



FCC CO-LOCATION RADIO TEST REPORT

FCC ID : S9GR550
Equipment : Wireless Access Point
Brand Name : Ruckus
Model Name : R550
Applicant : Ruckus Wireless Inc.
350 W. Java Dr., Sunnyvale CA 94089 USA
Manufacturer : Ruckus Wireless Inc.
350 W. Java Dr., Sunnyvale CA 94089 USA
Standard : FCC Part 15 Subpart E §15.407

The product was received on Jan. 22, 2020 and testing was started from Feb. 06, 2020 and completed on Mar. 10, 2020. We, Sporton International (USA) 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 report must not be used by the client to claim product certification, approval, or endorsement by A2LA or any agency of government.

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

Approved by: Ken Chen

Sporton International (USA) Inc.
1175 Montague Expressway, Milpitas, CA 95035



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History of this test report

Report No.	Version	Description	Issued Date
FR200117001G	01	Initial issue of report	Apr. 13, 2020
FR200117001G	02	Revise Antenna Information in Section 1.1	Apr. 16, 2020



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.407(b)	Unwanted Emissions	Pass	Under limit 0.35 dB at 2374.000 MHz
3.2	15.203 15.407(a)	Antenna Requirement	Pass	-

Declaration of Conformity:

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

Comments and Explanations:

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



1 General Description

1.1 Product Feature of Equipment Under Test

Bluetooth, Wi-Fi 2.4GHz 802.11b/g/n/ax, Wi-Fi 5GHz 802.11a/n/ac/ax, and Zigbee.

Product Specification subjective to this standard	
Antenna Type	WLAN: <Ant. 1> Internal Antenna <Ant. 2> Internal Antenna Bluetooth: Metal Antenna Zigbee: Metal Antenna

1.2 Modification of EUT

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

1.3 Testing Location

Test Site	Sporton International (USA) Inc.
Test Site Location	1175 Montague Expressway, Milpitas, CA 95035 TEL : 408 9043300
Test Site No.	Sporton Site No.
	03CH02-CA

1.4 Applicable Standards

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

- ♦ FCC Part 15 Subpart E
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01.
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

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, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz Zigbee		2400-2483.5 MHz 802.11g		5150-5250 MHz 802.11a	
Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
11	2405	06	2437	40	5200

2.2 Test Mode

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

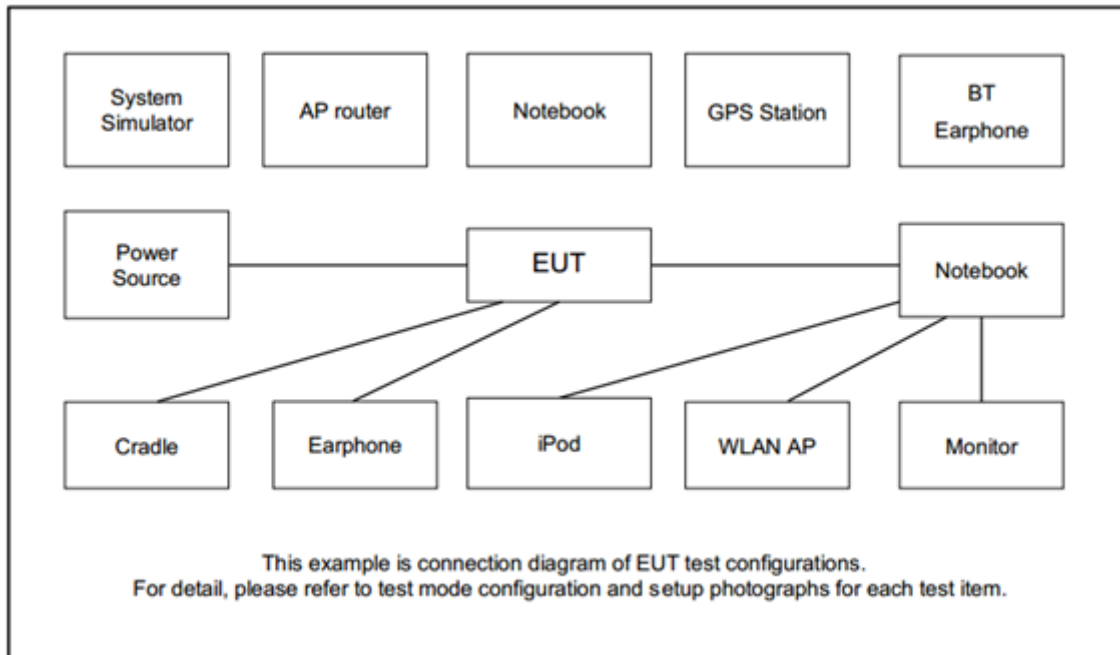
<Co-Location>

Modulation	Data Rate
2.4GHz 802.11g + Zigbee	6Mbps+ 250kbps
5GHz 802.11a + Zigbee	6Mbps+ 250kbps

Remark:

1. Only scan intermodulation signal base on customer requirement.
2. Radiated Spurious Emissions for LF and above 18G only test the worst case. Please refer to Sporton Report Number FR200117001D.

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Laptop	DELL	E6430	N/A	N/A	N/A
2.	PoE Adapter	Ruckus Wireless Inc.	N/A	N/A	N/A	N/A
3.	Adapter	Ruckus Wireless Inc.	APH-5020	N/A	N/A	N/A

2.5 EUT Operation Test Setup

The RF test items, utility “Putty” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

3 Test Result

3.1 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.1.1 Limit of Unwanted Emissions

(1) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table,

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: The following formula is used to convert the EIRP to field strength.

$$E = \frac{1000000\sqrt{30P}}{3} \mu\text{V/m, where P is the eirp (Watts)}$$

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

(2) KDB789033 D02 v02r01 G)2)c)

- (i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz.
- (ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

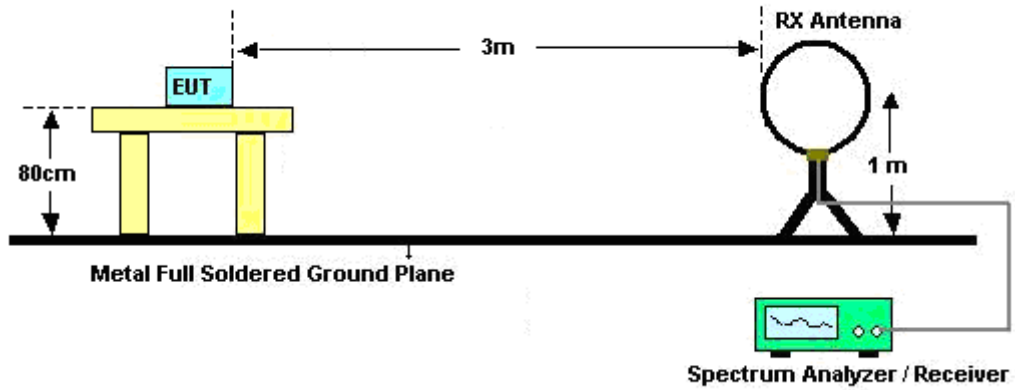


3.1.3 Test Procedures

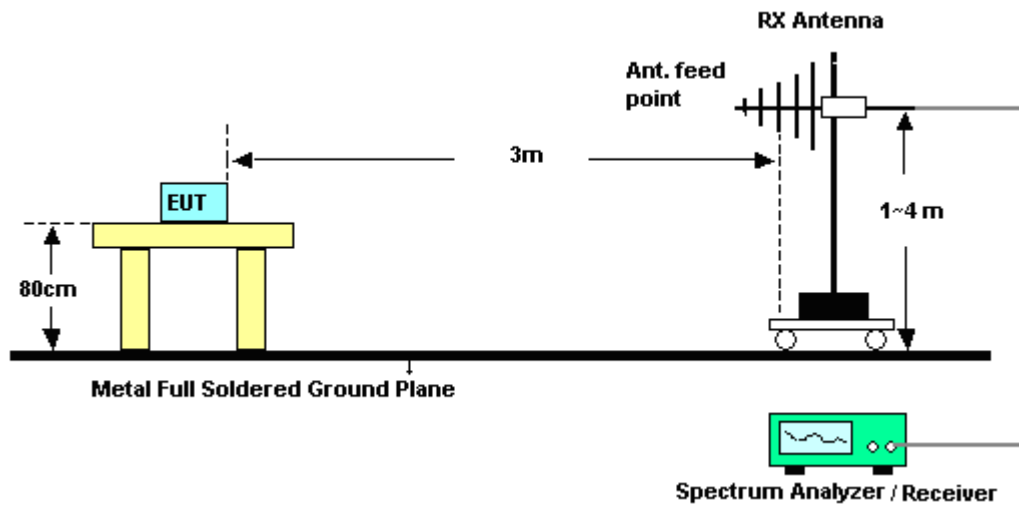
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW \geq 3 MHz
 - Detector = Peak
 - Sweep time = auto
 - Trace mode = max hold
 - (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz
 - RBW = 1 MHz
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW \geq 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.
2. 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.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
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.

3.1.4 Test Setup

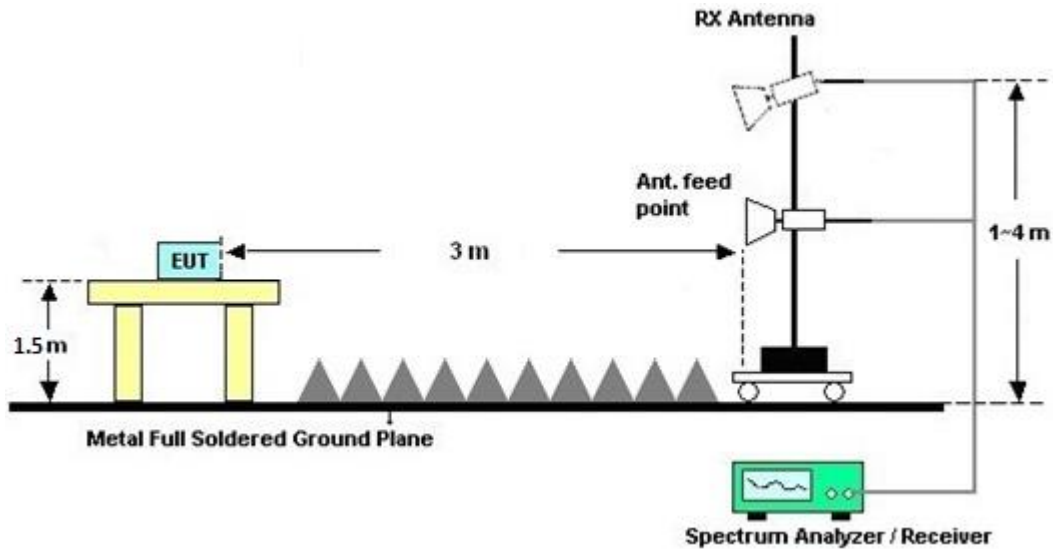
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

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 alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

3.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.1.7 Duty Cycle

Please refer to Appendix C.

3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A and B.



3.2 Antenna Requirements

3.2.1 Standard Applicable

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.2.3 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
Bilog Antenna	TESEQ	6111D	50392	30MHz~1GHz	May 15, 2019	Feb. 06, 2020~ Mar. 10, 2020	May 14, 2020	Radiation (03CH02-CA)
Horn Antenna	SCHWARZBE CK	BBHA 9120D	01894	1GHz~18GHz	Jul. 22, 2019	Feb. 06, 2020~ Mar. 10, 2020	Jul. 21, 2020	Radiation (03CH02-CA)
Amplifier	SONOMA	310N	372241	N/A	Jul. 26, 2019	Feb. 06, 2020~ Mar. 10, 2020	Jul. 25, 2020	Radiation (03CH02-CA)
Preamplifier	Keysight	83017A	MY5327032 1	1GHz~26.5GHz	Jul. 26, 2019	Feb. 06, 2020~ Mar. 10, 2020	Jul. 25, 2020	Radiation (03CH02-CA)
Preamplifier	Jet-Power	JPA0118-55-3 03	171000180 0055007	1GHz~18GHz	Apr. 01, 2019	Feb. 06, 2020~ Mar. 10, 2020	Mar. 31, 2020	Radiation (03CH02-CA)
Spectrum Analyzer	Keysight	N9010A	MY5742022 1	10Hz~44GHz	Sep. 11, 2019	Feb. 06, 2020~ Mar. 10, 2020	Sep. 10, 2020	Radiation (03CH02-CA)
Filter	Wainwright	WLK12-1200- 1272-11000-4 0SS	SN2	1.2G Low Pass	Aug. 02, 2019	Feb. 06, 2020~ Mar. 10, 2020	Aug. 01, 2020	Radiation (03CH02-CA)
Filter	Wainwright	WHKX12-270 0-3000-18000 -60ST	SN10	3G Highpass	Aug. 02, 2019	Feb. 06, 2020~ Mar. 10, 2020	Aug. 01, 2020	Radiation (03CH02-CA)
Hygrometer	TESEO	608-H1	45142602	N/A	Jul. 25, 2019	Feb. 06, 2020~ Mar. 10, 2020	Jul. 24, 2020	Radiation (03CH02-CA)
Controller	ChainTek	3000-1	N/A	Control Turn table & Ant Mast	N/A	Feb. 06, 2020~ Mar. 10, 2020	N/A	Radiation (03CH02-CA)
Antenna Mast	ChainTek	MBS-520-1	N/A	1m~4m	N/A	Feb. 06, 2020~ Mar. 10, 2020	N/A	Radiation (03CH02-CA)
Turn Table	ChainTek	T-200-S-1	N/A	0~360 Degree	N/A	Feb. 06, 2020~ Mar. 10, 2020	N/A	Radiation (03CH02-CA)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.4
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.5
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.3
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Appendix A. Radiated Spurious Emission

Test Engineer :	Calvin Wu, Leo Luo, and Jacky Hong	Temperature :	19~22°C
		Relative Humidity :	36~45%

802.11g_Tx_CH 06 + Zigbee_Tx_CH 11

WIFI	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11g CH 06 + Zigbee CH 11		2405	109.55	35.55	74	95.83	27.53	17.35	31.16	100	0	P	H
		2437	110.92	36.92	74	97.18	27.48	17.4	31.14	100	0	P	H
	*	4810	48.36	-25.64	74	71.71	31.38	11.55	66.28	100	0	P	H
		7215	48.19	-25.81	74	64.27	36.24	13.52	65.84	100	0	P	H
		2374	61.16	-12.84	74	47.24	27.8	17.3	31.18	265	166	P	V
		2374	53.65	-0.35	54	39.73	27.8	17.3	31.18	265	166	A	V
	*	2405	110.81	36.81	74	97.06	27.56	17.35	31.16	100	0	P	V
	*	2437	110.04	36.04	74	96.34	27.44	17.4	31.14	100	0	P	V
		3180	52.81	-21.19	74	79.4	28.96	9.95	65.5	200	170	P	V
		3270	52.63	-21.37	74	79.84	28.45	9.84	65.5	159	205	P	V
		3270	38.45	-15.55	54	65.66	28.45	9.84	65.5	159	205	A	V
		4810	49.75	-24.25	74	73.08	31.4	11.55	66.28	100	0	P	V
		6255	47.02	-26.98	74	66.75	33.1	12.42	65.25	100	0	P	V
	7215	53.43	-20.57	74	69.55	36.2	13.52	65.84	100	0	P	V	

Remark	1. No other spurious found.
	2. All results are PASS against Peak and Average limit line.



802.11a_Tx_CH 40 + Zigbee_Tx_CH 11

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11a CH 40 + Zigbee CH 11		2405	109.07	35.07	74	94.48	27.53	18.22	31.16	100	0	P	H
	*	5200	111.49	43.29	68.2	98.03	31.68	11.7	29.92	100	0	P	H
		7215	48.82	-19.38	68.2	64.45	36.24	13.97	65.84	100	0	P	H
		2405	110.06	36.06	74	95.44	27.56	18.22	31.16	100	0	P	V
	*	4810	55.5	-18.5	74	42.54	31.4	11.55	29.99	100	277	P	V
	*	4810	46.52	-7.48	54	33.56	31.4	11.55	29.99	100	277	A	V
		5200	111.73	43.53	68.2	98.21	31.74	11.55	29.92	100	0	P	V
		7215	52.77	-15.43	68.2	68.44	36.2	11.7	65.84	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average 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.
!	Test result is over limit line.
P/A	Peak or Average
H/V	Horizontal or Vertical



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

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 00													
2402MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path 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) + Path 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 B. Radiated Spurious Emission Plots

Test Engineer :	Calvin Wu, Leo Luo, and Jacky Hong	Temperature :	19~22°C
		Relative Humidity :	36~45%

802.11g_Tx_CH 06 + Zigbee_Tx_CH 11

802.11g_Tx_CH 06 + Zigbee_Tx_CH 11		
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH02-CA Condition : PEAK_74 3m HORN 9120D-HF_01895 HORIZONTAL Detector : Peak</p>	<p>Site : 03CH02-CA Condition : PEAK_74 3m HORN 9120D-HF_01895 VERTICAL Detector : Peak</p>



802.11a_Tx_CH 40 + Zigbee_Tx_CH 11

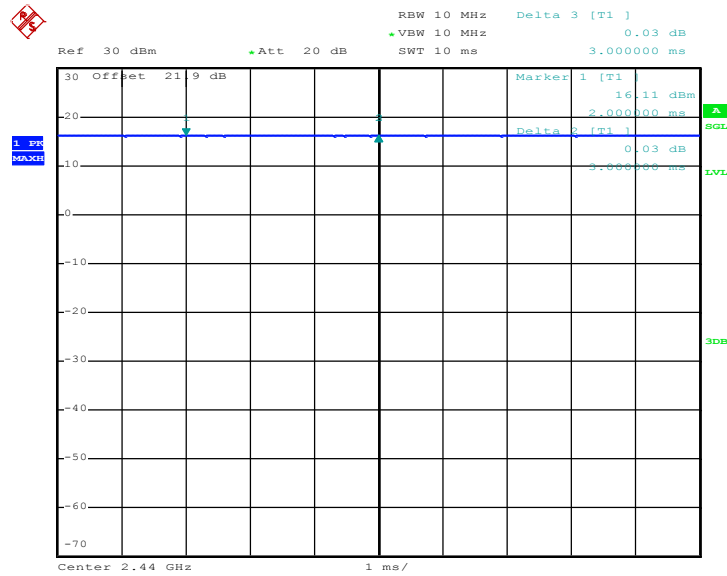
802.11a_Tx_CH 40 + Zigbee_Tx_CH 11		
	Horizontal	Vertical
QP / Peak	<p>Site : 03CH02-CA Condition : PEAK_74 3m HORN 9120D-HF_01895 HORIZONTAL Detector : Peak</p>	<p>Site : 03CH02-CA Condition : PEAK_74 3m HORN 9120D-HF_01895 VERTICAL Detector : Peak</p>



Appendix C. Duty Cycle Plots

Antenna	Band	Duty Cycle (%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor (dB)
-	Zigbee	100	-	-	10Hz	0.00
1+2	802.11g for Ant. 1	94.19	1977	0.51	1kHz	0.26
1+2	802.11g for Ant. 2	94.05	1975	0.51	1kHz	0.27
1+2	802.11a for Ant. 1	94.29	1980	0.51	1kHz	0.26
1+2	802.11a for Ant. 2	94.29	1980	0.51	1kHz	0.26

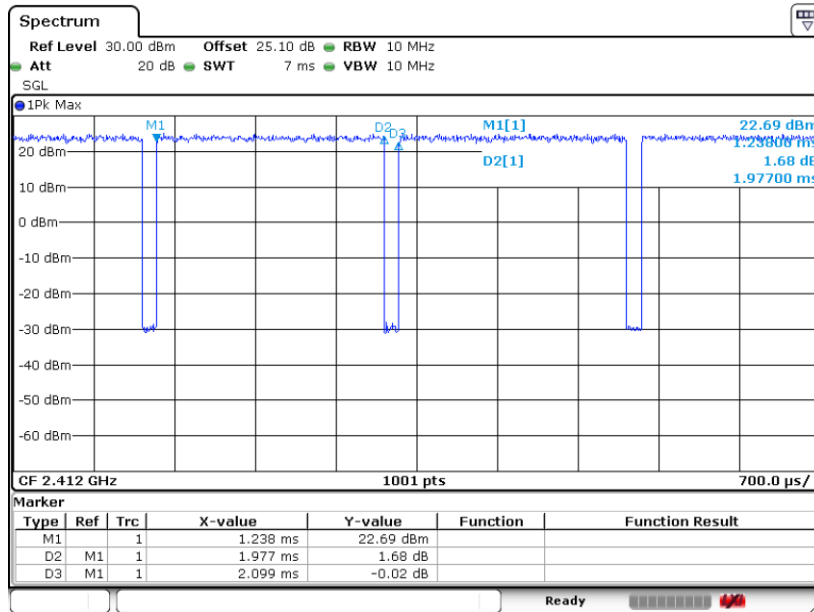
Zigbee





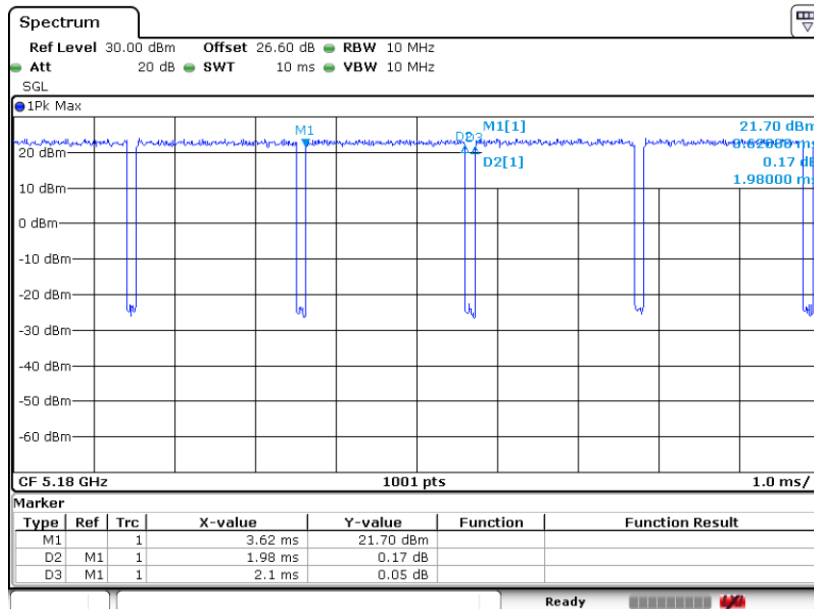
MIMO <Ant. 1>

802.11g



Date: 27. JAN 2020 11:26:37

802.11a

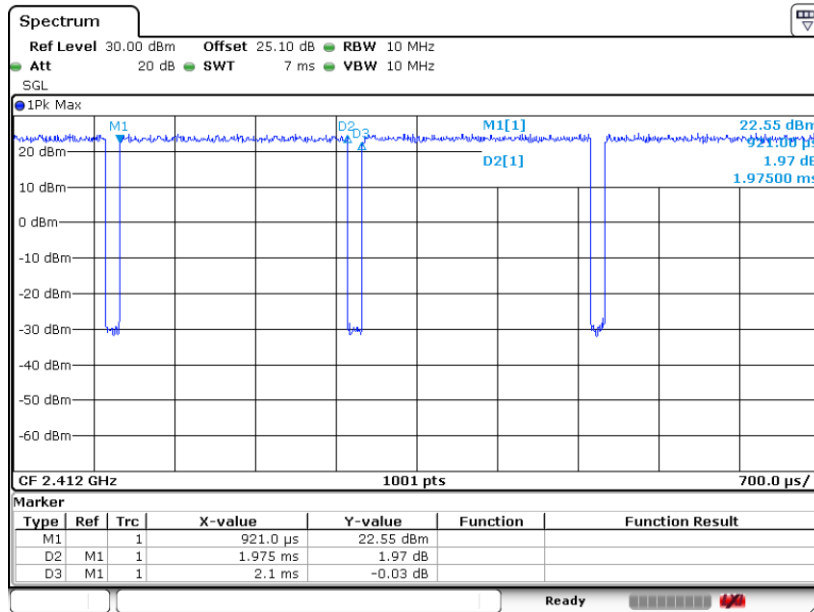


Date: 27. JAN 2020 13:47:01



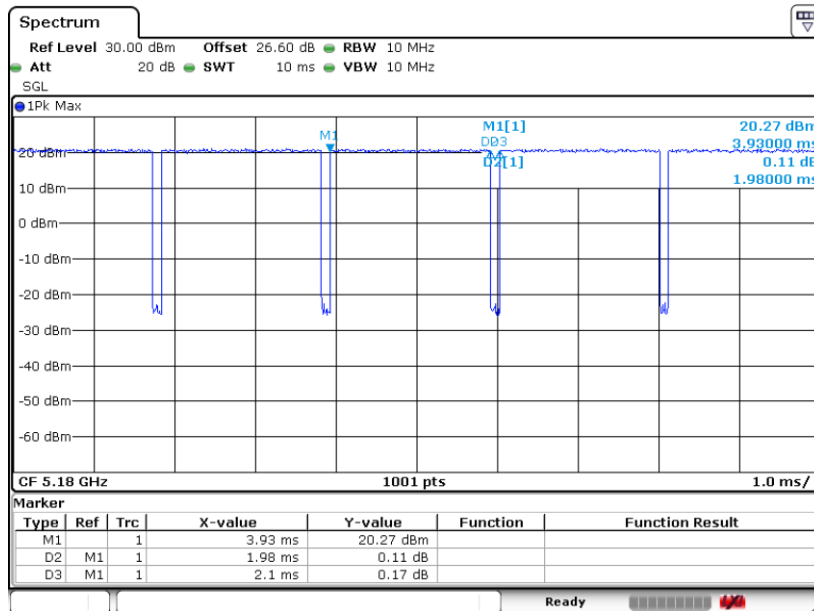
MIMO <Ant. 2>

802.11g



Date: 27 JAN 2020 11:27:43

802.11a



Date: 27 JAN 2020 13:46:39