FCC RF Test Report

APPLICANT	:	Nest Labs Inc.
EQUIPMENT	:	Nest Cam IQ
MODEL NAME	:	A0053
FCC ID	:	ZQANC31
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System

The product was completed on Mar. 08, 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

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR630207-02B	Rev. 01	Initial issue of report	Apr. 19, 2017
FR630207-02B	Rev. 02	Revising the test procedures description of peak output power in section 3.2.3 and antenna information in section 1.2, and add description of radiated spurious emissions below 30MHz in section 3.5.5.	May 05, 2017
FR630207-02B	Rev. 03	Add Zigbee information in section 1.2 and revising connection diagram of test system in section 2.4.	May 09, 2017

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass
3.1	-	99% Bandwidth	-	Pass
3.2	15.247(b)(3)	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
3.6	15.207	AC Conducted Emission	15.207(a)	Pass
3.7	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass

1 General Description

1.1 Applicant

Nest Labs Inc.
3400 Hillview Ave.Palo Alto, CA 94304 USA

1.2 Product Feature of Equipment Under Test

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

Product Specification subjective to this standard	
Antenna Type	ANT FPC 1 2.4G/5G : Fixed Internal Antenna ANT FPC 2 2.4G/5G : Fixed Internal Antenna ANT FPC 15.4 2.4G : Fixed Internal Antenna

1.3 Modification of EUT

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

1.4 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1190 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.**	
	TH02-HY	CO05-HY

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

Test Site	SPORTON INTERNATIONAL (SHENZHEN) INC.
Test Site Location	No. 101, Complex Building C, Guanlong Village, Xili Town, Nanshan District, Shenzhen, Guangdong, P.R.C. TEL: +86-755-8637-9589 (TAF Code: 2353)
Test Site No.	**Sporton Site No.**
	03CH02-SZ

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

1.5 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 Descriptions of Test Mode

The RF output power was recorded in the following table:

Channel	Frequency	Bluetooth – LE RF Output Power
		Data Rate / Modulation
		GFSK
		1Mbps
Ch00	2402MHz	9.10 dBm
Ch19	2440MHz	9.48 dBm
Ch39	2480MHz	**9.70** 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). Pre-scanned tests, X, Y, Z in three orthogonal panels to determine the final configuration (X plane as worst plane) from all possible combinations.

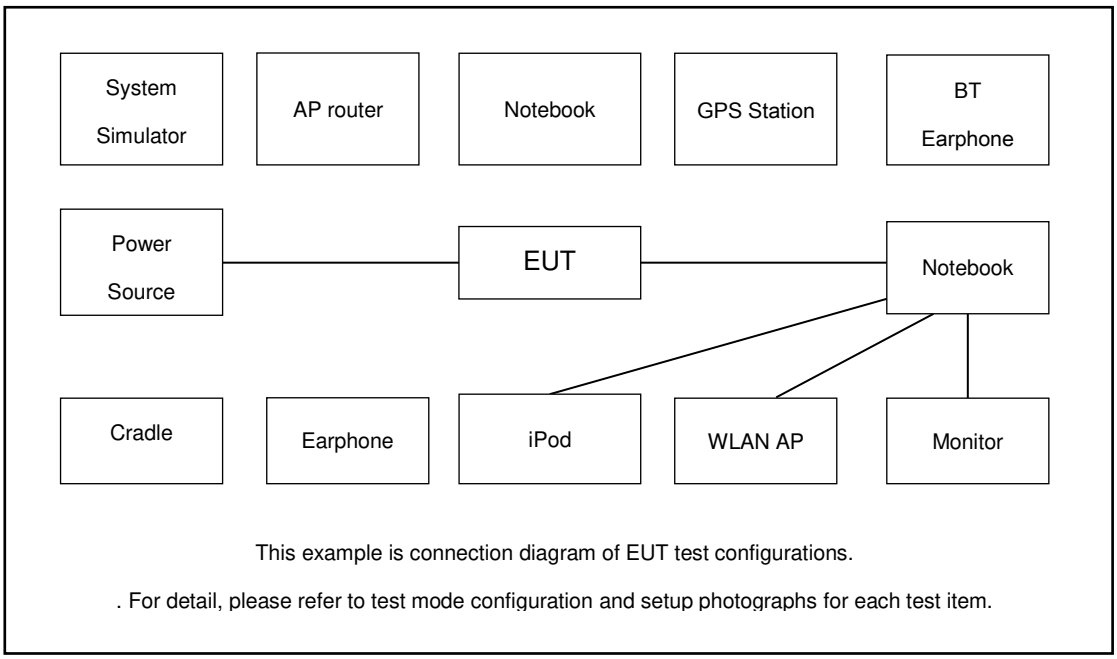
b. AC power line Conducted Emission was tested under maximum output power.

2.3 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 – 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
AC Conducted Emission	Mode 1: WLAN Tx + Bluetooth Tx + Zigbee Idle + Y Cable + USB Cable (Charging from Adapter 1) Mode 2: WLAN Tx + Bluetooth Idle + Zigbee Tx + Y Cable + USB Cable (Charging from Adapter 1)
Remark: The worst case of conducted emission is mode 1; only the test data of it was reported.	

2.4 Connection Diagram of Test System



2.5 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
2.	Notebook	DELL	Latitude E3340	FCC DoC/ Contains FCC ID: PD97260NGU	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
3.	iPod	Apple	A1285	FCC DoC	Shielded, 1.0 m	N/A

2.6 EUT Operation Test Setup

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

2.7 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 and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

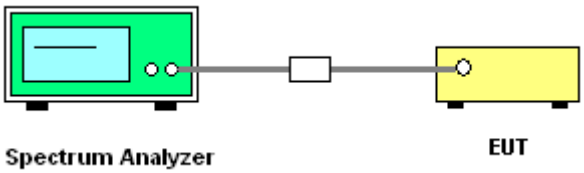
3.1.2 Measuring Instruments

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 FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
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. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.
6. Measure and record the results in the test report.

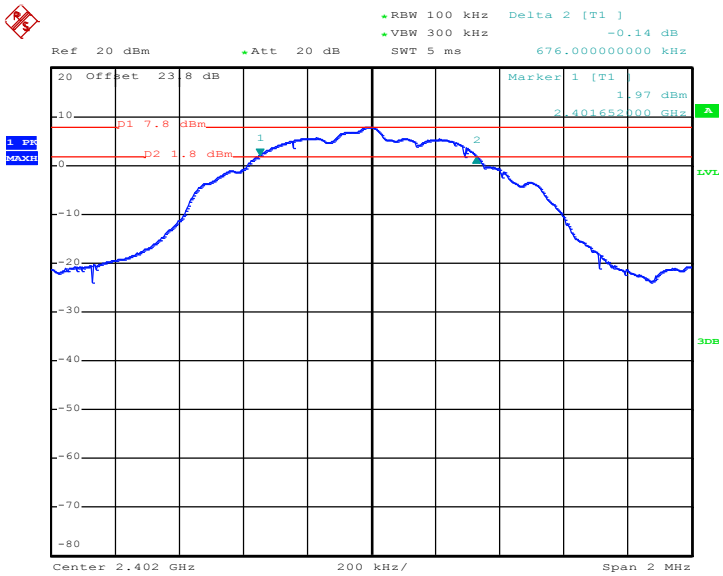
3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

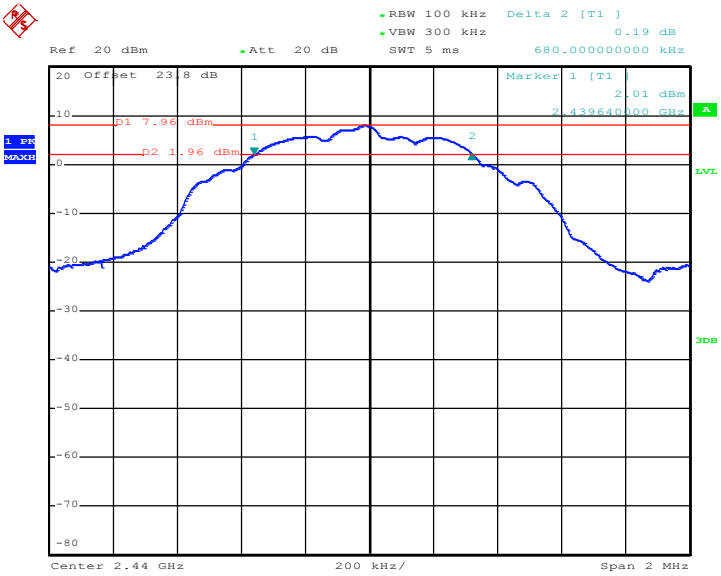
Test data refer to Appendix A.

6 dB Bandwidth Plot on Channel 00



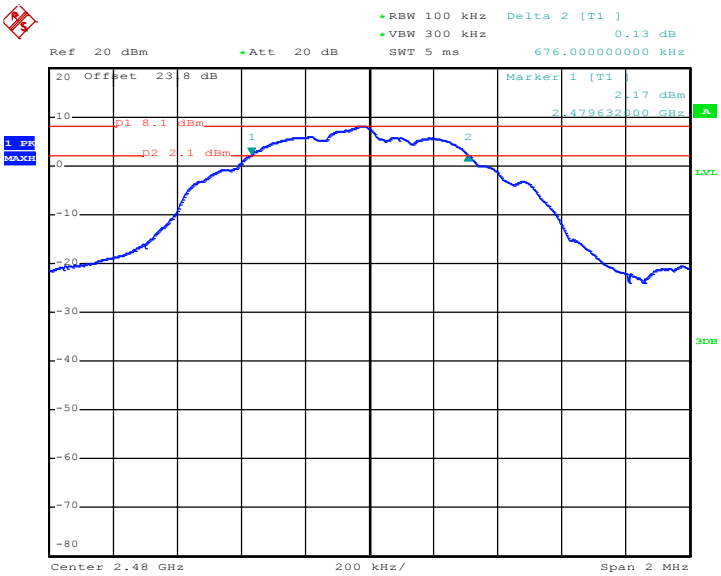
Date: 11.JAN.2017 23:08:18

6 dB Bandwidth Plot on Channel 19



Date: 11.JAN.2017 23:10:40

6 dB Bandwidth Plot on Channel 39



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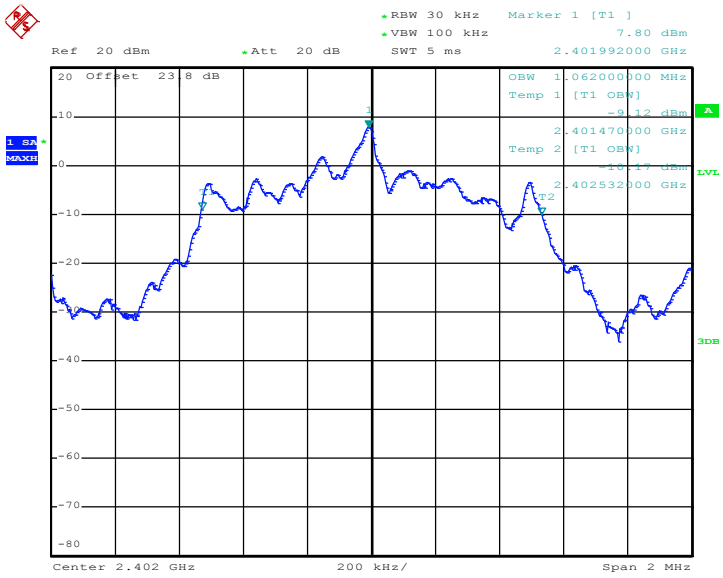
3.1.6 Test Result of 99% Occupied Bandwidth

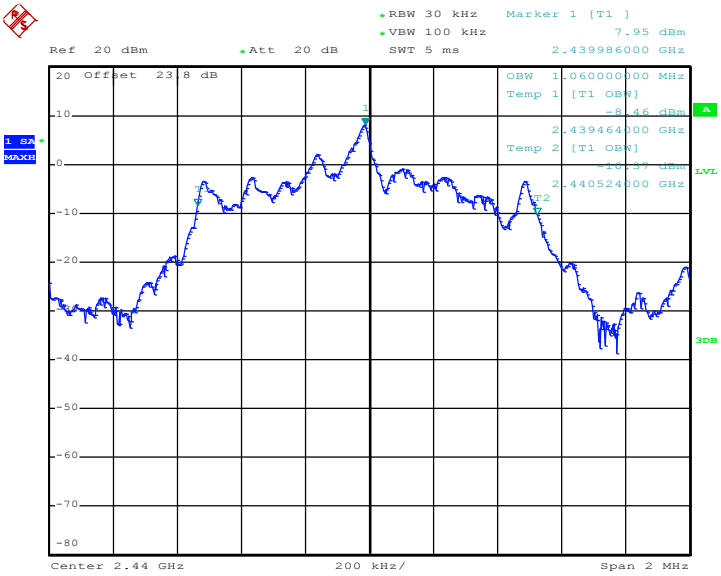
Test data refer to Appendix A.

99% Bandwidth Plot on Channel 00



Date: 11.JAN.2017 23:09:37

99% Occupied Bandwidth Plot on Channel 19



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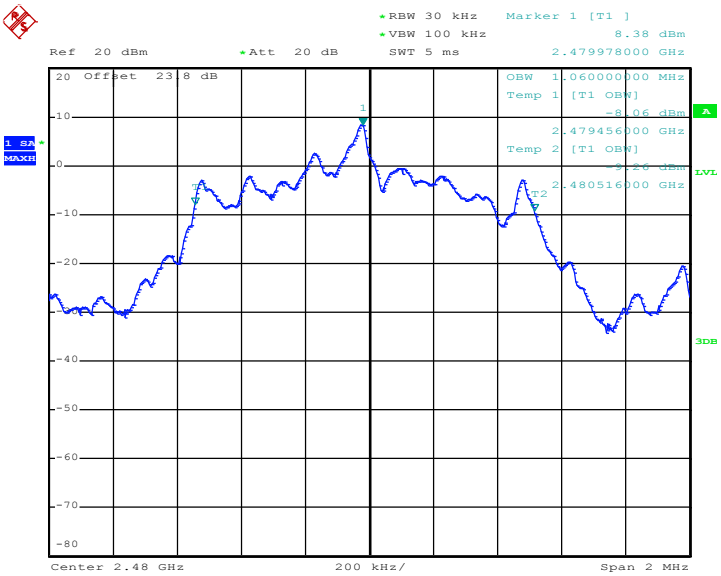
99% Occupied Bandwidth Plot on Channel 39



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Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

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.

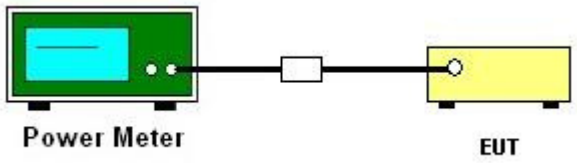
3.2.2 Measuring Instruments

The 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 the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.3 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 data refers to Appendix A.

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.

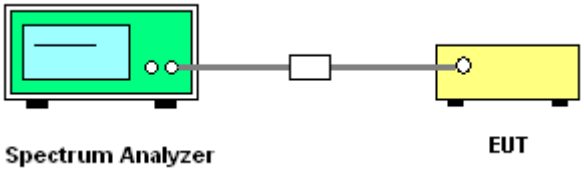
3.3.2 Measuring Instruments

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

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 v04
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

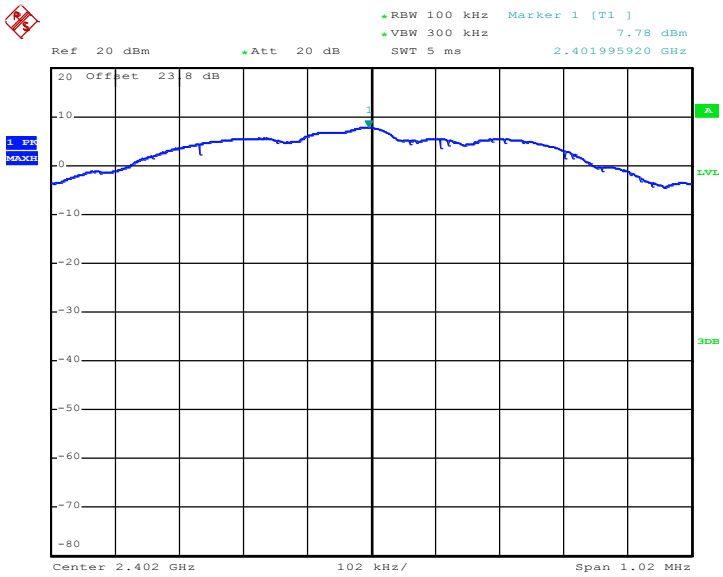


3.3.5 Test Result of Power Spectral Density

Test data refers to Appendix A.

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

PSD 100kHz Plot on Channel 00



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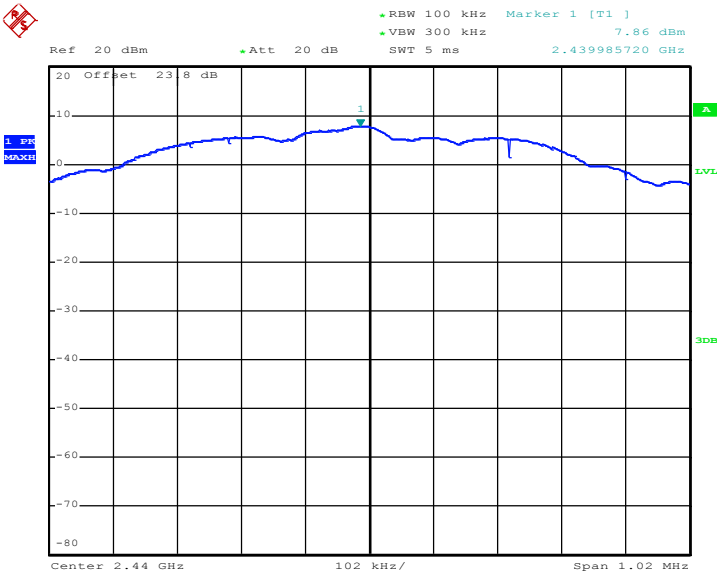
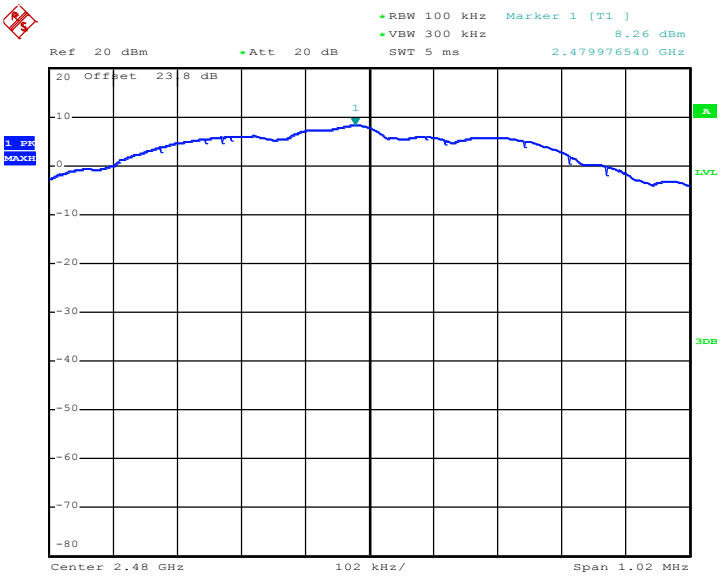
PSD 100kHz Plot on Channel 19



Date: 11.JAN.2017 23:11:22

PSD 100kHz Plot on Channel 39



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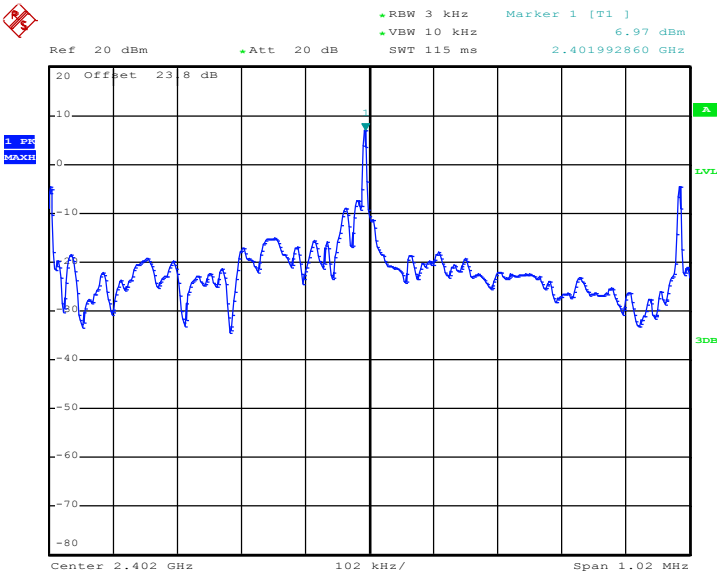
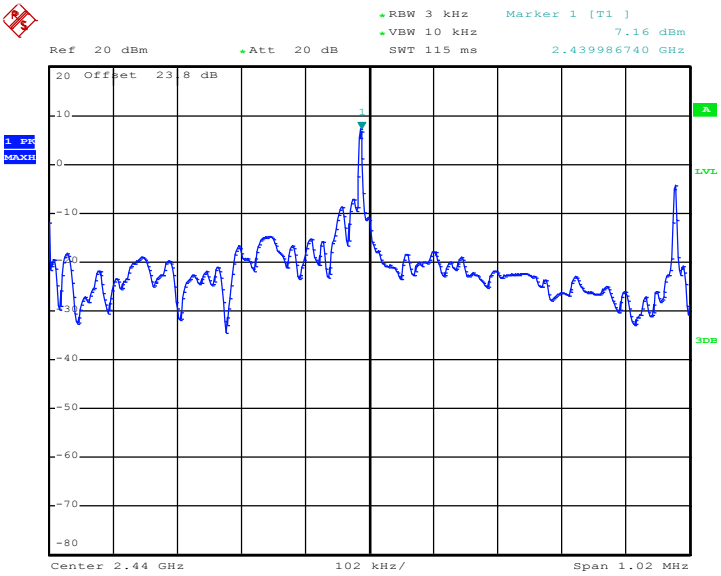
3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 00



Date: 11.JAN.2017 23:08:30

PSD 3kHz Plot on Channel 19



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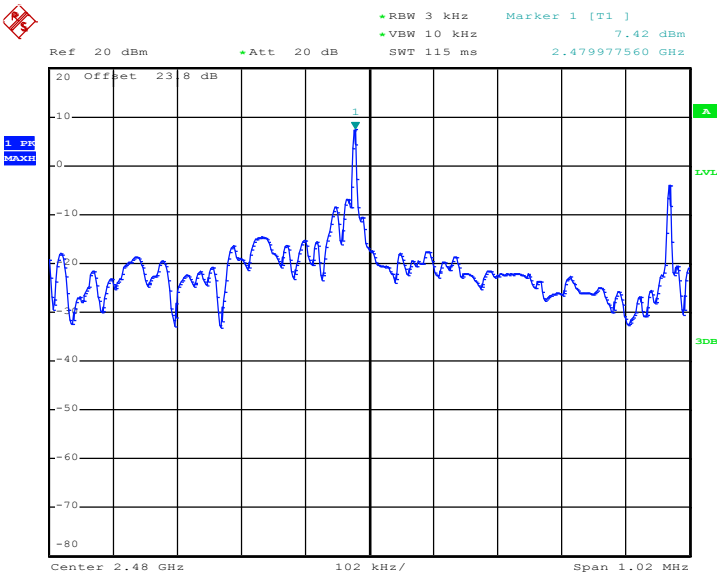
PSD 3kHz Plot on Channel 39



Date: 11.JAN.2017 23:24:21

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.

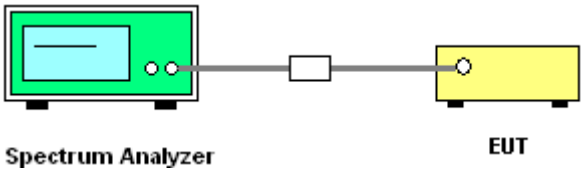
3.4.2 Measuring Instruments

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

3.4.3 Test Procedure

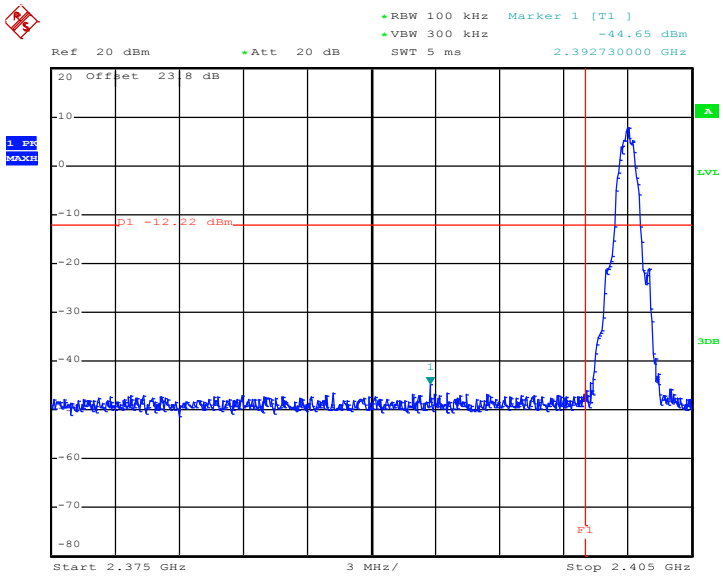
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit 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

Low Band Edge Plot on Channel 00



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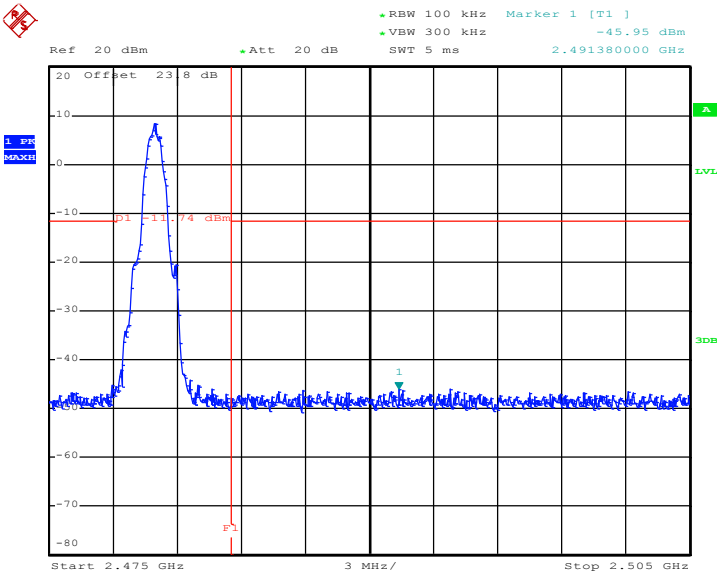
High Band Edge Plot on Channel 39



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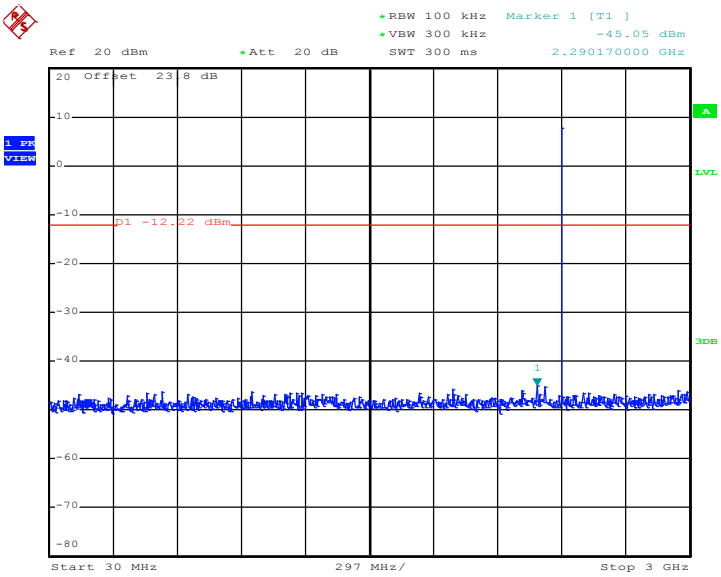
3.4.6 Test Result of Conducted Spurious Emission Plots

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

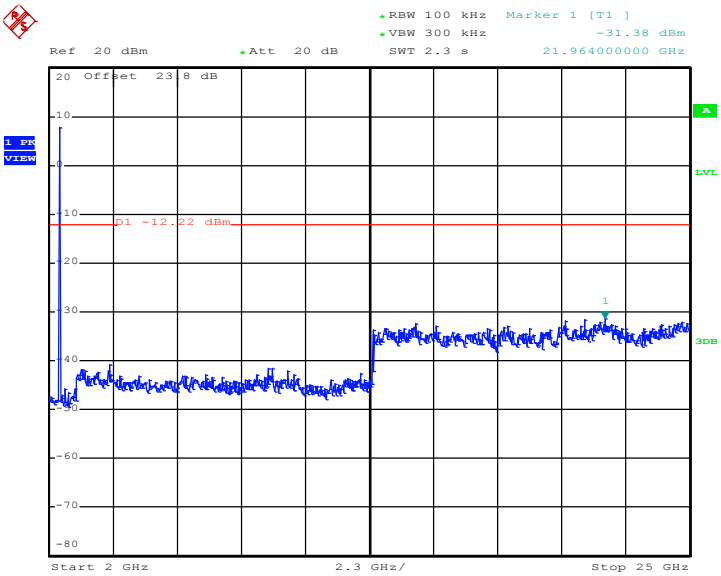
GFSK Channel 00



Date: 11.JAN.2017 23:09:13

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 00



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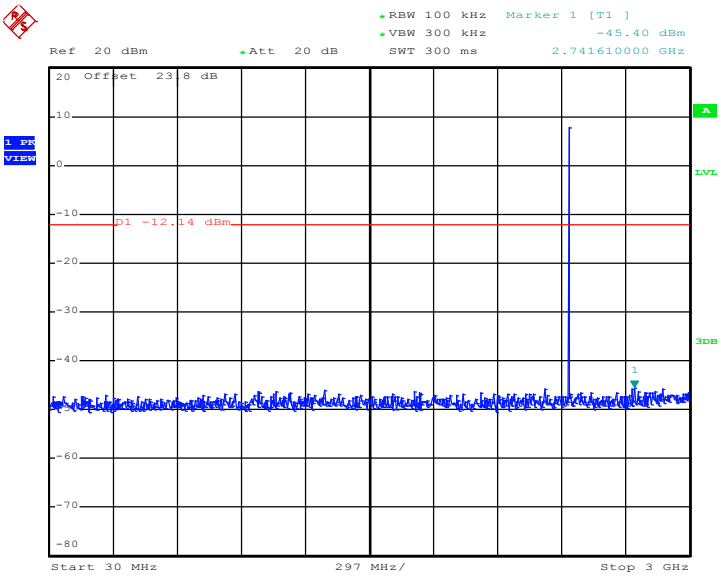
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 19



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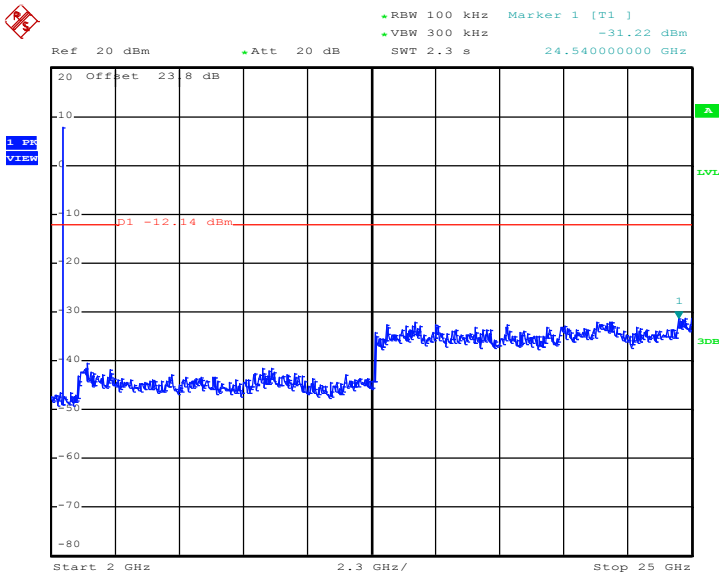
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

GFSK Channel 19



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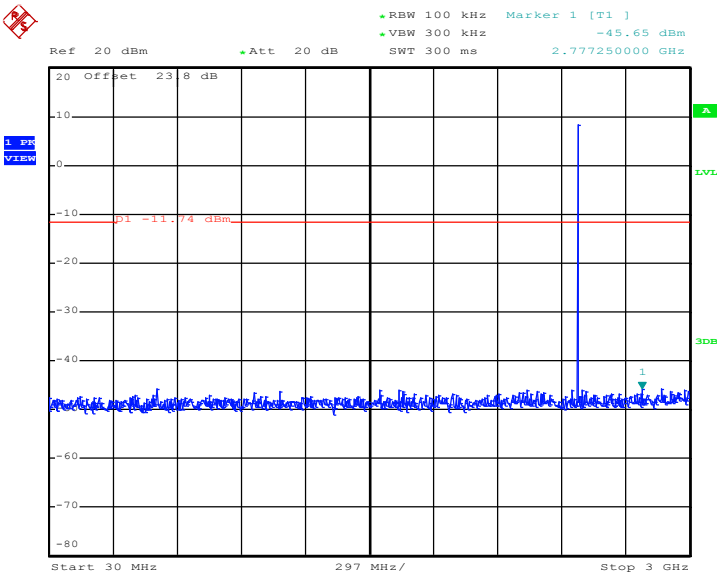
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

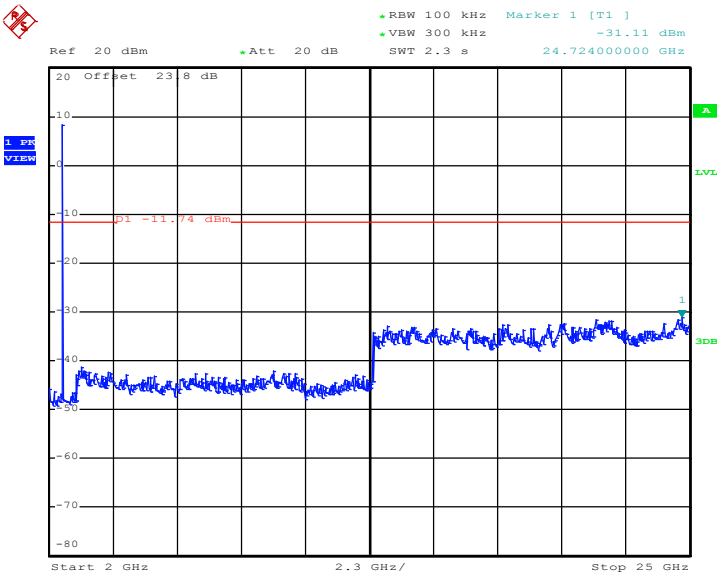
GFSK Channel 39



Date: 11.JAN.2017 23:25:02

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 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

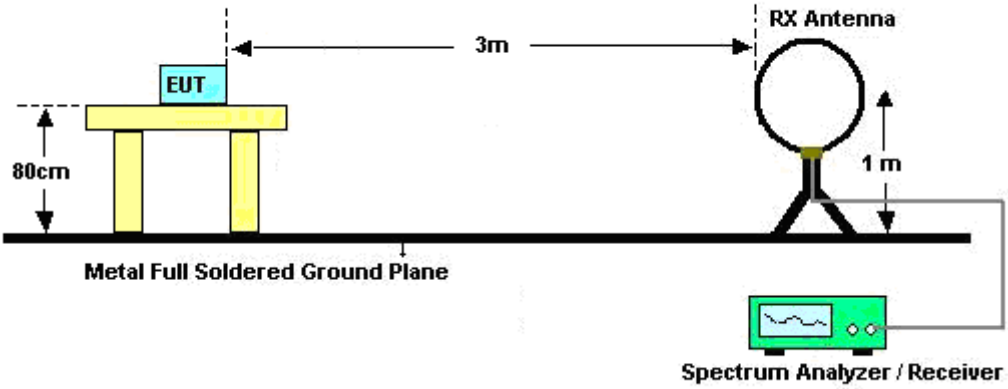
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.5.3 Test Procedures

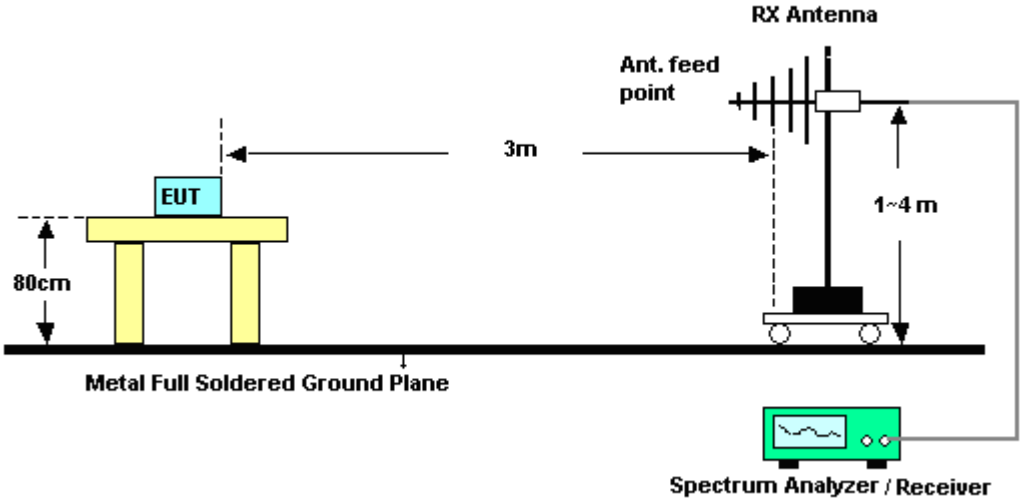
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test 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 testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. 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.

3.5.4 Test Setup

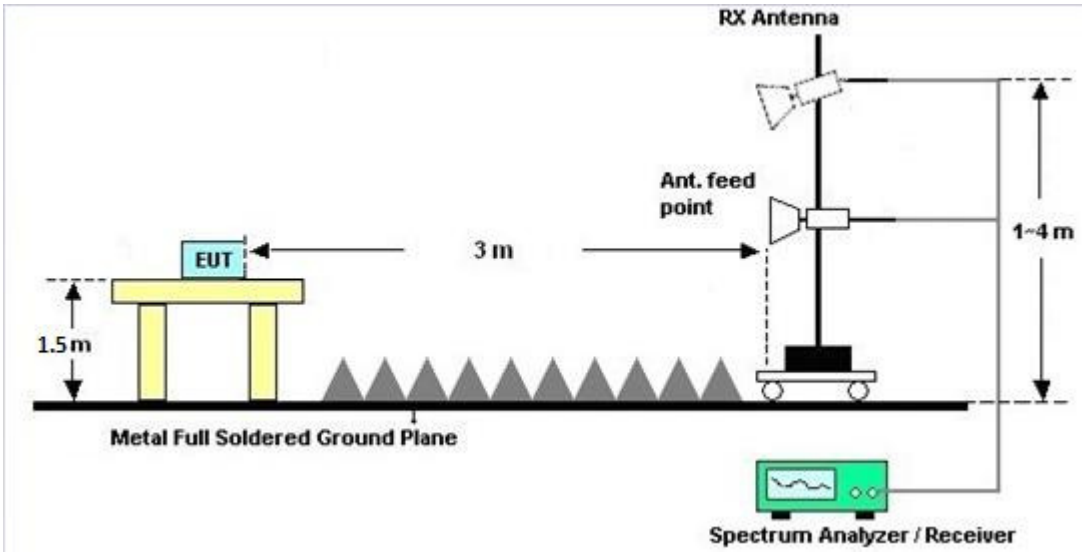
For radiated emissions below 30MHz



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 was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B and C.

3.5.7 Duty Cycle

Please refer to Appendix D.

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

Please refer to Appendix B and C.

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.

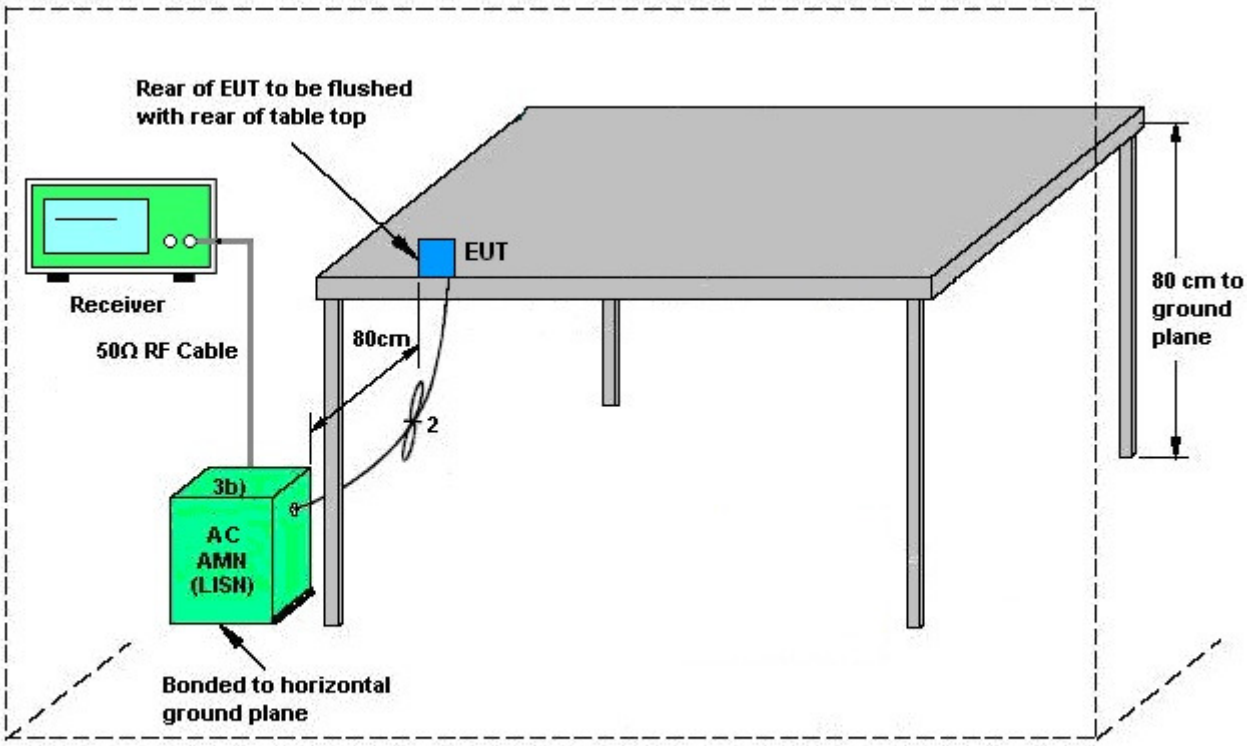
3.6.2 Measuring Instruments

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

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.

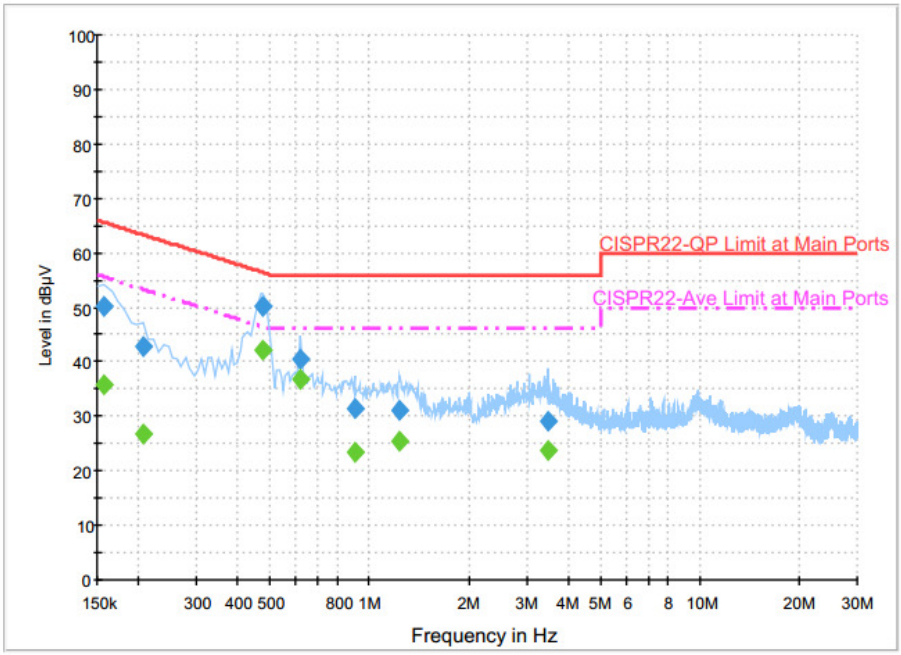
3.6.4 Test Setup



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 :**	21~22℃
Test Engineer :	Kai-Chun Chu	**Relative Humidity :**	48~49%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Function Type :	WLAN Tx + Bluetooth Tx + Zigbee Idle + Y Cable + USB Cable (Charging from Adapter 1)		



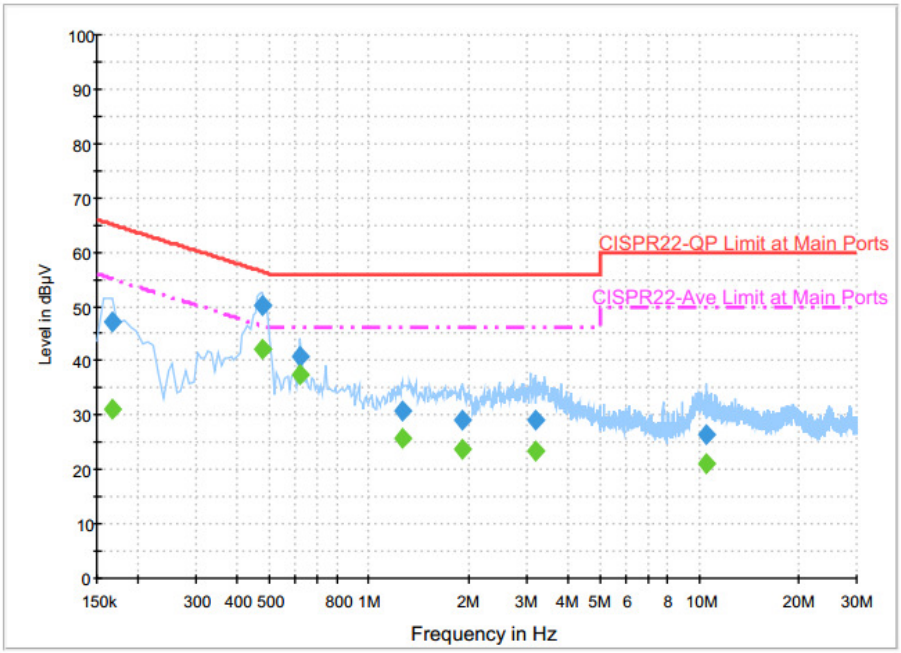
Final Result : Quasi-Peak

Frequency (MHz)	Quasi-Peak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	50.3	Off	L1	19.6	15.3	65.6
0.206000	42.6	Off	L1	19.6	20.8	63.4
0.478000	50.3	Off	L1	19.6	6.1	56.4
0.622000	40.6	Off	L1	19.6	15.4	56.0
0.902000	31.6	Off	L1	19.6	24.4	56.0
1.238000	31.0	Off	L1	19.6	25.0	56.0
3.470000	29.0	Off	L1	19.6	27.0	56.0

Final Result : Average

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	35.7	Off	L1	19.6	19.9	55.6
0.206000	26.7	Off	L1	19.6	26.7	53.4
0.478000	42.0	Off	L1	19.6	4.4	46.4
0.622000	36.8	Off	L1	19.6	9.2	46.0
0.902000	23.4	Off	L1	19.6	22.6	46.0
1.238000	25.3	Off	L1	19.6	20.7	46.0
3.470000	23.6	Off	L1	19.6	22.4	46.0

Test Mode :	Mode 1	**Temperature :**	21~22℃
Test Engineer :	Kai-Chun Chu	**Relative Humidity :**	48~49%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral
Function Type :	WLAN Tx + Bluetooth Tx + Zigbee Idle + Y Cable + USB Cable (Charging from Adapter 1)		



Final Result : Quasi-Peak

Frequency (MHz)	Quasi-Peak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.166000	47.0	Off	N	19.6	18.2	65.2
0.478000	50.3	Off	N	19.6	6.1	56.4
0.622000	41.0	Off	N	19.6	15.0	56.0
1.262000	30.9	Off	N	19.6	25.1	56.0
1.910000	29.2	Off	N	19.6	26.8	56.0
3.190000	29.0	Off	N	19.6	27.0	56.0
10.526000	26.3	Off	N	20.1	33.7	60.0

Final Result : Average

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.166000	31.0	Off	N	19.6	24.2	55.2
0.478000	42.1	Off	N	19.6	4.3	46.4
0.622000	37.6	Off	N	19.6	8.4	46.0
1.262000	25.9	Off	N	19.6	20.1	46.0
1.910000	23.8	Off	N	19.6	22.2	46.0
3.190000	23.5	Off	N	19.6	22.5	46.0
10.526000	21.2	Off	N	20.1	28.8	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 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	Dec. 26, 2016	Dec. 30, 2016 ~ Mar. 08, 2017	Dec. 25, 2017	Conducted (TH02-HY)
Power Sensor	Agilent	E9327A	US40441548	300MHz~40GHz	Dec. 26, 2016	Dec. 30, 2016 ~ Mar. 08, 2017	Dec. 25, 2017	Conducted (TH02-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	100055	9kHz~40GHz	Jun. 17, 2016	Dec. 30, 2016 ~ Mar. 08, 2017	Jun. 16, 2017	Conducted (TH02-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Jan. 24, 2017	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESCI 7	100724	9kHz~7GHz	Aug. 30, 2016	Jan. 24, 2017	Aug. 29, 2017	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Nov. 29, 2016	Jan. 24, 2017	Nov. 28, 2017	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Dec. 06, 2016	Jan. 24, 2017	Dec. 05, 2017	Conduction (CO05-HY)
EXA Spectrum Anaiyzer	KEYSIGHT	N9010A	MY55150246	10Hz~44GHz;	May 07, 2016	Jan. 06, 2017~ Jan. 21, 2017	May 06, 2017	Radiation (03CH02-SZ
EMI Test Receiver&SA	KEYSIGHT	N9038A	MY54450083	20Hz~8.4GHz	May 07, 2016	Jan. 06, 2017~ Jan. 21, 2017	May 06, 2017	Radiation (03CH02-SZ)
Bilog Antenna	TeseQ	CBL6112D	35407	30MHz-2GHz	May 21, 2016	Jan. 06, 2017~ Jan. 21, 2017	May 20, 2017	Radiation (03CH02-SZ)
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1355	1GHz~18GHz	May 07, 2016	Jan. 06, 2017~ Jan. 21, 2017	May 06, 2017	Radiation (03CH02-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Jul. 16, 2016	Jan. 06, 2017~ Jan. 21, 2017	Jul. 15, 2017	Radiation (03CH02-SZ
SHF-EHF Horn	com-power	AH-840	101071	18Ghz-40GHz	Aug.10, 2016	Jan. 06, 2017~ Jan. 21, 2017	Aug. 09, 2017	Radiation (03CH02-SZ)
Amplifier	Agilent Technologies	83017A	MY39501302	500MHz~26.5GHz	Jan. 06, 2017	Jan. 06, 2017~ Jan. 21, 2017	Jan. 05, 2018	Radiation (03CH02-SZ)
HF Amplifier	MITEQ	AMF-7D-00101800-30-10P-R	1707137	1GHz~18GHz	Oct. 11, 2016	Jan. 06, 2017~ Jan. 21, 2017	Oct. 10, 2017	Radiation (03CH02-SZ)
Amplifier	Burgeon	BPA-530	102210	0.01Hz ~3000MHz	Oct. 11, 2016	Jan. 06, 2017~ Jan. 21, 2017	Oct. 10, 2017	Radiation (03CH02-SZ)
AC Power Source	Chroma	61601	616010002470	N/A	NCR	Jan. 06, 2017~ Jan. 21, 2017	NCR	Radiation (03CH02-SZ)
Turn Table	Chaintek	T-200	N/A	0~360 degree	NCR	Jan. 06, 2017~ Jan. 21, 2017	NCR	Radiation (03CH02-SZ)
Antenna Mast	Chaintek	MBS-400	N/A	1 m~4 m	NCR	Jan. 06, 2017~ Jan. 21, 2017	NCR	Radiation (03CH02-SZ)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100321	9kHz~30MHz	Oct. 23, 2016	Jan. 06, 2017~ Jan. 21, 2017	Oct. 22, 2017	Radiation (03CH02-SZ)

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))	2.7

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.1

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.1

Appendix A. Conducted Test Results

Bluetooth Low Energy

Test Engineer:	Derek Hsu	Temperature:	21~25	°C
Test Date:	2016/12/30~2017/03/08	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.06	0.68	0.50	Pass
BLE	1Mbps	1	19	2440	1.06	0.68	0.50	Pass
BLE	1Mbps	1	39	2480	1.06	0.68	0.50	Pass

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	9.10	30.00	0.58	9.68	36.00	Pass
BLE	1Mbps	1	19	2440	9.48	30.00	0.58	10.06	36.00	Pass
BLE	1Mbps	1	39	2480	9.70	30.00	0.58	10.28	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	2.09	8.70
BLE	1Mbps	1	19	2440	2.09	8.89
BLE	1Mbps	1	39	2480	2.09	9.14

TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
BLE	1Mbps	1	0	2402	7.78	6.97	0.58	8.00	Pass
BLE	1Mbps	1	19	2440	7.86	7.16	0.58	8.00	Pass
BLE	1Mbps	1	39	2480	8.26	7.42	0.58	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

Appendix B. Radiated Spurious Emission

Test Engineer :	Taigong Lin	Temperature :	20~24°C
		Relative Humidity :	48~50%

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		2385.285	38.69	-35.31	74	40.95	27.26	3.81	33.33	145	109	P	H
		2381.085	28.98	-25.02	54	31.24	27.26	3.81	33.33	145	109	A	H
	*	2402	99.95	-	-	102.17	27.29	3.81	33.32	145	109	P	H
	*	2402	99.38	-	-	101.6	27.29	3.81	33.32	145	109	A	H
													H
													H
		2383.29	39.28	-34.72	74	41.54	27.26	3.81	33.33	133	4	P	V
		2388.855	30.05	-23.95	54	32.28	27.29	3.81	33.33	133	4	A	V
	*	2402	104.79	-	-	107.01	27.29	3.81	33.32	133	4	P	V
	*	2402	104.23	-	-	106.45	27.29	3.81	33.32	133	4	A	V
													V
													V
BLE CH 19 2440MHz		2312.8	37.46	-36.54	74	39.94	27.12	3.74	33.34	100	7	P	H
		2327.64	28.79	-25.21	54	31.22	27.16	3.74	33.33	100	7	A	H
	*	2440	97.44	-	-	99.51	27.4	3.84	33.31	100	7	P	H
	*	2440	96.81	-	-	98.88	27.4	3.84	33.31	100	7	A	H
		2490.97	38.05	-35.95	74	39.95	27.5	3.91	33.31	100	7	P	H
		2489.43	29.14	-24.86	54	31.04	27.5	3.91	33.31	100	7	A	H
		2370.9	38.91	-35.09	74	41.17	27.26	3.81	33.33	100	3	P	V
		2365.16	31.21	-22.79	54	33.55	27.22	3.77	33.33	100	3	A	V
	*	2440	104.91	-	-	106.98	27.4	3.84	33.31	100	3	P	V
	*	2440	104.43	-	-	106.5	27.4	3.84	33.31	100	3	A	V
		2490.62	39.42	-34.58	74	41.32	27.5	3.91	33.31	100	3	P	V
		2488.1	30.46	-23.54	54	32.39	27.5	3.88	33.31	100	3	A	V

BLE CH 39 2480MHz	*	2480	100.47	-	-	102.43	27.47	3.88	33.31	215	117	P	H
	*	2480	99.97	-	-	101.93	27.47	3.88	33.31	215	117	A	H
		2484.16	41.93	-32.07	74	43.89	27.47	3.88	33.31	215	117	P	H
		2483.64	32.53	-21.47	54	34.49	27.47	3.88	33.31	215	117	A	H
													H
													H
	*	2480	104.08	-	-	106.04	27.47	3.88	33.31	106	360	P	V
	*	2480	103.57	-	-	105.53	27.47	3.88	33.31	106	360	A	V
		2483.72	43.93	-30.07	74	45.89	27.47	3.88	33.31	106	360	P	V
		2483.52	35.67	-18.33	54	37.63	27.47	3.88	33.31	106	360	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 (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	46.39	-27.61	74	64.64	32.52	5.87	56.64	400	0	P	H
													H
													H
													H
		4804	44.56	-29.44	74	62.81	32.52	5.87	56.64	400	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	50.34	-23.66	74	68.61	32.66	5.98	56.91	400	0	P	H
		7320	45.47	-28.53	74	58.75	37.66	6.92	57.86	400	0	P	H
													H
													H
		4880	48.56	-25.44	74	66.83	32.66	5.98	56.91	400	0	P	V
		7320	44.98	-29.02	74	58.26	37.66	6.92	57.86	400	0	P	V
													V
													V
BLE CH 39 2480MHz		4960	53.2	-20.8	74	70.53	32.83	6.09	56.25	100	145	P	H
		4960	48.53	-5.47	54	65.86	32.83	6.09	56.25	100	145	A	H
		7440	44.04	-29.96	74	57.19	37.69	6.94	57.78	400	0	P	H
													H
		4960	50.76	-23.24	74	68.09	32.83	6.09	56.25	400	0	P	V
		7440	44.84	-29.16	74	57.99	37.69	6.94	57.78	400	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)

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		32.16	25.29	-14.71	40	31.9	23.94	0.65	31.2	100	0	P	H
		53.76	22.38	-17.62	40	38.69	14.1	0.83	31.24			P	H
		151.77	25.19	-18.31	43.5	37.3	17.89	1.08	31.08			P	H
		442.1	23.57	-22.43	46	31.38	21.44	1.67	30.92			P	H
		569.5	26.32	-19.68	46	30.93	24.57	1.86	31.04			P	H
		781.6	28.52	-17.48	46	30.95	26.7	2.2	31.33			P	H
													H
													H
													H
													H
													H
													H
		33.78	30.54	-9.46	40	38.32	22.78	0.65	31.21	100	0	P	V
		53.49	29.96	-10.04	40	46.27	14.1	0.83	31.24		0	P	V
		197.67	20.71	-22.79	43.5	35.18	15.21	1.17	30.85			P	V
		554.1	27.07	-18.93	46	31.88	24.35	1.86	31.02			P	V
		785.8	28.87	-17.13	46	31.22	26.78	2.2	31.33			P	V
		976.2	30.8	-23.2	54	30.6	29.11	2.47	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”.

Appendix C. Radiated Spurious Emission

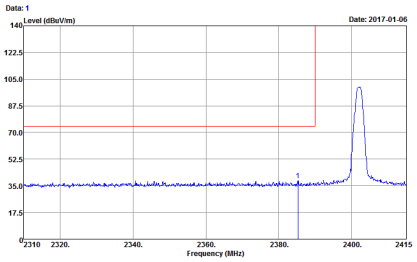
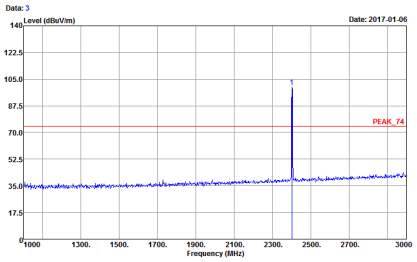
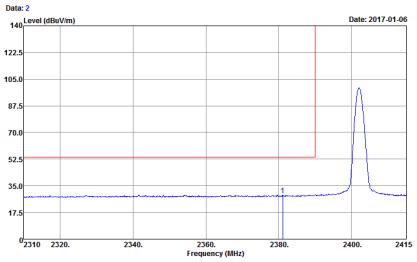
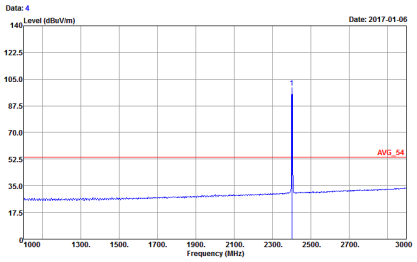
Test Engineer :	Taigong Lin and	**Temperature :**	20~24°C
		Relative Humidity :	48~50%

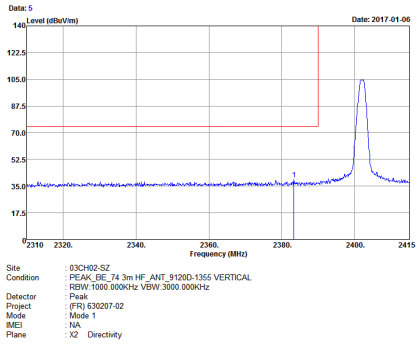
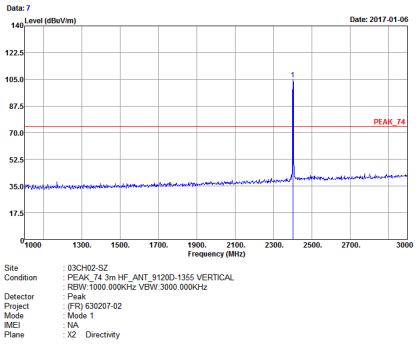
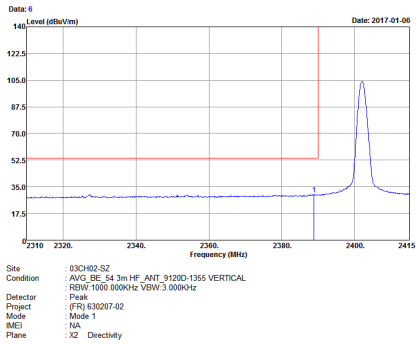
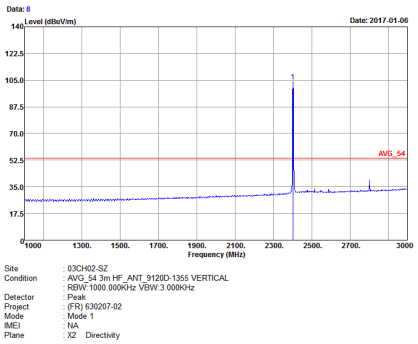
Note symbol

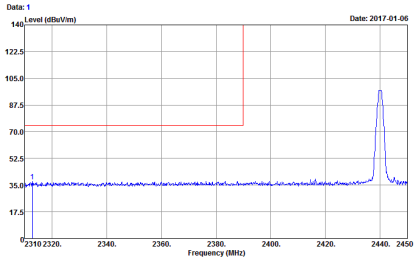
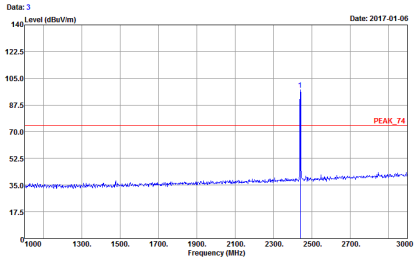
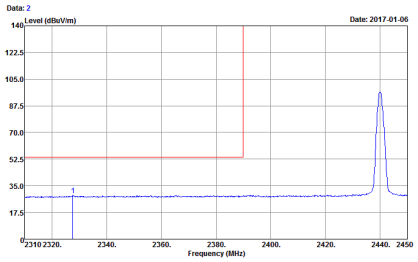
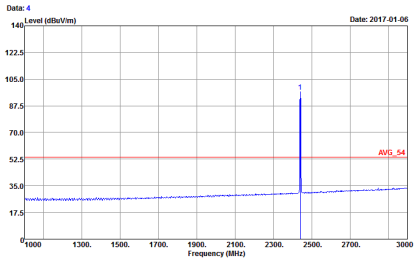
-L	**Low channel location**
-R	**High channel location**

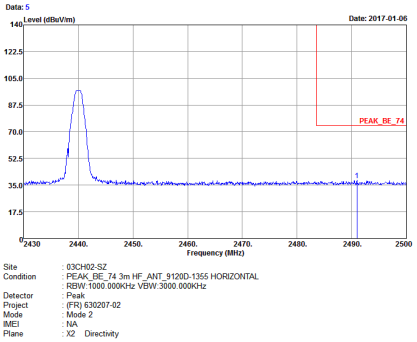
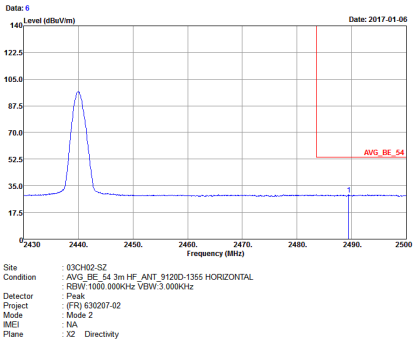
2.4GHz 2400~2483.5MHz

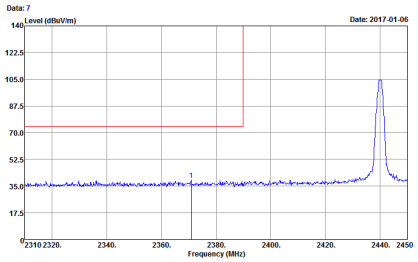
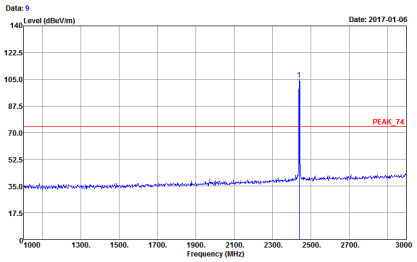
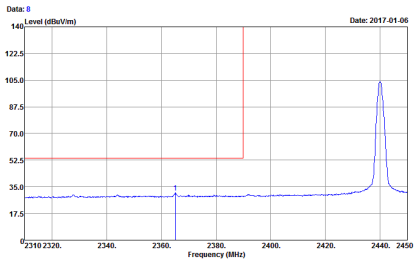
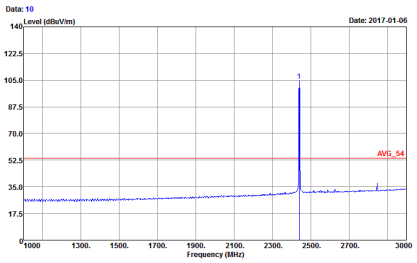
BLE (Band Edge @ 3m)

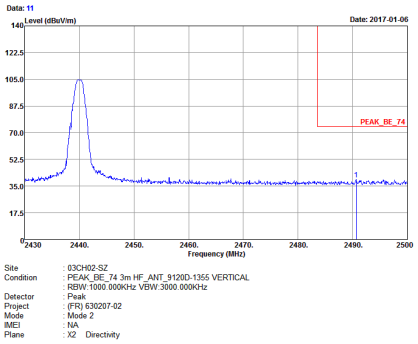
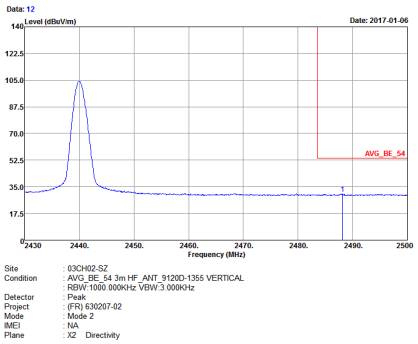
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH00 2402MHz	
1	Horizontal	Fundamental
Peak	 Site : 03CH02-SZ Condition : PEAK_BE_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity
Avg.	 Site : 03CH02-SZ Condition : AVG_BE_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : AVG_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity

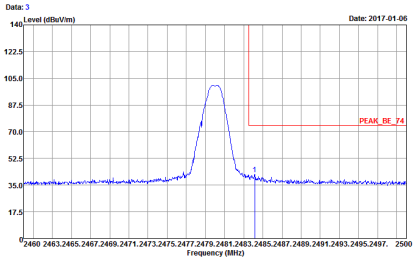
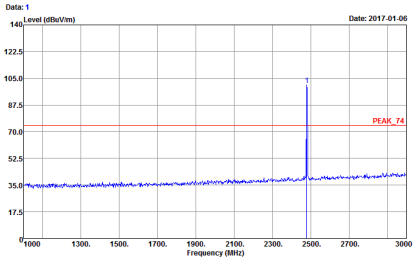
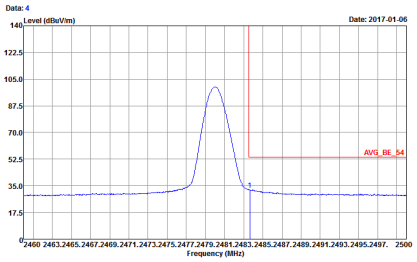
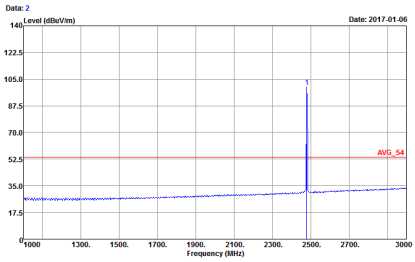
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH00 2402MHz	
1	Vertical	Fundamental
Peak		
Avg		

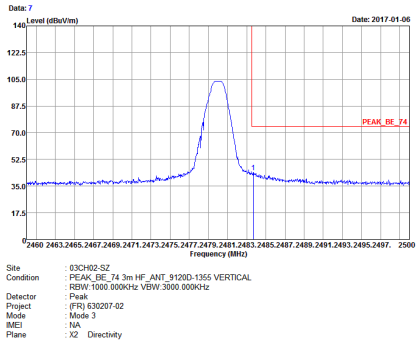
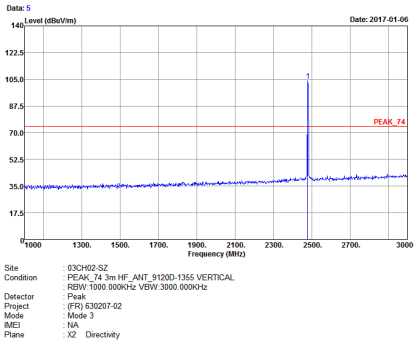
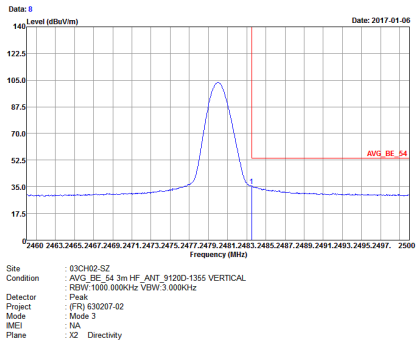
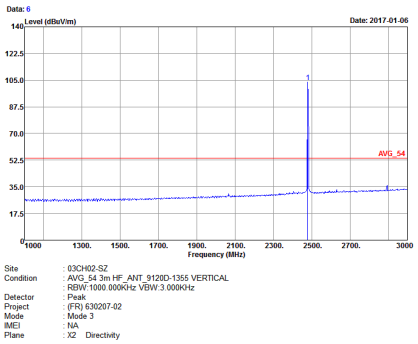
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz - L	
1	Horizontal	Fundamental
Peak	 Site : 03CH02-SZ Condition : PEAK_BE_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity
Avg.	 Site : 03CH02-SZ Condition : AVG_BE_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : AVG_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz - R	
1	Horizontal	Fundamental
Peak		Left blank
Avg.		Left blank

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz - L	
1	Vertical	Fundamental
Peak	 Site : 03CH02-SZ Condition : PEAK_BE_74 3m HF_ANT_9120D-1355 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity
Avg.	 Site : 03CH02-SZ Condition : AVG_BE_54 3m HF_ANT_9120D-1355 VERTICAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : AVG_54 3m HF_ANT_9120D-1355 VERTICAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity

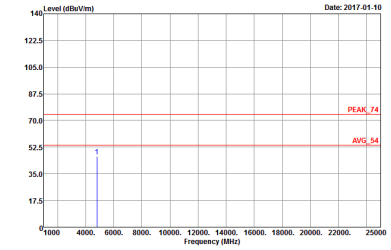
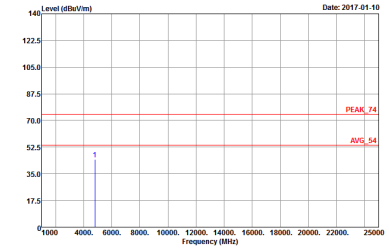
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz - R	
1	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

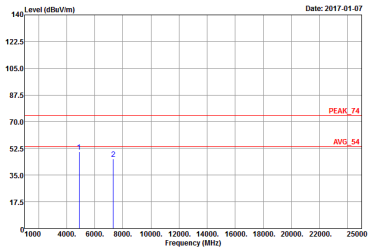
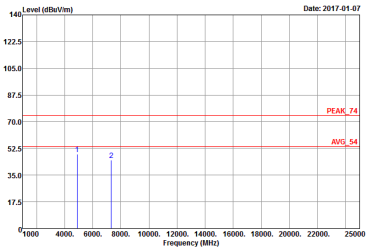
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
1	Horizontal	Fundamental
Peak	 Site : 03CH02-SZ Condition : PEAK_BE_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 3 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 3 IMEI : NA Plane : X2 Directivity
Avg.	 Site : 03CH02-SZ Condition : AVG_BE_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 3 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : AVG_54 3m HF_ANT_9120D-1355 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz Detector : Peak Project : (FR) 630207-02 Mode : Mode 3 IMEI : NA Plane : X2 Directivity

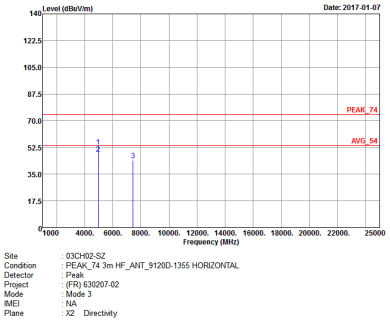
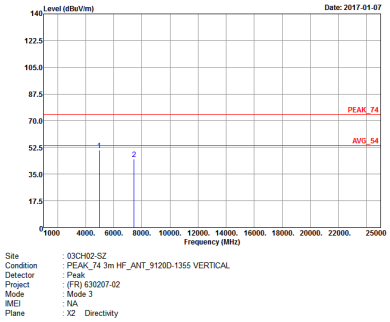
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
1	Vertical	Fundamental
Peak		
Avg.		

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

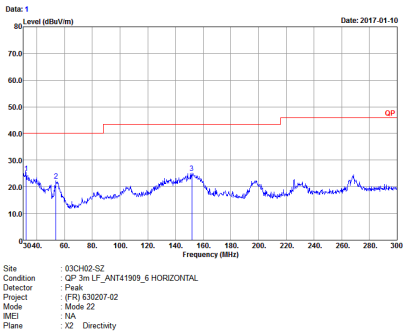
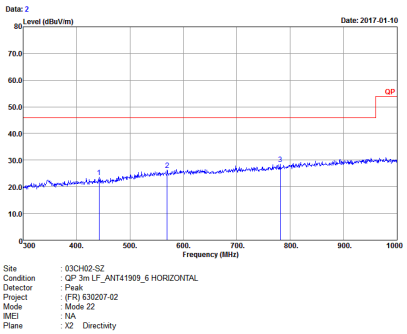
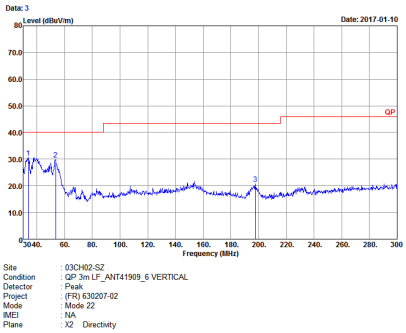
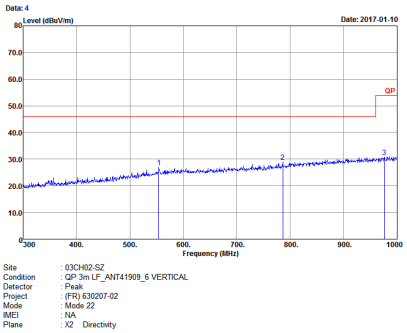
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH00 2402MHz	
1	Horizontal	Vertical
Peak Avg.	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 HORIZONTAL Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 VERTICAL Detector : Peak Project : (FR) 630207-02 Mode : Mode 1 IMEI : NA Plane : X2 Directivity

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH19 2440MHz	
1	Horizontal	Vertical
Peak Avg.	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 HORIZONTAL Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity	 Site : 03CH02-SZ Condition : PEAK_74 3m HF_ANT_9120D-1355 VERTICAL Detector : Peak Project : (FR) 630207-02 Mode : Mode 2 IMEI : NA Plane : X2 Directivity

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH39 2480MHz	
1	Horizontal	Vertical
Peak		

Emission below 1GHz

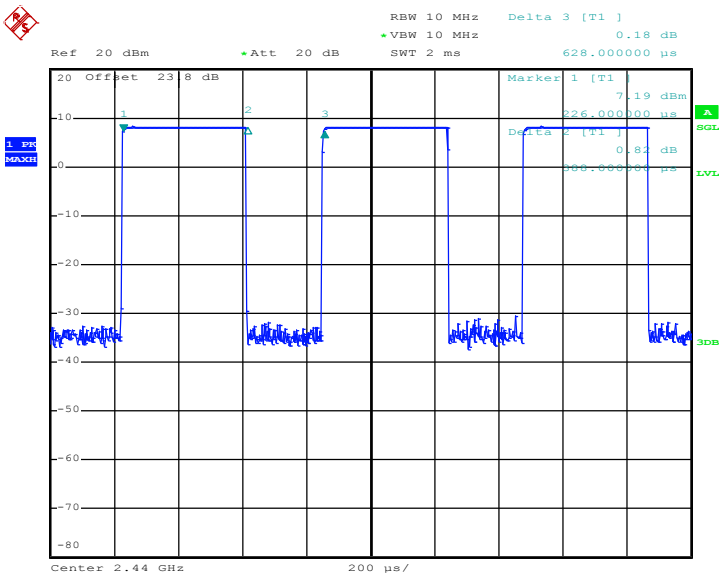
2.4GHz BLE (LF)

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

Appendix D. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth -LE	61.78	388	2.577319588	3KHz

Bluetooth - LE



Date: 30.DEC.2016 03:28:49