RADIO TEST REPORT

Product	:	WLAN TRANSCEIVER
Model Name	:	IP110H
FCC ID	:	AFJ399510
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date	:	2022/10/19
Test Date	:	2022/10/24 ~ 2022/11/4
Issued Date	:	2023/2/9
Applicant	:	Icom Incorporated 1-1-32, Kamiminami, Hirano-Ku, Osaka, 547-0003, Japan
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

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REVISION HISTORY

Original Test Report No.: 4790590080-US-R0-V1

Rev.	Test report No.	Date	Page revised	Contents
Original	4790590080-US-R0-V0	2022/12/27	-	Initial issue
V1	4790590080-US-R0-V1	2023/2/9	P.11 P.16	1. Add sample calculation. 2. Add attenuator information into the table of antenna port conducted measurement

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1. Attestation of Test Results

APPLICANT:	Icom Incorporated 1-1-32, Kamiminami, Hirano-Ku, Osaka, 547-0003, Japan
MANUFACTURER:	Icom Incorporated 1-1-32, Kamiminami, Hirano-Ku, Osaka, 547-0003, Japan
EUT DESCRIPTION:	WLAN TRANSCEIVER
BRAND:	ICOM
MODEL:	IP110H
SAMPLE STAGE:	Engineering Verification Test sample
DATE of TESTED:	2022/10/24 ~ 2022/11/4

APPLICABLE STANDARDS	
STANDARD	**Test Results**
FCC 47 CFR PART 15 Subpart C (Section 15.247)	PASS

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

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

Prepared By:

Cindy Hsin Date : 2023/2/9
Project Handler

Approved and Authorized By:

Eric Lee Date : 2023/2/9
Senior Laboratory Engineer

2. Summary of Test Results

Summary of Test Results		
FCC Clause	**Test Items**	**Result**
15.247(a)(2)	6dB Bandwidth	PASS
15.247(b)	Conducted Output Power	PASS
15.247(e)	Power Spectral Density	PASS
15.247(d)	Antenna Port Emission	PASS
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS
15.207	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013.

4. Facilities and Accreditation

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

5. Measurement Uncertainty

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

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

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	±2.9 dB
RF Conducted	9 kHz - 40GHz	±2.4 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	±1.9 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	±5.8 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	±4.8 dB

6. Equipment under Test

6.1. Description of EUT

Product	WLAN TRANSCEIVER
Brand Name	ICOM
Model Name	IP110H
Operating Frequency	2412MHz ~ 2462MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Transfer Rate	802.11b: up to 11 Mbps 802.11g: up to 54 Mbps 802.11n: up to MCS7
Number of Channel	11 for 802.11b, 802.11g, 802.11n (HT20) 7 for 802.11n (HT40)
Maximum Output Power	802.11b: 15.44 dBm 802.11g: 15.87 dBm 802.11n (HT20): 18.86 dBm 802.11n (HT40): 18.51 dBm
Normal Voltage	5Vdc from host 3.75Vdc for battery
Sample ID	5427308

Note:

1. The EUT incorporates a SISO function. Physically, the EUT provides one completed transmitters and one receivers.

Modulation Mode	Tx,Rx Function
802.11b	1TX,1RX
802.11g	1TX,1RX
802.11n (HT20)	1TX,1RX
802.11n (HT40)	1TX,1RX

2. The EUT contains following accessory devices:

Product	Brand	Model	Description
AC Adapter 1	ICOM	BC-258	Input: 100-240V, 50/60Hz, 0.45A, Output: 5.0V, 2A
USB Cable	ICOM	OPC-2480	Length: 1m
Charger Cradle	ICOM	BC-257	-
AC Adapter (for Cradle)	ICOM	BC-228	-

3. The EUT could be supplied with rechargeable battery as the following table:

Brand Name	Model	Description
ICOM	RB-LB1081	3.75V, 3200mAh 12Wh

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

6.2. Channel List

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20):

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

7 channels are provided for 802.11n (HT40):

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

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	21~28℃/ 51~58%RH	3.75Vdc from battery & 5Vdc from host	2022/10/24~ 2022/11/04	Rex Chen
Radiated Spurious Emission	966-2	21~28℃/ 51~58%RH	3.75Vdc from battery & 5Vdc from host	2022/10/24~ 2022/11/04	Rex Chen
AC power Line Conducted Emission	SR1	21~28℃/ 51~58%RH	3.75Vdc from battery & 5Vdc from host	2022/10/24~ 2022/11/04	Rex Chen

FCC Test Firm Registration Number: 498077

Sample Calculation:

Antenna Port Conducted Measurement:

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

Radiated Spurious Emission:

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

AC power Line Conducted Emission:

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

6.4. Description of Available Antennas

Ant. No.	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)
1	Japan Aviation Electronics Industry, Limited	AN01DL25C00R3200	Split ring	2.4GHz: 1.15 5.18~5.32GHz: 0.15 5.50~5.82GHz:0.62

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

6.5. Test Mode Applicability and Tested Channel Detail

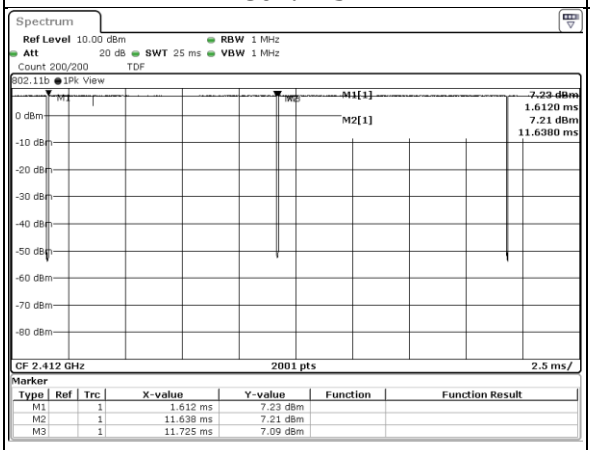
- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that Y-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in Y-Z plane.
- The EUT has two power source types: 3.75Vdc from battery and 5Vdc from Host, above two types was pre-tested, the worst case was found in the 5Vdc. Therefore only the test data of the 5Vdc was recorded in this report.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Test Item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11b	DSSS	DBPSK	1 to 11	1,6,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,6,11	6 Mbps
	802.11n20	OFDM	BPSK	1 to 11	1,6,11	MCS0
	802.11n40	OFDM	BPSK	3 to 9	3,6,9	MCS0
Radiated Emissions (Below 1GHz)	802.11n20	OFDM	BPSK	1 to 11	1	MCS0
AC Power Line Conducted Emission	802.11n20	OFDM	BPSK	1 to 11	1	MCS0
*Antenna Port Conducted Measurement	802.11b	DSSS	DBPSK	1 to 11	1,6,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,6,11	6 Mbps
	802.11n20	OFDM	BPSK	1 to 11	1,6,11	MCS0
	802.11n40	OFDM	BPSK	3 to 9	3,6,9	MCS0

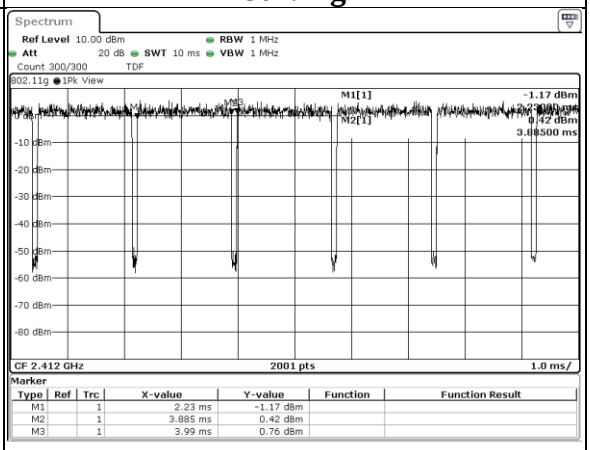
6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
802.11b	10.025	10.113	0.9913	N/A	10Hz
802.11g	1.655	1.760	0.9403	0.27	1kHz
802.11n(HT20)	1.548	1.660	0.9325	0.30	1kHz
802.11n(HT40)	0.775	0.870	0.8908	0.50	2kHz

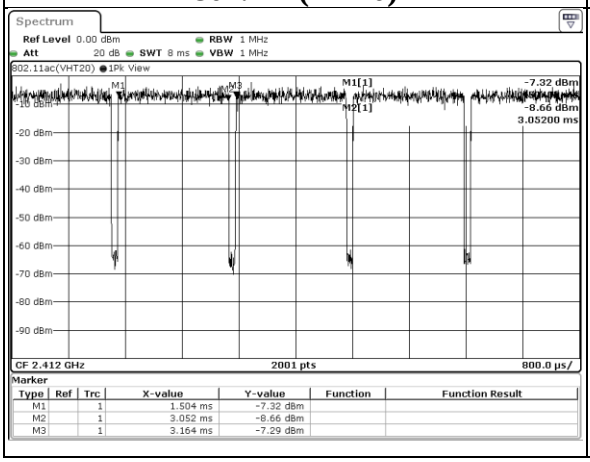
802.11b



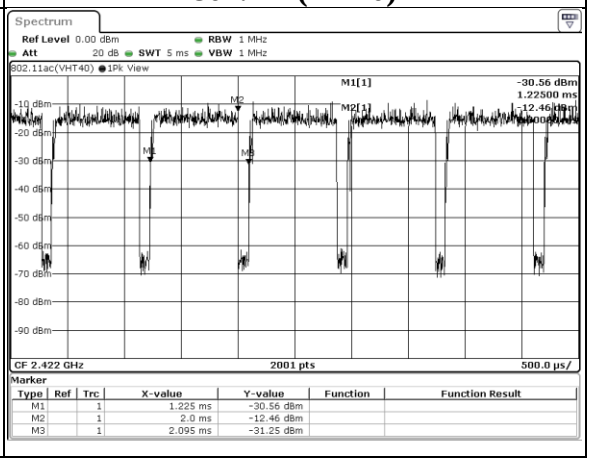
802.11g



802.11n(HT20)



802.11n(HT40)



7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2021/11/9	2022/11/8
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2021/12/10	2022/12/9
Loop Antenna	ETS lindgren	6502	00213440	2021/12/23	2022/12/22
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2022/2/8	2023/2/7
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2021/12/13	2022/12/12
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2021/12/17	2022/12/16
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2022/6/7	2023/6/6
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2022/2/16	2023/2/15
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2022/5/17	2023/5/16
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2021/12/3	2022/12/2
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2021/12/3	2022/12/2

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2022/10/24	2023/10/23
Pulse Power Sensor	Anritsu	MA2411B	1531202	2021/12/22	2022/12/21
Attenuator	EMCI	EMC-40ATK2W10	17002	2022/12/9	2023/12/8
Power Meter	Anritsu	ML2495A	1645002	2021/12/22	2022/12/21
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2021/11/15	2022/11/14
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2022/8/29	2023/8/28
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2022/8/30	2023/8/29
Cables	TITAN	CFD200	T0732ACFD20020A300-2	2022/4/9	2023/4/8

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

8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	DELL	Latitude E5470	3JFKWF2	Provide by lab
B	Adapter	ICOM	BC-258	DYS810-050200U-6	Supplied by client

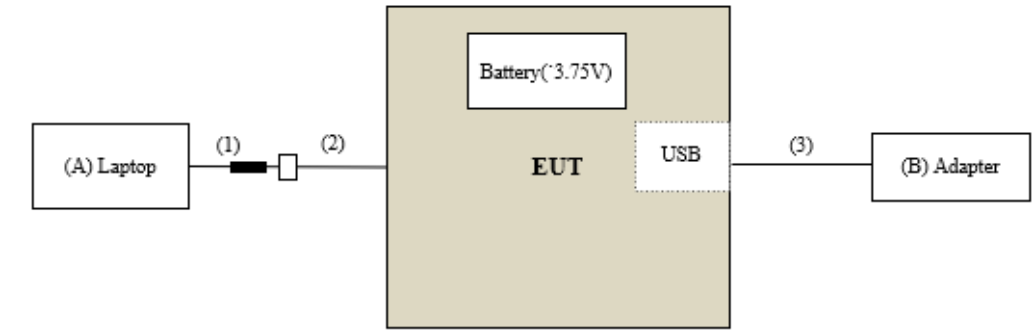
I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Mini USB Cable	ICOM	N/A	1.5	Supplied by client with one core
2	Type B Cable	ICOM	OPC-478UC	0.83	Supplied by client
3	USB cable (typeA-typeC)	ICOM	OPC-2480	1	Supplied by client

Test Setup

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

Setup Diagram for Test



9. Test Results

9.1. 6dB Bandwidth

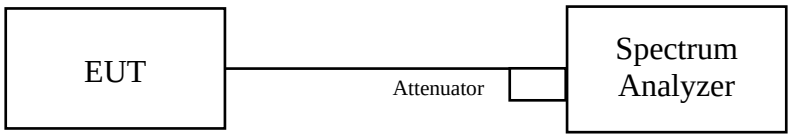
Requirements

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

Test procedure

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

Test Setup

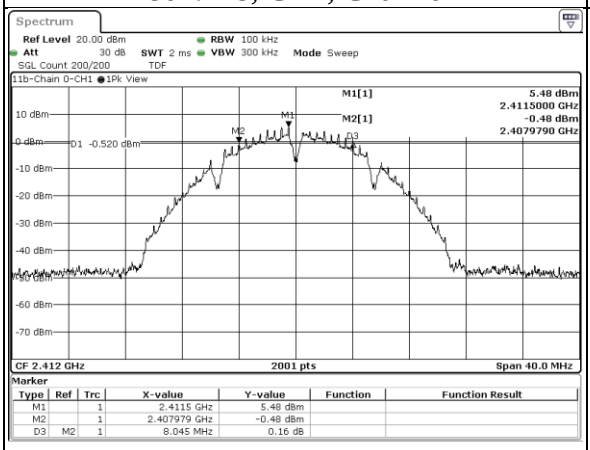


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

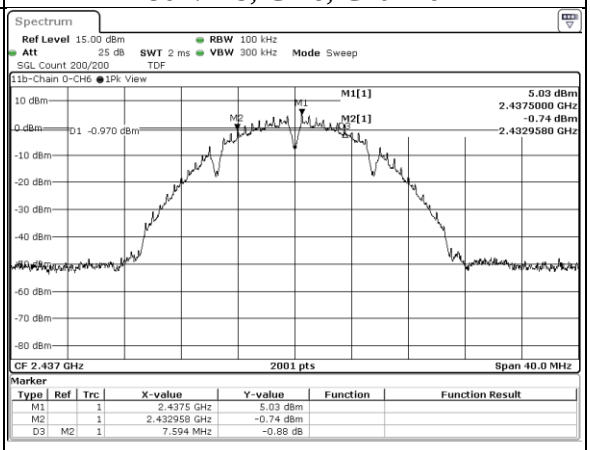
Test Data

Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11b	1	2412	8.045	0.5	PASS
	6	2437	7.594	0.5	PASS
	11	2462	7.562	0.5	PASS

802.11b, CH1, Chain 0



802.11b, CH6, Chain 0



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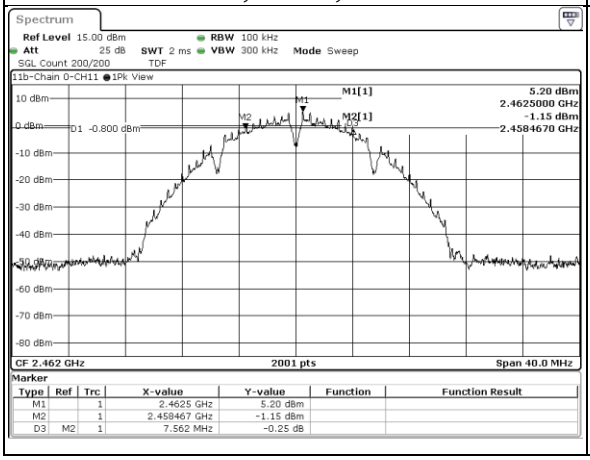
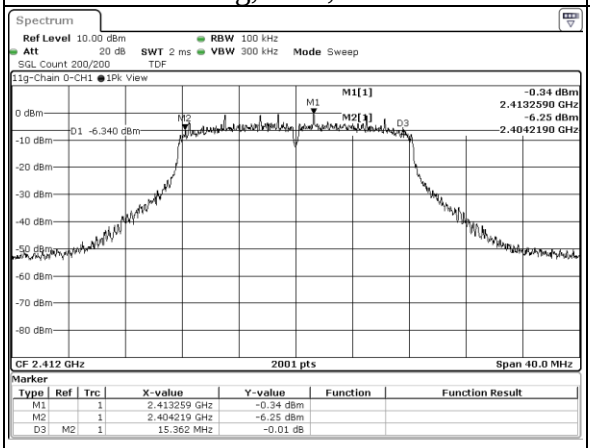
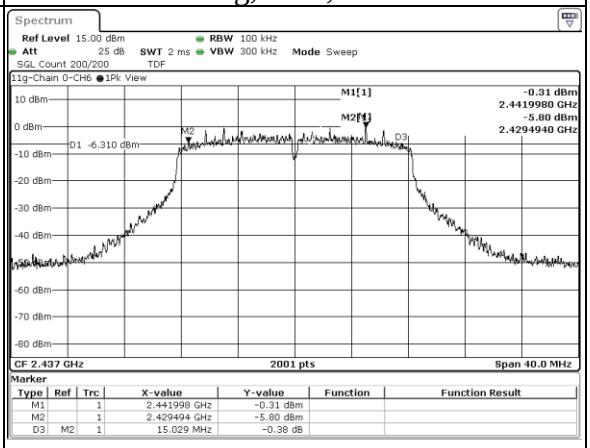


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11g	1	2412	15.362	0.5	PASS
	6	2437	15.029	0.5	PASS
	11	2462	15.142	0.5	PASS

802.11g, CH1, Chain 0



802.11g, CH6, Chain 0



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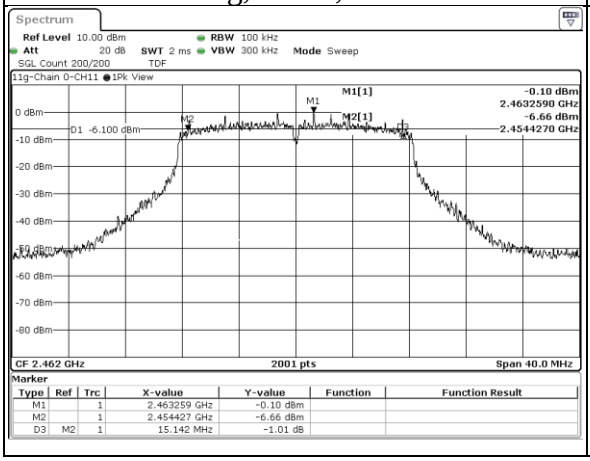
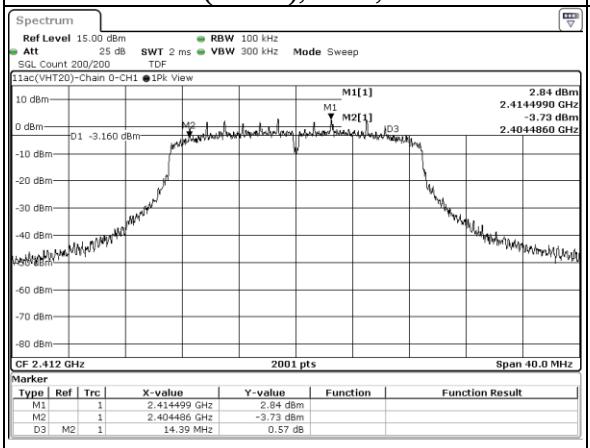


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11n(HT20)	1	2412	14.390	0.5	PASS
	6	2437	15.133	0.5	PASS
	11	2462	15.147	0.5	PASS

802.11n(HT20), CH1, Chain 0



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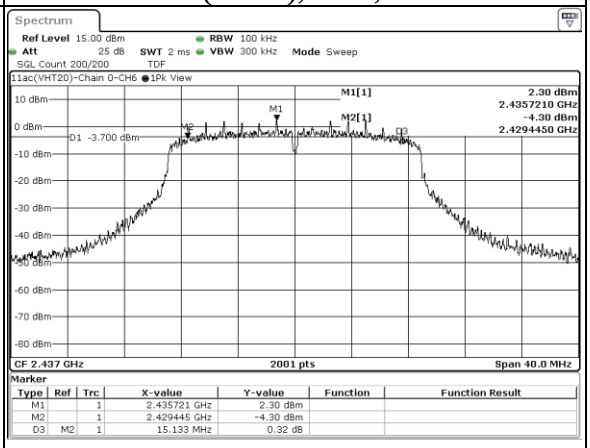

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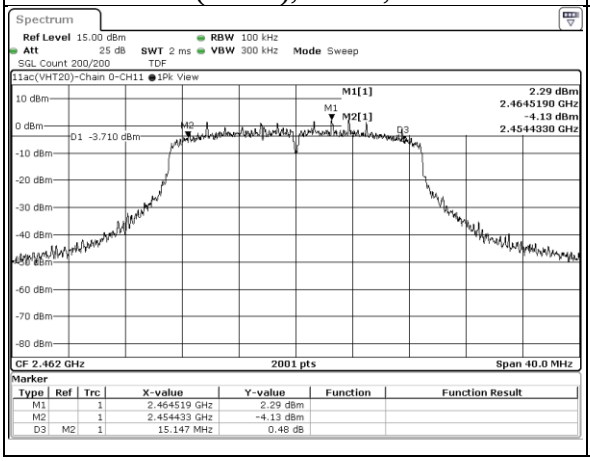
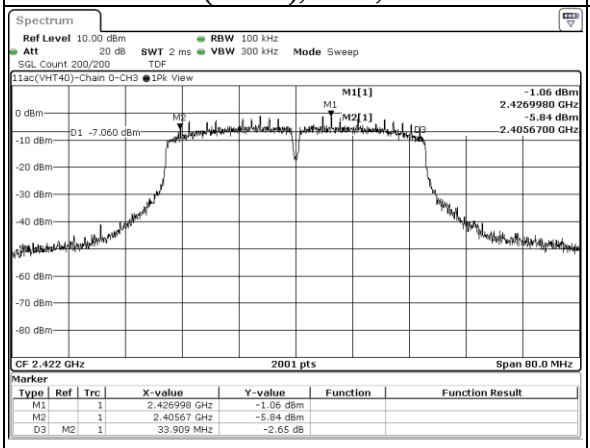
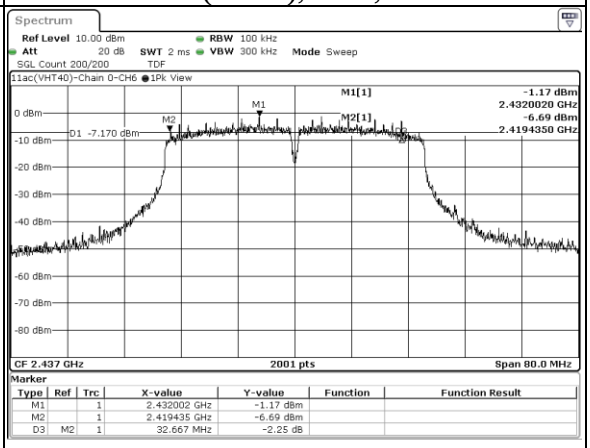


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11n(HT40)	3	2422	33.909	0.5	PASS
	6	2437	32.667	0.5	PASS
	9	2452	35.137	0.5	PASS

802.11n(HT40), CH3, Chain 0



802.11n(HT40), CH6, Chain 0



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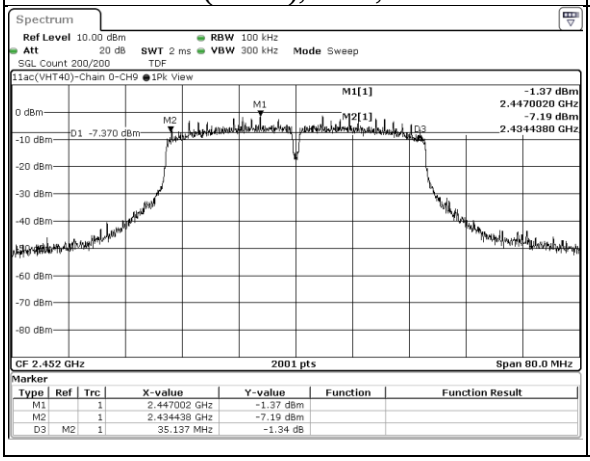


9.2. Conducted Output Power

Requirements

For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

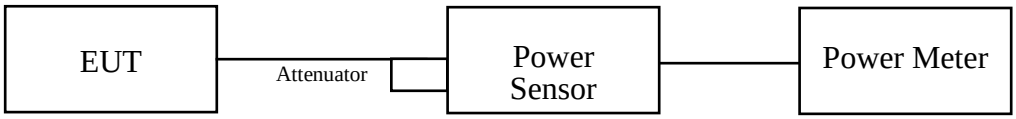
Note:
1. Directional Gain = G_{ant} + 10 log (Nant) dBi.

   N*a*nt: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas (Same for Each Antenna)

Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Test Setup



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

Test Data

Peak Power

802.11b

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	34.995	15.44	30	PASS
6	2437	33.963	15.31	30	PASS
11	2462	33.42	15.24	30	PASS

802.11g

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	38.637	15.87	30	PASS
6	2437	37.757	15.77	30	PASS
11	2462	36.983	15.68	30	PASS

802.11n (HT20)

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	76.913	18.86	30	PASS
6	2437	71.614	18.55	30	PASS
11	2462	66.681	18.24	30	PASS

802.11n (HT40)

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
3	2422	70.958	18.51	30	PASS
6	2437	69.343	18.41	30	PASS
9	2452	68.234	18.34	30	PASS

Average Power (Reference Only)

802.11b

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	19.364	12.87
6	2437	19.187	12.83
11	2462	18.923	12.77

802.11g

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	9.727	9.88
6	2437	9.705	9.87
11	2462	9.616	9.83

802.11n (HT20)

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	19.77	12.96
6	2437	19.679	12.94
11	2462	19.143	12.82

802.11n (HT40)

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
3	2422	15.56	11.92
6	2437	15.346	11.86
9	2452	15.241	11.83

9.3. Power Spectral Density

Requirements

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz (If G_{TX} > 6 dBi, then PSD = 8 – (G_{TX} – 6)).

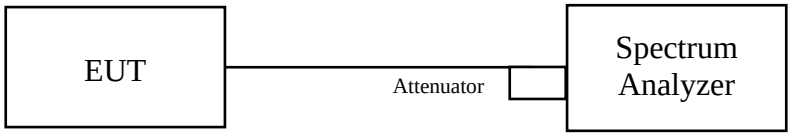
Note:
1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz.
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = G_{ant} + 10 log (Nant) dBi.

   N*a*nt: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas (Same for Each Antenna)

Test procedure

a. Set analyzer center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × RBW.
e. Detector = peak.
f. Sweep time = auto couple.
g. Trace mode = max hold.
h. Allow trace to fully stabilize.
i. Use the peak marker function to determine the maximum amplitude level within the RBW.

Test Setup



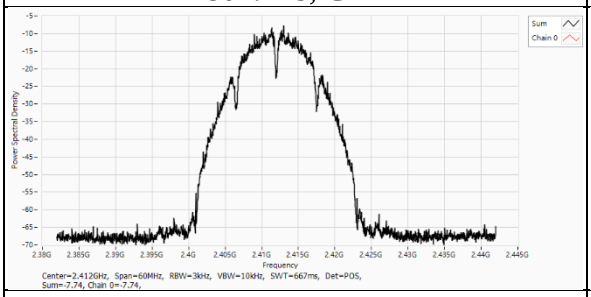
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

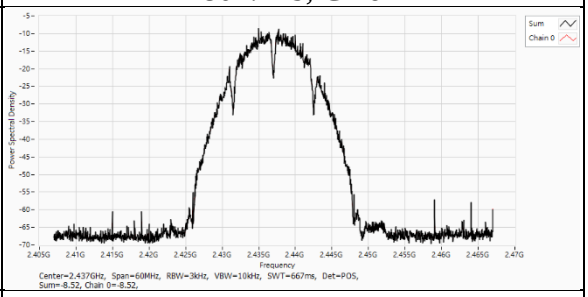
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11b	1	2412	-7.74	8	1.15	PASS
	6	2437	-8.52	8	1.15	PASS
	11	2462	-8.92	8	1.15	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)
			Chain 0
802.11b	1	2412	-7.741
	6	2437	-8.523
	11	2462	-8.925

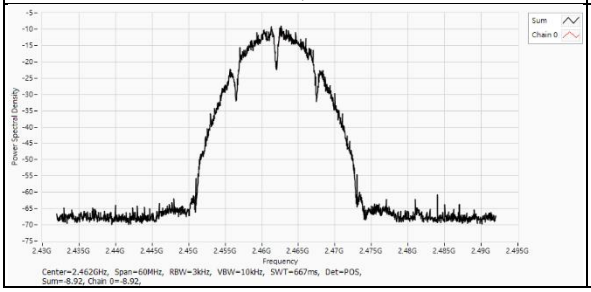
802.11b, CH1



802.11b, CH6



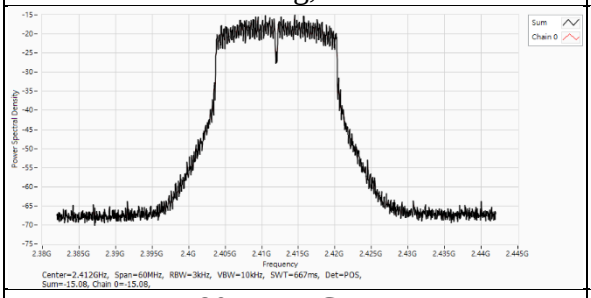
802.11b, CH11



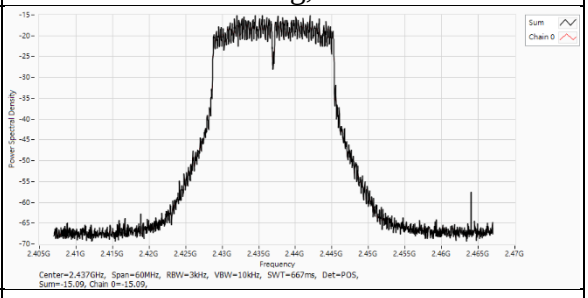
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11g	1	2412	-15.08	8	1.15	PASS
	6	2437	-15.09	8	1.15	PASS
	11	2462	-14.58	8	1.15	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz) Chain 0
802.11g	1	2412	-15.077
	6	2437	-15.094
	11	2462	-14.583

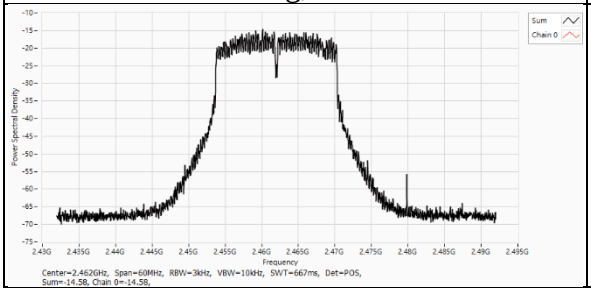
802.11g, CH1



802.11g, CH6



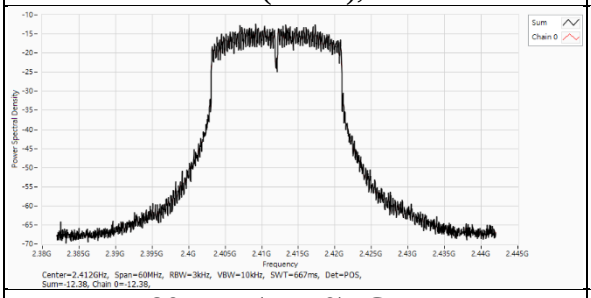
802.11g, CH11



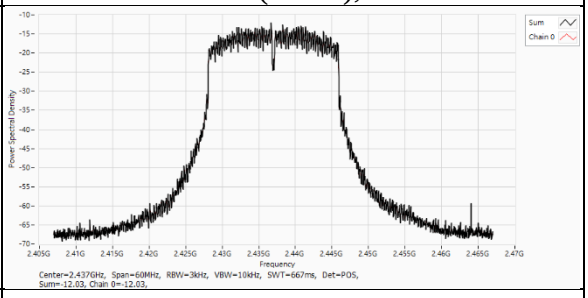
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11n(HT20)	1	2412	-12.38	8	1.15	PASS
	6	2437	-12.03	8	1.15	PASS
	11	2462	-11.56	8	1.15	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz) Chain 0
802.11n(HT20)	1	2412	-12.382
	6	2437	-12.028
	11	2462	-11.563

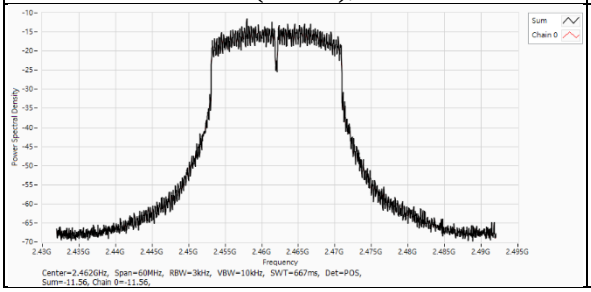
802.11n(HT20), CH1



802.11n(HT20), CH6



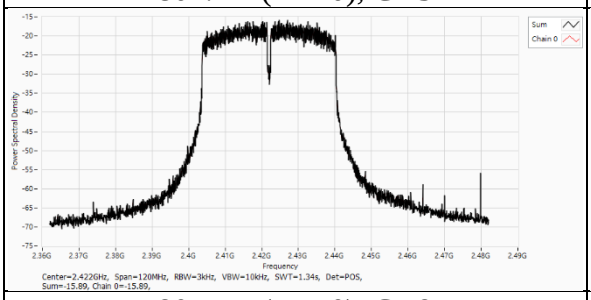
802.11n(HT20), CH11



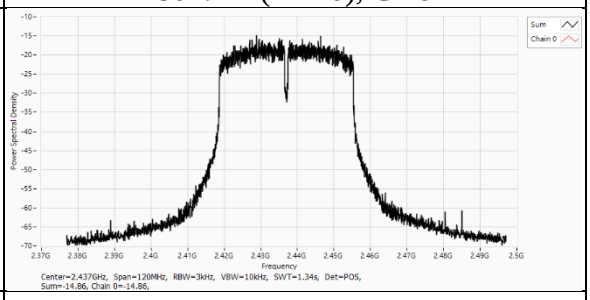
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11n(HT40)	3	2422	-15.89	8	1.15	PASS
	6	2437	-14.86	8	1.15	PASS
	9	2452	-15.54	8	1.15	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz) Chain 0
802.11n(HT40)	3	2422	-15.89
	6	2437	-14.856
	9	2452	-15.536

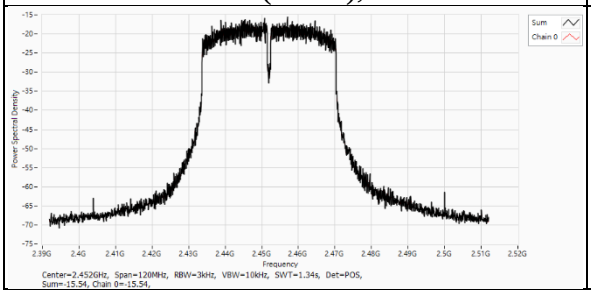
802.11n(HT40), CH3



802.11n(HT40), CH6



802.11n(HT40), CH9



9.4. Conducted Out of Band Emission

Requirements

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b) (3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209 (a) is not required.

Test procedure

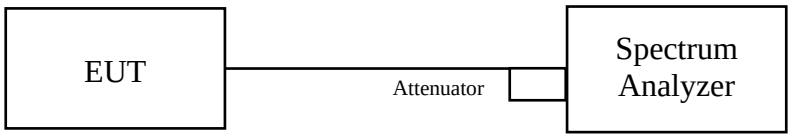
Measurement Procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

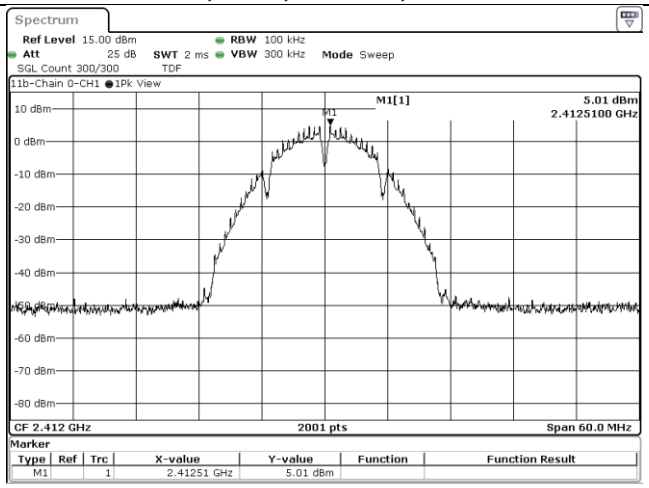
Test Setup



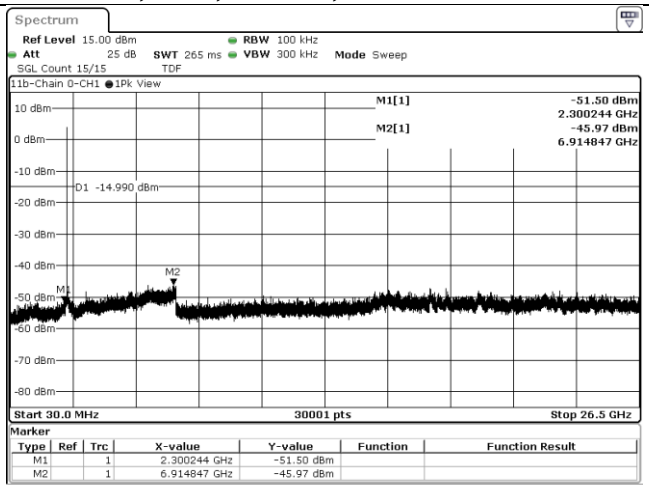
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

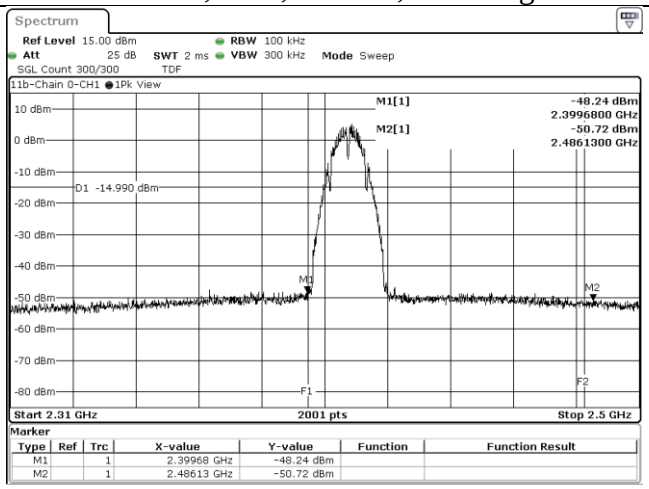
802.11b, CH1, Chain 0, Reference



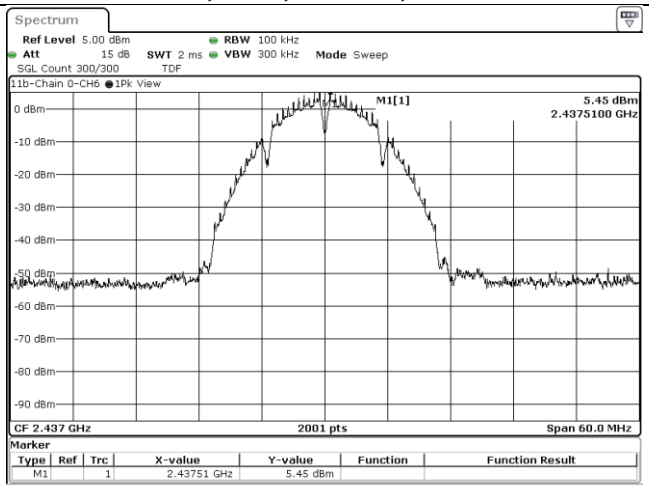
802.11b, CH1, Chain 0, Conducted Emission



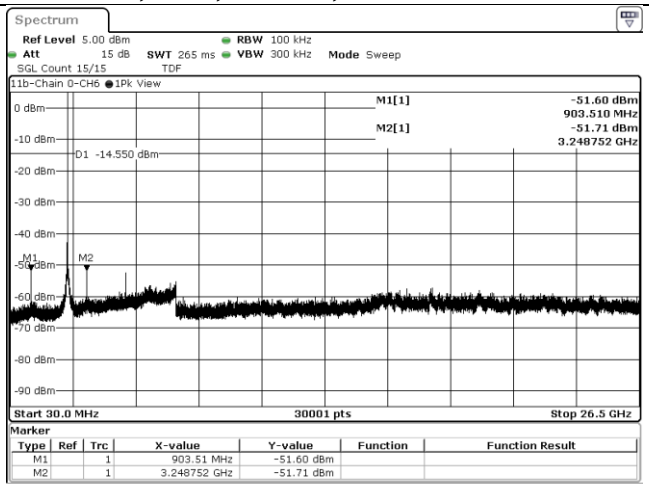
802.11b, CH1, Chain 0, Band edge



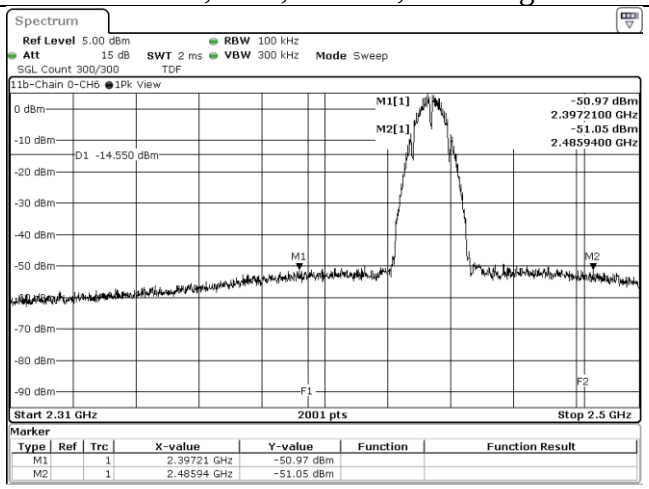
802.11b, CH6, Chain 0, Reference



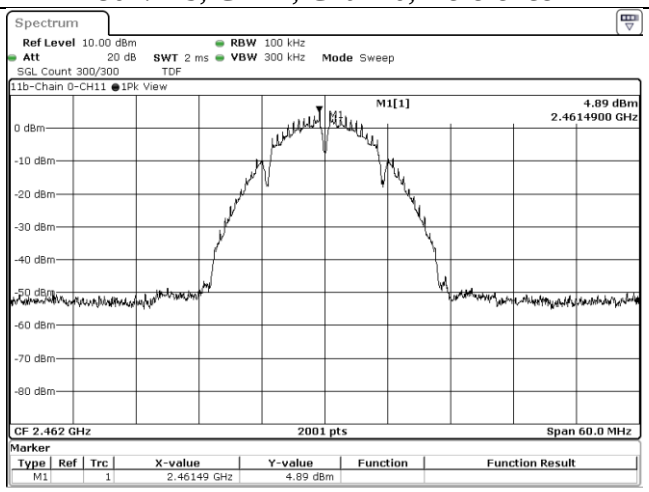
802.11b, CH6, Chain 0, Conducted Emission



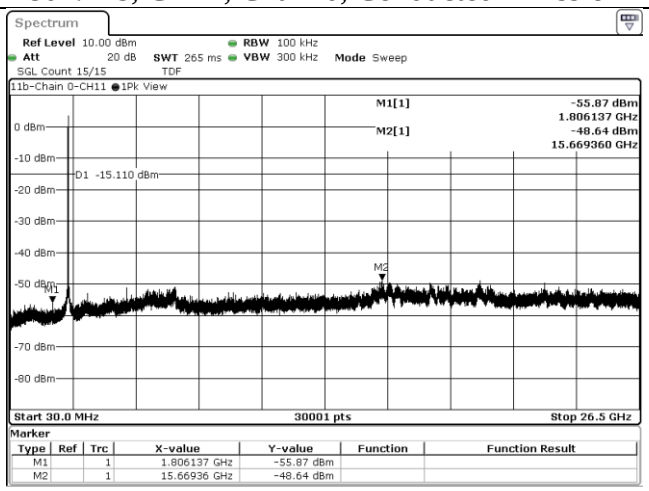
802.11b, CH6, Chain 0, Band edge



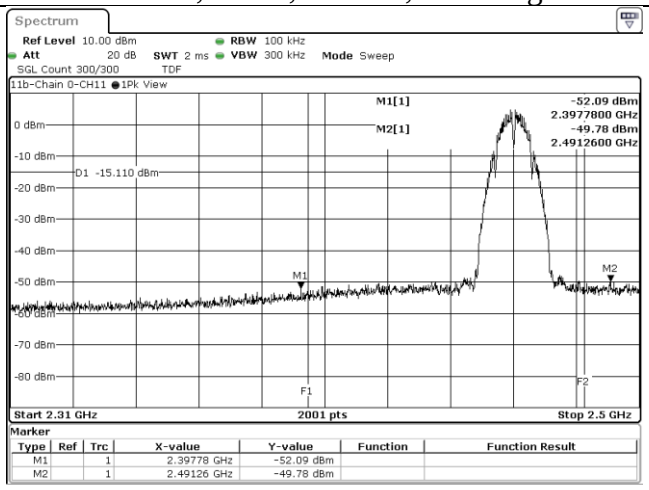
802.11b, CH11, Chain 0, Reference



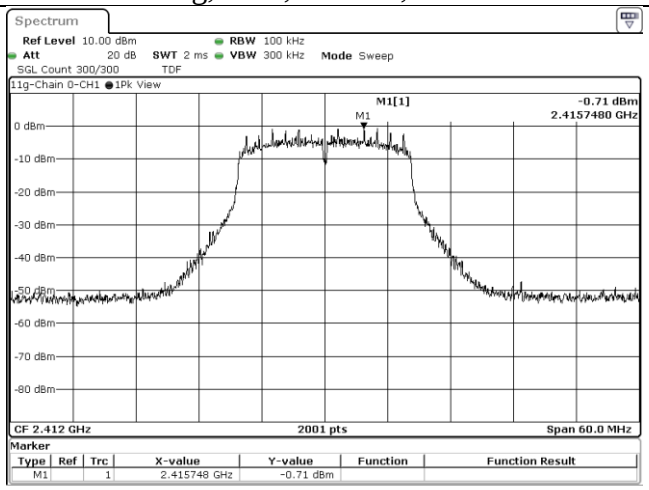
802.11b, CH11, Chain 0, Conducted Emission



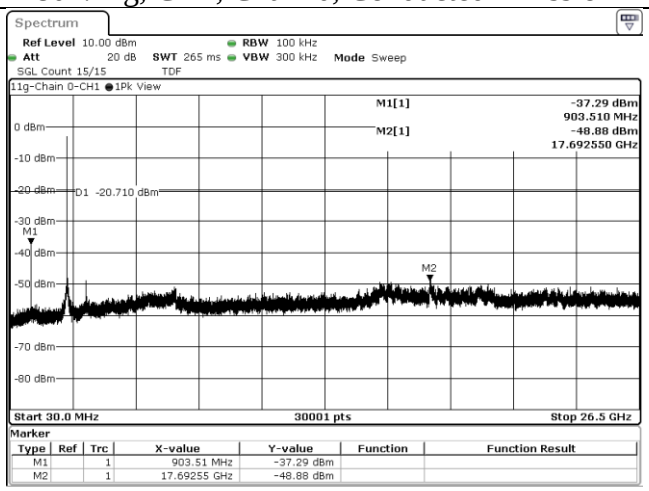
802.11b, CH11, Chain 0, Band edge



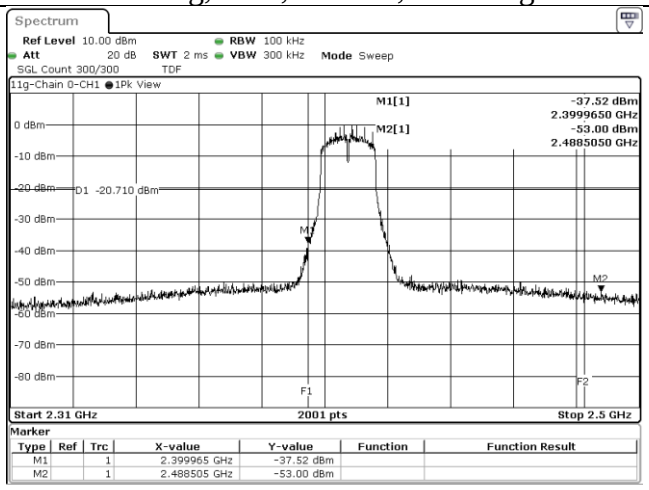
802.11g, CH1, Chain 0, Reference



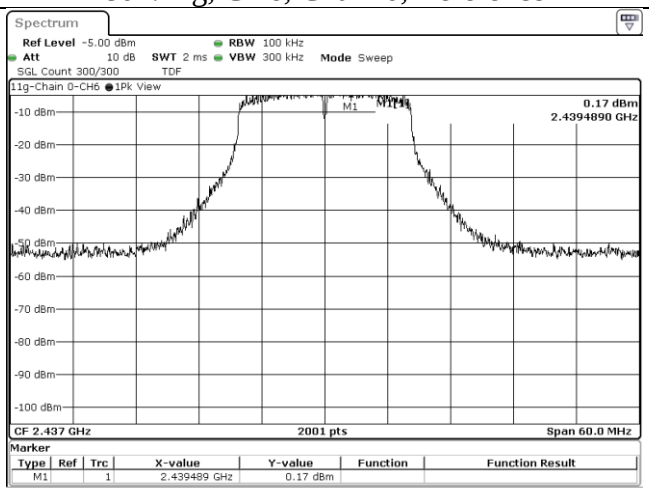
802.11g, CH1, Chain 0, Conducted Emission



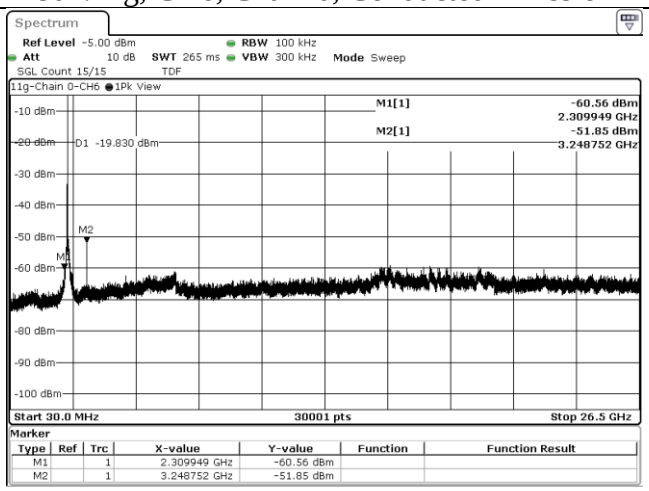
802.11g, CH1, Chain 0, Band edge



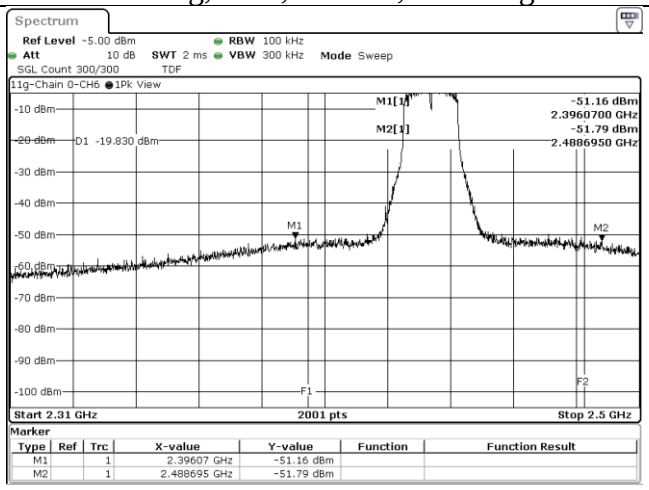
802.11g, CH6, Chain 0, Reference



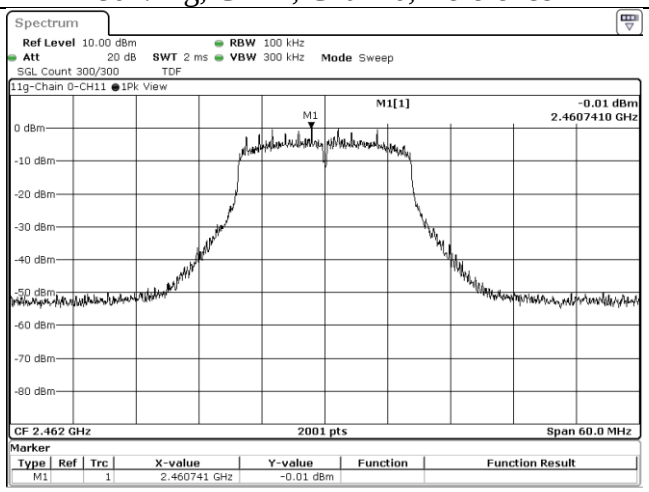
802.11g, CH6, Chain 0, Conducted Emission



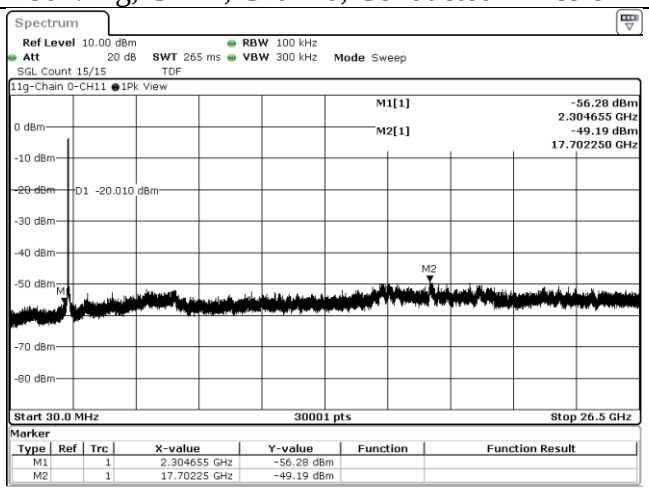
802.11g, CH6, Chain 0, Band edge



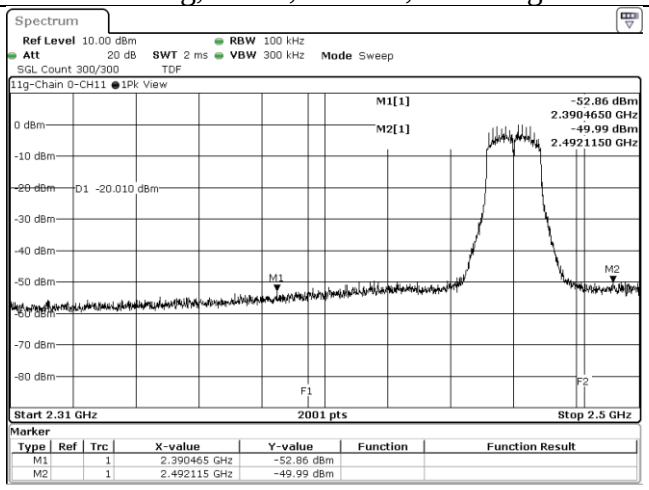
802.11g, CH11, Chain 0, Reference



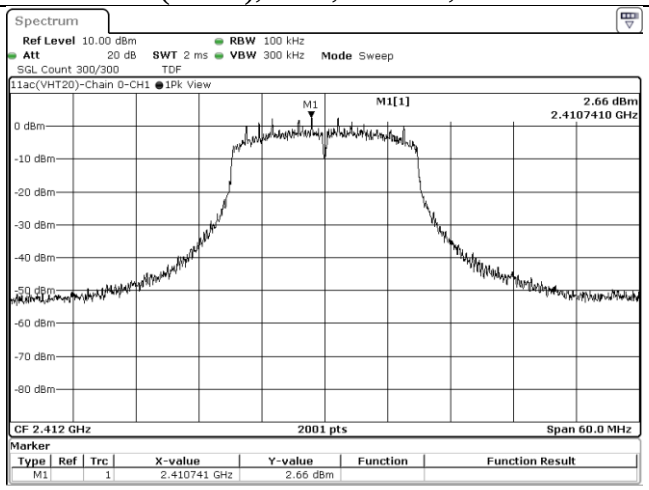
802.11g, CH11, Chain 0, Conducted Emission



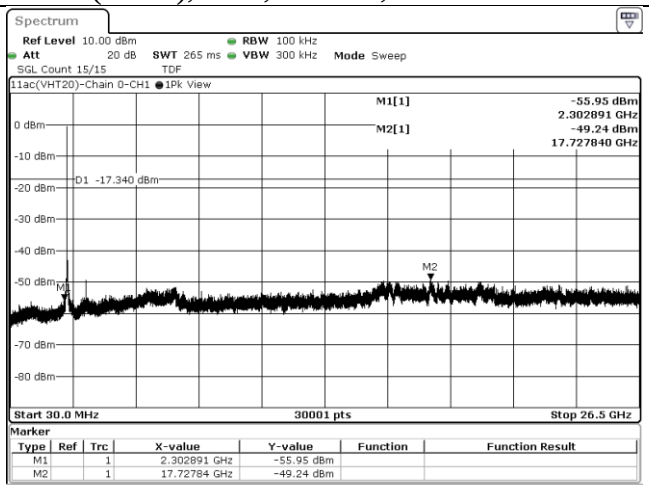
802.11g, CH11, Chain 0, Band edge



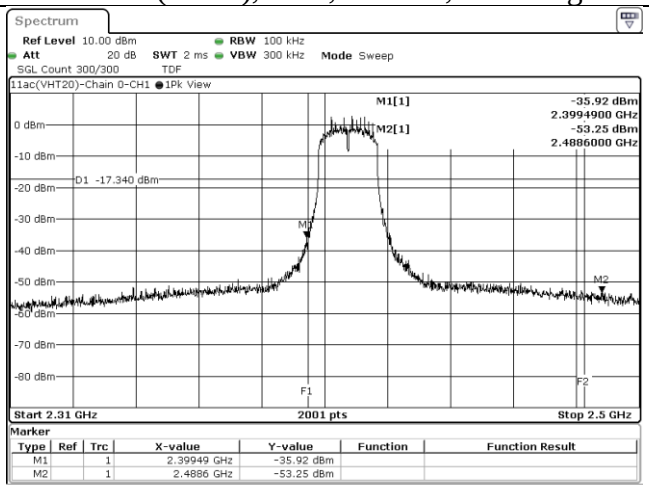
802.11n(HT20), CH1, Chain 0, Reference



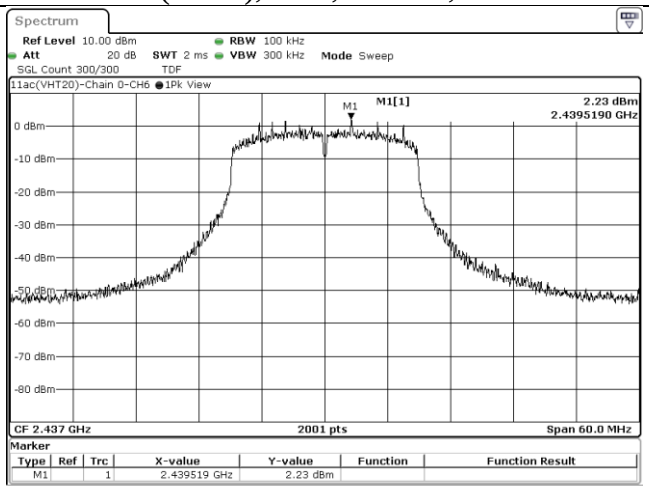
802.11n(HT20), CH1, Chain 0, Conducted Emission



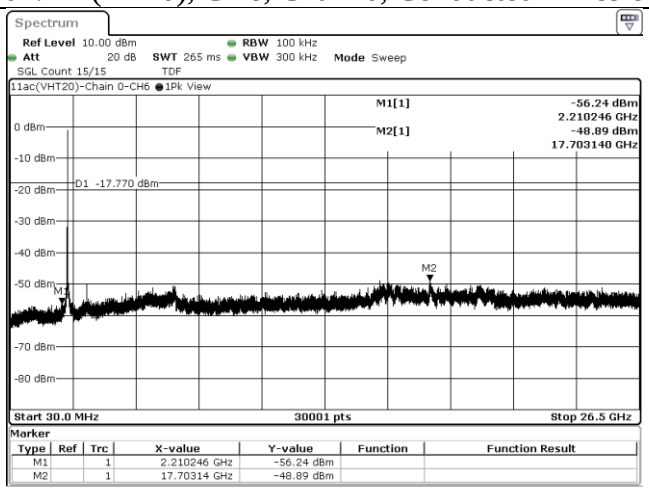
802.11n(HT20), CH1, Chain 0, Band edge



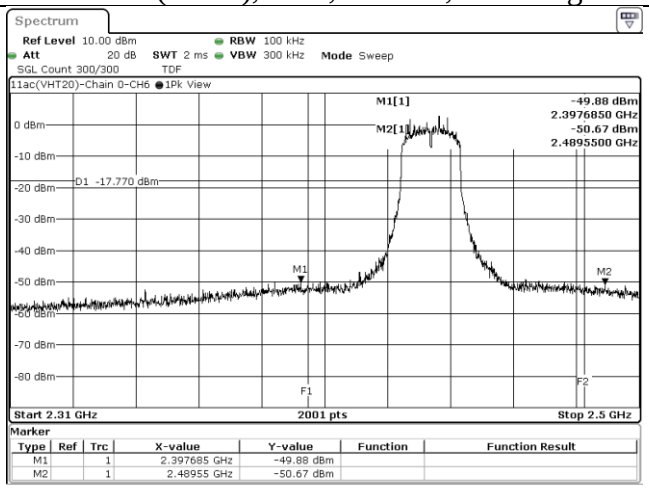
802.11n(HT20), CH6, Chain 0, Reference



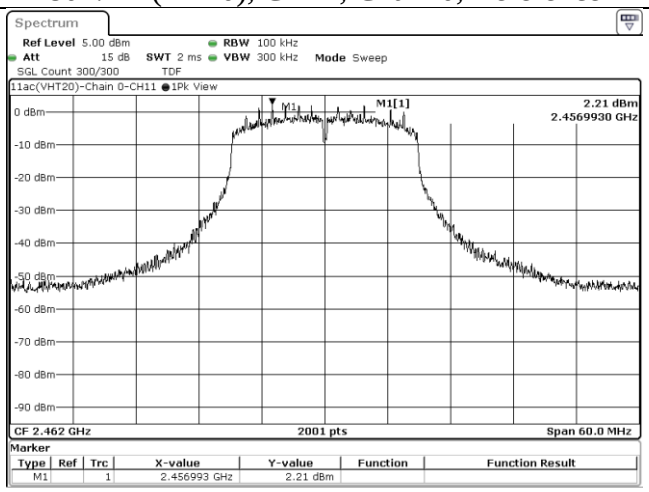
802.11n(HT20), CH6, Chain 0, Conducted Emission



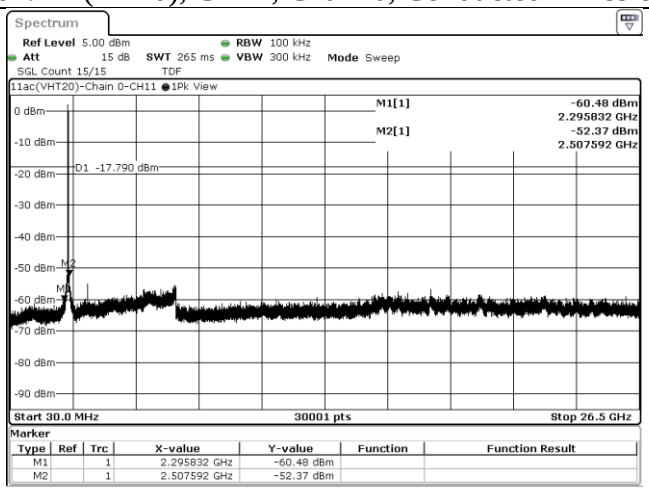
802.11n(HT20), CH6, Chain 0, Band edge



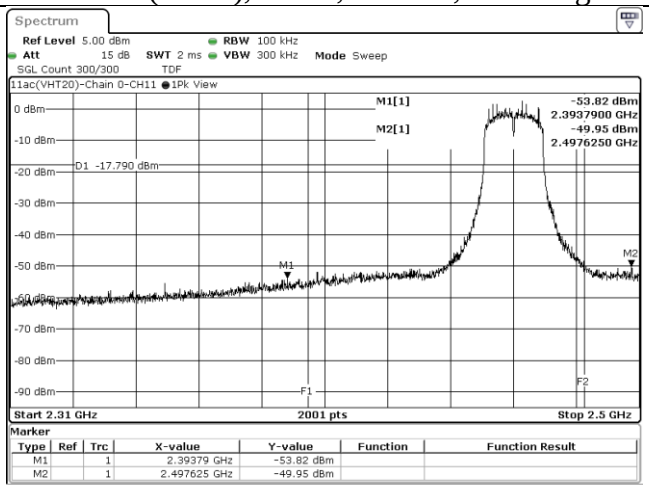
802.11n(HT20), CH11, Chain 0, Reference



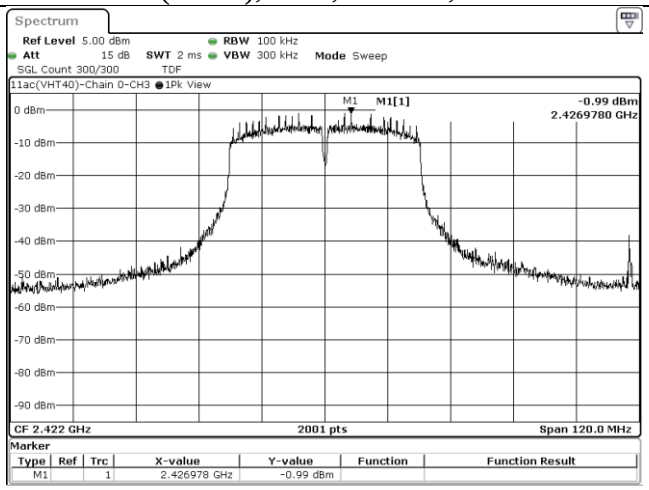
802.11n(HT20), CH11, Chain 0, Conducted Emission



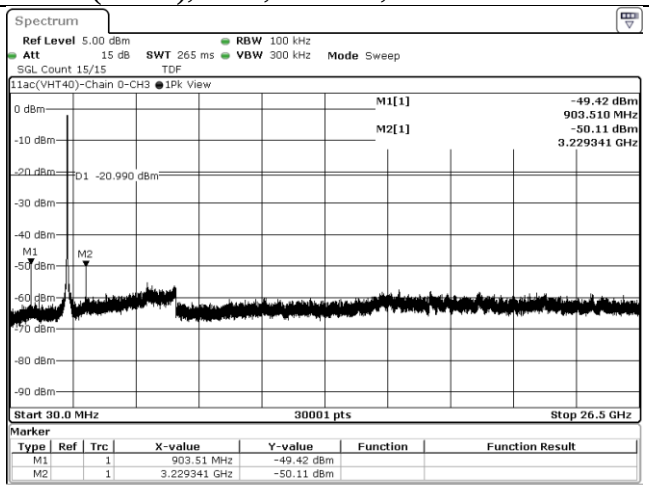
802.11n(HT20), CH11, Chain 0, Band edge



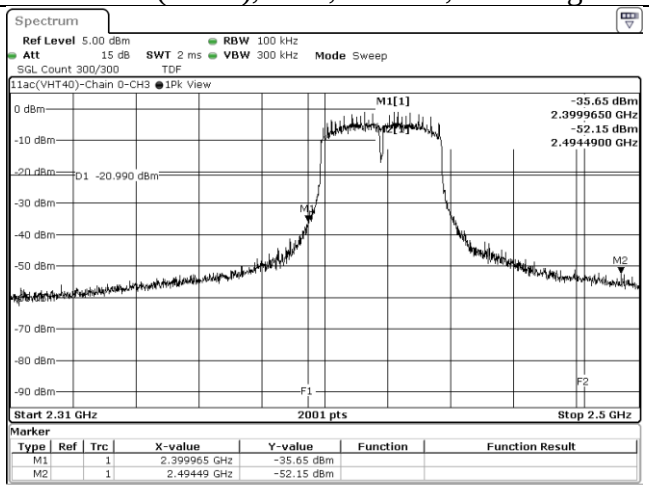
802.11n(HT40), CH3, Chain 0, Reference



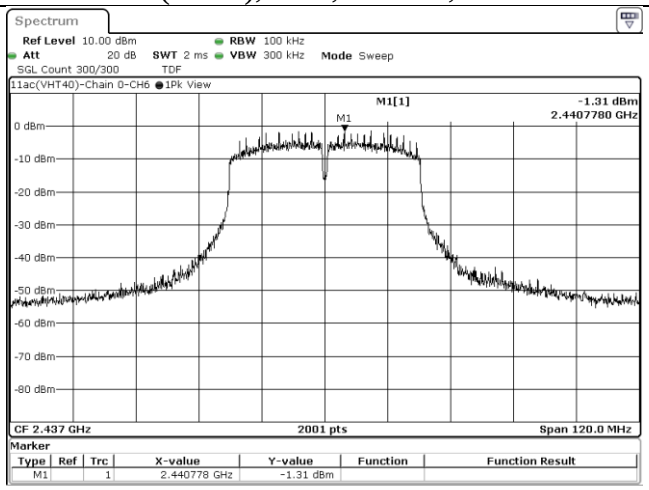
802.11n(HT40), CH3, Chain 0, Conducted Emission



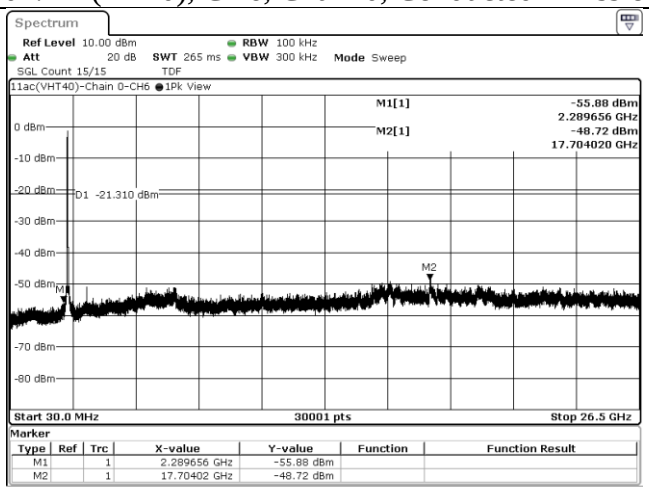
802.11n(HT40), CH3, Chain 0, Band edge



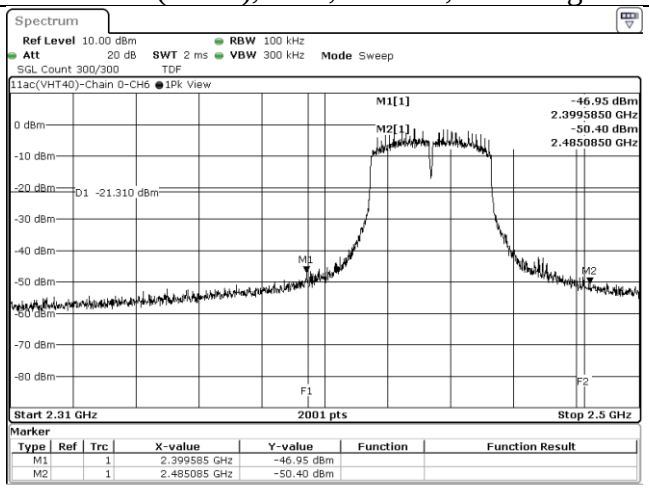
802.11n(HT40), CH6, Chain 0, Reference



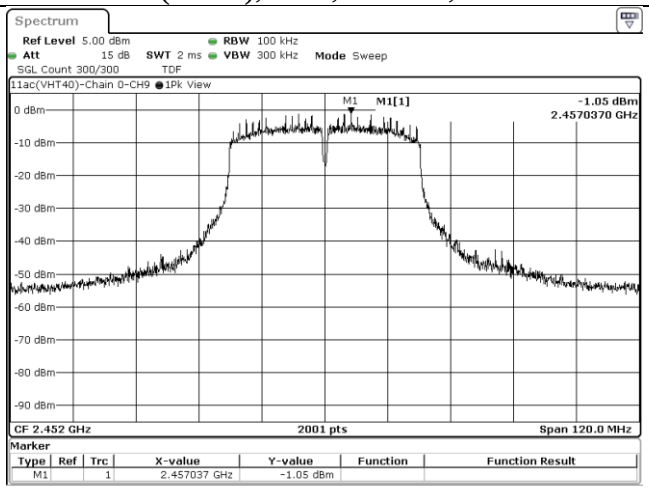
802.11n(HT40), CH6, Chain 0, Conducted Emission



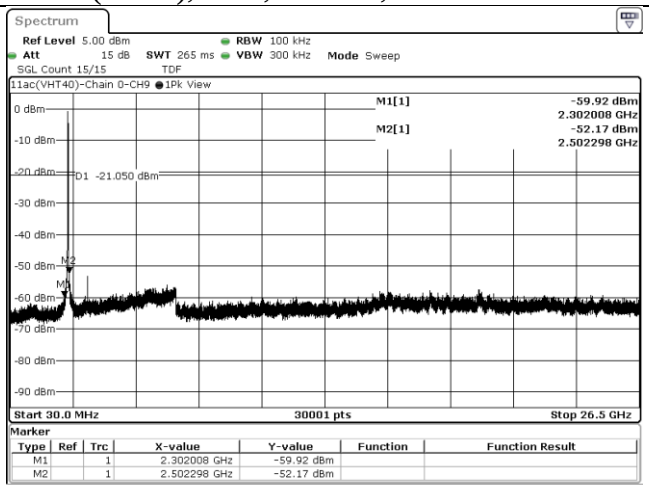
802.11n(HT40), CH6, Chain 0, Band edge



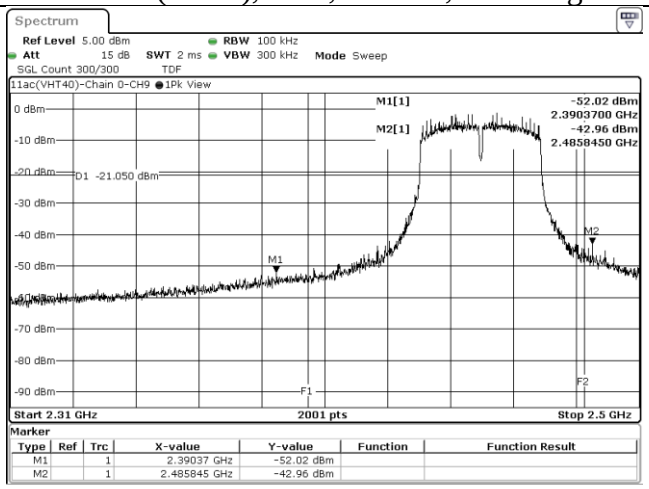
802.11n(HT40), CH9, Chain 0, Reference



802.11n(HT40), CH9, Chain 0, Conducted Emission



802.11n(HT40), CH9, Chain 0, Band edge



9.5. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequency(MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

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

Test Procedures

[For 9 kHz ~ 30 MHz]

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

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

[For above 30 MHz]

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

Note:

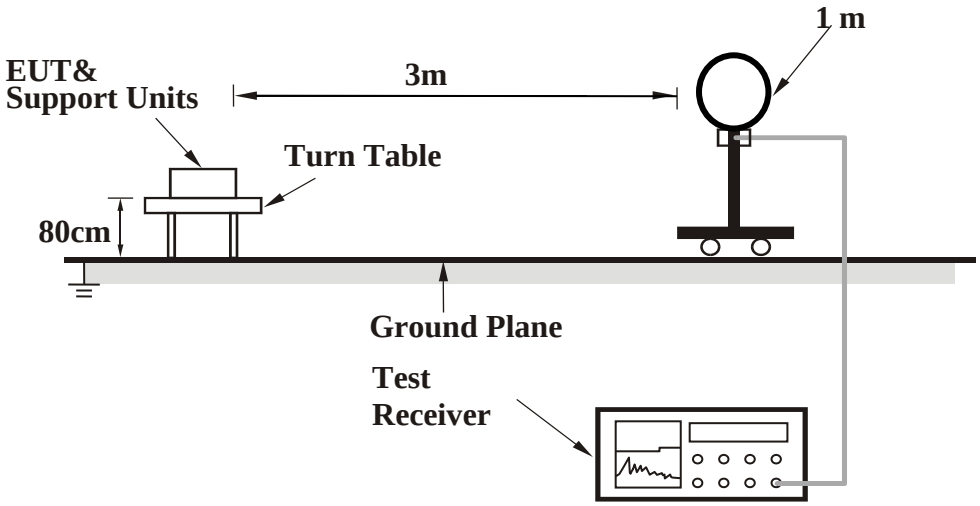
a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.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

Configuration	Average	
	RBW	VBW
802.11b	1MHz	Refer to section 6.6 for duty cycle.
802.11g		
802.11n (HT20)		
802.11n (HT40)		

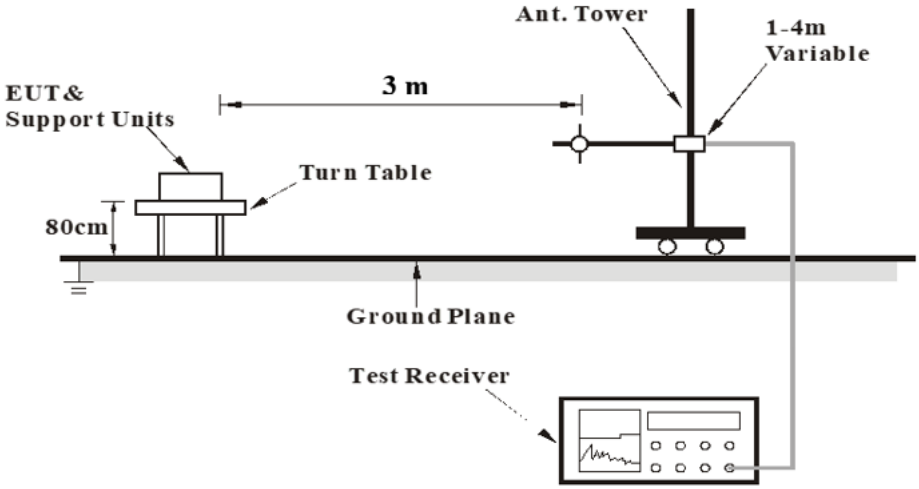
d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
f. Test data of Margin(dB) = Result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

Test Setup

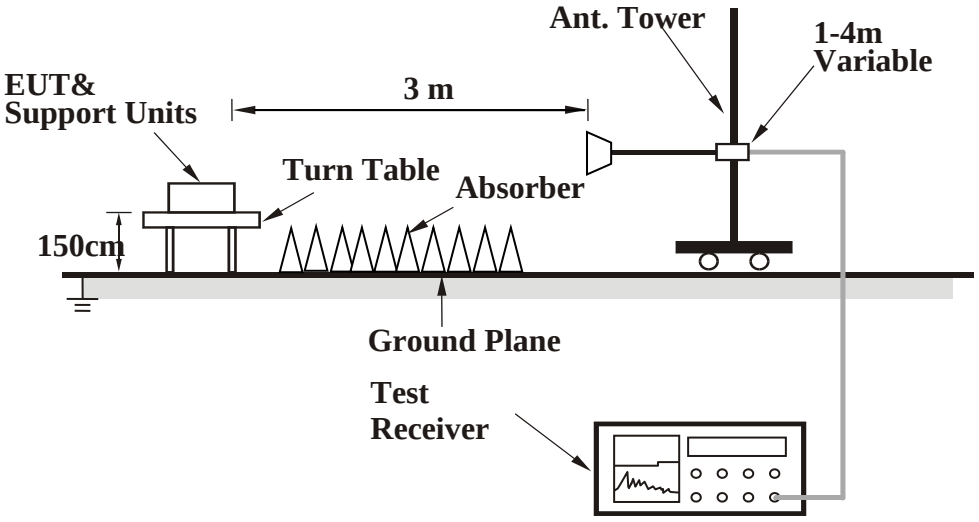
<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



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

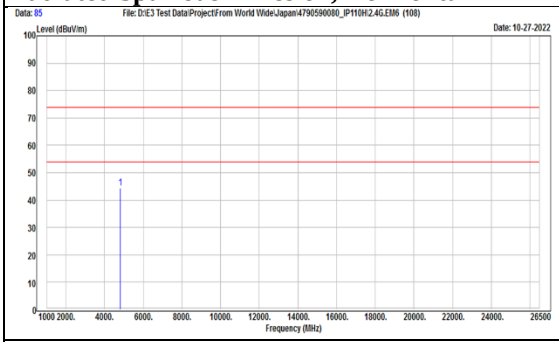
Test Data

Above 1 GHz

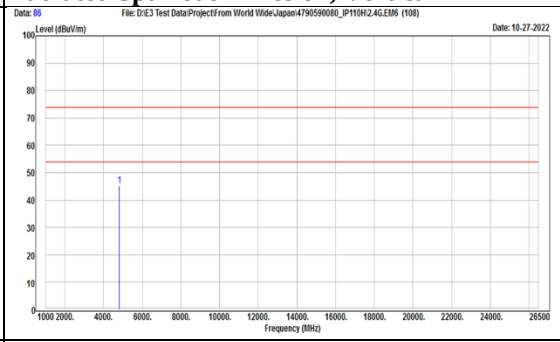
Mode	802.11b	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2359.4	41.18	15.88	57.06	74	-16.94	PK
		2376.69	30.37	15.84	46.21	54	-7.79	AVG
	@	2412	86.79	15.83	102.62	N/A	N/A	PK
	@	2412	83.16	15.83	98.99	N/A	N/A	AVG
	*	4824	42.14	2.35	44.49	74	-29.51	PK
Vertical		2358.26	43.17	15.89	59.06	74	-14.94	PK
		2382.96	30.75	15.83	46.58	54	-7.42	AVG
	@	2412	87.58	15.83	103.41	N/A	N/A	PK
	@	2412	83.83	15.83	99.66	N/A	N/A	AVG
	*	4824	42.75	2.35	45.1	74	-28.9	PK

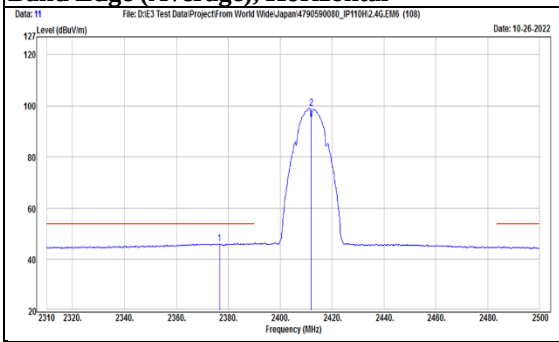
TX, 802.11b (Ch 1)
Radiated Spurious Emission, Horizontal



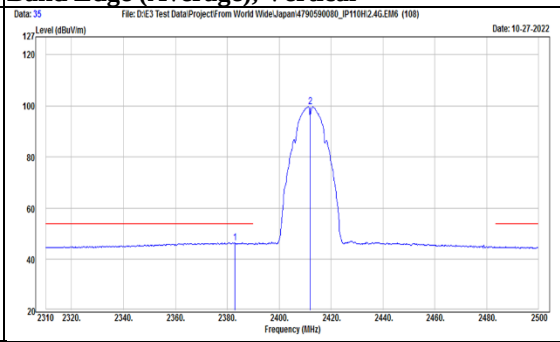
TX, 802.11b (Ch 1)
Radiated Spurious Emission, Vertical



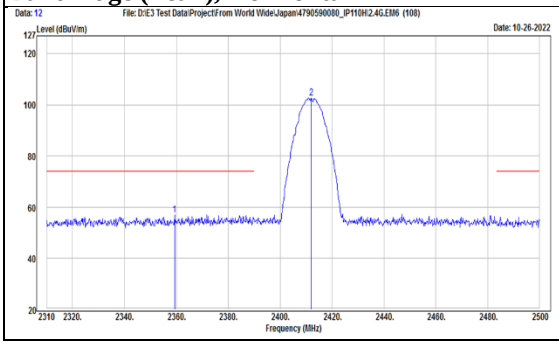
TX, 802.11b (Ch 1)
Band Edge (Average), Horizontal



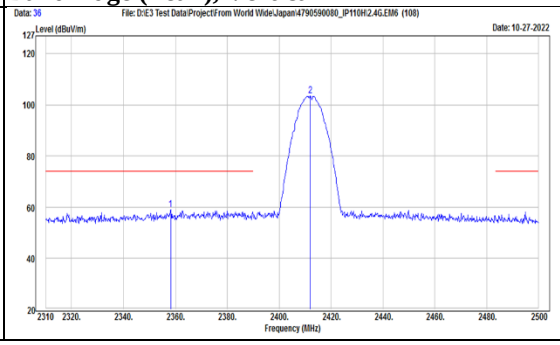
TX, 802.11b (Ch 1)
Band Edge (Average), Vertical



TX, 802.11b (Ch 1)
Band Edge (Peak), Horizontal



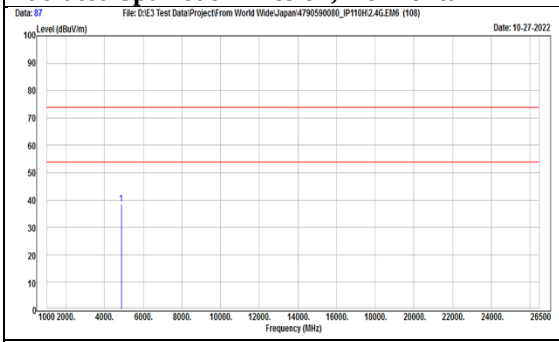
TX, 802.11b (Ch 1)
Band Edge (Peak), Vertical



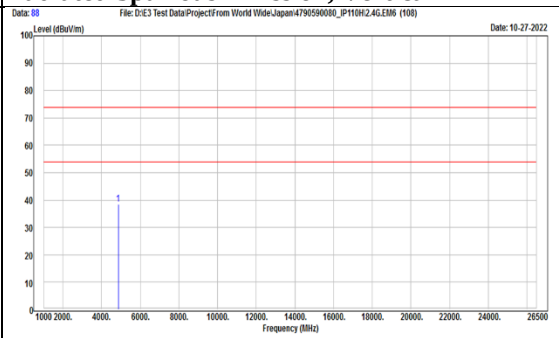
Mode	802.11b	Channel	6

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2379.16	41.2	15.84	57.04	74	-16.96	PK
		2389.99	29.95	15.82	45.77	54	-8.23	AVG
	@	2437	84.78	15.92	100.7	N/A	N/A	PK
	@	2437	81.17	15.92	97.09	N/A	N/A	AVG
		2484.04	29.49	15.68	45.17	54	-8.83	AVG
		2484.61	40.99	15.67	56.66	74	-17.34	PK
	*	4874	36.06	2.4	38.46	74	-35.54	PK
Vertical		2385.43	42.58	15.83	58.41	74	-15.59	PK
		2388.85	30.52	15.81	46.33	54	-7.67	AVG
	@	2437	86.86	15.92	102.78	N/A	N/A	PK
	@	2437	83.35	15.92	99.27	N/A	N/A	AVG
		2484.23	29.66	15.68	45.34	54	-8.66	AVG
		2500	40.34	15.55	55.89	74	-18.11	PK
	*	4874	36.06	2.4	38.46	74	-35.54	PK

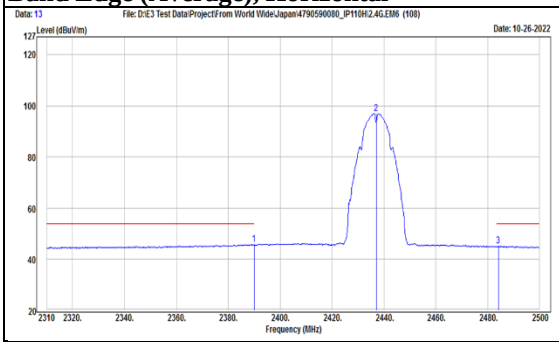
TX, 802.11b (Ch 6)
Radiated Spurious Emission, Horizontal



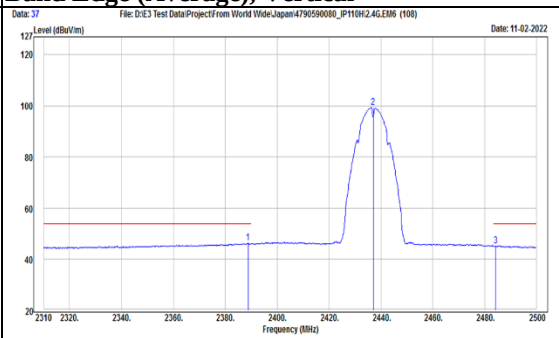
TX, 802.11b (Ch 6)
Radiated Spurious Emission, Vertical



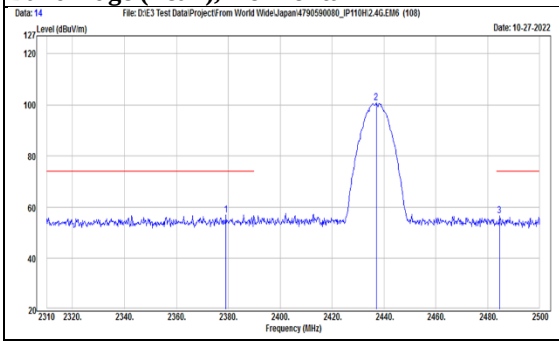
TX, 802.11b (Ch 6)
Band Edge (Average), Horizontal



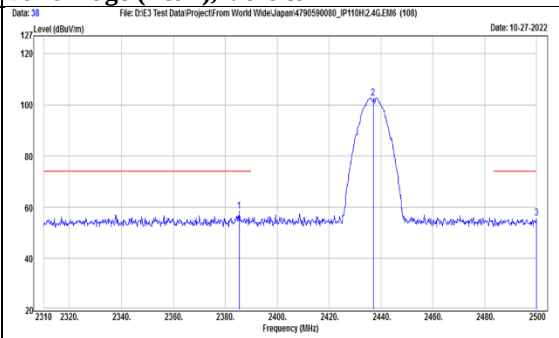
TX, 802.11b (Ch 6)
Band Edge (Average), Vertical



TX, 802.11b (Ch 6)
Band Edge (Peak), Horizontal

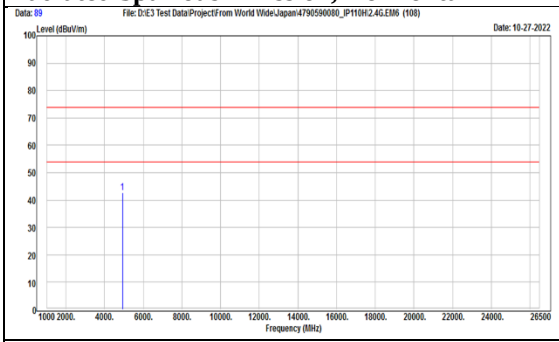
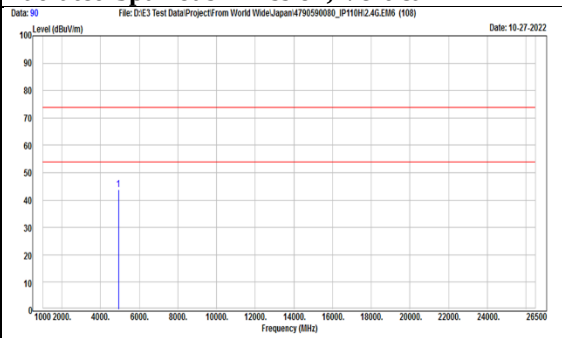
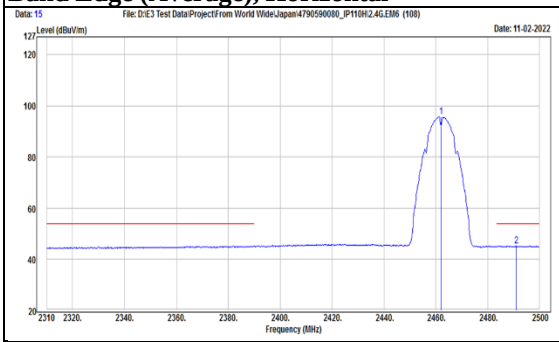
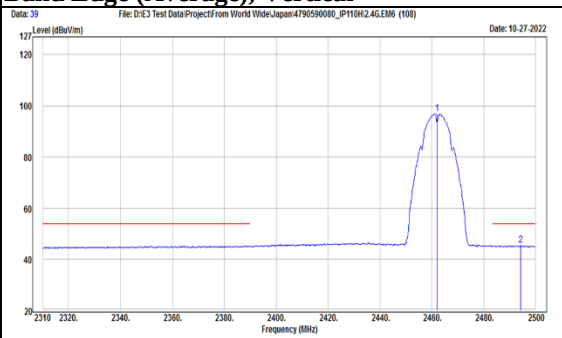
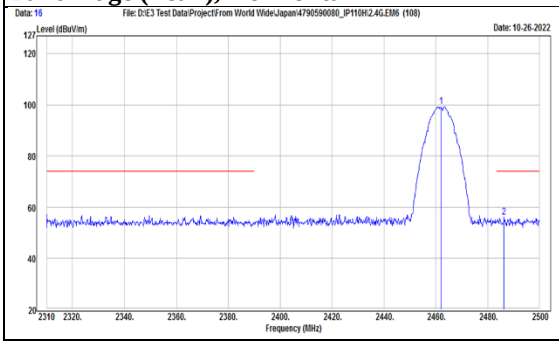
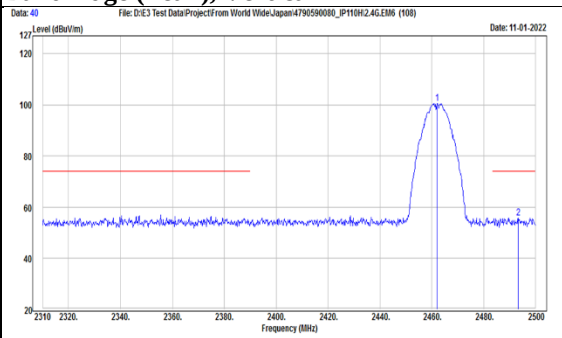


TX, 802.11b (Ch 6)
Band Edge (Peak), Vertical



Mode	802.11b	Channel	11

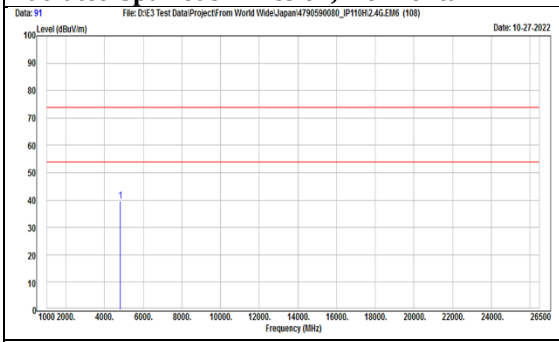
Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2462	83.37	15.87	99.24	N/A	N/A	PK
	@	2462	79.8	15.87	95.67	N/A	N/A	AVG
		2486.32	40.51	15.67	56.18	74	-17.82	PK
		2491.07	29.61	15.62	45.23	54	-8.77	AVG
	*	4924	40.25	2.4	42.65	74	-31.35	PK
Vertical	@	2462	84.71	15.87	100.58	N/A	N/A	PK
	@	2462	81.16	15.87	97.03	N/A	N/A	AVG
		2493.35	40.11	15.61	55.72	74	-18.28	PK
		2494.3	29.86	15.6	45.46	54	-8.54	AVG
	*	4924	41.28	2.4	43.68	74	-30.32	PK

TX, 802.11b (Ch 11) **Radiated Spurious Emission, Horizontal**	**TX, 802.11b (Ch 11)** **Radiated Spurious Emission, Vertical**
	
TX, 802.11b (Ch 11) **Band Edge (Average), Horizontal**	**TX, 802.11b (Ch 11)** **Band Edge (Average), Vertical**
	
TX, 802.11b (Ch 11) **Band Edge (Peak), Horizontal**	**TX, 802.11b (Ch 11)** **Band Edge (Peak), Vertical**
	

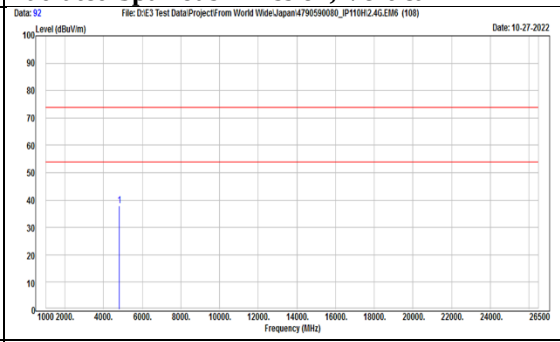
Mode	802.11g	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2363.58	41.37	15.88	57.25	74	-16.75	PK
		2378.59	30.47	15.85	46.32	54	-7.68	AVG
	@	2412	83.04	15.83	98.87	N/A	N/A	PK
	@	2412	74.1	15.83	89.93	N/A	N/A	AVG
	*	4824	37.3	2.35	39.65	74	-34.35	PK
Vertical		2361.68	41.54	15.88	57.42	74	-16.58	PK
		2378.97	30.82	15.84	46.66	54	-7.34	AVG
	@	2412	85.11	15.83	100.94	N/A	N/A	PK
	@	2412	77.04	15.83	92.87	N/A	N/A	AVG
	*	4824	35.65	2.35	38	74	-36	PK

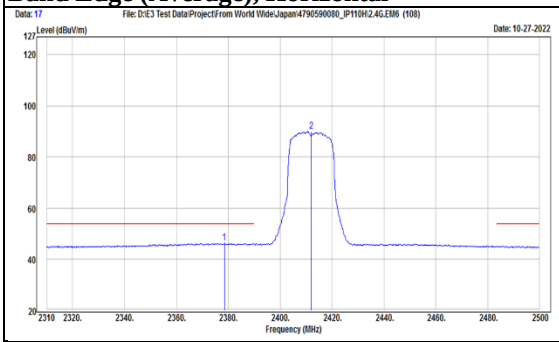
TX, 802.11g (Ch 1)
Radiated Spurious Emission, Horizontal



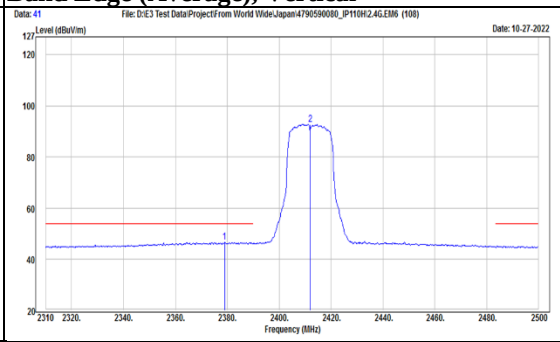
TX, 802.11g (Ch 1)
Radiated Spurious Emission, Vertical



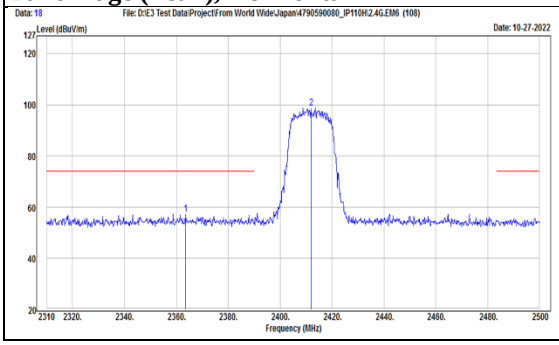
TX, 802.11g (Ch 1)
Band Edge (Average), Horizontal



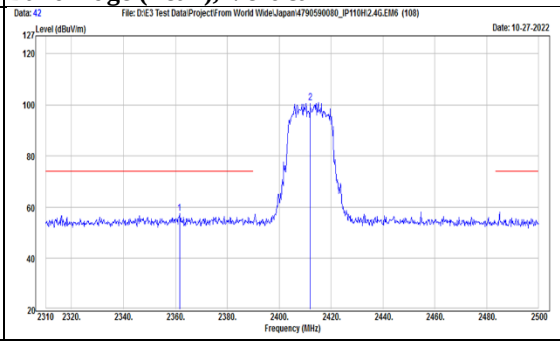
TX, 802.11g (Ch 1)
Band Edge (Average), Vertical



TX, 802.11g (Ch 1)
Band Edge (Peak), Horizontal



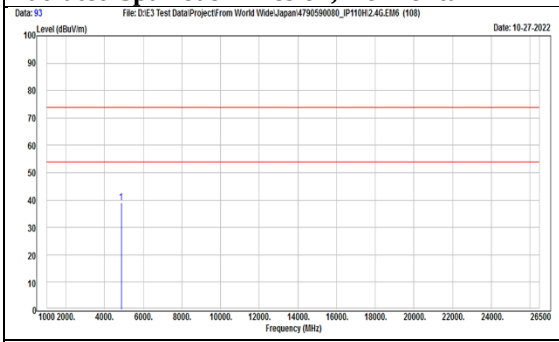
TX, 802.11g (Ch 1)
Band Edge (Peak), Vertical



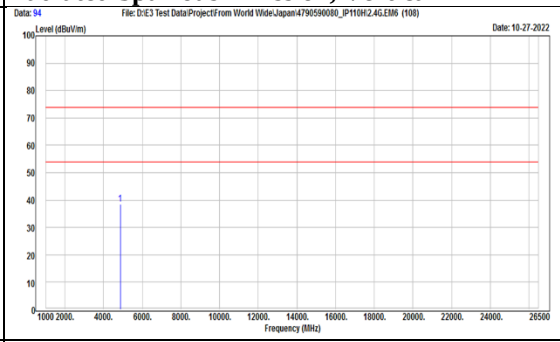
Mode	802.11g	Channel	6

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2383.91	29.92	15.83	45.75	54	-8.25	AVG
		2386.19	41.38	15.83	57.21	74	-16.79	PK
	@	2437	82.53	15.92	98.45	N/A	N/A	PK
	@	2437	73.15	15.92	89.07	N/A	N/A	AVG
		2484.99	29.72	15.67	45.39	54	-8.61	AVG
		2487.65	41.36	15.65	57.01	74	-16.99	PK
	*	4874	36.54	2.4	38.94	74	-35.06	PK
Vertical		2324.25	41.02	15.87	56.89	74	-17.11	PK
		2383.91	30.56	15.83	46.39	54	-7.61	AVG
	@	2437	85.31	15.92	101.23	N/A	N/A	PK
	@	2437	77.22	15.92	93.14	N/A	N/A	AVG
		2484.61	29.88	15.67	45.55	54	-8.45	AVG
		2486.13	41.59	15.67	57.26	74	-16.74	PK
	*	4874	35.96	2.4	38.36	74	-35.64	PK

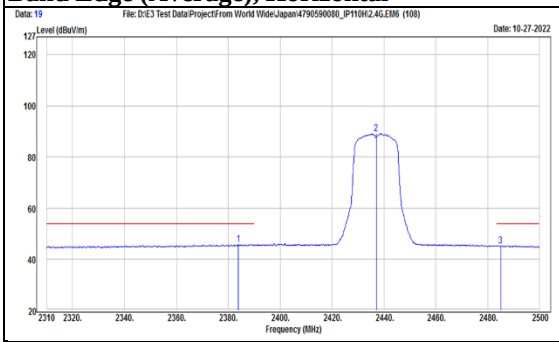
TX, 802.11g (Ch 6)
Radiated Spurious Emission, Horizontal



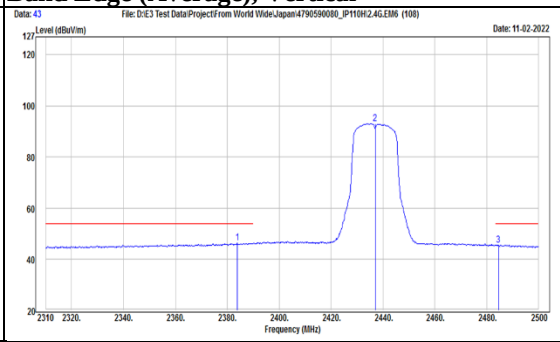
TX, 802.11g (Ch 6)
Radiated Spurious Emission, Vertical



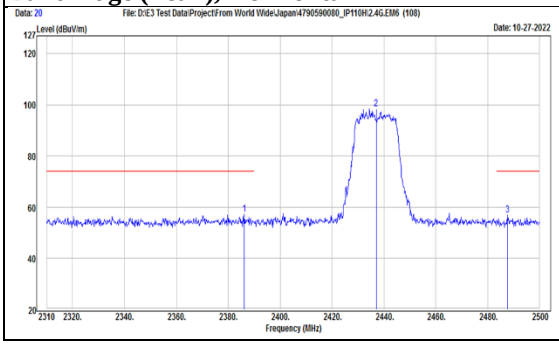
TX, 802.11g (Ch 6)
Band Edge (Average), Horizontal



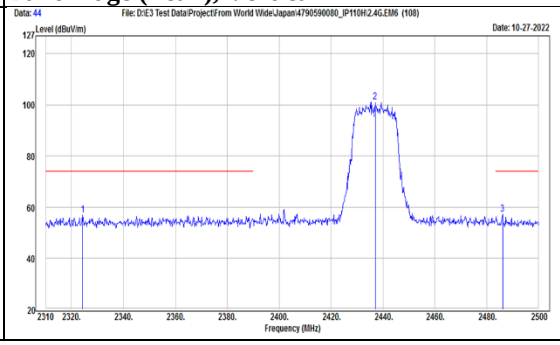
TX, 802.11g (Ch 6)
Band Edge (Average), Vertical



TX, 802.11g (Ch 6)
Band Edge (Peak), Horizontal

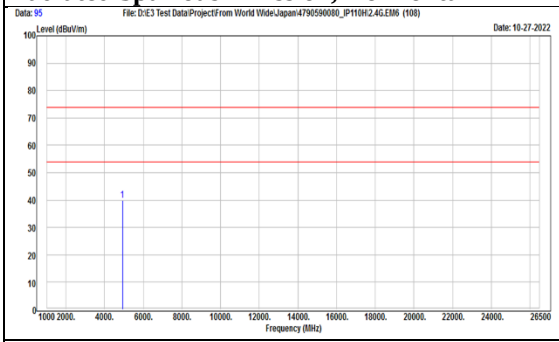
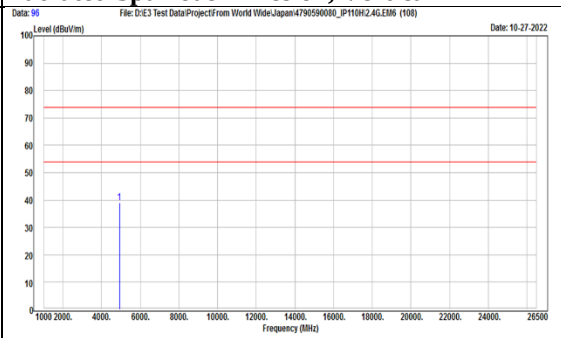
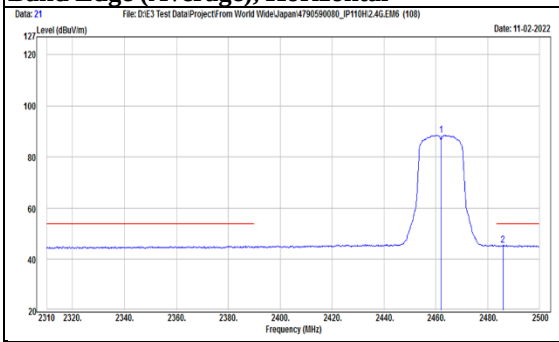
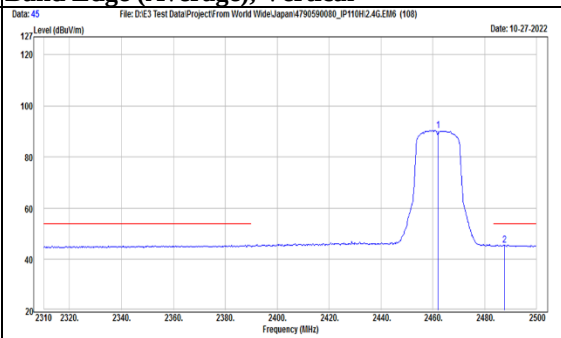
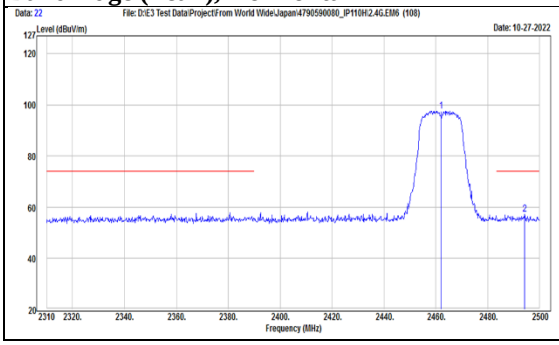
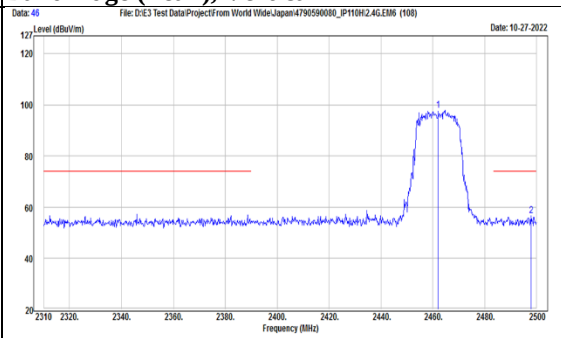


TX, 802.11g (Ch 6)
Band Edge (Peak), Vertical



Mode	802.11g	Channel	11

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2462	81.7	15.87	97.57	N/A	N/A	PK
	@	2462	72.67	15.87	88.54	N/A	N/A	AVG
		2485.94	29.92	15.67	45.59	54	-8.41	AVG
		2494.3	41.65	15.6	57.25	74	-16.75	PK
	*	4924	37.47	2.4	39.87	74	-34.13	PK
Vertical	@	2462	81.83	15.87	97.7	N/A	N/A	PK
	@	2462	74.51	15.87	90.38	N/A	N/A	AVG
		2487.65	29.96	15.65	45.61	54	-8.39	AVG
		2497.91	40.95	15.57	56.52	74	-17.48	PK
	*	4924	36.65	2.4	39.05	74	-34.95	PK

TX, 802.11g (Ch 11) **Radiated Spurious Emission, Horizontal**	**TX, 802.11g (Ch 11)** **Radiated Spurious Emission, Vertical**
	
TX, 802.11g (Ch 11) **Band Edge (Average), Horizontal**	**TX, 802.11g (Ch 11)** **Band Edge (Average), Vertical**
	
TX, 802.11g (Ch 11) **Band Edge (Peak), Horizontal**	**TX, 802.11g (Ch 11)** **Band Edge (Peak), Vertical**
	

Mode	802.11n(HT20)	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2374.22	30.58	15.85	46.43	54	-7.57	AVG
		2377.45	41.77	15.84	57.61	74	-16.39	PK
	@	2412	85.59	15.83	101.42	N/A	N/A	PK
	@	2412	76.41	15.83	92.24	N/A	N/A	AVG
	*	4824	37.43	2.35	39.78	74	-34.22	PK
Vertical		2319.5	41.29	15.86	57.15	74	-16.85	PK
		2389.99	31.15	15.82	46.97	54	-7.03	AVG
	@	2412	88.36	15.83	104.19	N/A	N/A	PK
	@	2412	79.64	15.83	95.47	N/A	N/A	AVG
	*	4824	37.29	2.35	39.64	74	-34.36	PK