

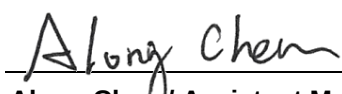
FCC Test Report

FCC ID : MXF-EL4000
Equipment : Wireless Home Internet
Model No. : EL4000
Brand Name : EarthLink
Applicant : Gemtek Technology Co., Ltd.
Address : No. 15-1 Zhonghua Road, Hsinchu Industrial Park,
Hukou, Hsinchu, Taiwan, 30352.
Standard : 47 CFR FCC Part 15.247
Received Date : Jan. 25, 2022
Tested Date : Jan. 26 ~ Feb. 15, 2022

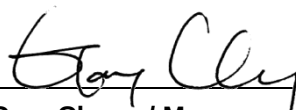
We, International Certification Corporation, would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:

Approved by:



Along Chen / Assistant Manager



Gary Chang / Manager

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Release Record

Report No.	Version	Description	Issued Date
FR212101AC	Rev. 01	Initial issue	Mar. 01, 2022

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.356MHz 32.75 (Margin -16.07dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 2390.00MHz 53.89 (Margin -0.11dB) - AV	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 28.69	Pass
15.247(a)(2)	6dB Bandwidth	Meet the requirement of limit	Pass
15.247(e)	Power Spectral Density	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information					
Frequency Range (MHz)	IEEE Std. 802.11	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N _{TX})	Data Rate / MCS
2400-2483.5	b	2412-2462	1-11 [11]	1	1-11 Mbps
2400-2483.5	g	2412-2462	1-11 [11]	2	6-54 Mbps
2400-2483.5	n (HT20)	2412-2462	1-11 [11]	2	MCS 0-15
2400-2483.5	n (HT40)	2422-2452	3-9 [7]	2	MCS 0-15
2400-2483.5	ax (HE20)	2412-2462	1-11 [11]	2	MCS 0-11
2400-2483.5	ax (HE40)	2422-2452	3-9 [7]	2	MCS 0-11

Note 1: RF output power specifies that Maximum Conducted (Average) Output Power.
 Note 2: DSSS-DBPSK, DQPSK, CCK modulation
 OFDM/OFDMA- BPSK, QPSK, 16QAM, 64QAM, 256QAM and 1024QAM modulation.
 Note 3: 802.11ax supports beamforming function.

1.1.2 Antenna Details

Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)		
				2400~2483.5	5150~5250	5725~5850
1	2.4G -1	Dipole	UFL	4.2	---	---
2	2.4G -2	Dipole	UFL	3.4	---	---
3	5G - 1	Dipole	UFL	---	5.1	4.2
4	5G - 2	Dipole	UFL	---	4.9	5

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	12Vdc from adapter
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1.1.4 Accessories

Accessories		
No.	Equipment	Description
1	AC adapter	Brand: MOSO Model: MSS-V2500WR120-030E0-US I/P: 100-240V~ 50/60Hz, 1.0A max O/P: 12V=2.5A Power Line: 1.8m non-shielded without core
2	AC adapter	Brand: LEI Model: ML30B1120250-A1 I/P: 100-120V~ 50/60Hz, 0.8A O/P: 12V=2.5A Power Line: 1.8m non-shielded without core
3	RJ45 cable	1.8m non-shielded without core

1.1.5 Channel List

Frequency band (MHz)		2400~2483.5	
802.11bg / n HT20 / ax HE20		802.11n HT40 / ax HE40	
Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	2412	3	2422
2	2417	4	2427
3	2422	5	2432
4	2427	6	2437
5	2432	7	2442
6	2437	8	2447
7	2442	9	2452
8	2447	---	---
9	2452	---	---
10	2457	---	---
11	2462	---	---

1.1.6 Test Tool and Duty Cycle

Test Tool	Intel DUT GUI, V610.36		
Duty Cycle and Duty Factor	Mode	Duty Cycle (%)	Duty Factor (dB)
	11b	100.00%	0.00
	11g	99.51%	0.02
	ax HE20-OFDMA	100.00%	0.00
	ax HE40-OFDMA	100.00%	0.00

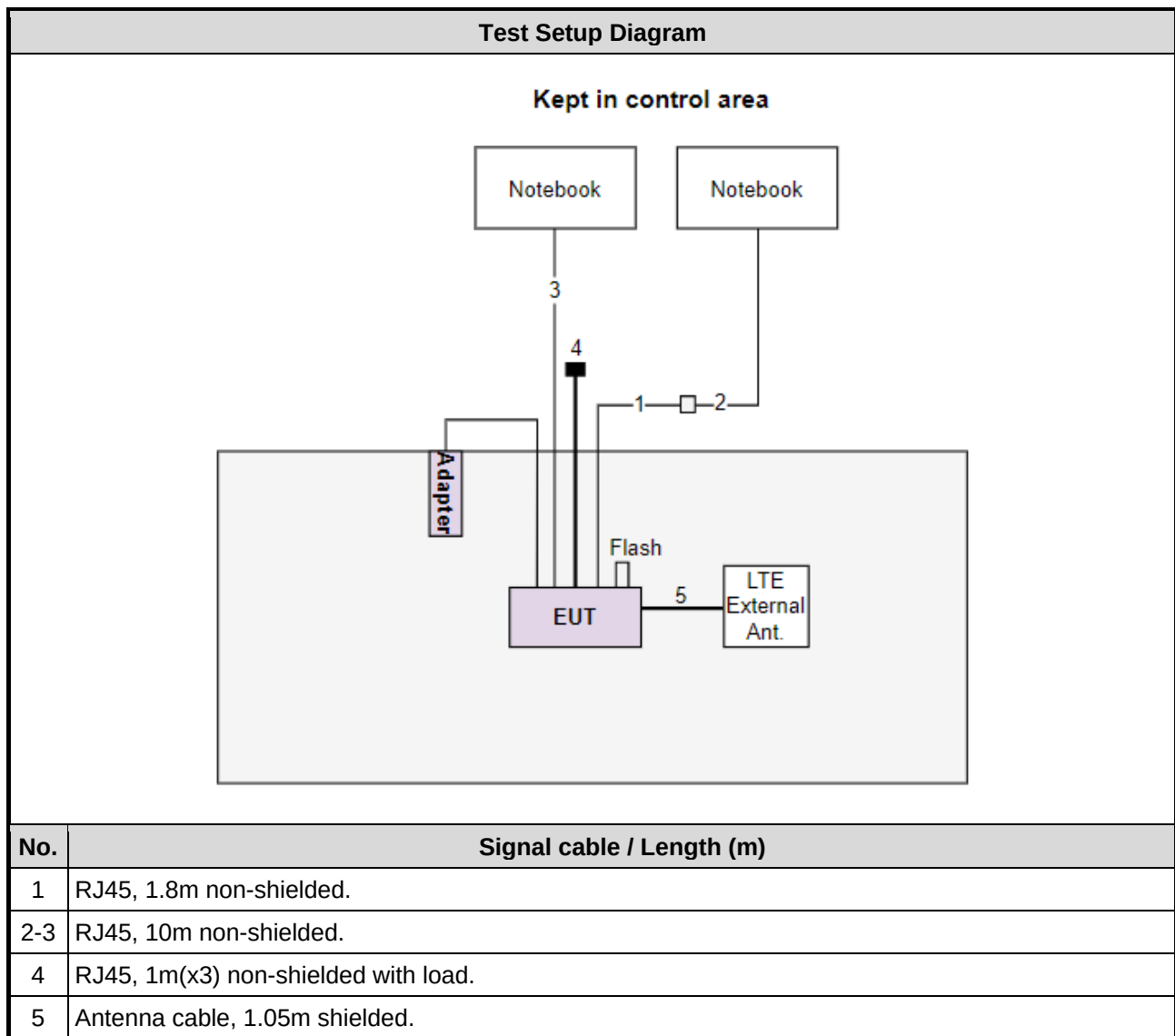
1.1.7 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)	Power Index	
		Non-beamforming	Beamforming
11b	2412	26.5	--
11b	2437	26.5	--
11b	2462	26.5	--
11g	2412	19	--
11g	2437	26.5	--
11g	2462	20	--
ax HE20-OFDMA	2412	19	19
ax HE20-OFDMA	2437	25.5	25.5
ax HE20-OFDMA	2462	20	20
ax HE40-OFDMA	2422	17.5	17.5
ax HE40-OFDMA	2437	21	21
ax HE40-OFDMA	2452	20	20

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Notebook	DELL	Latitude E6440	DoC	---
2	Notebook	DELL	Latitude 5400	---	---
3	USB 3.0 Flash	Transcend	JetFlash 700	---	---
4	RJ45 load	ICC	---	---	---
5	LTE external antenna	---	---	---	Provided by applicant.

1.3 Test Setup Chart



1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Feb. 14, 2022				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 12, 2021	Mar. 11, 2022
LISN	R&S	ENV216	101579	Mar. 17, 2021	Mar. 16, 2022
LISN (Support Unit)	SCHWARZBECK MESS-ELEKTRONIK	NSLK 8127	8127477	Feb. 25, 2021	Feb. 24, 2022
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 19, 2021	Oct. 18, 2022
50 ohm terminal (Support Unit)	NA	50	04	May 25, 2021	May 24, 2022
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Jan. 26 ~ Jan. 28, 2022				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 12, 2021	Mar. 11, 2022
Spectrum Analyzer	R&S	FSV40	101498	Nov. 29, 2021	Nov. 28, 2022
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 08, 2021	Nov. 07, 2022
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jun. 30, 2021	Jun. 29, 2022
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 03, 2021	Dec. 02, 2022
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170508	Jan. 11, 2022	Jan. 10, 2023
Preamplifier	EMC	EMC02325	980225	Jun. 29, 2021	Jun. 28, 2022
Preamplifier	Agilent	83017A	MY39501308	Sep. 28, 2021	Sep. 27, 2022
Preamplifier	EMC	EMC184045B	980192	Jul. 14, 2021	Jul. 13, 2022
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 05, 2021	Oct. 04, 2022
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 05, 2021	Oct. 04, 2022
LF cable 11M	EMC	EMCCFD400-NW-N W-11000	200801	Oct. 05, 2021	Oct. 04, 2022
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	160502	Oct. 05, 2021	Oct. 04, 2022
RF Cable	EMC	EMC104-35M-35M- 8000	210920	Oct. 05, 2021	Oct. 04, 2022
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Oct. 05, 2021	Oct. 04, 2022
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Feb. 15, 2022				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Nov. 29, 2021	Nov. 28, 2022
Power Meter	Anritsu	ML2495A	1241002	Nov. 07, 2021	Nov. 06, 2022
Power Sensor	Anritsu	MA2411B	1207366	Nov. 07, 2021	Nov. 06, 2022
Measurement Software	Sporton	SENSE-15247_DTS	V5.10	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.247

ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$)).

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	± 34.130 Hz
Conducted power	± 0.808 dB
Power density	± 0.583 dB
Conducted emission	± 2.715 dB
AC conducted emission	± 2.92 dB
Radiated emission ≤ 1 GHz	± 3.41 dB
Radiated emission > 1 GHz	± 4.59 dB

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corporation
Test Site	CO01-WS, 03CH01-WS, TH01-WS
Address of Test Site	No.3-1, Lane 6, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- ISED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate (Mbps) / MCS	Test Configuration
Non-beamforming mode				
Conducted Emissions	11g	2437	6 Mbps	--
Radiated Emissions ≤1GHz	11g	2437	6 Mbps	--
Maximum Output Power	11b 11g ax HE20-OFDMA ax HE40-OFDMA	2412 / 2437 / 2462 2412 / 2437 / 2462 2412 / 2437 / 2462 2422 / 2437 / 2452	1 Mbps 6 Mbps MCS 0 MCS 0	--
Radiated Emissions >1GHz 6dB bandwidth Power spectral density	11b 11g ax HE20-OFDMA ax HE40-OFDMA	2412 / 2437 / 2462 2412 / 2437 / 2462 2412 / 2437 / 2462 2422 / 2437 / 2452	1 Mbps 6 Mbps MCS 0 MCS 0	--
Beamforming mode				
Maximum Output Power	ax HE20-OFDMA ax HE40-OFDMA	2412 / 2437 / 2462 2422 / 2437 / 2452	MCS 0 MCS 0	--
NOTE:				
1. Two adapters (MOSO & LEI) had been covered during the pretest and found that LEI adapter was the worst case for radiated emission test and MOSO adapter was the worst case for conducted emission test.				
2. Non-beamforming and beamforming mode had been covered during the pretest. The worst mode is Non-beamforming thus Non-beamforming is tested for all test items.				

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

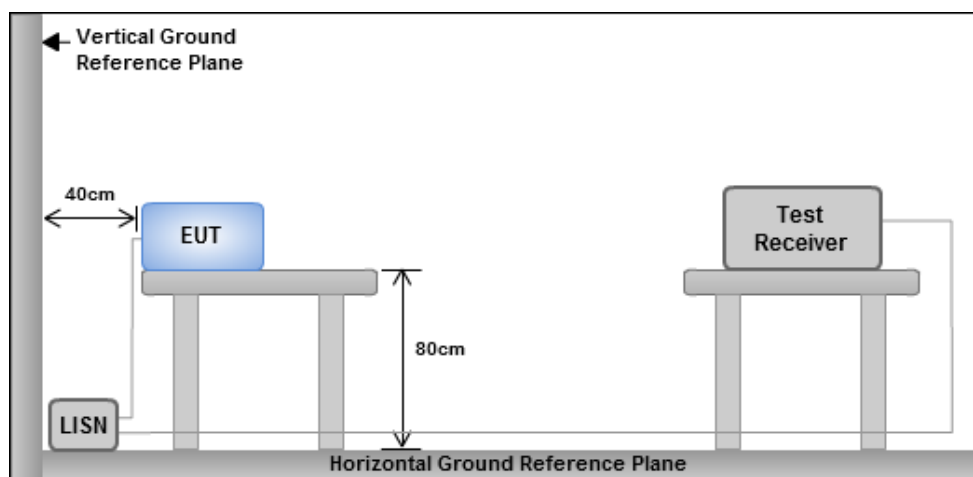
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V / 60Hz.

3.1.3 Test Setup



- Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

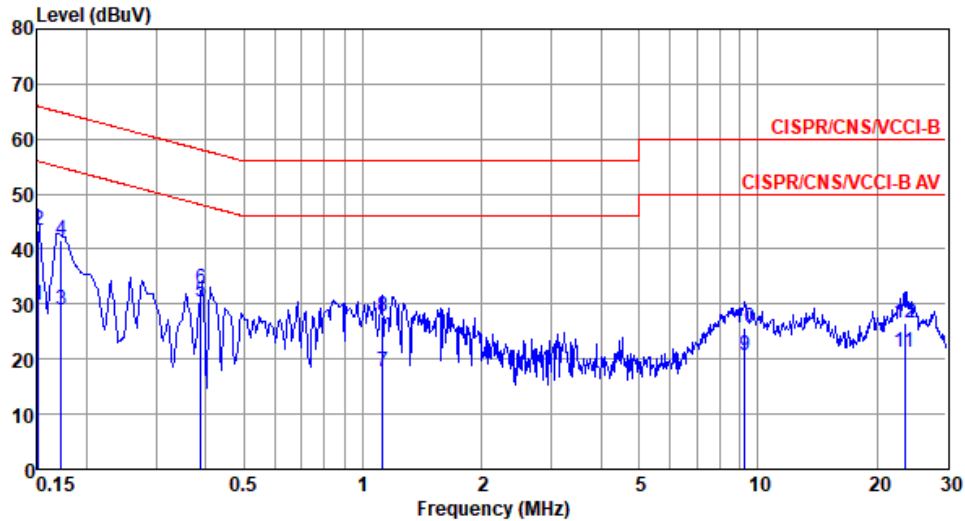
Modulation	11g	Test Freq. (MHz)	2437																																																																																																																																		
Power Phase	Line																																																																																																																																				
Test by : Joe Liao Temperature: 16°C Humidity: 64%																																																																																																																																					
Level (dBUV) <table><thead><tr><th></th><th>Freq MHz</th><th>Level dBUV</th><th>Limit Line dBUV</th><th>Over Limit dB</th><th>Read Level dBUV</th><th>Factor dB</th><th>Cable loss dB</th><th>Aux dB</th><th>Remark</th></tr></thead><tbody><tr><td>1</td><td>0.175</td><td>32.42</td><td>54.73</td><td>-22.31</td><td>22.48</td><td>9.65</td><td>0.08</td><td>0.21</td><td>Average</td></tr><tr><td>2</td><td>0.175</td><td>44.21</td><td>64.73</td><td>-20.52</td><td>34.27</td><td>9.65</td><td>0.08</td><td>0.21</td><td>QP</td></tr><tr><td>3</td><td>0.249</td><td>28.25</td><td>51.78</td><td>-23.53</td><td>18.26</td><td>9.65</td><td>0.08</td><td>0.26</td><td>Average</td></tr><tr><td>4</td><td>0.249</td><td>36.38</td><td>61.78</td><td>-25.40</td><td>26.39</td><td>9.65</td><td>0.08</td><td>0.26</td><td>QP</td></tr><tr><td>5*</td><td>0.356</td><td>32.75</td><td>48.82</td><td>-16.07</td><td>22.69</td><td>9.64</td><td>0.08</td><td>0.34</td><td>Average</td></tr><tr><td>6</td><td>0.356</td><td>35.97</td><td>58.82</td><td>-22.85</td><td>25.91</td><td>9.64</td><td>0.08</td><td>0.34</td><td>QP</td></tr><tr><td>7</td><td>1.269</td><td>17.74</td><td>46.00</td><td>-28.26</td><td>7.54</td><td>9.65</td><td>0.17</td><td>0.38</td><td>Average</td></tr><tr><td>8</td><td>1.269</td><td>26.71</td><td>56.00</td><td>-29.29</td><td>16.51</td><td>9.65</td><td>0.17</td><td>0.38</td><td>QP</td></tr><tr><td>9</td><td>8.869</td><td>18.53</td><td>50.00</td><td>-31.47</td><td>7.97</td><td>9.70</td><td>0.42</td><td>0.44</td><td>Average</td></tr><tr><td>10</td><td>8.869</td><td>23.49</td><td>60.00</td><td>-36.51</td><td>12.93</td><td>9.70</td><td>0.42</td><td>0.44</td><td>QP</td></tr><tr><td>11</td><td>21.715</td><td>20.25</td><td>50.00</td><td>-29.75</td><td>9.25</td><td>9.67</td><td>0.67</td><td>0.66</td><td>Average</td></tr><tr><td>12</td><td>21.715</td><td>25.29</td><td>60.00</td><td>-34.71</td><td>14.29</td><td>9.67</td><td>0.67</td><td>0.66</td><td>QP</td></tr></tbody></table>					Freq MHz	Level dBUV	Limit Line dBUV	Over Limit dB	Read Level dBUV	Factor dB	Cable loss dB	Aux dB	Remark	1	0.175	32.42	54.73	-22.31	22.48	9.65	0.08	0.21	Average	2	0.175	44.21	64.73	-20.52	34.27	9.65	0.08	0.21	QP	3	0.249	28.25	51.78	-23.53	18.26	9.65	0.08	0.26	Average	4	0.249	36.38	61.78	-25.40	26.39	9.65	0.08	0.26	QP	5*	0.356	32.75	48.82	-16.07	22.69	9.64	0.08	0.34	Average	6	0.356	35.97	58.82	-22.85	25.91	9.64	0.08	0.34	QP	7	1.269	17.74	46.00	-28.26	7.54	9.65	0.17	0.38	Average	8	1.269	26.71	56.00	-29.29	16.51	9.65	0.17	0.38	QP	9	8.869	18.53	50.00	-31.47	7.97	9.70	0.42	0.44	Average	10	8.869	23.49	60.00	-36.51	12.93	9.70	0.42	0.44	QP	11	21.715	20.25	50.00	-29.75	9.25	9.67	0.67	0.66	Average	12	21.715	25.29	60.00	-34.71	14.29	9.67	0.67	0.66	QP
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12	21.715	25.29	60.00	-34.71	14.29	9.67	0.67	0.66	QP																																																																																																																												
Note 1: Level (dBUV) = Read Level (dBUV) + LISN Factor (dB) + Cable Loss (dB) + Aux (dB). 2: Over Limit (dB) = Level (dBUV) – Limit Line (dBUV).																																																																																																																																					

Modulation	11g	Test Freq. (MHz)	2437
Power Phase	Neutral		

Test by : Joe Liao

Temperature: 16°C

Humidity: 64%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	Factor dB	Cable loss dB	Aux dB	Remark
1	0.151	29.72	55.96	-26.24	19.79	9.69	0.08	0.16	Average
2	0.151	43.52	65.96	-22.44	33.59	9.69	0.08	0.16	QP
3	0.172	28.86	54.86	-26.00	18.92	9.69	0.08	0.17	Average
4	0.172	41.54	64.86	-23.32	31.60	9.69	0.08	0.17	QP
5*	0.390	30.28	48.07	-17.79	20.34	9.67	0.08	0.19	Average
6	0.390	32.67	58.07	-25.40	22.73	9.67	0.08	0.19	QP
7	1.123	17.78	46.00	-28.22	7.65	9.68	0.17	0.28	Average
8	1.123	27.78	56.00	-28.22	17.65	9.68	0.17	0.28	QP
9	9.253	20.67	50.00	-29.33	10.12	9.75	0.43	0.37	Average
10	9.253	25.59	60.00	-34.41	15.04	9.75	0.43	0.37	QP
11	23.511	21.33	50.00	-28.67	10.31	9.84	0.68	0.50	Average
12	23.511	26.66	60.00	-33.34	15.64	9.84	0.68	0.50	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB) + Aux (dB).

2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 6dB and Occupied Bandwidth

3.2.1 Limit of 6dB Bandwidth

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

3.2.2 Test Procedures

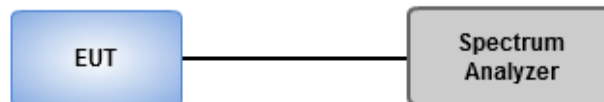
6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set resolution bandwidth (RBW) = 1% ~ 5 % of OBW, Video bandwidth = 3 x RBW
2. Detector = Sample, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

3.2.3 Test Setup



3.2.4 Test Result of 6dB and Occupied Bandwidth

Ambient Condition	21°C / 66%	Tested By	Aska Huang
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Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
802.11b_Nss1,(1Mbps)_1TX	8.116M	11.939M	11M9G1D	8.043M	11.867M
802.11g_Nss1,(6Mbps)_2TX	16.377M	19.03M	19M0D1D	16.159M	16.57M
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	19.13M	19.103M	19M1D1D	18.841M	18.958M
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	38.261M	38.495M	38M5D1D	38.116M	37.627M

Max-N dB = Maximum 6dB down bandwidth; **Max-OBW** = Maximum 99% occupied bandwidth;
Min-N dB = Minimum 6dB down bandwidth; **Min-OBW** = Minimum 99% occupied bandwidth;

Result

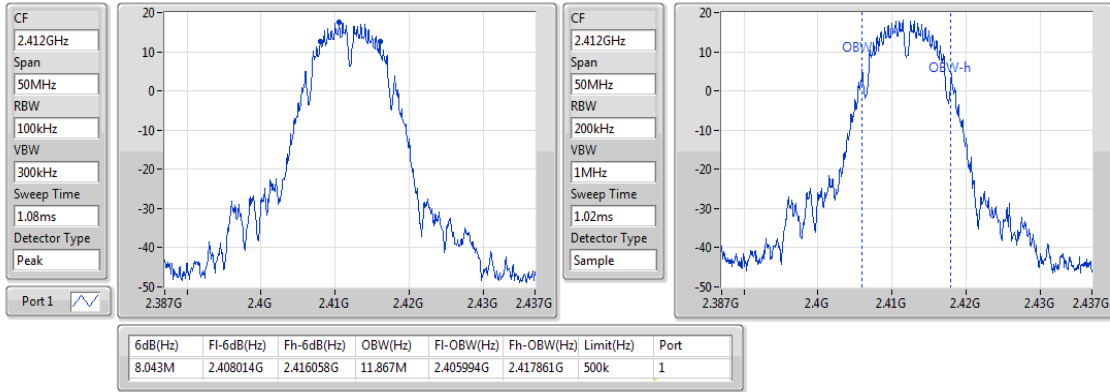
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)	Port 2-N dB (Hz)	Port 2-OBW (Hz)
802.11b_Nss1,(1Mbps)_1TX	-	-	-	-	-	-
2412MHz	Pass	500k	8.043M	11.867M		
2437MHz	Pass	500k	8.043M	11.939M		
2462MHz	Pass	500k	8.116M	11.939M		
802.11g_Nss1,(6Mbps)_2TX	-	-	-	-	-	-
2412MHz	Pass	500k	16.377M	16.787M	16.377M	16.57M
2437MHz	Pass	500k	16.304M	19.03M	16.377M	18.741M
2462MHz	Pass	500k	16.159M	16.787M	16.377M	16.643M
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-
2412MHz	Pass	500k	19.058M	18.958M	18.841M	18.958M
2437MHz	Pass	500k	19.058M	19.103M	19.13M	19.03M
2462MHz	Pass	500k	19.13M	18.958M	19.13M	18.958M
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-
2422MHz	Pass	500k	38.116M	38.205M	38.116M	38.35M
2437MHz	Pass	500k	38.261M	38.495M	38.261M	38.061M
2452MHz	Pass	500k	38.116M	37.916M	38.116M	37.627M

Port X-N dB = Port X 6dB down bandwidth; **Port X-OBW** = Port X 99% occupied bandwidth;

802.11b_Nss1,(1Mbps)_1TX

EBW

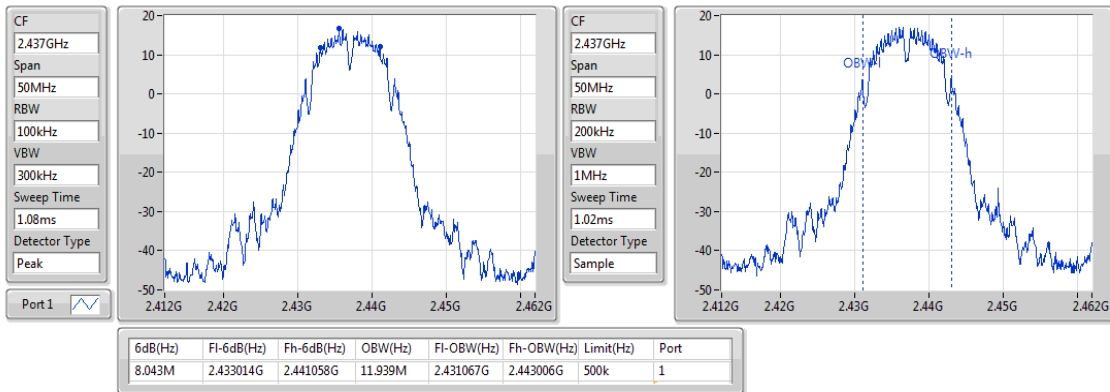
2412MHz



802.11b_Nss1,(1Mbps)_1TX

EBW

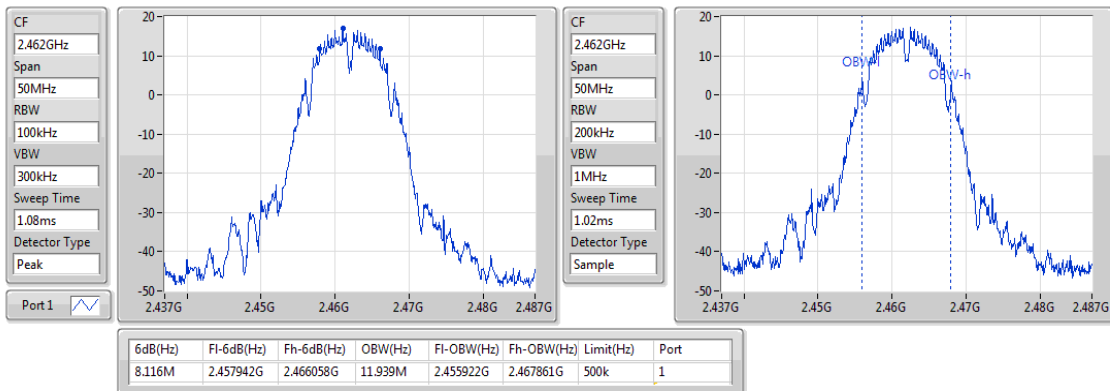
2437MHz



802.11b_Nss1,(1Mbps)_1TX

EBW

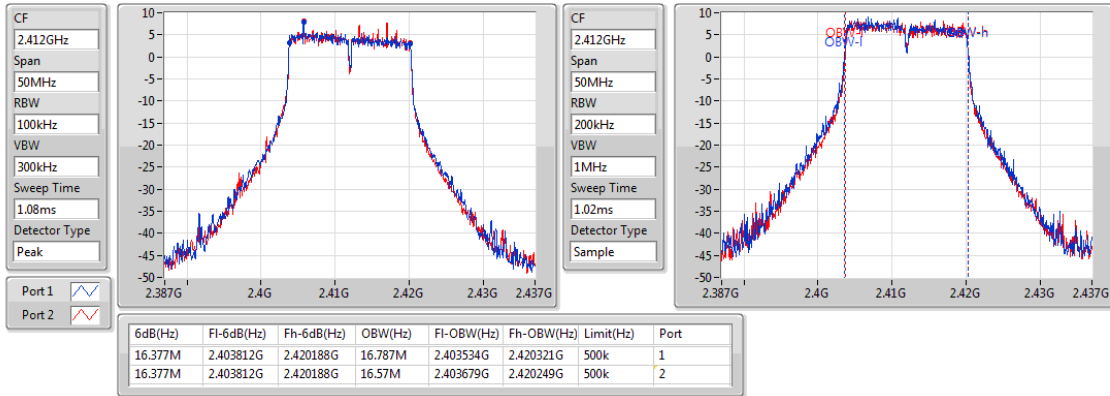
2462MHz



802.11g_Nss1,(6Mbps)_2TX

EBW

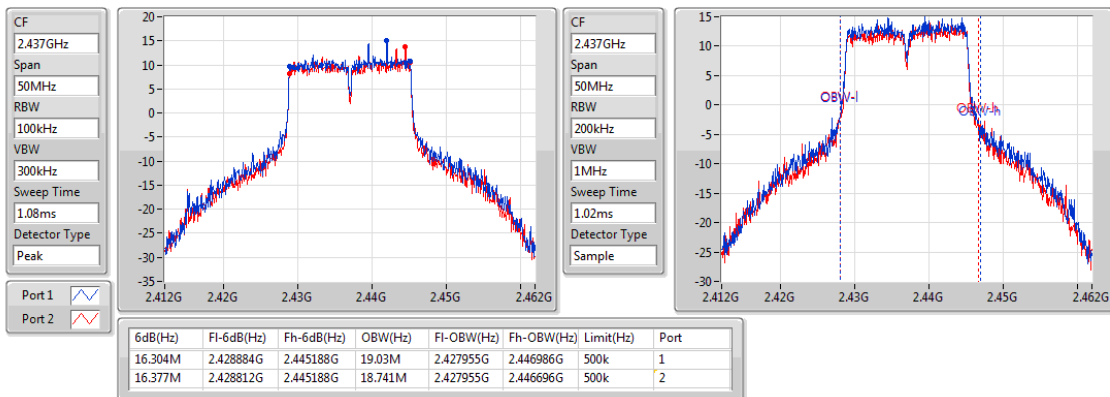
2412MHz



802.11g_Nss1,(6Mbps)_2TX

EBW

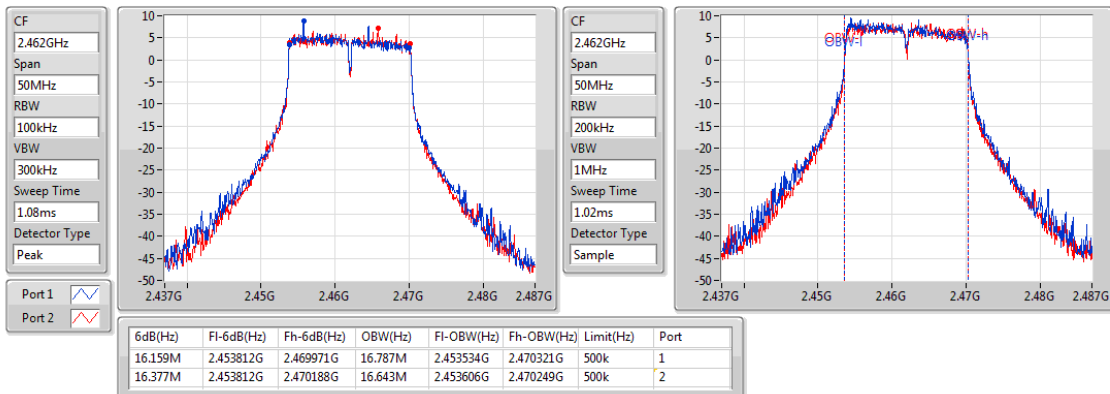
2437MHz



802.11g_Nss1,(6Mbps)_2TX

EBW

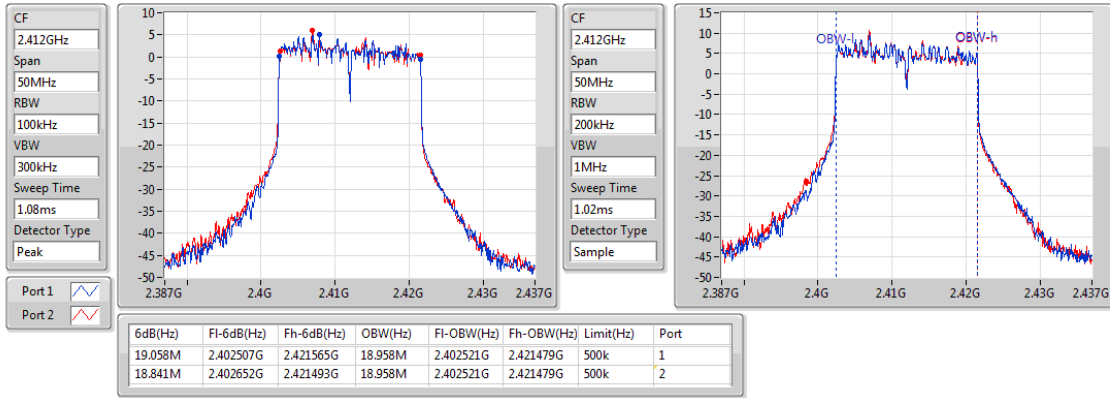
2462MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

EBW

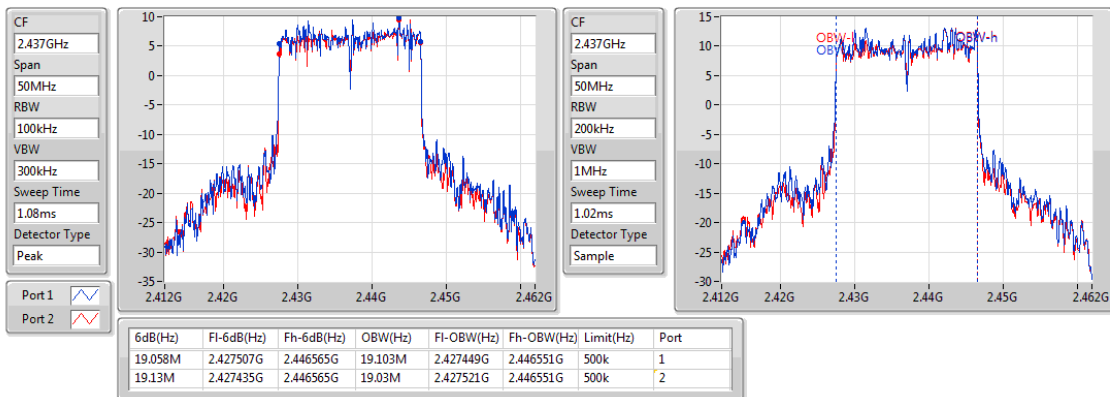
2412MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

EBW

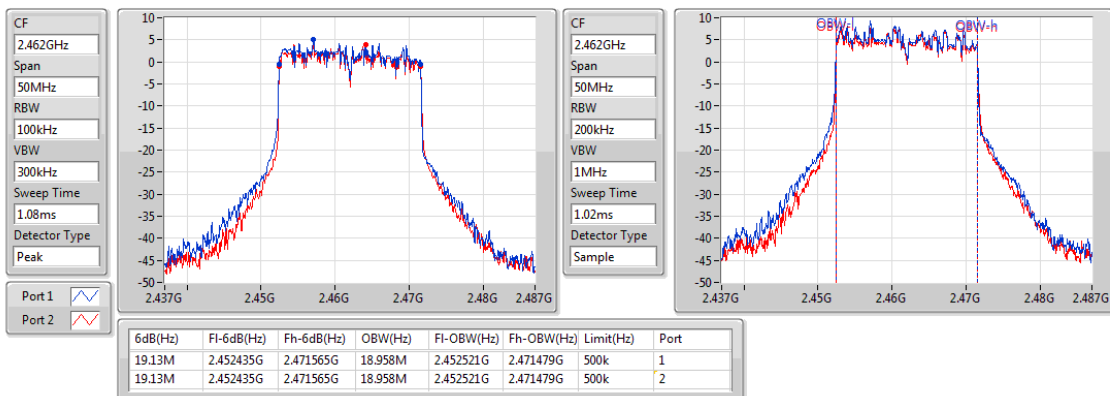
2437MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

EBW

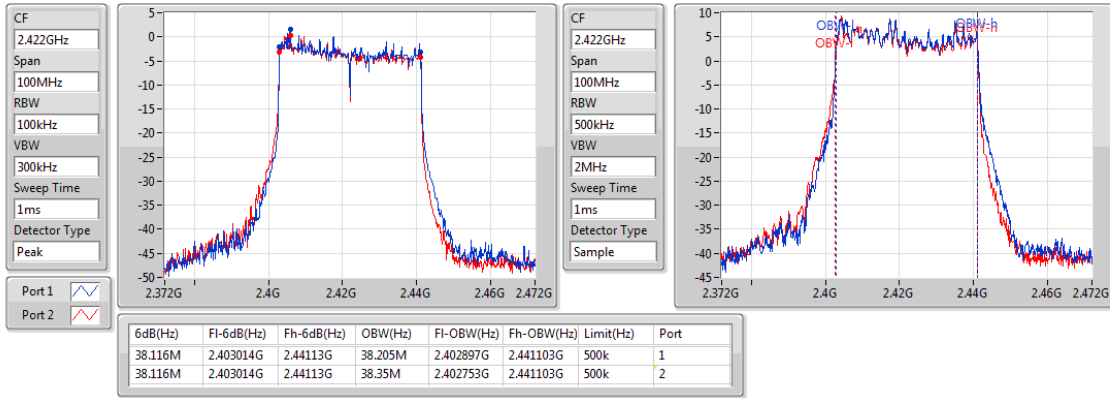
2462MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

EBW

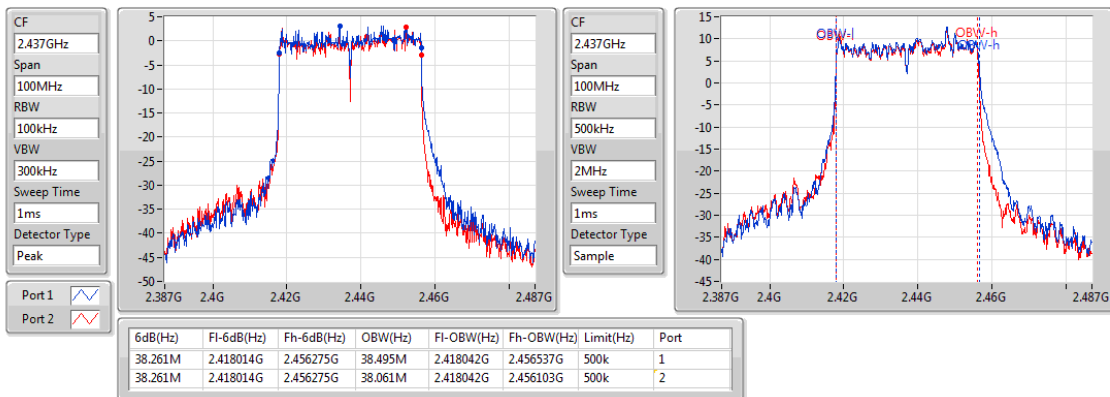
2422MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

EBW

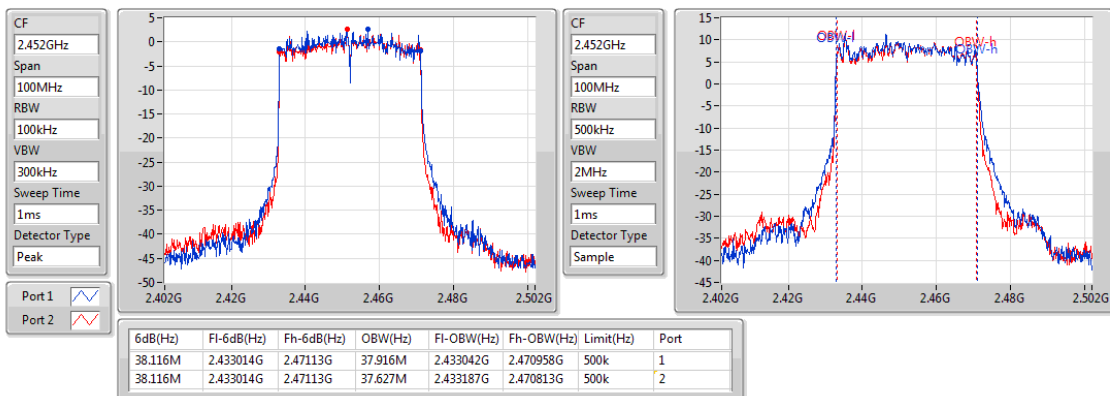
2437MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

EBW

2452MHz



3.3 RF Output Power

3.3.1 Limit of RF Output Power

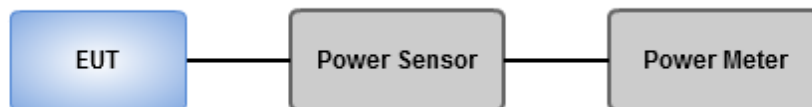
Conducted power shall not exceed 1Watt.

Antenna gain $\leq 6\text{dBi}$, no any corresponding reduction is in output power limit.

3.3.2 Test Procedures

A broadband RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.

3.3.3 Test Setup



3.3.4 Test Result of Maximum Output Power

Ambient Condition	21°C / 66%	Tested By	Aska Huang
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Non-beamforming mode

Summary of Conducted (Average) Output Power

Mode	Total Power (dBm)	Total Power (W)
2.4-2.4835GHz	-	-
802.11b_Nss1,(1Mbps)_1TX	26.23	0.41976
802.11g_Nss1,(6Mbps)_2TX	28.69	0.73961
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	27.08	0.51050
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	24.00	0.25119

Result

Mode	Result	DG (dBi)	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	EIRP (dBm)	EIRP Limit (dBm)
802.11b_Nss1,(1Mbps)_1TX	-	-	-	-	-	-	-	-
2412MHz	Pass	4.20	26.23	-	26.23	30.00	30.43	36.00
2437MHz	Pass	4.20	25.76	-	25.76	30.00	29.96	36.00
2462MHz	Pass	4.20	25.77	-	25.77	30.00	29.97	36.00
802.11g_Nss1,(6Mbps)_2TX	-	-	-	-	-	-	-	-
2412MHz	Pass	4.20	19.61	19.76	22.70	30.00	26.90	36.00
2437MHz	Pass	4.20	25.75	25.61	28.69	30.00	32.89	36.00
2462MHz	Pass	4.20	20.1	20.05	23.09	30.00	27.29	36.00
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-	-	-
2412MHz	Pass	4.20	19.93	19.73	22.84	30.00	27.04	36.00
2437MHz	Pass	4.20	24.14	23.99	27.08	30.00	31.28	36.00
2462MHz	Pass	4.20	20.09	20.12	23.12	30.00	27.32	36.00
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-	-	-
2422MHz	Pass	4.20	17.82	17.63	20.74	30.00	24.94	36.00
2437MHz	Pass	4.20	21.11	20.86	24.00	30.00	28.20	36.00
2452MHz	Pass	4.20	19.93	20.12	23.04	30.00	27.24	36.00

DG = Directional Gain; Port X = Port X output power

Beamforming mode

Summary of Conducted (Average) Output Power

Mode	Total Power (dBm)	Total Power (W)
2.4-2.4835GHz	-	-
802.11ax HEW20-BF_Nss1,(MCS0)_2TX-OFDMA	27.03	0.50466
802.11ax HEW40-BF_Nss1,(MCS0)_2TX-OFDMA	23.90	0.24547

Result

Mode	Result	DG (dBi)	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	EIRP (dBm)	EIRP Limit (dBm)
802.11ax HEW20-BF_Nss1,(MCS0)_2TX-OFDM A	-	-	-	-	-	-	-	-
2412MHz	Pass	6.82	19.81	19.65	22.74	29.18	29.56	36.00
2437MHz	Pass	6.82	24.09	23.95	27.03	29.18	33.85	36.00
2462MHz	Pass	6.82	20.03	20.01	23.03	29.18	29.85	36.00
802.11ax HEW40-BF_Nss1,(MCS0)_2TX-OFDM A	-	-	-	-	-	-	-	-
2422MHz	Pass	6.82	17.71	17.52	20.63	29.18	27.45	36.00
2437MHz	Pass	6.82	21.05	20.73	23.90	29.18	30.72	36.00
2452MHz	Pass	6.82	19.82	20.05	22.95	29.18	29.77	36.00

DG = Directional Gain; Port X = Port X output power

Directional Gain = $10 * \log((10^{4.2/20} + 10^{3.4/20})^2 / 2) = 6.82 \text{ dBi} > 6 \text{ dBi}$, limit shall be reduced to $30 \text{ dBm} - (6.82 \text{ dBi} - 6 \text{ dBi}) = 29.18 \text{ dBm}$

3.4 Power Spectral Density

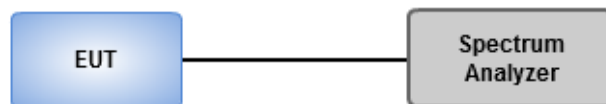
3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

3.4.2 Test Procedures

- 1 Set RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, Set VBW $\geq [3 \times \text{RBW}]$. Detector = RMS.
- 2 Sweep time = auto couple.
- 3 Employ trace averaging (RMS) mode over a minimum of 100 traces.
- 4 Use the peak marker function to determine the maximum amplitude level.

3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Ambient Condition	21°C / 66%	Tested By	Aska Huang
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Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
802.11b_Nss1,(1Mbps)_1TX	-2.69
802.11g_Nss1,(6Mbps)_2TX	-3.12
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	7.00
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	1.97

RBW= 3 kHz

Result

Mode	Result	DG (dBi)	Port 1 (dBm/RBW)	Port 2 (dBm/RBW)	PD (dBm/RBW)	PD Limit (dBm/RBW)
802.11b_Nss1,(1Mbps)_1TX	-	-	-	-	-	-
2412MHz	Pass	4.20	-2.69	-	-2.69	8.00
2437MHz	Pass	4.20	-3.91	-	-3.91	8.00
2462MHz	Pass	4.20	-3.98	-	-3.98	8.00
802.11g_Nss1,(6Mbps)_2TX	-	-	-	-	-	-
2412MHz	Pass	6.82	-11.17	-11.52	-9.49	7.18
2437MHz	Pass	6.82	-5.95	-5.81	-3.12	7.18
2462MHz	Pass	6.82	-11.43	-11.48	-9.08	7.18
802.11ax HEW20_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-
2412MHz	Pass	6.82	-1.11	-0.59	2.01	7.18
2437MHz	Pass	6.82	4.27	3.70	7.00	7.18
2462MHz	Pass	6.82	-0.26	-0.50	2.63	7.18
802.11ax HEW40_Nss1,(MCS0)_2TX-OFDMA	-	-	-	-	-	-
2422MHz	Pass	6.82	-4.44	-5.56	-1.95	7.18
2437MHz	Pass	6.82	-1.20	-0.89	1.97	7.18
2452MHz	Pass	6.82	-2.42	-2.22	0.69	7.18

DG = Directional Gain

For 2TX function

Directional Gain = $10 * \log((10^{4.2/20} + 10^{3.4/20})^2 / 2) = 6.82 \text{ dBi} > 6 \text{ dBi}$, limit shall be reduced to 8 dBm – (6.82 dBi – 6 dBi) = 7.18 dBm

PD = trace bin-by-bin of each transmits port summing can be performed maximum power density;

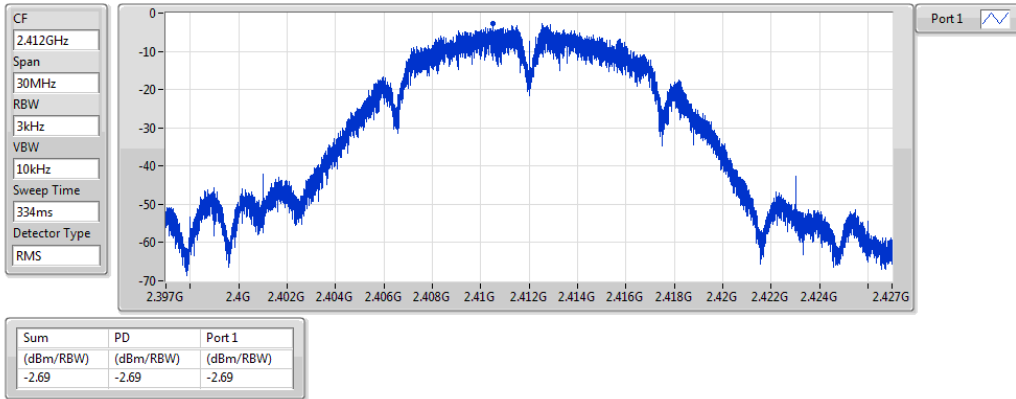
Port X = Port X power density;

RBW= 3 kHz

802.11b_Nss1,(1Mbps)_1TX

PSD

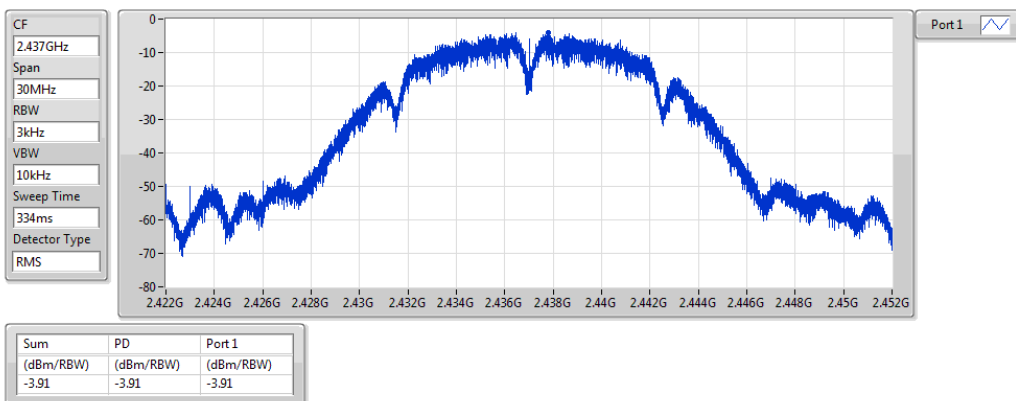
2412MHz



802.11b_Nss1,(1Mbps)_1TX

PSD

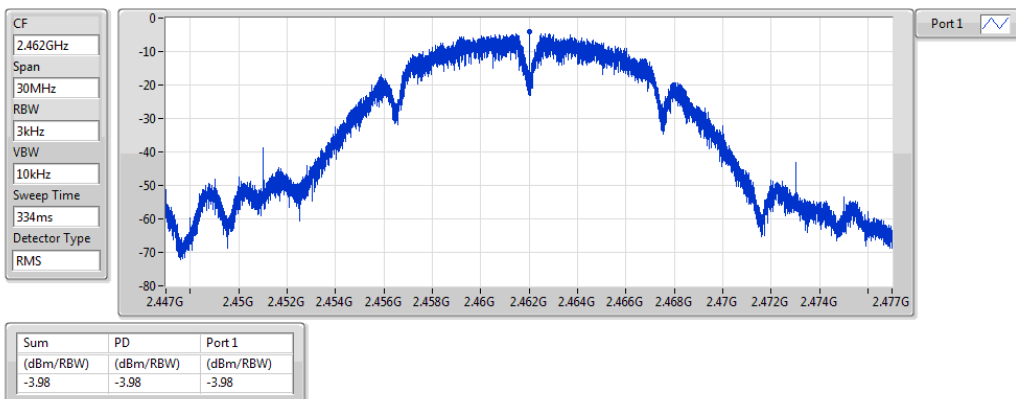
2437MHz



802.11b_Nss1,(1Mbps)_1TX

PSD

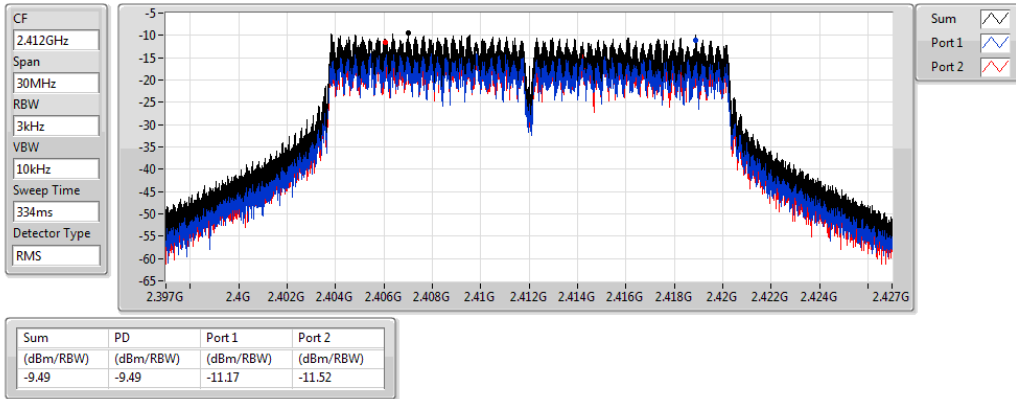
2462MHz



802.11g_Nss1,(6Mbps)_2TX

PSD

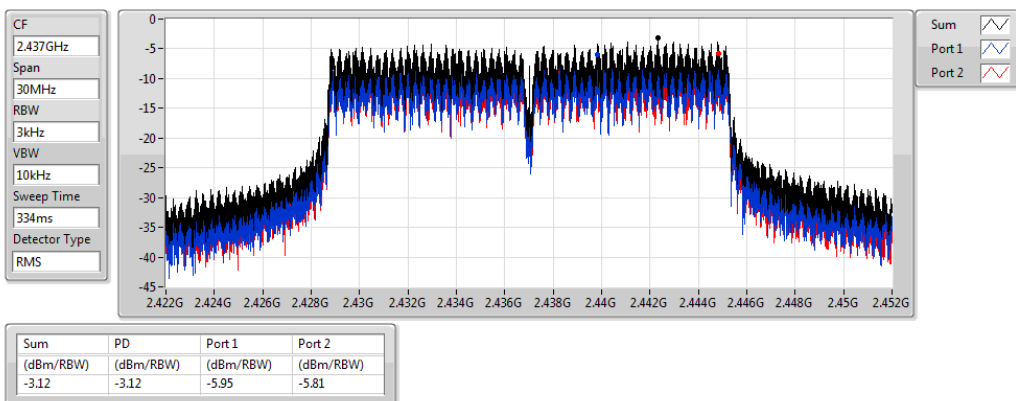
2412MHz



802.11g_Nss1,(6Mbps)_2TX

PSD

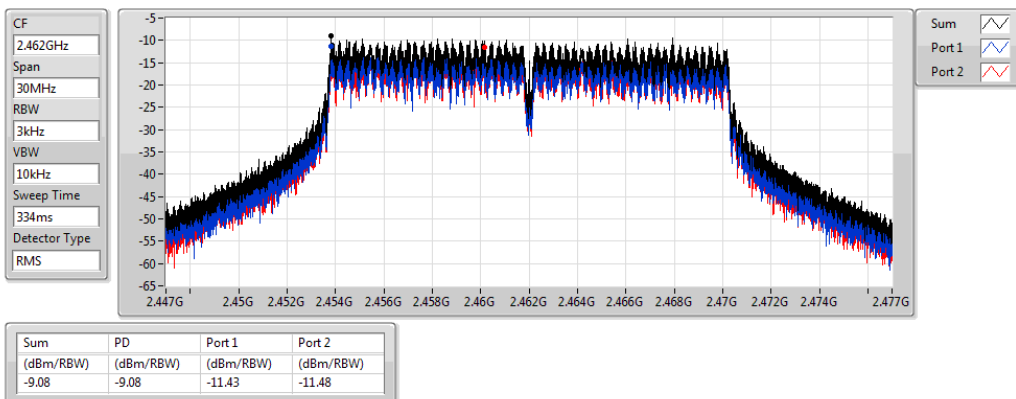
2437MHz



802.11g_Nss1,(6Mbps)_2TX

PSD

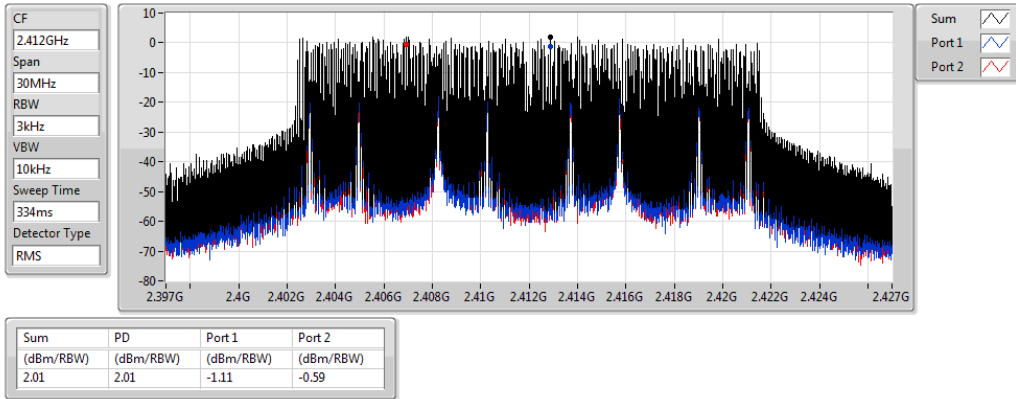
2462MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

PSD

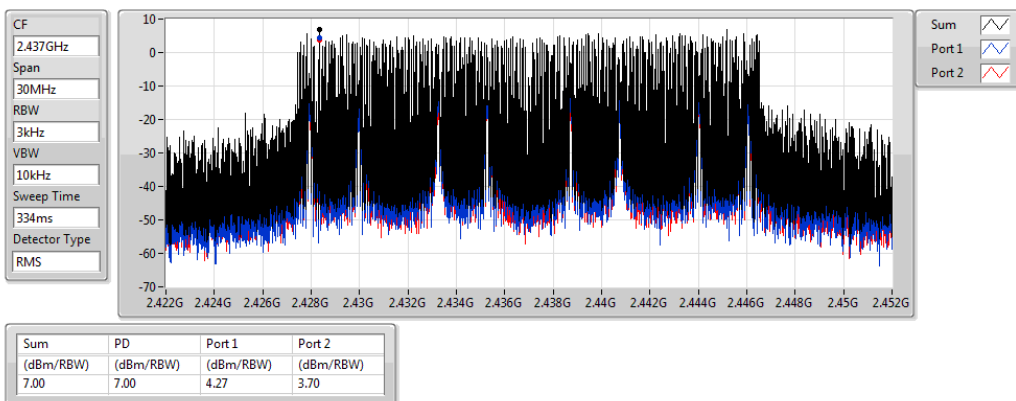
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802.11ax HEW20_Nss1,(MCS0)_2TX

PSD

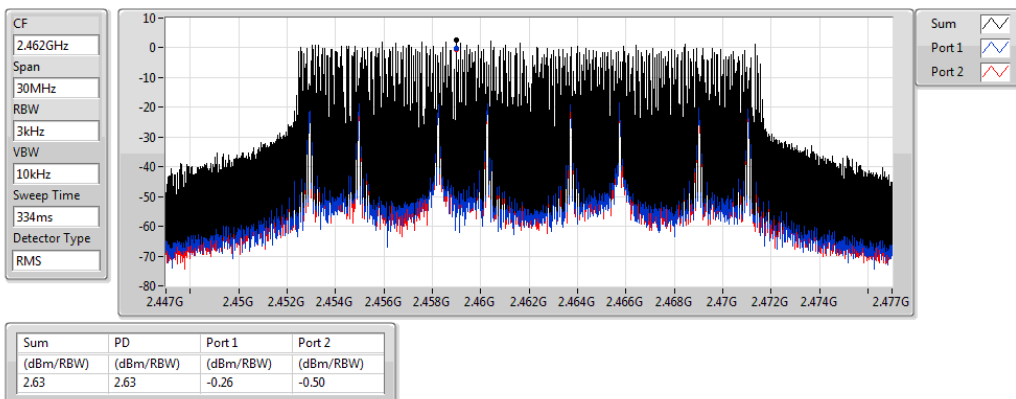
2437MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

PSD

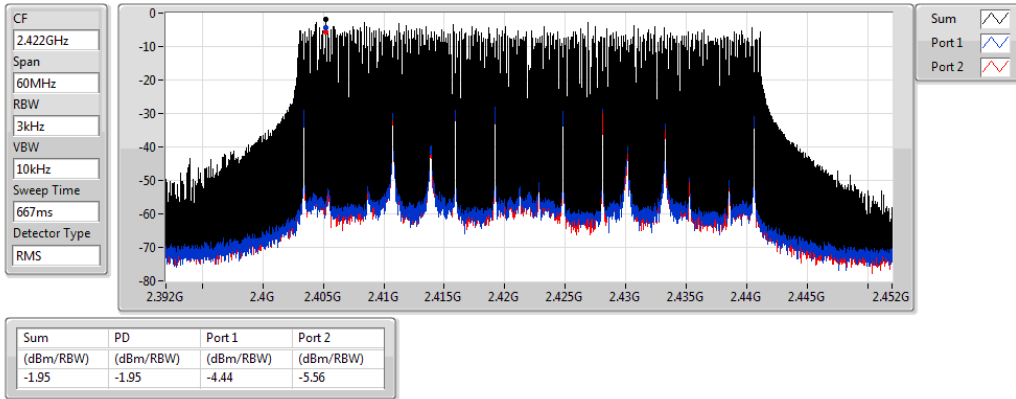
2462MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

PSD

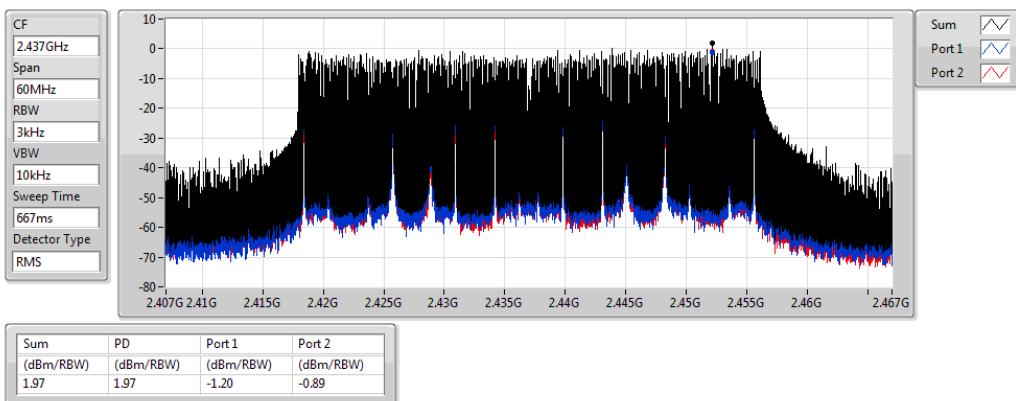
2422MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

PSD

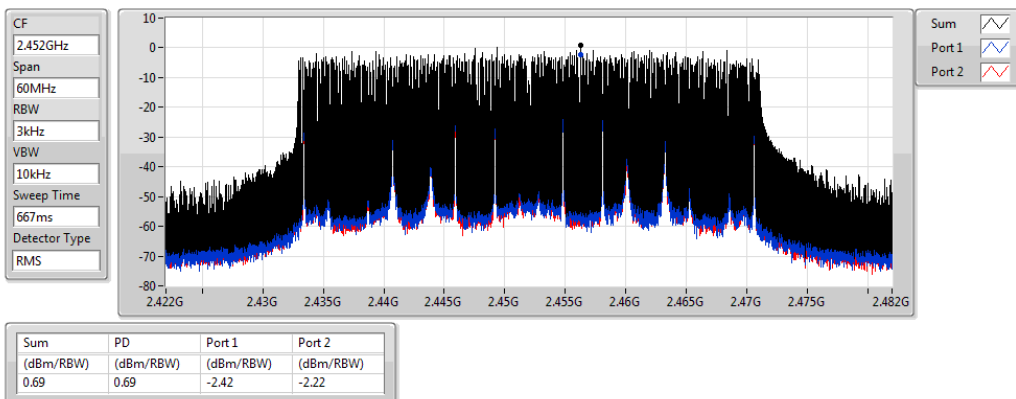
2437MHz



802.11ax HEW40_Nss1,(MCS0)_2TX

PSD

2452MHz



3.5 Unwanted Emissions into Restricted Frequency Bands

3.5.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Quasi-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.5.2 Test Procedures

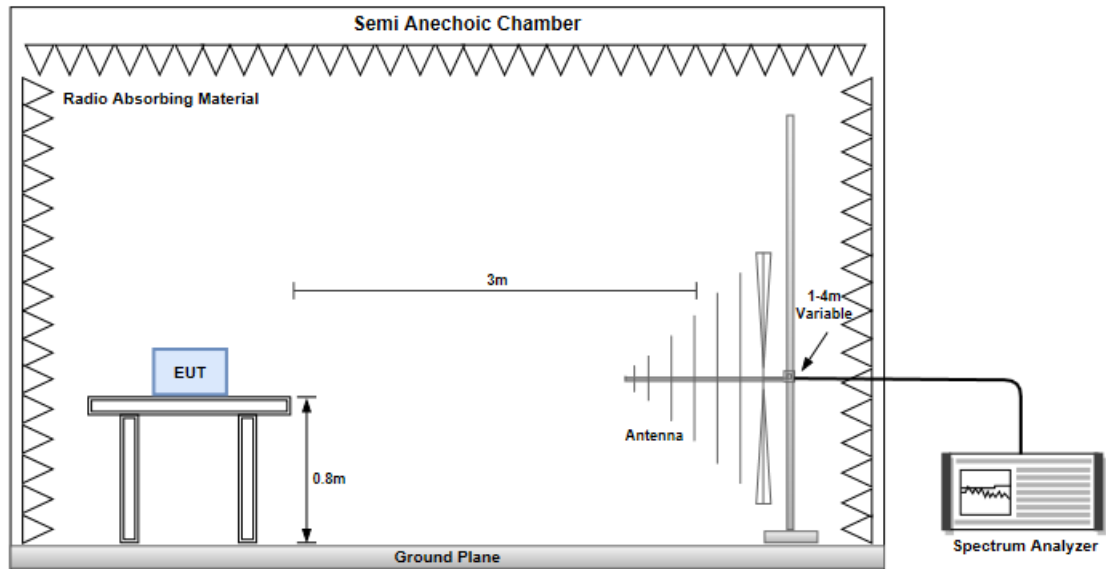
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

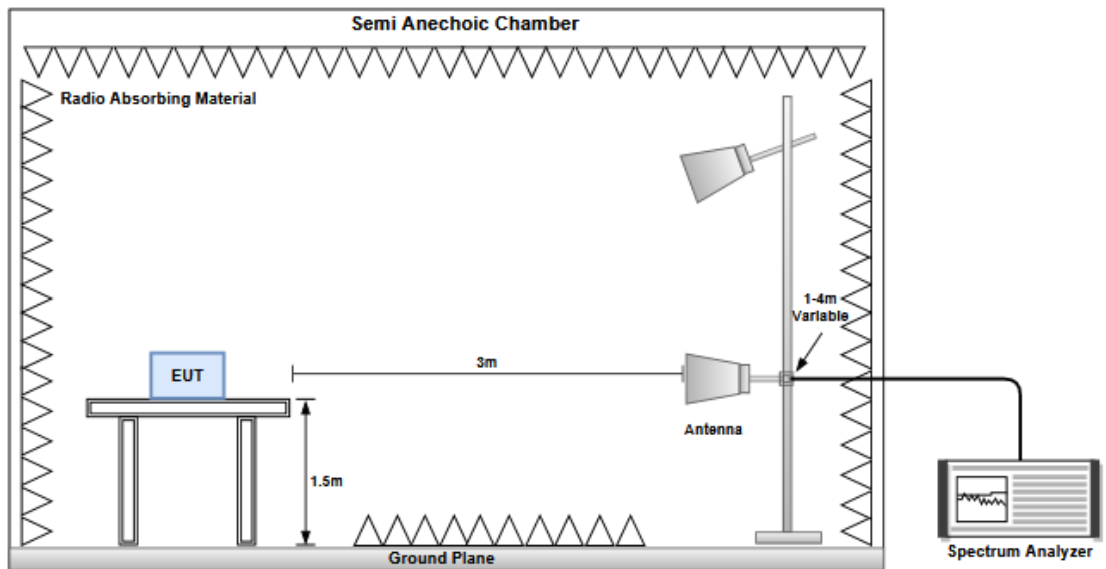
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

3.5.3 Test Setup

Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



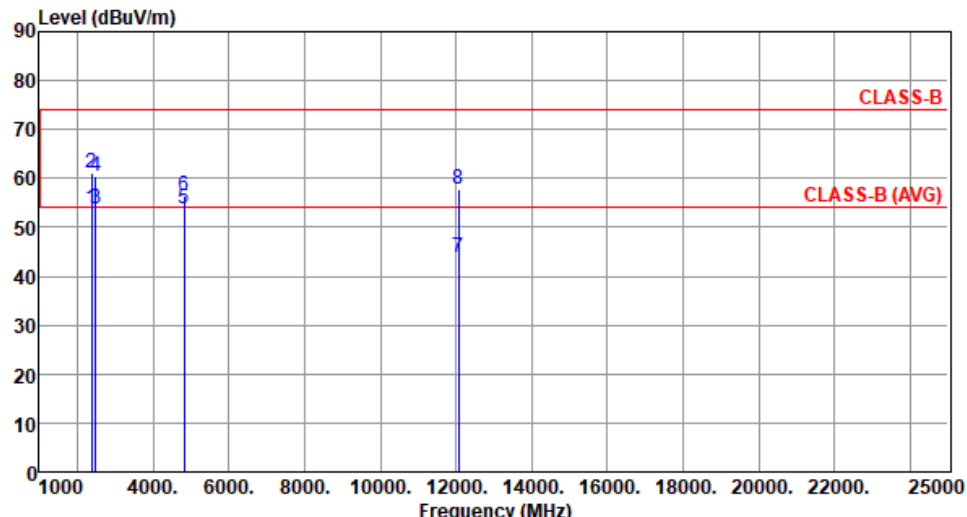
3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):23 Humidity(%):67			
Level (dBUV/m)			

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):23 Humidity(%):67			
Level (dBUV/m)			

3.5.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11b

Modulation	11b		Test Freq. (MHz)		2412	
Polarization	Horizontal					
Test By :Akun Chung Temperature(°C):23 Humidity(%):65						
Level (dBuV/m) <						

Modulation	11b	Test Freq. (MHz)	2412																																																																																																														
Polarization	Vertical																																																																																																																
Test By :Akun Chung Temperature(°C):23 Humidity(%):65																																																																																																																	
Level (dBuV/m)  <table><thead><tr><th></th><th>Freq.</th><th>Emission</th><th>Limit</th><th>Margin</th><th>SA</th><th>Factor</th><th>Remark</th><th>ANT</th><th>Turn</th></tr><tr><th></th><th>MHz</th><th>level</th><th>dBuV/m</th><th>dB</th><th>reading</th><th>dB/m</th><th></th><th>High</th><th>Table</th></tr><tr><th></th><th></th><th>dBuV/m</th><th></th><th></th><th>dBuV</th><th></th><th></th><th>cm</th><th>deg</th></tr></thead><tbody><tr><td>1</td><td>2390.00</td><td>53.82</td><td>54.00</td><td>-0.18</td><td>56.57</td><td>-2.75</td><td>Average</td><td>172</td><td>96</td></tr><tr><td>2</td><td>2390.00</td><td>61.13</td><td>74.00</td><td>-12.87</td><td>63.88</td><td>-2.75</td><td>Peak</td><td>172</td><td>96</td></tr><tr><td>3</td><td>2483.50</td><td>53.87</td><td>54.00</td><td>-0.13</td><td>56.57</td><td>-2.70</td><td>Average</td><td>172</td><td>96</td></tr><tr><td>4</td><td>2483.50</td><td>60.59</td><td>74.00</td><td>-13.41</td><td>63.29</td><td>-2.70</td><td>Peak</td><td>172</td><td>96</td></tr><tr><td>5</td><td>4824.00</td><td>53.68</td><td>54.00</td><td>-0.32</td><td>49.54</td><td>4.14</td><td>Average</td><td>351</td><td>352</td></tr><tr><td>6</td><td>4824.00</td><td>56.50</td><td>74.00</td><td>-17.50</td><td>52.36</td><td>4.14</td><td>Peak</td><td>351</td><td>352</td></tr><tr><td>7</td><td>12060.00</td><td>43.74</td><td>54.00</td><td>-10.26</td><td>29.95</td><td>13.79</td><td>Average</td><td>100</td><td>345</td></tr><tr><td>8</td><td>12060.00</td><td>57.75</td><td>74.00</td><td>-16.25</td><td>43.96</td><td>13.79</td><td>Peak</td><td>100</td><td>345</td></tr></tbody></table>					Freq.	Emission	Limit	Margin	SA	Factor	Remark	ANT	Turn		MHz	level	dBuV/m	dB	reading	dB/m		High	Table			dBuV/m			dBuV			cm	deg	1	2390.00	53.82	54.00	-0.18	56.57	-2.75	Average	172	96	2	2390.00	61.13	74.00	-12.87	63.88	-2.75	Peak	172	96	3	2483.50	53.87	54.00	-0.13	56.57	-2.70	Average	172	96	4	2483.50	60.59	74.00	-13.41	63.29	-2.70	Peak	172	96	5	4824.00	53.68	54.00	-0.32	49.54	4.14	Average	351	352	6	4824.00	56.50	74.00	-17.50	52.36	4.14	Peak	351	352	7	12060.00	43.74	54.00	-10.26	29.95	13.79	Average	100	345	8	12060.00	57.75	74.00	-16.25	43.96	13.79	Peak	100	345
	Freq.	Emission	Limit	Margin	SA	Factor	Remark	ANT	Turn																																																																																																								
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV) + Factor* (dB/m) *Factor includes antenna factor , cable loss and amplifier gain Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).																																																																																																																	

Modulation	11b	Test Freq. (MHz)	2437
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m) </			

Modulation	11b	Test Freq. (MHz)	2437
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m) </			

3.5.6 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11g

Modulation	11g	Test Freq. (MHz)	2412
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m)			

Modulation	11g	Test Freq. (MHz)	2412
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m) <			

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m) </			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m) <			

3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz) for ax HE20-OFDMA

Modulation	ax HE20		Test Freq. (MHz)		2412	
Polarization	Horizontal					
Test By :Akun Chung Temperature(°C):23 Humidity(%):65						
Level (dBUV/m)						

Modulation	ax HE20		Test Freq. (MHz)		2412	
Polarization	Vertical					
Test By :Akun Chung Temperature(°C):23 Humidity(%):65						
Level (dBUV/m)						

Modulation	ax HE20	Test Freq. (MHz)	2437
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m) </			

Modulation	ax HE20	Test Freq. (MHz)	2437
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m) <			

Modulation	ax HE20	Test Freq. (MHz)	2462
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	ax HE20	Test Freq. (MHz)	2462
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

3.5.8 Transmitter Radiated Unwanted Emissions (Above 1GHz) for ax HE40-OFDMA

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2422
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m)			

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2422
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m)			

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2437
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m)			

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2437
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBuV/m) <			

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2452
Polarization	Horizontal		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m)			

Modulation	ax HE40-OFDMA	Test Freq. (MHz)	2452
Polarization	Vertical		
Test By :Akun Chung Temperature(°C):23 Humidity(%):65			
Level (dBUV/m) </			

3.6 Emissions in Non-Restricted Frequency Bands

3.6.1 Emissions in Non-Restricted Frequency Bands Limit

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.6.2 Test Procedures

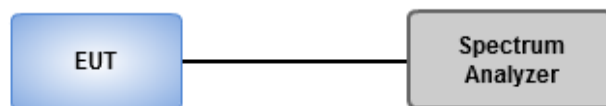
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

Emission level measurement

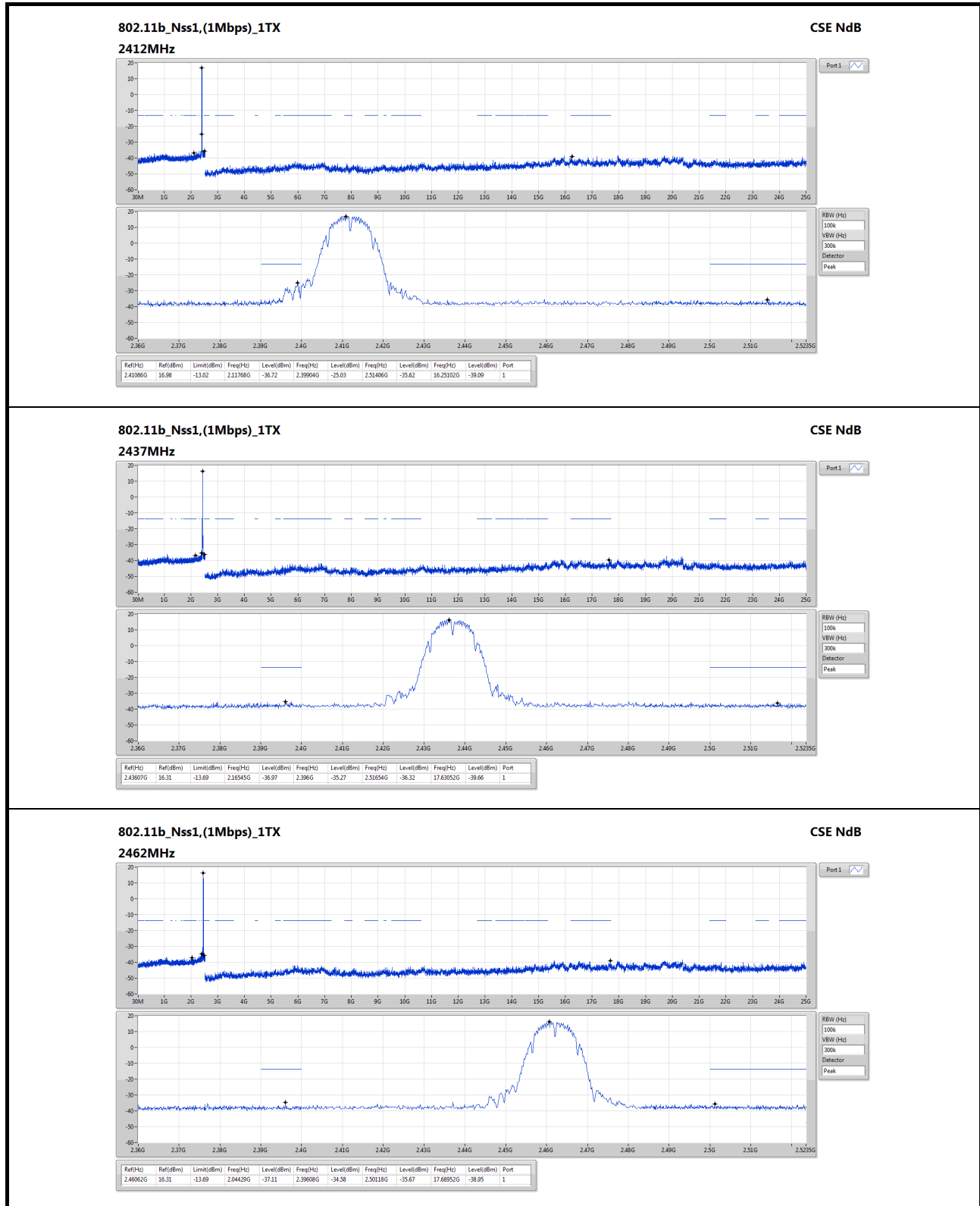
1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

3.6.3 Test Setup



3.6.4 Unwanted Emissions into Non-Restricted Frequency Bands

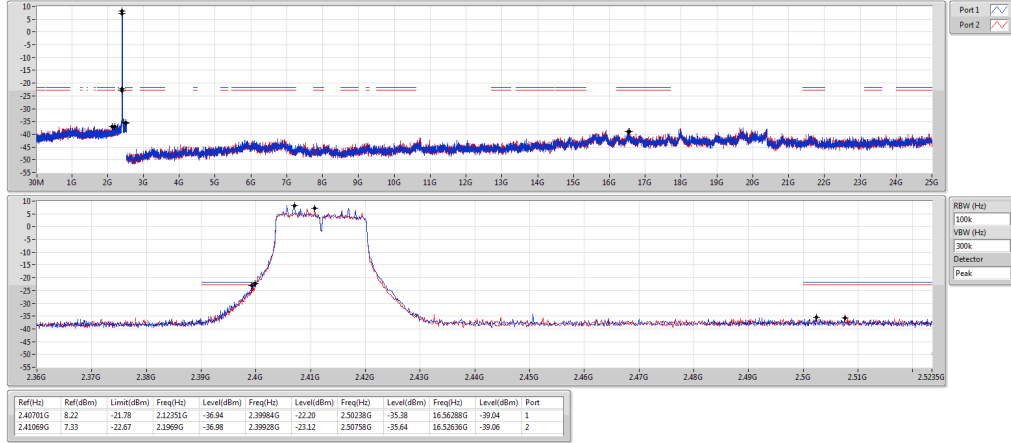
Ambient Condition	21°C / 66%	Tested By	Aska Huang
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802.11g_Nss1,(6Mbps)_2TX

CSE NdB

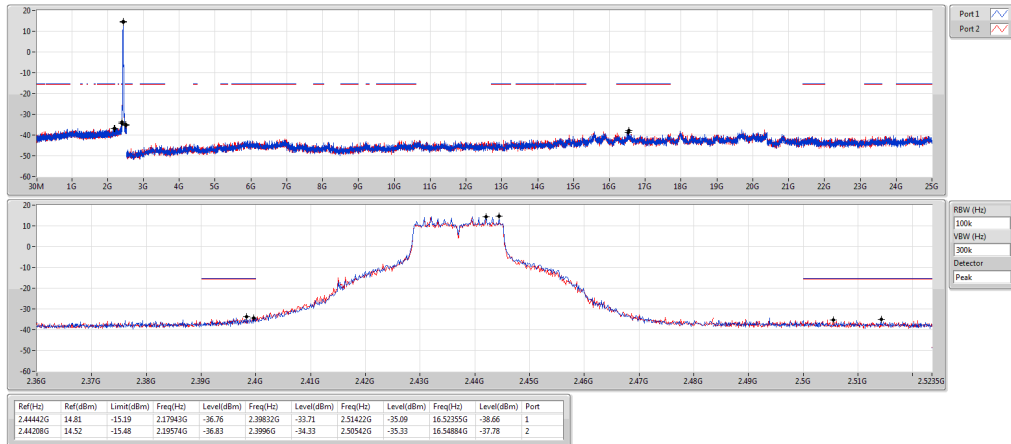
2412MHz



802.11g_Nss1,(6Mbps)_2TX

CSE NdB

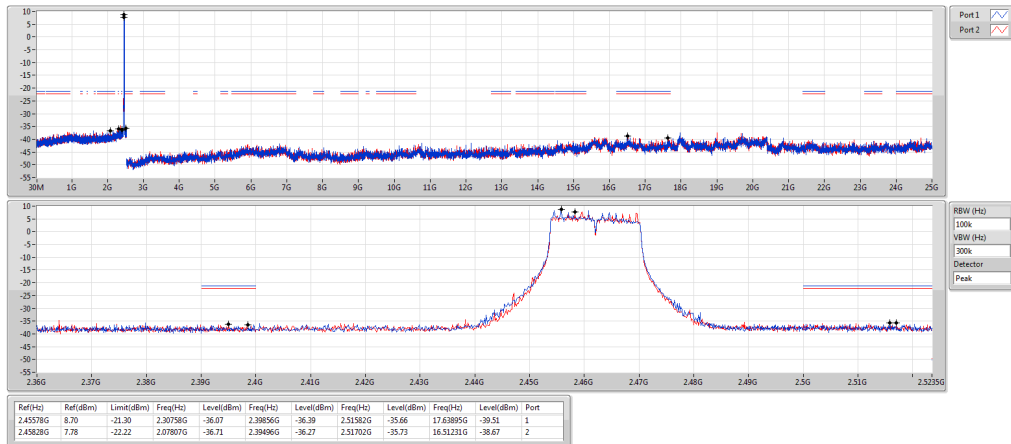
2437MHz



802.11g_Nss1,(6Mbps)_2TX

CSE NdB

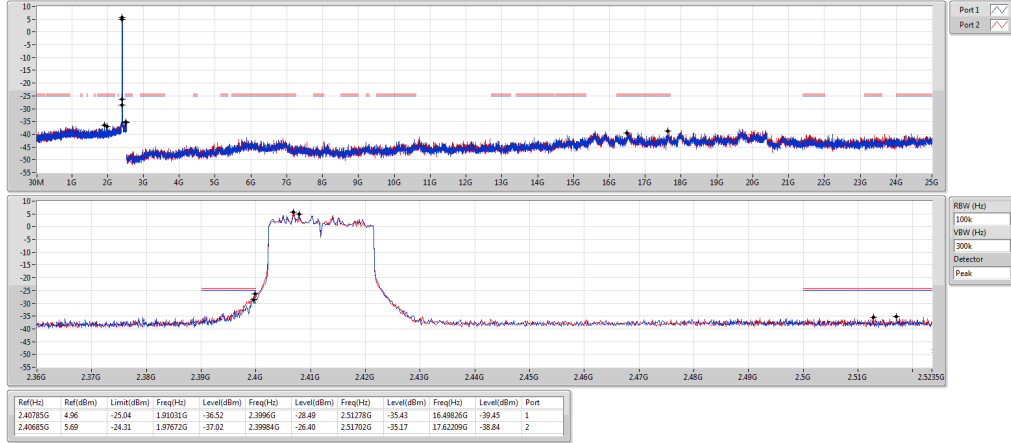
2462MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

CSE NdB

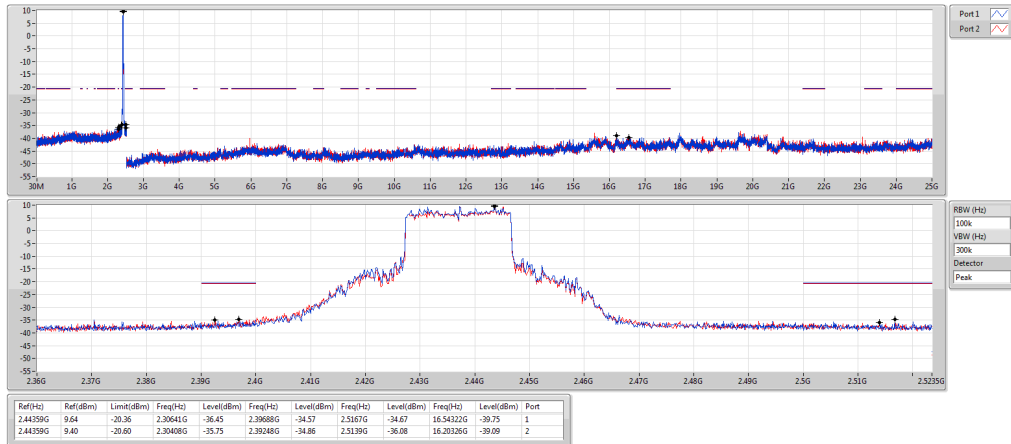
2412MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

CSE NdB

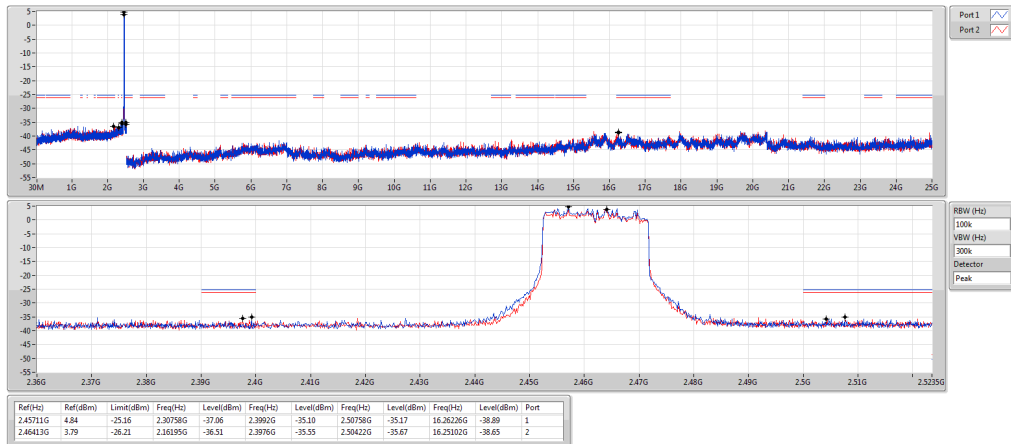
2437MHz



802.11ax HEW20_Nss1,(MCS0)_2TX

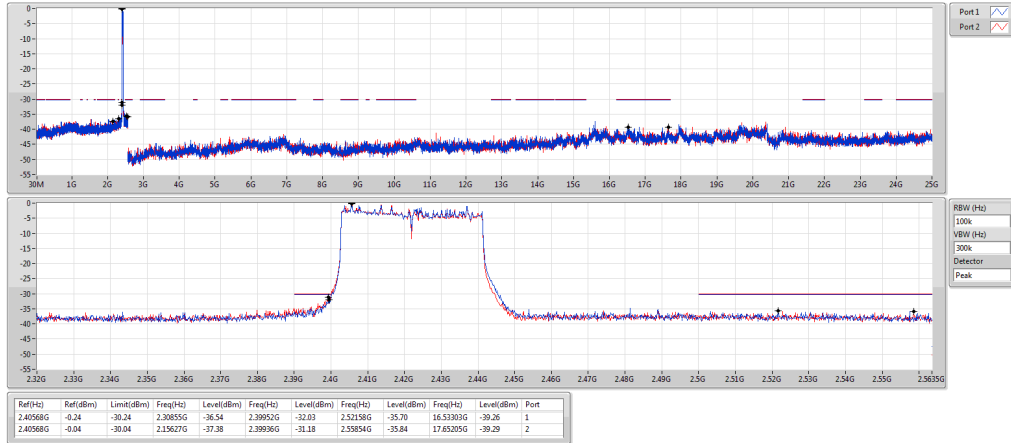
CSE NdB

2462MHz



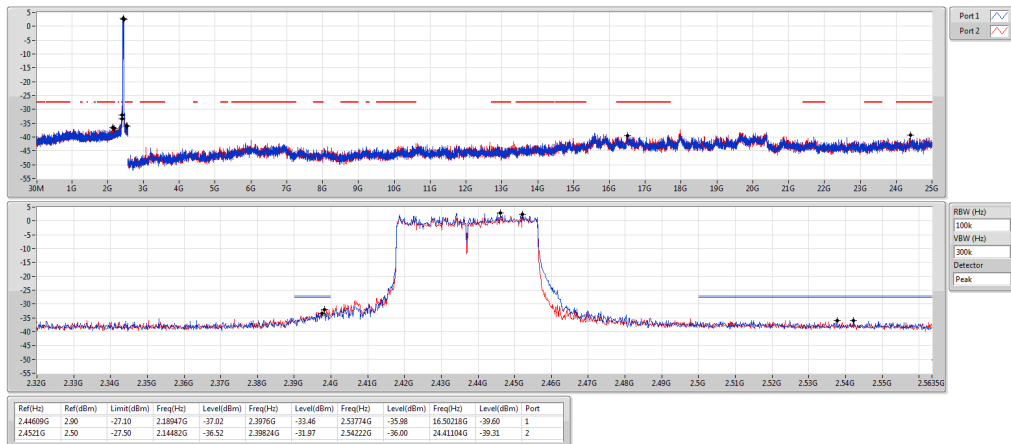
802.11ax HEW40_Nss1,(MCS0)_2TX
2422MHz

CSE NdB



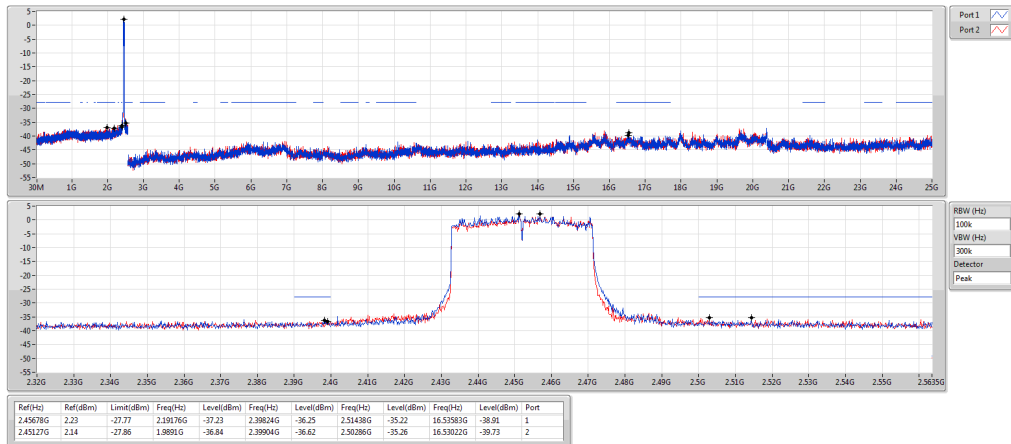
802.11ax HEW40_Nss1,(MCS0)_2TX
2437MHz

CSE NdB



802.11ax HEW40_Nss1,(MCS0)_2TX
2452MHz

CSE NdB



4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corporation (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

Tel: 886-2-2601-1640

No.30-2, Ding Fwu Tsuen, Lin Kou
District, New Taipei City, Taiwan
(R.O.C.)

Kwei Shan

Tel: 886-3-271-8666

No.3-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)
No.2-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

Kwei Shan Site II

Tel: 886-3-271-8640

No.14-1, Lane 19, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 333, Taiwan (R.O.C.)

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0345

Email: ICC_Service@icertifi.com.tw

==END==