FCC RF Test Report

APPLICANT	:	LC Future Center Limited Taiwan Branch
EQUIPMENT	:	Notebook
BRAND NAME	:	Lenovo
MODEL NAME	:	TP00086B
FCC ID	:	2AJN7-TP00086B
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DSS) Spread Spectrum Transmitter

This is a partial report. The product was received on Oct. 25, 2017 and testing was completed on Dec. 04, 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

Testing Laboratory
1190

SPORTON INTERNATIONAL INC.
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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR7O2534A	Rev. 01	Initial issue of report	Dec. 19, 2017

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(b)(1)	Peak Output Power	≤ 125 mW	Pass	-
3.2	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.92 dB at 747.300 MHz
3.3	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 10.00 dB at 0.182 MHz
3.4	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

1 General Description

1.1 Applicant

LC Future Center Limited Taiwan Branch
7F., No.780, Bei'an Rd., Zhongshan Dist., Taipei City 104, Taiwan (R.O.C.)

1.2 Manufacturer

LC Future Center Limited Taiwan Branch
7F., No.780, Bei'an Rd., Zhongshan Dist., Taipei City 104, Taiwan (R.O.C.)

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Notebook
Brand Name	Lenovo
Model Name	TP00086B
FCC ID	2AJN7-TP00086B
Sample 1	EUT with Amphenol Antenna
Sample 2	EUT with Speedwire Antenna
Integrated in WLAN Module	Brand Name: Intel Model Name: 8265NGW
EUT supports Radios application	WCDMA/HSPA/LTE WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. All the tests were performed for Sample 1.

Antenna Information			
Antenna 1	**Manufacturer**	Amphenol	
	Antenna Type	Main:PIFA Antenna	Aux:PIFA Antenna
	Part number	LX7847-16-000-C	LX7848-16-000-C
	Peak gain (dbi)	Main Antenna :	Aux Antenna :
		WLAN(2.4G):1.63	WLAN(2.4G):1.97 BT :1.97
Antenna 2	**Manufacturer**	Speedwire	
	Antenna Type	Main:PIFA Antenna	Aux:PIFA Antenna
	Part number	F.0G.ZV-0006-003-00	F.0G.ZV-0006-004-00
	Peak gain (dbi)	Main Antenna :	Aux Antenna :
		WLAN(2.4G):1.44	WLAN(2.4G):1.86 BT :1.86

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Maximum Output Power to Antenna	Bluetooth BR(1Mbps) : 10.01 dBm (0.0100 W) Bluetooth EDR (2Mbps) : 8.52 dBm (0.0071 W) Bluetooth EDR (3Mbps) : 8.02 dBm (0.0063 W)
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : π/4-DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

1.5 Modification of EUT

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

1.6 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.	
Test Site No.	**Sporton Site No.**	
	TH05-HY	CO05-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.)
Test Site No.	**Sporton Site No.**
	03CH12-HY

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

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
- 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

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

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: conduction emission (150 kHz to 30 MHz), 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 mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.

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

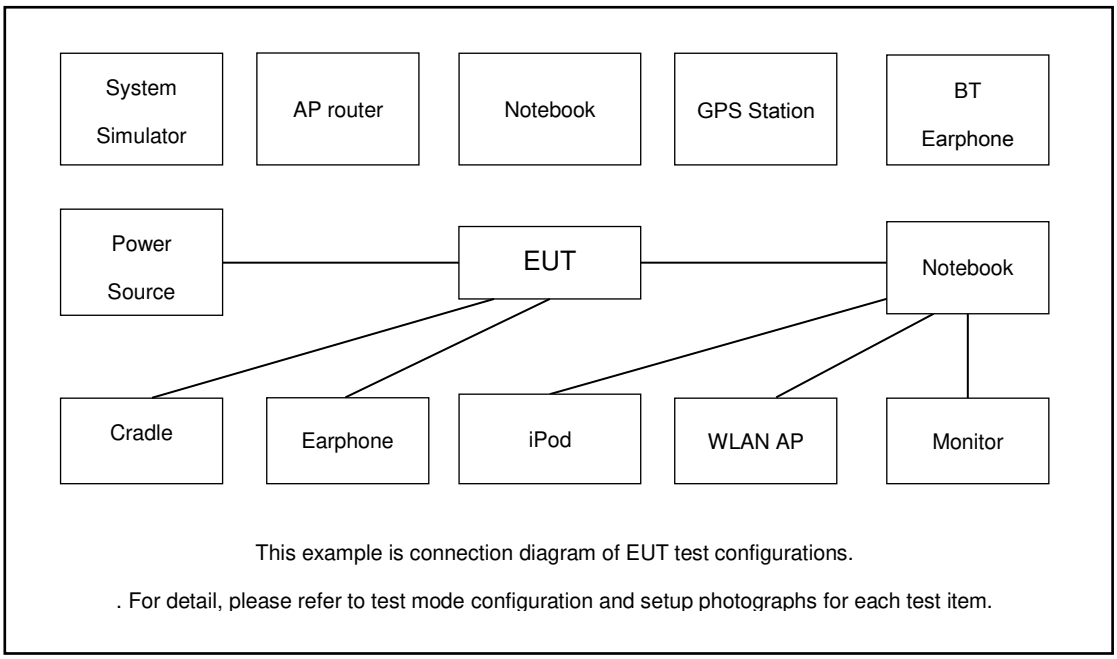
The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases			
Test Item	**Data Rate / Modulation**		
	Bluetooth BR 1Mbps GFSK	**Bluetooth EDR 2Mbps π/4-DQPSK**	**Bluetooth EDR 3Mbps 8-DPSK**
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz	Mode 4: CH00_2402 MHz Mode 5: CH39_2441 MHz Mode 6: CH78_2480 MHz	Mode 7: CH00_2402 MHz Mode 8: CH39_2441 MHz Mode 9: CH78_2480 MHz
Radiated Test Cases	**Bluetooth BR 1Mbps GFSK**		
	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz		
AC Conducted Emission	Mode 1 :WLAN (2.4GHz) Link + Bluetooth Link + TF + TC		

Remark:

1. 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. TC stands for Test Configuration, and consists of Earphone and USB (HD, iPod…).
3. TF stands for Test Function, and consists of MPEG4 and Camera.

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.	Bluetooth Base Station	R&S	CBT32	N/A	N/A	Unshielded, 1.8 m
2.	iPod	Apple	A1285	FCC DoC	Shielded, 1.0 m	N/A
3.	iPod Earphone	Apple	N/A	DoC	UnShielded, 1.2m	N/A
4.	USB HD	WD	WDBAAR3200 ABK-PESN	FCC DoC	Shielded, 0.5m	N/A
5.	USB HD	PQI	H568V	FCC DoC	Shielded, 0.5m	N/A
6.	HD USB 3.0	lenovo	F310S	FCC DoC	Shielded, 0.5m	N/A

2.5 EUT Operation Test Setup

The RF test items utility, “DRTU” was installed in EUT which was programmed in order to make the EUT get into the engineering modes to contact with base station 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.

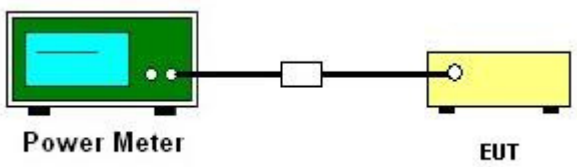
3.1.2 Measuring Instruments

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.

3.2 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.

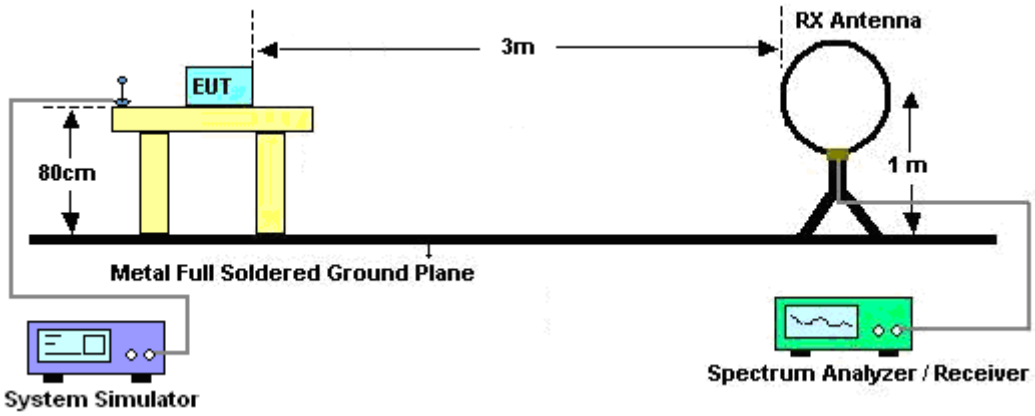
3.2.3 Test Procedures

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

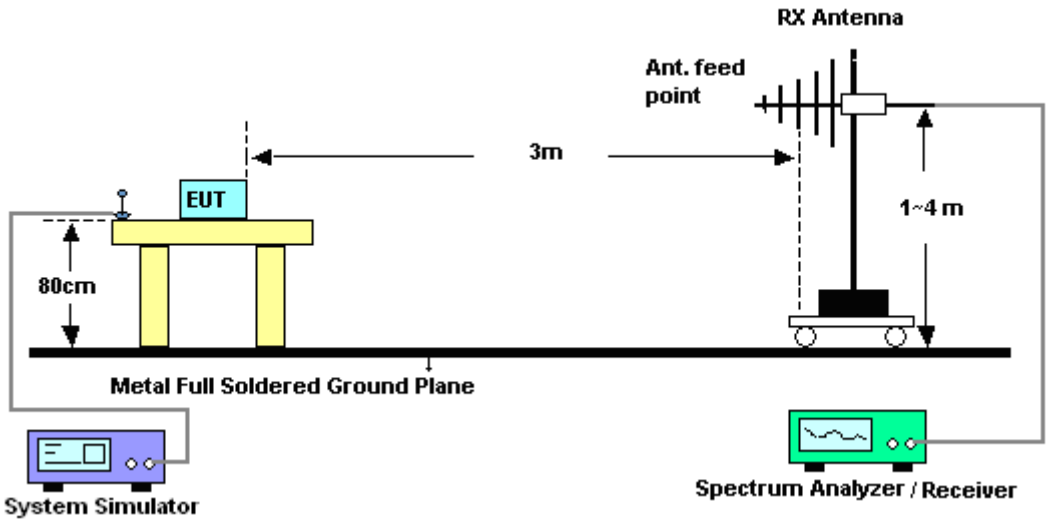
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.77dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

3.2.4 Test Setup

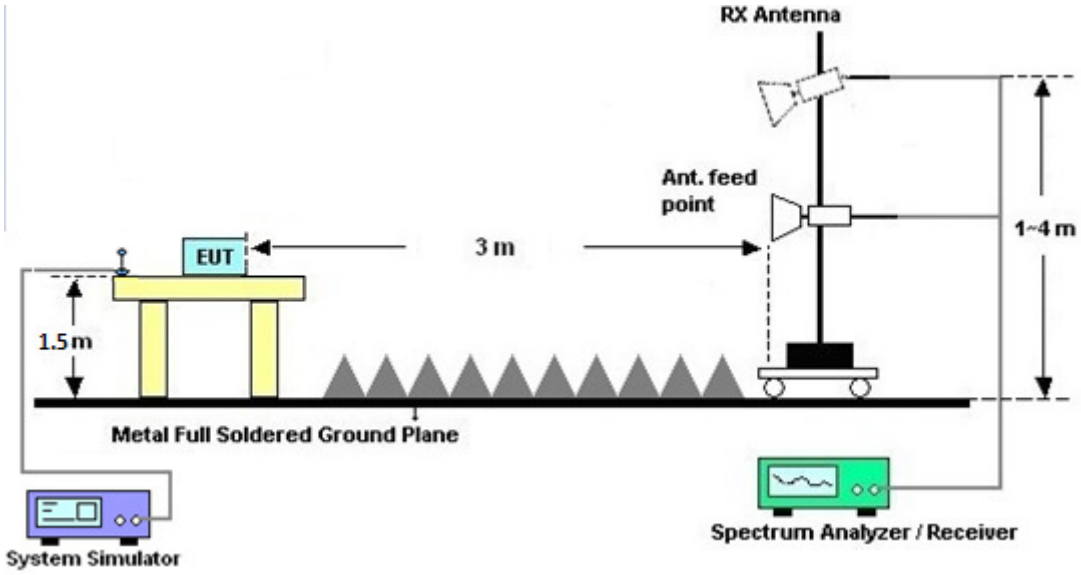
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.2.5 Test Results of Radiated Spurious Emissions (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 per 15.31(o) was not reported.

3.2.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.2.7 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

3.3 AC Conducted Emission Measurement

3.3.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

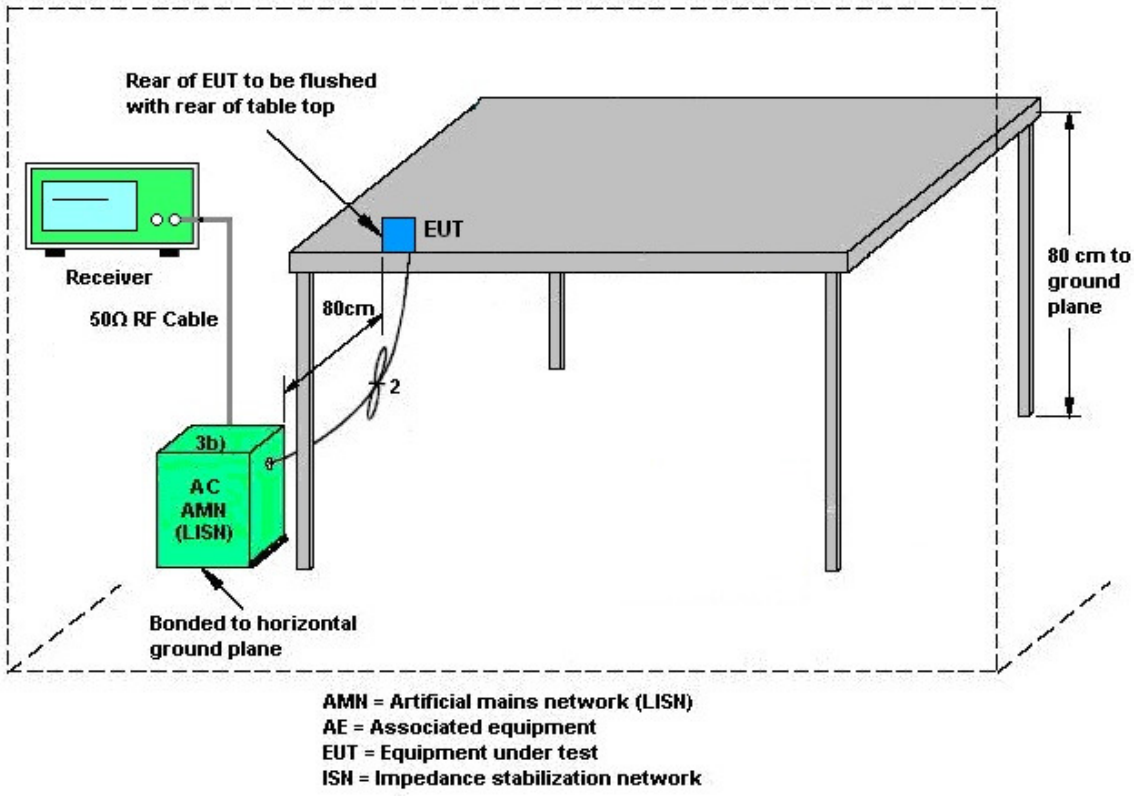
3.3.2 Measuring Instruments

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

3.3.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.3.4 Test Setup



3.3.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.4 Antenna Requirements

3.4.1 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.

3.4.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.4.3 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	Anritsu	ML2495A	0932001	N/A	Sep. 26, 2017	Oct. 25, 2017	Sep. 25, 2018	Conducted (TH05-HY)
Power Sensor	Anritsu	MA2411B	0846202	300MHz~40GHz	Sep. 26, 2017	Oct. 25, 2017	Sep. 25, 2018	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP30	101067	9kHz ~ 30GHz	Nov. 17, 2016	Oct. 25, 2017	Nov. 16, 2017	Conducted (TH05-HY)
BT Base Station(Measure)	Rohde & Schwarz	CBT	101136	BT 3.0	Sep. 20, 2017	Oct. 25, 2017	Sep. 19, 2018	Conducted (TH05-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Dec. 01, 2017	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESCI 7	100724	9kHz~7GHz	Sep. 20, 2017	Dec. 01, 2017	Sep. 19, 2018	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Dec. 06, 2016	Dec. 01, 2017	Dec. 05, 2017	Conduction (CO05-HY)
Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz, VSWR : 2.5:1 max	Jul. 18, 2017	Nov. 09, 2017~ Dec. 04, 2017	Jul. 17, 2018	Radiation (03CH12-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800N1D01N-06	35413&02	30MHz~1GHz	Jan. 07, 2017	Nov. 09, 2017~ Dec. 04, 2017	Jan. 06, 2018	Radiation (03CH12-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Oct. 20, 2016	Nov. 09, 2017~ Dec. 04, 2017	Oct. 19, 2018	Radiation (03CH12-HY)
EMI Test Receiver	Rohde & Schwarz	ESU26	100390	20Hz~26.5GHz	Dec. 23, 2016	Nov. 09, 2017~ Dec. 04, 2017	Dec. 22, 2017	Radiation (03CH12-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1328	1GHz ~ 18GHz	Oct. 20, 2017	Nov. 09, 2017~ Dec. 04, 2017	Oct. 19, 2018	Radiation (03CH12-HY)
Preamplifier	COM-POWER	PA-103	161075	10MHz~1GHz	Mar. 23, 2017	Nov. 09, 2017~ Dec. 04, 2017	Mar. 22, 2018	Radiation (03CH12-HY)
Preamplifier	MITEQ	AMF-7D-00101800	2025787	1GHz~18GHz	Feb. 13, 2017	Nov. 09, 2017~ Dec. 04, 2017	Feb. 12, 2018	Radiation (03CH12-HY)
Preamplifier	Keysight	83017A	MY53270148	1GHz~26.5GHz	Jan. 12, 2017	Nov. 09, 2017~ Dec. 04, 2017	Jan. 11, 2018	Radiation (03CH12-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60ST	SN2	3 GHz Highpass	Jul. 17, 2017	Nov. 09, 2017~ Dec. 04, 2017	Jul. 16, 2018	Radiation (03CH12-HY)
Filter	Wainwright	WLKS1200-12SS	SN2	1.2G Low Pass	Mar. 24, 2017	Nov. 09, 2017~ Dec. 04, 2017	Mar. 23, 2018	Radiation (03CH12-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Nov. 09, 2017~ Dec. 04, 2017	N/A	Radiation (03CH12-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Nov. 09, 2017~ Dec. 04, 2017	N/A	Radiation (03CH12-HY)
Attenuator	Fairview Microwave	SA18S5W-10	n/a	10db	Mar. 24, 2017	Nov. 09, 2017~ Dec. 04, 2017	Mar. 23, 2018	Radiation (03CH12-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170576	18GHz ~ 40GHz	Apr. 27, 2017	Nov. 09, 2017~ Dec. 04, 2017	Apr. 26, 2018	Radiation (03CH12-HY)

5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.70

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.10

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

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

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.70

Appendix A. Conducted Test Results

Remark: For Conducted Test Items, Ant. 1 means Chain 1 and Ant. 2 means Chain 2

Report Number : FR7O2534A

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Aking chang	Temperature:	21~25	°C
Test Date:	2017/10/25	Relative Humidity:	51~54	%

TEST RESULTS DATA
Peak Power Table

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	0	1	9.95	20.97	Pass
	39	1	**9.99**	20.97	Pass
	78	1	9.76	20.97	Pass

2DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
2DH1	0	1	8.41	20.97	Pass
	39	1	**8.52**	20.97	Pass
	78	1	8.28	20.97	Pass

3DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
3DH1	0	1	7.59	20.97	Pass
	39	1	**8.02**	20.97	Pass
	78	1	7.86	20.97	Pass

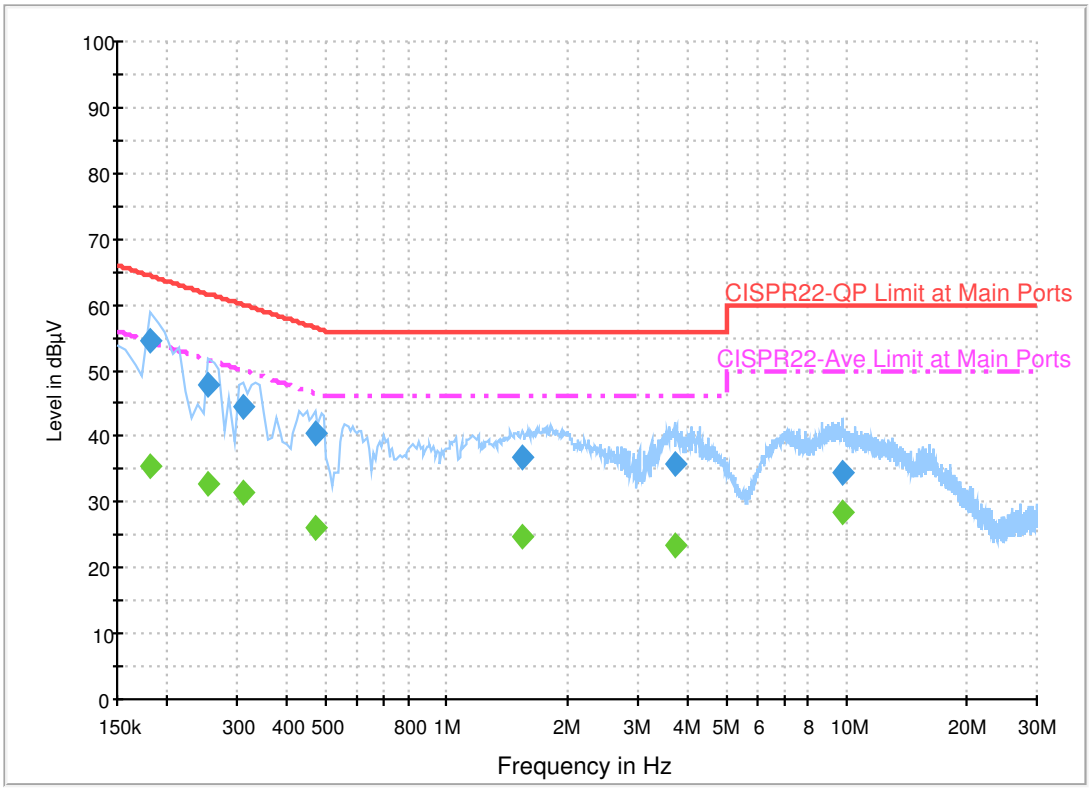
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Shareef Yu	**Temperature :**	26~27℃
		Relative Humidity :	58~62%

EUT Information

Report NO :	7O2534
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Line

ENV216 Auto Test-L



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.182000	54.4	Off	L1	19.5	10.0	64.4
0.254000	47.9	Off	L1	19.5	13.7	61.6
0.310000	44.4	Off	L1	19.5	15.6	60.0
0.470000	40.6	Off	L1	19.5	15.9	56.5
1.542000	36.8	Off	L1	19.5	19.2	56.0
3.718000	35.8	Off	L1	19.6	20.2	56.0
9.758000	34.5	Off	L1	19.7	25.5	60.0

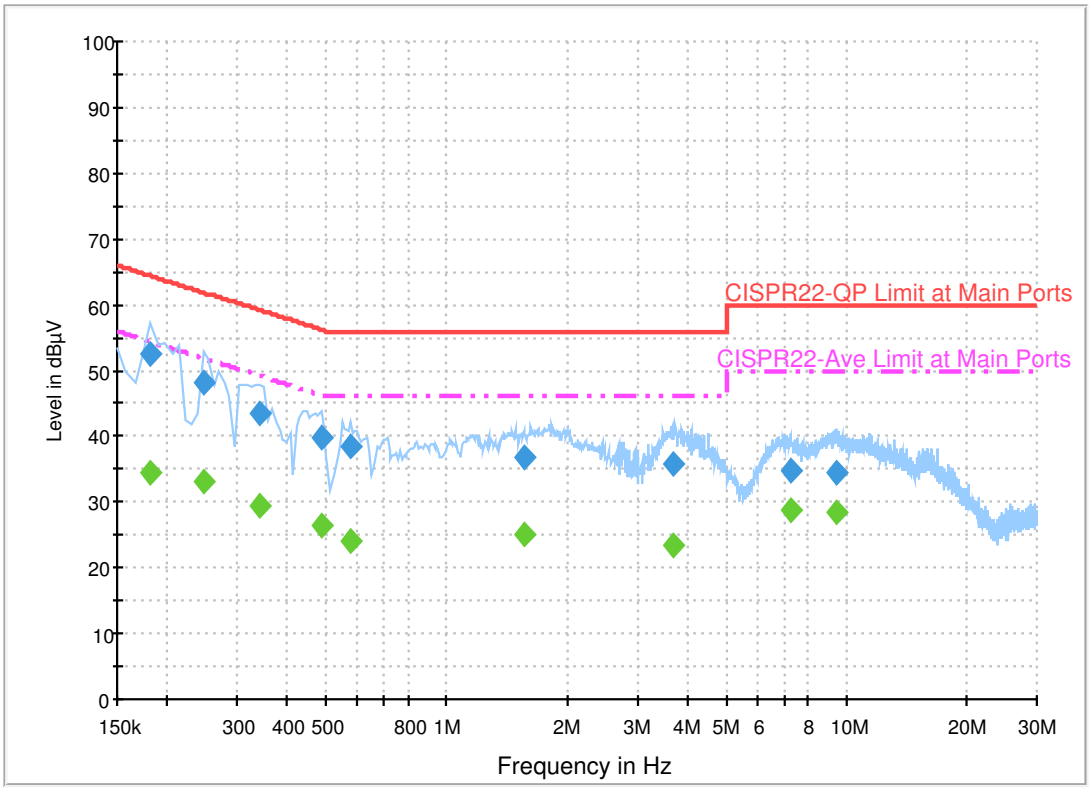
Final Result 2

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.182000	35.4	Off	L1	19.5	19.0	54.4
0.254000	32.8	Off	L1	19.5	18.8	51.6
0.310000	31.5	Off	L1	19.5	18.5	50.0
0.470000	25.9	Off	L1	19.5	20.6	46.5
1.542000	24.7	Off	L1	19.5	21.3	46.0
3.718000	23.3	Off	L1	19.6	22.7	46.0
9.758000	28.6	Off	L1	19.7	21.4	50.0

EUT Information

Report NO :	7O2534
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Neutral

ENV216 Auto Test-N



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.182000	52.6	Off	N	19.5	11.8	64.4
0.246000	48.2	Off	N	19.5	13.7	61.9
0.342000	43.4	Off	N	19.5	15.8	59.2
0.486000	39.9	Off	N	19.5	16.3	56.2
0.574000	38.6	Off	N	19.5	17.4	56.0
1.574000	36.9	Off	N	19.5	19.1	56.0
3.694000	35.8	Off	N	19.6	20.2	56.0
7.270000	34.9	Off	N	19.6	25.1	60.0
9.470000	34.6	Off	N	19.7	25.4	60.0

Final Result 2

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.182000	34.4	Off	N	19.5	20.0	54.4
0.246000	33.0	Off	N	19.5	18.9	51.9
0.342000	29.3	Off	N	19.5	19.9	49.2
0.486000	26.6	Off	N	19.5	19.6	46.2
0.574000	23.9	Off	N	19.5	22.1	46.0
1.574000	25.0	Off	N	19.5	21.0	46.0
3.694000	23.6	Off	N	19.6	22.4	46.0
7.270000	28.8	Off	N	19.6	21.2	50.0
9.470000	28.4	Off	N	19.7	21.6	50.0

Appendix C. Radiated Spurious Emission

Test Engineer :	Nick Yu, Karl Hou, Peter Liao, and Ray chen	Temperature :	23~25℃
		Relative Humidity :	62~67%

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT Chain 2	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 CH00 2402MHz		2321.97	44.9	-29.1	74	45.44	26.99	3.98	31.51	399	124	P	H
		2321.97	20.13	-33.87	54	-	-	-	-	-	-	A	H
	*	2402	103.72	-	-	104.02	27.15	4.04	31.49	399	124	P	H
	*	2402	78.95	-	-	-	-	-	-	-	-	A	H
													H
													H
		2322.075	51.93	-22.07	74	52.47	26.99	3.98	31.51	385	174	P	V
		2322.075	27.16	-26.84	54	-	-	-	-	-	-	A	V
	*	2402	110.25	-	-	110.55	27.15	4.04	31.49	385	174	P	V
	*	2402	85.48	-	-	-	-	-	-	-	-	A	V
													V
													V
BT CH 39 2441MHz		2360.96	45.16	-28.84	74	45.58	27.07	4.01	31.5	384	120	P	H
		2360.96	20.39	-33.61	54	-	-	-	-	-	-	A	H
	*	2441	104.39	-	-	104.51	27.28	4.07	31.47	384	120	P	H
	*	2441	79.62	-	-	-	-	-	-	-	-	A	H
		2487.75	43.53	-30.47	74	43.49	27.4	4.11	31.47	384	120	P	H
		2487.75	18.76	-35.24	54	-	-	-	-	-	-	A	H
		2360.82	53.66	-20.34	74	54.08	27.07	4.01	31.5	328	167	P	V
		2360.82	28.89	-25.11	54	-	-	-	-	-	-	A	V
	*	2441	110.95	-	-	111.07	27.28	4.07	31.47	328	167	P	V
	*	2441	86.18	-	-	-	-	-	-	-	-	A	V
		2486.35	43.65	-30.35	74	43.65	27.36	4.11	31.47	328	167	P	V
		2486.35	18.88	-35.12	54	-	-	-	-	-	-	A	V

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BT CH 78 2480MHz	*	2480	100.41	-	-	100.43	27.36	4.09	31.47	370	119	P	H
	*	2480	75.64	-	-	-	-	-	-	-	-	A	H
		2489.88	54.56	-19.44	74	54.52	27.4	4.11	31.47	370	119	P	H
		2489.88	29.79	-24.21	54	-	-	-	-	-	-	A	H
													H
													H
	*	2480	106.68	-	-	106.7	27.36	4.09	31.47	322	161	P	V
	*	2480	81.91	-	-	-	-	-	-	-	-	A	V
		2490.04	60.72	-13.28	74	60.68	27.4	4.11	31.47	322	161	P	V
		2490.04	35.95	-18.05	54	-	-	-	-	-	-	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

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2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

BT Chain 2	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	40.07	-33.93	74	66.8	31.32	6.16	64.75	100	0	P	H
		4804	15.3	-38.7	54	-	-	-	-	-	-	A	H
													H
													H
		4804	38.9	-35.1	74	65.63	31.32	6.16	64.75	100	0	P	V
		4804	14.13	-39.87	54	-	-	-	-	-	-	A	V
													V
													V
BT CH 39 2441MHz		4882	40	-34	74	66.51	31.46	6.21	64.7	100	0	P	H
		4882	15.23	-38.77	54	-	-	-	-	-	-	A	H
		7323	50.13	-23.87	74	70.75	36.15	7.72	64.83	100	0	P	H
		7323	25.36	-28.64	54	-	-	-	-	-	-	A	H
		4882	40.02	-33.98	74	66.53	31.46	6.21	64.7	100	0	P	V
		4882	15.25	-38.75	54	-	-	-	-	-	-	A	V
		7323	54.68	-19.32	74	75.3	36.15	7.72	64.83	100	0	P	V
		7323	29.91	-24.09	54	-	-	-	-	-	-	A	V
BT CH 78 2480MHz		4960	40.48	-33.52	74	66.73	31.63	6.26	64.63	100	0	P	H
		4960	15.71	-38.29	54	-	-	-	-	-	-	A	H
		7440	53.79	-20.21	74	74.13	36.47	7.75	64.88	100	0	P	H
		7440	29.02	-24.98	54	-	-	-	-	-	-	A	H
		4960	39.79	-34.21	74	66.04	31.63	6.26	64.63	100	0	P	V
		4960	15.02	-38.98	54	-	-	-	-	-	-	A	V
		7440	57.88	-16.12	74	78.22	36.47	7.75	64.88	100	0	P	V
		7440	33.11	-20.89	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

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Emission below 1GHz

2.4GHz BT (LF)

BT Chain 2	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)
2.4GHz BT LF		34.32	22.33	-17.67	40	32.82	19.31	0.48	30.25	-	-	P	H
		182.82	24.42	-19.08	43.5	41.68	11.73	1.14	30.29	-	-	P	H
		240.06	26.03	-19.97	46	40.8	14.02	1.28	30.22	-	-	P	H
		458.2	24.13	-21.87	46	32.01	20.2	1.73	29.87	-	-	P	H
		729.1	34.65	-11.35	46	37.24	24.61	2.18	29.48	100	0	P	H
		960.8	31.59	-22.41	54	29.34	28.54	2.51	29.04	-	-	P	H
													H
													H
													H
													H
													H
													H
		34.32	28.65	-11.35	40	39.14	19.31	0.48	30.25	-	-	P	V
		59.97	27.51	-12.49	40	48.67	8.56	0.68	30.44	-	-	P	V
		183.09	21.85	-21.65	43.5	39.11	11.73	1.14	30.29	-	-	P	V
		458.2	27.45	-18.55	46	35.33	20.2	1.73	29.87	-	-	P	V
		610.8	30.35	-15.65	46	35.17	22.77	1.97	29.65	-	-	P	V
		747.3	42.08	-3.92	46	44.22	24.99	2.21	29.44	100	0	P	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

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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”.

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Appendix D. Radiated Spurious Emission Plots

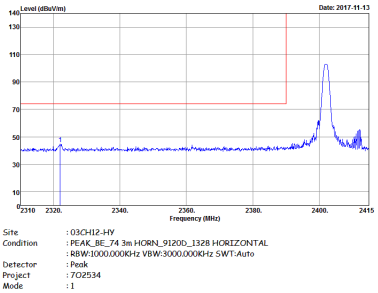
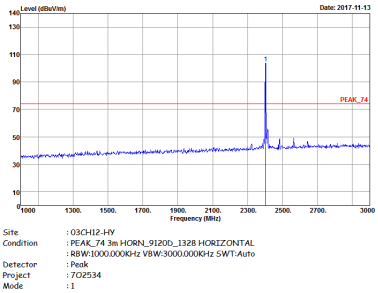
Test Engineer :	Nick Yu, Karl Hou, Peter Liao, and Ray chen	Temperature :	23~25℃
		Relative Humidity :	62~67%

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	
Chain	BT CH00 2402MHz	
2	Horizontal	Fundamental
Peak		

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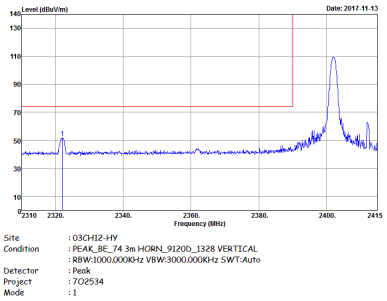
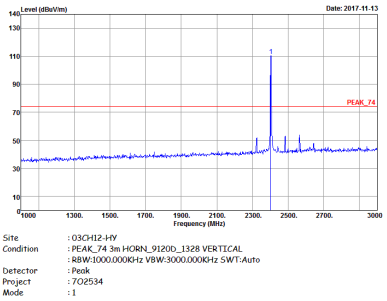
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BT CH00 2402MHz	
2	Vertical	Fundamental
Peak		

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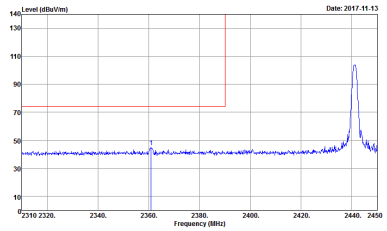
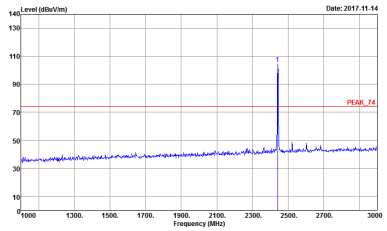
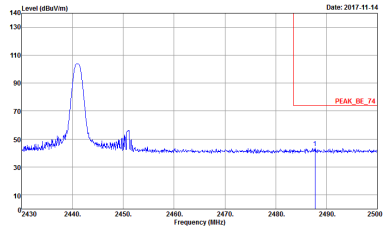
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BT CH39 2441MHz	
2	Horizontal	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2	Left blank

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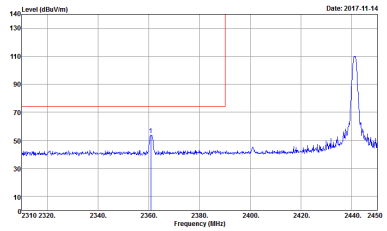
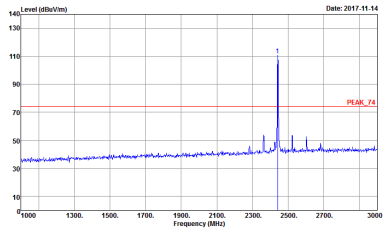
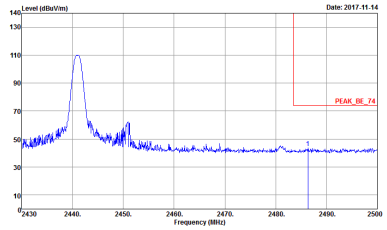
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BT CH39 2441MHz	
2	Vertical	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 2	Left blank

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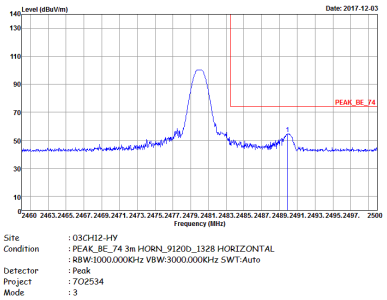
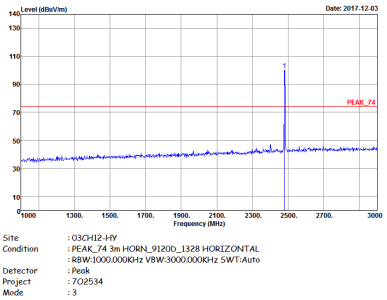
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BT CH78 2480MHz	
2	Horizontal	Fundamental
Peak		

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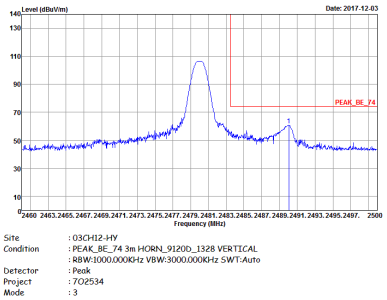
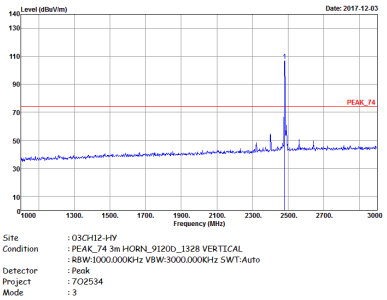
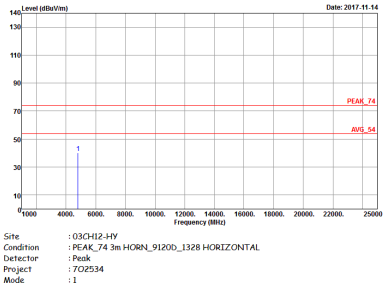
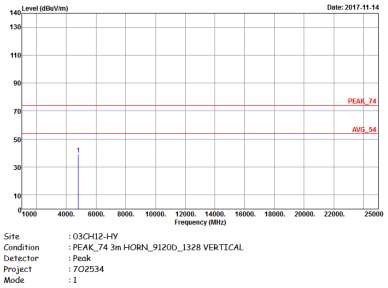
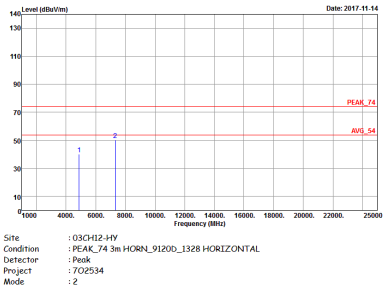
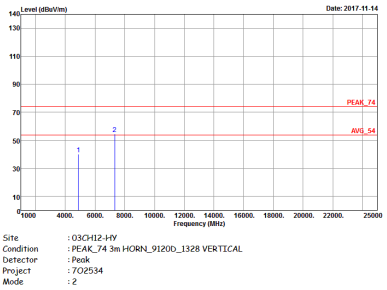
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BT CH78 2480MHz	
2	Vertical	Fundamental
Peak		

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

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

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
Chain	BT CH39 2441MHz	
2	Horizontal	Vertical
Peak Avg.	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 2	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 2

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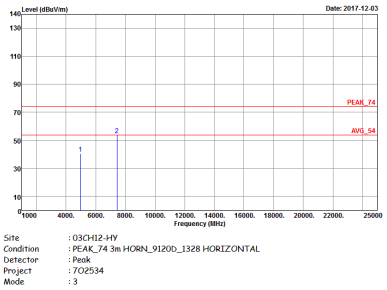
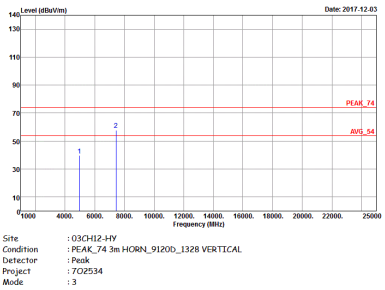
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
Chain	BT CH78 2480MHz	
2	Horizontal	Vertical
Peak Avg.		

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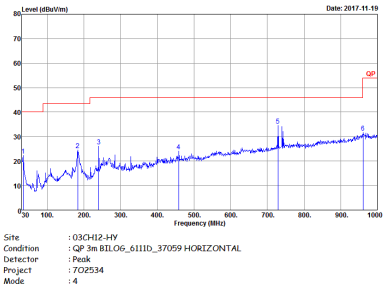
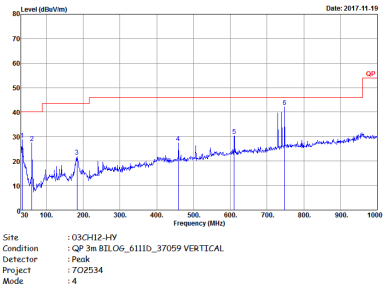
Emission below 1GHz

2.4GHz BT (LF)

BT	2.4GHz 2400~2483.5MHz	
Chain	BT LF	
2	Horizontal	Vertical
QP / Peak		

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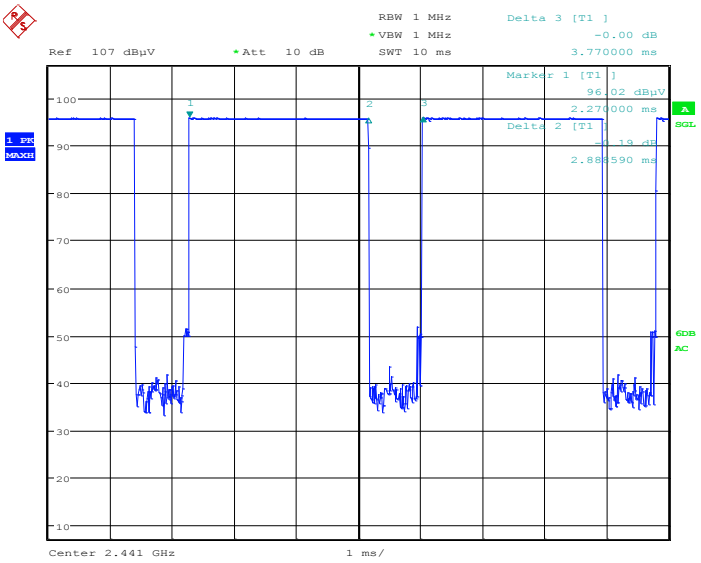
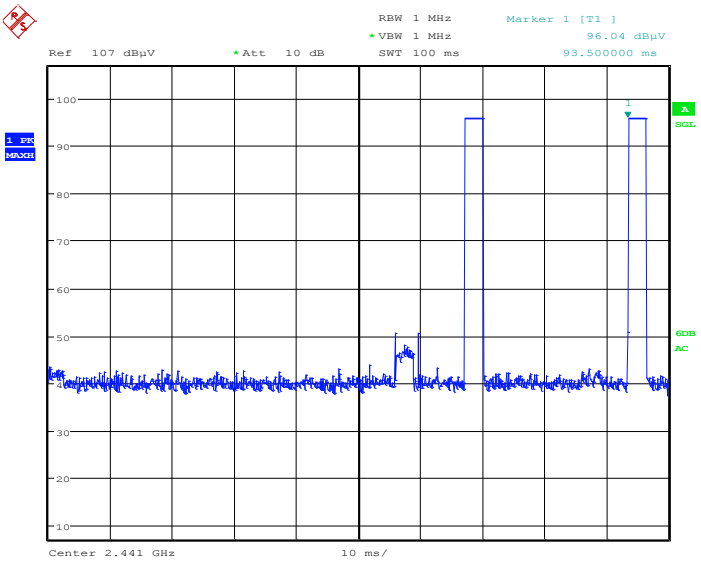
Appendix E. Duty Cycle Plots

DH5 on time (One Pulse) Plot on Channel 39



Date: 13.NOV.2017 23:27:41

on time (Count Pulses) Plot on Channel 39



Date: 13.NOV.2017 23:29:10

Note:

1. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.89 / 100 = 5.788 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.77 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

2.89ms x 20 channels = 57.8 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:

2.89 ms x 2 = 5.78 ms

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

20 x log(5.7878 ms/100ms) = -24.77 dB

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