

FCC Test Report (Co-Located)

Report No.: RFBGSN-WTW-P22060933-2

FCC ID: I4L-GRAX66

Test Model: GRAX66

Received Date: Jun. 27, 2022

Test Date: Aug. 18, 2022

Issued Date: Oct. 07, 2022

Applicant: Micro-Star International Co., Ltd.

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Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
Lin Kou Laboratories

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Test Location: No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City
33383, Taiwan

**FCC Registration /
Designation Number:** 788550 / TW0003



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Release Control Record

Issue No.	Description	Date Issued
RFBGSN-WTW-P22060933-2	Original Release	Oct. 07, 2022

1 Certificate of Conformity

Product: RadiX AX6600 WiFi 6 Tri-Band Gaming Router

Brand: msi

Test Model: GRAX66

Sample Status: Identical Prototype

Applicant: Micro-Star International Co., Ltd.

Test Date: Aug. 18, 2022

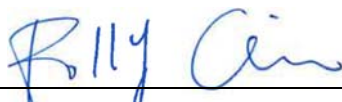
Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)

47 CFR FCC Part 15, Subpart E (Section 15.407)

ANSI C63.10:2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by :


Polly Chien / Specialist

Date:

Oct. 07, 2022

Approved by :



Jeremy Lin / Senior Engineer

Date:

Oct. 07, 2022

2 Summary of Test Results

Applied Standard:	47 CFR FCC Part 15, Subpart C (Section 15.247) 47 CFR FCC Part 15, Subpart E (Section 15.407)		
FCC Clause	Test Item	Result	Remarks
15.205 / 15.209 / 15.247(d) 15.407(b) (1/2/3/4(i/ii)/9)	Radiated Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -8.5dB at 11570.00 MHz.

Note:

1. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. For U-NII-3 band compliance with rule part 15.407(b)(4)(i), the OOB test plots were recorded in Annex A.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) ($\pm$)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.04 dB
	30MHz ~ 200MHz	2.93 dB
	200MHz ~ 1000MHz	2.95 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.26 dB
	18GHz ~ 40GHz	1.94 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	RadiX AX6600 WiFi 6 Tri-Band Gaming Router
Brand	msi
Test Model	GRAX66
Sample Status	Identical Prototype
Power Supply Rating	12Vdc (adapter)
Modulation Type	CCK, DQPSK, DBPSK for DSSS 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM 1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA
Transfer Rate	802.11a: 54/48/36/24/18/12/9/6Mbps 802.11b: 11/5.5/2/1Mbps 802.11g: 54/48/36/24/18/12/9/6Mbps 802.11n (2.4GHz Band): up to 300Mbps 802.11n (5GHz Band): up to 600Mbps VHT (2.4GHz Band): up to 400Mbps 802.11ac (5GHz Band): up to 3466.8Mbps 802.11ax (2.4GHz Band): up to 573Mbps 802.11ax (5GHz Band): up to 4900Mbps
Operating Frequency	2.4GHz: 2412 ~ 2462MHz 5.0GHz: 5180 ~ 5240MHz, 5260 ~ 5320MHz, 5500 ~ 5720MHz, 5745 ~ 5825MHz
Number of Channel	2412 ~ 2462MHz: 11 for 802.11b, 802.11g, 802.11n (HT20), VHT20, 802.11ax (HE20) 7 for 802.11n (HT40), VHT40, 802.11ax (HE40) 5180 ~ 5320 MHz: 8 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20) 4 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40) 2 for 802.11ac (VHT80), 802.11ax (HE80) 5500 ~ 5720MHz: 12 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20) 6 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40) 3 for 802.11ac (VHT80), 802.11ax (HE80) 1 for 802.11ac (VHT160), 802.11ax (HE160) 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)

Output Power	CDD Mode 2.412 ~ 2.462GHz: 802.11b: 983.839 mW (29.93 dBm) 802.11g: 980.921 mW (29.92 dBm) 802.11a 5.18 GHz ~ 5.24 GHz : 654.886 mW (28.16 dBm) 5.26 GHz ~ 5.32 GHz : 235.811 mW (23.73 dBm) 5.50 GHz ~ 5.72 GHz : 152.612 mW (21.84 dBm) 5.745 GHz ~ 5.825 GHz : 943.377 mW (29.75 dBm) NSS 1: 2.412 ~ 2.462GHz: 854.555 mW (29.32 dBm) 5.18 GHz ~ 5.24 GHz : 735.268 mW (28.66 dBm) 5.26 GHz ~ 5.32 GHz : 239.371 mW (23.79 dBm) 5.50 GHz ~ 5.72 GHz : 236.297 mW (23.73 dBm) 5.745 GHz ~ 5.825 GHz : 947.169 mW (29.76 dBm) NSS 2: 2.412 ~ 2.462GHz: 909.306 mW (29.59 dBm) 5.18 GHz ~ 5.24 GHz : 681.278 mW (28.33 dBm) 5.26 GHz ~ 5.32 GHz : 239.651 mW (23.80 dBm) 5.50 GHz ~ 5.72 GHz : 242.228 mW (23.84 dBm) 5.745 GHz ~ 5.825 GHz : 926.398 mW (29.67 dBm) NSS 4: 5.50 GHz ~ 5.72 GHz : 241.008 mW (23.82 dBm) 5.745 GHz ~ 5.825 GHz : 962.109 mW (29.83 dBm) Beamforming Mode NSS 1: 2.412 ~ 2.462GHz: 854.555 mW (29.32 dBm) 5.18 GHz ~ 5.24 GHz : 735.268 mW (28.66 dBm) 5.26 GHz ~ 5.32 GHz : 239.371 mW (23.79 dBm) 5.50 GHz ~ 5.72 GHz : 171.182 mW (22.33 dBm) 5.745 GHz ~ 5.825 GHz : 787.820 mW (28.96 dBm) NSS 2: 2.412 ~ 2.462GHz: 909.306 mW (29.59 dBm) 5.18 GHz ~ 5.24 GHz : 681.278 mW (28.33 dBm) 5.26 GHz ~ 5.32 GHz : 239.651 mW (23.80 dBm) 5.50 GHz ~ 5.72 GHz : 242.228 mW (23.84 dBm) 5.745 GHz ~ 5.825 GHz : 926.398 mW (29.67 dBm) NSS 4: 5.50 GHz ~ 5.72 GHz : 241.008 mW (23.82 dBm) 5.745 GHz ~ 5.825 GHz : 962.109 mW (29.83 dBm)
	Antenna Type
	Antenna Connector
	Accessory Device
	Cable Supplied
	Refer to note
	Refer to note
	Refer to note
	Refer to note
	Refer to note

Note:

1. The EUT incorporates a MIMO function. Physically, the EUT provides 4 completed transmitters and 4 receivers.

2.4G Band			
Modulation Mode	CDD Mode	Beamforming Mode	TX Function
802.11b	Support	Not Support	2TX
802.11g	Support	Not Support	2TX
802.11n (HT20)	Support	Not Support	2TX (NSS1 / NSS2)
802.11n (HT40)	Support	Not Support	2TX (NSS1 / NSS2)
VHT20	Support	Support	2TX (NSS1 / NSS2)
VHT40	Support	Support	2TX (NSS1 / NSS2)
802.11ax (HE20)	Support	Support	2TX (NSS1 / NSS2)
802.11ax (HE40)	Support	Support	2TX (NSS1 / NSS2)

5.0GHz			
Modulation Mode	CDD Mode	Beamforming Mode	TX Function
Band 1, 2			
802.11a	Support	Not Support	2TX
802.11n (HT20)	Support	Not Support	2TX (NSS1 / NSS2)
802.11n (HT40)	Support	Not Support	2TX (NSS1 / NSS2)
802.11ac (VHT20)	Support	Support	2TX (NSS1 / NSS2)
802.11ac (VHT40)	Support	Support	2TX (NSS1 / NSS2)
802.11ac (VHT80)	Support	Support	2TX (NSS1 / NSS2)
802.11ax (HE20)	Support	Support	2TX (NSS1 / NSS2)
802.11ax (HE40)	Support	Support	2TX (NSS1 / NSS2)
802.11ax (HE80)	Support	Support	2TX (NSS1 / NSS2)
Band 3, 4			
802.11a	Support	Not Support	4TX
802.11n (HT20)	Support	Not Support	4TX (NSS1 / NSS2 / NSS4)
802.11n (HT40)	Support	Not Support	4TX (NSS1 / NSS2 / NSS4)
802.11ac (VHT20)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ac (VHT40)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ac (VHT80)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ac (VHT160)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ax (HE20)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ax (HE40)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ax (HE80)	Support	Support	4TX (NSS1 / NSS2 / NSS4)
802.11ax (HE160)	Support	Support	4TX (NSS1 / NSS2 / NSS4)

* The bandwidth and modulation are similar for HT20/HT40 on 802.11n mode and VHT20/VHT40 on 802.11ac mode and HE20/HE40 on 802.11ax mode. The bandwidth and modulation are similar for VHT80/VHT160 on 802.11ac mode and HE80/HE160 on 802.11ax mode. Therefore the investigated worst case is the representative mode in test report. (Final test mode refer section 3.2.1)

2. The antenna information is listed as below.

RF Chain NO.	Type	Connector	Brand	Model	Frequency Range (MHz)	Gain (dBi)				Directional Gain (dBi)		
						Chain 0	Chain 1	Chain 2	Chain 3	NSS 1	NSS 2	NSS 4
2G	Dipole	I-PEX	Wieson	Chain 0: ARY121-0307-001-00 Chain 1: ARY121-0307-003-00	2400 ~ 2483.5	2.05	2.07	-	-	4.24	1.97	-
5G_L				Chain 0: ARY121-0307-001-00 Chain 1: ARY121-0307-003-00	5150 ~ 5250	4.54	4.59	-	-	5.68	3.21	-
					5250 ~ 5350	4.60	4.65	-	-	5.69	3.54	-
5G_H				Chain 0: ARY121-0307-002-00 Chain 1: ARY121-0307-004-00 Chain 2: ARY121-0307-005-00 Chain 3: ARY121-0307-006-00	5470 ~ 5725	3.02	3.69	2.89	3.02	7.59	5.56	2.47
					5725 ~ 5850	3.01	2.88	3.72	3.27	6.99	4.91	2.33

* Detail antenna specification please refer to antenna datasheet and/or antenna measurement report.

3. The EUT uses following accessories.

AC Adapter		
Brand	Model	Specification
CWT	2AEJ042FC	I/P: 100-240 Vac, 50/60Hz, 1.3A O/P: 12.0 Vdc, 3.5 A, 42.0W
Ethernet cable		
Brand	Model	Specification
NA	NA	Signal Line : 0.96M

4. Both of the 2.4GHz and 5GHz can transmit simultaneously

5. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

For WLAN 2.4G:

11 channels are provided for 802.11b, 802.11g, 802.11n (HT20), VHT20, 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

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

Channel	Frequency	Channel	Frequency
3	2422MHz	7	2442MHz
4	2427MHz	8	2447MHz
5	2432MHz	9	2452MHz
6	2437MHz		

For 5180 ~ 5320MHz:

8 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
52	5260 MHz	60	5300 MHz
56	5280 MHz	64	5320 MHz

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

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz
54	5270 MHz	62	5310 MHz

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

Channel	Frequency	Channel	Frequency
42	5210MHz	58	5290MHz

For 5500 ~ 5720MHz:

12 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	144	5720 MHz

6 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	142	5710 MHz

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

Channel	Frequency	Channel	Frequency
106	5530 MHz	138	5690 MHz
122	5610 MHz		

1 channel is provided for 802.11ac (VHT160), 802.11ax (HE160):

Channel	Frequency
114	5570MHz

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

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to			Description
	RE $\geq$ 1G	RE<1G	COBE	
-	√	√	√	-

Where RE $\geq$ 1G: Radiated Emission above 1GHz & Bandedge Measurement RE<1G: Radiated Emission below 1GHz
COBE: Conducted Out of Band Emission Measurement

NOTE:

- The EUT had been pre-tested on the positioned of each 2 axis (X & Z). The worst case was found when positioned on **X-plane**.
- For radiated emission (below 1GHz) and power line conducted emission test items, the worst radiated emission mode was selected.

Radiated Emission Test (Above 1 GHz):

- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology	Remark
-	802.11b + 802.11 ax (HE40)	2412-2462	1 to 11	6 + 46	DSSS	-
		5180-5240	38 to 46		OFDMA	NSS 1
		5260-5320	54 to 62			
-	802.11b + 802.11 ax (HE20)	2412-2462	1 to 11	6 + 157	DSSS	-
		5500-5720	100 to 144		OFDMA	NSS 1
		5745-5825	149 to 165			

Radiated Emission Test (Below 1GHz):

- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology	Remark
-	802.11b + 802.11 ax (HE40)	2412-2462	1 to 11	6 + 46	DSSS	-
		5180-5240	38 to 46		OFDMA	NSS 1
		5260-5320	54 to 62			
-	802.11b + 802.11 ax (HE20)	2412-2462	1 to 11	6 + 157	DSSS	-
		5500-5720	100 to 144		OFDMA	NSS 1
		5745-5825	149 to 165			

Conducted Out of Band Emission Measurement:

- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology	Remark
-	802.11b + 802.11 ax (HE40)	2412-2462	1 to 11	6 + 46	DSSS	-
		5180-5240	38 to 46		OFDMA	NSS 1
		5260-5320	54 to 62			

Test Condition:

Applicable to	Environmental Conditions	Input Power	Tested by
RE $\geq$ 1G	23 deg. C, 69% RH	120 Vac, 60 Hz	Vincent Chen
RE<1G	23 deg. C, 69% RH	120 Vac, 60 Hz	Vincent Chen
COBE	23 deg. C, 69% RH	120 Vac, 60 Hz	Vincent Chen

3.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

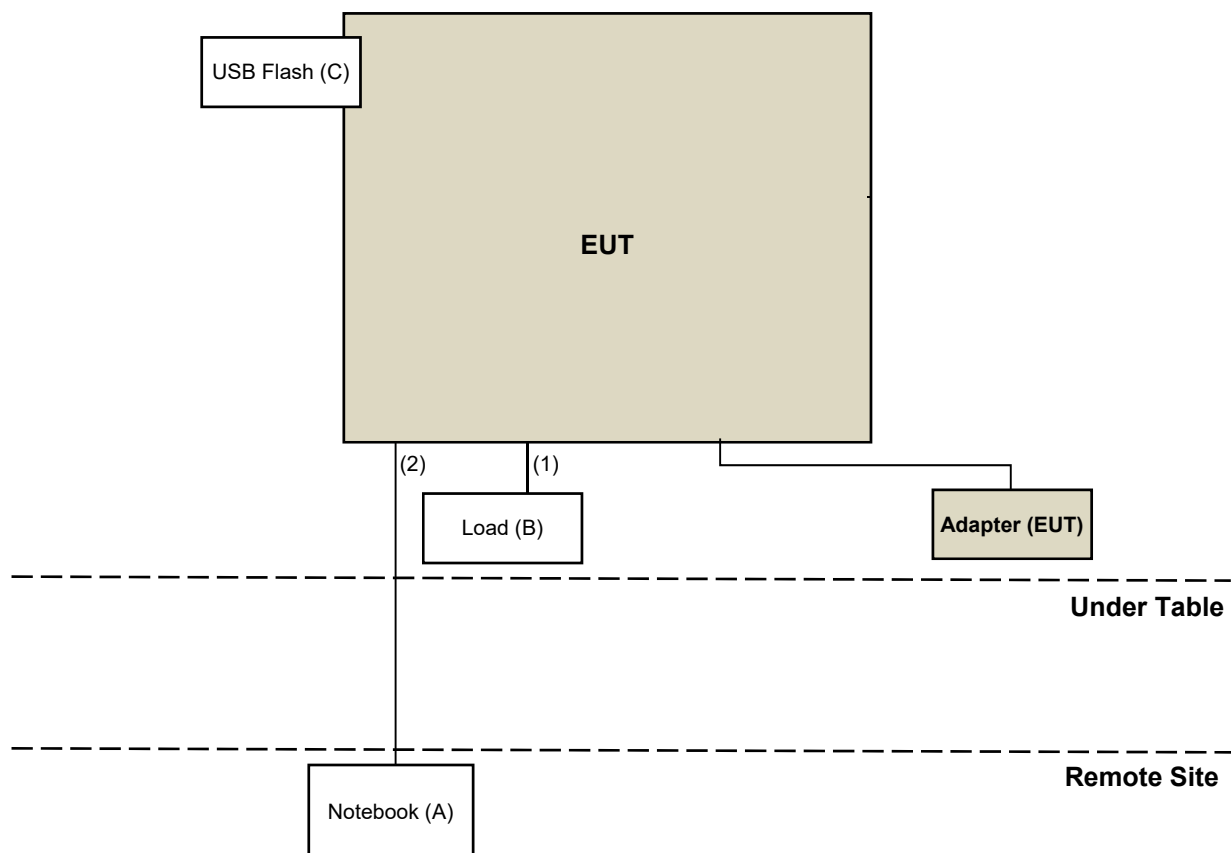
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Notebook	Lenovo	L440	R9-0GFJKK	N/A	Provided by Lab
B.	Load	NA	NA	NA	NA	Provided by Lab
C.	USB Flash	SanDisk	32G	NA	NA	Provided by Lab

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as a communication partner to transfer data.

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	RJ-45 Cable	4	1.5	NO	0	Provided by Lab
2.	RJ-45 Cable	1	7	NO	0	Provided by Lab

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and references:

Test Standard:

FCC Part 15, Subpart C (15.247)

FCC Part 15, Subpart E (15.407)

ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

References Test Guidance:

KDB 789033 D02 General UNII Test Procedure New Rules v02r01

KDB 662911 D01 Multiple Transmitter Output v02r01

KDB 291074 D02 EMC Measurement v01

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

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

Frequencies (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.

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 equipment isotropic radiated power (eirp) to field strength:

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

4.1.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer Agilent	N9010A	MY52220314	Dec. 03, 2021	Dec. 02, 2022
Spectrum Analyzer ROHDE & SCHWARZ	FSU43	101261	Apr. 11, 2022	Apr. 10, 2023
HORN Antenna SCHWARZBECK	BBHA 9120D	9120D-969	Nov. 14, 2021	Nov. 13, 2022
BILOG Antenna SCHWARZBECK	VULB 9168	9168-472	Oct. 28, 2021	Oct. 27, 2022
Fixed Attenuator WOKEN	MDCS18N-10	MDCS18N-10-01	Apr. 05, 2022	Apr. 04, 2023
Loop Antenna TESEQ	HLA 6121	45745	Jul. 27, 2022	Jul. 26, 2023
Preamplifier EMCI	EMC 012645	980115	Oct. 05, 2021	Oct. 04, 2022
RF Coaxial Cable EMCI	EMC104-SM-SM-8000	171005	Oct. 05, 2021	Oct. 04, 2022
RF Coaxial Cable HUBER+SUHNNER	SUCOFLEX 104	EMC104-SM-SM-1000(140807)	Oct. 05, 2021	Oct. 04, 2022
RF Coaxial Cable WOKEN	8D-FB	Cable-Ch10-01	Oct. 05, 2021	Oct. 04, 2022
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA
Software BV ADT	E3 6.120103	NA	NA	NA
Antenna Tower MF	MFA-440H	NA	NA	NA
Turn Table MF	MFT-201SS	NA	NA	NA
Antenna Tower & Turn Table Controller MF	MF-7802	NA	NA	NA
Peak Power Analyzer KEYSIGHT	8990B	MY51000485	Jan. 18, 2022	Jan. 17, 2023
Wideband Power Sensor KEYSIGHT	N1923A	MY58190002	May 06, 2022	May 05, 2023

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
 2. The test was performed in HwaYa Chamber 10.

4.1.3 Test Procedures

For Radiated emission below 30MHz

- 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. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

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

For Radiated emission above 30MHz

- 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. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detect 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.

Note:

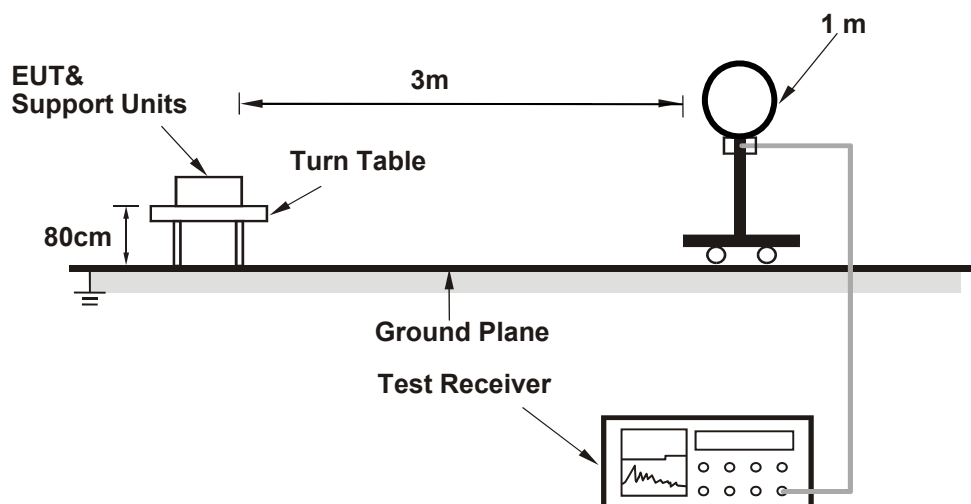
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. For WLAN device measurement, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz. 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.
3. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

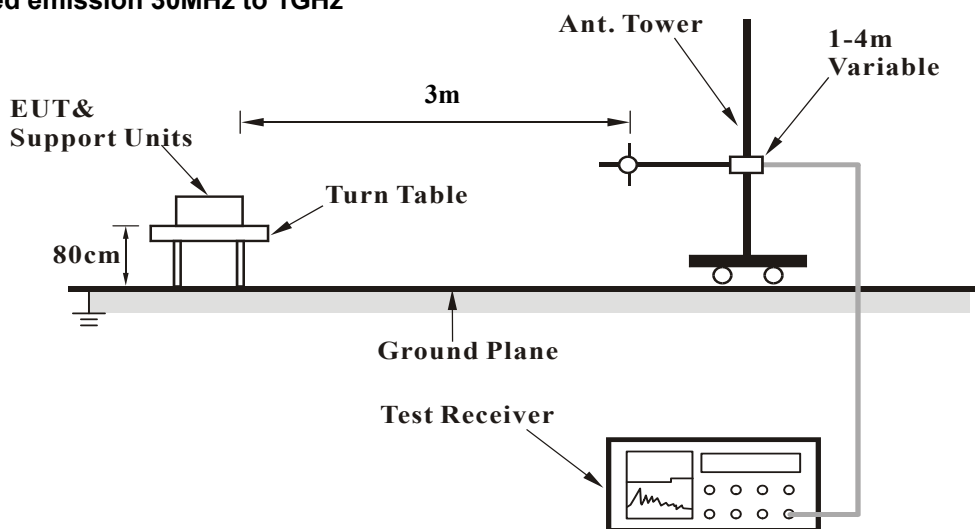
No deviation.

4.1.5 Test Setup

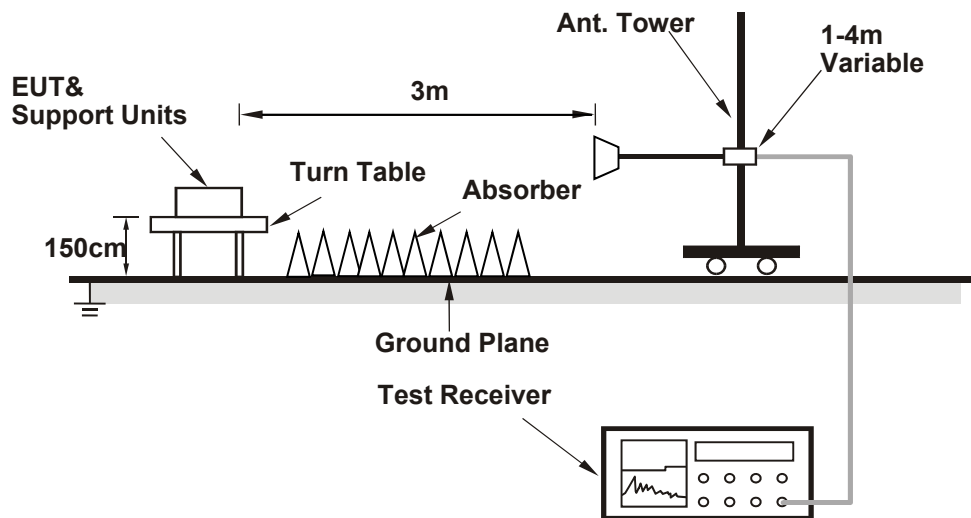
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

- Placed the EUT on the testing table.
- Prepared a notebook to act as a communication partner and placed it outside of testing area.
- The communication partner connected with EUT via a RJ45 cable and ran a test program (provided by manufacturer) to enable EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz Data:

802.11b + 802.11ax (HE40)

CHANNEL	CH 6 + CH 46	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 40GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2437.00	107.0 PK			1.18 H	256	76.1	30.9
2	*2437.00	103.7 AV			1.18 H	256	72.8	30.9
3	4874.00	40.1 PK	74.0	-33.9	2.32 H	312	56.0	-15.9
4	4874.00	30.8 AV	54.0	-23.2	2.32 H	312	46.7	-15.9
5	*5230.00	110.3 PK			1.02 H	48	74.0	36.3
6	*5230.00	99.7 AV			1.02 H	48	63.4	36.3
7	5350.00	49.1 PK	74.0	-24.9	1.02 H	48	65.6	-16.5
8	5350.00	38.1 AV	54.0	-15.9	1.02 H	48	54.6	-16.5
9	#10460.00	49.9 PK	68.2	-18.3	3.04 H	145	53.8	-3.9
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2437.00	118.4 PK			1.10 V	252	87.5	30.9
2	*2437.00	116.2 AV			1.10 V	252	85.3	30.9
3	4874.00	40.4 PK	74.0	-33.6	3.02 V	100	56.3	-15.9
4	4874.00	31.7 AV	54.0	-22.3	3.02 V	100	47.6	-15.9
5	*5230.00	116.4 PK			1.02 V	93	80.1	36.3
6	*5230.00	106.6 AV			1.02 V	93	70.3	36.3
7	5350.00	49.1 PK	74.0	-24.9	1.02 V	93	65.6	-16.5
8	5350.00	38.1 AV	54.0	-15.9	1.02 V	93	54.6	-16.5
9	#10460.00	50.4 PK	68.2	-17.8	1.66 V	245	54.3	-3.9

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. Margin value = Emission Level – Limit value.
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

802.11b + 802.11ax (HE20)

CHANNEL	CH 6 + CH 157	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 40GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2437.00	107.8 PK			1.12 H	243	75.8	32.0
2	*2437.00	104.6 AV			1.12 H	243	72.6	32.0
3	4874.00	38.3 PK	74.0	-35.7	2.53 H	287	55.8	-17.5
4	4874.00	29.0 AV	54.0	-25.0	2.53 H	287	46.5	-17.5
5	#5640.80	50.6 PK	68.2	-17.6	1.71 H	169	66.5	-15.9
6	*5785.00	109.3 PK			1.71 H	169	72.3	37.0
7	*5785.00	101.9 AV			1.71 H	169	64.9	37.0
8	#5972.80	50.9 PK	68.2	-17.3	1.71 H	169	66.4	-15.5
9	11570.00	54.3 PK	74.0	-19.7	3.24 H	278	57.1	-2.8
10	11570.00	44.5 AV	54.0	-9.5	3.24 H	278	47.3	-2.8
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2437.00	119.5 PK			1.53 V	242	87.5	32.0
2	*2437.00	117.3 AV			1.53 V	242	85.3	32.0
3	4874.00	37.9 PK	74.0	-36.1	3.20 V	102	55.4	-17.5
4	4874.00	30.1 AV	54.0	-23.9	3.20 V	102	47.6	-17.5
5	#5648.40	52.4 PK	68.2	-15.8	1.93 V	52	68.2	-15.8
6	*5785.00	122.1 PK			1.93 V	52	85.1	37.0
7	*5785.00	114.7 AV			1.93 V	52	77.7	37.0
8	#5954.40	53.7 PK	68.2	-14.5	1.93 V	52	69.3	-15.6
9	11570.00	55.6 PK	74.0	-18.4	3.52 V	178	58.4	-2.8
10	11570.00	45.5 AV	54.0	-8.5	3.52 V	178	48.3	-2.8

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. Margin value = Emission Level – Limit value.
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

Below 1GHz data

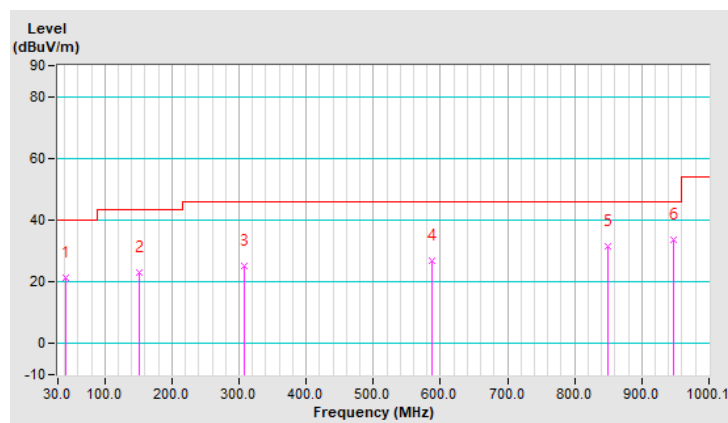
802.11b + 802.11ax (HE40)

CHANNEL	CH 6 + CH 46	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	41.64	21.4 QP	40.0	-18.6	2.00 H	228	34.5	-13.1
2	151.26	23.1 QP	43.5	-20.4	1.01 H	87	35.3	-12.2
3	308.42	25.2 QP	46.0	-20.8	1.50 H	241	36.9	-11.7
4	587.81	26.8 QP	46.0	-19.2	1.50 H	130	30.7	-3.9
5	848.76	31.6 QP	46.0	-14.4	2.00 H	4	30.6	1.0
6	946.74	33.5 QP	46.0	-12.5	1.50 H	8	30.8	2.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. The other emission levels were very low against the limit of frequency range 30MHz ~ 1000MHz.
4. Margin value = Emission Level – Limit value.
5. The emission levels were very low against the limit of frequency range 9kHz ~ 30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

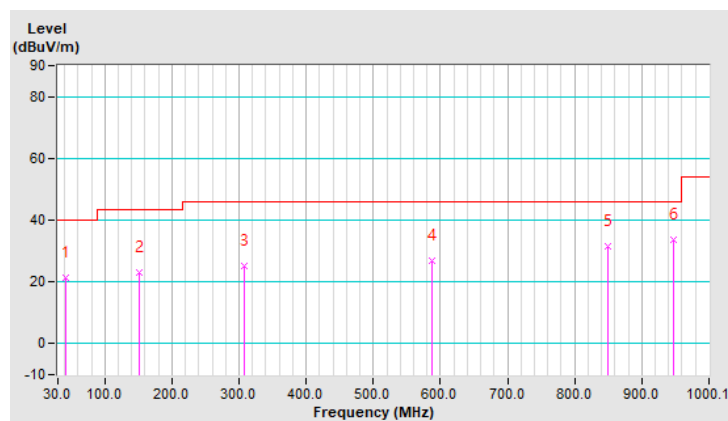


CHANNEL	CH 6 + CH 46	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	41.64	21.4 QP	40.0	-18.6	2.00 V	228	34.5	-13.1
2	151.26	23.1 QP	43.5	-20.4	1.01 V	87	35.3	-12.2
3	308.42	25.2 QP	46.0	-20.8	1.50 V	241	36.9	-11.7
4	587.81	26.8 QP	46.0	-19.2	1.01 V	130	30.7	-3.9
5	848.76	31.6 QP	46.0	-14.4	1.50 V	4	30.6	1.0
6	946.74	33.5 QP	46.0	-12.5	1.01 V	8	30.8	2.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. The other emission levels were very low against the limit of frequency range 30MHz ~ 1000MHz.
4. Margin value = Emission Level – Limit value.
5. The emission levels were very low against the limit of frequency range 9kHz ~ 30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



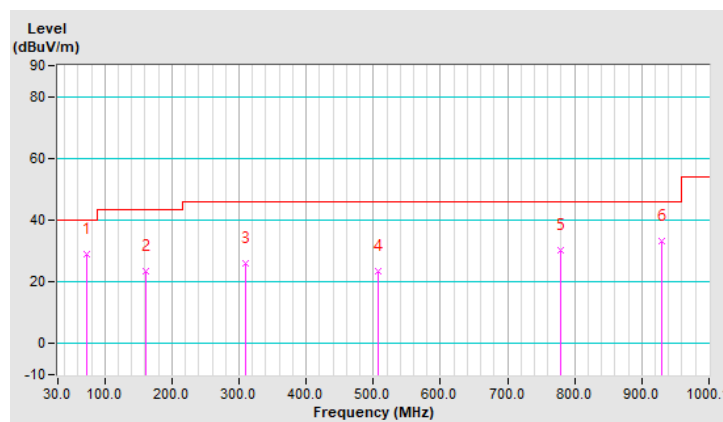
802.11b + 802.11ax (HE20)

CHANNEL	CH 6 + CH 157	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	72.68	28.8 QP	40.0	-11.2	2.00 H	296	44.4	-15.6
2	161.93	23.6 QP	43.5	-19.9	1.01 H	272	36.2	-12.6
3	310.36	25.9 QP	46.0	-20.1	2.00 H	32	37.4	-11.5
4	506.32	23.5 QP	46.0	-22.5	1.50 H	299	29.5	-6.0
5	779.89	30.1 QP	46.0	-15.9	1.50 H	110	30.0	0.1
6	930.25	33.1 QP	46.0	-12.9	2.00 H	18	30.7	2.4

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. The other emission levels were very low against the limit of frequency range 30MHz ~ 1000MHz.
4. Margin value = Emission Level – Limit value.
5. The emission levels were very low against the limit of frequency range 9kHz ~ 30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

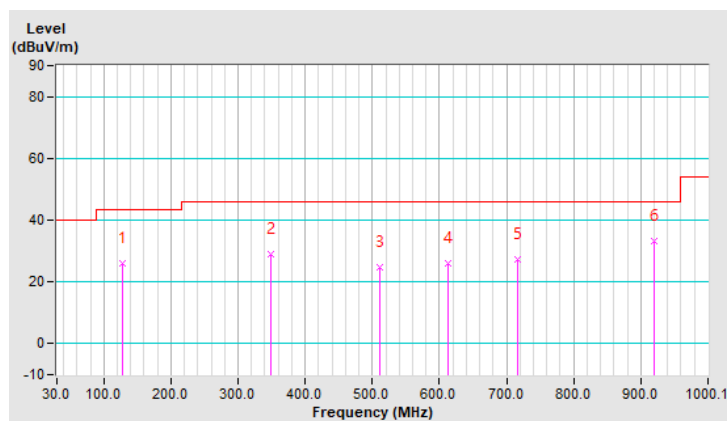


CHANNEL	CH 6 + CH 157	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	127.01	26.1 QP	43.5	-17.4	2.00 V	245	39.9	-13.8
2	349.16	29.1 QP	46.0	-16.9	2.00 V	321	39.4	-10.3
3	511.17	24.8 QP	46.0	-21.2	1.01 V	315	30.7	-5.9
4	612.06	26.0 QP	46.0	-20.0	1.50 V	102	29.2	-3.2
5	716.83	27.3 QP	46.0	-18.7	1.01 V	18	29.0	-1.7
6	920.55	33.3 QP	46.0	-12.7	1.01 V	1	31.2	2.1

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB).
3. The other emission levels were very low against the limit of frequency range 30MHz ~ 1000MHz.
4. Margin value = Emission Level – Limit value.
5. The emission levels were very low against the limit of frequency range 9kHz ~ 30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

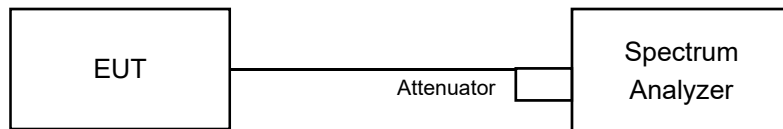


4.2 Conducted Out of Band Emission Measurement

4.2.1 Limits of Conducted Out of Band Emission Measurement

Below 30dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 Test Procedure

MEASUREMENT PROCEDURE REF

- Set the RBW = 100 kHz.
- Set the VBW $\geq$ 300 kHz.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOB

- Set RBW = 100 kHz.
- Set VBW $\geq$ 300 kHz.
- Detector = peak.
- Sweep = auto couple.
- Trace Mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

4.2.5 Deviation from Test Standard

No deviation.

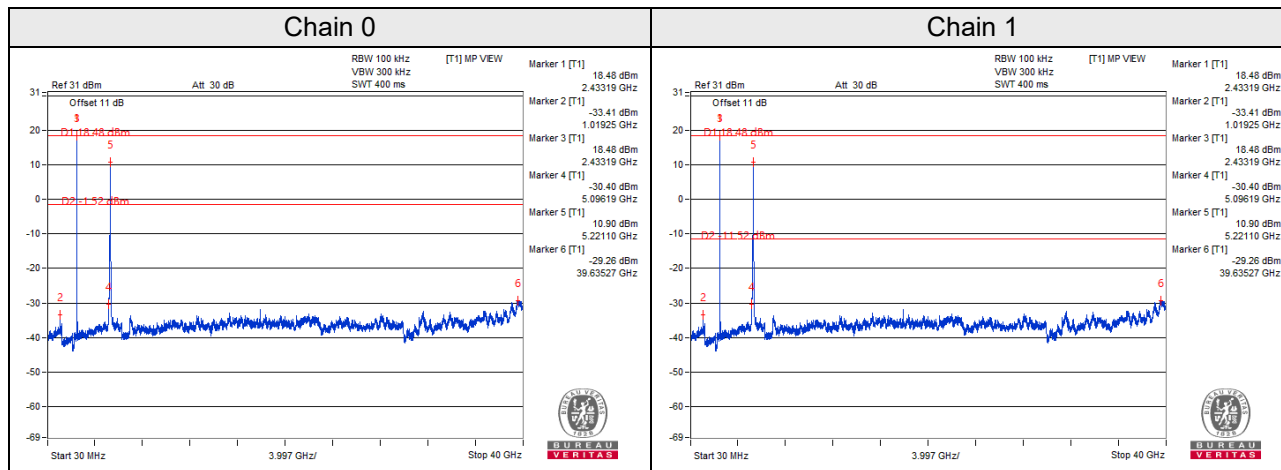
4.2.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.2.7 Test Results

The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 30dB offset below D1. It shows compliance with the requirement.

802.11b + 802.11 ax (HE40)

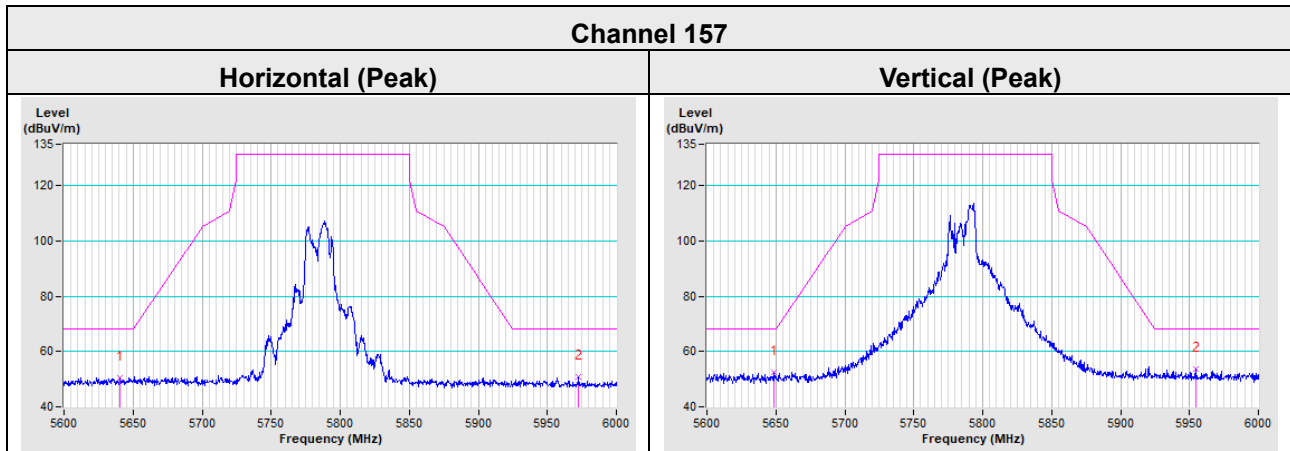


5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Annex A – Band Edge Measurement

802.11b+ 802.11 ax (HE20)



Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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Tel: 886-2-26052180

Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab

Tel: 886-3-6668565

Fax: 886-3-6668323

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Tel: 886-3-3183232

Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com

Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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