



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 : (DTS) Digital Transmission System

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.

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR7O2534B	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)(3)	Peak Output Power	≤ 30dBm	Pass	-
3.2	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 4.61 dB at 2489.800 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 : WLAN(2.4G):1.63	Aux Antenna : 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 : WLAN(2.4G):1.44	Aux Antenna : 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	40
Carrier Frequency of Each Channel	40 Channel(37 hopping + 3 advertising channel)
Maximum Output Power to Antenna	5.65 dBm (0.0037 W)
Type of Modulation	Bluetooth LE : GFSK

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 1 st 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
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ♦ 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)
2400-2483.5 MHz	0	2402	21	2444
	1	2404	22	2446
	2	2406	23	2448
	3	2408	24	2450
	4	2410	25	2452
	5	2412	26	2454
	6	2414	27	2456
	7	2416	28	2458
	8	2418	29	2460
	9	2420	30	2462
	10	2422	31	2464
	11	2424	32	2466
	12	2426	33	2468
	13	2428	34	2470
	14	2430	35	2472
	15	2432	36	2474
	16	2434	37	2476
	17	2436	38	2478
	18	2438	39	2480
	19	2440	-	-
20	2442	-	-	



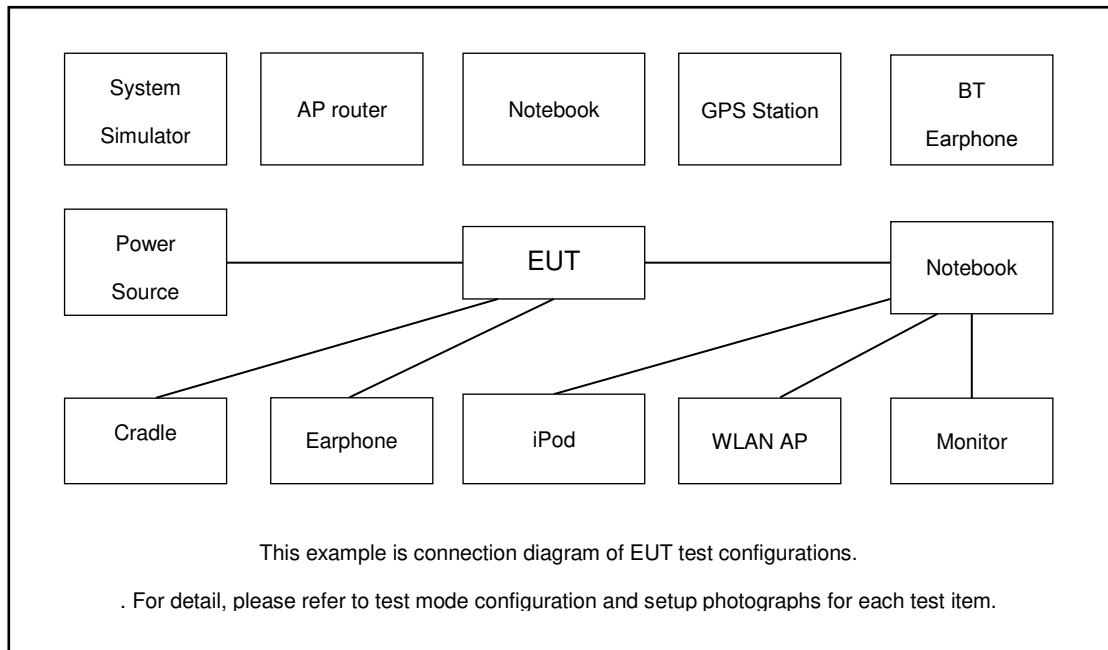
2.2 Test Mode

- 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).
- 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 – LE / GFSK
Radiated TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps
AC Conducted Emission	Mode 1: WLAN (2.4GHz) Link + Bluetooth Link + TF + TC
Remark:	
1. TC stands for Test Configuration, and consists of Earphone and USB (HD, iPod...).	
2. 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.	iPod	Apple	A1285	FCC DoC	Shielded, 1.0 m	N/A
2.	iPod Earphone	Apple	N/A	DoC	UnShielded, 1.2m	N/A
3.	USB HD	WD	WDBAAR3200 ABK-PESN	FCC DoC	Shielded, 0.5m	N/A
4.	USB HD	PQI	H568V	FCC DoC	Shielded, 0.5m	N/A
5.	HD USB 3.0	lenovo	F310S	FCC DoC	Shielded, 0.5m	N/A

2.5 EUT Operation Test Setup

For Bluetooth function, programmed RF utility, “DRTU” 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

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

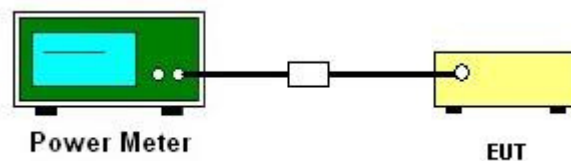
3.1.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.1.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.2 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.1.4 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. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.2.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

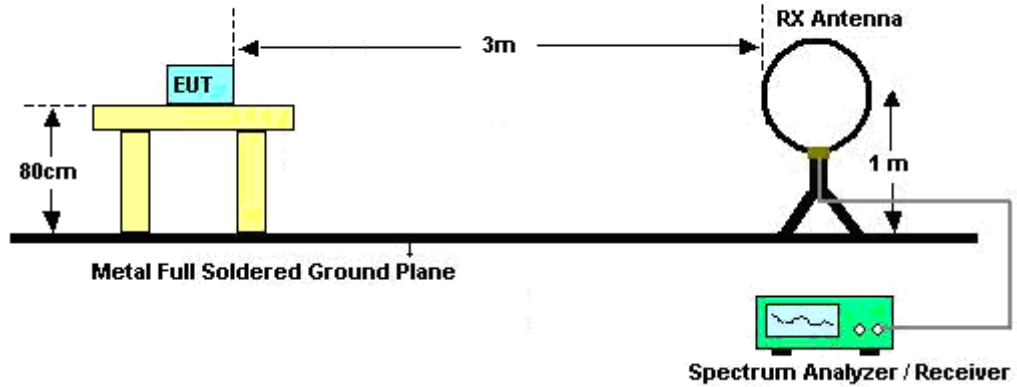


3.2.3 Test Procedures

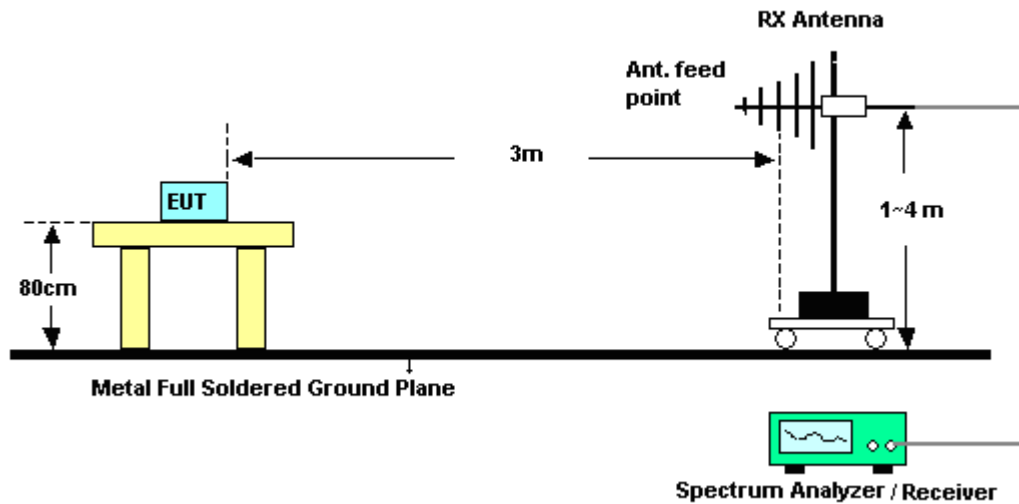
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
For average measurement:
 - 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.

3.2.4 Test Setup

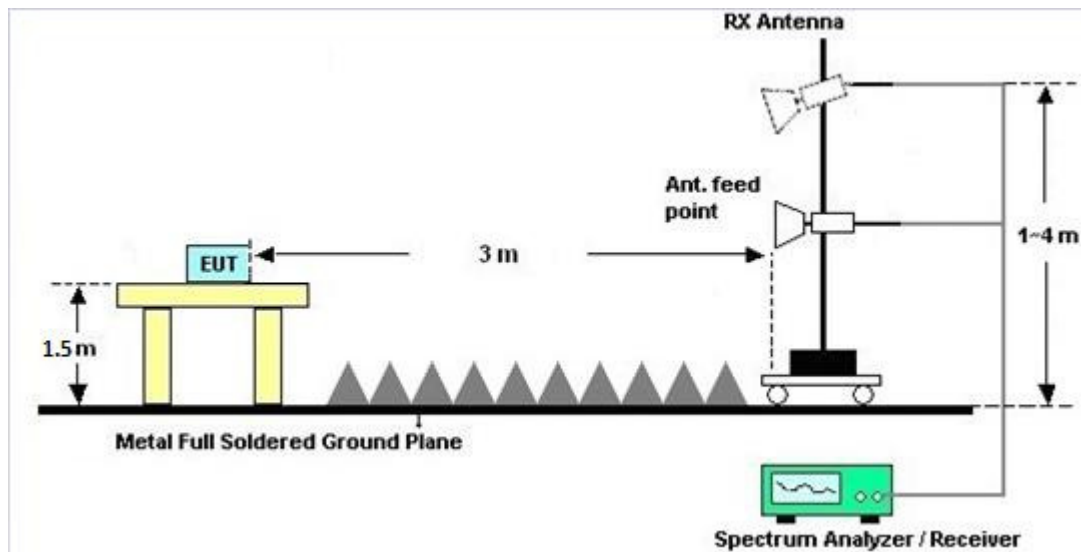
For radiated emissions below 30MHz



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 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 (dB μ V)	
	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.

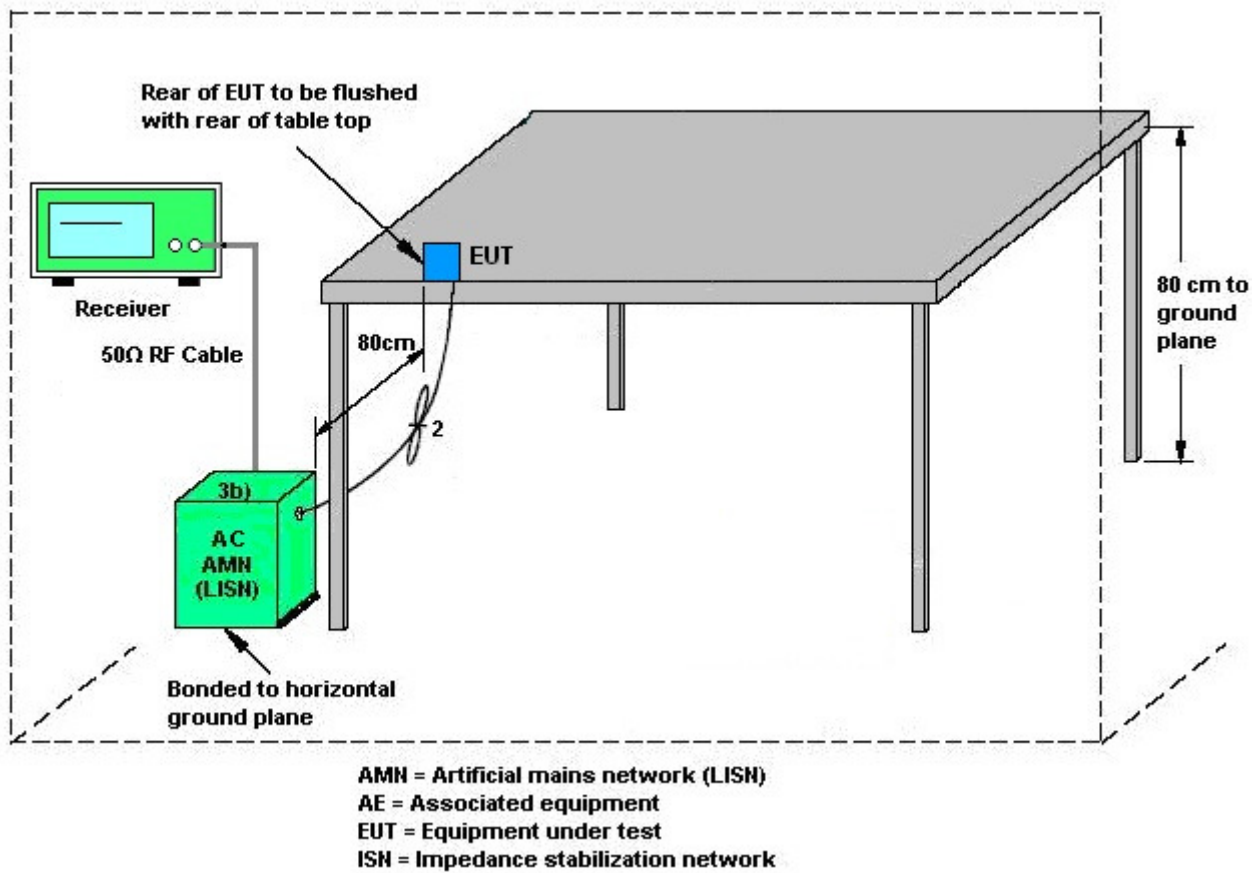
3.3.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

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)
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&00800 N1D01N-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-0010 1800	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	WHKX12-270 0-3000-18000 -60ST	SN2	3 GHz Highpass	Jul. 17, 2017	Nov. 09, 2017~ Dec. 04, 2017	Jul. 16, 2018	Radiation (03CH12-HY)
Filter	Wainwright	WLKS1200-1 2SS	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	BBHA9170 576	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
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.10
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.20
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.70
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Appendix A. Conducted test results

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

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**

Mod.	Data Rate	Ntx	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	1	0	2402	5.35	30.00	1.97	7.32	36.00	Pass
BLE	1Mbps	1	19	2440	5.64	30.00	1.97	7.61	36.00	Pass
BLE	1Mbps	1	39	2480	5.65	30.00	1.97	7.62	36.00	Pass

TEST RESULTS DATA**Average Power Table****(Reporting Only)**

Mod.	Data Rate	Ntx	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)
BLE	1Mbps	1	0	2402	2.06	5.09
BLE	1Mbps	1	19	2440	2.06	5.38
BLE	1Mbps	1	39	2480	2.06	5.39



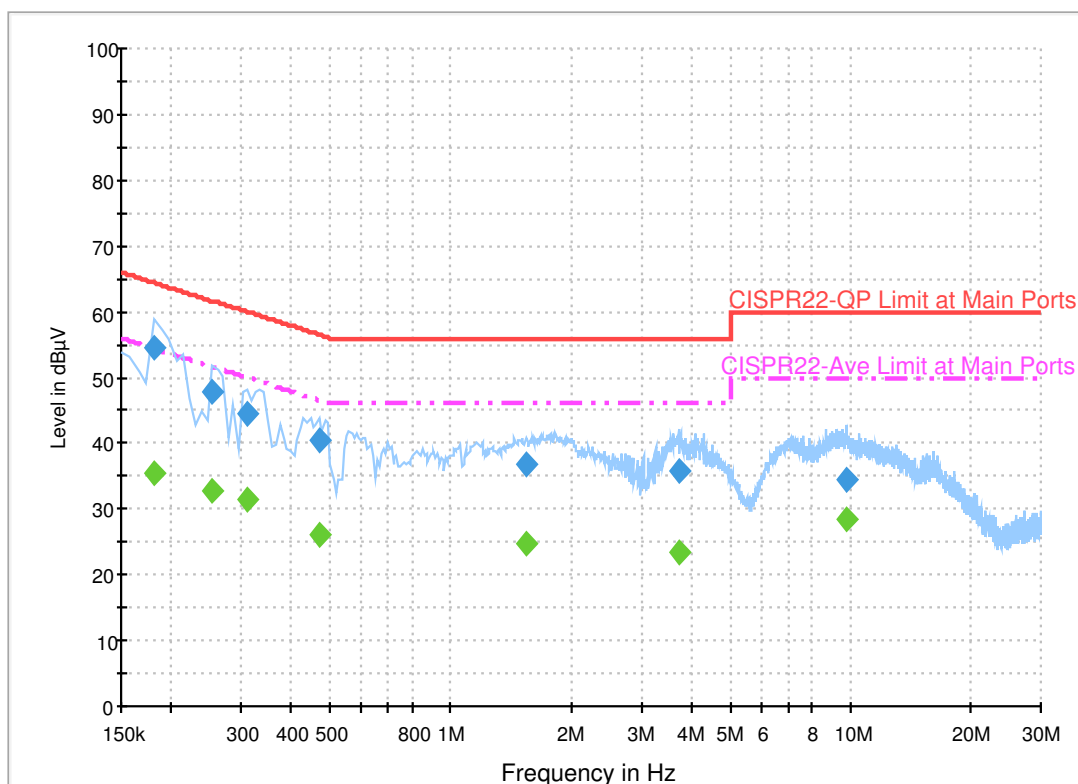
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Shareef Yu	Temperature :	26~27°C
		Relative Humidity :	58~62%

EUT Information

Report NO : 702534
 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

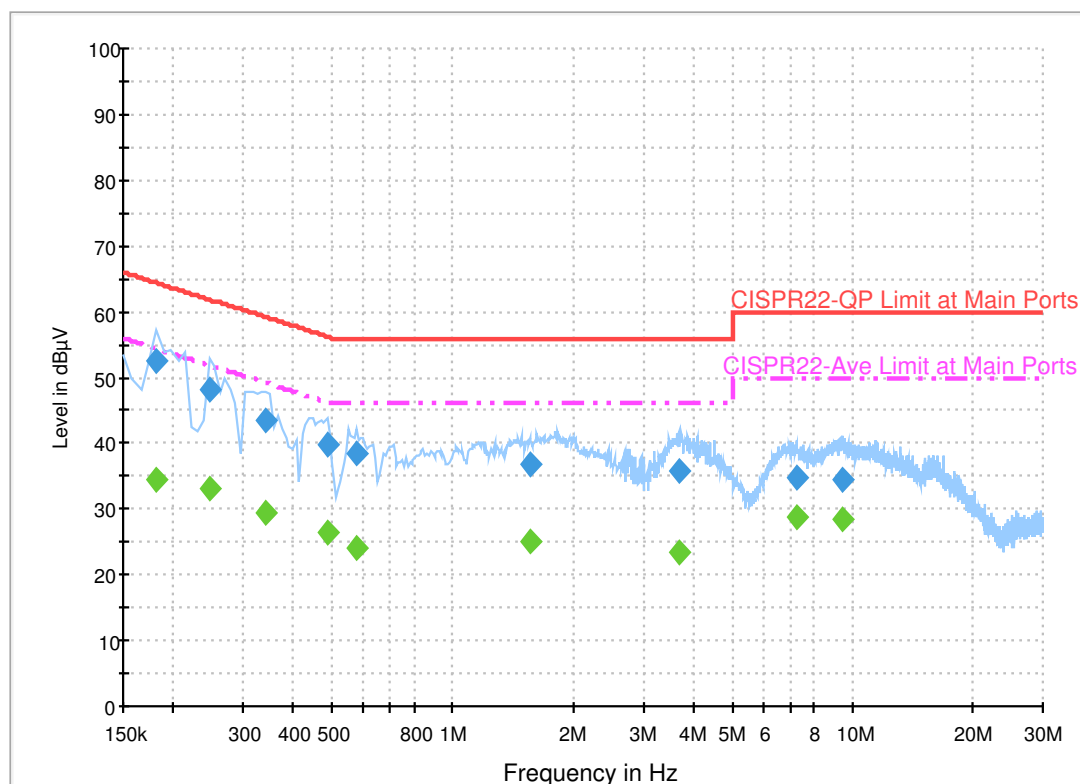
Final Result 2

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°C
		Relative Humidity :	62~67%

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE Chain	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)	
BLE CH 00 2402MHz		2336.985	53.81	-20.19	74	44.28	27.03	3.98	31.51	400	129	P	H	
		2371.53	43.04	-10.96	54	33.38	27.11	4.01	31.49	400	129	A	H	
	*	2402	98.89	-	-	89.16	27.15	4.04	31.49	400	129	P	H	
	*	2402	97.92	-	-	88.19	27.15	4.04	31.49	400	129	A	H	
													H	
														H
			2321.76	54.54	-19.46	74	45.05	26.99	3.98	31.51	387	173	P	V
			2321.865	46.8	-7.2	54	37.31	26.99	3.98	31.51	387	173	A	V
	*		2402	104.95	-	-	95.22	27.15	4.04	31.49	387	173	P	V
	*		2402	103.93	-	-	94.2	27.15	4.04	31.49	387	173	A	V
														V
														V
BLE CH 39 2441MHz		2358.02	53.36	-20.64	74	43.75	27.07	4.01	31.5	385	121	P	H	
		2359.7	43.29	-10.71	54	33.68	27.07	4.01	31.5	385	121	A	H	
	*	2441	99.03	-	-	89.13	27.28	4.07	31.48	385	121	P	H	
	*	2441	97.87	-	-	87.97	27.28	4.07	31.48	385	121	A	H	
			2485.79	54.19	-19.81	74	44.16	27.36	4.11	31.47	385	121	P	H
			2484.46	42.93	-11.07	54	32.9	27.36	4.11	31.47	385	121	A	H
			2360.26	54.62	-19.38	74	45.01	27.07	4.01	31.5	334	168	P	V
			2359.98	47.91	-6.09	54	38.3	27.07	4.01	31.5	334	168	A	V
	*		2441	105.28	-	-	95.38	27.28	4.07	31.48	334	168	P	V
	*		2441	104.3	-	-	94.4	27.28	4.07	31.48	334	168	A	V
			2495.52	53.86	-20.14	74	43.78	27.4	4.11	31.46	334	168	P	V
			2491.25	43.11	-10.89	54	33.04	27.4	4.11	31.47	334	168	A	V



BLE CH 78 2480MHz	*	2480	95.81	-	-	85.8	27.36	4.09	31.47	370	124	P	H
	*	2480	94.81	-	-	84.8	27.36	4.09	31.47	370	124	A	H
		2489.92	59.35	-14.65	74	49.28	27.4	4.11	31.47	370	124	P	H
		2489.88	46.4	-7.6	54	36.33	27.4	4.11	31.47	370	124	A	H
													H
													H
	*	2480	100.95	-	-	90.94	27.36	4.09	31.47	322	160	P	V
	*	2480	99.9	-	-	89.89	27.36	4.09	31.47	322	160	A	V
		2490.08	61.99	-12.01	74	51.92	27.4	4.11	31.47	322	160	P	V
		2489.8	49.39	-4.61	54	39.32	27.4	4.11	31.47	322	160	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

BLE (Harmonic @ 3m)

BLE Chain	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)	
BLE CH 00 2402MHz		4804	39.01	-34.99	74	65.74	31.32	6.16	64.75	100	0	P	H	
													H	
													H	
													H	
			4804	38.99	-35.01	74	65.72	31.32	6.16	64.75	100	0	P	V
														V
														V
BLE CH 39 2441MHz		4880	39.88	-34.12	74	66.39	31.46	6.21	64.7	100	0	P	H	
		7320	44.26	-29.74	74	64.88	36.15	7.72	64.83	100	0	P	H	
													H	
													H	
			4880	39.67	-34.33	74	66.18	31.46	6.21	64.7	100	0	P	V
			7320	44.24	-29.76	74	64.86	36.15	7.72	64.83	100	0	P	V
														V
BLE CH 78 2480MHz		4960	39.54	-34.46	74	65.79	31.63	6.26	64.63	100	0	P	H	
		7440	44.32	-29.68	74	64.66	36.47	7.75	64.88	100	0	P	H	
													H	
													H	
			4960	39.61	-34.39	74	65.86	31.63	6.26	64.63	100	0	P	V
			7440	45.62	-28.38	74	65.96	36.47	7.75	64.88	100	0	P	V
														V
Remark	1. No other spurious found.													
	2. All results are PASS against Peak and Average limit line.													



Emission below 1GHz

2.4GHz BLE (LF)

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.	
Chain				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.		
2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
2.4GHz BLE LF		34.59	21.05	-18.95	40	32.37	18.48	0.48	30.25	-	-	P	H	
		182.82	25.78	-17.72	43.5	43.04	11.73	1.14	30.29	-	-	P	H	
		240.06	26.89	-19.11	46	41.66	14.02	1.28	30.22	-	-	P	H	
		458.2	23.39	-22.61	46	31.27	20.2	1.73	29.87	-	-	P	H	
		746.6	34.18	-11.82	46	36.32	24.99	2.21	29.44	100	0	P	H	
		982.5	31.48	-22.52	54	29.87	27.85	2.53	29	-	-	P	H	
														H
														H
														H
														H
														H
														H
			34.32	28.61	-11.39	40	39.1	19.31	0.48	30.25	-	-	P	V
			58.35	25.74	-14.26	40	46.34	9.12	0.68	30.44	-	-	P	V
			182.28	24.45	-19.05	43.5	41.71	11.77	1.09	30.29	-	-	P	V
			458.2	27.35	-18.65	46	35.23	20.2	1.73	29.87	-	-	P	V
			610.8	31.68	-14.32	46	36.5	22.77	1.97	29.65	-	-	P	V
			747.3	38.1	-7.9	46	40.24	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.													



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:

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		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

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

For Peak Limit @ 2390MHz:

- 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)
- Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

- 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)
- 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 D. Radiated Spurious Emission Plots

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

Note symbol

-L	Low channel location
-R	High channel location

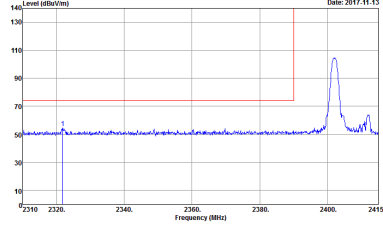
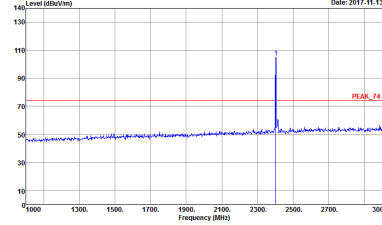
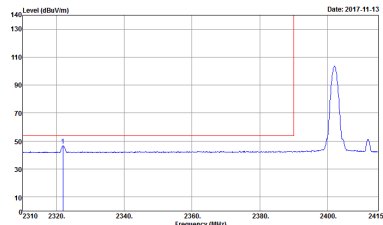
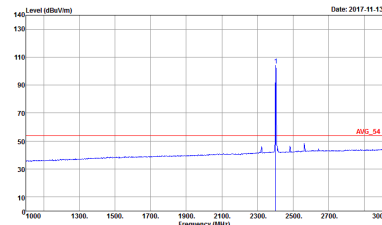


2.4GHz 2400~2483.5MHz

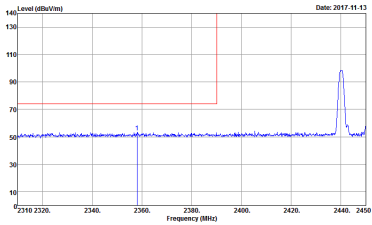
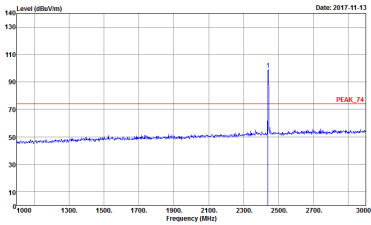
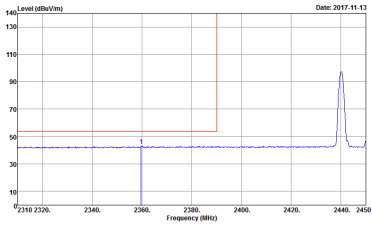
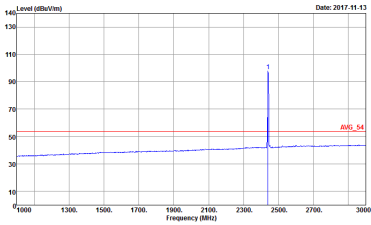
BLE (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH00 2402MHz	
2	Horizontal	Fundamental
Peak	<p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>	<p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>
Avg.	<p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_91200_1328 HORIZONTAL : RBW:1000.0000Hz VBW:3.0000Hz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>	<p>Site : 03CH12-HY Condition : AVG_54 3m HORN_91200_1328 HORIZONTAL : RBW:1000.0000Hz VBW:3.0000Hz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>

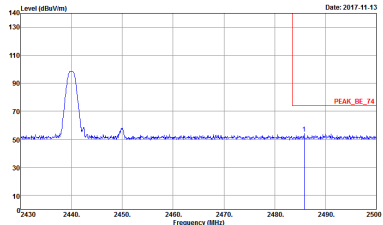
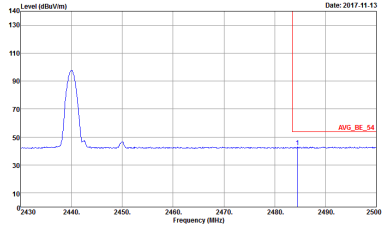


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH00 2402MHz	
2	Vertical	Fundamental
Peak	 <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>	 <p>Site : 03CH12-HY Condition : PEAK_F4 3m HORN_9120D_1328 VERTICAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>
Avg	 <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL RBW:1000.000kHz VBW:3.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>	 <p>Site : 03CH12-HY Condition : AVG_F4 3m HORN_9120D_1328 VERTICAL RBW:1000.000kHz VBW:3.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 5</p>



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH19 2440MHz - L	
2	Horizontal	Fundamental
Peak	 <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_91200_1328 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>	 <p>Site : 03CH12-HY Condition : PEAK_F4 3m HORN_91200_1328 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>
Avg.	 <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_91200_1328 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>	 <p>Site : 03CH12-HY Condition : AVG_F4 3m HORN_91200_1328 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>

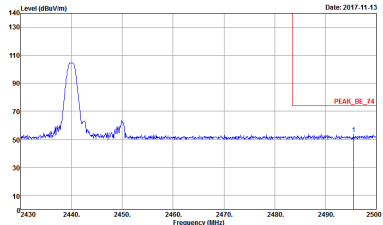
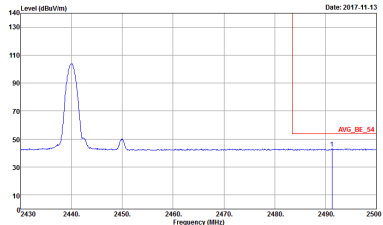


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH19 2440MHz - R	
2	Horizontal	Fundamental
<p>Peak</p>	 <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Left blank</p>
<p>Avg.</p>	 <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL RBW:1000.000kHz VBW:3.000kHz SWT:Auto Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Left blank</p>

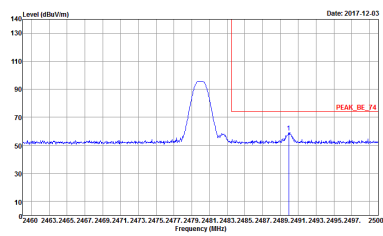
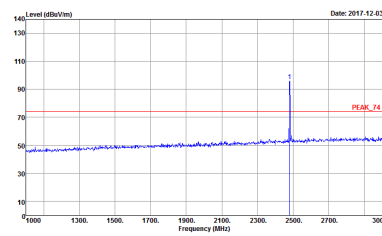
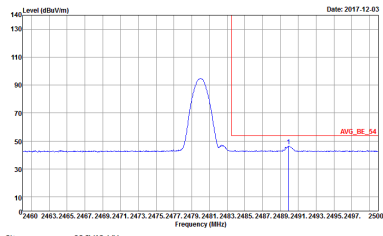
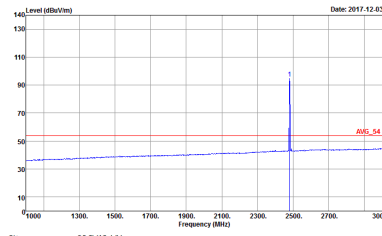


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH19 2440MHz - L	
2	Vertical	Fundamental
Peak	<p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Site : 03CH12-HY Condition : PEAK_F4 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>
Avg.	<p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Site : 03CH12-HY Condition : AVG_F4 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>

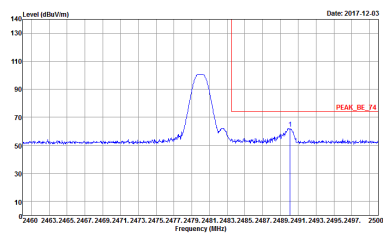
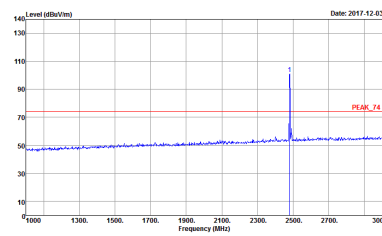
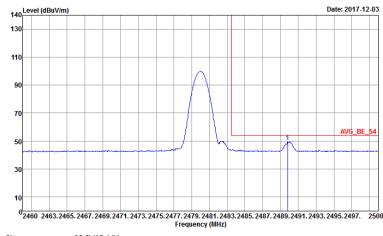
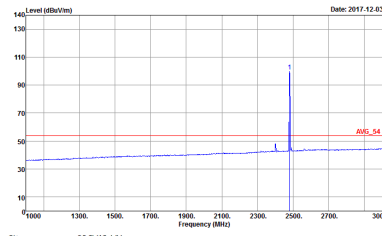


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH19 2440MHz - R	
2	Vertical	Fundamental
<p>Peak</p>	 <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Left blank</p>
<p>Avg.</p>	 <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 6</p>	<p>Left blank</p>



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH39 2480MHz	
2	Horizontal	Fundamental
Peak	 <p>Date: 2017-12-03</p> <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 7</p>	 <p>Date: 2017-12-03</p> <p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 7</p>
Avg.	 <p>Date: 2017-12-03</p> <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 7</p>	 <p>Date: 2017-12-03</p> <p>Site : 03CH12-HY Condition : AVG_54 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 7</p>



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Chain	BLE CH39 2480MHz	
2	Vertical	Fundamental
Peak	 <p>Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 7</p>	 <p>Site : 03CH12-HY Condition : PEAK_F4 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 7</p>
Avg.	 <p>Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 7</p>	 <p>Site : 03CH12-HY Condition : AVG_54 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 7</p>



2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
Chain	BLE CH00 2402MHz	
2	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 5</p>	<p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 5</p>



BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
Chain	BLE CH19 2440MHz	
2	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : -6</p>	<p>Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : -6</p>



BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
Chain	BLE CH39 2480MHz	
2	Horizontal	Vertical
Peak	<p> Date: 2017-12-03 Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 7 </p>	<p> Date: 2017-12-03 Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 VERTICAL Detector : Peak Project : 7O2534 Mode : 7 </p>



Emission below 1GHz

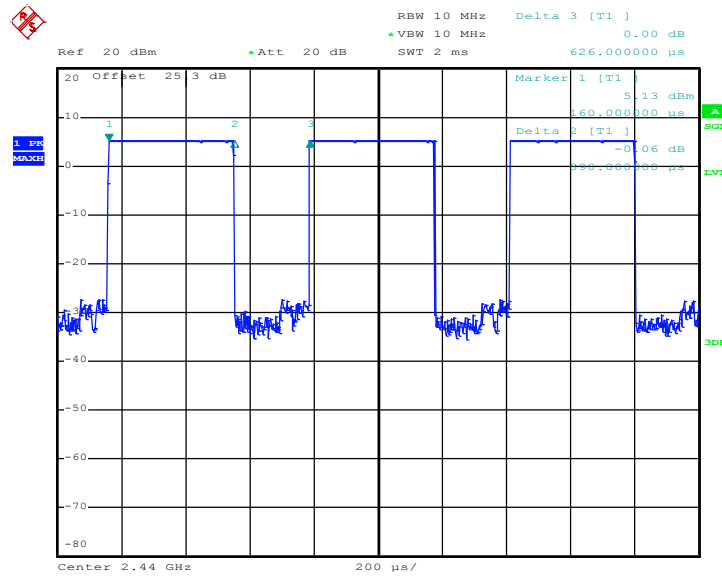
2.4GHz BLE (LF)

BLE	2.4GHz 2400~2483.5MHz	
Chain	BLE LF	
2	Horizontal	Vertical
QP / Peak	<p>Site : 03CH12-HY Condition : QP 3m BILDG_6111D_37059 HORIZONTAL Detector : Peak Project : 7O2534 Mode : 8</p>	<p>Site : 03CH12-HY Condition : QP 3m BILDG_6111D_37059 VERTICAL Detector : Peak Project : 7O2534 Mode : 8</p>

Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth -LE	62.30	390	2.56	3kHz

Bluetooth - LE



Date: 25.OCT.2017 22:28:49