FCC RF Test Report

APPLICANT	:	**iRobot Corporation**
EQUIPMENT	:	**Harpoon**
BRAND NAME	:	**iRobot**
MODEL NAME	:	**AXE-Y1**
FCC ID	:	**UFEAXE-Y1**
STANDARD	:	**47 CFR Part 15 Subpart C §15.247**
CLASSIFICATION	:	**(DTS) Digital Transmission System**

The product was received on Nov. 13, 2018 and testing was completed on Nov. 26, 2018. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

James Huang

NVLAP TESTING
NVLAP LAB CODE 600155-0

Approved by: James Huang / Manager

Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone,
Jiangsu Province 215335, China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR8N1306B	Rev. 01	Initial issue of report	Jan. 04, 2019

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Pass	-
3.2	15.247(b)	Power Output Measurement	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
		Conducted Spurious Emission		Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.04 dB at 2483.560 MHz
3.6	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

1 General Description

1.1 Applicant

iRobot Corporation
8 Crosby Drive, Bedford, Massachusetts 01730, United States

1.2 Manufacturer

Huizhou BYD Electronic Co.,Ltd.
Xiangshui River,Economic Development Zone,Daya Bay,Huizhou,Guangdong Province,P.R.China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Harpoon
Brand Name	iRobot
Model Name	AXE-Y1
FCC ID	UFEAXE-Y1
EUT supports Radios application	WLAN 2.4GHz 802.11b/g/n HT20 WLAN 5GHz 802.a/n HT20/HT40 Bluetooth LE
HW Version	Harpoon B2
SW Version	lewis+2.0.0_rc13+tridentAPQ8009+0000
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Channel Frequency Range	2412 MHz ~ 2462 MHz
Maximum (Peak) Output Power to antenna	802.11b : 17.35 dBm (0.0543 W) 802.11g : 20.83 dBm (0.1211 W) 802.11n HT20 : 20.43 dBm (0.1104 W)
99% Occupied Bandwidth	802.11b : 12.44MHz 802.11g : 19.03MHz 802.11n HT20 : 19.58MHz
Antenna Type / Gain	PCB internal Antenna with gain 3.04 dBi
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)

Remark: The antenna provided to the EUT, please refer to the following table.

Antenna No.	Brand	Model	Gain(dBi)	Antenna Type	Frequency range (GHz to GHz)
1	iRobot	AXE-Y1	3.04	PCB internal antenna	2.4-2.4835
1	iRobot	AXE-Y1	1.57	PCB internal antenna	5.15-5.25
1	iRobot	AXE-Y1	1.97	PCB internal antenna	5.25-5.35
1	iRobot	AXE-Y1	2.96	PCB internal antenna	5.47-5.725
1	iRobot	AXE-Y1	1.94	PCB internal antenna	5.725-5.85

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO 17025 by National Voluntary Laboratory Accreditation Program (NVLAP code: 600155-0).

Test Site	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone, Jiangsu Province 215335, China TEL : 86-512-57900158 FAX : 86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC designation No.**	**FCC Test Firm Registration No.**
	TH01-KS 03CH06-KS	CN5013	630927

1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05
- ANSI C63.10-2013

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

2 Test Configuration of Equipment Under Test

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the worst cases were recorded in this report.

b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

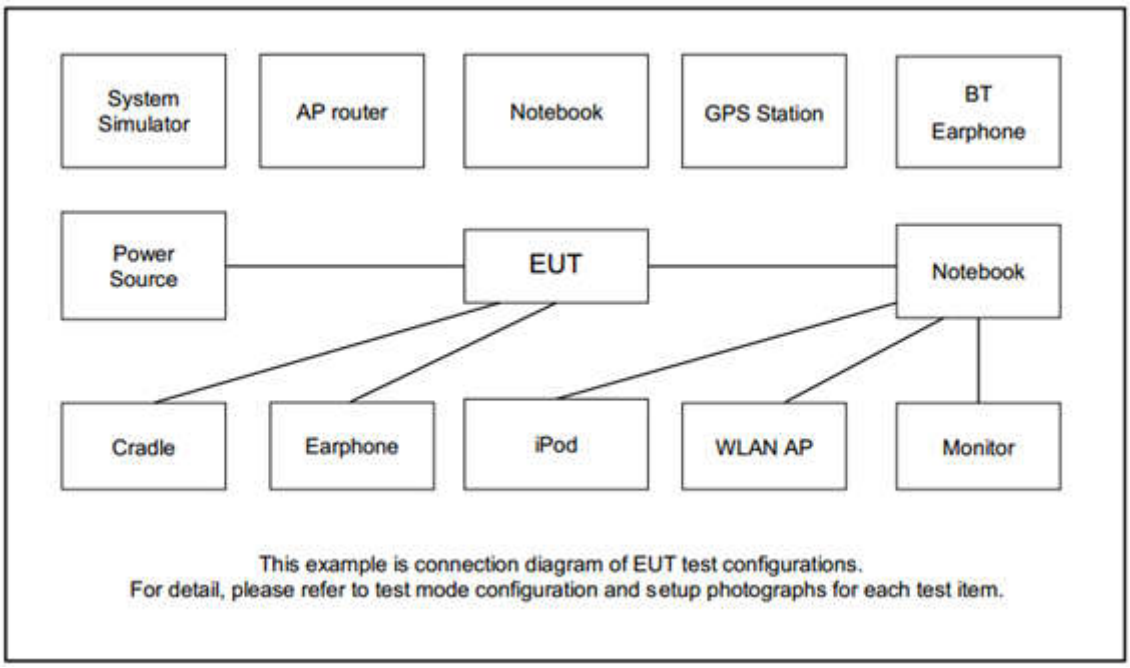
Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		

2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0

2.3 Connection Diagram of Test System



2.4 EUT Operation Test Setup

For WLAN function, the engineering test program was provided and enabled to make EUT continuous transmit/receive.

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2.5 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss.

Offset = RF cable loss.

Following shows an offset computation example with cable loss 5.9dB

Offset(dB) = RF cable loss(dB).

=5.9 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

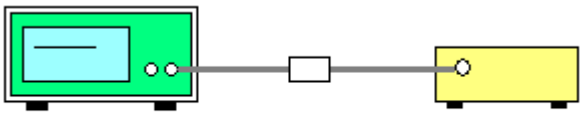
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

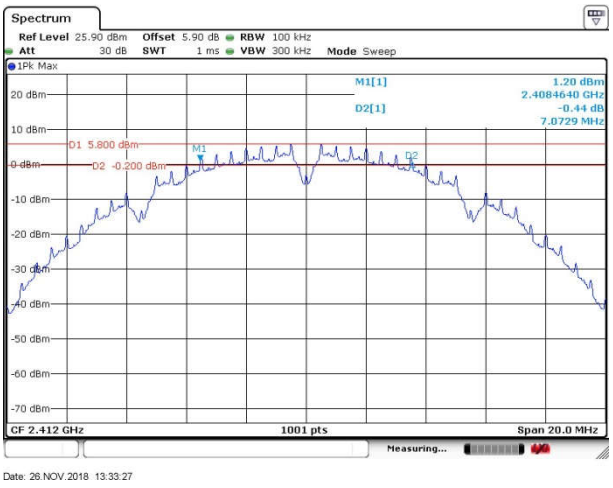
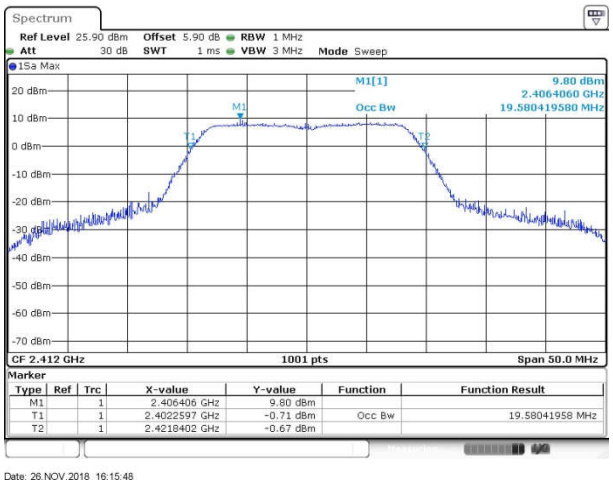
1. The testing follows ANSI C63.10-2013 clause 11.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) = 1MHz and set the Video bandwidth (VBW) = 3MHz.
6. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

Please refer to Appendix A.

Minimum 6dB Bandwidth	Maximum 99% Occupied Bandwidth
	

Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

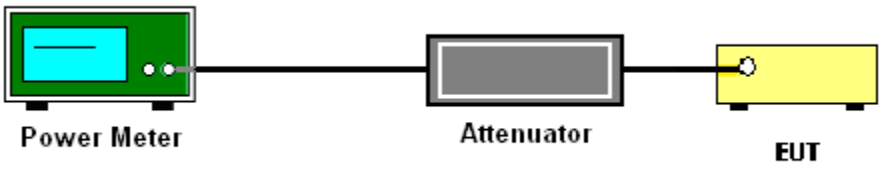
3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.3 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average output Power (Reporting Only)

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

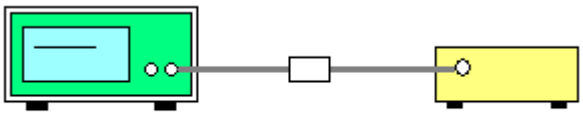
3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 11.10.2 Method PKPSD
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.

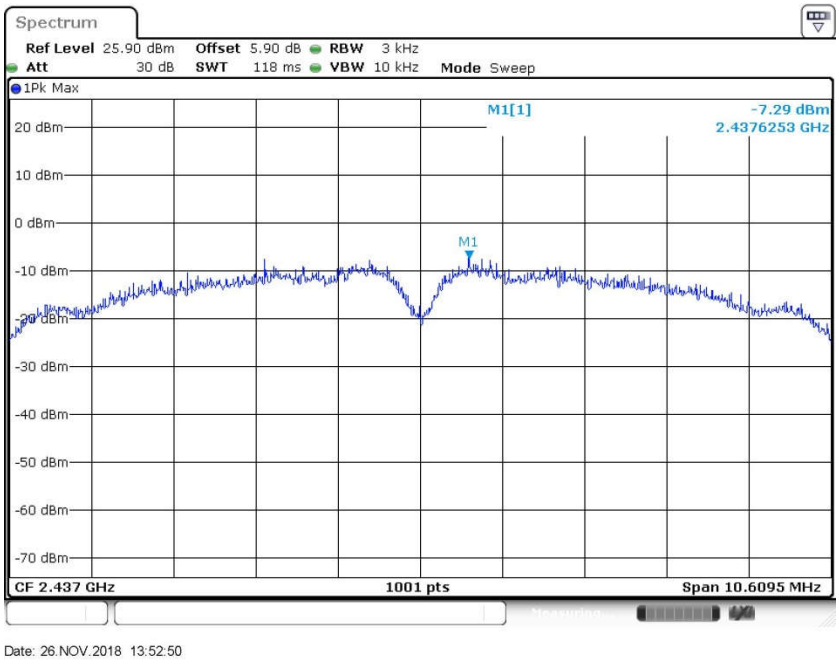
3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

Worst Case Power Density (dBm/3kHz)



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

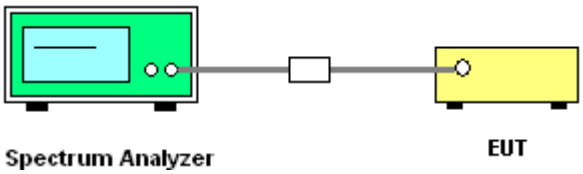
3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.13
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

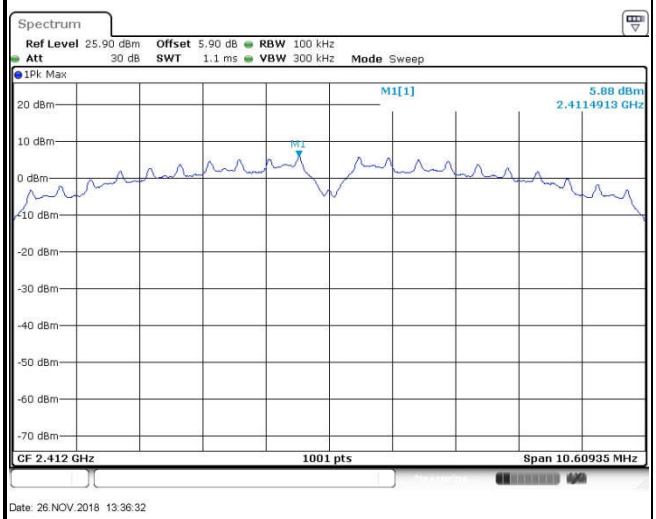
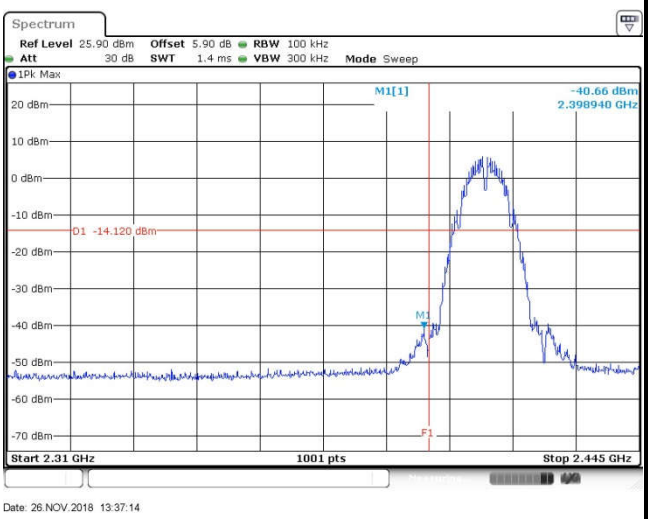
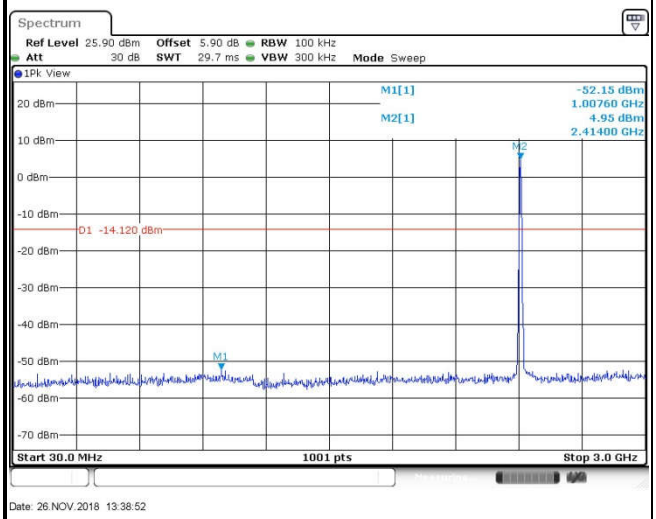
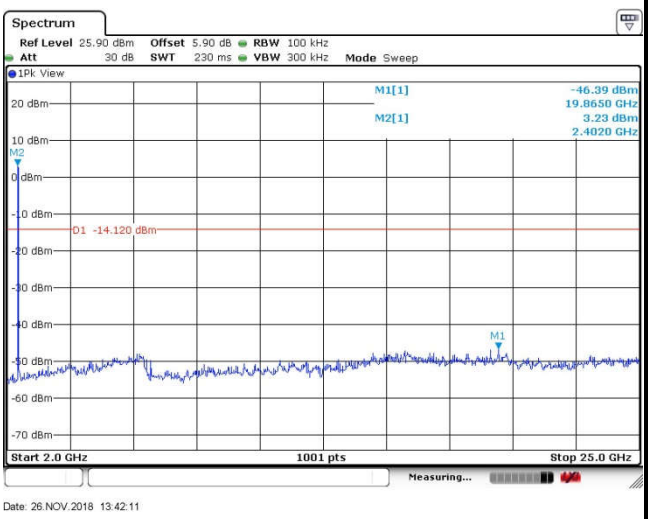
3.4.4 Test Setup



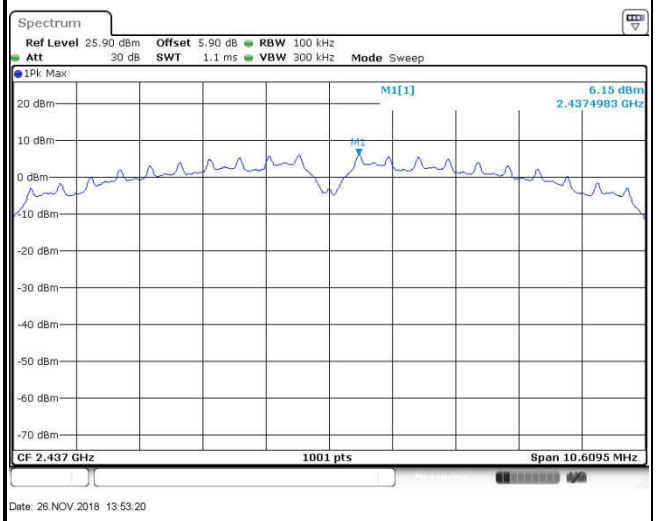
3.4.5 Test Result of Conducted Band Edges and Spurious Emission

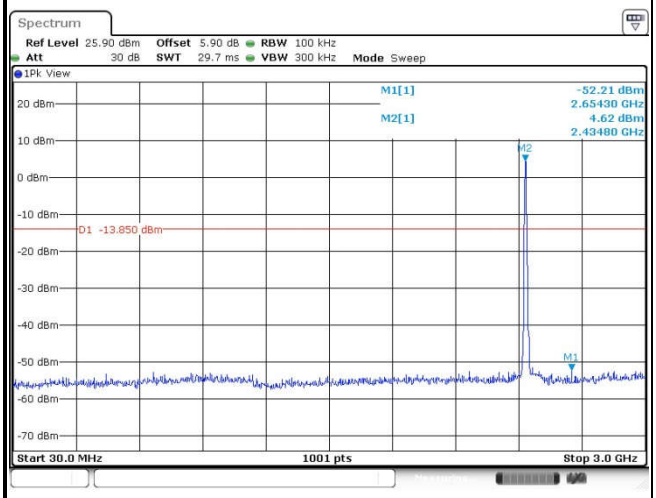
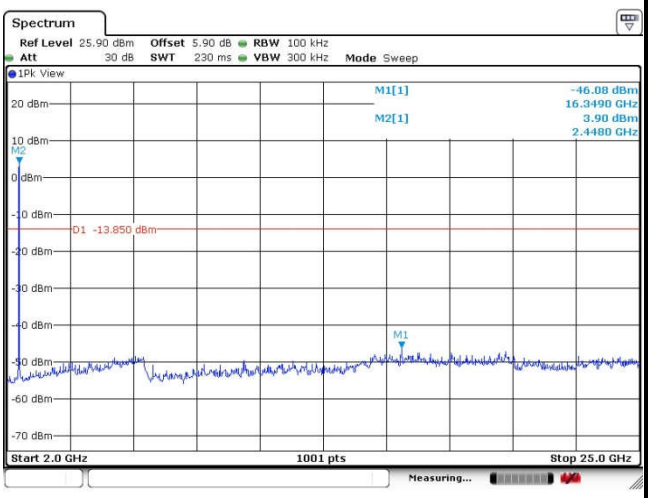
Test Engineer :	Silent Hai	**Temperature :**	21~25℃
		Relative Humidity :	49~51%

Test Mode :	802.11b	**Test Channel :**	01

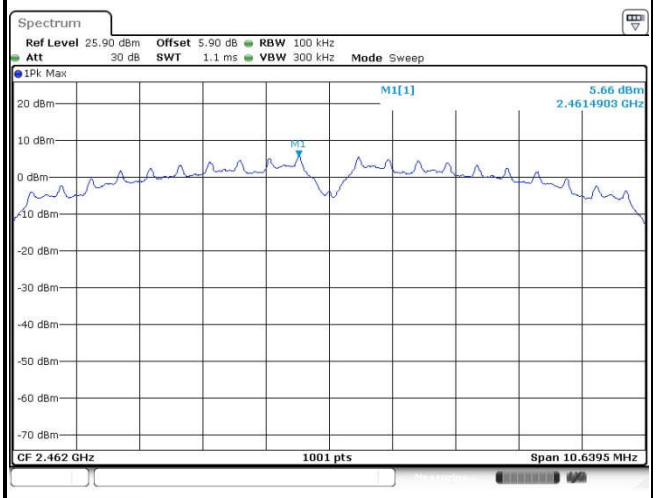
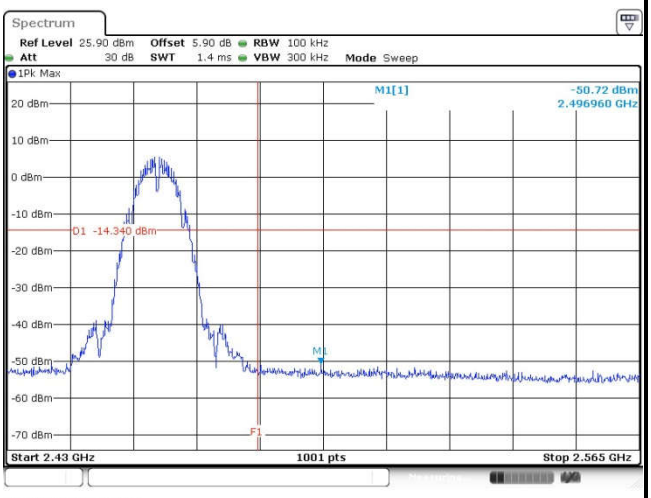
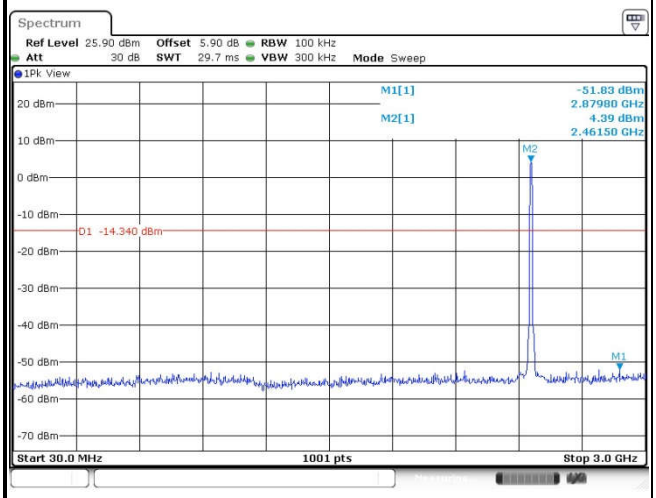
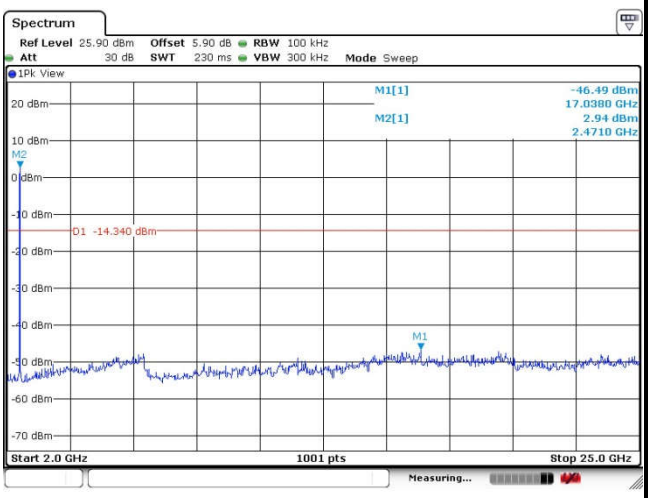
100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	**Spurious Emission 2GHz~25GHz**
	

Test Mode :	802.11b	Test Channel :	06

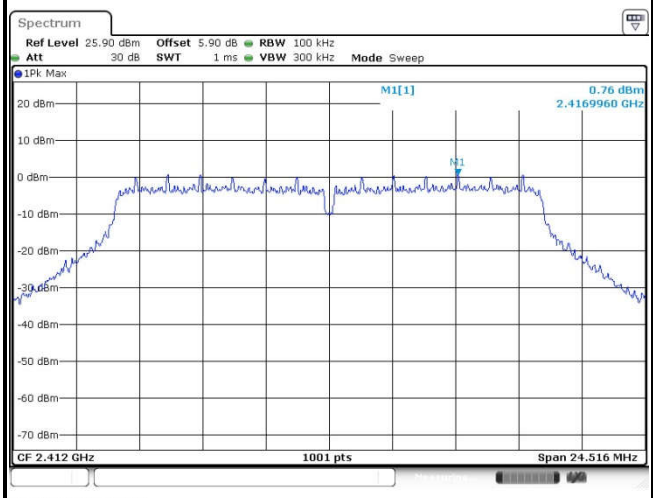
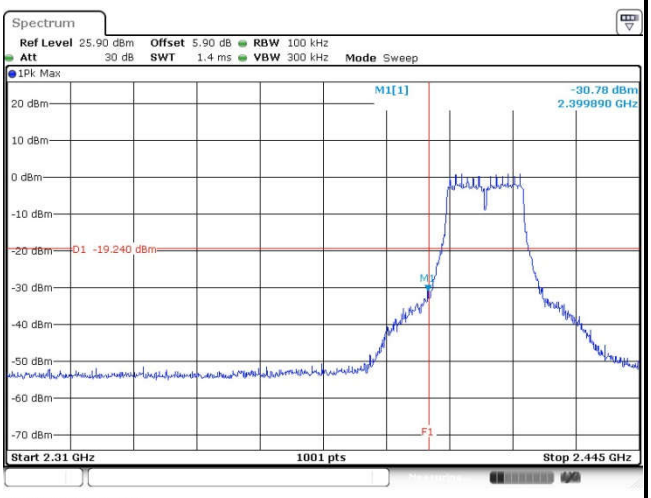
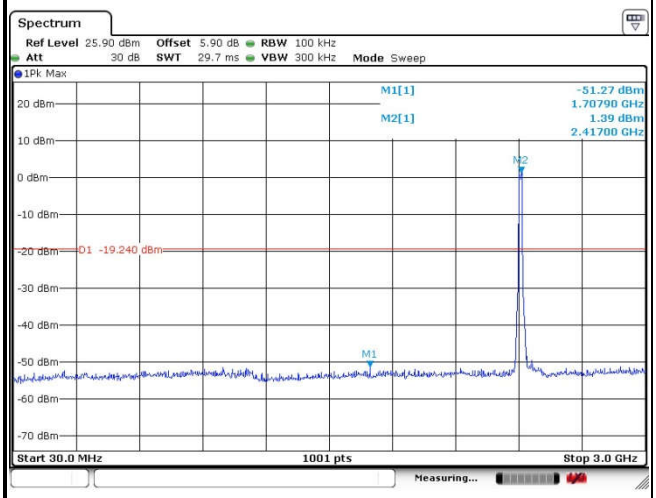
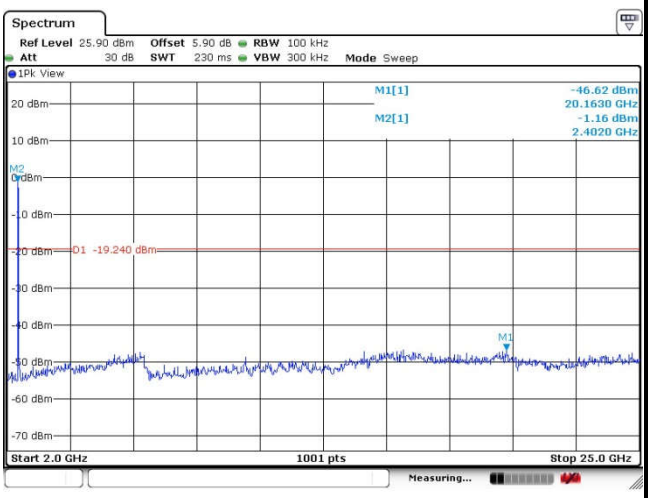
100kHz PSD reference Level	
	

Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
	

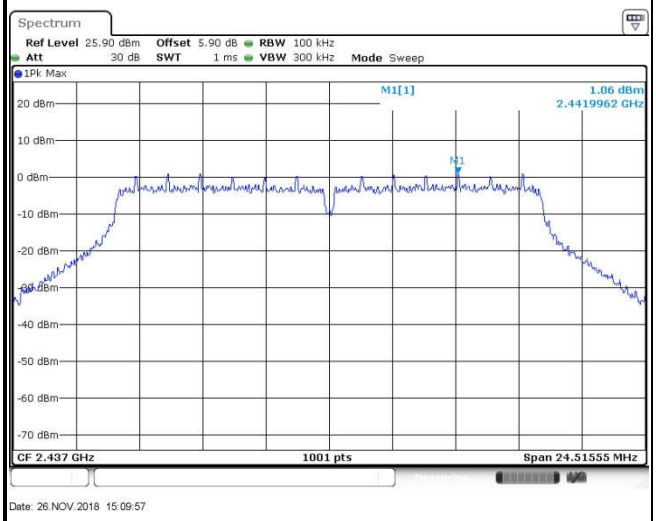
Test Mode :	802.11b	Test Channel :	11

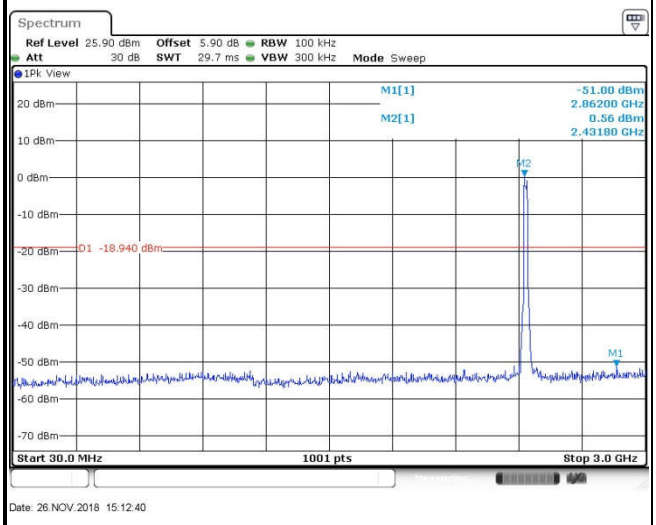
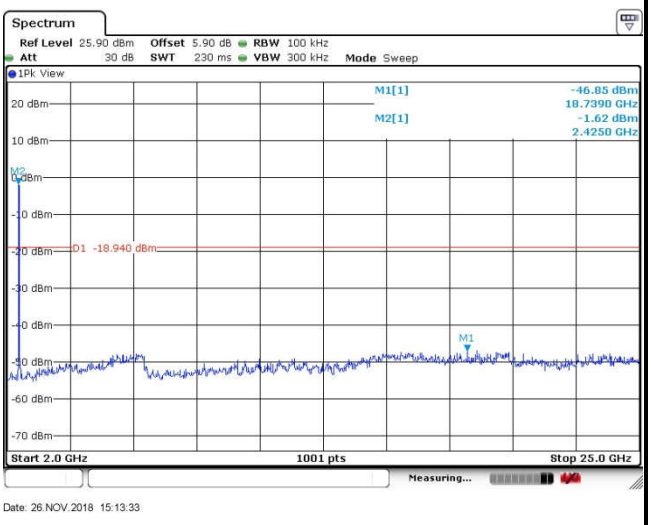
100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	**Spurious Emission 2GHz~25GHz**
	

Test Mode :	802.11g	Test Channel :	01

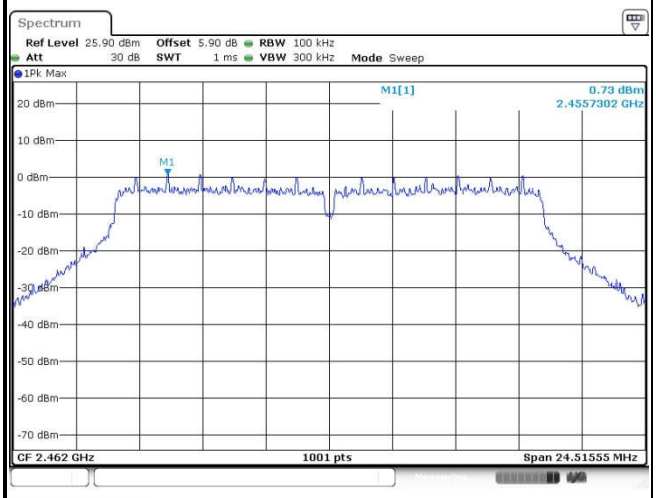
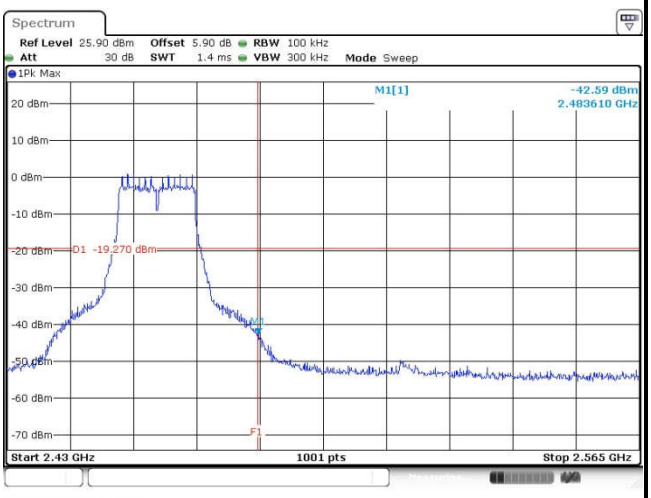
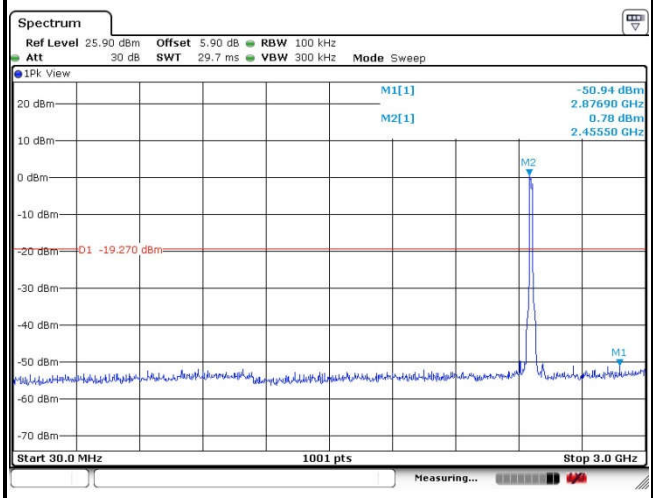
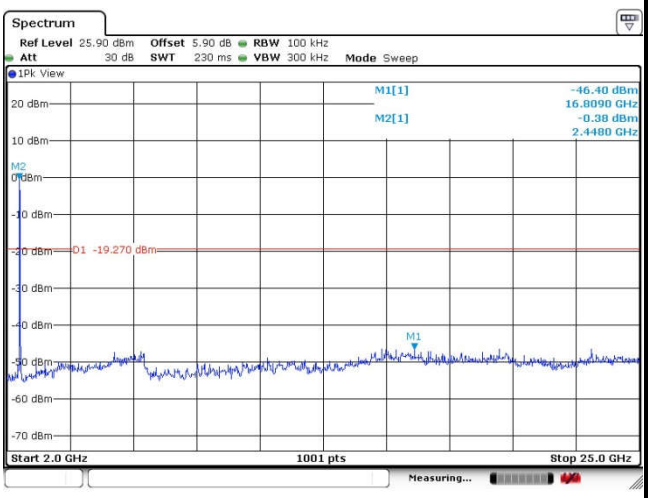
100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	**Spurious Emission 2GHz~25GHz**
	

Test Mode :	802.11g	Test Channel :	06

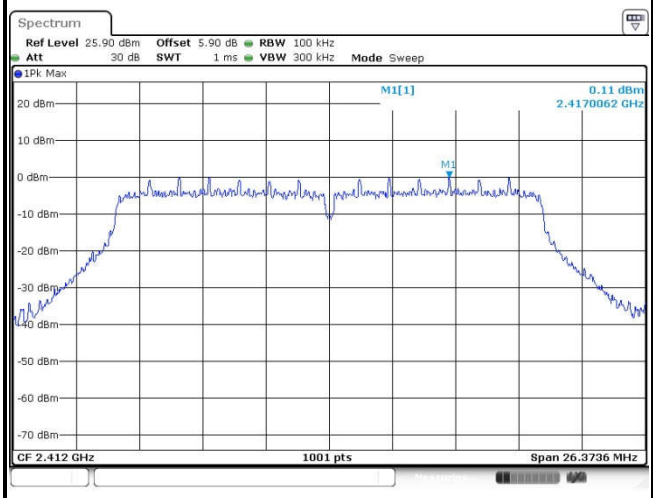
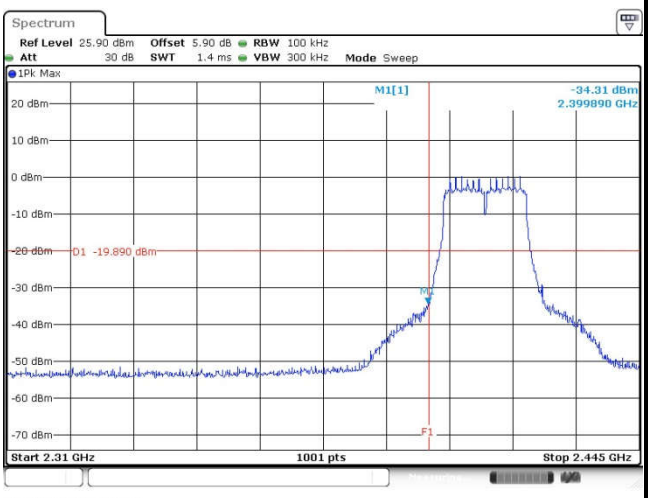
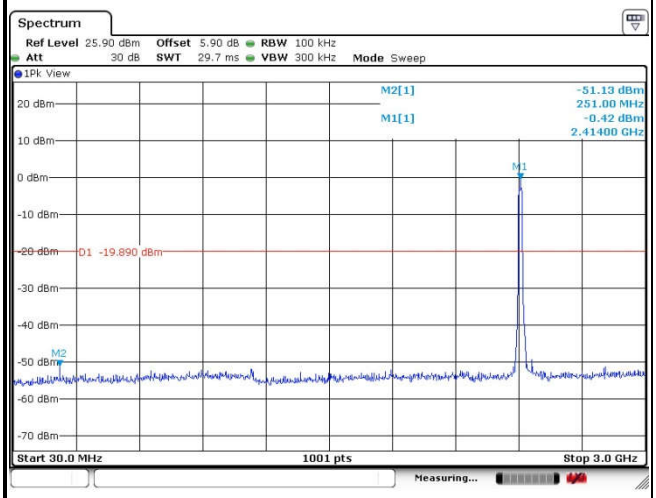
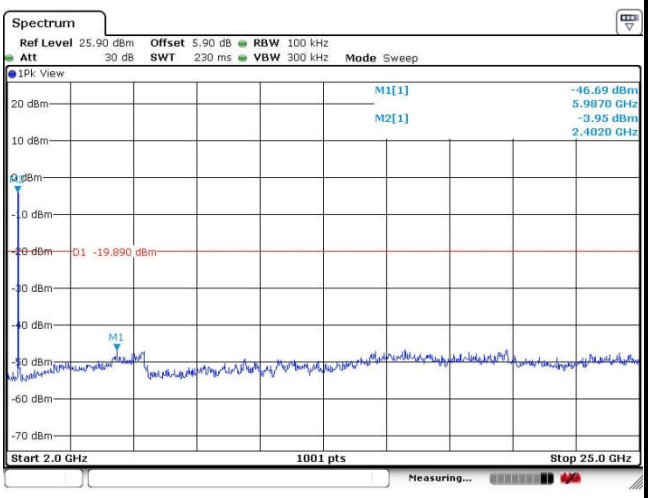
100kHz PSD reference Level	
	

Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
	

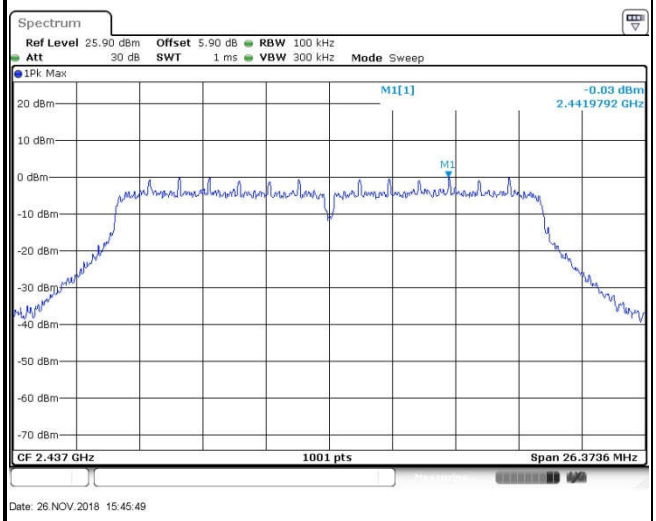
Test Mode :	802.11g	Test Channel :	11

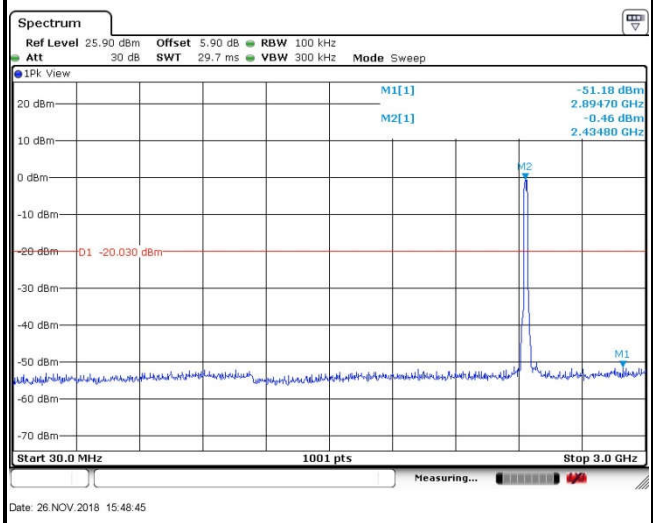
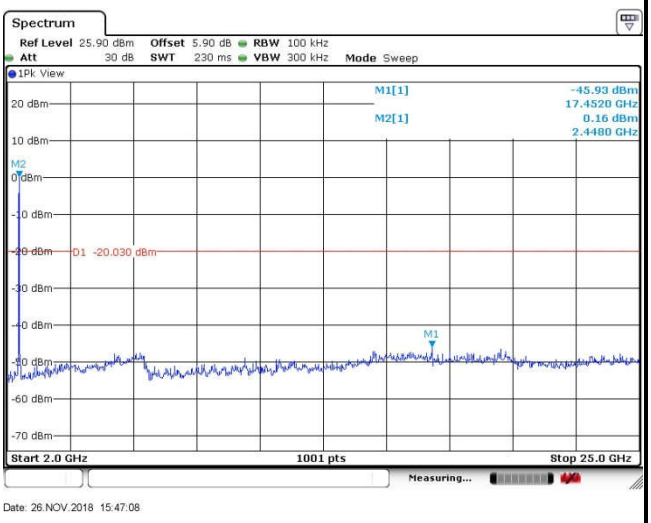
100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	**Spurious Emission 2GHz~25GHz**
	

Test Mode :	802.11n HT20	Test Channel :	01

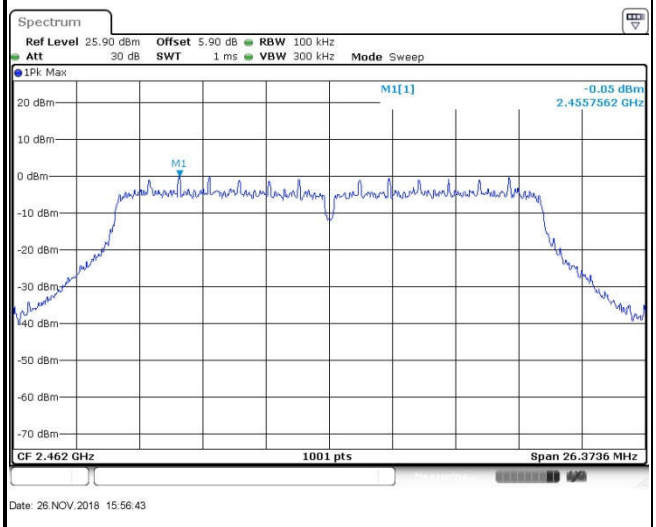
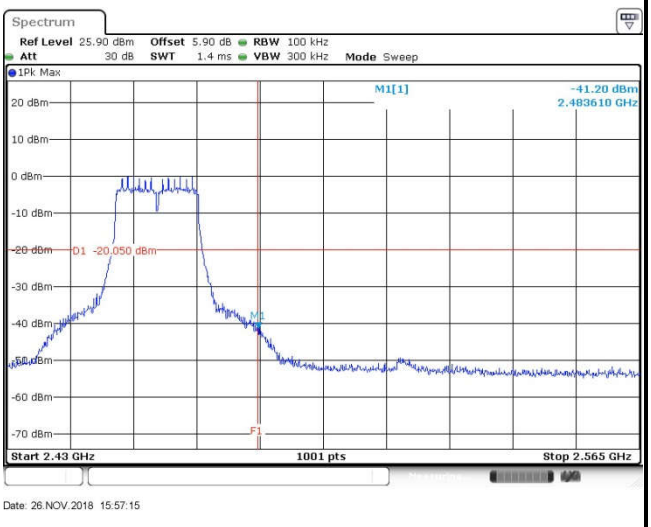
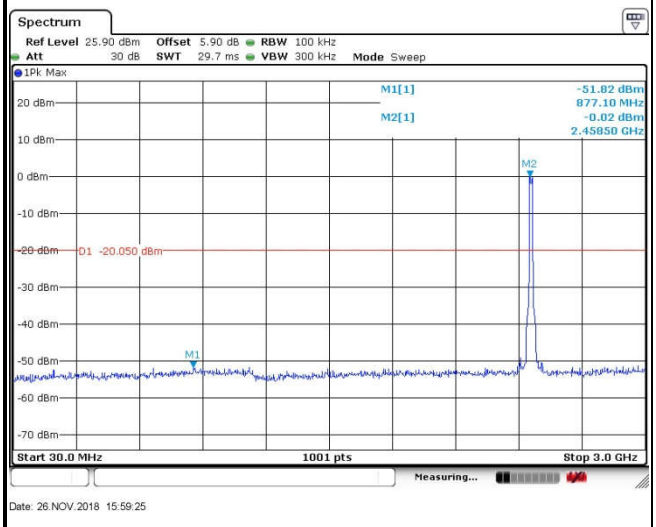
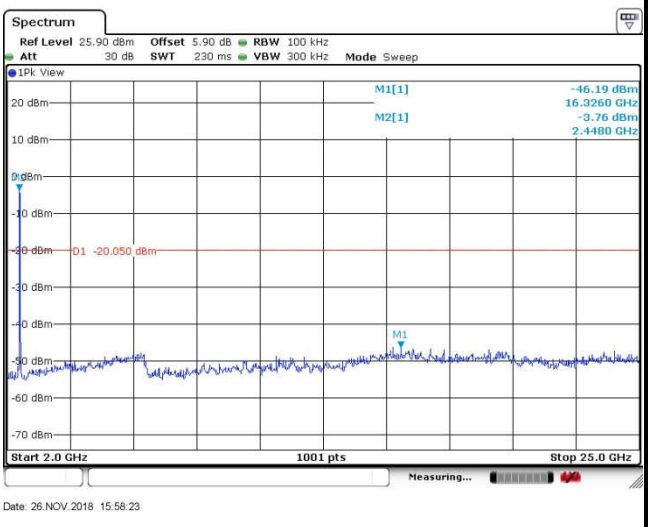
100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
	

Test Mode :	802.11n HT20	Test Channel :	06

100kHz PSD reference Level	
	

Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
	

Test Mode :	802.11n HT20	Test Channel :	11

100kHz PSD reference Level	Channel Plot
	
Spurious Emission 30MHz~3GHz	**Spurious Emission 2GHz~25GHz**
	

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated band edge and Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.5.2 Measuring Instruments

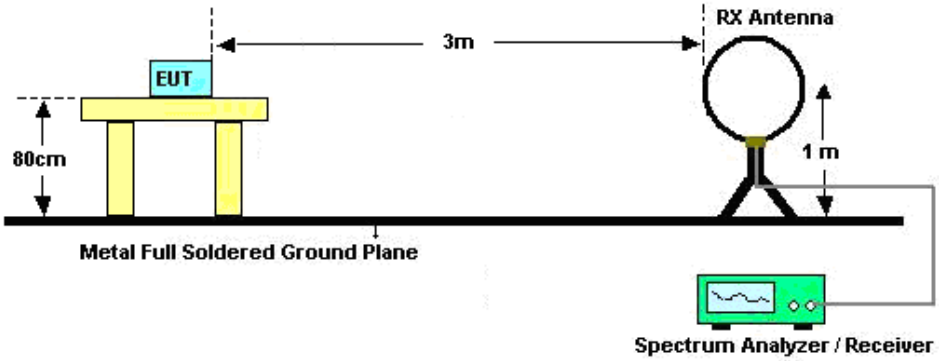
The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

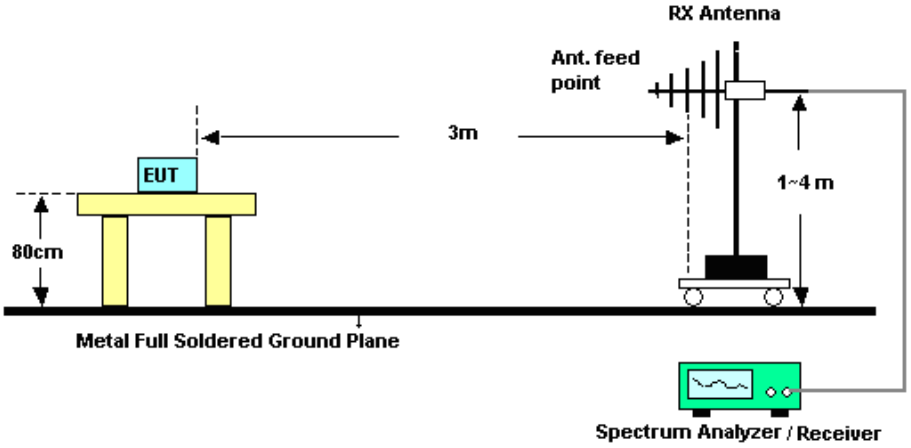
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

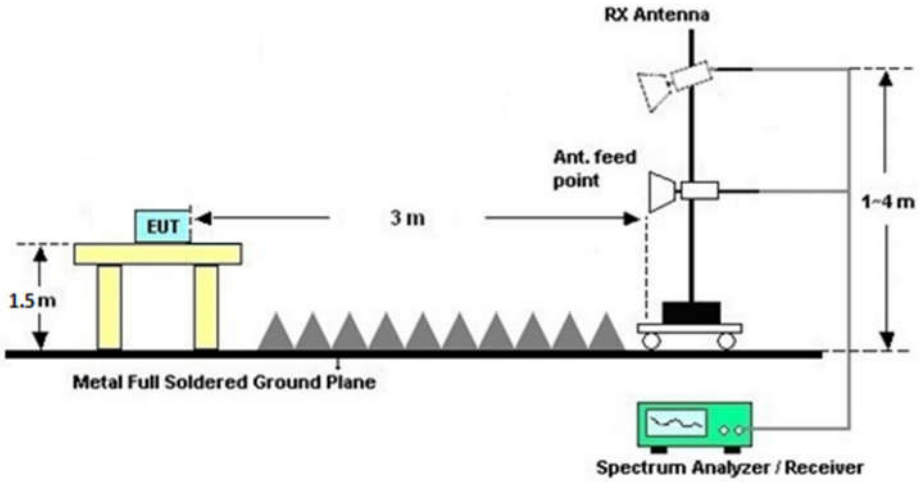
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9kHz ~ 30MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B.

3.5.7 Duty Cycle

Please refer to Appendix C.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix B.

3.6 Antenna Requirements

3.6.1 Standard Applicable

If directional gain of transmitting Antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached Antenna or of an Antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.6.2 Antenna Anti-Replacement Construction

Antenna permanently attached.

3.6.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Aug. 07, 2018	Nov. 26, 2018	Aug. 06, 2019	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 18, 2018	Nov. 26, 2018	Jan. 17, 2019	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 18, 2018	Nov. 26, 2018	Jan. 17, 2019	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400023	3Hz~8.5GHz;Max 30dBm	Oct. 12, 2018	Nov. 24, 2018	Oct. 11, 2019	Radiation (03CH06-KS)
EXA Spectrum Analyzer	Keysight	N9010B	MY57471084	10Hz-44GHz	Jun. 25, 2018	Nov. 24, 2018	Jun. 24, 2019	Radiation (03CH06-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Oct. 19, 2018	Nov. 24, 2018	Oct. 18, 2019	Radiation (03CH06-KS)
Bilog Antenna	TeseQ	CBL6111D	44483	30MHz-1GHz	Jan. 29, 2018	Nov. 24, 2018	Jan. 28, 2019	Radiation (03CH06-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	75957	1GHz~18GHz	Oct. 20, 2018	Nov. 24, 2018	Oct. 19, 2019	Radiation (03CH06-KS)
SHF-EHF Horn	Schwarzbeck	BBHA 9170	BBHA170249	15GHz~40GHz	Feb. 07, 2018	Nov. 24, 2018	Feb. 06, 2019	Radiation (03CH06-KS)
Amplifier	SONOMA	310N	187289	9KHz ~1GHZ	Aug. 06, 2018	Nov. 24, 2018	Aug. 05, 2019	Radiation (03CH06-KS)
Amplifier	MITEQ	TTA1840-35-HG	2014749	18~40GHz	Feb. 08, 2018	Nov. 24, 2018	Feb. 07, 2019	Radiation (03CH06-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2025788	1Ghz-18Ghz	Apr. 17, 2018	Nov. 24, 2018	Apr. 16, 2019	Radiation (03CH06-KS)
Amplifier	Keysight	83017A	MY53270203	500MHz~26.5GHz	Dec. 16, 2017	Nov. 24, 2018	Dec. 15, 2018	Radiation (03CH06-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Nov. 24, 2018	NCR	Radiation (03CH06-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Nov. 24, 2018	NCR	Radiation (03CH06-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Nov. 24, 2018	NCR	Radiation (03CH06-KS)

NCR: No Calibration Required

5 Uncertainty of Evaluation

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.9 dB

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

Appendix A. Conducted Test Results

Report Number : FR8N1306B

A1 - DTS Part

Test Engineer:	Silent Hai	Temperature:	21~25	°C
Test Date:	2018/11/26	Relative Humidity:	49~51	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

2.4GHz Band								
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
11b	1Mbps	1	1	2412	12.29	7.07	0.50	Pass
11b	1Mbps	1	6	2437	12.39	7.07	0.50	Pass
11b	1Mbps	1	11	2462	12.44	7.09	0.50	Pass
11g	6Mbps	1	1	2412	18.73	16.34	0.50	Pass
11g	6Mbps	1	6	2437	18.38	16.34	0.50	Pass
11g	6Mbps	1	11	2462	19.03	16.34	0.50	Pass
HT20	MCS0	1	1	2412	19.58	17.58	0.50	Pass
HT20	MCS0	1	6	2437	19.53	17.58	0.50	Pass
HT20	MCS0	1	11	2462	19.53	17.58	0.50	Pass

TEST RESULTS DATA
Peak Power Table

2.4GHz Band										
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
11b	1Mbps	1	1	2412	17.35	30.00	3.04	20.39	36.00	Pass
11b	1Mbps	1	6	2437	16.93	30.00	3.04	19.97	36.00	Pass
11b	1Mbps	1	11	2462	16.39	30.00	3.04	19.43	36.00	Pass
11g	6Mbps	1	1	2412	20.83	30.00	3.04	23.87	36.00	Pass
11g	6Mbps	1	6	2437	20.76	30.00	3.04	23.80	36.00	Pass
11g	6Mbps	1	11	2462	20.26	30.00	3.04	23.30	36.00	Pass
HT20	MCS0	1	1	2412	20.43	30.00	3.04	23.47	36.00	Pass
HT20	MCS0	1	6	2437	20.12	30.00	3.04	23.16	36.00	Pass
HT20	MCS0	1	11	2462	19.82	30.00	3.04	22.86	36.00	Pass

TEST RESULTS DATA
Average Power Table
(Reporting Only)

2.4GHz Band						
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)
11b	1Mbps	1	1	2412	0.11	14.23
11b	1Mbps	1	6	2437	0.11	13.82
11b	1Mbps	1	11	2462	0.11	13.56
11g	6Mbps	1	1	2412	0.60	12.14
11g	6Mbps	1	6	2437	0.60	11.91
11g	6Mbps	1	11	2462	0.60	11.49
HT20	MCS0	1	1	2412	0.64	11.19
HT20	MCS0	1	6	2437	0.64	11.03
HT20	MCS0	1	11	2462	0.64	10.62

TEST RESULTS DATA
Peak Power Density

2.4GHz Band								
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
11b	1Mbps	1	1	2412	-8.34	3.04	8.00	Pass
11b	1Mbps	1	6	2437	-7.29	3.04	8.00	Pass
11b	1Mbps	1	11	2462	-8.55	3.04	8.00	Pass
11g	6Mbps	1	1	2412	-12.33	3.04	8.00	Pass
11g	6Mbps	1	6	2437	-9.49	3.04	8.00	Pass
11g	6Mbps	1	11	2462	-13.21	3.04	8.00	Pass
HT20	MCS0	1	1	2412	-14.11	3.04	8.00	Pass
HT20	MCS0	1	6	2437	-13.99	3.04	8.00	Pass
HT20	MCS0	1	11	2462	-13.03	3.04	8.00	Pass

Appendix B. Radiated Spurious Emission

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11b (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		2381.89	51.89	-22.11	74	53.73	25.55	5.61	33	120	185	P	H
		2389.82	41.34	-12.66	54	43.14	25.6	5.63	33.03	120	185	A	H
	*	2412	105.65	-	-	107.24	25.79	5.65	33.03	120	185	P	H
	*	2412	102.35	-	-	103.94	25.79	5.65	33.03	120	185	A	H
		2386.05	47.04	-26.96	74	48.81	25.6	5.63	33	400	84	P	V
		2389.56	36.47	-17.53	54	38.24	25.6	5.63	33	400	84	A	V
	*	2412	99.14	-	-	100.73	25.79	5.65	33.03	400	84	P	V
	*	2412	95.89	-	-	97.48	25.79	5.65	33.03	400	84	A	V
802.11b CH 11 2462MHz	*	2462	106.3	-	-	106.93	26.34	5.7	32.67	383	185	P	H
	*	2462	103.09	-	-	103.72	26.34	5.7	32.67	383	185	A	H
		2484.1	52.62	-21.38	74	52.86	26.53	5.72	32.49	383	185	P	H
		2483.62	42.08	-11.92	54	42.32	26.53	5.72	32.49	383	185	A	H
	*	2462	100.04	-	-	100.67	26.34	5.7	32.67	301	74	P	V
	*	2462	96.84	-	-	97.47	26.34	5.7	32.67	301	74	A	V
		2483.56	49.17	-24.83	74	49.41	26.53	5.72	32.49	301	74	P	V
		2483.8	38.24	-15.76	54	38.48	26.53	5.72	32.49	301	74	A	V

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11b (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		4824	37.82	-36.18	74	62.22	30.92	8.43	63.75	100	360	P	H
		4824	36.8	-37.2	74	61.2	30.92	8.43	63.75	100	360	P	V
802.11b CH 06 2437MHz		4872	38.39	-35.61	74	62.64	31.05	8.43	63.73	100	360	P	H
		7311	40.93	-33.07	74	59.71	35.52	10.07	64.37	100	360	P	H
		4874	37.28	-36.72	74	61.53	31.05	8.43	63.73	100	0	P	V
		7308	40.46	-33.54	74	59.24	35.52	10.07	64.37	100	0	P	V
802.11b CH 11 2462MHz		4926	35.68	-38.32	74	59.77	31.18	8.44	63.71	100	360	P	H
		7386	40.5	-33.5	74	59.04	35.69	10.15	64.38	100	360	P	H
		4926	35.75	-38.25	74	59.84	31.18	8.44	63.71	100	0	P	V
		7386	40.74	-33.26	74	59.28	35.69	10.15	64.38	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11g (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 01 2412MHz		2389.95	64.61	-9.39	74	66.41	25.6	5.63	33.03	100	176	P	H
		2389.95	47.82	-6.18	54	49.62	25.6	5.63	33.03	100	176	A	H
	*	2418	105.19	-	-	106.6	25.79	5.65	32.85	100	176	P	H
	*	2418	97.47	-	-	98.88	25.79	5.65	32.85	100	176	A	H
		2389.82	50.47	-23.53	74	52.27	25.6	5.63	33.03	393	83	P	V
		2389.95	38.24	-15.76	54	40.04	25.6	5.63	33.03	393	83	A	V
	*	2416	99.6	-	-	101.01	25.79	5.65	32.85	393	83	P	V
	*	2420	91.75	-	-	92.96	25.97	5.67	32.85	393	83	A	V
802.11g CH 11 2462MHz	*	2458	104.76	-	-	105.39	26.34	5.7	32.67	100	196	P	H
	*	2458	97	-	-	97.63	26.34	5.7	32.67	100	196	A	H
	!	2483.74	68.04	-5.96	74	68.28	26.53	5.72	32.49	100	196	P	H
	!	2483.51	50.78	-3.22	54	51.02	26.53	5.72	32.49	100	196	A	H
	*	2458	96.33	-	-	96.96	26.34	5.7	32.67	187	80	P	V
	*	2458	88.57	-	-	89.2	26.34	5.7	32.67	187	80	A	V
		2483.68	58.15	-15.85	74	58.39	26.53	5.72	32.49	187	80	P	V
		2483.5	42.15	-11.85	54	42.39	26.53	5.72	32.49	187	80	A	V

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11g (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 01 2412MHz		4824	38.22	-35.78	74	62.62	30.92	8.43	63.75	100	360	P	H
		4824	36.22	-37.78	74	60.62	30.92	8.43	63.75	100	0	P	V
802.11g CH 06 2437MHz		4872	38.05	-35.95	74	62.3	31.05	8.43	63.73	100	360	P	H
		7311	40.44	-33.56	74	59.22	35.52	10.07	64.37	100	360	P	H
		4874	37.08	-36.92	74	61.33	31.05	8.43	63.73	100	0	P	V
		7308	40.6	-33.4	74	59.38	35.52	10.07	64.37	100	0	P	V
802.11g CH 11 2462MHz		4926	36.25	-37.75	74	60.34	31.18	8.44	63.71	100	0	P	H
		7386	40.9	-33.1	74	59.44	35.69	10.15	64.38	100	0	P	H
		4924	35.5	-38.5	74	59.59	31.18	8.44	63.71	100	360	P	V
		7386	41.05	-32.95	74	59.59	35.69	10.15	64.38	100	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11n HT20 (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11n HT20 CH 01 2412MHz		2389.95	62.84	-11.16	74	64.64	25.6	5.63	33.03	100	180	P	H
		2389.95	47.27	-6.73	54	49.07	25.6	5.63	33.03	100	180	A	H
	*	2418	103.85	-	-	105.26	25.79	5.65	32.85	100	180	P	H
	*	2418	95.27	-	-	96.68	25.79	5.65	32.85	100	180	A	H
		2389.82	52.2	-21.8	74	54	25.6	5.63	33.03	393	82	P	V
		2389.82	38.36	-15.64	54	40.16	25.6	5.63	33.03	393	82	A	V
	*	2420	98.16	-	-	99.37	25.97	5.67	32.85	393	82	P	V
	*	2420	90.5	-	-	91.71	25.97	5.67	32.85	393	82	A	V
802.11n HT20 CH 11 2462MHz	*	2456	104.22	-	-	104.85	26.34	5.7	32.67	382	182	P	H
	*	2456	95.97	-	-	96.6	26.34	5.7	32.67	382	182	A	H
		2483.51	67.88	-6.12	74	68.12	26.53	5.72	32.49	382	182	P	H
		2483.56	50.96	-3.04	54	51.2	26.53	5.72	32.49	382	182	A	H
	*	2458	97.26	-	-	97.89	26.34	5.7	32.67	342	80	P	V
	*	2458	89.65	-	-	90.28	26.34	5.7	32.67	342	80	A	V
		2483.86	56.97	-17.03	74	57.21	26.53	5.72	32.49	342	80	P	V
		2483.5	42.62	-11.38	54	42.86	26.53	5.72	32.49	342	80	A	V

15C 2.4GHz 2400~2483.5MHz

WIFI 802.11n HT20 (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11n HT20 CH 01 2412MHz		4824	37.61	-36.39	74	62.01	30.92	8.43	63.75	100	360	P	H
		4824	36.81	-37.19	74	61.21	30.92	8.43	63.75	100	360	P	V
802.11n HT20 CH 06 2437MHz		4872	38.22	-35.78	74	62.47	31.05	8.43	63.73	100	360	P	H
		7311	41.45	-32.55	74	60.23	35.52	10.07	64.37	100	360	P	H
		4874	38.05	-35.95	74	62.3	31.05	8.43	63.73	100	0	P	V
		7308	40.61	-33.39	74	59.39	35.52	10.07	64.37	100	0	P	V
802.11n HT20 CH 11 2462MHz		4926	35.54	-38.46	74	59.63	31.18	8.44	63.71	100	0	P	H
		7386	39.93	-34.07	74	58.47	35.69	10.15	64.38	100	0	P	H
		4924	36.57	-37.43	74	60.66	31.18	8.44	63.71	100	360	P	V
		7386	41.67	-32.33	74	60.21	35.69	10.15	64.38	100	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

15C Emission below 1GHz

2.4GHz WIFI 802.11n HT20 (LF)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz 802.11n HT20 LF		83.35	23.22	-16.78	40	41.84	13.44	0.87	32.93	-	-	P	H
		169.68	31.12	-12.38	43.5	47.16	15.57	1.33	32.94	-	-	P	H
		229.82	33.62	-12.38	46	48.67	16.35	1.56	32.96	-	-	P	H
		384.05	29.79	-16.21	46	39.6	21.23	2.07	33.11	-	-	P	H
		748.77	36.02	-9.98	46	40.65	25.48	3	33.11	100	0	P	H
		786.6	35.39	-10.61	46	39.37	25.94	3.11	33.03	-	-	P	H
		37.76	22.7	-17.3	40	35.43	19.72	0.52	32.97	-	-	P	V
		63.95	22.29	-17.71	40	41.94	12.56	0.73	32.94	-	-	P	V
		460.68	32.71	-13.29	46	40.99	22.69	2.26	33.23	100	0	P	V
		595.51	31.88	-14.12	46	38.1	24.54	2.59	33.35	-	-	P	V
		748.77	30.56	-15.44	46	35.19	25.48	3	33.11	-	-	P	V
		786.6	29.67	-16.33	46	33.65	25.94	3.11	33.03	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency per 15.209(c).
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1+2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

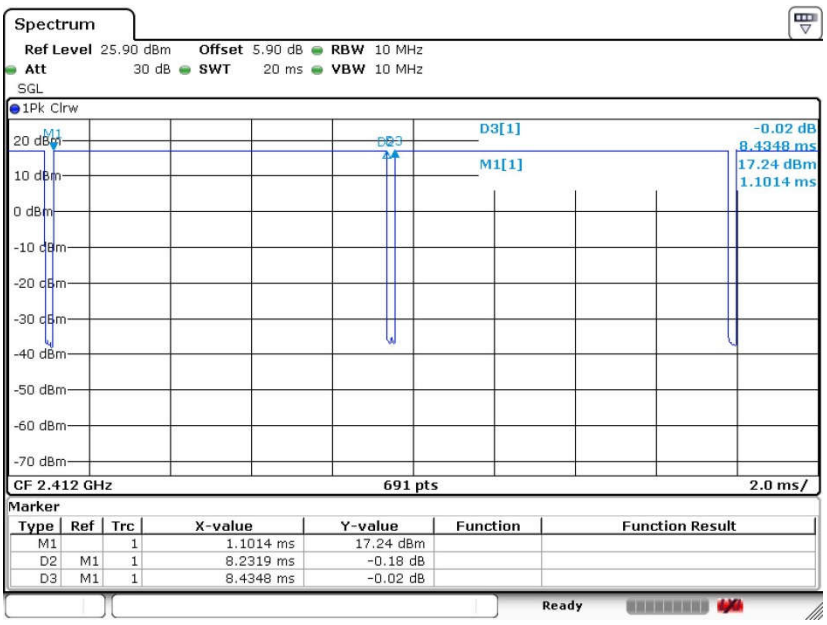
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is "PASS".

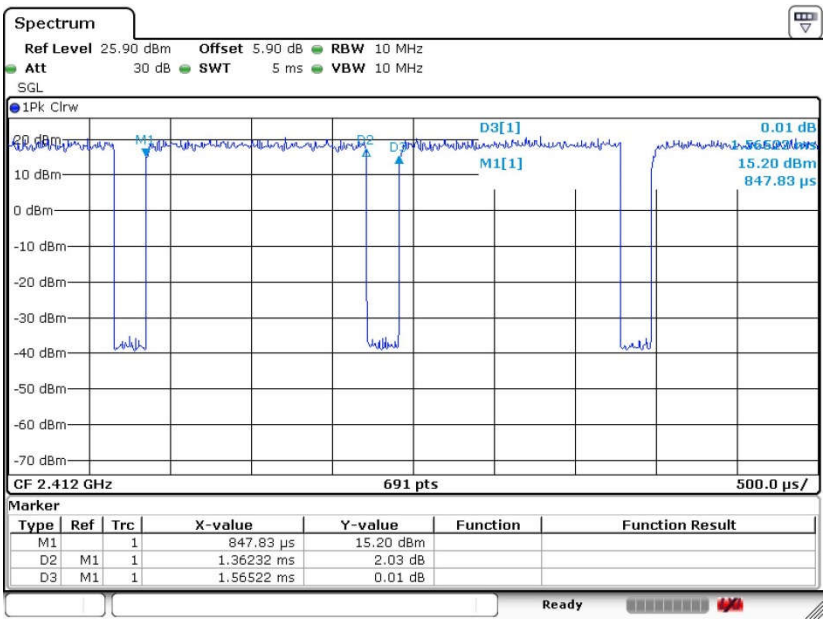
Appendix C. Duty Cycle Plots

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
802.11b	97.59	8.232	0.121	0.13KHz
802.11g	87.04	1.362	0.734	0.75KHz
802.11n HT20	86.27	1.275	0.784	0.82KHz

802.11b



802.11g



802.11n20