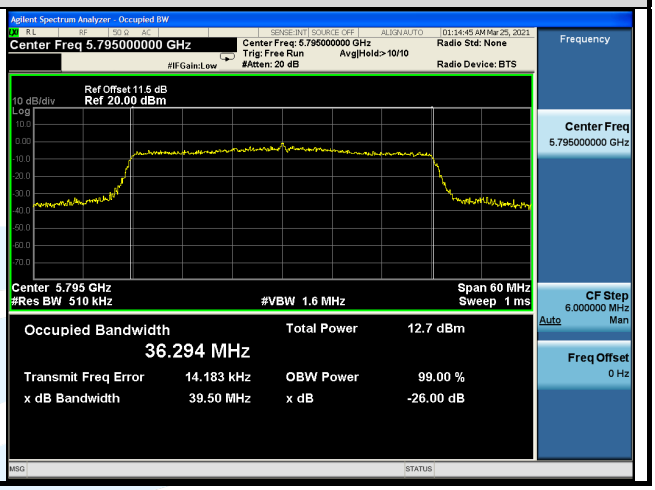
Channel 165



IEEE 802.11 ac-VHT40

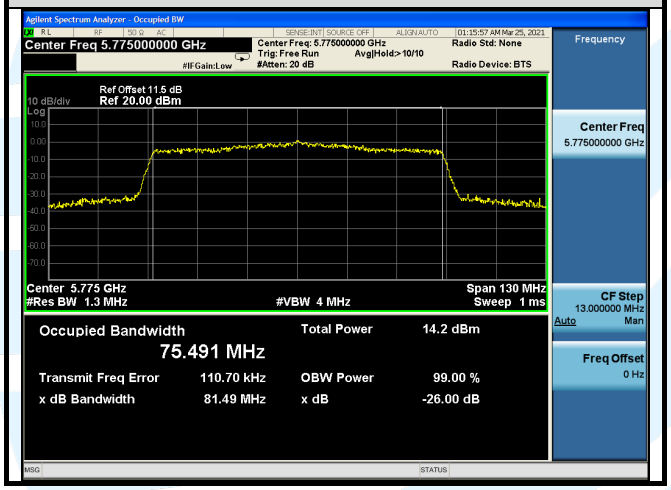
Channel 151

Channel 159



IEEE 802.11ac-VHT80

Channel 155



5.5 MAXIMUM CONDUCTED OUTPUT POWER OR E.I.R.P

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)
RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section E.3.a (Method PM)

Limits: FCC 47 CFR Part 15 Subpart E

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

   (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Limits: RSS-247 Issue 2

1. **Frequency band 5150-5250 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For other devices, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 $\log_{10}$B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

2. **Frequency band 5250-5350 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

Devices, other than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band;

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

Additional requirements
In addition to the above requirements, devices shall comply with the following, where applicable:

a) Outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevations, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

i. -13 dBW/MHz	for 0°≤ θ< 8°
ii. -13 − 0.716 (θ-8) dBW/MHz	for 8° ≤ θ< 40°
iii. -35.9 − 1.22 (θ-40) dBW/MHz	for 40° ≤ θ ≤45°
iv. -42 dBW/MHz	for θ > 45°

The measurement procedure defined in Annex A of this document shall be used to verify the compliance to the e.i.r.p. at different elevations.

b) Devices, other than outdoor fixed devices, having an e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:
   i. devices shall comply with the e.i.r.p. elevation mask in 6.2.2.3(a); or
   ii. devices shall implement a method to permanently reduce their e.i.r.p. via a firmwarefeature in the event that the Department requires it. The test report must demonstratehow the device's power table can be updated to meet this firmware requirement. Themanufacturer shall provide this firmware to update all systems automatically incompliance with the directions received from the Department.

3. **Frequency bands 5470-5600 MHz and 5650-5725 MHz**
The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

4. **Frequency band 5725-5850 MHz**
The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices

operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint[3] systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

Test Procedure:

1. Connected the EUT's antenna port to measure device by 10dB attenuator.
2. Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of Tx on burst.

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

Test Data:

Directional gain and the maximum output power limit.

RSS-247 Issue 2

Frequency Band	Antenna Gain (dBi))	Power Limits (dBm)
U-NII-1	6.5	22.50
U-NII-2A	6.5	23.50
U-NII-2C	6.5	23.50
U-NII-3	6.5	29.50

FCC 47 CFR Part 15 Subpart E

Frequency Band	Antenna Gain (dBi))	Power Limits (dBm)
U-NII-1	6.5	23.50
U-NII-2A	6.5	23.50
U-NII-2C	6.5	23.50
U-NII-3	6.5	29.50

Frequency band 5150-5250 MHz
RSS-247 Issue 2:
For IEEE 802.11a, the minimum 99% emission bandwidth is 16.882 MHz
10 dBm + $10\log_{10}$ (16.882) = 22.27 dBm < 22.50 dBm
So the 22.27dB limit applicable

For IEEE 802.11n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.923MHz
10 dBm + $10\log_{10}$ (17.923) = 22.53 dBm > 22.50 dBm
So the 22.50dB limit applicable

For IEEE 802.11n-HT40/ ac-VHT40/ ac-VHT80, the minimum 99% emission bandwidth is 36.328 MHz
10 dBm + $10\log_{10}$ (36.328) = 25.60 dBm > 22.50 dBm
So the 23 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum e.i.r.p (dBm)	Limit (dBm)	Pass / Fail
IEEE 802.11a	36 (5180)	15.58	22.27	Pass
	44 (5220)	15.33	22.27	Pass
	48 (5240)	15.27	22.27	Pass
IEEE 802.11n-HT20	36 (5180)	14.92	22.50	Pass
	44 (5220)	14.96	22.50	Pass
	48 (5240)	14.87	22.50	Pass
IEEE 802.11n-HT40	38 (5190)	16.22	22.50	Pass
	46 (5230)	15.88	22.50	Pass
IEEE 802.11ac-VHT20	36 (5180)	14.84	22.50	Pass
	44 (5220)	14.95	22.50	Pass
	48 (5240)	14.83	22.50	Pass
IEEE 802.11ac-VHT40	38 (5190)	16.15	22.50	Pass
	46 (5230)	15.77	22.50	Pass
IEEE 802.11ac-VHT80	42 (5210)	14.45	22.50	Pass

Remark:
1. Maximum e.i.r.p = Maximum conducted output power + Antenna Gain

FCC 47 CFR Part 15 Subpart E:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)	Pass / Fail
		Meas Power	Corr'd Power		
IEEE 802.11a	36 (5180)	8.77	9.08	24.00	Pass
	44 (5220)	8.52	8.83	24.00	Pass
	48 (5240)	8.46	8.77	24.00	Pass
IEEE 802.11n-HT20	36 (5180)	8.11	8.42	24.00	Pass
	44 (5220)	8.15	8.46	24.00	Pass
	48 (5240)	8.06	8.37	24.00	Pass
IEEE 802.11n-HT40	38 (5190)	9.08	9.72	24.00	Pass
	46 (5230)	8.74	9.38	24.00	Pass
IEEE 802.11ac-VHT20	36 (5180)	8.03	8.34	24.00	Pass
	44 (5220)	8.14	8.45	24.00	Pass
	48 (5240)	8.02	8.33	24.00	Pass
IEEE 802.11ac-VHT40	38 (5190)	9.01	9.65	24.00	Pass
	46 (5230)	8.63	9.27	24.00	Pass
IEEE 802.11ac-VHT80	42 (5210)	7.61	7.95	24.00	Pass

Remark:

1. Corr'd Power = Meas Power + Duty Cycle Factor

Frequency band 5250-5350 MHz
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.884 MHz
11 dBm + $10\log_{10}$ (16.884) = 23.27dBm < 23.50dBm
So the 23.27 dB limit applicable

For IEEE 802.11n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.906 MHz
11 dBm + $10\log_{10}$ (17.906) =23.53 dBm > 23.50dBm
So the 23.50 dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 36.268 MHz
11 dBm + $10\log_{10}$ (36.268) = 26.60 dBm > 23.50 dBm (200mW)
So the 23.50 dB limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is20.90MHz
11 dBm + $10\log_{10}$ (20.90) = 24.20 dBm> 23.50 dBm (200mW)
So the 23.50 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)		Pass / Fail
		Meas Power	Corr'd Power	FCC Part 15E	RSS-247	
IEEE 802.11a	52 (5260)	8.65	8.96	23.50	23.27	Pass
	60 (5300)	8.23	8.54	23.50	23.27	Pass
	64 (5320)	8.39	8.70	23.50	23.27	Pass
IEEE 802.11n-HT20	52 (5260)	8.21	8.52	23.50	23.50	Pass
	60 (5300)	8.00	8.31	23.50	23.50	Pass
	64 (5320)	8.16	8.47	23.50	23.50	Pass
IEEE 802.11n-HT40	54 (5270)	8.66	9.30	23.50	23.50	Pass
	62 (5310)	8.62	9.26	23.50	23.50	Pass
IEEE 802.11ac-VHT20	52 (5260)	8.16	8.47	23.50	23.50	Pass
	60 (5300)	7.95	8.26	23.50	23.50	Pass
	64 (5320)	8.11	8.42	23.50	23.50	Pass
IEEE 802.11ac-VHT40	54 (5270)	8.58	9.22	23.50	23.50	Pass
	62 (5310)	8.55	9.19	23.50	23.50	Pass
IEEE 802.11ac-VHT80	58 (5290)	7.27	7.61	23.50	23.50	Pass

Remark:
1. Maximum conducted output power = Conducted output power + Duty Cycle Factor

Frequency bands 5470-5725 MHz (RSS-247 Issue 2 Not including 5600-5650 MHz)
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.900MHz
11 dBm + $10\log_{10}$ (16.900) = 23.28 dBm < 23.50 dBm
So the 23.28 dB limit applicable

For IEEE 802.11n-HT20/ac-VHT20, the minimum 99% emission bandwidth is 17.926MHz
11 dBm + $10\log_{10}$ (17.926) = 23.53 dBm > 23.50 dBm
So the 23.50dB limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 36.276 MHz
11 dBm + $10\log_{10}$ (36.276) = 26.60dBm > 23.50 dBm
So the 23.50 dB limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is 21.10 MHz
11 dBm + $10\log_{10}$ (21.10) = 24.24 dBm > 23.50 dBm
So the 23.50 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)		Pass / Fail
		SISO				
		Meas Power	Corr'd Power	FCC Part 15E	RSS-247	
IEEE 802.11a	100 (5500)	6.17	6.48	23.50	23.28	Pass
	116 (5580)	5.58	5.89	23.50	23.28	Pass
	140 (5700)	5.92	6.23	23.50	23.28	Pass
IEEE 802.11n-HT20	100 (5500)	5.75	6.06	23.50	23.50	Pass
	116 (5580)	5.15	5.46	23.50	23.50	Pass
	140 (5700)	5.49	5.80	23.50	23.50	Pass
IEEE 802.11n-HT40	102 (5510)	6.51	7.15	23.50	23.50	Pass
	110 (5550)	6.11	6.75	23.50	23.50	Pass
	134 (5670)	6.12	6.76	23.50	23.50	Pass
IEEE 802.11ac-VHT20	100 (5500)	5.69	6.00	23.50	23.50	Pass
	116 (5580)	5.10	5.41	23.50	23.50	Pass
	140 (5700)	5.45	5.76	23.50	23.50	Pass
IEEE 802.11ac-VHT40	102 (5510)	6.50	7.14	23.50	23.50	Pass
	110 (5550)	6.06	6.70	23.50	23.50	Pass
	134 (5670)	6.08	6.72	23.50	23.50	Pass
IEEE 802.11ac-VHT80	106 (5530)	5.31	5.65	23.50	23.50	Pass

Remark:
1. Maximum conducted output power = Conducted output power + Duty Cycle Factor

Frequency band 5725-5850 MHz

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Limit (dBm)	Pass / Fail
		Meas Power	Corr'd Power		
IEEE 802.11a	149 (5745)	6.02	6.33	30	Pass
	157 (5785)	6.36	6.67	30	Pass
	165 (5825)	6.21	6.52	30	Pass
IEEE 802.11n-HT20	149 (5745)	5.63	5.94	30	Pass
	157 (5785)	5.98	6.29	30	Pass
	165 (5825)	5.87	6.18	30	Pass
IEEE 802.11n-HT40	151 (5755)	6.72	7.36	30	Pass
	159 (5795)	7.09	7.73	30	Pass
IEEE 802.11ac-VHT20	149 (5745)	5.58	5.89	30	Pass
	157 (5785)	5.94	6.25	30	Pass
	165 (5825)	5.81	6.12	30	Pass
IEEE 802.11ac-VHT40	151 (5755)	6.67	7.31	30	Pass
	159 (5795)	7.03	7.67	30	Pass
IEEE 802.11ac-VHT80	155 (5775)	5.73	6.07	30	Pass

Remark:

1. Maximum conducted output power = Conducted output power + Duty Cycle Factor

5.6 PEAK POWER SPECTRAL DENSITY

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)
RSS-247 Issue 2 Section 6.2.1.1/6.2.2.1/6.2.3.1/6.2.4.1

Test Method: KDB 789033 D02 v02r01 Section F

Limits: FCC 47 CFR Part 15 Subpart E

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

   (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3. For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Limits: RSS-247 Issue 2

1. **Frequency band 5150-5250 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For other devices, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 $\log_{10}$B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

2. **Frequency band 5250-5350 MHz**
For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 $\log_{10}$B, dBm, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

Devices, other than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band;

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

Additional requirements
In addition to the above requirements, devices shall comply with the following, where applicable:

a) Outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevations, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

i. -13 dBW/MHz for $0^o \leq \theta < 8^o$

ii. -13 − 0.716 (θ-8) dBW/MHz for $8^o \leq \theta < 40^o$

iii. -35.9 − 1.22 (θ-40) dBW/MHz for $40^o \leq \theta \leq 45^o$

iv. -42 dBW/MHz for $\theta > 45^o$

The measurement procedure defined in Annex A of this document shall be used to verify the compliance to the e.i.r.p. at different elevations.

b) Devices, other than outdoor fixed devices, having an e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:

iii. devices shall comply with the e.i.r.p. elevation mask in 6.2.2.3(a); or

iv. devices shall implement a method to permanently reduce their e.i.r.p. via a firmwarefeature in the event that the Department requires it. The test report must demonstratehow the device's power table can be updated to meet this firmware requirement. Themanufacturer shall provide this firmware to update all systems automatically incompliance with the directions received from the Department.

3. **Frequency bands 5470-5600 MHz and 5650-5725 MHz**
The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

4. **Frequency band 5725-5850 MHz**
The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices

operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint[3] systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

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:

1. For U-NII-1, U-NII-2A, U-NII-2C band:

Using method SA-2

a) Set span to encompass the entire emission bandwidth (EBW) of the signal.
b) Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c) Sweep time = auto, trigger set to “free run”.
d) Trace average at least 100 traces in power averaging mode.
e) Record the max value and add 10 log (1/duty cycle)

2. For U-NII-3 band:

a) Set span to encompass the entire emission bandwidth (EBW) of the signal.
b) Set RBW = 500 kHz, Set VBW ≥ 3 RBW, Detector = RMS
c) Use the peak marker function to determine the maximum power level in any 500 kHz band segment within the fundamental EBW.
d) Sweep time = auto, trigger set to “free run”.
e) Trace average at least 100 traces in power averaging mode.
f) Record the max value and add 10 log (1/duty cycle)

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

Test Data:

Directional gain and the maximum output power limit.

RSS-247 Issue 2:

Frequency Band	Antenna Gain (dBi))	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	6.5	9.50
U-NII-2A	6.5	10.50
U-NII-2C	6.5	10.50
U-NII-3	6.5	29.50

FCC 47 CFR Part 15 Subpart E:

Frequency Band	Antenna Gain (dBi))	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	6.5	10.50
U-NII-2A	6.5	10.50
U-NII-2C	6.5	10.50
U-NII-3	6.5	29.50

Frequency band 5150-5250 MHz
RSS-247 Issue 2

Mode	Channel/ Frequency (MHz)	e.i.r.p. spectral density (dBm/MHz)	Limit (dBm/MHz)	Pass / Fail
IEEE 802.11a	36 (5180)	5.177	9.50	Pass
	44 (5220)	4.256	9.50	Pass
	48 (5240)	4.387	9.50	Pass
IEEE 802.11n-HT20	36 (5180)	4.345	9.50	Pass
	44 (5220)	3.97	9.50	Pass
	48 (5240)	4.297	9.50	Pass
IEEE 802.11n-HT40	38 (5190)	3.207	9.50	Pass
	46 (5230)	3.594	9.50	Pass
IEEE 802.11ac-VHT20	36 (5180)	4.528	9.50	Pass
	44 (5220)	4.111	9.50	Pass
	48 (5240)	4.216	9.50	Pass
IEEE 802.11ac-VHT40	38 (5190)	3.279	9.50	Pass
	46 (5230)	3.37	9.50	Pass
IEEE 802.11ac-VHT80	42 (5210)	1.915	9.50	Pass

Remark:

1. e.i.r.p. spectral density = Power spectral density + Duty Cycle Factor + Antenna Gain

FCC 47 CFR Part 15 Subpart E

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz)		Limit (dBm/MHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	36 (5180)	-1.323	-1.014	10.50	Pass
	44 (5220)	-2.244	-1.935	10.50	Pass
	48 (5240)	-2.113	-1.804	10.50	Pass
IEEE 802.11n-HT20	36 (5180)	-2.155	-1.841	10.50	Pass
	44 (5220)	-2.530	-2.216	10.50	Pass
	48 (5240)	-2.203	-1.889	10.50	Pass
IEEE 802.11n-HT40	38 (5190)	-3.293	-2.652	10.50	Pass
	46 (5230)	-2.906	-2.265	10.50	Pass
IEEE 802.11ac-VHT20	36 (5180)	-1.972	-1.659	10.50	Pass
	44 (5220)	-2.389	-2.076	10.50	Pass
	48 (5240)	-2.284	-1.971	10.50	Pass
IEEE 802.11ac-VHT40	38 (5190)	-3.221	-2.580	10.50	Pass
	46 (5230)	-3.130	-2.489	10.50	Pass
IEEE 802.11ac-VHT80	42 (5210)	-4.585	-4.242	10.50	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor

Frequency band 5250-5350 MHz

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz)		Limit (dBm/MHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	52 (5260)	-2.199	-1.890	10.50	Pass
	60 (5300)	-3.259	-2.950	10.50	Pass
	64 (5320)	-3.312	-3.003	10.50	Pass
IEEE 802.11n-HT20	52 (5260)	-3.124	-2.810	10.50	Pass
	60 (5300)	-3.062	-2.748	10.50	Pass
	64 (5320)	-3.628	-3.314	10.50	Pass
IEEE 802.11n-HT40	54 (5270)	-4.568	-3.927	10.50	Pass
	62 (5310)	-4.981	-4.340	10.50	Pass
IEEE 802.11ac-VHT20	52 (5260)	-2.712	-2.399	10.50	Pass
	60 (5300)	-3.288	-2.975	10.50	Pass
	64 (5320)	-3.694	-3.381	10.50	Pass
IEEE 802.11ac-VHT40	54 (5270)	-4.200	-3.559	10.50	Pass
	62 (5310)	-4.384	-3.743	10.50	Pass
IEEE 802.11ac-VHT80	58 (5290)	-5.634	-5.291	10.50	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor

Frequency bands 5470-5725 MHz (RSS-247 Issue 2 Not including 5600-5650 MHz)

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/MHz)		Limit (dBm/MHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	100 (5500)	-8.210	-7.901	10.50	Pass
	116 (5580)	-9.106	-8.797	10.50	Pass
	140 (5700)	-7.526	-7.217	10.50	Pass
IEEE 802.11n-HT20	100 (5500)	-8.575	-8.261	10.50	Pass
	116 (5580)	-9.548	-9.234	10.50	Pass
	140 (5700)	-7.046	-6.732	10.50	Pass
IEEE 802.11n-HT40	102 (5510)	-10.353	-9.712	10.50	Pass
	110 (5550)	-11.580	-10.939	10.50	Pass
	134 (5670)	-9.649	-9.008	10.50	Pass
IEEE 802.11ac-VHT20	100 (5500)	-8.891	-8.578	10.50	Pass
	116 (5580)	-10.145	-9.832	10.50	Pass
	140 (5700)	-7.313	-7.000	10.50	Pass
IEEE 802.11ac-VHT40	102 (5510)	-10.343	-9.702	10.50	Pass
	110 (5550)	-10.655	-10.014	10.50	Pass
	134 (5670)	-8.620	-7.979	10.50	Pass
IEEE 802.11ac-VHT80	106 (5530)	-12.125	-11.782	10.50	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor

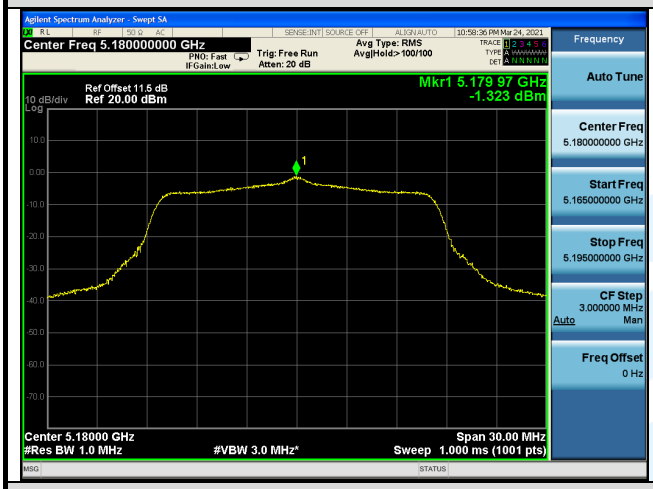
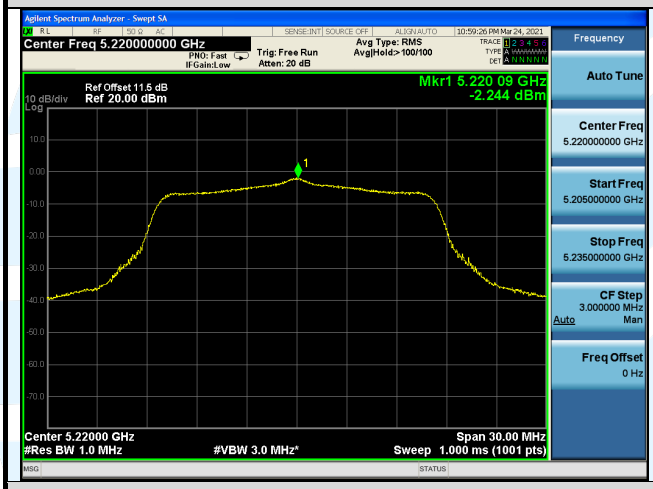
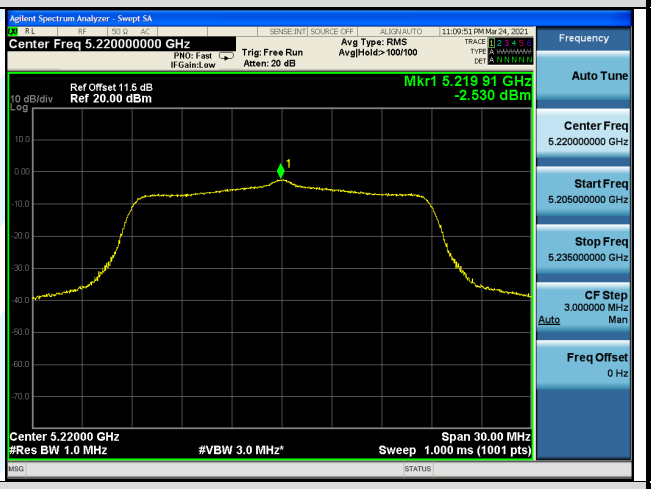
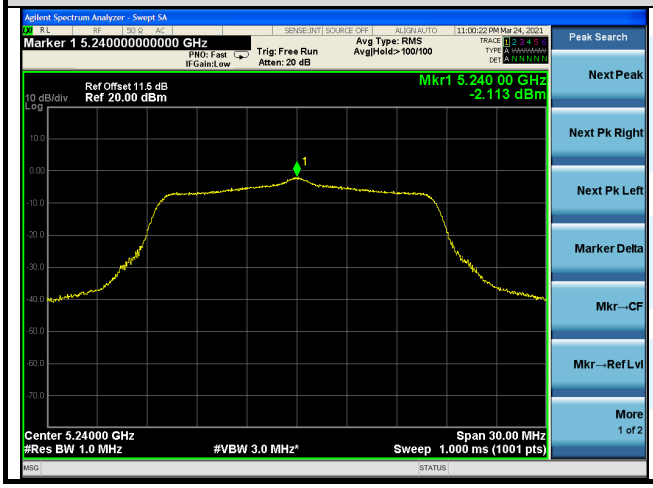
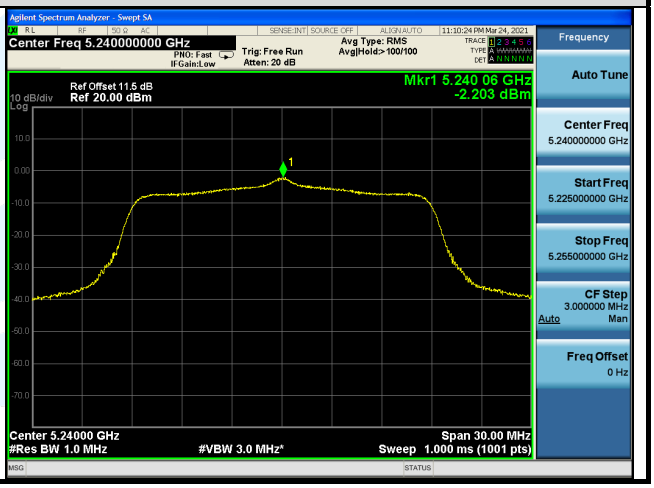
Frequency band 5725-5850 MHz

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/500kHz)		Limit (dBm/500KHz)	Pass / Fail
		Meas PSD	Corr'd PSD		
IEEE 802.11a	149 (5745)	-6.918	-6.609	29.50	Pass
	157 (5785)	-5.529	-5.220	29.50	Pass
	165 (5825)	-5.354	-5.045	29.50	Pass
IEEE 802.11n-HT20	149 (5745)	-7.253	-6.939	29.50	Pass
	157 (5785)	-5.576	-5.262	29.50	Pass
	165 (5825)	-5.234	-4.920	29.50	Pass
IEEE 802.11n-HT40	151 (5755)	-6.522	-5.881	29.50	Pass
	159 (5795)	-5.346	-4.705	29.50	Pass
IEEE 802.11ac-VHT20	149 (5745)	-7.142	-6.829	29.50	Pass
	157 (5785)	-5.619	-5.306	29.50	Pass
	165 (5825)	-5.370	-5.057	29.50	Pass
IEEE 802.11ac-VHT40	151 (5755)	-7.296	-6.655	29.50	Pass
	159 (5795)	-5.714	-5.073	29.50	Pass
IEEE 802.11ac-VHT80	155 (5775)	-7.508	-7.165	29.50	Pass

Remark:

1. Power spectral density = Conducted power spectral density + Duty Cycle Factor

The test plots as follows:

IEEE 802.11a	IEEE 802.11n-HT20
Channel 36	
	
Channel 44	
	
Channel 48