RADIO TEST REPORT

Product	:	HD Wireless Sender & Receiver
Model Name	:	WTR-5500
FCC ID	:	BY4WTR5500
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date	:	2023/7/13
Test Date	:	2023/7/24 ~ 2023/8/1
Issued Date	:	2023/10/24
Applicant	:	Trans Electric Co., Ltd 771 Sec.2 Chungsan Rd, Huatang, Changhua, Taiwan
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building A, B and 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.: 4791012519-US-R0-V0

Revision	Test report No.	Date	Page revised	Contents
Original	4791012519-US-R0-V0	2023/10/24	-	Initial issue

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1. Attestation of Test Results

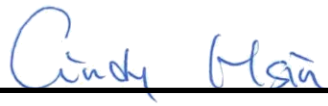
APPLICANT:	Trans Electric Co., Ltd 771 Sec.2 Chungsan Rd, Huatang, Changhua, Taiwan
MANUFACTURER:	Trans Electric Co., Ltd 771 Sec.2 Chungsan Rd, Huatang, Changhua, Taiwan
EUT DESCRIPTION:	HD Wireless Sender & Receiver
BRAND:	PX
MODEL:	WTR-5500
SAMPLE STAGE:	Engineering Verification Test sample
DATE of TESTED:	2023/7/24 ~ 2023/8/1

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 : 2023/10/24
Project Handler

Approved and Authorized By:

Eric Lee Date : 2023/10/24
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 A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

5. Measurement Uncertainty

For statement of conformity, simple acceptance (Section 4.3.4 of ISO Guide 115) was applied as decision rule for measurement in this test report.

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

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

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

6. Equipment under Test

6.1. Description of EUT

Product	HD Wireless Sender & Receiver
Brand Name	PX
Model Name	WTR-5500
Operating Frequency	2412MHz ~ 2462MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK
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: 21.48 dBm 802.11g: 25.57 dBm 802.11n (HT20): 25.76 dBm 802.11n (HT40): 24.55 dBm
Normal Voltage	5Vdc from adapter 5Vdc from host
Sample ID	Conducted Test: 6261654 Radiated Test: 6261652

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
USB cable	PX	F1546-02G	Length: 1 m
Adapter	AMIGO	AMS195-0502000FU	Input: 100-240Vac ~ 50/60Hz 0.5A Output: 5Vdc 2.0A
USB C to HDMI dongle	PX	B1183G	-

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

6.2. Channel List

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	22~24°C/ 60~66%RH	5Vdc	2023/07/26~ 2023/07/31	WaterNil Guan
Radiated Spurious Emission	966-2	22~24°C/ 59~68%RH	5Vdc	2023/07/24~ 2023/08/01	WaterNil Guan
AC power Line Conducted Emission	SR1	24~24°C/ 67~67%RH	110Vac/ 60Hz	2023/08/01~ 2023/08/01	WaterNil Guan

FCC Test Firm Registration Number: 498077

Sample Calculation:

Antenna Port Conducted Measurement:

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

Radiated Spurious Emission:

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

AC power Line Conducted Emission:

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

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)
1	Chain (0)	Redbirdtek	RBT-ANT-524-03-A002	Metal type antenna	0.56

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

6.5. Test Mode Applicability and Tested Channel Detail

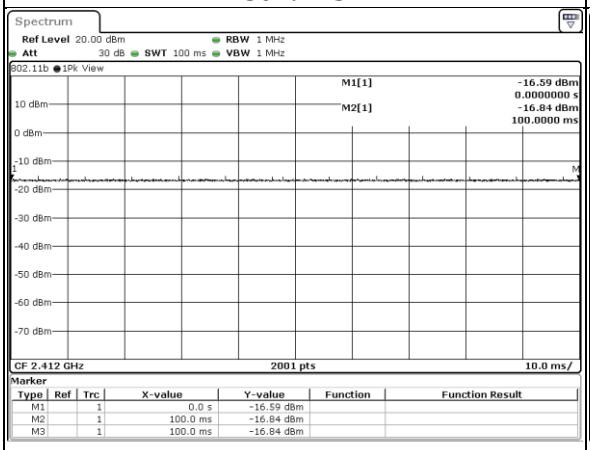
- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that Y-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in Y-Z plane.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, 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	DSSS	DBPSK	1 to 11	6	MCS0
AC Power Line Conducted Emission	802.11n20	DSSS	DBPSK	1 to 11	6	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

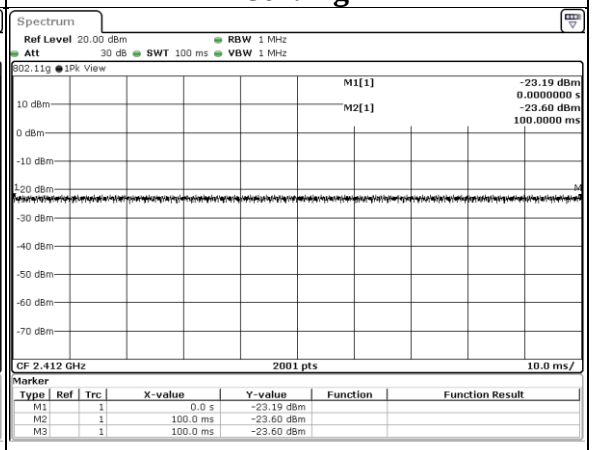
6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
802.11b	100.000	100.000	1.0000	N/A	10Hz
802.11g	100.000	100.000	1.0000	N/A	10Hz
802.11n(HT20)	100.000	100.000	1.0000	N/A	10Hz
802.11n(HT40)	100.000	100.000	1.0000	N/A	10Hz

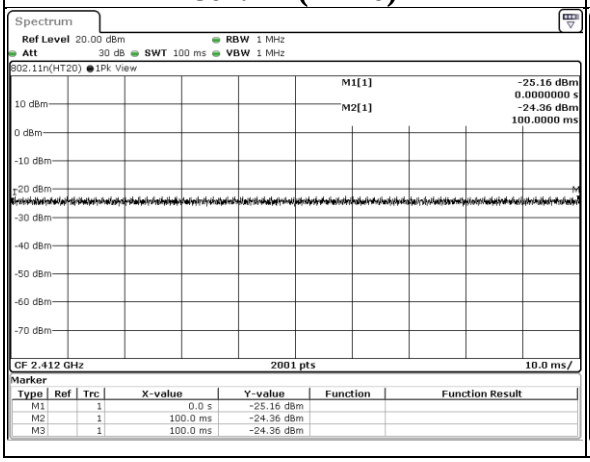
802.11b



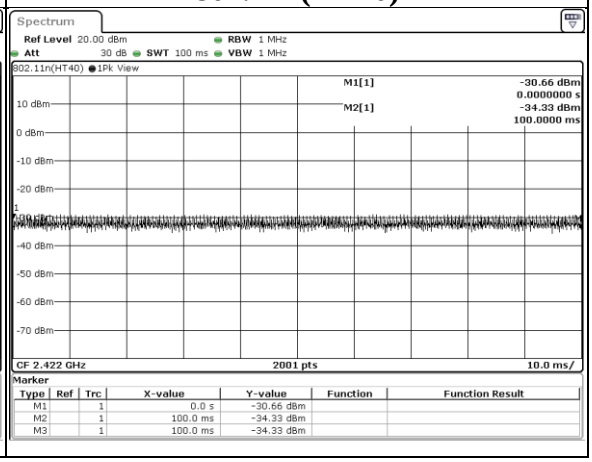
802.11g



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	2023/4/7	2024/4/6
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2022/12/13	2023/12/12
Loop Antenna	ETS lindgren	6502	00213440	2023/1/4	2024/1/3
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2023/2/13	2024/2/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2022/12/21	2023/12/20
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2022/12/30	2023/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2023/6/7	2024/6/6
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2023/2/17	2024/2/16
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2023/5/9	2024/5/8
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2022/12/1	2023/11/30
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2022/12/1	2023/11/30

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

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

8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Adapter	AMIGO	AMS195-0502000FU	N/A	Provided by Client
B	Laptop	DELL	Latitude E6430	2MMN3X1	Provided by LAB
C	female HDMI to female HDMI adapter	Benevo	BHDMICPLR	N/A	Provided by LAB

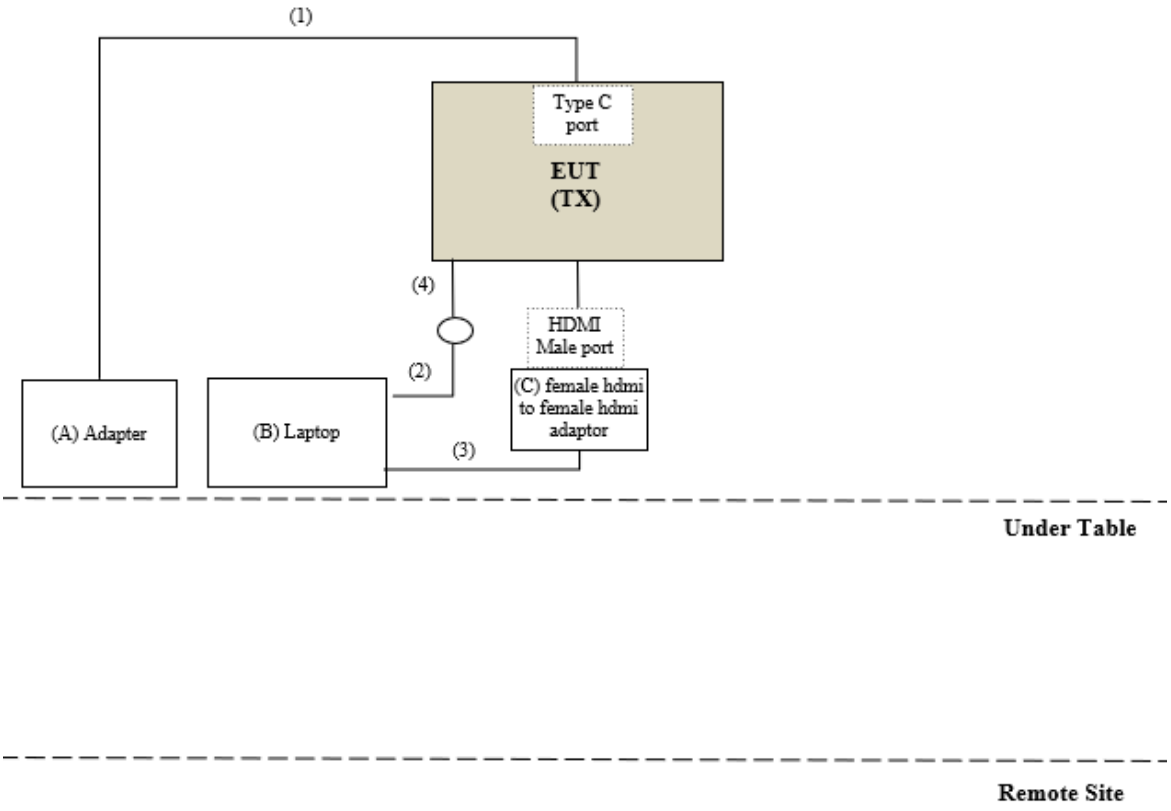
I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	USB cable	PX	F1546-02G	1	Provided by Client
2	USB Standard Type A Male to Female Cable	I - wiz	US-44	1	Provided by LAB
3	HDMI Cable	PX	HM2-AA120	2	Provided by Client
4	USB RF Console Cable	PX	USB A to B 4 core	0.08	Provided by Client

Test Setup

Controlled using a bespoke application (Realtek 11ac 8821C USB WLAN MP Diagnostic Program 0.0003.07.20190211) 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

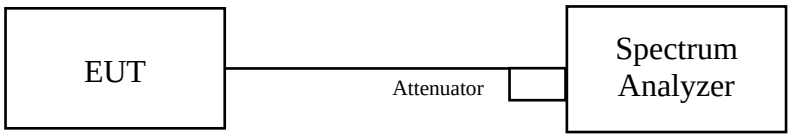
Requirements

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

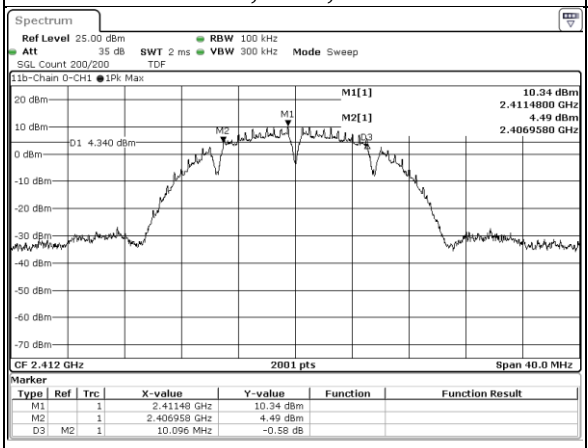


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

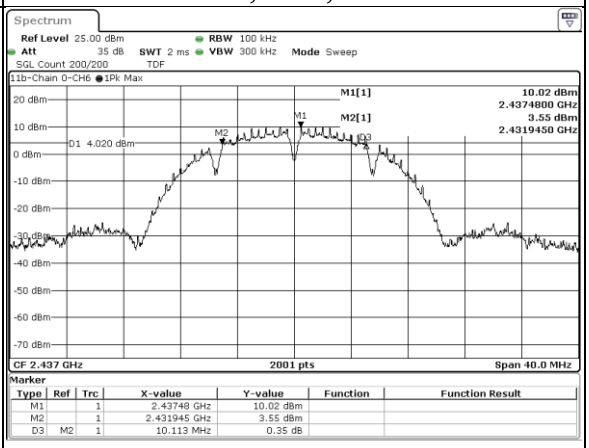
Test Data

Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11b	1	2412	10.096	0.5	PASS
	6	2437	10.113	0.5	PASS
	11	2462	10.089	0.5	PASS

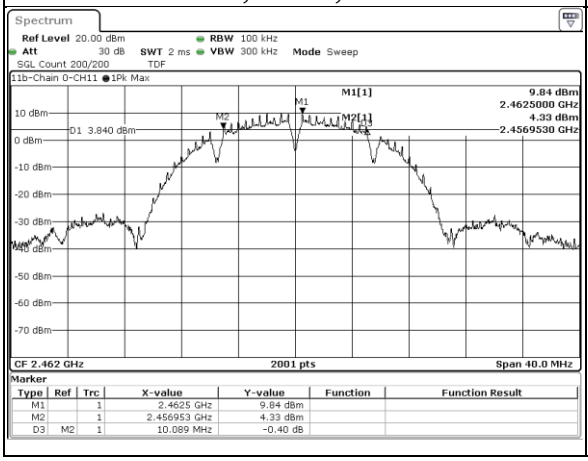
802.11b, CH1, Chain 0



802.11b, CH6, Chain 0

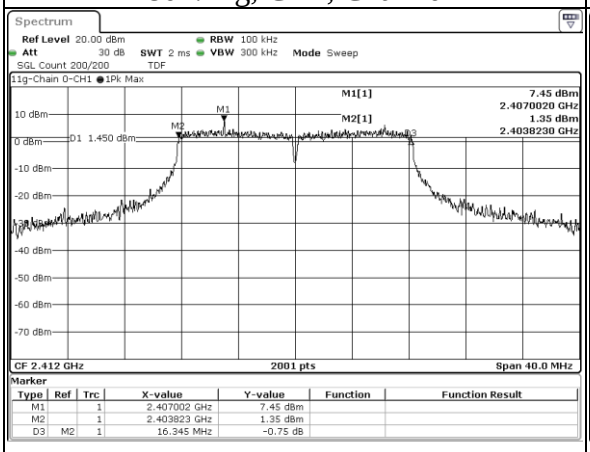


802.11b, CH11, Chain 0

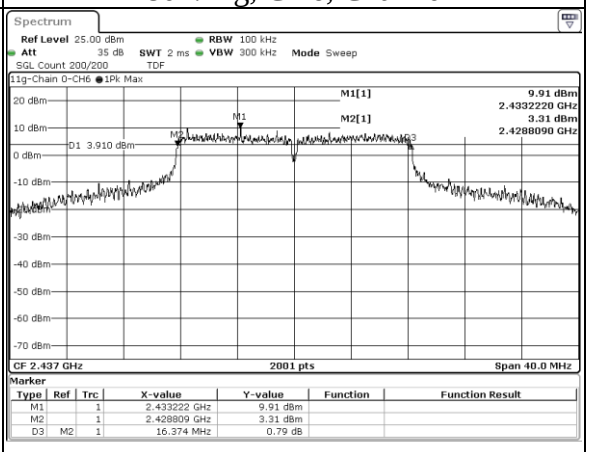


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11g	1	2412	16.345	0.5	PASS
	6	2437	16.374	0.5	PASS
	11	2462	16.408	0.5	PASS

802.11g, CH1, Chain 0



802.11g, CH6, Chain 0



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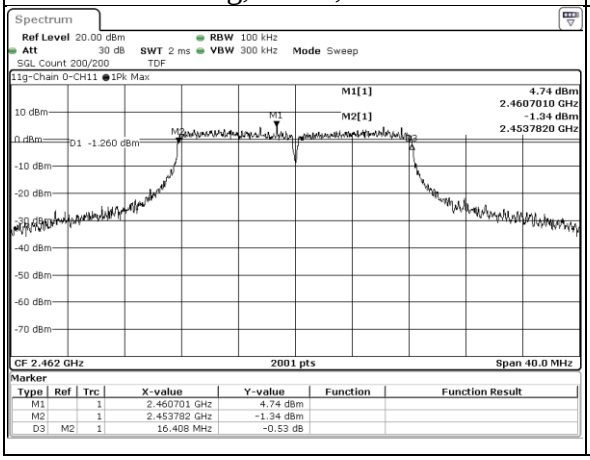
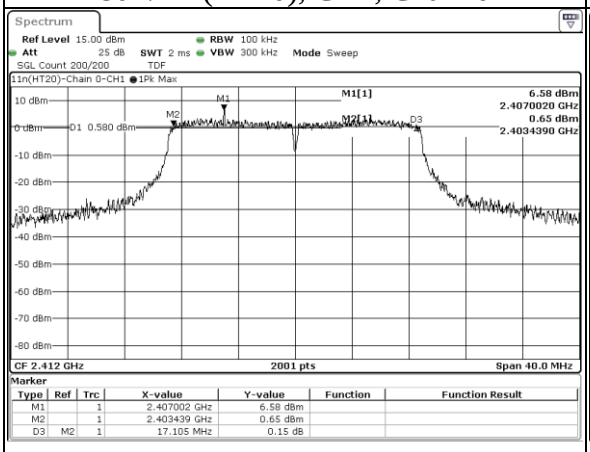
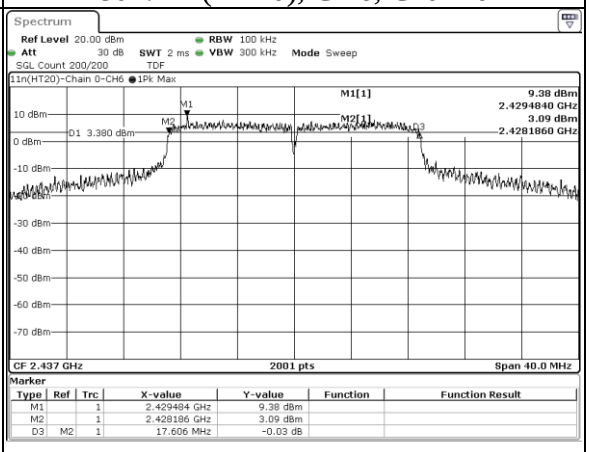


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11n(HT20)	1	2412	17.105	0.5	PASS
	6	2437	17.606	0.5	PASS
	11	2462	17.310	0.5	PASS

802.11n(HT20), CH1, Chain 0



802.11n(HT20), CH6, Chain 0



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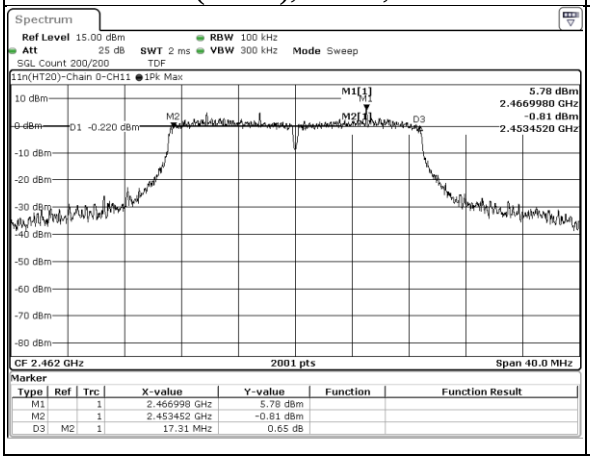
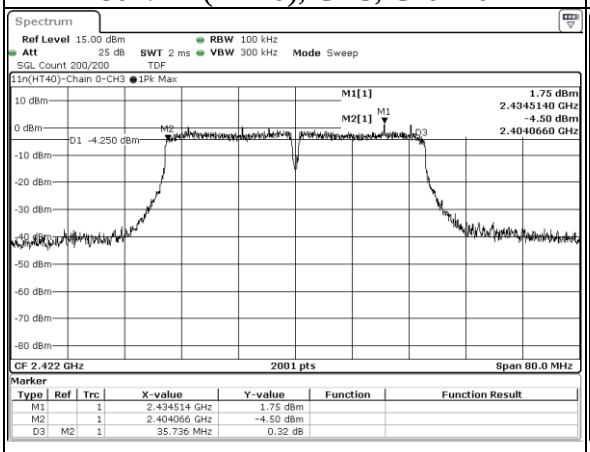
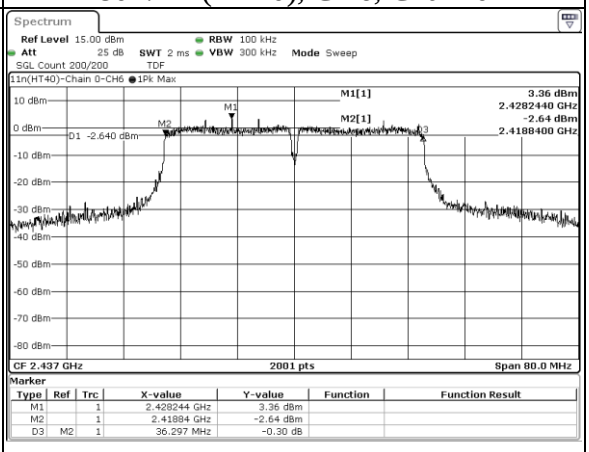


Mode	CH	Freq (MHz)	6dB BW (MHz) Chain 0	Limit (MHz)	Result
802.11n(HT40)	3	2422	35.736	0.5	PASS
	6	2437	36.297	0.5	PASS
	9	2452	35.732	0.5	PASS

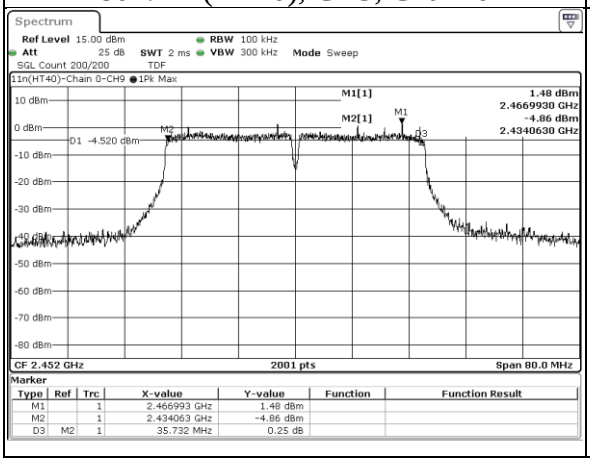
802.11n(HT40), CH3, Chain 0



802.11n(HT40), CH6, Chain 0



802.11n(HT40), CH9, Chain 0



9.2. Conducted Output Power

Requirements

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

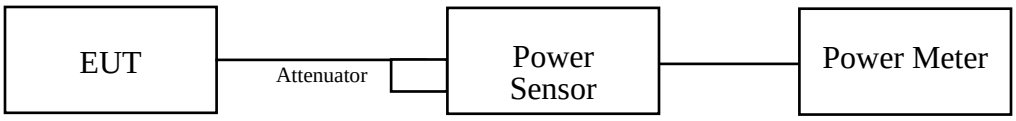
Note:
1. P_{Out} = maximum conducted output power in dBm, G_{TX} = the maximum transmitting antenna directional gain in dBi, B is the 26 dB emission bandwidth in megahertz

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.

a. Set the RBW ≥ DTS bandwidth.
b. Set VBW ≥ 3 × RBW.
c. Set span ≥ 3 x RBW.
d. Sweep time = auto couple.
e. Detector = peak.
f. Trace mode = max hold.
g. Allow trace to fully stabilize.
h. Use peak marker function to determine the peak amplitude 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	140.605	21.48	30	PASS
6	2437	135.519	21.32	30	PASS
11	2462	112.72	20.52	30	PASS

802.11g

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	286.418	24.57	30	PASS
6	2437	360.579	25.57	30	PASS
11	2462	228.56	23.59	30	PASS

802.11n (HT20)

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	265.461	24.24	30	PASS
6	2437	376.704	25.76	30	PASS
11	2462	210.863	23.24	30	PASS

802.11n (HT40)

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
3	2422	233.346	23.68	30	PASS
6	2437	285.102	24.55	30	PASS
9	2452	212.324	23.27	30	PASS

Average Power (Reference Only)

802.11b

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	79.616	19.01
6	2437	83.753	19.23
11	2462	70.958	18.51

802.11g

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	47.534	16.77
6	2437	140.281	21.47
11	2462	36.898	15.67

802.11n (HT20)

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2412	38.548	15.86
6	2437	144.212	21.59
11	2462	29.648	14.72

802.11n (HT40)

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
3	2422	25.586	14.08
6	2437	41.976	16.23
9	2452	23.442	13.70

9.3. Power Spectral Density

Requirements

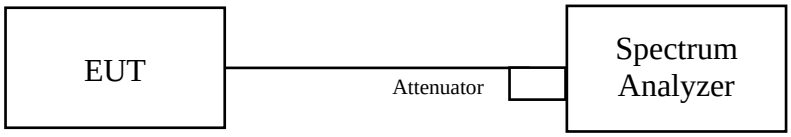
The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz (If G_{TX} > 6 dBi, then PSD = 8 – (G_{TX} – 6)).

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.

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



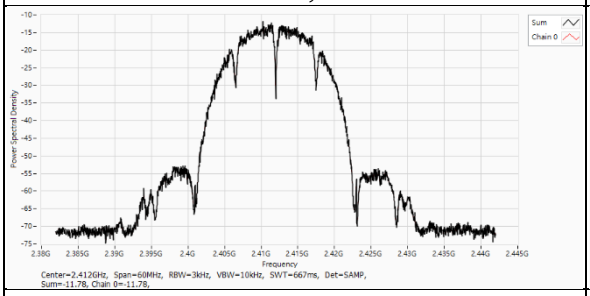
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

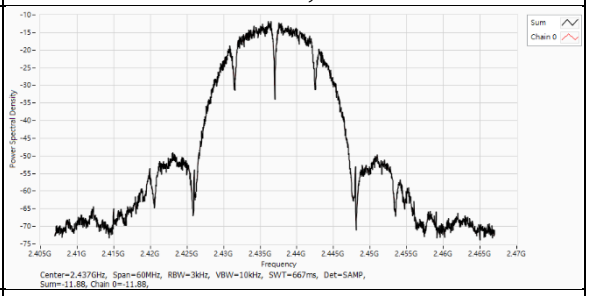
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11b	1	2412	-11.78	8	0.56	PASS
	6	2437	-11.88	8	0.56	PASS
	11	2462	-12.26	8	0.56	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)
			Chain 0
802.11b	1	2412	-11.777
	6	2437	-11.877
	11	2462	-12.257

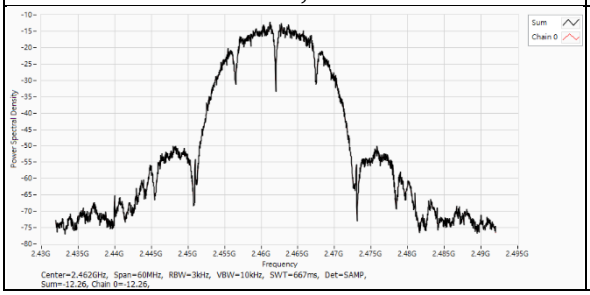
802.11b, CH1



802.11b, CH6



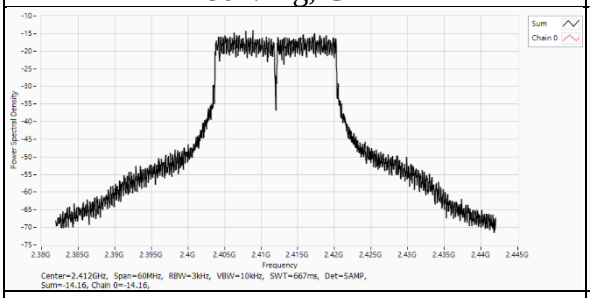
802.11b, CH11



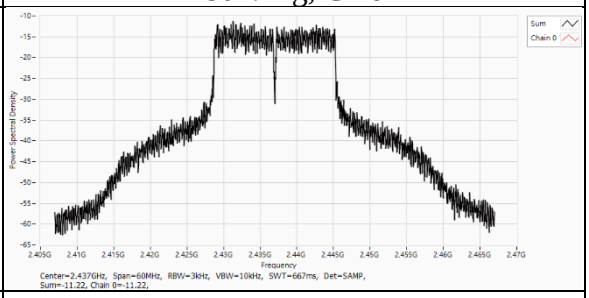
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11g	1	2412	-14.16	8	0.56	PASS
	6	2437	-11.22	8	0.56	PASS
	11	2462	-14.96	8	0.56	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)
			Chain 0
802.11g	1	2412	-14.16
	6	2437	-11.217
	11	2462	-14.963

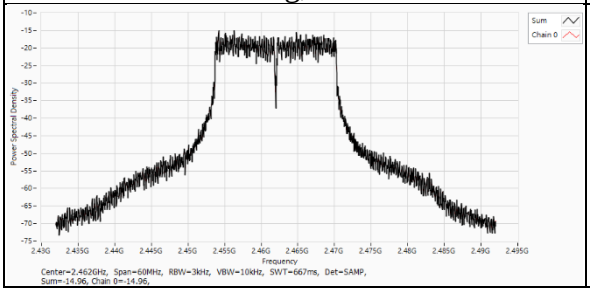
802.11g, CH1



802.11g, CH6



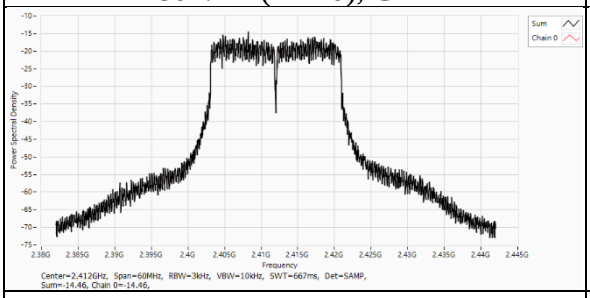
802.11g, CH11



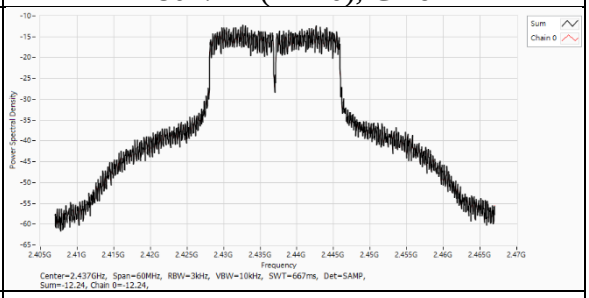
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11n(HT20)	1	2412	-14.46	8	0.56	PASS
	6	2437	-12.24	8	0.56	PASS
	11	2462	-16.29	8	0.56	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)
			Chain 0
802.11n(HT20)	1	2412	-14.458
	6	2437	-12.236
	11	2462	-16.286

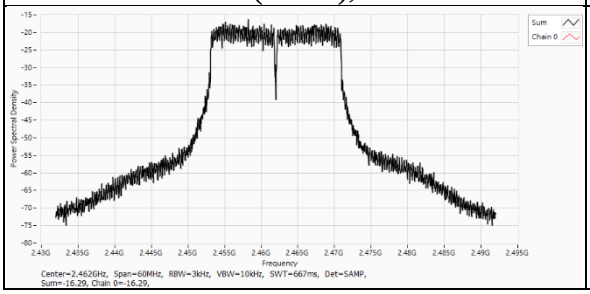
802.11n(HT20), CH1



802.11n(HT20), CH6



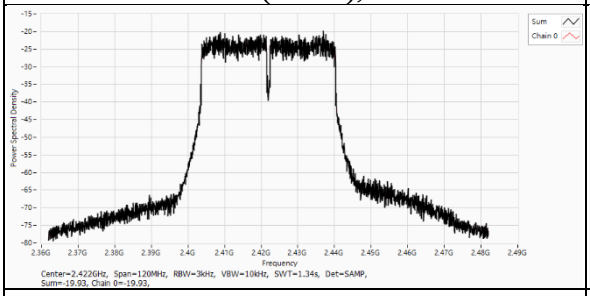
802.11n(HT20), CH11



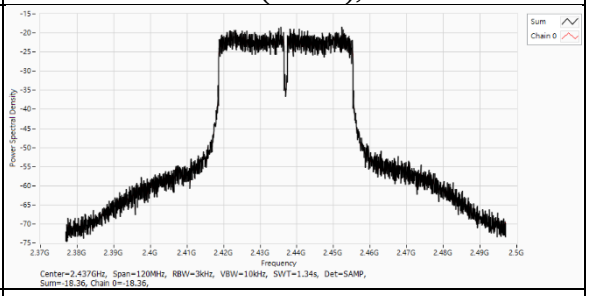
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11n(HT40)	3	2422	-19.93	8	0.56	PASS
	6	2437	-18.36	8	0.56	PASS
	9	2452	-19.89	8	0.56	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)
			Chain 0
802.11n(HT40)	3	2422	-19.933
	6	2437	-18.358
	9	2452	-19.89

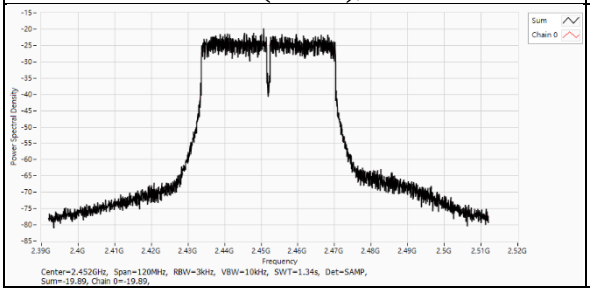
802.11n(HT40), CH3



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

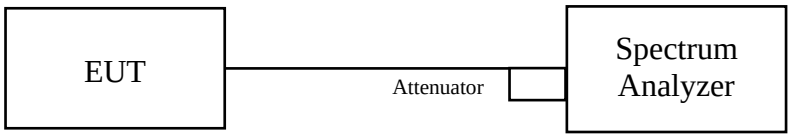
Measurement Procedure REF

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.

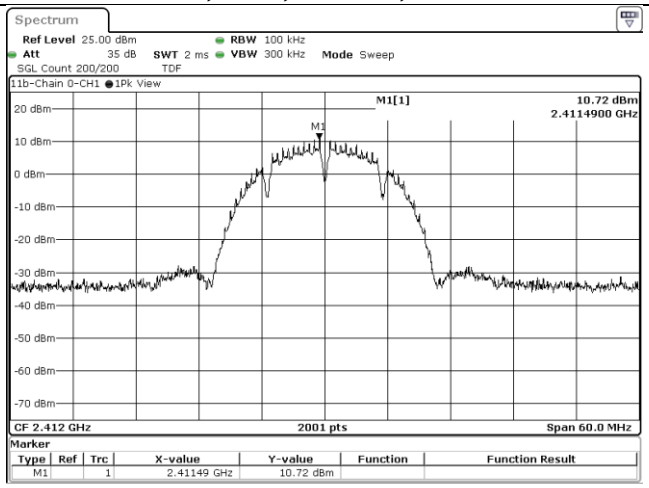
Test Setup



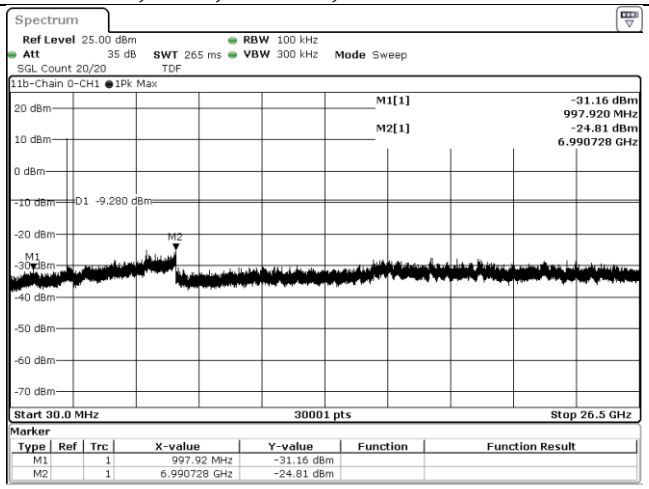
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

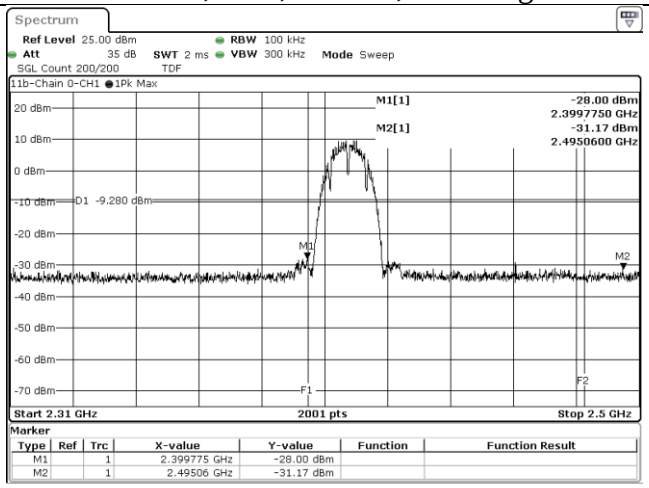
802.11b, CH1, Chain 0, Reference



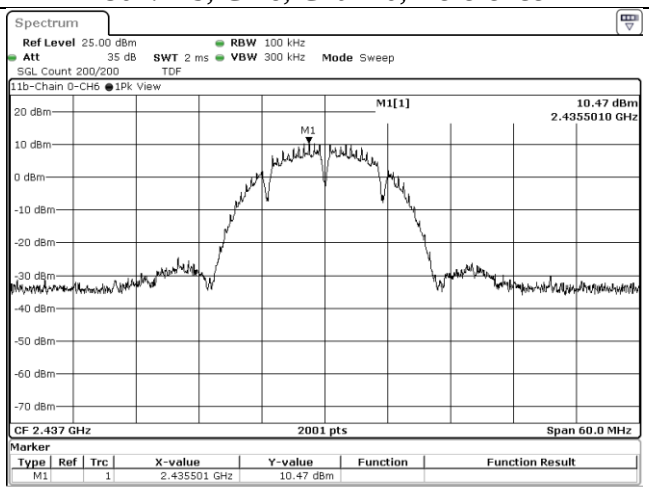
802.11b, CH1, Chain 0, Conducted Emission



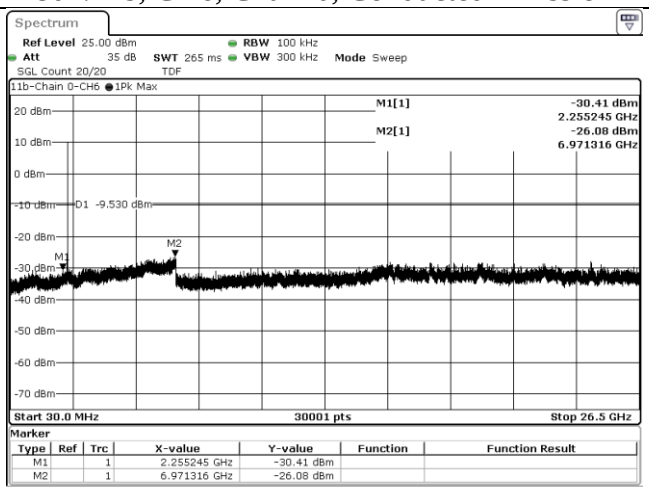
802.11b, CH1, Chain 0, Band edge



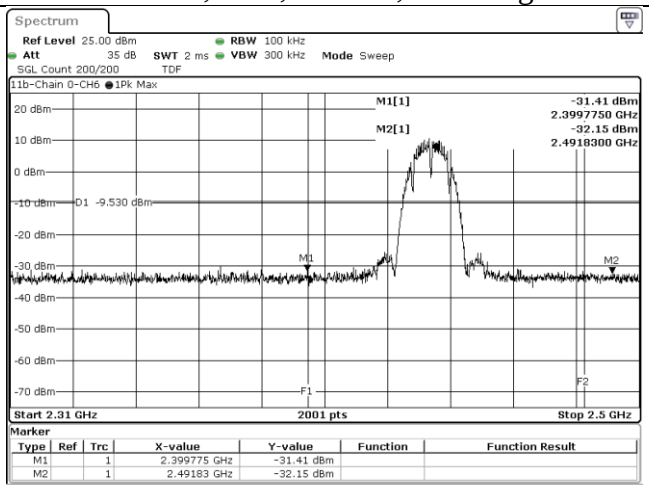
802.11b, CH6, Chain 0, Reference



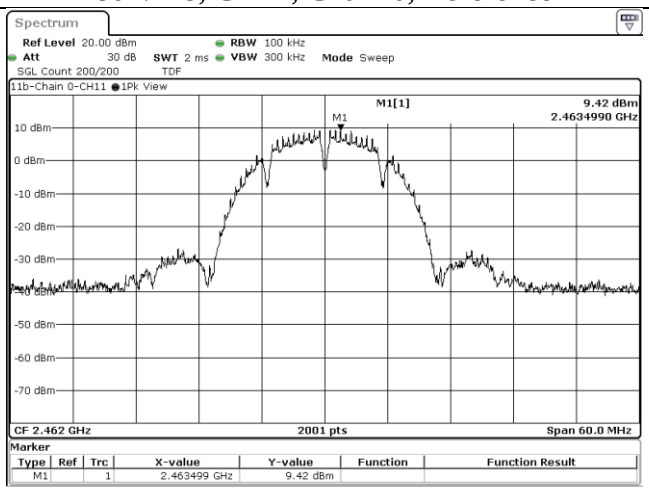
802.11b, CH6, Chain 0, Conducted Emission



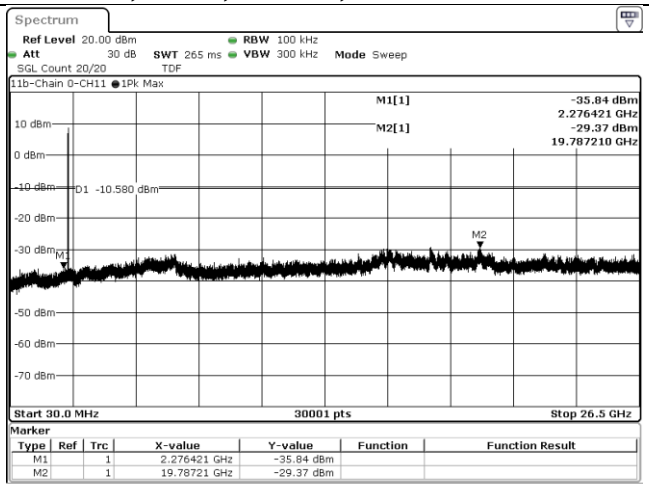
802.11b, CH6, Chain 0, Band edge



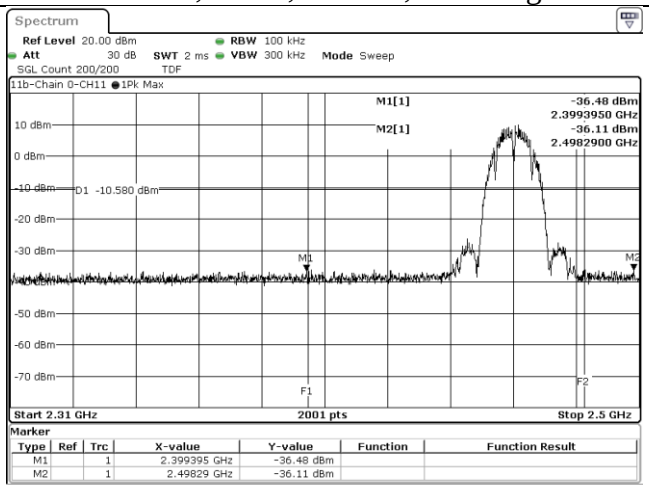
802.11b, CH11, Chain 0, Reference



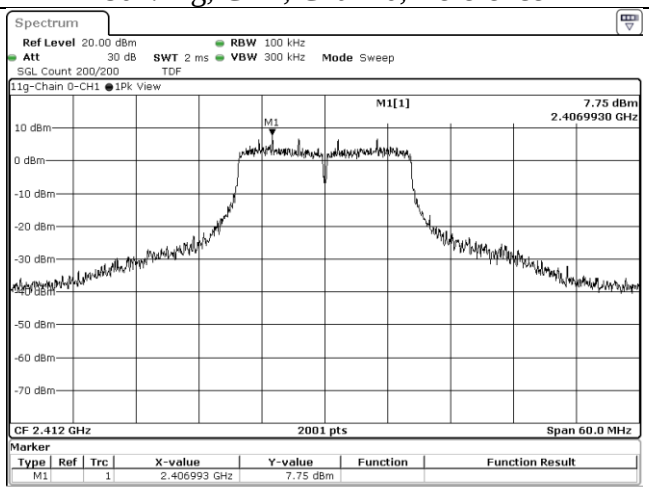
802.11b, CH11, Chain 0, Conducted Emission



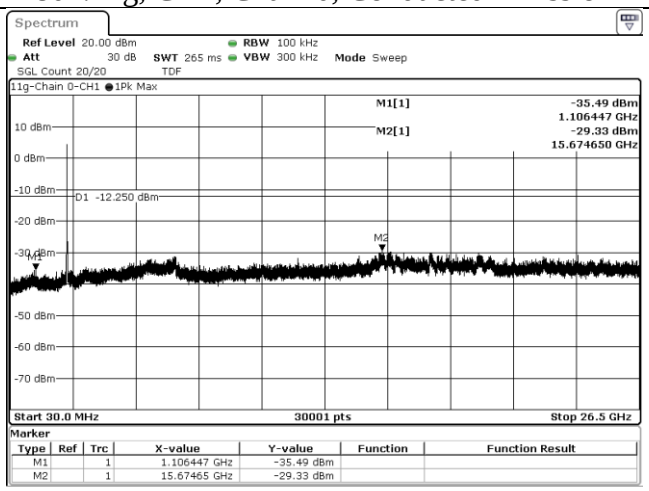
802.11b, CH11, Chain 0, Band edge



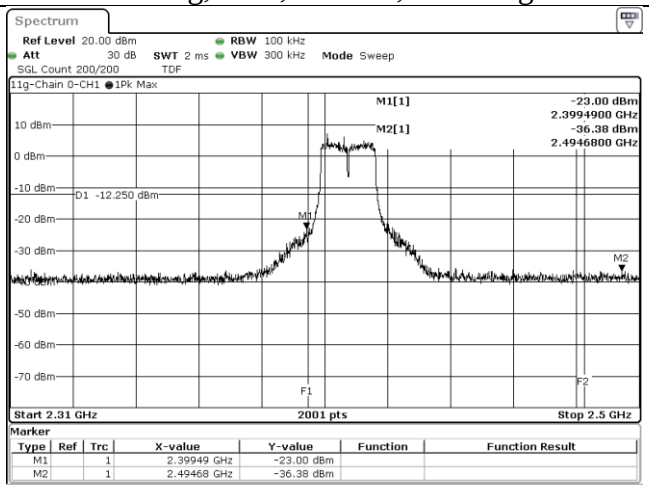
802.11g, CH1, Chain 0, Reference



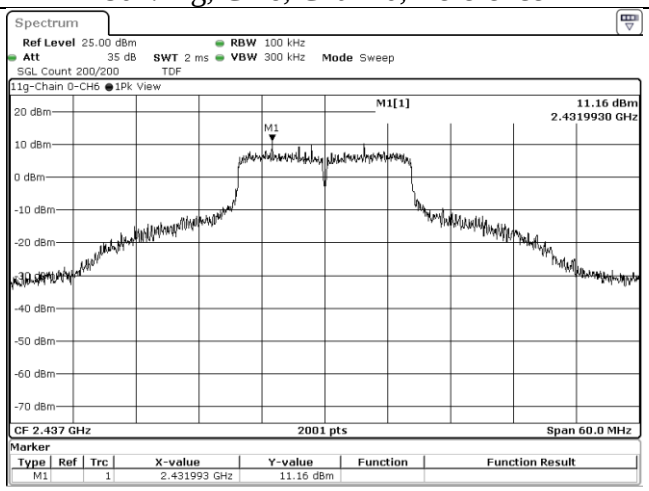
802.11g, CH1, Chain 0, Conducted Emission



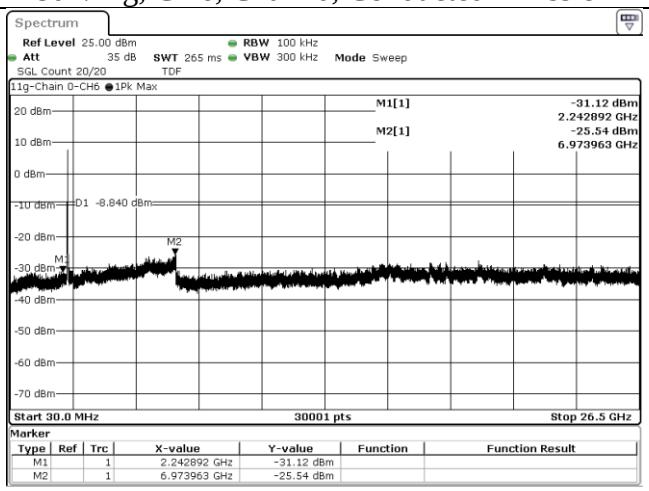
802.11g, CH1, Chain 0, Band edge



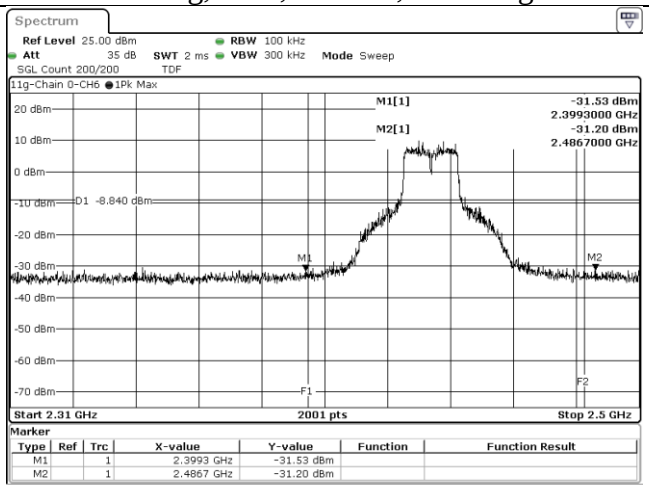
802.11g, CH6, Chain 0, Reference



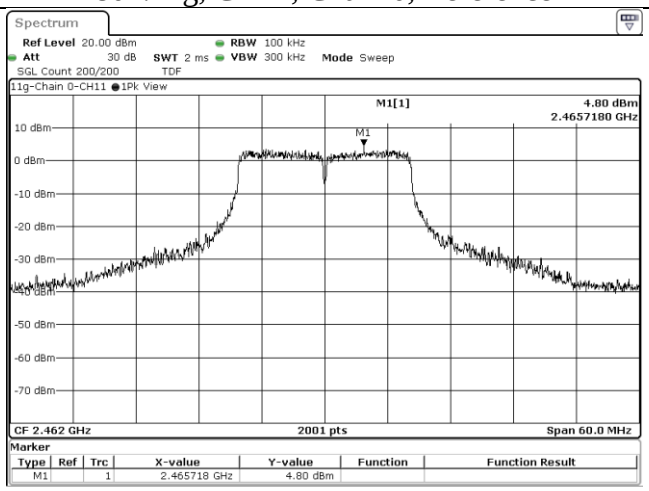
802.11g, CH6, Chain 0, Conducted Emission



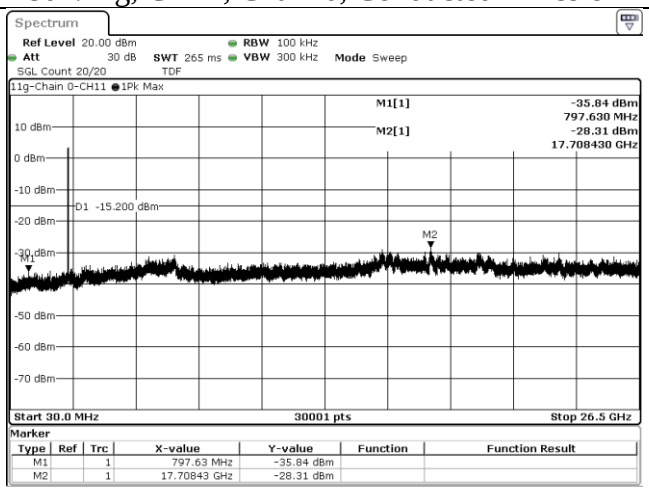
802.11g, CH6, Chain 0, Band edge



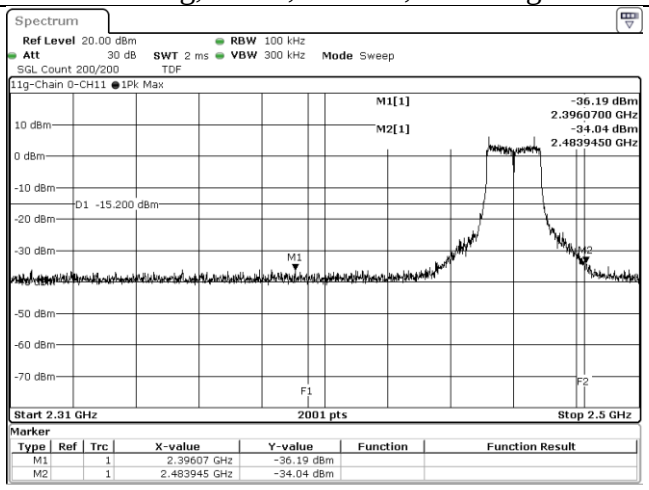
802.11g, CH11, Chain 0, Reference



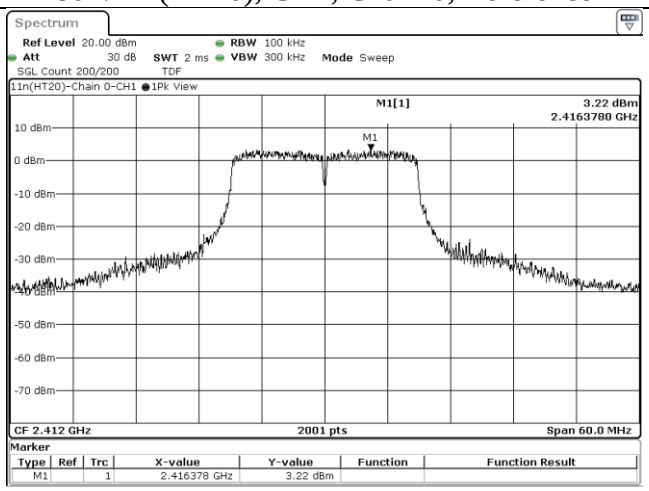
802.11g, CH11, Chain 0, Conducted Emission



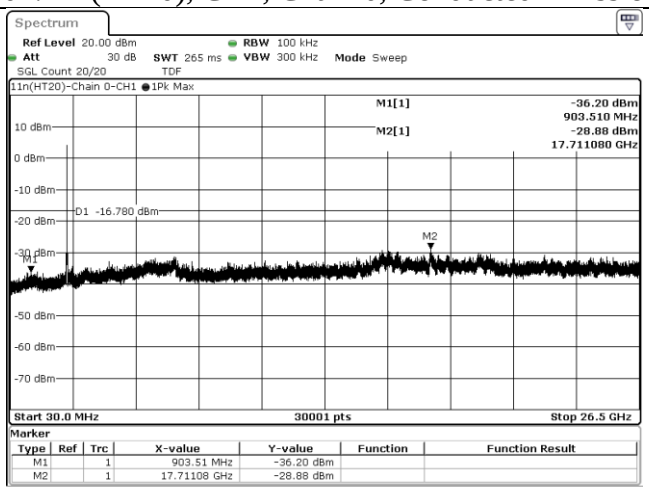
802.11g, CH11, Chain 0, Band edge



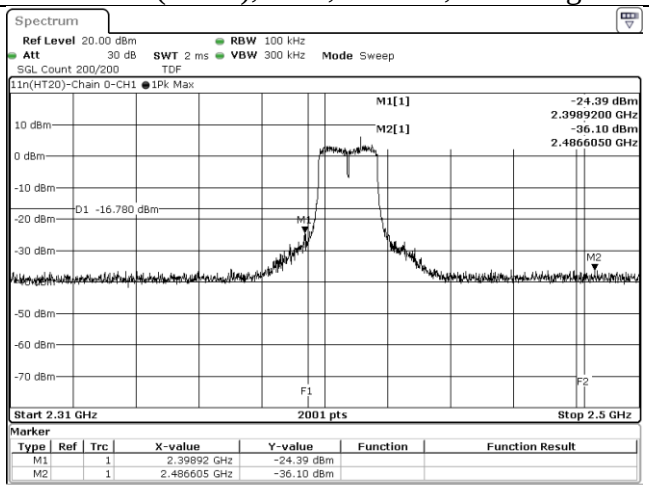
802.11n(HT20), CH1, Chain 0, Reference



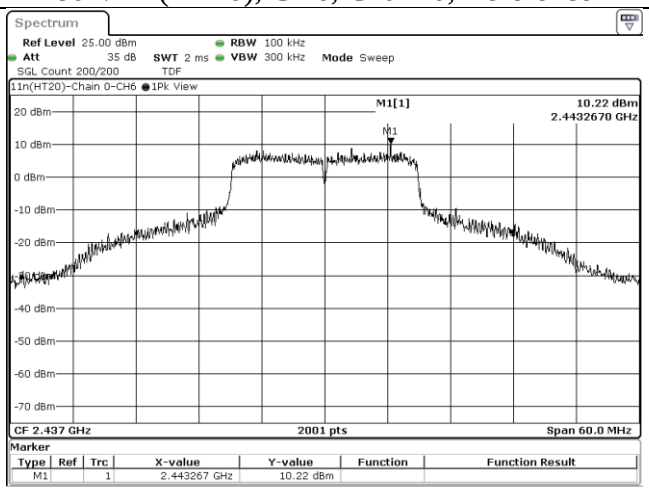
802.11n(HT20), CH1, Chain 0, Conducted Emission



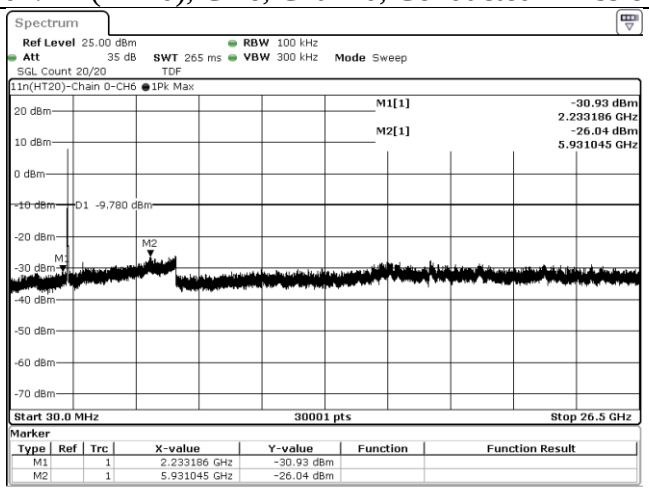
802.11n(HT20), CH1, Chain 0, Band edge



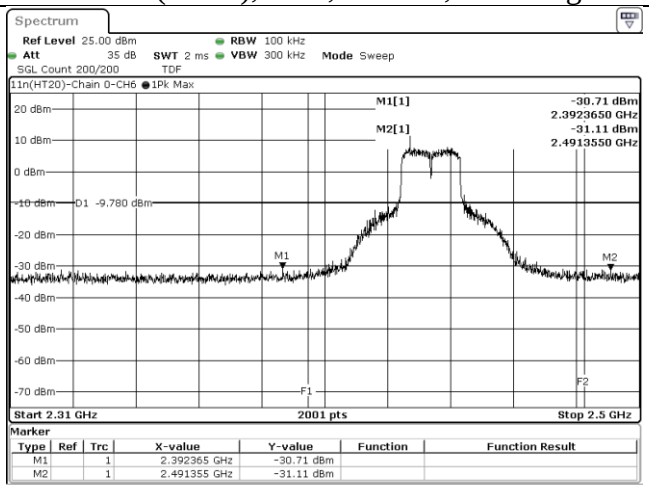
802.11n(HT20), CH6, Chain 0, Reference



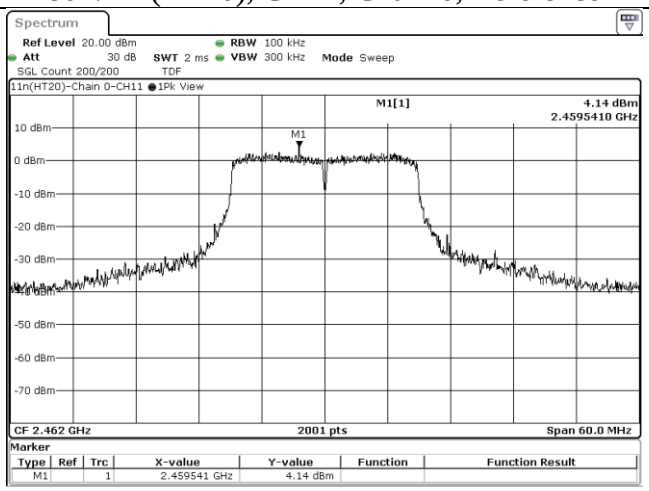
802.11n(HT20), CH6, Chain 0, Conducted Emission



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



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



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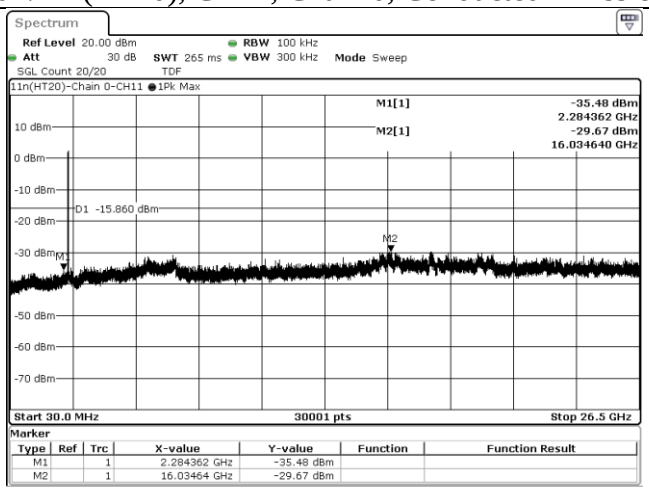
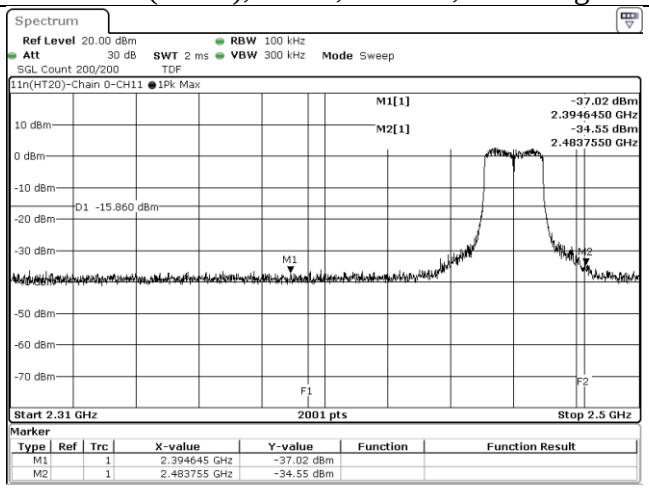
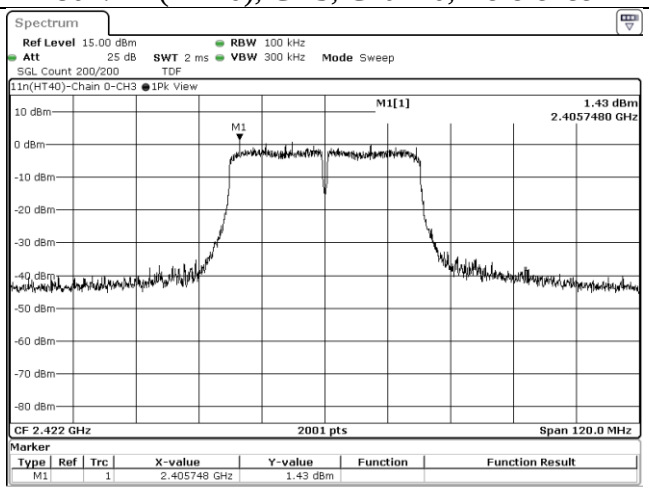


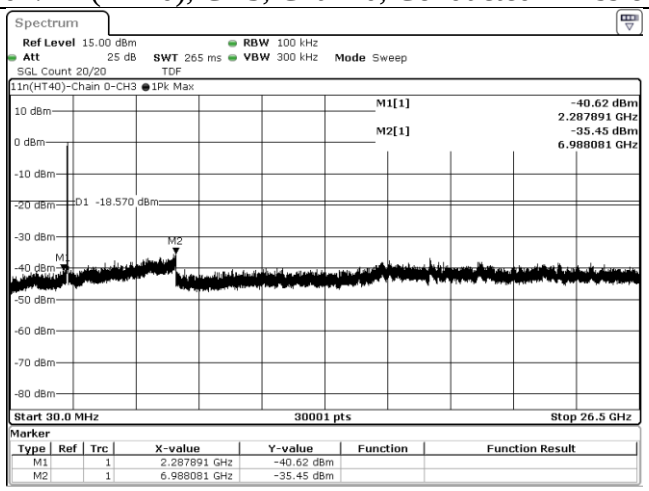
802.11n(HT20), CH11, Chain 0, Band edge



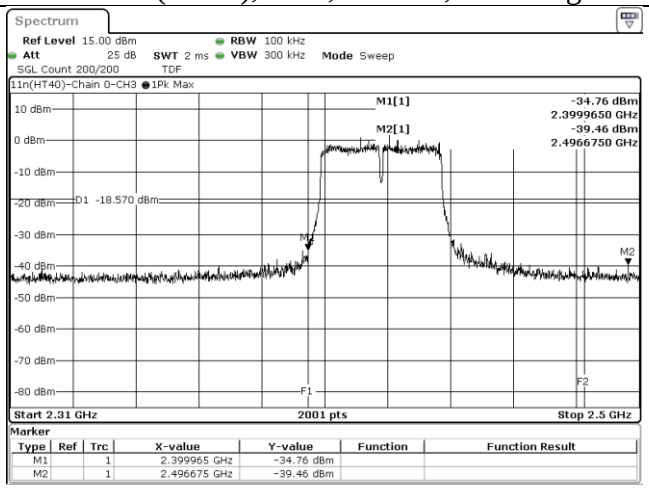
802.11n(HT40), CH3, Chain 0, Reference



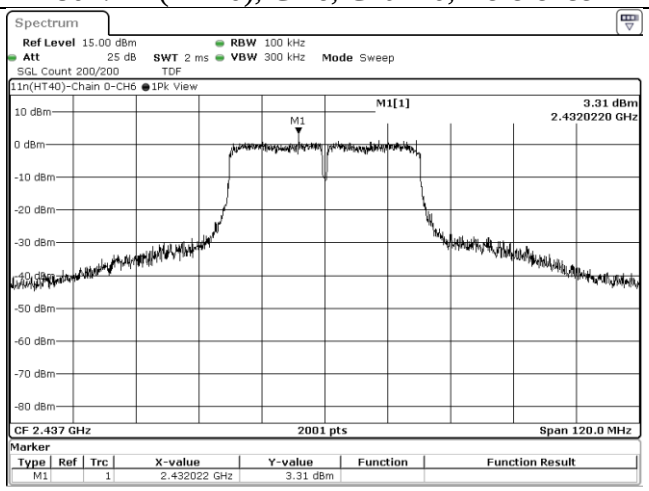
802.11n(HT40), CH3, Chain 0, Conducted Emission



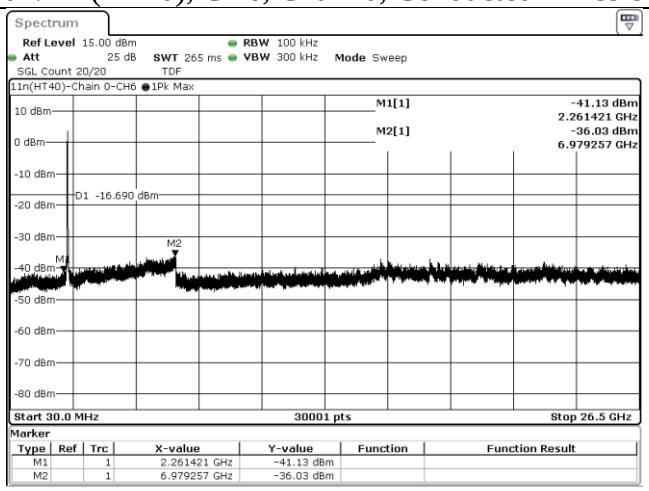
802.11n(HT40), CH3, Chain 0, Band edge



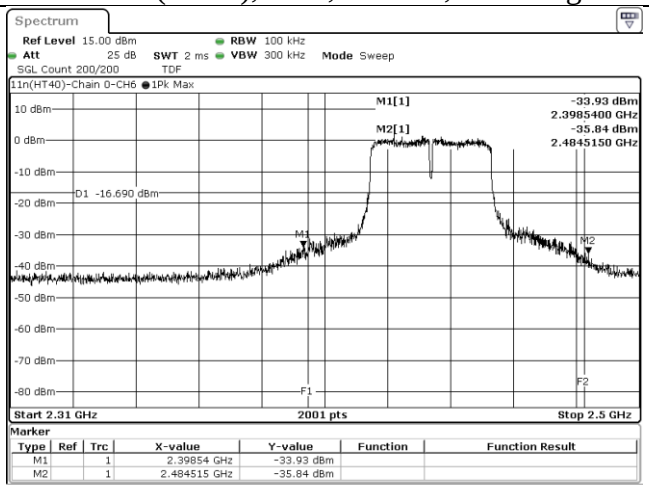
802.11n(HT40), CH6, Chain 0, Reference



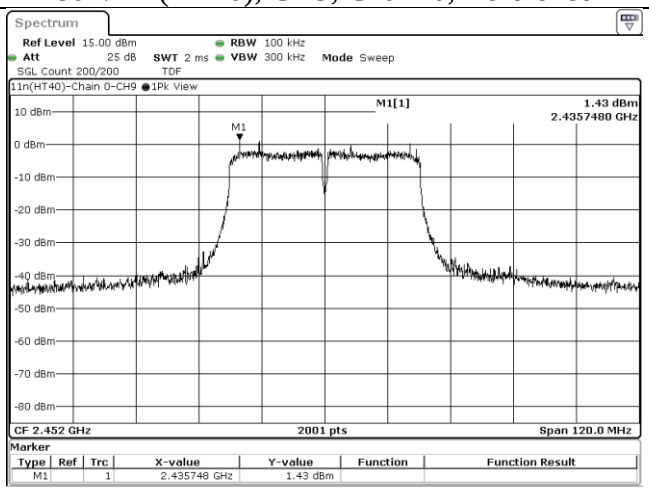
802.11n(HT40), CH6, Chain 0, Conducted Emission



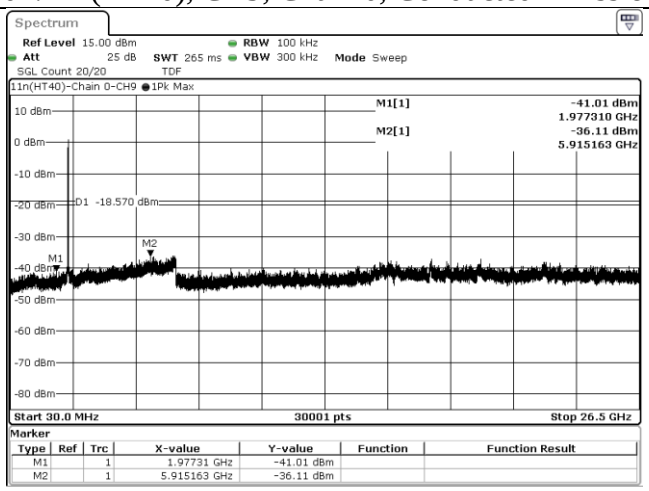
802.11n(HT40), CH6, Chain 0, Band edge



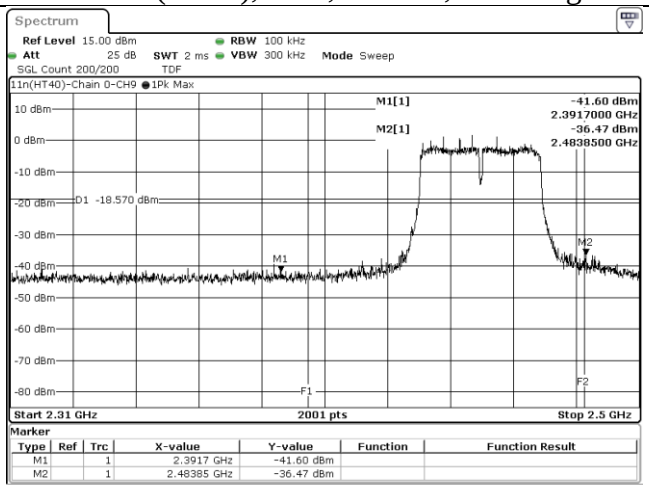
802.11n(HT40), CH9, Chain 0, Reference



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:

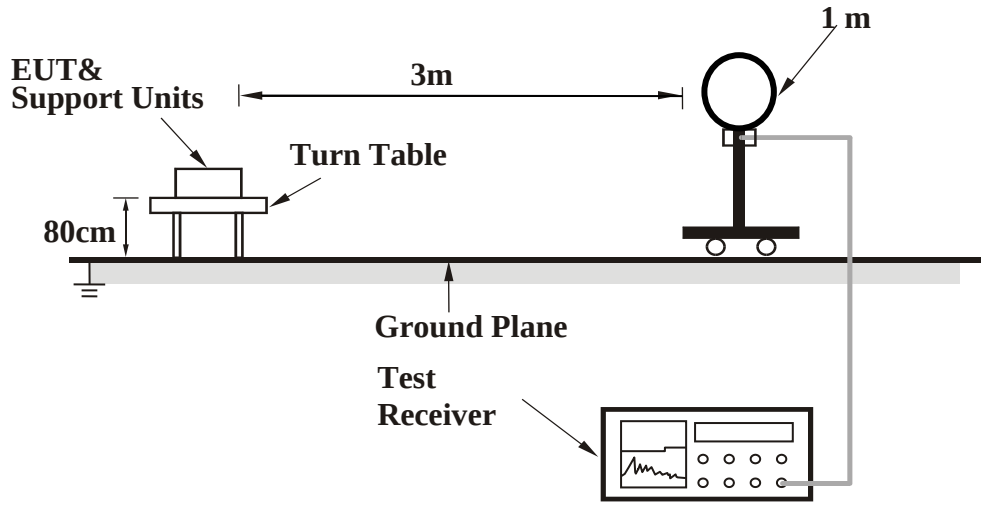
a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
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)		

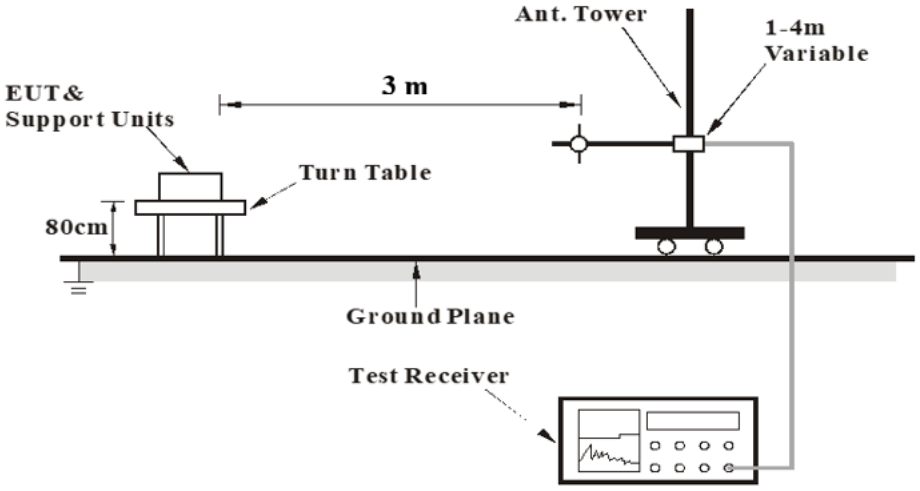
d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
f. Test data of Margin(dB) = Result 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

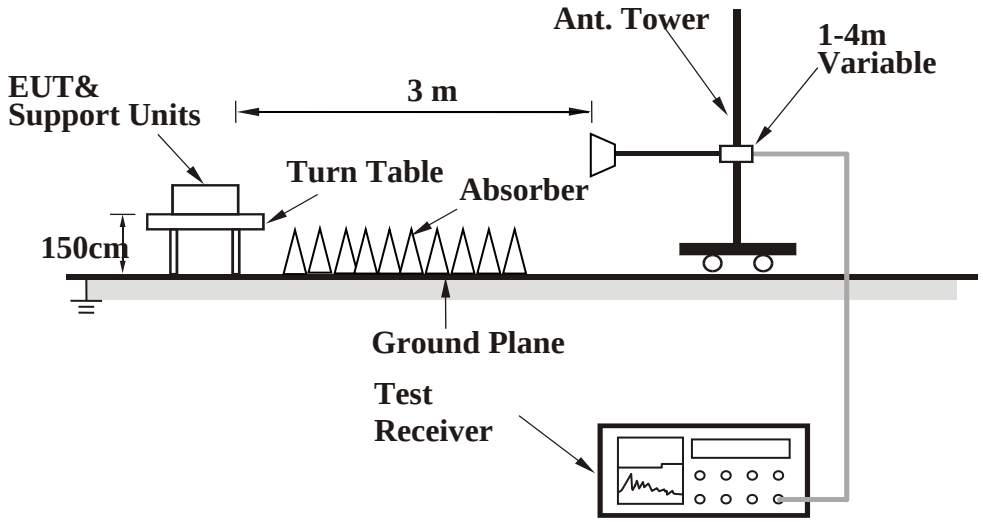
<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



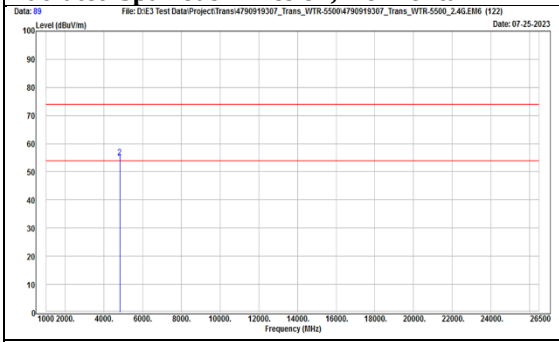
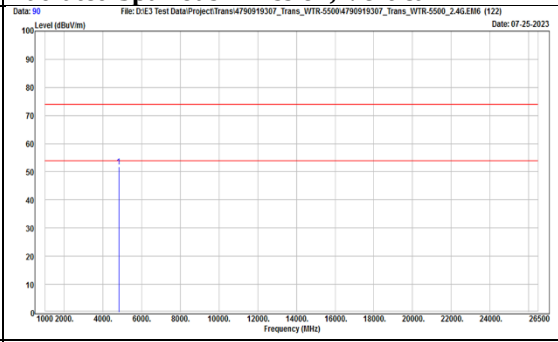
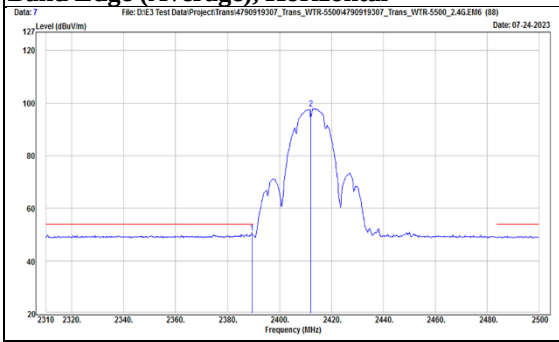
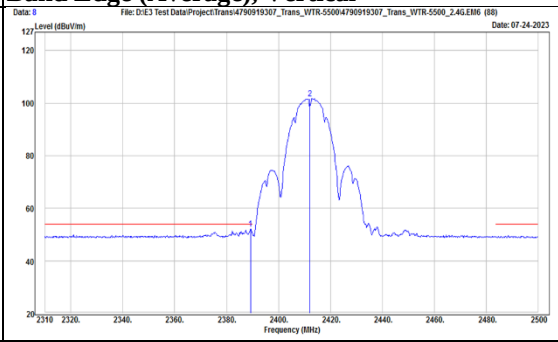
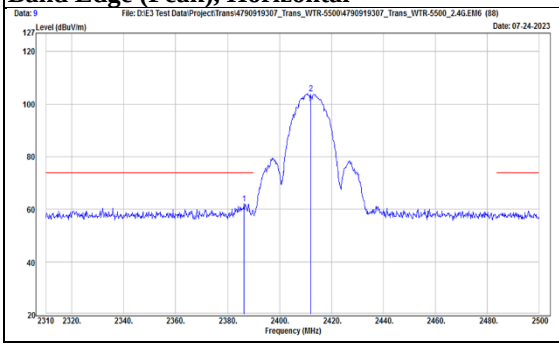
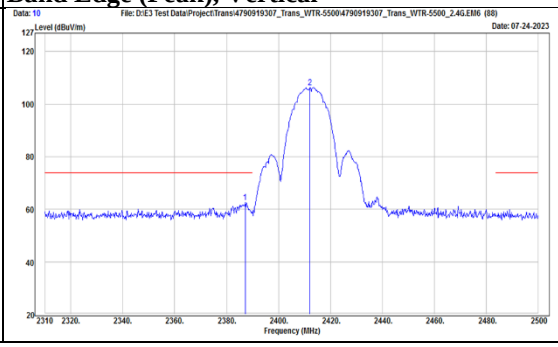
For the actual test configuration, please refer to the Setup Configurations.

Test Data

Above 1 GHz

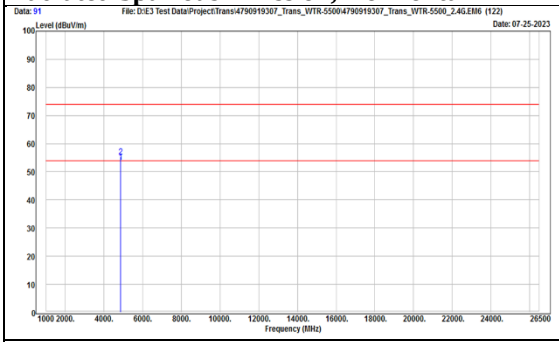
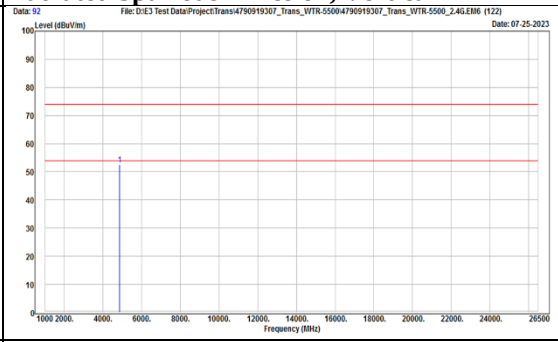
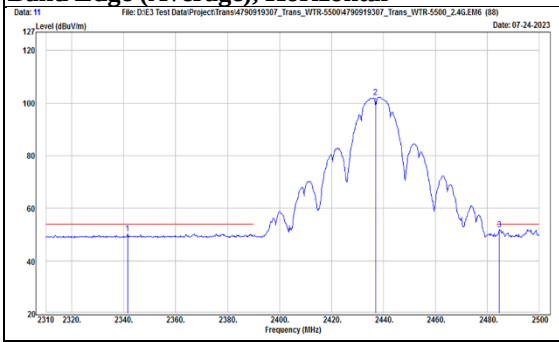
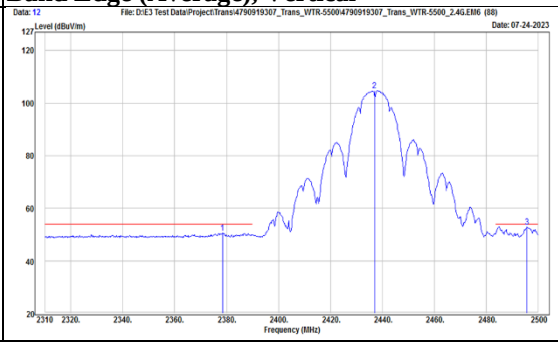
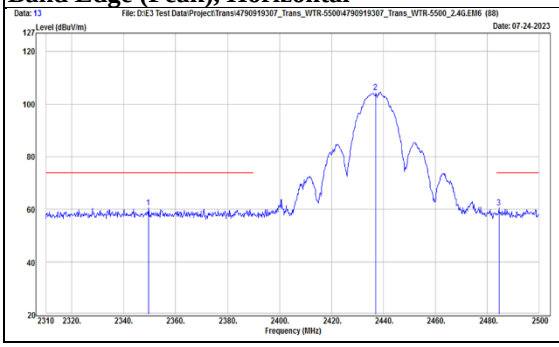
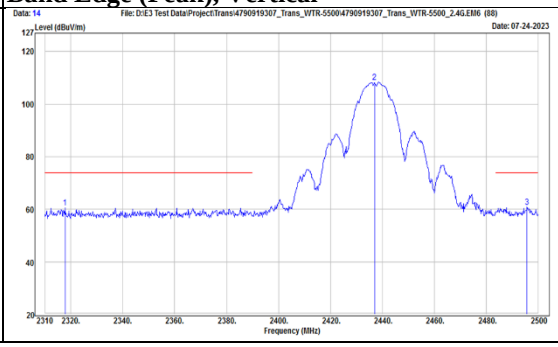
Mode	802.11b	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2386.38	43.33	18.87	62.2	74	-11.8	PK
		2389.42	31.87	18.86	50.73	54	-3.27	AVG
	@	2412	85.03	18.88	103.91	N/A	N/A	PK
	@	2412	78.94	18.88	97.82	N/A	N/A	AVG
		4824	53.01	2.16	55.17	74	-18.83	PK
		4824	51.26	2.16	53.42	54	-0.58	AVG
Vertical		2387.14	43.73	18.87	62.6	74	-11.4	PK
		2389.23	33.24	18.86	52.1	54	-1.9	AVG
	@	2412	87.55	18.88	106.43	N/A	N/A	PK
	@	2412	82.81	18.88	101.69	N/A	N/A	AVG
	*	4824	49.72	2.16	51.88	74	-22.12	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**
	

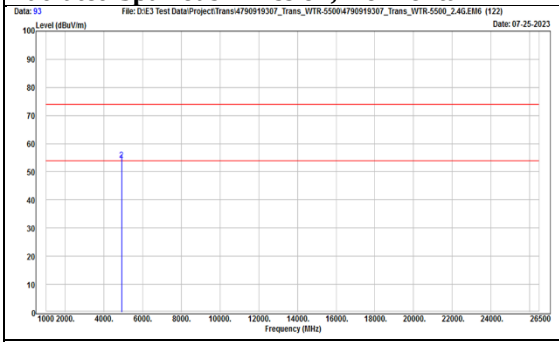
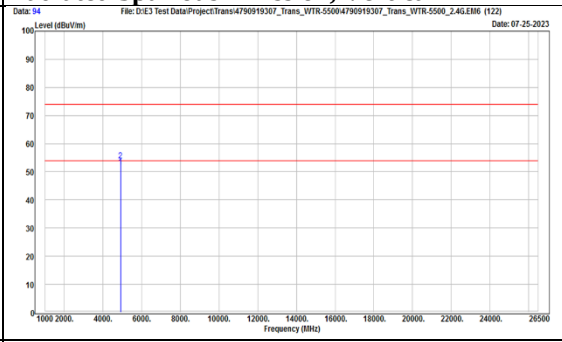
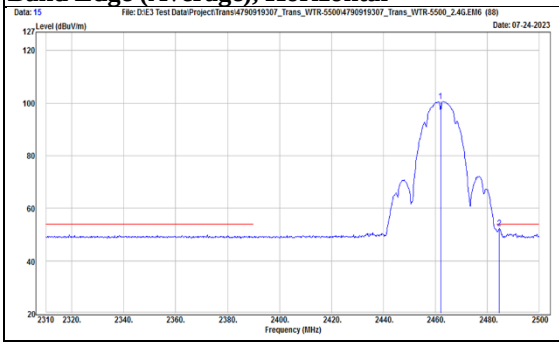
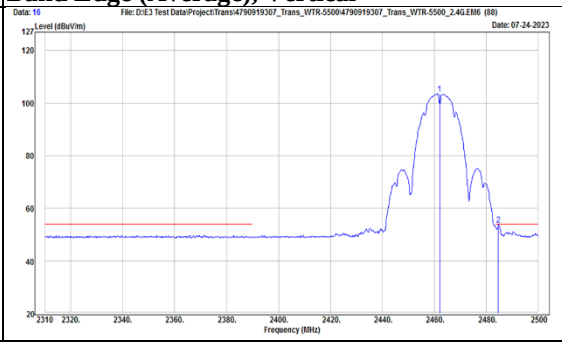
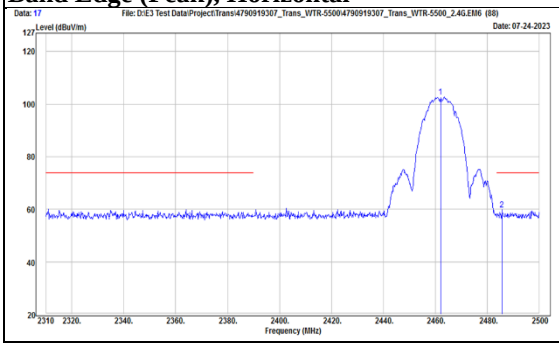
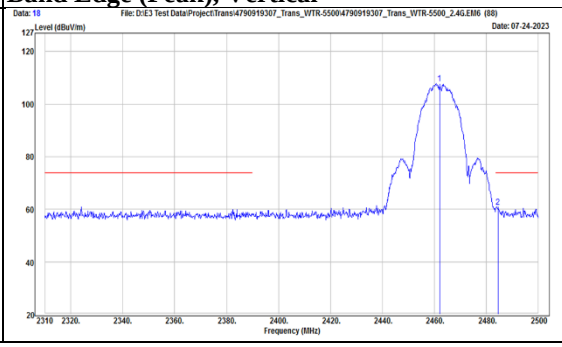
Mode	802.11b	Channel	6

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2341.54	31.36	18.96	50.32	54	-3.68	AVG
		2349.52	41.64	18.95	60.59	74	-13.41	PK
	@	2437	85.47	18.97	104.44	N/A	N/A	PK
	@	2437	83.26	18.97	102.23	N/A	N/A	AVG
		2484.42	41.75	18.8	60.55	74	-13.45	PK
		2484.61	33.16	18.8	51.96	54	-2.04	AVG
		4874	53.14	2.2	55.34	74	-18.66	PK
		4874	51.32	2.2	53.52	54	-0.48	AVG
Vertical		2317.79	41.72	18.95	60.67	74	-13.33	PK
		2378.4	31.73	18.89	50.62	54	-3.38	AVG
	@	2437	89.5	18.97	108.47	N/A	N/A	PK
	@	2437	85.82	18.97	104.79	N/A	N/A	AVG
		2495.63	42.2	18.73	60.93	74	-13.07	PK
		2495.63	34.15	18.73	52.88	54	-1.12	AVG
	*	4874	50.21	2.2	52.41	74	-21.59	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

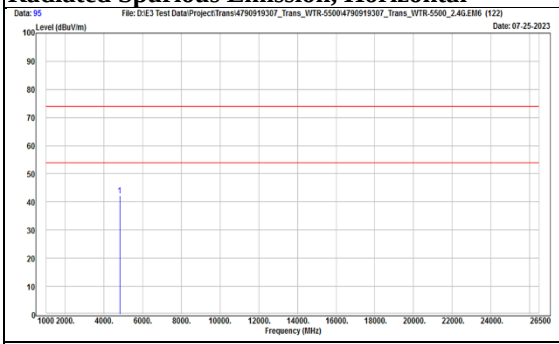
Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2462	83.87	18.95	102.82	N/A	N/A	PK
	@	2462	81.64	18.95	100.59	N/A	N/A	AVG
		2484.61	33.57	18.8	52.37	54	-1.63	AVG
		2485.56	41.09	18.8	59.89	74	-14.11	PK
		4924	51.9	2.25	54.15	74	-19.85	PK
		4924	51.05	2.25	53.3	54	-0.7	AVG
Vertical	@	2462	89.02	18.95	107.97	N/A	N/A	PK
	@	2462	84.56	18.95	103.51	N/A	N/A	AVG
		2484.42	42.09	18.8	60.89	74	-13.11	PK
		2484.61	34.96	18.8	53.76	54	-0.24	AVG
		4924	51.62	2.25	53.87	74	-20.13	PK
		4924	49.6	2.25	51.85	54	-2.15	AVG

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**
	

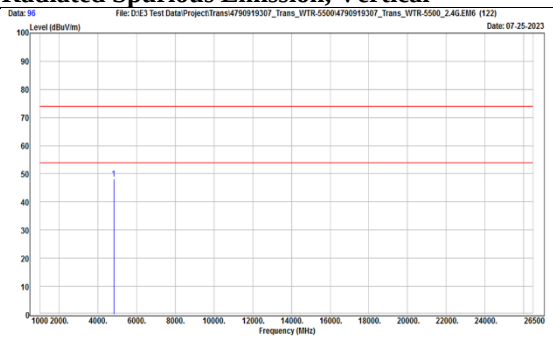
Mode	802.11g	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2389.99	41.79	18.86	60.65	74	-13.35	PK
		2389.99	34.47	18.86	53.33	54	-0.67	AVG
	@	2412	81.15	18.88	100.03	N/A	N/A	PK
	@	2412	73.82	18.88	92.7	N/A	N/A	AVG
	*	4824	40.04	2.16	42.2	74	-31.8	PK
Vertical		2389.8	49.23	18.86	68.09	74	-5.91	PK
		2389.99	34.69	18.86	53.55	54	-0.45	AVG
	@	2412	85.25	18.88	104.13	N/A	N/A	PK
	@	2412	76.61	18.88	95.49	N/A	N/A	AVG
	*	4824	46	2.16	48.16	74	-25.84	PK

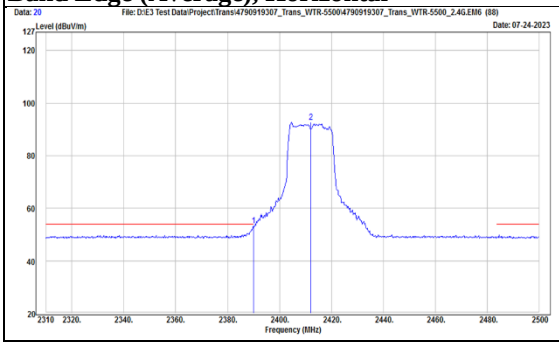
TX, 802.11g (Ch 1)
Radiated Spurious Emission, Horizontal



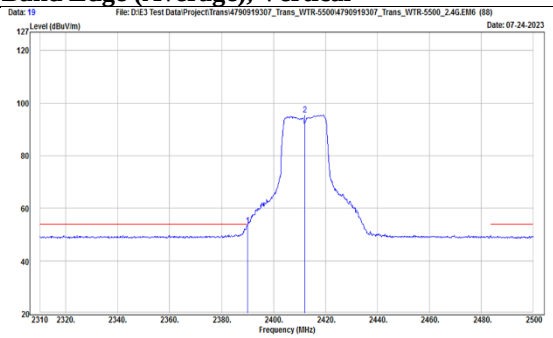
TX, 802.11g (Ch 1)
Radiated Spurious Emission, Vertical



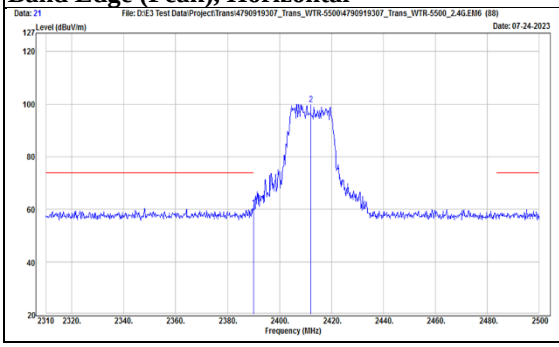
TX, 802.11g (Ch 1)
Band Edge (Average), Horizontal



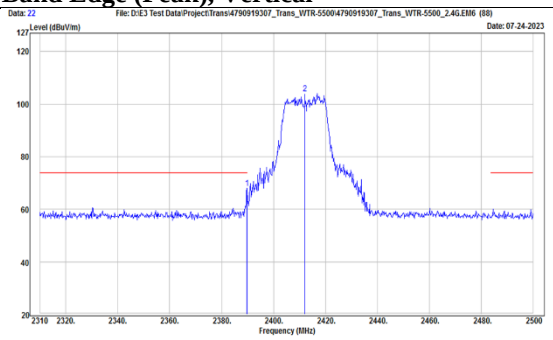
TX, 802.11g (Ch 1)
Band Edge (Average), Vertical



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



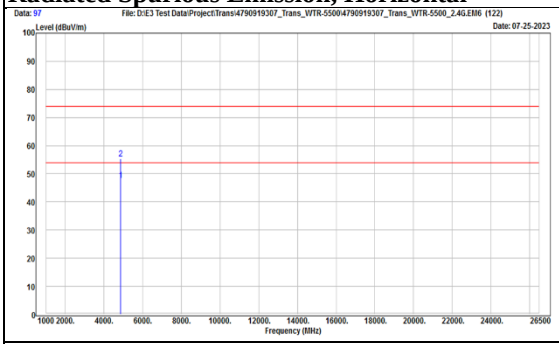
TX, 802.11g (Ch 1)
Band Edge (Peak), Vertical



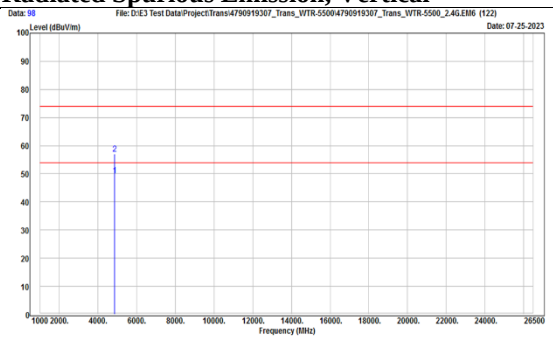
Mode	802.11g	Channel	6

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2323.3	30.87	18.95	49.82	54	-4.18	AVG
		2379.54	40.77	18.88	59.65	74	-14.35	PK
	@	2437	86.53	18.97	105.5	N/A	N/A	PK
	@	2437	77.56	18.97	96.53	N/A	N/A	AVG
		2485.18	31.36	18.8	50.16	54	-3.84	AVG
		2499.24	41.08	18.72	59.8	74	-14.2	PK
		4874	53.06	2.2	55.26	74	-18.74	PK
		4874	45.5	2.2	47.7	54	-6.3	AVG
Vertical		2372.13	41.9	18.9	60.8	74	-13.2	PK
		2389.04	31.27	18.86	50.13	54	-3.87	AVG
	@	2437	90.42	18.97	109.39	N/A	N/A	PK
	@	2437	81.73	18.97	100.7	N/A	N/A	AVG
		2483.66	42.58	18.81	61.39	74	-12.61	PK
		2484.23	32.71	18.81	51.52	54	-2.48	AVG
		4874	54.72	2.2	56.92	74	-17.08	PK
		4874	47.13	2.2	49.33	54	-4.67	AVG

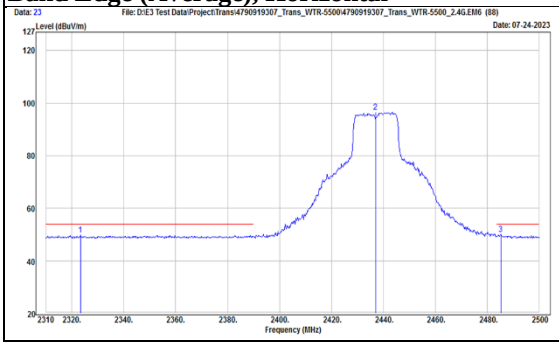
TX, 802.11g (Ch 6)
Radiated Spurious Emission, Horizontal



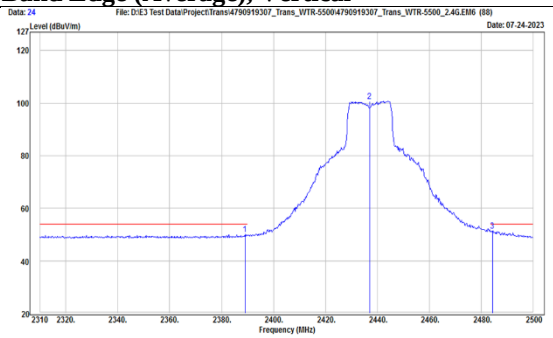
TX, 802.11g (Ch 6)
Radiated Spurious Emission, Vertical



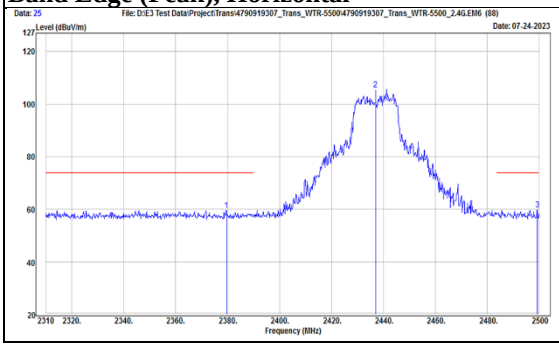
TX, 802.11g (Ch 6)
Band Edge (Average), Horizontal



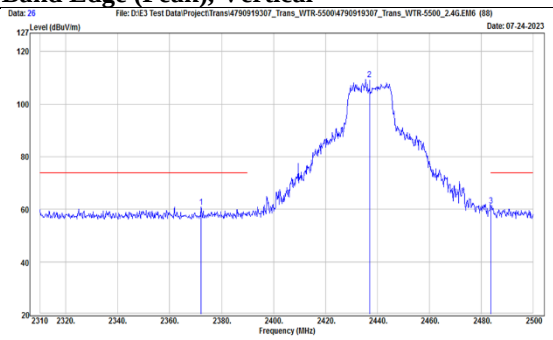
TX, 802.11g (Ch 6)
Band Edge (Average), Vertical



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

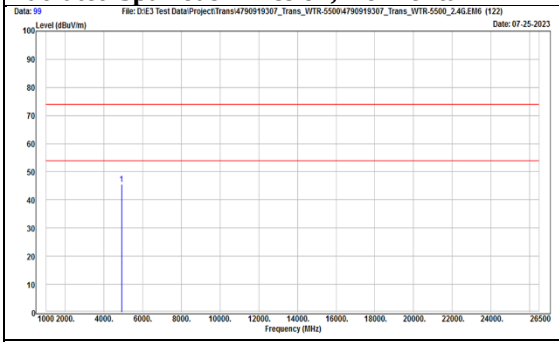
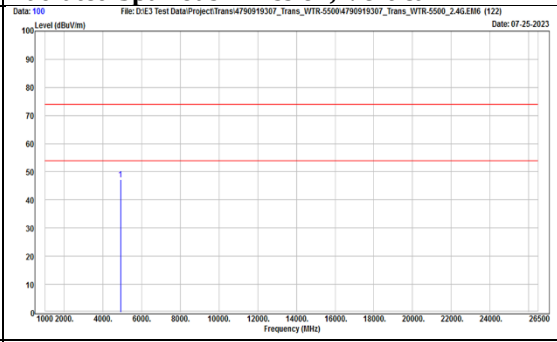
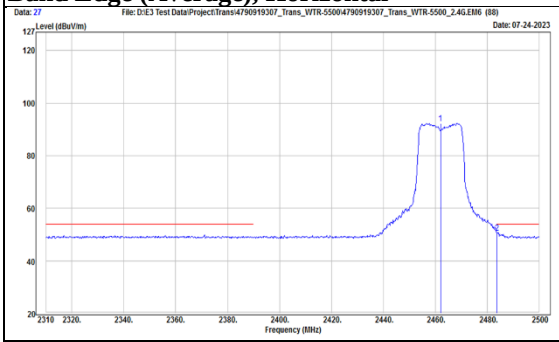
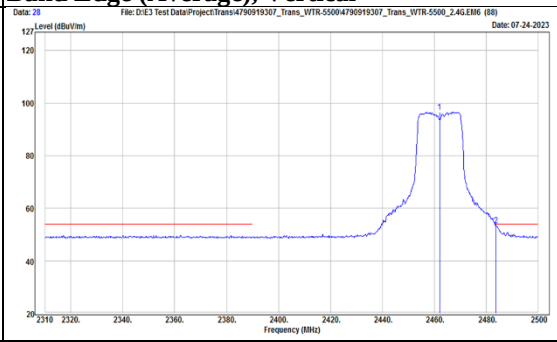
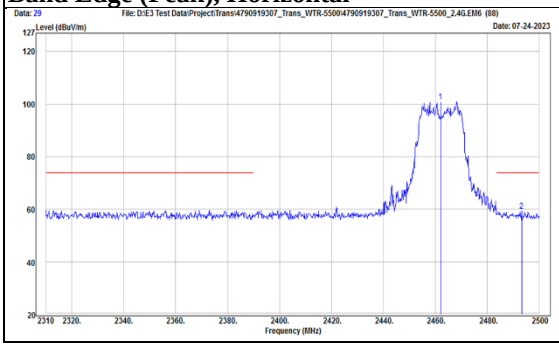
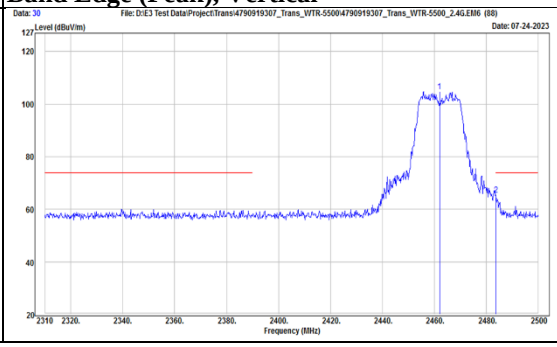


TX, 802.11g (Ch 6)
Band Edge (Peak), Vertical



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	81.97	18.95	100.92	N/A	N/A	PK
	@	2462	73.42	18.95	92.37	N/A	N/A	AVG
		2483.66	31.86	18.81	50.67	54	-3.33	AVG
		2493.16	40.47	18.75	59.22	74	-14.78	PK
	*	4924	43.25	2.25	45.5	74	-28.5	PK
Vertical	@	2462	85.84	18.95	104.79	N/A	N/A	PK
	@	2462	77.7	18.95	96.65	N/A	N/A	AVG
		2483.66	46.57	18.81	65.38	74	-8.62	PK
		2483.66	34.76	18.81	53.57	54	-0.43	AVG
	*	4924	44.96	2.25	47.21	74	-26.79	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		2387.9	41.51	18.87	60.38	74	-13.62	PK
		2389.8	33.81	18.86	52.67	54	-1.33	AVG
	@	2412	81.45	18.88	100.33	N/A	N/A	PK
	@	2412	73.46	18.88	92.34	N/A	N/A	AVG
	*	4824	39.75	2.16	41.91	74	-32.09	PK
Vertical		2389.99	44.97	18.86	63.83	74	-10.17	PK
		2389.99	34.59	18.86	53.45	54	-0.55	AVG
	@	2412	83.86	18.88	102.74	N/A	N/A	PK
	@	2412	75.73	18.88	94.61	N/A	N/A	AVG
	*	4824	41.67	2.16	43.83	74	-30.17	PK