FCC RF Test Report

APPLICANT	:	LC Future Center
EQUIPMENT	:	Tablet PC
BRAND NAME	:	Lenovo
MODEL NAME	:	TP00089A
FCC ID	:	2AJN7-TP00089ASI
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System

The product were integrated the WWAN module (Model Name: EM7455, FCC ID: N7NEM7455) and the BT/WLAN module: 2x2 PCIe M.2 1216 SD adapter card (Brand Name: Intel, Model Name: 8265D2W, FCC ID: PD98265D2) during the test.

The product was received on Sep. 08, 2017 and testing was completed on Nov. 20, 2017. We, Sporton International (Kunshan) 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 (Kunshan) Inc., the test report shall not be reproduced except in full.

James Huang

TESTING
NVLAP LAB CODE 600155-0

Approved by: James Huang / Manager

Sporton International (Kunshan) Inc.

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR790812B	Rev. 01	Initial issue of report	Nov. 29, 2017

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
-	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	1
-	-	99% Bandwidth	-	Pass	1
3.1	15.247(b)(3)	Peak and Average Output Power	≤ 30dBm	Pass	-
-	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	1
-	15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass	1
3.2	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 7.65 dB at 30.000 MHz
3.3	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 12.73 dB at 15.635 MHz
3.4	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

Remark:

1. All conducted test items were leverage from module RF report which can refer to Report No. “160321-02.TR04”.

1 General Description

1.1 Applicant

LC Future Center
7F., No.780,Beian Rd., Zhongshan Dist.,Taipei. Taiwan

1.2 Manufacturer

Lenovo PC HK Limited
23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, HongKong

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Tablet PC
Brand Name	Lenovo
Model Name	TP00089A
FCC ID	2AJN7-TP00089ASI
EUT supports Radios application	WCDMA/HSPA/DC-HSDPA/ HSPA+ (16QAM uplink is not supported)/LTE WLAN 2.4GHz 802.11b/g/n HT20/HT40 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz 802.11ac VHT20/VHT40/VHT80 Bluetooth v3.0+EDR/ Bluetooth v4.0 LE/ Bluetooth v4.1 LE
IMEI Code	Conducted/ Conduction: N/A Radiation: 014583000471168 for Sample 1 014583000471168 for Sample 2
HW Version	1.0
SW Version	Win 10 Pro 10.0.15063
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. There are two samples of EUT, the only difference between two samples are just for the WWAN antenna and WLAN/BT antenna with different suppliers, they are equivalent-type antennas , antenna type and gain are all the same between sample 1 and sample 2 . According to the difference, we evaluate sample 1 for full test, sample 2 only verified the worst cases of sample 1 for RSE test item.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	40
Carrier Frequency of Each Channel	40 Channel(37 hopping + 3 advertising channel)
Maximum Output Power to Antenna	Bluetooth LE: 5.24 dBm (0.0033 W)
Antenna Type / Gain	PCB Antenna type with gain 0.50 dBi
Type of Modulation	Bluetooth LE : GFSK

1.5 Modification of EUT

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

1.6 Testing Location

Sporton Lab is accredited to ISO 17025 by National Voluntary Laboratory Accreditation Program (NVLAP code: 600155-0) and the FCC designation No. is CN5013.

Test Site	Sporton International (Kunshan) Inc.			
Test Site Location	No.3-2 Ping-Xiang Rd, Kunshan Development Zone Kunshan City Jiangsu Province 215335 China TEL : +86-512-57900158 FAX : +86-512-57900958			
Test Site No.	**Sporton Site No.**			**FCC Test Firm Registration No.**
	TH01-KS	03CH03-KS	CO01-KS	630927

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

1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ANSI C63.10-2013

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

2 Test Configuration of Equipment Under Test

2.1 Descriptions of Test Mode

The RF output power was recorded in the following table:

Channel	Frequency	Bluetooth LE RF Peak Output Power
		Data Rate / Modulation
		GFSK
		1Mbps
Ch00	2402MHz	5.05 dBm
Ch19	2440MHz	**5.24 dBm**
Ch39	2480MHz	4.78 dBm

Channel	Frequency	Bluetooth LE RF Average Output Power
		Data Rate / Modulation
		GFSK
		1Mbps
Ch00	2402MHz	4.90 dBm
Ch19	2440MHz	**5.09 dBm**
Ch39	2480MHz	4.46 dBm

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).

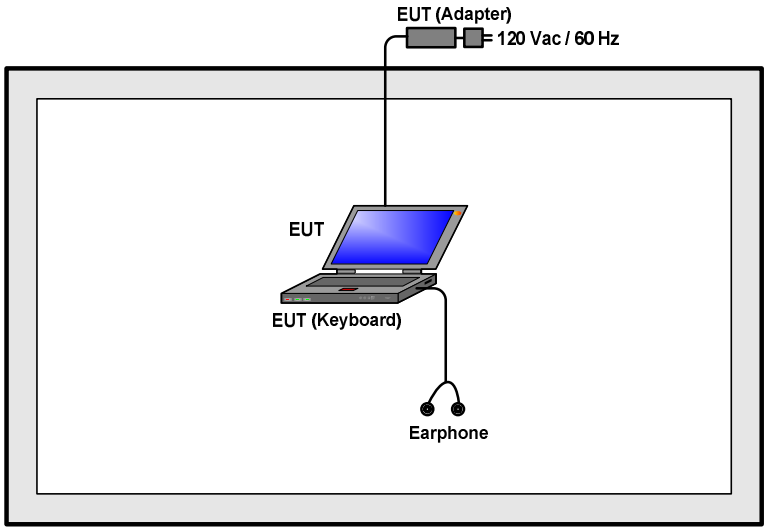
2.2 Test Mode

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

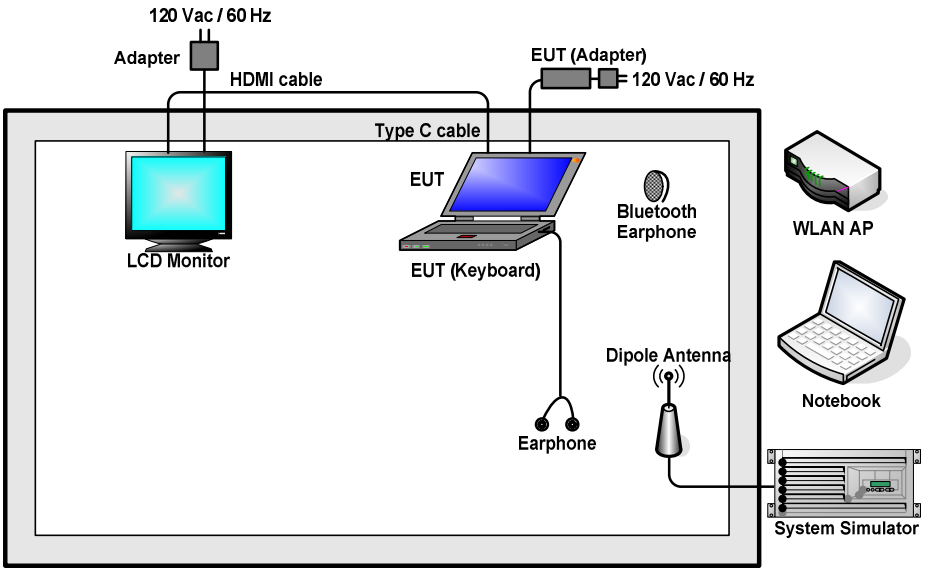
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
	Bluetooth – LE / GFSK
Radiated TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps
AC Conducted Emission	Mode 1 : WCDMA Band II Idle + Bluetooth Link + WLAN Link (2.4G) + Adaptor + display with type C cable + Earphone
Remark: For Radiated Test Cases, The tests were performed with Adapter and Earphone.	

2.3 Connection Diagram of Test System

<Bluetooth LE Tx Mode>



<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.	System Simulator	R&S	CMU 200	N/A	N/A	Unshielded, 1.8 m
2.	WLAN AP	LINKSYS	WRT600N	Q87-WRT600NV11	N/A	Unshielded, 1.8 m
3.	Notebook	Lenovo	G480	N/A	N/A	Shielded cable DC O/P 1.8m , Unshielded AC I/P cable 1.8m
4.	Bluetooth Earphone	Lenovo	LBH308	NA	N/A	N/A
5.	Earphone	Lenovo	LH102	N/A	Unshielded,1.2m	N/A
6.	Type C cable	N/A	N/A	N/A	Unshielded,0.2m	N/A
7.	HDMI cable	N/A	N/A	N/A	Shielded, 1.0 m	N/A
8.	LCD Monitor	Lenovo	6135-AB1	FCC DoC	N/A	Unshielded, 1.8 m

2.5 EUT Operation Test Setup

For BLE function, the engineering test program was provided and enabled to make EUT continuous transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

3 Test Result

3.1 Peak and Average Output Power Measurement

3.1.1 Limit of Peak and Average Output Power

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

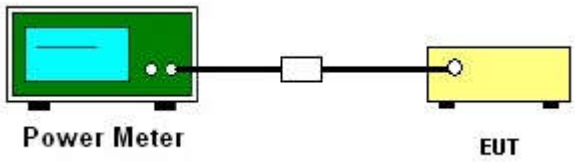
3.1.2 Measuring Instruments

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

3.1.3 Test Procedures

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

3.1.4 Test Setup



3.1.5 Test Result of Peak Output Power

Test data refers to Appendix A.

3.1.6 Test Result of Peak Output Power

Test Mode :	1Mbps	**Temperature :**	21~25℃
Test Engineer :	Silent Hai	**Relative Humidity :**	51~55%

Channel	Frequency (MHz)	RF Power (dBm)		
		GFSK	Max. Limits (dBm)	Pass/Fail
		1 Mbps		
Ch00	2402MHz	5.05	30.00	Pass
Ch19	2440MHz	5.24	30.00	Pass
Ch39	2480MHz	4.78	30.00	Pass

3.1.7 Test Result of Average Output Power (Report Only)

Test Mode :	1Mbps	**Temperature :**	21~25℃
Test Engineer :	Silent Hai	**Relative Humidity :**	51~55%

Channel	Frequency (MHz)	RF Power (dBm)		
		GFSK	Max. Limits (dBm)	Pass/Fail
		1 Mbps		
Ch00	2402MHz	4.90	-	-
Ch19	2440MHz	5.09	-	-
Ch39	2480MHz	4.46	-	-

3.2 Radiated Band Edges and Spurious Emission Measurement

3.2.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.2.2 Measuring Instruments

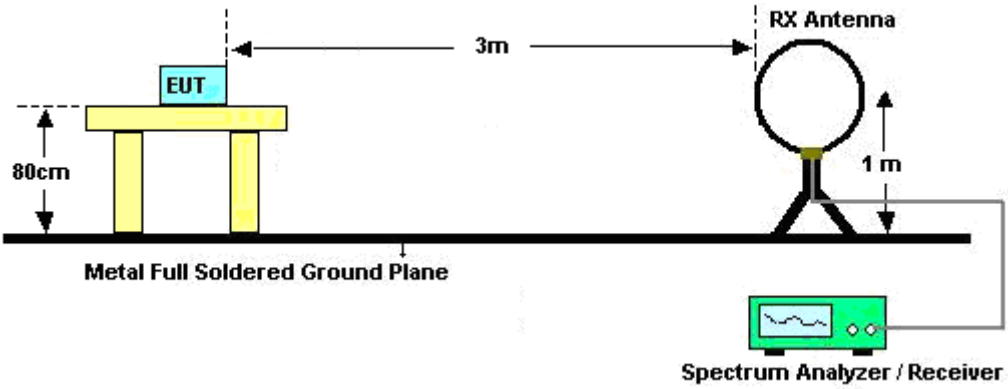
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.2.3 Test Procedures

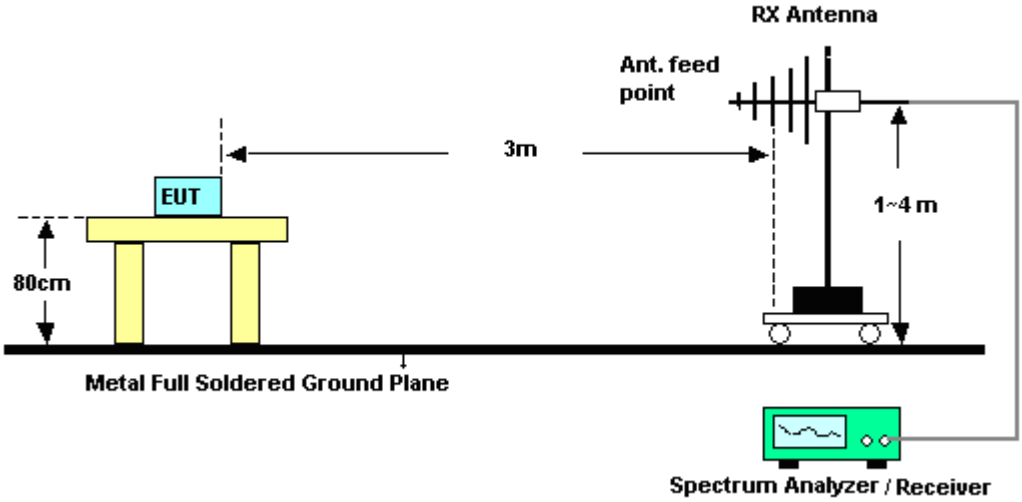
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test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

3.2.4 Test Setup

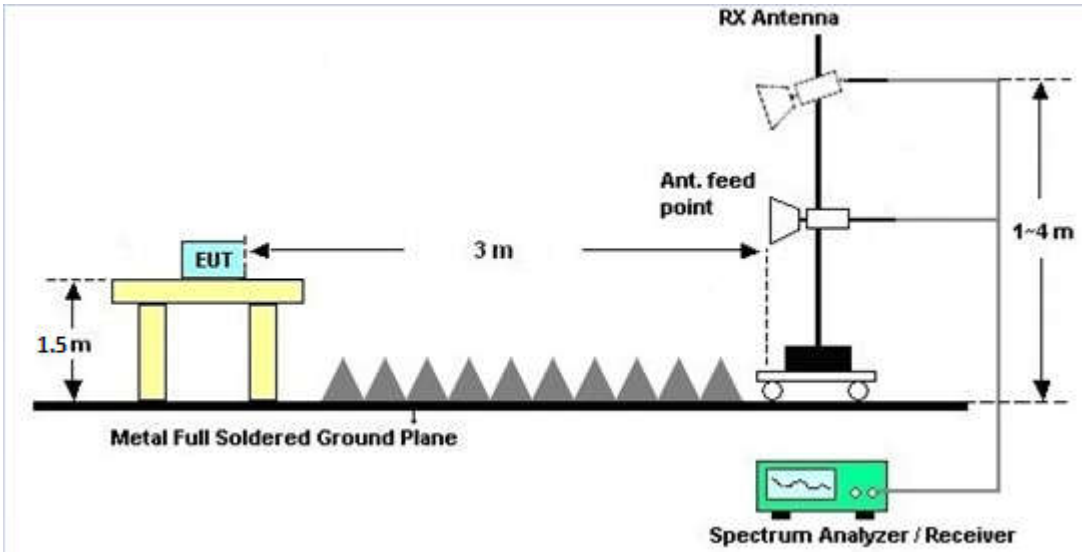
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

3.2.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.2.7 Duty Cycle

Please refer to Appendix C.

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

Please refer to Appendix A and B.

3.3 AC Conducted Emission Measurement

3.3.1 Limit of AC Conducted Emission

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

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

*Decreases with the logarithm of the frequency.

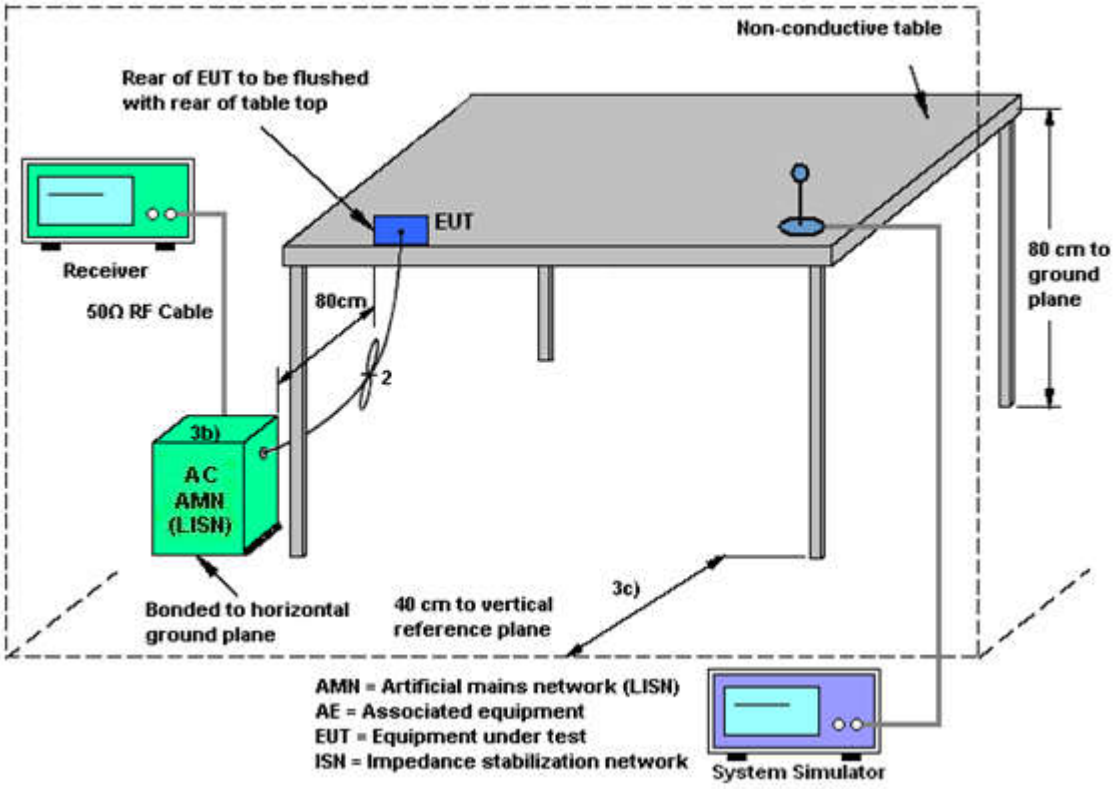
3.3.2 Measuring Instruments

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

3.3.3 Test Procedures

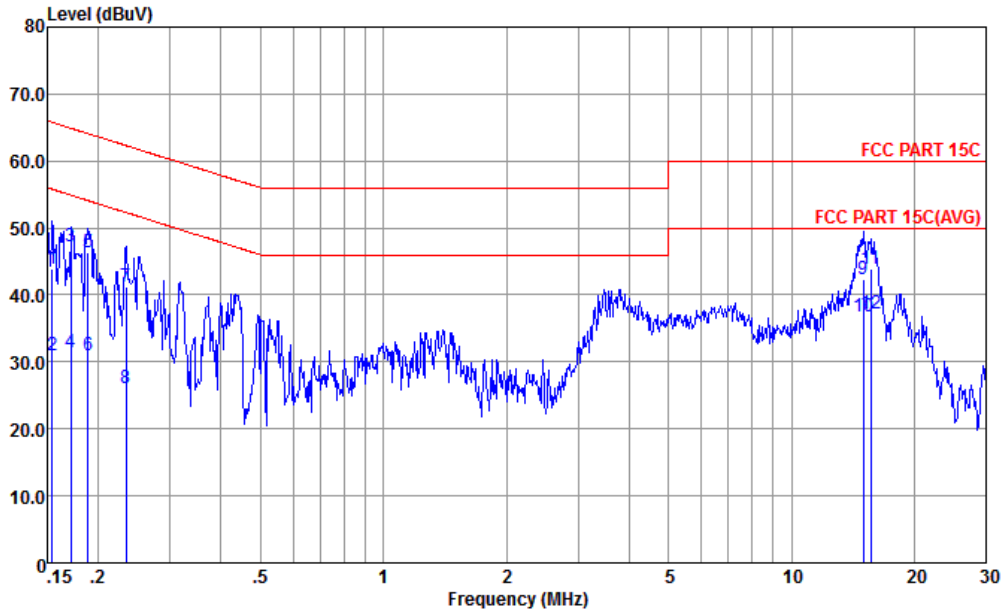
1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.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

3.3.4 Test Setup



3.3.5 Test Result of AC Conducted Emission

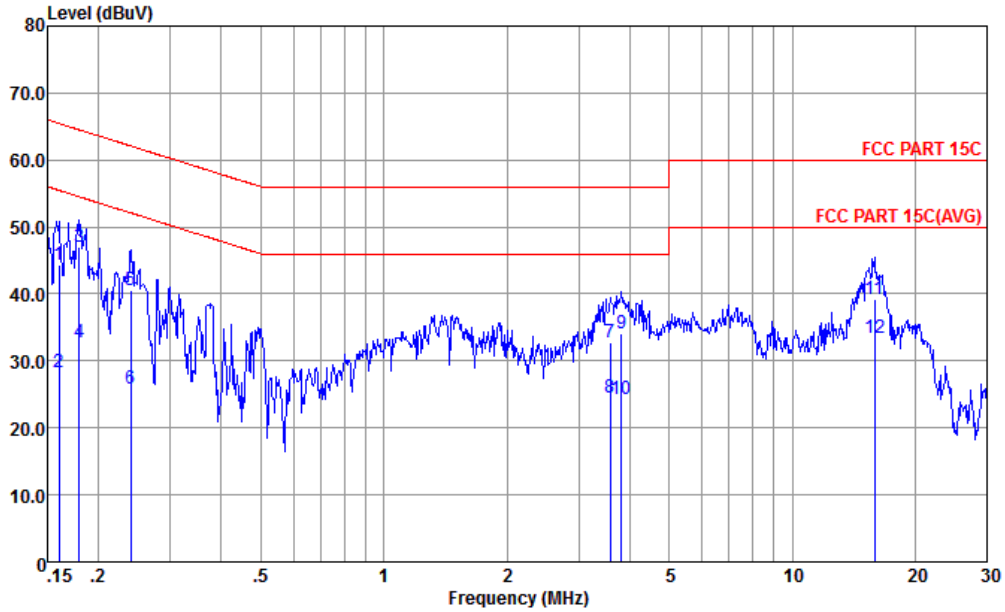
Test Mode :	Mode 1	**Temperature :**	22~24℃
Test Engineer :	Amos Zhang	**Relative Humidity :**	42~46%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Function Type :	WCDMA Band II Idle + Bluetooth Link + WLAN Link (2.4G) + Adaptor + display with type C cable + Earphone		



Site : CO01-KS
Condition : FCC PART 15C LISN-L-171013-060103 LINE

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.154	43.97	-21.81	65.78	33.21	0.16	10.60	QP
2	0.154	30.97	-24.81	55.78	20.21	0.16	10.60	Average
3	0.171	47.32	-17.58	64.90	36.59	0.18	10.55	QP
4	0.171	31.32	-23.58	54.90	20.59	0.18	10.55	Average
5	0.188	46.28	-17.83	64.11	35.60	0.19	10.49	QP
6	0.188	30.88	-23.23	54.11	20.20	0.19	10.49	Average
7	0.234	41.25	-21.05	62.30	30.60	0.21	10.44	QP
8	0.234	26.15	-26.15	52.30	15.50	0.21	10.44	Average
9	14.986	42.27	-17.73	60.00	31.60	0.26	10.41	QP
10	14.986	36.87	-13.13	50.00	26.20	0.26	10.41	Average
11	15.635	43.87	-16.13	60.00	33.20	0.25	10.42	QP
12 *	15.635	37.27	-12.73	50.00	26.60	0.25	10.42	Average

Test Mode :	Mode 1	**Temperature :**	22~24℃
Test Engineer :	Amos Zhang	**Relative Humidity :**	42~46%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral
Function Type :	WCDMA Band II Idle + Bluetooth Link + WLAN Link (2.4G) + Adaptor + display with type C cable + Earphone		



Site : CO01-KS
Condition : FCC PART 15C LISN-N-171013-060103 NEUTRAL

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.160	44.36	-21.11	65.47	33.50	0.28	10.58	QP
2	0.160	28.36	-27.11	55.47	17.50	0.28	10.58	Average
3	0.180	47.00	-17.50	64.50	36.20	0.28	10.52	QP
4	0.180	32.70	-21.80	54.50	21.90	0.28	10.52	Average
5	0.240	40.52	-21.56	62.08	29.80	0.28	10.44	QP
6	0.240	25.92	-26.16	52.08	15.20	0.28	10.44	Average
7	3.584	32.81	-23.19	56.00	22.31	0.33	10.17	QP
8	3.584	24.41	-21.59	46.00	13.91	0.33	10.17	Average
9	3.820	34.10	-21.90	56.00	23.60	0.33	10.17	QP
10	3.820	24.30	-21.70	46.00	13.80	0.33	10.17	Average
11	15.885	39.22	-20.78	60.00	28.60	0.19	10.43	QP
12 *	15.885	33.52	-16.48	50.00	22.90	0.19	10.43	Average

3.4 Antenna Requirements

3.4.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.4.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.4.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 19, 2017	Nov. 02, 2017	Jan. 18, 2018	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 19, 2017	Nov. 02, 2017	Jan. 18, 2018	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 19, 2017	Nov. 20, 2017	Oct. 18, 2018	Radiation (03CH03-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz-44GHz	Apr. 18, 2017	Nov. 20, 2017	Apr. 17, 2018	Radiation (03CH03-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 23, 2016	Nov. 20, 2017	Nov. 22, 2017	Radiation (03CH03-KS)
Bilog Antenna	TeseQ	CBL6112D	35406	25MHz-2GHz	Apr. 22, 2017	Nov. 20, 2017	Apr. 21, 2018	Radiation (03CH03-KS)
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1356	1GHz~18GHz	Apr. 22, 2017	Nov. 20, 2017	Apr. 21, 2018	Radiation (03CH03-KS)
SHF-EHF Horn	Schwarzbeck	BBHA 9170	BBHA170249	15GHz~40GHz	Feb. 15, 2017	Nov. 20, 2017	Feb. 14, 2018	Radiation (03CH03-KS)
Amplifier	com-power	PA-103A	161069	1MHz ~1000MHz / 32 dB	Apr. 18, 2017	Nov. 20, 2017	Apr. 17, 2018	Radiation (03CH03-KS)
Amplifier	MITEQ	TTA1840-35-HG	1887435	18GHz~40GHz	Oct. 12, 2017	Nov. 20, 2017	Oct. 11, 2018	Radiation (03CH03-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2025788	1Ghz-18Ghz	Apr. 18, 2017	Nov. 20, 2017	Apr. 17, 2018	Radiation (03CH03-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Nov. 20, 2017	NCR	Radiation (03CH03-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Nov. 20, 2017	NCR	Radiation (03CH03-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Nov. 20, 2017	NCR	Radiation (03CH03-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 20, 2017	Nov. 16, 2017	Apr. 19, 2018	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060103	9kHz~30MHz	Oct. 13, 2017	Nov. 16, 2017	Oct. 12, 2018	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060105	9kHz~30MHz	Oct. 13, 2017	Nov. 16, 2017	Oct. 12, 2018	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 12, 2017	Nov. 16, 2017	Oct. 11, 2018	Conduction (CO01-KS)

NCR: No Calibration Required

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))	2.3dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.6dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.5dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.7dB

Appendix A. Radiated Spurious Emission

Sample 1

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH 00 2402MHz		2367.59	40.24	-33.76	74	41.6	25.29	5.61	32.26	103	301	P	H
		2387.48	30.59	-23.41	54	31.84	25.4	5.65	32.3	103	301	A	H
	*	2402	94.51	-	-	95.76	25.4	5.65	32.3	103	301	P	H
	*	2402	94.08	-	-	95.33	25.4	5.65	32.3	103	301	A	H
		2330.8	40.43	-33.57	74	41.91	25.18	5.57	32.23	266	260	P	V
		2389.82	30.7	-23.3	54	31.95	25.4	5.65	32.3	266	260	A	V
	*	2402	95.99	-	-	97.24	25.4	5.65	32.3	266	260	P	V
	*	2402	95.63	-	-	96.88	25.4	5.65	32.3	266	260	A	V
BLE CH 19 2440MHz		2352.25	40.68	-33.32	74	42.04	25.29	5.61	32.26	102	303	P	H
		2388.52	30.74	-23.26	54	31.99	25.4	5.65	32.3	102	303	A	H
	*	2440	96.46	-	-	97.26	25.83	5.71	32.34	102	303	P	H
	*	2440	96.03	-	-	96.83	25.83	5.71	32.34	102	303	A	H
		2495.2	41.23	-32.77	74	41.59	26.26	5.77	32.39	102	303	P	H
		2485.84	31.54	-22.46	54	32.05	26.11	5.75	32.37	102	303	A	H
		2322.35	40.51	-33.49	74	41.99	25.18	5.57	32.23	255	266	P	V
		2379.94	30.53	-23.47	54	31.83	25.35	5.63	32.28	255	266	A	V
	*	2440	97.16	-	-	97.96	25.83	5.71	32.34	255	266	P	V
	*	2440	96.72	-	-	97.52	25.83	5.71	32.34	255	266	A	V
		2484.76	41.63	-32.37	74	42.14	26.11	5.75	32.37	255	266	P	V
		2499.52	31.42	-22.58	54	31.78	26.26	5.77	32.39	255	266	A	V

BLE CH 39 2480MHz		2483.68	49.13	-24.87	74	49.64	26.11	5.75	32.37	128	309	P	H
		2483.5	38.37	-15.63	54	38.88	26.11	5.75	32.37	128	309	A	H
	*	2480	95.2	-	-	95.71	26.11	5.75	32.37	128	309	P	H
	*	2480	94.78	-	-	95.29	26.11	5.75	32.37	128	309	A	H
		2484.16	47.05	-26.95	74	47.56	26.11	5.75	32.37	265	261	P	V
		2483.5	37.58	-16.42	54	38.09	26.11	5.75	32.37	265	261	A	V
	*	2480	94.24	-	-	94.75	26.11	5.75	32.37	265	261	P	V
	*	2480	93.84	-	-	94.35	26.11	5.75	32.37	265	261	A	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		4806	40.38	-33.62	74	63.03	30.86	7.84	61.35	100	360	P	H
		4806	40.1	-33.9	74	62.75	30.86	7.84	61.35	100	360	P	V
BLE CH 19 2440MHz		4878	39.31	-34.69	74	61.6	31.01	7.9	61.2	100	360	P	H
		7320	40.18	-33.82	74	58.39	35.39	9.51	63.11	100	360	P	H
		4878	38.55	-35.45	74	60.84	31.01	7.9	61.2	100	360	P	V
		7320	41.74	-32.26	74	59.95	35.39	9.51	63.11	100	360	P	V
BLE CH 39 2480MHz		4962	39.88	-34.12	74	61.73	31.19	7.97	61.01	100	360	P	H
		7440	40.98	-33.02	74	58.95	35.68	9.57	63.22	100	360	P	H
		4962	39.45	-34.55	74	61.3	31.19	7.97	61.01	100	139	P	V
		7440	40.8	-33.2	74	58.77	35.68	9.57	63.22	100	139	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Sample 2

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 39 2480MHz	*	2480	92.33	-	-	92.84	26.11	5.75	32.37	106	290	P	H
	*	2480	91.96	-	-	92.47	26.11	5.75	32.37	106	290	A	H
		2489.98	46.22	-27.78	74	46.58	26.26	5.77	32.39	107	290	P	H
		2489.92	37.15	-16.85	54	37.51	26.26	5.77	32.39	106	290	A	H
	*	2480	91.1	-	-	91.61	26.11	5.75	32.37	302	132	P	V
	*	2480	90.67	-	-	91.18	26.11	5.75	32.37	302	132	A	V
		2490.04	45.97	-28.03	74	46.33	26.26	5.77	32.39	302	132	P	V
		2489.86	36.68	-17.32	54	37.04	26.26	5.77	32.39	302	132	A	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 39 2480MHz		4962	40.22	-33.78	74	62.07	31.19	7.97	61.01	100	360	P	H
		7440	40.92	-33.08	74	58.89	35.68	9.57	63.22	100	360	P	H
		4962	38.45	-35.55	74	60.3	31.19	7.97	61.01	100	360	P	V
		7440	40.92	-33.08	74	58.89	35.68	9.57	63.22	100	360	P	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	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BLE LF		30	25.44	-14.56	40	29.67	26.3	0.57	31.1	100	69	P	H
		93.05	25.76	-17.74	43.5	38.29	17.14	1.05	30.72	-	-	P	H
		183.26	26.15	-17.35	43.5	39.49	16.23	1.46	31.03	-	-	P	H
		250.19	25.04	-20.96	46	36.62	17.9	1.72	31.2	-	-	P	H
		324.88	23.25	-22.75	46	32.38	20.4	1.97	31.5	-	-	P	H
		913.67	30.35	-15.65	46	28.66	29.4	3.44	31.15	-	-	P	H
		30	32.35	-7.65	40	36.58	26.3	0.57	31.1	100	25	P	V
		57.16	28.27	-11.73	40	45.85	13.14	0.82	31.54	-	-	P	V
		74.62	29.32	-10.68	40	45.2	14.6	0.92	31.4	-	-	P	V
		170.65	22.73	-20.77	43.5	35.65	16.64	1.42	30.98	-	-	P	V
		223.03	27.41	-18.59	46	40.23	16.72	1.61	31.15	-	-	P	V
		485.9	24.59	-21.41	46	29.87	23.87	2.45	31.6	-	-	P	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 B. Radiated Spurious Emission

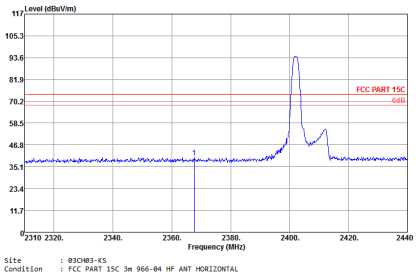
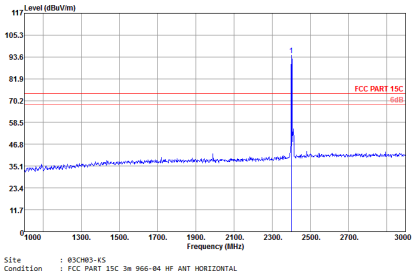
Note symbol

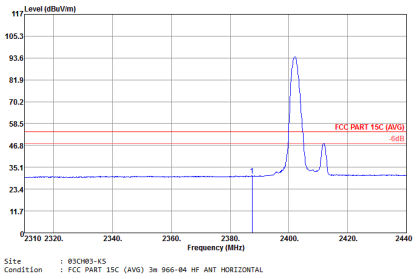
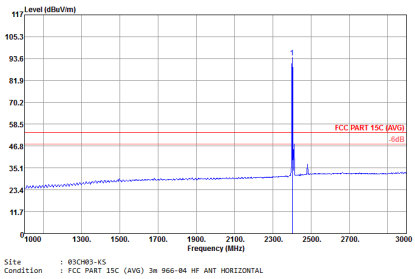
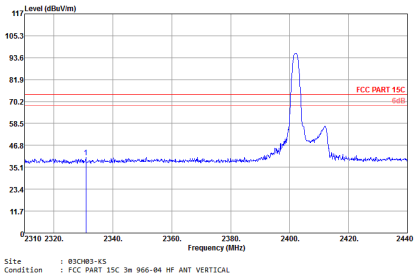
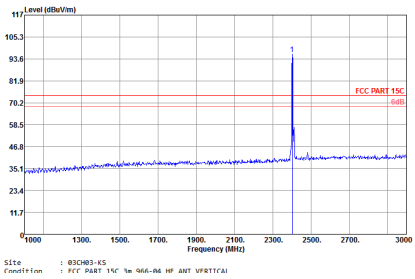
-L	**Low channel location**
-R	**High channel location**

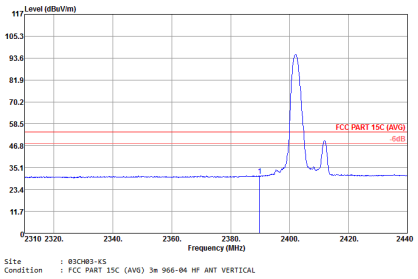
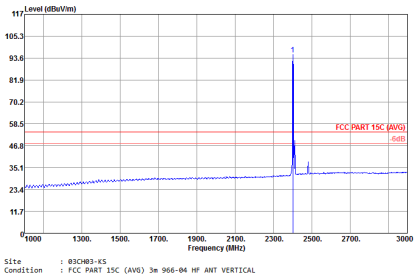
Sample 1

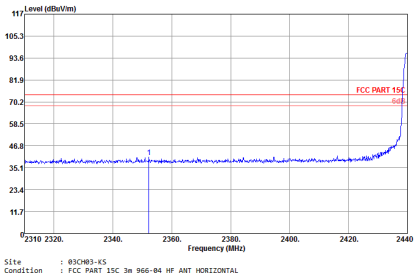
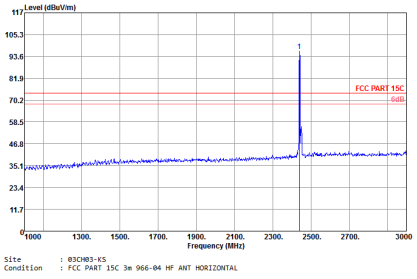
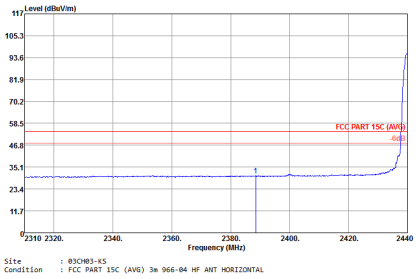
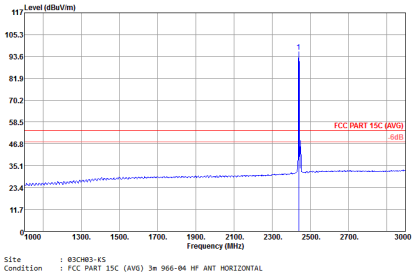
2.4GHz 2400~2483.5MHz

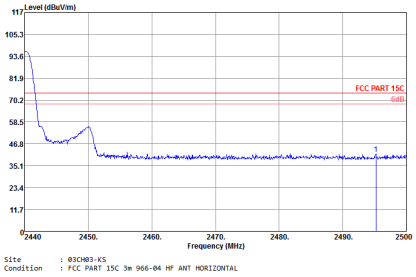
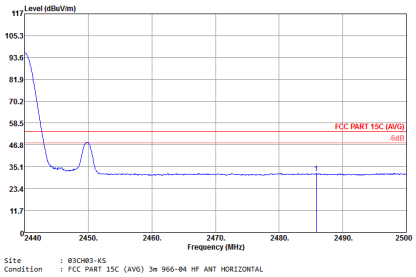
BLE (Band Edge @ 3m)

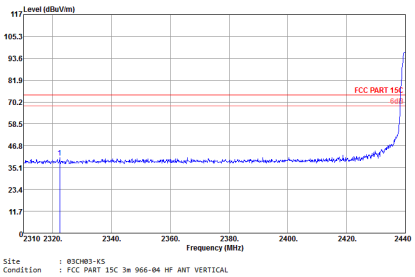
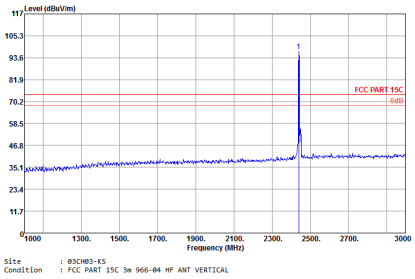
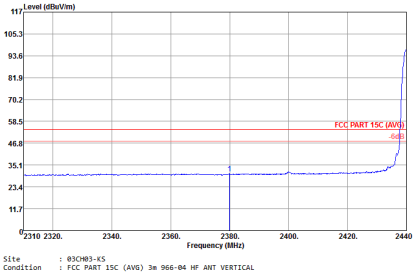
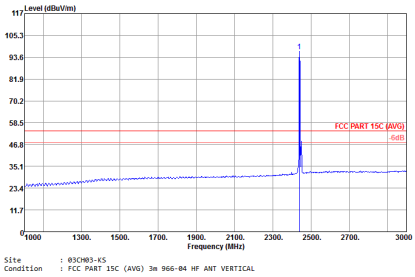
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH00 2402MHz	
1	Horizontal	Fundamental
Peak		

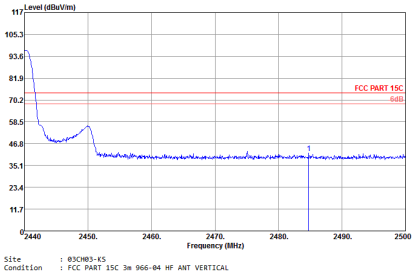
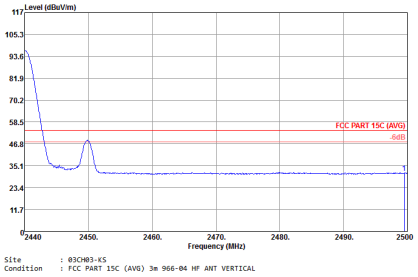
Avg.		
BLE	**2.4GHz 2400~2483.5MHz Band Edge @ 3m**	
ANT	**BLE CH00 2402MHz**	
1	**Vertical**	**Fundamental**
Peak		

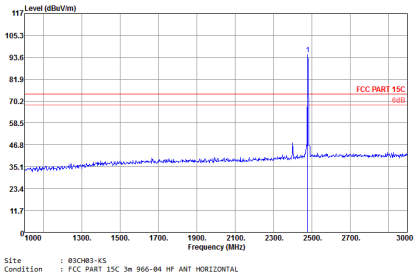
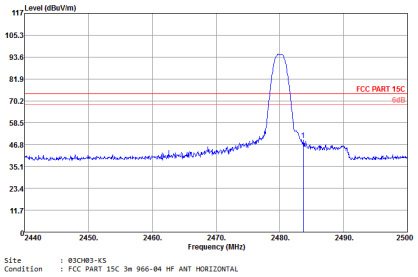
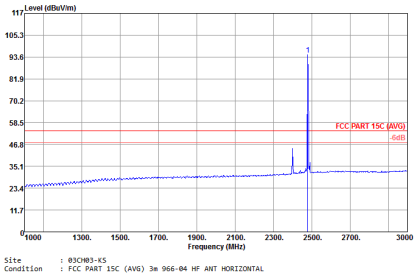
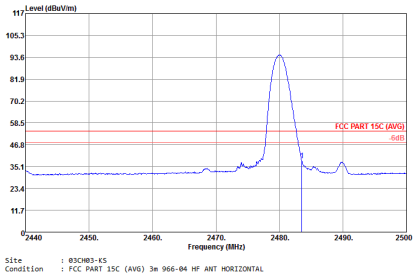
Avg	 Level (dBuV/m) 117 105.3 93.6 81.9 70.2 58.5 46.8 35.1 23.4 11.7 0 FCC PART 15C (AVG) -6dB 1 2310 2320. 2340. 2360. 2380. 2400. 2420. 2440 Frequency (MHz) Site : 03CH03-KS Condition : FCC PART 15C (AVG) 3m 966-04 HF ANT VERTICAL	 Level (dBuV/m) 117 105.3 93.6 81.9 70.2 58.5 46.8 35.1 23.4 11.7 0 FCC PART 15C (AVG) -6dB 1 1000 1300. 1500. 1700. 1900. 2100. 2300. 2500. 2700. 3000 Frequency (MHz) Site : 03CH03-KS Condition : FCC PART 15C (AVG) 3m 966-04 HF ANT VERTICAL

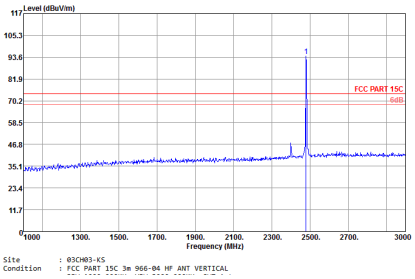
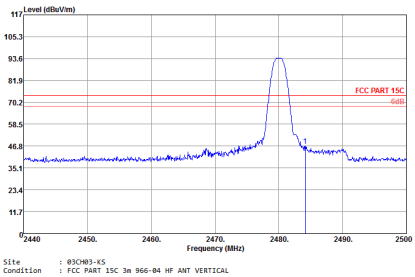
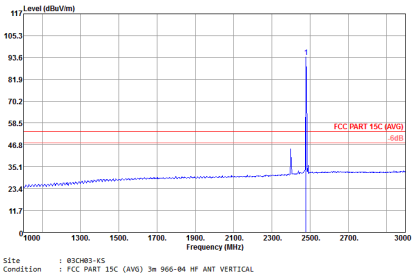
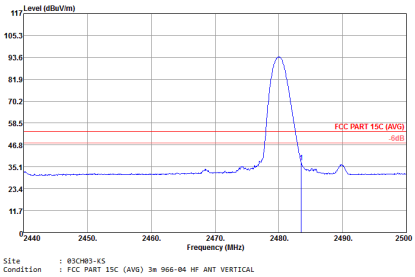
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz -L	
1	Horizontal	Fundamental
Peak		
Avg.		

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

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

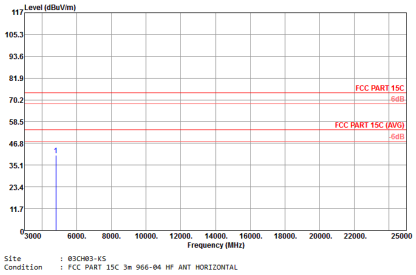
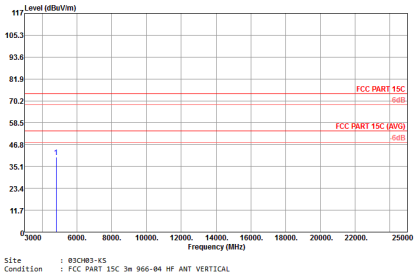
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH19 2440MHz - R	
1	Vertical	
Peak		
Avg.		

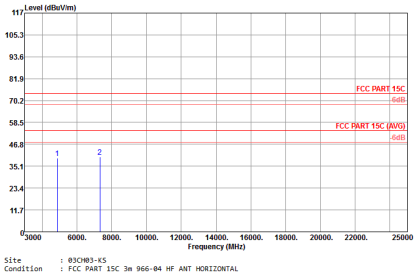
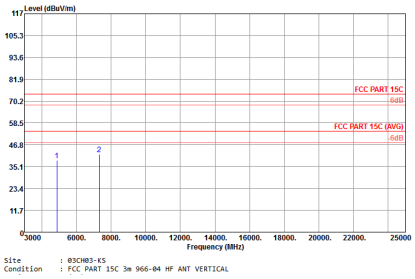
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
1	Fundamental	Horizontal
Peak		
Avg.		

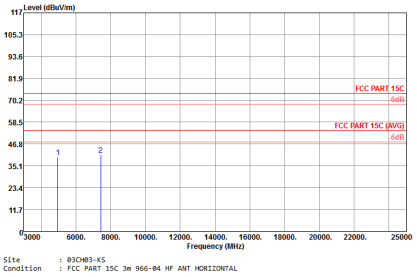
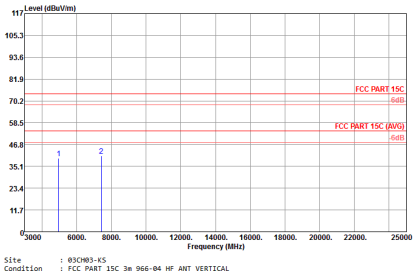
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
1	Fundamental	Vertical
Peak		
Avg.		

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

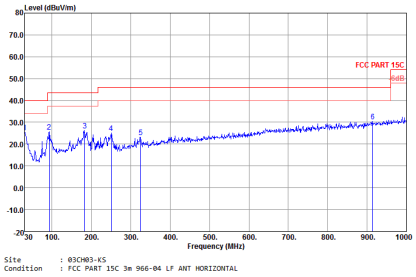
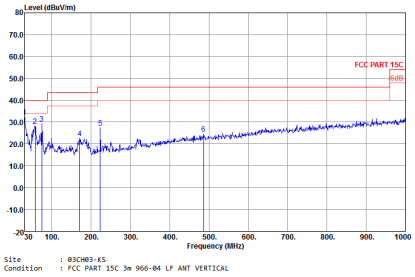
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH00 2402MHz	
1	Horizontal	Vertical
Peak Avg.		

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH19 2440MHz	
1	Horizontal	Vertical
Peak Avg.		

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

Emission below 1GHz

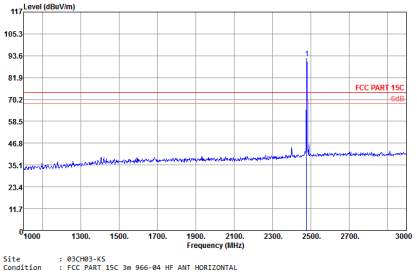
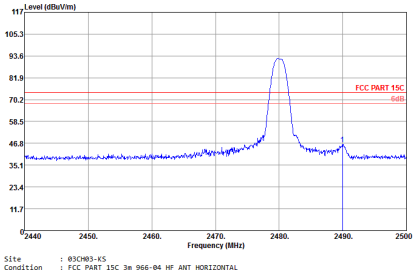
2.4GHz BLE (LF)

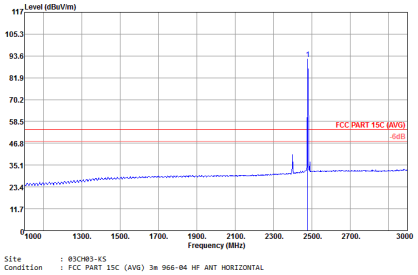
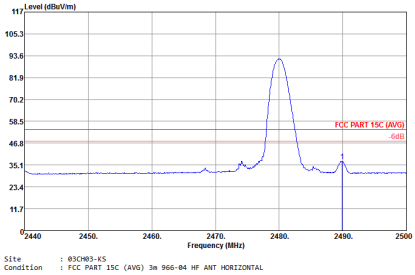
BLE	2.4GHz 2400~2483.5MHz	
ANT	BLE LF	
1	Horizontal	Vertical
QP / Peak		

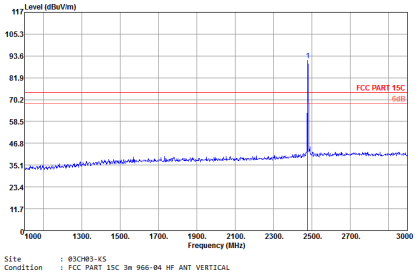
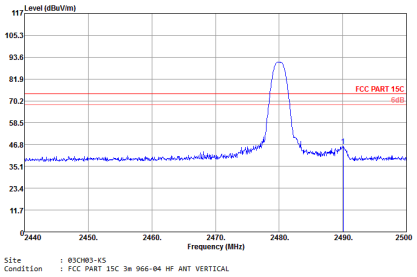
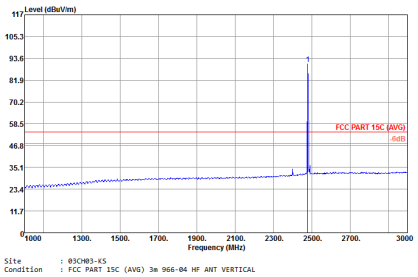
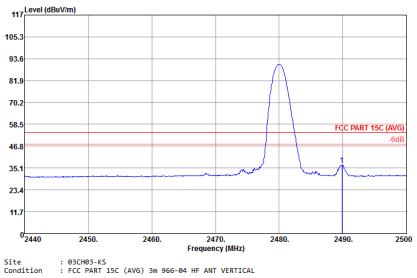
Sample 2

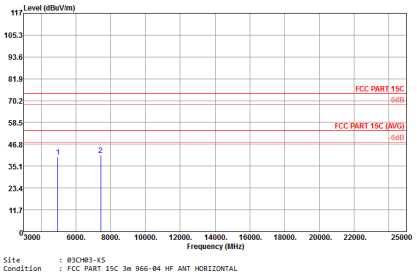
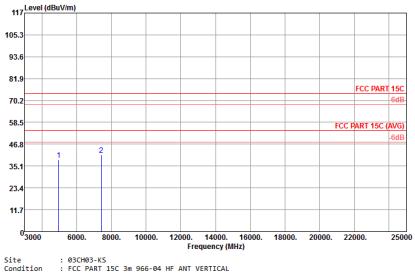
2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

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

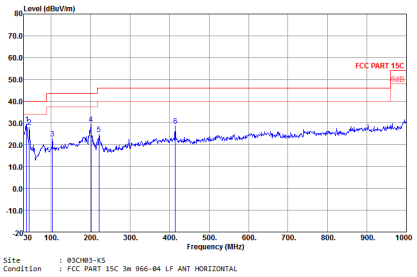
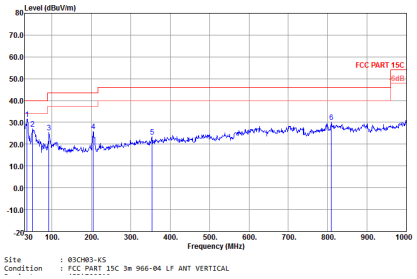
Avg.	 Level (dBuV/m) 117 105.3 93.6 81.9 70.2 58.5 46.8 35.1 23.4 11.7 0 1000 1300. 1500. 1700. 1900. 2100. 2300. 2500. 2700. 3000 Frequency (MHz) 1 FCC PART 15C (AVG) -6dB Site : 03CH03-KS Condition : FCC PART 15C (AVG) 3m 966-04 HF ANT HORIZONTAL	 Level (dBuV/m) 117 105.3 93.6 81.9 70.2 58.5 46.8 35.1 23.4 11.7 0 2440 2450. 2460. 2470. 2480. 2490. 2500 Frequency (MHz) FCC PART 15C (AVG) -6dB Site : 03CH03-KS Condition : FCC PART 15C (AVG) 3m 966-04 HF ANT HORIZONTAL

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

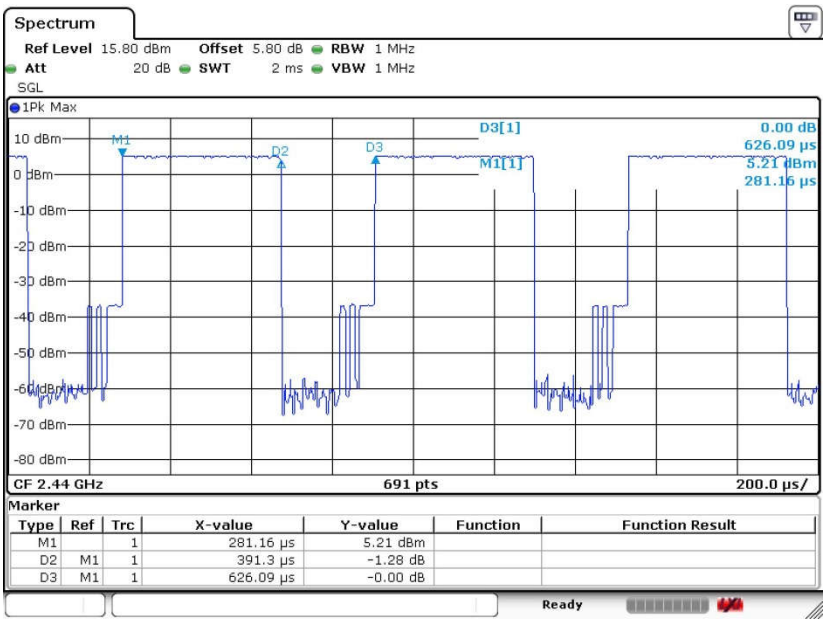
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BLE CH39 2480MHz	
1	Horizontal	Vertical
Peak		

Emission below 1GHz

2.4GHz BLE (LF)

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

Appendix C. Duty Cycle Plots

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
Bluetooth LE	62.50	0.391	2.556	3kHz

Bluetooth LE