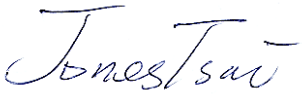
FCC RF Test Report

APPLICANT	:	Clarinox Technologies
EQUIPMENT	:	Koala Connect
BRAND NAME	:	Koala Connect
MODEL NAME	:	KM-153103
FCC ID	:	2AN5P1531
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DSS) Spread Spectrum Transmitter

This is a variant report. The product was received on Oct. 20, 2017 and testing was completed on Dec. 22, 2017. We, SPORTON INTERNATIONAL 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 INC., the test report shall not be reproduced except in full.

Reviewed by: Joseph Lin / Supervisor



Approved by: Jones Tsai / Manager

SPORTON INTERNATIONAL INC.
No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C.

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR7O2010A	Rev. 01	Initial issue of report	Dec. 27, 2017
FR7O2010A	Rev. 02	Change antenna gain with -1.4 dBi and update appendix a and appendix b	May 17, 2018

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
-	15.247(a)(1)	Number of Channels	≥ 15Chs	Not Required	-
-	15.247(a)(1)	Hopping Channel Separation	≥ 2/3 of 20dB BW	Not Required	-
-	15.247(a)(1)	Dwell Time of Each Channel	≤ 0.4sec in 31.6sec period	Not Required	-
-	15.247(a)(1)	20dB Bandwidth	NA	Not Required	-
-	-	99% Bandwidth	-	Not Required	-
3.1	15.247(b)(1)	Peak Output Power	≤ 125 mW	Pass	-
-	15.247(d)	Conducted Band Edges	≤ 20dBc	Not Required	-
-	15.247(d)	Conducted Spurious Emission	≤ 20dBc	Not Required	-
3.2	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.29 dB at 30.270 MHz
-	15.207	AC Conducted Emission	15.207(a)	Not Required	-
3.2.5	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

Note:
1. Not required means after assessing, test items are not necessary to carry out.
2. This is a variant report which can be referred Product Equality Declaration. All the test cases were performed on original report which can be referred to Sporton Report Number FR4O2349A. Based on the original report, the conducted power and radiated emission test cases were verified.

1 General Description

1.1 Applicant

Clarinox Technologies
28/296 Bay Rd, Cheltenham, VIC 3192, Australia

1.2 Manufacturer

Jorjin Technologies. Inc.
17F., No.239, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)

1.3 Product Feature of Equipment Under Test

Bluetooth and Wi-Fi 2.4GHz 802.11b/g/n

Product Specification subjective to this standard	
Antenna Type	WLAN: Chip Antenna Bluetooth: Chip Antenna

1.4 Modification of EUT

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

1.5 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1190 and TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	TH05-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd. Guishan Dist, Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	03CH11-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

1.6 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
- 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

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	27	2429	54	2456
	1	2403	28	2430	55	2457
	2	2404	29	2431	56	2458
	3	2405	30	2432	57	2459
	4	2406	31	2433	58	2460
	5	2407	32	2434	59	2461
	6	2408	33	2435	60	2462
	7	2409	34	2436	61	2463
	8	2410	35	2437	62	2464
	9	2411	36	2438	63	2465
	10	2412	37	2439	64	2466
	11	2413	38	2440	65	2467
	12	2414	39	2441	66	2468
	13	2415	40	2442	67	2469
	14	2416	41	2443	68	2470
	15	2417	42	2444	69	2471
	16	2418	43	2445	70	2472
	17	2419	44	2446	71	2473
	18	2420	45	2447	72	2474
	19	2421	46	2448	73	2475
	20	2422	47	2449	74	2476
	21	2423	48	2450	75	2477
	22	2424	49	2451	76	2478
	23	2425	50	2452	77	2479
	24	2426	51	2453	78	2480
	25	2427	52	2454	-	-
	26	2428	53	2455	-	-

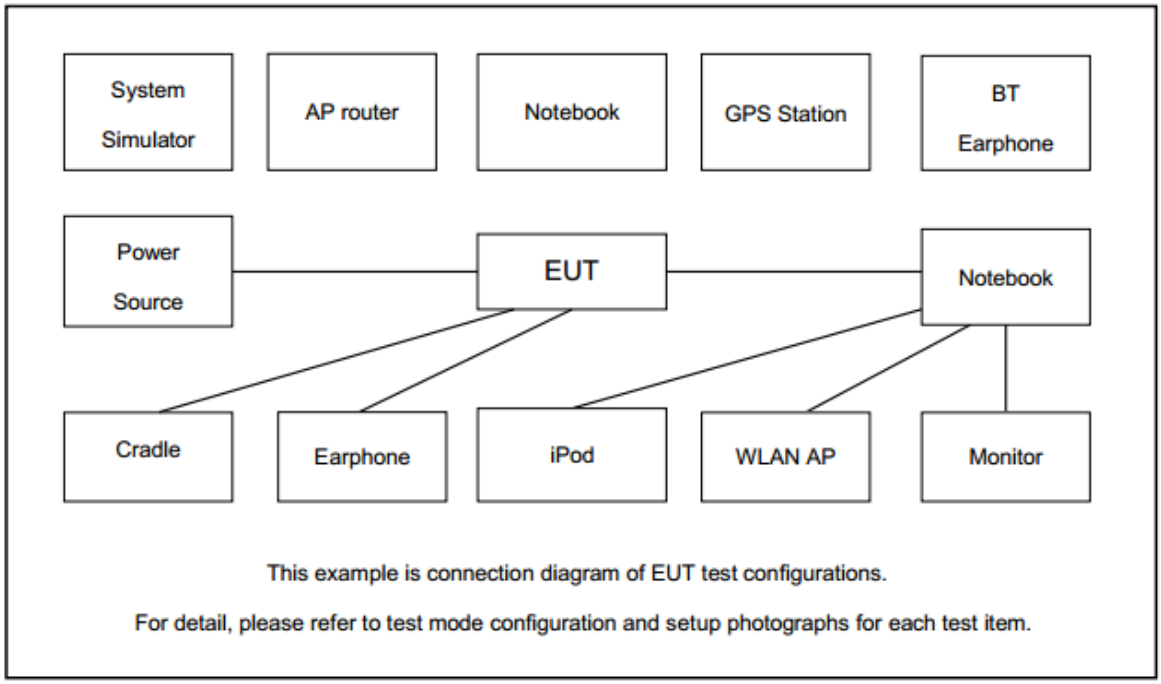
2.2 Test Mode

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). The worst mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
	Bluetooth BR 1Mbps GFSK
Radiated Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz
Remark: For radiated test cases, the worst mode data rate 1Mbps was reported only, because this data rate has the highest RF output power at preliminary tests, and the conducted spurious emissions and conducted band edge measurement for each data rate are no worse than 1Mbps, and no other significantly frequencies found in conducted spurious emission.	

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.	Notebook-41	Lenovo	G480	N/A	N/A	N/A
2.	Notebook-40	Lenovo	IdeaPad (80O7)	N/A	N/A	N/A

2.5 EUT Operation Test Setup

The RF test items, programmed RF utility, “HCI_Tester” installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.

3 Test Result

3.1 Peak Output Power Measurement

3.1.1 Limit of Peak Output Power

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts. The power limit for 1Mbps, 2Mbps, 3Mbps and AFH modes are 0.125 watts.

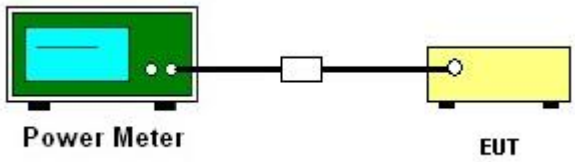
3.1.2 Measuring Instruments

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 7.8.5.
1. 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.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Measure the conducted output power with cable loss and record the results in the test report.
4. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.1.6 Test Result of Average output Power (Reporting Only)

Please refer to Appendix A.

3.2 Radiated Band Edges and Spurious Emission Measurement

3.2.1 Limit of Radiated Band Edges and Spurious Emission

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. 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

3.2.2 Measuring Instruments

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

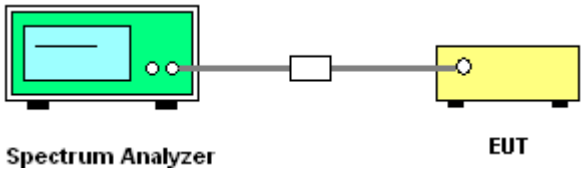
3.2.3 Test Procedures

1. 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.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, 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 to comply with the guidelines.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. 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, RBW=1MHz for f>1GHz ; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
   (3) For average measurement: use duty cycle correction factor method per 15.35(c).
   Duty cycle = On time/100 milliseconds
   On time = $N_1*L_1+N_2*L_2+...+N_{n-1}*LN_{n-1}+N_n*L_n$
   Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
   Average Emission Level = Peak Emission Level + 20*log(Duty cycle)
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

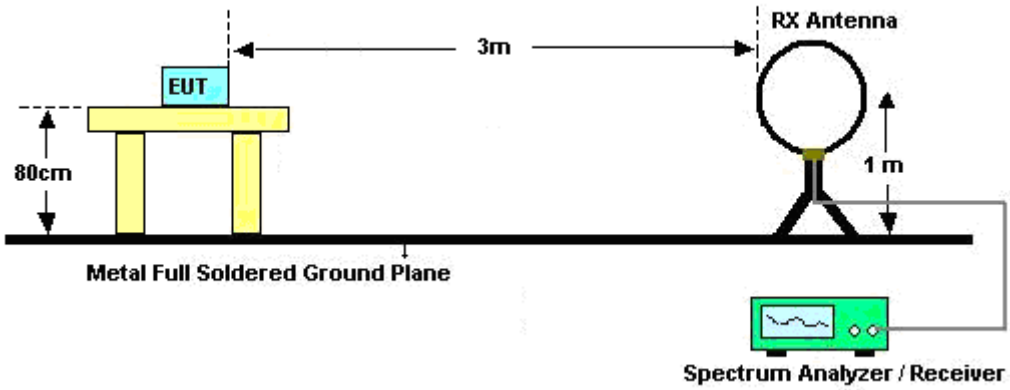
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.73dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

3.2.4 Test Setup

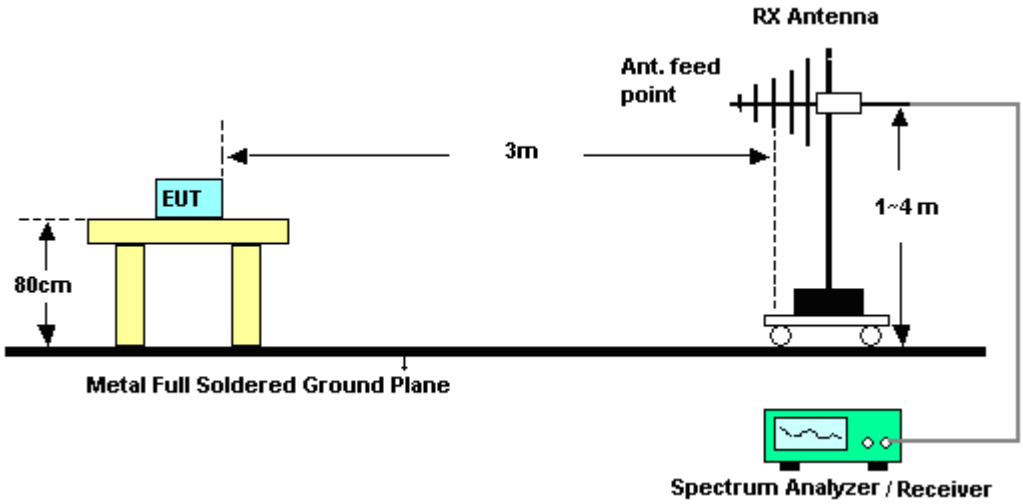
For Conducted Measurement:



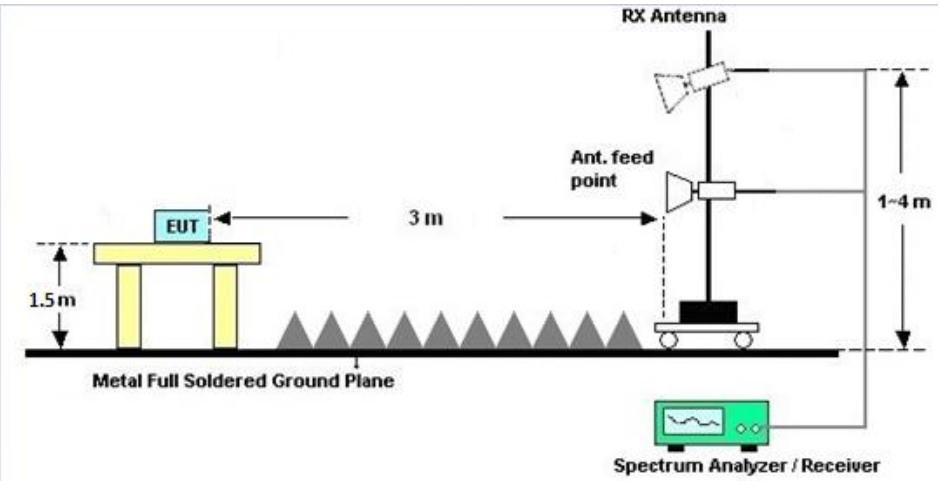
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.2.5 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.

3.2.6 Test Result of Conducted Spurious at Band Edges in the Restricted Band

Please refer to Appendix B and C.

3.2.7 Test Result of Conducted Spurious Emission in the Restricted Band

Please refer to Appendix B and C.

3.2.8 Test Result of Cabinet Radiated Spurious at Band Edges

Please refer to Appendix D and E.

3.2.9 Duty Cycle

Please refer to Appendix F.

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

Please refer to Appendix D and E.

3.3 Antenna Requirements

3.3.1 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.

3.3.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.3.3 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
Power Meter	Agilent	E4416A	GB41292344	N/A	Dec. 26, 2016	Dec. 07, 2017~ Dec. 08, 2017	Dec. 25, 2017	Conducted (TH05-HY)
Power Sensor	Agilent	E9327A	US40441548	50MHz~18GHz	Dec. 26, 2016	Dec. 07, 2017~ Dec. 08, 2017	Dec. 25, 2017	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	100057	9kHz-40GHz	Nov. 21, 2017	Dec. 07, 2017~ Dec. 08, 2017	Nov. 20, 2018	Conducted (TH05-HY)
BT Base Station(Measure)	Rohde & Schwarz	CBT	101136	BT 3.0	Sep. 20, 2017	Dec. 07, 2017~ Dec. 08, 2017	Sep. 19, 2018	Conducted (TH05-HY)
Spectrum Analyzer	Aglient	N9030A	MY52350276	3Hz~44GHz	Mar. 23, 2017	Dec. 14, 2017~ Dec. 20,2017	Mar. 22, 2018	CSE (TH05-HY)
Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz, VSWR : 2.5:1 max	Jul. 18, 2017	Dec. 12, 2017~ Dec. 22, 2017	Jul. 17, 2018	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Nov. 10, 2016	Dec. 12, 2017~ Dec. 22, 2017	Nov. 09, 2018	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D&N-6-06	35414&AT-N0602	30MHz~1GHz	Oct. 14, 2017	Dec. 12, 2017~ Dec. 22, 2017	Oct. 13, 2018	Radiation (03CH11-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Oct. 16, 2017	Dec. 12, 2017~ Dec. 22, 2017	Oct. 15, 2018	Radiation (03CH11-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Nov. 24, 2017	Dec. 12, 2017~ Dec. 22, 2017	Nov. 23, 2019	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 10, 2016	Dec. 12, 2017~ Dec. 22, 2017	Nov. 09, 2018	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55-303	1710001800054001	1GHZ~18GHZ	Dec. 07, 2017	Dec. 12, 2017~ Dec. 22, 2017	Dec. 06, 2018	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz ~ 44GHz	Oct. 19, 2017	Dec. 12, 2017~ Dec. 22, 2017	Oct. 18, 2018	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Dec. 12, 2017~ Dec. 22, 2017	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Dec. 12, 2017~ Dec. 22, 2017	N/A	Radiation (03CH11-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Nov. 29, 2017	Dec. 12, 2017~ Dec. 22, 2017	Nov. 28, 2018	Radiation (03CH11-HY)

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))	**5.20**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.50**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.20**

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Kai Liao	Temperature:	21~25	°C
Test Date:	2017/12/7	Relative Humidity:	51~54	%

TEST RESULTS DATA
Peak Power Table

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	0	1	**11.27**	20.97	Pass
	39	1	11.26	20.97	Pass
	78	1	11.05	20.97	Pass
2DH1	0	1	**9.02**	20.97	Pass
	39	1	9.00	20.97	Pass
	78	1	8.68	20.97	Pass
3DH1	0	1	**9.57**	20.97	Pass
	39	1	9.52	20.97	Pass
	78	1	9.28	20.97	Pass

TEST RESULTS DATA
Average Power Table
(Reporting Only)

DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
DH1	0	1	**11.18**	4.94
	39	1	11.17	4.94
	78	1	10.94	4.94
2DH1	0	1	**6.47**	4.85
	39	1	6.35	4.85
	78	1	5.98	4.85
3DH1	0	1	**6.50**	4.85
	39	1	6.35	4.85
	78	1	6.00	4.85

Appendix B. Conducted Spurious Emission

Test Engineer :	Rebecca Lee and Karl Hou	Temperature :	22~24°C
		Relative Humidity :	51~55%

2.4GHz 2400~2483.5MHz

BT (Band Edge @ CSE)

BT	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Gain	Cable Loss	Aux Factor	Aux2 Factor	Peak Avg.
		(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBi)	(dB)	(dB)	(dB)	(P/A)
BT CH00 2402MHz		2376.78	-35.54	-14.34	-21.2	-40.1	2	2.06	0.5	0	P
		2376.78	-60.27	-19.07	-41.2	-	-	-	-	-	A
	*	2402	12.79	-	-	8.23	2	2.06	0.5	0	P
	*	2402	-11.94	-	-	-	-	-	-	-	A
BT CH 39 2441MHz		2389.94	-40.83	-19.63	-21.2	-45.39	2	2.06	0.5	0	P
		2389.94	-65.56	-24.36	-41.2	-	-	-	-	-	A
	*	2441	12.61	-	-	8.03	2	2.08	0.5	0	P
	*	2441	-12.12	-	-	-	-	-	-	-	A
		2491.88	-40.7	-19.5	-21.2	-45.31	2	2.11	0.5	0	P
		2491.88	-65.43	-24.23	-41.2	-	-	-	-	-	A
BT CH 78 2480MHz	*	2480	12.73	-	-	8.13	2	2.1	0.5	0	P
	*	2480	-12	-	-	-	-	-	-	-	A
		2486.63	-38.13	-16.93	-21.2	-42.73	2	2.1	0.5	0	P
		2486.63	-63.86	-21.66	-41.2	-	-	-	-	-	A
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.										

2.4GHz 2400~2483.5MHz

BT (Harmonic @ CSE)

BT	Note	Frequency (MHz)	Level (dBm)	Over Limit (dB)	Limit Line (dBm)	Read Level (dBm)	Antenna Gain (dBi)	Cable Loss (dB)	Aux Factor (dB)	Aux2 Factor (dB)	Peak Avg. (P/A)
BT CH 00 2402MHz		4000.4	-59.15	-37.95	-21.2	-65.2	2	2.72	0.68	0.65	P
		4000.4	-83.88	-42.68	-41.2	-	-	-	-	-	A
		4804	-52.33	-31.13	-21.2	-58.69	2	3.03	0.53	0.8	P
		4804	-77.06	-35.86	-41.2	-	-	-	-	-	A
BT CH 39 2441MHz		4067.5	-58.22	-37.02	-21.2	-64.34	2	2.75	0.7	0.67	P
		4067.5	-82.95	-41.75	-41.2	-	-	-	-	-	A
		4882	-41.44	-20.24	-21.2	-47.84	2	3.07	0.52	0.81	P
		4882	-66.17	-24.97	-41.2	-	-	-	-	-	A
		7323	-53.89	-32.69	-21.2	-61.34	2	4.01	0.45	0.99	P
		7323	-78.62	-37.42	-41.2	-	-	-	-	-	A
		12204	-62.94	-41.74	-21.2	-72.57	2	5.55	0.42	1.66	P
		12204	-87.67	-46.47	-41.2	-	-	-	-	-	A
		15462	-62.75	-41.55	-21.2	-74.25	2	6.42	0.53	2.55	P
		15462	-87.48	-46.28	-41.2	-	-	-	-	-	A
BT CH 78 2480MHz		4134.6	-60.33	-39.13	-21.2	-66.51	2	2.78	0.72	0.68	P
		4134.6	-85.06	-43.86	-41.2	-	-	-	-	-	A
		4960	-44.02	-22.82	-21.2	-50.43	2	3.1	0.5	0.81	P
		4960	-68.75	-27.55	-41.2	-	-	-	-	-	A
		7440	-60.31	-39.11	-21.2	-67.85	2	4.07	0.48	0.99	P
		7440	-85.04	-43.84	-41.2	-	-	-	-	-	A
		9090	-59.93	-38.73	-21.2	-68.2	2	4.7	0.44	1.13	P
		9090	-84.66	-43.46	-41.2	-	-	-	-	-	A
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.										

Emission below 1GHz

2.4GHz BT (LF)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Aux	Aux2	Peak
				Limit	Line	Level	Gain	Loss	Factor	Factor	Avg.
		(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBi)	(dB)	(dB)	(dB)	(P/A)
2.4GHz BT LF		75.09	-88.02	-32.82	-55.2	-95.15	3.2	0.34	0.09	4.7	P
		150.96	-88.29	-36.59	-51.7	-95.58	3.2	0.46	0.13	4.7	P
		166.35	-88.25	-36.55	-51.7	-95.59	3.2	0.46	0.18	4.7	P
		399.4	-86.58	-37.38	-49.2	-94.12	3.2	0.77	0.07	4.7	P
		491.8	-84.87	-35.67	-49.2	-92.53	3.2	0.86	0.1	4.7	P
		763.4	-85.25	-36.05	-49.2	-93.16	3.2	1.07	0.14	4.7	P
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.
AUX Factor	Connector lose、High/Low pass filter
AUX2 Factor	Grounding factor
P/A	**P**eak or **A**verage

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

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Aux	Aux2	Peak
Ant.				Limit	Line	Level	Gain	Loss	Factor	Factor	Avg.
1		(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dBi)	(dB)	(dB)	(dB)	(P/A)
802.11b CH 01 2412MHz		2386.545	-39.03	-17.83	-21.2	-44.06	2	2.09	0.94	0	P
		2386.125	-48.1	-6.9	-41.2	-53.13	2	2.09	0.94	0	A

1. Level(dBm) =

Antenna Factor(dB) + Cable Loss(dB) + Read Level(dBm) + Aux Factor(dB) + Aux2 Factor(dB)

2. Over Limit(dB) = Level(dBm) – Limit Line(dBm)

For Peak Limit @ 2386.545MHz:

1. Level(dBm)

= Antenna Factor(dB) + Cable Loss(dB) + Read Level(dBm) + Aux Factor(dB) + Aux2 Factor(dB)

= 2(dB) + 2.09(dB) – 44.06(dBm) + 0.94(dB)

= -39.03(dBm)

2. Over Limit(dB)

= Level(dBm) – Limit Line(dBm)

= -39.03(dBm) + 21.2(dBm)

= -17.83(dB)

For Average Limit @ 2386.125MHz:

1. Level(dBm)

= Antenna Factor(dB) + Cable Loss(dB) + Read Level(dBm) + Aux Factor(dB) + Aux2 Factor(dB)

= 2(dB) + 2.09(dB) – 53.13(dBm) + 0.94(dB)

= -48.1(dBm)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -6.9(dB)

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

Appendix C. Conducted Spurious Emission Plots

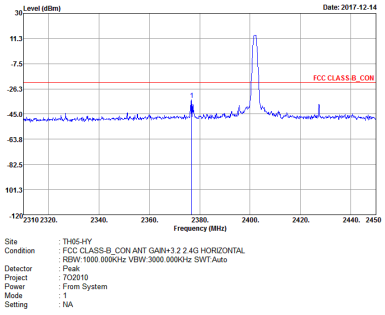
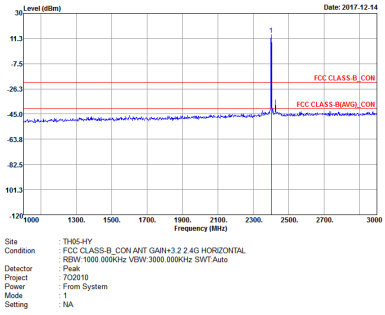
Test Engineer :	Rebecca Lee and Karl Hou	**Temperature :**	22~24°C
		Relative Humidity :	51~55%

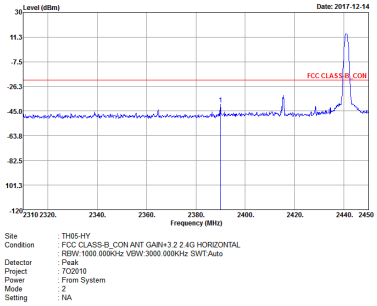
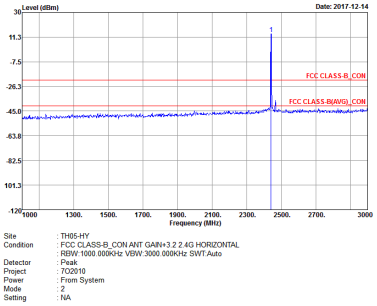
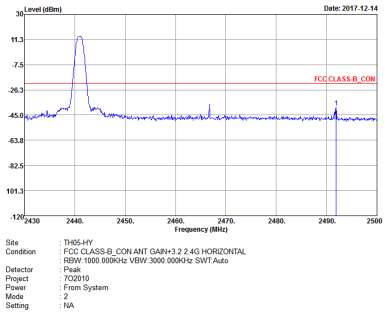
Note symbol

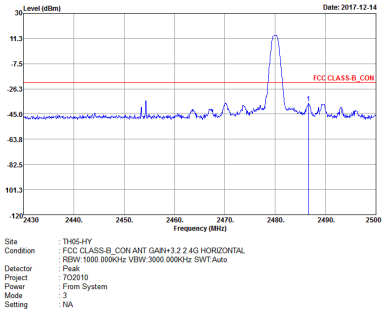
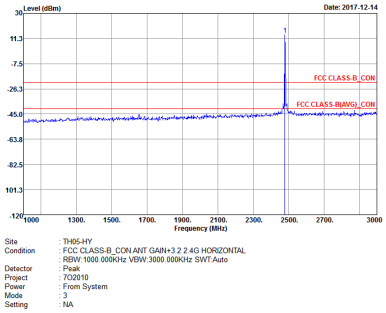
-L	**Low channel location**
-R	**High channel location**

2.4GHz 2400~2483.5MHz

BT (Band Edge @ Conducted)

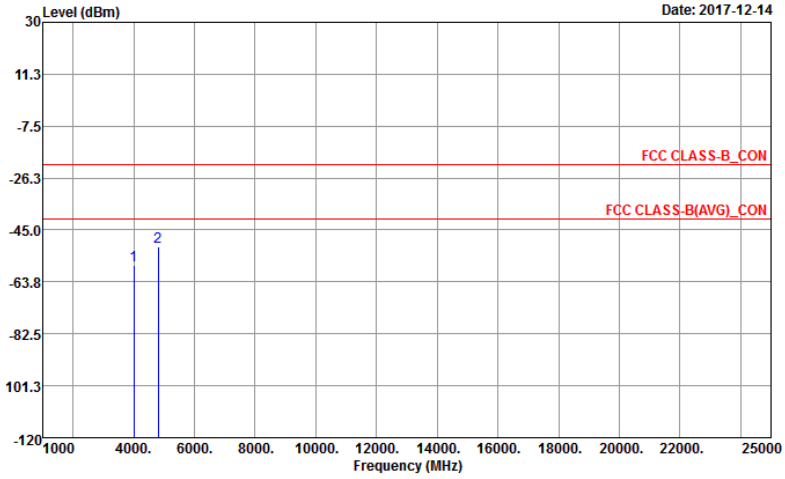
BLE	**2.4GHz 2400~2483.5MHz Band Edge @ Conducted**	
ANT	**BT CH00 2402MHz**	
1	**Band Edge - L**	**Fundamental**
Peak		

BLE	2.4GHz 2400~2483.5MHz Band Edge @ Conducted	
ANT	BT CH39 2441MHz	
1	Band Edge - L	Fundamental
Peak		
Peak		Left blank

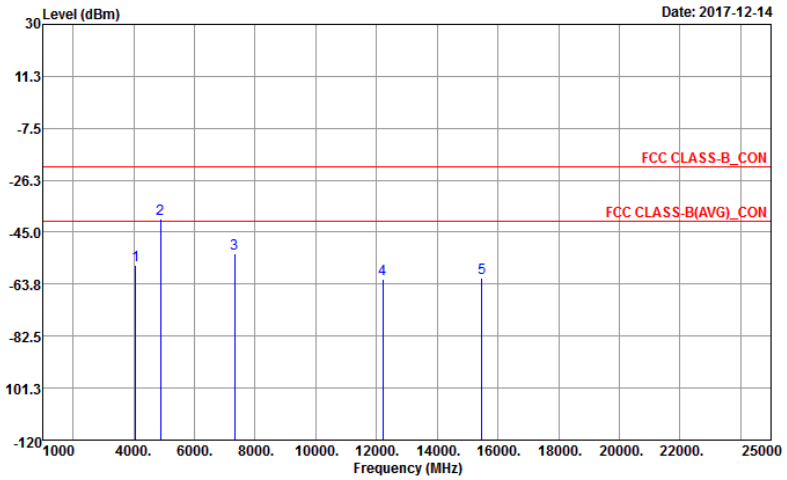
BLE	2.4GHz 2400~2483.5MHz Band Edge @ Conducted	
ANT	BT CH78 2480MHz	
1	Band Edge - R	Fundamental
Peak		

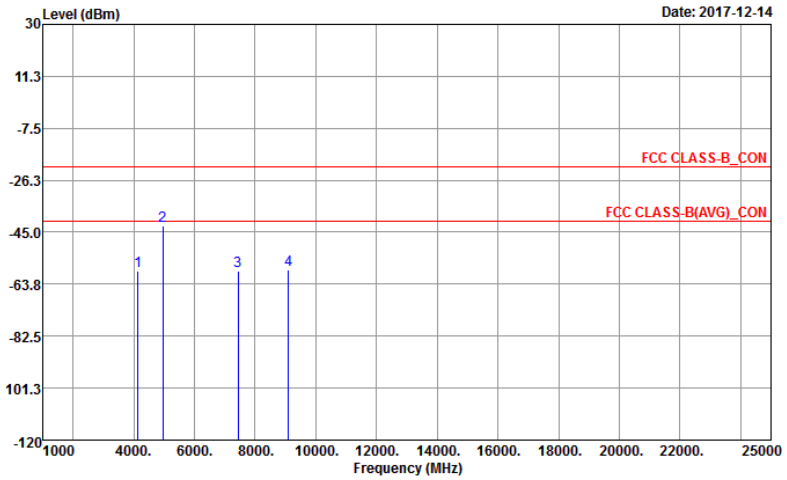
2.4GHz 2400~2483.5MHz

BLE (Harmonic @ Conducted)

BLE	2.4GHz 2400~2483.5MHz Harmonic @ Conducted
ANT	BT CH00 2402MHz
1	
Peak	

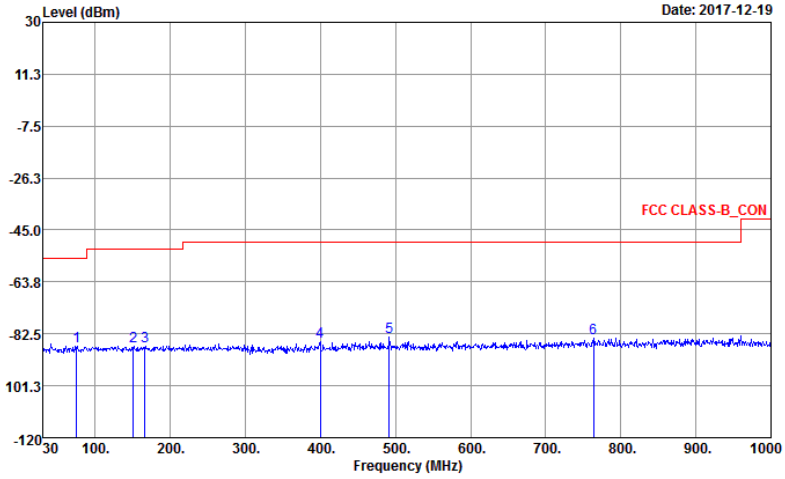
Site : TH05-HY
Condition : FCC CLASS-B_CON ANT GAIN+3.2 2.4G HORIZONTAL
Detector : Peak
Project : 7O2010
Power : From System
Mode : 1
Setting : NA

BLE	2.4GHz 2400~2483.5MHz Harmonic @ Conducted
ANT	BT CH39 2441MHz
1	
Peak	 Site : TH05-HY Condition : FCC CLASS-B_CON ANT GAIN+3.2 2.4G HORIZONTAL Detector : Peak Project : 7O2010 Power : From System Mode : 2 Setting : NA

BLE	2.4GHz 2400~2483.5MHz Harmonic @ Conducted
ANT	BT CH78 2480MHz
1	
Peak	 Site : TH05-HY Condition : FCC CLASS-B_CON ANT GAIN+3.2 2.4G HORIZONTAL Detector : Peak Project : 7O2010 Power : From System Mode : 3 Setting : NA

Emission below 1GHz

2.4GHz BT (LF)

BLE	2.4GHz 2400~2483.5MHz
ANT	BT LF
1	
QP / Peak	 Site : TH05-HY Condition : FCC CLASS-B_CON ANT GAIN+3.2 2.4G HORIZONTAL Detector : Peak Project : 7O2010 Power : From System Mode : 19

Appendix D. Cabinet Radiation Spurious Emission

Test Engineer :	Hao Hsu, Jacky Huang, and Ken Wu	Temperature :	26~28°C
		Relative Humidity :	52~57%

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH00 2402MHz		2344.86	41.89	-32.11	74	42.27	27	6.22	33.6	114	124	P	H
		2344.86	17.16	-36.84	54	-	-	-	-	-	-	A	H
	*	2402	83.23	-	-	83.33	27.13	6.36	33.59	114	124	P	H
	*	2402	58.5	-	-	-	-	-	-	-	-	A	H
													H
													H
		2340.345	41.83	-32.17	74	42.21	27	6.22	33.6	104	148	P	V
		2340.345	17.1	-36.9	54	-	-	-	-	-	-	A	V
	*	2402	82.25	-	-	82.35	27.13	6.36	33.59	104	148	P	V
	*	2402	57.52	-	-	-	-	-	-	-	-	A	V
													V
													V
BT CH 39 2441MHz		2324	42.03	-31.97	74	42.54	26.95	6.15	33.61	106	132	P	H
		2324	17.3	-36.7	54	-	-	-	-	-	-	A	H
	*	2441	82.46	-	-	82.39	27.27	6.38	33.58	106	132	P	H
	*	2441	57.73	-	-	-	-	-	-	-	-	A	H
		2494.82	41.87	-32.13	74	41.65	27.4	6.39	33.57	106	132	P	H
		2494.82	17.14	-36.86	54	-	-	-	-	-	-	A	H
		2369.36	42.27	-31.73	74	42.49	27.09	6.29	33.6	128	148	P	V
		2369.36	17.54	-36.46	54	-	-	-	-	-	-	A	V
	*	2441	79.37	-	-	79.3	27.27	6.38	33.58	128	148	P	V
	*	2441	54.64	-	-	-	-	-	-	-	-	A	V
		2485.02	42.13	-31.87	74	41.96	27.36	6.39	33.58	128	148	P	V
		2485.02	17.4	-36.6	54	-	-	-	-	-	-	A	V

BT CH 78 2480MHz	*	2480	82.66	-	-	82.5	27.36	6.38	33.58	325	65	P	H
	*	2480	57.93	-	-	-	-	-	-	-	-	A	H
		2499.2	43	-31	74	42.78	27.4	6.39	33.57	325	65	P	H
		2499.2	18.27	-35.73	54	-	-	-	-	-	-	A	H
													H
													H
	*	2480	78.45	-	-	78.29	27.36	6.38	33.58	300	91	P	V
	*	2480	53.72	-	-	-	-	-	-	-	-	A	V
		2498.8	42.06	-31.94	74	41.84	27.4	6.39	33.57	300	91	P	V
		2498.8	17.33	-36.67	54	-	-	-	-	-	-	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH 00 2402MHz		4804	51.23	-22.77	74	68.48	31.26	9.6	58.54	100	0	P	H
		4804	26.5	-27.5	54	-	-	-	-	-	-	A	H
													H
													H
		4804	50.47	-23.53	74	67.72	31.26	9.6	58.54	100	0	P	V
		4804	25.74	-28.26	54	-	-	-	-	-	-	A	V
													V
													V
BT CH 39 2441MHz		4882	53.08	-20.92	74	70.23	31.38	9.56	58.52	100	0	P	H
		4882	28.35	-25.65	54	-	-	-	-	-	-	A	H
		7323	51.02	-22.98	74	61.89	36.32	11.31	58.94	100	0	P	H
		7323	26.29	-27.71	54	-	-	-	-	-	-	A	H
		4882	51.21	-22.79	74	68.36	31.38	9.56	58.52	100	0	P	V
		4882	26.48	-27.52	54	-	-	-	-	-	-	A	V
		7323	51.49	-22.51	74	62.36	36.32	11.31	58.94	100	0	P	V
		7323	26.76	-27.24	54	-	-	-	-	-	-	A	V
BT CH 78 2480MHz		4960	54.94	-19.06	74	71.94	31.54	9.53	58.51	100	0	P	H
		4960	30.21	-23.79	54	-	-	-	-	-	-	A	H
		7440	51.52	-22.48	74	62.05	36.59	11.34	58.84	100	0	P	H
		7440	26.79	-27.21	54	-	-	-	-	-	-	A	H
		4960	52.78	-21.22	74	69.78	31.54	9.53	58.51	100	0	P	V
		4960	28.05	-25.95	54	-	-	-	-	-	-	A	V
		7440	52.47	-21.53	74	63	36.59	11.34	58.84	100	0	P	V
		7440	27.74	-26.26	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz BT (LF)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BT LF		170.13	30.87	-12.63	43.5	46.05	15.53	1.61	32.42	-	-	P	H
		200.37	30.73	-12.77	43.5	46.39	14.95	1.72	32.39	-	-	P	H
		253.29	33.46	-12.54	46	44.75	18.93	2.09	32.38	-	-	P	H
		300.7	32.08	-13.92	46	42.91	19.22	2.22	32.37	-	-	P	H
		479.9	33.23	-12.77	46	39.02	23.76	2.77	32.37	-	-	P	H
		955.2	34.37	-11.63	46	30.43	31.02	3.9	31.15	100	0	P	H
													H
													H
													H
													H
													H
													H
		30.27	36.71	-3.29	40	44	24.36	0.82	32.5	100	0	P	V
		48.9	34.17	-5.83	40	50.67	14.96	1.02	32.49	-	-	P	V
		62.4	32.21	-7.79	40	51.9	11.76	1.02	32.49	-	-	P	V
		369.3	30.1	-15.9	46	39.09	20.82	2.48	32.34	-	-	P	V
		477.1	32.41	-13.59	46	38.25	23.71	2.77	32.37	-	-	P	V
		958.7	34.5	-11.5	46	30.4	31.14	3.9	31.12	-	-	P	V
													V
													V
													V
													V
													V
													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.
!	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 E. Cabinet Radiation Spurious Emission Plots

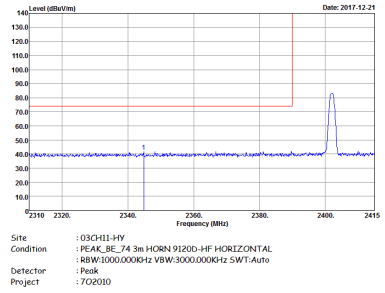
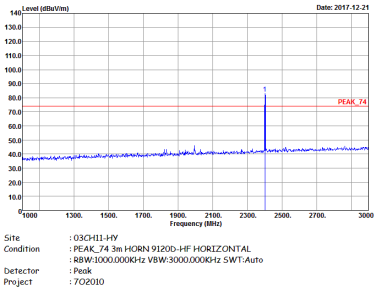
Test Engineer :	Hao Hsu, Jacky Huang, and Ken Wu	**Temperature :**	26~28°C
		Relative Humidity :	52~57%

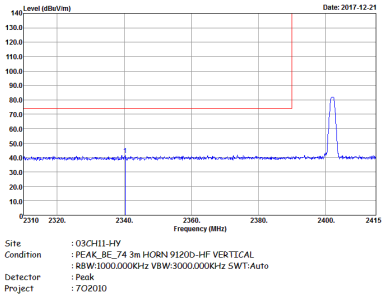
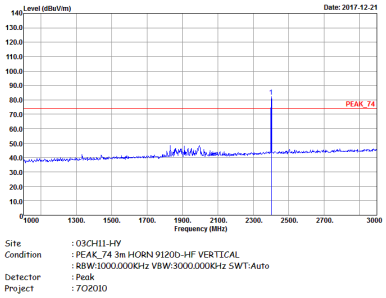
Note symbol

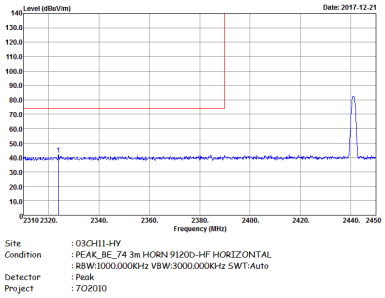
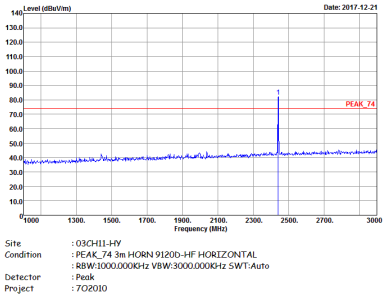
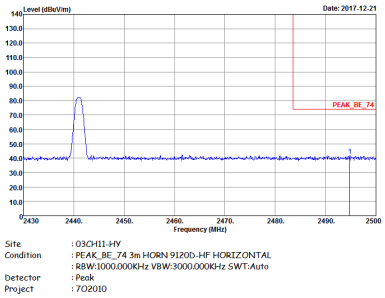
-L	**Low channel location**
-R	**High channel location**

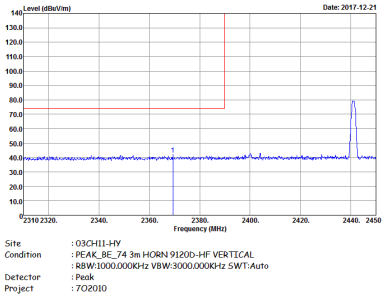
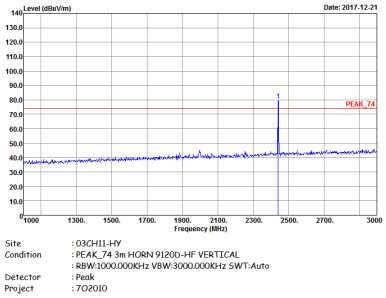
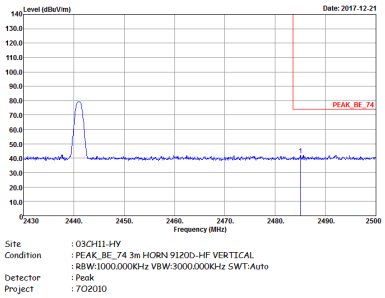
2.4GHz 2400~2483.5MHz

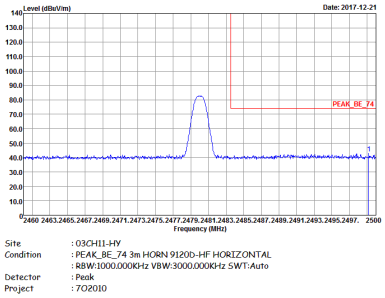
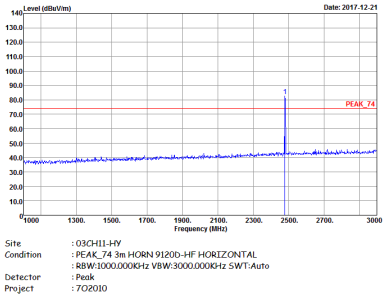
BT (Band Edge @ 3m)

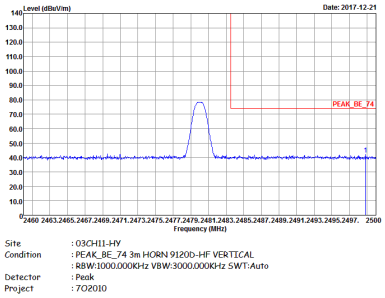
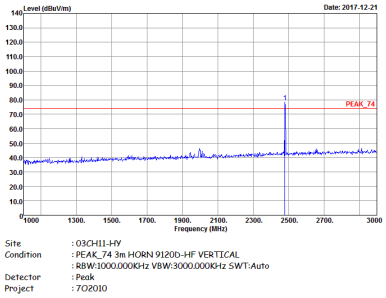
BT	**2.4GHz 2400~2483.5MHz Band Edge @ 3m**	
ANT	**BT CH00 2402MHz**	
1	**Horizontal**	**Fundamental**
Peak		

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH00 2402MHz	
1	Vertical	Fundamental
Peak		

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Fundamental
Peak		
Peak		Left blank

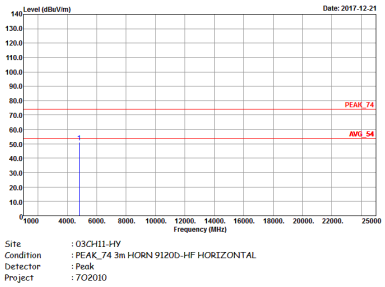
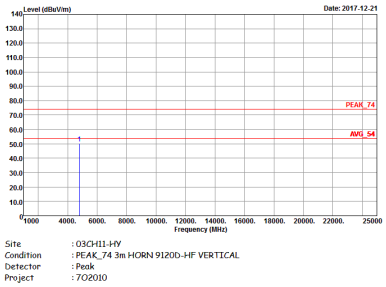
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Vertical	Fundamental
Peak		
Peak		Left blank

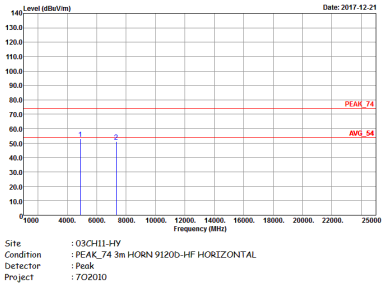
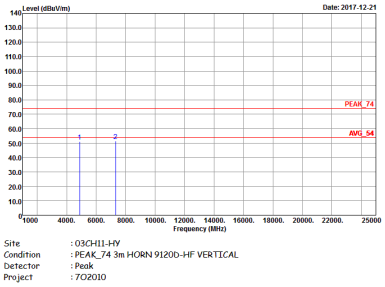
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz	
1	Horizontal	Fundamental
Peak		

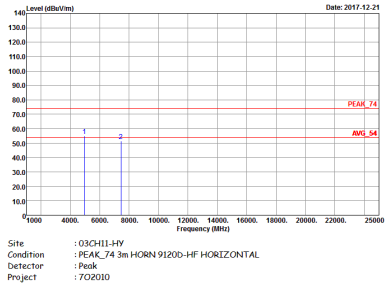
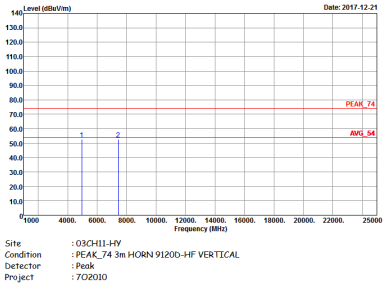
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz	
1	Vertical	Fundamental
Peak		

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

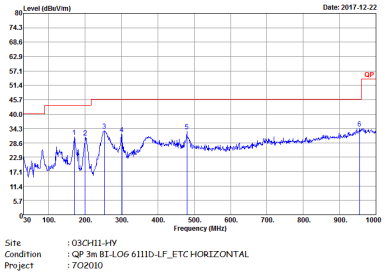
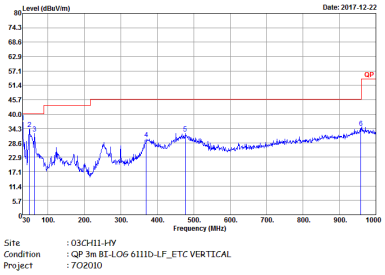
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH00 2402MHz	
1	Horizontal	Vertical
Peak Avg.		

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Vertical
Peak Avg.		

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH78 2480MHz	
1	Horizontal	Vertical
Peak Avg.		

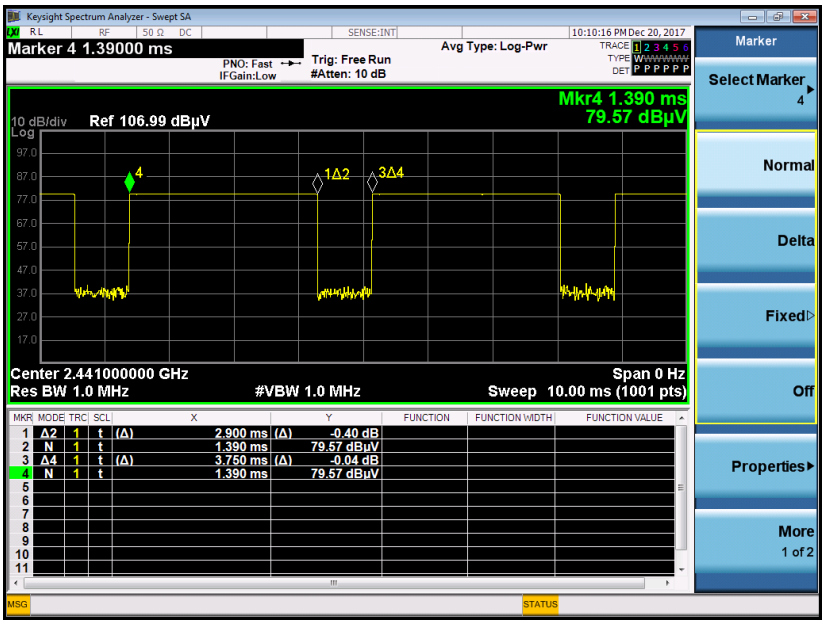
Emission below 1GHz

2.4GHz BT (LF)

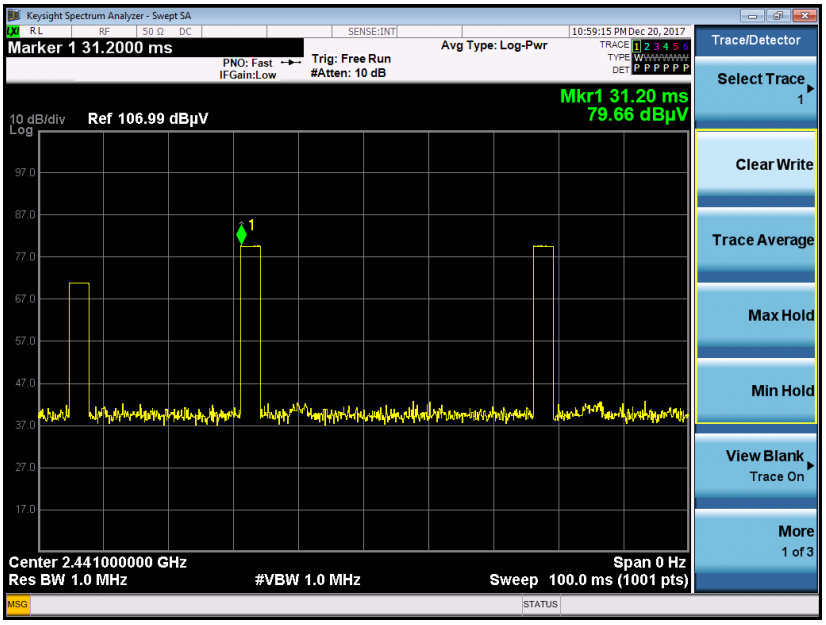
BT	2.4GHz 2400~2483.5MHz	
ANT	BT LF	
1	Horizontal	Vertical
QP / Peak		

Appendix F. Duty Cycle Plots

DH5 on time (One Pulse) Plot on Channel 39



on time (Count Pulses) Plot on Channel 39



Note:

1. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.9 / 100 = 5.8 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.73 dB
3. **DH5** has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

2.9 ms x 20 channels = 58 ms

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. [100ms / 57.6ms] = 2 hops

Thus, the maximum possible ON time:

2.9 ms x 2 = 5.8 ms

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

20 x log(5.8 ms/100ms) = -24.73 dB