NCC RADIO TEST REPORT

Equipment	:	**Rechargeable Li-Ion Battery**
Brand Name	:	**Zebra**
Model Name	:	**BT-000443**
Applicant	:	台灣斑馬科技股份有限公司 台北市信義區松高路 **9** 號 **13** 樓
Manufacturer	:	**Zebra Technologies Corporation** **1 Zebra Plaza, Holtsville, NY 11742**
Standard	:	**NCC LP0002 (2020-07-01)**

The product was received on May 03, 2021 and testing was started from May 17, 2021 and completed on Jul. 22, 2021. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures NCC LP0002 (2020-07-01) 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. Wensan Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory
No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issued Date
TR130701	01	Initial issue of report	Aug. 02, 2021
TR130701	02	Revise Test Result of Average Output Power	Aug. 04, 2021

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	LP0002 4.10.1.6 (2)(A)	6dB Bandwidth	Pass	-
3.1	-	99% Occupied Bandwidth	Reporting only	-
3.2	LP0002 4.10.1.2 (1)(C)	Output Power	Pass	-
3.3	LP0002 4.10.1.6 (2)(B)	Power Spectral Density	Pass	-
3.4	LP0002 4.10.1.5	Conducted Band Edges and Spurious Emission	Pass	-
3.5	LP0002 4.10.1.5	Radiated Band Edges and Spurious Emission	Pass	Under limit 3.58 dB at 7320.000 MHz
3.6	LP0002 3.3	AC Conducted Emission	Pass	Under limit 17.64 dB at 0.254 MHz
3.7	LP0002 3.2 4.10.1.3 4.10.1.4	Antenna Requirement	Pass	-
Annex A	LP0002 3.9	Receiver Radiated Emission	Pass	Please refer to Annex A
-	LP0002 3.2 6.20.2	Maximum Power Density	Not Required	-

Note: Not required means after assessing, test items are not necessary to carry out.

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Wei Chen

Report Producer: Vivian Hsu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Rechargeable Li-Ion Battery
Brand Name	Zebra
Model Name	BT-000443
EUT supports Radios application	Bluetooth - LE
HW Version	DV3A
SW Version	3.11
MFD	20JUL21
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer.

Supported Unit Used in Test Configuration and System				
Terminal	**Brand Name**	Zebra	**Model Name**	TC520L
Adapter	**Brand Name**	Zebra	**Part Number**	PWR-WUA5V12W0US
Rugged Charge/USB cable	**Brand Name**	Zebra	**Part Number**	CBL-TC51-USB1-01

1.2 Product Specification of Equipment Under Test

Product Specification subjective to this standard	
Tx/Rx Frequency Range	2400 MHz ~ 2483.5 MHz
Number of Channels	40
Carrier Frequency of Each Channel	40 Channel (37 hopping + 3 advertising channel)
Maximum Output Power to Antenna	0.65 dBm (0.0012 W) for 1Mbps 0.65 dBm (0.0012 W) for 2Mbps
99% Occupied Bandwidth	1.037 MHz for 1Mbps 2.042 MHz for 2Mbps
Type of Modulation	Bluetooth LE : GFSK

Antenna Information				
Antenna	**Brand Name**	Auden	**Peak Gain**	Bluetooth-LE: 3.1 dBi
	Part Number	AN-000316-01	**Type**	Monopole Antenna

Remark:

1. The detail internal, external and transmit antenna photo please refer to Sporton report no.: EP130701.
2. The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.3 Modification of EUT

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

1.4 Testing Location

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	TH05-HY, CO07-HY 03CH20-HY

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

FCC designation No.: TW3786

1.5 Applicable Standards

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

- NCC LP0002 (2020-07-01)
- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	21	2444
	1	2404	22	2446
	2	2406	23	2448
	3	2408	24	2450
	4	2410	25	2452
	5	2412	26	2454
	6	2414	27	2456
	7	2416	28	2458
	8	2418	29	2460
	9	2420	30	2462
	10	2422	31	2464
	11	2424	32	2466
	12	2426	33	2468
	13	2428	34	2470
	14	2430	35	2472
	15	2432	36	2474
	16	2434	37	2476
	17	2436	38	2478
	18	2438	39	2480
	19	2440	-	-
	20	2442	-	-

2.2 Test Mode

Channel	Frequency	Bluetooth – LE RF Average Output Power
		Data Rate / Modulation
		GFSK
		1Mbps
Ch00	2402MHz	**0.65 dBm**
Ch19	2440MHz	**0.65 dBm**
Ch39	2480MHz	0.55 dBm

Channel	Frequency	Bluetooth – LE RF Average Output Power
		Data Rate / Modulation
		GFSK
		2Mbps
Ch00	2402MHz	**0.65 dBm**
Ch19	2440MHz	**0.65** dBm
Ch39	2480MHz	0.55 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 emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). The measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and find X plane as worst plane.

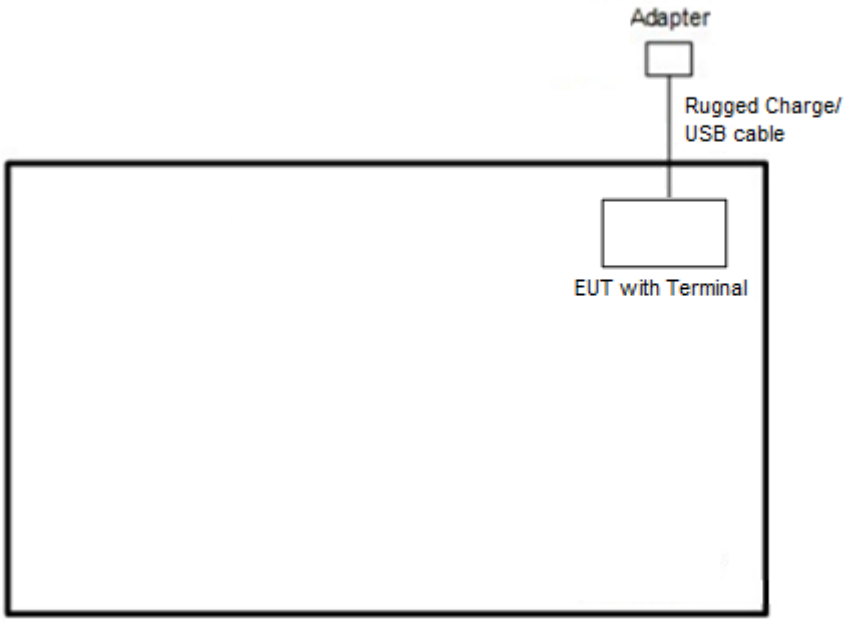
b. AC power line Conducted Emission was tested under maximum output power.

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

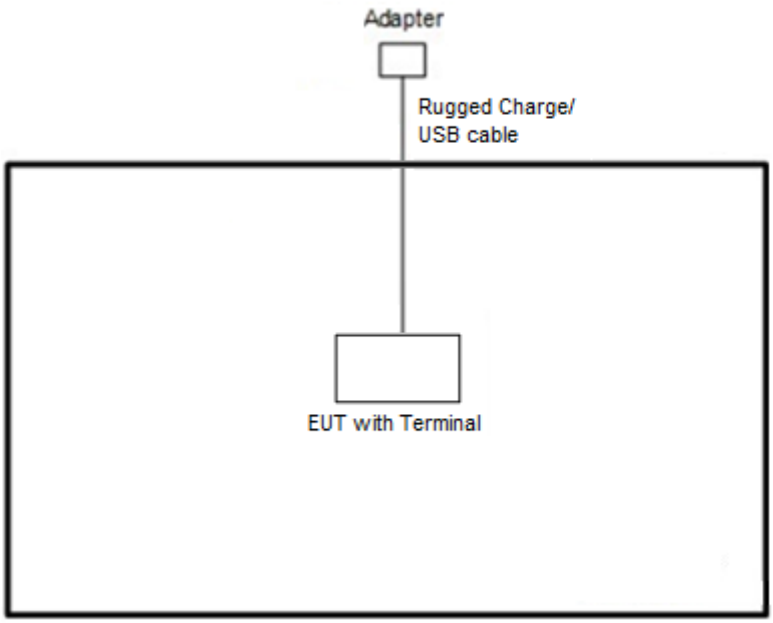
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
Conducted Test Cases	**Bluetooth – LE / GFSK**
	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps Mode 4: Bluetooth Tx CH00_2402 MHz_2Mbps Mode 5: Bluetooth Tx CH19_2440 MHz_2Mbps Mode 6: Bluetooth Tx CH39_2480 MHz_2Mbps
Radiated Test Cases	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps Mode 4: Bluetooth Tx CH00_2402 MHz_2Mbps Mode 5: Bluetooth Tx CH19_2440 MHz_2Mbps Mode 6: Bluetooth Tx CH39_2480 MHz_2Mbps
AC Conducted Emission	Mode 1: EUT with Terminal + Bluetooth - LE TX + USB Cable (Charging from Adapter)
Remark: For radiated spurious emission, after the test voltage (120Vac/60Hz and 110Vac/60Hz) is verified by lab, the test data can conform to the test requirements of NCC rule.	

2.3 Connection Diagram of Test System

<AC Conducted Emission Mode>



<Bluetooth - LE Tx Mode>



2.4 EUT Operation Test Setup

The RF test items, utility “CMD V6.1.7601” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.5 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 10 dB 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.

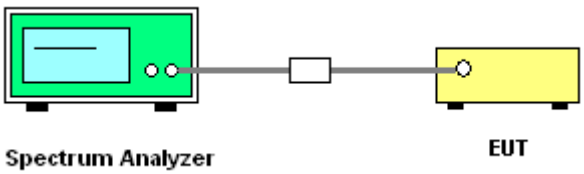
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
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 the maximum power setting and enable the EUT to 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 6dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW) ≥ 3 * RBW.
6. Measure and record the results in the test report.

3.1.4 Test Setup

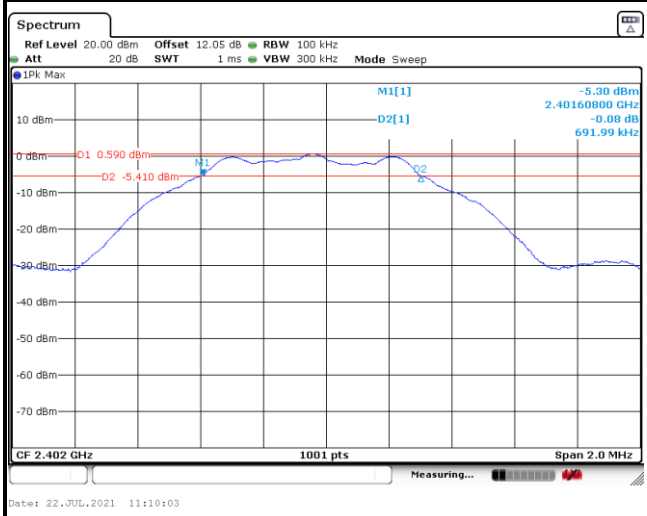
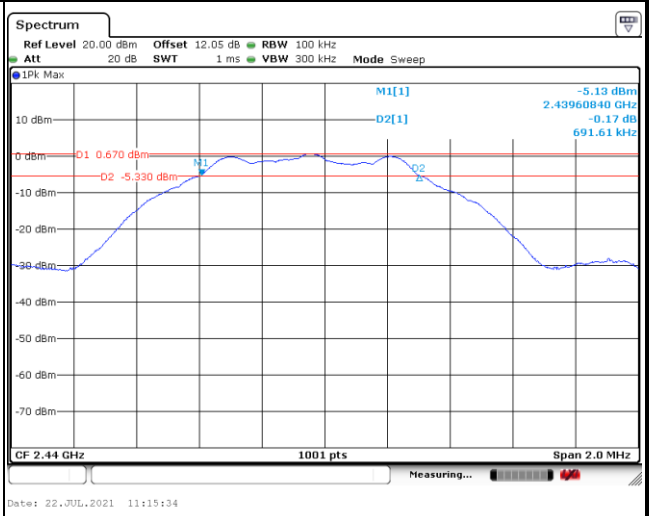
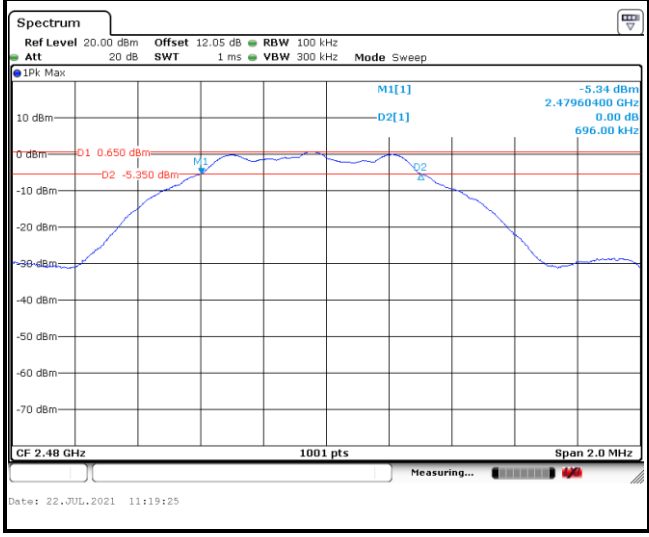


3.1.5 Test Result of 6dB Bandwidth

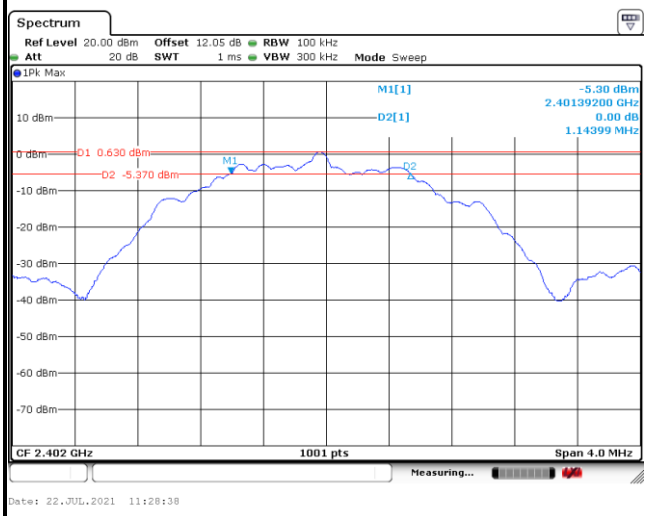
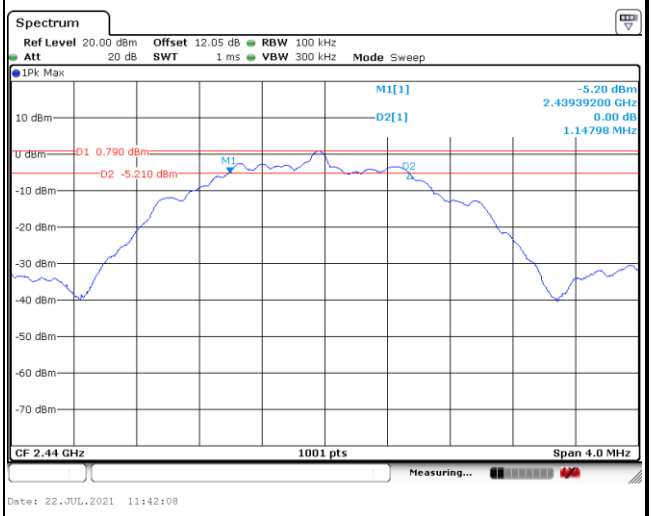
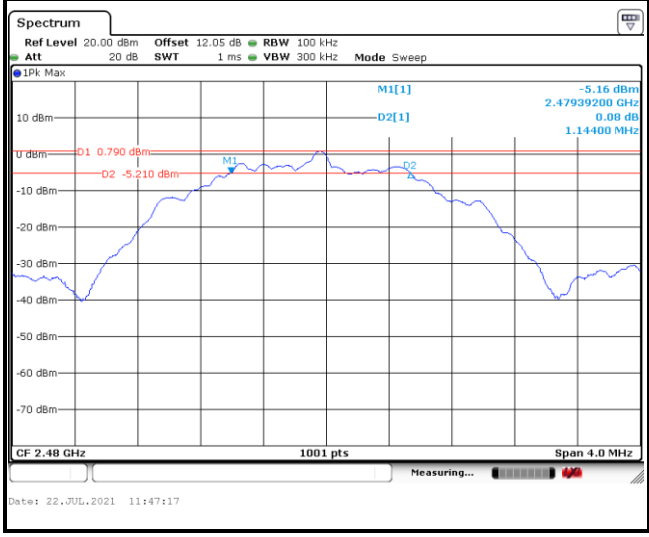
Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	0.692	0.50	Pass
BLE	1Mbps	1	19	2440	0.692	0.50	Pass
BLE	1Mbps	1	39	2480	0.696	0.50	Pass
BLE	2Mbps	1	0	2402	1.144	0.50	Pass
BLE	2Mbps	1	19	2440	1.148	0.50	Pass
BLE	2Mbps	1	39	2480	1.144	0.50	Pass

<1Mbps>

6 dB Bandwidth Plot on Channel 00	6 dB Bandwidth Plot on Channel 19
	
6 dB Bandwidth Plot on Channel 39	**N/A**
	

<2Mbps>

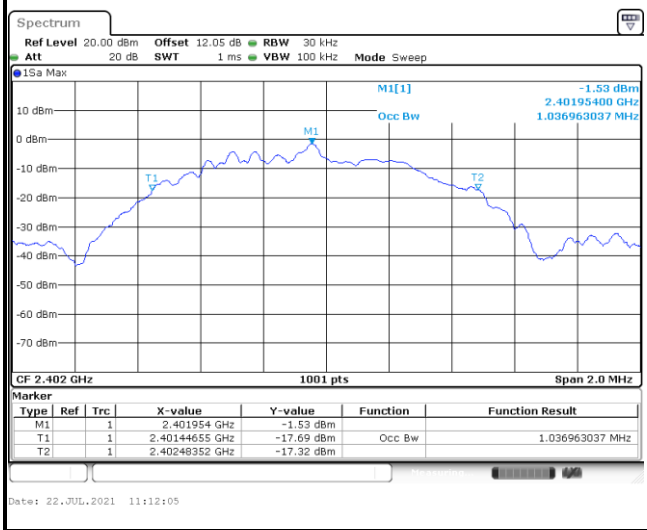
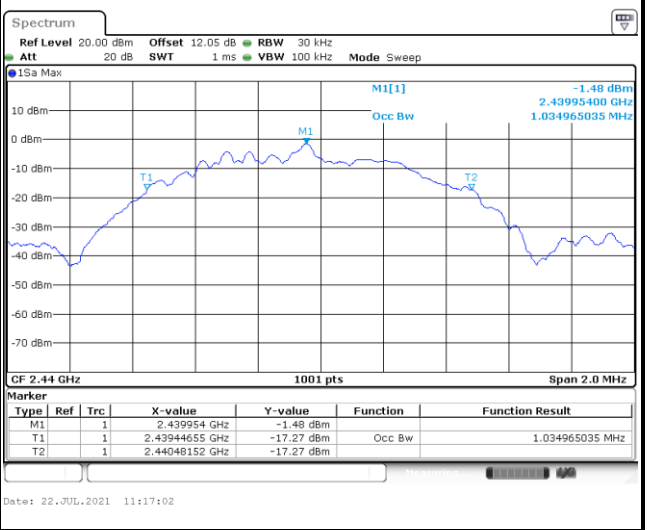
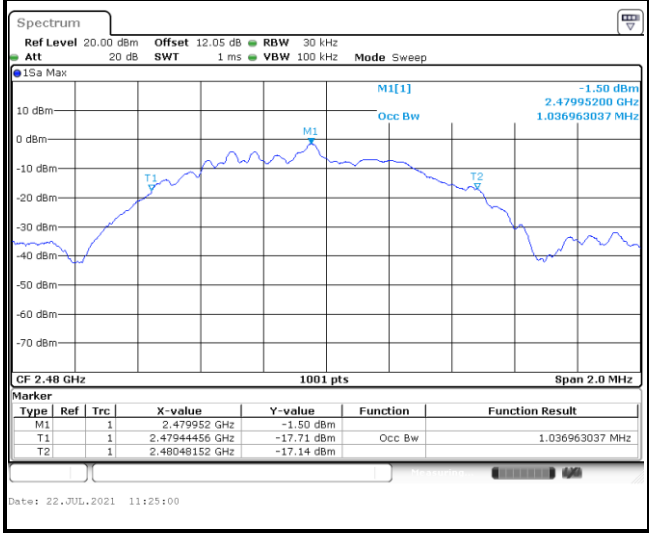
6 dB Bandwidth Plot on Channel 00	6 dB Bandwidth Plot on Channel 19
	
6 dB Bandwidth Plot on Channel 39	**N/A**
	

3.1.6 Test Result of 99% Occupied Bandwidth

Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

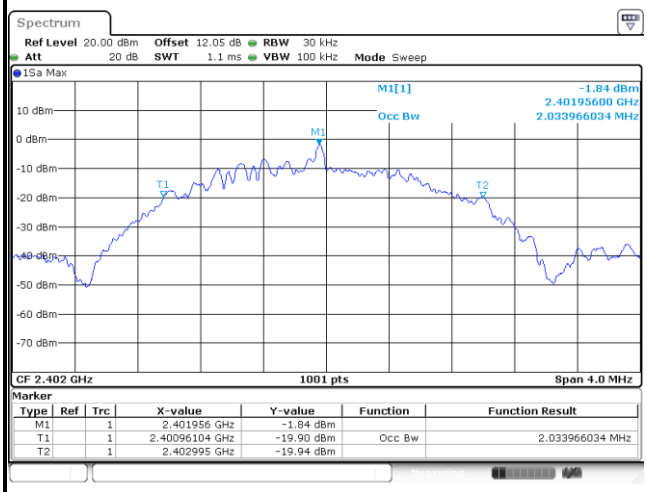
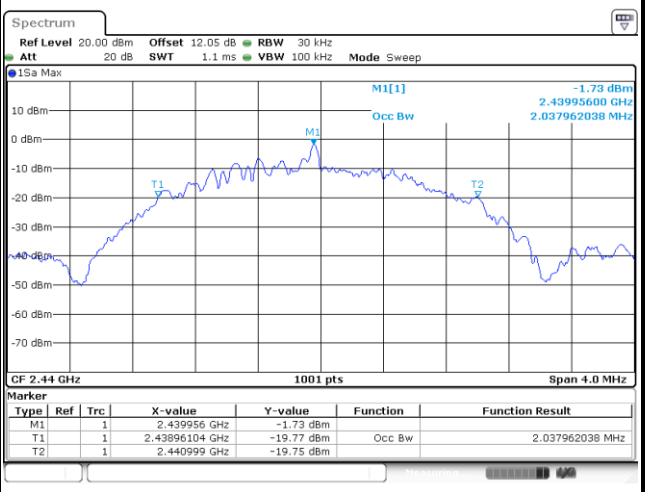
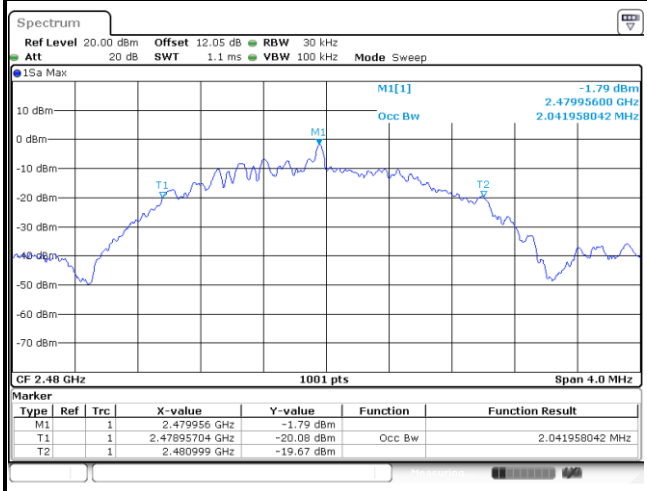
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.037	Pass
BLE	1Mbps	1	19	2440	1.035	Pass
BLE	1Mbps	1	39	2480	1.037	Pass
BLE	2Mbps	1	0	2402	2.034	Pass
BLE	2Mbps	1	19	2440	2.038	Pass
BLE	2Mbps	1	39	2480	2.042	Pass

<1Mbps>

99% Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 19
	
99% Occupied Bandwidth Plot on Channel 39	**N/A**
	

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

<2Mbps>

99% Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 19
	
99% Occupied Bandwidth Plot on Channel 39	**N/A**
	

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

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5 MHz, the limit for output power is 30 dBm. If transmitting antenna of directional gain greater than 6 dBi 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 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

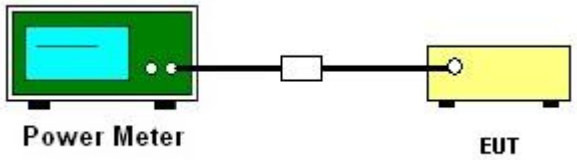
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
2. The RF output of EUT was connected to the power meter by RF cable and attenuator.
3. The path loss was compensated to the results for each measurement.
4. Set the maximum power setting and enable the EUT to transmit continuously.
5. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Average Output Power

Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail	Command for power setting
BLE	1Mbps	1	0	2402	**0.65**	30.00	2.70	3.35	36.00	Pass	bleutils dtm tx 0 2 255
BLE	1Mbps	1	19	2440	**0.65**	30.00	2.70	3.35	36.00	Pass	bleutils dtm tx 0 2 255
BLE	1Mbps	1	39	2480	0.55	30.00	2.70	3.25	36.00	Pass	bleutils dtm tx 0 2 255
BLE	2Mbps	1	0	2402	**0.65**	30.00	2.70	3.35	36.00	Pass	bleutils dtm tx 0 2 255
BLE	2Mbps	1	19	2440	**0.65**	30.00	2.70	3.35	36.00	Pass	bleutils dtm tx 0 2 255
BLE	2Mbps	1	39	2480	0.55	30.00	2.70	3.25	36.00	Pass	bleutils dtm tx 0 2 255

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

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

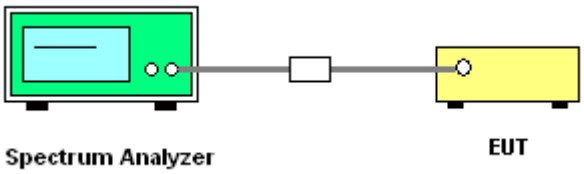
3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.10.2 Method PKPSD.
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 the maximum power setting and enable the EUT to 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)/ 100 kHz is a reference level and is used as 20 dBc 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

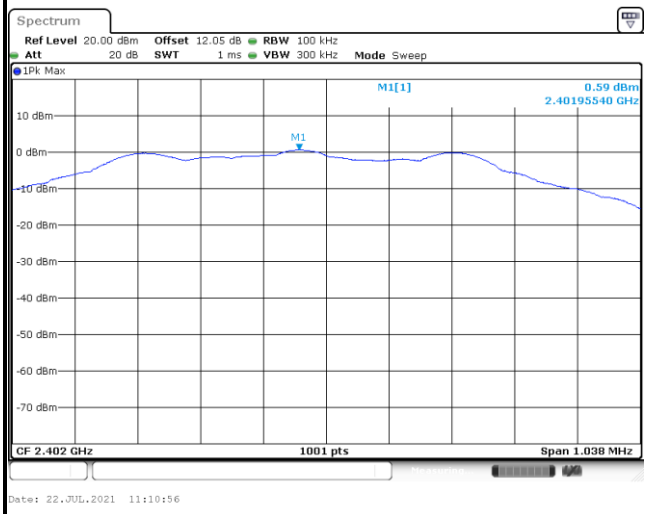
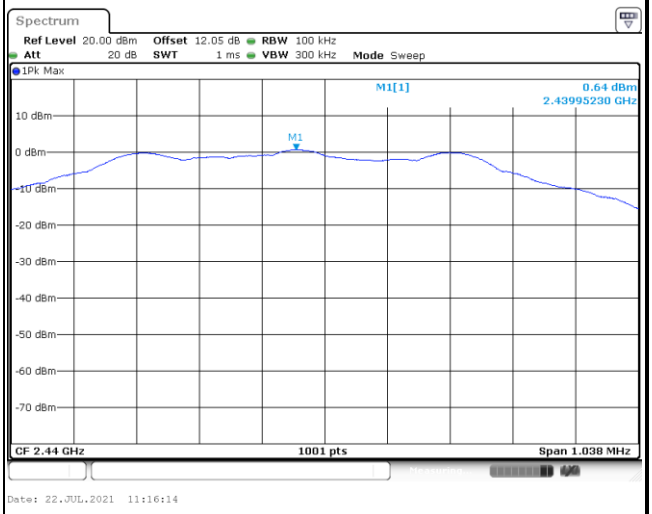
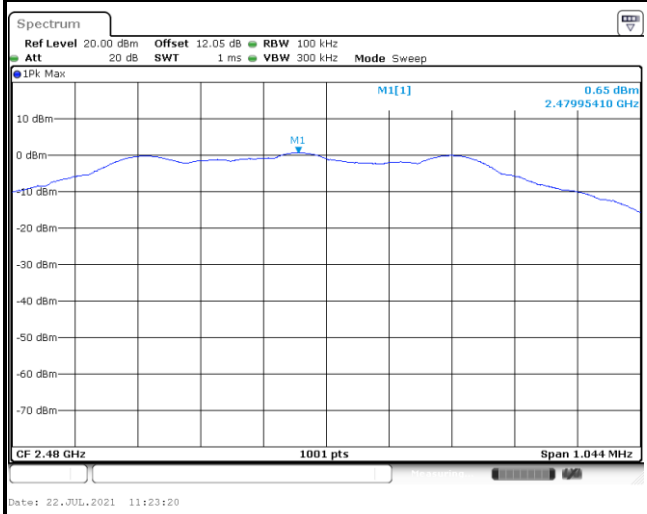
Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

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	0.59	-14.47	2.70	8.00	Pass
BLE	1Mbps	1	19	2440	0.64	-14.45	2.70	8.00	Pass
BLE	1Mbps	1	39	2480	**0.65**	**-14.42**	2.70	8.00	Pass
BLE	2Mbps	1	0	2402	0.59	-17.07	2.70	8.00	Pass
BLE	2Mbps	1	19	2440	**0.74**	-16.92	2.70	8.00	Pass
BLE	2Mbps	1	39	2480	**0.74**	**-16.94**	2.70	8.00	Pass

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

Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

<1Mbps>

PSD 100kHz Plot on Channel 00	PSD 100kHz Plot on Channel 19
	
PSD 100kHz Plot on Channel 39	**N/A**
	

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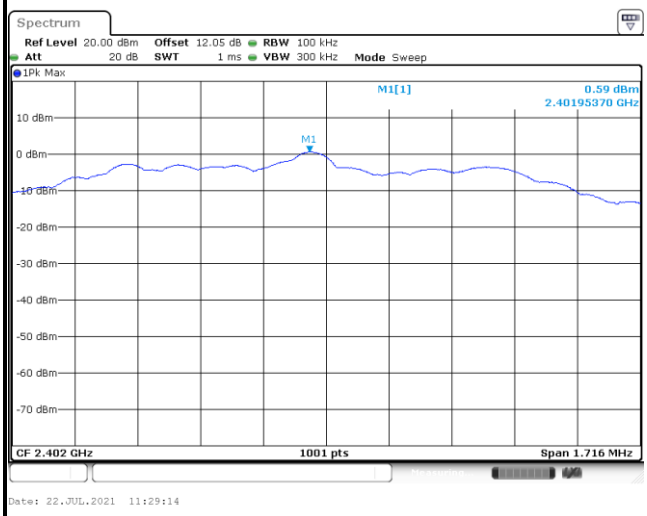
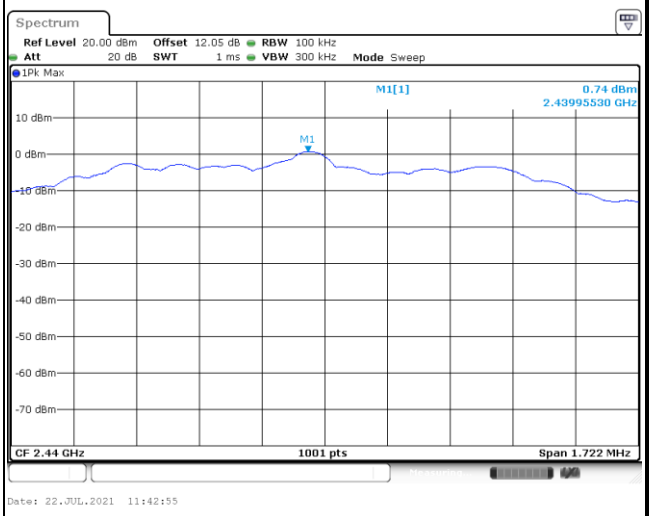
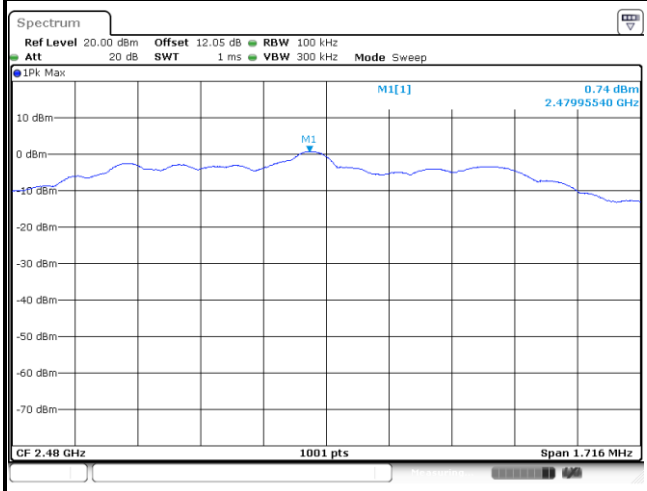
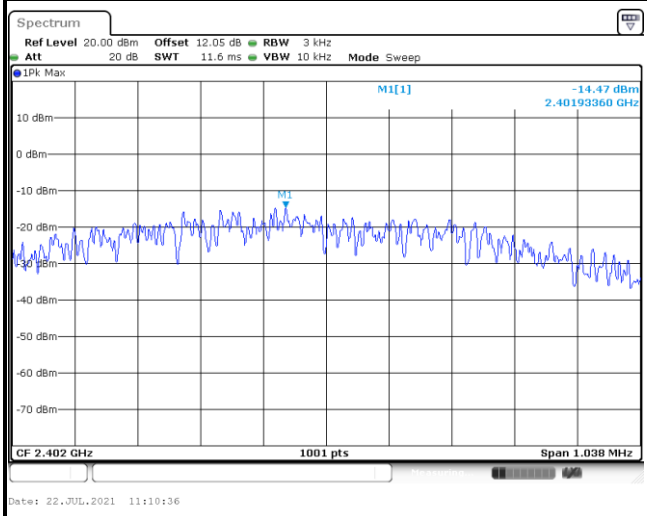
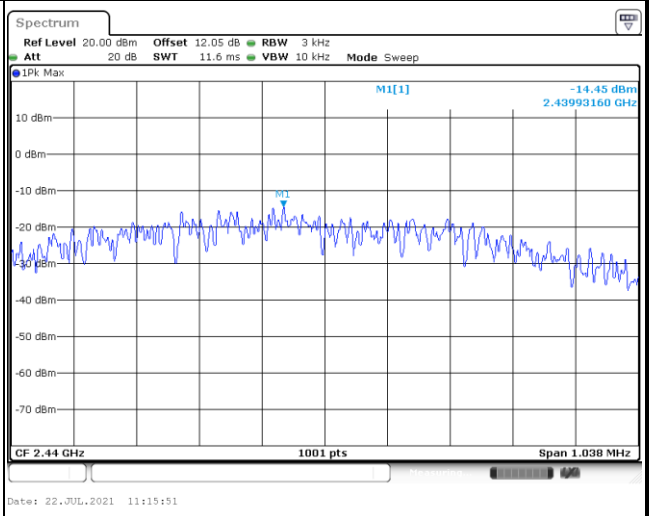
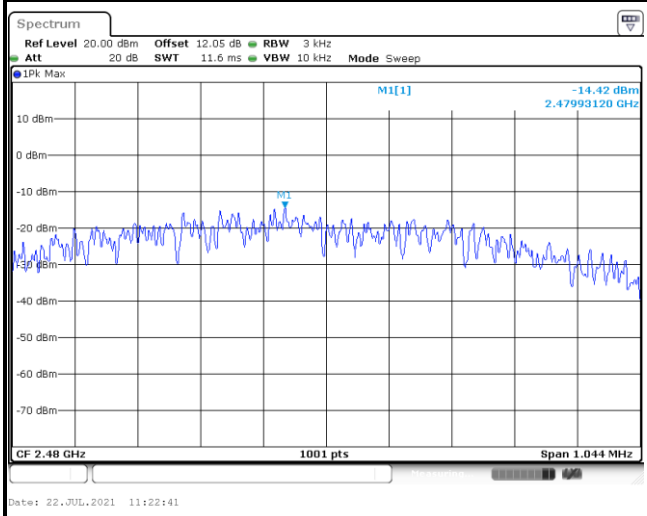
PSD 100kHz Plot on Channel 00	PSD 100kHz Plot on Channel 19
	
PSD 100kHz Plot on Channel 39	**N/A**
	

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

Test Engineer :	Jacob Yu	**Temperature :**	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

<1Mbps>

PSD 3kHz Plot on Channel 00	PSD 3kHz Plot on Channel 19
	
PSD 3kHz Plot on Channel 39	**N/A**
	

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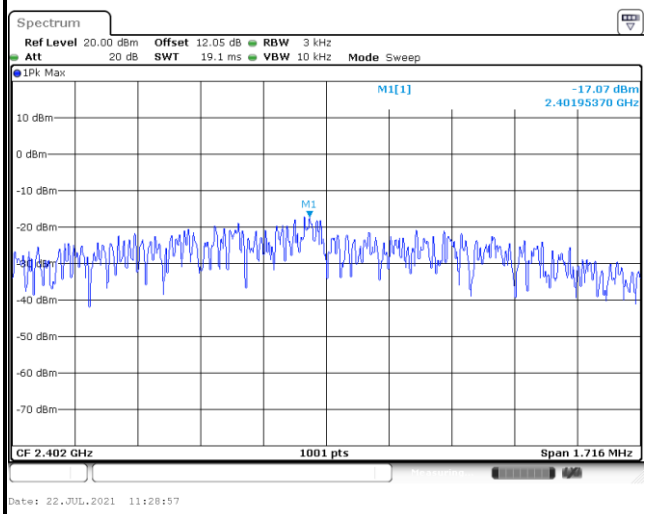
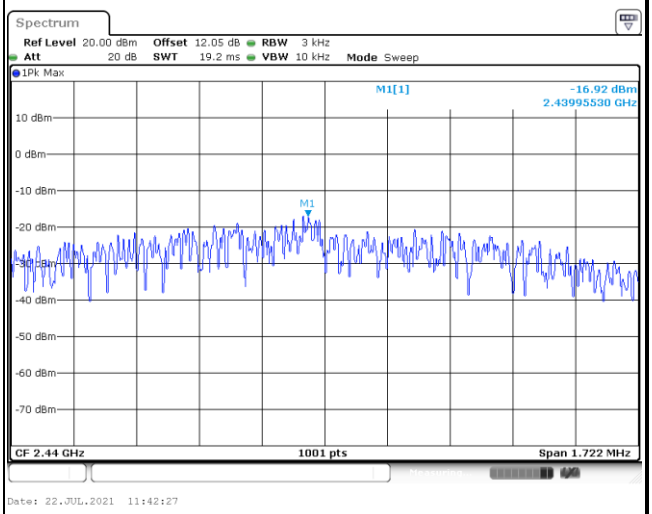
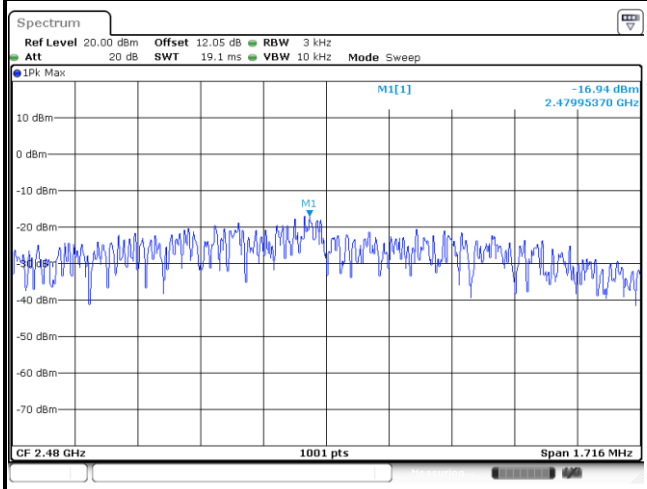
PSD 3kHz Plot on Channel 00	PSD 3kHz Plot on Channel 19
	
PSD 3kHz Plot on Channel 39	**N/A**
	

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.

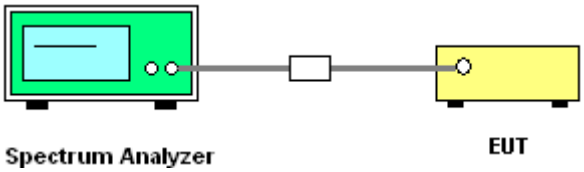
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedure

1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
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 the maximum power setting and enable the EUT to 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.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

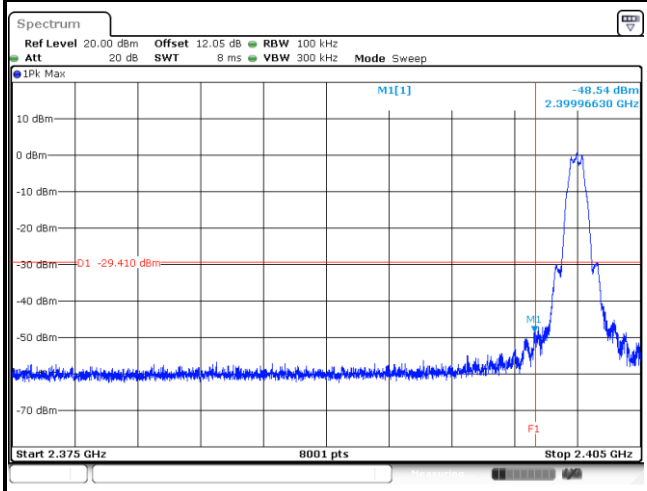
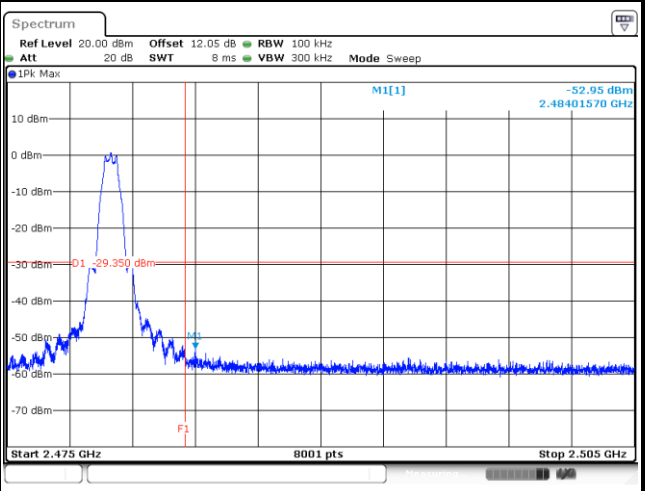
3.4.4 Test Setup



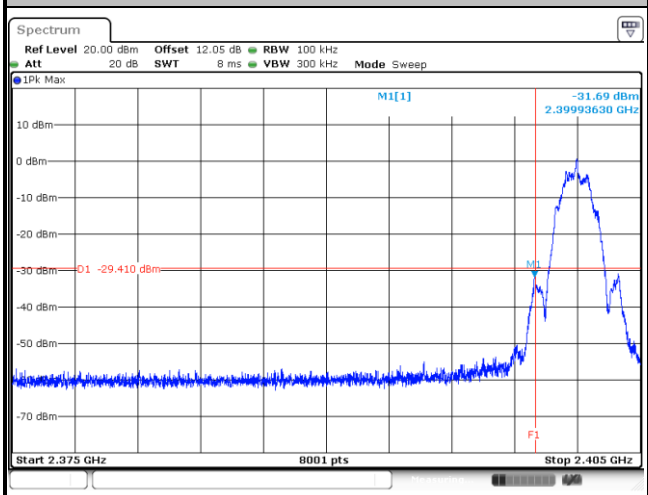
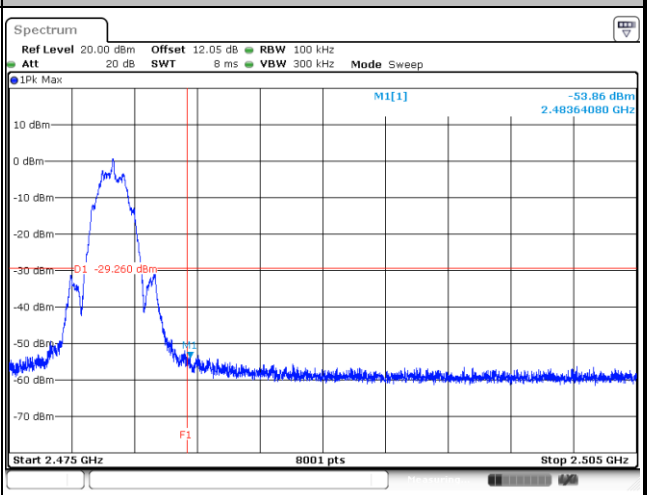
3.4.5 Test Result of Conducted Band Edges Plots

Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

<1Mbps>

Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 39
	

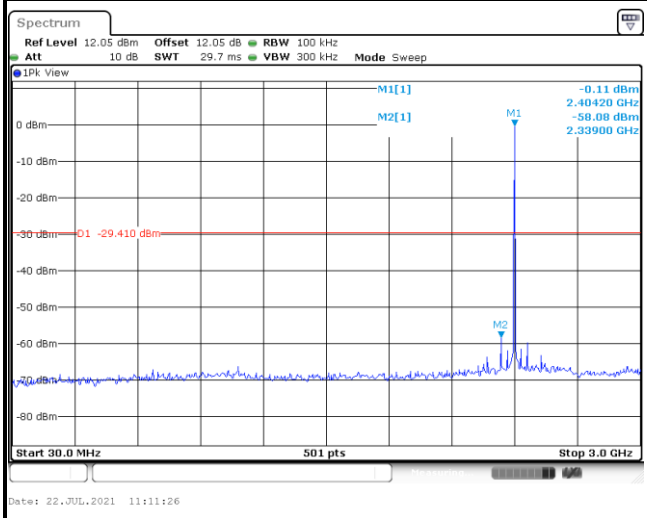
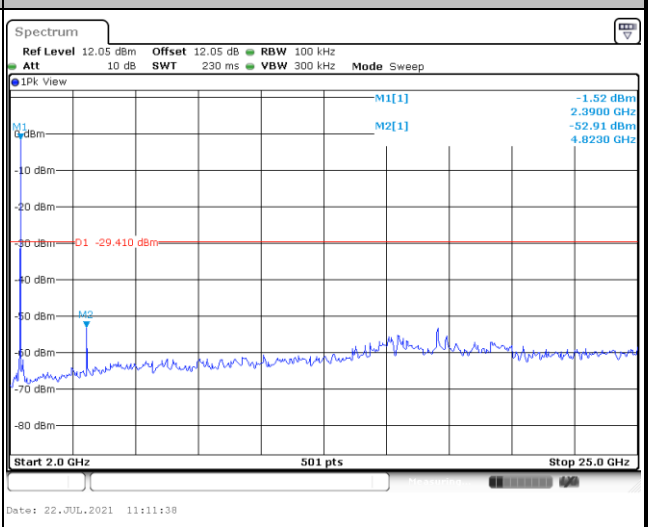
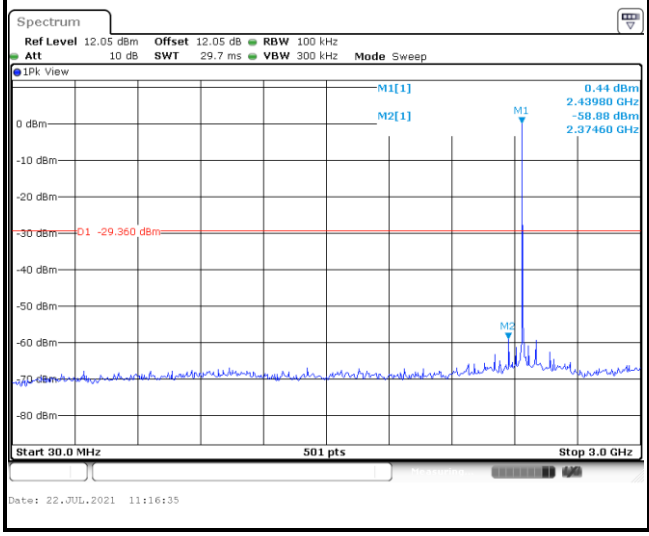
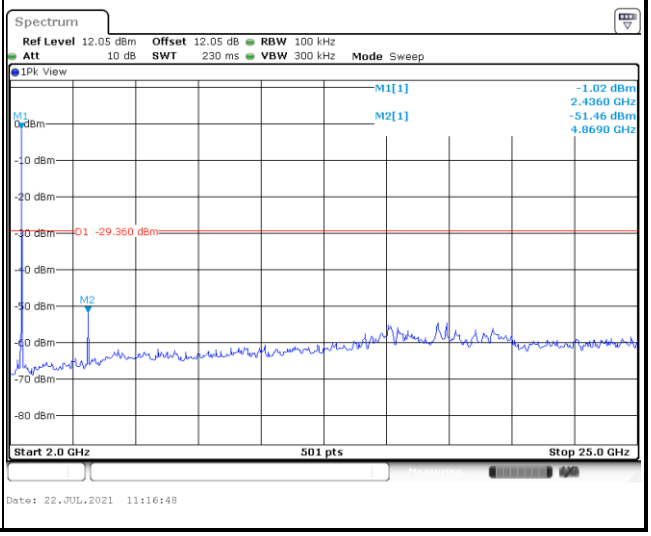
<2Mbps>

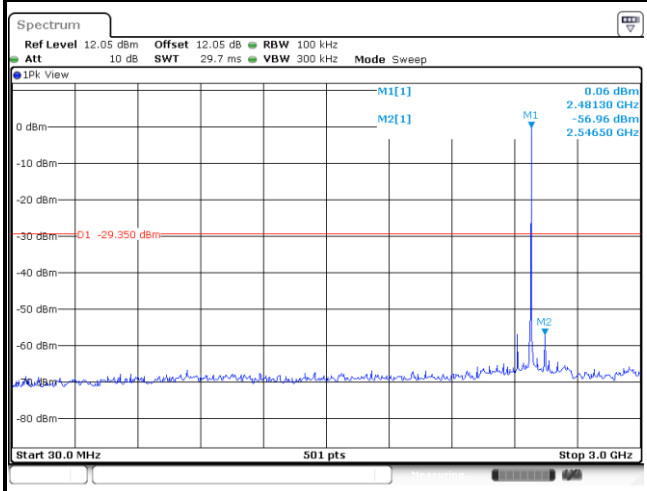
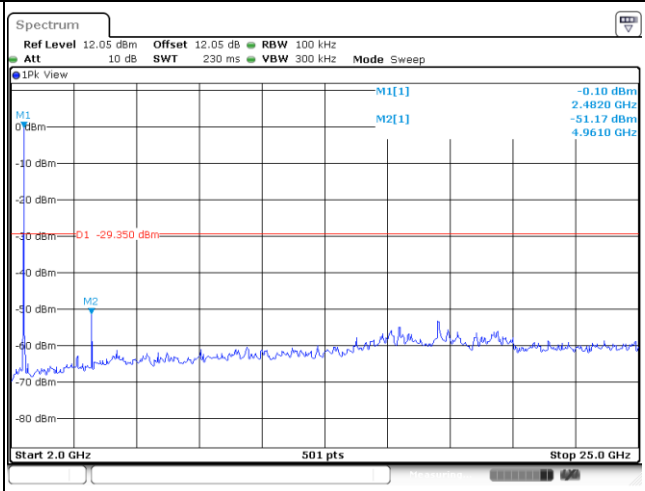
Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 39
	

3.4.6 Test Result of Conducted Spurious Emission Plots

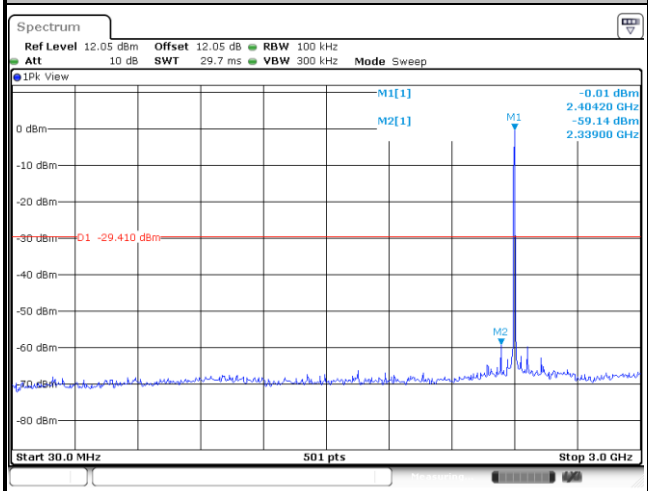
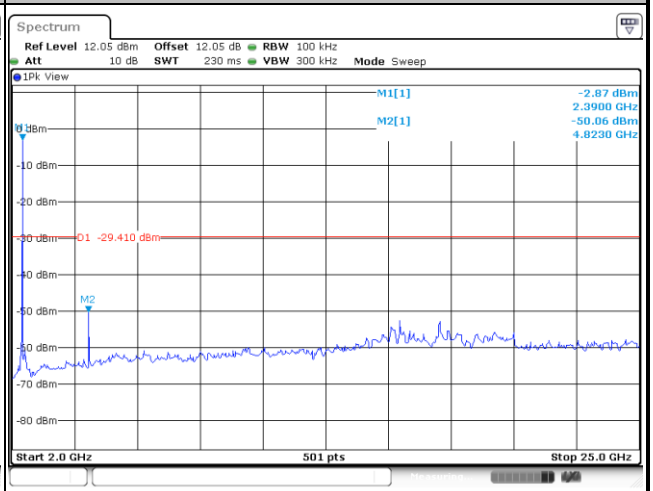
Test Engineer :	Jacob Yu	Temperature :	23.2~24.5℃
		Relative Humidity :	55.9~61.2%

<1Mbps>

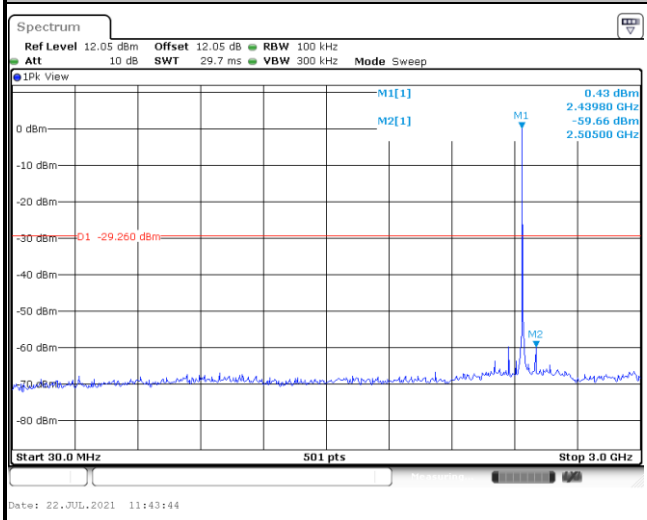
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00	Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00
	
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 19	**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 19**
	

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 39	Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 39
	

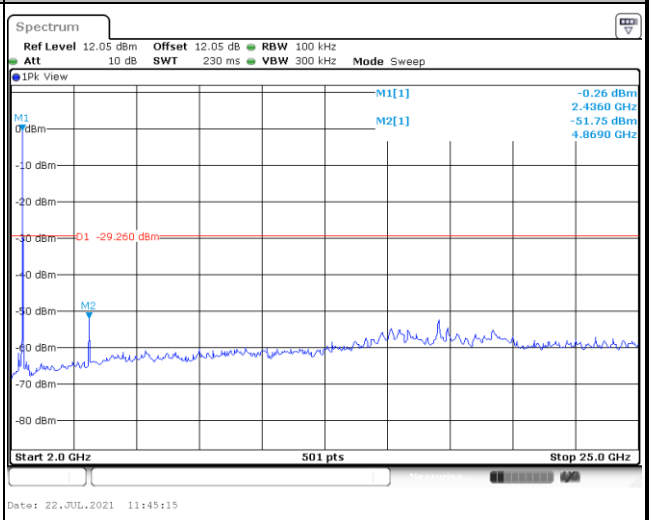
<2Mbps>

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 00	Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 00
	

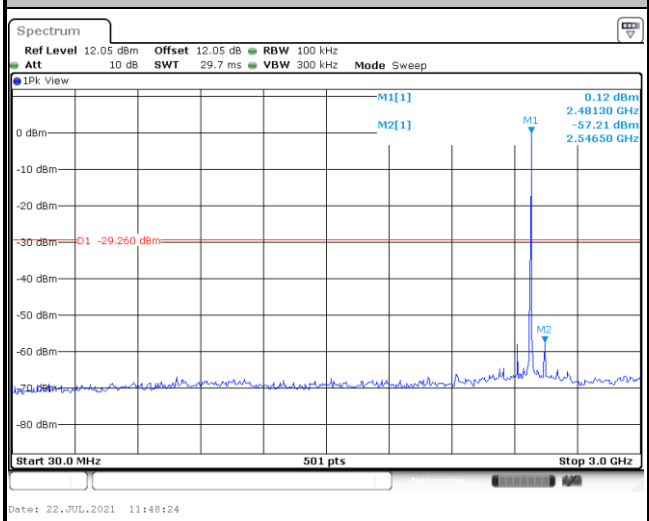
Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 19



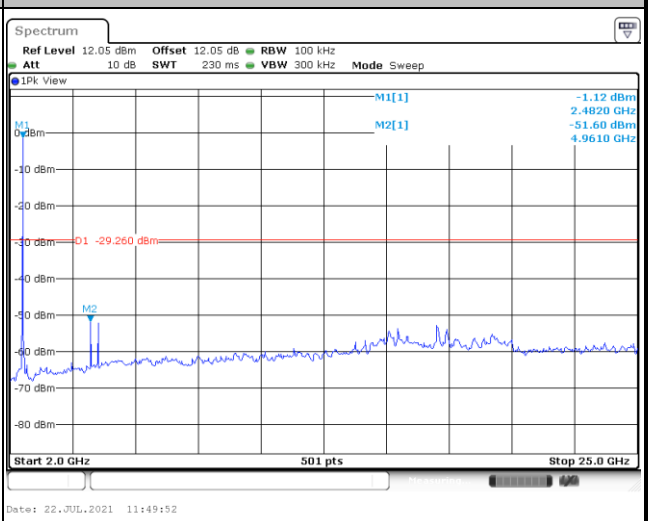
Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 19



Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 39



Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 39



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 NCC LP0002 section 3.6 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

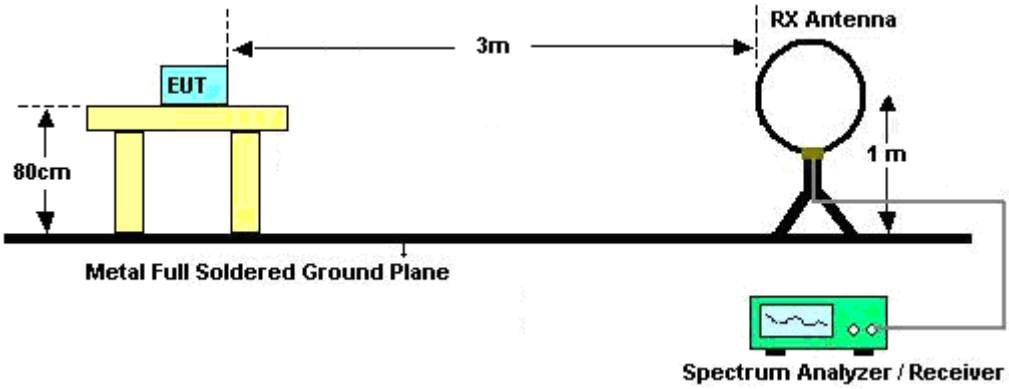
See list of measuring equipment of this test report.

3.5.3 Test Procedures

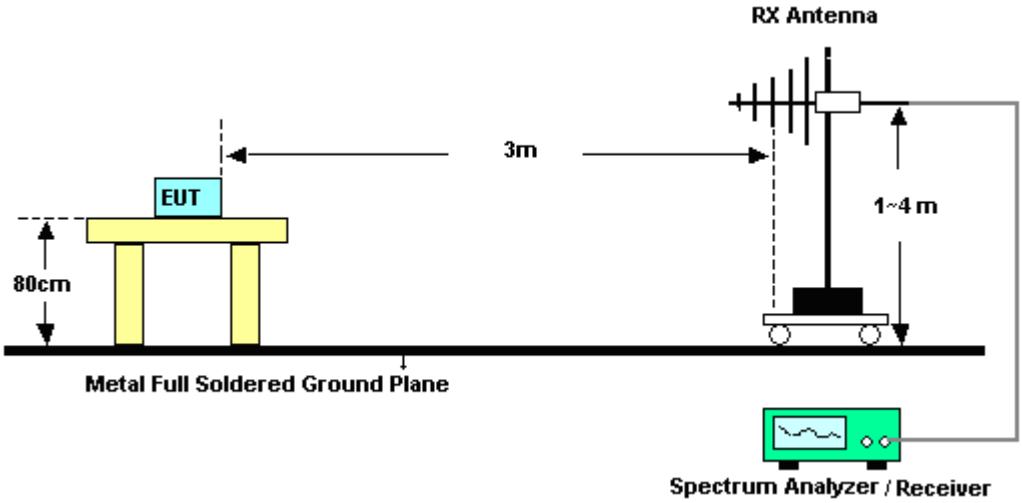
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz 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 1 GHz, 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 be reported.
7. For testing above 1 GHz, the emission level of the EUT in peak mode was 20 dB 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 be 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 = 3 MHz 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

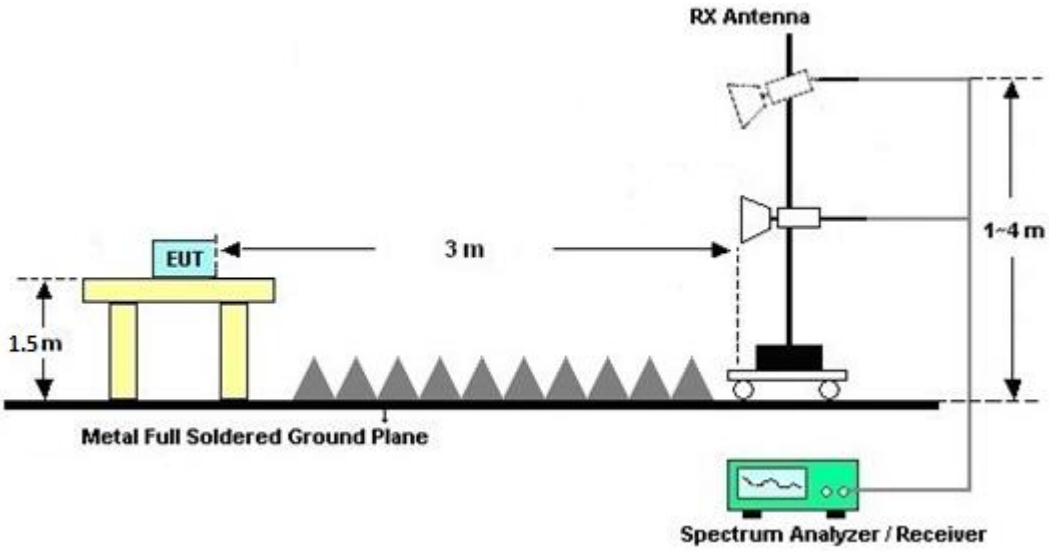
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per NCC LP0002 section 6.13 was not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, 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 (30 MHz ~ 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.

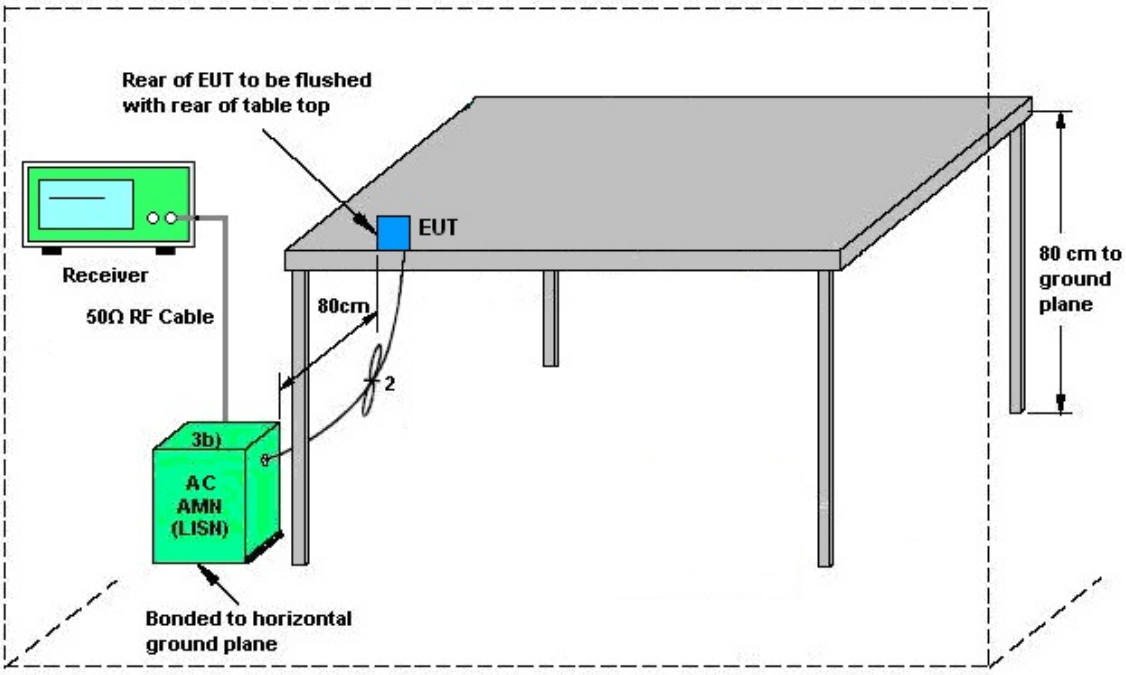
3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN shall 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

Please refer to Appendix A.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. 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 LP0002 Section 3.2, Section 4.10.1.3, and Section 4.10.1.4.

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	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Hygrometer	Testo	608-H1	34893241	N/A	Mar. 02, 2021	Jul. 22, 2021	Mar. 01, 2022	Conducted (TH05-HY)
Power Sensor	DARE	RPR3006W	16I00054SNO12	10MHz~6GHz	Dec. 16, 2020	Jul. 22, 2021	Dec. 15, 2021	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	101905	9kHz-40GHz	May 18, 2021	Jul. 22, 2021	May 17, 2022	Conducted (TH05-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2021	Jul. 22, 2021	Mar. 16, 2022	Conducted (TH05-HY)
AC Power Source	ACPOWER	AFC-11003G	F317040033	N/A	N/A	May 17, 2021	N/A	Conduction (CO07-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	May 17, 2021	N/A	Conduction (CO07-HY)
Pulse Limiter	SCHWARZBECK	VTSD 9561-F N	9561-F N00373	9kHz-200MHz	Nov. 02, 2020	May 17, 2021	Nov. 01, 2021	Conduction (CO07-HY)
RF Cable	HUBER + SUHNER	RG 214/U	1358175	9kHz~30MHz	N/A	May 17, 2021	N/A	Conduction (CO07-HY)
Two-Line V-Network	TESEQ	NNB 51	45051	N/A	Feb. 01, 2021	May 17, 2021	Jan. 31, 2022	Conduction (CO07-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102317	9kHz~3.6GHz	Sep. 11, 2020	May 17, 2021	Sep. 10, 2021	Conduction (CO07-HY)
EMI Test Receicver	Keysight	N9010B	MY60240520	10Hz~44GHz	Dec. 02, 2020	Jul. 21, 2021~ Jul. 22, 2021	Dec. 01, 2021	Radiation (03CH20-HY)
Preamplifier	COM-POWER	PAM-103	18020201	1MHz-1000MHz	Jan. 04, 2021	Jul. 21, 2021~ Jul. 22, 2021	Jan. 03, 2022	Radiation (03CH20-HY)
Amplifier	EMCI	EMC118A45SE	980792	N/A	Nov. 16, 2020	Jul. 21, 2021~ Jul. 22, 2021	Nov. 15, 2021	Radiation (03CH20-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz~40GHz	Dec. 11, 2020	Jul. 21, 2021~ Jul. 22, 2021	Dec. 10, 2021	Radiation (03CH20-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 04, 2021	Jul. 21, 2021~ Jul. 22, 2021	Jan. 03, 2022	Radiation (03CH20-HY)
Bilog Antenna	TESEQ	CBL 6111D&00802N1D01N-06	55606 & 08	30MHz~1GHz	Oct. 22, 2020	Jul. 21, 2021~ Jul. 22, 2021	Oct. 21, 2021	Radiation (03CH20-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	002360	1GHz-18GHz	Nov. 03, 2020	Jul. 21, 2021~ Jul. 22, 2021	Nov. 02, 2021	Radiation (03CH20-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA9170	009910	18GHz-40GHz	May 12, 2021	Jul. 21, 2021~ Jul. 22, 2021	May 11, 2022	Radiation (03CH20-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN27	1.53GHz Low Pass Filter	May 25, 2021	Jul. 21, 2021~ Jul. 22, 2021	May 24, 2022	Radiation (03CH20-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60ST	SN8	N/A	Mar. 26, 2021	Jul. 21, 2021~ Jul. 22, 2021	Mar. 25, 2022	Radiation (03CH20-HY)
Hygrometer	TECPEL	DTM-303B	TP200728	N/A	Mar. 09, 2021	Jul. 21, 2021~ Jul. 22, 2021	Mar. 08, 2022	Radiation (03CH20-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	519229/2,804015/2,804027/2	N/A	Jan. 20, 2021	Jul. 21, 2021~ Jul. 22, 2021	Jan. 19, 2022	Radiation (03CH20-HY)
Software	Audix	E3 6.2009-8-24	RK-002156	N/A	N/A	Jul. 21, 2021~ Jul. 22, 2021	N/A	Radiation (03CH20-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Jul. 21, 2021~ Jul. 22, 2021	N/A	Radiation (03CH20-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Jul. 21, 2021~ Jul. 22, 2021	N/A	Radiation (03CH20-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Jul. 21, 2021~ Jul. 22, 2021	N/A	Radiation (03CH20-HY)

5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.2 dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	3.9 dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.8 dB

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

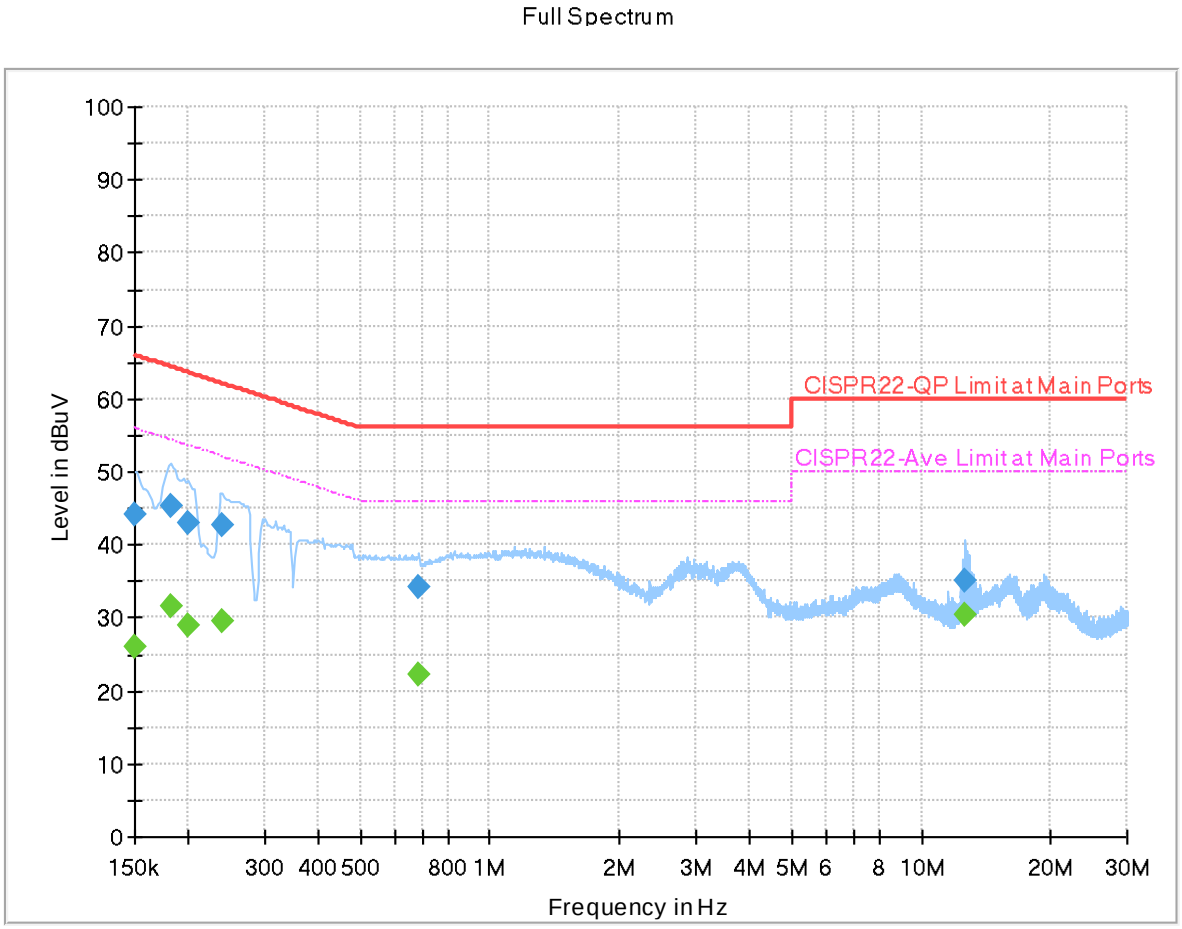
Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.5 dB

Appendix A. AC Conducted Emission Test Results

Test Engineer :	Tom Lee	**Temperature :**	23~26℃
		Relative Humidity :	40~50%

EUT Information

Report NO :	130701
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Line

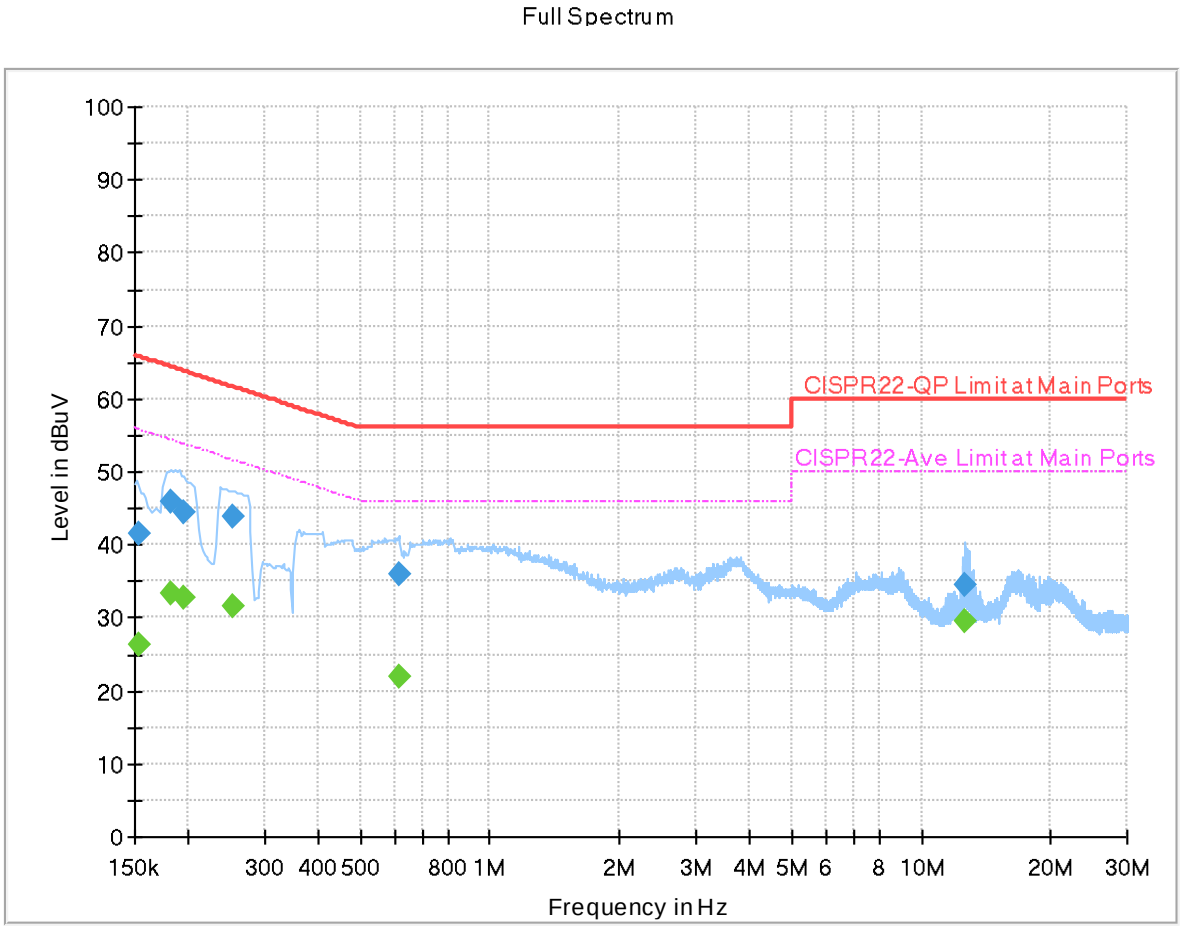


Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	---	26.15	56.00	29.85	L1	OFF	20.0
0.150000	44.19	---	66.00	21.81	L1	OFF	20.0
0.181500	---	31.55	54.42	22.87	L1	OFF	20.0
0.181500	45.25	---	64.42	19.17	L1	OFF	20.0
0.199500	---	29.03	53.63	24.60	L1	OFF	20.0
0.199500	42.95	---	63.63	20.68	L1	OFF	20.0
0.240000	---	29.66	52.10	22.44	L1	OFF	20.0
0.240000	42.81	---	62.10	19.29	L1	OFF	20.0
0.683250	---	22.21	46.00	23.79	L1	OFF	20.0
0.683250	34.33	---	56.00	21.67	L1	OFF	20.0
12.684750	---	30.47	50.00	19.53	L1	OFF	20.2
12.684750	35.14	---	60.00	24.86	L1	OFF	20.2

EUT Information

Report NO :	130701
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Neutral



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.153308	---	26.43	55.82	29.39	N	OFF	20.0
0.153308	41.42	---	65.82	24.40	N	OFF	20.0
0.181590	---	33.37	54.41	21.04	N	OFF	20.0
0.181590	45.93	---	64.41	18.48	N	OFF	20.0
0.195000	---	32.69	53.82	21.13	N	OFF	20.0
0.195000	44.50	---	63.82	19.32	N	OFF	20.0
0.253680	---	31.66	51.64	19.98	N	OFF	20.0
0.253680	44.00	---	61.64	17.64	N	OFF	20.0
0.615750	---	21.88	46.00	24.12	N	OFF	20.0
0.615750	35.93	---	56.00	20.07	N	OFF	20.0
12.684120	---	29.61	50.00	20.39	N	OFF	20.2
12.684120	34.51	---	60.00	25.49	N	OFF	20.2

Appendix B. Radiated Spurious Emission

Test Engineer :	JC Liang and Steven Wu	Temperature :	20~21°C
		Relative Humidity :	66%

<1Mbps>

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 00 2402MHz		2388.96	50.04	-23.96	74	40.55	27.26	18.42	36.19	154	304	P	H
		2370.165	40.13	-13.87	54	30.76	27.18	18.38	36.19	154	304	P	H
	*	2402	93.67	-	-	84.12	27.31	18.44	36.2	154	304	P	H
	*	2402	93.03	-	-	83.48	27.31	18.44	36.2	154	304	A	H
													H
													H
		2369.115	49.17	-24.83	74	39.8	27.18	18.38	36.19	400	251	P	V
		2361.345	39.48	-14.52	54	30.15	27.15	18.37	36.19	400	251	A	V
	*	2402	88.53	-	-	78.98	27.31	18.44	36.2	400	251	P	V
	*	2402	87.95	-	-	78.4	27.31	18.44	36.2	400	251	A	V
													V
													V
BLE CH 19 2440MHz		2359.76	48.7	-25.3	74	39.38	27.14	18.37	36.19	109	300	P	H
		2385.68	39.66	-14.34	54	30.2	27.24	18.41	36.19	109	300	A	H
	*	2440	94.51	-	-	84.75	27.46	18.51	36.21	109	300	P	H
	*	2440	93.82	-	-	84.06	27.46	18.51	36.21	109	300	A	H
		2485.12	49.63	-24.37	74	39.63	27.64	18.59	36.23	109	300	P	H
		2493.2	40.12	-13.88	54	30.08	27.67	18.6	36.23	109	300	A	H
		2369.2	48.97	-25.03	74	39.6	27.18	18.38	36.19	398	246	P	V
		2367.6	39.51	-14.49	54	30.15	27.17	18.38	36.19	398	246	A	V
	*	2440	91.02	-	-	81.26	27.46	18.51	36.21	398	246	P	V
	*	2440	90.41	-	-	80.65	27.46	18.51	36.21	398	246	A	V
		2495.52	49.4	-24.6	74	39.34	27.68	18.61	36.23	398	246	P	V
		2497.92	40.21	-13.79	54	30.14	27.69	18.61	36.23	398	246	A	V

BLE CH 39 2480MHz	*	2480	90.81	-	-	80.83	27.62	18.58	36.22	112	298	P	H
	*	2480	90.19	-	-	80.21	27.62	18.58	36.22	112	298	A	H
		2483.72	53.87	-20.13	74	43.87	27.63	18.59	36.22	112	298	P	H
		2483.56	40.95	-13.05	54	30.95	27.63	18.59	36.22	112	298	A	H
													H
													H
	*	2480	86.25	-	-	76.27	27.62	18.58	36.22	385	258	P	V
	*	2480	85.73	-	-	75.75	27.62	18.58	36.22	385	258	A	V
		2483.6	50.76	-23.24	74	40.76	27.63	18.59	36.22	385	258	P	V
		2485.4	40.15	-13.85	54	30.15	27.64	18.59	36.23	385	258	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)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 00 2402MHz		4804	52.23	-21.77	74	44.92	32.02	12.71	37.42	100	20	P	H
		4804	48.4	-5.6	54	41.09	32.02	12.71	37.42	100	20	A	H
													H
													H
		4804	44.37	-29.63	74	37.06	32.02	12.71	37.42	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	48.9	-25.1	74	41.31	32.3	12.77	37.48	100	0	P	H
		7320	55.6	-18.4	74	41.85	36.72	15.39	38.36	100	12	P	H
		7320	50.14	-3.86	54	36.39	36.72	15.39	38.36	100	12	A	H
													H
		4880	45.25	-28.75	74	37.66	32.3	12.77	37.48	100	0	P	V
		7320	52.56	-21.44	74	38.81	36.72	15.39	38.36	101	236	P	V
		7320	45.2	-8.8	54	31.45	36.72	15.39	38.36	101	236	A	V
													V
BLE CH 39 2480MHz		4965	48.06	-25.94	74	40.03	32.76	12.82	37.55	100	0	P	H
		7440	55.42	-18.58	74	42.19	36.32	15.36	38.45	101	16	P	H
		7440	49.7	-4.3	54	36.47	36.32	15.36	38.45	101	16	A	H
													H
		4960	46.25	-27.75	74	38.24	32.74	12.82	37.55	100	0	P	V
		7440	52.81	-21.19	74	39.58	36.32	15.36	38.45	100	110	P	V
		7440	46.78	-7.22	54	33.55	36.32	15.36	38.45	100	110	A	V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

<2Mbps>

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path 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		2355.15	49.19	-24.81	74	39.89	27.12	18.36	36.18	153	309	P	H
		2363.34	41.27	-12.73	54	31.94	27.15	18.37	36.19	153	309	A	H
	*	2402	94.39	-	-	84.84	27.31	18.44	36.2	153	309	P	H
	*	2402	93.13	-	-	83.58	27.31	18.44	36.2	153	309	A	H
													H
													H
		2368.695	48.92	-25.08	74	39.56	27.17	18.38	36.19	400	242	P	V
		2373.735	41.16	-12.84	54	31.77	27.19	18.39	36.19	400	242	A	V
	*	2402	89.71	-	-	80.16	27.31	18.44	36.2	400	242	P	V
	*	2402	88.33	-	-	78.78	27.31	18.44	36.2	400	242	A	V
													V
													V
BLE CH 19 2440MHz		2379.16	49.26	-24.74	74	39.83	27.22	18.4	36.19	100	298	P	H
		2368.52	41.48	-12.52	54	32.12	27.17	18.38	36.19	100	298	A	H
	*	2440	91.13	-	-	81.37	27.46	18.51	36.21	100	298	P	H
	*	2440	88.85	-	-	79.09	27.46	18.51	36.21	100	298	A	H
		2485.79	49.25	-24.75	74	39.25	27.64	18.59	36.23	100	298	P	H
		2493.42	41.72	-12.28	54	31.68	27.67	18.6	36.23	100	298	A	H
		2364.04	49.44	-24.56	74	40.1	27.16	18.37	36.19	398	255	P	V
		2335.76	41.13	-12.87	54	31.92	27.07	18.32	36.18	398	255	A	V
	*	2440	86.13	-	-	76.37	27.46	18.51	36.21	398	255	P	V
	*	2440	84.67	-	-	74.91	27.46	18.51	36.21	398	255	A	V
		2485.16	49.19	-24.81	74	39.19	27.64	18.59	36.23	398	255	P	V
		2492.23	41.69	-12.31	54	31.65	27.67	18.6	36.23	398	255	A	V

BLE CH 39 2480MHz	*	2480	92.07	-	-	82.09	27.62	18.58	36.22	115	292	P	H
	*	2480	90.94	-	-	80.96	27.62	18.58	36.22	115	292	A	H
		2483.52	55.62	-18.38	74	45.62	27.63	18.59	36.22	115	292	P	H
		2483.52	44.01	-9.99	54	34.01	27.63	18.59	36.22	115	292	A	H
													H
													H
	*	2480	87.65	-	-	77.67	27.62	18.58	36.22	380	247	P	V
	*	2480	86.54	-	-	76.56	27.62	18.58	36.22	380	247	A	V
		2484.04	51.81	-22.19	74	41.8	27.64	18.59	36.22	380	247	P	V
		2494.36	42.06	-11.94	54	32	27.68	18.61	36.23	380	247	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)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 00 2402MHz		4804	48.83	-25.17	74	41.52	32.02	12.71	37.42	100	0	P	H
													H
													H
													H
		4804	43.5	-30.5	74	36.19	32.02	12.71	37.42	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	46.9	-27.1	74	39.31	32.3	12.77	37.48	100	0	P	H
		7320	55.57	-18.43	74	41.82	36.72	15.39	38.36	100	18	P	H
		7320	50.42	-3.58	54	36.67	36.72	15.39	38.36	100	18	A	H
													H
		4880	43.27	-30.73	74	35.68	32.3	12.77	37.48	100	0	P	V
		7320	53.63	-20.37	74	39.88	36.72	15.39	38.36	101	237	P	V
		7320	48.28	-5.72	54	34.53	36.72	15.39	38.36	101	237	A	V
													V
BLE CH 39 2480MHz		4960	45.35	-28.65	74	37.34	32.74	12.82	37.55	100	0	P	H
		7440	54.46	-19.54	74	41.23	36.32	15.36	38.45	100	15	P	H
		7440	49.74	-4.26	54	36.51	36.32	15.36	38.45	100	15	A	H
													H
		4960	42.71	-31.29	74	34.7	32.74	12.82	37.55	100	0	P	V
		7440	52.94	-21.06	74	39.71	36.32	15.36	38.45	100	235	P	V
		7440	47.7	-6.3	54	34.47	36.32	15.36	38.45	100	235	A	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	Path	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		71.71	27.4	-12.6	40	49.2	12.45	1.44	35.69	-	-	P	H
		117.3	31.48	-12.02	43.5	47.68	17.54	1.88	35.62	-	-	P	H
		263.77	21.24	-24.76	46	33.59	20.15	2.83	35.33	-	-	P	H
		481.05	31.43	-14.57	46	38.56	23.77	3.88	34.78	-	-	P	H
		774.96	32.22	-13.78	46	32.96	28.12	4.94	33.8	-	-	P	H
		959.26	36.03	-9.97	46	32.39	31.1	5.65	33.11	100	0	P	H
													H
													H
													H
													H
													H
													H
		71.71	30.43	-9.57	40	52.23	12.45	1.44	35.69	100	0	P	V
		117.3	32.43	-11.07	43.5	48.63	17.54	1.88	35.62	-	-	P	V
		328.76	21.59	-24.41	46	33.81	19.79	3.16	35.17	-	-	P	V
		481.05	32.36	-13.64	46	39.49	23.77	3.88	34.78	-	-	P	V
		847.71	32.25	-13.75	46	31.55	28.98	5.26	33.54	-	-	P	V
		954.41	35.58	-10.42	46	32.12	30.97	5.62	33.13	-	-	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:

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	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		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. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path 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) + Path 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 Plots

Test Engineer :	JC Liang and Steven Wu	**Temperature :**	20~21°C
		Relative Humidity :	66%

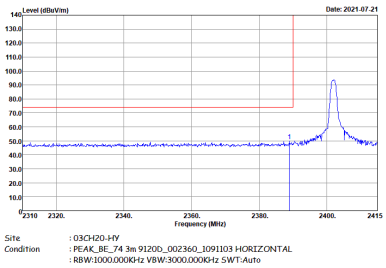
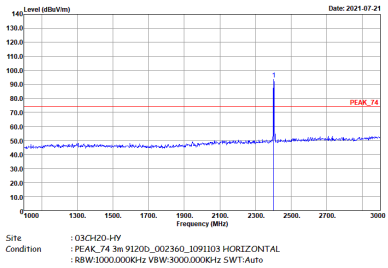
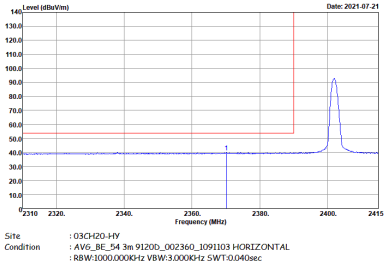
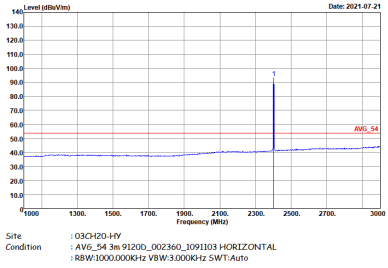
Note symbol

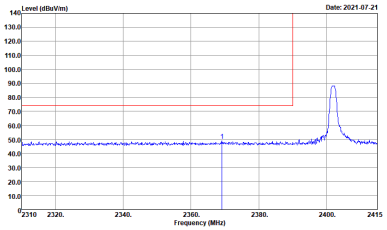
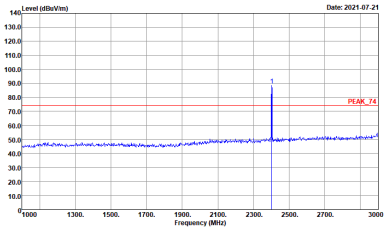
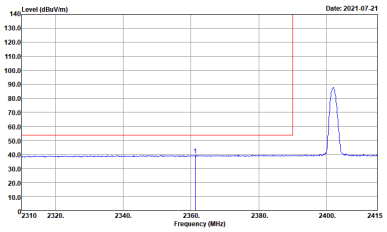
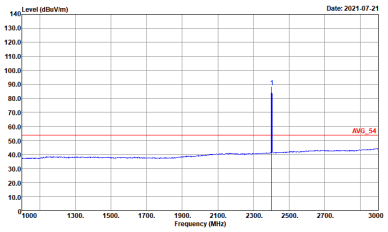
-L	**Low channel location**
-R	**High channel location**

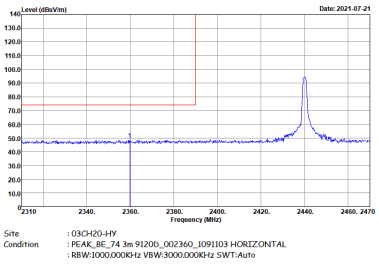
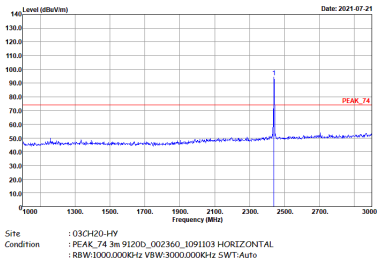
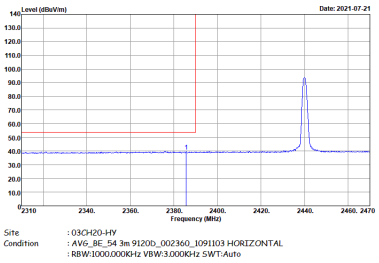
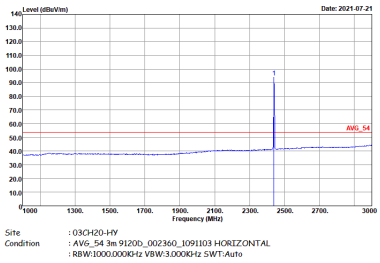
<1Mbps>

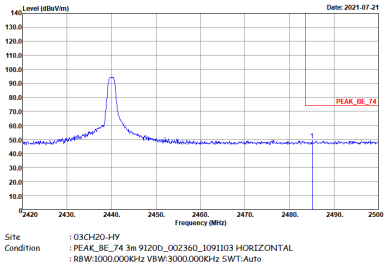
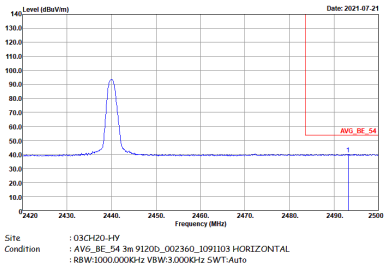
2.4GHz 2400~2483.5MHz

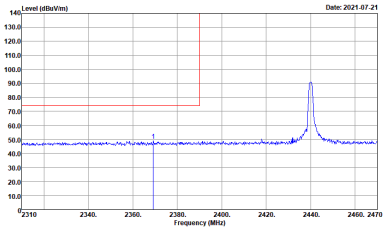
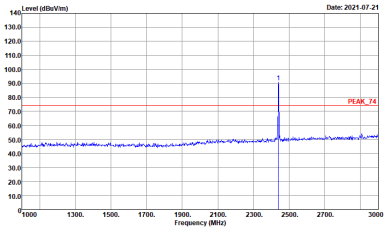
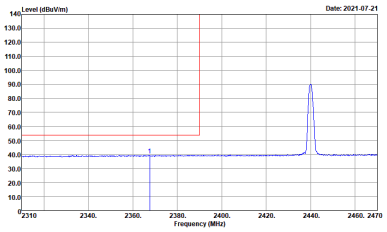
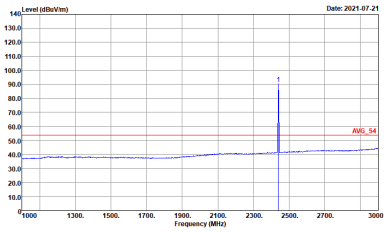
BLE (Band Edge @ 3m)

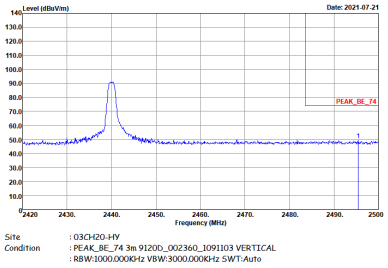
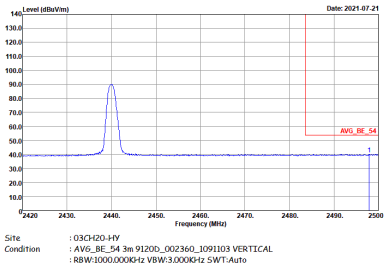
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak		
Avg.		

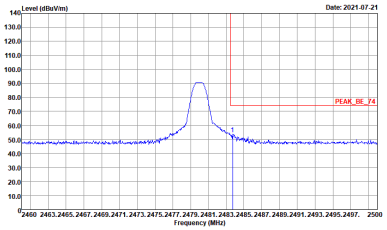
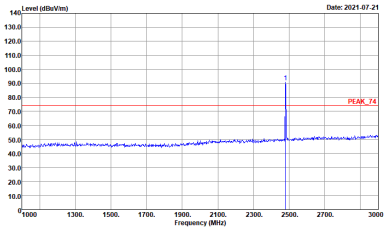
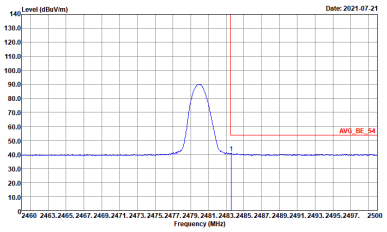
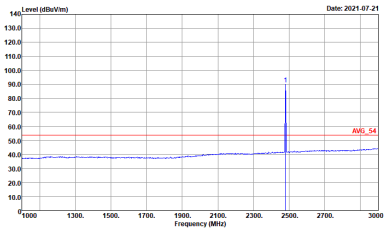
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto

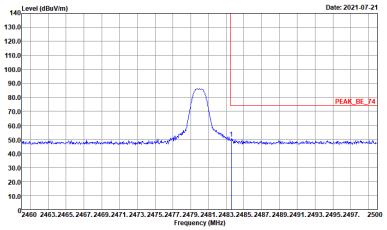
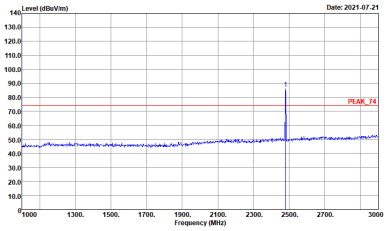
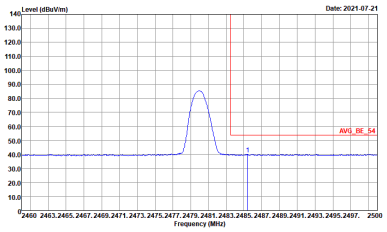
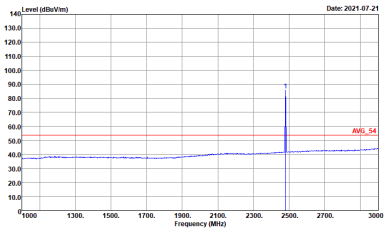
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak		
Avg.		

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

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto

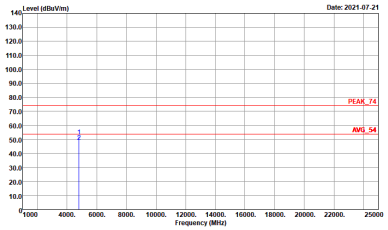
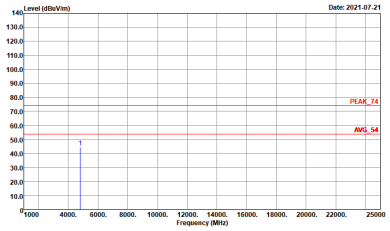
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

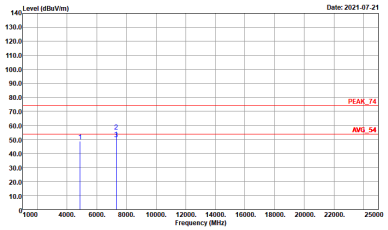
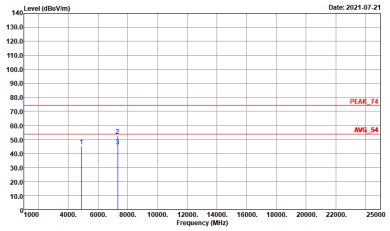
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto

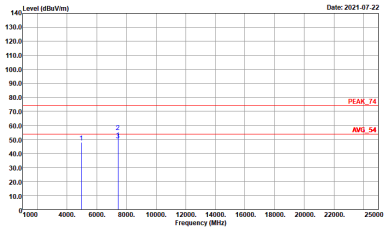
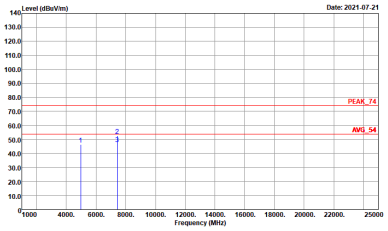
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

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

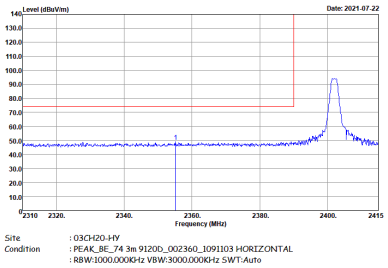
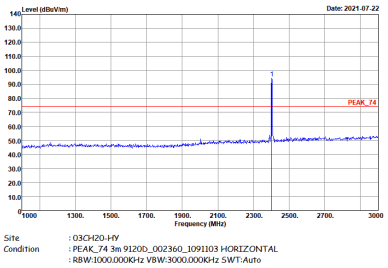
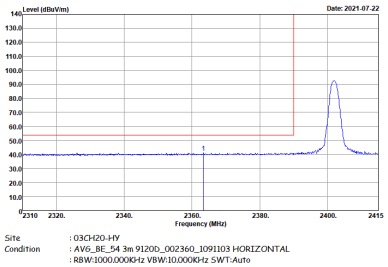
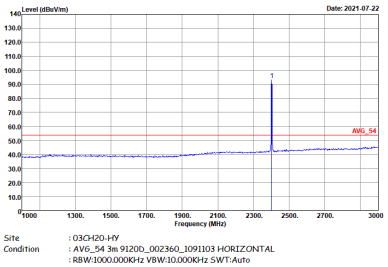
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH19 2440MHz	
	Horizontal	Vertical
Peak Avg.		

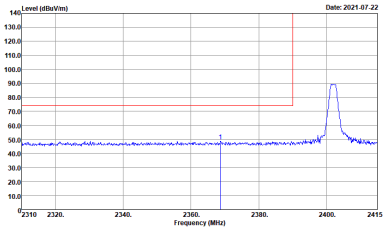
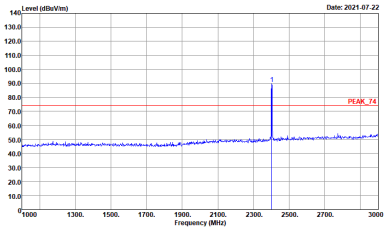
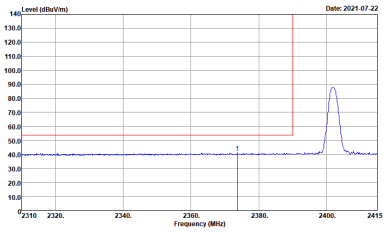
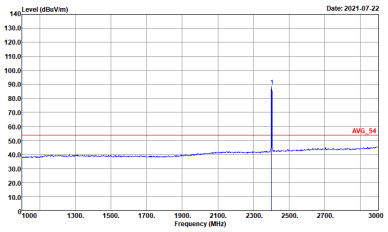
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Vertical
Peak	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 HORIZONTAL Detector : Peak	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL Detector : Peak

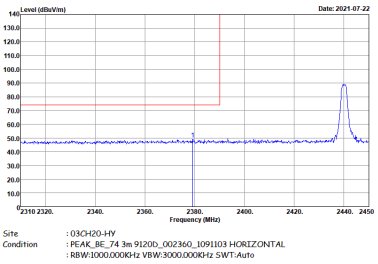
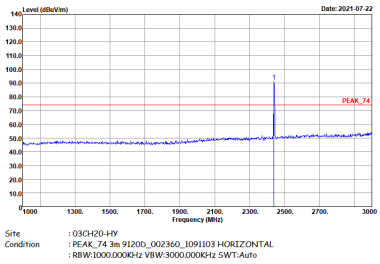
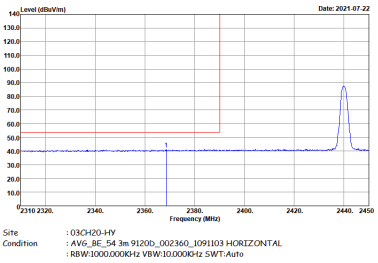
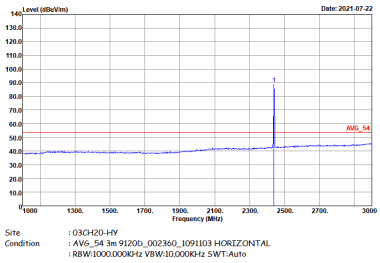
<2Mbps>

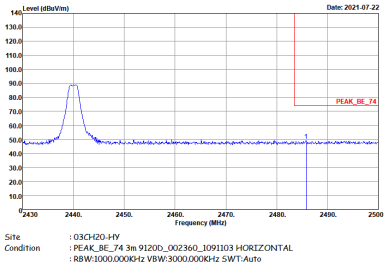
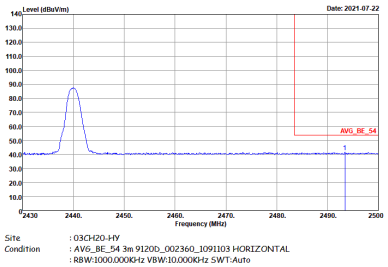
2.4GHz 2400~2483.5MHz

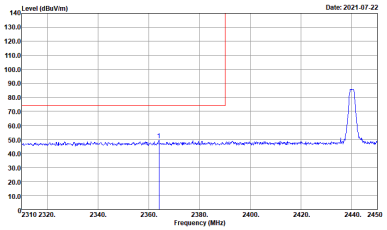
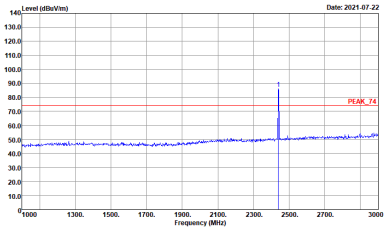
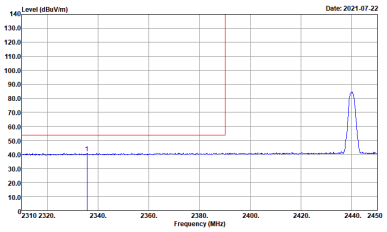
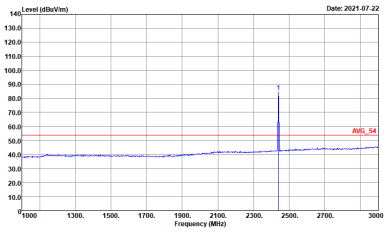
BLE (Band Edge @ 3m)

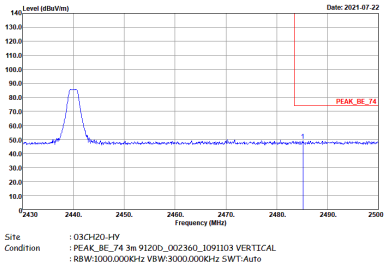
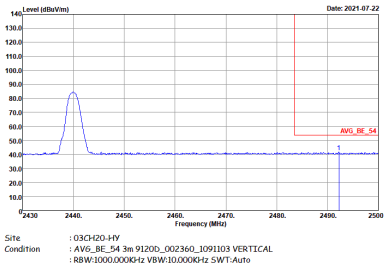
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak		
Avg.		

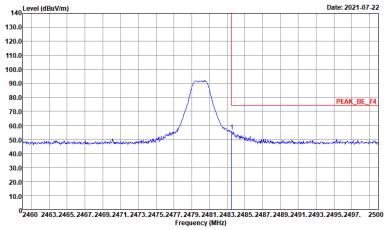
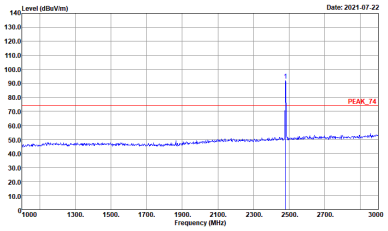
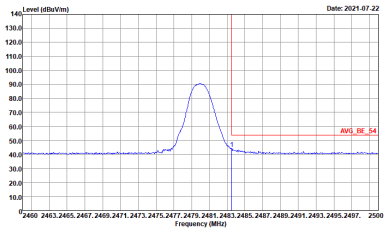
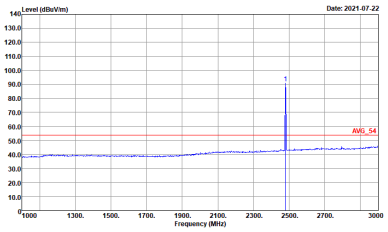
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto

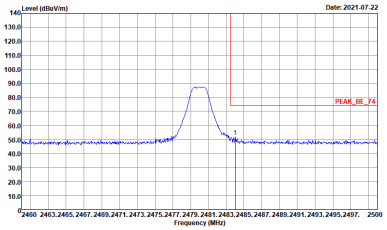
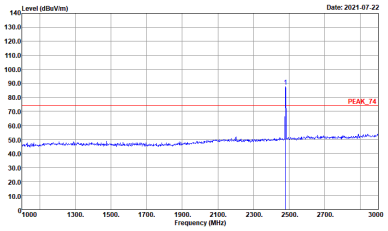
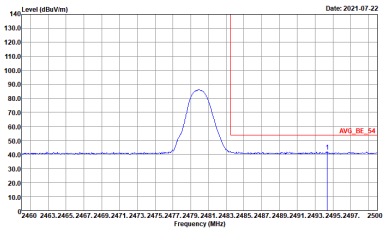
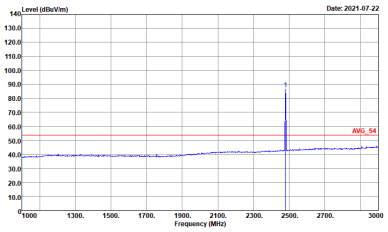
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak		
Avg.		

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

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto

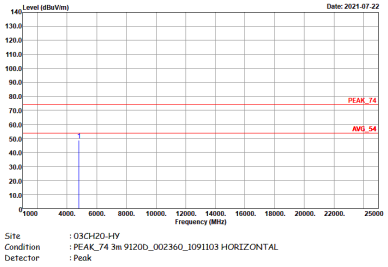
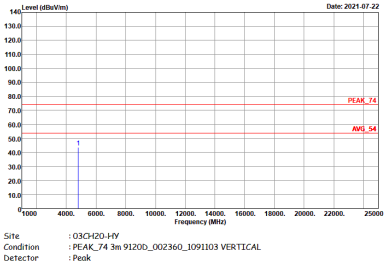
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

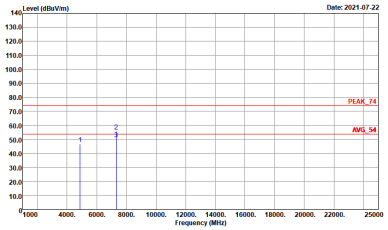
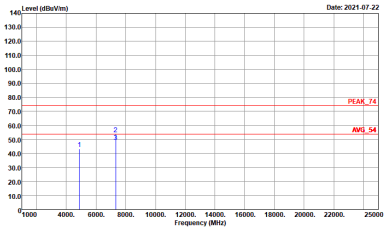
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 HORIZONTAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto

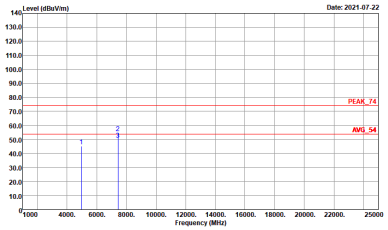
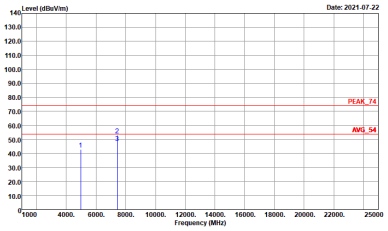
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak	 Site : 03CH20-HY Condition : PEAK_BE_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH20-HY Condition : AV6_BE_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto	 Site : 03CH20-HY Condition : AV6_54 3m 9120D_002360_1091103 VERTICAL : RBW:1000.000KHz VBW:10.000KHz SWT:Auto

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

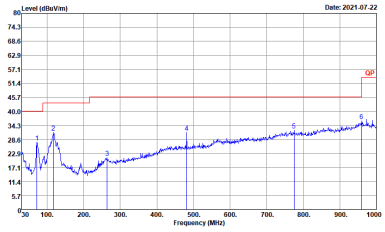
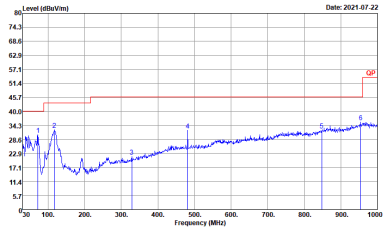
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.		

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

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Vertical
Peak	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 HORIZONTAL Detector : Peak	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL Detector : Peak

Emission below 1GHz

2.4GHz BLE (LF)

BLE	2.4GHz 2400~2483.5MHz	
	BLE LF	
	Horizontal	Vertical
QP / Peak	 Site : 03CH20-HY Condition : QP 3m LF_55606&08_1091022 HORIZONTAL Detector : Peak	 Site : 03CH20-HY Condition : QP 3m LF_55606&08_1091022 VERTICAL Detector : Peak

Annex. A Receiver Radiated Emission Measurement

A.1 Limit of Receiver Radiated Emission

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

A.2 Measuring Instruments

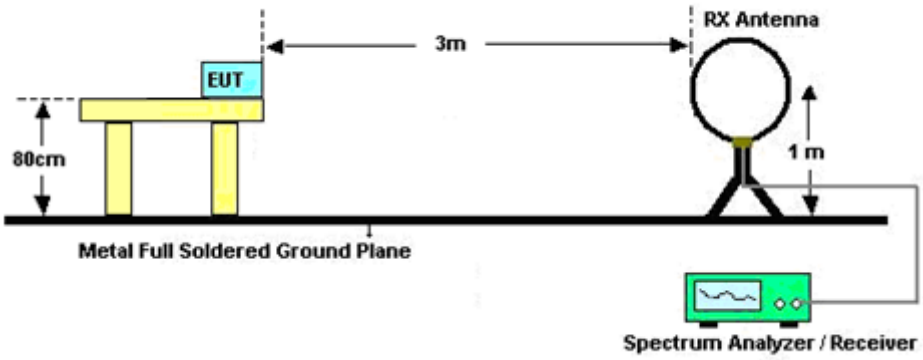
See list of measuring equipment of this test report.

A.3 Test Procedures

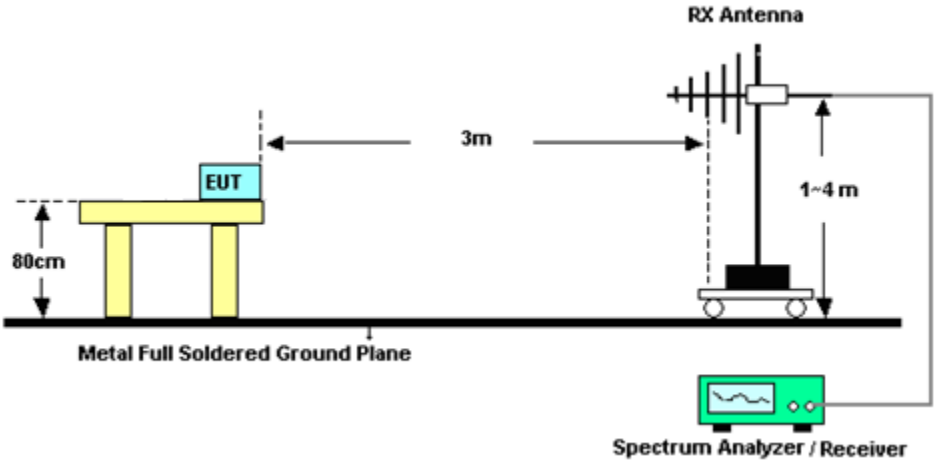
1. The EUT was placed on a turntable with 0.8 meter above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. The table was rotated 360 degrees to determine the position of the highest radiation.
4. The antenna is a Bi-Log antenna and its height is adjusted between one to four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode (RBW=120kHz/VBW=300kHz for frequency below 1GHz; RBW=1MHz VBW=3MHz (Peak), RBW=1MHz/VBW=10Hz (Average) for frequency above 1GHz).
7. If the emission level of the EUT in peak mode was 3 dB lower than the limit specified, peak values of EUT will be reported. Otherwise, the emission will be repeated by using the quasi-peak method and reported.
8. Emission level (dBμV/m) = 20 log Emission level (μV/m)
9. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

A.4 Test Setup

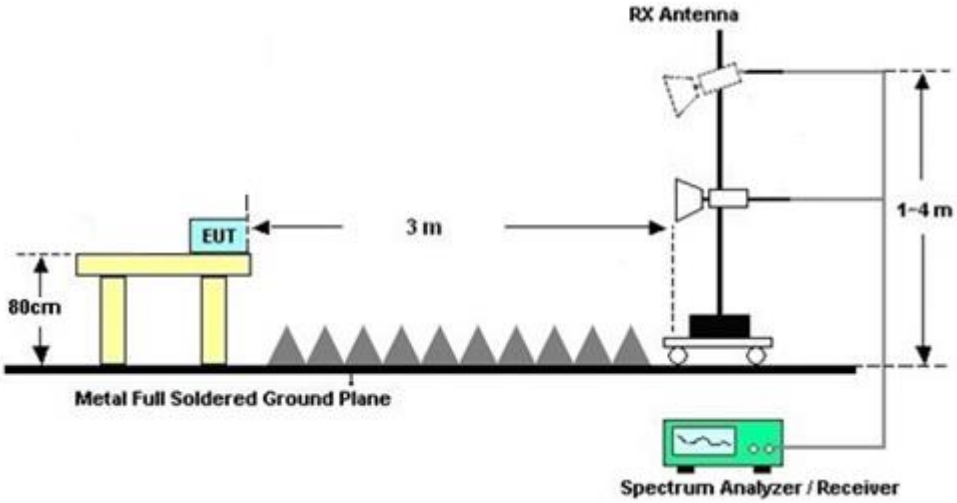
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz

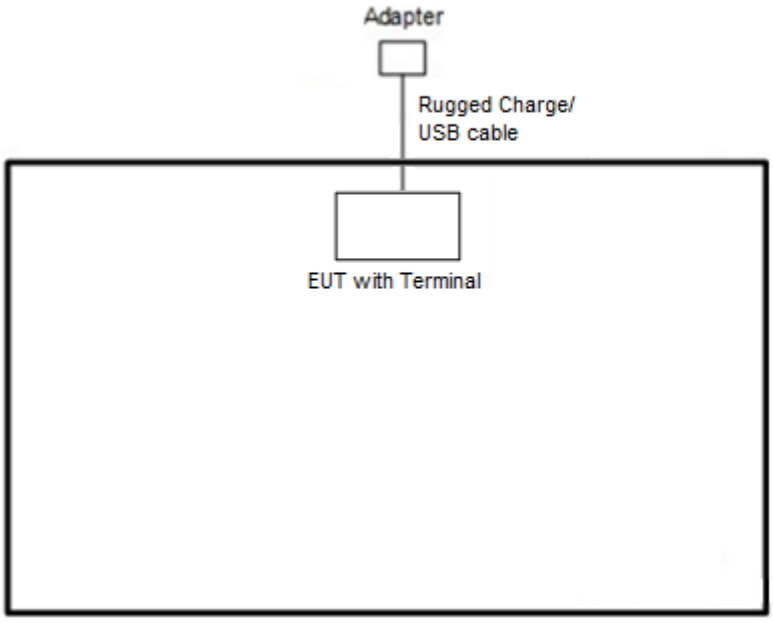


A.5 Test Result of Receiver Radiated Spurious Emissions (9kHz ~ 30MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per NCC LP0002 section 6.13 was not reported.

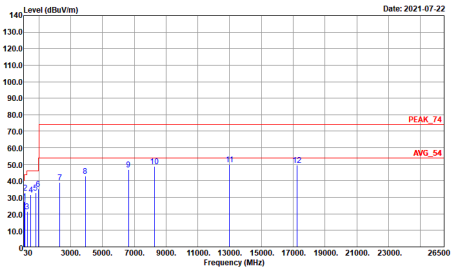
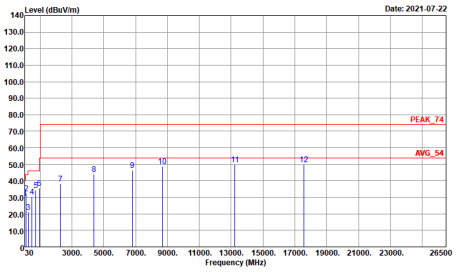
There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

A.6 Connection Diagram of Test System



A.7 Test Result of Receiver Radiated Spurious Emission (30MHz ~ 5th Harmonic)

Test Engineer :	JC Liang and Steven Wu	**Temperature :**	20~21°C
		Relative Humidity :	66%
Frequency :	37.760 MHz	**Margin :**	Under 10.23 dB
Test Mode :	Bluetooth - LE Idle		

	Idle Mode	
	Horizontal	**Vertical**
Peak **Avg.**	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 HORIZONTAL Detector : Peak Project : 130701	 Site : 03CH20-HY Condition : PEAK_74 3m 9120D_002360_1091103 VERTICAL Detector : Peak Project : 130701

Horizontal:

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	71.71	27.41	-12.59	40.00	49.21	12.45	1.40	35.69	---	---	Peak
2	122.15	32.60	-10.90	43.50	48.75	17.54	1.85	35.61	100	0	Peak
3	264.74	21.34	-24.66	46.00	33.67	20.16	2.76	35.33	---	---	Peak
4	481.05	31.53	-14.47	46.00	38.66	23.77	3.75	34.78	---	---	Peak
5	784.66	32.87	-13.13	46.00	33.51	28.14	4.76	33.77	---	---	Peak
6	959.26	35.07	-10.93	46.00	31.43	31.10	5.26	33.11	---	---	Peak
7	2314.00	38.88	-35.12	74.00	39.77	27.03	8.25	36.17	---	---	Peak
8	3922.00	42.76	-31.24	74.00	37.77	30.80	11.23	37.04	---	---	Peak
9	6628.00	46.97	-27.03	74.00	35.15	35.51	14.26	37.95	---	---	Peak
10	8265.00	48.61	-25.39	74.00	35.45	37.03	15.33	39.20	---	---	Peak
11	12995.00	49.96	-24.04	74.00	33.18	39.59	20.06	42.87	100	0	Peak
12	17263.00	49.35	-24.65	74.00	31.98	38.24	23.68	44.55	---	---	Peak

Vertical:

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	37.76	29.77	-10.23	40.00	43.87	20.54	1.06	35.72	100	0	Peak
2	118.27	32.47	-11.03	43.50	48.63	17.57	1.82	35.62	---	---	Peak
3	262.80	21.14	-24.86	46.00	33.51	20.14	2.75	35.34	---	---	Peak
4	481.05	30.36	-15.64	46.00	37.49	23.77	3.75	34.78	---	---	Peak
5	739.07	34.28	-11.72	46.00	35.39	28.03	4.62	33.93	---	---	Peak
6	957.32	35.32	-10.68	46.00	31.75	31.06	5.25	33.12	---	---	Peak
7	2272.00	38.17	-35.83	74.00	39.16	27.00	8.17	36.16	---	---	Peak
8	4390.00	44.03	-29.97	74.00	37.62	31.38	12.18	37.15	---	---	Peak
9	6802.00	46.24	-27.76	74.00	34.14	35.70	14.42	38.02	---	---	Peak
10	8661.00	48.90	-25.10	74.00	34.87	37.82	15.85	39.64	---	---	Peak
11	13226.00	49.79	-24.21	74.00	32.90	39.45	20.41	42.97	---	---	Peak
12	17571.00	49.98	-24.02	74.00	31.96	39.08	23.77	44.83	100	0	Peak

<Receiver Radiated Emission>

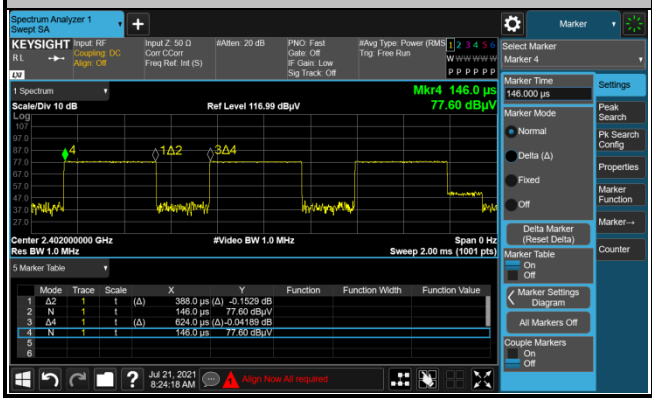
LF

HF

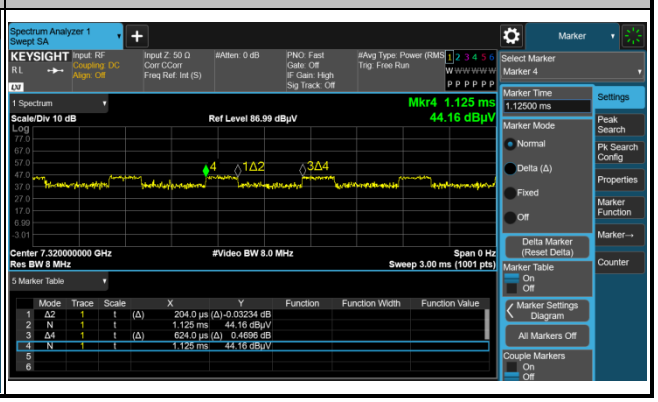
Appendix D. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth - LE for 1Mbps	62.18	388	2.58	3kHz
Bluetooth - LE for 2Mbps	32.69	204	4.90	10kHz

Bluetooth - LE for 1Mbps



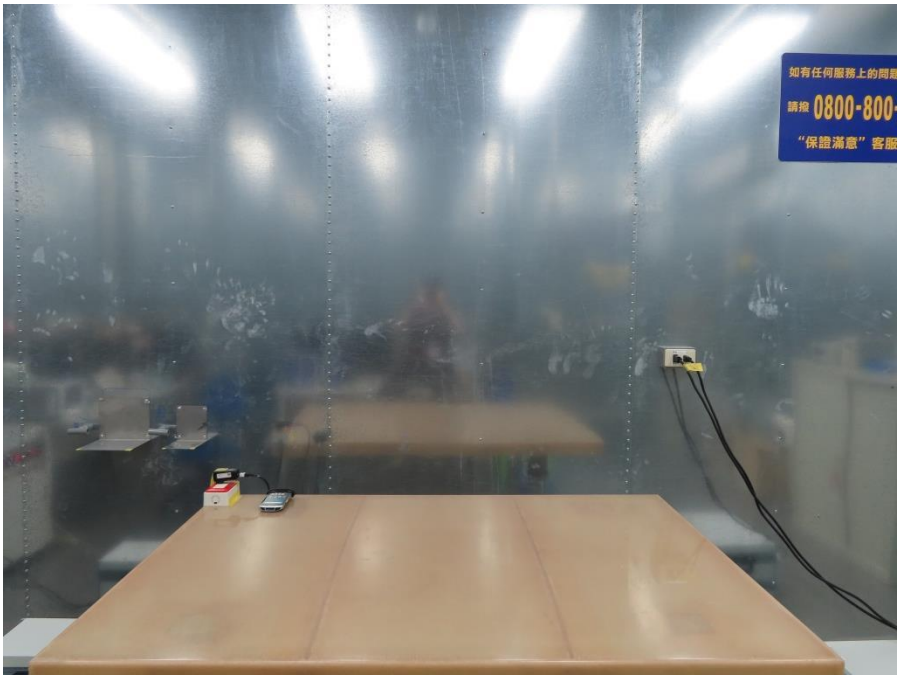
Bluetooth - LE for 2Mbps



Appendix E. Setup Photographs

<Conducted Emission>

Remote View

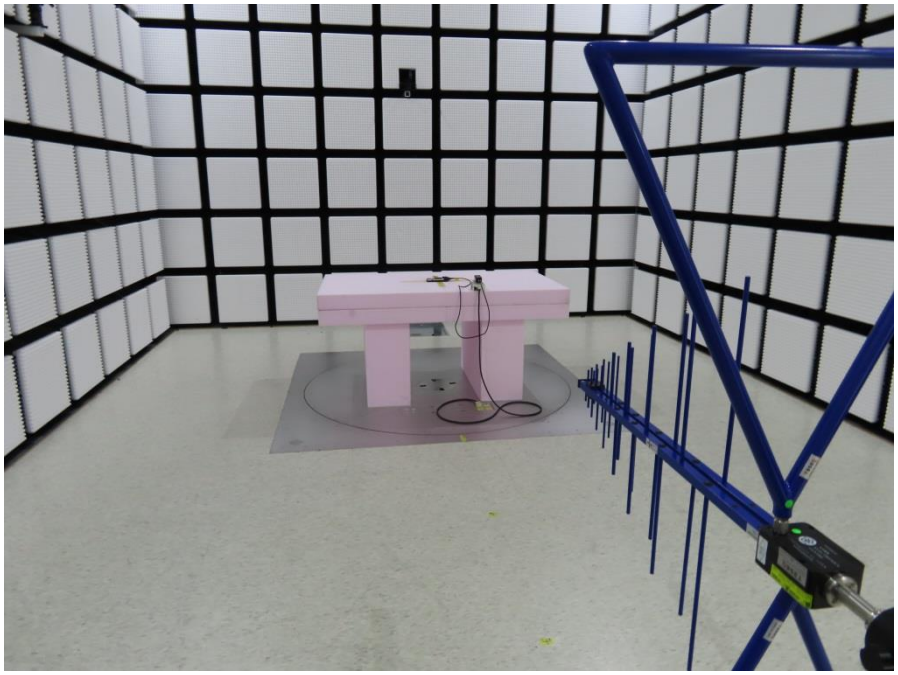


Rear View

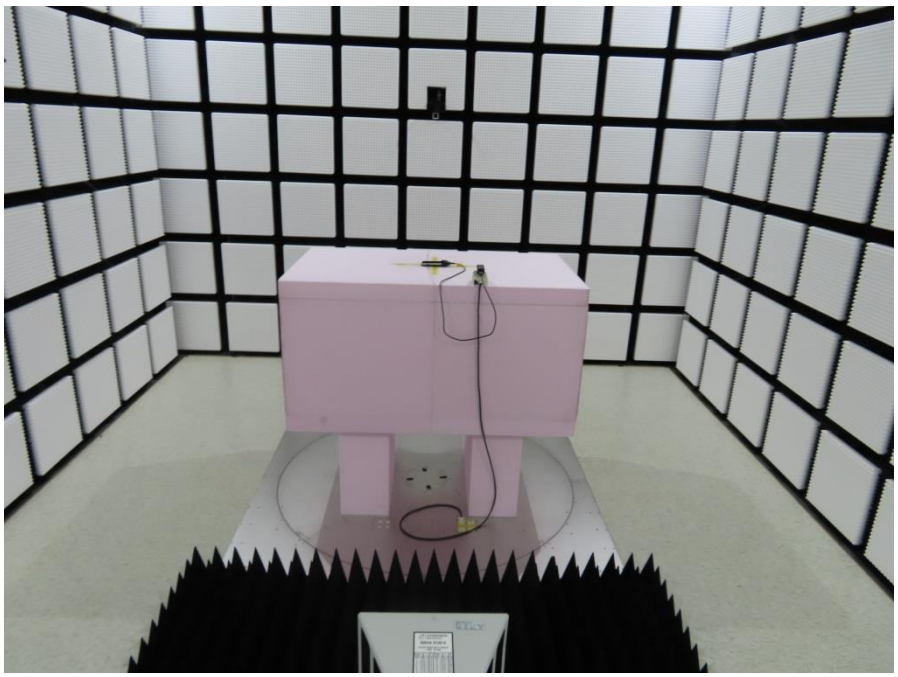
<Radiated Emission>

X Plane

LF



HF



————THE END————