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FCC RF Test Report

Test Report Number	WAP-22021511-LC-FCC IC-WLAN5G
FCC ID	KMH-14H317-NA1
IC	1422A-14H317NA1
Applicant	Ford Motor Company
Applicant Address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Product Name	Vehicle Telematics Control Unit
Model Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Date of Receipt	04/05/2022
Date of Test	05/17/2022 – 06/01/2022
Report Issue Date	06/03/2022
Test Standards	47CFR Part 15.407 RSS 247 Issue 2: February 2017
Test Result	**PASS**

Issued by:

Vista Compliance Laboratories
1261 Puerta Del Sol, San Clemente, CA 92673 USA
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Devin Tai (Test Engineer)

David Zhang (Technical Manager)

REVISION HISTORY

Report Number	Version	Description	Issued Date
WAP-22021511-LC-FCC IC-WLAN5G	Original	Initial report	06/03/2022

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1 Test Summary

Test Item	Test Requirement	Test Method	Result
Antenna Requirement	47CFR Part 15.203	N/A	Pass
26 dB Bandwidth	47CFR Part 15.407 (a) RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Occupied Bandwidth	47CFR Part 15.407 (a) RSS-Gen Issue 5, Mar 2019	ANSI C63.10 (2013) RSS-Gen Issue 5, Mar 2019	Pass
Maximum Conducted Output Power	47CFR Part 15.407 (a) RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Power Spectral Density	47CFR Part 15.407 (a) RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Radiated Spurious Emission	47CFR Part 15.407 (b) RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
Radiated Band-Edge into Restricted Frequency Bands	47CFR Part 15.205, 15.209 47CFR Part 15.407 (b) RSS-247 Issue 2, Feb 2017	ANSI C63.10 (2013)	Pass
AC Power Line Conducted Emissions	47CFR Part 15.207 RSS-Gen Issue 5, Mar 2019	ANSI C63.10 (2013) RSS-Gen Issue 5, Mar 2019	N/A

Note: EUT is powered by Vehicle mains. It does not connect to public AC mains. This item is not applicable.

2 General Information

2.1 Applicant

Applicant	Ford Motor Company
Applicant address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Manufacturer	Ford Motor Company
Manufacturer Address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124

2.2 Product information

Product Name	Vehicle Telematics Control Unit
Mode Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Family Model Number	N/A
Serial Number	ANHGG22022104741, ANHGG22027104975 (Conducted), ANHGG22022104737, ANHGG21328102795 (Radiated)
Frequency Band	BT BDR/EDR: 2402-2480MHz BLE: 2402-2480MHz 802.11b/g/n-20MHz: 2412-2462MHz 802.11n-40MHz: 2422-2452MHz 802.11a/n-20MHz: 5500-5580MHz, 5660-5720, 5725-5825MHz 802.11n-40MHz: 5510-5550MHz, 5630-5710, 5755-5795MHz 802.11ac: 5530, 5690MHz, 5775MHz WCDMA Band 2: UL: 1850- 1910MHz; DL: 1930-1990MHz WCDMA Band 4: UL: 1710- 1755MHz. DL: 2110-2155MHz WCDMA Band 5: UL: 824- 849MHz; DL: 869-894MHz LTE Band 2: UL: 1850-1910MHz; DL: 1930-1990MHz LTE Band 4: UL:1710-1755MHz; DL: 2110-2155MHz LTE Band 5: UL:824-849MHz; DL: 869-894MHz LTE Band 7: UL:2500-2570MHz; DL: 2620-2690MHz LTE Band 12: UL:699-716MHz; DL: 729-746MHz LTE Band 13: UL:777-787MHz; DL:746-756MHz LTE Band 17: UL: 704-716MHz; DL: 734-746MHz LTE Band 29: DL: 717-728MHz (UE Receive Only) LTE Band 38: UL: 2570-2620MHz; DL: 2570-2620MHz LTE Band 66: UL:1710-1780MHz; DL: 2110-2200MHz LTE Band 71: UL: 663-698MHz; DL: 617-652MHz 5G NR n2: UL: 1850-1910MHz; DL: 1930-1990MHz 5G NR n5: UL:824-849MHz; DL: 869-894MHz 5G NR n7: UL:2500-2570MHz; DL: 2620-2690MHz 5G NR n41: UL:2496-2690MHz; DL: 2496-2690MHz 5G NR n66: UL:1710-1780MHz; DL: 2110-2200MHz 5G NR n71: UL:663-698MHz; DL: 617-652MHz 5G NR n77-L: UL:3450-3550MHz; DL: 3450-3550MHz 5G NR n77-H: UL:3700-3980MHz; DL: 3700-3980MHz 5G NR n78-L: UL:3450-3550MHz; DL: 3450-3550MHz

	5G NR n78-H: UL: 3700-3800MHz; DL: 3700-3800MHz
Type of modulation	BT BDR/EDR: GFSK, π/4DQPSK, 8DPSK BLE: GFSK 802.11b: DSSS (CCK, DQPSK, DBPSK) 802.11g: OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM) 802.11a/n/ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) WCDMA: QPSK LTE: QPSK, 16QAM, 64QAM, 256QAM 5G NR: Pi/2-BPSK, QPSK, 16QAM, 64QAM, 256QAM
Equipment Class/ Category	DSS, DTS, UNII, PCB
Maximum output power	See test result
Antenna Information	**2 x Internal BT/WLAN PCB trace antenna** Peak Gain: - 3.7 dBi @2.4GHz WiFi/Bluetooth, 6.4 dBi @5GHz WiFi **Cellular External antennas:** Peak Gain: 6 dBi @ 617 - 960 MHz 8 dBi @ 1710-2200MHz 8.5 dBi @ 2300-2700MHz 9.5 dBi @ 3300-4200MHz 11.0 dBi @ 4400-5000MHz *Antenna connector type: quad mini-Fakra connector* Modem 6 TCU will support 4 vehicle cellular antenna ports. The antenna port mapping is at below table,

Antenna	LB	MB	HB	N77/78/79	N41
Antenna1	DRX	TX+PRX	TX+PRX	TX+PRX	TX+PRX
Antenna2	TX+PRX	DRX	DRX	DRX	DRX
Antenna3	-	MIMO	MIMO	MIMO	MIMO
Antenna4	-	MIMO	MIMO	MIMO	MIMO

Note:

1. Antenna 1 and 3 go to the left-side rooftop external antenna (cellular antennas) and antenna 2 and 4 go to the right-side rooftop external antenna (cellular antennas). The cable length between left left-side and right-side rooftop external antenna are more than 20 cm.
2. Antenna 3 and 4 are for 4G-5G MIMO diversity only, no TX.
3. The antenna gain is declared by the manufacturer. Not all antennas support TX. The declared peak gain may have overestimated the TX gain of the single cellular antenna. For ERP/EIRP, radiated power will be measured in case when the calculated ERP/EIRP with declared antenna gain and measured conducted power is high.
4. For Bluetooth/WLAN, EUT has an option to use an external antenna with 10 dBi peak gain in 2.4GHz and 11 dBi gain in 5GHz. This antenna has not been evaluated in current report. However, the conservative 10 dBi gain (2.4GHz) and 11 dBi gain (5GH) are used for power related evaluation in current report.

Clock Frequencies	N/A
Port/Connectors	CAN bus
Input Power	Vehicle Battery powered: 12VDC
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	BT/BLE, WLAN and cellular radio can transmit simultaneously
Additional Info	This product is a DFS client device without radar detection when operating in the DFS frequency bands.

2.3 Test standard and method

Test standard	47CFR Part 15.407 RSS-247 Issue 2, Feb 2017 RSS-Gen Issue 5, Mar 2019
Test method	ANSI C63.10 (2013) 789033 D02 General UNII Test Procedures New Rules v02r01

3 Test Site Information

Lab performing tests	Vista Laboratories, Inc.
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www.vista-compliance.com

Test Condition	Temperature	Humidity	Atmospheric Pressure
RF Testing	23.5°C	61.3%	1002 mbar
Radiated Emission Testing	23.5°C	61.3%	1002 mbar

4 Modification of EUT / Deviations from Standards

The EUT is an engineering test sample loaded with RF testing firmware specifically designed to support the RF TX/RX measurement in different aspects.

5 Test Configuration and Operation

5.1 EUT Test Configuration

EUT is powered by external DC power supply for testing purpose. EUT's RF antenna port is connected to spectrum analyzer through RF test cable for measurement. The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc. For Cellular radio, it's controlled by communication tester to change to different mode.

The following software was used for testing and to monitor EUT performance

Software	Description
EMISoft Vasona	EMC/RF Spurious emission test software used during testing
QRCT	Set the module work at different mode, channel, bandwidth, etc.

5.2 Supporting Equipment

Description	Manufacturer	Model #	Serial #
AC/DC Adapter	MEAN WELL	GST60A12-P1J	EB74Q81066

6 Uncertainty of Measurement

Test item	Measurement Uncertainty (dB)
RF Output Power (Conducted)	±1.2 dB
Power Spectral Density	±0.9 dB
Unwanted Emission (conducted)	±2.6 dB
Occupied Channel Bandwidth	±5 %
Radiated Emission (9KHz-30MHz)	±3.5 dB
Radiated Emission (30MHz-1GHz)	±4.6 dB
Radiated Emission (1-18GHz)	±4.9 dB
Radiated Emission (18-40GHz)	±3.5 dB

7 Test Results

7.1 Antenna Requirements

7.1.1 Requirement

Per § 15.203, 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 shall be considered sufficient to comply with the provisions of this section. 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.

7.1.2 Conclusion

Analysis:

EUT has internal and optional external antennas.

- For Internal antennas, they're PCB trace antennas. No standard RF connector or coupling is used.
- For External antennas, they're connected using non-standard coupling port. No standard RF connector or coupling is used.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

7.2 26 dB Bandwidth & 6 dB Bandwidth

7.2.1 Requirement

§ 15.407 (a) (2); RSS-247 §6.2.1.2

26 dB Bandwidth: This section is for reporting purpose only. There are no restriction limits for bandwidth.

§ 15.407 (e); RSS-247 §6.2.4.1

6 dB Bandwidth: Within the 5.725-5.850 GHz and 5.850-5.895 GHz bands, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

7.2.2 Test Setup

7.2.3 Test Procedure

26 dB Bandwidth:
According to subclause 12.4.1 of ANSI C63.10-2013:
subclause C.1 of 789033 D02 General UNII Test Procedures New Rules v02r01

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 26 dB, if the functionality described above (i.e., RBW, VBW ≥ 3 x RBW, peak detector with maximum hold) is implemented by the instrumentation function.

1) Set RBW = approximately 1% of the emission bandwidth.
2) Set the VBW > RBW.
3) Detector = peak.
4) Trace mode = max hold.
5) 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 instrument. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

According to subclause C.2 of 789033 D02 General UNII Test Procedures New Rules v02r01
6 dB Bandwidth:

1) Set RBW = 100 kHz.
2) Set the video bandwidth (VBW) ≥ 3 x RBW.
3) Detector = Peak.
4) Trace mode = max hold.
5) Sweep = auto couple.
6) Allow the trace to stabilize.
7) Use automatic bandwidth measurement capability on instrument to obtain BW result.

7.2.4 Test Result

26dB Bandwidth for U-NII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	10*log (B) (Reference)	Result
802.11a	100	5500	6Mbps	20.67	13.15	N/A
	116	5580	6Mbps	20.95	13.21	N/A
	140	5700	6Mbps	20.52	13.12	N/A
802.11n	100	5500	HT_MCS0_20	20.54	13.13	N/A
	116	5580	HT_MCS0_20	20.72	13.16	N/A
	140	5700	HT_MCS0_20	21.65	13.35	N/A
802.11n40	102	5510	HT_MCS0_40	40.68	16.09	N/A
	110	5550	HT_MCS0_40	40.67	16.09	N/A
	134	5670	HT_MCS0_40	40.10	16.03	N/A
802.11ac80	106	5530	VHT_MCS0_80	82.42	19.16	N/A

6dB Bandwidth for U-NII-3 Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Result
802.11a	149	5745	6Mbps	15.13	0.5	PASS
	157	5785	6Mbps	15.47	0.5	PASS
	165	5825	6Mbps	15.10	0.5	PASS
802.11n	149	5745	HT_MCS0_20	15.14	0.5	PASS
	157	5785	HT_MCS0_20	15.15	0.5	PASS
	165	5825	HT_MCS0_20	15.58	0.5	PASS
802.11n40	151	5755	HT_MCS0_40	35.34	0.5	PASS
	159	5795	HT_MCS0_40	35.59	0.5	PASS
802.11ac80	155	5775	VHT_MCS0_80	75.14	0.5	PASS

26dB Bandwidth for Cross Band

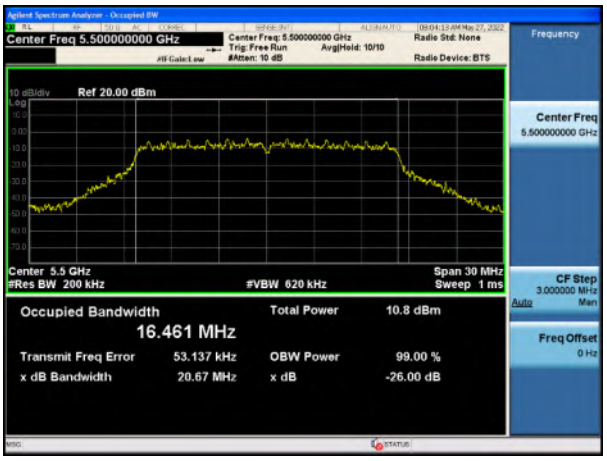
Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	10*log (B) (Reference)	Result
802.11a	149	5720	6Mbps	20.54	13.13	N/A
802.11n	149	5720	HT_MCS0_20	20.88	13.20	N/A
802.11n40	151	5710	HT_MCS0_40	41.24	16.15	N/A
802.11ac80	155	5690	VHT_MCS0_80	82.32	19.16	N/A

6dB Bandwidth for Cross Band

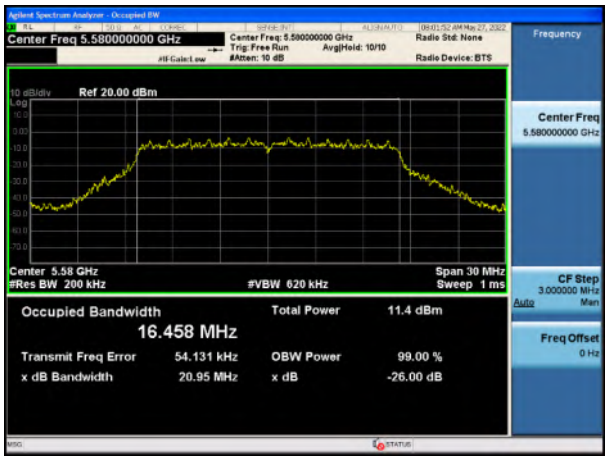
Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Result
802.11a	149	5720	6Mbps	15.14	0.5	PASS
802.11n	149	5720	HT_MCS0_20	15.15	0.5	PASS
802.11n40	151	5710	HT_MCS0_40	35.12	0.5	PASS
802.11ac80	155	5690	VHT_MCS0_80	75.78	0.5	PASS

7.2.5 Test Plots

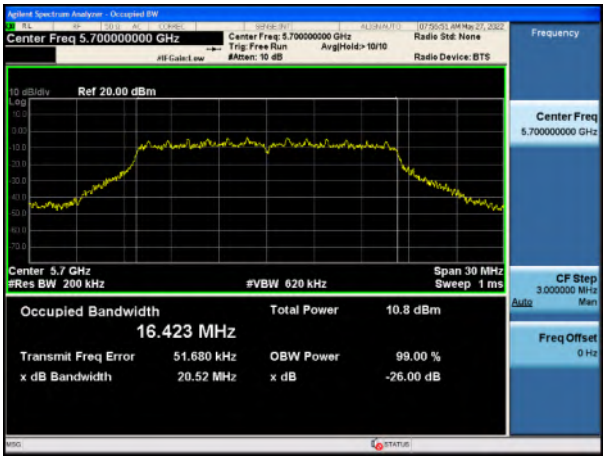
26 dB & 99% Bandwidth of U-NII-2C Band



26 dB & 99% BW_U-NII-2C_802.11a_5500

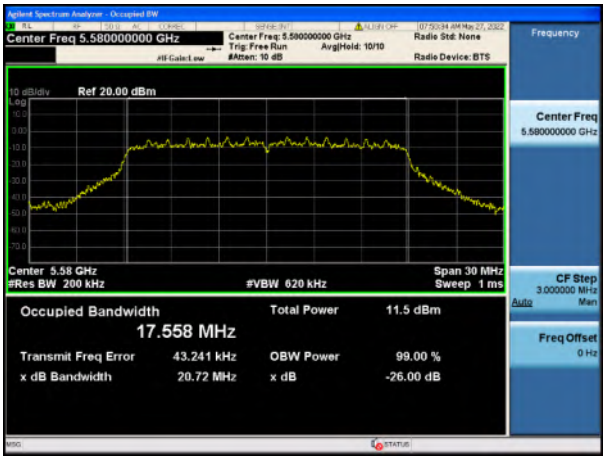


26 dB & 99% BW_U-NII-2C_802.11a_5580

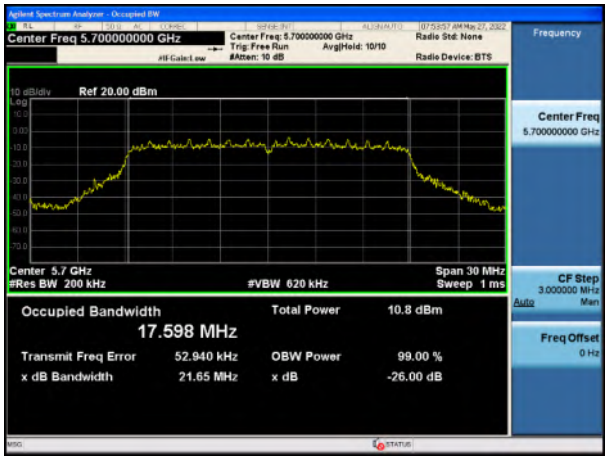


26 dB & 99% BW_U-NII-2C_802.11a_5700

26 dB & 99% BW_U-NII-2C_802.11n_5500

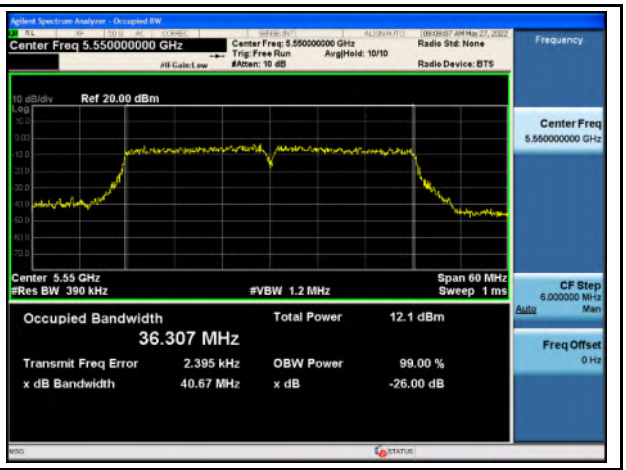


26 dB & 99% BW_U-NII-2C_802.11n_5580



26 dB & 99% BW_U-NII-2C_802.11n_5700

26 dB & 99% BW_U-NII-2C_802.11n40_5510



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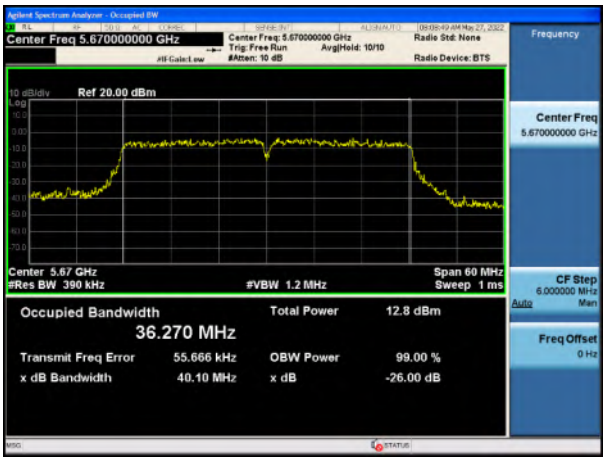

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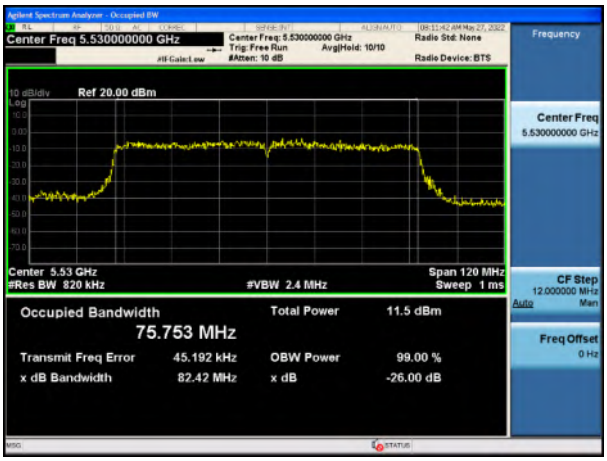
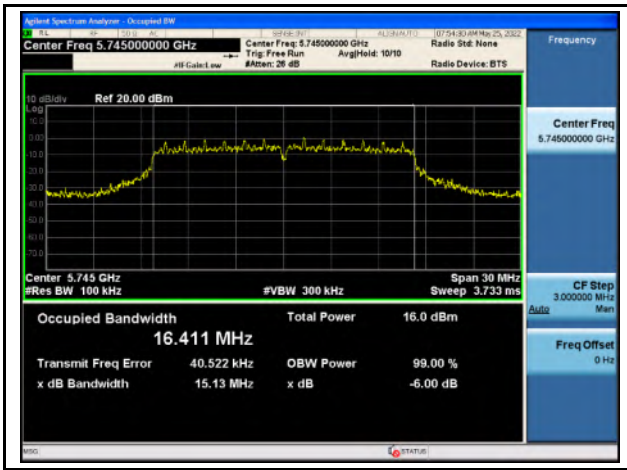
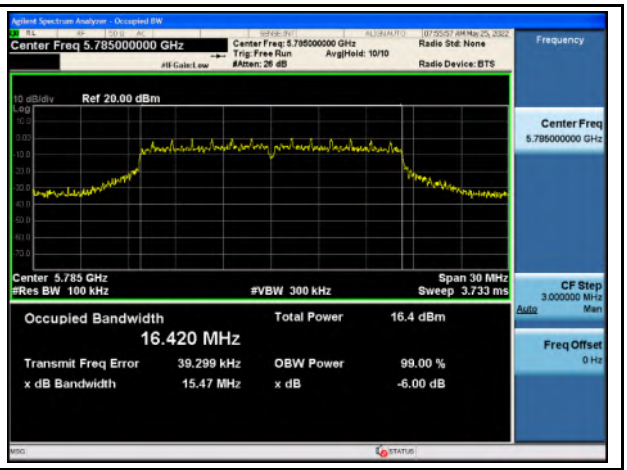


26 dB & 99% BW_U-NII-2C_802.11ac80_5530

6 dB & 99% Bandwidth of U-NII-3 Band



6 dB & 99% BW_U-NII-3_802.11a_5745



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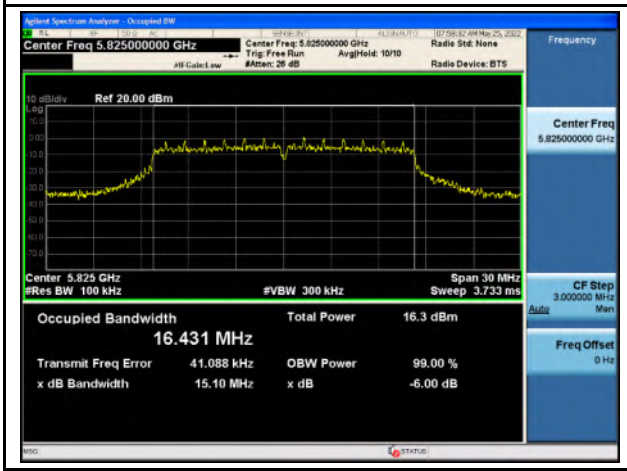

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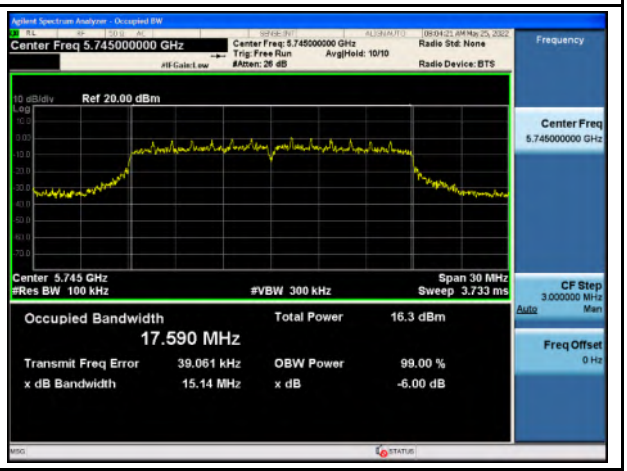
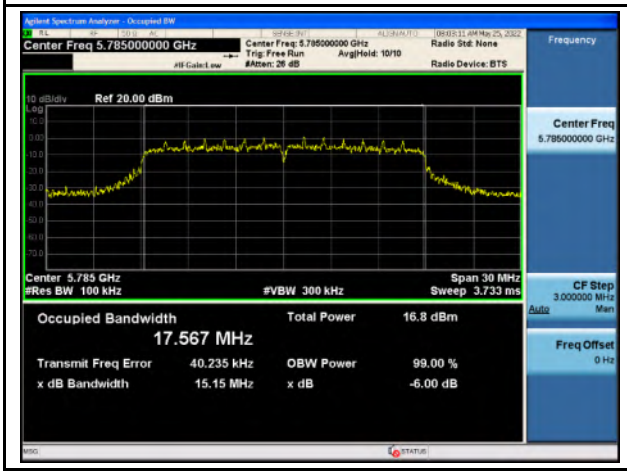


6 dB & 99% BW_U-NII-3_802.11n_5745



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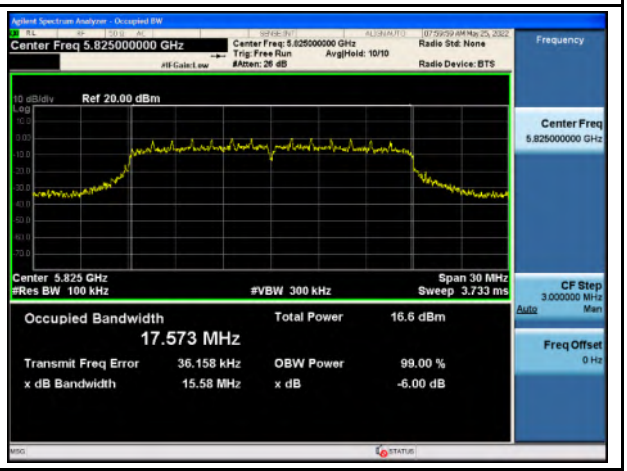
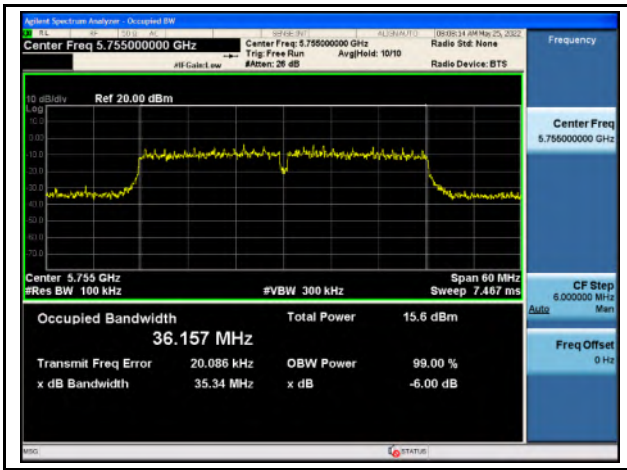
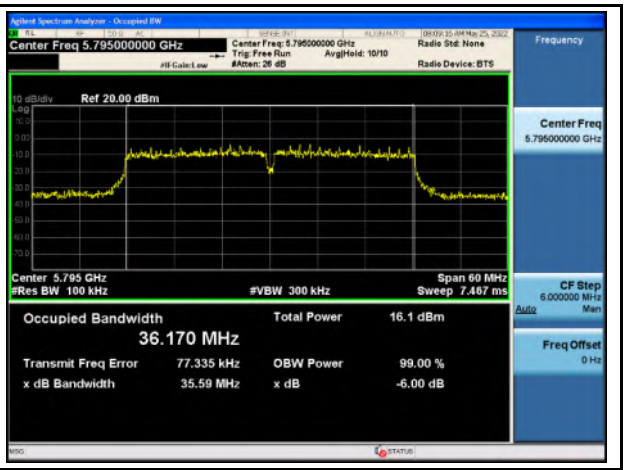


6 dB & 99% BW_U-NII-3_802.11n_5825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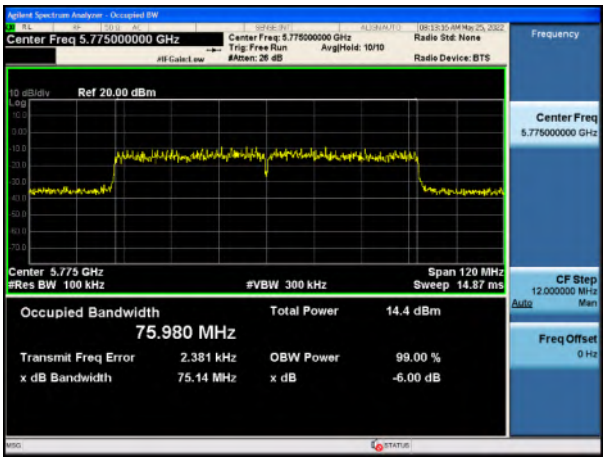	
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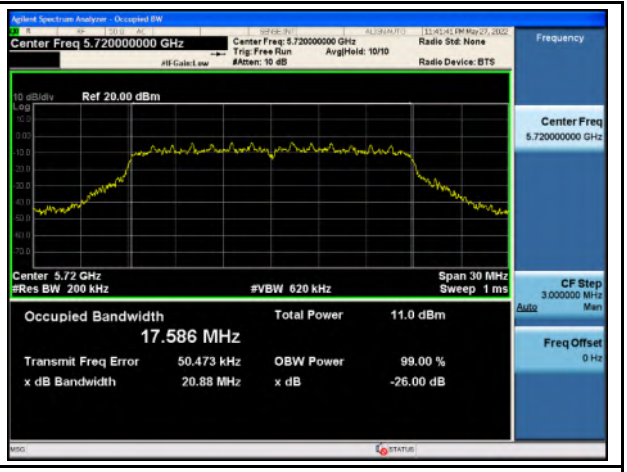
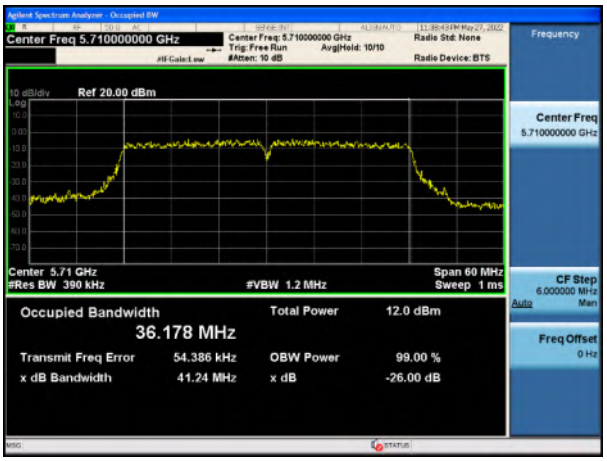
26dB Bandwidth for Cross band

26 dB & 99% BW_Cross band_802.11a_5720



26 dB & 99% BW_ Cross band _802.11n_5720



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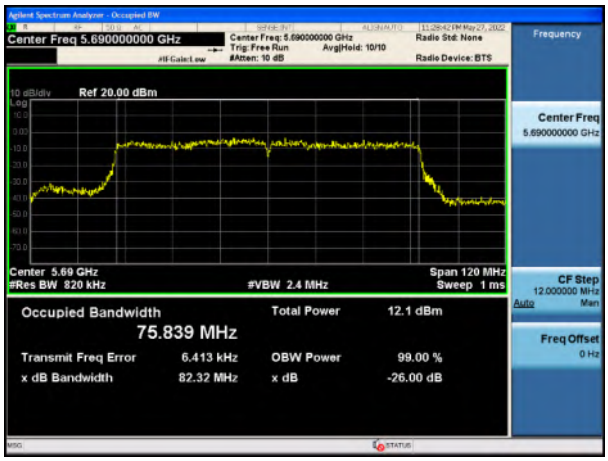
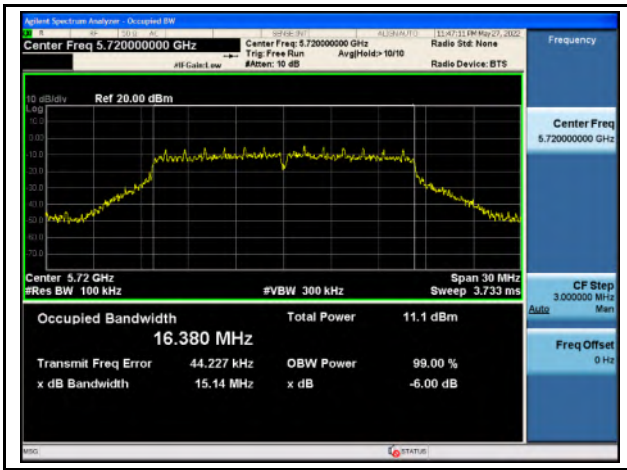
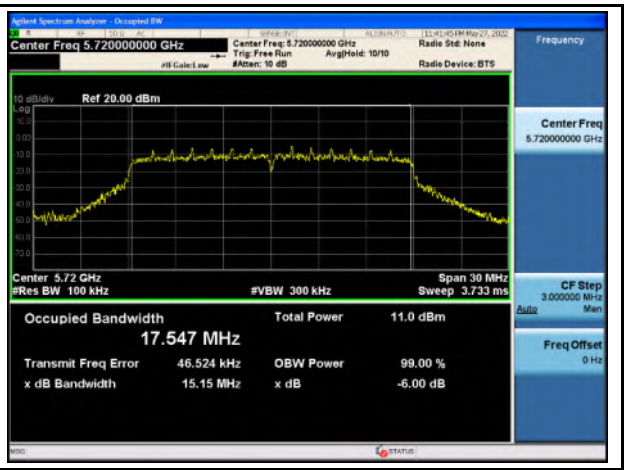


26 dB & 99% BW_ Cross band _802.11ac80_5690

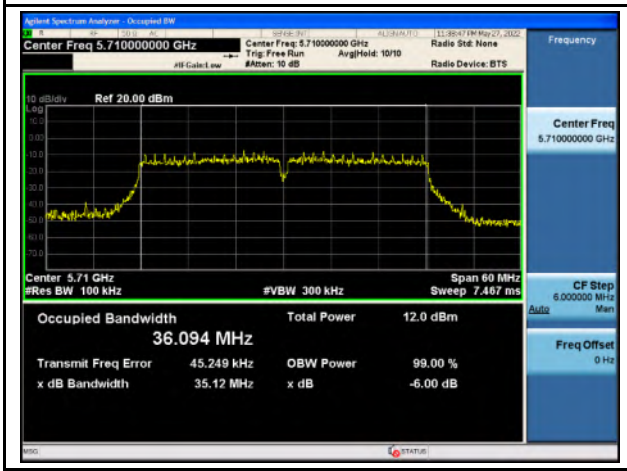
6dB Bandwidth for Cross band



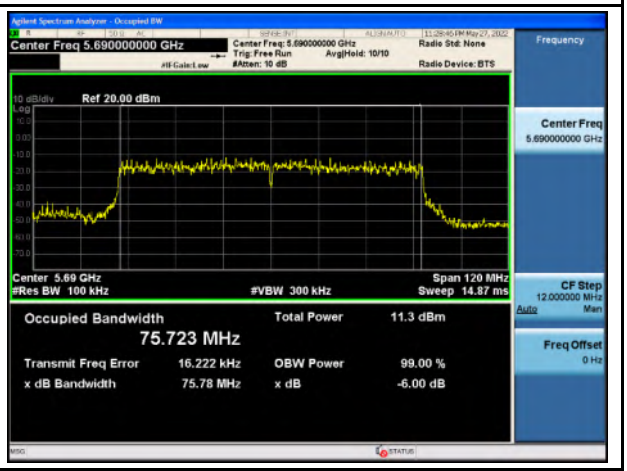
6 dB BW_Cross band_802.11a_5720



6 dB BW_ Cross band _802.11n_5720



6 dB BW_ Cross band _802.11n40_5710



6 dB BW_ Cross band _802.11ac80_5690

7.3 Occupied Bandwidth (99%)

7.3.1 Requirement

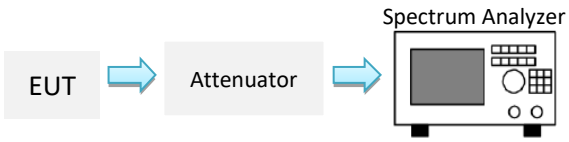
The 99% OBW is for reporting purpose only. The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

7.3.2 Test Procedure

According to subclause 6.9.3 of ANSI C63.10-2013:
subclause D of 789033 D02 General UNII Test Procedures New Rules v02r01

1. Set RBW = 1% to 5% of the actual occupied BW.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Span = large enough to capture all products of the modulation process
7. Allow the trace to stabilize.
8. Use automatic bandwidth measurement capability on instrument to obtain BW result.

7.3.3 Test Setup



7.3.4 Test Result

U-NII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	10*log (B) (Reference)	Result
802.11a	100	5500	6Mbps	16.461	12.16	N/A
	116	5580	6Mbps	16.458	12.16	N/A
	140	5700	6Mbps	16.423	12.15	N/A
802.11n	100	5500	HT20_MCS0	17.607	12.46	N/A
	116	5580	HT20_MCS0	17.558	12.44	N/A
	140	5700	HT20_MCS0	17.598	12.45	N/A
802.11n40	102	5510	HT40_MCS0	36.142	15.58	N/A
	110	5550	HT40_MCS0	36.307	15.60	N/A
	134	5670	HT40_MCS0	36.270	15.60	N/A
802.11ac80	106	5530	VHT80_MCS0	75.753	18.79	N/A

U-NII-3 Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	10*log (B) (Reference)	Result
802.11a	149	5745	6Mbps	16.411	12.15	N/A
	157	5785	6Mbps	16.420	12.15	N/A
	165	5825	6Mbps	16.431	12.16	N/A
802.11n	149	5745	HT20_MCS0	17.590	12.45	N/A
	157	5785	HT20_MCS0	17.567	12.45	N/A
	165	5825	HT20_MCS0	17.573	12.45	N/A
802.11n40	151	5755	HT40_MCS0	36.157	15.58	N/A
	159	5795	HT40_MCS0	36.170	15.58	N/A
802.11ac80	155	5775	VHT80_MCS0	75.980	18.81	N/A

99% Bandwidth for Cross Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Bandwidth (MHz)	10*log (B) (Reference)	Result
802.11a	149	5720	6Mbps	16.432	12.16	N/A
802.11n	149	5720	HT_MCS0_20	17.586	12.45	N/A
802.11n40	151	5710	HT_MCS0_40	36.178	15.58	N/A
802.11ac80	155	5690	VHT_MCS0_80	75.839	18.80	N/A

7.3.5 Test Plots

Please refer to section 7.2.5

7.4 Maximum Conducted Output Power

7.4.1 Requirement

§ 15.407 (a)

(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.

(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.

(3) (i) For the band 5.725-5.850 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Note that U-NII-2 band, 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.

RSS-247

6.2.1 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 + 10log10B, 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 log10B, 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.

6.2.2 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 + 10log10B, 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 than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less.

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in MHz.

6.2.3 Frequency bands 5470-5600 MHz and 5650-5725 MHz

The maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less.

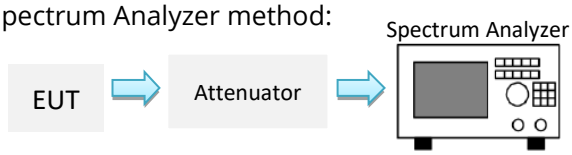
The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in MHz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

6.2.4 Frequency band 5725-5850 MHz

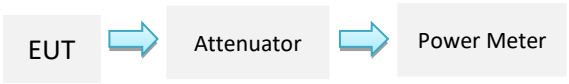
The maximum conducted output power shall not exceed 1 W. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.4.2 Test Setup

Spectrum Analyzer method:



Power Meter



7.4.3 Test Procedure

Spectrum Analyzer method:

According to subclause 12.3.2.2 of ANSI C63.10-2013:

subclause E.2.b of 789033 D02 General UNII Test Procedures New Rules v02r01

1) Set span to encompass the entire 26 dB EBW or 99% OBW of the signal.
2) Set RBW = 1MHz
3) Set VBW ≥ 3 MHz.
4) Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrow band signals are not lost between frequency bins.)
5) Sweep time = auto
6) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
7) If transmit duty cycle < 98%, use a video trigger with the trigger level set to enable triggering only on full power pulses. The transmitter shall operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run.”

8) Trace average at least 100 traces in power averaging (rms) mode.

9) Compute power by integrating the spectrum across the 26 dB EBW or 99% OBW of the signal using the instrument's band power measurement function, with band limits set equal to the EBW or OBW band edges. If the instrument does not have a band power function, then sum the spectrum levels (in power units) at 1 MHz intervals extending across the 26 dB EBW or 99% OBW of the spectrum.

Power Meter Method:

According to subclause 12.3.3.2 of ANSI C63.10-2013:

subclause E.3.b of 789033 D02 General UNII Test Procedures New Rules v02r01

Method PM-G is measurement using a gated RF average power meter.
Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

7.4.4 Test Result

Conducted Output power measurement result

U-NII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Output Power (dBm)		Highest/ Total Power (dBm)	Output Power Limit (dBm)	Result
				Chain 1	Chain 2			
802.11a	100	5500	6Mbps	4.08	4.10	4.10	19	PASS
	116	5580	6Mbps	4.85	4.82	4.85	19	PASS
	140	5700	6Mbps	4.11	4.13	4.13	19	PASS
802.11n	100	5500	HT20_MCS0	4.73	4.81	7.78	19	PASS
	116	5580	HT20_MCS0	4.78	4.81	7.81	19	PASS
	140	5700	HT20_MCS0	4.15	4.09	7.13	19	PASS
802.11n40	102	5510	HT40_MCS0	4.61	4.64	7.64	19	PASS
	110	5550	HT40_MCS0	4.00	4.12	7.07	19	PASS
	134	5670	HT40_MCS0	4.79	4.66	7.73	19	PASS
802.11ac80	106	5530	VHT80_MCS0	1.03	1.20	4.13	19	PASS

Cross Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Output Power (dBm)		Highest/ Total Power (dBm)	Output Power Limit (dBm)	Result
				Chain 1	Chain 2			
802.11a	149	5720	6Mbps	4.75	4.55	4.75	19	PASS
802.11n	149	5720	HT20_MCS0	4.42	4.44	7.44	19	PASS
802.11n40	151	5710	HT40_MCS0	4.19	4.08	7.15	19	PASS
802.11ac80	155	5690	VHT80_MCS0	2.24	2.19	5.23	19	PASS

U-NII-3 Band

Mode	Channel	Frequency (MHz)	Data rate	Measured Output Power (dBm)		Highest/ Total Power (dBm)	Output Power Limit (dBm)	Result
				Chain 1	Chain 2			
802.11a	149	5745	6Mbps	9.54	9.50	9.54	25	PASS
	157	5785	6Mbps	10.00	9.54	10.00	25	PASS
	165	5825	6Mbps	9.99	9.17	9.99	25	PASS
802.11n	149	5745	HT20_MCS0	9.65	9.57	12.62	25	PASS
	157	5785	HT20_MCS0	10.08	9.63	12.87	25	PASS
	165	5825	HT20_MCS0	10.00	9.12	12.59	25	PASS
802.11n40	151	5755	HT40_MCS0	7.81	7.45	10.65	25	PASS
	159	5795	HT40_MCS0	8.18	7.46	10.85	25	PASS
802.11ac80	155	5775	VHT80_MCS0	4.97	4.50	7.75	25	PASS

Note:
1) For 802.11a, the highest output power is recorded.
2) For 5GHz non-11a mode, it's under 2x2 MIMO mode, the output power is combined together to compare to limit. Directional gain is calculated per KDB 662911 D01. For 2.4GHz WiFi, directional gain = 9.4 dBi. The output power limit is reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
3) The actual power and PSD limit will be reduced by the amount that it exceeds 6 dBi based on a conservative 11 dBi peak gain (optional external antenna that is to be evaluated)

EIRP measurement result (For ISED requirement)

U-NII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Highest/ Total Power (dBm)	Directional Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
802.11a	100	5500	6Mbps	4.10	11	15.1	30	PASS
	116	5580	6Mbps	4.85	11	15.85	30	PASS
	140	5700	6Mbps	4.13	11	15.13	30	PASS
802.11n	100	5500	HT20_MCS0	7.78	11	18.78	30	PASS
	116	5580	HT20_MCS0	7.81	11	18.81	30	PASS
	140	5700	HT20_MCS0	7.13	11	18.13	30	PASS
802.11n40	102	5510	HT40_MCS0	7.64	11	18.64	30	PASS
	110	5550	HT40_MCS0	7.07	11	18.07	30	PASS
	134	5670	HT40_MCS0	7.73	11	18.73	30	PASS
802.11ac80	106	5530	VHT80_MCS0	4.13	11	15.13	30	PASS

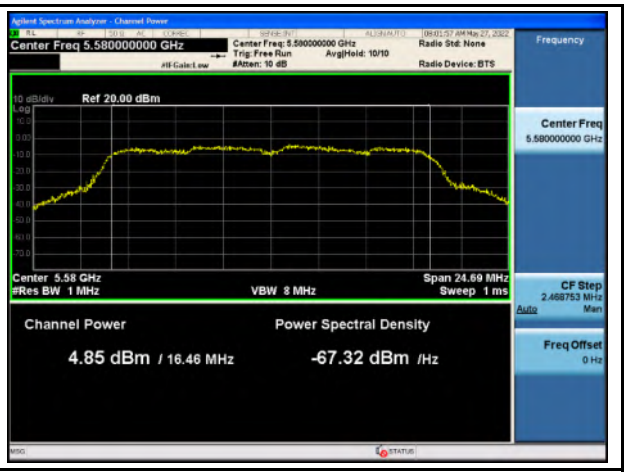
Cross Band

Mode	Channel	Frequency (MHz)	Data rate	Highest/ Total Power (dBm)	Directional Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
802.11a	149	5720	6Mbps	4.75	11	18.66	30	PASS
802.11n	149	5720	HT20_MCS0	7.44	14.01	21.45	30	PASS
802.11n40	151	5710	HT40_MCS0	7.15	14.01	21.16	30	PASS
802.11ac80	155	5690	VHT80_MCS0	5.23	14.01	19.24	30	PASS

7.4.5 Test Plots

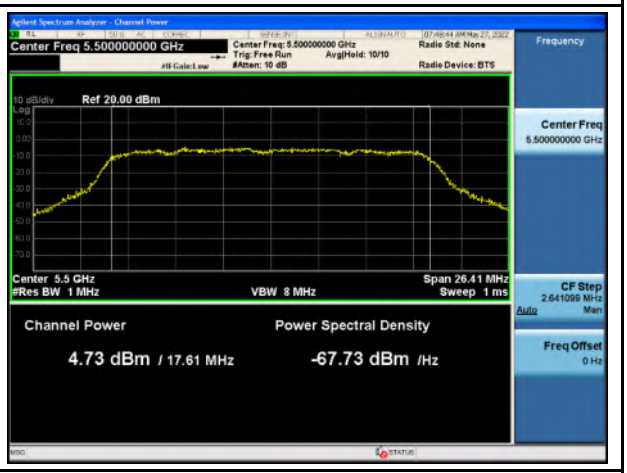
Chain 1

Output Power _U-NII-2C_802.11a_5500



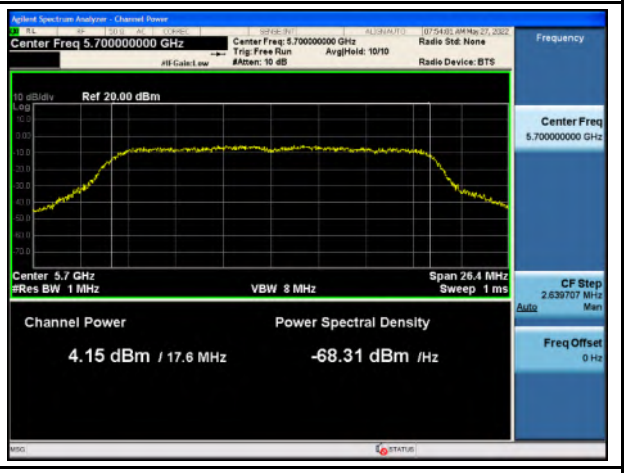
Output Power _U-NII-2C_802.11a_5580

Output Power _U-NII-2C_802.11a_5700



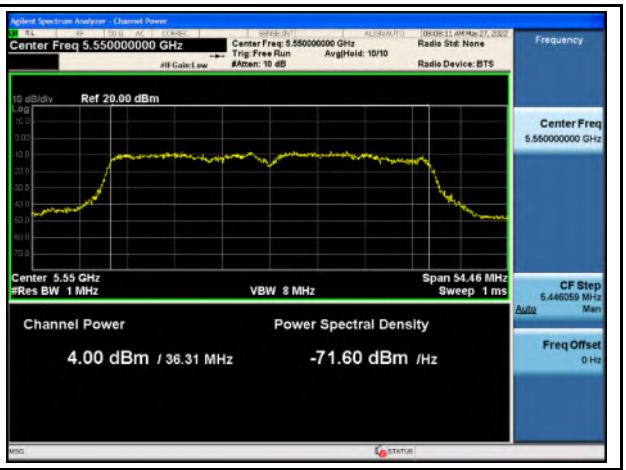
Output Power _U-NII-2C_802.11n_5500

Output Power _U-NII-2C_802.11n_5580

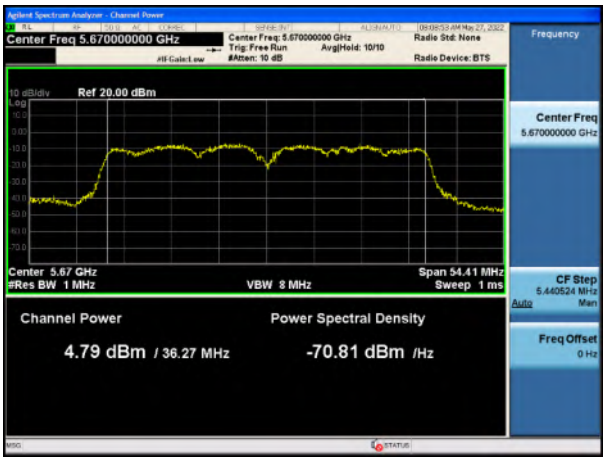


Output Power _U-NII-2C_802.11n_5700

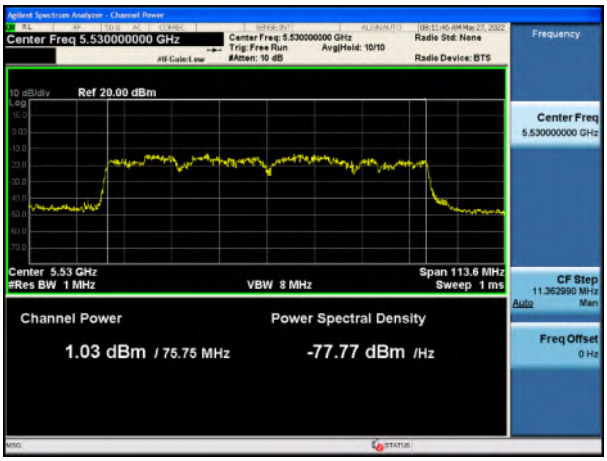
Output Power _U-NII-2C_802.11n40_5510



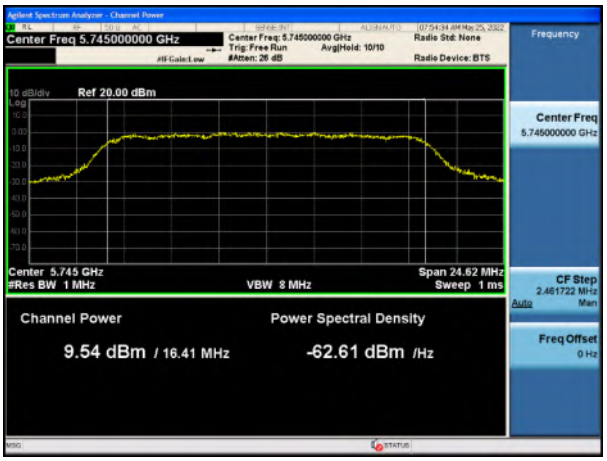
Output Power _U-NII-2C_802.11n40_5550



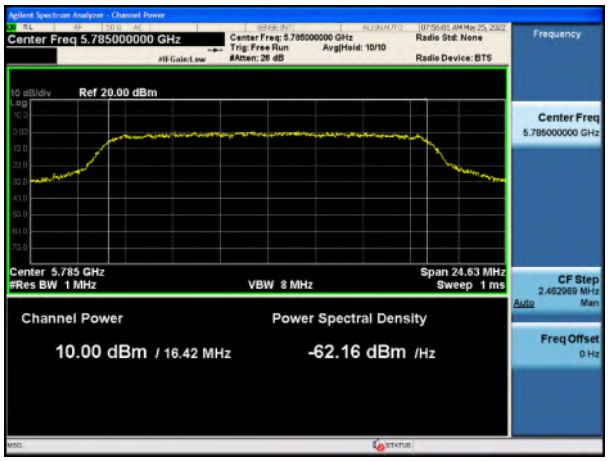
Output Power _U-NII-2C_802.11n40_5670



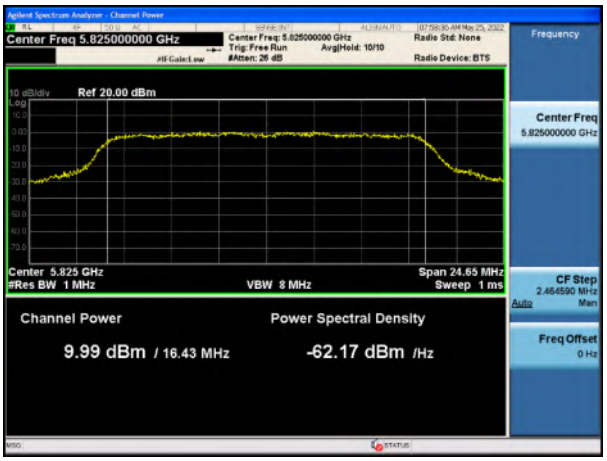
Output Power _U-NII-2C_802.11ac_5530



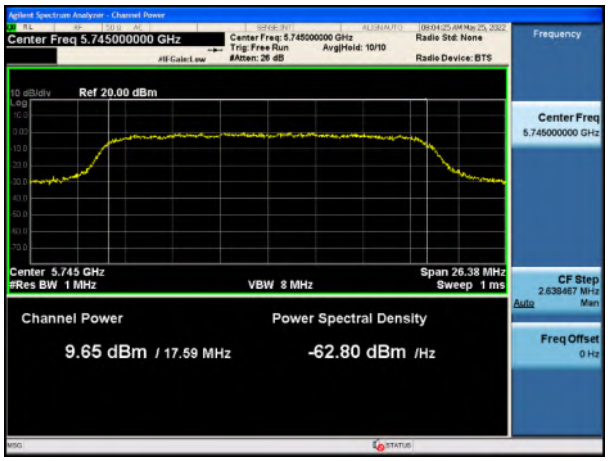
Output Power _U-NII-3_802.11a_5745



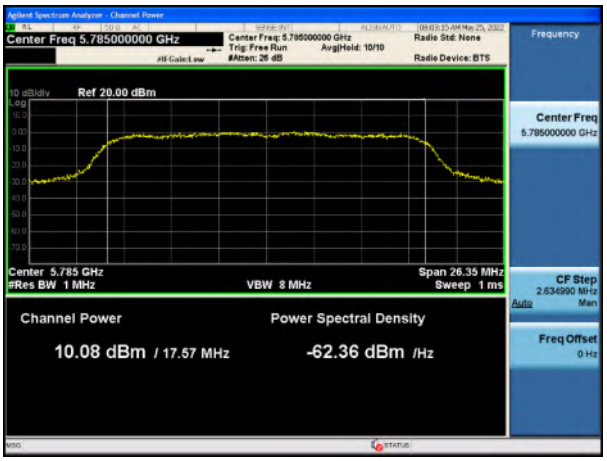
Output Power _U-NII-3_802.11a_5785



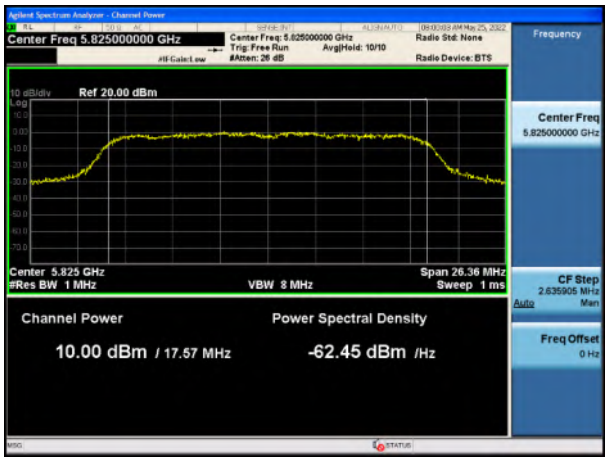
Output Power _U-NII-3_802.11a_5825



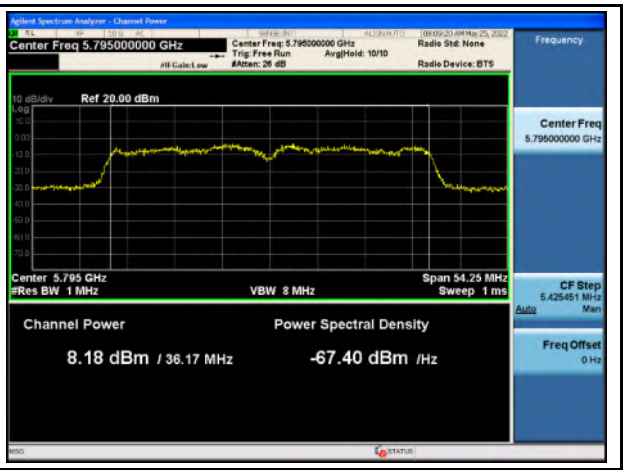
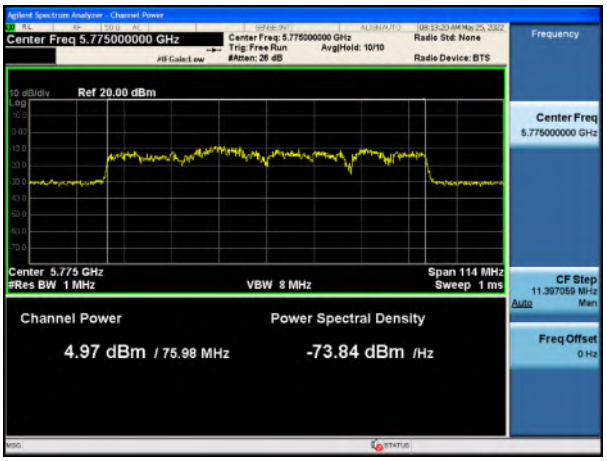
Output Power _U-NII-3_802.11n_5745



Output Power _U-NII-3_802.11n_5785

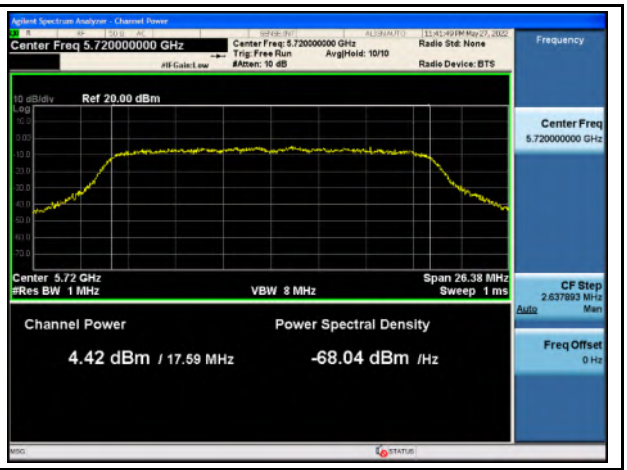


Output Power _U-NII-3_802.11n_5825

	
Output Power _U-NII-3_802.11n40_5755	Output Power _U-NII-3_802.11n_5795
	
Output Power _U-NII-3_802.11n_5775	

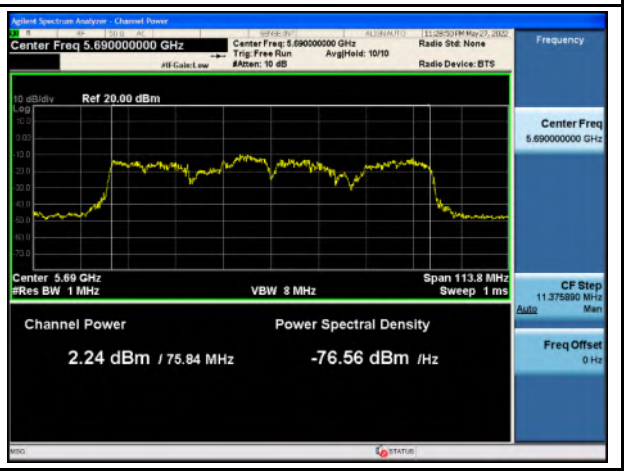
Cross band

Output Power _Cross band_802.11a_5720



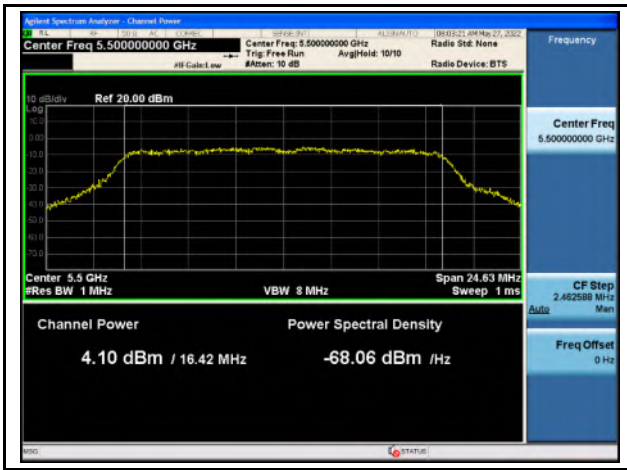
Output Power _ Cross band _802.11n_5720

Output Power _ Cross band _802.11n40_5710

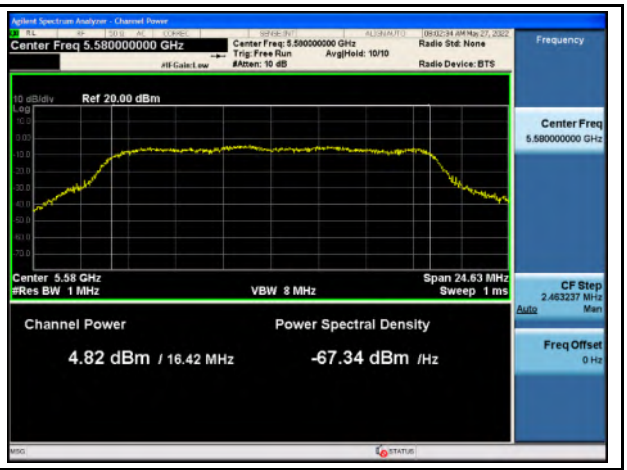


Output Power _ Cross band _802.11ac80_5690

Chain 2

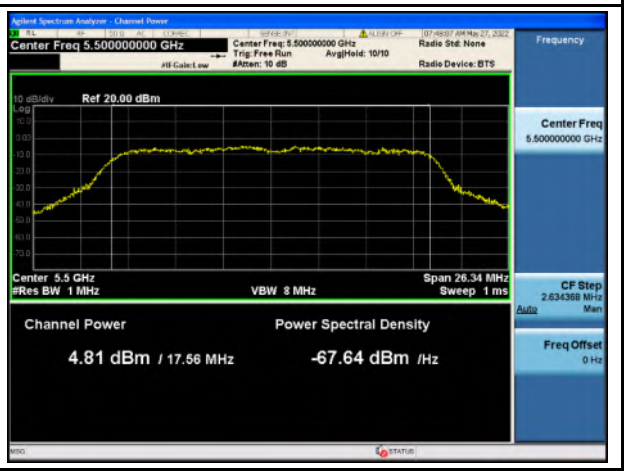


Output Power _U-NII-2C_802.11a_5500



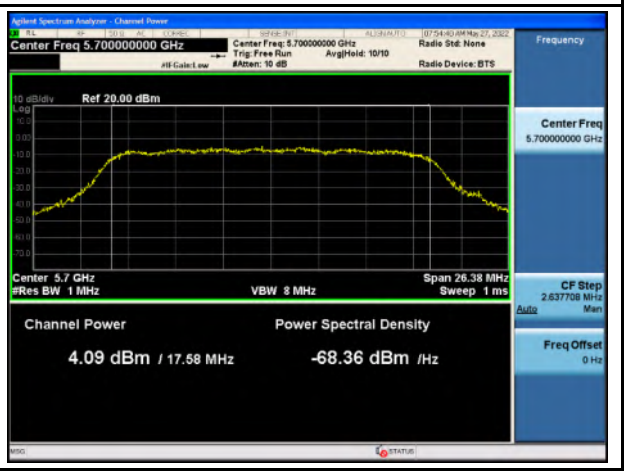
Output Power _U-NII-2C_802.11a_5580

Output Power _U-NII-2C_802.11a_5700



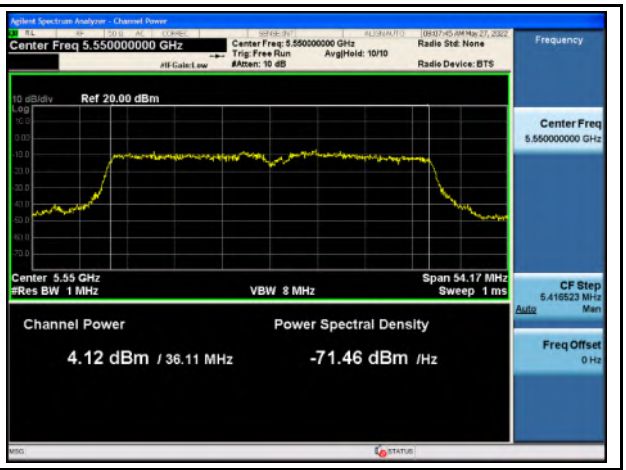
Output Power _U-NII-2C_802.11n_5500

Output Power _U-NII-2C_802.11n_5580



Output Power _U-NII-2C_802.11n_5700

Output Power _U-NII-2C_802.11n40_5510



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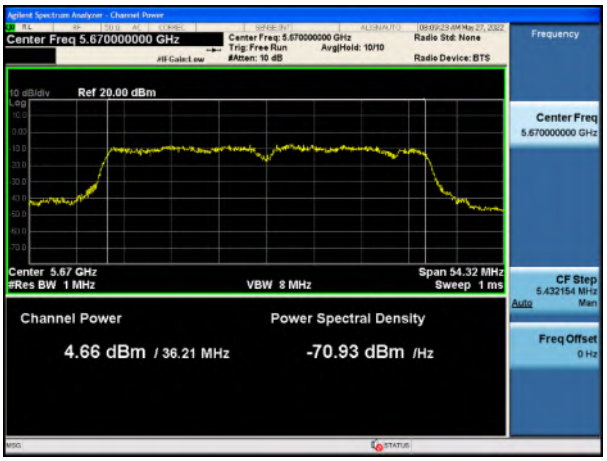

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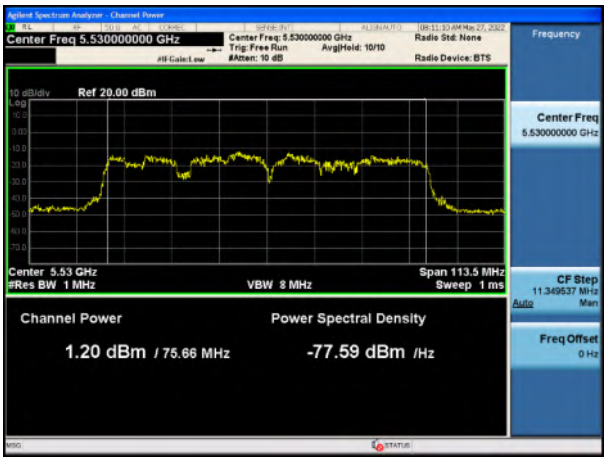

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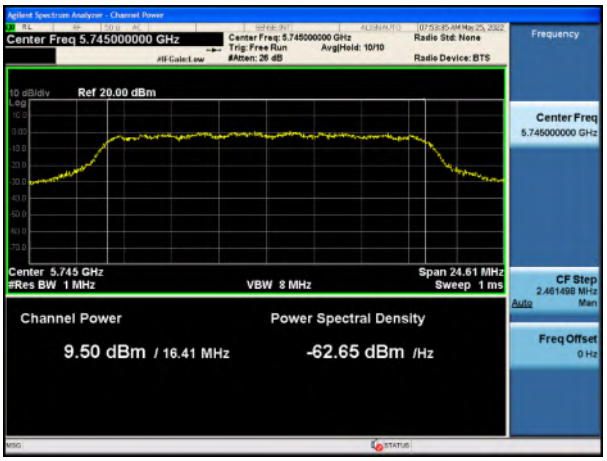

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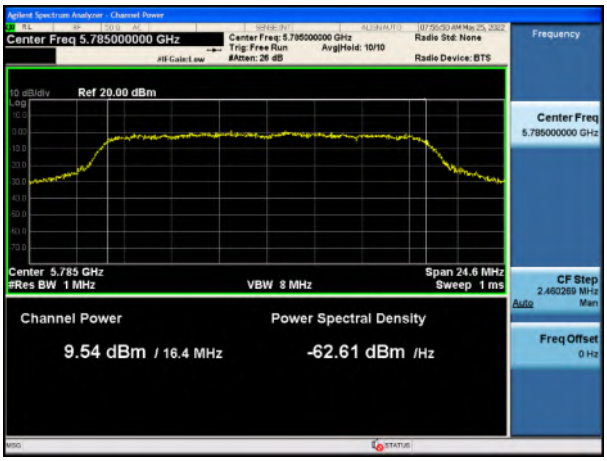

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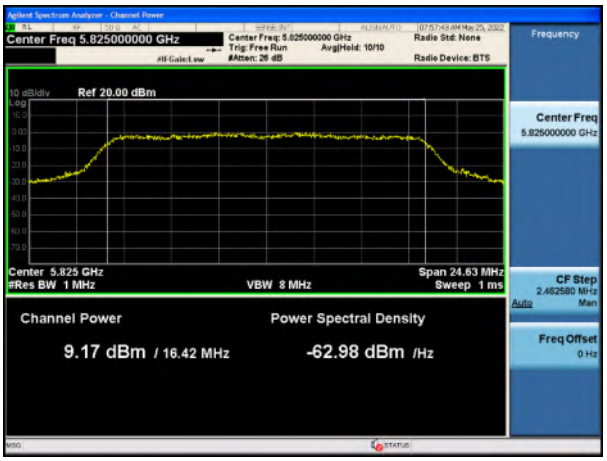

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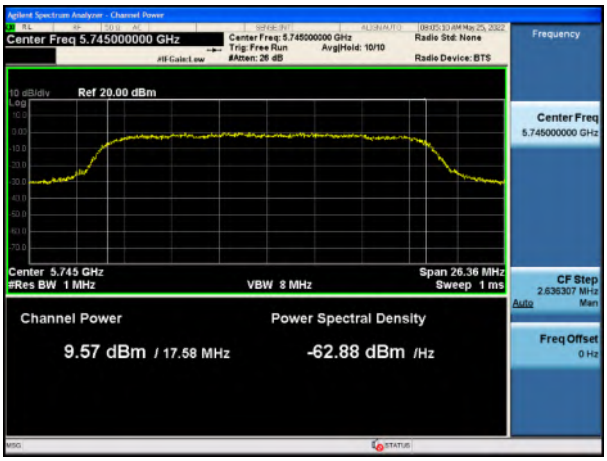

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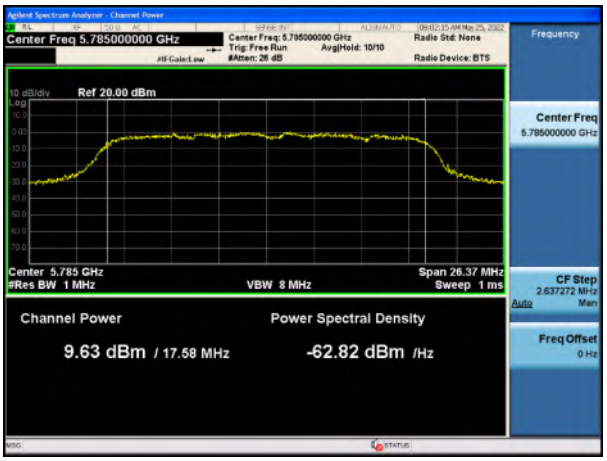

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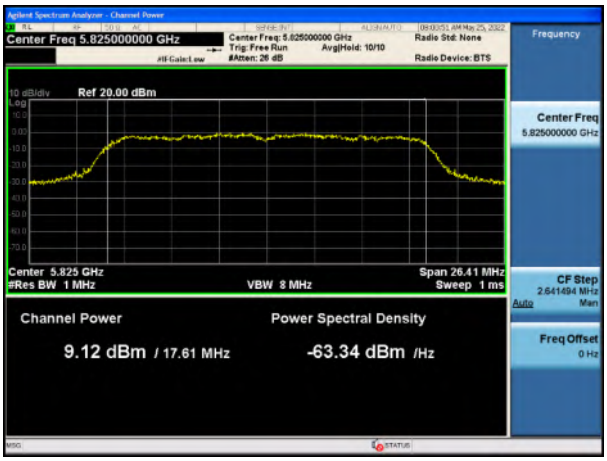

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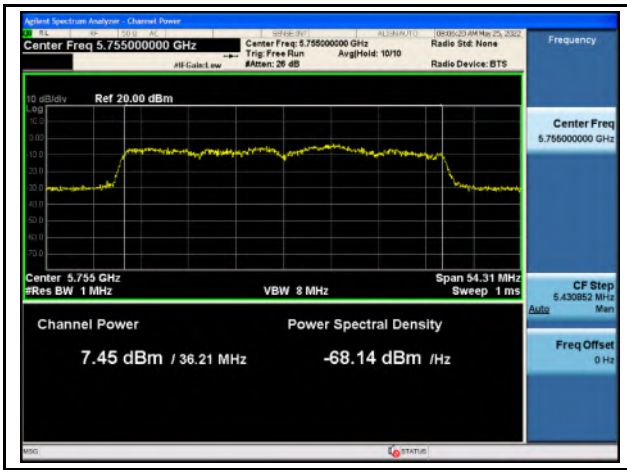

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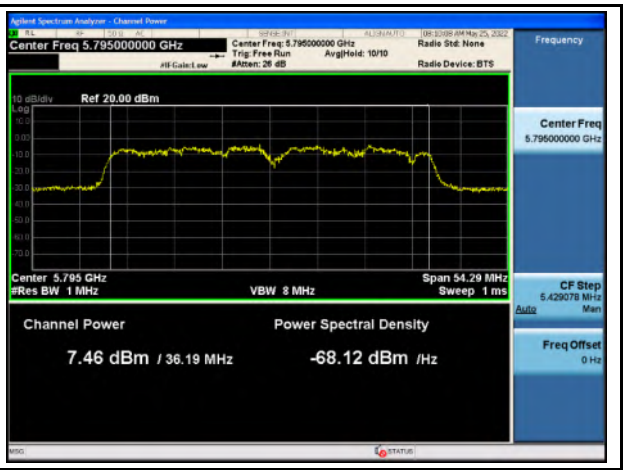

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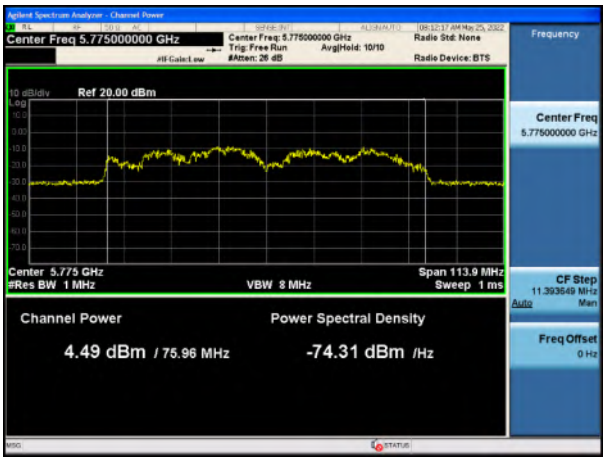
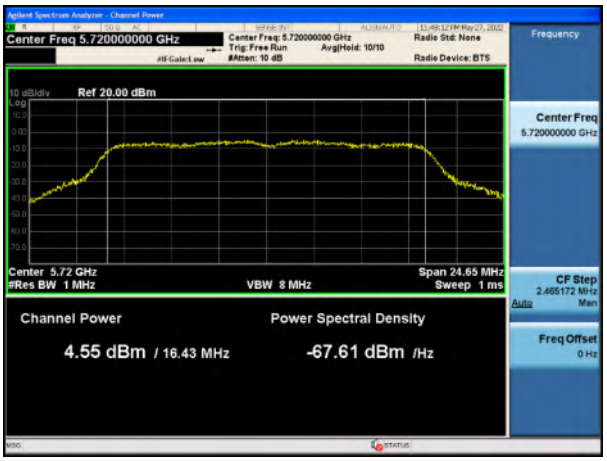
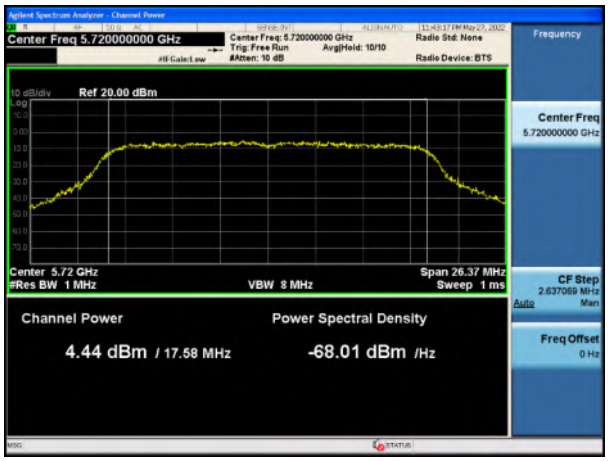


Output Power _U-NII-3_802.11n_5775

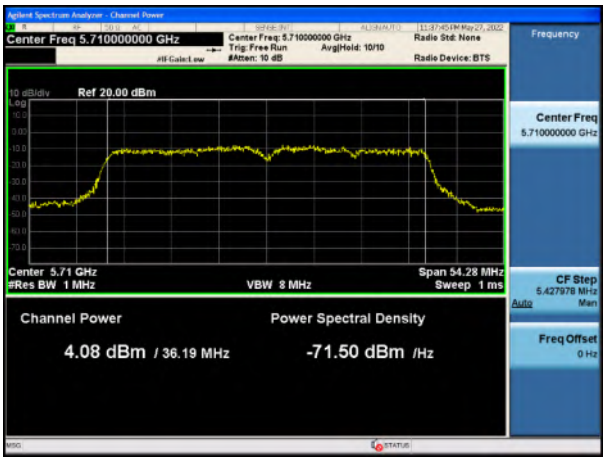
Cross channel



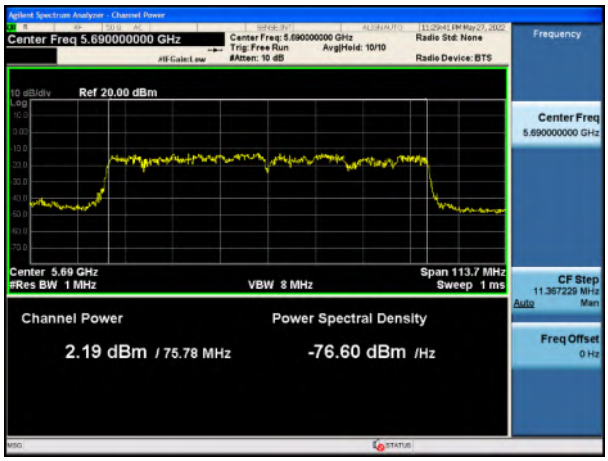
Output Power _Cross band_802.11a_5720



Output Power _ Cross band _802.11n_5720



Output Power _ Cross band _802.11n40_5710



Output Power _ Cross band _802.11ac80_5690

7.5 Power Spectral Density

7.5.1 Requirement

§ 15.407 (a)

(iv) For client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1MHz band.

(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands. The maximum power spectral density shall not exceed 11 dBm in any 1MHz band.

(3) (i) For the band 5.725-5.850 GHz, 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, the maximum power spectral density from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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6.2.1 Frequency band 5150-5250 MHz:

The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

6.2.2 Frequency band 5250-5350 MHz:

The power spectral density shall not exceed 11 dBm in any 1.0 MHz band

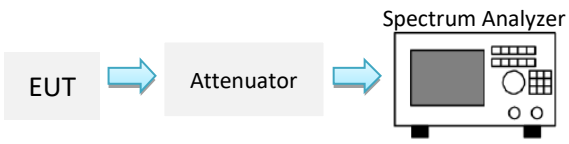
6.2.3 Frequency bands 5470-5600 MHz and 5650-5725 MHz

The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

6.2.4 Frequency band 5725-5850 MHz

The output power spectral density shall not exceed 30 dBm in any 500 kHz band.

7.5.2 Test Setup



7.5.3 Test Procedure

According to subclause 12.5 of ANSI C63.10-2013:
subclause F of 789033 D02 General UNII Test Procedures New Rules v02r01

1) Create an average power spectrum for the EUT operating mode being tested by following the instructions in 12.3.2 for measuring maximum conducted output power using a spectrum analyzer or EMI receiver; that is, select the appropriate test method (SA-1, SA-2, SA-3, or their respective alternatives) and apply it up to, but not including, the step labeled, "Compute power…." (This procedure is required even if the maximum conducted output power measurement was performed using the power meter method PM.)
2) Use the peak search function on the instrument to find the peak of the spectrum.
3) Make the following adjustments to the peak value of the spectrum, if applicable:
    a. If method SA-2 or SA-2A was used, then add [10 log (1 / *D*)], where *D* is the duty cycle, to the peak of the spectrum.
    b. If method SA-3A was used and the linear mode was used in step h) of 12.3.2.7, add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
4) The result is the PPSD.
5) The procedure in item a) through item c) requires the use of 1 MHz resolution bandwidth to satisfy the 1 MHz measurement bandwidth specified by some regulatory authorities.95 This requirement also permits use of resolution bandwidths less than 1 MHz "provided that the measured power is integrated to show the total power over the measurement bandwidth" (i.e., 1 MHz). If measurements are performed using a reduced resolution bandwidth and integrated over 1 MHz bandwidth, the following adjustments to the procedures apply:
    a. Set RBW ≥ 1 / *T*, where *T* is defined in 12.2 a).
    b. Set VBW ≥ [3 × RBW].
    c. If measurement bandwidth of Maximum PSD is specified in 500 kHz, add 10 log (500 kHz/RBW) to the measured result, whereas RBW (<500 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
    d. If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10 log (1MHz/RBW) to the measured result, whereas RBW (< 1 MHz) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
    e. Care shall be taken such that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

7.5.4 Test Result

U-NII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Measured PSD (dBm/MHz)		Highest/ Total PSD (dBm/MHz)	PSD Limit (dBm/MHz)	Result
				Chain 1	Chain 2			
802.11a	100	5500	6Mbps	-7.115	-7.367	-7.115	6	PASS
	116	5580	6Mbps	-6.103	-6.683	-6.103	6	PASS
	140	5700	6Mbps	-7.215	-7.491	-7.215	6	PASS
802.11n	100	5500	HT20_MCS0	-6.654	-6.622	-3.628	6	PASS
	116	5580	HT20_MCS0	-6.721	-6.840	-3.770	6	PASS
	140	5700	HT20_MCS0	-7.287	-7.507	-4.385	6	PASS
802.11n40	102	5510	HT40_MCS0	-9.782	-9.317	-6.533	6	PASS
	110	5550	HT40_MCS0	-10.243	-10.552	-7.384	6	PASS
	134	5670	HT40_MCS0	-9.725	-10.052	-6.875	6	PASS
802.11ac80	106	5530	VHT80_MCS0	-16.110	-16.038	-13.064	6	PASS

Cross Band for UNII-2C Band

Mode	Channel	Frequency (MHz)	Data rate	Measured PSD (dBm/MHz)		Highest/ Total PSD (dBm/MHz)	PSD Limit (dBm/MHz)	Result
				Chain 1	Chain 2			
802.11a	149	5720	6Mbps	-6.854	-6.826	-6.826	6	PASS
802.11n	149	5720	HT20_MCS0	-7.103	-6.826	-3.95	6	PASS
802.11n40	151	5710	HT40_MCS0	-10.289	-10.643	-7.45	6	PASS
802.11ac80	155	5690	VHT80_MCS0	-14.332	-14.647	-11.48	6	PASS

Note:
1) For 802.11a, the highest output power is recorded.
2) For 5GHz non-11a mode, it's under 2x2 MIMO mode, the output power is combined together to compare to limit. Directional gain is calculated per KDB 662911 D01. For 2.4GHz WiFi, directional gain = 9.4 dBi. The output power limit is reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
3) The actual power and PSD limit will be reduced by the amount that it exceeds 6 dBi based on a conservative 11 dBi peak gain (optional external antenna that is to be evaluated)

Cross Band for UNII-3 Band

Mode	Ch	Frequency (MHz)	Data rate	Measured PSD (dBm/100kHz)		Highest/ Total PSD (dBm/100kHz)	Corrected PSD (dBm/500KHz)	PSD Limit (dBm/500kHz)	Result
				Chain 1	Chain 2				
802.11a	149	5720	6Mbps	-13.520	-13.324	-13.324	-6.334	25	PASS
802.11n	149	5720	HT20_MCS0	-13.463	-13.591	-10.516	-3.526	25	PASS
802.11n40	151	5710	HT40_MCS0	-15.377	-15.928	-12.633	-5.643	25	PASS
802.11ac80	155	5690	VHT80_MCS0	-19.537	-18.868	-16.179	-9.189	25	PASS

U-NII-3 Band

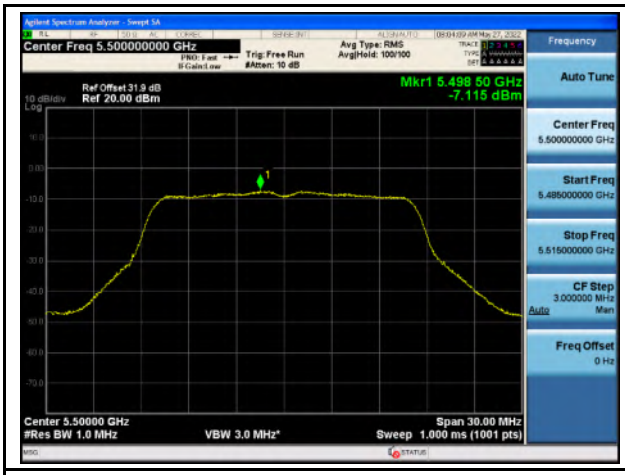
Mode	Ch	Frequency (MHz)	Data rate	Measured PSD (dBm/100kHz)		Highest/ Total PSD (dBm/100kHz)	Corrected PSD (dBm/500KHz)	PSD Limit (dBm/500kHz)	Result
				Chain 1	Chain 2				
802.11a	149	5745	6Mbps	-8.338	-8.424	-8.338	-1.348	25	PASS
	157	5785	6Mbps	-8.270	-8.358	-8.270	-1.280	25	PASS
	165	5825	6Mbps	-8.024	-9.037	-8.024	-1.034	25	PASS
802.11n	149	5745	HT20_MCS0	-9.874	-8.681	-6.226	0.764	25	PASS
	157	5785	HT20_MCS0	-7.777	-8.237	-4.991	1.999	25	PASS
	165	5825	HT20_MCS0	-7.947	-9.195	-5.516	1.474	25	PASS
802.11n40	151	5755	HT40_MCS0	-11.764	-12.004	-8.872	-1.882	25	PASS
	159	5795	HT40_MCS0	-11.127	-12.275	-8.653	-1.663	25	PASS
802.11ac80	155	5775	VHT80_MCS0	-16.289	-16.332	-13.300	-6.310	25	PASS

Note:

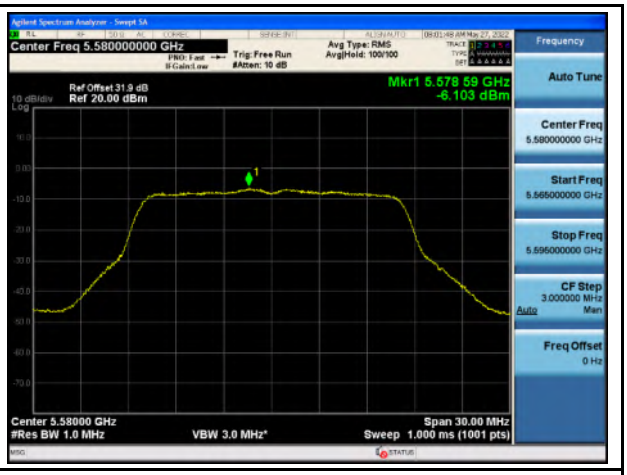
1) For 802.11a, the highest PSD is recorded.
2) For 5GHz non-11a mode, it's under 2x2 MIMO mode, the PSD is combined together to compare to limit.
3) For 5GHz non-11a mode, directional gain is calculated per KDB 662911 D01. For 5GHz WiFi non-11a mode, directional gain = 14.01 dBi, exceeding 6 dBi. The power and PSD limit will be reduced by the amount that it exceeds 6 dBi.
4)Corrected PSD (dBm/500kHz) = Measured PSD (dBm/100kHz) + Correction Factor[10*log(500/RBW)]
= Measured PSD (dBm/100kHz) + 10*Log (500/100)
= Measured PSD (dBm/100kHz) + 6.99

7.5.5 Test Plots

Chain 1



PSD _U-NII-2C_802.11a_5500



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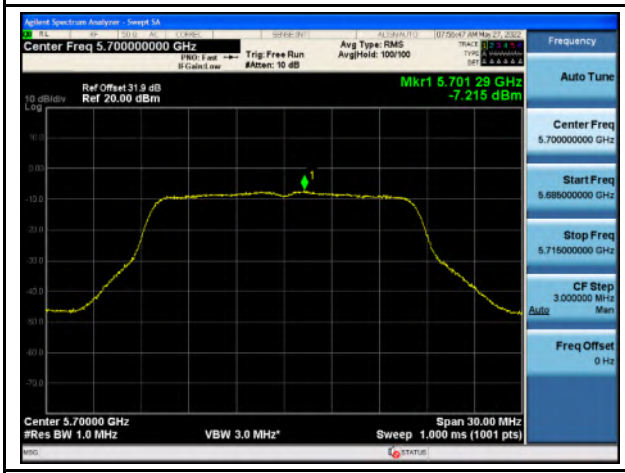

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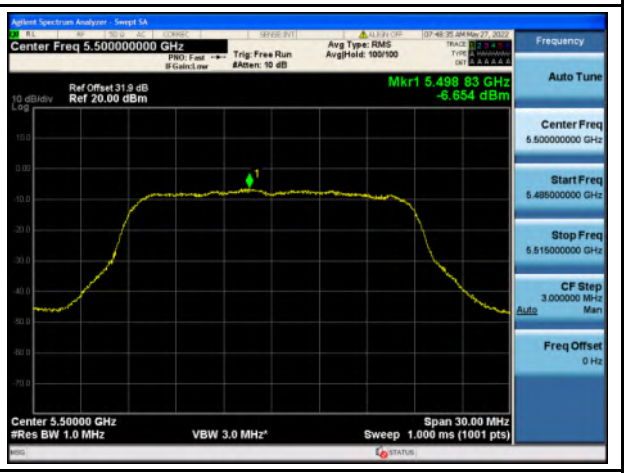

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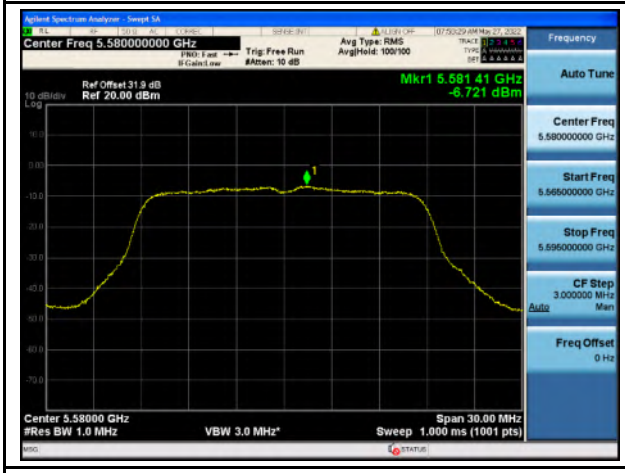

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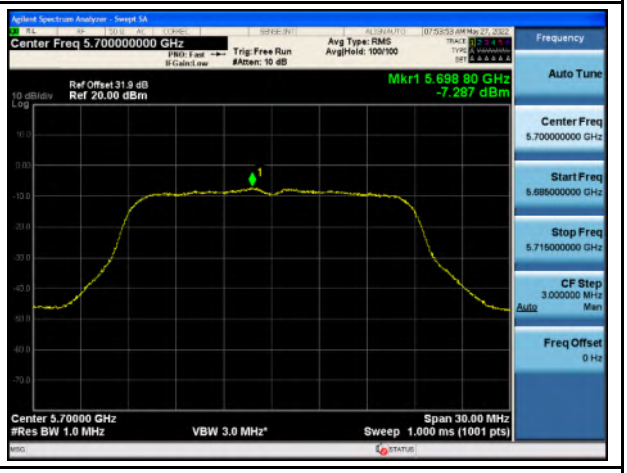

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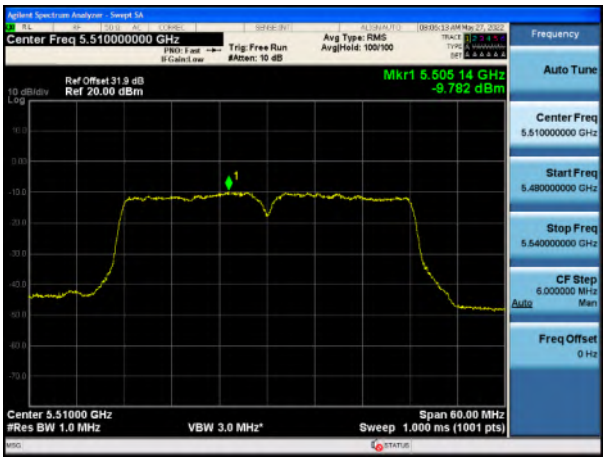

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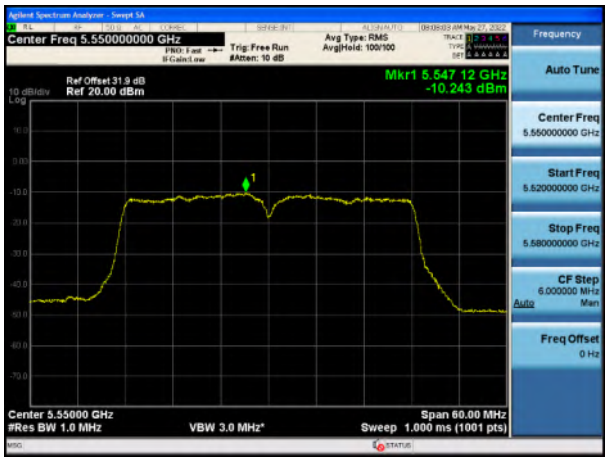

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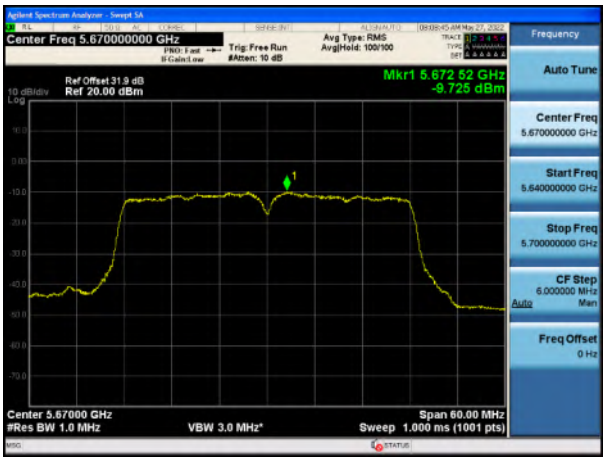

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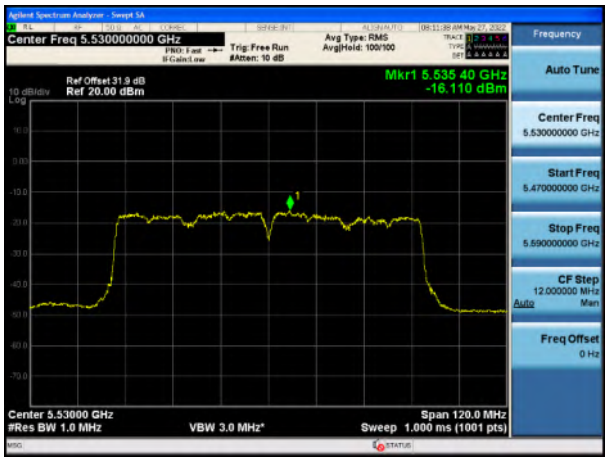

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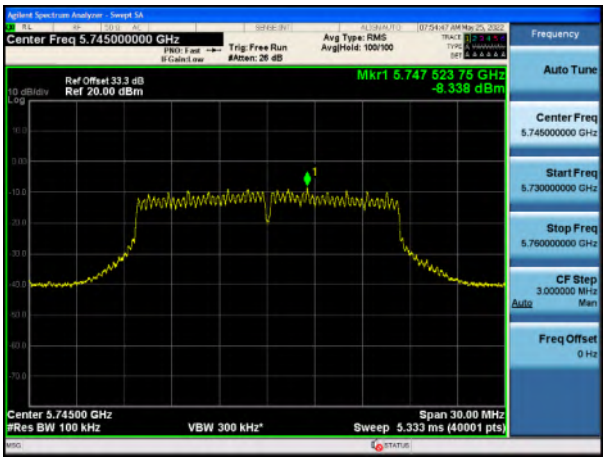

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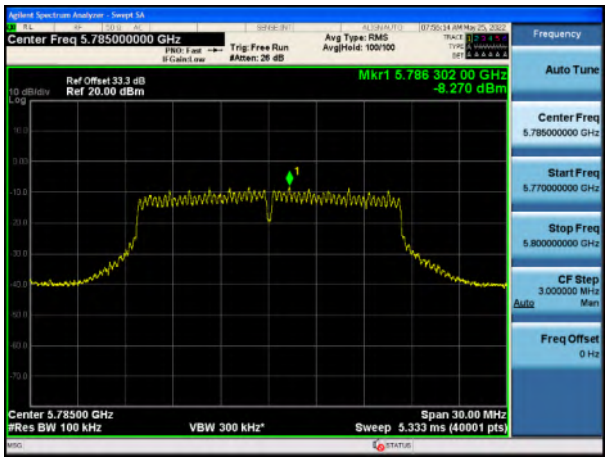

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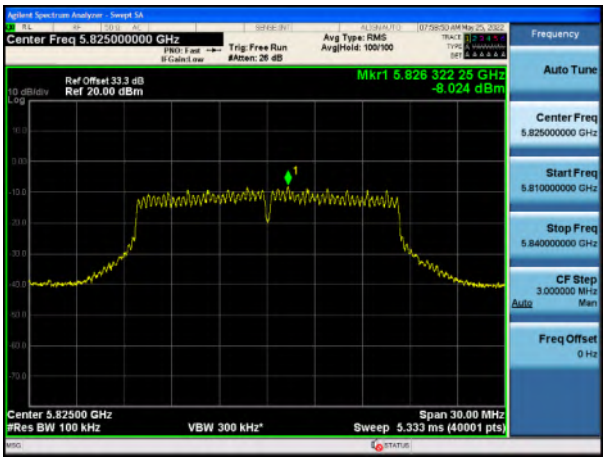

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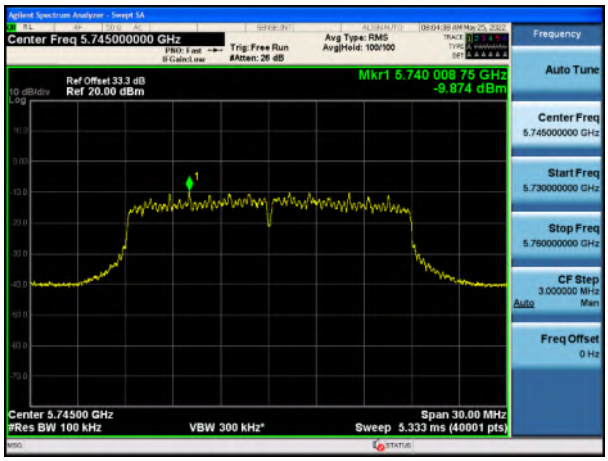
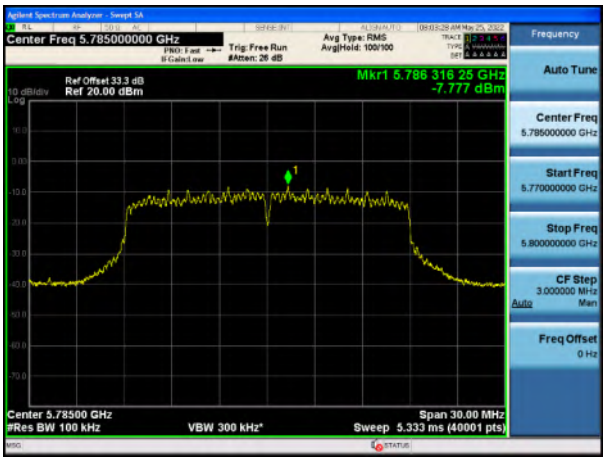
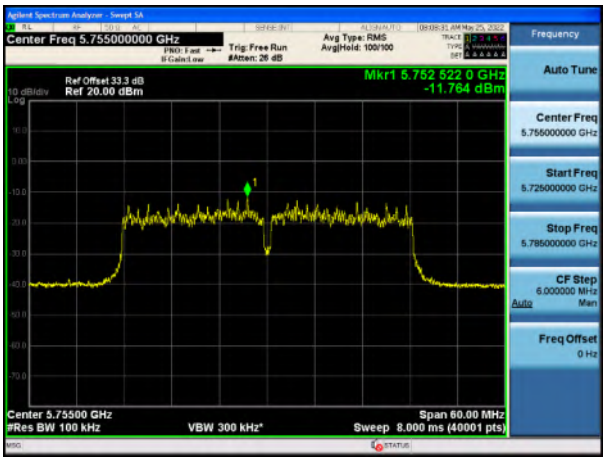
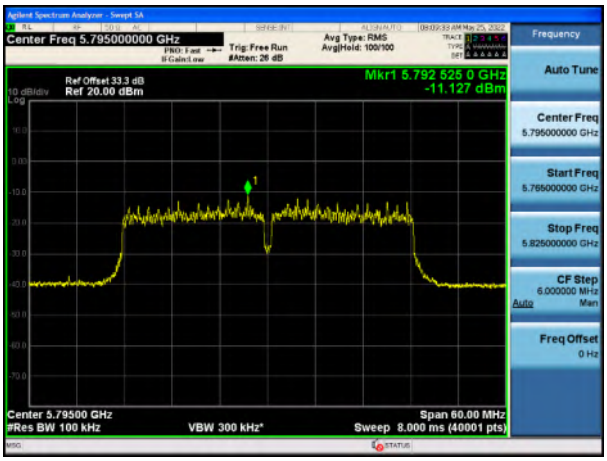


PSD _U-NII-3_802.11n_5745



PSD _U-NII-3_802.11n_5785

PSD _U-NII-3_802.11n_5825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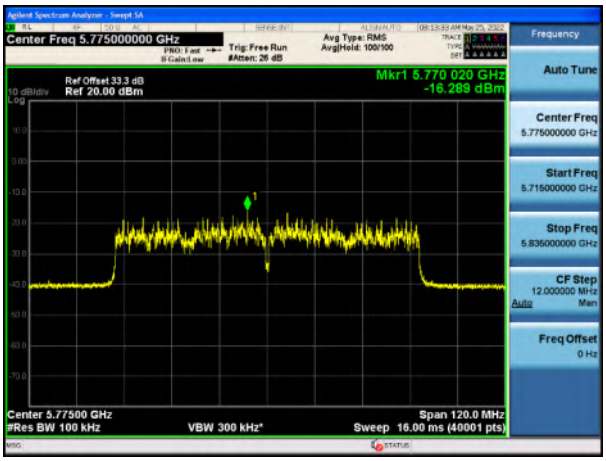
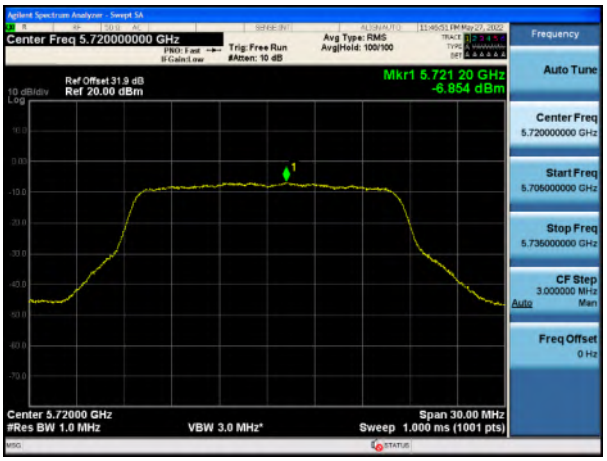
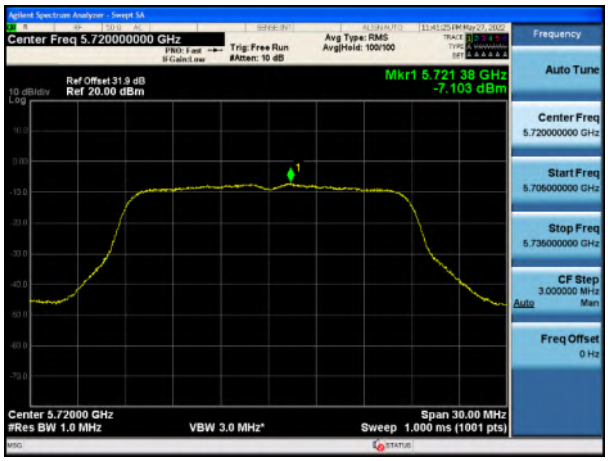
	
PSD _U-NII-3_802.11ac_5775	

Cross channel for UNII-2C Band



PSD _Cross channel_802.11a_5720



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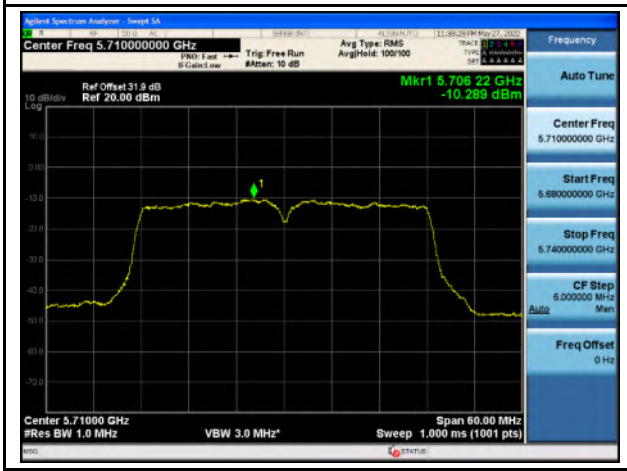

PSD _Cross channel_802.11n40_5710

PSD _Cross channel_802.11ac_5690

Cross channel for UNII-3 Band

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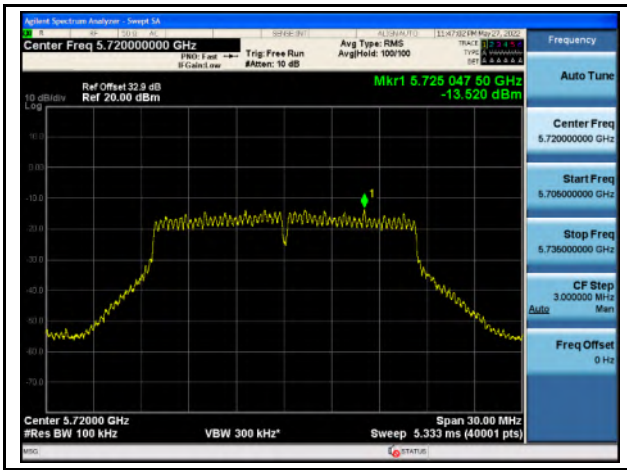
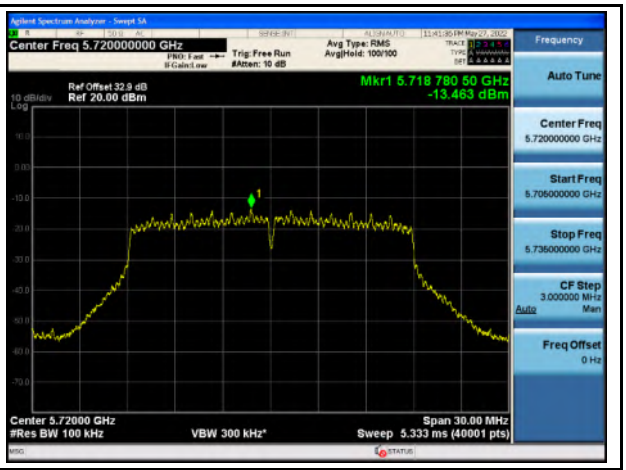
<tr><td> 
</td><td> 
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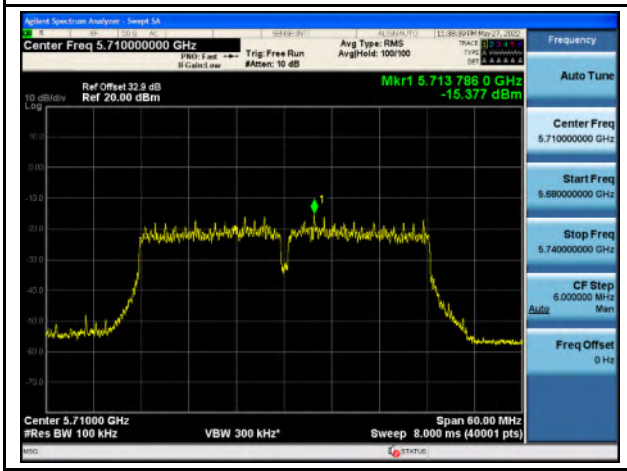
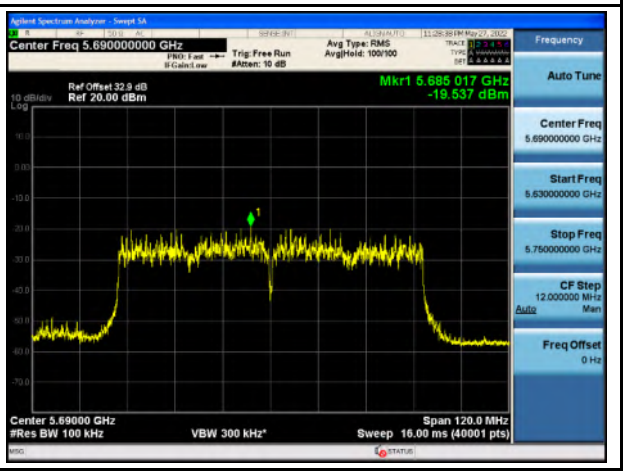
<tr><td> 
</td><td> 
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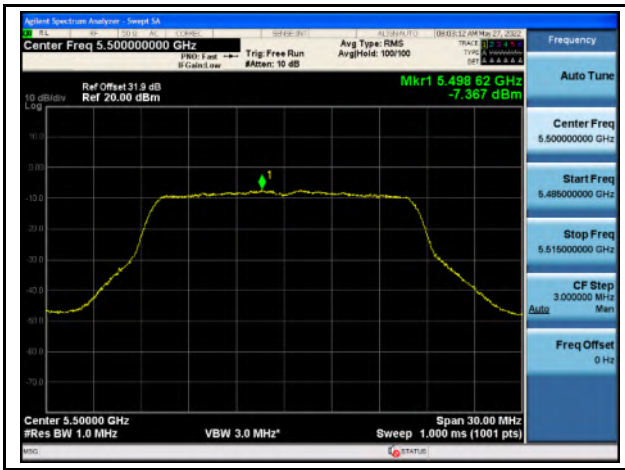

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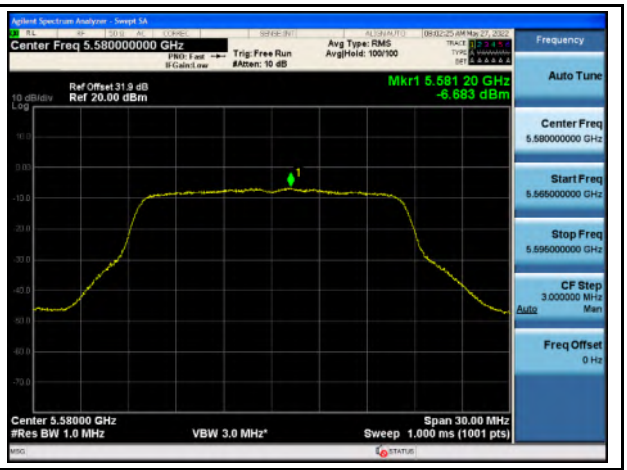

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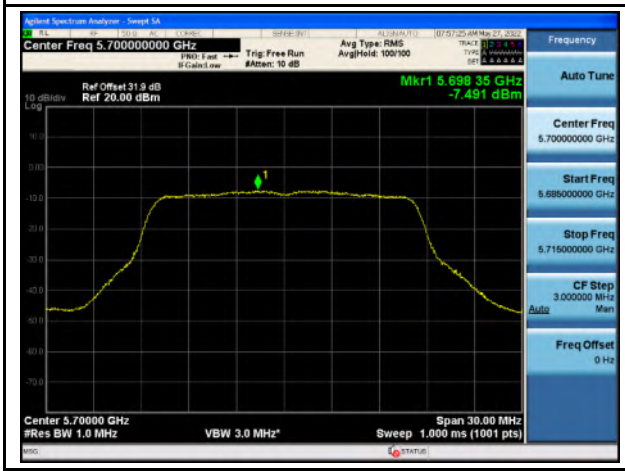

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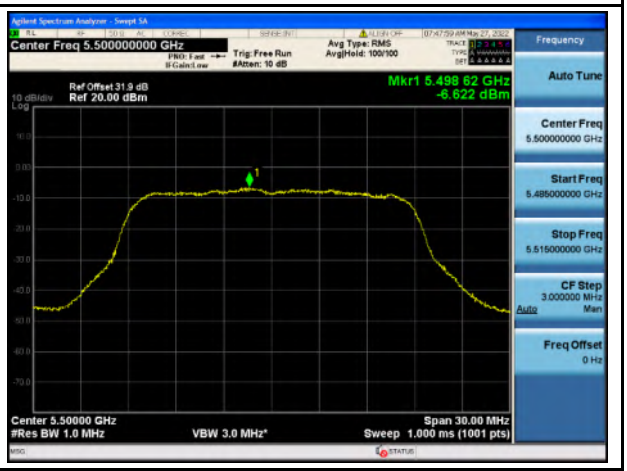

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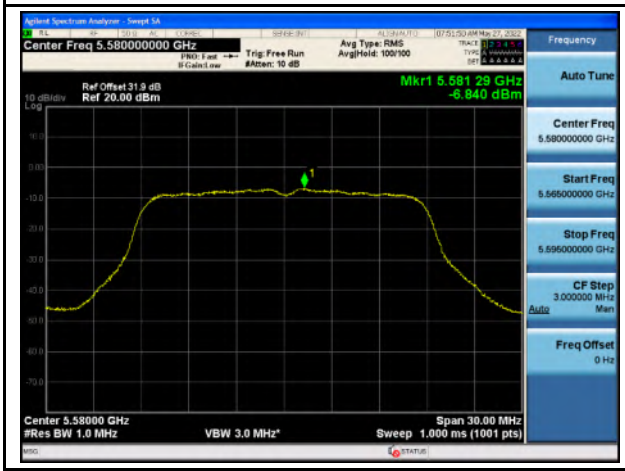

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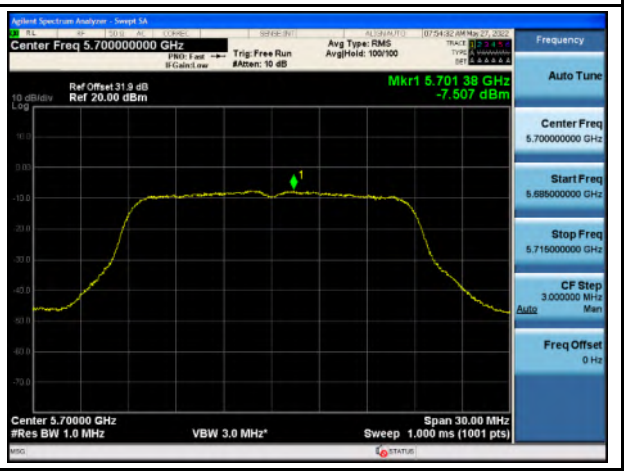

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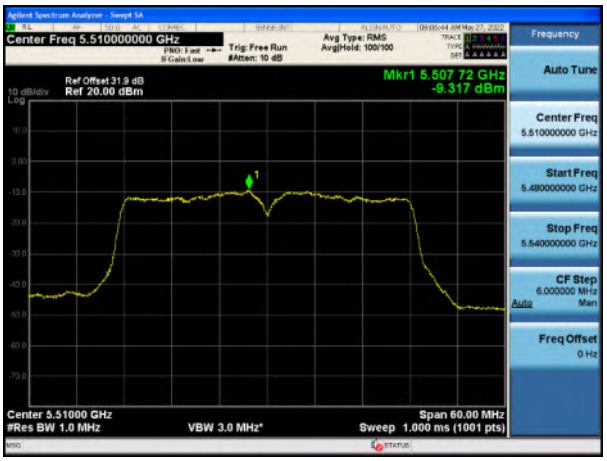

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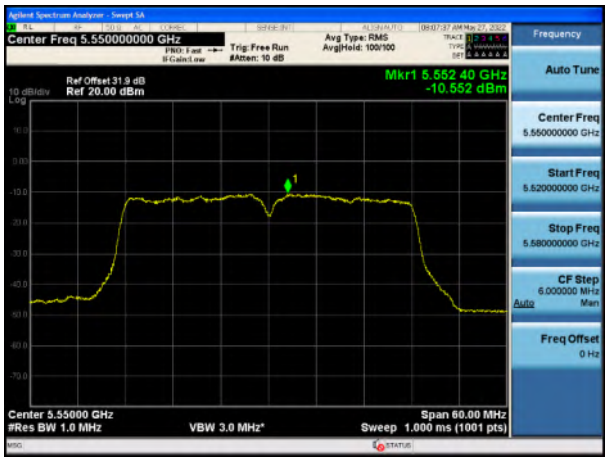

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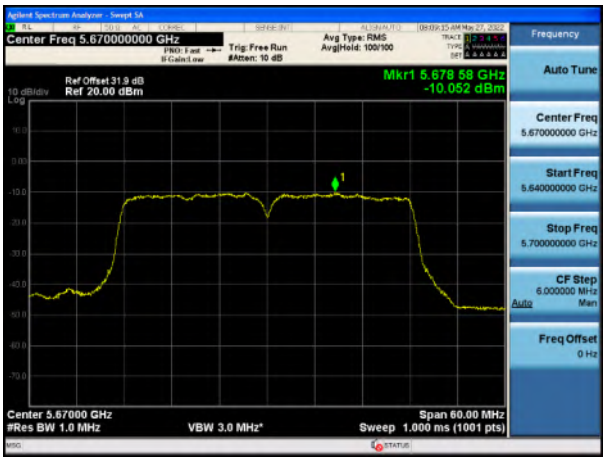

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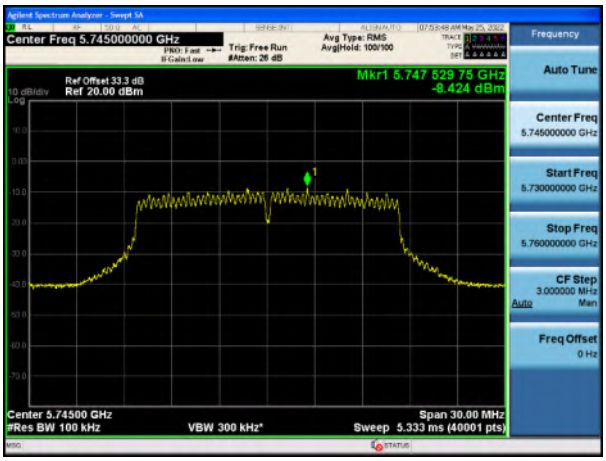

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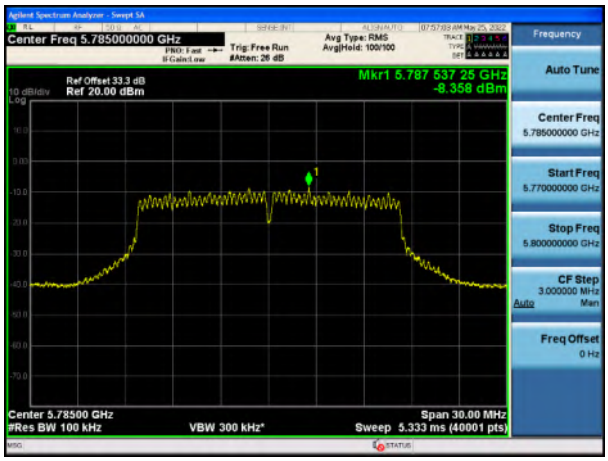

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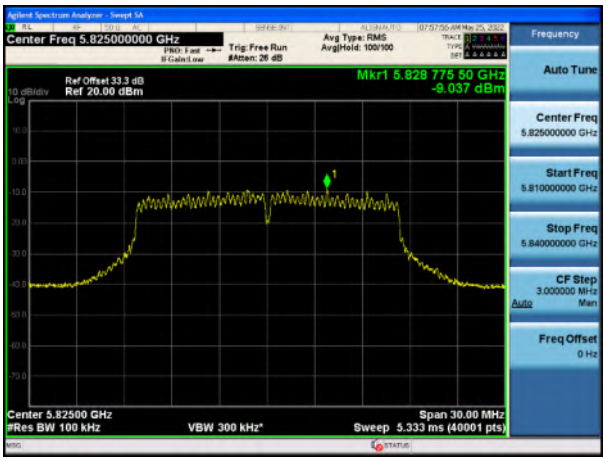

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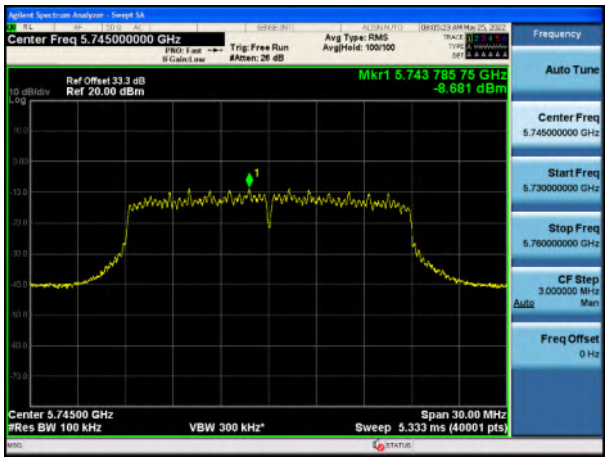

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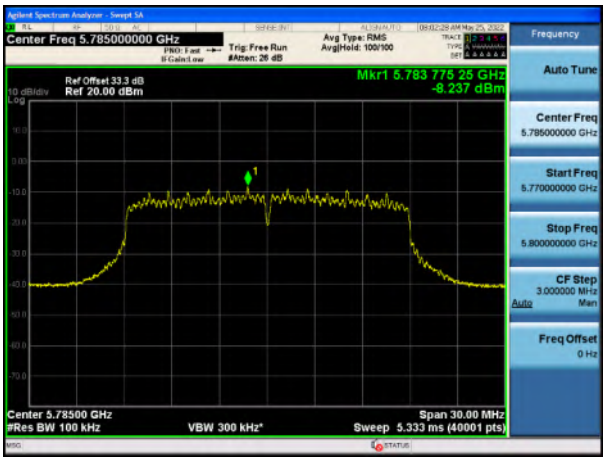

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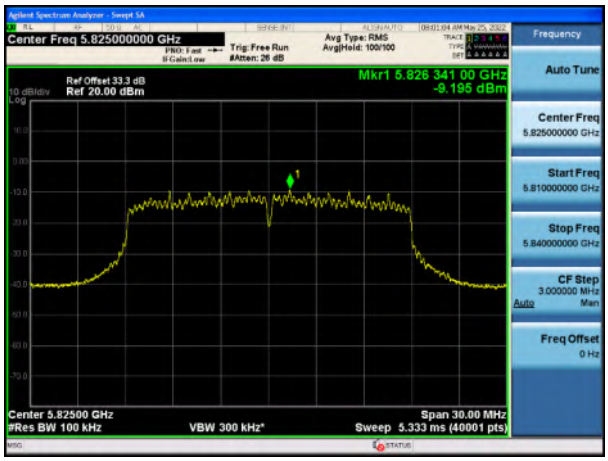

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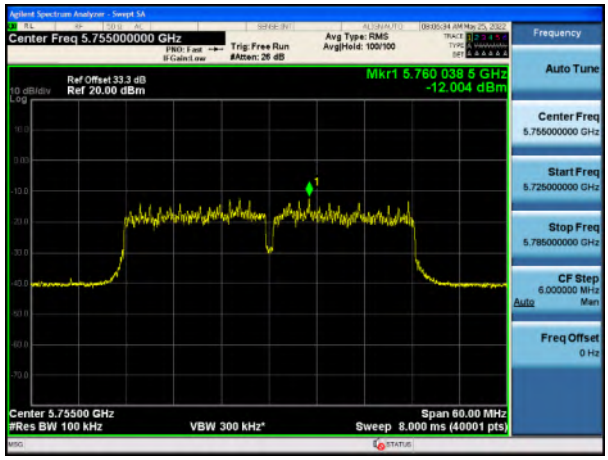

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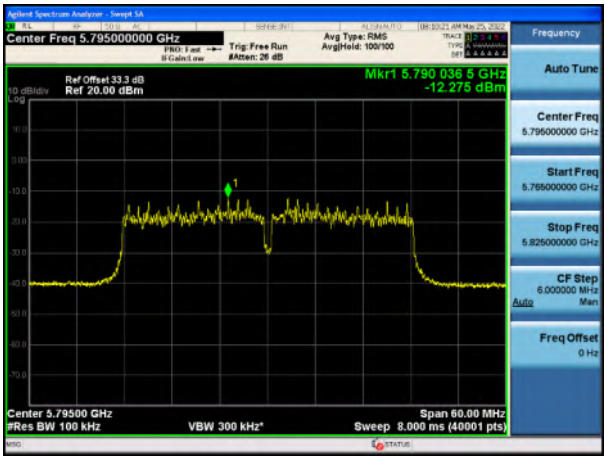

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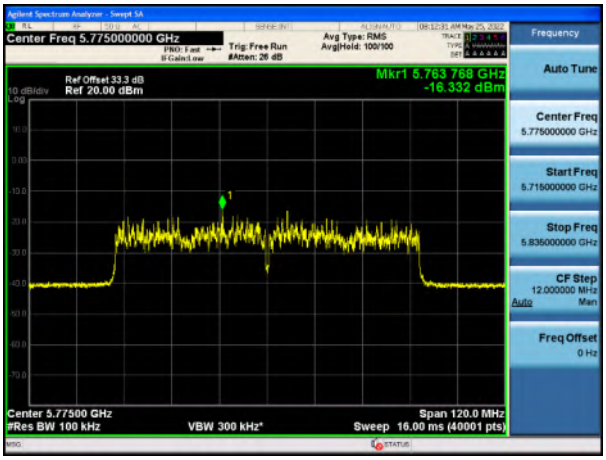

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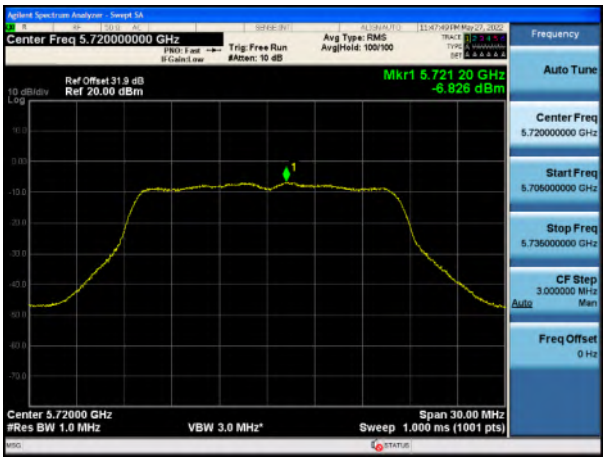
Cross channel for UNII-2C Band



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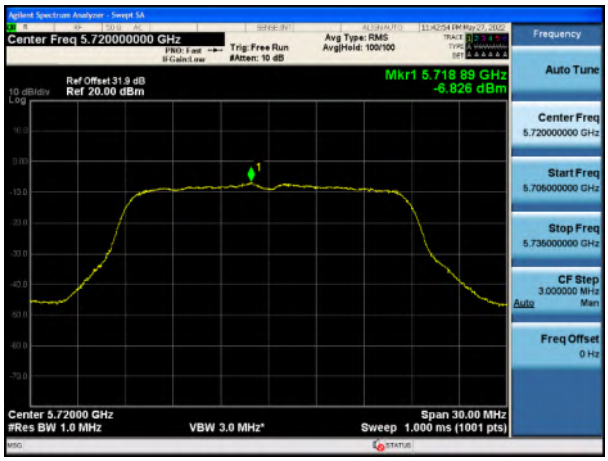

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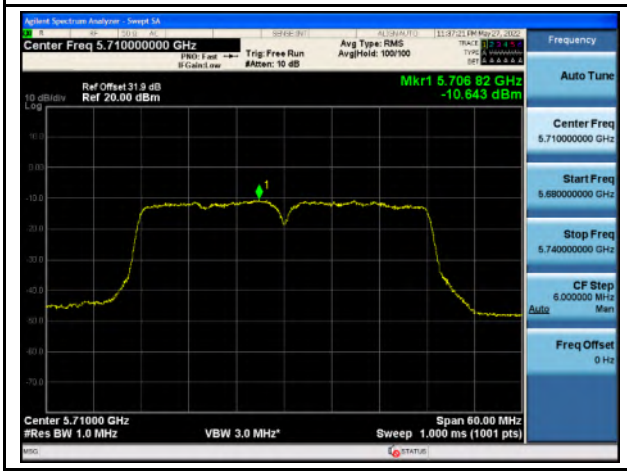

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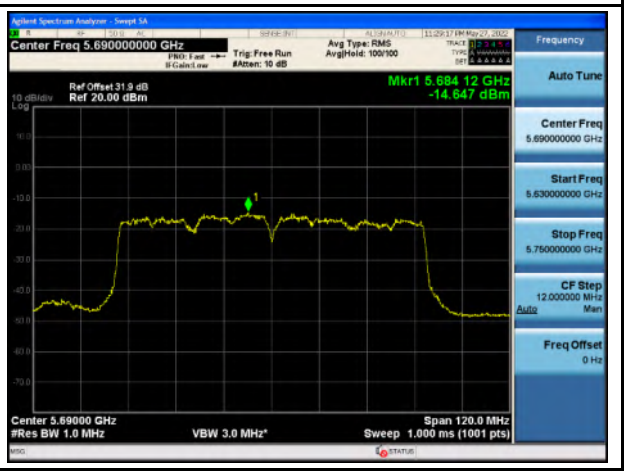

PSD _Cross channel_802.11ac_5690

Cross channel for UNII-3 Band

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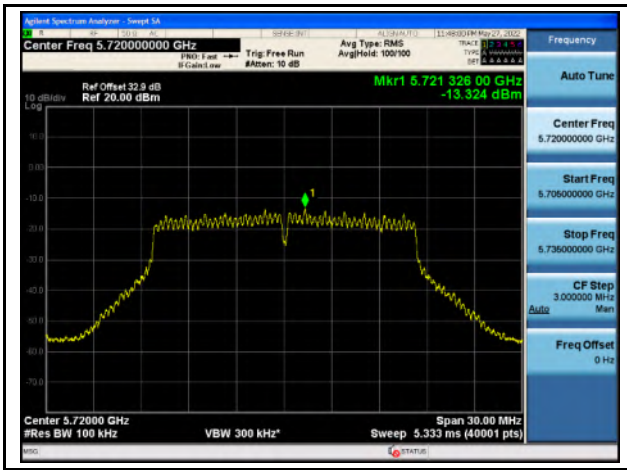
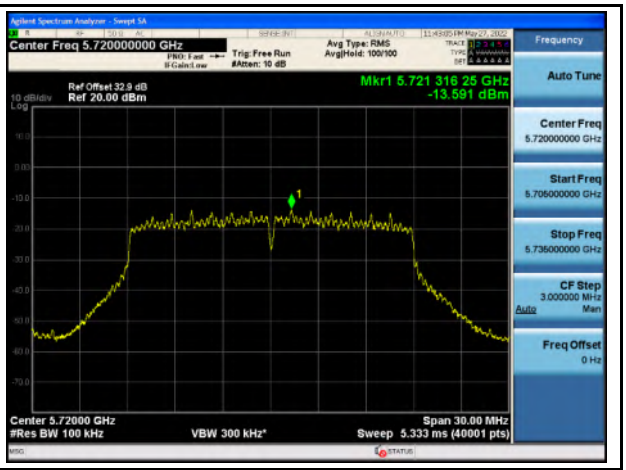
<tr><td> 
</td><td> 
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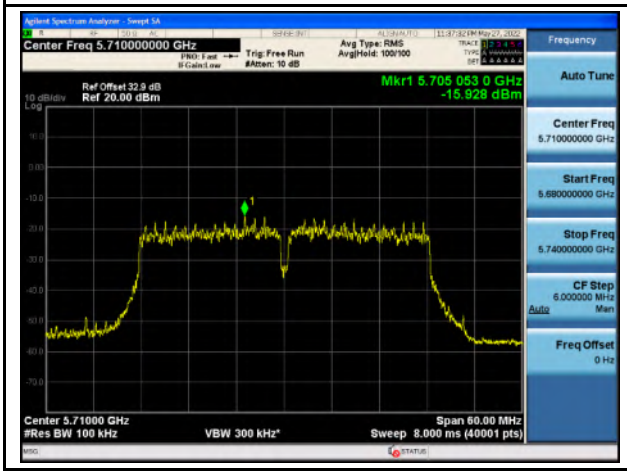
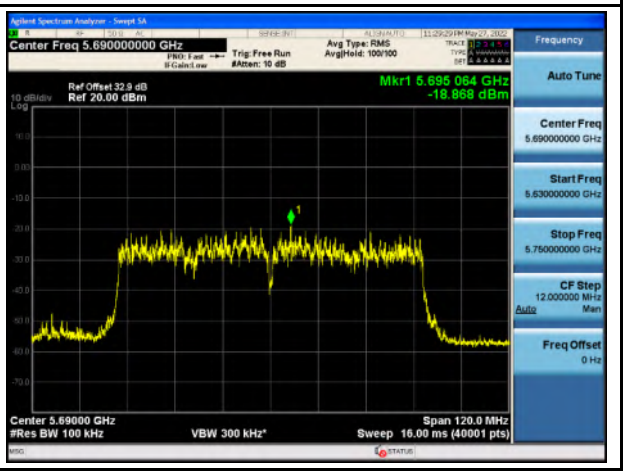
<tr><td> 
</td><td> 
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7.6 Dynamic Frequency Selection (DFS) Introduction

7.6.1 Requirement

Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see note)
≥ 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 spectra density requirement	-64 dBm
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 Response requirement 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 UNII 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 facilitating 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.	

7.6.2 Radar type and test waveforms

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms

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: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	Roundup { (1/360) * (19*10^6/ PRI_{usec}	60%	30
		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	-		
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.					

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

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse radar test signal. If more than 30 waveforms are used for the Long Pulse radar test signal, then each additional waveform must also be unique and not repeated from the previous

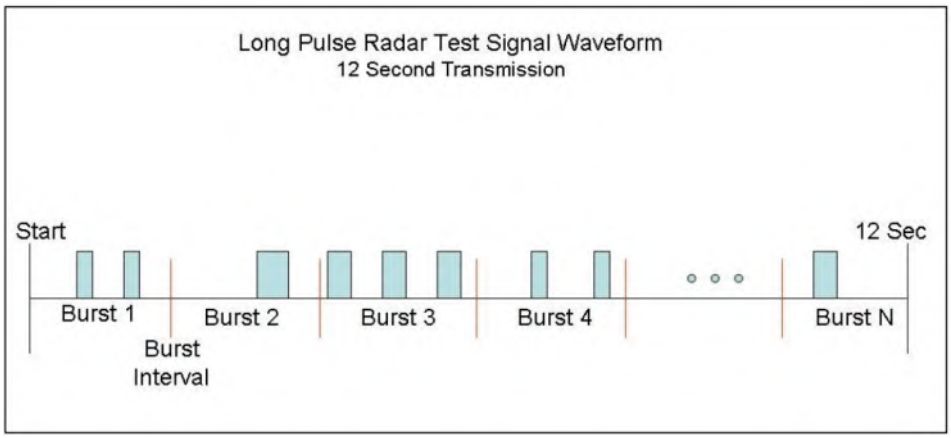
waveforms.

Each waveform is defined as follows:

1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 Bursts in the 12 second period, with the number of Bursts being randomly chosen. This number is Burst Count.
3) Each Burst consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each Burst within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a Burst will have the same pulse width. Pulses in different Bursts may have different pulse widths.
5) Each pulse has a linear FM chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a Burst will have the same chirp width. Pulses in different Bursts may have different chirp widths. The chirp is centered on the pulse. For example, with a radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz
6) If more than one pulse is present in a Burst, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a Burst, the time between the first and second pulses is chosen independently of the time between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst Count. Each interval is of length (12,000,000 / Burst Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 1 and [(12,000,000 / Burst Count) – (Total Burst Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The s9tart time for each Burst is chosen independently.

A representative example of a Long Pulse radar test waveform:

1) The total test signal length is 12 seconds.
2) 8 Bursts are randomly generated for the Burst Count.
3) Burst 1 has 2 randomly generated pulses.
4) The pulse width (for both pulses) is randomly selected to be 75 microseconds.
5) The PRI is randomly selected to be at 1213 microseconds.
6) Bursts 2 through 8 are generated using steps 3 – 5.
7) Each Burst is contained in even intervals of 1,500,000 microseconds. The starting location for Pulse 1, Burst 1 is randomly generated (1 to 1,500,000 minus the total Burst 1 length + 1 random PRI interval) at the 325,001 microsecond step. Bursts 2 through 8 randomly fall in successive 1,500,000 microsecond intervals (i.e. Burst 2 falls in the 1,500,001 – 3,000,000 microsecond range).



Frequency Hopping Radar Type

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	.333	300	70%	30

For the Frequency Hopping Radar Type, the same Burst parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected 1 from the hopping sequence defined by the following algorithm:

The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

7.7 Dynamic Frequency Selection (DFS) Applicability

7.7.1 Requirement

A U-NII network will employ a DFS function to detect signals from radar systems and to avoid co-channel operation with these systems. This applies to the 5250-5350 MHz and/or 5470-5725 MHz bands.1

Within the context of the operation of the DFS function, a U-NII device will operate in either Master Mode or Client Mode. U-NII devices operating in Client Mode can only operate in a network controlled by a UNII device operating in Master Mode.

Following tables shown below summarize the DFS testing applicability.

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	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	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.		

7.7.2 Conclusion

EUT is client device without radar detection function. Only the Channel Closing Transmission Time and Channel Move time testing are required. EUT only support 20MHz bandwidth.

7.8 Dynamic Frequency Selection (DFS) Testing

7.8.1 Requirement

Channel Closing Transmission Time

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.

The channel closing transmission time shall be less than (200 milliseconds + an aggregate of 60 milliseconds) over remaining 10 second period

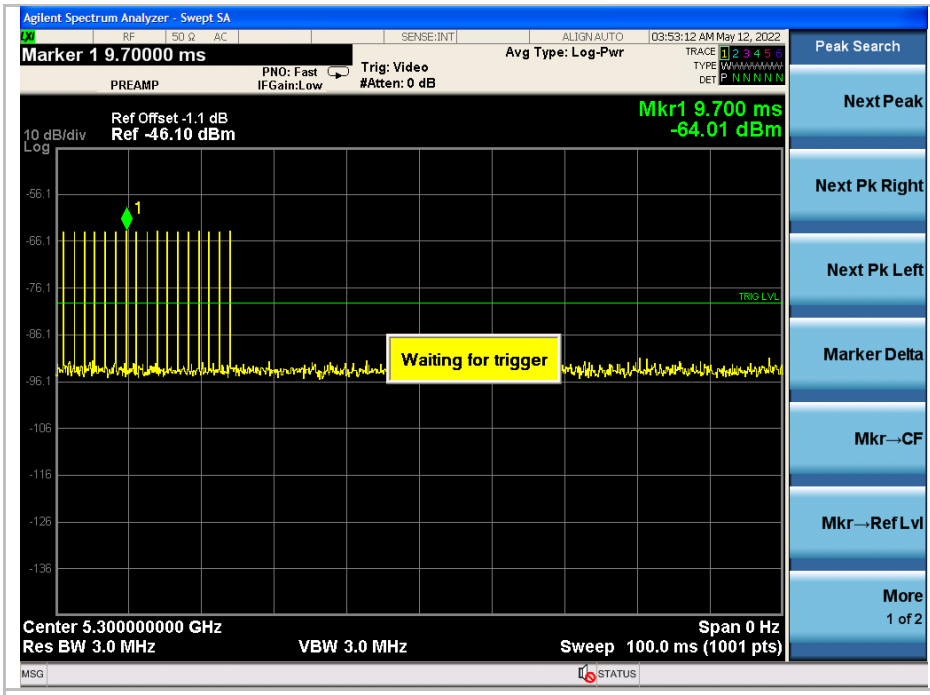
Channel Move Time

After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

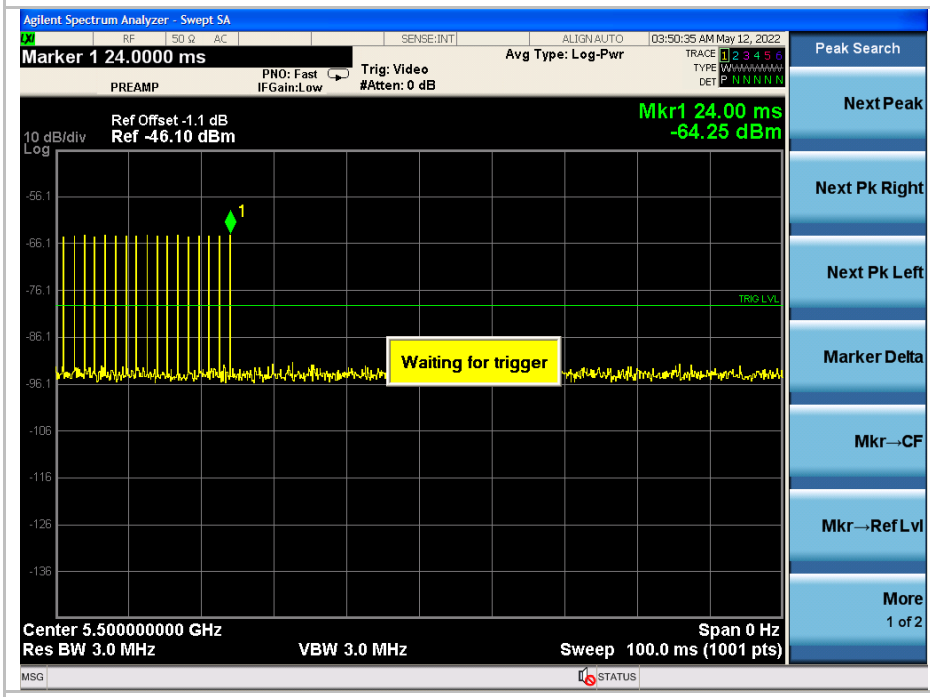
7.8.2 Radar Waveform Calibration

The following equipment setup was used to calibrate the conducted Radar Waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized.

Calibration Test Plots



5250MHz to 5350MHz bands – Radar Type 1 @ 5300MHz



5470MHz to 5725MHz bands – Radar Type 0 @ 5500MHz

7.8.3 DFS Test Procedure

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

These tests define how the following DFS parameters are verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time, and Non-Occupancy Period.

The steps below define the procedure to determine the above-mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold + 1dB is generated on the Operating Channel of the U-NII device.

UUT operating as a Client Device will associate with the Master at test Channel. DFS testing was performed while EUT is associated with the HME master device (Remote Transceiver) that it's designed to use with. EUT communicates with master device through the unique frame structure with fixed data rate and duty cycle.

At time T0 the Radar Waveform generator sends a Burst of pulses for each of the radar types.

Observe the transmissions of the UUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (Channel Move Time). Compare the Channel Move Time and Channel Closing Transmission Time results to the limits defined in the DFS Response requirement values table.

Channel Closing Transmission Time- Measurement

A type 1 waveform was introduced to the EUT and the Spectrum Analyzer sweep time was set to 1s for monitoring and capturing the plot. A LabVIEW program was created to collect trace data and capturing the plot. The program will calculate the channel closing time base on the spectrum analyzer result. The result will be calculated based on FCC procedure.

C= N*Dwell

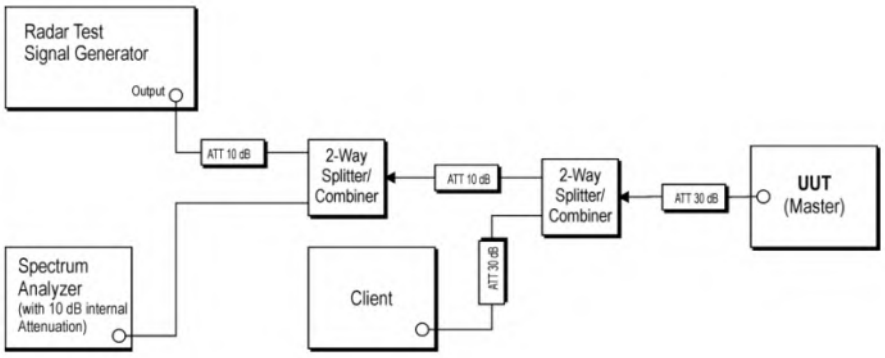
C is the closing time, N is the number of spectrum analyzer sampling bins showing a U-NII transmission and dwell is the dwell time per bin.

Dwell= S/B

Where Dwell is the dwell time per spectrum analyzer sampling bin, S is the sweep time and B is the number 0f spectrum analyzer sampling bins.

7.8.4 DFS Test Setup

Conducted measurement setup was used for full DFS testing.
Test Setup Block Diagram for conducted measurement is as below,



The radio was set at the center channel frequency of tested Channel.
A FCC approved Master device – (FCC ID: Q87-EA8300) AP was used to link with DUT device.

The master device provides, on aggregate, uniform loading of the spectrum across all devices by selecting an operating channel among the available channels using a random algorithm.

The rated output power of the Master unit is > 23 dBm (EIRP). Therefore, the required interference threshold is – 64 dBm. After correction for procedural adjustment, the required radiated threshold at the antenna port is -64 + 1 = -63 dBm.

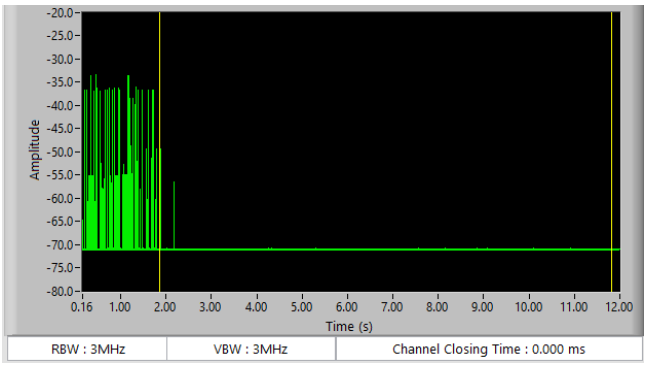
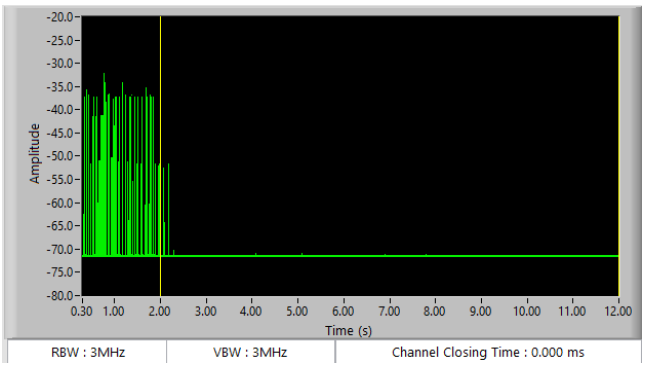
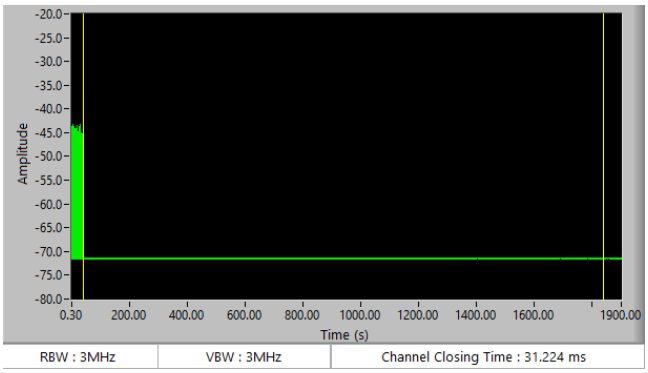
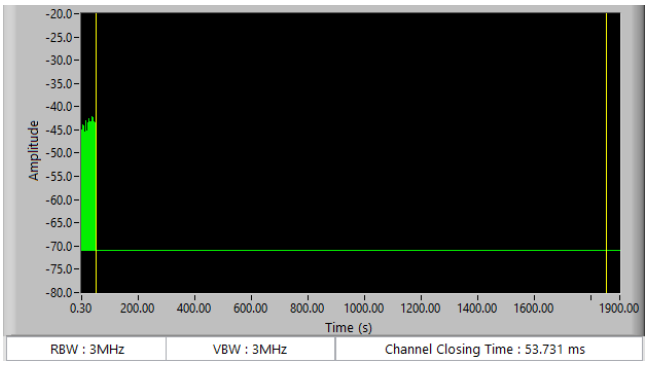
The calibrated radiated DFS detection threshold level is set to -64 dBm. The tested level is lower than the required level hence it provides margining to the limit.

7.8.5 DFS Test Results

BW / Channel	Test Item	Test Result	Limit	Verdict
11ac-5530MHz	Channel Move Time	< 10s	< 10s	Pass
11ac-5530MHz	Channel Closing Transmission Time	0ms	< 260ms	Pass
11n-5500MHz	Non-Occupancy Period	≥ 30min	≥ 30 min	Pass

7.8.6 DFS Test Plots

Plots for Channel closing time and Channel Move Time

<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Channel Move Time & Closing Time – 5300MHz</td><td>Channel Move Time & Closing Time – 5500MHz</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Non-occupancy period - 5300MHz (Type0)</td><td>Non-occupancy period - 5500MHz (Type0)</td></tr>
</table>

7.9 Radiated Spurious Emission

7.9.1 Requirement

§ 15.407 (b) RSS-247 6.2

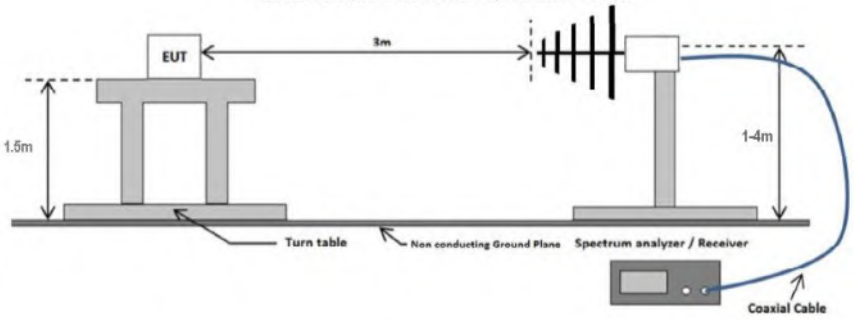
1) For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.
2) For transmitters operating in the 5.25-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
3) For transmitters operating in the 5.47-5.725 GHz band: all emissions outside of the 5.47-5.725 GHz band shall not exceed an EIRP of −27 dBm/MHz.
4) For transmitters operating in the 5.725-5.825 GHz band: all emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
5) Restricted band, emission must also comply with the radiated emission limits specified in 15.209

Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

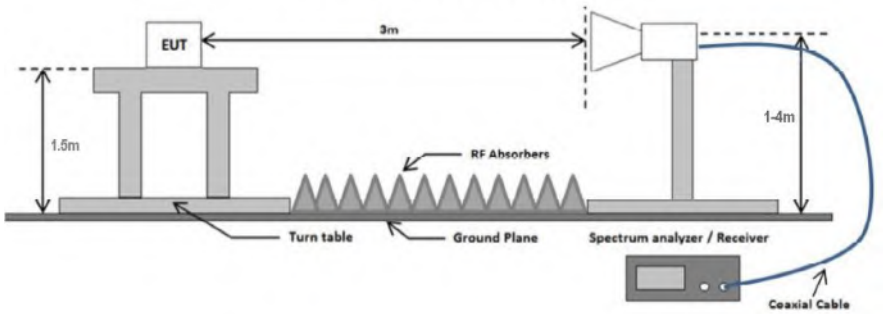
Frequency Range (MHZ)	Field Strength (μV/m)	Measurement Distance (m)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	24000/F(kHz)	30
1.705~30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 960	200	3
Above 960	500	3

7.9.2 Test Setup

Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



7.9.3 Test Procedure

According to subclause 12.7, radiated spurious emission measurements, in ANSI C63.10-2013:

1) The EUT was switched on and allowed to warm up to its normal operating condition.
2) The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
    a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT was chosen.
    b. The EUT was then rotated to the direction that gave the maximum emission.
    c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3) The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300Hz for frequencies below 150kHz.
4) The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10kHz for frequency between 150kHz-30MHz.
5) The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for quasi-peak detection at frequency between 30MHz-1GHz.
6) The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with peak detection for peak and average measurement at frequency above 1GHz.
7) Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

7.9.4 Test Result

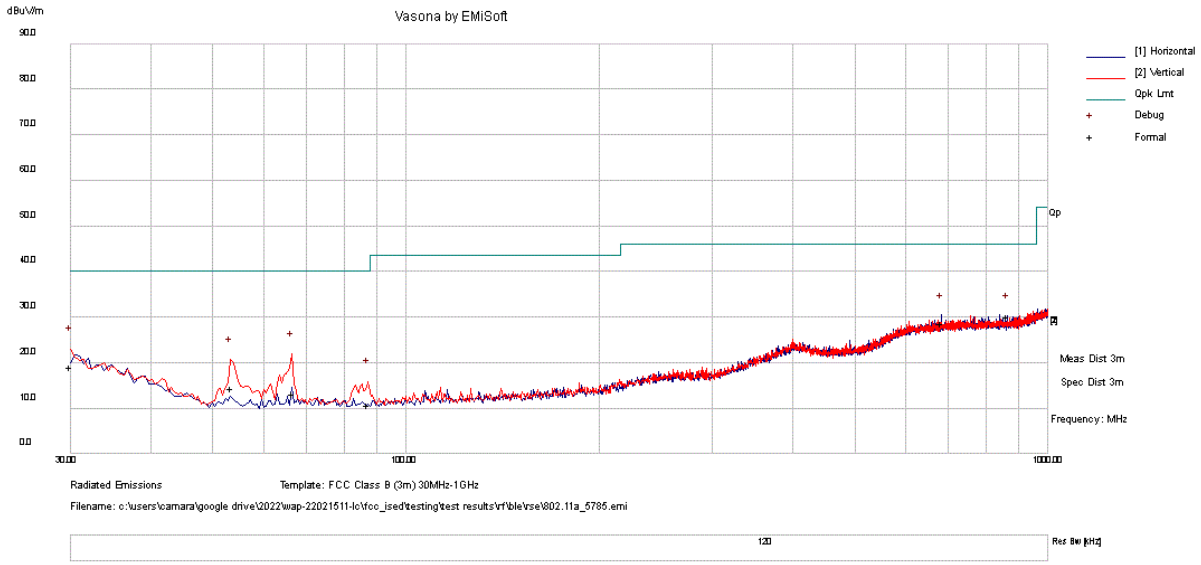
Radiated Emission between 9KHz – 30MHz test result

Note: no substantial emission is found other than the noise floor. Different modes have been verified.

RADIATED SPURIOUS EMISSION BELOW 1GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Below 1GHz_802.11a
Frequency Range:	30 MHz - 1 GHz	Test Date:	05/19/2022
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 157	Test Result:	Pass

Radiated Spurious Emission-Below 1GHz-11a-20MHz BW-5300MHz



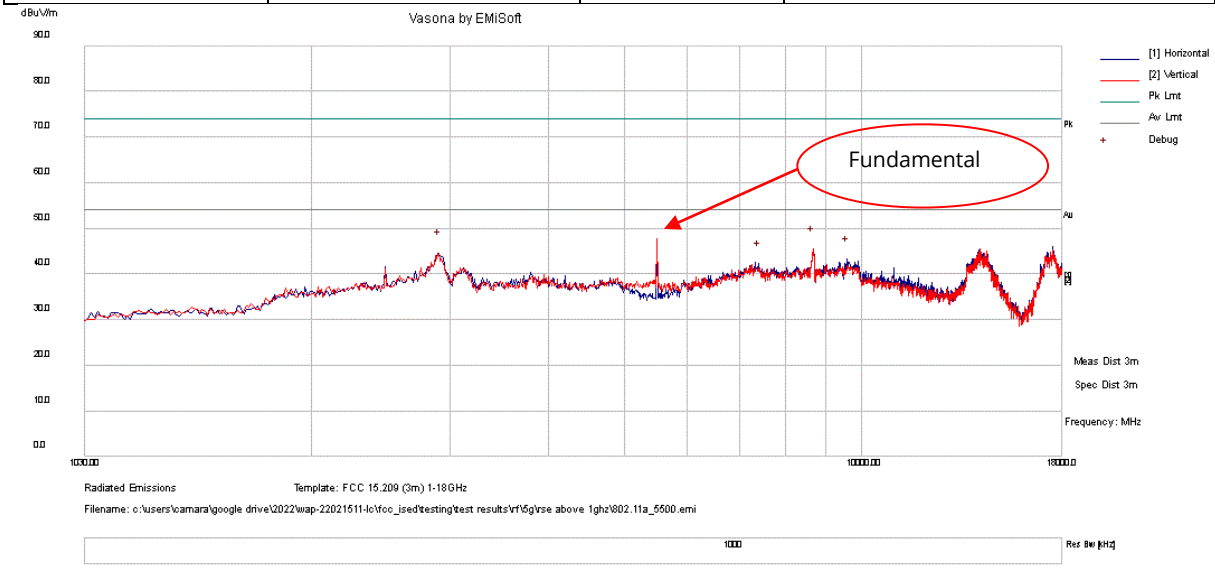
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	682.613	26.7	7.3	-5.3	28.6	Quasi Max	H	306	351	46	-17.4	Pass
2	864.793	26.6	7.5	-3.9	30.2	Quasi Max	H	253	8	46	-15.8	Pass
3	30.014	28.4	2.2	-11.5	19.1	Quasi Max	V	101	97	40	-20.9	Pass
4	66.618	30.4	3.1	-20.3	13.2	Quasi Max	V	120	61	40	-26.8	Pass
5	53.466	32.5	2.9	-20.9	14.5	Quasi Max	V	107	30	40	-25.5	Pass
6	87.139	27.5	3.4	-20.2	10.7	Quasi Max	V	363	94	40	-29.3	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED SPURIOUS EMISSION ABOVE 1GHZ

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 100	Test Result:	Pass

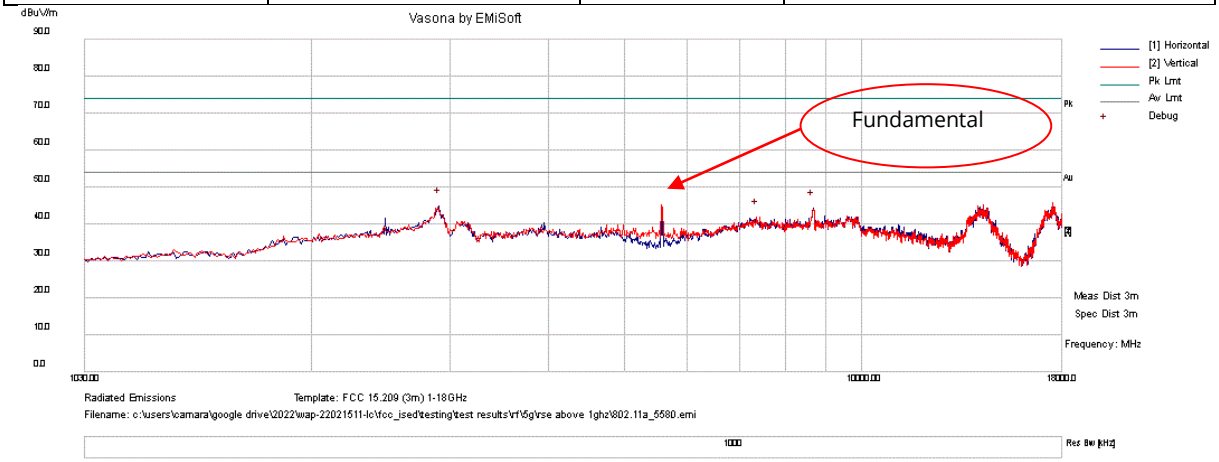


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8687.713	33.8	17.4	-5.7	45.4	Peak [Scan]	V	100	0	54	-8.6	Pass
2	2907.306	20	20.8	3.9	44.6	Peak [Scan]	V	200	0	54	-9.4	Pass
3	9599.85	34.3	14.1	-5.2	43.2	Peak [Scan]	H	100	0	54	-10.8	Pass
4	7415.489	35.8	12	-5.6	42.3	Peak [Scan]	V	101	0	54	-11.8	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. The peak value is less than average limit, No average record.

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 116	Test Result:	Pass

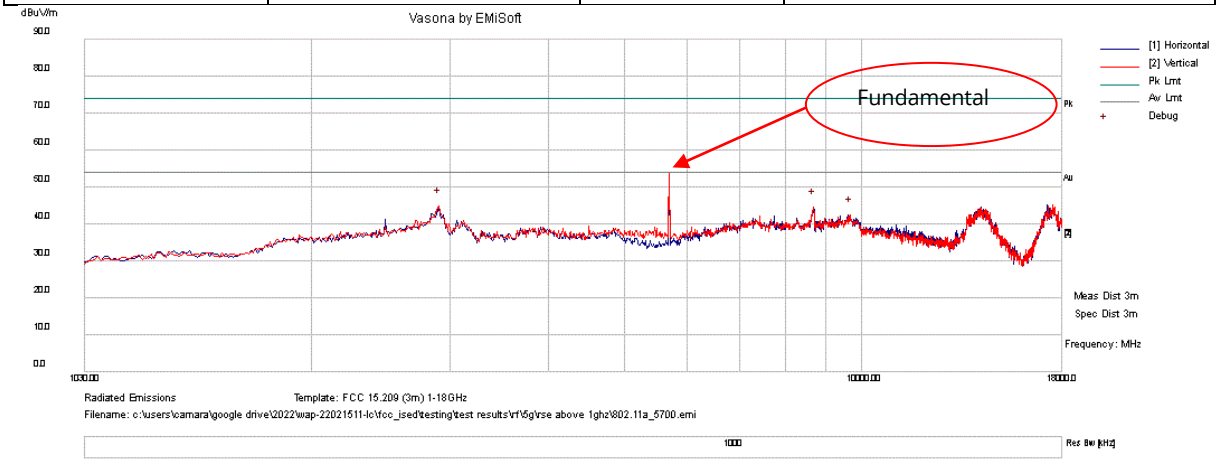


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	20.2	20.8	3.9	44.8	Peak [Scan]	H	200	0	54	-9.2	Pass
2	8687.713	32.5	17.4	-5.7	44.2	Peak [Scan]	H	200	0	54	-9.8	Pass
3	7362.461	35.3	11.9	-5.5	41.8	Peak [Scan]	V	101	0	54	-12.2	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 140	Test Result:	Pass

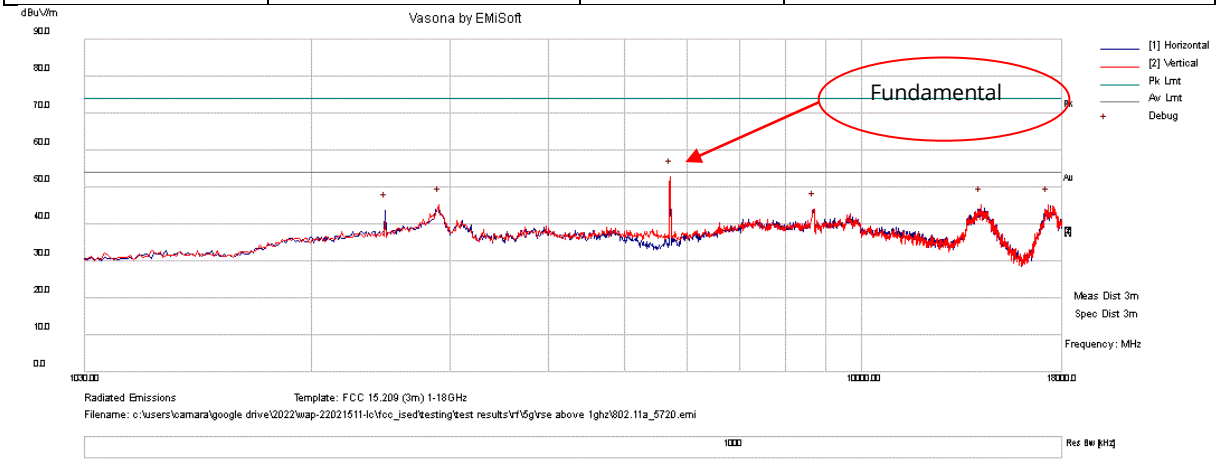


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	20.1	20.8	3.9	44.8	Peak [Scan]	V	100	0	54.0	-9.2	Pass
2	8698.319	32.4	17.9	-5.7	44.6	Peak [Scan]	V	100	0	54.0	-9.4	Pass
3	9684.700	32.9	14.6	-5.1	42.4	Peak [Scan]	V	200	0	54.0	-11.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 144	Test Result:	Pass

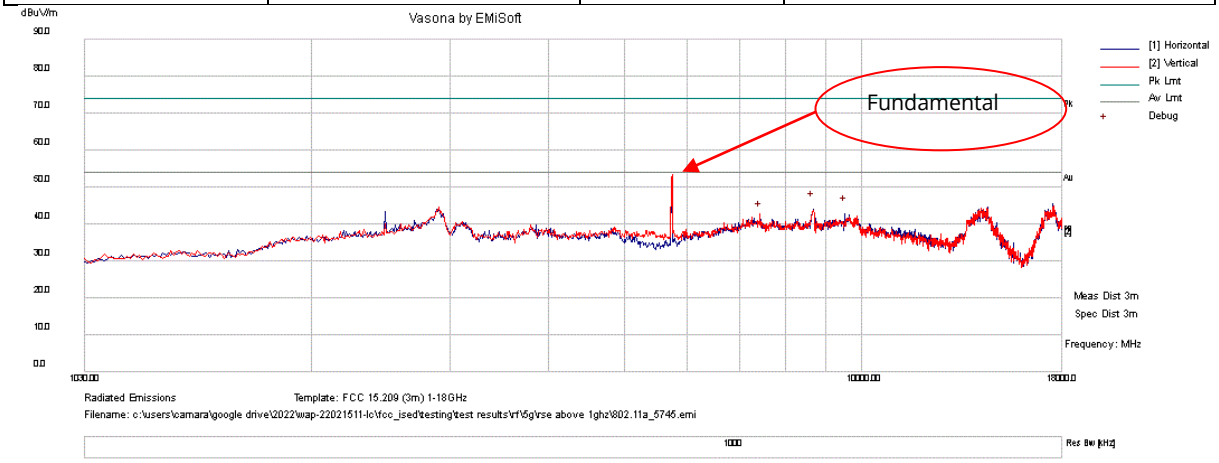


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	20.5	20.8	3.9	45.1	Peak [Scan]	V	200	0	54	-8.9	Pass
2	8708.925	32	17.6	-5.7	43.9	Peak [Scan]	V	200	0	54	-10.1	Pass
3	2483.056	19.7	21.3	2.6	43.5	Peak [Scan]	H	200	0	54	-10.5	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 149	Test Result:	Pass

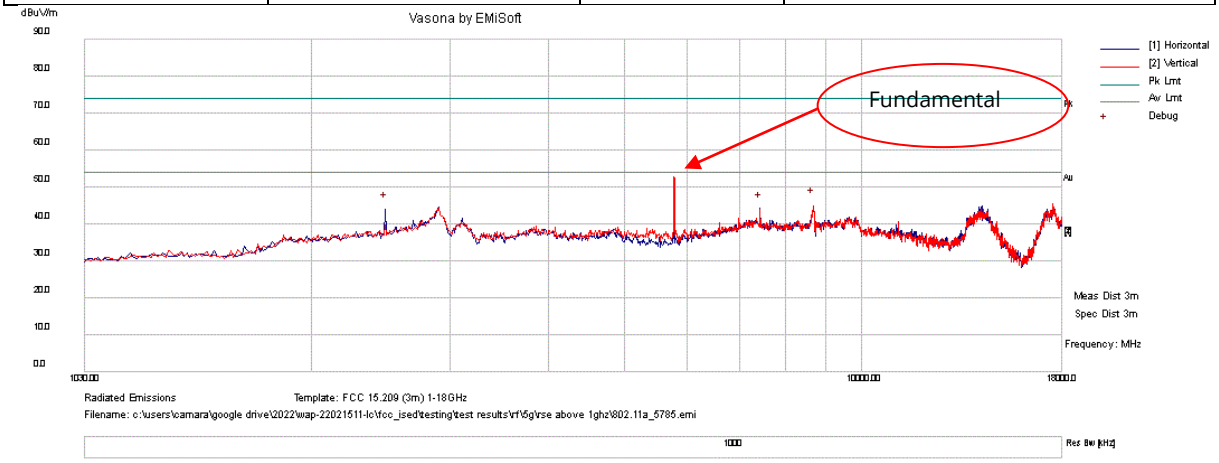


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8687.713	32.2	17.4	-5.7	43.9	Peak [Scan]	H	100	0	54	-10.1	Pass
2	9536.213	33.9	13.9	-5.2	42.6	Peak [Scan]	H	200	0	54	-11.4	Pass
3	7441.532	34.8	11.9	-5.6	41.1	Peak [Scan]	V	101	0	54	-12.9	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 157	Test Result:	Pass

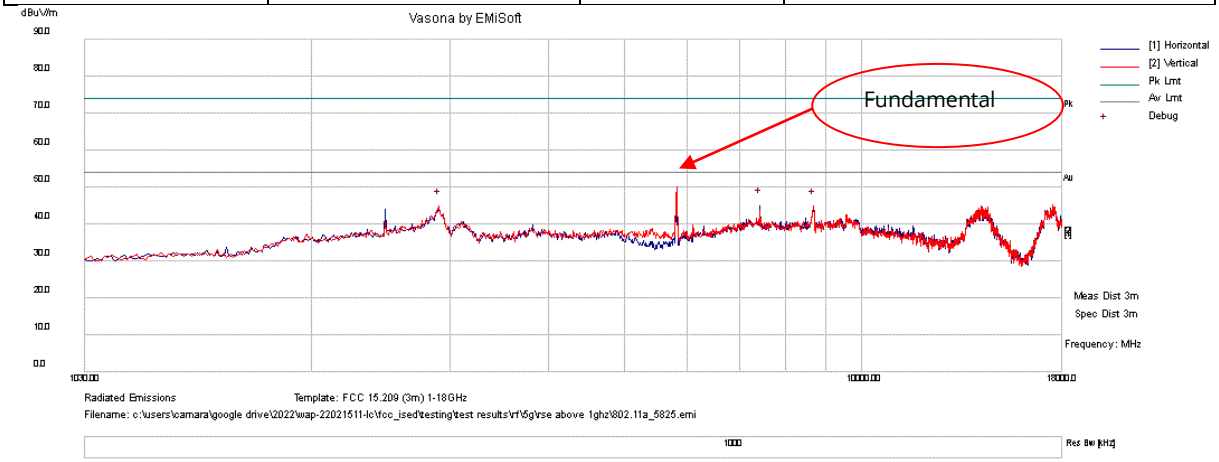


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7447.55	42.6	11.9	5.1	59.7	Peak Max	H	206	64	74	-14.3	Pass
2	4251.673	33.4	8.3	1.2	42.8	Peak Max	V	239	101	74	-31.2	Pass
3	8512	34.5	12.9	5.3	52.8	Peak Max	H	174	30	74	-21.2	Pass
4	7447.55	28.5	11.9	5.1	45.5	Average Max	H	206	64	54	-8.5	Pass
5	4251.673	21.9	8.3	1.2	31.3	Average Max	V	239	101	54	-22.7	Pass
6	8512	30.3	12.9	5.3	48.6	Average Max	H	174	30	54	-5.4	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11a
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 165	Test Result:	Pass

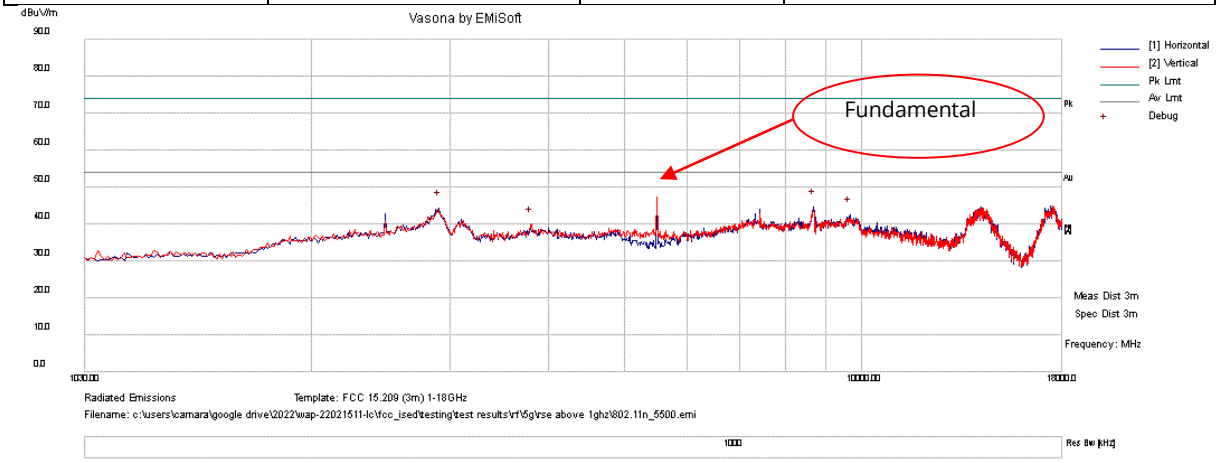


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	7436.175	38.5	11.9	-5.6	44.8	Peak Max	H	134	34	54	-9.2	Pass
2	8698.319	32.5	17.9	-5.7	44.7	Peak Max	V	113	225	54	-9.3	Pass
3	2934.733	21.1	16.7	4	41.8	Peak Max	V	232	34	54	-12.2	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 100	Test Result:	Pass

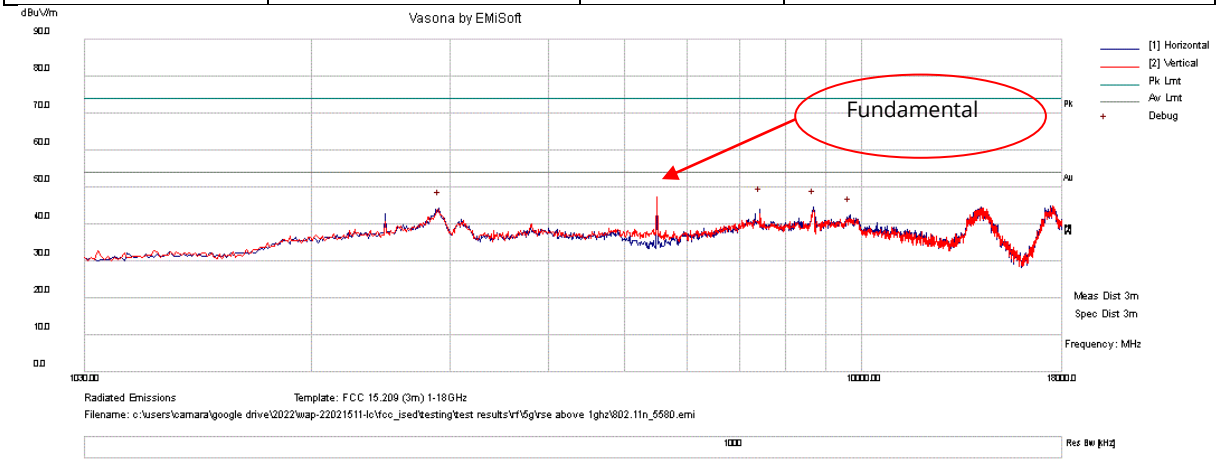


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8698.319	32.4	17.9	-5.7	44.5	Peak Max	H	100	0	54	-9.5	Pass
2	2907.306	19.6	20.8	3.9	44.3	Peak Max	H	200	0	54	-9.7	Pass
3	9674.094	32.9	14.5	-5.1	42.3	Peak Max	H	200	0	54	-11.7	Pass
4	3807.937	26.2	8.2	5.5	39.8	Peak Max	V	101	0	54	-14.2	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 116	Test Result:	Pass

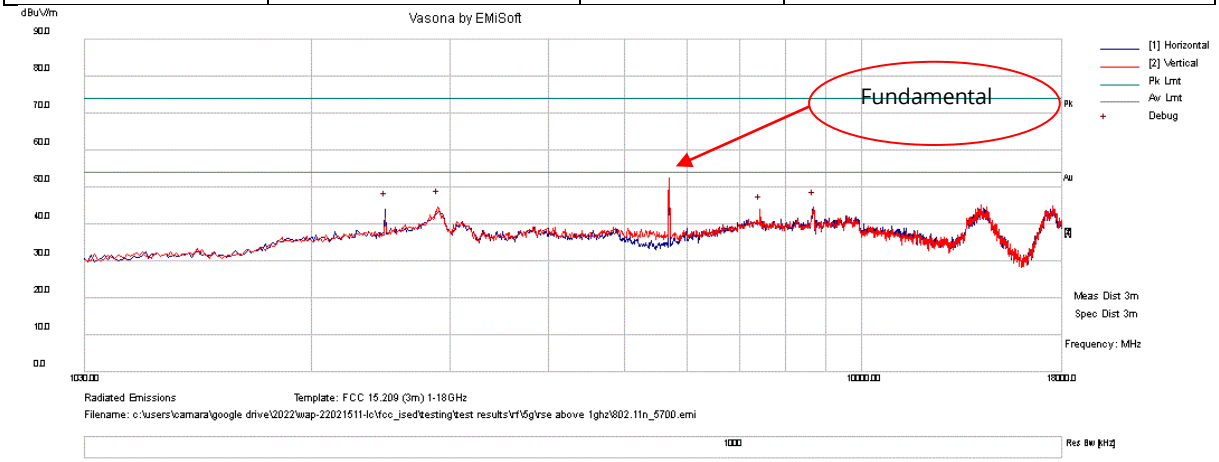


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2896.700	20.3	21.9	3.8	46.0	Peak Max	H	100	0	54.0	-8.0	Pass
2	8698.319	32.1	17.9	-5.7	44.3	Peak Max	H	200	0	54.0	-9.7	Pass
3	9621.063	32.9	14.2	-5.2	41.9	Peak Max	H	200	0	54.0	-12.1	Pass
4	7438.892	36.6	11.9	-5.6	42.9	Peak Max	H	101	0	54.0	-11.1	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 140	Test Result:	Pass

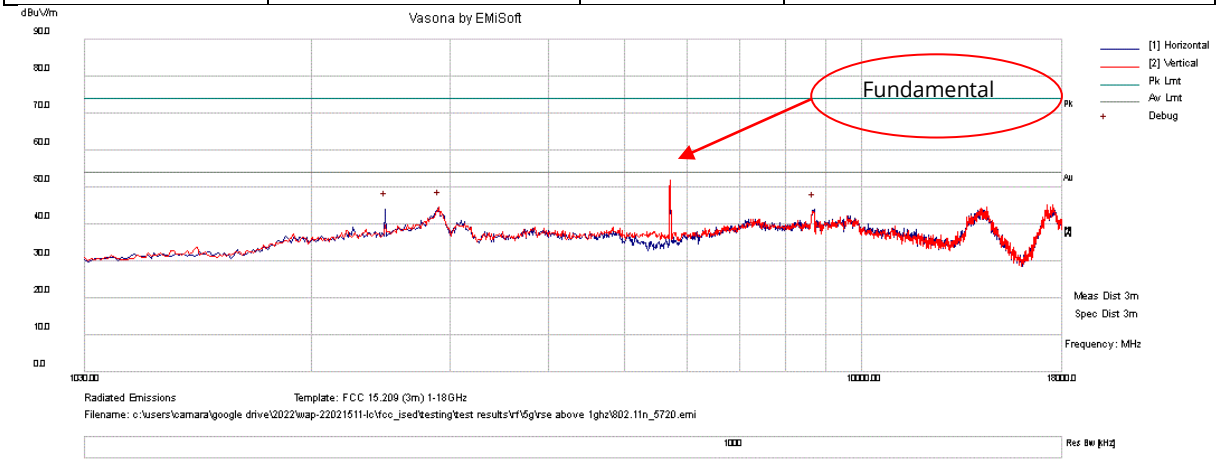


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2896.7	18.9	21.9	3.8	44.6	Peak Max	V	200	0	54	-9.4	Pass
2	8698.319	32.2	17.9	-5.7	44.4	Peak Max	V	200	0	54	-9.6	Pass
3	2483.056	20.1	21.3	2.6	44	Peak Max	H	200	0	54	-10	Pass
4	7436.797	36.7	11.9	-5.6	43.1	Peak Max	V	101	0	54	-11	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 144	Test Result:	Pass

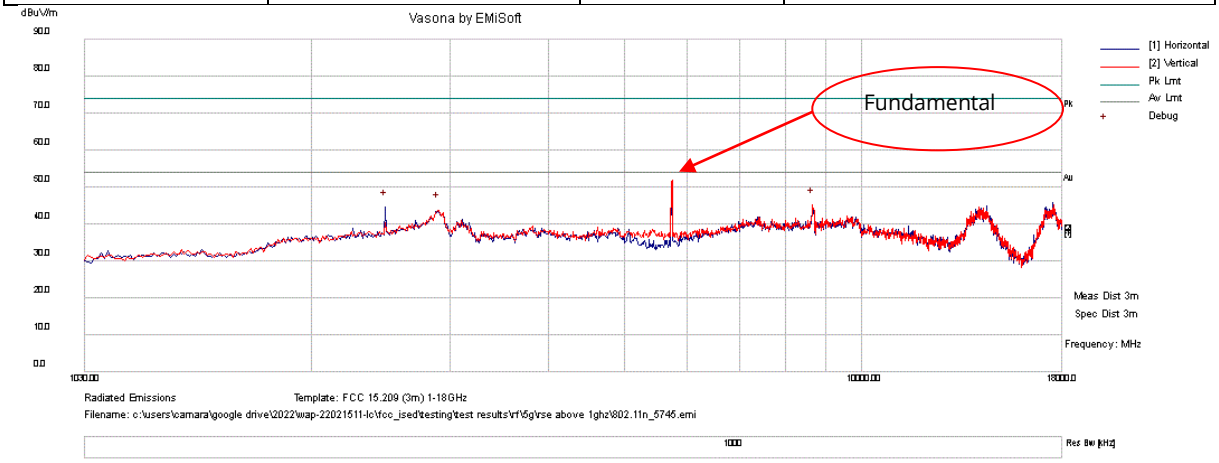


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	19.7	20.8	3.9	44.3	Peak Max	V	100	0	54	-9.7	Pass
2	2483.056	20.2	21.3	2.6	44	Peak Max	H	200	0	54	-10	Pass
3	8708.925	31.9	17.6	-5.7	43.8	Peak Max	H	100	0	54	-10.2	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 149	Test Result:	Pass

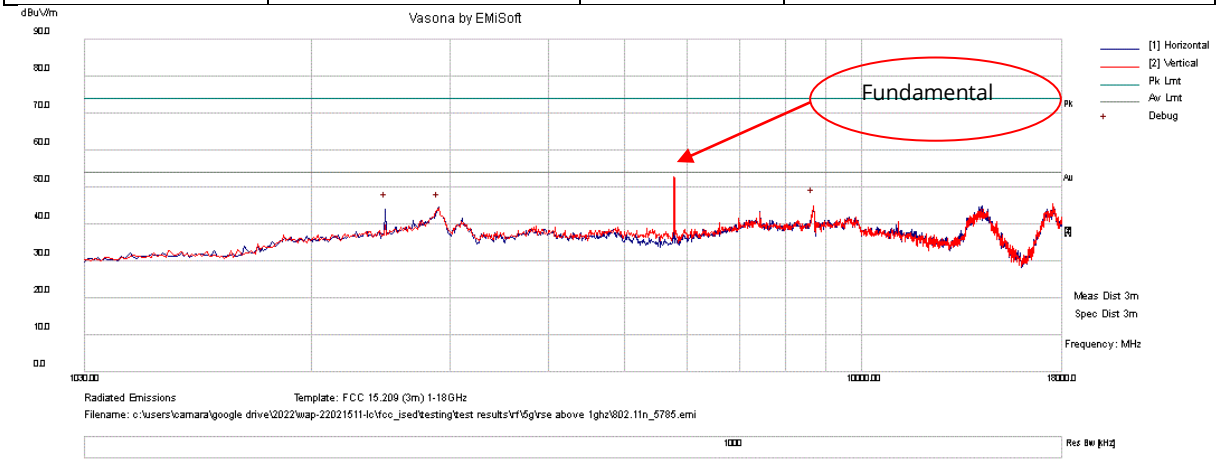


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8677.106	33.7	16.9	-5.7	44.9	Peak Max	V	200	0	54	-9.1	Pass
2	2483.056	20.5	21.3	2.6	44.4	Peak Max	H	200	0	54	-9.6	Pass
3	2896.7	18	21.9	3.8	43.7	Peak Max	V	200	0	54	-10.3	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 157	Test Result:	Pass

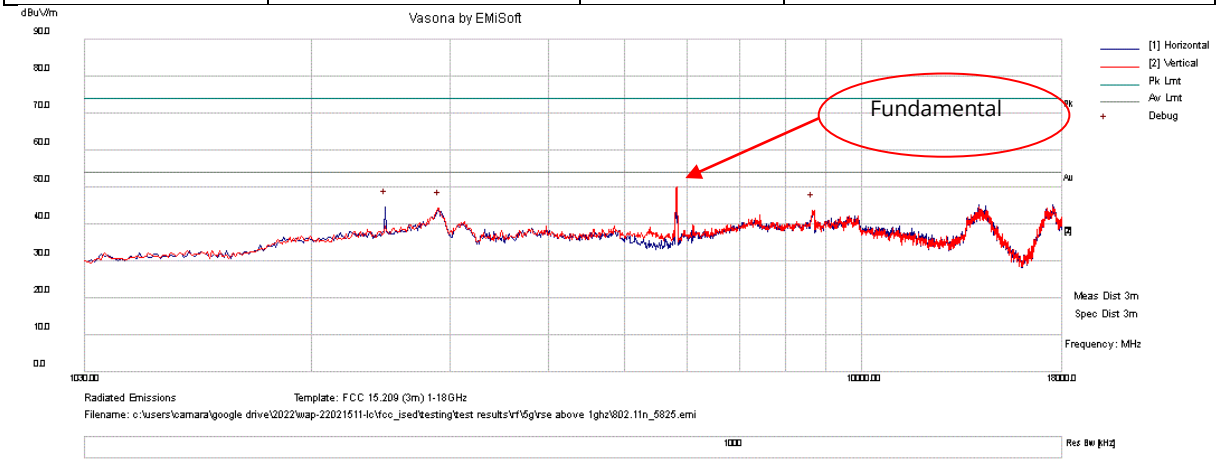


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8677.106	33.4	16.9	-5.7	44.6	Peak Max	V	200	0	54	-9.4	Pass
2	2875.488	18.9	21.8	3.7	44.4	Peak Max	V	200	0	54	-9.6	Pass
3	2483.056	20.1	21.3	2.6	44	Peak Max	H	200	0	54	-10	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 165	Test Result:	Pass

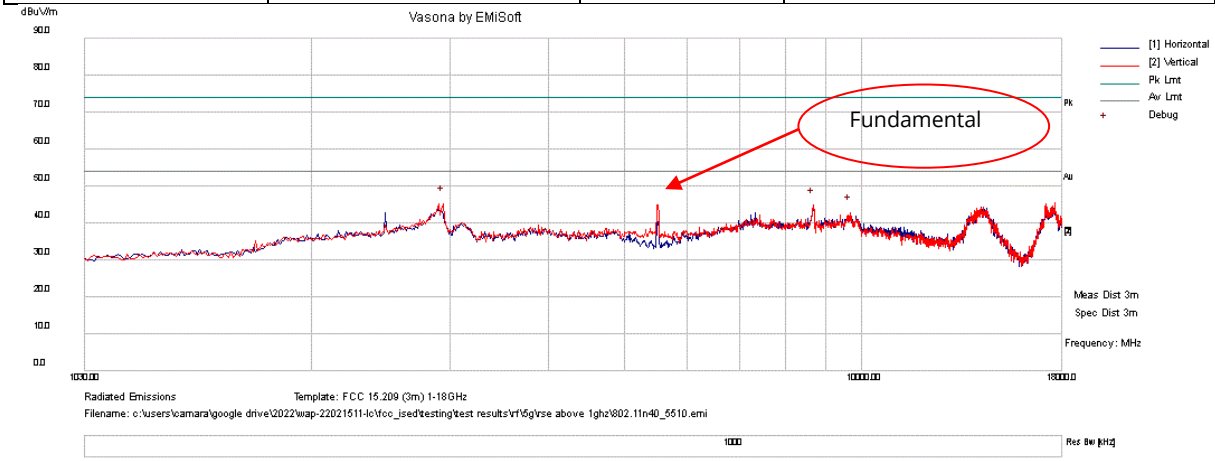


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2483.056	20.8	21.3	2.6	44.6	Peak Max	H	200	0	54	-9.4	Pass
2	2907.306	19.6	20.8	3.9	44.2	Peak Max	H	200	0	54	-9.8	Pass
3	8677.106	32.5	16.9	-5.7	43.7	Peak Max	V	100	0	54	-10.3	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 102	Test Result:	Pass

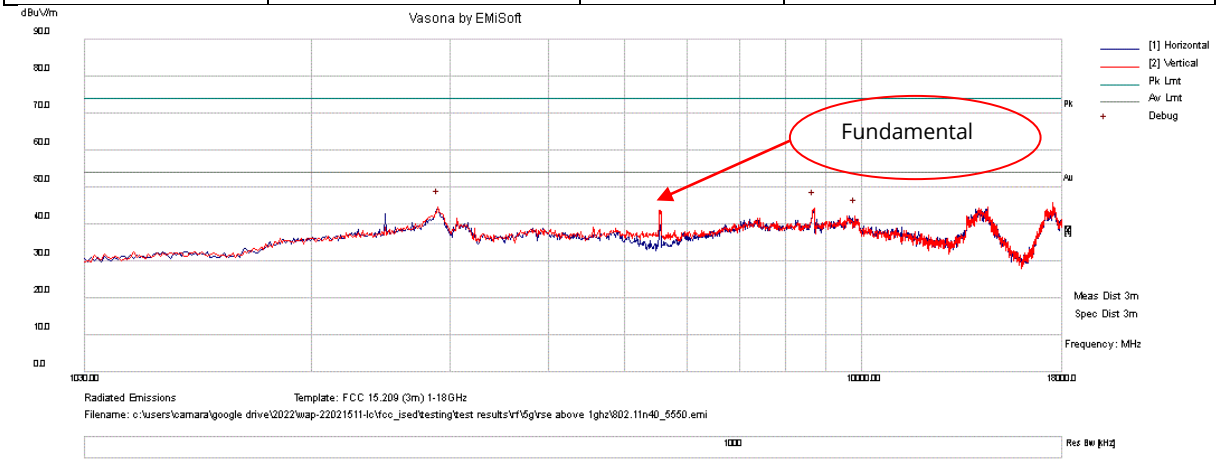


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2939.125	25.1	16	4	45.1	Peak Max	V	100	0	54	-8.9	Pass
2	8687.713	33	17.4	-5.7	44.7	Peak Max	V	100	0	54	-9.3	Pass
3	9674.094	33.4	14.5	-5.1	42.8	Peak Max	V	200	0	54	-11.2	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 110	Test Result:	Pass

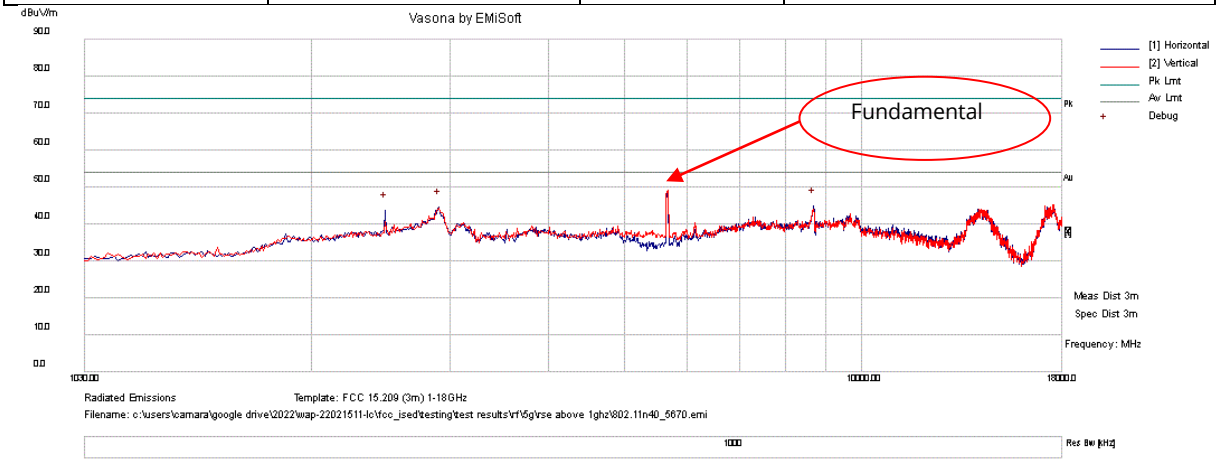


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2896.7	18.9	21.9	3.8	44.5	Peak Max	H	200	0	54	-9.5	Pass
2	8708.925	32.3	17.6	-5.7	44.2	Peak Max	V	100	0	54	-9.8	Pass
3	9822.581	33.1	14.1	-5.1	42.1	Peak Max	V	100	0	54	-11.9	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 134	Test Result:	Pass

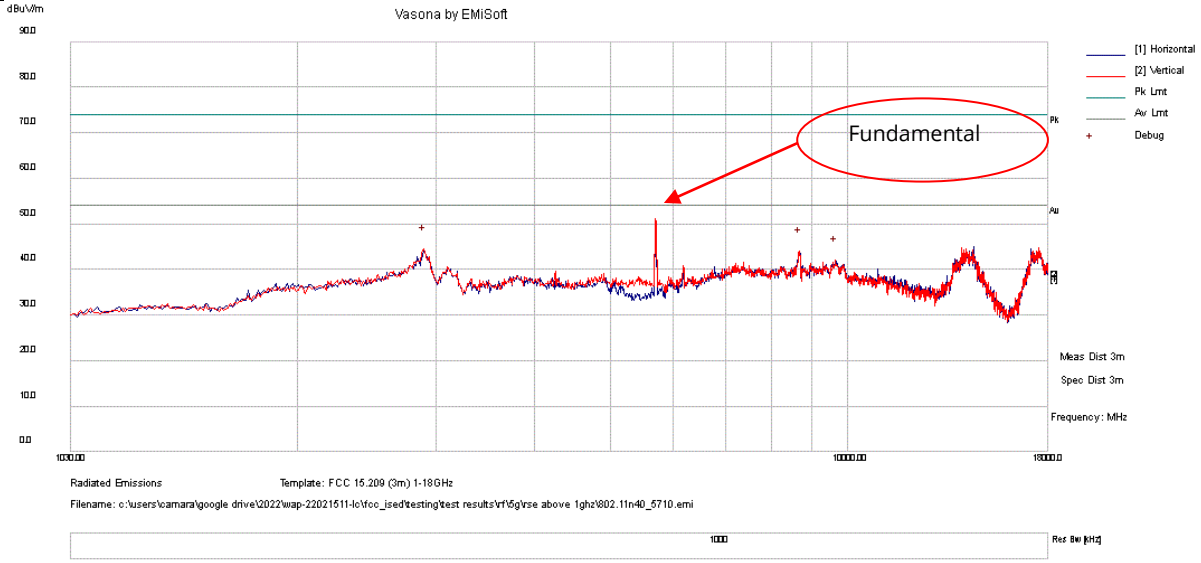


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8698.319	32.6	17.9	-5.7	44.8	Peak Max	H	100	0	54	-9.2	Pass
2	2907.306	19.9	20.8	3.9	44.5	Peak Max	H	100	0	54	-9.5	Pass
3	2483.056	19.7	21.3	2.6	43.5	Peak Max	H	200	0	54	-10.5	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 142	Test Result:	Pass

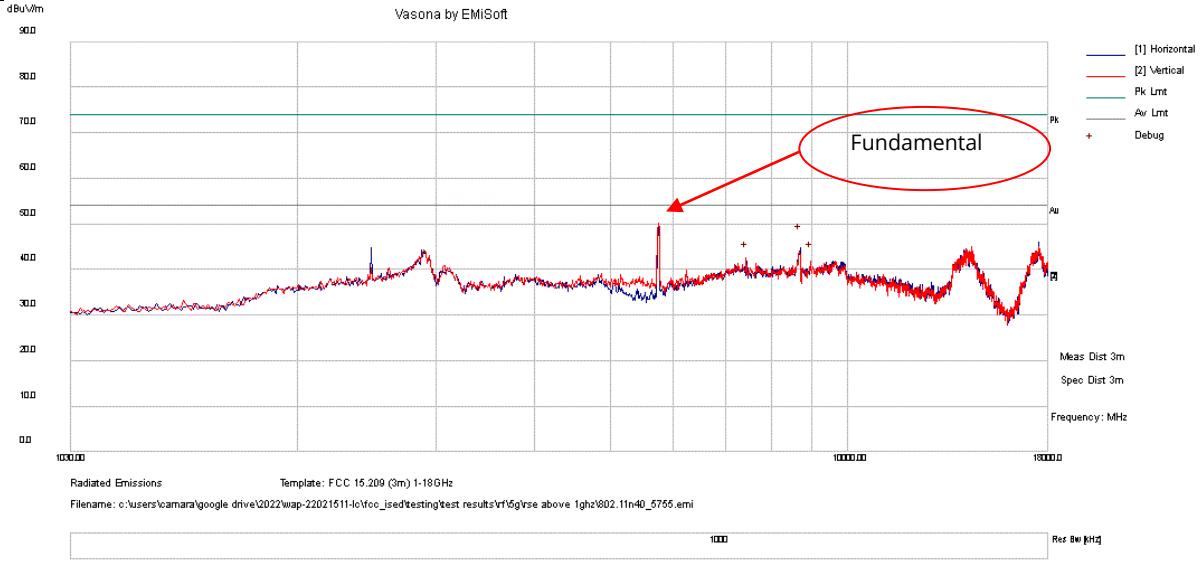


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2896.7	18.9	21.9	3.8	44.6	Peak Max	V	200	0	54	-9.4	Pass
2	8698.319	31.8	17.9	-5.7	44	Peak Max	H	100	0	54	-10	Pass
3	9652.881	32.9	14.4	-5.2	42.1	Peak Max	V	100	0	54	-11.9	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 151	Test Result:	Pass

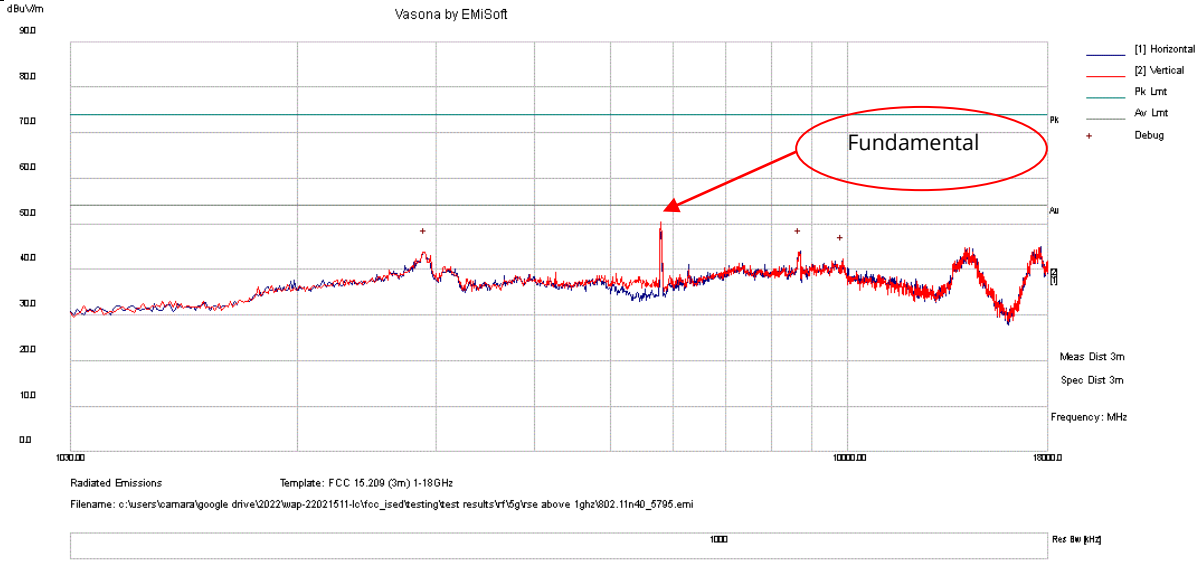


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8708.925	32.9	17.6	-5.7	44.8	Peak Max	H	200	0	54	-9.2	Pass
2	7450.606	34.6	11.9	-5.6	41	Peak Max	V	101	0	54	-13.1	Pass
3	8984.595	33.3	13.4	-5.8	40.9	Peak Max	V	101	0	54	-13.1	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11ac
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 159	Test Result:	Pass

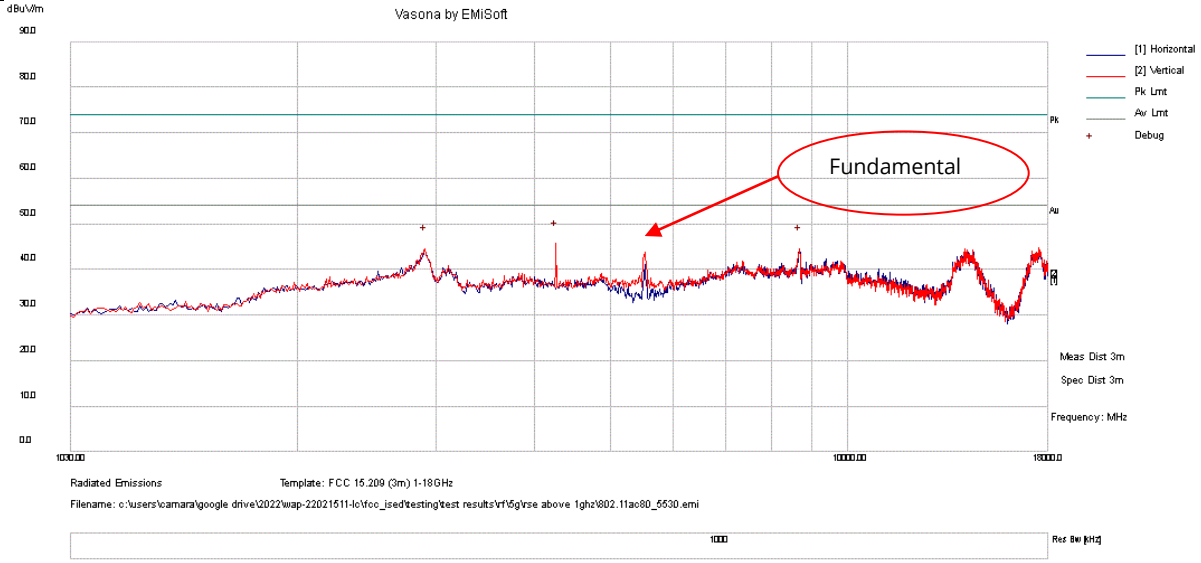


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8708.925	32	17.6	-5.7	43.9	Peak Max	H	100	0	54	-10.1	Pass
2	2907.306	19.2	20.8	3.9	43.9	Peak Max	V	100	0	54	-10.1	Pass
3	9865.006	33.2	14.4	-5.2	42.4	Peak Max	V	200	0	54	-11.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11ac
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 106	Test Result:	Pass

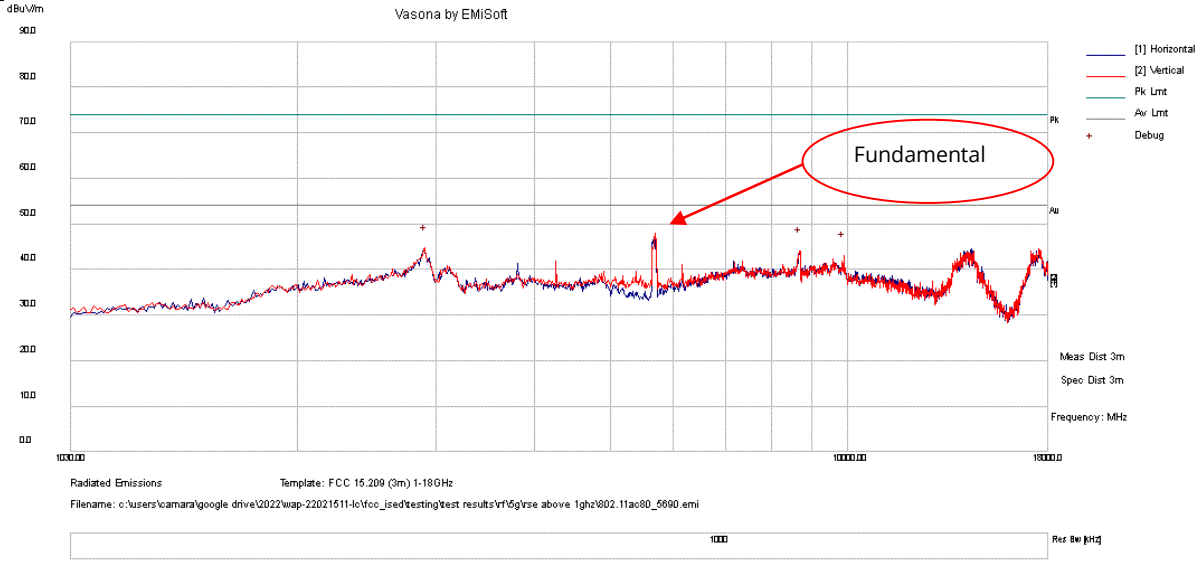


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	4264.906	35.2	8.3	2.2	45.7	Peak Max	V	100	0	54	-8.3	Pass
2	8698.319	32.5	17.9	-5.7	44.6	Peak Max	H	100	0	54	-9.4	Pass
3	2907.306	19.9	20.8	3.9	44.6	Peak Max	H	200	0	54	-9.4	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11ac
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 138	Test Result:	Pass

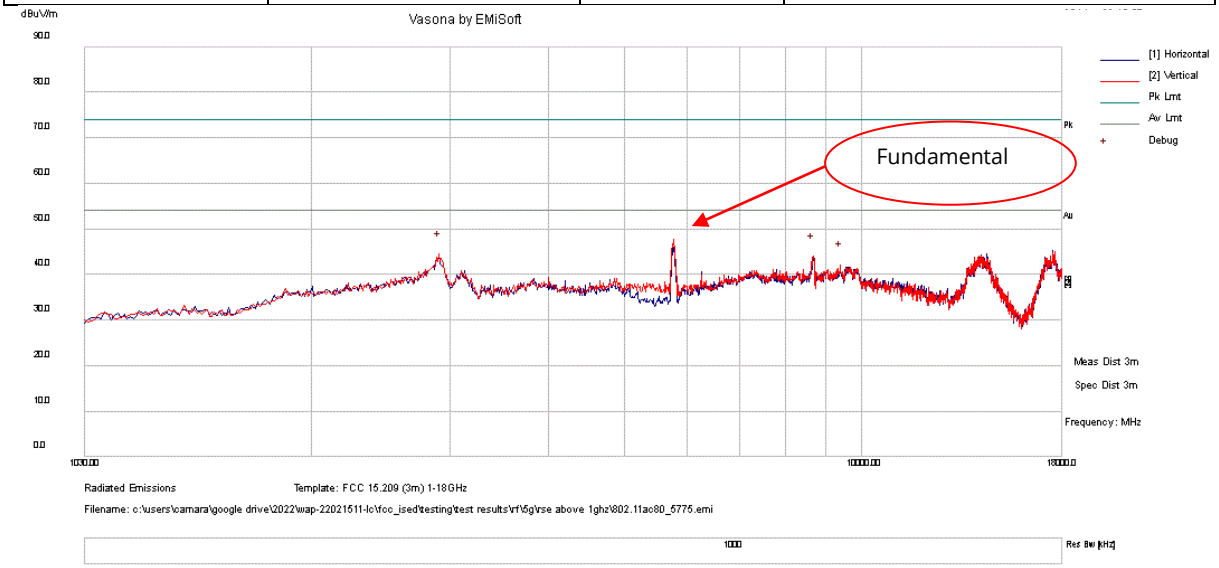


No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	20	20.8	3.9	44.7	Peak Max	V	100	0	54	-9.3	Pass
2	8698.319	31.9	17.9	-5.7	44.1	Peak Max	H	100	0	54	-9.9	Pass
3	9896.825	33.6	14.6	-5.2	43	Peak Max	V	200	0	54	-11	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

Test Standard:	FCC15.247, 15.209, RSS-247	Mode:	RSE-Above 1GHz-802.11n
Frequency Range:	1 GHz - 18 GHz	Test Date:	05/19/2022-05/25/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Ch 155	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2907.306	19.8	20.8	3.9	44.4	Peak Max	V	100	0	54	-9.6	Pass
2	8687.713	32.3	17.4	-5.7	44	Peak Max	V	100	0	54	-10	Pass
3	9408.938	32.7	14.6	-5.2	42.2	Peak Max	V	100	0	54	-11.8	Pass

Remarks:

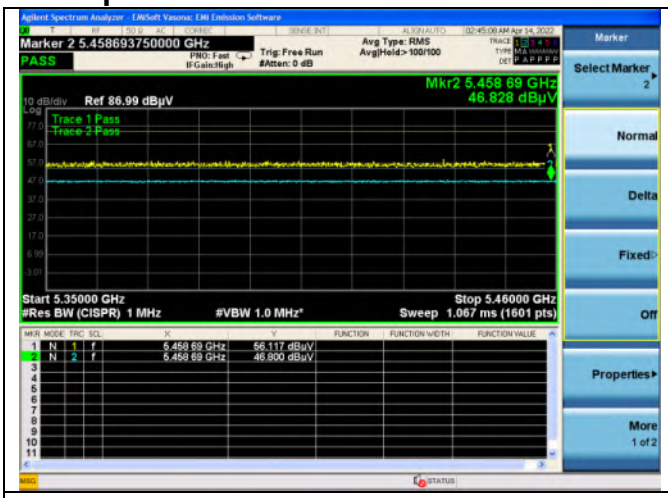
1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)
4. Final average measurement is not necessary since peak level is below average limit

18GHz – 40GHz test result

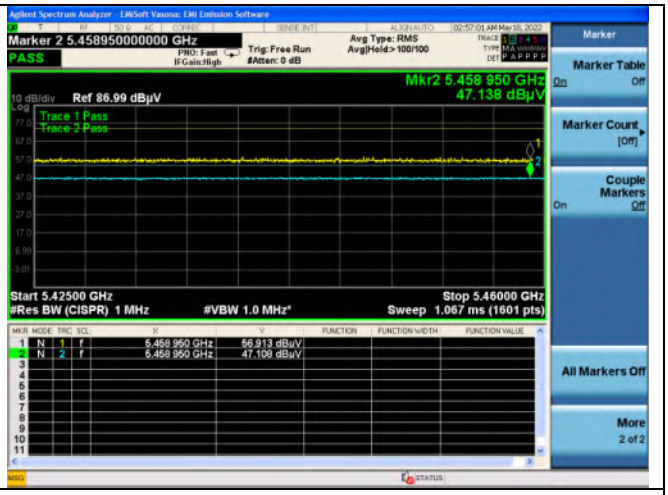
Note: no substantial emission is found other than the noise floor.

Restricted Band measurement result

Test plots

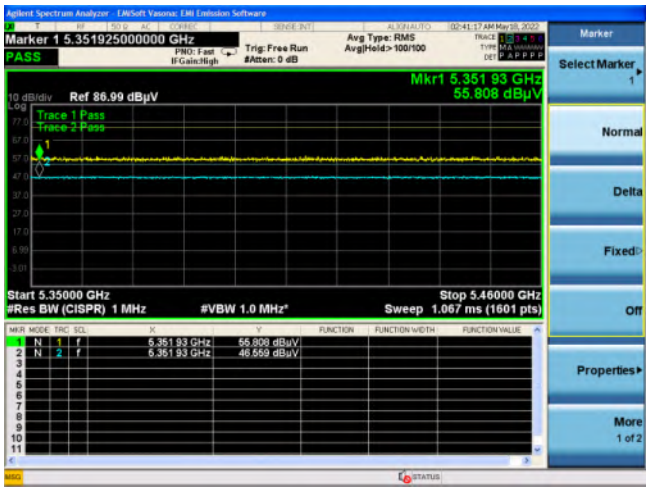


Restricted Band -11a-5500MHz



Restricted Band -11n-5500MHz

Restricted Band -11n40-5510MHz



Restricted Band -11ac-5530MHz

8 EUT and Test Setup Photos

See FCC exhibits

9 Test Instrument List

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2021	10/18/2022
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/17/2021	06/17/2022
EMC Test Receiver	R&S	ESL6	100230	06/14/2021	06/14/2022
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2021	11/15/2022
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	05/14/2022	05/14/2023
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	06/24/2021	06/24/2022
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2021	07/16/2022
True RMS Multi-meter	UNI-T	UT181A	C173014829	05/05/2022	05/05/2023
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	05/05/2022	05/05/2023
RF Attenuator	Pasternack	PE7005-3	VL061	07/16/2021	07/16/2022
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	07/16/2021	07/16/2022
EM Center Control	ETS-Lindgren	7006-001	160136	N/A	N/A
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A	N/A
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A	N/A
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	05/16/2022	05/16/2023
RE test cable (below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	07/16/2021	07/16/2022
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	07/16/2021	07/16/2022
RE test cable (>18GHz)	Sucoflex	104	344903/4	07/16/2021	07/16/2022
Pulse limiter	Com-Power	LIT-930A	531727	07/16/2021	07/16/2022
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	07/16/2021	07/16/2022
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	07/16/2021	07/16/2022
Vector Signal Generator	Keysight	N5182A	US47080548	06/17/2021	06/17/2022
USB RF Power Sensor	ETS-Lindgren	7002-006	SN 00151268	05/15/2022	05/15/2023
RF Power Amplifier (80-1000MHz)	Ophir	5226FE	1013/1815	N/A	N/A
RF Power Amplifier (700-6000MHz)	Ophir	5293FE	1063/1815	N/A	N/A
Horn Antenna (1-18GHz)	FT-RF	HA-07M18G-NF	180010HA	N/A	N/A
Wideband Communication	R&S	CMW500	147508	05/10/2022	05/10/2023
Radio Communication Tester	Anritsu	MT8000a	6262261939	02/23/2022	02/23/2023
Temperature/Humidity Chamber	Thermotron	SM-8-8200	40991	09/08/2021	09/08/2022

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