

RADIO TEST REPORT

Product : PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module

Model Name : ACB-QCA6391

Series Model : ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5

FCC ID : 2AE3B-ACB-QCA6391

Test Regulation : FCC 47 CFR Part 15 Subpart E (Section 15.407)

Received Date : 2021/5/18

Test Date : 2023/6/1 ~ 2023/8/16

Issued Date : 2023/9/12

Applicant : VOXMICRO LTD
20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA

Issued By : Underwriters Laboratories Taiwan Co., Ltd.
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan



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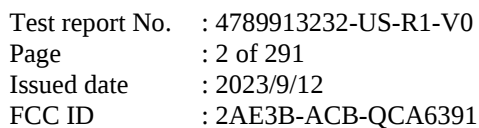
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Doc No: Form-ULID-004739 (DCS:17-EM-F0878) / 6.1



Original Test Report No.: 4789913232-US-R1-V0

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Doc No: Form-ULID-004739 (DCS:17-EM-F0878) / 6.1

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1. Attestation of Test Results

APPLICANT: VOXMICRO LTD
20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA

MANUFACTURER: VOXMICRO LTD
8F.-3, No.5, Aly. 22, Ln. 513, Rueiguang Rd., Neihu Dist., Taipei City 114, Taiwan

EUT DESCRIPTION: PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module

BRAND: AIRETOS

MODEL: ACB-QCA6391

SERIES MODEL: ACB-QCA6391-WX1, ACB-QCA6391-WX2,
ACB-QCA6391-WX4, ACB-QCA6391-WX5,
ACB-QCA6391-WI1, ACB-QCA6391-WI2,
ACB-QCA6391-WI4, ACB-QCA6391-WI5

SAMPLE STAGE: Design Verification Test sample

DATE of TESTED: 2023/6/1 ~ 2023/8/16

APPLICABLE STANDARDS	
STANDARD	Test Results
FCC 47 CFR PART 15 Subpart E (Section 15.407)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

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Approved and Authorized By:

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Project Handler

Date : 2023/9/12

Eric Lee
Senior Laboratory Engineer

Date : 2023/9/12

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2. Summary of Test Results

Summary of Test Results		
FCC Clause	Test Items	Result
15.407(e)	6dB Bandwidth	PASS
15.403(i)	26dB Bandwidth	PASS
2.1049	Occupied Bandwidth	See Note1
15.407(a)(1/2/3)	Conducted Output Power	PASS
15.407(a)(1/2/3)	Power Spectral Density	PASS
15.407(g)	Frequency Stability	PASS
15.407(b) (1/2/3/4(i/ii)/9)	Radiated Emissions and Band Edge Measurement	PASS
15.407(b)(9)	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS
15.407(h)	Dynamic Frequency Selection & Transmit power control	See Note2

Note:

1. The Occupied Bandwidth was reference only.
2. The “Dynamic Frequency Selection & Transmit power control measurement” was recorded in Report No.: 4789913232-US-R2-V0.

3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB 789033 D02 General UNII Test Procedure New Rules v02r01, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

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5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k=2$.

Determining compliance based on the results of the compliance measurement, not considering measurement instrumentation uncertainty.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	± 3.1 dB
RF Conducted	9 kHz - 40GHz	± 2.3 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	± 3.2 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	± 6.1 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	± 5.1 dB

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6. Equipment under Test

6.1. Description of EUT

Product	PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module	
Brand Name	AIRETOS	
Model Name	ACB-QCA6391	
Series Model	ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5	
Operating Frequency	5180 ~ 5240 MHz, 5260 ~ 5320 MHz, 5500 ~ 5700 MHz, 5745 ~ 5825 MHz	
Modulation	1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK	
Transfer Rate	802.11a: up to 54 Mbps 802.11n: up to MCS15 802.11ac: up to MCS9 802.11ax: up to MCS11	
Number of Channel	5180 ~ 5240 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
	5260 ~ 5320 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
	5500 ~ 5700 MHz	11 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		5 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		2 for 802.11ac (VHT80), 802.11ax (HE80)
	5745 ~ 5825 MHz	5 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)

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Maximum Output Power	Non-Beamforming mode: 5180 ~ 5240 MHz: 16.62 dBm 5260 ~ 5320 MHz: 17.91 dBm 5500 ~ 5700 MHz: 21.77 dBm 5745 ~ 5825 MHz: 22.12 dBm Beamforming mode: 5180 ~ 5240 MHz: 14.93 dBm 5260 ~ 5320 MHz: 14.83 dBm 5500 ~ 5700 MHz: 21.66 dBm 5745 ~ 5825 MHz: 21.96 dBm
Normal Voltage	3.7Vdc
S/N	E63B
Sample ID	3920615

Note:

1. The models difference table as below:

Brand	Model	Difference
AIRETOS	ACB-QCA6391	-
	ACB-QCA6391-WX1	Market assignment classification for application and grade finish
	ACB-QCA6391-WX2	
	ACB-QCA6391-WX4	
	ACB-QCA6391-WX5	
	ACB-QCA6391-WI1	
	ACB-QCA6391-WI2	
	ACB-QCA6391-WI4	
	ACB-QCA6391-WI5	

2. The EUT incorporates a MIMO function. Physically, the EUT provides two completed transmitters and two receivers.

Modulation Mode	Tx,Rx Function
802.11a	2TX,2RX
802.11n (HT20)	2TX,2RX
802.11n (HT40)	2TX,2RX
802.11ac (VHT20)	2TX,2RX
802.11ac (VHT40)	2TX,2RX
802.11ac (VHT80)	2TX,2RX
802.11ax (HE20)	2TX,2RX
802.11ax (HE40)	2TX,2RX
802.11ax (HE80)	2TX,2RX

* The modulation and bandwidth are similar for 802.11n mode for HT20 / HT40 and 802.11ac mode for VHT20 / VHT40 / VHT80 and 802.11ax mode for HE20 / HE40 / HE80, therefore investigated worst case to representative mode in test report.

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual, the laboratory shall not be held responsible.

6.2. Channel List

FOR 5180 ~ 5240MHz

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz

1 channel is provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency
42	5210MHz

FOR 5260 ~ 5320MHz

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
52	5260 MHz	60	5300 MHz
56	5280 MHz	64	5320 MHz

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
54	5270 MHz	62	5310 MHz

1 channel is provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency
58	5290MHz

FOR 5500 ~ 5700MHz

11 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
100	5500 MHz	124	5620 MHz
104	5520 MHz	128	5640 MHz
108	5540 MHz	132	5660 MHz
112	5560 MHz	136	5680 MHz
116	5580 MHz	140	5700 MHz
120	5600 MHz	-	-

5 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
102	5510 MHz	126	5630 MHz
110	5550 MHz	134	5670 MHz
118	5590 MHz	-	-

2 channels are provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency	Channel	Frequency
106	5530MHz	122	5610 MHz

FOR 5745 ~ 5825MHz:

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz	-	-

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
151	5755MHz	159	5795MHz

1 channel is provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency
155	5775MHz

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan
Radiated Spurious Emission	966-2	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan
AC power Line Conducted Emission	SR1	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan

FCC Test Firm Registration Number: 498077

Sample Calculation:

Antenna Port Conducted Measurement:

- Where relevant, the follow sample calculation is provided:
Result Value (dBm) = Reading Value (dBm) +Attenuator Factor (dB) + Cable Loss (dB).
Example: Result Value (10dBm) = Reading Value (-2dBm) +Attenuator Factor (10dB) + Cable Loss(2dB).
*Test plot only shown the “Result Value”.

Radiated Spurious Emission:

- Where relevant, the follow sample calculation is provided:
Result Value (dBuV/m) = Reading Value (dBuV) + Correction Factor (dB/m).
Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
Example: Result Value (34.5dBuV/m) = Reading Value (40.1dBuV) + Antenna Factor (18.7dB/m) + Cable Loss (4.2dB) - Preamp Factor (28.5dB).

AC power Line Conducted Emission:

- Where relevant, the follow sample calculation is provided:
Result Value (dBuV) = Reading Value (dBuV) + Correction Factor (dB).
Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).
Example: Result Value (53.7dBuV) = Reading Value (35.1dBuV) + Insertion loss(18.1dB) + Cable loss(0.5dB).

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6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)	Remark
1	Chain (0)+(1)	ethertronics	M830520	Chip	2.4GHz:1 5GHz: 2.6	UFL
2	Chain (0)+(1)	OXFORDTEC	WAFH-2DBI-15	FPC	2.4GHz: 2.7 5GHz: 2.6	UFL
3	Chain (0)+(1)	OXFORDTEC	WAND2DBI-SMA	Dipole	2.4GHz: 2 5GHz: 3	RP-SMA
4	Chain (0)+(1)	OXFORDTEC	WAND5DBI-SMA	Dipole	2.4GHz:3 5GHz: 5	RP-SMA
5	Chain (0)+(1)	OXFORDTEC	WAPH2DB4-15	PCB	2.4GHz:2.18 5GHz: 2.69	UFL

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual, the laboratory shall not be held responsible.

6.5. Test Mode Applicability and Tested Channel Detail

- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case)
- The antennas No.4 has the highest gain, the following conducted tests are all carried out using this antenna.
- The fundamental of the antennas(M830520, WAFH-2DBI-15, WAND2DBI-SMA, WAND5DBI-SMA, and WAPH2DB4-15) were investigated in three orthogonal axes X-Y/Y-Z/X-Z. The M830520 and WAFH-2DBI-15 determined that the X-Y axis was the worst-case; and the WAND2DBI-SMA, WAND5DBI-SMA, and WAPH2DB4-15 determined that the Y-Z axis was the worst-case. Therefore, all of the final radiated testing was performed with the worst case to execute the test.
- The antennas No.3/ No.4 has the same type, therefore, the highest gain was determined antenna No.4 worst-case, the Antenna No.4 was selected for the final radiated testing.
- The antennas No.4 has the highest gain, the following conducted tests are all carried out using this antenna.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Non-Beamforming mode:

Test item	Mode	Frequency Band (MHz)	Modulation	Available	Test Channel	Data Rate
			Technology	Channel		
Radiated Emissions (Above 1GHz)	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6Mbps
	802.11ax20		OFDMA	36 to 48	36, 44, 48	HE0
	802.11ax40			38 to 46	38, 46	HE0
	802.11ax80			42	42	HE0
	802.11a	5260-5320	OFDM	52 to 64	52, 60, 64	6Mbps
	802.11ax20		OFDMA	52 to 64	52, 60, 64	HE0
	802.11ax40			54 to 62	54, 62	HE0
	802.11ax80			58	58	HE0
	802.11a	5500-5700	OFDM	100 to 140	100, 116, 140	6Mbps
	802.11ax20		OFDMA	100 to 140	100, 116, 140	HE0
	802.11ax40			102 to 134	102, 110, 134	HE0
	802.11ax80			106, 122	106, 122	HE0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6Mbps
	802.11ax20		OFDMA	149 to 165	149, 157, 165	HE0
	802.11ax40			151 to 159	151, 159	HE0
	802.11ax80			155	155	HE0
Radiated Emissions (Below 1GHz)	802.11ax20	5745-5825	OFDMA	149 to 165	149	HE0
AC Power Line Conducted Emission	802.11ax20	5745-5825	OFDMA	149 to 165	149	HE0
Antenna Port Conducted Measurement	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6Mbps
	802.11ax20		OFDMA	36 to 48	36, 44, 48	HE0
	802.11ax40			38 to 46	38, 46	HE0
	802.11ax80			42	42	HE0
	802.11a	5260-5320	OFDM	52 to 64	52, 60, 64	6Mbps
	802.11ax20		OFDMA	52 to 64	52, 60, 64	HE0
	802.11ax40			54 to 62	54, 62	HE0
	802.11ax80			58	58	HE0
	802.11a	5500-5700	OFDM	100 to 140	100, 116, 140	6Mbps
	802.11ax20		OFDMA	100 to 140	100, 116, 140	HE0
	802.11ax40			102 to 134	102, 110, 134	HE0
	802.11ax80			106, 122	106, 122	HE0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6Mbps
	802.11ax20		OFDMA	149 to 165	149, 157, 165	HE0
	802.11ax40			151 to 159	151, 159	HE0
	802.11ax80			155	155	HE0

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Beamforming mode:

Test item	Mode	Frequency Band (MHz)	Modulation	Available	Test Channel	Data Rate
			Technology	Channel		
Antenna Port Conducted Measurement	802.11ax20	5180-5240	OFDMA	36 to 48	36, 44, 48	HE0
	802.11ax40			38 to 46	38, 46	HE0
	802.11ax80			42	42	HE0
	802.11ax20	5260-5320	OFDMA	52 to 64	52, 60, 64	HE0
	802.11ax40			54 to 62	54, 62	HE0
	802.11ax80			58	58	HE0
	802.11ax20	5500-5700	OFDMA	100 to 140	100, 116, 140	HE0
	802.11ax40			102 to 134	102, 110, 134	HE0
	802.11ax80			106, 122	106, 122	HE0
	802.11ax20	5745-5825	OFDMA	149 to 165	149, 157, 165	HE0
	802.11ax40			151 to 159	151, 159	HE0
	802.11ax80			155	155	HE0

*Note: The worse spurious emissions test and maximum output power was found in Non-Beamforming mode. Therefore Beamforming mode only the test data of the RF output power were recorded in this report.

Simultaneously transmission condition:

Condition	Technology	
1	BT-GFSK	WLAN (5GHz)

Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.

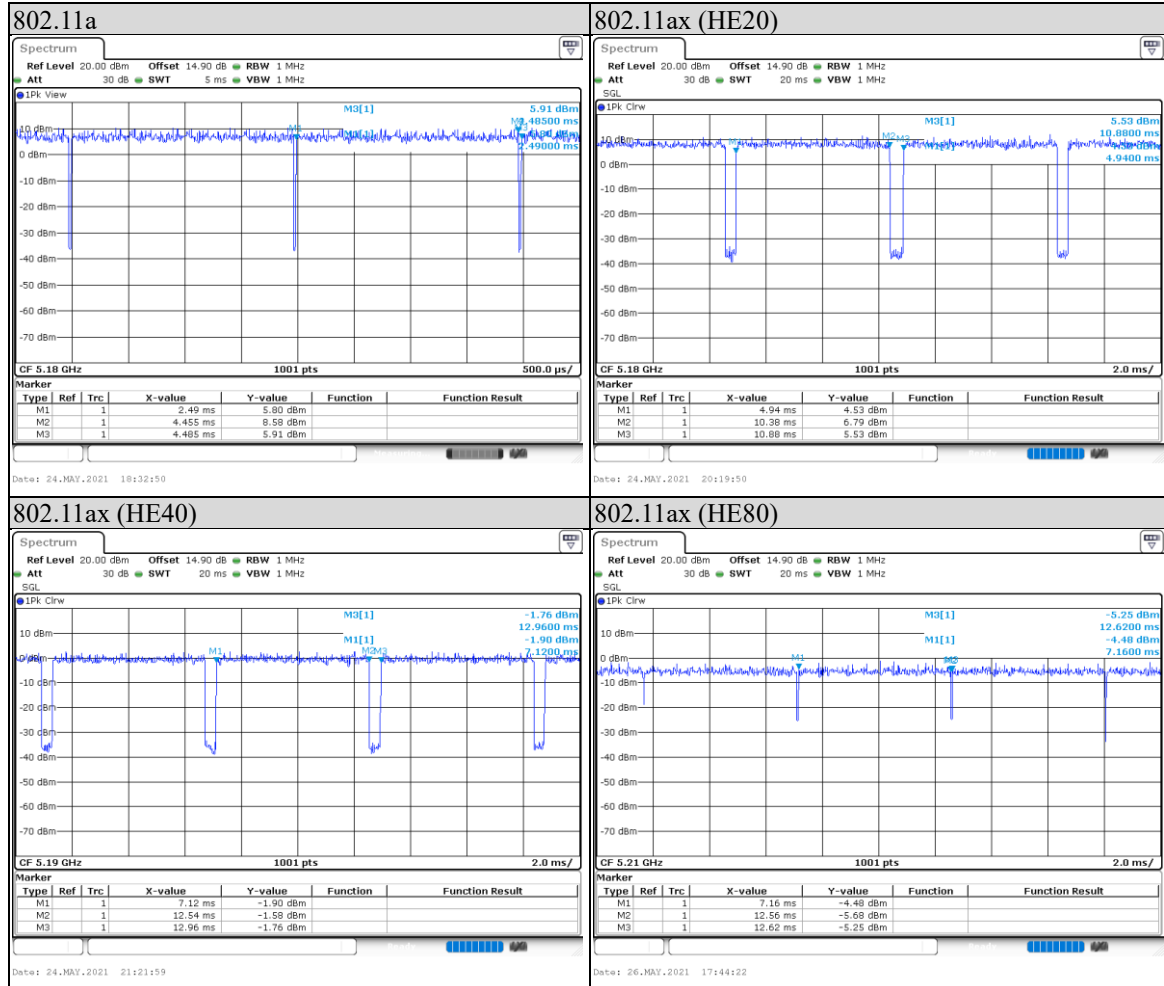
6.6. Duty cycle

802.11a: Duty cycle = $1.965/1.995 = 0.985$ duty cycle of test signal is $\geq 98\%$, duty factor is not required.

802.11ax (HE20): Duty cycle = $5.44/5.94 = 0.916$, Duty factor(dB) = $10 * \log(1/0.916) = 0.39$

802.11ax (HE40): Duty cycle = $5.42/5.84 = 0.928$, Duty factor(dB) = $10 * \log(1/0.928) = 0.33$

802.11ax (HE80): Duty cycle = $5.4/5.46 = 0.989$ duty cycle of test signal is $\geq 98\%$, duty factor is not required.



7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2023/4/7	2024/4/6
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2022/12/13	2023/12/12
Loop Antenna	ETS lindgren	6502	00213440	2023/1/4	2024/1/3
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2023/2/13	2024/2/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2022/12/21	2023/12/20
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2022/12/30	2023/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980404	2023/5/24	2024/5/23
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2023/2/17	2024/2/16
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2023/5/9	2024/5/8
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2022/12/1	2023/11/30
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2022/12/1	2023/11/30

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Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2022/10/24	2023/10/23
Attenuator	EMCI	EMC-40ATK2W10	17002	2022/12/9	2023/12/8
Pulse Power Sensor	Anritsu	MA2411B	1531202	2023/1/4	2024/1/3
Power Meter	Anritsu	ML2495A	1645002	2023/1/4	2024/1/3
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2022/11/10	2023/11/9
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2023/5/24	2024/5/23
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2022/8/30	2023/8/29
Cables	TITAN	CFD200	T0732ACFD200 20A300-2	2023/5/23	2024/5/22

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF-Conducted-FCC 15247	ver 1.0
AC power Line Conducted Emission	EZ_EMG	UL-3A1.2

8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	Lenovo	T460	PC0FWU5Y	Provide by Lab
B	Mini PCI-E to ExpressCard board	PHIYO TECH	ExpressCard Extender	19	Provide by Client
C	Adapter	Phihong	PSAA12A-120L6	N/A	Provide by Client

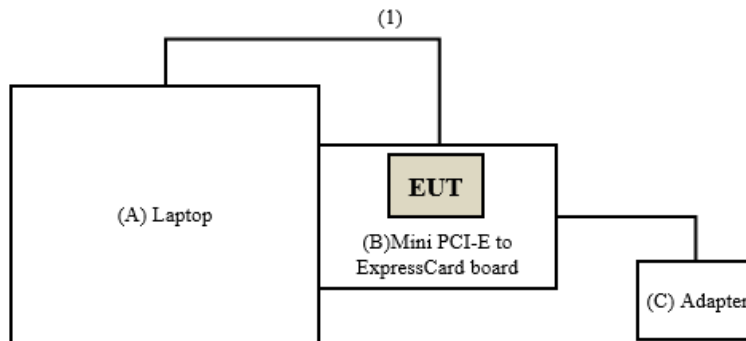
I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Micro USB Cable	fujiei	US0082	1	Provide by Client

Test Setup

Controlled using a bespoke application (QRCT_Version 4.0.00185.0) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test



Under Table

Remote Site

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9. Test Results

9.1. 6dB Bandwidth

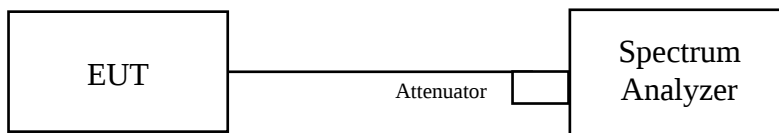
Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz.

Test procedure

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

802.11a

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	15.62	15.42	0.5	PASS
157	5785	15.34	15.58	0.5	PASS
165	5825	16.30	15.98	0.5	PASS

802.11ax (HE20)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	17.70	17.06	0.5	PASS
157	5785	17.62	17.78	0.5	PASS
165	5825	18.14	16.46	0.5	PASS

802.11ax (HE40)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
151	5755	37.24	37.00	0.5	PASS
159	5795	37.08	35.72	0.5	PASS

802.11ax (HE80)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
155	5775	76.40	66.17	0.5	PASS

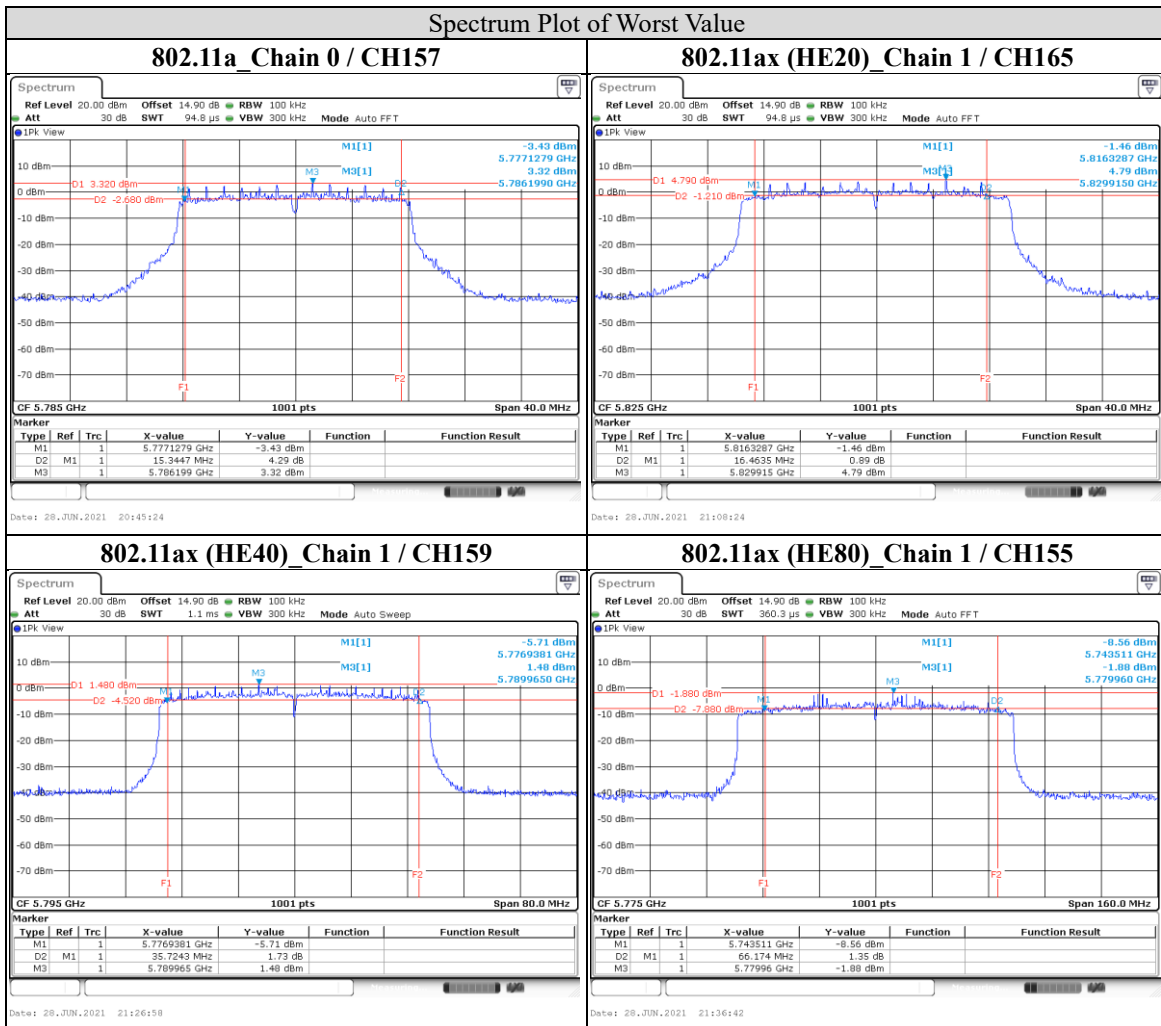
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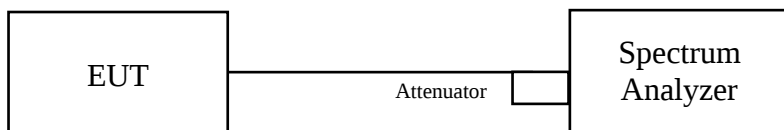


9.2. 26dB Bandwidth

Test procedure

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

802.11a

Channel	Channel Frequency (MHz)	26 dB Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	19.50	19.46
44	5220	20.46	19.70
48	5240	19.90	19.82
52	5260	20.50	19.38
60	5300	19.82	19.58
64	5320	19.86	19.82
100	5500	19.46	19.54
116	5580	19.90	20.02
140	5700	20.22	19.74

802.11ax (HE20)

Channel	Channel Frequency (MHz)	26 dB Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	20.82	20.98
44	5220	20.78	21.18
48	5240	20.86	20.94
52	5260	20.90	21.34
60	5300	20.74	20.90
64	5320	20.74	20.98
100	5500	20.82	20.90
116	5580	20.70	20.66
140	5700	21.06	21.22

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802.11ax (HE40)

Channel	Channel Frequency (MHz)	26 dB Bandwidth (MHz)	
		Chain 0	Chain 1
38	5190	40.68	40.60
46	5230	40.68	40.60
54	5270	40.20	40.44
62	5310	40.60	40.52
102	5510	40.44	40.28
110	5550	40.36	40.44
134	5670	40.36	40.52

802.11ax (HE80)

Channel	Channel Frequency (MHz)	26 dB Bandwidth (MHz)	
		Chain 0	Chain 1
42	5210	82.48	82.00
58	5290	82.48	82.32
106	5530	82.16	82.48
122	5610	82.16	82.64

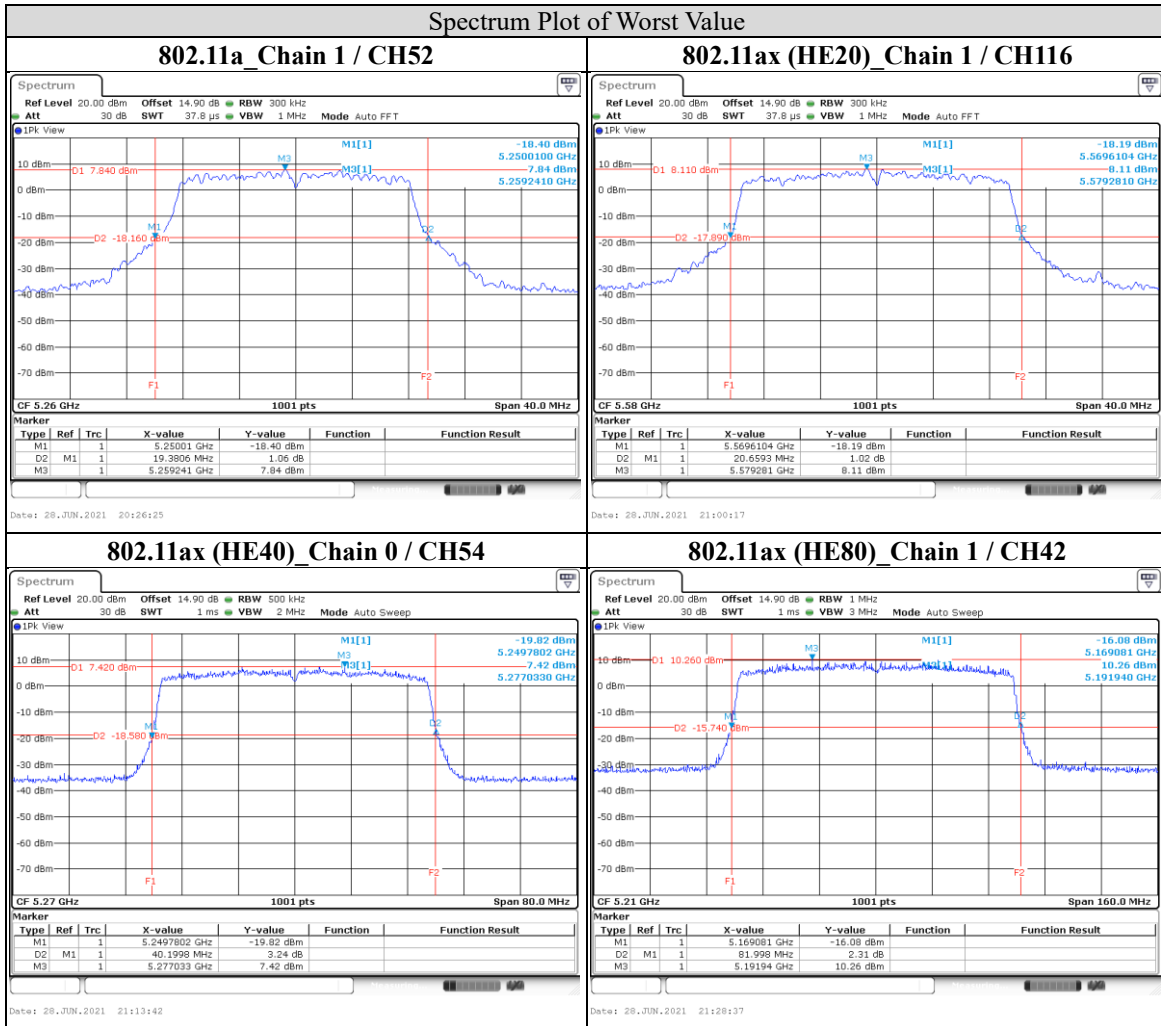
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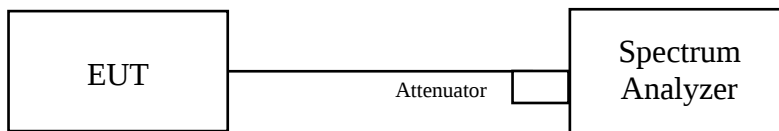


9.3. Occupied Bandwidth

Test procedure

- a. Set center frequency to the nominal EUT channel center frequency.
- b. Set span = 1.5 times to 5.0 times the OBW.
- c. Set RBW = 1% to 5% of the OBW
- d. Set VBW $\geq 3 \times$ RBW
- e. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f. Use the 99% power bandwidth function of the instrument (if available).
- g. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

802.11a

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	16.38	16.42
44	5220	16.42	16.42
48	5240	16.34	16.42
52	5260	16.38	16.42
60	5300	16.38	16.42
64	5320	16.38	16.38
100	5500	16.38	16.38
116	5580	16.34	16.38
140	5700	16.38	16.38
149	5745	16.38	16.42
157	5785	16.38	16.42
165	5825	16.38	16.38

802.11ax (HE20)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	18.90	18.90
44	5220	18.90	18.90
48	5240	18.90	18.90
52	5260	18.94	18.90
60	5300	18.90	18.90
64	5320	18.90	18.90
100	5500	18.82	18.86
116	5580	18.90	18.86
140	5700	18.90	18.90
149	5745	18.90	18.86
157	5785	18.90	18.86
165	5825	18.86	18.86

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802.11ax (HE40)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		Chain 0	Chain 1
38	5190	37.64	37.64
46	5230	37.56	37.64
54	5270	37.64	37.64
62	5310	37.64	37.64
102	5510	37.64	37.64
110	5550	37.64	37.72
134	5670	37.56	37.64
151	5755	37.64	37.64
159	5795	37.64	37.64

802.11ax (HE80)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		Chain 0	Chain 1
42	5210	77.04	77.20
58	5290	77.04	77.04
106	5530	77.04	77.04
122	5610	77.04	77.04
155	5775	77.20	77.04

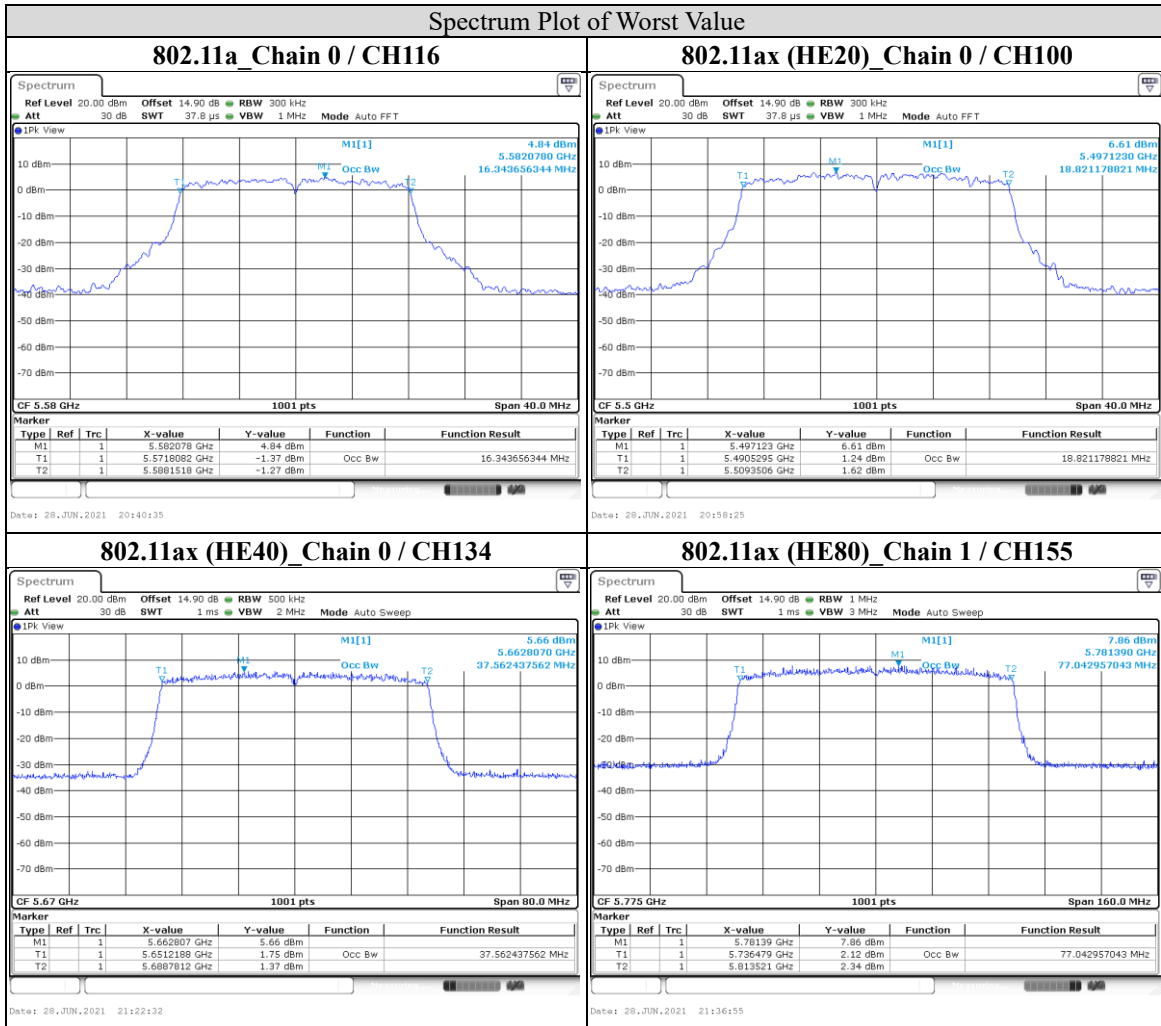
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9.4. Conducted output power

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) Max. e.i.r.p $\leq$ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$
		Fixed point-to-point Access Point	1 Watt (30 dBm) If $G_{TX} > 23$ dBi, then $P_{Out} = 30 - (G_{TX} - 23)$
		Indoor Access Point	1 Watt (30 dBm) If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$
	√	Client device	250mW (24 dBm) If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-2A	√		250mW (24 dBm) or 11 dBm+10 log B* If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-2C	√		250mW (24 dBm) or 11 dBm+10 log B* If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-3	√		For Point-to-multipoint systems (P2M): 1 Watt (30 dBm). If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$ For Point-to-point systems (P2P): 1 Watt (30 dBm)

Note:

- P_{Out} = maximum conducted output power in dBm, G_{TX} = the maximum transmitting antenna directional gain in dBi, B is the 26 dB emission bandwidth in megahertz
- Directional Gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{Gn/20})^2 / N_{ant}]$ dBi.
 N_{ant} : Number of Transmit Antennas
 $G1, G2, \dots, Gn$: Gain of Individual Antennas
Example: two antenna and gain 5 dBi / 3dBi, so if it was used for TxBF power measurement
Directional Gain = $10 \log[(10^{5/20} + 10^{3/20})^2 / 2]$ dBi = 7.07 dBi
- Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices, CDD
Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT} ;
Array Gain = $5 \log(N_{ANT}/N_{SS})$ dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.
Example: Maximum antenna gain = 5 dBi and $N_{ANT} \leq 4$, so if it was used for CDD power measurement
Directional Gain = 5 dBi + Array Gain = 5 dBi + 0 dB = 5 dBi
- For power measurement of KDB 662911 is used with multiple transmitter output. Total conducted power is the sum of the conducted power levels measured at the various output ports.

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Test Procedure

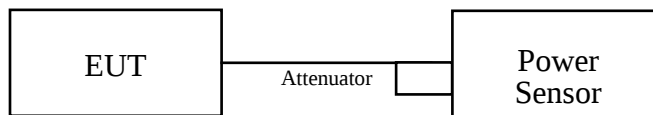
For Average Power Measurement

Test method PM

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

Test Setup

For Average Power Measurement



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

Test Data**Non-Beamforming mode****802.11a**

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
36	5180	12.00	11.51	29.992	14.77	23.98	PASS
44	5220	12.29	11.53	31.189	14.94	23.98	PASS
48	5240	12.21	11.30	30.13	14.79	23.98	PASS
52	5260	15.19	14.52	61.376	17.88	23.87	PASS
60	5300	15.15	14.01	57.943	17.63	23.91	PASS
64	5320	15.03	14.19	58.076	17.64	23.97	PASS
100	5500	17.01	17.90	111.944	20.49	23.89	PASS
116	5580	16.81	17.87	109.144	20.38	23.98	PASS
140	5700	17.44	17.47	111.429	20.47	23.95	PASS
149	5745	17.43	17.39	110.154	20.42	30	PASS
157	5785	17.36	17.26	107.647	20.32	30	PASS
165	5825	17.60	17.38	112.202	20.50	30	PASS

Note: The directional gain = 5 dBi < 6 dBi, so the power limit shall not be reduced.

802.11ax (HE20)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
36	5180	11.57	10.97	26.853	14.29	23.98	PASS
44	5220	11.72	11.06	27.606	14.41	23.98	PASS
48	5240	11.68	10.78	26.669	14.26	23.98	PASS
52	5260	15.23	14.54	61.802	17.91	23.98	PASS
60	5300	14.71	13.70	52.966	17.24	23.98	PASS
64	5320	14.68	13.87	53.703	17.30	23.98	PASS
100	5500	16.09	17.05	91.411	19.61	23.98	PASS
116	5580	18.26	19.20	150.314	21.77	23.98	PASS
140	5700	13.95	13.02	44.875	16.52	23.98	PASS
149	5745	19.33	18.88	162.93	22.12	30	PASS
157	5785	19.22	18.92	161.436	22.08	30	PASS
165	5825	19.35	18.71	160.325	22.05	30	PASS

Note: The directional gain = 5 dBi < 6 dBi, so the power limit shall not be reduced.

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802.11ax (HE40)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
38	5190	13.43	13.79	45.92	16.62	23.98	PASS
46	5230	12.05	12.14	32.434	15.11	23.98	PASS
54	5270	14.92	14.01	56.234	17.50	23.98	PASS
62	5310	12.40	11.44	31.333	14.96	23.98	PASS
102	5510	13.19	14.35	48.084	16.82	23.98	PASS
110	5550	17.27	18.39	122.462	20.88	23.98	PASS
134	5670	16.78	17.62	105.439	20.23	23.98	PASS
151	5755	17.84	18.23	127.35	21.05	30	PASS
159	5795	17.95	18.27	129.42	21.12	30	PASS

Note: The directional gain = 5 dBi < 6 dBi, so the power limit shall not be reduced.

802.11ax (HE80)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
42	5210	11.84	11.52	29.444	14.69	23.98	PASS
58	5290	12.02	11.12	28.84	14.60	23.98	PASS
106	5530	13.74	13.12	44.157	16.45	23.98	PASS
122	5610	12.94	12.27	36.559	15.63	23.98	PASS
155	5775	12.06	12.43	33.574	15.26	30	PASS

Note: The directional gain = 5 dBi < 6 dBi, so the power limit shall not be reduced.

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Beamforming mode

802.11ax (HE20)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
36	5180	11.48	10.78	26.002	14.15	21.97	PASS
44	5220	11.54	10.93	26.669	14.26	21.97	PASS
48	5240	11.59	10.62	25.942	14.14	21.97	PASS
52	5260	11.86	11.12	28.314	14.52	21.97	PASS
60	5300	11.77	11.04	27.733	14.43	21.97	PASS
64	5320	11.73	11.12	27.861	14.45	21.97	PASS
100	5500	15.96	17.02	89.743	19.53	21.97	PASS
116	5580	18.17	19.08	146.555	21.66	21.97	PASS
140	5700	13.85	12.88	43.652	16.40	21.97	PASS
149	5745	19.21	18.68	157.036	21.96	27.99	PASS
157	5785	19.00	18.77	154.882	21.90	27.99	PASS
165	5825	19.20	18.57	155.239	21.91	27.99	PASS

Note: The directional gain = 8.01 dBi > 6 dBi, so the power limit shall be reduced.

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802.11ax (HE40)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
38	5190	11.57	11.39	28.119	14.49	21.97	PASS
46	5230	11.85	11.99	31.117	14.93	21.97	PASS
54	5270	11.55	11.49	28.379	14.53	21.97	PASS
62	5310	12.24	11.36	30.409	14.83	21.97	PASS
102	5510	13.12	14.28	47.315	16.75	21.97	PASS
110	5550	17.26	18.31	121.06	20.83	21.97	PASS
134	5670	16.48	17.52	100.925	20.04	21.97	PASS
151	5755	17.59	18.03	121.06	20.83	27.99	PASS
159	5795	17.76	18.11	124.451	20.95	27.99	PASS

Note: The directional gain = 8.01 dBi > 6 dBi, so the power limit shall be reduced.

802.11ax (HE80)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)		Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass/Fail
		Chain 0	Chain 1				
42	5210	11.81	11.33	28.774	14.59	21.97	PASS
58	5290	11.93	11.04	28.314	14.52	21.97	PASS
106	5530	12.60	14.02	43.451	16.38	21.97	PASS
122	5610	13.29	11.83	36.559	15.63	21.97	PASS
155	5775	11.78	12.30	32.063	15.06	27.99	PASS

Note: The directional gain = 8.01 dBi > 6 dBi, so the power limit shall be reduced.

9.5. Power Spectral Density

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 17 - (G_{TX} - 6)$
		Fixed point-to-point Access Point	17dBm/ MHz If $G_{TX} > 23$ dBi, then $PSD = 17 - (G_{TX} - 23)$
		Indoor Access Point	17dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 17 - (G_{TX} - 6)$
	√	Client device	11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-2A	√		11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-2C	√		11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-3	√		For Point-to-multipoint systems (P2M): 30dBm/ 500kHz. If $G_{TX} > 6$ dBi, then $PSD = 30 - (G_{TX} - 6)$ For Point-to-point systems (P2P): 30dBm/ 500kHz

Note:

- PSD = power spectral density that the same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz
- G_{TX} = the maximum transmitting antenna directional gain in dBi.
- Directional Gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{Gn/20})^2 / N_{ant}]$ dBi.
 N_{ant} : Number of Transmit Antennas
 $G1, G2, \dots, Gn$: Gain of Individual Antennas
Example: two antenna and gain 5 dBi / 3dBi, so if it was used for power density measurement
Directional Gain = $10 \log[(10^{5/20} + 10^{3/20})^2 / 2]$ dBi = 7.07 dBi
- "PSD per chain" of the report shown is maximum value for each chain, at the "Total PSD" is summing entire spectra across corresponding frequency bins on the various outputs by computer, refer KDB 662911 Method a) for calculating total power density.
- Method a) of power density measurement of KDB 662911 is used for calculating total power density with multiple transmitter output. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
- Refer to section 6.6 for duty cycle spectrum plot. (If duty cycle < 98%)

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Test procedure

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

Using method as below:

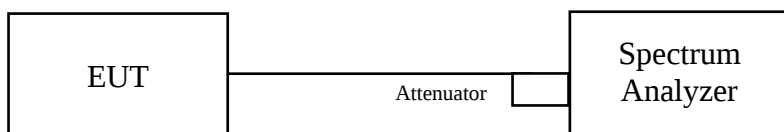
- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 1 MHz, Set VBW $\geq$ 3 RBW, Detector = RMS
- Sweep time = auto, trigger set to “free run”.
- Trace average at least 100 traces in power averaging mode.
- Record the max value. (if Duty cycle <98 %, add 10 log (1/duty cycle))

For U-NII-3 band:

Using method as below:

- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 300 kHz, Set VBW $\geq$ 1 MHz, Detector = RMS
- Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
- Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10 \log (500 \text{ kHz}/300\text{kHz})$
- Sweep time = auto, trigger set to “free run”.
- Trace average at least 100 traces in power averaging mode.
- Record the max value. (if Duty cycle <98 %, add 10 log (1/duty cycle))

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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Test Data

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

802.11a

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/MHz)		Total PSD with duty factor (dBm/MHz)	PSD Maximum Limit (dBm/MHz)	Pass/Fail
		Chain 0	Chain 1			
36	5180	-1.01	-1.59	1.72	8.99	PASS
44	5220	-0.59	-1.86	1.83	8.99	PASS
48	5240	-0.91	-1.95	1.61	8.99	PASS
52	5260	3.29	2.76	6.04	8.99	PASS
60	5300	2.76	1.63	5.24	8.99	PASS
64	5320	2.37	1.67	5.04	8.99	PASS
100	5500	4.78	5.42	8.12	8.99	PASS
116	5580	4.68	5.59	8.17	8.99	PASS
140	5700	3.69	5.93	7.96	8.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.

802.11ax (HE20)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/MHz)		Total PSD with duty factor (dBm/MHz)	PSD Maximum Limit (dBm/MHz)	Pass/Fail
		Chain 0	Chain 1			
36	5180	-1.16	-1.81	1.93	8.99	PASS
44	5220	-1.50	-2.22	1.56	8.99	PASS
48	5240	-1.49	-2.51	1.43	8.99	PASS
52	5260	2.58	2.02	5.71	8.99	PASS
60	5300	2.16	1.47	5.23	8.99	PASS
64	5320	1.97	1.15	4.98	8.99	PASS
100	5500	4.28	5.25	8.19	8.99	PASS
116	5580	4.29	5.39	8.28	8.99	PASS
140	5700	0.99	0.10	3.97	8.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.

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802.11ax (HE40)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/MHz)		Total PSD with duty factor (dBm/MHz)	PSD Maximum Limit (dBm/MHz)	Pass/Fail
		Chain 0	Chain 1			
38	5190	-3.53	-3.64	-0.24	8.99	PASS
46	5230	-3.95	-3.95	-0.61	8.99	PASS
54	5270	-0.63	-1.56	2.27	8.99	PASS
62	5310	-0.58	-1.41	2.37	8.99	PASS
102	5510	0.43	1.09	4.11	8.99	PASS
110	5550	3.91	4.26	7.43	8.99	PASS
134	5670	2.65	3.79	6.6	8.99	PASS

Note:

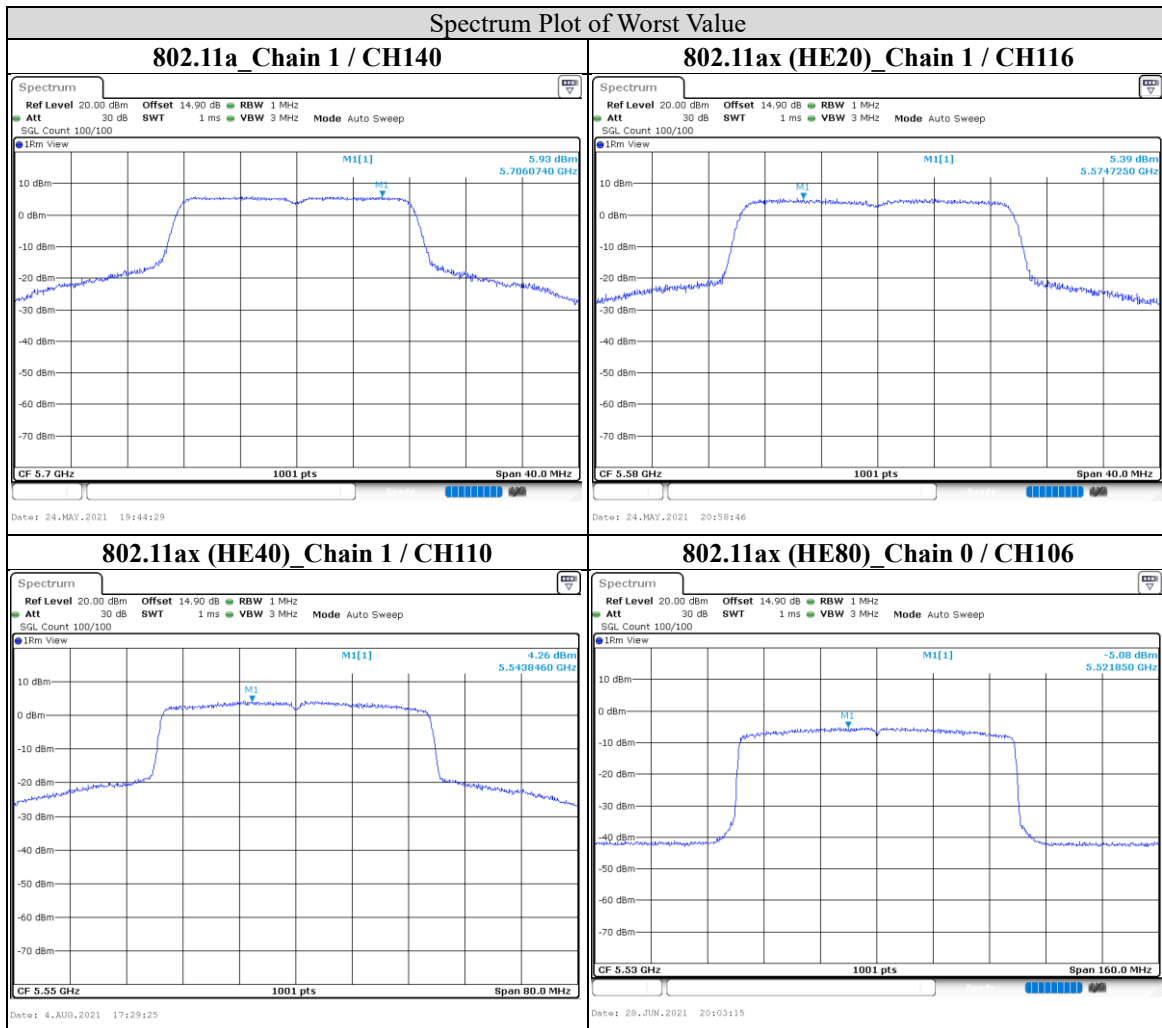
1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.

802.11ax (HE80)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/MHz)		Total PSD with duty factor (dBm/MHz)	PSD Maximum Limit (dBm/MHz)	Pass/Fail
		Chain 0	Chain 1			
42	5210	-7.81	-6.69	-4.2	8.99	PASS
58	5290	-7.56	-6.42	-3.94	8.99	PASS
106	5530	-5.08	-6.77	-2.83	8.99	PASS
122	5610	-6.32	-7.74	-3.96	8.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.



For U-NII-3 Band

802.11a

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/300 kHz)		Total PSD w/o BWCF (dBm/300 kHz)	Total PSD with BWCF (dBm/500 kHz)	Total PSD with duty factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
		Chain 0	Chain 1					
149	5745	1.47	1.71	4.6	6.82	6.82	27.99	PASS
157	5785	1.65	1.75	4.71	6.93	6.93	27.99	PASS
165	5825	0.72	0.77	3.76	5.98	5.98	27.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(500 \text{ kHz}/300\text{kHz})$.

802.11ax (HE20)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/300 kHz)		Total PSD w/o BWCF (dBm/300 kHz)	Total PSD with BWCF (dBm/500 kHz)	Total PSD with duty factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
		Chain 0	Chain 1					
149	5745	2.19	2.36	5.29	7.51	7.9	27.99	PASS
157	5785	2.82	2.48	5.66	7.88	8.27	27.99	PASS
165	5825	2.49	1.37	4.98	7.20	7.59	27.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(500 \text{ kHz}/300\text{kHz})$.

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802.11ax (HE40)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/300 kHz)		Total PSD w/o BWCF (dBm/300 kHz)	Total PSD with BWCF (dBm/500 kHz)	Total PSD with duty factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
		Chain 0	Chain 1					
151	5755	-1.60	-0.80	1.83	4.05	4.38	27.99	PASS
159	5795	-1.34	-0.55	2.08	4.30	4.63	27.99	PASS

Note:

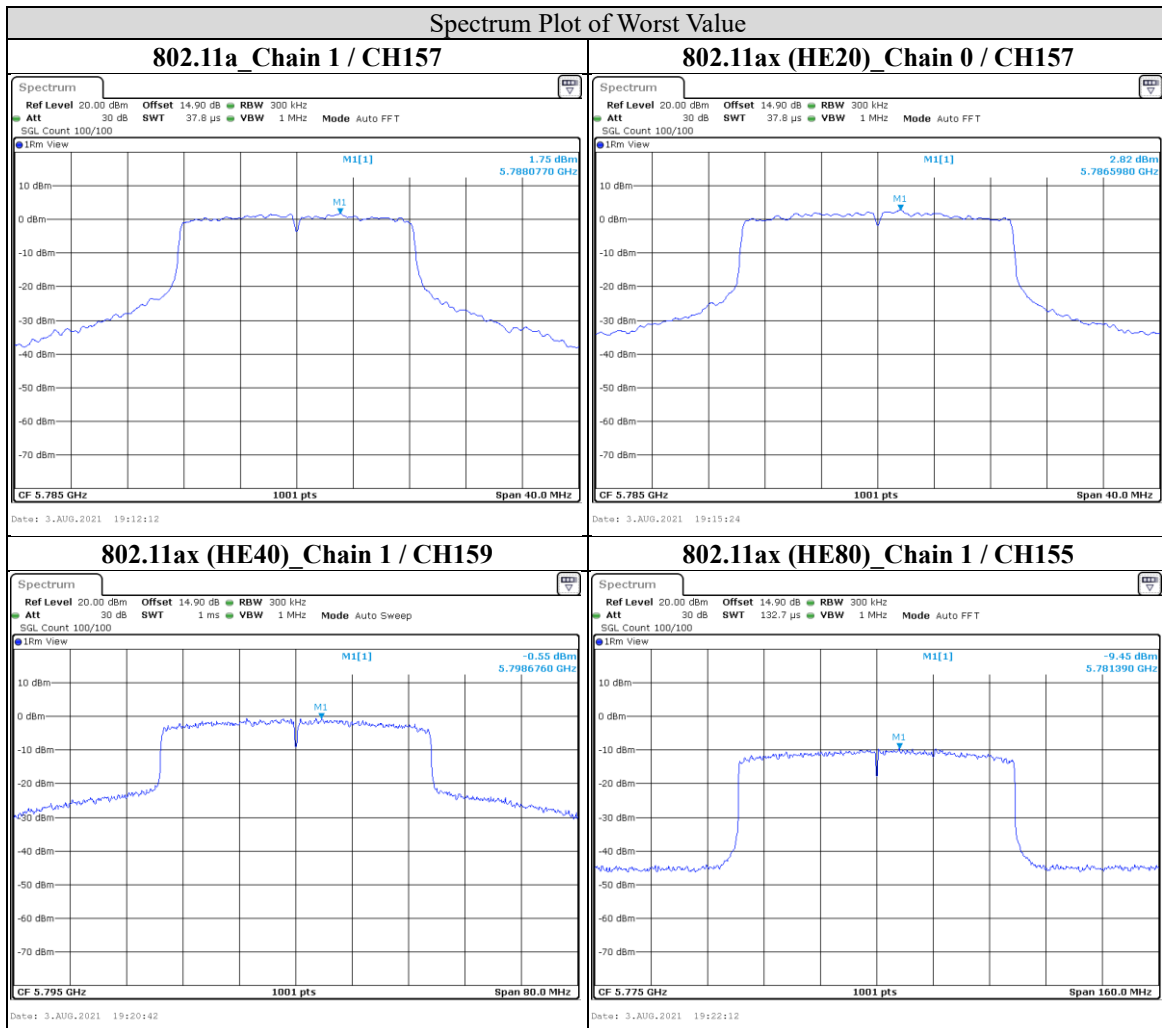
1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(500 \text{ kHz}/300\text{kHz})$.

802.11ax (HE80)

Channel	Frequency (MHz)	PSD w/o duty factor (dBm/300 kHz)		Total PSD w/o BWCF (dBm/300 kHz)	Total PSD with BWCF (dBm/500 kHz)	Total PSD with duty factor (dBm/500 kHz)	Limit (dBm/500 kHz)	Pass / Fail
		Chain 0	Chain 1					
155	5775	-10.22	-9.45	-6.81	-4.59	-4.59	27.99	PASS

Note:

1. Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.
2. Refer to section 6.6 for duty cycle spectrum plot.
3. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(500 \text{ kHz}/300\text{kHz})$.



9.6. Frequency Stability

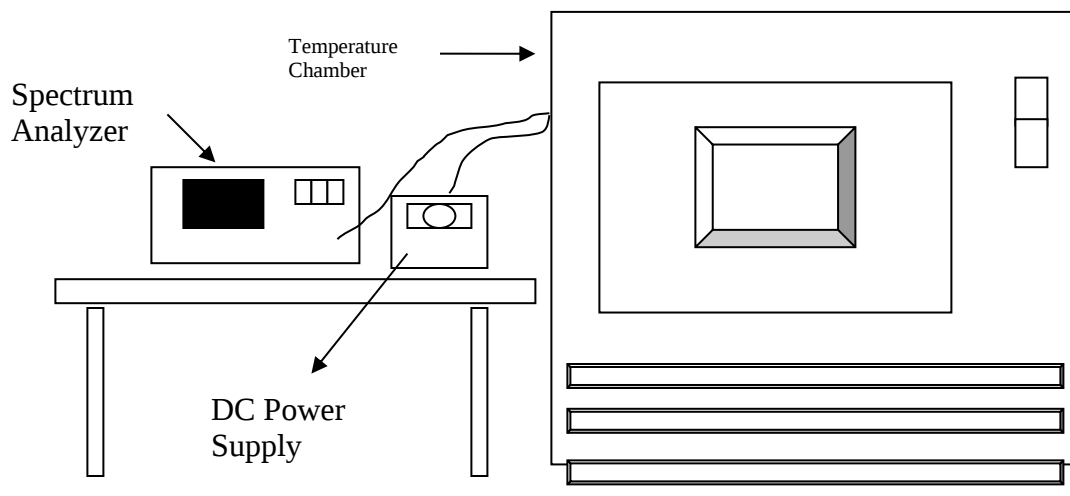
Requirements

The frequency of the carrier signal shall be maintained within band of operation.

Test procedure

- The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
- Turn the EUT on and couple its output to a spectrum analyzer.
- Turn the EUT off and set the chamber to the highest temperature specified.
- Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
- Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
- The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

Test Setup



Test Data

Frequency Stability Versus Temp.									
Operating Frequency: 5180 MHz									
TEMP. (°C)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
85	3.7	5180.0229	4.42	5180.0278	5.37	5180.0244	4.71	5180.0252	4.86
80	3.7	5179.9949	-0.98	5179.9952	-0.93	5179.9911	-1.72	5179.9924	-1.47
70	3.7	5179.9877	-2.37	5179.9875	-2.41	5179.9888	-2.16	5179.9897	-1.99
60	3.7	5180.0247	4.77	5180.0233	4.50	5180.0274	5.29	5180.0277	5.35
50	3.7	5179.9872	-2.47	5179.9869	-2.53	5179.9863	-2.64	5179.9857	-2.76
40	3.7	5179.9809	-3.69	5179.9809	-3.69	5179.9797	-3.92	5179.9816	-3.55
30	3.7	5180.0139	2.68	5180.0122	2.36	5180.0149	2.88	5180.0153	2.95
20	3.7	5180.0246	4.75	5180.0232	4.48	5180.0205	3.96	5180.0202	3.90
10	3.7	5180.0079	1.53	5180.0113	2.18	5180.0096	1.85	5180.0077	1.49
0	3.7	5179.9874	-2.43	5179.9866	-2.59	5179.9871	-2.49	5179.9857	-2.76
-10	3.7	5180.0032	0.62	5180.0027	0.52	5180.0001	0.02	5180.0004	0.08
-20	3.7	5179.9761	-4.61	5179.978	-4.25	5179.9787	-4.11	5179.9757	-4.69
-30	3.7	5179.9882	-2.28	5179.9906	-1.81	5179.9876	-2.39	5179.9871	-2.49
-40	3.7	5180.016	3.09	5180.0185	3.57	5180.0199	3.84	5180.0192	3.71
TEMP. (°C)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
20	4.25	5180.0244	4.71	5180.0228	4.40	5180.0195	3.76	5180.0208	4.02
20	3.7	5180.0246	4.75	5180.0232	4.48	5180.0205	3.96	5180.0202	3.90
20	3.15	5180.0251	4.85	5180.0234	4.52	5180.0204	3.94	5180.0206	3.98

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9.7. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

Frequency(MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
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

NOTE:

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

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Limits of unwanted emission out of the restricted bands

Applicable To		Limit	
789033 D02 General UNII Test Procedure New Rules v02r01		Field Strength at 3m	
		PK:74 (dBμV/m)	AV:54 (dBμV/m)
Frequency Band	Applicable To	EIRP Limit	Equivalent Field Strength at 3m
5150~5250 MHz	15.407(b)(1)	PK:-27 (dBm/MHz)	PK:68.2(dBμV/m)
5250~5350 MHz	15.407(b)(2)		
5470~5725 MHz	15.407(b)(3)		
5725~5850 MHz	15.407(b)(4)(i)	PK:-27 (dBm/MHz) ^{*1} PK:10 (dBm/MHz) ^{*2} PK:15.6 (dBm/MHz) ^{*3} PK:27 (dBm/MHz) ^{*4}	PK: 68.2(dBμV/m) ^{*1} PK:105.2 (dBμV/m) ^{*2} PK: 110.8(dBμV/m) ^{*3} PK:122.2 (dBμV/m) ^{*4}
*1 beyond 75 MHz or more above of the band edge. *2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above. *3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above. *4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.			

Note:

The following formula is used to convert the effective isotropic radiated power (eirp) to field strength:

$$E = \frac{1000000\sqrt{30P}}{3} \mu\text{V/m, where P is the eirp (Watts).}$$

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Test Procedures

[For 9 kHz ~ 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

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Note:

- a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle $< 98\%$) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

Configuration	Average	
	RBW	VBW
802.11a	1MHz	10Hz
802.11ax (HE20)		200Hz
802.11ax (HE40)		200Hz
802.11ax (HE80)		10Hz

Note: Refer to section 6.6 for duty cycle.

- d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
- e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
- f. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
- g. Test data of Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
- h. Test data of Notation "@" = Fundamental Frequency
- i. Test data of Notation "*" = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

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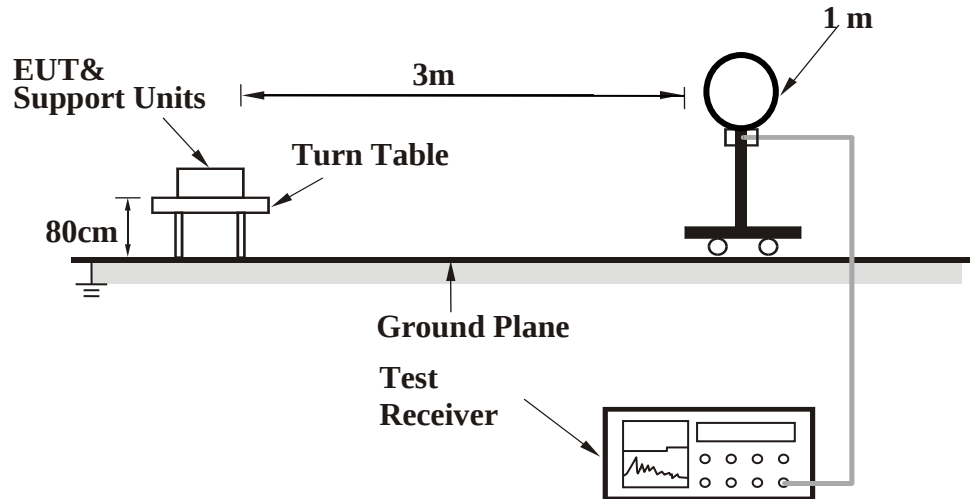
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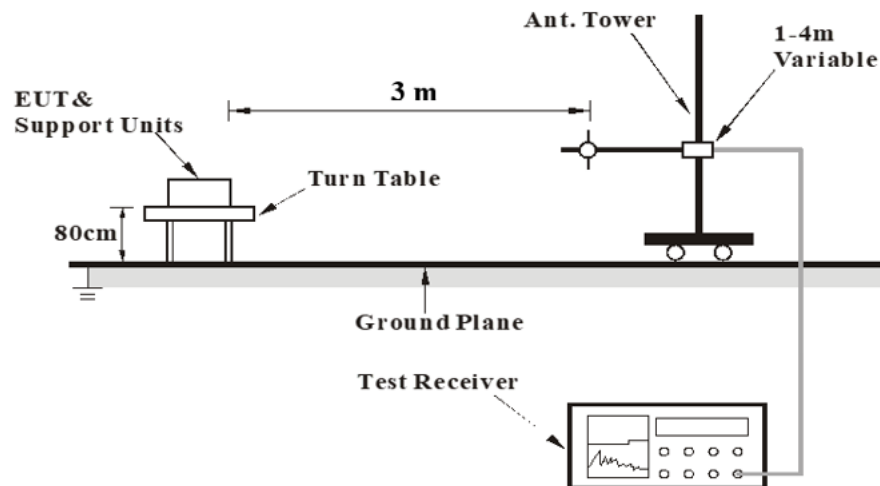
Doc No: Form-ULID-004739 (DCS:17-EM-F0878) / 6.1

Test Setup

<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



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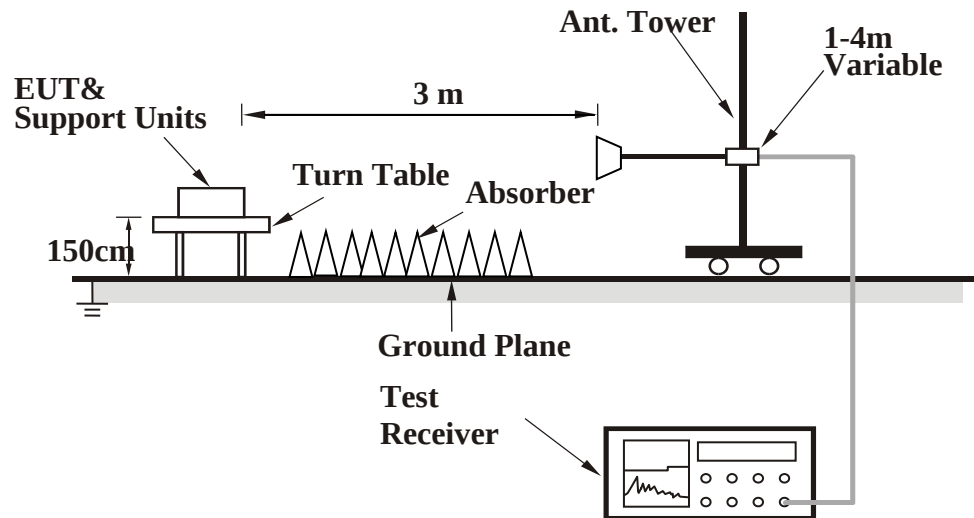
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

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Doc No: Form-ULID-004739 (DCS:17-EM-F0878) / 6.1

<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

Test Data

Chip Antenna

Above 1 GHz

Mode	802.11a	Channel	36
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		5136.85	43.01	13.44	56.45	74	-17.55	PK
		5149.8	35.56	13.43	48.99	54	-5.01	AVG
	@	5180	94.97	13.4	108.37	N/A	N/A	PK
	@	5180	90.35	13.4	103.75	N/A	N/A	AVG
	*	10360	29.8	17.39	47.19	68.2	-21.01	PK
Vertical		5149.8	42.63	13.43	56.06	74	-17.94	PK
		5149.8	34.57	13.43	48	54	-6	AVG
	@	5180	95.97	13.4	109.37	N/A	N/A	PK
	@	5180	89.25	13.4	102.65	N/A	N/A	AVG
	*	10360	31.35	17.39	48.74	68.2	-19.46	PK

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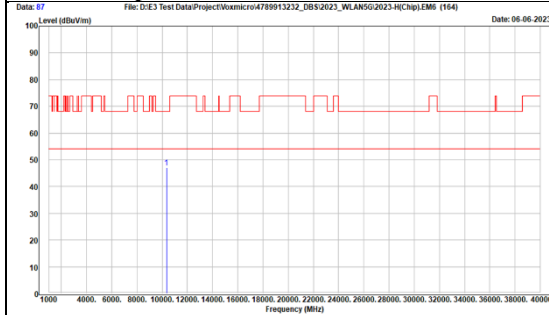
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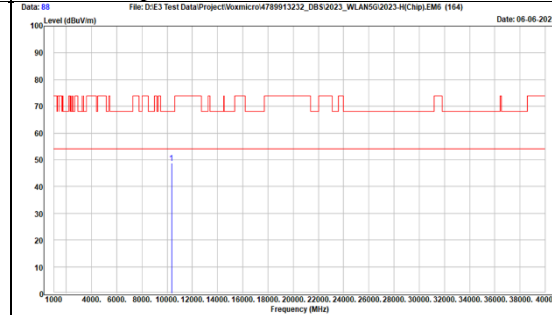
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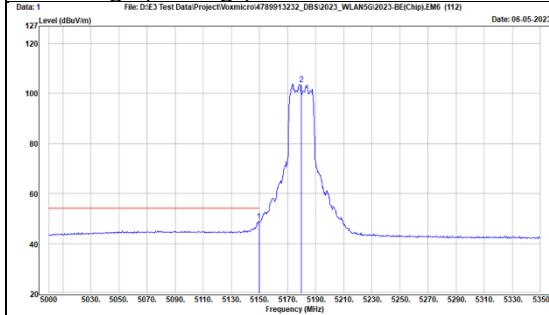
TX, 802.11a (Ch 36)
Radiated Spurious Emission, Horizontal



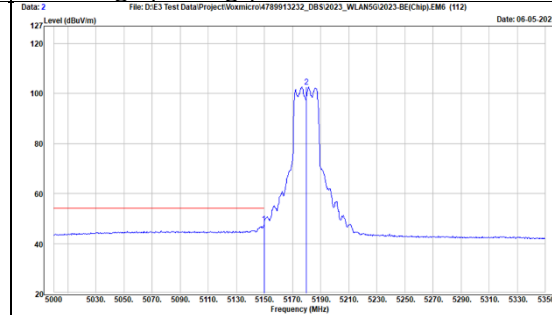
TX, 802.11a (Ch 36)
Radiated Spurious Emission, Vertical



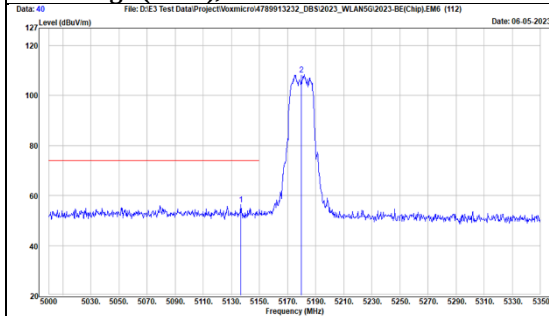
TX, 802.11a (Ch 36)
Band Edge (Average), Horizontal



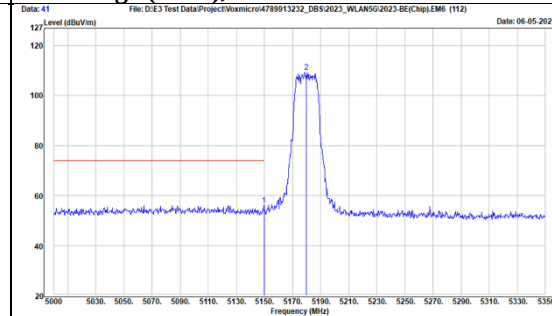
TX, 802.11a (Ch 36)
Band Edge (Average), Vertical



TX, 802.11a (Ch 36)
Band Edge (Peak), Horizontal



TX, 802.11a (Ch 36)
Band Edge (Peak), Vertical



Mode	802.11a	Channel	44
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		5111.3	31.62	13.46	45.08	54	-8.92	AVG
		5122.5	41.86	13.46	55.32	74	-18.68	PK
	@	5220	96.58	13.33	109.91	N/A	N/A	PK
	@	5220	88.91	13.33	102.24	N/A	N/A	AVG
	*	10440	30.2	17.63	47.83	68.2	-20.37	PK
Vertical		5022.75	43.11	12.99	56.1	74	-17.9	PK
		5090.3	31.5	13.43	44.93	54	-9.07	AVG
	@	5220	95.27	13.33	108.6	N/A	N/A	PK
	@	5220	87.78	13.33	101.11	N/A	N/A	AVG
	*	10440	30.27	17.63	47.9	68.2	-20.3	PK

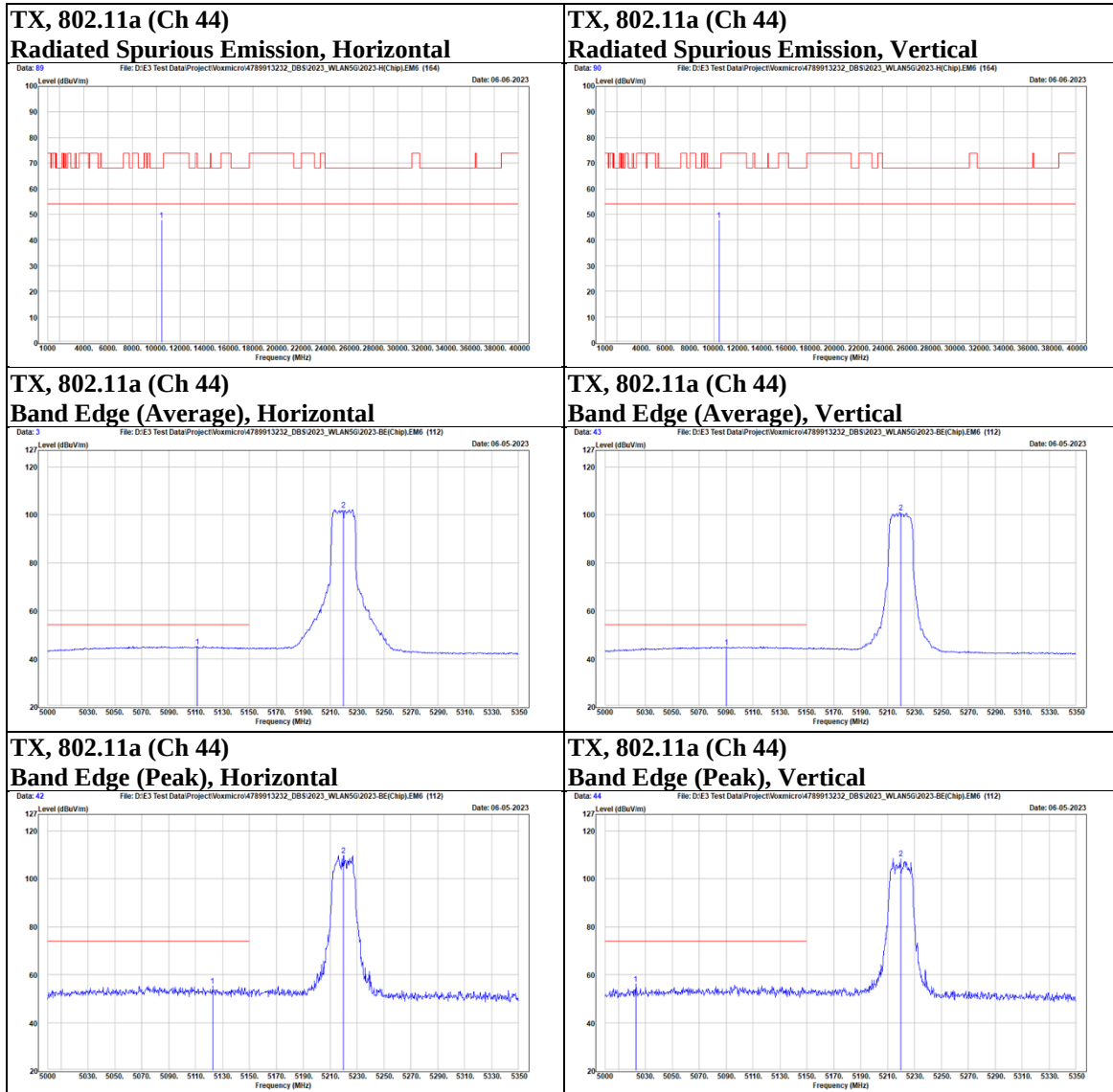
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Mode	802.11a	Channel	48
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		5056.35	42.39	13.32	55.71	74	-18.29	PK
		5115.15	31.79	13.45	45.24	54	-8.76	AVG
	@	5240	96.12	13.27	109.39	N/A	N/A	PK
	@	5240	89.2	13.27	102.47	N/A	N/A	AVG
	*	10480	29.53	17.69	47.22	68.2	-20.98	PK
Vertical		5099.4	31.53	13.46	44.99	54	-9.01	AVG
		5133.7	42.44	13.43	55.87	74	-18.13	PK
	@	5240	93.11	13.27	106.38	N/A	N/A	PK
	@	5240	87.14	13.27	100.41	N/A	N/A	AVG
	*	10480	31.57	17.69	49.26	68.2	-18.94	PK

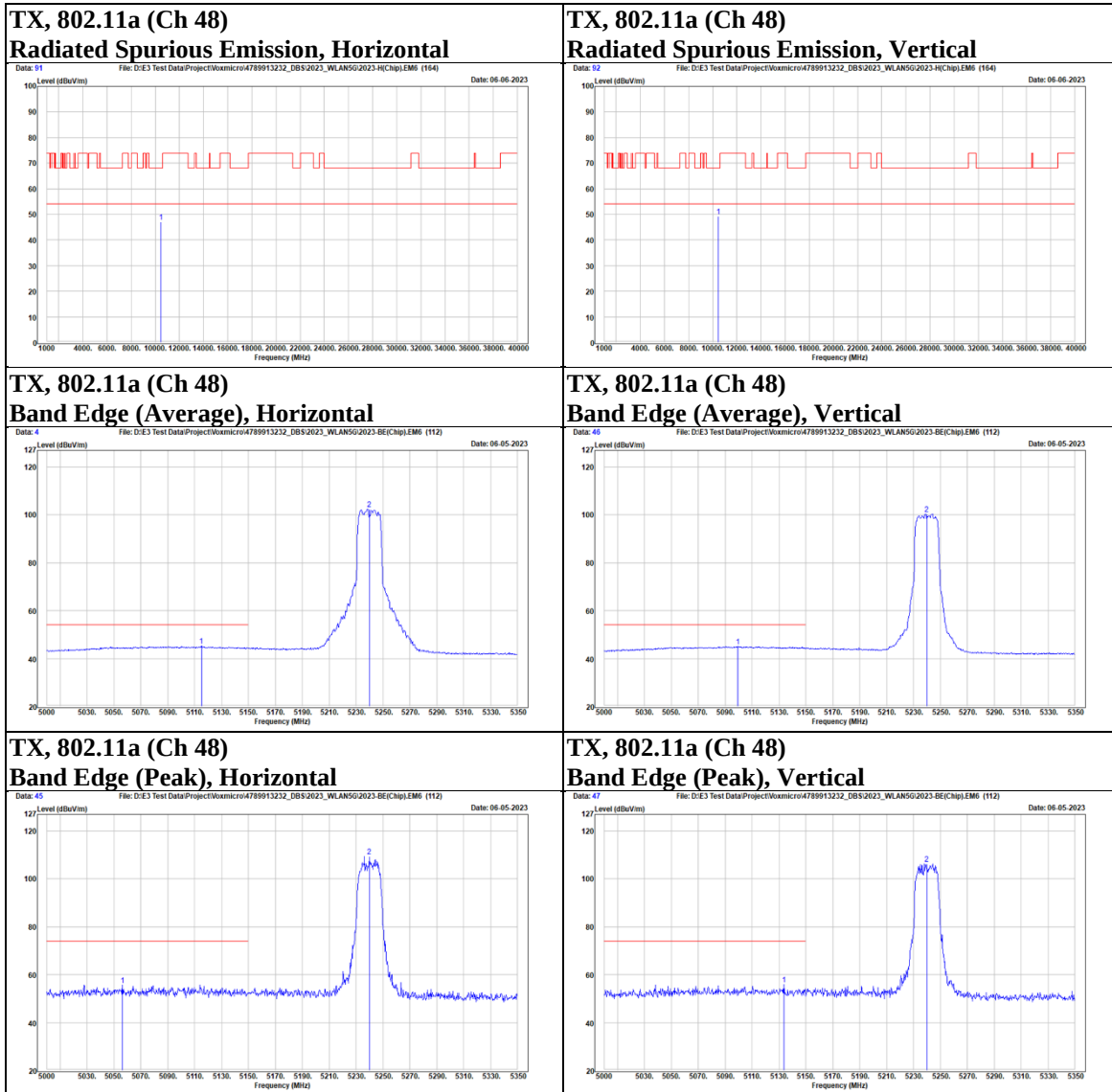
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Mode	802.11a	Channel	52
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	5260	95.32	13.24	108.56	N/A	N/A	PK
	@	5260	89.07	13.24	102.31	N/A	N/A	AVG
		5439.6	29.43	13.63	43.06	54	-10.94	AVG
		5441.4	40.06	13.64	53.7	74	-20.3	PK
	*	10520	30.19	17.73	47.92	68.2	-20.28	PK
Vertical	@	5260	95.75	13.24	108.99	N/A	N/A	PK
	@	5260	87.85	13.24	101.09	N/A	N/A	AVG
		5444.1	29.68	13.65	43.33	54	-10.67	AVG
		5454.6	39.52	13.69	53.21	74	-20.79	PK
	*	10520	31.16	17.73	48.89	68.2	-19.31	PK

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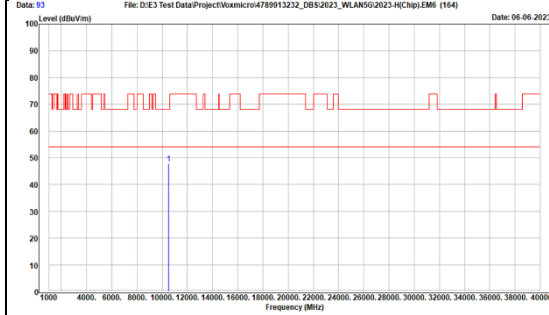
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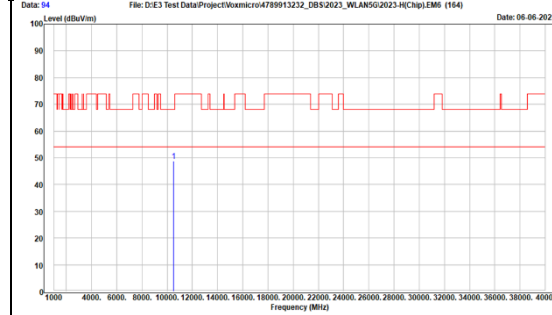
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004739 (DCS:17-EM-F0878) / 6.1

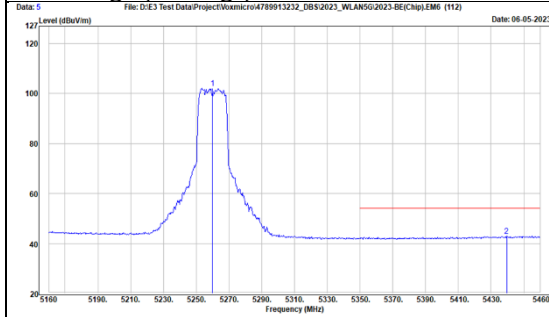
TX, 802.11a (Ch 52)
Radiated Spurious Emission, Horizontal



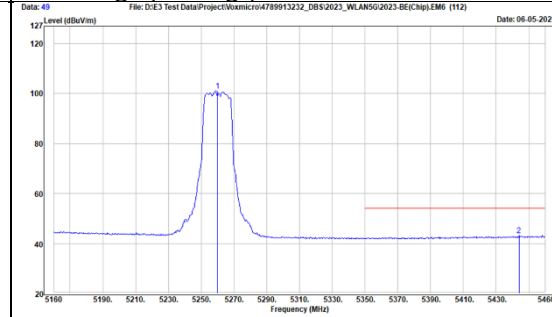
TX, 802.11a (Ch 52)
Radiated Spurious Emission, Vertical



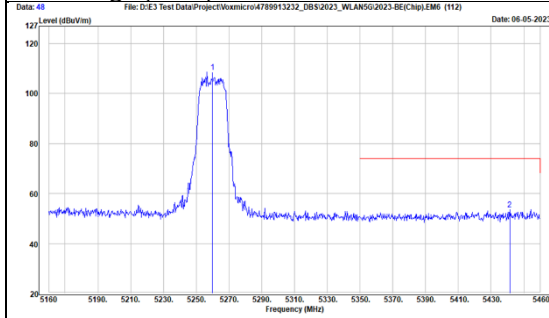
TX, 802.11a (Ch 52)
Band Edge (Average), Horizontal



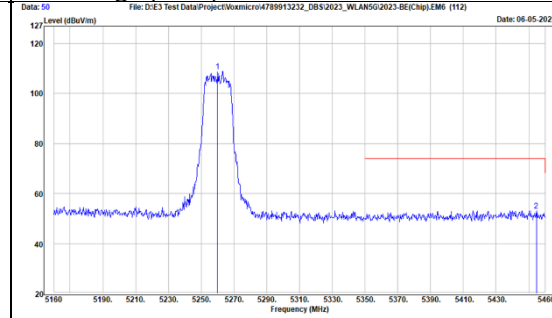
TX, 802.11a (Ch 52)
Band Edge (Average), Vertical



TX, 802.11a (Ch 52)
Band Edge (Peak), Horizontal



TX, 802.11a (Ch 52)
Band Edge (Peak), Vertical



Mode	802.11a	Channel	60
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	5300	94.95	13.21	108.16	N/A	N/A	PK
	@	5300	88.77	13.21	101.98	N/A	N/A	AVG
		5452.8	29.27	13.68	42.95	54	-11.05	AVG
		5458.5	40.95	13.7	54.65	74	-19.35	PK
	*	10600	30.49	17.73	48.22	68.2	-19.98	PK
Vertical	@	5300	93.45	13.21	106.66	N/A	N/A	PK
	@	5300	86.66	13.21	99.87	N/A	N/A	AVG
		5445.3	39.49	13.65	53.14	74	-20.86	PK
		5455.2	29.27	13.69	42.96	54	-11.04	AVG
	*	10600	29.74	17.73	47.47	68.2	-20.73	PK

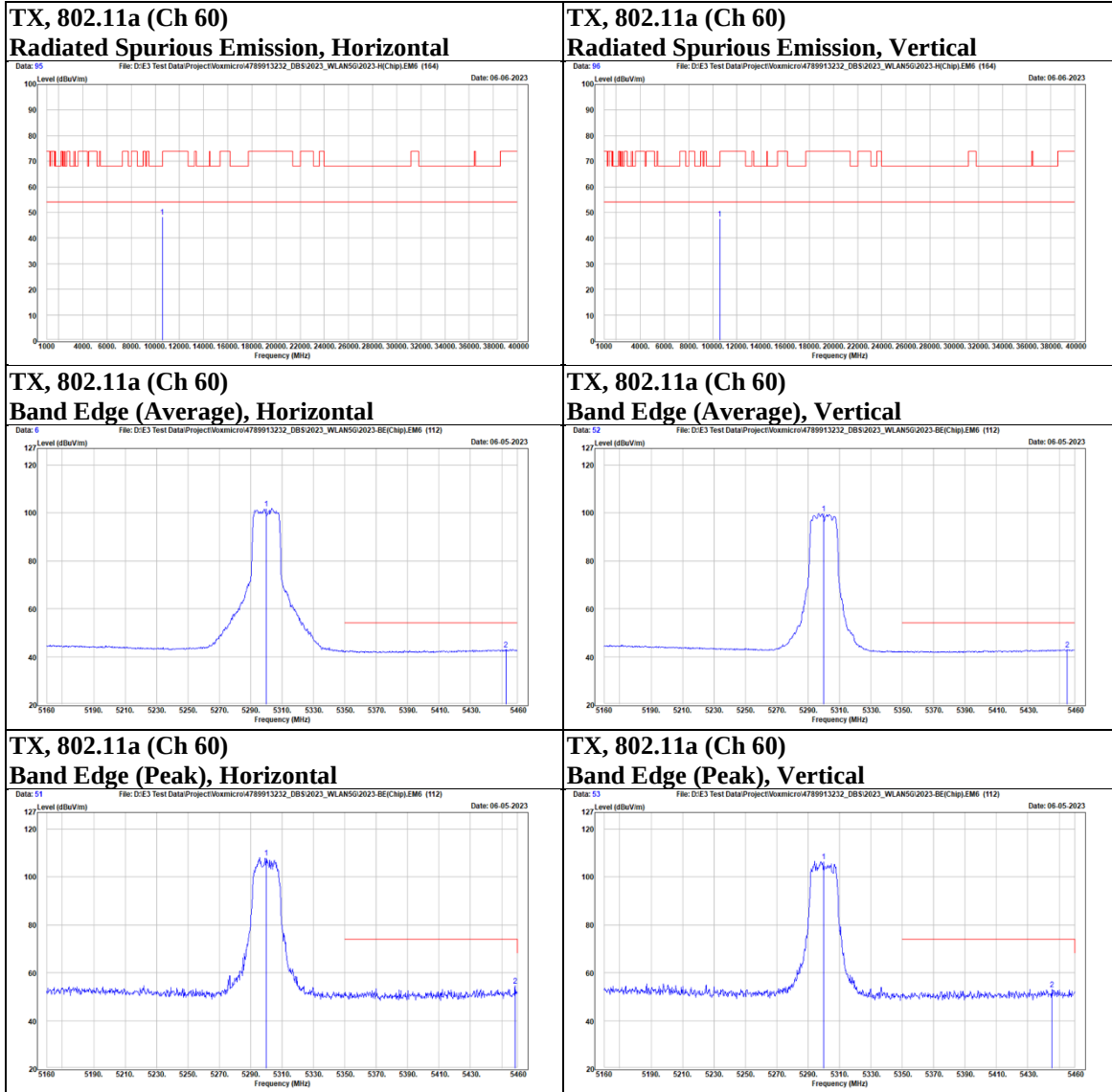
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Mode	802.11a	Channel	64
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	5320	95.98	13.23	109.21	N/A	N/A	PK
	@	5320	88.57	13.23	101.8	N/A	N/A	AVG
		5351.1	33.11	13.26	46.37	54	-7.63	AVG
		5413.8	40.37	13.49	53.86	74	-20.14	PK
	*	10640	30.41	17.82	48.23	74	-25.77	PK
Vertical	@	5320	94.11	13.23	107.34	N/A	N/A	PK
	@	5320	86.7	13.23	99.93	N/A	N/A	AVG
		5381.1	39.65	13.35	53	74	-21	PK
		5453.1	29.36	13.68	43.04	54	-10.96	AVG
	*	10640	30.26	17.82	48.08	74	-25.92	PK

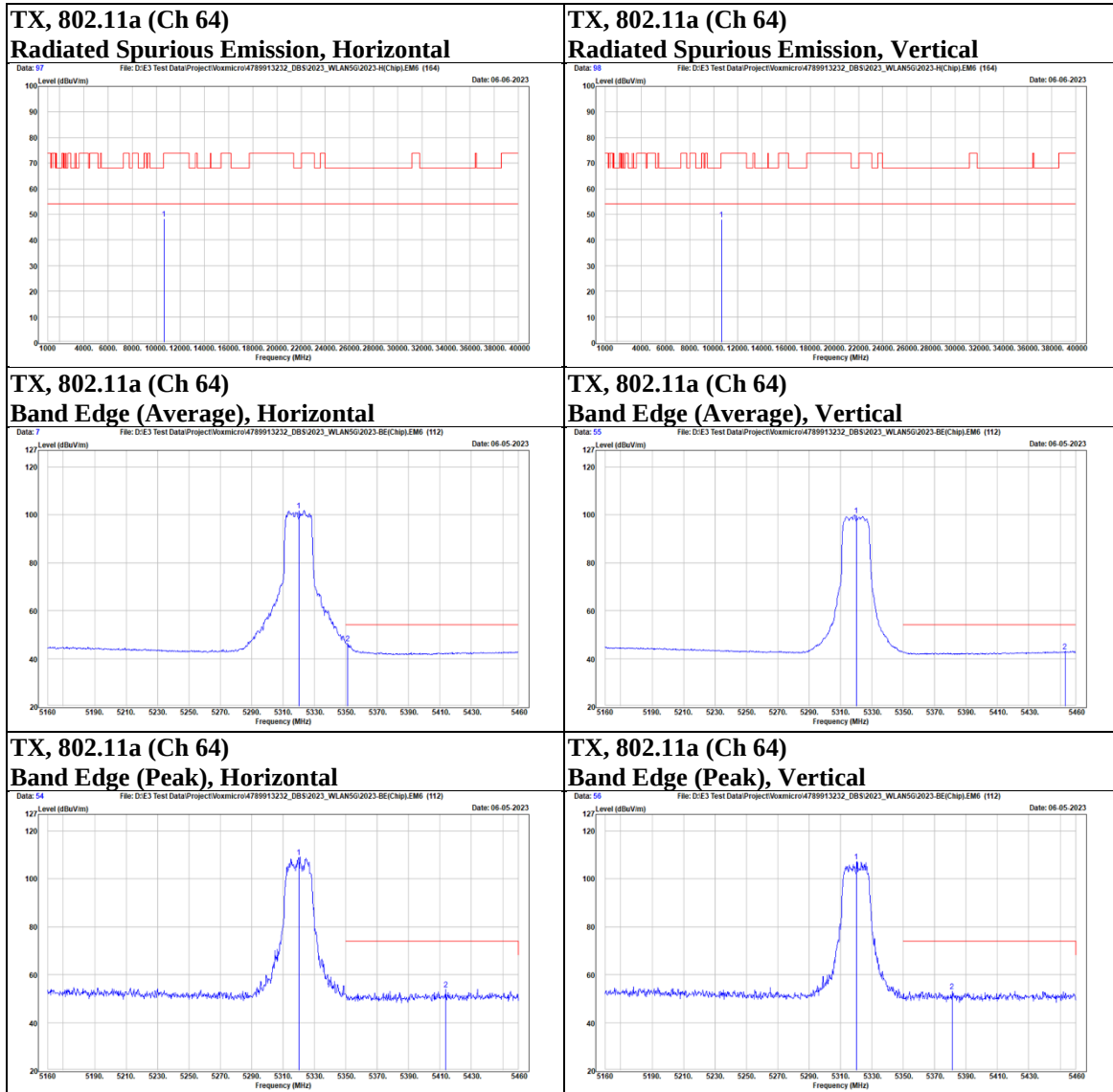
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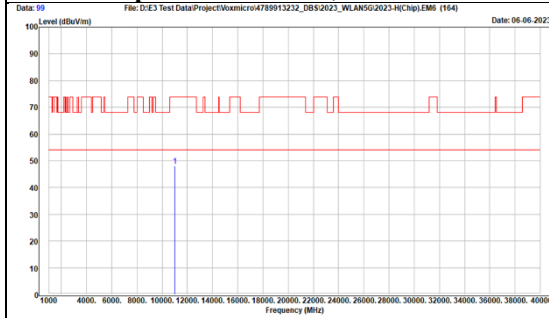
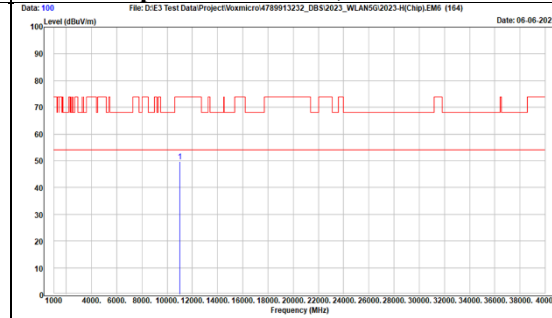
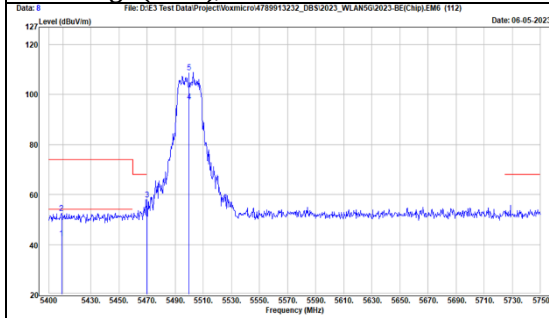
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Mode	802.11a	Channel	100
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		5409.1	39.18	13.47	52.65	74	-21.35	PK
		5409.1	29.09	13.47	42.56	54	-11.44	AVG
		5470	44.34	13.74	58.08	68.2	-10.12	PK
	@	5500	94.99	13.83	108.82	N/A	N/A	PK
	@	5500	83.4	13.83	97.23	N/A	N/A	AVG
	*	11000	29.72	18.28	48	74	-26	PK
Vertical		5410.85	40.78	13.46	54.24	74	-19.76	PK
		5410.85	28.41	13.46	41.87	54	-12.13	AVG
		5467.2	39.16	13.72	52.88	68.2	-15.32	PK
	@	5500	93.14	13.83	106.97	N/A	N/A	PK
	@	5500	83.2	13.83	97.03	N/A	N/A	AVG
	*	11000	31.4	18.28	49.68	74	-24.32	PK

TX, 802.11a (Ch 100)
Radiated Spurious Emission, Horizontal

TX, 802.11a (Ch 100)
Radiated Spurious Emission, Vertical

TX, 802.11a (Ch 100)
Band Edge (Peak), Horizontal

TX, 802.11a (Ch 100)
Band Edge (Peak), Vertical
