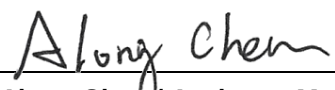


FCC Test Report

FCC ID : O6ZHLC0000
Equipment : 8-Channel LoRa Gateway
Model No. : HXQX1AM0S
Brand Name : machineQ
Applicant : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, South Korea, 17040
Standard : 47 CFR FCC Part 15.247
Received Date : Sep. 12, 2018
Tested Date : Sep. 17 ~ Sep. 21, 2018

We, International Certification Corp., 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 may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:


Along Chen / Assistant Manager

Approved by:

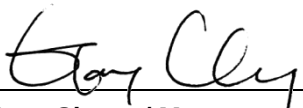

Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
FR891201	Rev. 01	Initial issue	Nov. 05, 2018

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.307MHz 42.40 (Margin -7.66dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 2483.50MHz 52.99(Margin -1.01dB) - AV	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 27.52	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

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]	1	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
Note 1: RF output power specifies that Maximum Peak Conducted Output Power. Note 2: 802.11b uses a combination of DSSS-DBPSK, DQPSK, CCK modulation. Note 3: 802.11g/n uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM modulation. Note 4: 802.11b/g supports TX diversity function.					

1.1.2 Antenna Details

Ant. No.	Model	Type	Gain (dBi)	Connector	Remark
1	CON 1	PIFA	3.76	UFL	---
2	CON 2	PIFA	3.86	UFL	---
3	LoRa antenna (External)	Dipole	0.96	SMA	---
4	LoRa antenna (Internal)	Monopole	1.98	UFL	---

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	12Vdc from adapter
-------------------	--------------------

1.1.4 Accessories

Accessories		
No.	Equipment	Description
1	AC adapter	Brand Name: machineQ Model Name: WB-24J12FU Power Rating: I/P: 100-240Vac, 50-60Hz, 0.7A Max O/P: 12Vdc, 2A DC 1.2m non-shielded cable without core
2	AC adapter	Brand Name: PHIHONG Model Name: PSAC24A-120L6 Power Rating: I/P: 100-240Vac, 50-60Hz, 0.6A, 51-73VA O/P: 12Vdc, 2.0A DC 1.2m non-shielded cable without core
3	RJ45 cable	1m non-shielded cable without core

1.1.5 Channel List

Frequency band (MHz)		2400~2483.5	
802.11 b / g / n HT20		802.11n HT40	
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	Putty, V0.60.0.0		
Duty Cycle and Duty Factor	Mode	Duty cycle (%)	Duty factor (dB)
	11b	100.00%	0.00
	11g	88.24%	0.54
	HT20	87.56%	0.58
	HT40	77.44%	1.11

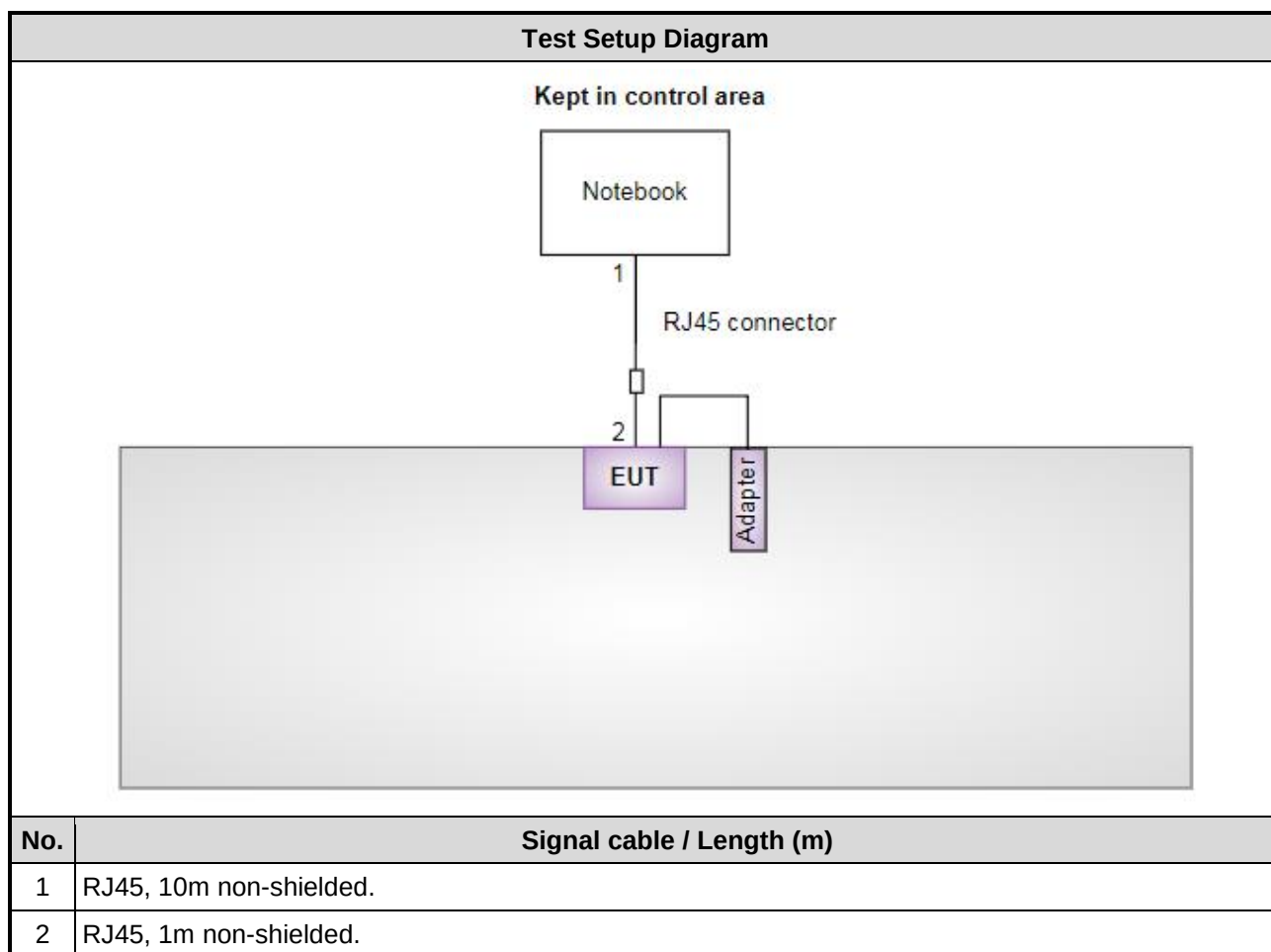
1.1.7 Power Setting

Modulation Mode	Test Frequency (MHz)	Power Set
11b	2412	10
11b	2437	10
11b	2462	10
11g	2412	15
11g	2437	16
11g	2462	16
HT20	2412	10/11
HT20	2437	18/17
HT20	2462	10/11
HT40	2422	5/5
HT40	2437	18/17
HT40	2452	5/5

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Notebook	DELL	Latitude E5470	DoC	---

1.3 Test Setup Chart



1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Sep. 18, 2018				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Jan. 05, 2018	Jan. 04, 2019
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 13, 2017	Nov. 12, 2018
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 18, 2017	Dec. 17, 2018
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	Sep. 17 ~ Sep. 18, 2018				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Dec. 04, 2017	Dec. 03, 2018
Receiver	R&S	ESR3	101658	Nov. 20, 2017	Nov. 19, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 18, 2018	Jul. 17, 2019
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 20, 2017	Dec. 19, 2018
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 23, 2017	Nov. 22, 2018
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 07, 2017	Dec. 06, 2018
Preamplifier	EMC	EMC02325	980225	Jul. 20, 2018	Jul. 19, 2019
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2017	Oct. 05, 2018
Preamplifier	EMC	EMC184045B	980192	Aug. 09, 2018	Aug. 08, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	May. 09, 2018	May. 08, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 07, 2017	Dec. 06, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 07, 2017	Dec. 06, 2018
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	16052	Dec. 07, 2017	Dec. 06, 2018
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 07, 2017	Dec. 06, 2018
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 07, 2017	Dec. 06, 2018
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	Sep. 21, 2018				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Apr. 16, 2018	Apr. 15, 2019
Power Meter	Anritsu	ML2495A	1241002	Oct. 16, 2017	Oct. 15, 2018
Power Sensor	Anritsu	MA2411B	1207366	Oct. 16, 2017	Oct. 15, 2018
AC POWER SOURCE	APC	AFC-500W	F312060012	Dec. 01, 2017	Nov. 30, 2018
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.247

ANSI C63.10-2013

FCC KDB 558074 D01 15.247 Meas Guidance v05

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

1.6 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$))

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	± 34.134 Hz
Conducted power	± 0.808 dB
Power density	± 0.463 dB
Conducted emission	± 2.670 dB
AC conducted emission	± 2.90 dB
Radiated emission ≤ 1 GHz	± 3.66 dB
Radiated emission > 1 GHz	± 5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	25°C / 58%	Alex Tsai
Radiated Emissions	03CH01-WS	25°C / 61%	Akun Chung Roger Lu
RF Conducted	TH01-WS	24°C / 66%	Aska Huang

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-1

2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Test Configuration
Conducted Emissions	HT20	2437	MCS 0	---
Radiated Emissions ≤1GHz	HT20	2437	MCS 0	---
Radiated Emissions >1GHz	11b	2412 / 2437 / 2462	1 Mbps	---
Maximum Output Power	11g	2412 / 2437 / 2462	6 Mbps	
6dB bandwidth	HT20	2412 / 2437 / 2462	MCS 0	
Power spectral density	HT40	2422 / 2437 / 2452	MCS 0	

NOTE:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **X-plane** results were found as the worst case and were shown in this report.
- Three adapters (machineQ and PHIHONG) had been covered during the pretest, and found that **PHIHONG adapter** was the worst case and was selected for final test.
- 802.11b/g supports TX diversity function. Antenna 1 and antenna 2 had been covered during the pretest, and found that **Antenna 1** was the worst case and was selected for final test

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

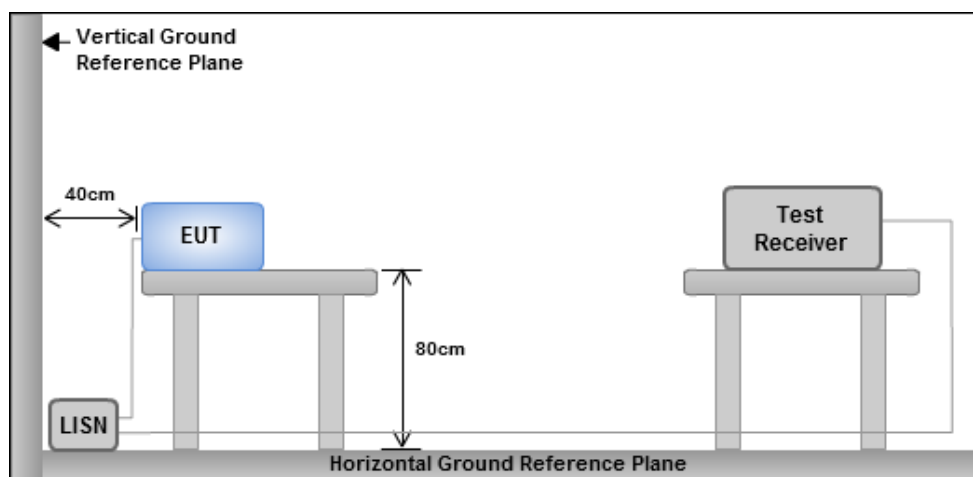
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

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.

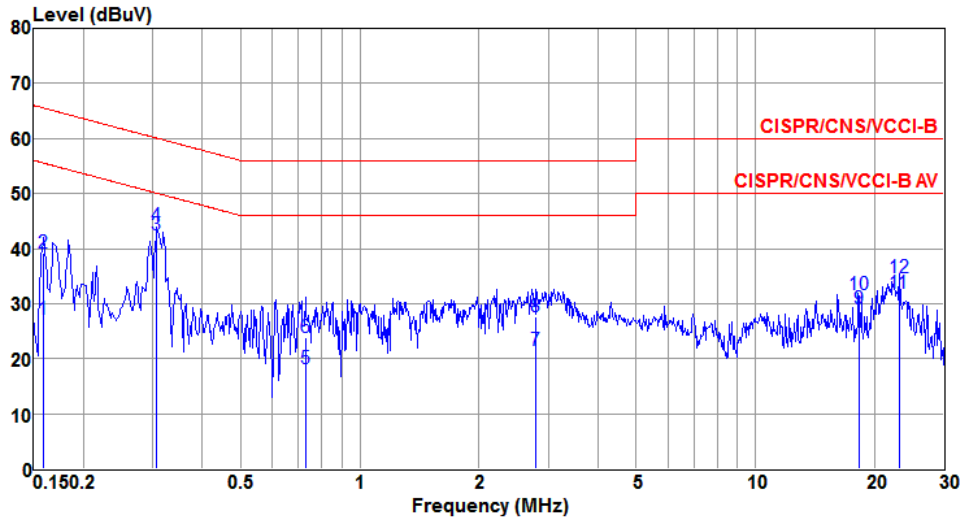
3.1.3 Test Setup



- 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

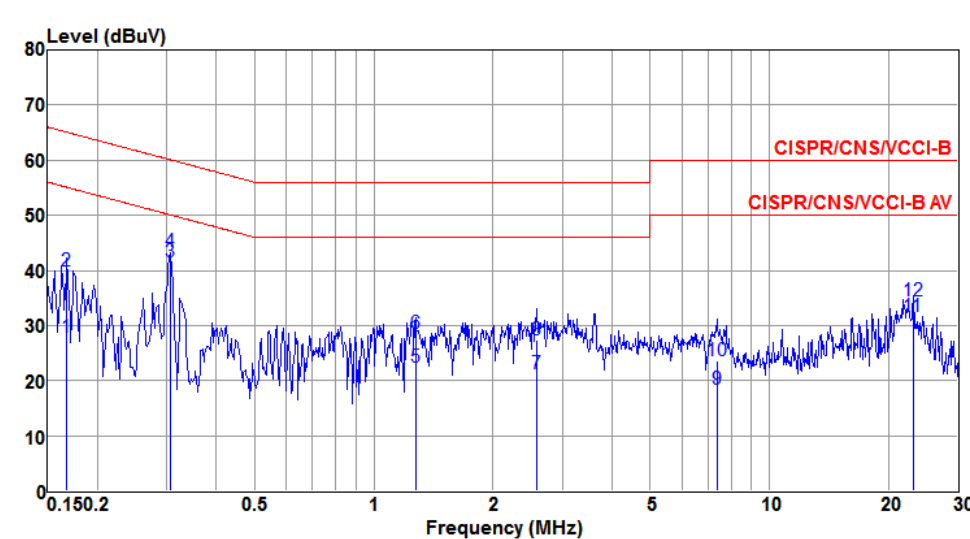
Modulation	HT20	Test Freq. (MHz)	2437
Power Phase	Line		



	Freq	Level	Limit	Over	Read	LISN	cable	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.159	27.16	55.52	-28.36	26.88	0.27	0.01	Average
2	0.159	39.29	65.52	-26.23	39.01	0.27	0.01	QP
3	0.307	42.40	50.06	-7.66	42.06	0.32	0.02	Average
4	0.307	44.13	60.06	-15.93	43.79	0.32	0.02	QP
5	0.727	18.22	46.00	-27.78	17.82	0.37	0.03	Average
6	0.727	23.85	56.00	-32.15	23.45	0.37	0.03	QP
7	2.794	21.38	46.00	-24.62	20.77	0.45	0.16	Average
8	2.794	27.71	56.00	-28.29	27.10	0.45	0.16	QP
9	18.242	29.11	50.00	-20.89	27.97	0.81	0.33	Average
10	18.242	31.55	60.00	-28.45	30.41	0.81	0.33	QP
11	23.129	31.94	50.00	-18.06	30.64	0.93	0.37	Average
12	23.129	34.67	60.00	-25.33	33.37	0.93	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation	HT20	Test Freq. (MHz)	2437
Power Phase	Neutral		



Freq	Level	Limit	Over	Read	LISN	cable	Remark	
MHz	dBuV	Line	Limit	Level	factor	loss		
		dBuV	dB	dBuV	dB	dB		
1	0.168	27.75	55.08	-27.33	27.59	0.14	0.02	Average
2	0.168	39.85	65.08	-25.23	39.69	0.14	0.02	QP
3@	0.307	41.61	50.06	-8.45	41.42	0.17	0.02	Average
4	0.307	43.42	60.06	-16.64	43.23	0.17	0.02	QP
5	1.276	22.38	46.00	-23.62	22.05	0.28	0.05	Average
6	1.276	28.48	56.00	-27.52	28.15	0.28	0.05	QP
7	2.581	21.29	46.00	-24.71	20.83	0.32	0.14	Average
8	2.581	27.28	56.00	-28.72	26.82	0.32	0.14	QP
9	7.376	18.32	50.00	-31.68	17.61	0.42	0.29	Average
10	7.376	23.61	60.00	-36.39	22.90	0.42	0.29	QP
11	23.130	31.60	50.00	-18.40	30.41	0.82	0.37	Average
12	23.130	34.44	60.00	-25.56	33.25	0.82	0.37	QP

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

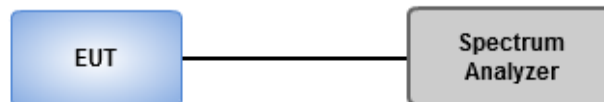
6dB Bandwidth

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

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	10.072M	12.446M	12M4G1D	10.072M	12.373M
802.11g_Nss1,(6Mbps)_1TX	16.377M	16.787M	16M8D1D	16.377M	16.715M
802.11n HT20_Nss1,(MCS0)_2TX	17.464M	17.728M	17M7D1D	17.101M	17.656M
802.11n HT40_Nss1,(MCS0)_2TX	36.377M	36.758M	36M8D1D	35.797M	36.179M

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

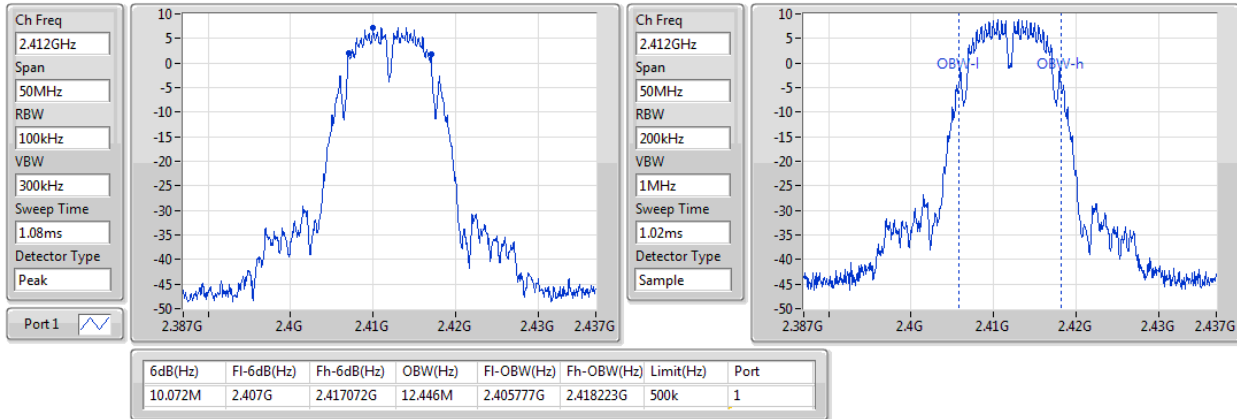
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)	Port 2-N dB (Hz)	Port 2-OBW (Hz)
802.11b_Nss1,(1Mbps)_1TX	-	-	-	-	-	-
2412MHz	Pass	500k	10.072M	12.446M		
2437MHz	Pass	500k	10.072M	12.373M		
2462MHz	Pass	500k	10.072M	12.373M		
802.11g_Nss1,(6Mbps)_1TX	-	-	-	-	-	-
2412MHz	Pass	500k	16.377M	16.715M		
2437MHz	Pass	500k	16.377M	16.787M		
2462MHz	Pass	500k	16.377M	16.715M		
802.11n HT20_Nss1,(MCS0)_2TX	-	-	-	-	-	-
2412MHz	Pass	500k	17.101M	17.656M	17.101M	17.656M
2437MHz	Pass	500k	17.319M	17.728M	17.319M	17.656M
2462MHz	Pass	500k	17.319M	17.656M	17.464M	17.656M
802.11n HT40_Nss1,(MCS0)_2TX	-	-	-	-	-	-
2422MHz	Pass	500k	36.232M	36.324M	36.377M	36.179M
2437MHz	Pass	500k	36.087M	36.758M	36.232M	36.469M
2452MHz	Pass	500k	35.797M	36.324M	36.377M	36.324M

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

802.11b_Nss1,(1Mbps)_1TX

EBW

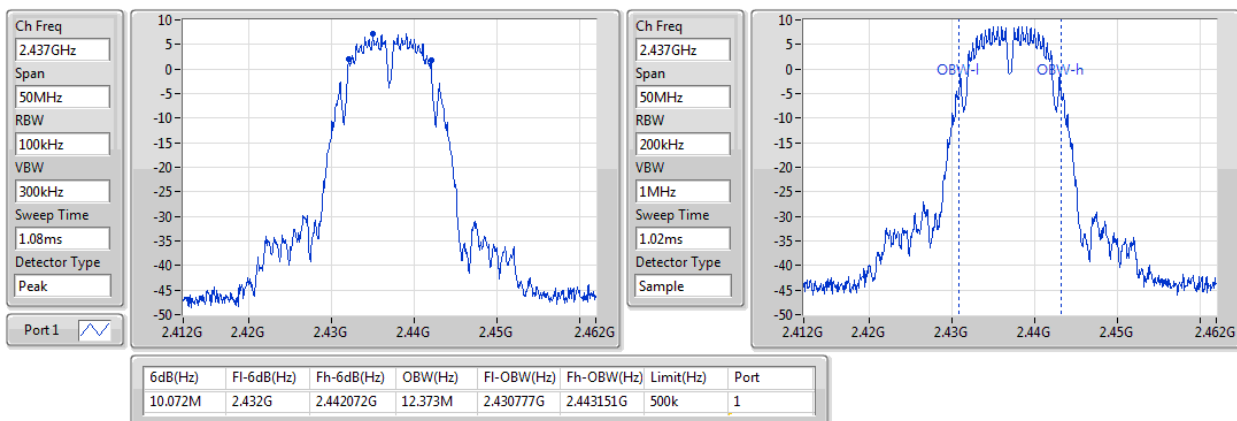
2412MHz



802.11b_Nss1,(1Mbps)_1TX

EBW

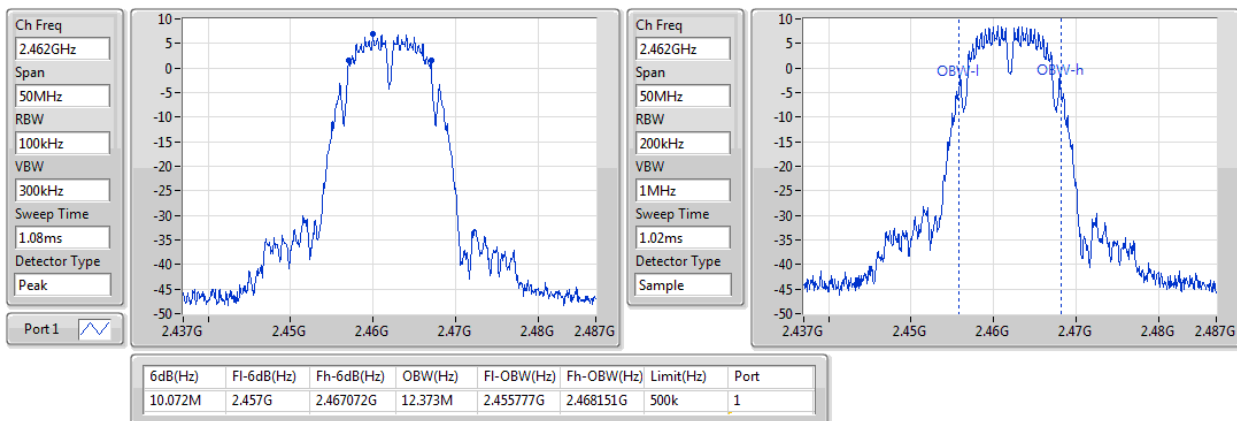
2437MHz



802.11b_Nss1,(1Mbps)_1TX

EBW

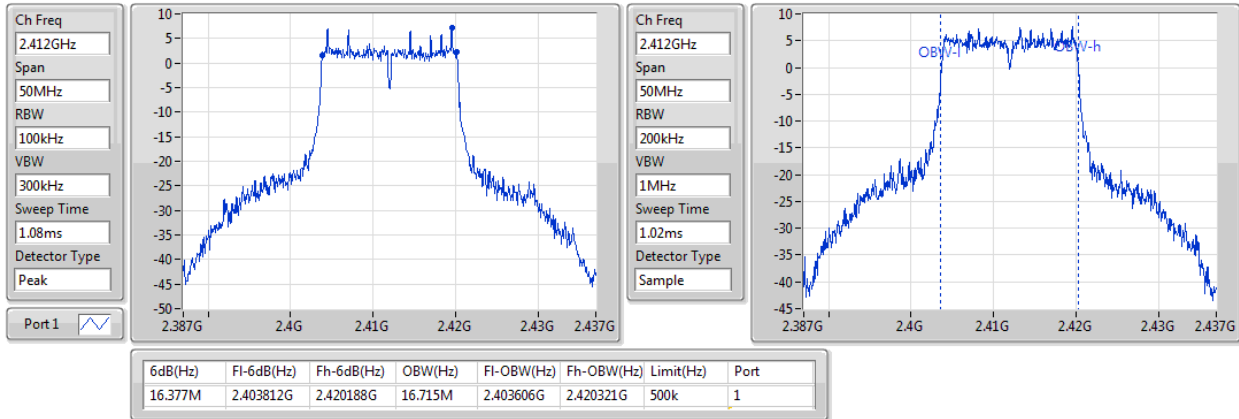
2462MHz



802.11g_Nss1,(6Mbps)_1TX

EBW

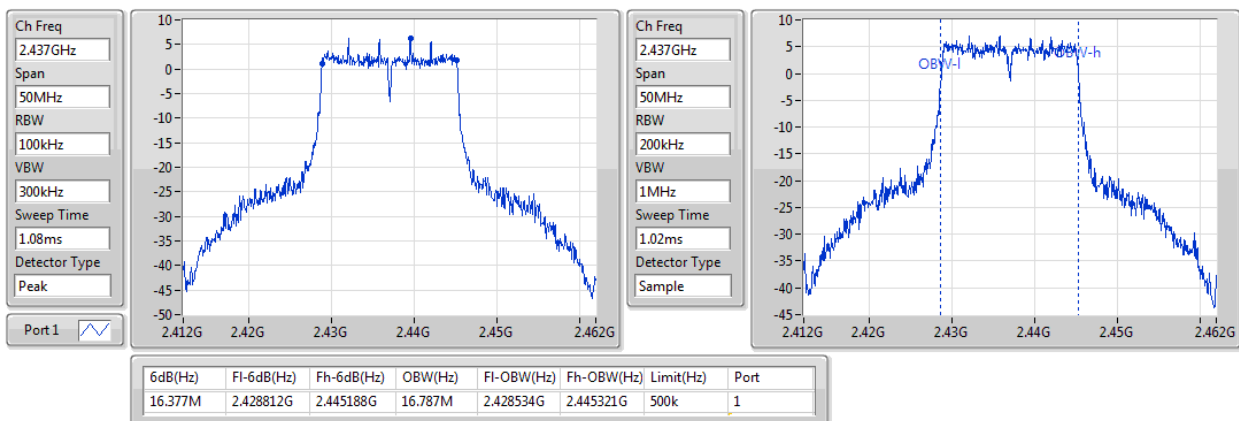
2412MHz



802.11g_Nss1,(6Mbps)_1TX

EBW

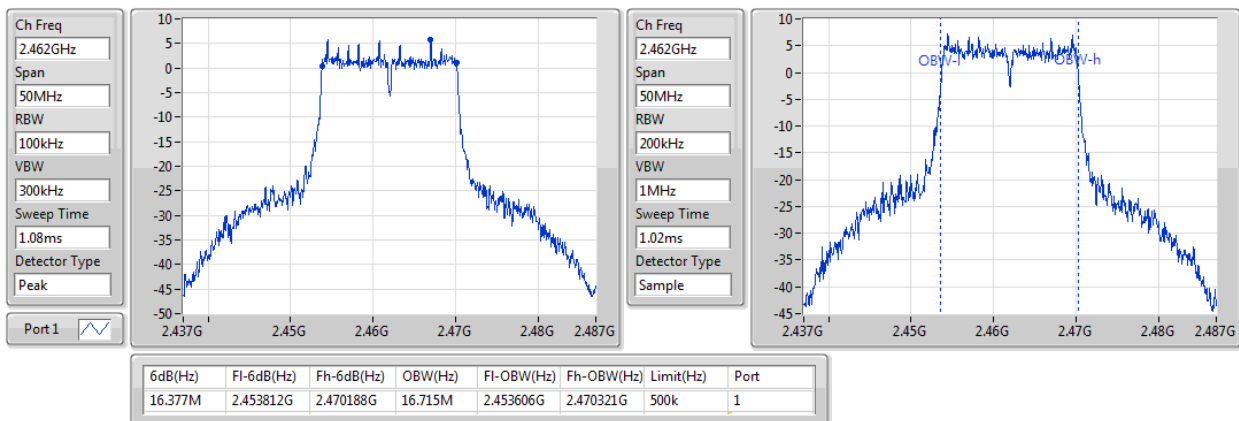
2437MHz



802.11g_Nss1,(6Mbps)_1TX

EBW

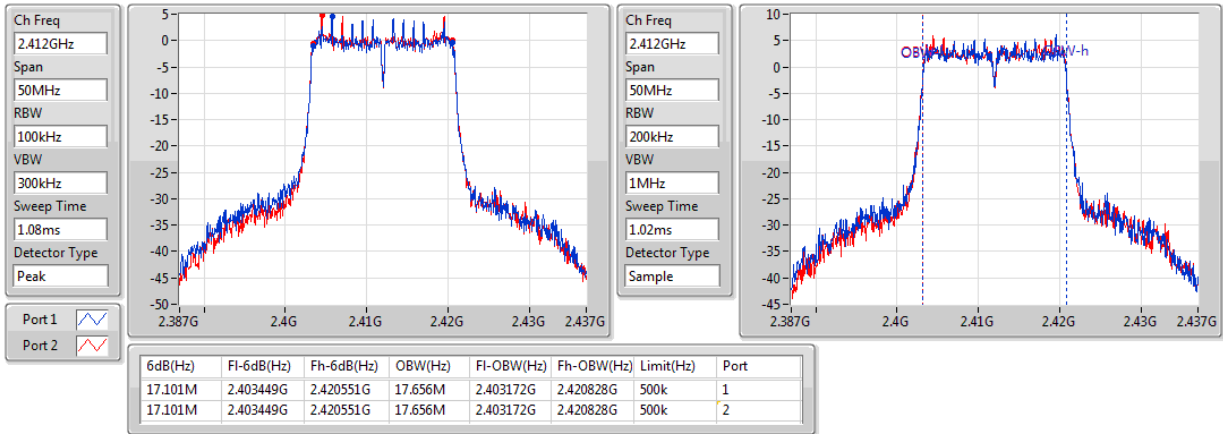
2462MHz



802.11n HT20_Nss1,(MCS0)_2TX

EBW

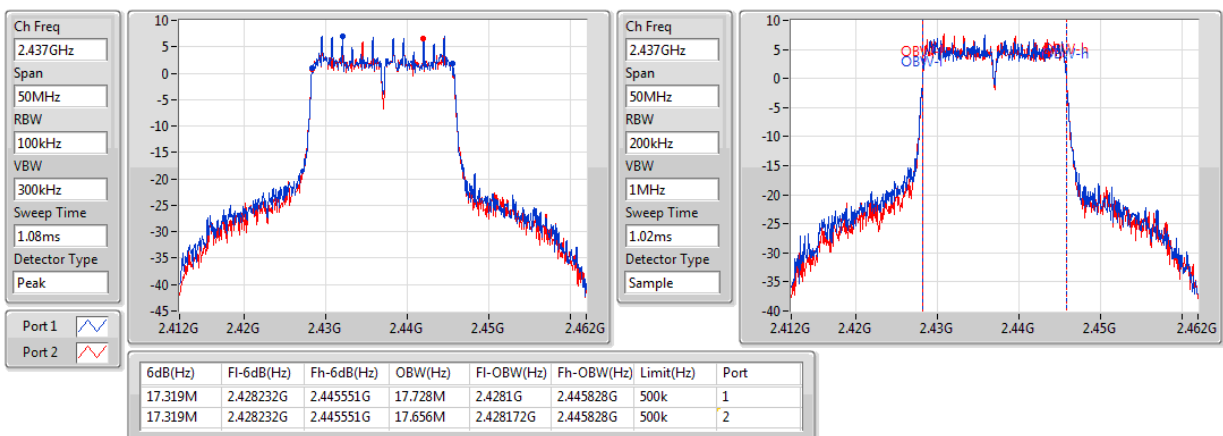
2412MHz



802.11n HT20_Nss1,(MCS0)_2TX

EBW

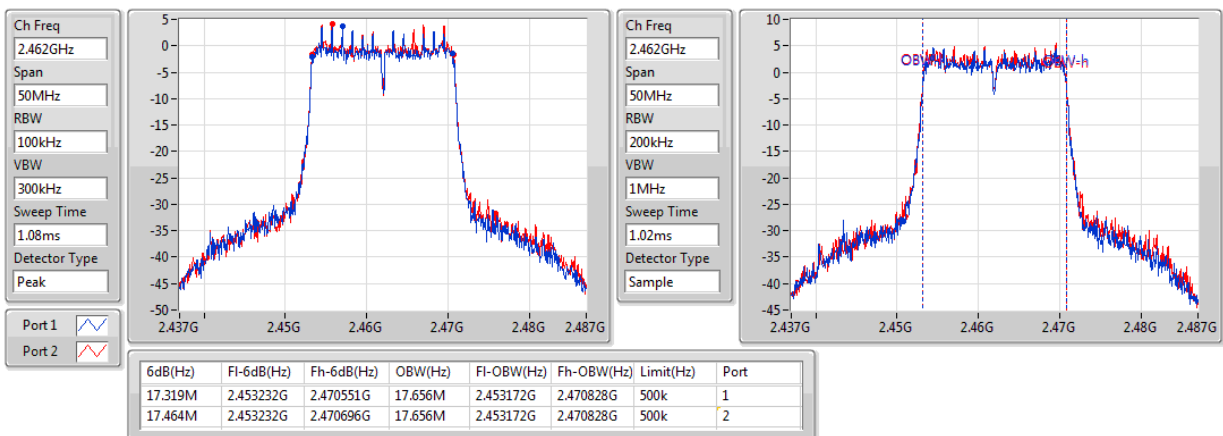
2437MHz



802.11n HT20_Nss1,(MCS0)_2TX

EBW

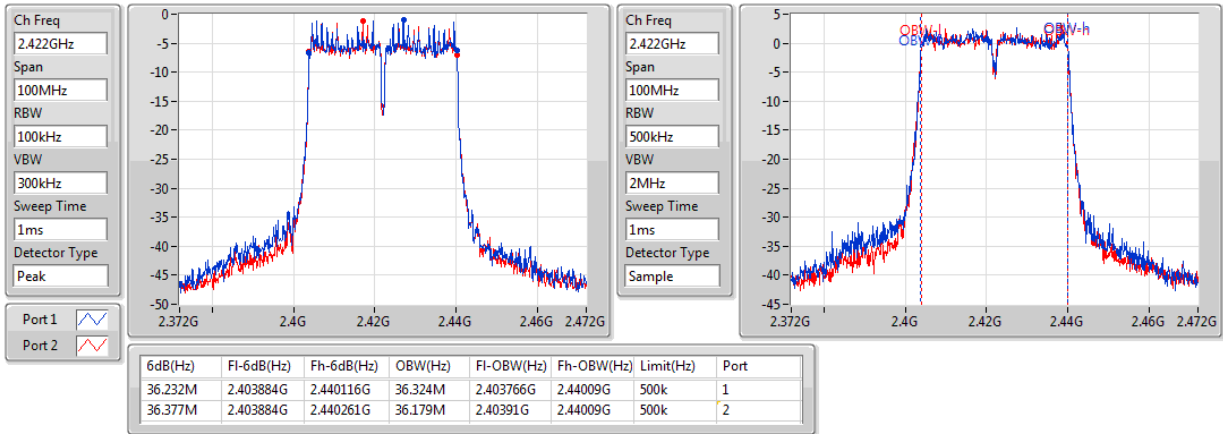
2462MHz



802.11n HT40_Nss1,(MCS0)_2TX

EBW

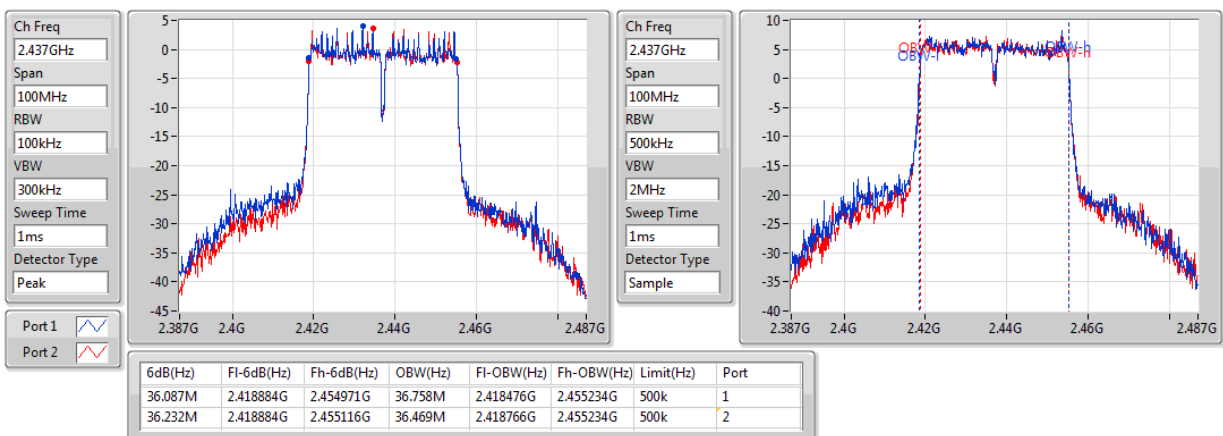
2422MHz



802.11n HT40_Nss1,(MCS0)_2TX

EBW

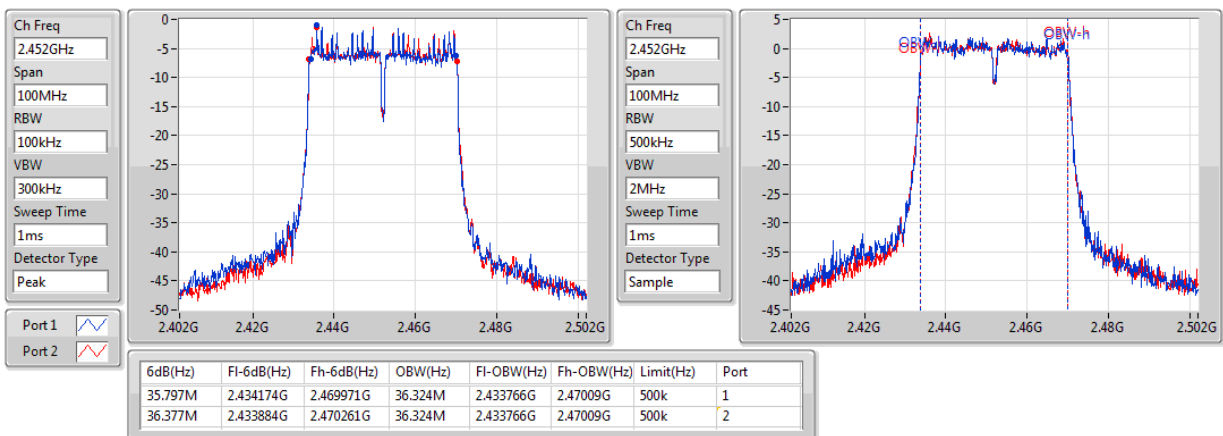
2437MHz



802.11n HT40_Nss1,(MCS0)_2TX

EBW

2452MHz



3.3 RF Output Power

3.3.1 Limit of RF Output Power

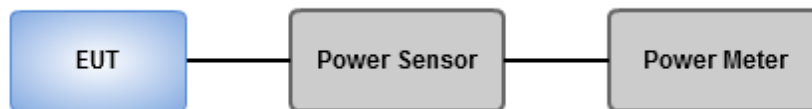
Conducted power shall not exceed 1Watt.

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

Peak Power Summary

Mode	Total Power (dBm)	Total Power (W)
2.4-2.4835GHz	-	-
802.11b_Nss1,(1Mbps)_1TX	21.10	0.12882
802.11g_Nss1,(6Mbps)_1TX	24.52	0.28314
802.11n HT20_Nss1,(MCS0)_2TX	27.52	0.56494
802.11n HT40_Nss1,(MCS0)_2TX	26.75	0.47315

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	3.86	21.00		21.00	30.00	24.86	36.00
2437MHz	Pass	3.86	21.10		21.10	30.00	24.96	36.00
2462MHz	Pass	3.86	20.78		20.78	30.00	24.64	36.00
802.11g_Nss1,(6Mbps)_1TX	-	-	-	-	-	-	-	-
2412MHz	Pass	3.86	24.40		24.40	30.00	28.26	36.00
2437MHz	Pass	3.86	24.52		24.52	30.00	28.38	36.00
2462MHz	Pass	3.86	24.15		24.15	30.00	28.01	36.00
802.11n HT20_Nss1,(MCS0)_2TX	-	-	-	-	-	-	-	-
2412MHz	Pass	3.86	22.96	23.22	26.10	30.00	29.96	36.00
2437MHz	Pass	3.86	24.55	24.46	27.52	30.00	31.38	36.00
2462MHz	Pass	3.86	22.71	23.01	25.87	30.00	29.73	36.00
802.11n HT40_Nss1,(MCS0)_2TX	-	-	-	-	-	-	-	-
2422MHz	Pass	3.86	20.41	20.33	23.38	30.00	27.24	36.00
2437MHz	Pass	3.86	23.75	23.72	26.75	30.00	30.61	36.00
2452MHz	Pass	3.86	20.31	20.44	23.39	30.00	27.25	36.00

DG = Directional Gain; **Port X** = Port X output power
Maximum antenna gain is selected to calculate EIRP

Average Power Summary

Mode	Total Power (dBm)	Total Power (W)
2.4-2.4835GHz	-	-
802.11b_Nss1,(1Mbps)_1TX	17.70	0.05888
802.11g_Nss1,(6Mbps)_1TX	17.50	0.05623
802.11n HT20_Nss1,(MCS0)_2TX	20.55	0.11350
802.11n HT40_Nss1,(MCS0)_2TX	20.52	0.11272

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	3.86	17.65		17.65	-	21.51	-
2437MHz	Pass	3.86	17.70		17.70	-	21.56	-
2462MHz	Pass	3.86	17.49		17.49	-	21.35	-
802.11g_Nss1,(6Mbps)_1TX	-	-	-	-	-	-	-	-
2412MHz	Pass	3.86	17.40		17.40	-	21.26	-
2437MHz	Pass	3.86	17.50		17.50	-	21.36	-
2462MHz	Pass	3.86	17.13		17.13	-	20.99	-
802.11n HT20_Nss1,(MCS0)_2TX	-	-	-	-	-	-	-	-
2412MHz	Pass	3.86	15.41	15.61	18.52	-	22.38	-
2437MHz	Pass	3.86	17.55	17.52	20.55	-	24.41	-
2462MHz	Pass	3.86	14.71	15.25	18.00	-	21.86	-
802.11n HT40_Nss1,(MCS0)_2TX	-	-	-	-	-	-	-	-
2422MHz	Pass	3.86	12.82	12.71	15.78	-	19.64	-
2437MHz	Pass	3.86	17.51	17.50	20.52	-	24.38	-
2452MHz	Pass	3.86	12.41	12.52	15.48	-	19.34	-

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

Maximum antenna gain is selected to calculate EIRP

Note : Conducted average output power is for reference only

3.4 Power Spectral Density

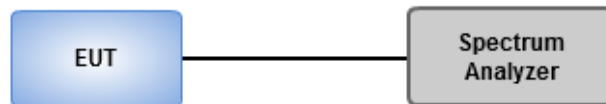
3.4.1 Limit of Power Spectral Density

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

3.4.2 Test Procedures

1. Set the RBW = 3 kHz, VBW = 10 kHz.
2. Detector = Peak, Sweep time = auto couple.
3. Trace mode = max hold, allow trace to fully stabilize.
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

Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
802.11b_Nss1,(1Mbps)_1TX	-11.21
802.11g_Nss1,(6Mbps)_1TX	-10.04
802.11n HT20_Nss1,(MCS0)_2TX	-7.47
802.11n HT40_Nss1,(MCS0)_2TX	-9.54

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	3.86	-11.21	-	-11.21	8.00
2437MHz	Pass	3.86	-11.28	-	-11.28	8.00
2462MHz	Pass	3.86	-11.50	-	-11.50	8.00
802.11g_Nss1, (6Mbps)_1TX	-	-	-	-	-	-
2412MHz	Pass	3.86	-10.13	-	-10.13	8.00
2437MHz	Pass	3.86	-10.14	-	-10.14	8.00
2462MHz	Pass	3.86	-10.04	-	-10.04	8.00
802.11n HT20_Nss1, (MCS0)_2TX	-	-	-	-	-	-
2412MHz	Pass	6.82	-11.38	-10.72	-8.77	7.18
2437MHz	Pass	6.82	-9.66	-9.82	-7.47	7.18
2462MHz	Pass	6.82	-13.00	-11.85	-10.13	7.18
802.11n HT40_Nss1, (MCS0)_2TX	-	-	-	-	-	-
2422MHz	Pass	6.82	-16.63	-16.11	-14.31	7.18
2437MHz	Pass	6.82	-11.28	-12.20	-9.54	7.18
2452MHz	Pass	6.82	-17.36	-17.51	-14.62	7.18

DG = Directional Gain

Directional Gain for 1TX mode is maximum antenna gain

Directional Gain for 2TX mode = $10 * \log((10^{3.76/20} + 10^{3.86/20})/2) = 6.82 \text{ dBi} > 6 \text{ dBi}$;

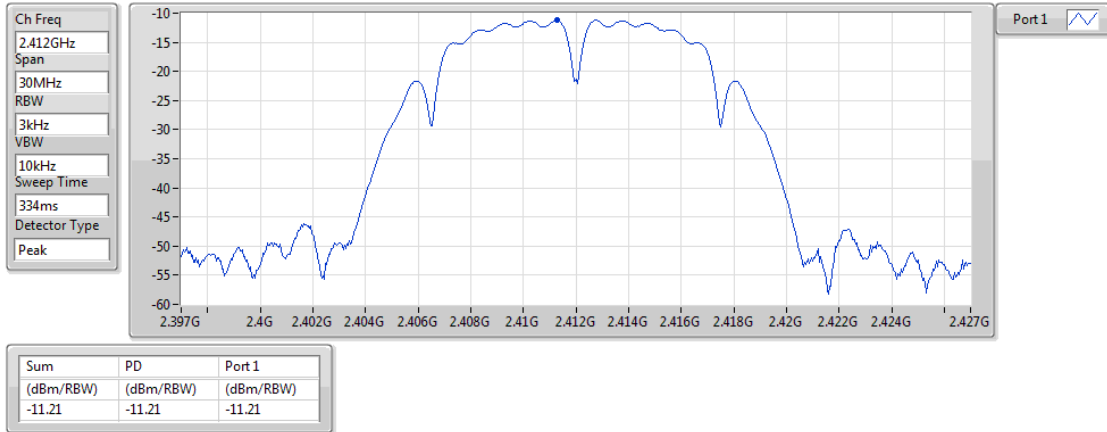
Power limit shall be reduced to 8 dBm – (6.82 dBi – 6 dBi) = 7.18 dBm

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

802.11b_Nss1,(1Mbps)_1TX

PSD

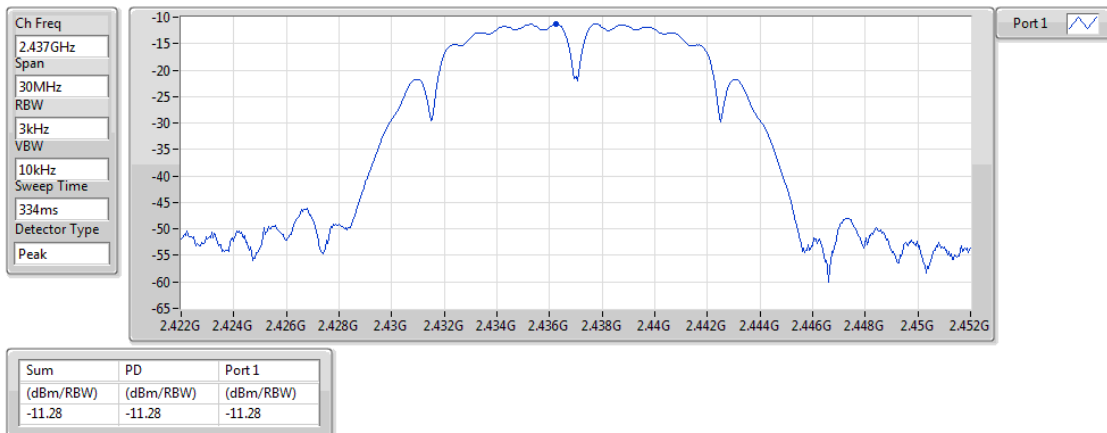
2412MHz



802.11b_Nss1,(1Mbps)_1TX

PSD

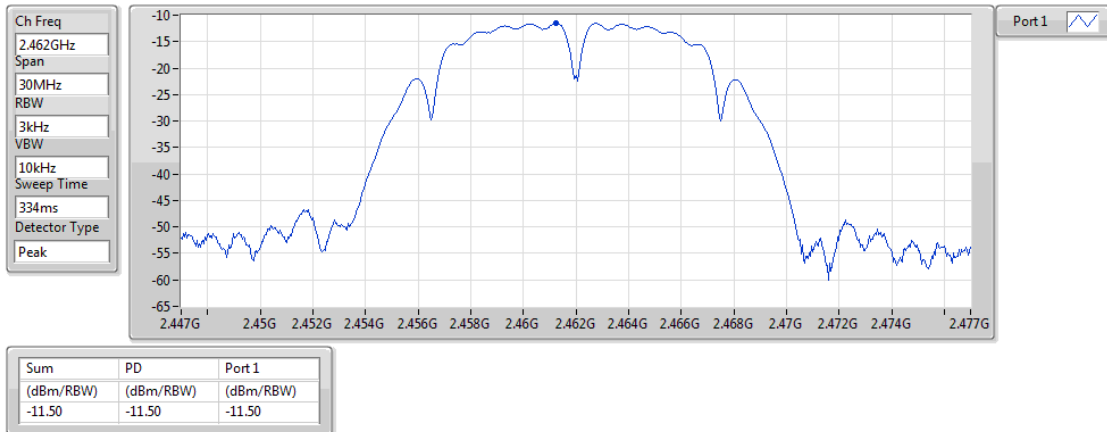
2437MHz



802.11b_Nss1,(1Mbps)_1TX

PSD

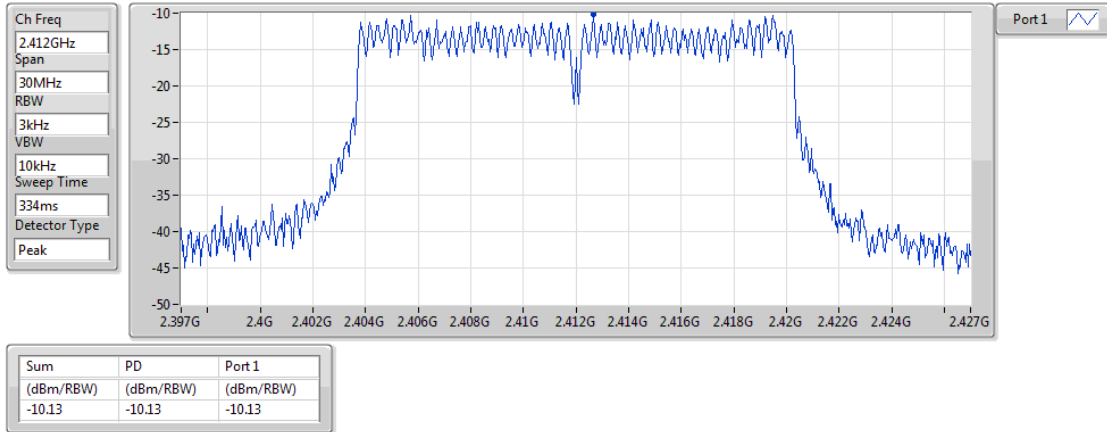
2462MHz



802.11g_Nss1,(6Mbps)_1TX

PSD

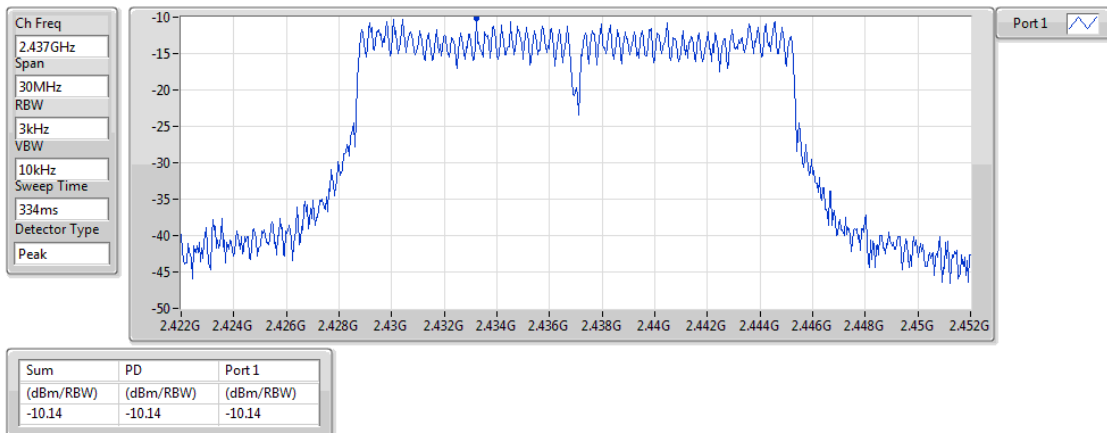
2412MHz



802.11g_Nss1,(6Mbps)_1TX

PSD

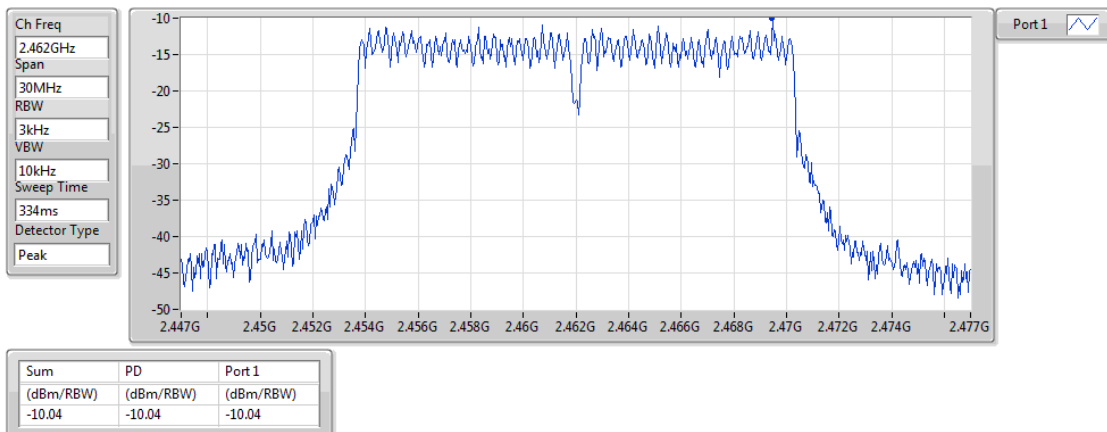
2437MHz



802.11g_Nss1,(6Mbps)_1TX

PSD

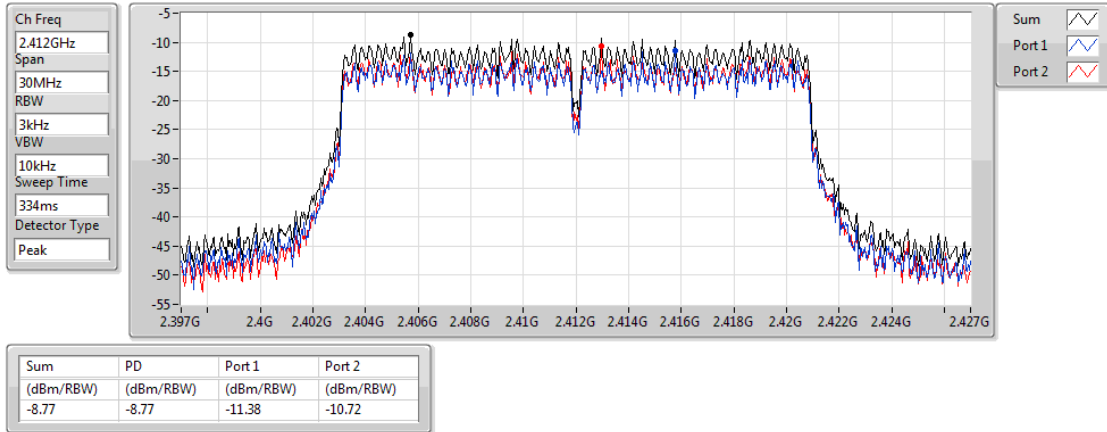
2462MHz



802.11n HT20_Nss1,(MCS0)_2TX

PSD

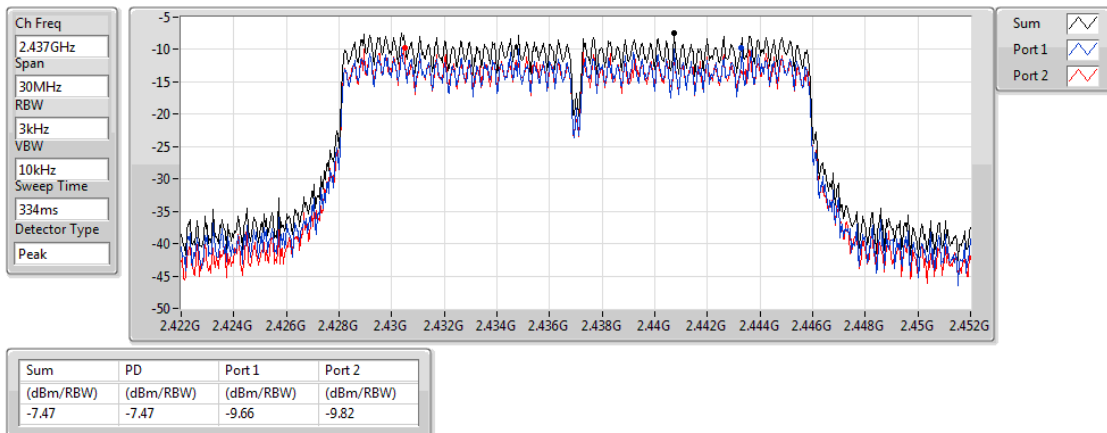
2412MHz



802.11n HT20_Nss1,(MCS0)_2TX

PSD

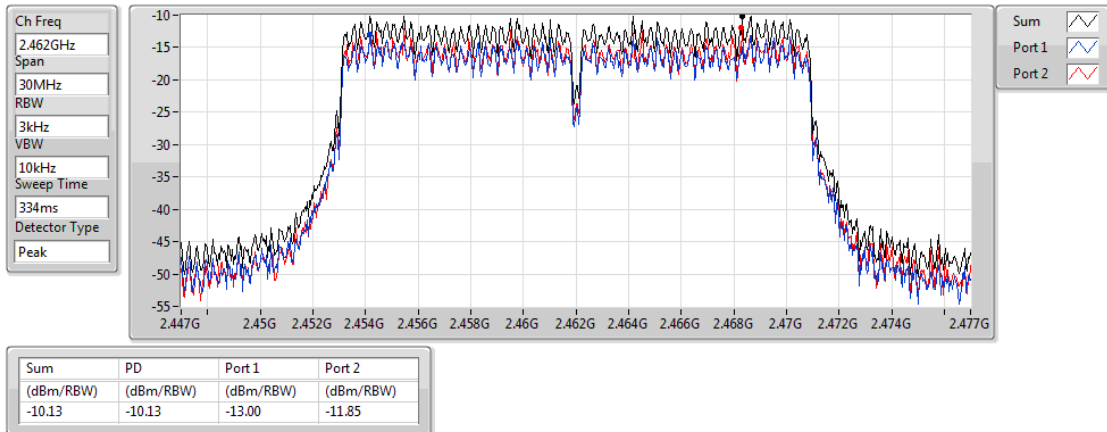
2437MHz



802.11n HT20_Nss1,(MCS0)_2TX

PSD

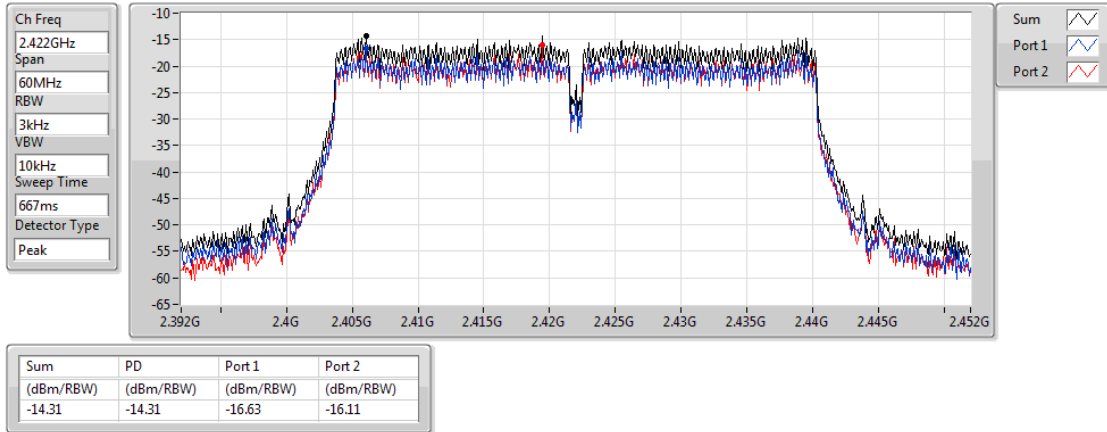
2462MHz



802.11n HT40_Nss1,(MCS0)_2TX

PSD

2422MHz



802.11n HT40_Nss1,(MCS0)_2TX

PSD

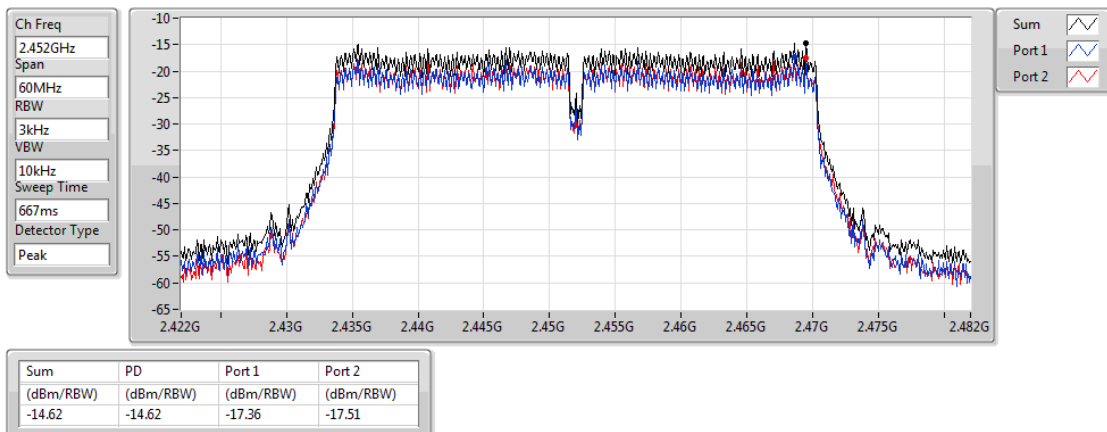
2437MHz



802.11n HT40_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

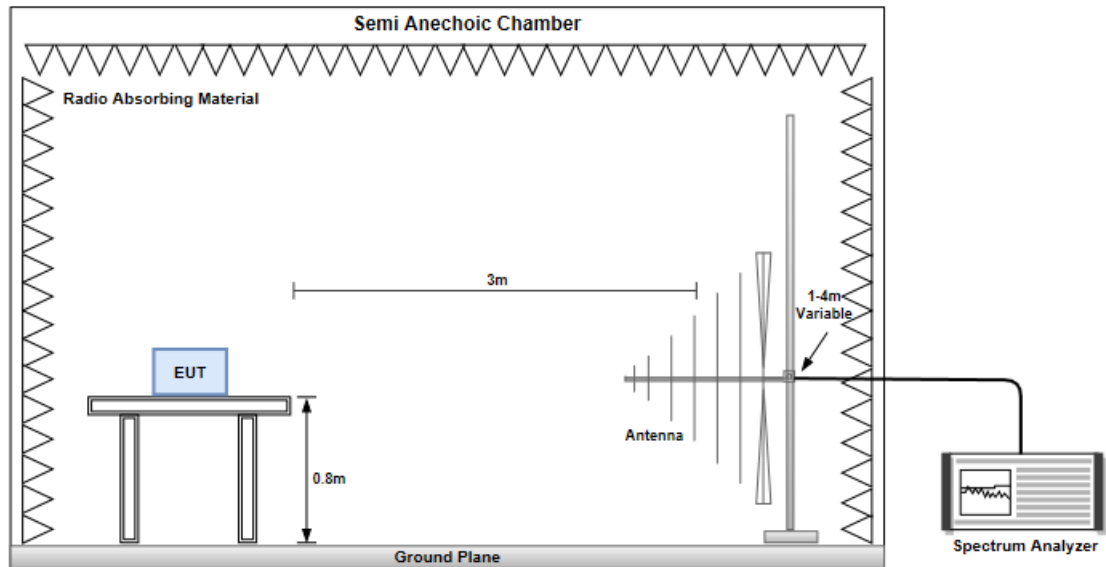
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

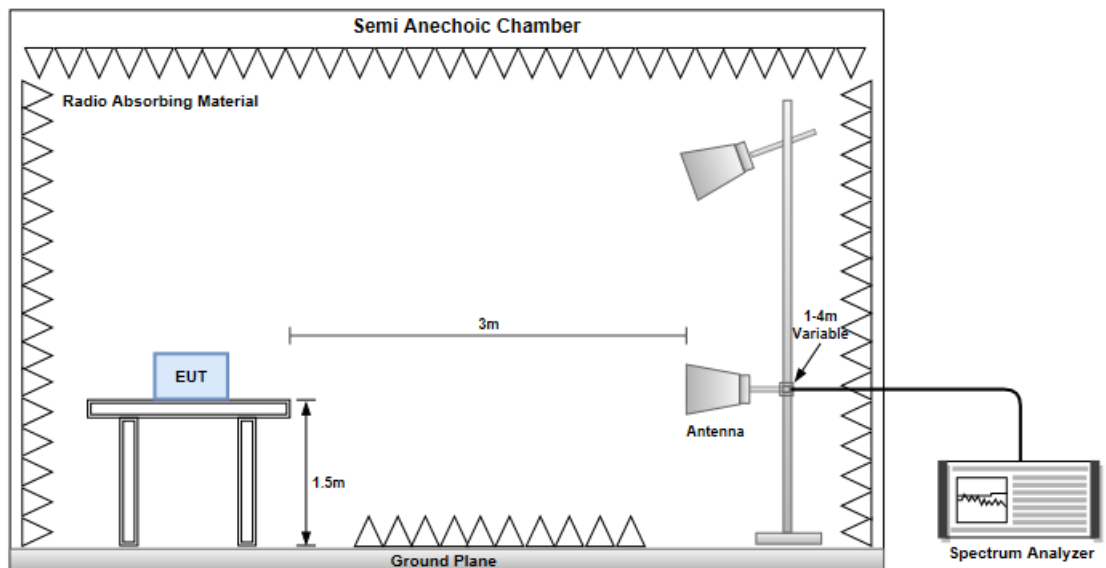
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

Radiated Emissions below 1 GHz

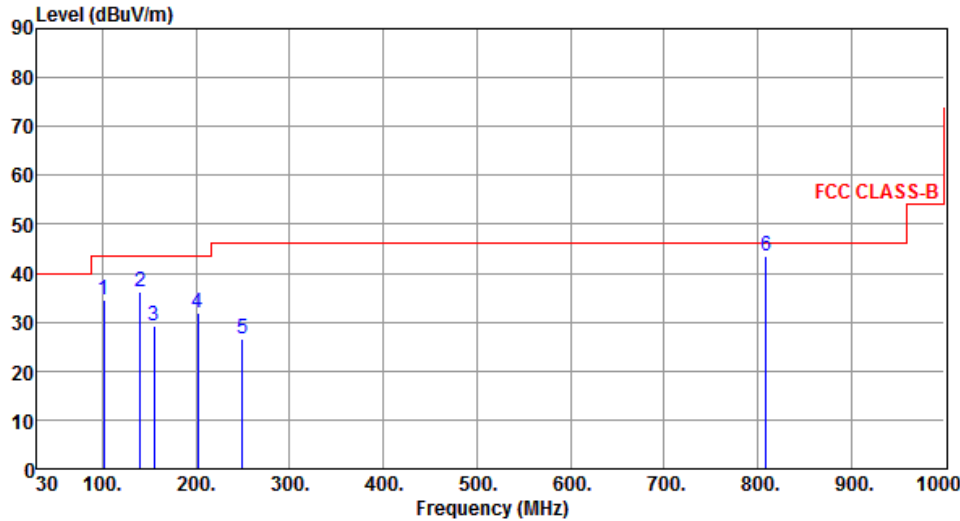


Radiated Emissions above 1 GHz



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	HT20	Test Freq. (MHz)	2437
Polarization	Horizontal		



The graph displays the Level (dBUV/m) on the Y-axis (0 to 90) against Frequency (MHz) on the X-axis (30 to 1000). A red line represents the FCC CLASS-B limit, which is 40 dBUV/m from 30 to 100 MHz, 45 dBUV/m from 100 to 150 MHz, 46 dBUV/m from 150 to 1000 MHz, and 55 dBUV/m from 1000 to 10000 MHz. Six measured emissions are shown as blue vertical lines, labeled 1 through 6. The data for these emissions is provided in the table below.

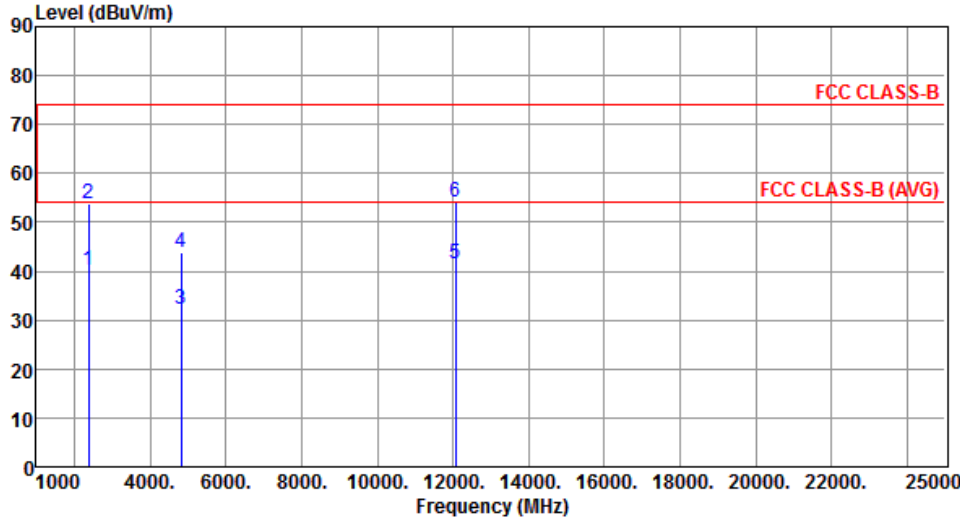
	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	101.78	34.46	43.50	-9.04	47.20	-12.74	Peak	---	---
2	140.58	36.05	43.50	-7.45	44.75	-8.70	Peak	---	---
3	155.13	29.28	43.50	-14.22	37.63	-8.35	Peak	---	---
4	201.69	31.94	43.50	-11.56	42.94	-11.00	Peak	---	---
5	249.22	26.53	46.00	-19.47	36.03	-9.50	Peak	---	---
6	809.34	43.60	46.00	-2.40	41.41	2.19	QP	100	200

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)
 *Factor includes antenna factor , cable loss and amplifier gain
 Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).
 Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation	HT20		Test Freq. (MHz)		2437	
Polarization	Vertical					
Level (dBuV/m) 1 2 3 4 5 6 30 100. 200. 300. 400. 500. 600. 700. 800. 900. 1000 Frequency (MHz) </						

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

Modulation	11b	Test Freq. (MHz)	2412
Polarization	Horizontal		



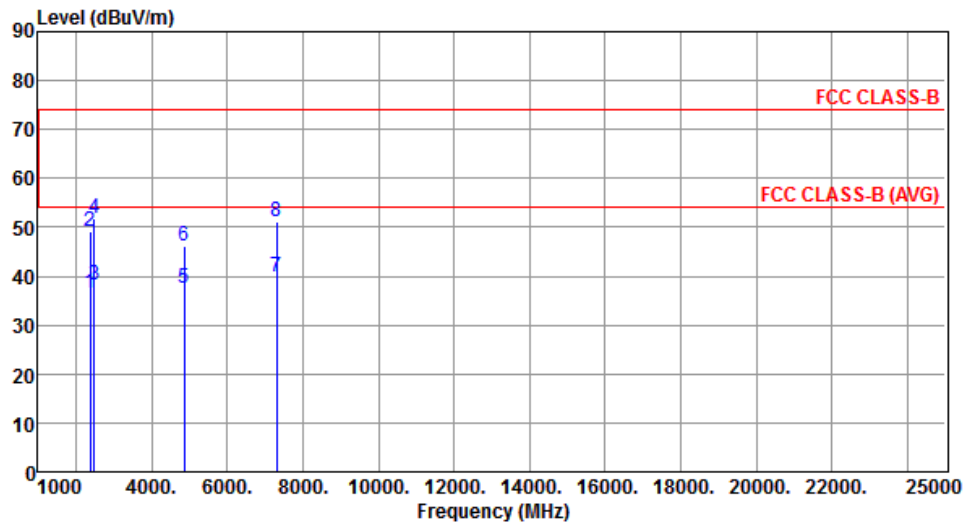
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	40.03	54.00	-13.97	43.54	-3.51	Average	207	94
2	2390.00	53.67	74.00	-20.33	57.18	-3.51	Peak	207	94
3	4824.00	32.21	54.00	-21.79	28.68	3.53	Average	100	131
4	4824.00	43.89	74.00	-30.11	40.36	3.53	Peak	100	131
5	12060.00	41.58	54.00	-12.42	28.26	13.32	Average	100	38
6	12060.00	54.17	74.00	-19.83	40.85	13.32	Peak	100	38

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*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)	2412
Polarization	Vertical		
Level (dBUV/m)			

Modulation	11b	Test Freq. (MHz)	2437
Polarization	Horizontal		
Level (dBUV/m) </			

Modulation	11b	Test Freq. (MHz)	2437
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	36.49	54.00	-17.51	40.00	-3.51	Average	186	200
2	2390.00	49.12	74.00	-24.88	52.63	-3.51	Peak	186	200
3	2483.50	38.22	54.00	-15.78	41.33	-3.11	Average	186	200
4	2483.50	51.84	74.00	-22.16	54.95	-3.11	Peak	186	200
5	4874.00	37.58	54.00	-16.42	33.90	3.68	Average	100	88
6	4874.00	46.28	74.00	-27.72	42.60	3.68	Peak	100	88
7	7311.00	39.80	54.00	-14.20	31.40	8.40	Average	120	140
8	7311.00	51.19	74.00	-22.81	42.79	8.40	Peak	120	140

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

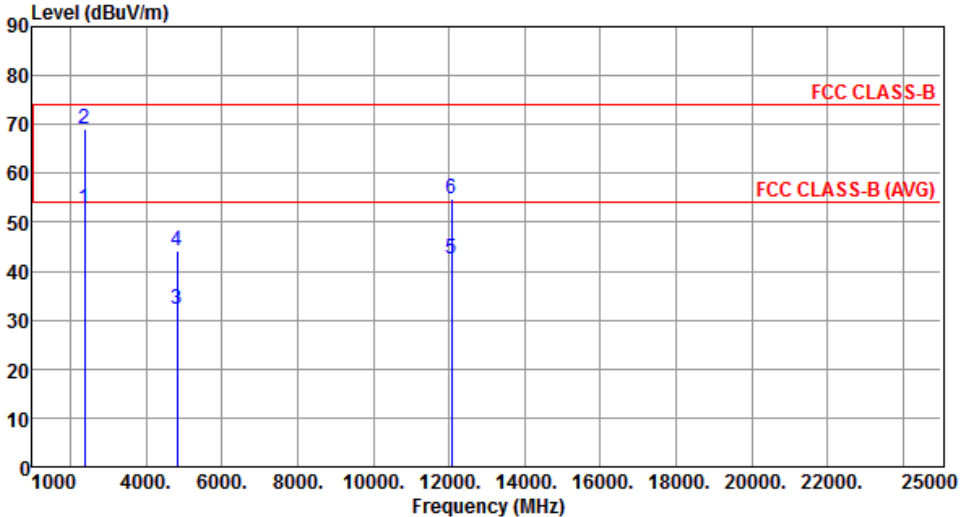
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Horizontal		
Level (dBuV/m)			

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Vertical		
Level (dBUV/m)			

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

Modulation	11g	Test Freq. (MHz)	2412
Polarization	Horizontal		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.66	54.00	-1.34	56.17	-3.51	Average	203	100
2	2390.00	69.15	74.00	-4.85	72.66	-3.51	Peak	203	100
3	4824.00	32.18	54.00	-21.82	28.65	3.53	Average	100	140
4	4824.00	44.14	74.00	-29.86	40.61	3.53	Peak	100	140
5	12060.00	42.66	54.00	-11.34	29.34	13.32	Average	100	41
6	12060.00	54.88	74.00	-19.12	41.56	13.32	Peak	100	41

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

Modulation	11g	Test Freq. (MHz)	2412
Polarization	Vertical		
Level (dBUV/m) </			

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Horizontal		
Level (dBuV/m) <			

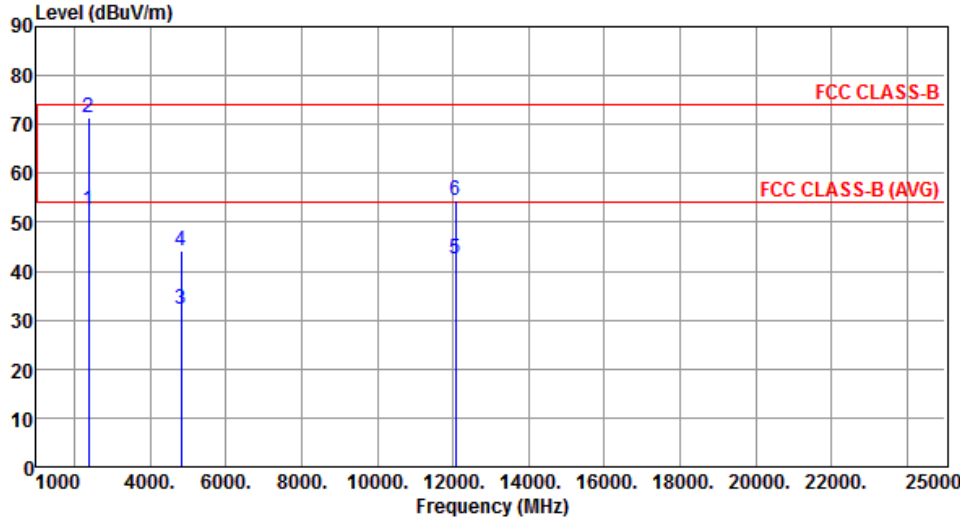
Modulation	11g	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m)			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Horizontal		
Level (dBUV/m)			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Vertical		
Level (dBUV/m) <			

3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT20

Modulation	HT20	Test Freq. (MHz)	2412
Polarization	Horizontal		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.33	54.00	-1.67	55.84	-3.51	Average	222	270
2	2390.00	71.55	74.00	-2.45	75.06	-3.51	Peak	222	270
3	4824.00	32.25	54.00	-21.75	28.72	3.53	Average	100	142
4	4824.00	44.11	74.00	-29.89	40.58	3.53	Peak	100	142
5	12060.00	42.55	54.00	-11.45	29.23	13.32	Average	100	43
6	12060.00	54.63	74.00	-19.37	41.31	13.32	Peak	100	43

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

Modulation	HT20		Test Freq. (MHz)		2412	
Polarization	Vertical					
Level (dBUV/m) </						

Modulation	HT20	Test Freq. (MHz)	2437
Polarization	Horizontal		
Level (dBuV/m)			

Modulation	HT20	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m)			

Modulation	HT20		Test Freq. (MHz)		2462	
Polarization	Horizontal					

	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	52.99	54.00	-1.01	56.10	-3.11	Average	171	272
2	2483.50	71.93	74.00	-2.07	75.04	-3.11	Peak	171	272
3	4924.00	32.52	54.00	-21.48	28.67	3.85	Average	100	137
4	4924.00	44.39	74.00	-29.61	40.54	3.85	Peak	100	137
5	7386.00	37.14	54.00	-16.86	28.58	8.56	Average	100	163
6	7386.00	48.57	74.00	-25.43	40.01	8.56	Peak	100	163

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)

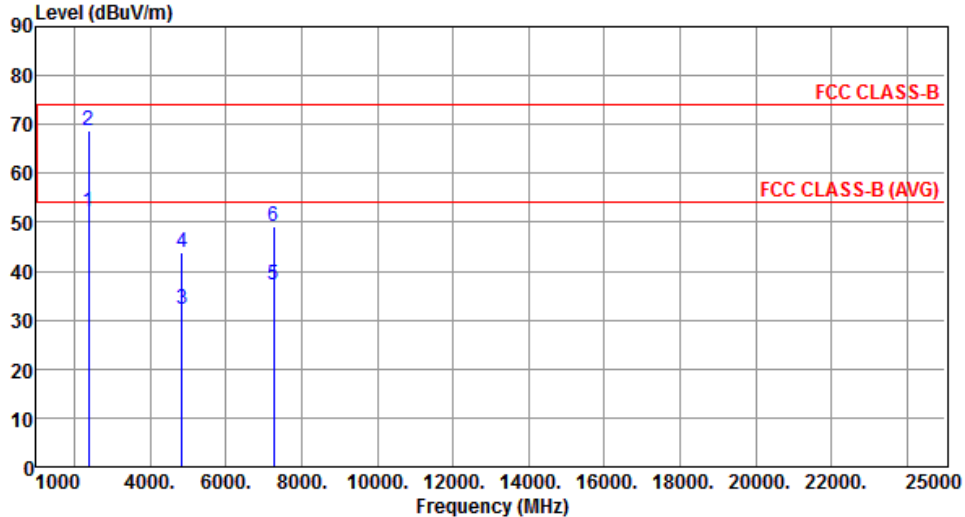
*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

Modulation	HT20	Test Freq. (MHz)	2462
Polarization	Vertical		
Level (dBUV/m) <			

3.5.8 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT40

Modulation	HT40	Test Freq. (MHz)	2422
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.16	54.00	-1.84	55.67	-3.51	Average	221	270
2	2390.00	68.89	74.00	-5.11	72.40	-3.51	Peak	221	270
3	4844.00	32.24	54.00	-21.76	28.64	3.60	Average	100	140
4	4844.00	43.99	74.00	-30.01	40.39	3.60	Peak	100	140
5	7266.00	37.11	54.00	-16.89	28.82	8.29	Average	100	157
6	7266.00	49.27	74.00	-24.73	40.98	8.29	Peak	100	157

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
 *Factor includes antenna factor , cable loss and amplifier gain
 Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	HT40	Test Freq. (MHz)	2422
Polarization	Vertical		
Level (dBuV/m)			

Modulation	HT40	Test Freq. (MHz)	2437
Polarization	Horizontal		

	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.98	54.00	-1.02	56.49	-3.51	Average	258	275
2	2390.00	69.86	74.00	-4.14	73.37	-3.51	Peak	258	275
3	2483.50	52.95	54.00	-1.05	56.06	-3.11	Average	155	271
4	2483.50	71.06	74.00	-2.94	74.17	-3.11	Peak	155	271
5	4874.00	32.56	54.00	-21.44	28.88	3.68	Average	100	135
6	4874.00	44.16	74.00	-29.84	40.48	3.68	Peak	100	135
7	7311.00	36.74	54.00	-17.26	28.34	8.40	Average	100	155
8	7311.00	49.35	74.00	-24.65	40.95	8.40	Peak	100	155

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

Modulation	HT40	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBUV/m)			

Modulation	HT40	Test Freq. (MHz)	2452
Polarization	Horizontal		
Level (dBUV/m)			

Modulation	HT40	Test Freq. (MHz)	2452
Polarization	Vertical		
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 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.6.2 Test Procedures

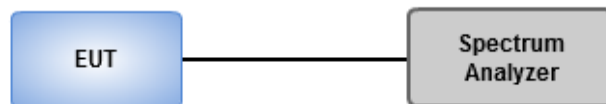
Reference level measurement

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

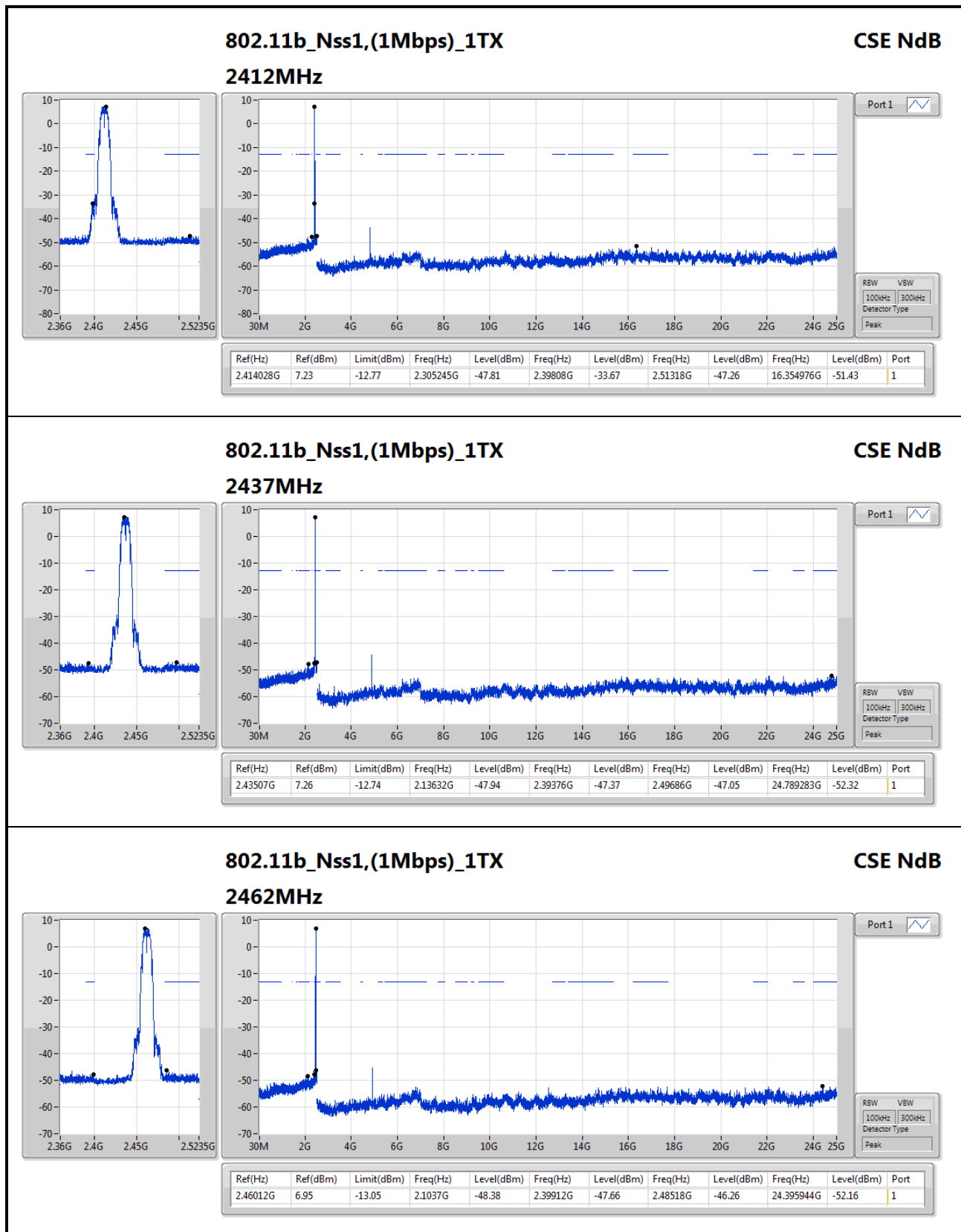
Emission level measurement

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



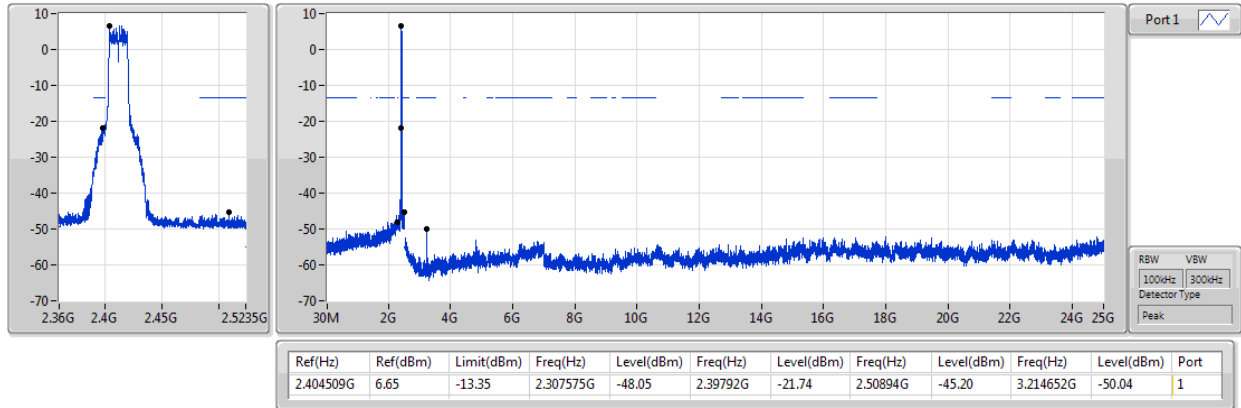
3.6.4 Unwanted Emissions into Non-Restricted Frequency Bands



802.11g_Nss1,(6Mbps)_1TX

CSE NdB

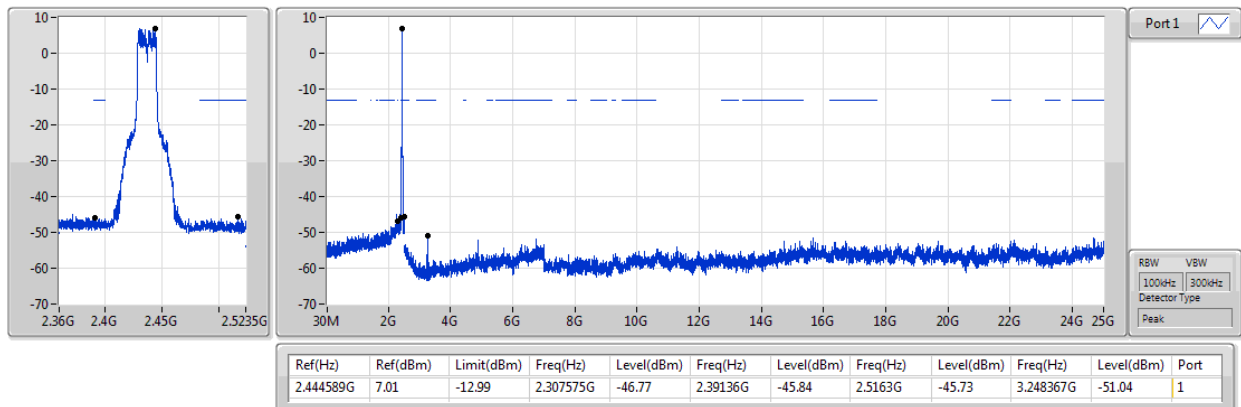
2412MHz



802.11g_Nss1,(6Mbps)_1TX

CSE NdB

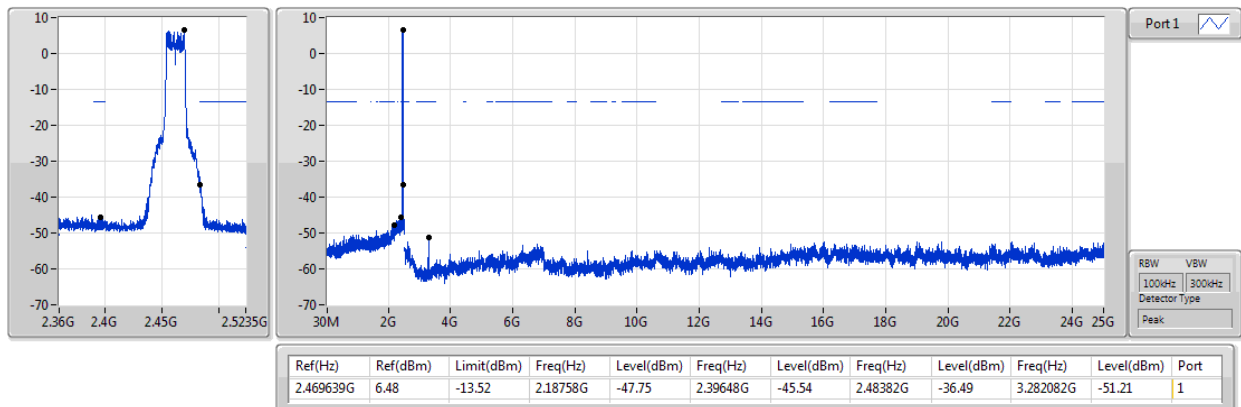
2437MHz



802.11g_Nss1,(6Mbps)_1TX

CSE NdB

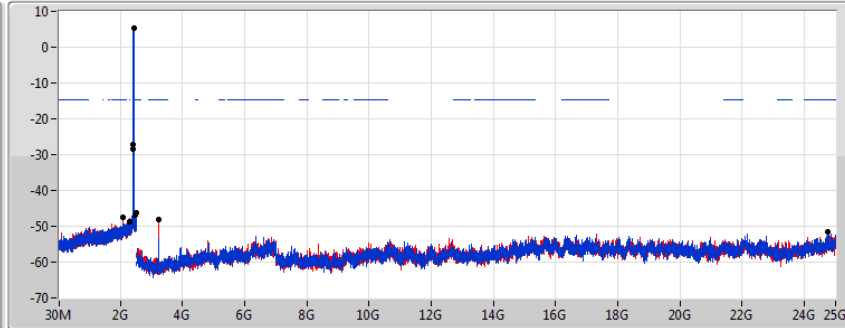
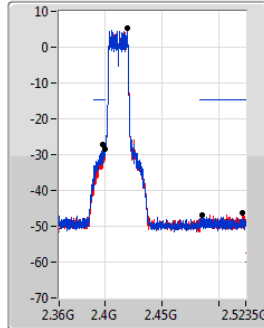
2462MHz



802.11n HT20_Nss1,(MCS0)_2TX

CSE NdB

2412MHz



Port 1 
Port 2 

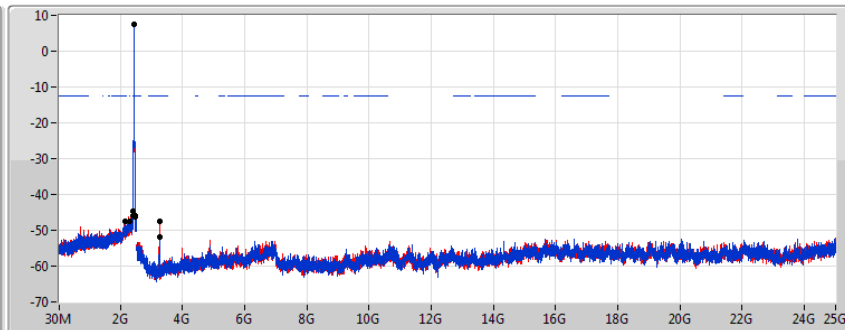
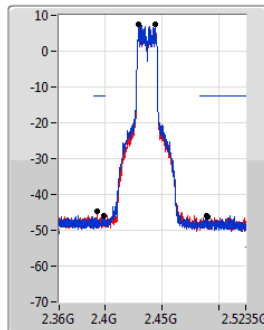
RBW VBW
100kHz 300kHz
Detector Type
Peak

Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.419539G	5.17	-14.83	2.30175G	-48.85	2.39832G	-27.22	2.48534G	-47.03	24.735901G	-51.44	1
2.419539G	5.43	-14.57	2.081565G	-47.60	2.39992G	-28.45	2.52046G	-46.37	3.214652G	-48.15	2

802.11n HT20_Nss1,(MCS0)_2TX

CSE NdB

2437MHz



Port 1 
Port 2 

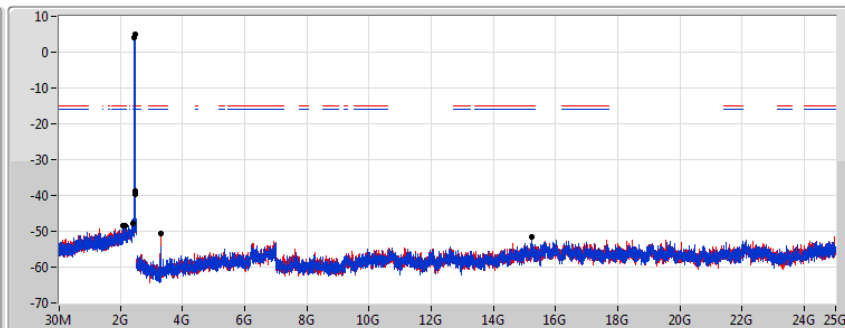
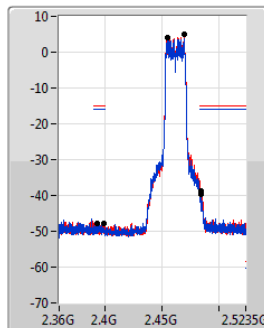
RBW VBW
100kHz 300kHz
Detector Type
Peak

Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.429559G	7.46	-12.54	2.142145G	-47.55	2.39952G	-46.05	2.48886G	-45.96	3.248367G	-51.82	1
2.444589G	7.51	-12.49	2.302915G	-47.56	2.39288G	-44.65	2.49046G	-46.25	3.248367G	-47.42	2

802.11n HT20_Nss1,(MCS0)_2TX

CSE NdB

2462MHz



Port 1 
Port 2 

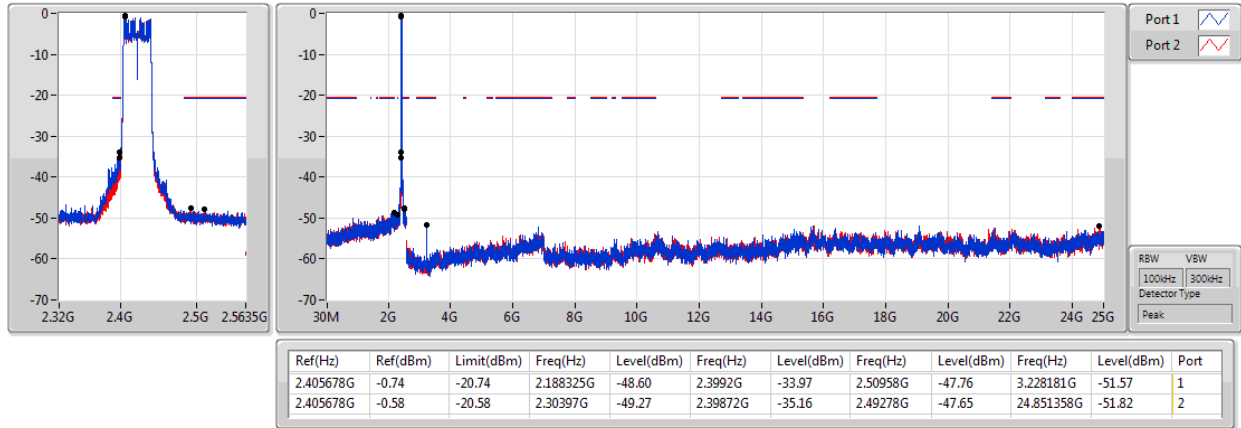
RBW VBW
100kHz 300kHz
Detector Type
Peak

Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.454609G	4.07	-15.93	2.090885G	-48.33	2.39352G	-47.88	2.48446G	-39.55	15.219913G	-51.64	1
2.469639G	4.88	-15.12	2.158455G	-48.51	2.3988G	-47.71	2.48478G	-38.71	3.282082G	-50.54	2

802.11n HT40_Nss1,(MCS0)_2TX

CSE NdB

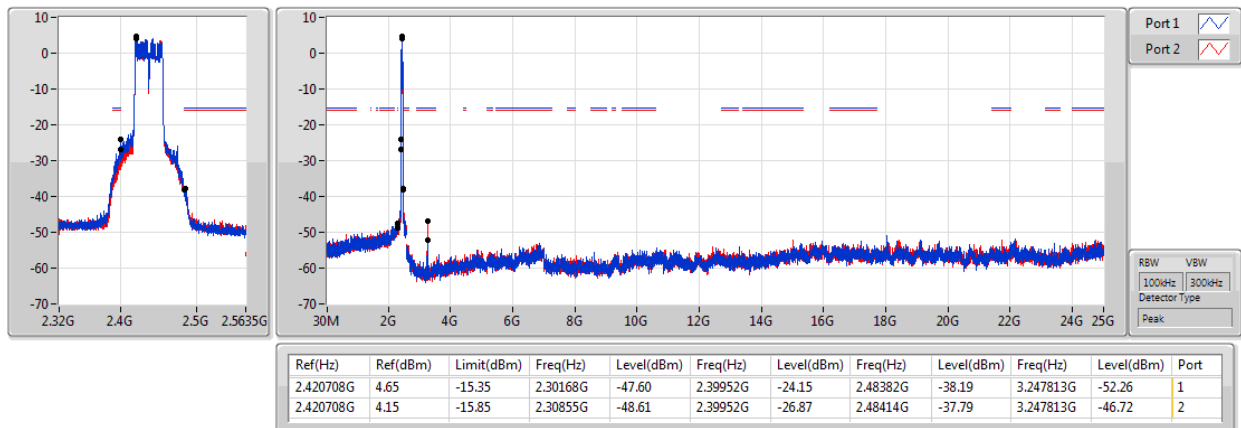
2422MHz



802.11n HT40_Nss1,(MCS0)_2TX

CSE NdB

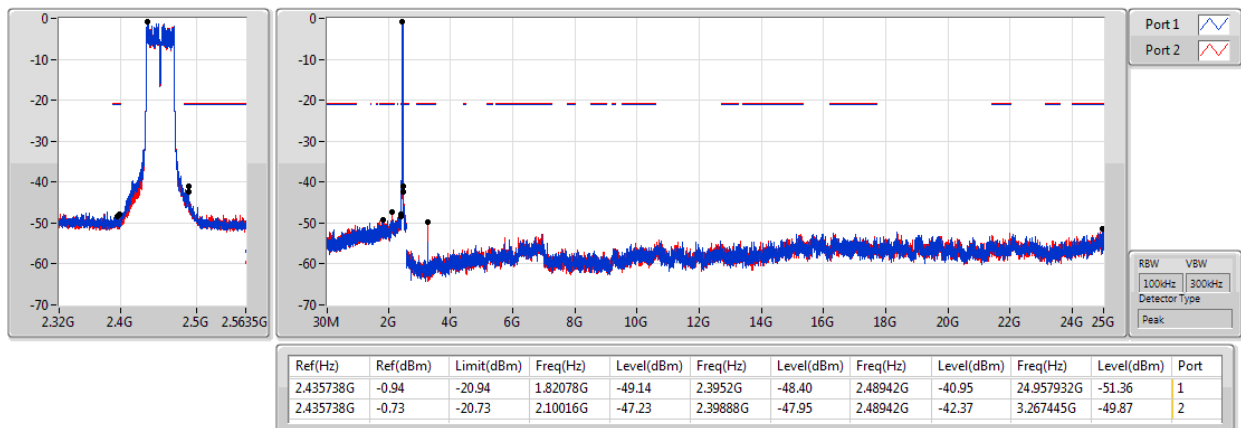
2437MHz



802.11n HT40_Nss1,(MCS0)_2TX

CSE NdB

2452MHz



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 Corp (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

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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 District, Tao Yuan City
333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd
St., Kwei Shan District, 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: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

==END==