Certificate #4312.01

TEST REPORT

Product Name:	SIP/Multicast Talk-Back Speaker
Trade Mark:	GRANDSTREAM
Model No. / HVIN:	GSC3516
Report Number:	220720530RFC-4
Test Standards:	FCC 47 CFR Part 15 Subpart E RSS-247 Issue 2 RSS-Gen Issue 5
FCC ID:	YZZGSC3516
IC:	11964A-GSC3516
Test Result:	PASS
Date of Issue:	August 24, 2022

Prepared for:

Grandstream Networks, Inc.
126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA

Prepared by:

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Prepared by: Kieron Luo
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Team Leader

Approved by: Kevin Liang
Assistant Manager

Date: August 24, 2022

Version

Version No.	Date	Description
V1.0	August 24, 2022	Original

CONTENTS

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Grandstream Networks, Inc.
Address of Applicant:	126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA
Manufacturer:	Grandstream Networks, Inc.
Address of Manufacturer:	126 Brookline Ave., 3rd Floor, Boston, MA 02215, USA

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	SIP/Multicast Talk-Back Speaker		
Model No. / HVIN:	GSC3516		
Trade Mark:	GRANDSTREAM		
DUT Stage:	Identical Prototype		
EUT Supports Function: (Provided by the customer)	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:	July 19, 2022		
Sample Tested Date:	July 19, 2022 to August 10, 2022		

Remark: The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.

1.2.2 Description of Accessories

Others
1x Metal Bracket, 1x Plastic Bracket

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
	5745 MHz to 5825 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:	Dipole Antenna				
Antenna Gain: (Provided by the customer)	5150 MHz to 5250 MHz: 3.5 dBi				
	5250 MHz to 5350 MHz: 3.5 dBi				
	5470 MHz to 5725 MHz: 3.5 dBi				
	5725 MHz to 5850 MHz: 3.5 dBi				
Maximum conducted output power (dBm):		**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	14.21	14.00	15.64	15.17
	IEEE 802.11n-HT20:	14.35	14.17	15.30	15.00
	IEEE 802.11n-HT40:	14.35	14.05	14.94	14.87
	IEEE 802.11ac-VHT20	14.33	14.18	15.43	14.97
	IEEE 802.11ac-VHT40	14.30	13.78	14.80	14.72
	IEEE 802.11ac-VHT80:	13.38	13.28	14.29	14.25
Maximum EIRP (dBm):		**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	17.71	17.50	19.14	18.67
	IEEE 802.11n-HT20:	17.85	17.67	18.80	18.50
	IEEE 802.11n-HT40:	17.85	17.55	18.44	18.37
	IEEE 802.11ac-VHT20	17.83	17.68	18.93	18.47
	IEEE 802.11ac-VHT40	17.80	17.28	18.30	18.22
	IEEE 802.11ac-VHT80:	16.88	16.78	17.79	17.75
Normal Test Voltage:	48Vdc				

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	DELL	Inspiron 5409	N/A	N/A	Notebook
Mouse	DELL	MS111	CN-011D3V-738	N/A	UnionTrust
Wireless Home Router	SAGEMCOM	FAST5280	253703944	VW3FAST5280	UnionTrust
Key-Press Attenuator	Huaxin	KT2.5-90/1S-2S	N/A	N/A	UnionTrust
4 Way Divider	WOKEN	0120A040560002D	N/A	N/A	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.1Meter	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 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 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	± 0.68 dB
10	Occupied Bandwidth	± 1.86 %
11	Radio Frequency	5.6 GHz: ± 6.4 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.			
Disclaimer and Explanations: The declared of product specification and data (e.g. antenna gain, RF specification, etc) for EUT presented in the report are provided by the customer, and the customer takes all the responsibilities for the accuracy of product specification.			

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 SAC	ETS-LINDGREN	3m	Euroshiedpn-CT001270-1317	Jan. 22, 2021	Jan. 21, 2024
☒	Receiver	R&S	ESIB26	100114	Nov. 05, 2021	Nov. 04, 2022
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Apr. 15, 2022	Apr. 14, 2023
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	Nov. 11, 2021	Nov. 10, 2023
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Nov. 11, 2021	Nov. 10, 2023
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	Nov. 11, 2021	Nov. 10, 2023
☒	Preamplifier	HP	8447F	2805A02960	Nov. 05, 2021	Nov. 04, 2022
☒	Double-Ridged Waveguide Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201541	Apr. 30, 2021	Apr. 29, 2023
☒	Pre-amplifier	ETS-Lindgren	00118385	00201874	Nov. 06, 2021	Nov. 05, 2022
☒	Double-Ridged Waveguide Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Nov. 14, 2020	Nov. 13, 2023
☒	Pre-amplifier	ETS-Lindgren	00118384	00202652	Nov. 17, 2020	Nov. 16, 2022
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☐	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	Nov. 06, 2021	Nov. 05, 2022
☒	Band Rejection Filter (5150MHz~5880MHz)	Micro-Tronics	BRM50716	G186	Nov. 06, 2021	Nov. 05, 2022
☒	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. 05, 2021	Nov. 04, 2022
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 05, 2021	Nov. 04, 2022
☒	LISN	R&S	ESH2-Z5	860014/024	Nov. 05, 2021	Nov. 04, 2022
☒	LISN	ETS-Lindgren	3816/2SH	00201088	Nov. 05, 2021	Nov. 04, 2022
☒	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	Apr. 15, 2022	Apr. 14, 2023
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 05, 2021	Nov. 04, 2022
☐	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Nov. 05, 2021	Nov. 04, 2022
☒	MXG X-Series RF Vector Signal Generator	KEYSIGHT	N5182B	MY51350267	Nov. 05, 2021	Nov. 04, 2022

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	48	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment and Test Sample

Test Item	Temperature (°C)	Relative Humidity (%)	Pressure (kPa)	Sample No.	Tested by
26 dB emission bandwidth	24.5	51	100.2	S20220719209-ZJA02/4	Rain Wang
6 dB bandwidth					
Occupied Bandwidth					
Maximum conducted output power					
Peak Power Spectral Density					
Dynamic Frequency Selection					
Radiated Emissions and Band Edge Measurement	25.3	51	100.02	S20220719209-ZJA01/4	Andy Lin
AC Power Line Conducted Emission	25.3	45	100.1	S20220719209-ZJA01/4	Davin Zhang

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.

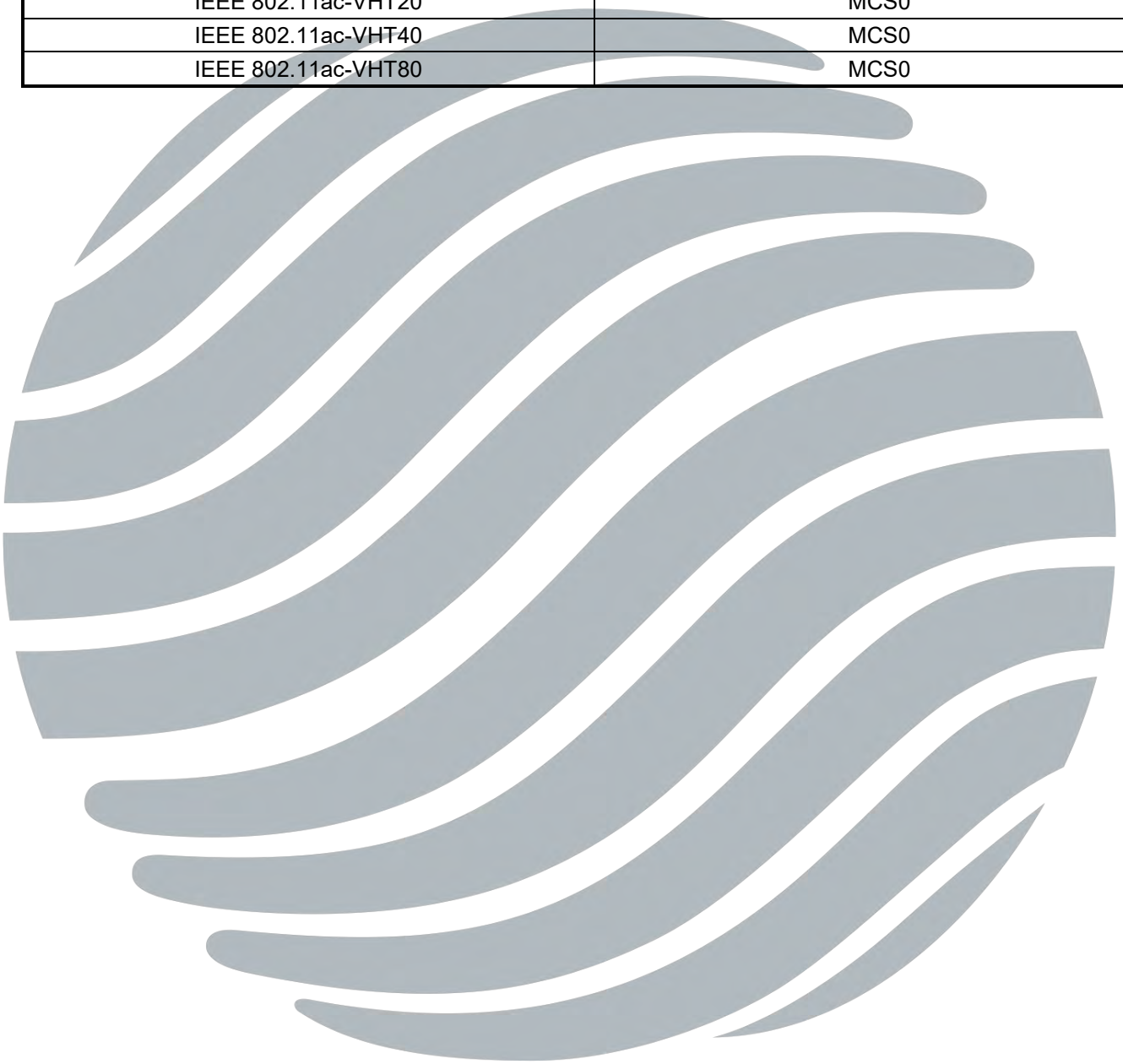
Power Setting				
	U-NII-1	U-NII-2A	U-NII-2C	U-NII-3
IEEE 802.11a	16	16	16	15
IEEE 802.11n-HT20	16	16	16	15
IEEE 802.11n-HT40	16	16	15	15
IEEE 802.11ac-VHT20	16	16	16	15
IEEE 802.11ac-VHT40	16	16	15	15
IEEE 802.11ac-VHT80	15	15	15	15

Test Software
Test software name: Qualcomm Radio Control Tool Version 4.0.00108;

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

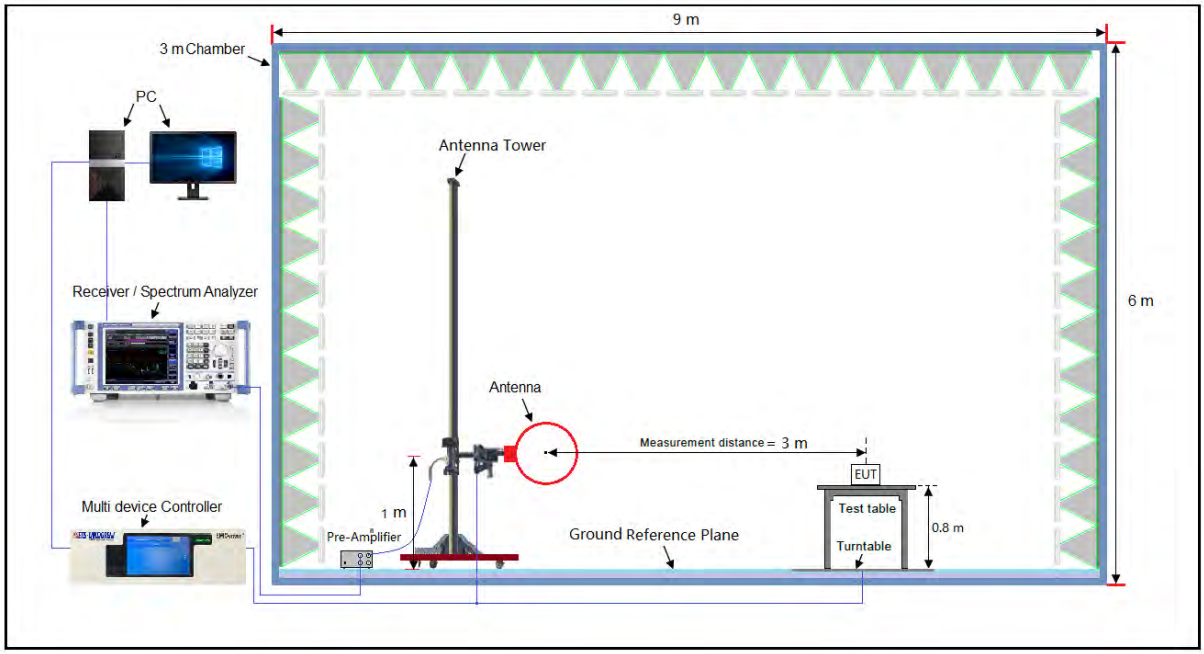


Figure 2. 30MHz to 1GHz

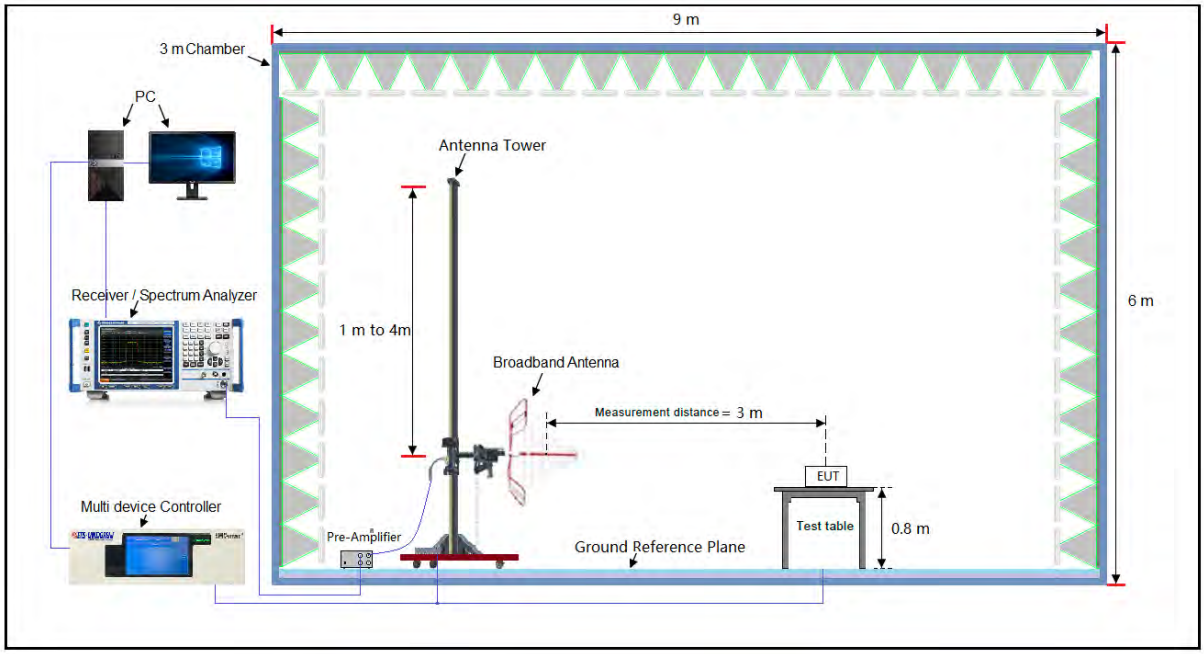
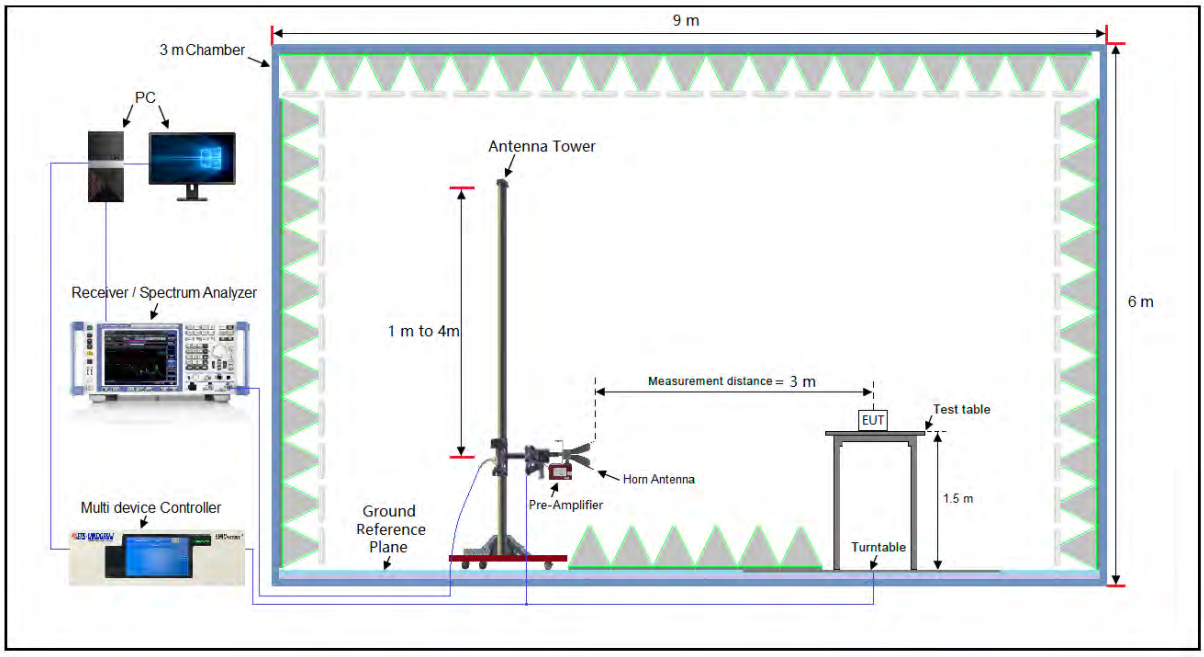
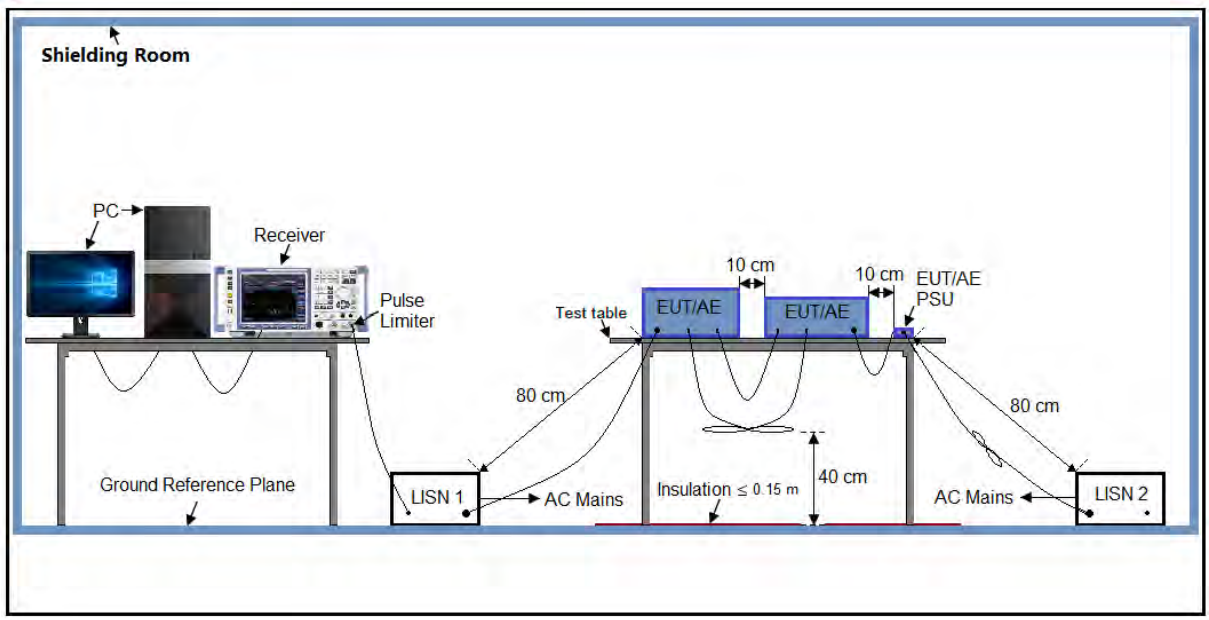


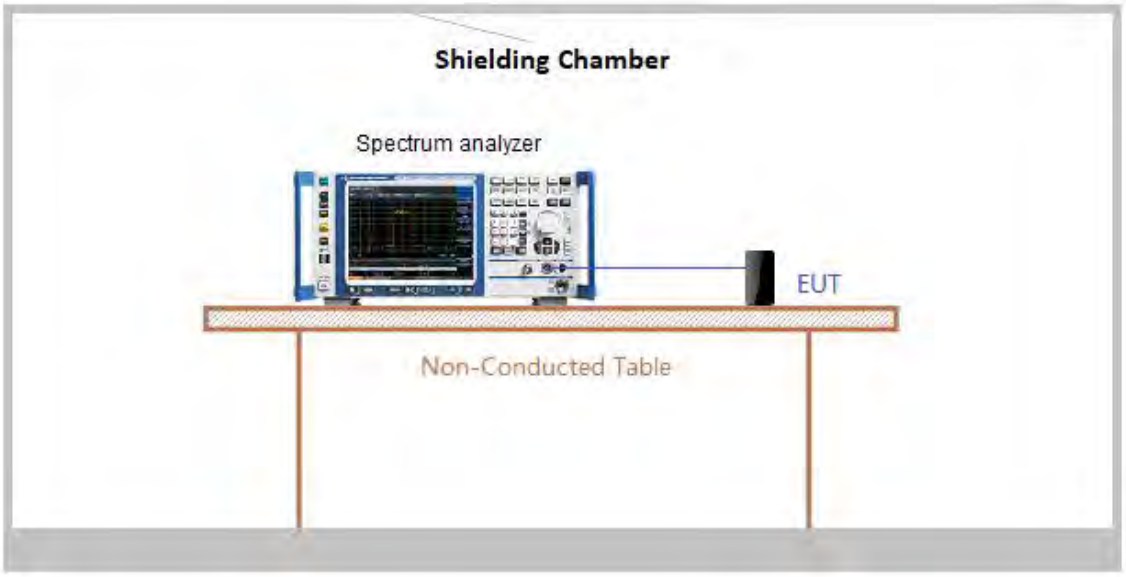
Figure 3. Above 1GHz



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.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	Z 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

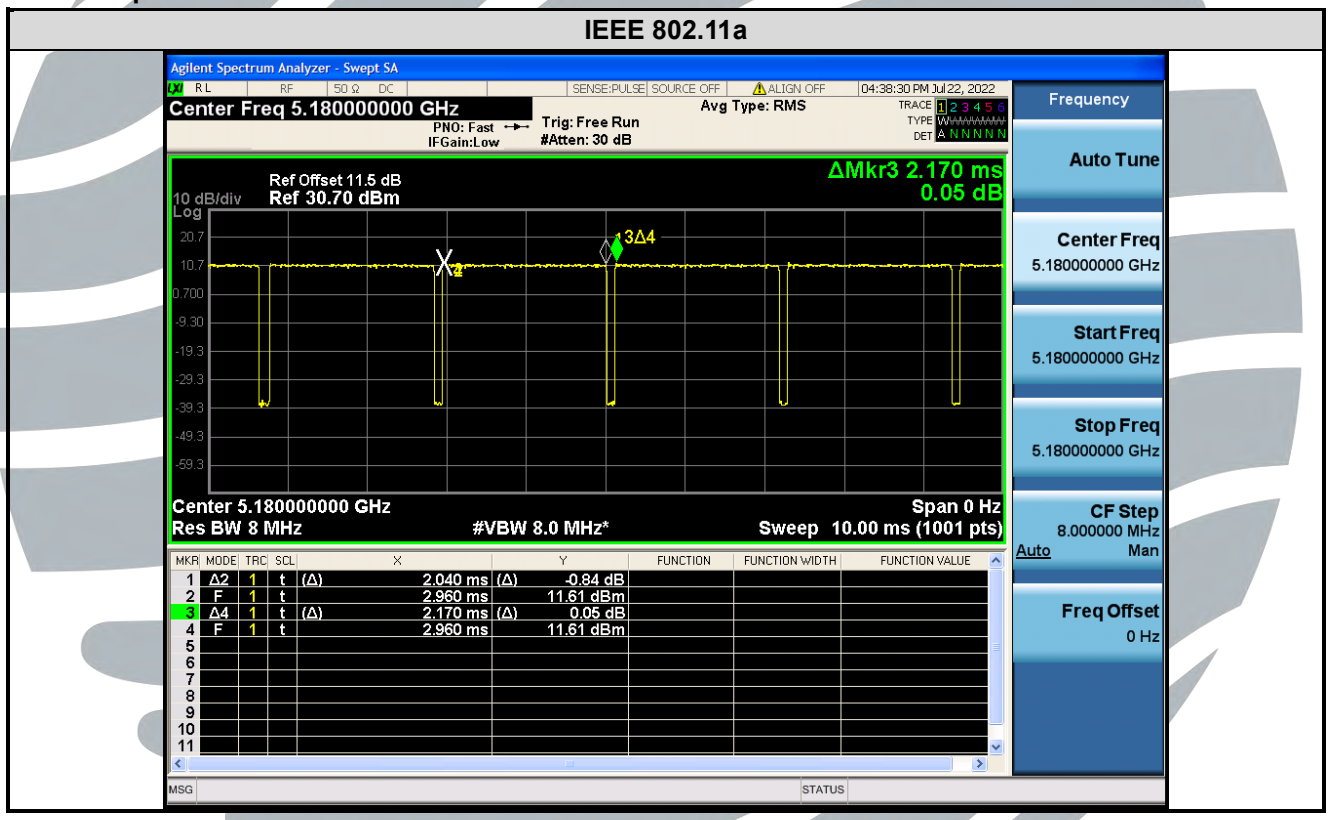
Mode	Data Rates	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/T Minimum VBW (kHz)
IEEE 802.11a	6 Mbps	2.040	2.170	0.94	94.01	0.27	0.49
IEEE 802.11n-HT20	MCS 0	1.900	2.030	0.94	93.60	0.29	0.53
IEEE 802.11n-HT40	MCS 0	0.940	1.115	0.84	84.30	0.74	1.06
IEEE 802.11ac-VHT20	MCS 0	1.910	2.050	0.93	93.17	0.31	0.52
IEEE 802.11ac-VHT40	MCS 0	0.940	1.085	0.87	86.64	0.62	1.06
IEEE 802.11ac-VHT80	MCS 0	0.459	0.591	0.78	77.66	1.10	2.18

Remark:

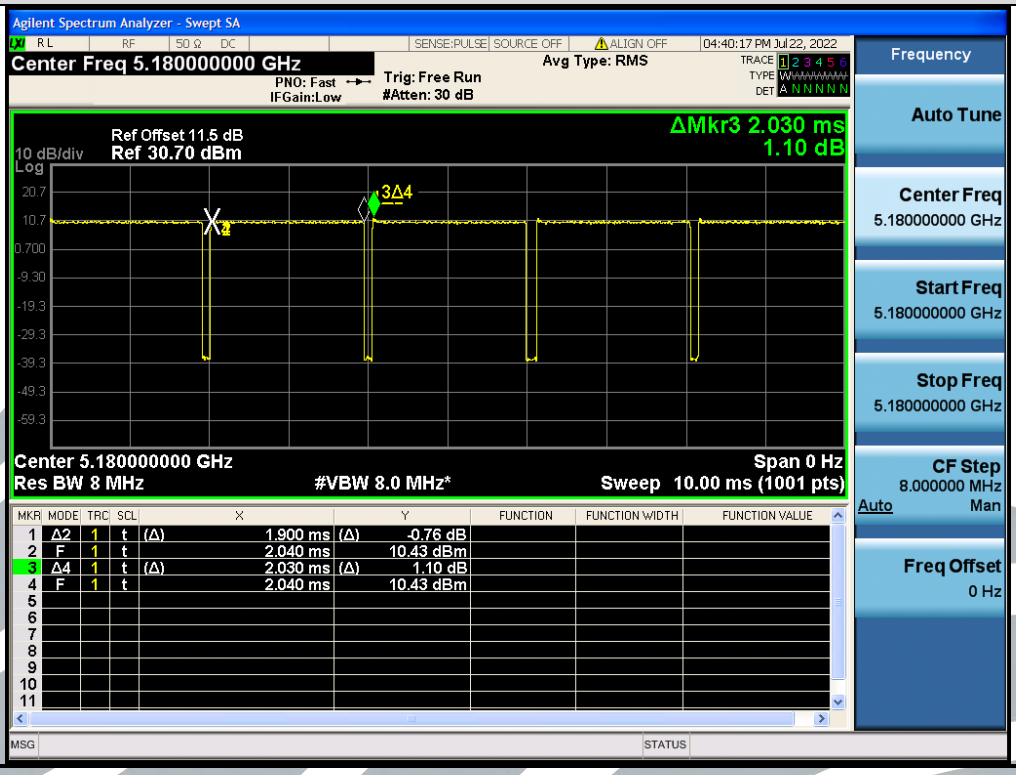
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plots as follows

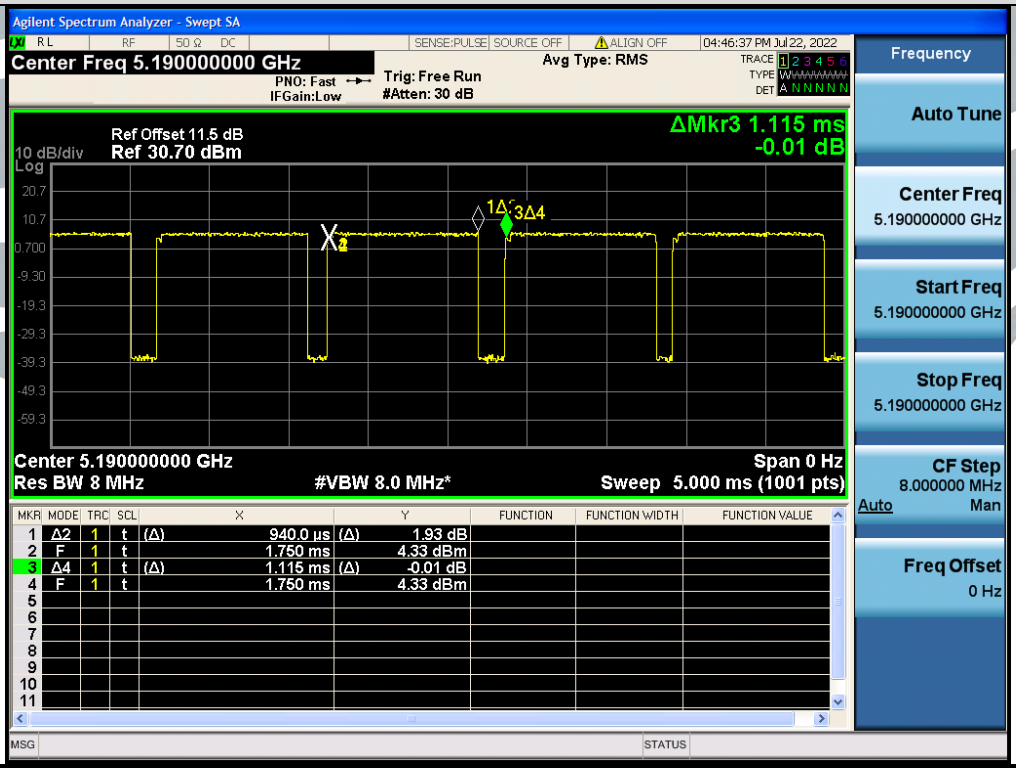
IEEE 802.11a



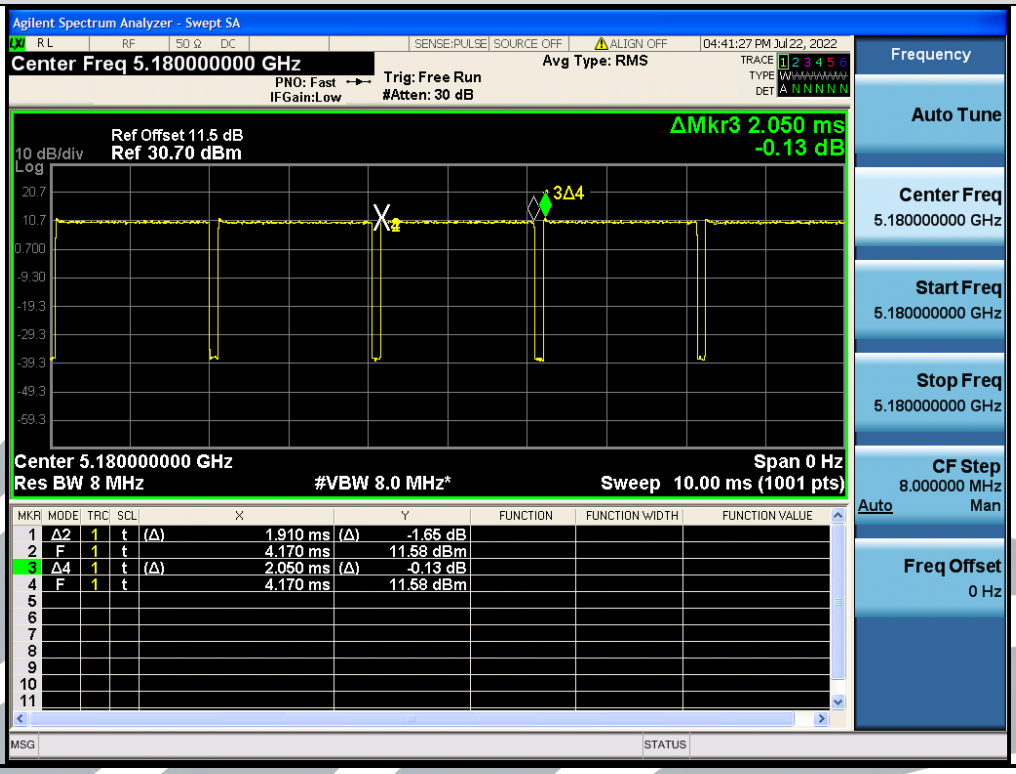
IEEE 802.11n-HT20



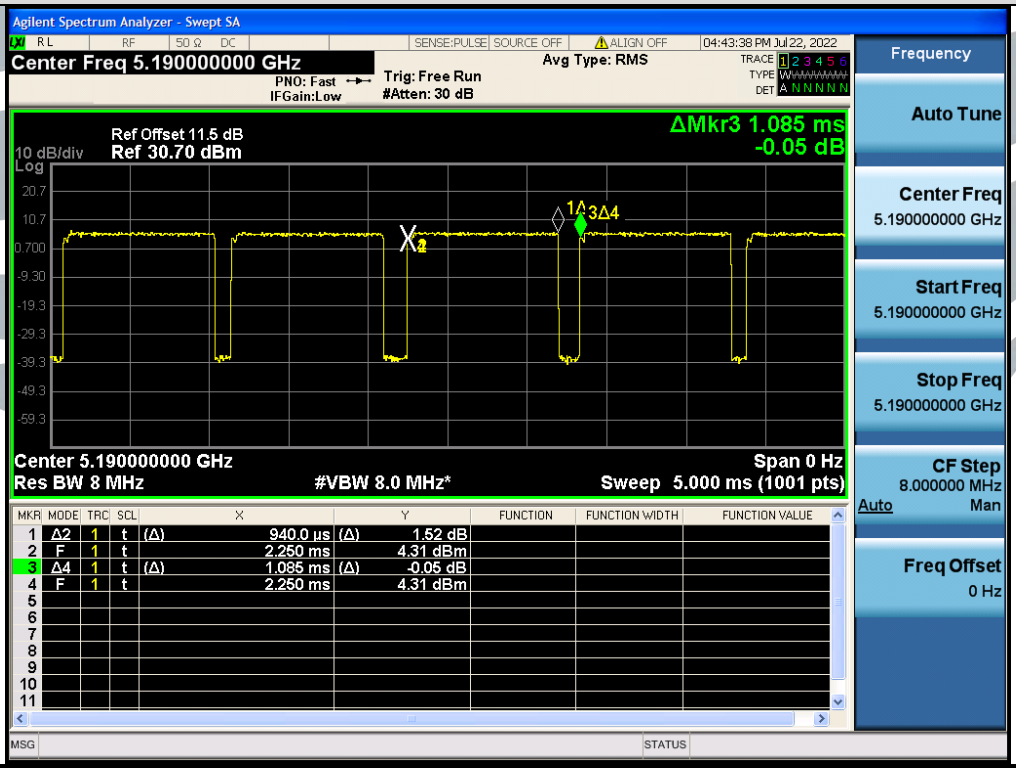
IEEE 802.11n-HT40



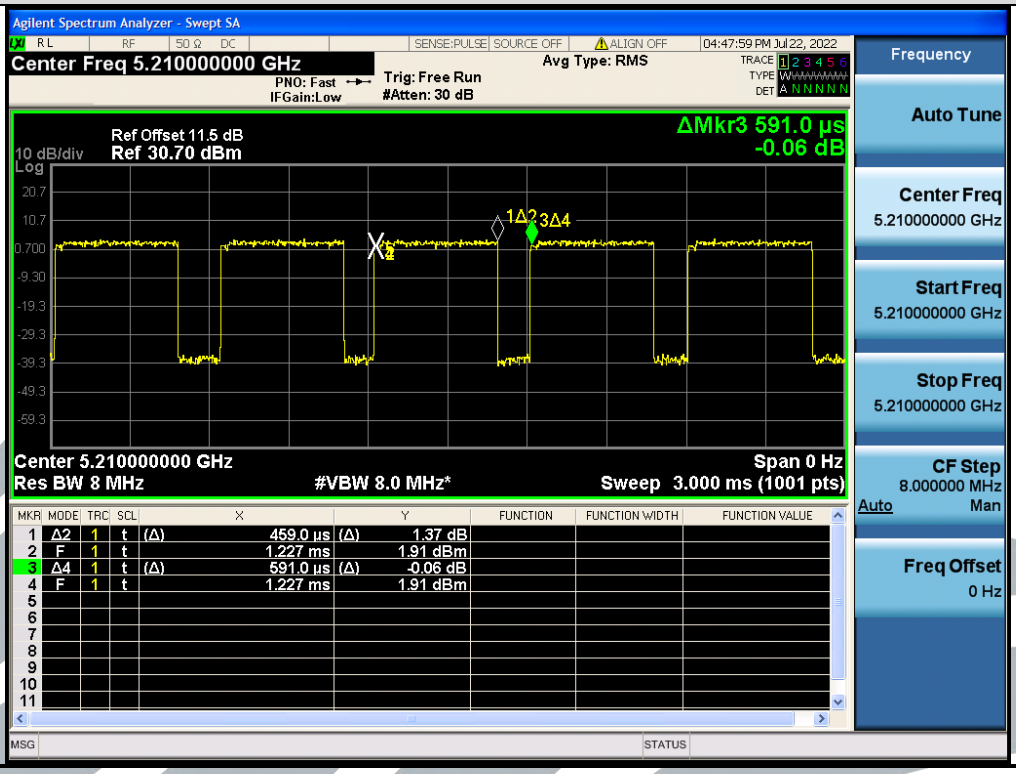
IEEE 802.11ac-VHT20



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 3.5 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.

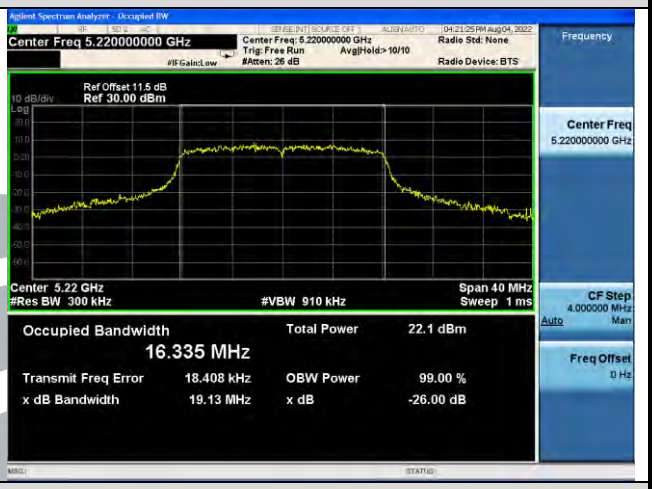
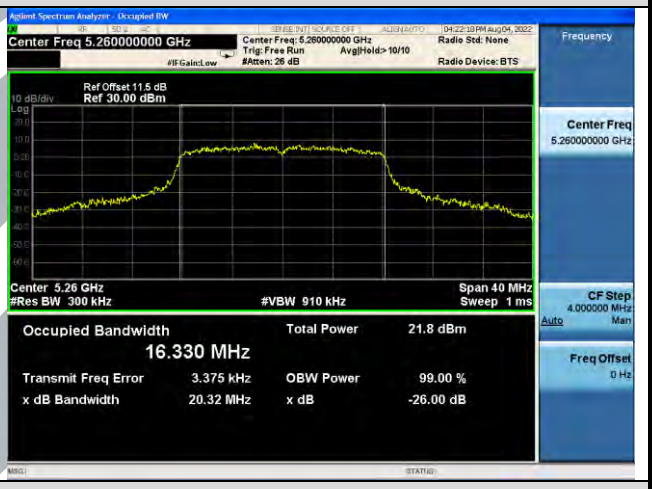
Instruments Used: Refer to section 3 for details

Test Results: Pass

Mode	Channel	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
IEEE 802.11a	36 (5180)	21.01	16.336
	44 (5220)	19.13	16.335
	48 (5240)	20.62	16.353
	52 (5260)	20.32	16.330
	60 (5300)	20.46	16.353
	64 (5320)	21.06	16.353
	100 (5500)	21.08	16.365
	116 (5580)	26.97	16.607
	140 (5700)	26.53	16.594
IEEE 802.11n-HT20	36 (5180)	21.06	17.436
	44 (5220)	20.84	17.444
	48 (5240)	20.80	17.462
	52 (5260)	20.83	17.463
	60 (5300)	21.11	17.452
	64 (5320)	21.51	17.463
	100 (5500)	21.92	17.478
	116 (5580)	25.28	17.600
	140 (5700)	24.72	17.595
IEEE 802.11n-HT40	38 (5190)	44.39	35.972
	46 (5230)	44.71	35.957
	54 (5270)	43.16	35.907
	62 (5310)	43.78	35.954
	102 (5510)	44.14	36.036
	110 (5550)	43.09	35.900
	134 (5670)	42.30	35.901

Mode	Channel	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
IEEE 802.11ac-VHT20	36 (5180)	21.00	17.467
	44 (5220)	21.11	17.468
	48 (5240)	21.63	17.469
	52 (5260)	20.85	17.456
	60 (5300)	21.59	17.484
	64 (5320)	20.96	17.458
	100 (5500)	26.43	17.561
	116 (5580)	25.58	17.608
	140 (5700)	26.85	17.629
IEEE 802.11ac-VHT40	38 (5190)	43.99	35.887
	46 (5230)	43.19	35.951
	54 (5270)	42.33	35.879
	62 (5310)	46.17	35.974
	102 (5510)	41.52	35.878
	110 (5550)	42.95	35.901
	134 (5670)	41.70	35.881
IEEE 802.11ac-VHT80	42 (5230)	83.67	75.438
	58 (5290)	84.64	75.524
	106 (5530)	82.75	75.560

The test plots as follows:

IEEE 802.11a	
Channel 36	**Channel 44**
	
Channel 48	**Channel 52**
	
Channel 60	**Channel 64**
	

Channel 100	Channel 116
	

Channel 140

IEEE 802.11n-HT20	
Channel 36	Channel 44
	
Channel 48	Channel 52
	
Channel 60	Channel 64
	

Channel 100	Channel 116
	

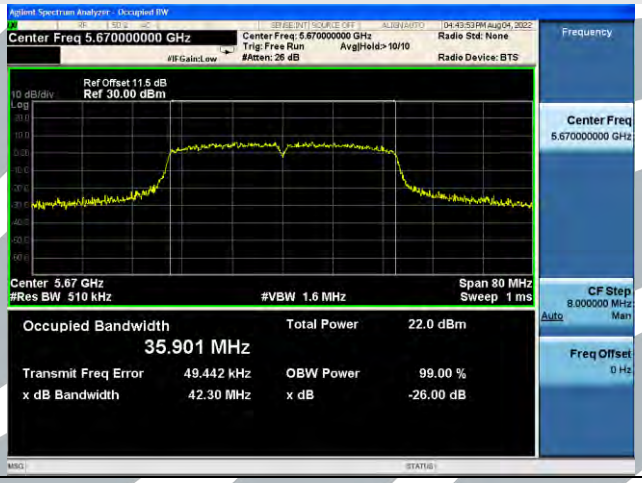
Channel 140

IEEE 802.11n-HT40	
Channel 38	Channel 46
	
Channel 54	Channel 62
	

Channel 102

Channel 110

Channel 134



IEEE 802.11ac-VHT20

Channel 36

Channel 44

Channel 48

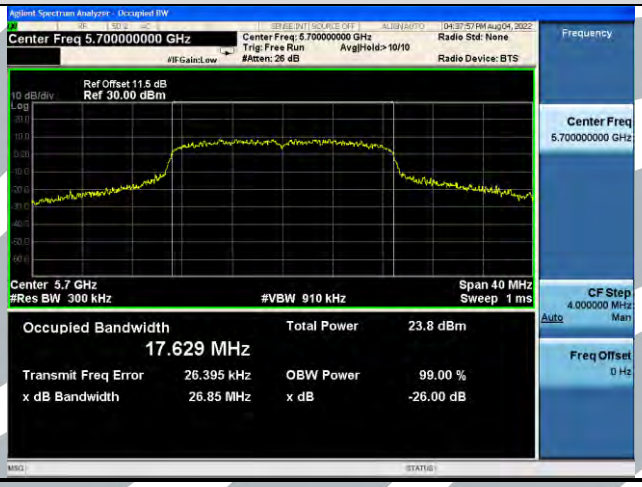
Channel 52

Channel 60

Channel 64

Channel 100	Channel 116
	

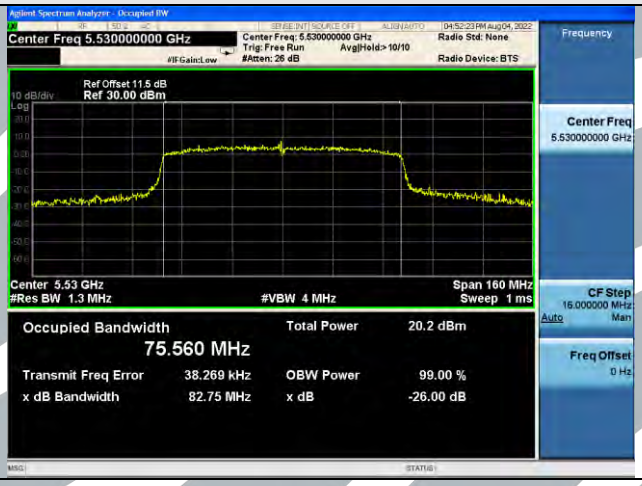
Channel 140



IEEE 802.11ac-VHT40	
Channel 38	Channel 46
	
Channel 54	Channel 62
	

Channel 102	Channel 110
	

Channel 134

IEEE 802.11ac-VHT80	
Channel 42	Channel 58
	
Channel 106	
	

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:

6dB Bandwidth

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.

Occupied Bandwidth

a) Set RBW = 1% to 5% of the occupied bandwidth
b) Set the video bandwidth (VBW) ≥ 3 x RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.

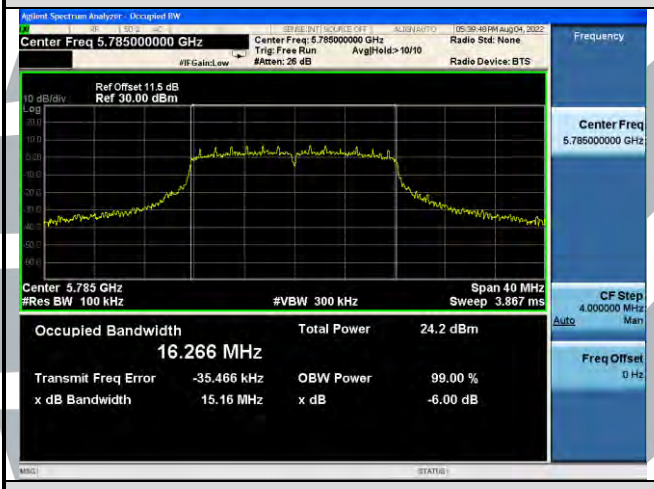
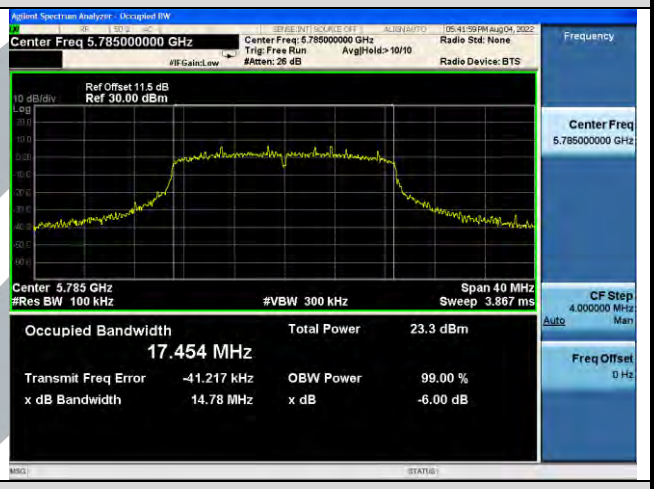
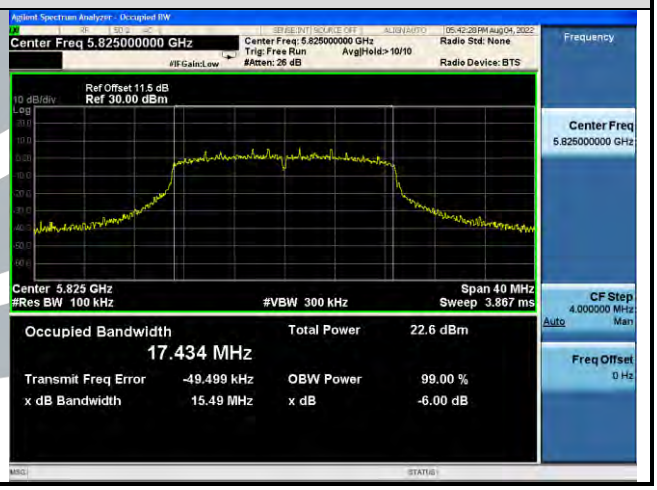
Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

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:

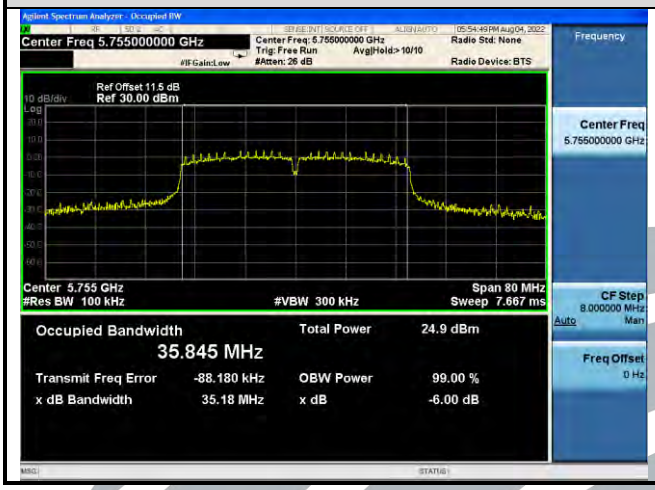
Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
IEEE 802.11a	149 (5745)	14.49	16.357	> 500 kHz	Pass
	157 (5785)	15.16	16.287	> 500 kHz	Pass
	165 (5825)	14.71	16.291	> 500 kHz	Pass
IEEE 802.11n-HT20	149 (5745)	15.16	17.479	> 500 kHz	Pass
	157 (5785)	14.78	17.430	> 500 kHz	Pass
	165 (5825)	15.49	17.442	> 500 kHz	Pass
IEEE 802.11n-HT40	151 (5755)	35.18	35.889	> 500 kHz	Pass
	159 (5795)	33.95	35.843	> 500 kHz	Pass
IEEE 802.11ac-VHT20	149 (5745)	15.18	17.461	> 500 kHz	Pass
	157 (5785)	15.11	17.423	> 500 kHz	Pass
	165 (5825)	15.46	17.447	> 500 kHz	Pass
IEEE 802.11ac-VHT40	151 (5755)	35.07	35.884	> 500 kHz	Pass
	159 (5795)	35.15	35.824	> 500 kHz	Pass
IEEE 802.11ac-VHT80	155 (5775)	72.72	75.580	> 500 kHz	Pass

The test plots as follows:
6 dB Bandwidth

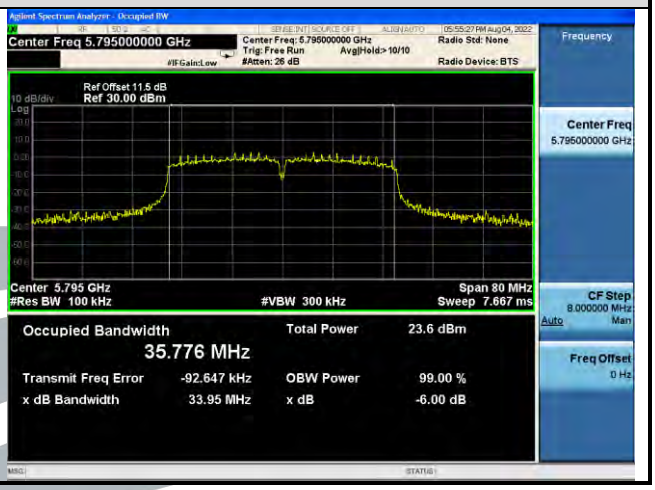
IEEE 802.11a	IEEE 802.11n-HT20
Channel 149	
	
Channel 157	
	
Channel 165	
	

IEEE 802.11n-HT40

Channel 151



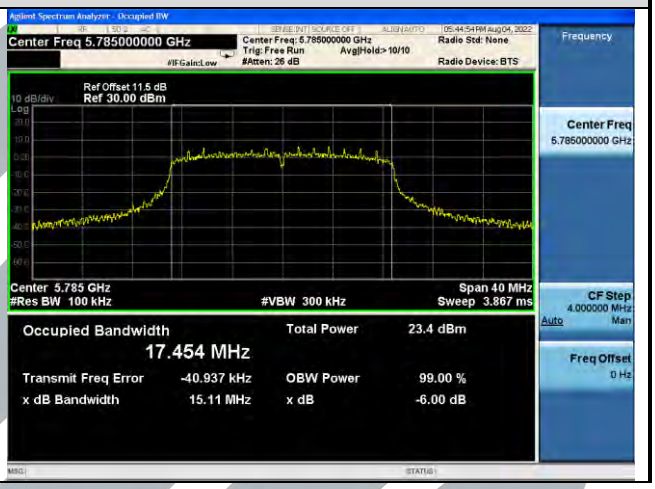
Channel 159



IEEE 802.11ac-VHT20

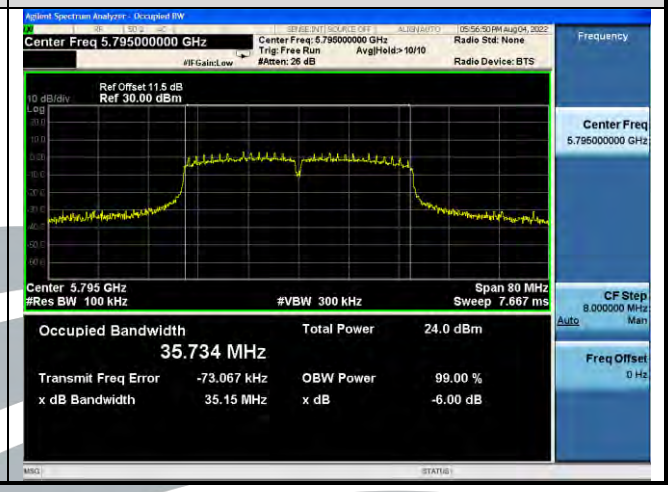
Channel 149

Channel 157

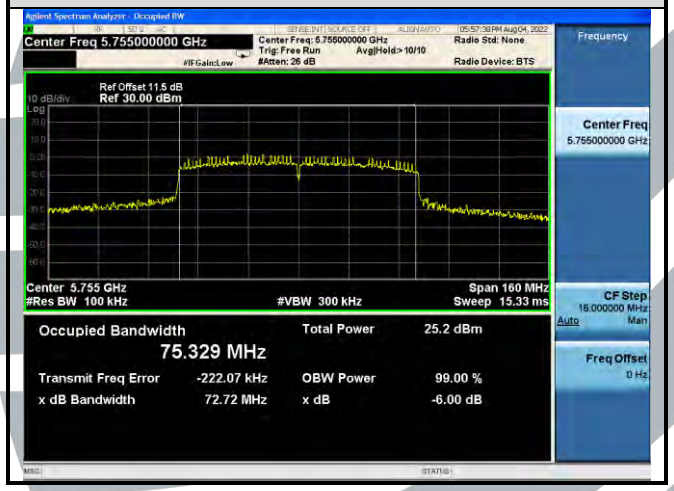


Channel 165

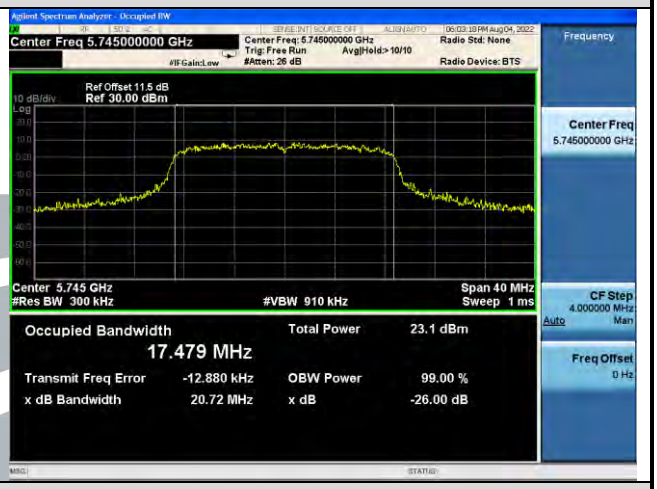
IEEE 802.11 ac-VHT40	
Channel 151	Channel 159



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 $0^o \leq \theta < 8^o$

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:

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:

Gain and the maximum output power limit.

RSS-247 Issue 2

Frequency Band	Antenna Gain (dBi)	Power Limits (dBm)
U-NII-1	3.5	23.0
U-NII-2A	3.5	24.0
U-NII-2C	3.5	24.0
U-NII-3	3.5	30.0

FCC 47 CFR Part 15 Subpart E

Frequency Band	Antenna Gain (dBi)	Power Limits (dBm)
U-NII-1	3.5	24.0
U-NII-2A	3.5	24.0
U-NII-2C	3.5	24.0
U-NII-3	3.5	30.0

Frequency band 5150-5250 MHz
RSS-247 Issue 2:
For IEEE 802.11a, the minimum 99% emission bandwidth is 16.335MHz
10 dBm + 10log$_{10}$ (16.335) = 22.13 dBm < 23 dBm
So the 22.13 dBm limit applicable

For IEEE 802.11n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.436 MHz
10 dBm + 10log$_{10}$ (17.436) = 22.41 dBm < 23 dBm
So the 22.41 dBm limit applicable

For IEEE 802.11n-HT40/ ac-VHT40/ ac-VHT80, the minimum 99% emission bandwidth is 35.887 MHz
10 dBm + 10log$_{10}$ (35.887) = 25.55 dBm > 23 dBm
So the 23 dBm limit applicable

Frequency band 5250-5350 MHz
RSS-247 Issue 2:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 16.330 MHz
11 dBm + 10log$_{10}$ (16.330) = 23.13 dBm < 24dBm
So the 23.13 dBm limit applicable

For IEEE 802.11n-HT20/ ac-VHT20, the minimum 99% emission bandwidth is 17.452 MHz
11 dBm + 10log$_{10}$ (17.452) = 23.42 dBm < 24dBm
So the 23.42 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.879 MHz
11 dBm + 10log$_{10}$ (35.879) = 26.55 dBm > 24 dBm
So the 24 dBm limit applicable

EIRP:
For IEEE 802.11 a/n-HT20/ac-VHT20, the minimum 99% emission bandwidth is 16.330MHz
17 dBm + 10log$_{10}$ (16.330) =29.13 dBm
29.13 dBm > 27 dBm
So the 27 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.879 MHz
17 dBm + 10log$_{10}$ (35.879) = 32.55 dBm > 27 dBm
So the 27 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is 20.32 MHz
11 dBm + 10log$_{10}$ (20.32) = 24.08 dBm > 24 dBm
So the 24 dBm limit applicable

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 16.365 MHz
11 dBm + 10log$_{10}$ (16.365) = 23.14 dBm < 24 dBm
So the 23.14 dBm limit applicable

For IEEE 802.11n-HT20/ac-VHT20, the minimum 99% emission bandwidth is 17.478 MHz
11 dBm + 10log$_{10}$ (17.478) = 23.42 dBm < 24 dBm
So the 23.42 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ac-VHT80, the minimum 99% emission bandwidth is 35.878 MHz
11 dBm + 10log$_{10}$ (35.878) = 26.55 dBm > 24 dBm
So the 24 dBm limit applicable

EIRP:
For IEEE 802.11 a/n-HT20/ac-VHT20, the minimum 99% emission bandwidth is 16.365 MHz
17 dBm + $10\log_{10}$ (16.365) = 29.14 dBm
29.14 dBm > 27 dBm
So the 27 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40 /ac-VHT80, the minimum 99% emission bandwidth is 35.878 MHz
17 dBm + $10\log_{10}$ (35.878) = 32.55 dBm > 27 dBm
So the 27 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is 21.08 MHz
11 dBm + $10\log_{10}$ (21.08) = 24.24 dBm > 24 dBm
So the 24 dBm limit applicable

Mode	Band	Channel	CONDUCTED AVG POWER				EIRP			
			Meas Value (dBm)	Corr'd Value (dBm)	FCC Limit (dBm)	ISED Limit (dBm)	EIRP (dBm)	FCC Limit (dBm)	ISED Limit (dBm)	Result
			Ant. 0	Ant. 0			Ant. 0			
IEEE 802.11a	U-NII-1	36	13.90	14.17	24.00	--	17.67	--	22.13	Pass
		44	13.94	14.21	24.00	--	17.71	--	22.13	Pass
		48	13.91	14.18	24.00	--	17.68	--	22.13	Pass
	U-NII-2A	52	13.59	13.86	24.00	23.13	17.36	--	27.00	Pass
		60	13.68	13.95	24.00	23.13	17.45	--	27.00	Pass
		64	13.73	14.00	24.00	23.13	17.50	--	27.00	Pass
	U-NII-2C	100	14.71	14.98	24.00	23.14	18.48	--	27.00	Pass
		116	15.10	15.37	24.00	23.14	18.87	--	27.00	Pass
		140	15.37	15.64	24.00	23.14	19.14	--	27.00	Pass
	U-NII-3	149	14.90	15.17	30.00	30.00	18.67	--	36.02	Pass
		157	14.06	14.33	30.00	30.00	17.83	--	36.02	Pass
		165	13.30	13.57	30.00	30.00	17.07	--	36.02	Pass
IEEE 802.11n-HT20	U-NII-1	36	14.03	14.32	24.00	--	17.82	--	22.41	Pass
		44	14.06	14.35	24.00	--	17.85	--	22.41	Pass
		48	13.95	14.24	24.00	--	17.74	--	22.41	Pass
	U-NII-2A	52	13.76	14.05	24.00	23.42	17.55	--	27.00	Pass
		60	13.73	14.02	24.00	23.42	17.52	--	27.00	Pass
		64	13.88	14.17	24.00	23.42	17.67	--	27.00	Pass
	U-NII-2C	100	14.96	15.25	24.00	23.42	18.75	--	27.00	Pass
		116	14.92	15.21	24.00	23.42	18.71	--	27.00	Pass
		140	15.01	15.30	24.00	23.42	18.80	--	27.00	Pass
	U-NII-3	149	14.71	15.00	30.00	30.00	18.50	--	36.02	Pass
		157	13.78	14.07	30.00	30.00	17.57	--	36.02	Pass
		165	13.02	13.31	30.00	30.00	16.81	--	36.02	Pass
IEEE 802.11n-HT40	U-NII-1	38	13.61	14.35	24.00	--	17.85	--	23.01	Pass
		46	13.48	14.22	24.00	--	17.72	--	23.01	Pass
	U-NII-2A	54	13.07	13.81	24.00	24.00	17.31	--	27.00	Pass
		62	13.31	14.05	24.00	24.00	17.55	--	27.00	Pass
	U-NII-2C	102	13.52	14.26	24.00	24.00	17.76	--	27.00	Pass
		110	13.30	14.04	24.00	24.00	17.54	--	27.00	Pass
		134	14.20	14.94	24.00	24.00	18.44	--	27.00	Pass
	U-NII-3	151	14.13	14.87	30.00	30.00	18.37	--	36.02	Pass
		159	13.46	14.20	30.00	30.00	17.70	--	36.02	Pass
IEEE 802.11ac-VHT20	U-NII-1	36	13.96	14.27	24.00	--	17.77	--	22.41	Pass
		44	14.02	14.33	24.00	--	17.83	--	22.41	Pass
		48	13.81	14.12	24.00	--	17.62	--	22.41	Pass
	U-NII-2A	52	13.62	13.93	24.00	23.42	17.43	--	27.00	Pass

		60	13.65	13.96	24.00	23.42	17.46	--	27.00	Pass
		64	13.87	14.18	24.00	23.42	17.68	--	27.00	Pass
	U-NII-2C	100	14.80	15.11	24.00	23.42	18.61	--	27.00	Pass
		116	14.88	15.19	24.00	23.42	18.69	--	27.00	Pass
		140	15.12	15.43	24.00	23.42	18.93	--	27.00	Pass
	U-NII-3	149	14.66	14.97	30.00	30.00	18.47	--	36.02	Pass
		157	13.85	14.16	30.00	30.00	17.66	--	36.02	Pass
		165	13.07	13.38	30.00	30.00	16.88	--	36.02	Pass
IEEE 802.11ac-VHT40	U-NII-1	38	13.68	14.30	24.00	--	17.80	--	23.01	Pass
		46	13.63	14.25	24.00	--	17.75	--	23.01	Pass
	U-NII-2A	54	13.11	13.73	24.00	24.00	17.23	--	27.00	Pass
		62	13.16	13.78	24.00	24.00	17.28	--	27.00	Pass
	U-NII-2C	102	13.45	14.07	24.00	24.00	17.57	--	27.00	Pass
		110	13.35	13.97	24.00	24.00	17.47	--	27.00	Pass
		134	14.18	14.80	24.00	24.00	18.30	--	27.00	Pass
	U-NII-3	151	14.10	14.72	30.00	30.00	18.22	--	36.02	Pass
		159	13.37	13.99	30.00	30.00	17.49	--	36.02	Pass
IEEE 802.11ac-VHT80	U-NII-1	42	12.28	13.38	24.00	--	16.88	--	23.01	Pass
	U-NII-2A	58	12.18	13.28	24.00	24.00	16.78	--	27.00	Pass
	U-NII-2C	106	12.97	14.07	24.00	24.00	17.57	--	27.00	Pass
	U-NII-3	155	13.15	14.25	30.00	30.00	17.75	--	36.02	Pass

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:

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	3.5	10.0
U-NII-2A	3.5	11.0
U-NII-2C	3.5	11.0
U-NII-3	3.5	30.0

FCC 47 CFR Part 15 Subpart E:

Frequency Band	Antenna Gain (dBi)	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	3.5	11.0
U-NII-2A	3.5	11.0
U-NII-2C	3.5	11.0
U-NII-3	3.5	30.0

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)	9.095	10	Pass
	44 (5220)	8.992	10	Pass
	48 (5240)	9.016	10	Pass
IEEE 802.11n-HT20	36 (5180)	8.517	10	Pass
	44 (5220)	8.402	10	Pass
	48 (5240)	8.626	10	Pass
IEEE 802.11n-HT40	38 (5190)	5.952	10	Pass
	46 (5230)	5.978	10	Pass
IEEE 802.11ac-VHT20	36 (5180)	8.797	10	Pass
	44 (5220)	8.810	10	Pass
	48 (5240)	8.645	10	Pass
IEEE 802.11ac-VHT40	38 (5190)	5.514	10	Pass
	46 (5230)	5.687	10	Pass
IEEE 802.11ac-VHT80	42 (5210)	1.847	10	Pass

Remark:

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

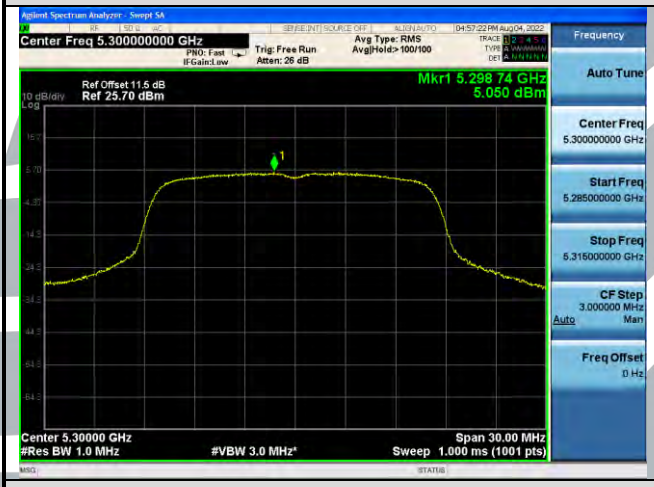
FCC 47 CFR Part 15 Subpart E

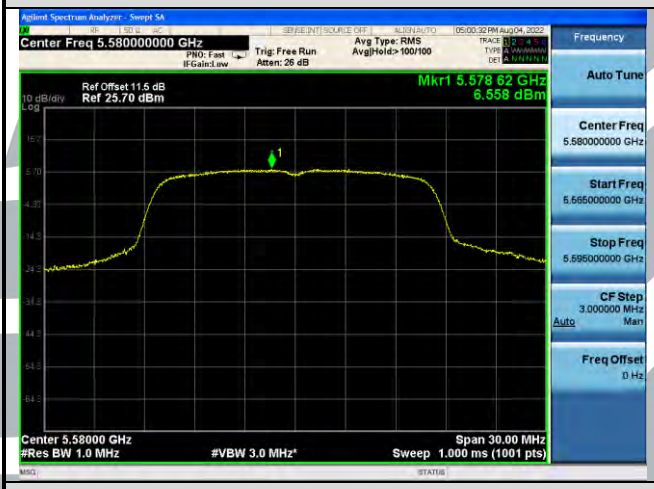
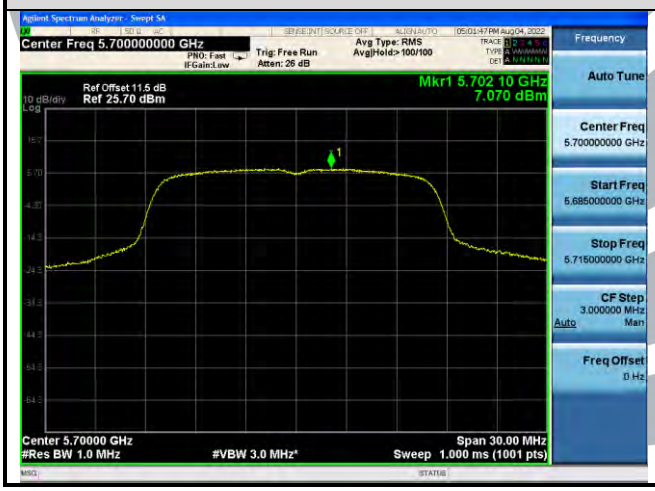
Mode	Band	Channel	Freq. (MHz)	CONDUCTED AVG POWER			
				Meas Value (dBm/MHz or dBm/500kHz)	Corr'd Value (dBm/MHz or dBm/500kHz)	FCC Limit (dBm/MHz or 500kHz)	FCC Result
				Ant. 0	Ant. 0		
IEEE 802.11a	U-NII-1	36	5180	5.327	5.595	11.00	Pass
		44	5220	5.224	5.492	11.00	Pass
		48	5240	5.248	5.516	11.00	Pass
	U-NII-2A	52	5260	5.261	5.529	11.00	Pass
		60	5300	5.050	5.318	11.00	Pass
		64	5320	4.988	5.256	11.00	Pass
	U-NII-2C	100	5500	5.924	6.192	11.00	Pass
		116	5580	6.558	6.826	11.00	Pass
		140	5700	7.070	7.338	11.00	Pass
	U-NII-3	149	5745	4.145	4.413	30.00	Pass
		157	5785	2.818	3.086	30.00	Pass
		165	5825	2.075	2.343	30.00	Pass
IEEE 802.11n-HT20	U-NII-1	36	5180	4.730	5.017	11.00	Pass
		44	5220	4.615	4.902	11.00	Pass
		48	5240	4.839	5.126	11.00	Pass
	U-NII-2A	52	5260	4.593	4.880	11.00	Pass
		60	5300	4.567	4.854	11.00	Pass
		64	5320	4.500	4.787	11.00	Pass
	U-NII-2C	100	5500	5.666	5.953	11.00	Pass
		116	5580	6.128	6.415	11.00	Pass
		140	5700	6.743	7.030	11.00	Pass
	U-NII-3	149	5745	3.658	3.945	30.00	Pass
		157	5785	2.739	3.026	30.00	Pass
		165	5825	1.891	2.178	30.00	Pass

IEEE 802.11n-HT40	U-NII-1	38	5190	1.711	2.452	11.00	Pass
		46	5230	1.737	2.478	11.00	Pass
	U-NII-2A	54	5270	0.980	1.721	11.00	Pass
		62	5310	1.390	2.131	11.00	Pass
	U-NII-2C	102	5510	1.158	1.899	11.00	Pass
		110	5550	1.368	2.109	11.00	Pass
		134	5670	2.410	3.151	11.00	Pass
	U-NII-3	151	5755	0.088	0.829	30.00	Pass
		159	5795	-0.736	0.005	30.00	Pass
IEEE 802.11ac-VHT20	U-NII-1	36	5180	4.990	5.297	11.00	Pass
		44	5220	5.003	5.310	11.00	Pass
		48	5240	4.838	5.145	11.00	Pass
	U-NII-2A	52	5260	4.858	5.165	11.00	Pass
		60	5300	4.715	5.022	11.00	Pass
		64	5320	4.497	4.804	11.00	Pass
	U-NII-2C	100	5500	5.550	5.857	11.00	Pass
		116	5580	6.229	6.536	11.00	Pass
		140	5700	6.778	7.085	11.00	Pass
	U-NII-3	149	5745	3.632	3.939	30.00	Pass
		157	5785	2.870	3.177	30.00	Pass
		165	5825	1.521	1.828	30.00	Pass
IEEE 802.11ac-VHT40	U-NII-1	38	5190	1.391	2.014	11.00	Pass
		46	5230	1.564	2.187	11.00	Pass
	U-NII-2A	54	5270	1.307	1.930	11.00	Pass
		62	5310	0.962	1.585	11.00	Pass
	U-NII-2C	102	5510	1.254	1.877	11.00	Pass
		110	5550	1.436	2.059	11.00	Pass
		134	5670	2.222	2.845	11.00	Pass
	U-NII-3	151	5755	0.053	0.676	30.00	Pass
		159	5795	-0.742	-0.119	30.00	Pass
IEEE 802.11ac-VHT80	U-NII-1	42	5210	-2.751	-1.653	11.00	Pass
	U-NII-2A	58	5290	-2.809	-1.711	11.00	Pass
	U-NII-2C	106	5530	-2.671	-1.573	11.00	Pass
	U-NII-3	155	5775	-3.938	-2.840	30.00	Pass

The test plots as follows:

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

IEEE 802.11a	IEEE 802.11n-HT20
Channel 52	
	
Channel 60	
	
Channel 64	
	

IEEE 802.11a	IEEE 802.11n-HT20
Channel 100	
	
Channel 116	
	
Channel 140	
	

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

IEEE 802.11n-HT40	
Channel 38	Channel 46
	
Channel 54	Channel 62
	
Channel 102	Channel 110
	

IEEE 802.11n-HT40	
Channel 134	
	
Channel 151	Channel 159
	

IEEE 802.11ac-VHT20	IEEE 802.11ac-VHT40
Channel 36	Channel 38
	
Channel 44	
	
Channel 48	Channel 46