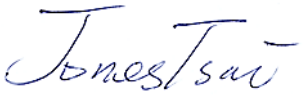
FCC RF Test Report

APPLICANT	**:**	**Harmony Swan LLC**
EQUIPMENT	**:**	**Bluetooth Keyboard Case**
MODEL NAME	**:**	**WK94BZ**
FCC ID	**:**	**2AETJ-1229**
STANDARD	**:**	**FCC Part 15 Subpart C §15.247**
CLASSIFICATION	**:**	**(DTS) Digital Transmission System**

The testing was completed on Jun. 17, 2015. 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
FR521610-01	Rev. 01	Initial issue of report	Jul. 23, 2015

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.2	15.247(b)(1)	Peak Output Power	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 1.54 dB at 2483.520 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 14.90 dB at 0.510 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

1 General Description

1.1 Applicant

Harmony Swan LLC
8400 Normandale Lake Blvd.
Suite 920
Bloomington, Minnesota 55437

1.2 Product Feature of Equipment Under Test

Product Feature	
Equipment	Bluetooth Keyboard Case
Model Name	WK94BZ
FCC ID	2AETJ-1229
EUT supports Radios application	Bluetooth v4.1 LE

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

1.3 Product Specification subjective to this standard

Product Specification subjective to this standard	
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	0.23 dBm (0.0011 W)
Antenna Type	Fixed Internal Antenna with gain 2.35 dB
Type of Modulation	Bluetooth LE : GFSK

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. TW1022 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	CO05-HY

Note: The test site complies with ANSI C63.4 2009 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.**
	03CH10-HY

Note: The test site complies with ANSI C63.4 2009 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
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r03
- ANSI C63.10-2009

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. FCC permits the use of the 1.5 meter table as an alternative in C63.10-2013 through inquiry tracking number 961829.
3. 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 Descriptions of Test Mode

The RF output power was recorded in the following table:

Channel	Frequency	Bluetooth 4.1 – LE RF Output Power
		Data Rate / Modulation
		GFSK
		1Mbps
Ch00	2402MHz	-0.01 dBm
Ch19	2440MHz	**0.23 dBm**
Ch39	2480MHz	0.18 dBm

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 (150 kHz to 30 MHz), radiation (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.

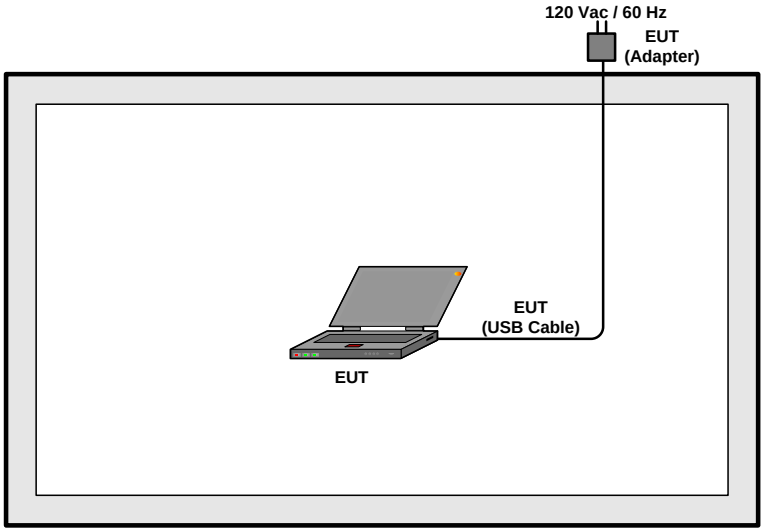
2.2 Test Mode

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

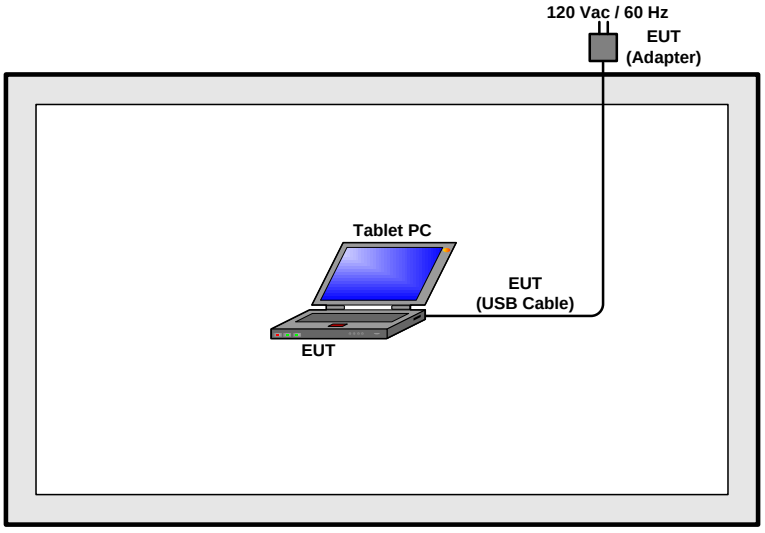
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
	Bluetooth 4.1 – LE / GFSK
Conducted TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps
Radiated TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps Mode 4: Bluetooth Tx CH39_2480 MHz_1Mbps with Tablet
AC Conducted Emission	Mode 1: Bluetooth Link + USB Cable (Charging from Adapter)

2.3 Connection Diagram of Test System

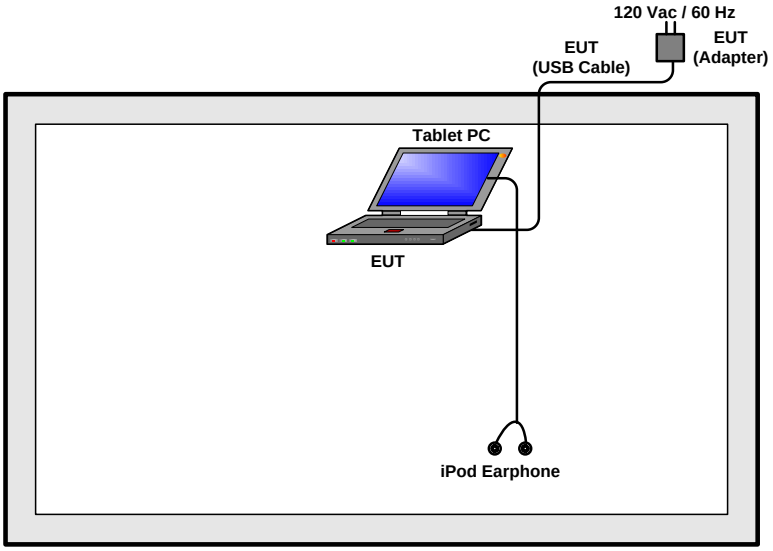
<Bluetooth 4.1 – LE Tx Mode>



<Bluetooth 4.1 – LE Tx Mode with Tablet>



<AC Conducted Emission Mode>



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Tablet	N/A	SR87CV	2ACBF-6708	N/A	Shielded, 1.0 m
2.	iPod Earphone	Apple	N/A	Verification	Unshielded, 1.0 m	N/A

2.5 EUT Operation Test Setup

For Bluetooth function, programmed RF utility, “PuTTy” installed in the tablet make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.

2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example :
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.
Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB Bandwidth Measurement

3.1.1 Limit of 6dB Bandwidth

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

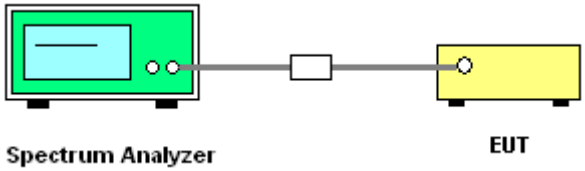
3.1.2 Measuring Instruments

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

3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r03.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. Measure and record the results in the test report.

3.1.4 Test Setup

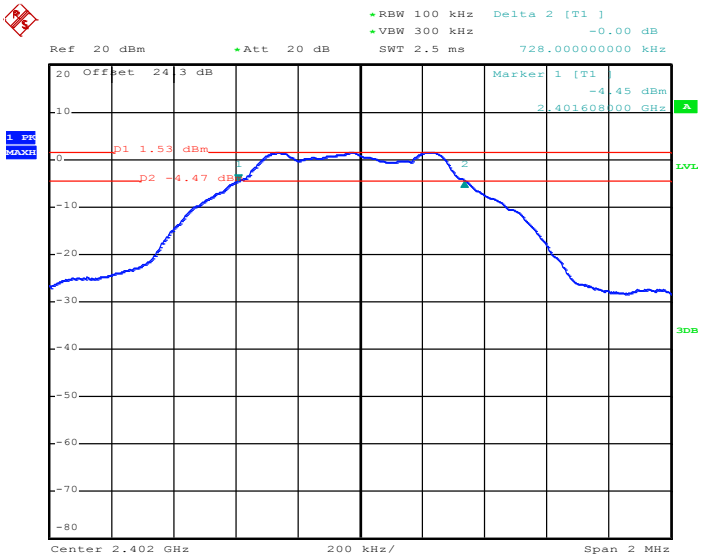


3.1.5 Test Result of 6dB Bandwidth

Test Mode :	Bluetooth 4.1 - LE	Temperature :	22~25℃
Test Engineer :	Osolemio Chang	Relative Humidity :	51~55%

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	6dB Bandwidth Min. Limit (MHz)	Pass/Fail
00	2402	0.728	0.5	Pass
19	2440	0.720	0.5	Pass
39	2480	0.720	0.5	Pass

6 dB Bandwidth Plot on Channel 00



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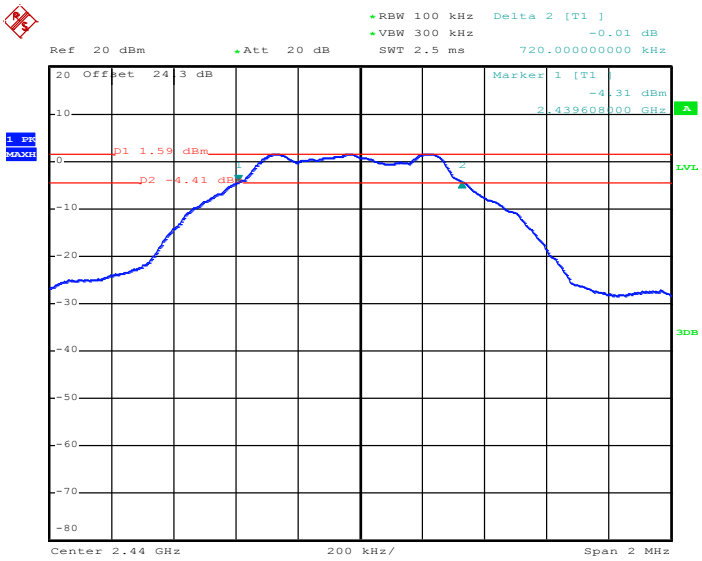
6 dB Bandwidth Plot on Channel 19



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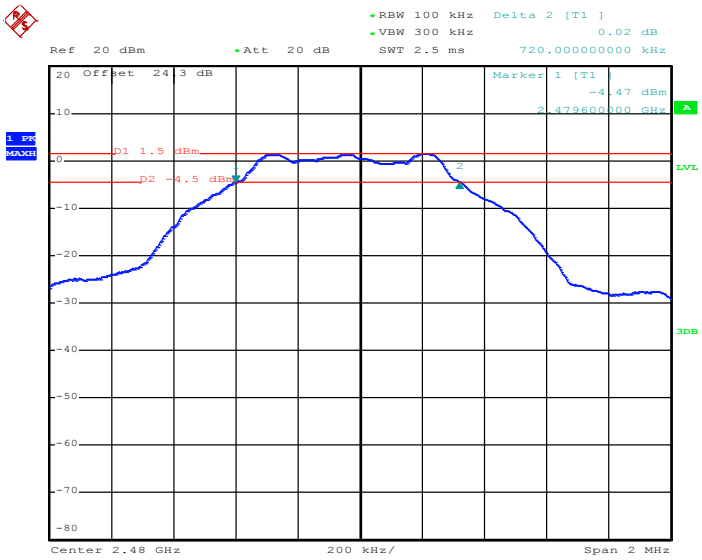
6 dB Bandwidth Plot on Channel 39



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3.2 Peak Output Power Measurement

3.2.1 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.

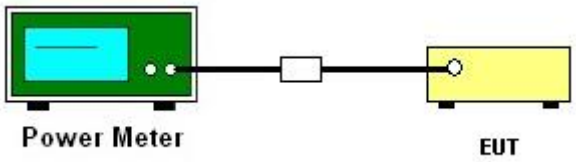
3.2.2 Measuring Instruments

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

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v03r03 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.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Test Mode :	Bluetooth 4.1 - LE	Temperature :	22~25℃
Test Engineer :	Osolemio Chang	Relative Humidity :	51~55%

Channel	Frequency (MHz)	RF Power (dBm)		
		GFSK	Max. Limits (dBm)	Pass/Fail
		1 Mbps		
00	2402	-0.01	30.00	Pass
19	2440	0.23	30.00	Pass
39	2480	0.18	30.00	Pass

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

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

3.3.2 Measuring Instruments

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

3.3.3 Test Procedures

1. The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r03
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

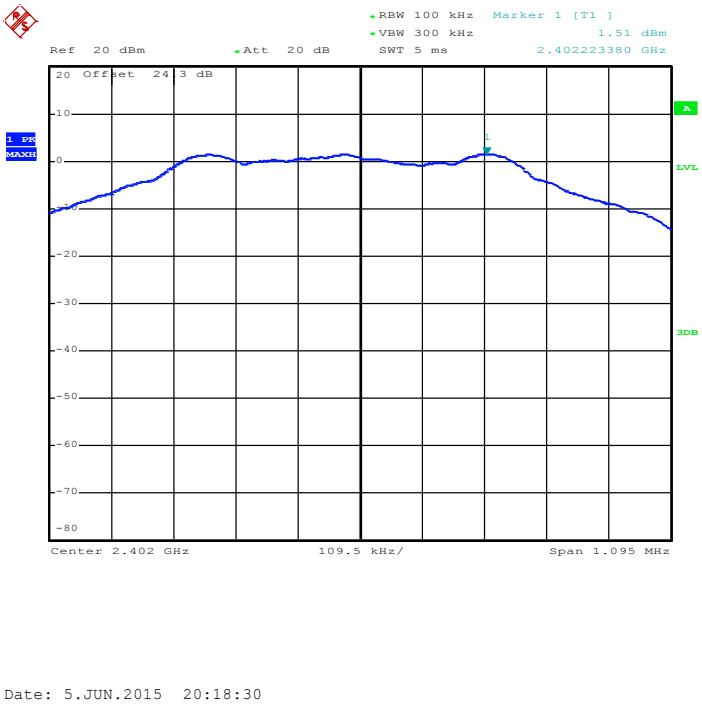
3.3.5 Test Result of Power Spectral Density

Test Mode :	Bluetooth 4.1 - LE	Temperature :	22~25℃
Test Engineer :	Osolemio Chang	Relative Humidity :	51~55%

Channel	Frequency (MHz)	Power Density		Max. Limits (dBm/3kHz)	Pass/Fail
		PSD/100kHz (dBm)	PSD/3kHz (dBm)		
00	2402	1.51	-12.72	8	Pass
19	2440	1.58	-12.79	8	Pass
39	2480	1.48	-12.94	8	Pass

3.3.6 Test Result of Power Spectral Density Plots (100kHz)

PSD 100kHz Plot on Channel 00



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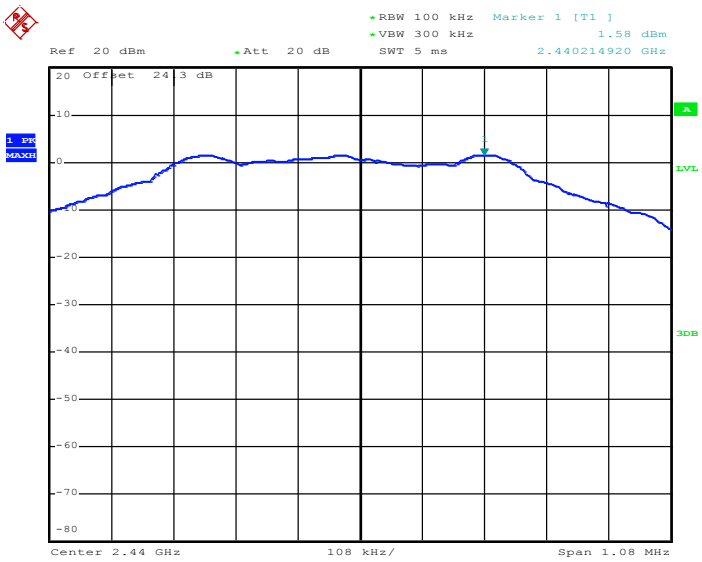
PSD 100kHz Plot on Channel 19



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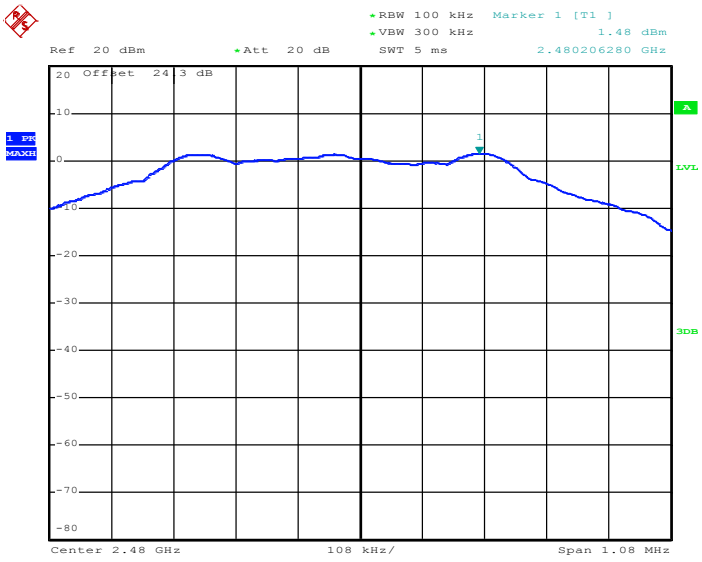
PSD 100kHz Plot on Channel 39



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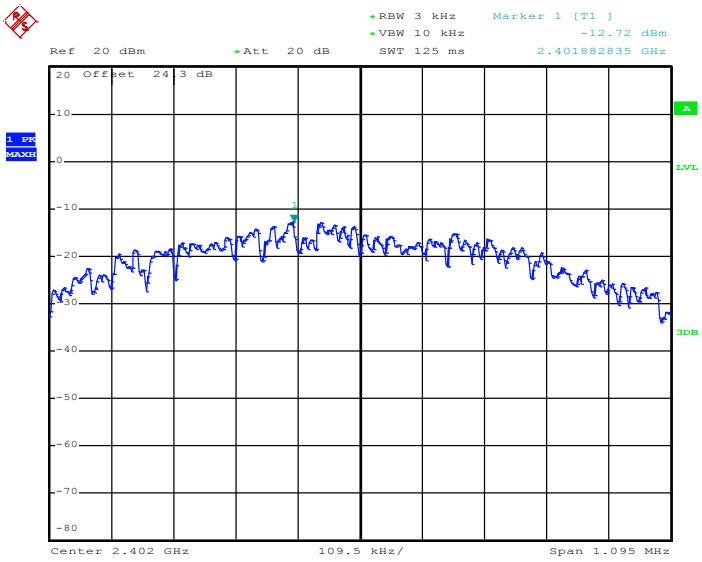
3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 00



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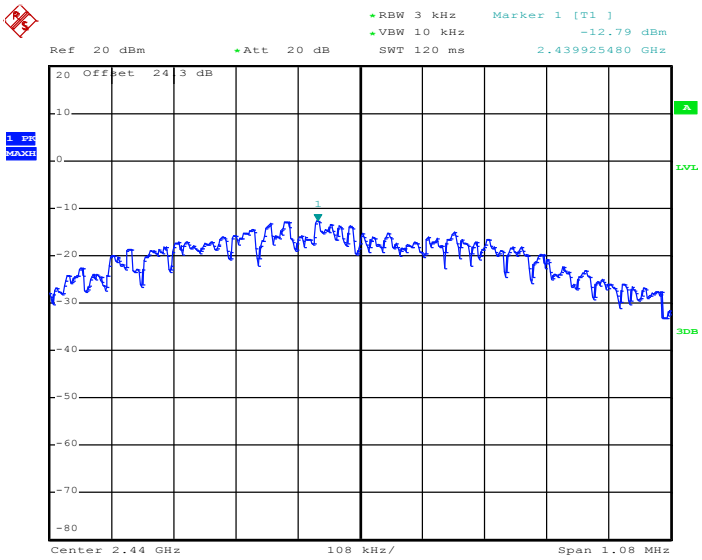
PSD 3kHz Plot on Channel 19



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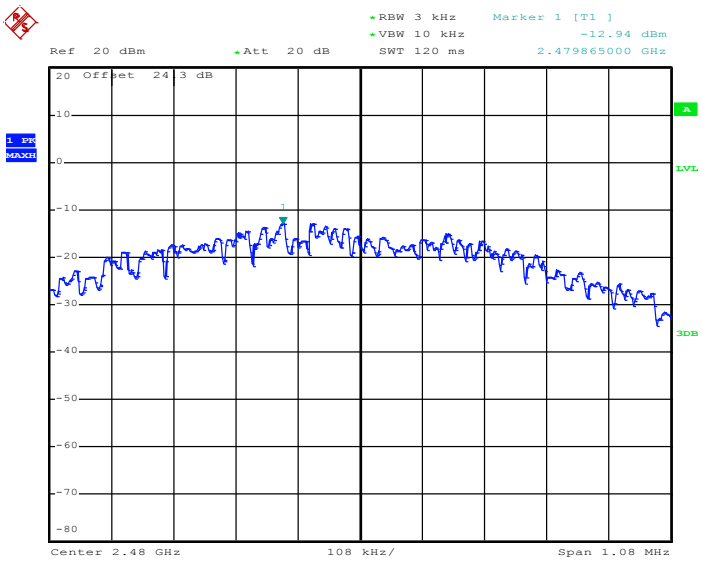
PSD 3kHz Plot on Channel 39



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3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

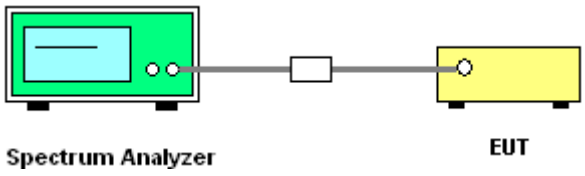
3.4.2 Measuring Instruments

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

3.4.3 Test Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r03.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

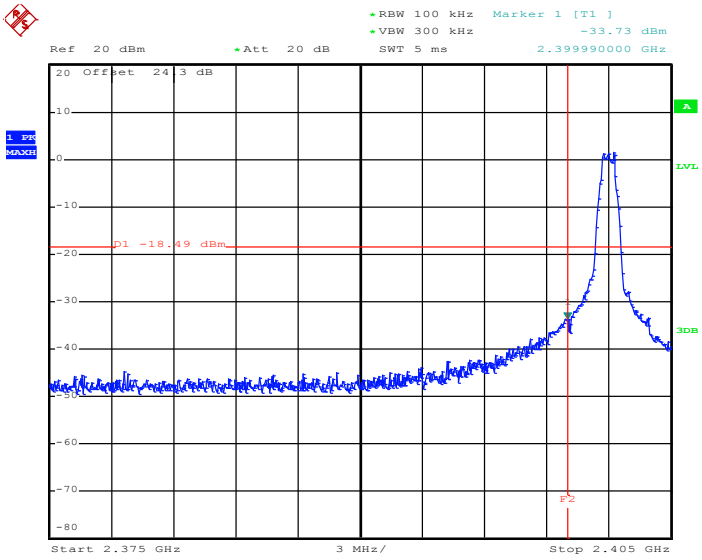
3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges Plots

Test Mode :	Bluetooth 4.1 - LE	Temperature :	22~25℃
Test Channel :	00 and 39	Relative Humidity :	51~55%
		Test Engineer :	Osolemio Chang

Low Band Edge Plot on Channel 00



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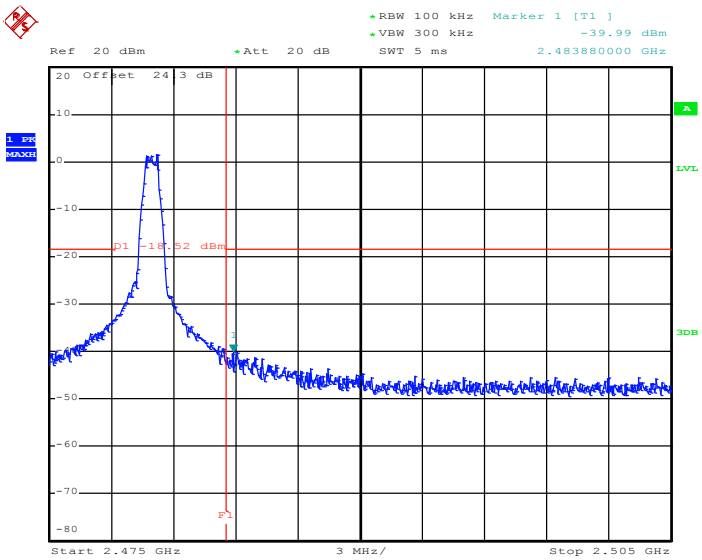
High Band Edge Plot on Channel 39



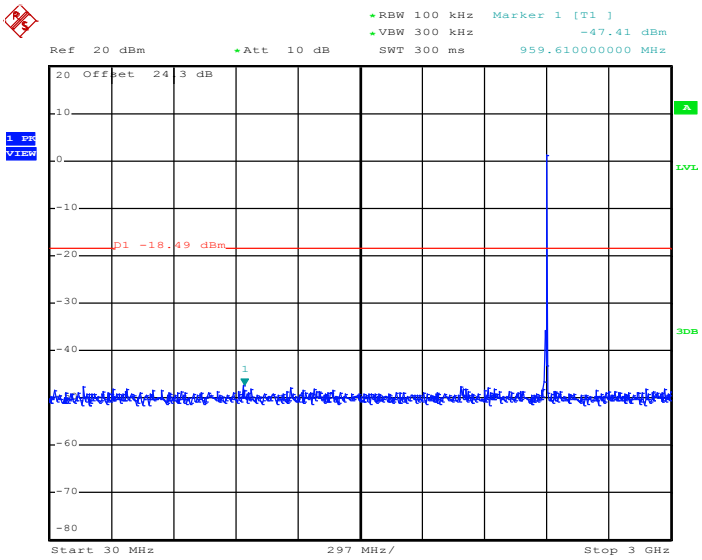
Date: 5.JUN.2015 20:38:29

3.4.6 Test Result of Conducted Spurious Emission Plots

Test Mode :	Bluetooth 4.1 - LE	Temperature :	22~25℃
Test Channel :	00	Relative Humidity :	51~55%
		Test Engineer :	Osolemio Chang

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 00



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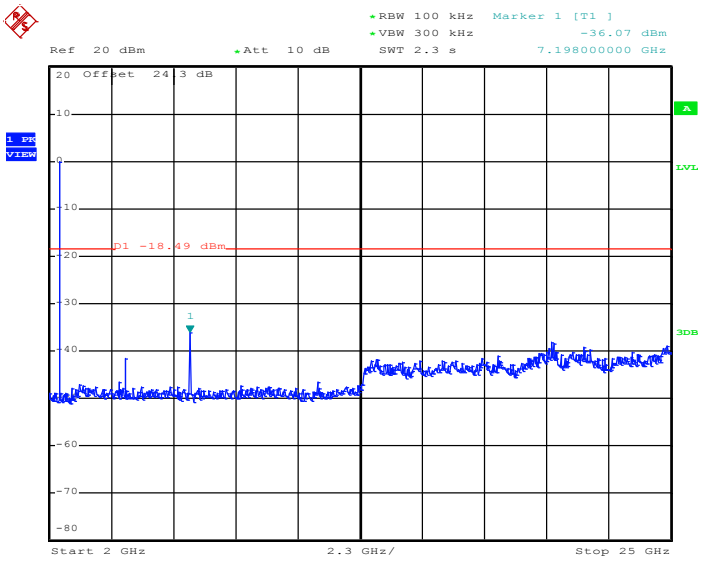
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 00



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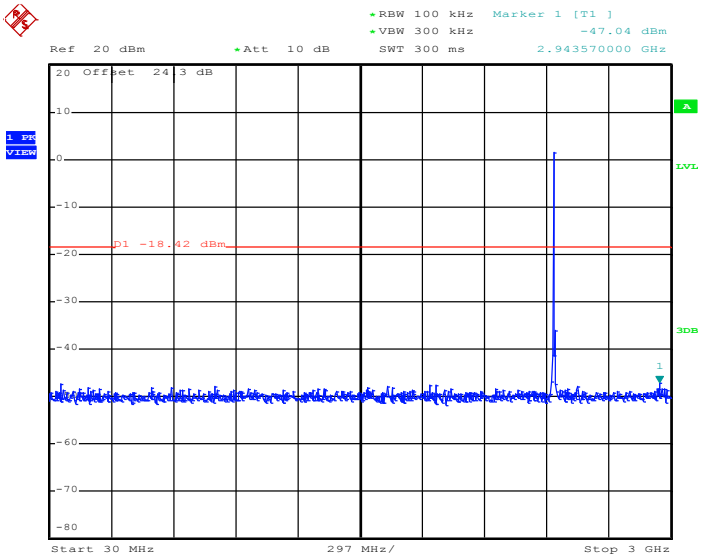
Test Mode :	Bluetooth 4.1 - LE	**Temperature :**	22~25℃
Test Channel :	19	**Relative Humidity :**	51~55%
		Test Engineer :	Osolemio Chang

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 19



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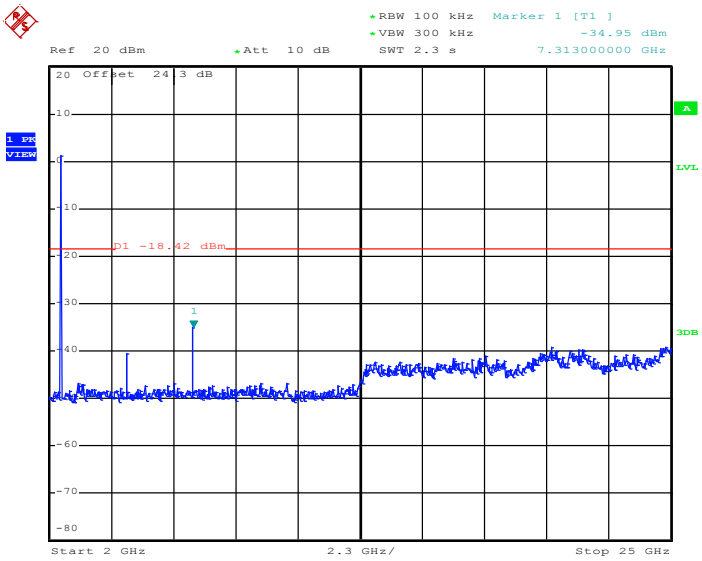
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 19



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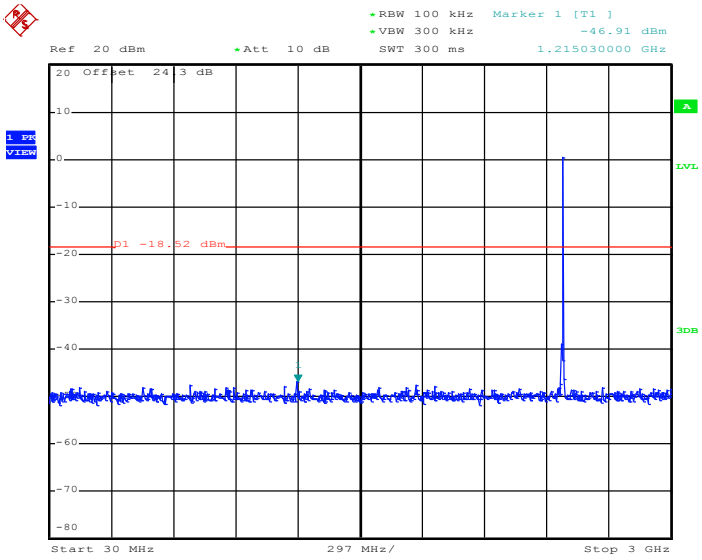
Test Mode :	Bluetooth 4.1 - LE	**Temperature :**	22~25℃
Test Channel :	39	**Relative Humidity :**	51~55%
		Test Engineer :	Osolemio Chang

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 39



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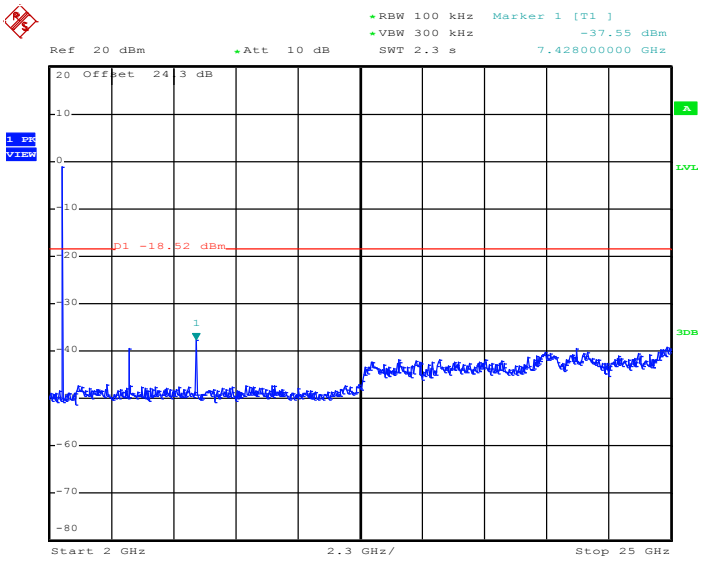
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 39



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3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 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 FCC section 15.209 limits as below.

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

3.5.2 Measuring Instruments

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

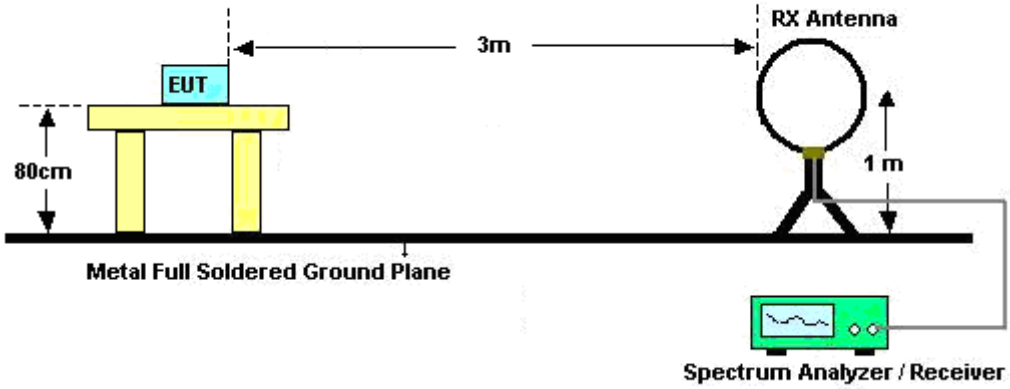
3.5.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r03.
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 ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

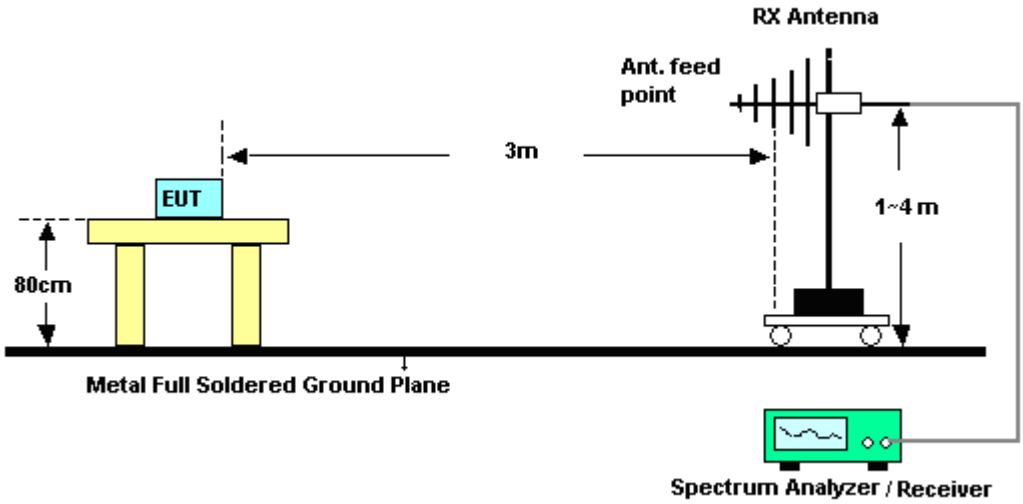
Band	Duty Cycle(%)	T(μs)	1/T(kHz)	VBW Setting
Bluetooth 4.1 - LE	62.03	392.00	2.55	3kHz

3.5.4 Test Setup

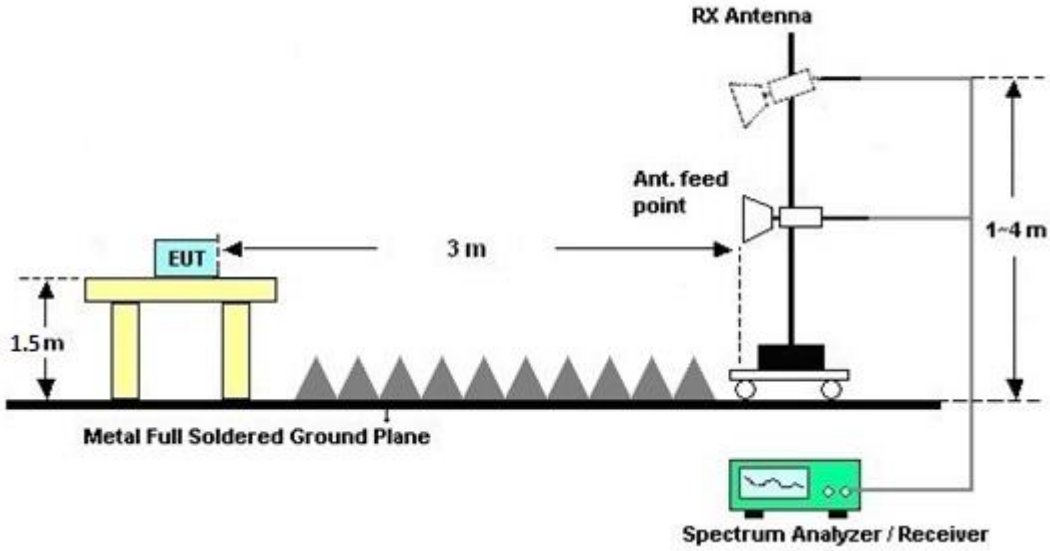
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



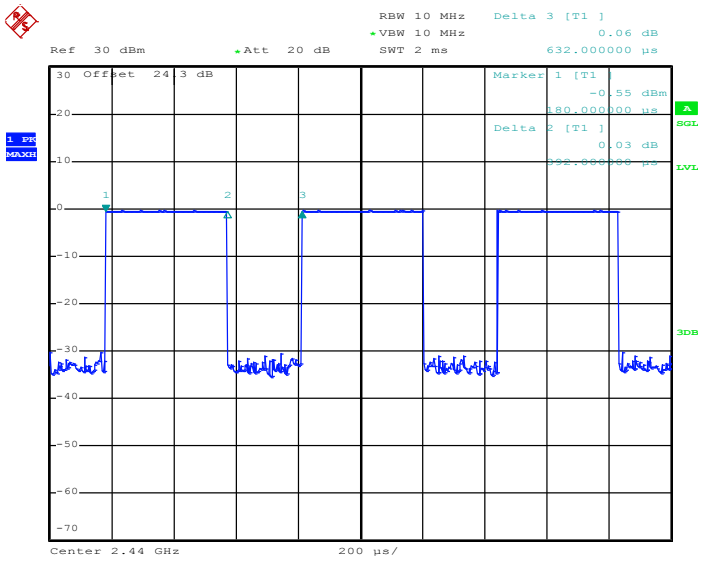
3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

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.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A.

3.5.7 Duty Cycle



Date: 5.JUN.2015 19:28:44

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

Please refer to Appendix A.

3.6 AC Conducted Emission Measurement

3.6.1 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.

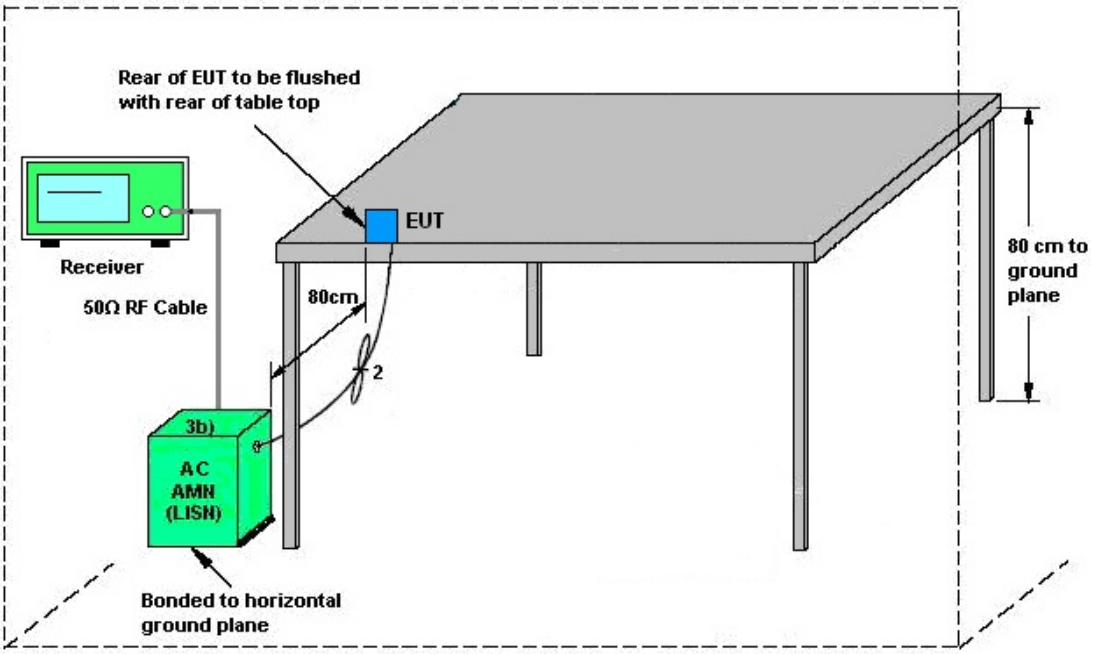
3.6.2 Measuring Instruments

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

3.6.3 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.

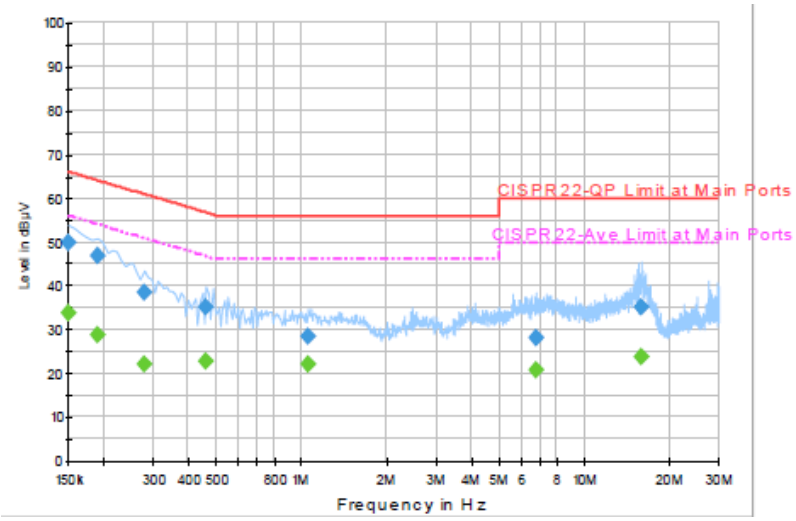
3.6.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.6.5 Test Result of AC Conducted Emission

Test Mode :	Mode 1	Temperature :	23~25℃
Test Engineer :	Eric Jeng	Relative Humidity :	57~60%
Test Voltage :	120Vac / 60Hz	Phase :	Line
Function Type :	Bluetooth Link + USB Cable (Charging from Adapter)		



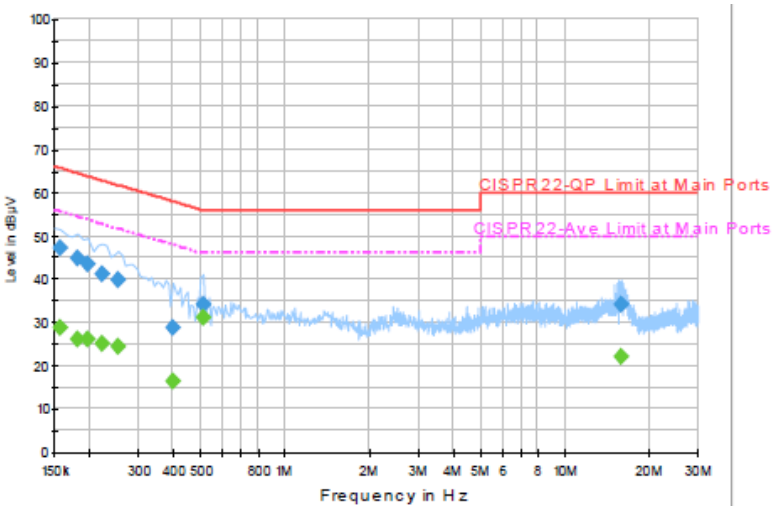
Final Result : Quasi-Peak

Frequency (MHz)	Quasi-Peak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	50.0	Off	L1	19.5	16.0	66.0
0.190000	46.8	Off	L1	19.5	17.2	64.0
0.278000	38.6	Off	L1	19.4	22.3	60.9
0.462000	35.0	Off	L1	19.4	21.7	56.7
1.062000	28.4	Off	L1	19.5	27.6	56.0
6.798000	28.1	Off	L1	19.7	31.9	60.0
15.902000	35.2	Off	L1	19.9	24.8	60.0

Final Result : Average

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	33.9	Off	L1	19.5	22.1	56.0
0.190000	28.8	Off	L1	19.5	25.2	54.0
0.278000	22.1	Off	L1	19.4	28.8	50.9
0.462000	22.8	Off	L1	19.4	23.9	46.7
1.062000	22.2	Off	L1	19.5	23.8	46.0
6.798000	20.6	Off	L1	19.7	29.4	50.0
15.902000	23.9	Off	L1	19.9	26.1	50.0

Test Mode :	Mode 1	Temperature :	23~25℃
Test Engineer :	Eric Jeng	Relative Humidity :	57~60%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Function Type :	Bluetooth Link + USB Cable (Charging from Adapter)		



Final Result : Quasi-Peak

Frequency (MHz)	Quasi-Peak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	47.2	Off	N	19.5	18.4	65.6
0.182000	44.8	Off	N	19.5	19.6	64.4
0.198000	43.5	Off	N	19.4	20.2	63.7
0.222000	41.0	Off	N	19.4	21.7	62.7
0.254000	39.8	Off	N	19.4	21.8	61.6
0.398000	28.9	Off	N	19.6	29.0	57.9
0.510000	34.0	Off	N	19.5	22.0	56.0
16.014000	34.1	Off	N	20.0	25.9	60.0

Final Result : Average

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	28.8	Off	N	19.5	26.8	55.6
0.182000	26.0	Off	N	19.5	28.4	54.4
0.198000	26.2	Off	N	19.4	27.5	53.7
0.222000	25.1	Off	N	19.4	27.6	52.7
0.254000	24.5	Off	N	19.4	27.1	51.6
0.398000	16.4	Off	N	19.6	31.5	47.9
0.510000	31.1	Off	N	19.5	14.9	46.0
16.014000	22.2	Off	N	20.0	27.8	50.0

3.7 Antenna Requirements

3.7.1 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 FCC rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 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	300MHz~40GHz	Jan. 14, 2015	Jun. 05, 2015	Jan. 13, 2016	Conducted (TH05-HY)
Power Sensor	Agilent	E9327A	US40441548	300MHz~40GHz	Jan. 14, 2015	Jun. 05, 2015	Jan. 13, 2016	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	100057	9kHz-40GHz	Oct. 17, 2014	Jun. 05, 2015	Oct. 16, 2015	Conducted (TH05-HY)
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Nov. 03, 2014	Jun. 08, 2015	Nov. 02, 2015	Radiation (03CH10-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jul. 28, 2014	Jun. 08, 2015	Jul. 27, 2015	Radiation (03CH10-HY)
Amplifier	SONOMA	310N	187311	9kHz~1GHz	Nov. 24, 2014	Jun. 08, 2015	Nov. 23, 2015	Radiation (03CH10-HY)
Bilog Antenna	TESEQ	CBL 6111D	35413	30MHz~1GHz	Oct. 24, 2014	Jun. 08, 2015	Oct. 23, 2015	Radiation (03CH10-HY)
EMI Test Receiver	Keysight	N9038A	MY54130085	20Hz ~ 8.4GHz	Nov. 05, 2014	Jun. 08, 2015	Nov. 04, 2015	Radiation (03CH10-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1325	1GHz ~ 18GHz	Oct. 03, 2014	Jun. 08, 2015	Oct. 02, 2015	Radiation (03CH10-HY)
Preamplifier	Keysight	83017A	MY53270078	1GHz~26.5GHz	Nov. 20, 2014	Jun. 08, 2015	Nov. 19, 2015	Radiation (03CH10-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1902246	1GHz~18GHz	Nov. 25, 2014	Jun. 08, 2015	Nov. 24, 2015	Radiation (03CH10-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200485	10Hz ~ 44GHZ	Oct. 14, 2014	Jun. 08, 2015	Oct. 13, 2015	Radiation (03CH10-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Jun. 08, 2015	N/A	Radiation (03CH10-HY)
Turn Table	EMEC	TT 2200	N/A	0-360 degree	N/A	Jun. 08, 2015	N/A	Radiation (03CH10-HY)
Preamplifier	MITEQ	JS44-18004000-33-8P	1840917	18GHz ~ 40GHz	Jun. 02, 2015	Jun. 08, 2015	Jun. 01, 2016	Radiation (03CH10-HY)
EMI Test Receiver	Rohde & Schwarz	ESCS 30	100356	9kHz – 2.75GHz	Dec. 01, 2014	Jun. 17, 2015	Nov. 30, 2015	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Dec. 02, 2014	Jun. 17, 2015	Dec. 01, 2015	Conduction (CO05-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Jun. 17, 2015	N/A	Conduction (CO05-HY)
LISN (for auxiliary equipment)	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Dec. 08, 2014	Jun. 17, 2015	Dec. 07, 2015	Conduction (CO05-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))	**2.26**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.90**

Appendix A. Radiated Spurious Emission

Test Engineer :	Lewis He	Temperature :	23~24°C
		Relative Humidity :	52~53%

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	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)
BLE CH 00 2402MHz		2389.92	60.46	-13.54	74	61.06	27.23	5.39	33.22	137	92	P	H
		2389.38	41.06	-12.94	54	41.68	27.23	5.39	33.24	137	92	A	H
	*	2402.254	97.29	-	-	97.89	27.23	5.39	33.22	137	92	P	H
	*	2402.004	96.62	-	-	97.22	27.23	5.39	33.22	137	92	A	H
													H
													H
		2389.47	55.24	-18.76	74	55.86	27.23	5.39	33.24	104	44	P	V
		2376.24	40.66	-13.34	54	41.32	27.19	5.39	33.24	104	44	A	V
	*	2401.753	91.08	-	-	91.68	27.23	5.39	33.22	104	44	P	V
	*	2402.004	90.38	-	-	90.98	27.23	5.39	33.22	104	44	A	V
													V
													V
BLE CH 19 2440MHz		2334.39	50.92	-23.08	74	51.8	27.05	5.33	33.26	129	55	P	H
		2386.68	40.74	-13.26	54	41.36	27.23	5.39	33.24	129	55	A	H
	*	2440.247	97.2	-	-	97.62	27.37	5.42	33.21	129	55	P	H
	*	2439.997	96.54	-	-	96.96	27.37	5.42	33.21	129	55	A	H
		2483.84	52.26	-21.74	74	52.52	27.46	5.46	33.18	129	55	P	H
		2484.28	41.05	-12.95	54	41.31	27.46	5.46	33.18	129	55	A	H
		2355.18	51.71	-22.29	74	52.49	27.14	5.33	33.25	100	86	P	V
		2382.81	40.77	-13.23	54	41.43	27.19	5.39	33.24	100	86	A	V
	*	2440.247	93.74	-	-	94.16	27.37	5.42	33.21	100	86	P	V
	*	2439.997	93.08	-	-	93.5	27.37	5.42	33.21	100	86	A	V
		2484.76	51.49	-22.51	74	51.75	27.46	5.46	33.18	100	86	P	V
		2499	41.07	-12.93	54	41.28	27.5	5.46	33.17	100	86	A	V

BLE CH 39 2480MHz	*	2479.742	99.3	-	-	99.58	27.46	5.44	33.18	129	57	P	H
	*	2479.993	98.62	-	-	98.9	27.46	5.44	33.18	129	57	A	H
		2483.52	72.46	-1.54	74	72.72	27.46	5.46	33.18	129	57	P	H
		2483.84	44.76	-9.24	54	45.02	27.46	5.46	33.18	129	57	A	H
													H
													H
	*	2479.742	95.34	-	-	95.62	27.46	5.44	33.18	328	337	P	V
	*	2479.993	94.69	-	-	94.97	27.46	5.44	33.18	328	337	A	V
		2483.64	68.48	-5.52	74	68.74	27.46	5.46	33.18	328	337	P	V
		2483.52	43.15	-10.85	54	43.41	27.46	5.46	33.18	328	337	A	V
													V
													V
BLE CH 39 2480MHz + Tablet	*	2480.243	97.84	-	-	98.12	27.46	5.44	33.18	100	64	P	H
	*	2479.993	97.1	-	-	97.38	27.46	5.44	33.18	100	64	A	H
		2483.56	70.97	-3.03	74	71.23	27.46	5.46	33.18	100	64	P	H
		2483.6	44.26	-9.74	54	44.52	27.46	5.46	33.18	100	64	A	H
													H
													H
	*	2480.243	93.07	-	-	93.35	27.46	5.44	33.18	374	332	P	V
	*	2479.993	92.41	-	-	92.69	27.46	5.44	33.18	374	332	A	V
		2483.52	66.64	-7.36	74	66.9	27.46	5.46	33.18	374	332	P	V
		2484.04	42.39	-11.61	54	42.65	27.46	5.46	33.18	374	332	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	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)
BLE CH 00 2402MHz		4804	52.15	-21.85	74	73.79	31.42	7.58	60.64	100	86	P	H
		4804	42.64	-11.36	54	64.28	31.42	7.58	60.64	100	86	A	H
													H
													H
		4804	44.86	-29.14	74	66.5	31.42	7.58	60.64	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	55.14	-18.86	74	76.4	31.56	7.7	60.52	100	87	P	H
		4880	44.27	-9.73	54	65.53	31.56	7.7	60.52	100	87	A	H
		7320	49	-25	74	64.27	36.22	9.49	60.98	100	0	P	H
													H
		4880	46.26	-27.74	74	67.52	31.56	7.7	60.52	100	0	P	V
		7320	46.63	-27.37	74	61.9	36.22	9.49	60.98	100	0	P	V
													V
													V
BLE CH 39 2480MHz		4962	56.21	-17.79	74	76.79	31.73	8.05	60.36	100	87	P	H
		4962	46.58	-7.42	54	67.16	31.73	8.05	60.36	100	87	A	H
		7440	47.29	-26.71	74	62.53	36.49	9.61	61.34	100	0	P	H
													H
		4960	45.97	-28.03	74	66.67	31.73	7.93	60.36	100	0	P	V
		7440	48.37	-25.63	74	63.61	36.49	9.61	61.34	100	0	P	V
													V
													V

BLE CH 39 2480MHz + Tablet		4960	56.23	-17.77	74	76.93	31.73	7.93	60.36	100	86	P	H
		4960	45.99	-8.01	54	66.69	31.73	7.93	60.36	100	86	A	H
		7440	47.82	-26.18	74	63.06	36.49	9.61	61.34	100	0	P	H
													H
		4960	47.44	-26.56	74	68.14	31.73	7.93	60.36	100	0	P	V
		7440	45.7	-28.3	74	60.94	36.49	9.61	61.34	100	0	P	V
													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 @ 3m)

BLE	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 BLE LF		150.96	19.43	-24.07	43.5	39.23	11.55	1.33	32.68	-	-	P	H
		173.1	19.59	-23.91	43.5	40.96	9.85	1.48	32.7	-	-	P	H
		195.51	19.66	-23.84	43.5	41.08	9.82	1.48	32.72	-	-	P	H
		655.6	21.38	-24.62	46	31.47	20.25	2.67	33.01	-	-	P	H
		823.6	23.88	-22.12	46	31.26	22.29	3.07	32.74	-	-	P	H
		955.2	26.62	-19.38	46	30.75	24.28	3.29	31.7	100	0	P	H
													H
													H
													H
													H
													H
													H
		35.67	25.38	-14.62	40	40.8	16.74	0.65	32.81	100	0	P	V
		95.61	20.64	-22.86	43.5	42.22	9.92	1.14	32.64	-	-	P	V
		171.75	17.02	-26.48	43.5	38.27	9.97	1.48	32.7	-	-	P	V
		766.9	23.49	-22.51	46	31.67	21.77	2.97	32.92	-	-	P	V
		929.3	26.08	-19.92	46	30.93	23.85	3.29	31.99	-	-	P	V
		985.3	26.23	-27.77	54	30.07	24.16	3.38	31.38	-	-	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".