Certificate #4312.01

TEST REPORT

Product Name:	IP Phone
Trade Mark:	GRANDSTREAM
Model No.:	GRP2650
HVIN:	GRP2650V2
Report Number:	24032510301RFC-4
Test Standards:	FCC 47 CFR Part 15 Subpart E RSS-247 Issue 3 RSS-Gen Issue 5
FCC ID:	YZZGRP2650V2
IC:	11964A-GRP2650V2
Test Result:	PASS
Date of Issue:	July 25, 2024

Prepared for:

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

Prepared by:

Shenzhen UnionTrust Quality and Technology Co., Ltd.
Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China
TEL: +86-755-2823 0888
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Prepared by: David Chen — David Chen, Senior Project Engineer

Reviewed by: Henry Lu — Henry Lu, Team Leader

Approved by: Robin Chen — Robin Chen, Assistant Manager

Date: July 25, 2024

Version

Version No.	Date	Description
V1.0	July 25, 2024	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:	IP Phone		
Model No.:	GRP2650		
HVIN:	GRP2650V2		
Trade Mark:	GRANDSTREAM		
DUT Stage:	Production Unit		
EUT Supports Function: (Provided by the customer)	2.4 GHz ISM Band:	IEEE 802.11b/g/n/ax	
		Bluetooth V5.0	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac/ax
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac/ax
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac/ax
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac/ax
Sample Received Date:	March 23, 2024		
Sample Tested Date:	May 4, 2024 to May 30, 2024		

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

Adapter (1)	
Model No.:	GQ12-120100-AU
Manufacture:	Dong Guan City GangQi Electronic Co., Ltd.
Input:	100-240V~50/60Hz 0.4 A Max
Output:	12.0V⎓1.0 A
DC Cable	2.5 Meter, Unshielded without ferrite

Adapter (2)	
Model No.:	F12US1200100A
Manufacture:	SHENZHEN SUNLIGHT ELECTRONIC TECHNOLOGY CO LTD
Input:	100-240V~50/60Hz 0.5 A Max
Output:	12.0V⎓1.0 A
DC Cable	2.5 Meter, Unshielded without ferrite

Adapter (3)	
Model No.:	DCT12W120100US-A2
Manufacture:	Zhuzhou Dachuan Electronic Technology Co., Ltd.
Input:	100-240V~50/60Hz 0.3 A Max
Output:	12.0V⎓1.0 A
DC Cable	2.5 Meter, Unshielded without ferrite

Cable(1)	
Description:	Ethernet Cable
Cable Type:	Unshielded without ferrite
Length:	1.5 Meter

Cable(2)	
Description:	Phone Cord
Cable Type:	Unshielded without ferrite
Length:	3.5 Meter

Others
1x Handset, 1x Phone Stand

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)				
	5725 MHz to 5850 MHz (U-NII-3)				
Frequency Ranges:	5180 MHz to 5240 MHz				
	5260 MHz to 5320 MHz				
	5500 MHz to 5720 MHz				
	5745 MHz to 5825 MHz				
Support Standards:	IEEE 802.11a/n/ac/ax				
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)				
	IEEE 802.11ax:OFDM/ OFDMA Note 1 (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)				
Channel Spacing:	IEEE 802.11a/n-HT20/ac-VHT20/ax-HE20: 20 MHz				
	IEEE 802.11n-HT40/ac-VHT40/ax-HE40: 40 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 802.11ax-HE20/HE40: Up to MCS11				
Number of Channels:	5150 MHz to 5250 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20/ax-HE20 2 for IEEE 802.11n-HT40)/ac-VHT40/ax-HE40				
	5250 MHz to 5350 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20/ax-HE20 2 for IEEE 802.11n-HT40)/ac-VHT40/ax-HE40				
	5470 MHz to 5725 MHz: 12 for IEEE 802.11a/n-HT20/ac-VHT20/ax-HE20 6 for IEEE 802.11n-HT40/ac-VHT40/ax-HE40				
	5725 MHz to 5850 MHz: 5 for IEEE 802.11a/n-HT20/ac-VHT20/ax-HE20 2 for IEEE 802.11n-HT40/ac-VHT40/ax-HE40				
Antenna Type:	Dipole Antenna				
Antenna Gain: (Provided by the customer)	5150 MHz to 5250 MHz: 4.0 dBi				
	5250 MHz to 5350 MHz: 4.0 dBi				
	5470 MHz to 5725 MHz: 4.0 dBi				
	5725 MHz to 5850 MHz: 4.0 dBi				
Maximum conducted output power (dBm):		**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	15.18	14.46	13.76	14.19
	IEEE 802.11n-HT20:	15.14	14.44	13.79	14.23
	IEEE 802.11n-HT40:	14.67	14.16	14.09	14.09
	IEEE 802.11ac-VHT20	15.14	14.45	13.78	14.25
	IEEE 802.11ac-VHT40	14.66	14.12	14.03	14.02

	IEEE 802.11ax-HE20	15.17	14.46	13.79	14.23
	IEEE 802.11ax-HE40	14.73	14.16	14.13	14.13
Maximum EIRP (dBm):		**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	19.18	18.46	17.76	18.19
	IEEE 802.11n-HT20:	19.14	18.44	17.79	18.23
	IEEE 802.11n-HT40:	18.67	18.16	18.09	18.09
	IEEE 802.11ac-VHT20	19.14	18.45	17.78	18.25
	IEEE 802.11ac-VHT40	18.66	18.12	18.03	18.02
	IEEE 802.11ax-HE20	19.17	18.46	17.79	18.23
	IEEE 802.11ax-HE40	18.73	18.16	18.13	18.13
Normal Test Voltage:	12Vdc				
Note 1: The customer declaration that OFDMA modulation supports only the SU mode.					

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 IEEE 802.11ax-HE20	**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 IEEE 802.11ax-HE40	**f = 5000 + 5k, k = 30 + 8n**			**f = 5000 + 5k, k = 143 + 8n**
	n = 1, 2	**n = 1,…, 5**	**n = 9,…, 13**	**n = 1, 2**
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	B40-80	MP12NEQ6	UnionTrust	UnionTrust
Mouse	DELL	MS111	CN-011D3V-738	UnionTrust	UnionTrust
Wireless Home Router	SAGEMCOM	FAST5280	253703944	VW3FAST5280	UnionTrust
Key-Press Attenuator	Huaxin	KT2.5-90/1S-2S	UTTL-EN023	N/A	UnionTrust
4 Way Divider	WOKEN	0120A040560002D	UTTL-EN028	N/A	UnionTrust

2) Support Cable

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

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 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

Tests were sub-contracted. (Radiated Emissions and Band Edge Measurement)
Dongguan DN Testing Co., Ltd.

Address: No. 1, West 4th Street, Xingfa South Road, Wusha Community, Chang'an Town, Dongguan, People's Republic of China
Telephone: +86-769-88087383
Email: joise.yang@dn-testing.com

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

Dongguan DN Testing Co., Ltd.

A2LA-Lab Certificate No.: 7050.01

CAB identifier: CN0149

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

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

No.	Item	Measurement Uncertainty
1	Conducted emission 9kHz-150kHz	±3.2 dB
2	Conducted emission 150kHz-30MHz	±2.7 dB
3	Radiated emission 9kHz-30MHz	± 4.7 dB
4	Radiated emission 30MHz-1GHz	± 4.6 dB
5	Radiated emission 1GHz-18GHz	± 4.4 dB
6	Radiated emission 18GHz-26GHz	± 4.6 dB
7	Radiated emission 26GHz-40GHz	± 4.6 dB
8	Conducted spurious emissions	± 2.7 dB
9	RF Power, Conducted	± 0.68 dB
10	Occupied Bandwidth	± 1.86 %
11	Radio Frequency	± 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 3 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 3 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 or e.i.r.p	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3) RSS-247 Issue 3 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 3 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 3 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 3 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
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 Note 1
U-NII Detection Bandwidth	N/A Note 1
Channel Closing Transmission Time	PASS
Channel Move Time	PASS
DFS Detection Threshold	N/A Note 1
Non- Occupancy Period	N/A Note 1

Note:

1) The EUT is slave, NA In this whole report not applicable.

3. EQUIPMENT LIST

Dongguan DN Testing Co., Ltd.

Test Equipment for Radiated Emission(30MHz-1000MHz)						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☒	Receiver	R&S	ESR7	102497	2023-10-24	2024-10-23
☒	Test Software	Tonscend	JS32-RE V5.0.0	NA	NA	NA
☒	RF Cable	ETS-LINDGREN	RFC-NMS-100-NMS-350-IN	DNT-001	2023-10-24	2024-10-23
☒	Log periodic antenna	ETS-LINDGREN	VULB 9168	01475	2023-10-24	2024-10-23
☒	Pre-amplifier	Schwarzbeck	BBV9743B	00423	2023-10-24	2024-10-23

Test Equipment for Radiated Emission(Above 1000MHz)						
☒	Frequency analyser	Keysight	N9010A	MY52221458	2023-10-24	2024-10-23
☒	RF Cable	ETS-LINDGREN	RFC-NMS-100-NMS-350-IN	DNT-002	2023-10-24	2024-10-23
☒	Horn Antenna	ETS-LINDGREN	3117	00252567	2023-10-24	2024-10-23
☒	Double ridged waveguide antenna	ETS-LINDGREN	3116C	00251780	2023-10-24	2024-10-23
☒	Test Software	Tonscend	JS32-RE V5.0.0	NA	NA	NA
☒	Pre-amplifier	ETS-LINDGREN	3117-PA	252567	2023-10-24	2024-10-23
☒	Pre-amplifier	ETS-LINDGREN	3116C-PA	251780	2023-10-24	2024-10-23

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Conducted Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☒	Receiver	R&S	ESR7	1316.3003K07 -101181-K3	27-Oct-2023	26-Oct-2024
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	27-Oct-2023	26-Oct-2024
☒	LISN	R&S	ESH2-Z5	860014/024	27-Oct-2023	26-Oct-2024
☒	LISN	ETS-Lindgren	3816/2SH	00201088	27-Oct-2023	26-Oct-2024
☒	Test Software	EZ-EMC	EZ-CON	Software Version: EMC-CON 3A1.1		

Conducted RF test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	29-Mar-2024	28-Mar-2025
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	27-Oct-2023	26-Oct-2024
☒	MXG X-Series RF Vector Signal Generator	KEYSIGHT	N5182B	MY51350267	27-Oct-2023	26-Oct-2024

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	12	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment and Test Sample

Test Item	Temp. (°C)	Relative Humidity (%)	Pressure (kPa)	Sample No.	Tested by
26 dB emission bandwidth	25.3	59	100.2	S202403232938-ZJA03/4	Allen Zhou
6 dB bandwidth					
Occupied Bandwidth					
Maximum conducted output power					
Peak Power Spectral Density					
Dynamic Frequency Selection					
Radiated Emissions and	25	60	100.1	S202403232938-ZJA04/4	Wayne Lin
Band Edge Measurement					
AC Power Line Conducted Emission	22.9	51.1	100.2	S202403232938-ZJA02/4	Linson Xie

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists			
		Lowest(L)	Middle(M)	Highest(H)	Straddle band
IEEE 802.11a IEEE 802.11n-HT20 IEEE 802.11ac-VHT20 IEEE 802.11ax-HE20	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	Channel 144
		5500 MHz	5580 MHz	5700 MHz	5720 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 IEEE 802.11ax-HE40	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	Channel 142
		5510 MHz	5550 MHz	5670 MHz	5710 MHz
	5725 MHz to 5850 MHz	Channel 151	--	Channel 159	--
		5755 MHz	--	5795 MHz	--
		--	5775 MHz	--	--

4.3 EUT TEST STATUS

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

Power Setting(Provided by the customer)
Power Setting: not applicable, test used software default power level.

Test Software
Test software name: Putty

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 802.11ax-HE20	MCS0
IEEE 802.11ax-HE40	MCS0

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

Figure 1. Below 30MHz

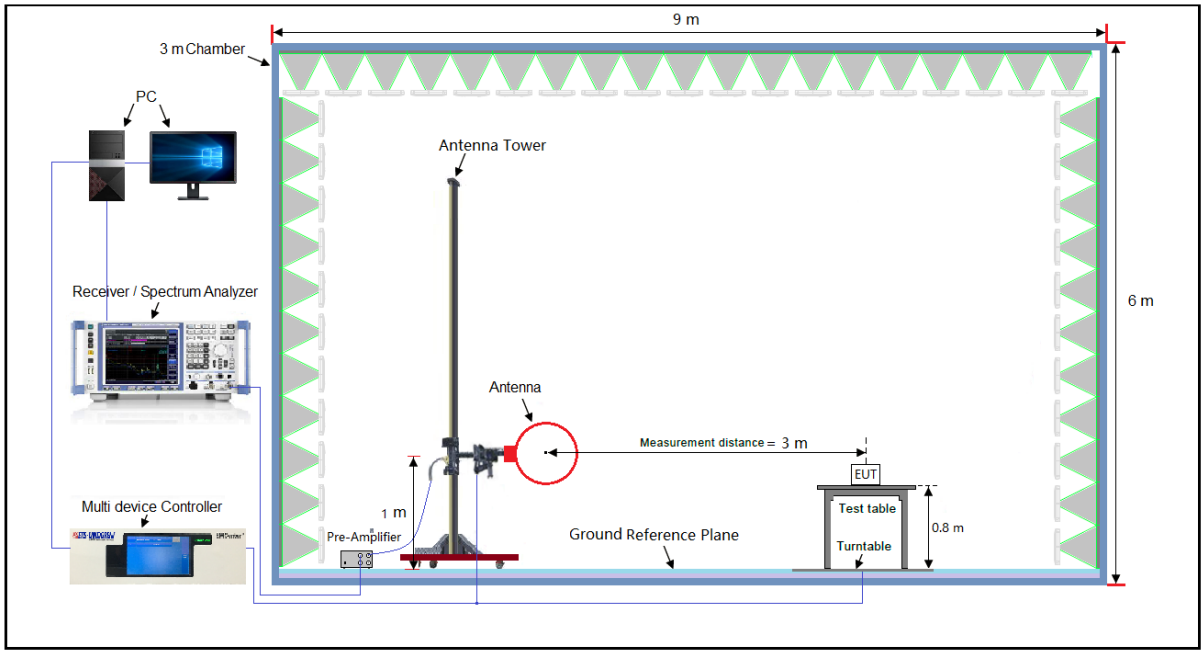


Figure 2. 30MHz to 1GHz

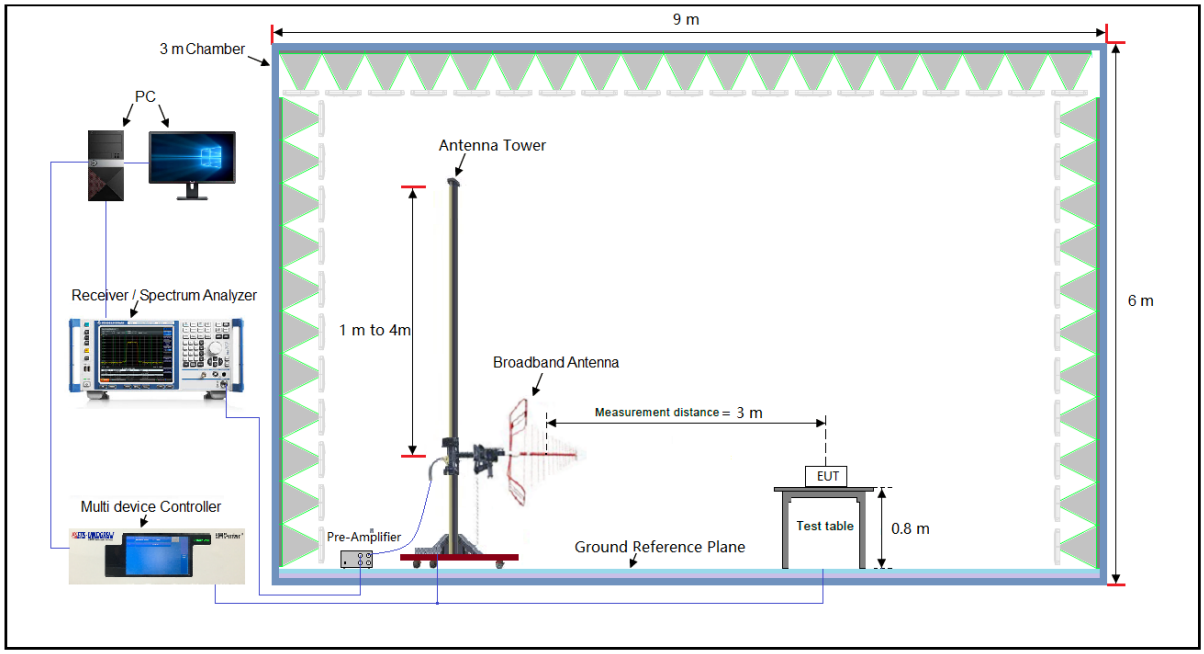
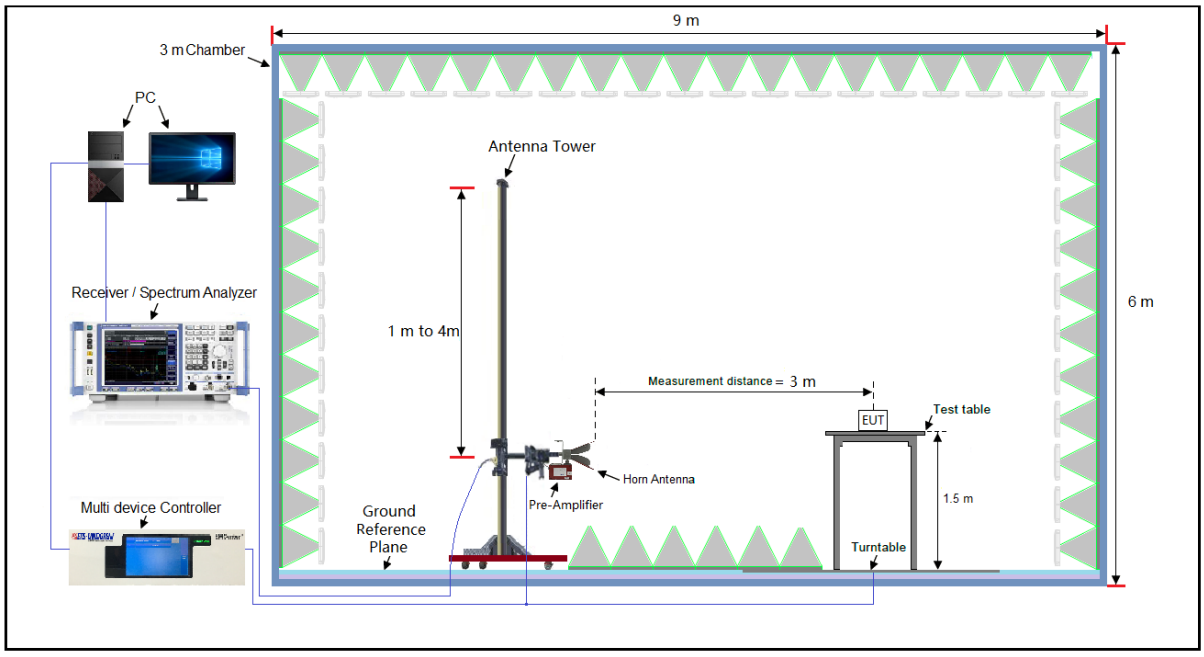
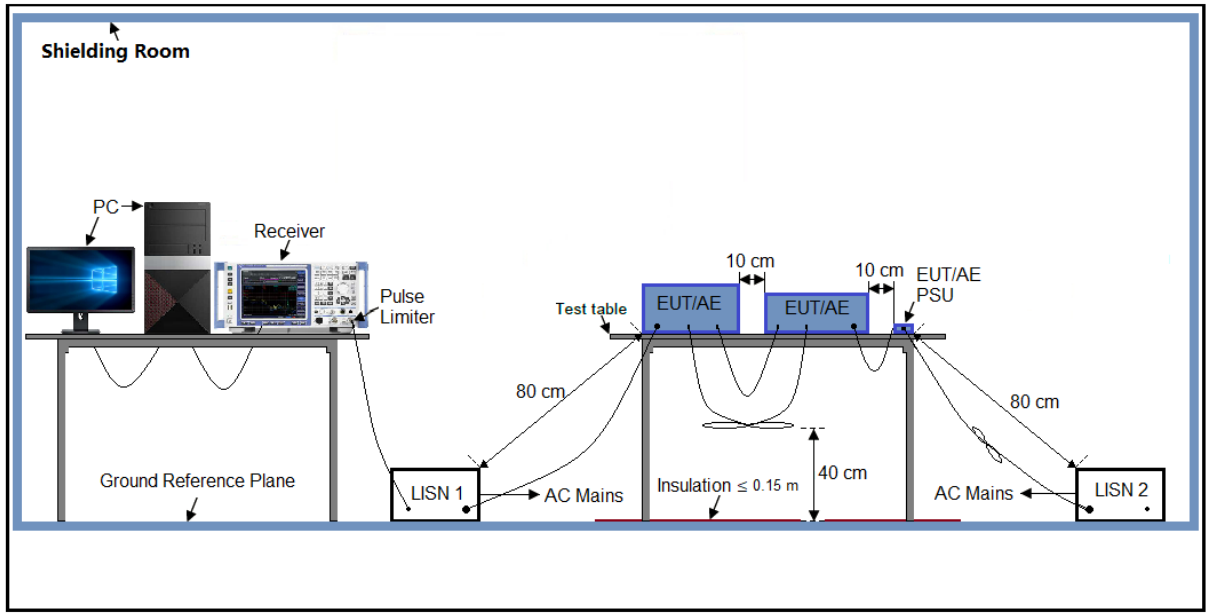


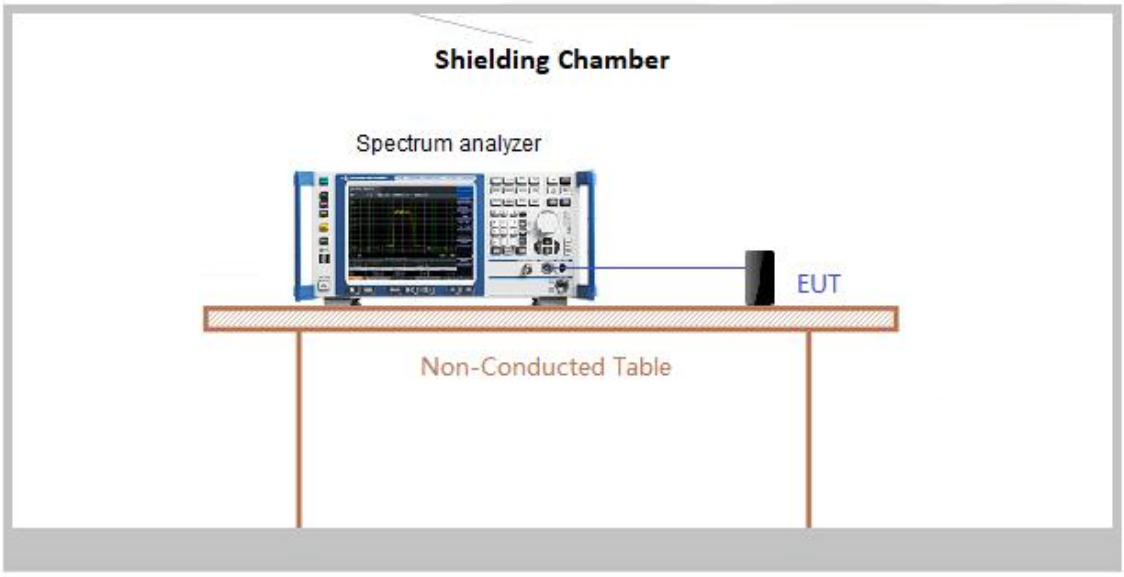
Figure 3. Above 1GHz



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.

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

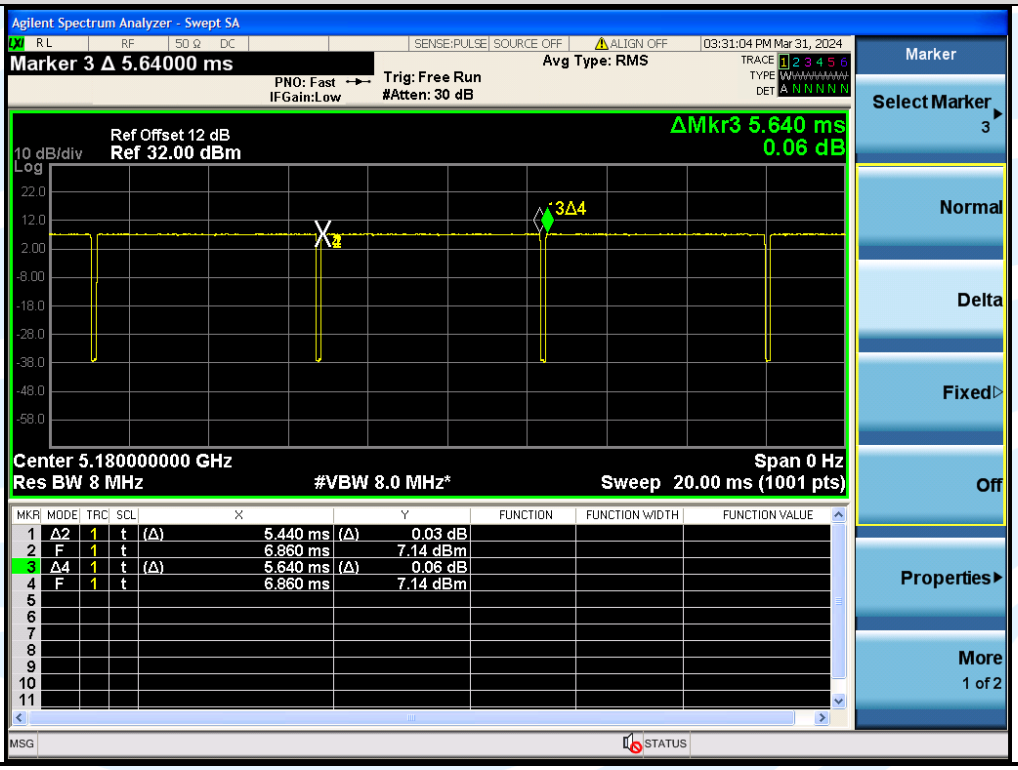
Mode	Data Rates	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/T Minimum VBW (kHz)
IEEE 802.11a	6 Mbps	5.440	5.640	0.96	96.45	0.16	0.18
IEEE 802.11n-HT20	MCS 0	5.340	5.520	0.97	96.74	0.14	0.19
IEEE 802.11n-HT40	MCS 0	2.980	3.180	0.94	93.71	0.28	0.34
IEEE 802.11ac-VHT20	MCS 0	5.360	5.520	0.97	97.10	0.13	0.19
IEEE 802.11ac-VHT40	MCS 0	5.115	5.310	0.96	96.33	0.16	0.20
IEEE 802.11ax-HE20	MCS 0	4.620	4.800	0.96	96.25	0.17	0.22
IEEE 802.11ax-HE40	MCS 0	4.590	4.785	0.96	95.92	0.18	0.22

Remark:

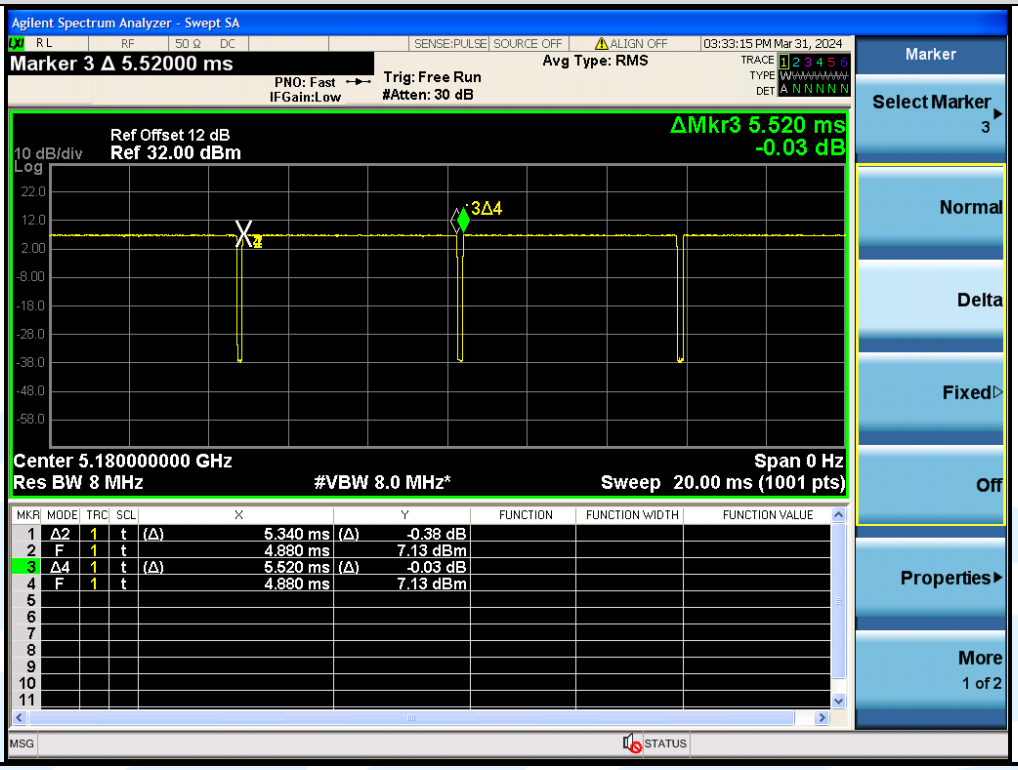
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plots as follows

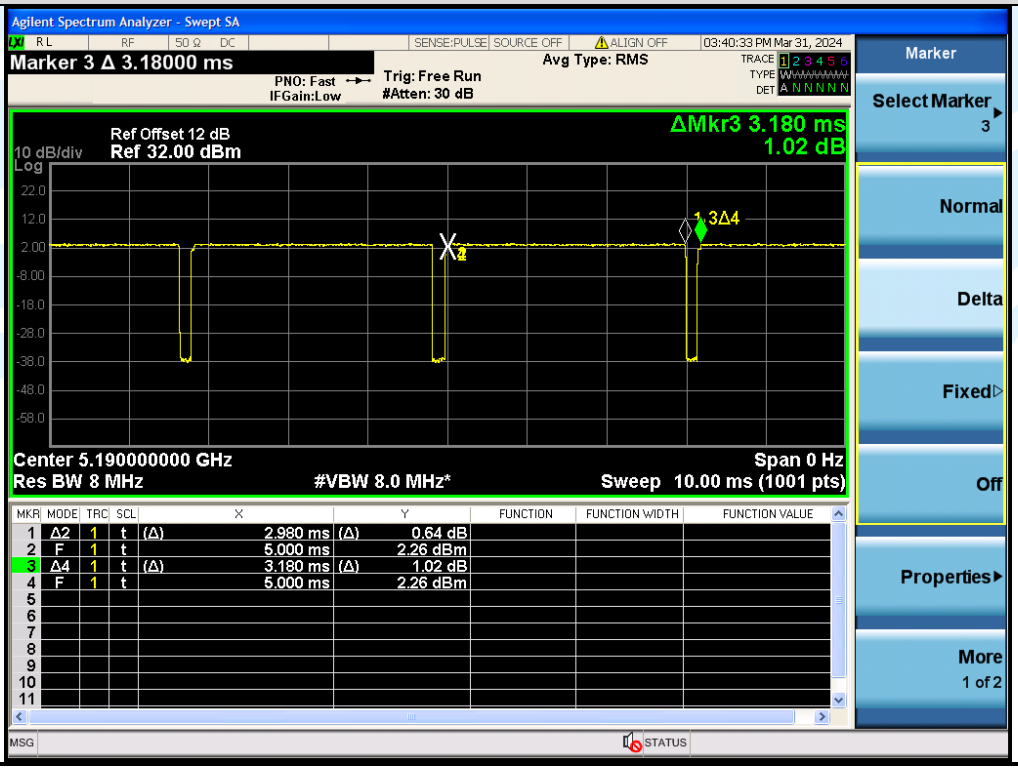
IEEE 802.11a



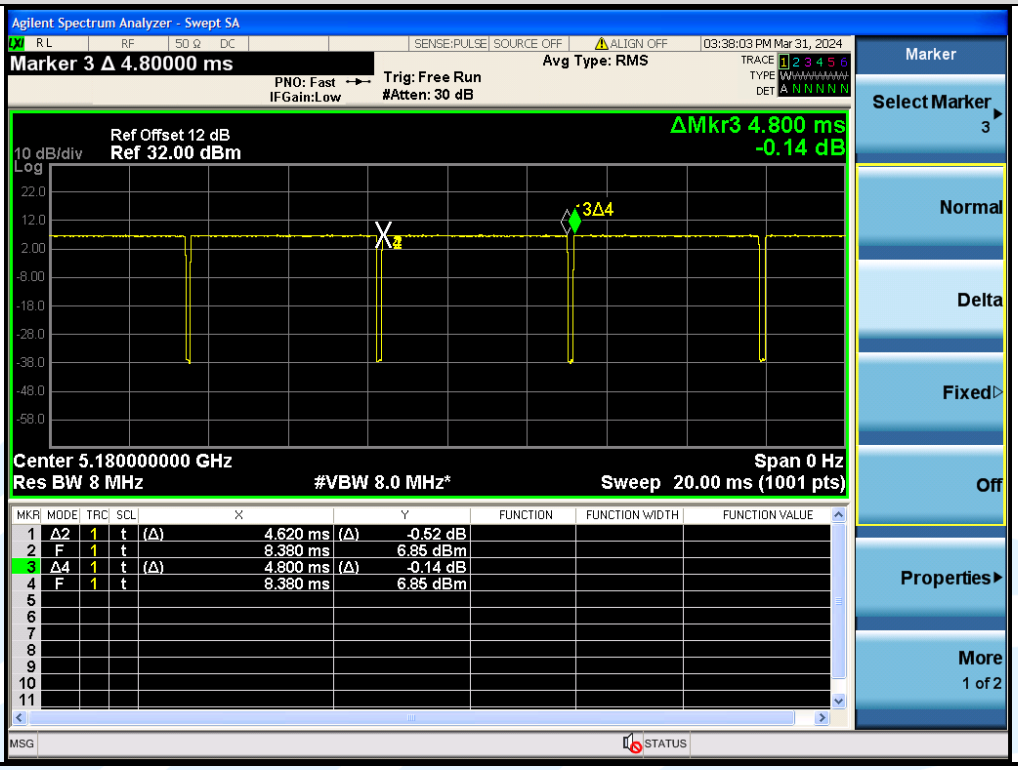
IEEE 802.11n-HT20



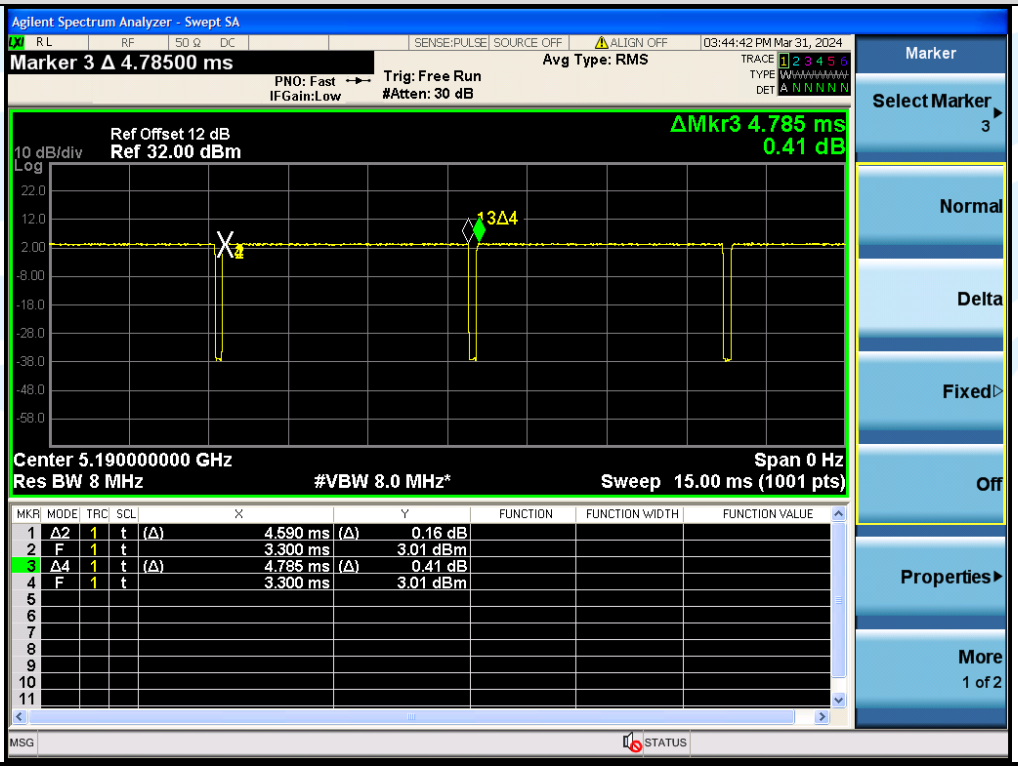
IEEE 802.11n-HT40



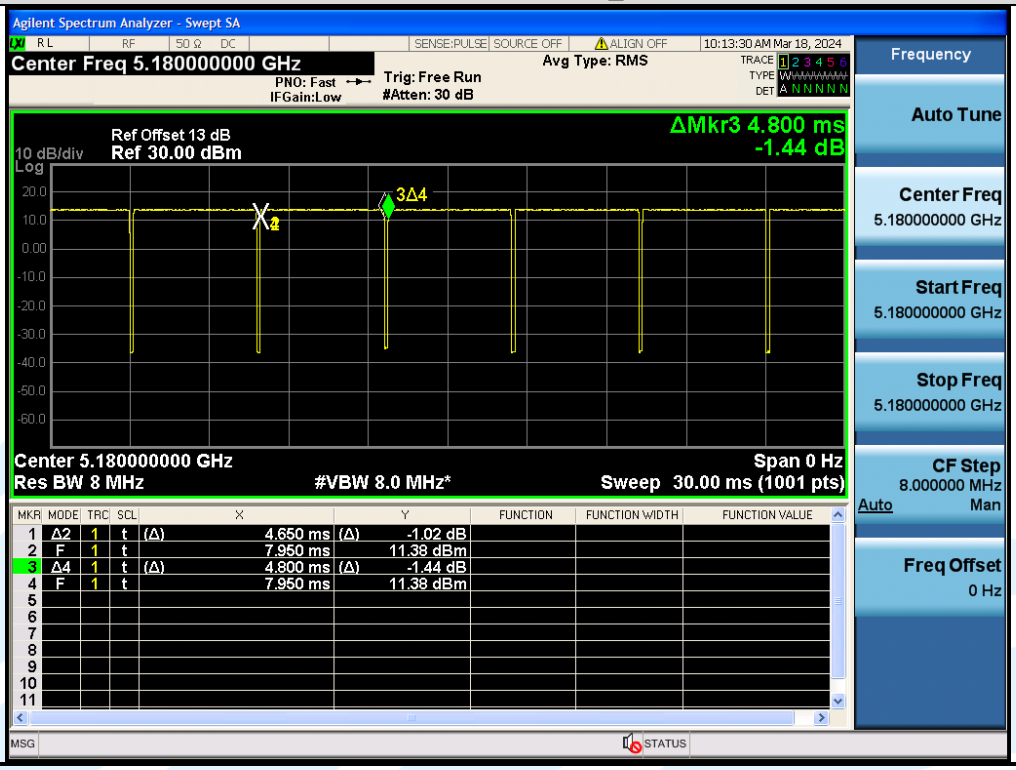
IEEE 802.11ac-VHT20



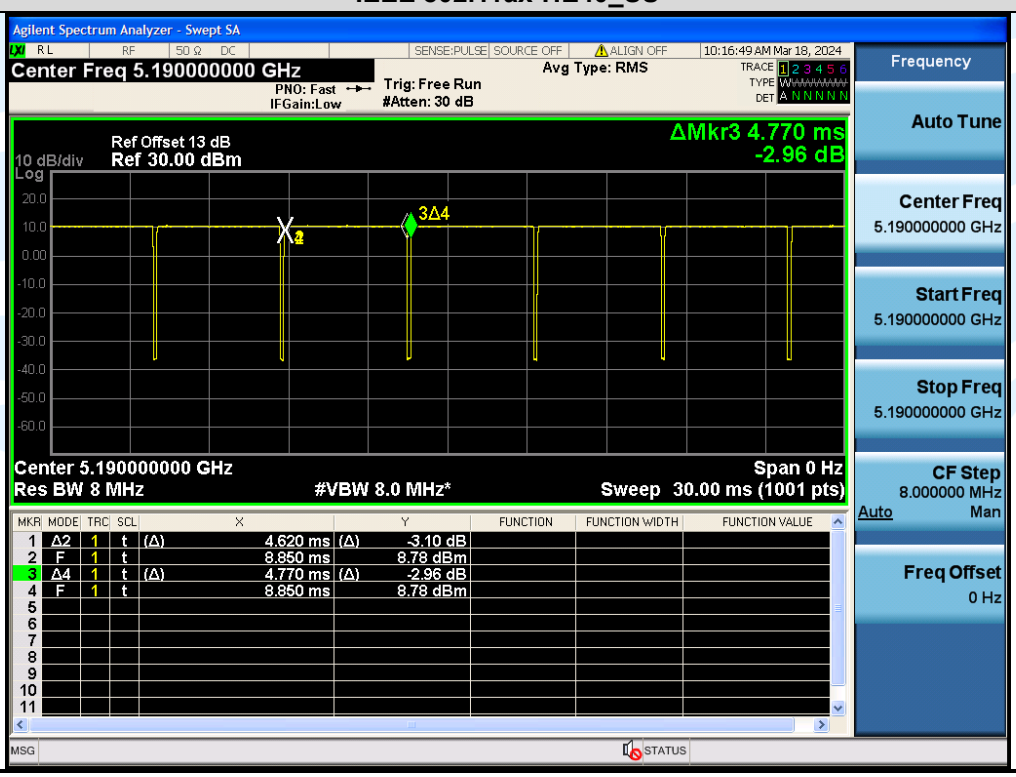
IEEE 802.11ac-VHT40



IEEE 802.11ax-HE20_SU



IEEE 802.11ax-HE40_SU



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 3	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 4.0 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 3 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 Mode:	Link mode
Test Results:	**Please refer to Appendix A**

5.46 DB BANDWIDTH & OCCUPIED BANDWIDTH

Test Requirement:	FCC 47 CFR Part 15 Subpart E Section 15.407 (e) RSS-247 Issue 3 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:	**Please refer to Appendix A**

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 3 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 3

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 3

Frequency Band	Antenna Gain (dBi)	Power Limits (dBm)
U-NII-1	4.0	23.0
U-NII-2A	4.0	24.0
U-NII-2C	4.0	24.0
U-NII-3	4.0	30.0

FCC 47 CFR Part 15 Subpart E

Frequency Band	Antenna Gain (dBi)	Power Limits (dBm)
U-NII-1	4.0	24.0
U-NII-2A	4.0	24.0
U-NII-2C	4.0	24.0
U-NII-3	4.0	30.0

Frequency band 5150-5250 MHz
RSS-247 Issue 3:
For IEEE 802.11a, the minimum 99% emission bandwidth is 17.047MHz
10 dBm + 10log$_{10}$ (17.036) = 22.32 dBm < 23 dBm
So the 22.32 dBm limit applicable

For IEEE 802.11n-HT20/ ac-VHT20/ax-HE20, the minimum 99% emission bandwidth is 18.070 MHz
10 dBm + 10log$_{10}$ (18.070) = 22.57 dBm < 23 dBm
So the 22.57 dBm limit applicable

For IEEE 802.11n-HT40/ ac-VHT40/ax-HE40, the minimum 99% emission bandwidth is 36.453 MHz
10 dBm + 10log$_{10}$ (36.453) = 25.62 dBm > 23 dBm
So the 23 dBm limit applicable

Frequency band 5250-5350 MHz
RSS-247 Issue 3:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 17.066MHz
11 dBm + 10log$_{10}$ (17.066) = 23.32 dBm < 24dBm
So the 23.32 dBm limit applicable

For IEEE 802.11n-HT20/ ac-VHT20/ax-HE20, the minimum 99% emission bandwidth is 18.100 MHz
11 dBm + 10log$_{10}$ (18.100) = 23.58 dBm < 24dBm
So the 23.58 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ax-HE40, the minimum 99% emission bandwidth is 36.389 MHz
11 dBm + 10log$_{10}$ (36.389) = 26.61 dBm > 24 dBm
So the 24 dBm limit applicable

EIRP:
For IEEE 802.11 a/n-HT20/ac-VHT20/ax-HE20, the minimum 99% emission bandwidth is 17.066MHz
17 dBm + 10log$_{10}$ (17.066) =29.32 dBm
29.32 dBm > 27 dBm
So the 27 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ax-HE40, the minimum 99% emission bandwidth is 36.389 MHz
17 dBm + 10log$_{10}$ (36.389) = 32.61 dBm > 27 dBm
So the 27 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac/ax, the minimum 26 dB emission bandwidth is 21.47 MHz
11 dBm + 10log$_{10}$ (21.47) = 24.32 dBm > 24 dBm
So the 24 dBm limit applicable

Frequency bands 5470-5725 MHz (RSS-247 Issue 3 Not including 5600-5650 MHz)
RSS-247 Issue 3:
For IEEE 802.11 a, the minimum 99% emission bandwidth is 17.036 MHz
11 dBm + 10log$_{10}$ (17.036) = 23.31 dBm < 24 dBm
So the 23.31 dBm limit applicable

For IEEE 802.11n-HT20/ac-VHT20/ax-HE20, the minimum 99% emission bandwidth is 18.073 MHz
11 dBm + 10log$_{10}$ (18.073) = 23.57 dBm < 24 dBm
So the 23.57 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ax-HE40, the minimum 99% emission bandwidth is 36.434 MHz
11 dBm + 10log$_{10}$ (36.434) = 26.62 dBm > 24 dBm
So the 24 dBm limit applicable

EIRP:
For IEEE 802.11 a/n-HT20/ac-VHT20/ax-HE20, the minimum 99% emission bandwidth is 17.036 MHz
17 dBm + $10\log_{10}$ (17.036) = 29.31 dBm
29.31 dBm > 27 dBm
So the 27 dBm limit applicable

For IEEE 802.11 n-HT40/ac-VHT40/ax-HE40, the minimum 99% emission bandwidth is 36.434 MHz
17 dBm + $10\log_{10}$ (36.434) = 32.62 dBm > 27 dBm
So the 27 dBm limit applicable

FCC 47 CFR Part 15 Subpart E:
For IEEE 802.11 a/n/ac/ax, the minimum 26 dB emission bandwidth is 21.55 MHz
11 dBm + $10\log_{10}$ (21.55) = 24.33 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
IEEE 802.11a	U-NII-1	36	15.02	15.18	24.00	--	19.18	--	22.32	Pass
		44	13.71	13.87	24.00	--	17.87	--	22.32	Pass
		48	13.52	13.68	24.00	--	17.68	--	22.32	Pass
	U-NII-2A	52	14.30	14.46	24.00	23.32	18.46	--	27.00	Pass
		60	14.00	14.16	24.00	23.32	18.16	--	27.00	Pass
		64	13.68	13.84	24.00	23.32	17.84	--	27.00	Pass
	U-NII-2C	100	12.47	12.63	24.00	23.31	16.63	--	27.00	Pass
		116	12.34	12.50	24.00	23.31	16.50	--	27.00	Pass
		140	13.60	13.76	24.00	23.31	17.76	--	27.00	Pass
		144	13.48	13.64	24.00	23.31	17.64	--	27.00	Pass
	U-NII-3	149	13.78	13.94	30.00	30.00	17.94	--	--	Pass
		157	14.03	14.19	30.00	30.00	18.19	--	--	Pass
		165	13.96	14.12	30.00	30.00	18.12	--	--	Pass
IEEE 802.11n-HT20	U-NII-1	36	15.00	15.14	24.00	--	19.14	--	22.57	Pass
		44	13.75	13.89	24.00	--	17.89	--	22.57	Pass
		48	13.56	13.70	24.00	--	17.70	--	22.57	Pass
	U-NII-2A	52	14.30	14.44	24.00	23.58	18.44	--	27.00	Pass
		60	14.02	14.16	24.00	23.58	18.16	--	27.00	Pass
		64	13.71	13.85	24.00	23.58	17.85	--	27.00	Pass
	U-NII-2C	100	12.50	12.64	24.00	23.57	16.64	--	27.00	Pass
		116	12.38	12.52	24.00	23.57	16.52	--	27.00	Pass
		140	13.65	13.79	24.00	23.57	17.79	--	27.00	Pass
		144	13.52	13.66	24.00	23.57	17.66	--	27.00	Pass
	U-NII-3	149	13.82	13.96	30.00	30.00	17.96	--	--	Pass
		157	14.09	14.23	30.00	30.00	18.23	--	--	Pass
		165	13.99	14.13	30.00	30.00	18.13	--	--	Pass
IEEE 802.11n-HT40	U-NII-1	38	14.39	14.67	24.00	--	18.67	--	23.00	Pass
		46	13.55	13.83	24.00	--	17.83	--	23.00	Pass
	U-NII-2A	54	13.88	14.16	24.00	24.00	18.16	--	27.00	Pass
		62	13.62	13.90	24.00	24.00	17.90	--	27.00	Pass
	U-NII-2C	102	12.23	12.51	24.00	24.00	16.51	--	27.00	Pass
		110	11.96	12.24	24.00	24.00	16.24	--	27.00	Pass
		134	13.81	14.09	24.00	24.00	18.09	--	27.00	Pass
		142	13.31	13.59	24.00	24.00	17.59	--	27.00	Pass
	U-NII-3	151	13.79	14.07	30.00	30.00	18.07	--	--	Pass
		159	13.81	14.09	30.00	30.00	18.09	--	--	Pass
IEEE 802.11ac-VHT20	U-NII-1	36	15.01	15.14	24.00	--	19.14	--	22.57	Pass
		44	13.73	13.86	24.00	--	17.86	--	22.57	Pass

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
		48	13.56	13.69	24.00	--	17.69	--	22.57	Pass
	U-NII-2A	52	14.32	14.45	24.00	23.58	18.45	--	27.00	Pass
		60	14.03	14.16	24.00	23.58	18.16	--	27.00	Pass
		64	13.72	13.85	24.00	23.58	17.85	--	27.00	Pass
	U-NII-2C	100	12.51	12.64	24.00	23.57	16.64	--	27.00	Pass
		116	12.40	12.53	24.00	23.57	16.53	--	27.00	Pass
		140	13.65	13.78	24.00	23.57	17.78	--	27.00	Pass
		144	13.55	13.68	24.00	23.57	17.68	--	27.00	Pass
	U-NII-3	149	13.86	13.99	30.00	30.00	17.99	--	--	Pass
		157	14.12	14.25	30.00	30.00	18.25	--	--	Pass
		165	14.00	14.13	30.00	30.00	18.13	--	--	Pass
IEEE 802.11ac-VHT40	U-NII-1	38	14.50	14.66	24.00	--	18.66	--	23.00	Pass
		46	13.61	13.77	24.00	--	17.77	--	23.00	Pass
	U-NII-2A	54	13.96	14.12	24.00	24.00	18.12	--	27.00	Pass
		62	13.68	13.84	24.00	24.00	17.84	--	27.00	Pass
	U-NII-2C	102	12.29	12.45	24.00	24.00	16.45	--	27.00	Pass
		110	12.02	12.18	24.00	24.00	16.18	--	27.00	Pass
		134	13.87	14.03	24.00	24.00	18.03	--	27.00	Pass
		142	13.35	13.51	24.00	24.00	17.51	--	27.00	Pass
	U-NII-3	151	13.86	14.02	30.00	30.00	18.02	--	--	Pass
		159	13.85	14.01	30.00	30.00	18.01	--	--	Pass

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)	ISED Result
IEEE 802.11ax-HE20	U-NII-1	36	15.00	15.17	24.00	--	19.17	--	22.57	Pass
		44	13.71	13.88	24.00	--	17.88	--	22.57	Pass
		48	13.55	13.72	24.00	--	17.72	--	22.57	Pass
	U-NII-2A	52	14.29	14.46	24.00	23.58	18.46	--	27.00	Pass
		60	14.02	14.19	24.00	23.58	18.19	--	27.00	Pass
		64	13.75	13.92	24.00	23.58	17.92	--	27.00	Pass
	U-NII-2C	100	12.50	12.67	24.00	23.57	16.67	--	27.00	Pass
		116	12.36	12.53	24.00	23.57	16.53	--	27.00	Pass
		140	13.62	13.79	24.00	23.57	17.79	--	27.00	Pass
		144	13.54	13.71	24.00	23.57	17.71	--	27.00	Pass
	U-NII-3	149	13.81	13.98	30.00	30.00	17.98	--	--	Pass
		157	14.06	14.23	30.00	30.00	18.23	--	--	Pass
		165	14.00	14.17	30.00	30.00	18.17	--	--	Pass
IEEE 802.11ax-HE40	U-NII-1	38	14.55	14.73	24.00	--	18.73	--	23.00	Pass
		46	13.68	13.86	24.00	--	17.86	--	23.00	Pass
	U-NII-2A	54	13.98	14.16	24.00	24.00	18.16	--	27.00	Pass
		62	13.75	13.93	24.00	24.00	17.93	--	27.00	Pass
	U-NII-2C	102	12.34	12.52	24.00	24.00	16.52	--	27.00	Pass
		110	12.09	12.27	24.00	24.00	16.27	--	27.00	Pass
		134	13.95	14.13	24.00	24.00	18.13	--	27.00	Pass
		142	13.46	13.64	24.00	24.00	17.64	--	27.00	Pass
	U-NII-3	151	13.91	14.09	30.00	30.00	18.09	--	--	Pass
		159	13.95	14.13	30.00	30.00	18.13	--	--	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 3 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 3

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: **Please refer to Appendix A**

Test Data:

Gain and the maximum output power limit.

RSS-247 Issue 3:

Frequency Band	Antenna Gain (dBi)	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	4.0	10.0
U-NII-2A	4.0	10.0
U-NII-2C	4.0	11.0
U-NII-3	4.0	30.0

FCC 47 CFR Part 15 Subpart E:

Frequency Band	Antenna Gain (dBi)	PSD Limits (dBm/MHz or dBm/500kHz)
U-NII-1	4.0	11.0
U-NII-2A	4.0	11.0
U-NII-2C	4.0	11.0
U-NII-3	4.0	30.0

5.7 RADIATED EMISSIONS AND BAND EDGE MEASUREMENT

Test Requirement: 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 3 Section 6.2.1.2/6.2.2.2/6.2.3.2/6.2.4.2

Test Method: KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6

Receiver Setup:

Frequency	RBW
0.009 MHz-0.150 MHz	200/300 kHz
0.150 MHz -30 MHz	9/10 kHz
30 MHz-1 GHz	100/120 kHz
Above 1 GHz	1 MHz

Limits:

1. Limits of Radiated Emission and Band edge Measurement

Radiated emissions that fall in the restricted bands must comply with the general emissions limits in 15.209(a) as below table. Other emissions shall be at least 20 dB below the highest level of the desired power.

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Remark:

a. The lower limit shall apply at the transition frequencies.
b. Emission level (dBuV/m) = 20 log Emission level (uV/m).
c. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

2. Limits of Unwanted Emission Out of the Restricted Bands

Applicable To	Limit	
789033 D02 General U-NII Test Procedures New Rules v01r04	Field Strength at 3 m	
	PK: 74 (dBμV/m)	AV: 54 (dBμV/m)
Applicable To	EIRP Limit	Equivalent Field Strength at 3 m
RSS-247 Issue 3 Section 6.2.1.2	PK: -27 (dBm/MHz)	PK: 74 (dBμV/m)
RSS-247 Issue 3 Section 6.2.2.2	PK: -27 (dBm/MHz)	PK: 74 (dBμV/m)
RSS-247 Issue 3 Section 6.2.3.2	PK: -27 (dBm/MHz)	PK: 68.2 (dBμV/m)
RSS-247 Issue 3 Section 6.2.4.2	27 dBm/MHz at frequencies from the band edges decreasing linearly to 15.6 dBm/MHz at 5 MHz above or below the band edges;	PK: 68.2 (dBμV/m)
	15.6 dBm/MHz at 5 MHz above or below the band edges decreasing linearly to 10 dBm/MHz at 25 MHz above or below the band edges;	
	10 dBm/MHz at 25 MHz above or below the band edges decreasing linearly to -27 dBm/MHz at 75 MHz above or below the band edges;	
	-27 dBm/MHz at frequencies more than 75 MHz above or below the band edges.	

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

1. The EUT was placed on the top of a rotating table 0.8 meters (for below 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
6. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Remark:

a) The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
b) The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
c) The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for RMS Average (Duty cycle < 98 %) for Average detection (AV) at frequency above 1 GHz, then the measurement results was added to a correction factor (10 log(1/duty cycle)).
d) The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz (Duty cycle ≥ 98 %) or ≥ 1/T(duty cycle is < 98%) for Average detection (AV) at frequency above 1 GHz.
e) All modes of operation were investigated and the worst-case emissions are reported.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

Please refer to Appendix A

Radiated Emission Test Data (9 KHz ~ 30 MHz):
The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

5.8 DYNAMIC FREQUENCY SELECTION

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (h)
RSS-247 Issue 3 Section 6.3

Test Method: KDB 905462 D03 Client Without DFS New Rules v01r02

EUT Operating Mode:

DFS Operational mode	Operating Frequency Range	
	5250 MHz to 5350 MHz	5470 MHz to 5725 MHz
Slave without radar Interference detection function	✓	✓

Applicability:

The following table from KDB905462 and the lists of the applicable requirements for the DFS testing.

Applicability of DFS Requirements Prior to Use of a Channel:

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
Non-Occupancy Period	✓	Not required	Yes
DFS Detection Threshold	✓	Not required	Yes
Channel Availability Check Time	✓	Not required	Not required
U-NII Detection Bandwidth	✓	Not required	Yes

Applicability of DFS requirements during normal operation:

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required
Additional requirements for devices with multiple bandwidth modes	**Master Device or Client with Radar Detection**	**Client Without Radar Detection**
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection:

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.
Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.
Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

DFS Radar Signal Parameter Values:

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds (See Note 1.)
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. (See Notes 1 and 2.)
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. (See Note 3.)

Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.
Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.
Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

DFS Radar Signal Parameter:

Radar Type 0 was used in the evaluation of the Client device for the purpose of measuring the Channel Move Time and the Channel Closing Transmission Time

Table 1-Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
0	1	1428	18	See Note 1.	See Note 1.
1	1	Test A Test B	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu sec}}\right)\right\}$	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.

Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a
Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A
A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms.
If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.
The aggregate is the average of the percentage of successful detections of short pulse radar types

1-4

Table 2-Long Pulse Radar Test Waveform

Radar Type	Pulse Width (μsec)	Chirp Width (MHz)	PRI (μsec)	Number of Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 3-Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	9	0.333	300	70%	30

In-Service Monitoring: Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period

Limit of In-Service Monitoring:

Reference to DFS Radar Signal Parameter Values.

Test Procedures:

a) One frequency will be chosen from the Operating Channels of the EUT within the 5250-5350 MHz or 5470-5725 MHz bands. For 802.11 devices, the test frequency must contain control signals. This can be verified by disabling channel loading and monitoring the spectrum analyzer. If no control signals are detected, another frequency must be selected within the emission bandwidth where control signals are detected.

b) In case the EUT is a Master Device, a U-NII device operating as a Client Device will be used and it is assumed that the Client will associate with the EUT (Master). For radiated tests, the emissions of the Radar Waveform generator will be directed towards the Master Device. If the Master Device has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.

c) The TCP protocol unicast data stream was generated by the iperf software command line with at least 17% activity ratio over any 100ms period.

d) Timing plots are reported with calculations demonstrating a minimum channel loading of approximately 17% or greater. For example, channel loading can be estimated by setting the spectrum analyzer for zero span and approximate the Time On/ (Time On + Off Time).

e) At time T0 the Radar Waveform generator sends a Burst of pulses for one of the Short Pulse Radar Types 1-4 at DFS Detection Threshold levels on the Operating Channel. An additional 1 dB is added to the radar test signal to ensure it is at or above the DFS Detection Threshold, accounting for equipment variations/errors.

f) Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). Measure and record the Channel Move Time and Channel Closing Transmission Time if radar detection occurs.

g) When operating as a Master Device, monitor the EUT for more than 30 minutes following instant T2 to verify that the EUT does not resume any transmissions on this Channel. Perform this test once and record the measurement result.

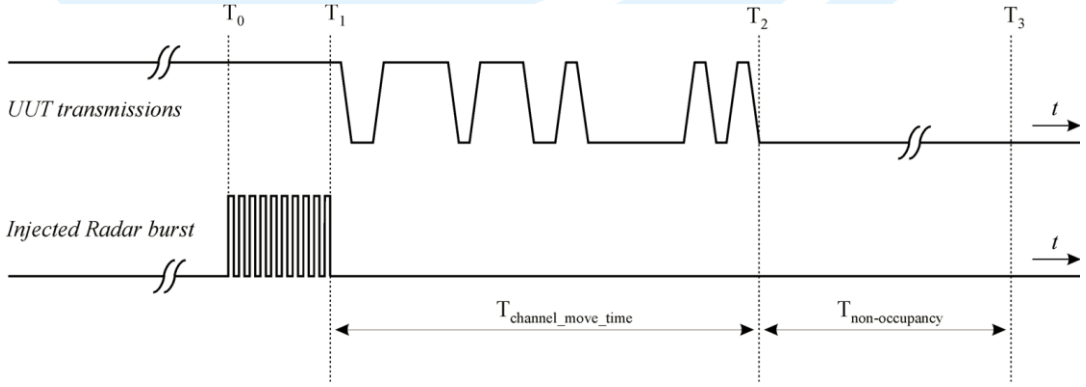
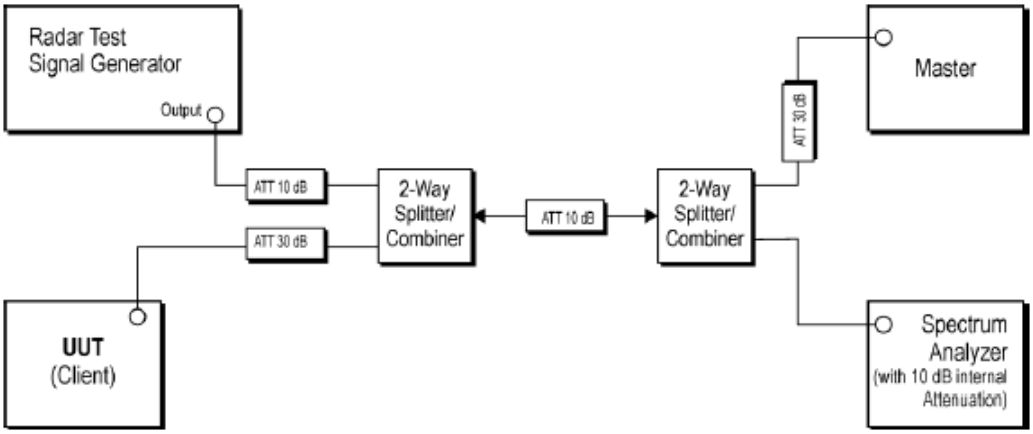


Figure 17: Channel Closing Transmission Time, Channel Move Time and Non-Occupancy Period

Conducted test setup



Setup for Client with injection at the Master

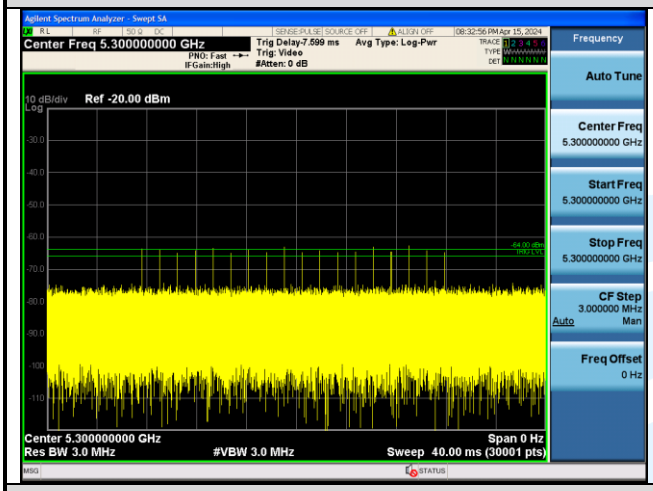
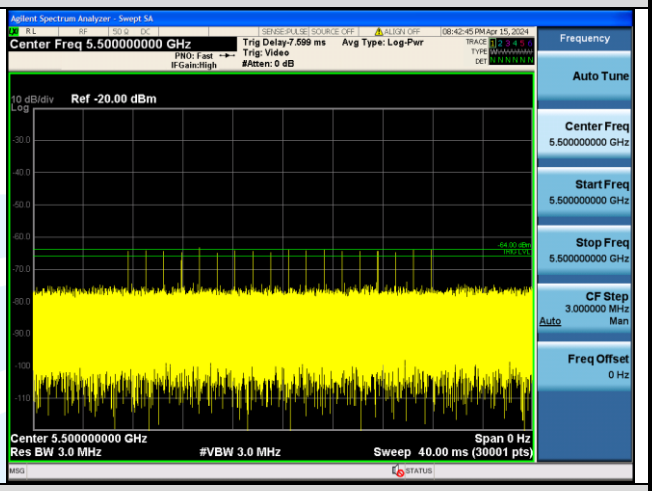
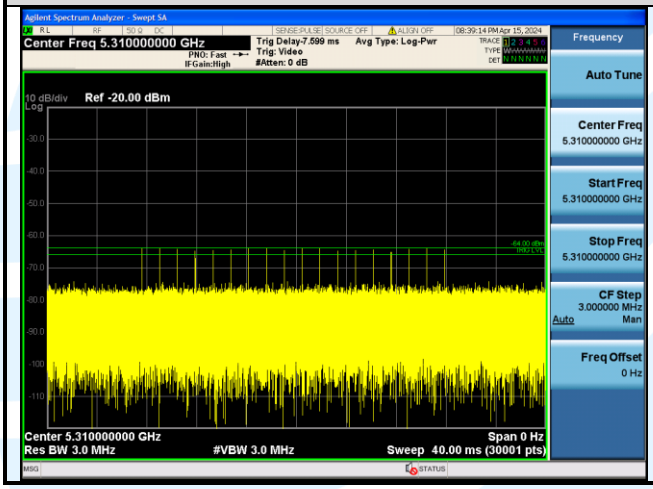
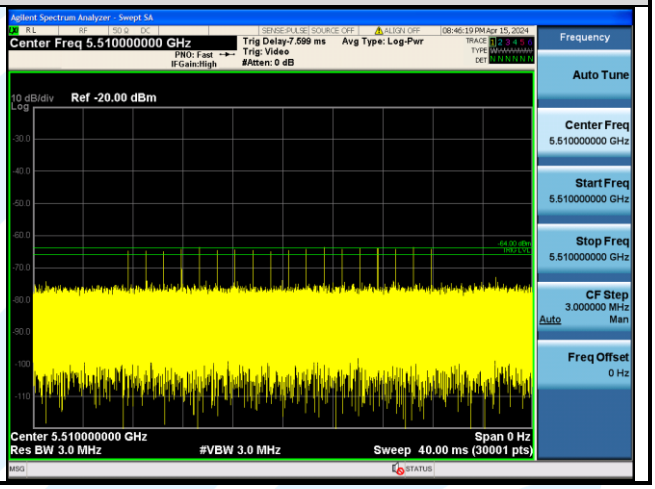
Equipment Used: Refer to section 3 for details.

Test Result: Result of Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period for Client Beacon Tes

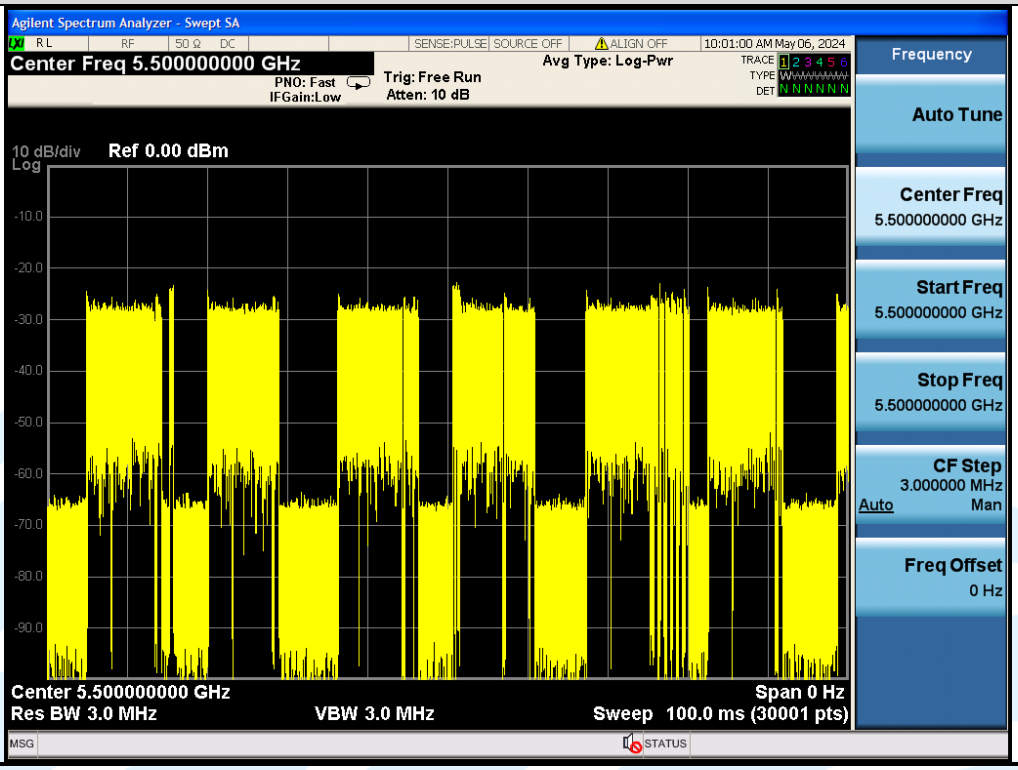
The measurement data as follows:

BW / Channel	Test Item	Test Result	Limit	Pass/Fail
20 MHz / 5300 MHz	Channel Move Time	1.0882 s	< 10s	Pass
	Channel Closing Transmission Time	13.6 ms	< 200+60ms	Pass
	Non-Occupancy Period	No transmission	30 minutes	Pass
20 MHz / 5500 MHz	Channel Move Time	1.0242 s	< 10s	Pass
	Channel Closing Transmission Time	4.4 ms	< 200+60ms	Pass
	Non-Occupancy Period	No transmission	30 minutes	Pass
40MHz / 5310 MHz	Channel Move Time	0.934 s	< 10s	Pass
	Channel Closing Transmission Time	9.6 ms	< 200+60ms	Pass
	Non-Occupancy Period	No transmission	30 minutes	Pass
40MHz / 5510 MHz	Channel Move Time	0.9526 s	< 10s	Pass
	Channel Closing Transmission Time	6.4 ms	< 200+60ms	Pass
	Non-Occupancy Period	No transmission	30 minutes	Pass

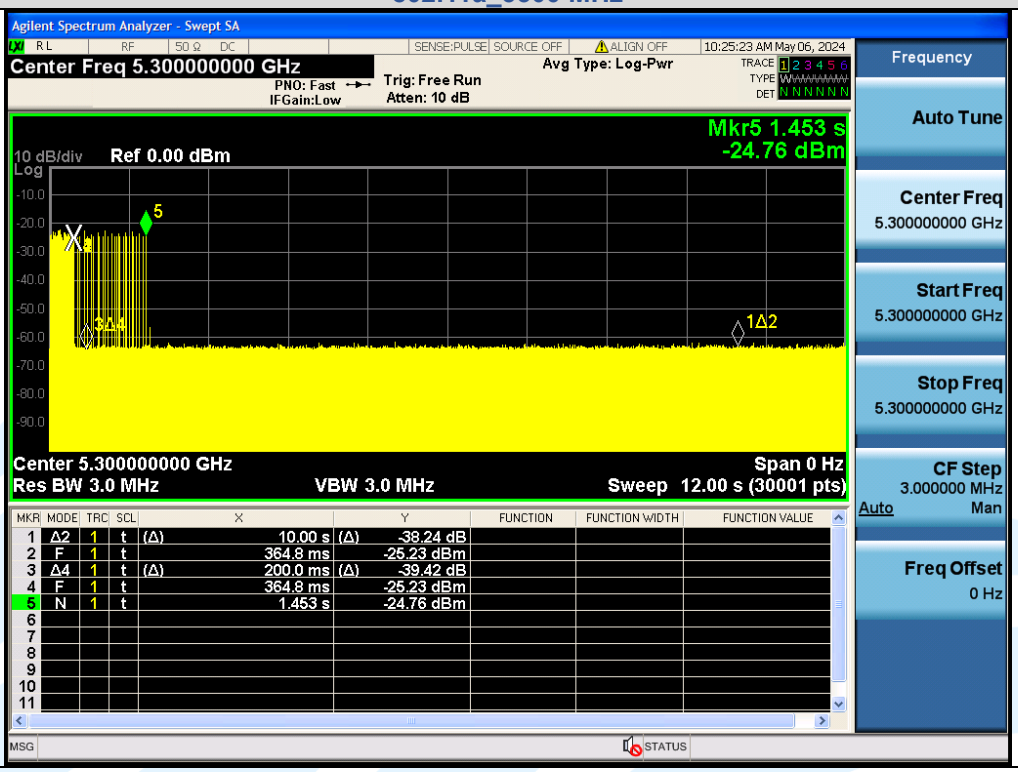
Radar Waveform calibration Plot

Reference DFS test signal	
5300 MHz	5500 MHz
	
5310 MHz	5510 MHz
	

Data Traffic Plot



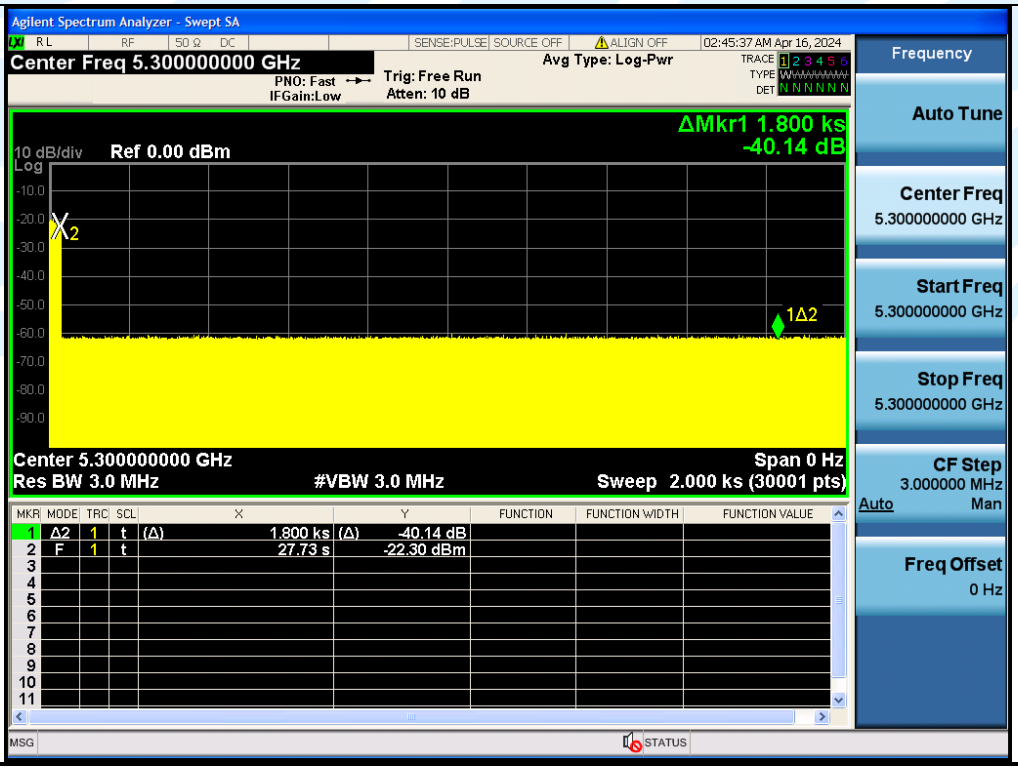
Channel Move Time & Channel Closing Transmission Time
802.11a_5300 MHz



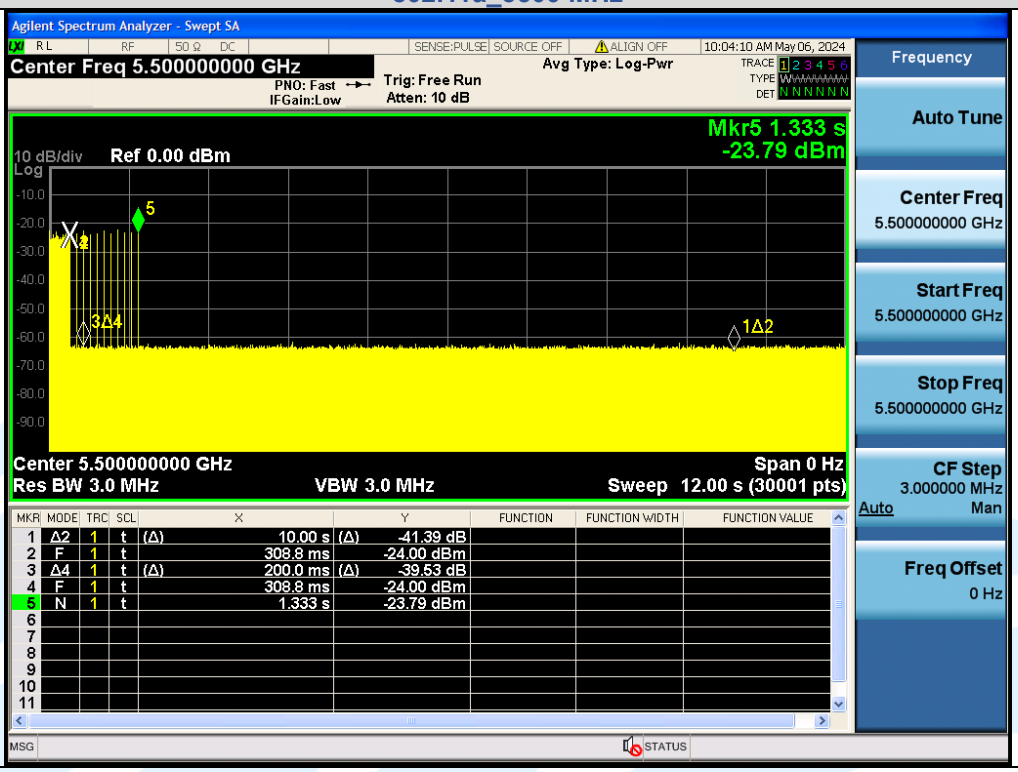
Note:

1) Mark1 Time: 364.8 ms, Mark2 Time: 10364.8 ms,Ontime Points: 34
2) Dwell = S/B = 12000 ms/30001 = 0.4 ms, C = N x Dwell = 34 x 0.4 = 13.6 ms
3) CMT =1.453s – 0.3648 s = 1.0882 s

Non-Occupancy Period_802.11a_CH60_5300 MHz



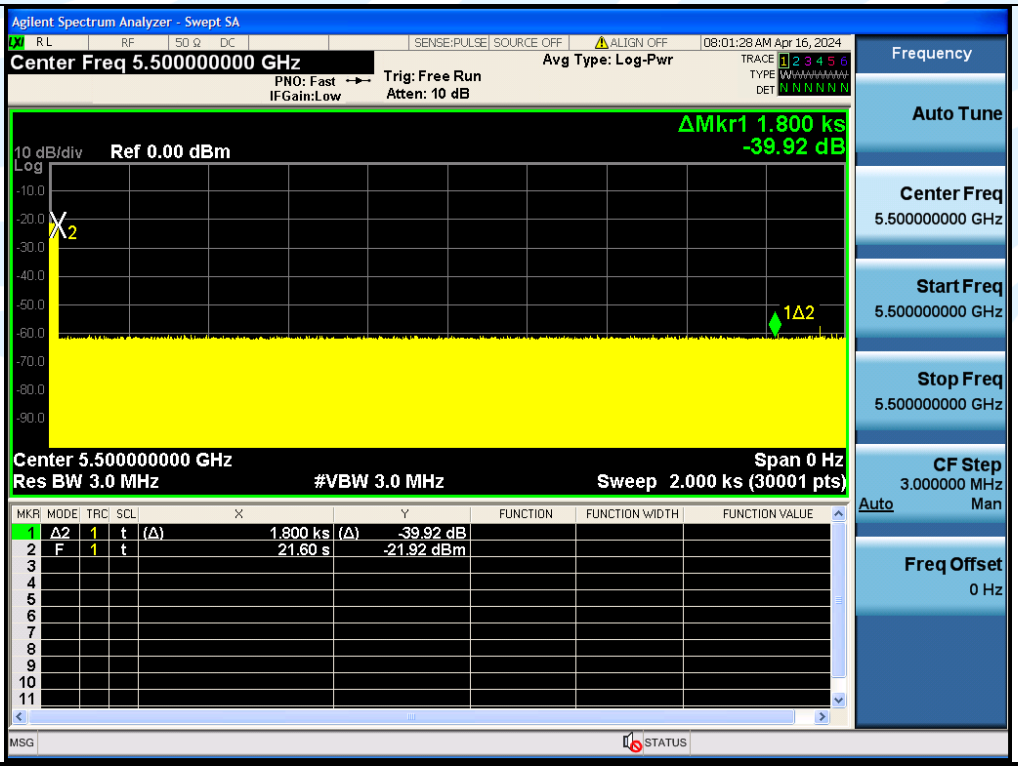
Channel Move Time & Channel Closing Transmission Time
802.11a_5500 MHz



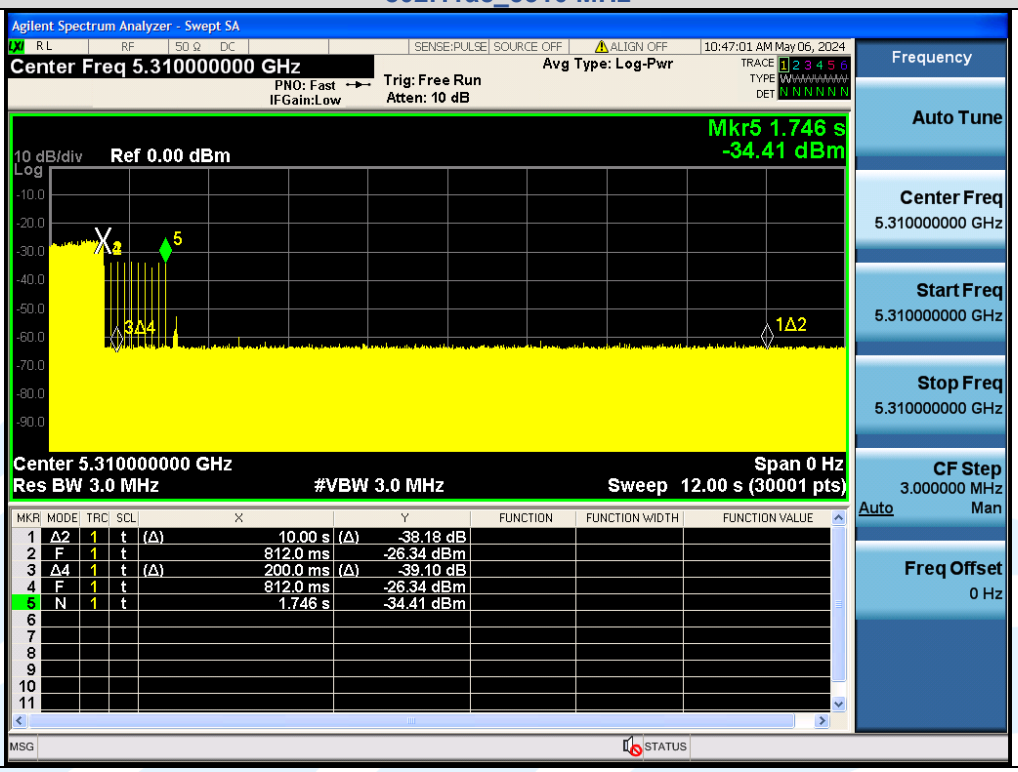
Note:

4) Mark1 Time: 308.8 ms, Mark2 Time: 10308.8 s,Ontime Points: 11
5) Dwell = S/B = 12000 ms/30001 = 0.4 ms, C = N x Dwell = 11 x 0.4=4.4 ms
6) CMT = 1.333 s – 0.3088 s = 1.0242 s

Non-Occupancy Period_802.11a_CH100_5500 MHz



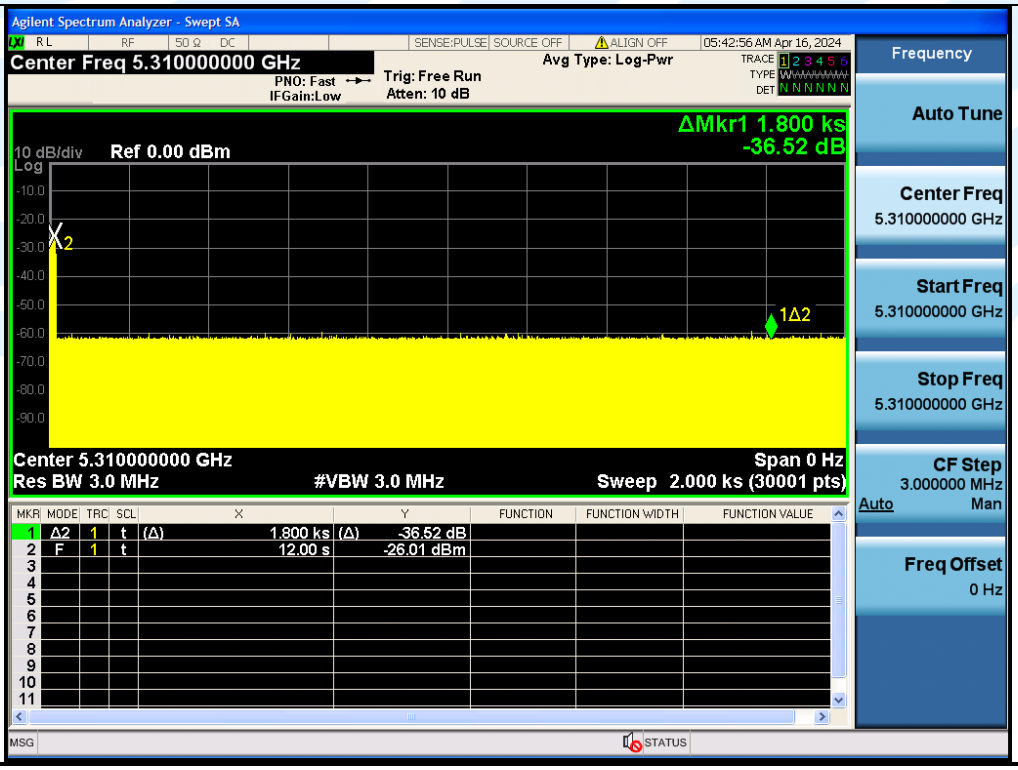
Channel Move Time & Channel Closing Transmission Time
802.11ac_5310 MHz



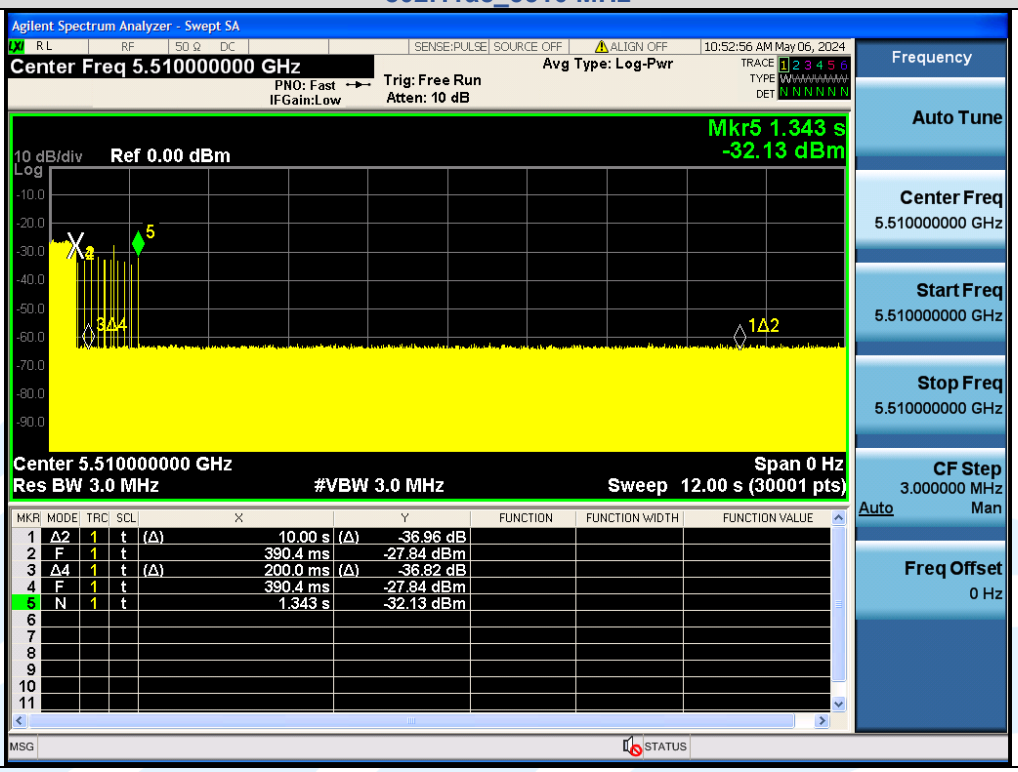
Note:

7) Mark1 Time: 812 ms, Mark2 Time: 10812 ms,Ontime Points: 24
8) Dwell = S/B = 12000 ms/30001 = 0.4 ms, C = N x Dwell = 24 x 0.4 = 9.6 ms
9) CMT = 1.746 s – 0.812 s =0.934 s

Non-Occupancy Period_802.11ac_CH58_5310 MHz



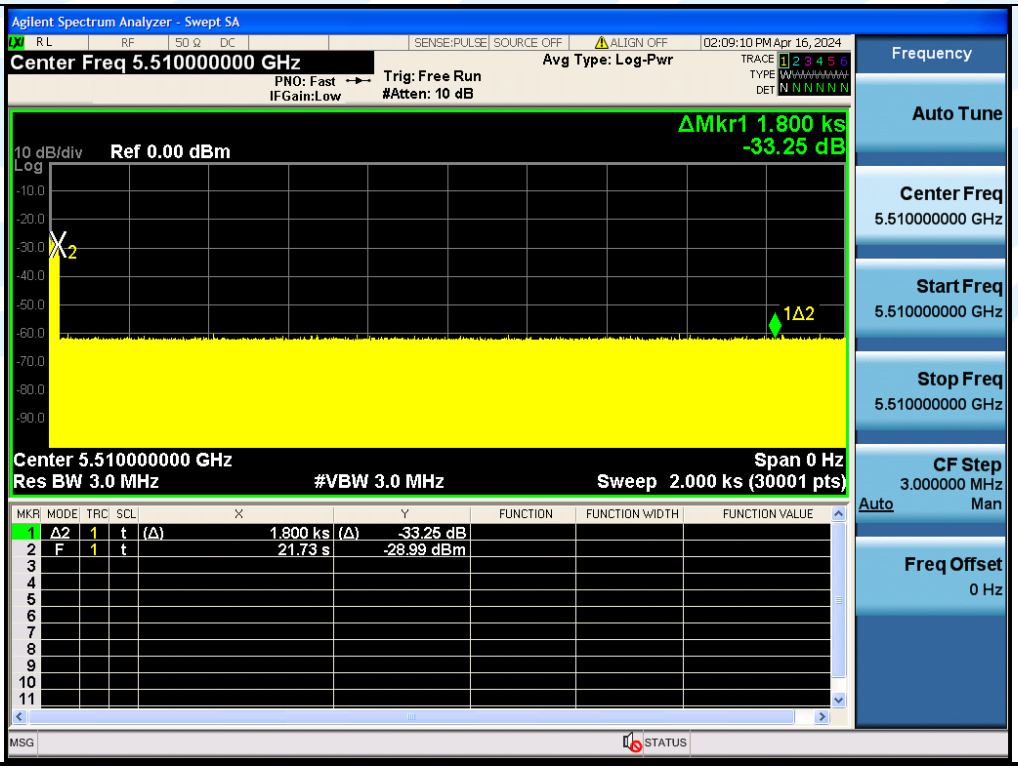
Channel Move Time & Channel Closing Transmission Time
802.11ac_5510 MHz



Note:

10) Mark1 Time: 390.4 ms, Mark2 Time: 10390.4 ms,Ontime Points: 16
11) Dwell = S/B = 12000 ms/30001 = 0.4 ms, C = N x Dwell = 16 x 0.4 = 6.4 ms
12) CMT = 1.343 s – 0.3904 s = 0.9526 s

Non-Occupancy Period_802.11ac_CH106_5510 MHz



5.9 AC POWER LINE CONDUCTED EMISSION

Test Requirement: 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

Test Method: ANSI C63.10-2013, Section 6.2.

Limits:

Frequency range (MHz)	Limits (dB(μV))	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50

Remark:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 to 0.50 MHz.

Test Setup: Refer to section 4.5.2 for details.

Test Procedures:

Test frequency range :150KHz-30MHz

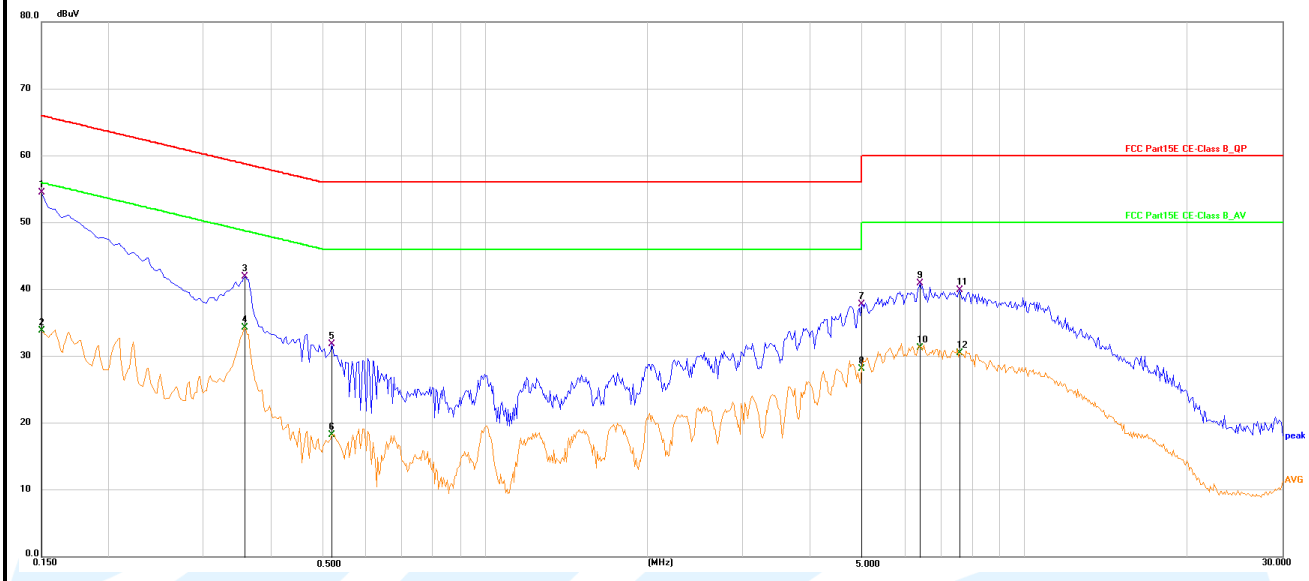
1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

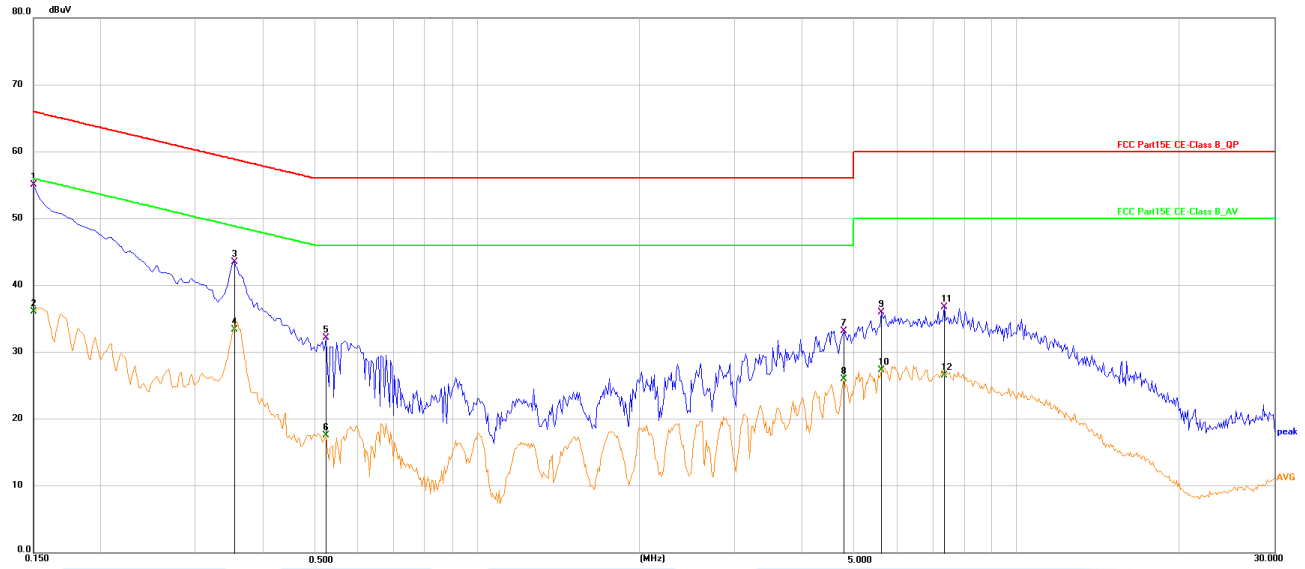
The measurement data as follows:
Quasi Peak and Average:
Mode: WIFI Link

Live Line



No.	Frequency (MHz)	Reading (dBμV)	Correction factor (dB)	Result (dBμV)	Limit (dBμV)	Margin (dB)	Detector
1	0.1500	44.33	10.20	54.53	66.00	-11.47	QP
2	0.1500	23.62	10.20	33.82	56.00	-22.18	AVG
3	0.3570	31.74	10.16	41.90	58.80	-16.90	QP
4	0.3570	24.14	10.16	34.30	48.80	-14.50	AVG
5	0.5190	21.60	10.19	31.79	56.00	-24.21	QP
6	0.5190	8.05	10.19	18.24	46.00	-27.76	AVG
7	5.0010	27.55	10.23	37.78	60.00	-22.22	QP
8	5.0010	17.85	10.23	28.08	50.00	-21.92	AVG
9	6.3915	30.45	10.43	40.88	60.00	-19.12	QP
10	6.3915	20.78	10.43	31.21	50.00	-18.79	AVG
11	7.5750	29.42	10.49	39.91	60.00	-20.09	QP
12	7.5750	19.99	10.49	30.48	50.00	-19.52	AVG

Neutral Line



No.	Frequency (MHz)	Reading (dBμV)	Correction factor (dB)	Result (dBμV)	Limit (dBμV)	Margin (dB)	Detector
1	0.1500	44.81	10.19	55.00	66.00	-11.00	QP
2	0.1500	25.91	10.19	36.10	56.00	-19.90	AVG
3	0.3524	33.28	10.15	43.43	58.91	-15.48	QP
4	0.3524	23.22	10.15	33.37	48.91	-15.54	AVG
5	0.5234	21.93	10.27	32.20	56.00	-23.80	QP
6	0.5234	7.27	10.27	17.54	46.00	-28.46	AVG
7	4.7895	22.89	10.28	33.17	56.00	-22.83	QP
8	4.7895	15.73	10.28	26.01	46.00	-19.99	AVG
9	5.5994	25.70	10.27	35.97	60.00	-24.03	QP
10	5.5994	17.09	10.27	27.36	50.00	-22.64	AVG
11	7.3365	26.47	10.31	36.78	60.00	-23.22	QP
12	7.3365	16.21	10.31	26.52	50.00	-23.48	AVG

Remark:

1. Correct Factor = LISN Factor + Cable Loss + Pulse Limiter Factor, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result - Limit
4. An initial pre-scan was performed on the Phase and neutral lines with peak detector. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

APPENDIX A RF TEST DATA

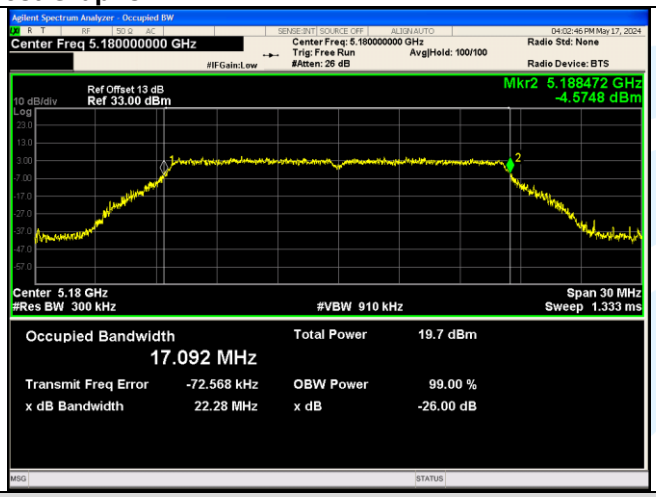
A.1 99% BANDWIDTH

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

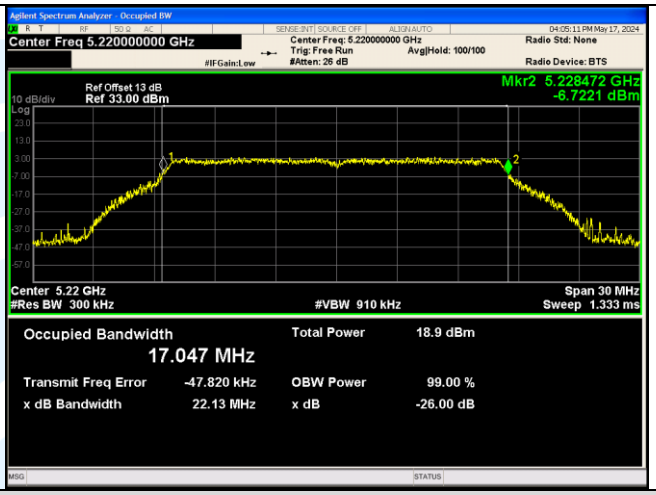
Mode	Channel	RU & Index	Ant.	99% BW (MHz)
IEEE 802.11a	36	N/A	0	17.092
	44			17.047
	48			17.094
	52			17.066
	60			17.090
	64			17.131
	100			17.080
	116			17.036
	140			17.063
	144			13.640
IEEE 802.11n_20	36			18.105
	44			18.085
	48			18.123
	52			18.106
	60			18.124
	64			18.141
	100			18.123
	116			18.108
	140			18.131
	144			14.120
IEEE 802.11n_40	38			36.509
	46			36.470
	54			36.436
	62			36.496
	102			36.438
	110			36.434
	134			36.454
	142			33.087
IEEE 802.11ac_20	36			18.094
	44			18.091
	48			18.070
	52			18.122
	60			18.161
	64			18.100
	100			18.073
	116			18.102
	140			18.110
	144			14.102
IEEE 802.11ac_40	38			36.461
	46			36.453
	54			36.389
	62			36.422
	102			36.455
	110			36.489
	134			36.465
	142			33.030
IEEE 802.11ax_20	36	SU		19.111
	44			19.190
	48			19.177
	52			19.099
	60			19.188
	64			19.208
	100			19.161
	116			19.216
	140			19.171
	144			14.640
IEEE 802.11ax_40	38			37.908

	46			37.866
	54			37.877
	62			37.866
	102			37.871
	110			37.907
	134			37.906
	142			33.756

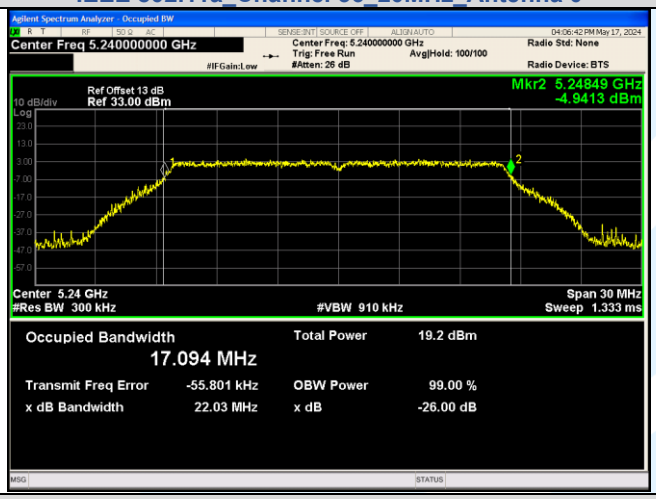
Test Graphs



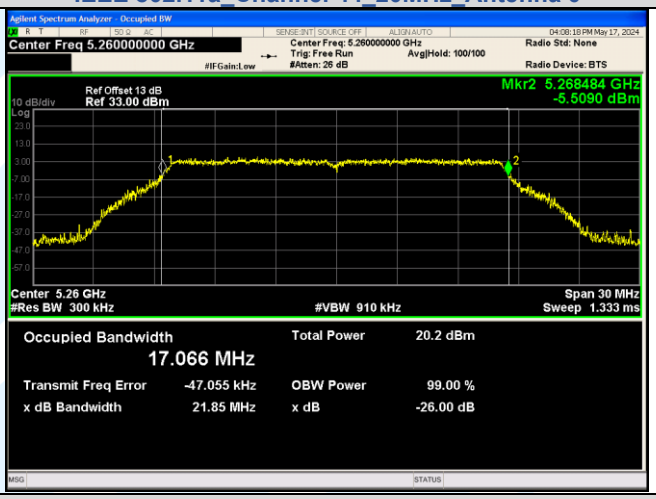
IEEE 802.11a_Channel 36_20MHz_Antenna 0



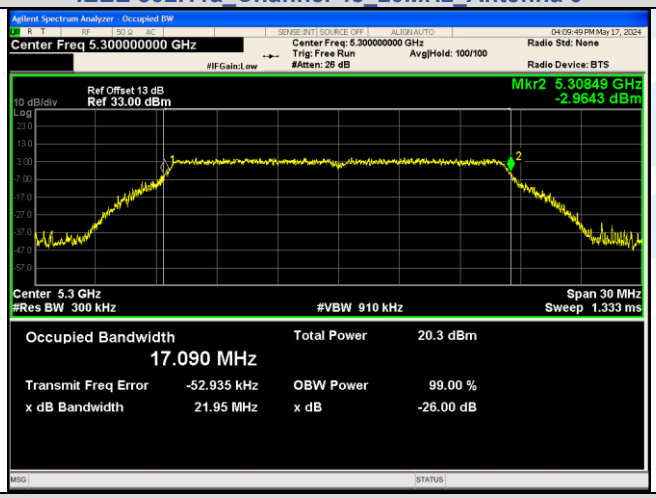
IEEE 802.11a_Channel 44_20MHz_Antenna 0



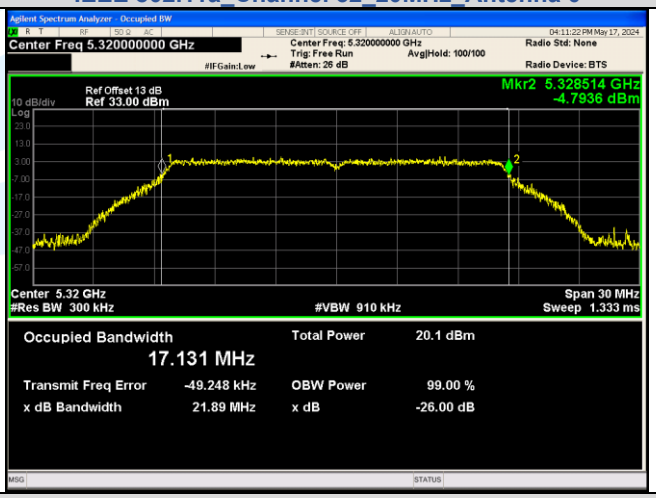
IEEE 802.11a_Channel 48_20MHz_Antenna 0



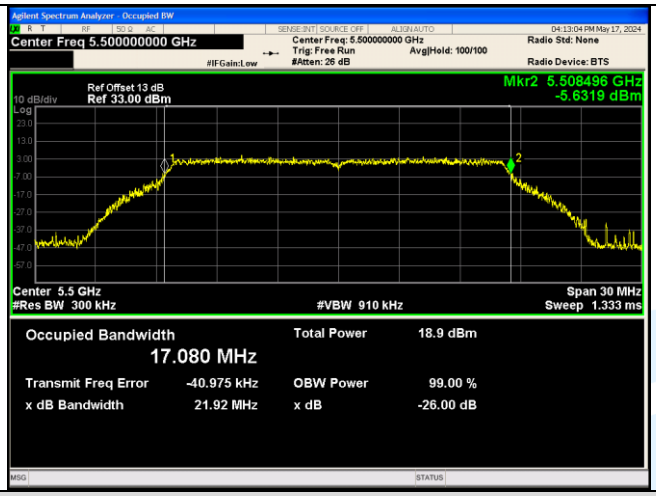
IEEE 802.11a_Channel 52_20MHz_Antenna 0



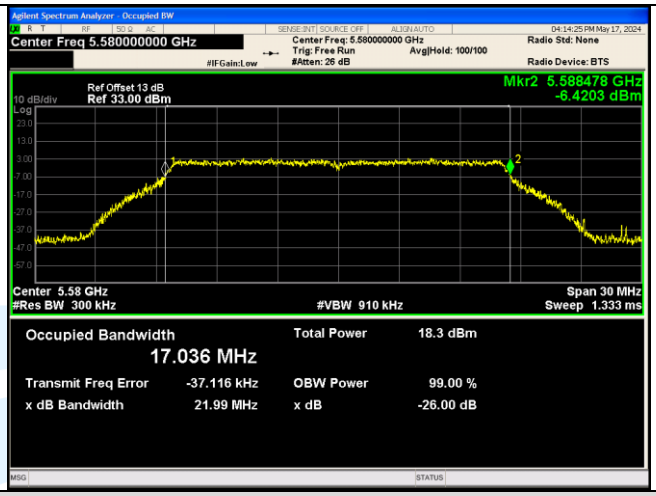
IEEE 802.11a_Channel 60_20MHz_Antenna 0



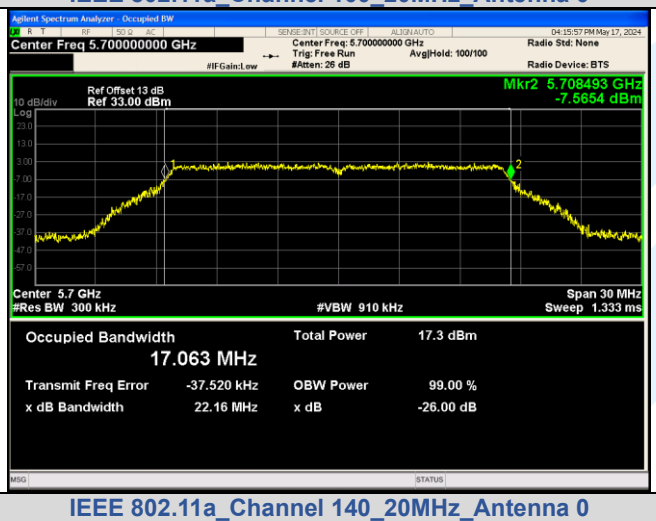
IEEE 802.11a_Channel 64_20MHz_Antenna 0



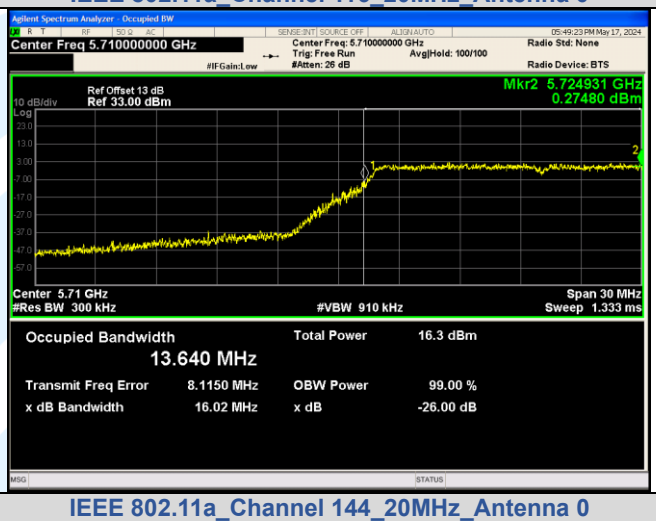
IEEE 802.11a_Channel 100_20MHz_Antenna 0



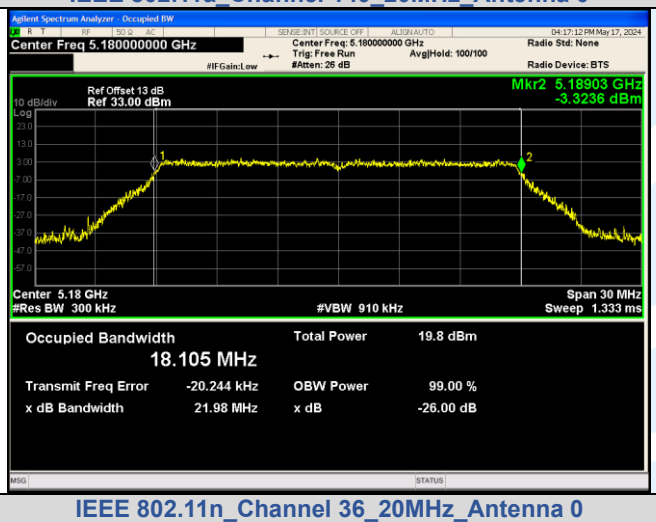
IEEE 802.11a_Channel 116_20MHz_Antenna 0



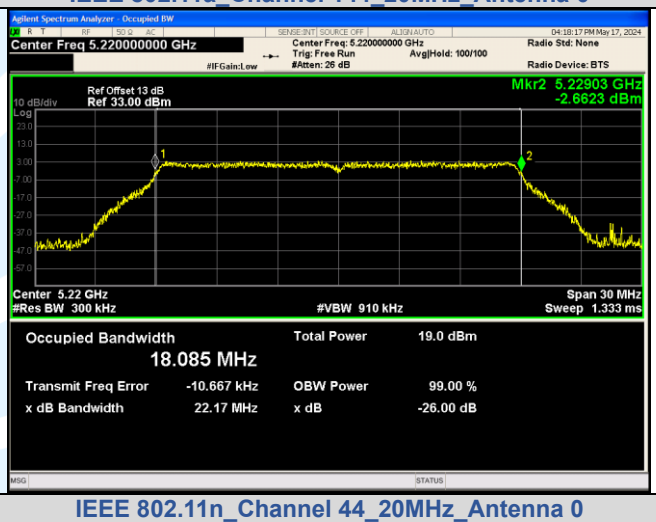
IEEE 802.11a_Channel 140_20MHz_Antenna 0



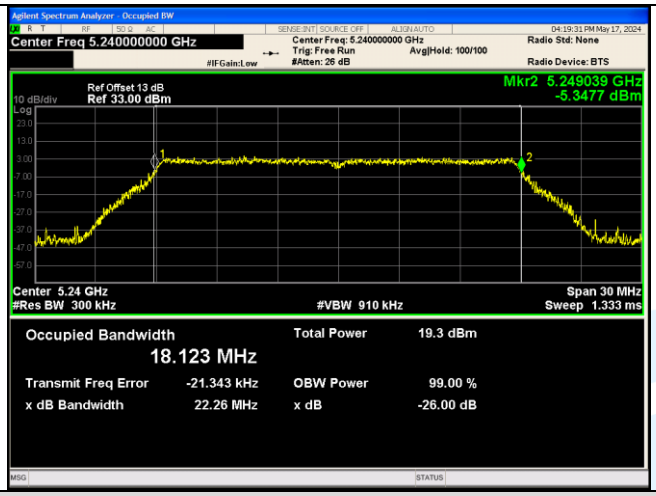
IEEE 802.11a_Channel 144_20MHz_Antenna 0



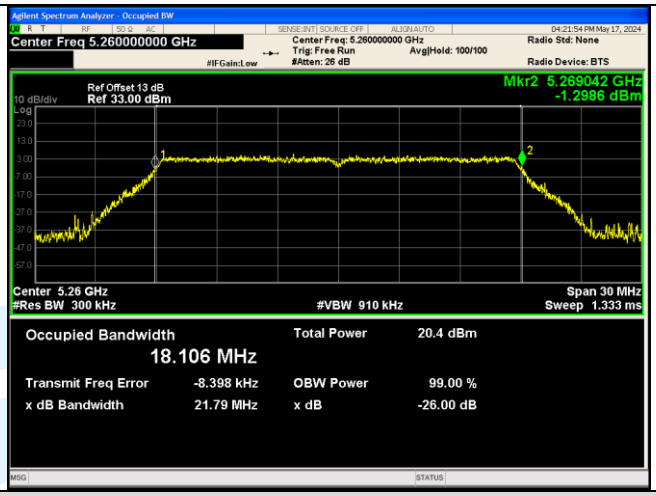
IEEE 802.11n_Channel 36_20MHz_Antenna 0



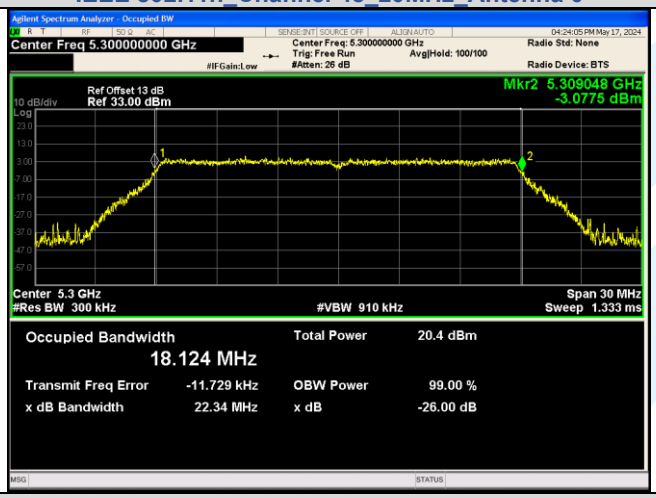
IEEE 802.11n_Channel 44_20MHz_Antenna 0



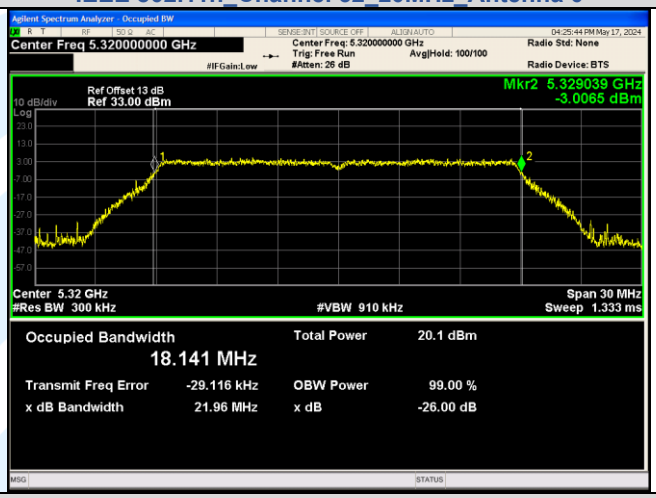
IEEE 802.11n_Channel 48_20MHz_Antenna 0



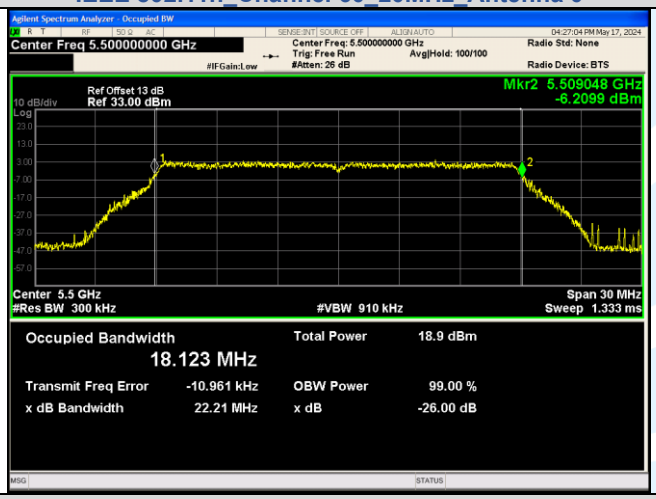
IEEE 802.11n_Channel 52_20MHz_Antenna 0



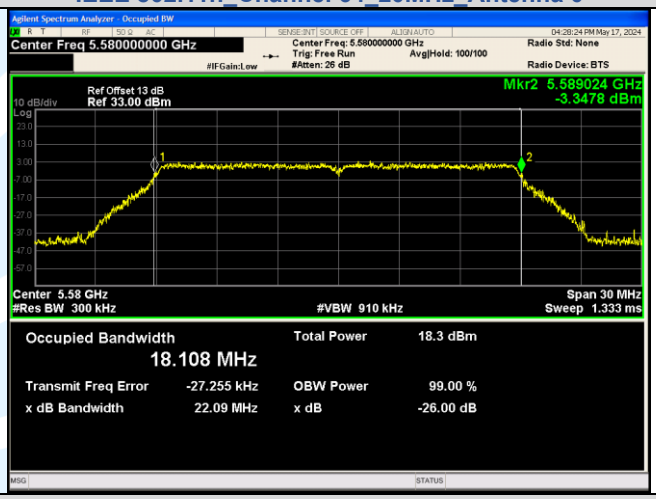
IEEE 802.11n_Channel 60_20MHz_Antenna 0



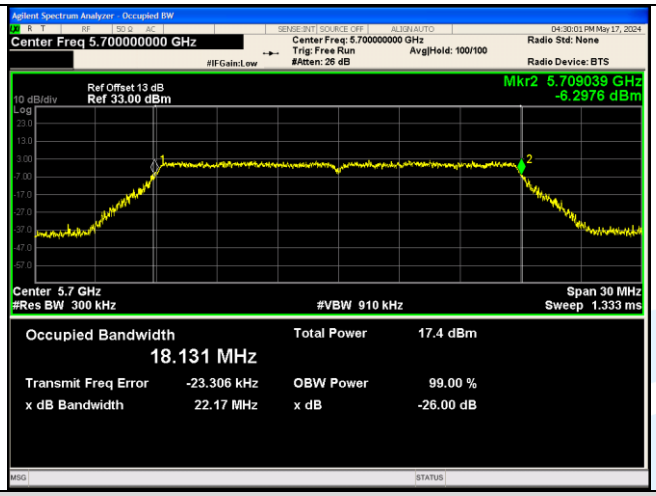
IEEE 802.11n_Channel 64_20MHz_Antenna 0



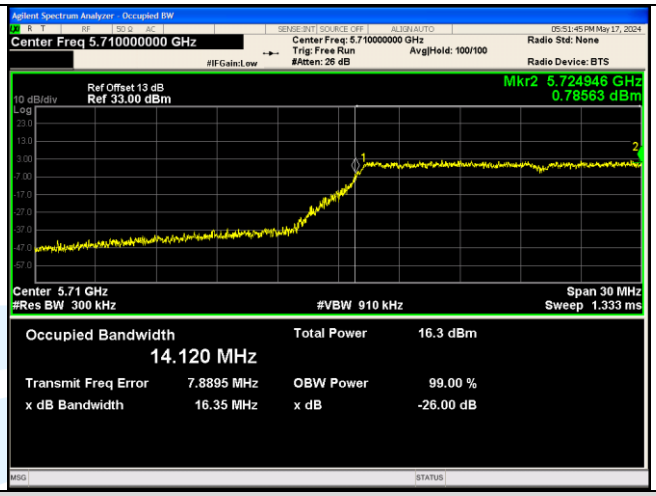
IEEE 802.11n_Channel 100_20MHz_Antenna 0



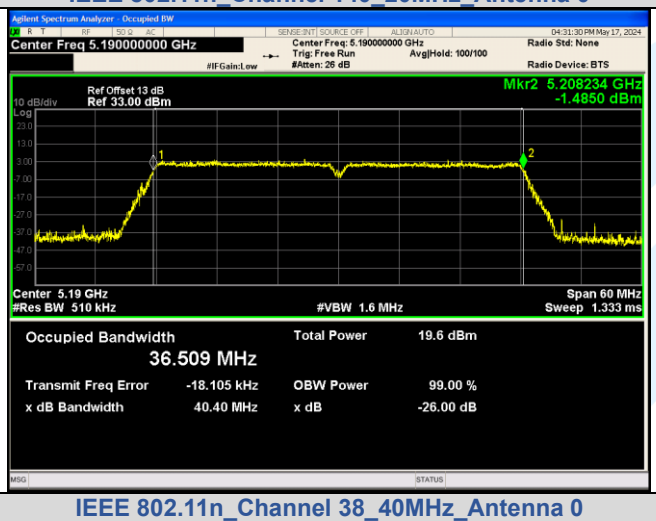
IEEE 802.11n_Channel 116_20MHz_Antenna 0



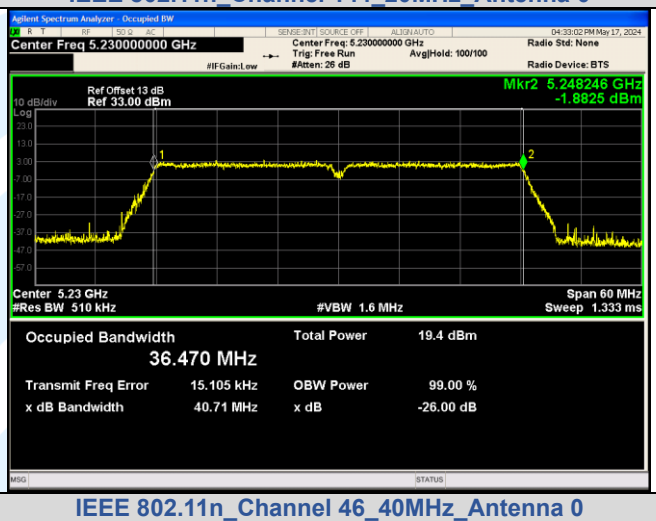
IEEE 802.11n_Channel 140_20MHz_Antenna 0



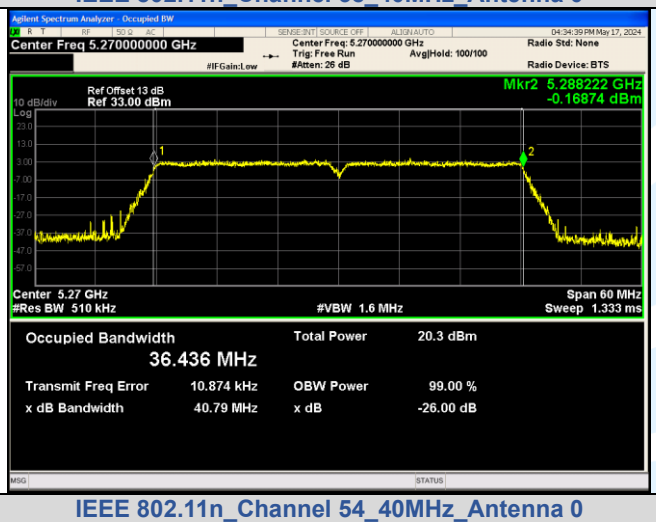
IEEE 802.11n_Channel 144_20MHz_Antenna 0



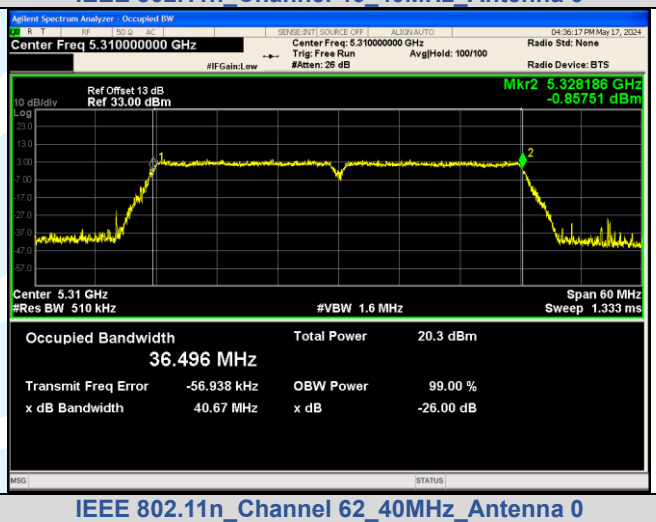
IEEE 802.11n_Channel 38_40MHz_Antenna 0



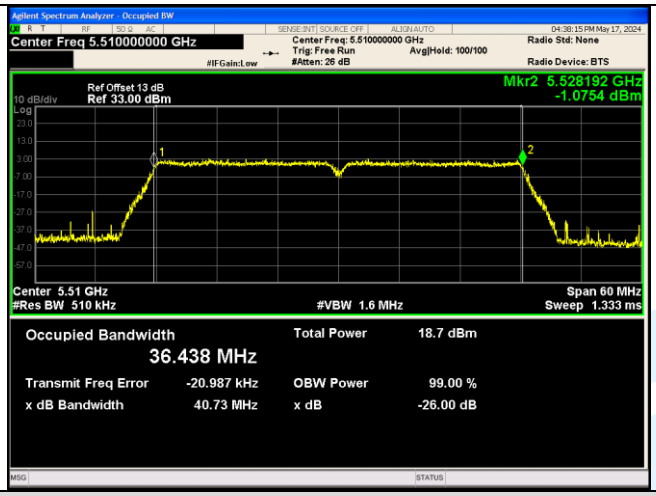
IEEE 802.11n_Channel 46_40MHz_Antenna 0



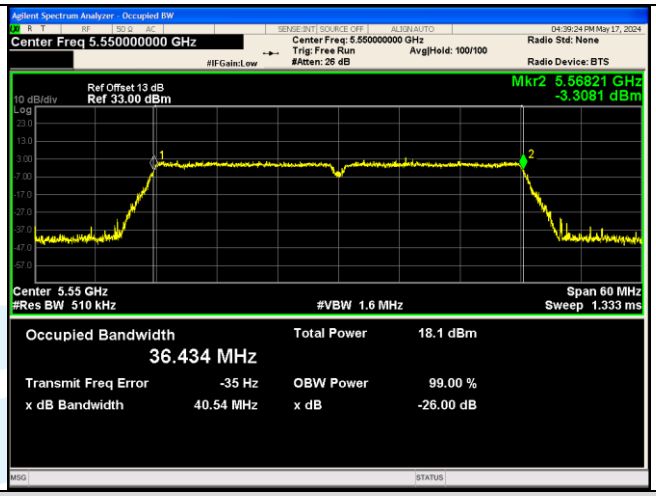
IEEE 802.11n_Channel 54_40MHz_Antenna 0



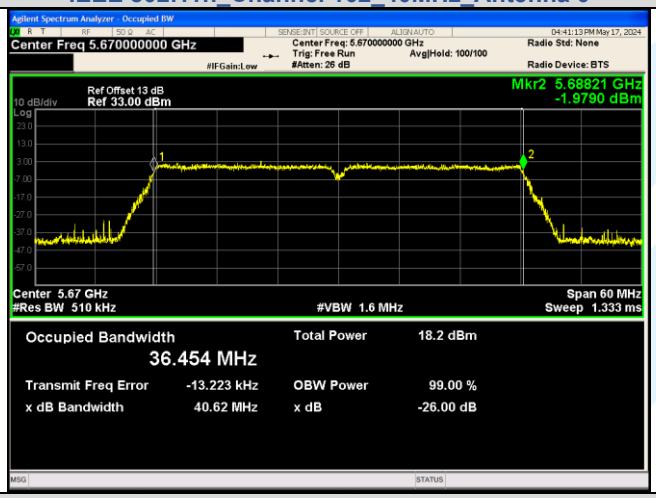
IEEE 802.11n_Channel 62_40MHz_Antenna 0



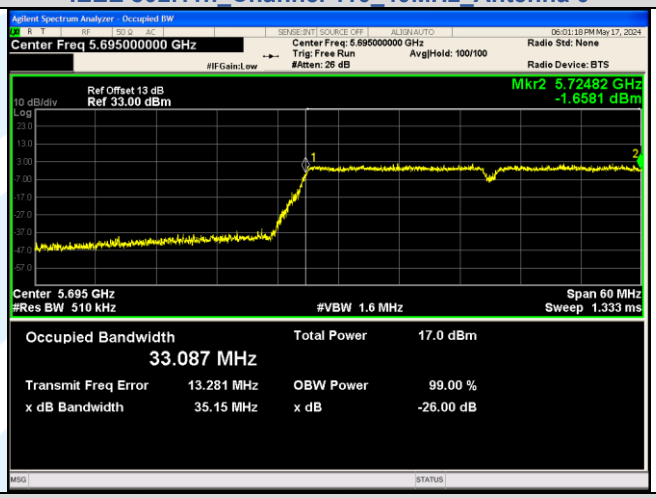
IEEE 802.11n_Channel 102_40MHz_Antenna 0



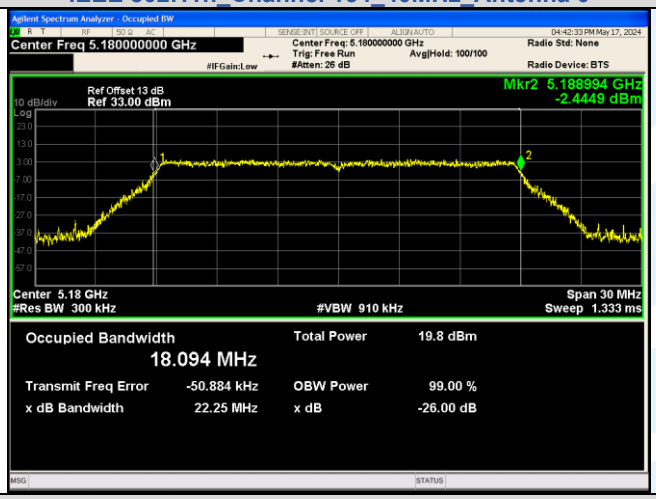
IEEE 802.11n_Channel 110_40MHz_Antenna 0



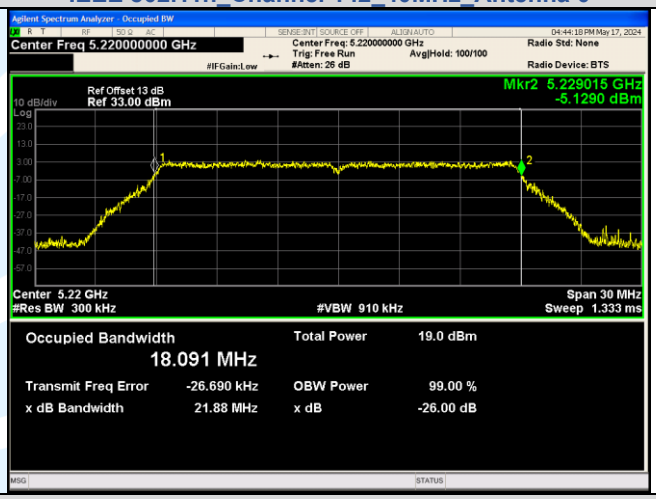
IEEE 802.11n_Channel 134_40MHz_Antenna 0



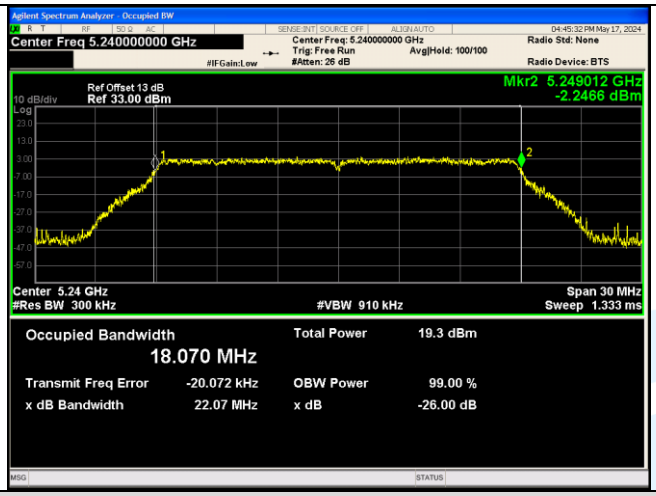
IEEE 802.11n_Channel 142_40MHz_Antenna 0



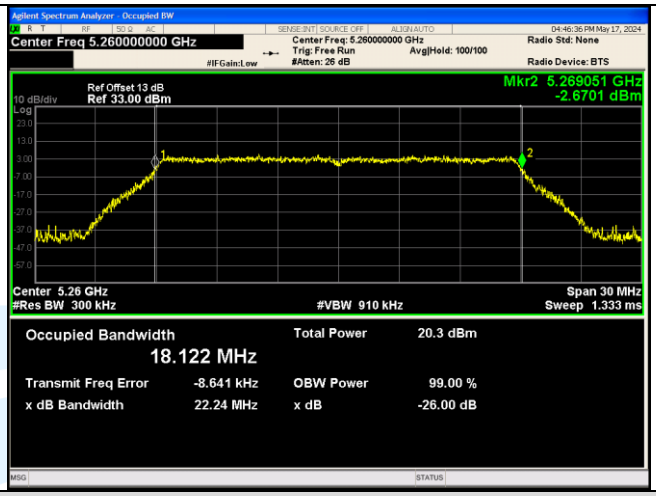
IEEE 802.11ac_Channel 36_20MHz_Antenna 0



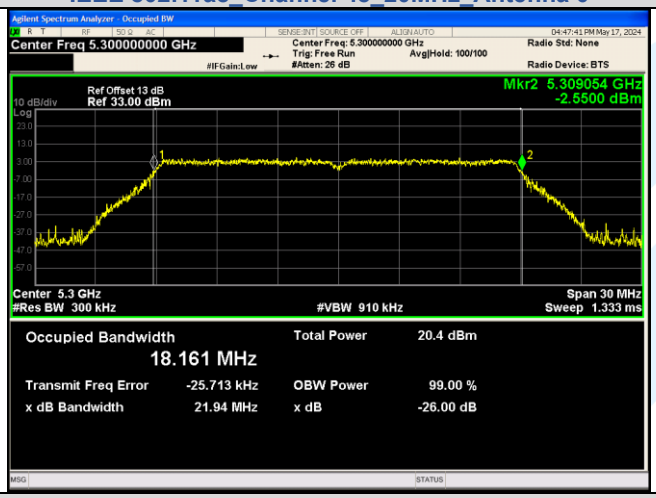
IEEE 802.11ac_Channel 44_20MHz_Antenna 0



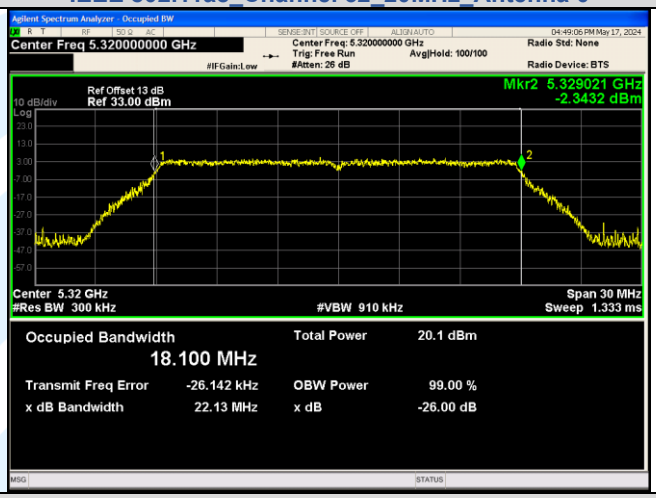
IEEE 802.11ac_Channel 48_20MHz_Antenna 0



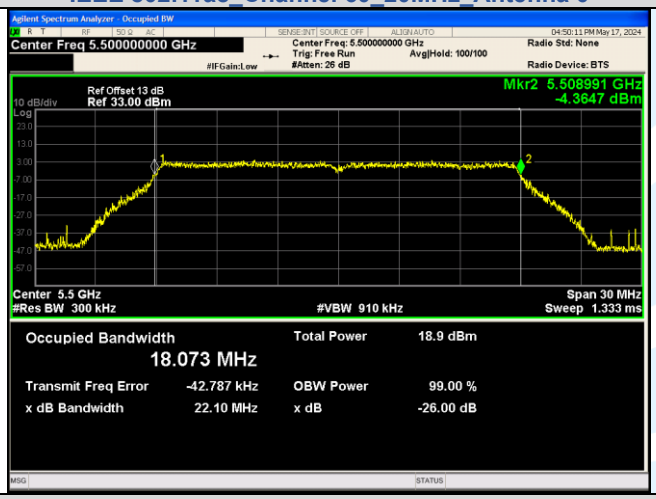
IEEE 802.11ac_Channel 52_20MHz_Antenna 0



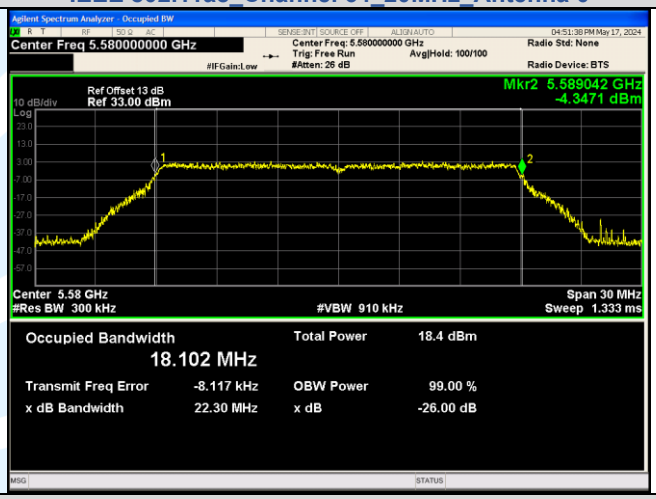
IEEE 802.11ac_Channel 60_20MHz_Antenna 0



IEEE 802.11ac_Channel 64_20MHz_Antenna 0



IEEE 802.11ac_Channel 100_20MHz_Antenna 0



IEEE 802.11ac_Channel 116_20MHz_Antenna 0