CERTIFICATE #3478.01

TEST REPORT

EUT Description	**WLAN and BT, 2x2 PCIe M.2 1216 SD adapter card**
Brand Name	**Intel® Wi-Fi 6E AX211**
Model Name	**AX211D2W**
FCC ID	**PD9AX211D2**
Date of Test Start/End	**2022-11-28 /2022-12-02**
Features	**802.11ax, Dual Band, 2x2 Wi-Fi 6 + Bluetooth® 5.2** (see section 5)

Applicant	**Intel Corporation SAS**
Address	**425 Rue de Goa – Le Cargo B6 – 06600 Antibes, FRANCE**
Contact Person	**Benjamin Lavenant**
Telephone/Fax/ Email	**Benjamin.lavenant@intel.com**

Reference Standards	**FCC CFR Title 47 Part 15 E** (see section 1)

Test Report identification	**220930-02.TR03**
Revision Control	**Rev. 01** **This test report revision replaces any previous test report revision** (see section 8)

The test results relate only to the samples tested.
Reference to accreditation shall be used only by full reproduction of test report.

Issued by

Digitally signed by Robin Luciani
Date: 2024.04.03 10:56:12 +02'00'

Robin LUCIANI
(Test Engineer Lead)

Reviewed by

Digitally signed by zayd
DN: cn=zayd, email=zayd.ouachicha@intel.com, c=US
Date: 2024.04.03 13:17:13 +02'00'

Zayd OUACHICHA
(Technical Manager)

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1. Table of Contents

1. Standards, reference documents and applicable test methods

FCC	1. FCC Title 47 eCFR part 15 – Subpart E - Unlicensed National Information Infrastructure Devices. 2021-10-01 edition 2. FCC Title 47 eCFR part 15 – Subpart C – §15.209 Radiated emission limits; general requirements. 2021-10-01 edition 3. FCC OET KDB 987594 D01 U-NII 6GHz General Requirements v02r01 4. FCC OET KDB 987594 D02 U-NII 6 GHz EMC Measurement v02r01 5. FCC OET KDB 987594 D03 U-NII 6 GHz QA v02 6. FCC OET KDB 789033 D02 v02r01 General U-NII Test Procedures New Rules – Guidelines for compliance testing of Unlicensed National Information Infrastructure (U-NII) Devices (Part 15, Subpart E). 1. ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

2. General conditions, competences and guarantees

- ✓ Tests performed under FCC standards identified in section 1 are covered by A2LA accreditation.
- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an ISO/IEC 17025:2017 laboratory accredited by the American Association for Laboratory Accreditation (A2LA) with the certificate number 3478.01.
- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an Accredited Test Firm recognized by the FCC, with Designation Number FR0011.
- ✓ Intel WRF Lab only provides testing services and is committed to providing reliable, unbiased test results and interpretations.
- ✓ Intel WRF Lab is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.
- ✓ Intel WRF Lab has developed calibration and proficiency programs for its measurement equipment to ensure correlated and reliable results to its customers.
- ✓ This report is only referred to the item that has undergone the test.
- ✓ This report does not imply an approval of the product by the Certification Bodies or competent Authorities.

3. Environmental Conditions

- ✓ At the site where the measurements were performed the following limits were not exceeded during the tests:

Temperature	22.0ºC ± 0.4ºC
Humidity	40.3% ± 1.5%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of receipt	Note
#01	201120-03.S08	WiFi 6E Module	AX211D2W	WFM:D8F8834E56AB	2020-11-23	Used for 30MHz-40GHz Radiated Spurious Emissions tests
	170000-01.S13	Laptop	Latitude E5470	FT6LMC2	2017-05-30	
	220225-03.S23	Extender	ADEXELEC	-	2022-03-14	
	180001-01.S02	Socket	1216SD to M.2	-	2017-08-09	
	200921-01.S01	Wieson Dipole Antenna	ARY121-0009-002-H0	-	2020-09-28	
	200921-01.S02	Wieson Dipole Antenna	ARY121-0009-002-H0	-	2020-09-28	

5. EUT Features

The herein information is provided by the customer.

Intel WRF Lab declines any responsibility for the accuracy of the stated customer provided information, especially if it has any impact on the correctness of test results presented in this report.

Brand Name	Intel® Wi-Fi 6E AX211
Model Name	AX211D2W
Software Version	DRTU Version: 11195_99_2100_51G
Driver Version	99.0.58.3
Prototype / Production	Production
Supported Radios	802.11b/g/n/ax: 2.4GHz (2400.0 – 2483.5 MHz) 5.2GHz (5150.0 – 5350.0 MHz) 5.6GHz (5470.0 – 5725.0 MHz) 5.8GHz (5725.0 – 5895.0 MHz) 802.11ax: 6.0GHz (5925.0 - 7125.0MHz) Bluetooth 5.2: 2.4GHz (2400.0 – 2483.5 MHz)

Antenna Information

Transmitter	Chain A (Main)	Chain B (Aux)
Manufacturer	Wieson	Wieson
Antenna type	Dipole	Dipole
Part number	ARY121-0009-002-H0	ARY121-0009-002-H0
Declared Antenna gain (dBi) – 6.2 GHz	+5.06	+5.06
Declared Antenna gain (dBi) – 6.5 GHz	+4.71	+4.71
Declared Antenna gain (dBi) – 6.7 GHz	+4.49	+4.49
Declared Antenna gain (dBi) – 6.9 GHz	+5.34	+5.34

6. Remarks and comments

1. No deviations were made from the test methods listed in section 1 of this report
2. The low, high and midle channels were tested for each RF chain (A, B or A+B), bandwidth, modulation and sub-band. Only the worst case among the low and high channels per sub-band has been reported in this test report
3. No standard deviation has been identified for RSE test cases.

7. Test Verdicts summary

The statement of conformity to applicable standards in the table below are based on the measured values, without taking into account the measurement uncertainties.

802.11 ax – U-NII- 5 to U-NII-8

FCC Part	Test name	Verdict
15.407 (b) (5) 15.209	Undesirable emissions limits (radiated)	P

8. Document Revision History

Revision #	Modified by	Revision Details
Rev. 00	R. Simonini	First Issue
Rev. 01	R. Luciani	Applicant Update – Front page Standard Update – Section 1

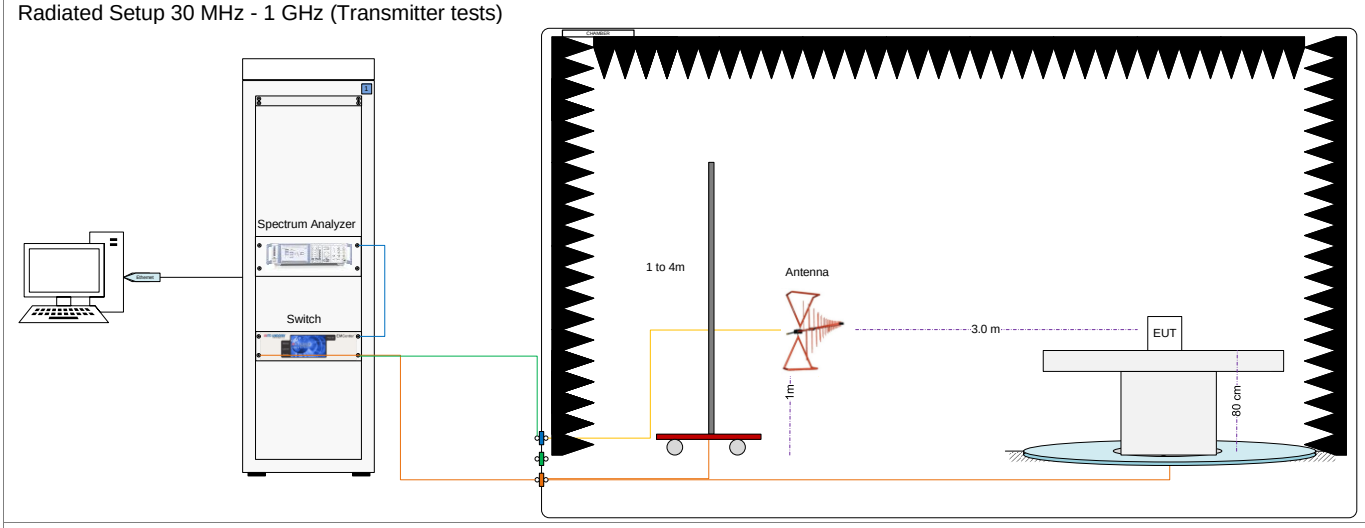
Annex A. Test & System Description

A.1 Measurement System

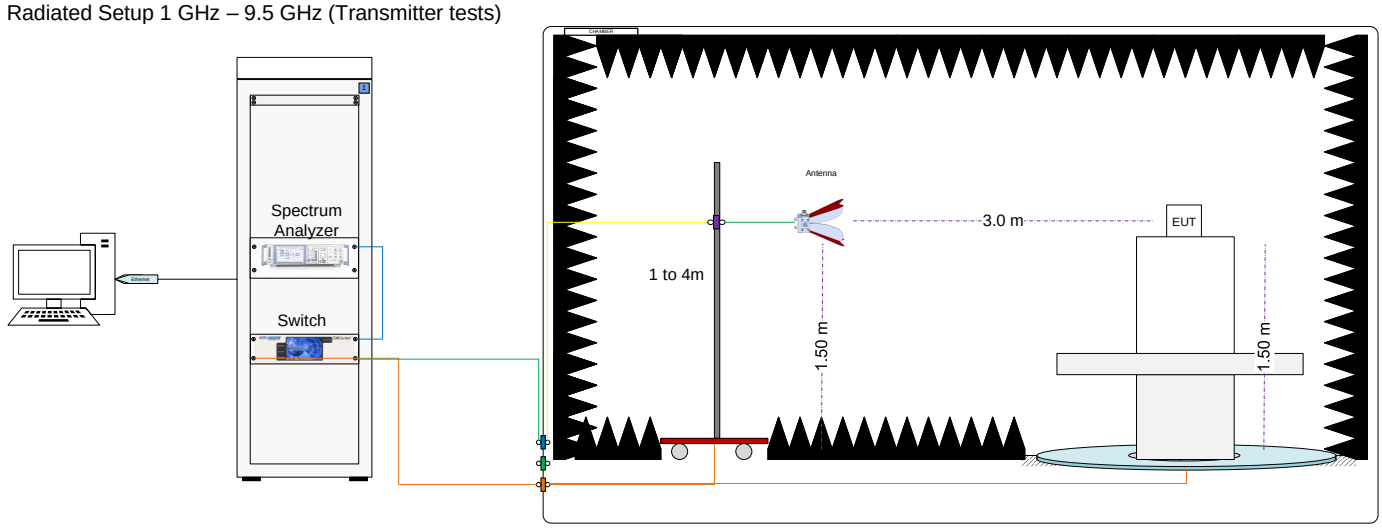
Measurements were performed using the following setups, made in accordance to the general provisions of ANSI C63.10 2013.
The DUT was installed in a test fixture and this test fixture is connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using all different modes and modulation schemes, using the Intel proprietary tool DRTU.

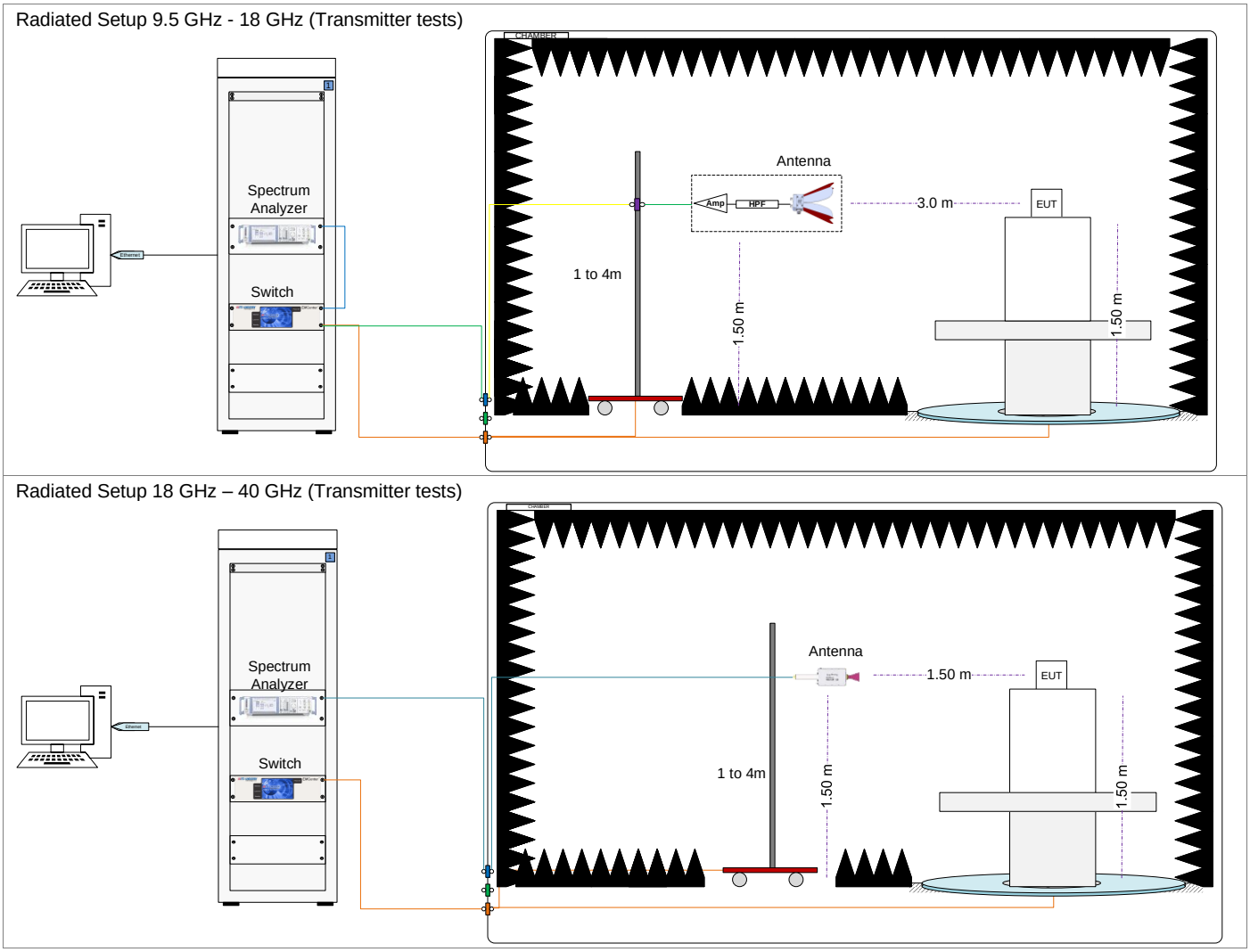
Radiated test setup

Radiated Setup 30 MHz - 1 GHz (Transmitter tests)



Radiated Setup 1 GHz – 9.5 GHz (Transmitter tests)





Sample Calculation

The spurious received voltage V(dBµV) in the spectrum Analyzer is converted to Electric field strength using the transducer factor F corresponding to the Rx path Loss:

F (dB/m)= Rx Antenna Factor (dB/m) + Cable losses (dB) – Amplifiers Gain (dBi)
E (dBµV/m) = V(dBµV) + F (dB/m)

For field strength measurements made at other than the distance at which the applicable limit is specified, the field strength of the emission at the distance specified by the limit is deduced as follows:

$$E_{SpecLimit} = E_{Meas} + 20*\log(D_{Meas}/D_{SpecLimit})$$

where

$E_{SpecLimit}$ is the field strength of the emission at the distance specified by the limit, in dBµV/m
E_{Meas} is the field strength of the emission at the measurement distance, in dBµV/m
D_{Meas} is the measurement distance, in m
$D_{SpecLimit}$ is the distance specified by the limit, in m

A.2 Test Equipment List

Radiated Setup #1

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
006-000	Anechoic chamber	FACT 3	5720	ETS Lindgren	2022-01-12	2024-01-21
006-001	Turntable	-	-	ETS Lindgren	N/A	N/A
006-008	Measurement Software v11.30.00	EMC32	100623	Rohde & Schwarz	N/A	N/A
127-000	Spectrum Analyzer	FSV40	101358	Rohde & Schwarz	2022-10-31	2024-10-31
006-002	Switch & Positioning	EMC center	00159757	ETS Lindgren	N/A	N/A
006-011	Boresight antenna mast	BAM4.0-P	P/278/2890.01	Maturo	N/A	N/A
006-061	Log-periodic Antenna 30 MHz – 1 GHz	CBL6143A	61382	Teseq	2022-10-24	2024-10-24
066-000	Horn Antenna 3117 + Amplifier + HPF9.5	3117-PA	00103954+00161429	ETS-Lindgren	2022-07-08	2024-07-08
007-008	Double Horn Ridged antenna	3116C-PA	00169308bis + 00196308	ETS-Lindgren	2021-08-05	2023-08-05
006-020	Double Ridged Horn Antenna 1 GHz – 18 GHz	3117	00157734	ETS Lindgren	2021-08-05	2023-08-05
006-059	RF Cable 7.0m	R286304174	20.46.369	Radiall	2022-08-25	2023-02-25
006-051	RF Cable 1.0m	CBL-1.5M-SMSM+	202879	Mini-Circuits	2022-08-29	2023-03-01
006-030	RF Cable 1.2m	UFA147A-0-0480-200200	MFR 64639223720-003	Micro-coax	2022-08-25	2023-02-25
006-034	Cable 1m - 1GHz to 18GHz	UFA147A	-	Utilflex	2022-08-25	2023-02-25
026-018	RF Cable 1.2m	0500990991200KE	18.23.179	Radiall	2022-08-29	2023-03-01
006-039	RF Cable 2.5m	0500990992500KE	19.23.395	Radiall	2022-08-25	2023-02-25
365-000	Temperature & Humidity logger	RA12E-TH1-RAS	00-80-A3-E1-6E-55	Avtech	2021-03-08	2023-03-08

N/A: Not Applicable

Shared Radiated Equipment

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
412-000	DRTU Power finder V2.0	-	-	Intel	NA	NA
139-000	Power Sensor	NRP-Z81	104383	Rohde & Schwarz	2021-04-07	2023-04-07
140-000	Power Sensor	NRP-Z81	104382	Rohde & Schwarz	2022-03-25	2024-03-25

A.3 Measurement Uncertainty Evaluation

The system uncertainty evaluation is shown in the table below with a coverage factor of k = 2 to indicate a 95% level of confidence:

Measurement type	Uncertainty	Unit
Radiated tests <1GHz	±6.40	dB
Radiated tests 1GHz – 40 GHz	±6.04	dB

Annex B. Test Results

The herein test results were performed by:

Test case measurement	Test Personnel
Radiated spurious emissions	R.SIMONINI

B.1 Test Conditions

For 802.11ax20 (20 MHz channel bandwidth), 802.11ax40 (40 MHz channel bandwidth), 802.11ax80 (80 MHz channel bandwidth) and 802.11ax160 (160 MHz channel bandwidth) modes the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, and also simultaneously.

The conducted RF output power at each chain was adjusted according to target values from the following table using the Intel DRTU tool and measuring the power by using a power meter.
Measured values for adjustment were within +/- 0.25 dB from the declared target values.

UNII-5 to UNII-8					Conducted Power, Target Value (dBm)		
Mode	BW (MHz)	Data Rate	CH #	Freq. (MHz)	SISO Chain A	SISO Chain B	MIMO at each ports A and B
802.11ax20	20	HE0	1	5955	21	21	21
			45	6175	21	21	21
			93	6415	21	21	21
			97	6435	18	18	15
			105	6475	18	18	15
			113	6515	18	18	15
			117	6535	21	21	21
			149	6695	21	21	21
			181	6855	21	21	21
			185	6875	18	18	15
			209	7095	18	18	15
			233	7115	18	18	15
802.11ax40	40	HE0	3	5965	21	21	21
			43	6165	21	21	21
			91	6405	21	21	21
			99	6445	18	18	15
			107	6485	18	18	15
			115	6525	18	18	15
			147	6685	21	21	21
			179	6845	21	21	21
			187	6885	18	18	15
			227	7085	18	18	15
802.11ax80	80	HE0	7	5985	21	21	21
			39	6145	21	21	21
			87	6385	21	21	21
			103	6465	18	18	15
			119	6545	18	18	15
			135	6625	21	21	21
			167	6785	21	21	21
			183	6865	18	18	15
			199	6945	18	18	15
			215	7025	18	18	15
802.11ax160	160	HE0	15	6015	21	19	18
			79	6345	21	21	21
			111	6175	18	18	15
			143	6335	21	21	21
			207	6985	18	18	15

B.2 Radiated spurious emission

Standard references

<table>
<tr><th>FCC part</th><th>Limits</th></tr>
<tr><td>15.407 (b) (5)</td><td>For transmitters operating within the 5.925-7.125 GHz band: Any emissions outside of the 5.925-7.125 GHz band must not exceed an e.i.r.p. of −27 dBm/MHz.</td></tr>
<tr><td>15.35 (b)</td><td>When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.</td></tr>
<tr><td>15.407 (b) (8)</td><td>Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in FCC Part 15.209.</td></tr>
<tr><td>15.209</td><td>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):
<table>
<tr><th>Freq Range (MHz)</th><th>Field Strength (µV/m)</th><th>Field Strength (dBµV/m)</th><th>Meas. Distance (m)</th></tr>
<tr><td>30-88</td><td>100</td><td>40</td><td>3</td></tr>
<tr><td>88-216</td><td>150</td><td>43.5</td><td>3</td></tr>
<tr><td>216-960</td><td>200</td><td>46</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>54</td><td>3</td></tr>
</table>
The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands above 1000 MHz. Radiated emission limits in this band is based on measurements employing an average detector.
For average radiated emission measurements above 1000 MHz, there is also a limit specified when measuring with peak detector function, corresponding to 20 dB above the indicated values in the table.</td></tr>
</table>

Test procedure

The radiated setups shown in section *Test & System Description* were used to measure the radiated spurious emissions.

Depending of the frequency range and bands being tested, different antennas and filters were used.

- For frequencies less than or equal to 1000 MHz, measurements were made with the CISPR quasi-peak detector with a resolution bandwidth of 120kHz and a video bandwith 3 times of the resolution bandwidth.
- For restricted bands, measurements above 1000 MHz were performed using average and peak detectors with a minimum resolution bandwidth of 1 MHz and a video bandwith 3 times of the resolution bandwidth
- For unrestricted bands, measurements above 1000 MHz were performed using RMS and peak detectors with a minimum resolution bandwidth of 1 MHz and a video bandwith 3 times of the resolution bandwidth

The final measurement is performed by varying the antenna height from 1 m to 4 m, the EUT rotating in azimuth over 360º for both vertical and horizontal polarizations.

The radiated spurious emission was measured on the worst case EUT configuration selected from the chapter B.1 and using the low, middle and high channels.

B.2.1 Test Results

30 MHz – 1 GHz, Radiated spurious emissions

Radiated Spurious – All modes

Frequency	QuasiPeak	Limit	Margin	Polar
MHz	dBµV/m	dBµV/m	dB	---
77.1	22.8	40.0	17.2	V

UNII-5

1 GHz – 40 GHz, 802.11ax20, HE0, Chain A+B

Radiated Spurious – CH93

Frequency	Level	Detector	Limit	Margin	Polar
MHz	dBµV/m	---	dBµV/m	dB	---
5131.9	52.4	Peak	74.0	21.6	H
5131.9	45.7	Average	54.0	8.3	V
17798.4	48.0	Average	54.0	6.0	V
17798.8	57.9	Peak	74.0	16.1	V
25660.1	55.8	Peak	88.2	32.4	V
25660.1	46.4	RMS	68.2	21.8	V

UNII-6

1 GHz – 40 GHz, 802.11ax20, HE0, Chain A+B

Radiated Spurious – CH97

Frequency	Level	Detector	Limit	Margin	Polar
MHz	dBµV/m	---	dBµV/m	dB	---
1715.9	47.5	Peak	88.2	40.8	H
1716.4	38.9	RMS	68.2	29.3	H
5147.5	53.1	Peak	74.0	20.9	V
5148.0	46.4	Average	54.0	7.6	V
17788.0	57.2	Peak	74.0	16.8	H
17788.0	47.9	Average	54.0	6.1	V
25739.9	48.3	Peak	88.2	39.9	V
25739.9	41.5	RMS	68.2	26.6	V

UNII-7

1 GHz – 40 GHz, 802.11ax20, HE0, Chain A+B

Radiated Spurious – CH181

Frequency	Level	Detector	Limit	Margin	Polar
MHz	dBµV/m	---	dBµV/m	dB	---
5483.8	54.3	Peak	88.2	33.9	V
5483.8	46.8	RMS	68.2	21.4	V
17831.9	58.1	Peak	74.0	15.9	V
17831.9	48.0	Average	54.0	6.0	H
27422.9	46.2	RMS	68.2	22.0	V
27423.6	55.6	Peak	88.2	32.6	V

UNII-8

1 GHz – 40 GHz, 802.11ax80, HE0, Chain A+B

Radiated Spurious – CH215

Frequency	Level	Detector	Limit	Margin	Polar
MHz	dBµV/m	---	dBµV/m	dB	---
5620.2	56.6	Peak	88.2	31.6	V
5620.2	50.9	RMS	68.2	17.3	V
17797.9	57.7	Peak	74.0	16.3	H
17797.9	48.0	Average	54.0	6.0	H
28099.4	50.1	Peak	88.2	38.1	H
28100.1	45.0	RMS	68.2	23.2	H