FCC RADIO TEST REPORT

FCC ID	:	**TTUBEOPLAYEXCG2**
Equipment	:	**Charging Case**
Brand Name	:	**Bang & Olufsen**
Model Name	:	**EX Case G2**
Applicant	:	**Bang & Olufsen A/S** **Bang og Olufsen Allé 1, 7600 Struer, Denmark**
Manufacturer	:	**Bang & Olufsen A/S** **Bang og Olufsen Allé 1, 7600 Struer, Denmark**
Standard	:	**FCC Part 15 Subpart C §15.247**

The product was received on Aug. 02, 2021 and testing was started from Aug. 10, 2021 to Sep. 27, 2024. We, Sporton International Inc. EMC & Wireless Communications Laboratory, 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 variant report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
FR490411	01	Initial issue of report	Nov. 07, 2024
FR490411	02	Revise Carrier Frequency Channel This report is an updated version, replacing the report issued on Nov. 07, 2024.	Nov. 12, 2024

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	-
3.1	2.1049	99% Occupied Bandwidth	Pass	-
3.2	15.247(b)(3) 15.247(b)(4)	Output Power	Pass	-
3.3	15.247(e)	Power Spectral Density	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	Pass	4.47 dB under the limit at 2483.64 MHz
3.6	15.207	AC Conducted Emission	Pass	9.65 dB under the limit at 0.17 MHz
3.7	15.203	Antenna Requirement	Pass	-

Note: This is a variant report by updating accessories and adding charging case 2. All the test cases were performed on original report which can be referred to Sporton Report Number FR180213-01. Based on the original report, only worst case was verified.

Conformity Assessment Condition:
1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account. 2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”.
Disclaimer:
The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Lewis Ho

Report Producer: Mila Chen

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
General Specs Bluetooth - LE and WPC Rx. **Antenna Type** Bluetooth - LE: Printed Antenna WPC Rx: Coil Antenna	
Sample 1	Charging case 1: CPS / CPS3039
Sample 2	Charging case 2: CPS / CPS4019 + TI / BQ25180

Antenna information		
2400 MHz ~ 2483.5 MHz	Peak Gain (dBi)	-2.10

Remark:

1. The difference between Sample 1 and Sample 2 is component replacement and not affect RF functionality.
2. The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

Specification of Accessory		
Bluetooth Earphone (R)	**Brand Name**	Bang & Olufsen
	Model Name	EX Earbud R
Bluetooth Earphone (L)	**Brand Name**	Bang & Olufsen
	Model Name	EX Earbud L
Battery 1	**Brand Name**	VDL
	Model Name	751646
Battery 2	**Brand Name**	Apower Electronics Co.,Ltd. (AEC)
	Model Name	751646
Battery 3	**Brand Name**	Apower Electronics Co.,Ltd. (AEC)
	Model Name	751646A
USB Cable 1	**Brand Name**	Bang & Olufsen
	Model Name	BHC568
	Manufacturer	Mingji
USB Cable 2	**Brand Name**	Bang & Olufsen
	Model Name	BHC568
	Manufacturer	Perfect Cable
USB Cable 3 (A to C)	**Brand Name**	Bang & Olufsen
	Model Name	BHC568
	Manufacturer	Yingtong
USB Cable 4 (C to C)	**Brand Name**	Bang & Olufsen
	Model Name	BHC569
	Manufacturer	Yongzhou SanYu Electronic Technology Co., LTD

1.2 Modification of EUT

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

1.3 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	TH02-HY, CO05-HY, 03CH07-HY

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

FCC designation No.: TW1190

1.4 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 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.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

2.1 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	-	-

Remark: The EUT pre-scanned EUT charging with notebook, Standalone (w/ or w/o earphone), and EUT charging with WPC , the worst case is standalone mode, and only the worst case emissions were reported in this report..

2.2 Test Mode

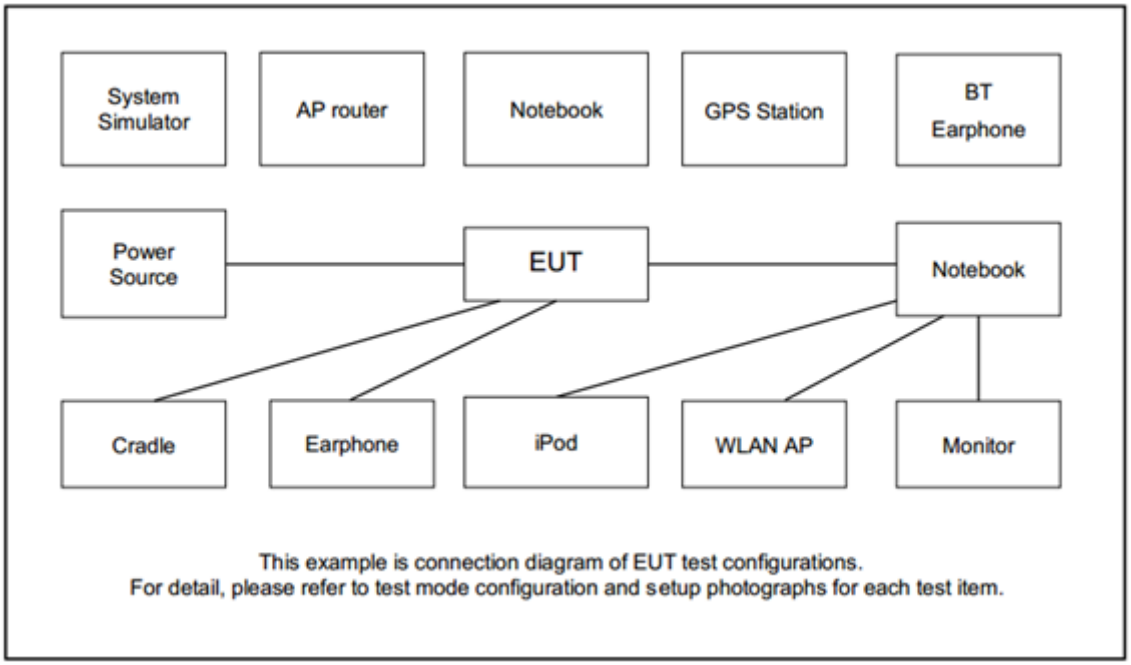
a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

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

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

Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
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: Bluetooth Link with mobile phone + Bluetooth Earphone (L+R) Charging mode via Charging Case + USB Cable 4 (Charging from Notebook) Mode 2: Bluetooth Link with mobile phone + Bluetooth Earphone (L+R) Charging mode via Charging Case + USB Cable 3 (Charging from Notebook)
Remark: 1. The worst case of Conducted Emission is mode 1; only the test data of it was reported. 2. For Radiated Test Cases, the tests were performed with USB Cable 3 and 4.	

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
2.	Notebook	DELL	Latitude 3420	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
3.	Phone	SAMSUNG	GT-N7000	A3LSMA730F	N/A	N/A
4.	iPod	Apple	A1285	FCC DoC	Shielded, 1.0 m	N/A

2.5 EUT Operation Test Setup

The RF test items, utility “btool V1.42.10” 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.

2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 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.

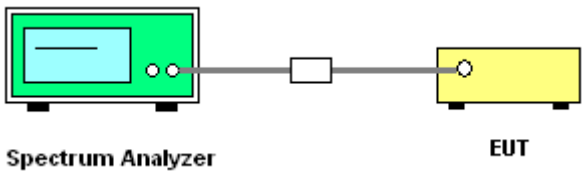
3.1.2 Measuring Instruments

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.

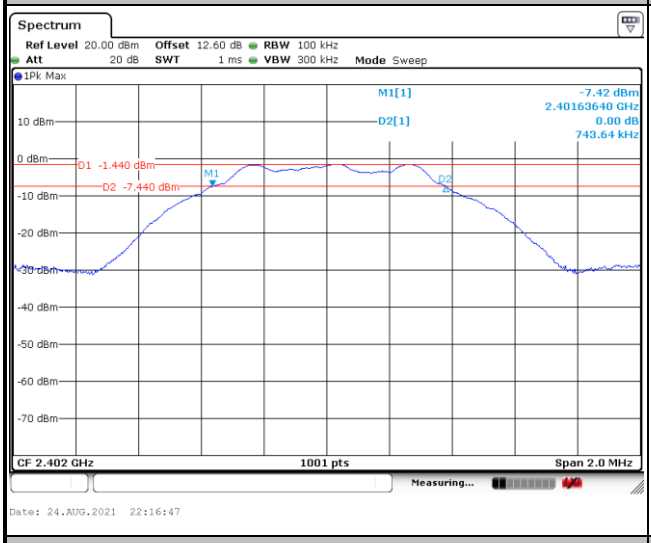
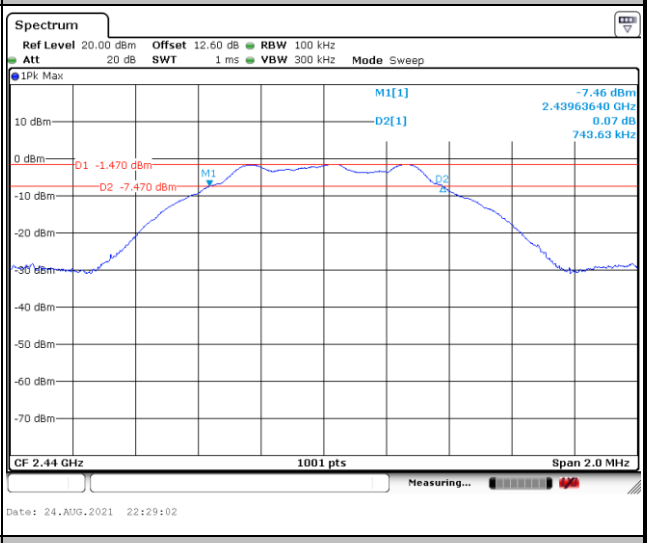
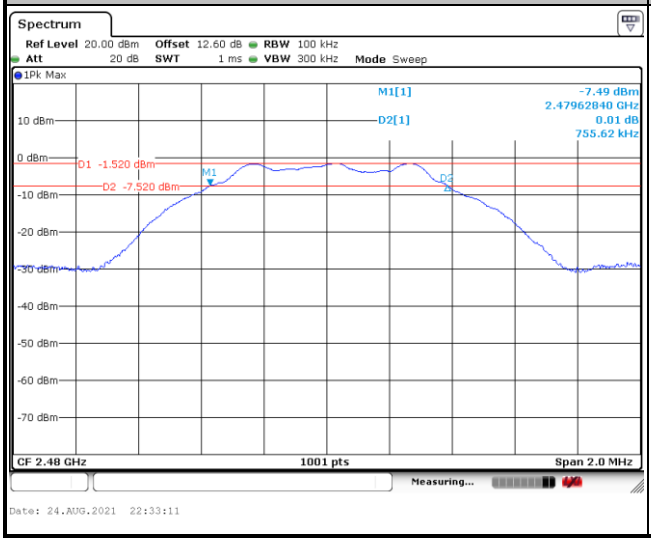
3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

<1Mbps>

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

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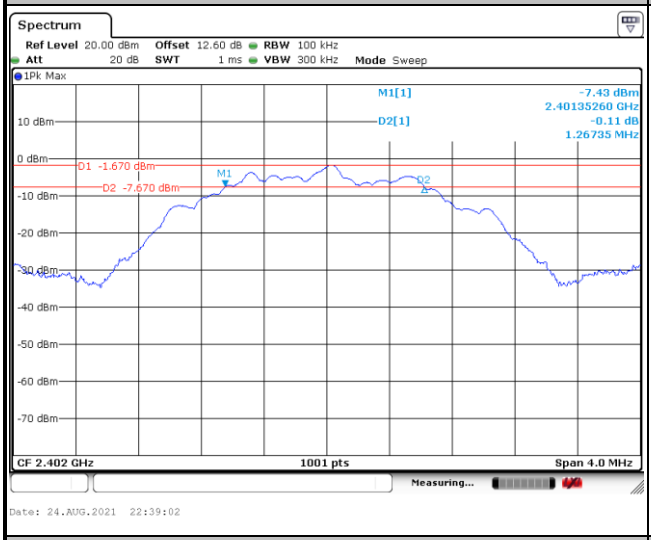
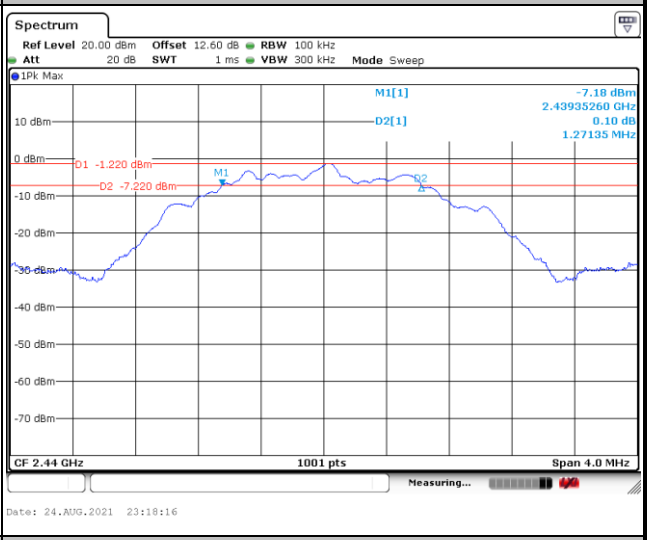
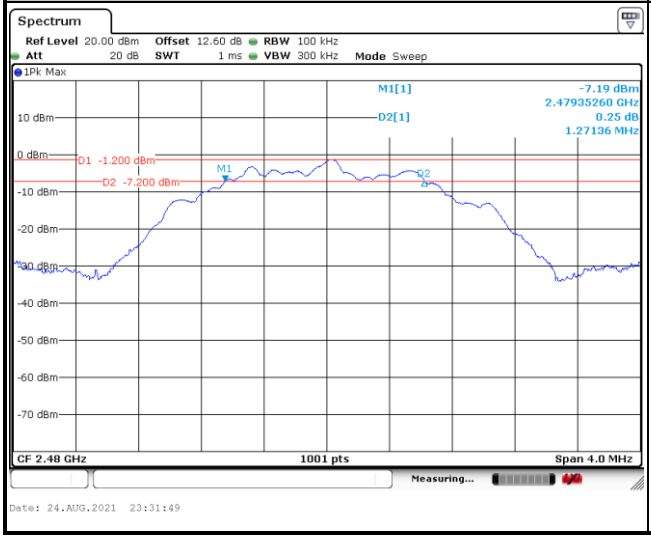
6 dB Bandwidth Plot on Channel 00	6 dB Bandwidth Plot on Channel 19
	
6 dB Bandwidth Plot on Channel 39	**N/A**
	

3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

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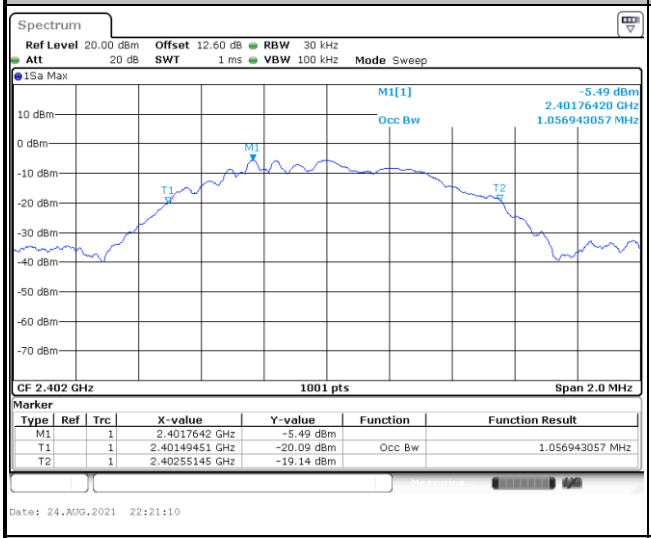
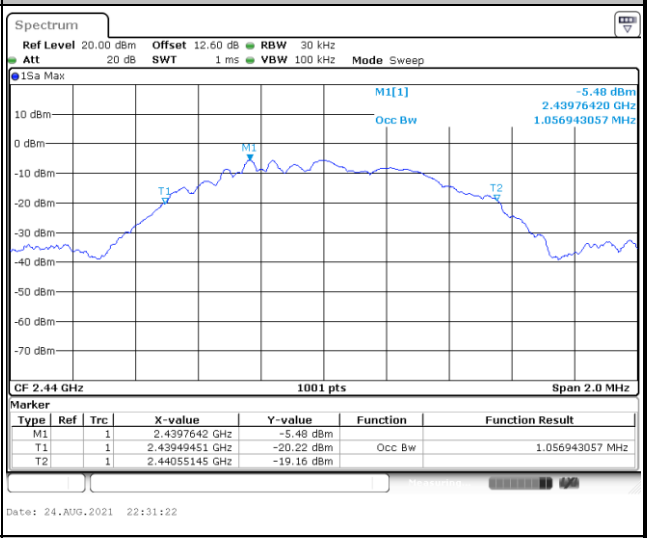
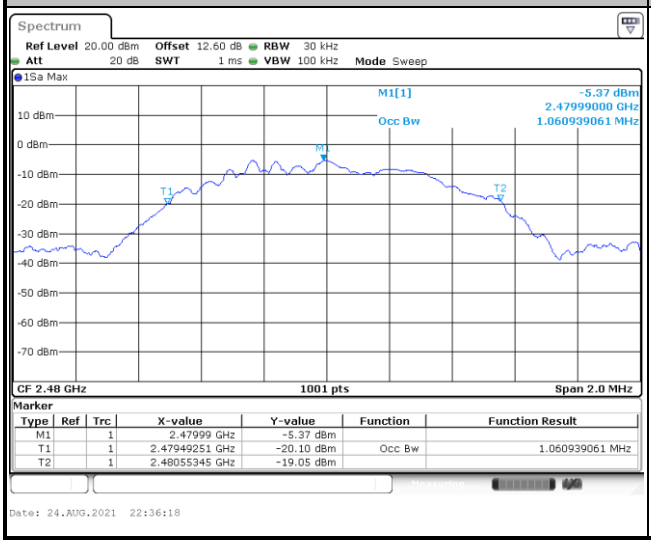
99% Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 19
	
99% Occupied Bandwidth Plot on Channel 39	**N/A**
	

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

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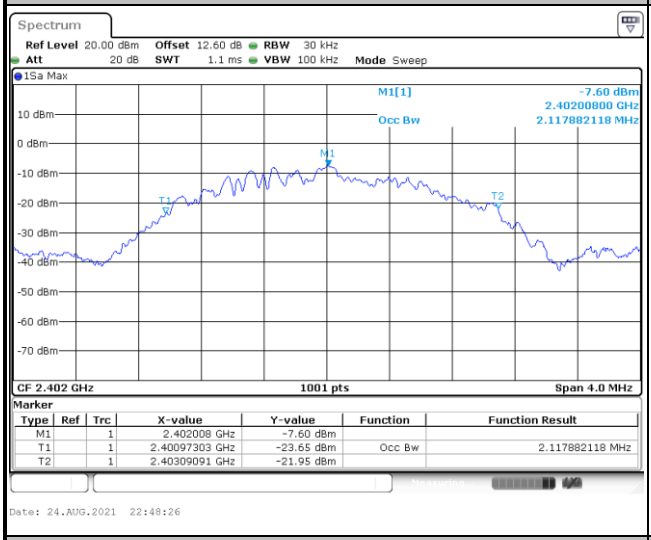
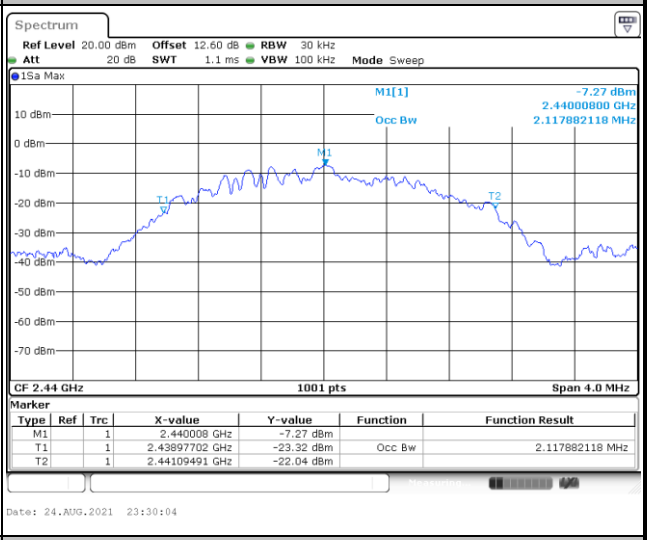
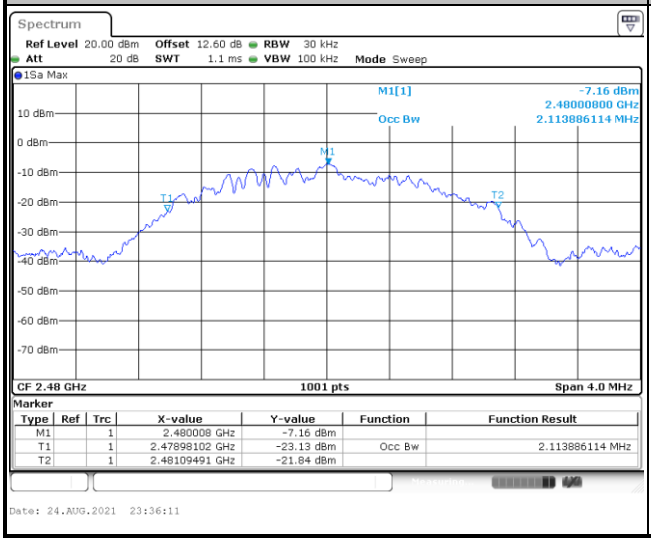
99% Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 19
	
99% Occupied Bandwidth Plot on Channel 39	**N/A**
	

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.

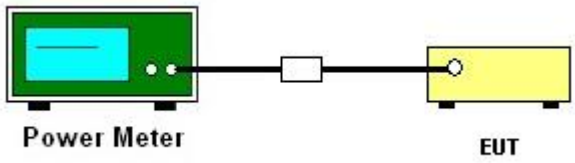
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. For Peak Power, the testing follows ANSI C63.10 Section 11.9.1.3 PKPM1.
2. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
3. The RF output of EUT was connected to the power meter by RF cable and attenuator.
4. The path loss was compensated to the results for each measurement.
5. Set the maximum power setting and enable the EUT to transmit continuously.
6. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 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.

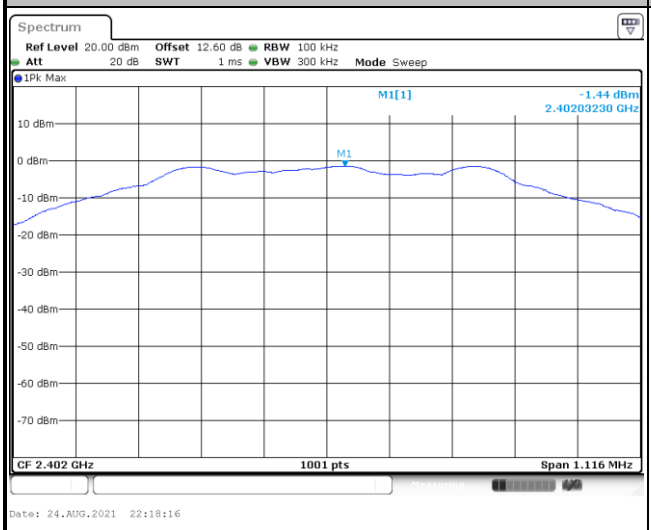
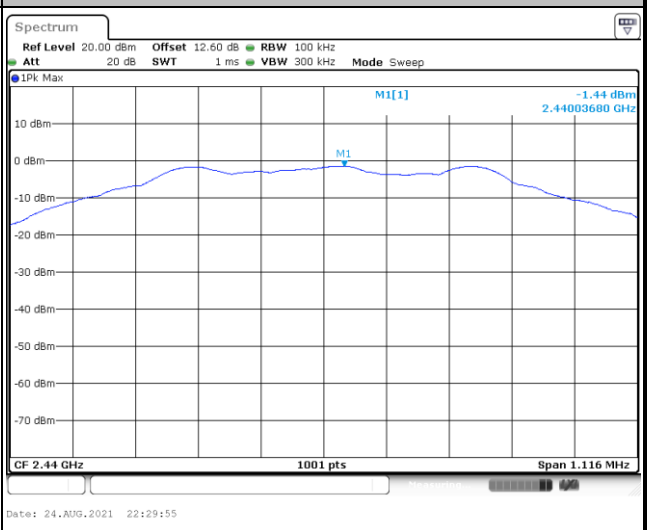
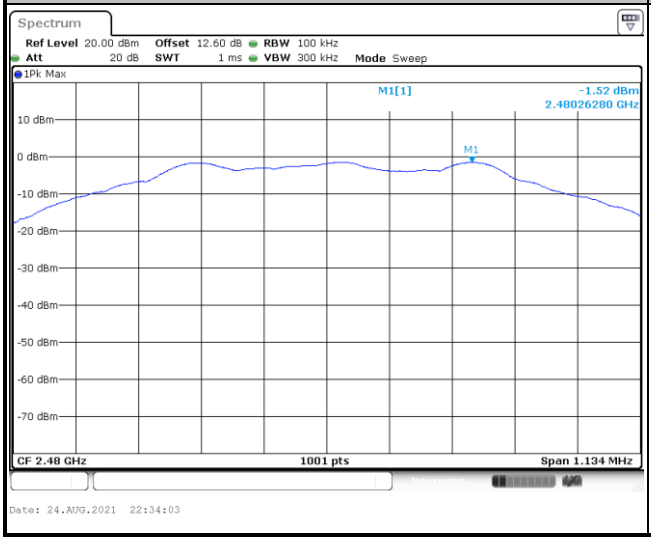
3.3.4 Test Setup

3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

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

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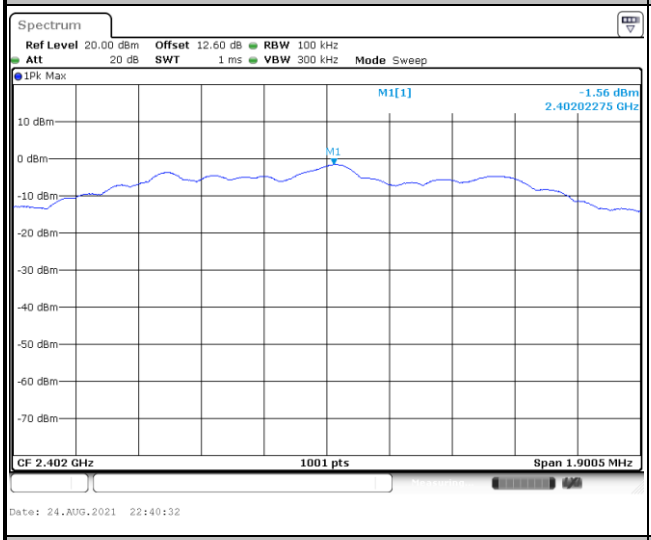
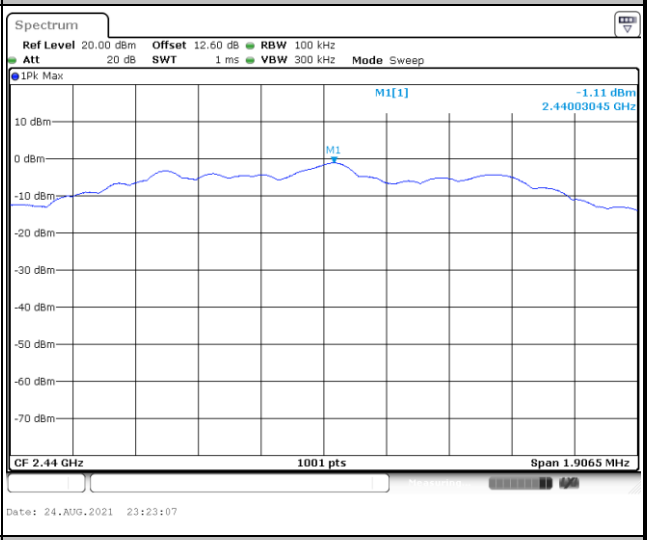
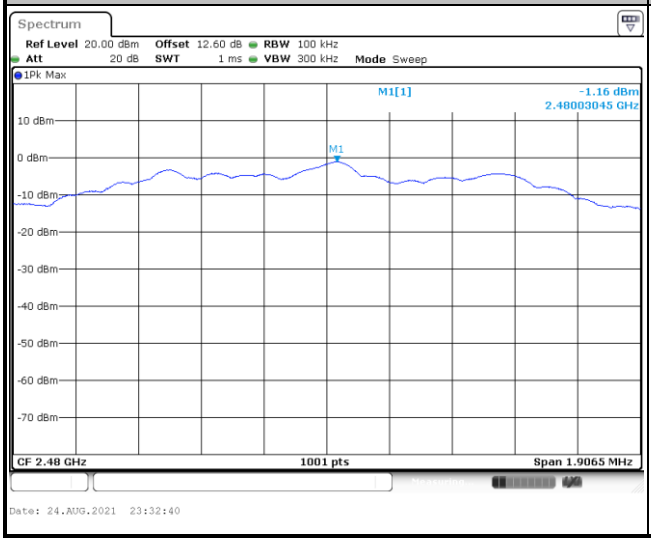
PSD 100kHz Plot on Channel 00	PSD 100kHz Plot on Channel 19
	
PSD 100kHz Plot on Channel 39	**N/A**
	

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

<1Mbps>

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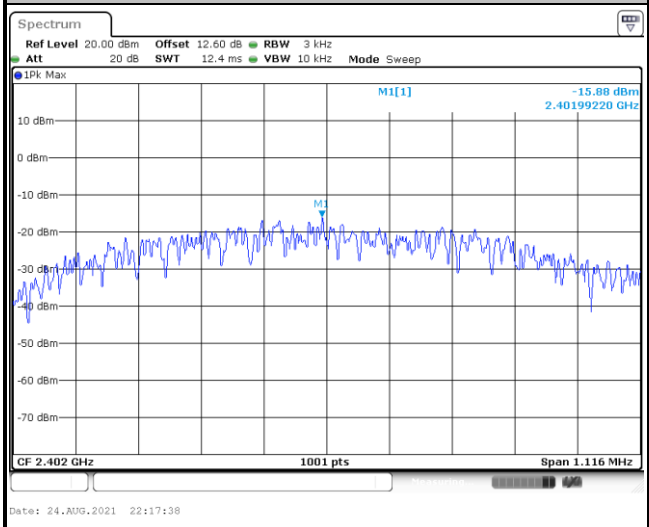	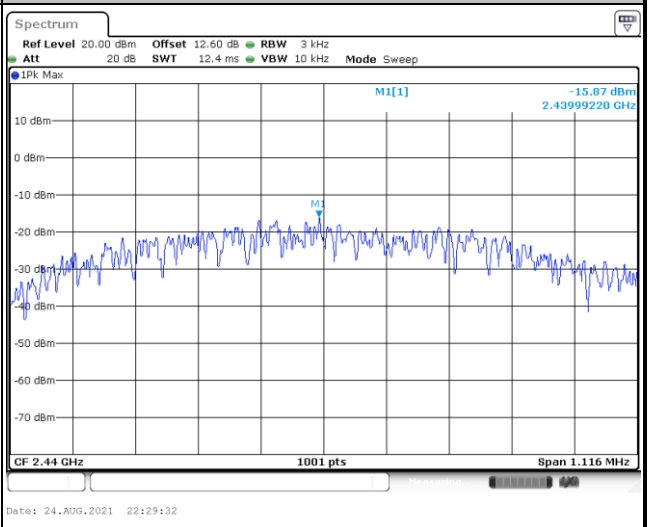
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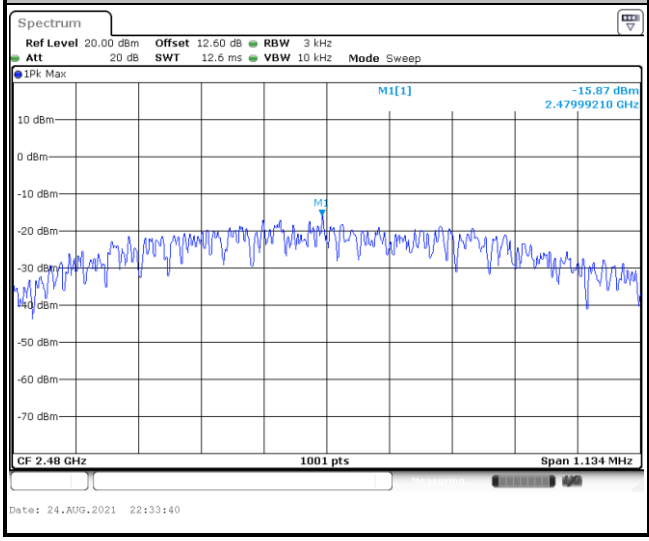
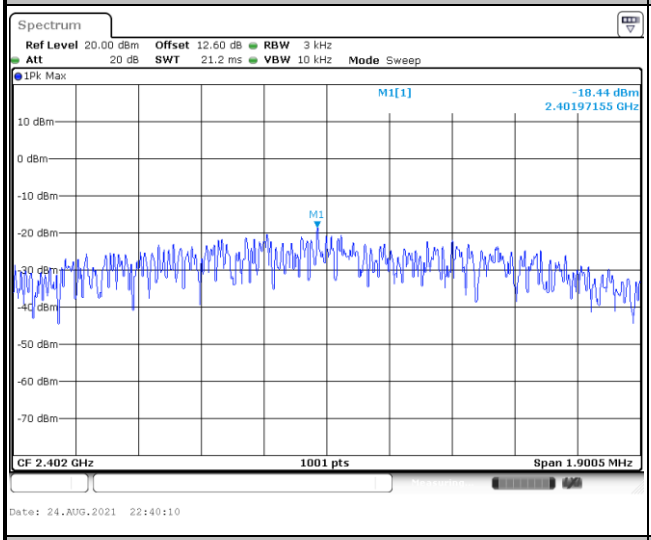
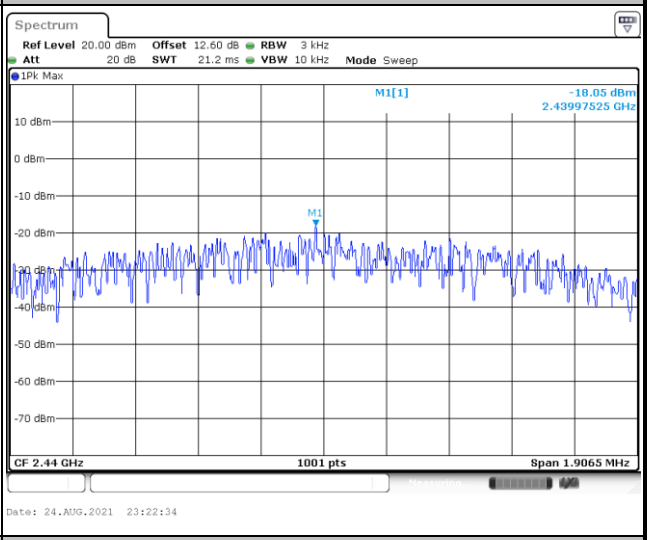
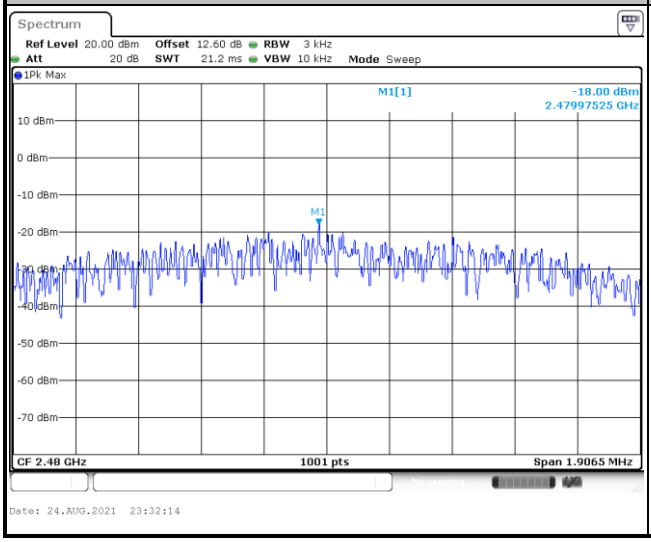
	

<2Mbps>

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.

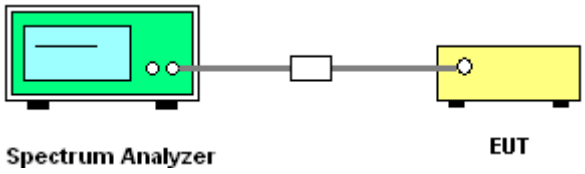
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedure

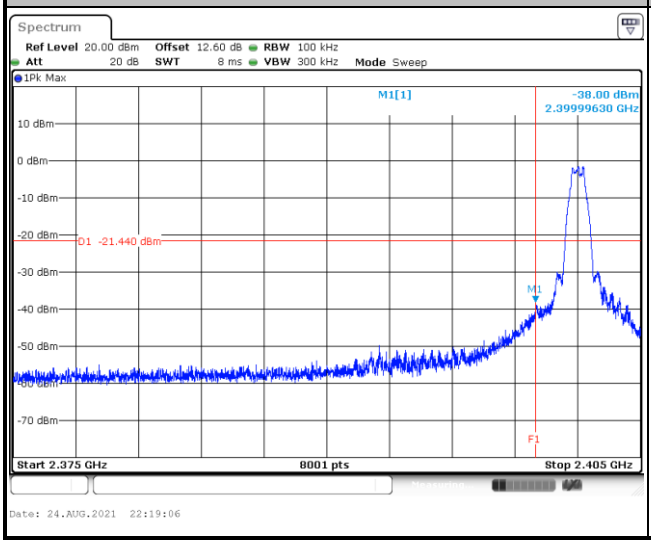
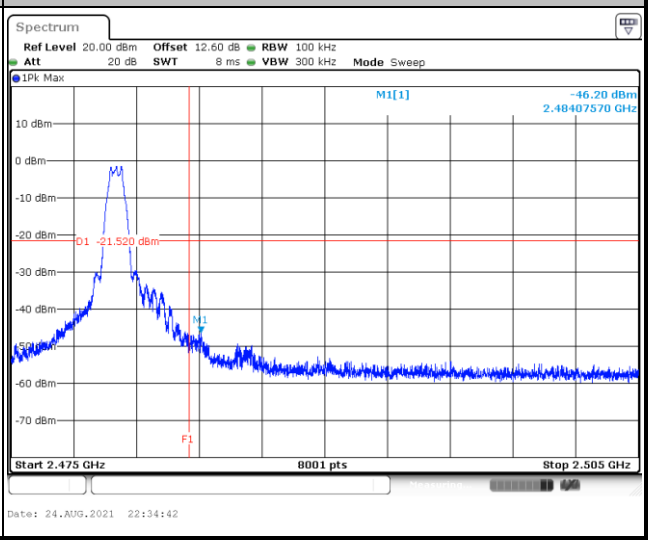
1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit 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

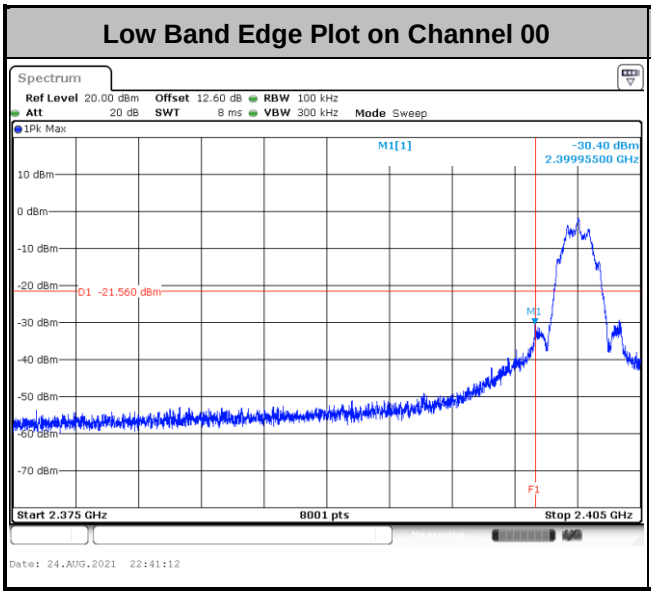
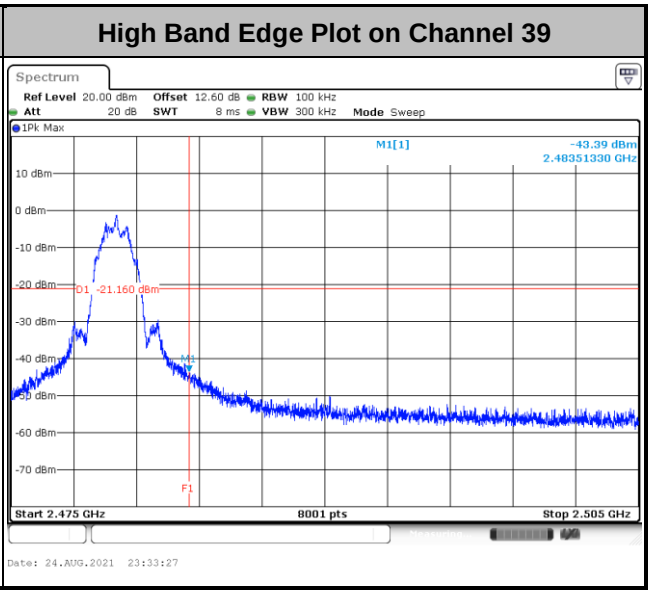


3.4.5 Test Result of Conducted Band Edges Plots

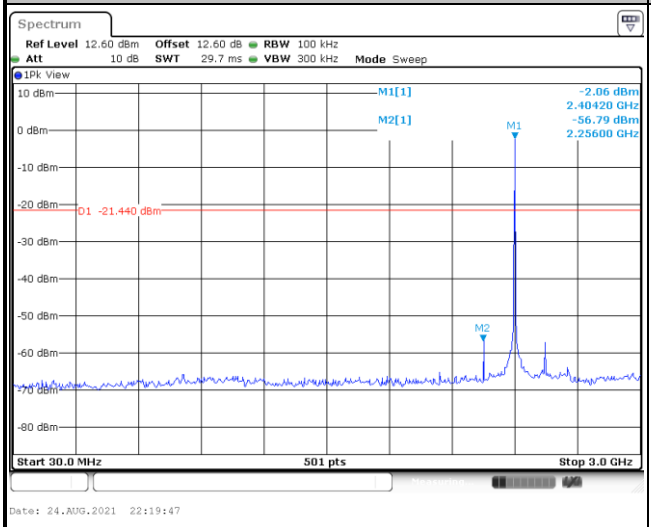
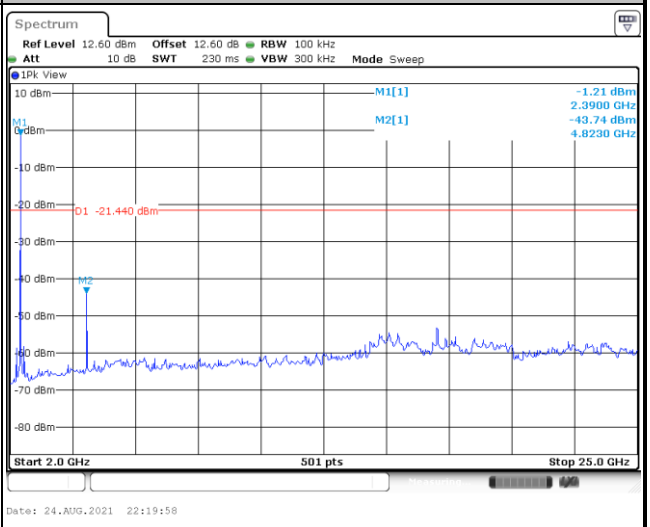
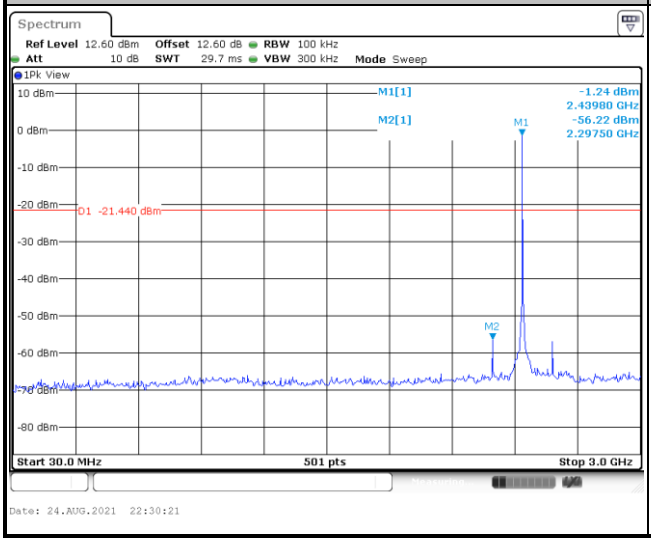
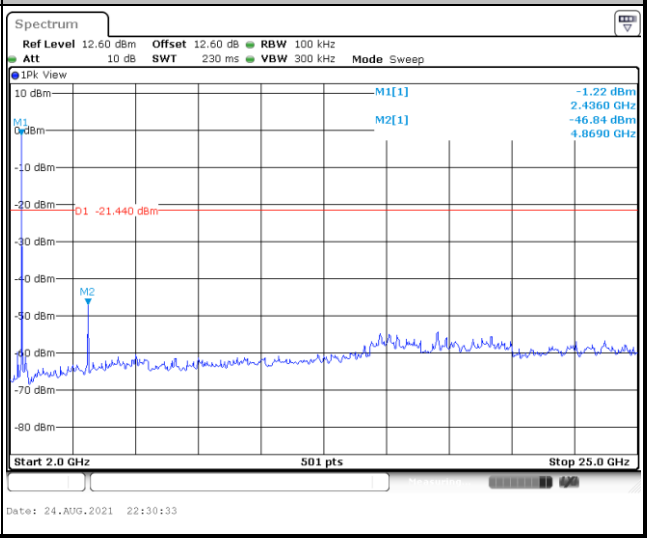
<1Mbps>

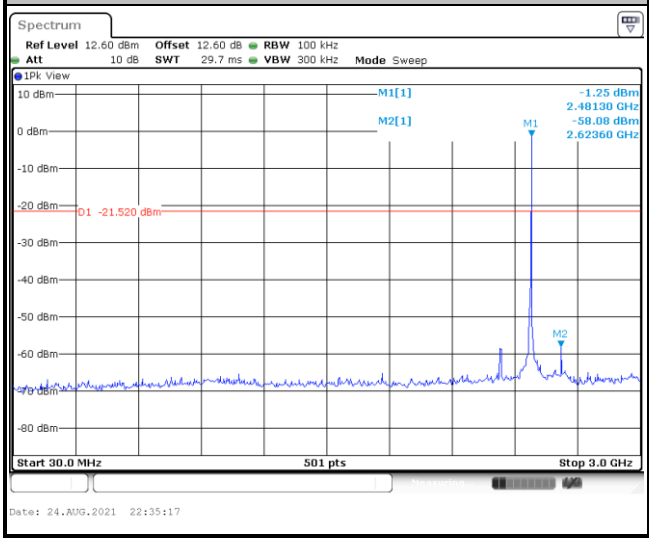
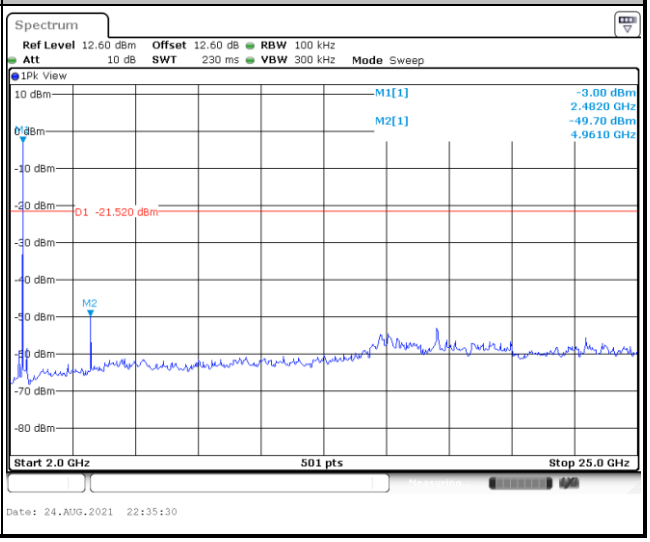
Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 39
	

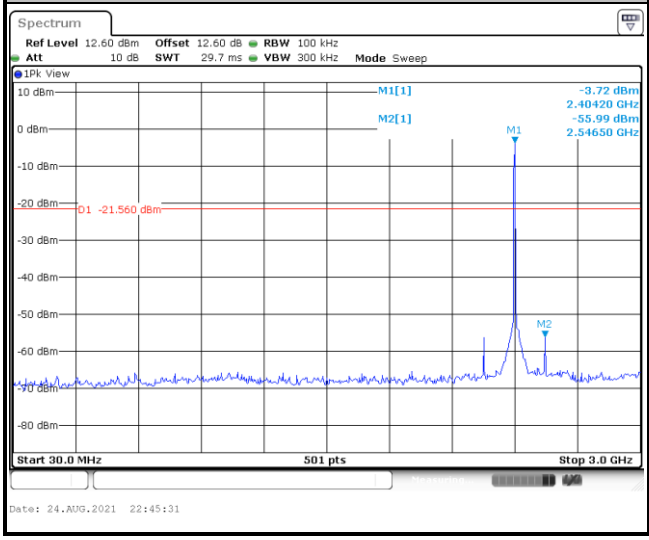
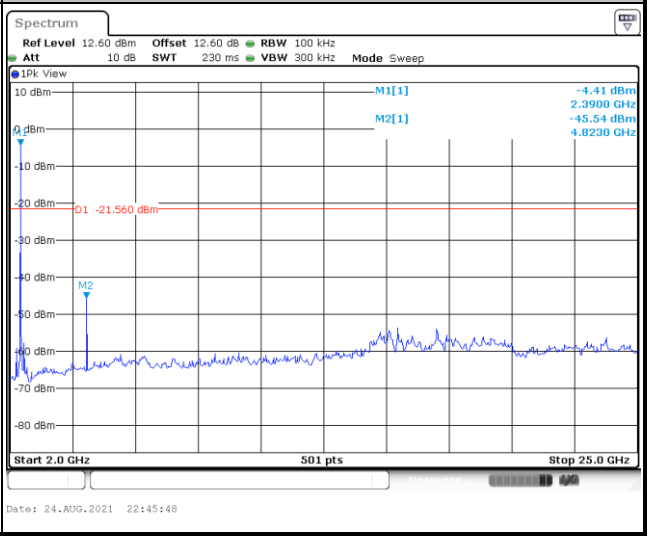
<2Mbps>

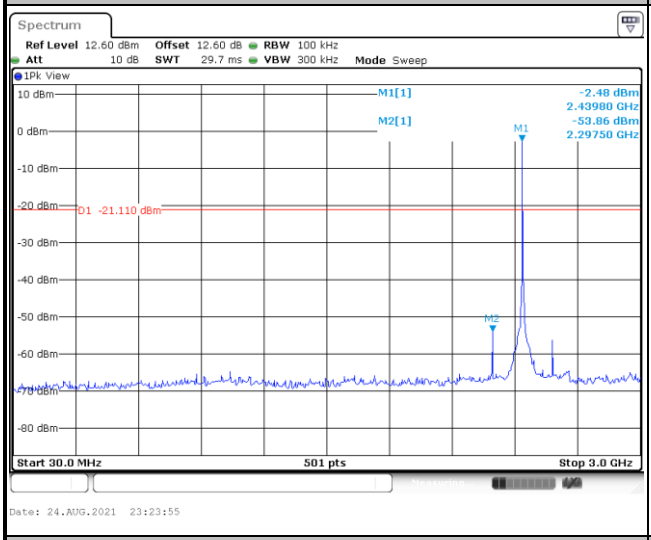
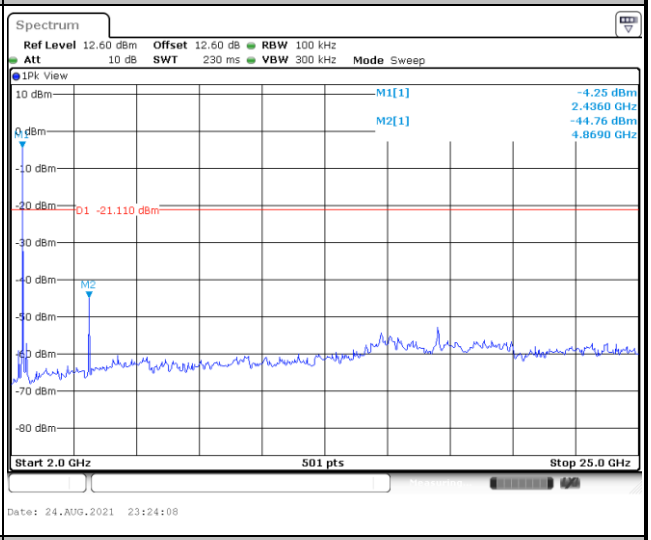
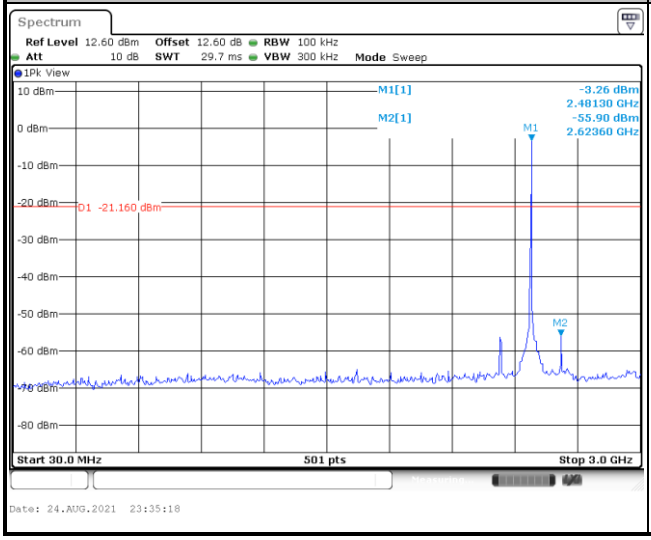
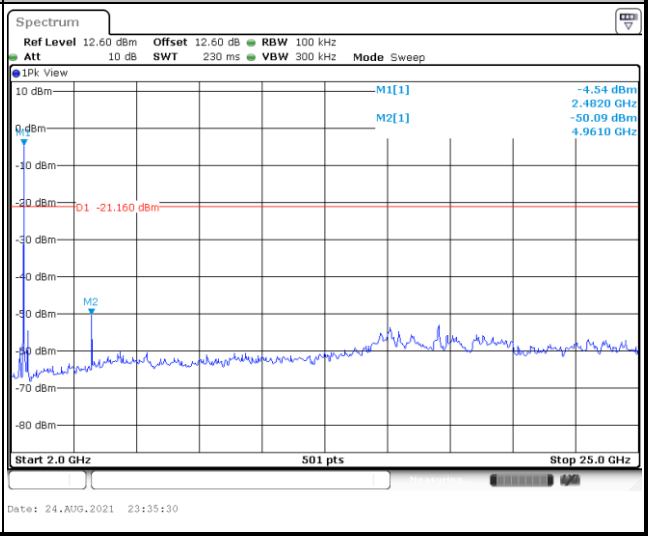
Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 39
	

3.4.6 Test Result of Conducted Spurious Emission Plots

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
	

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 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

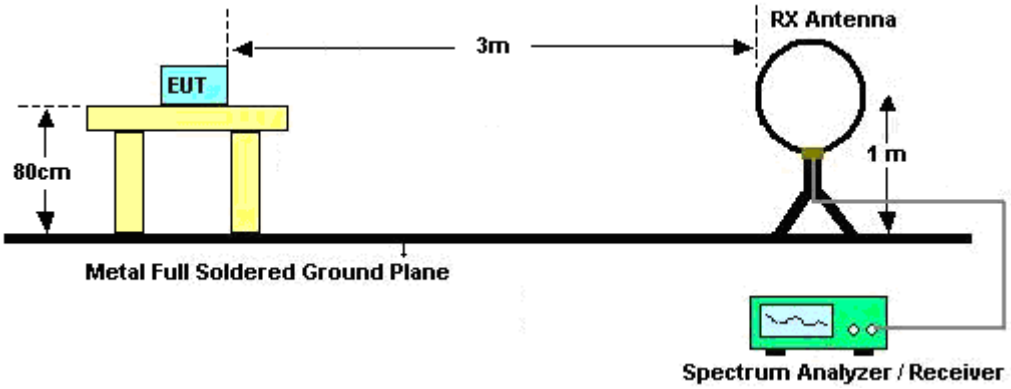
See list of measuring equipment of this test report.

3.5.3 Test Procedures

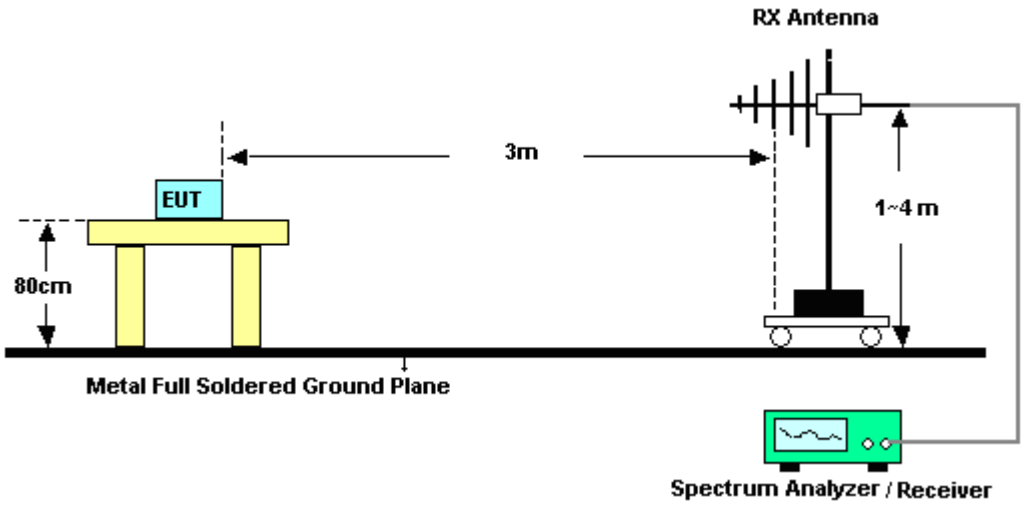
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the 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

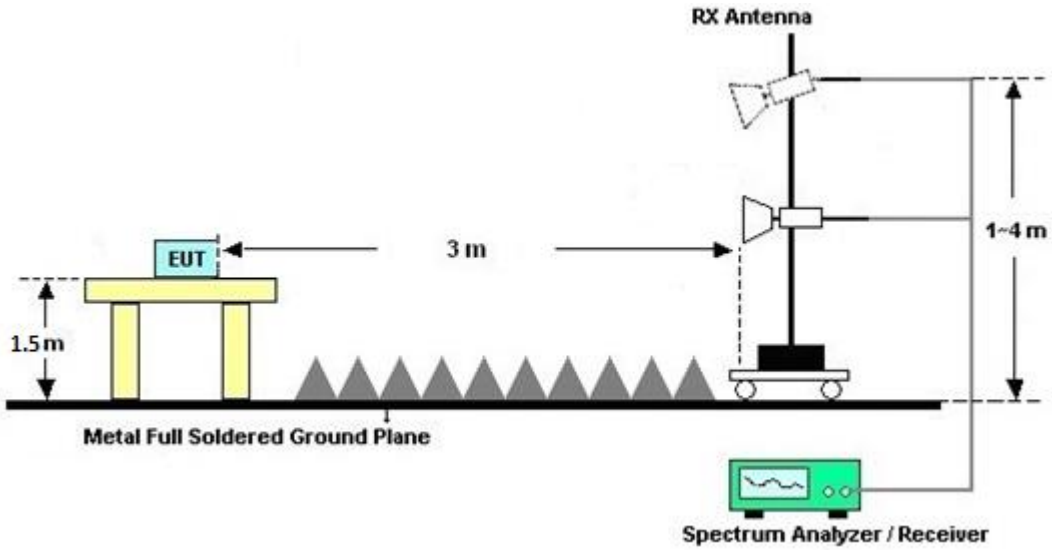
For radiated test below 30MHz



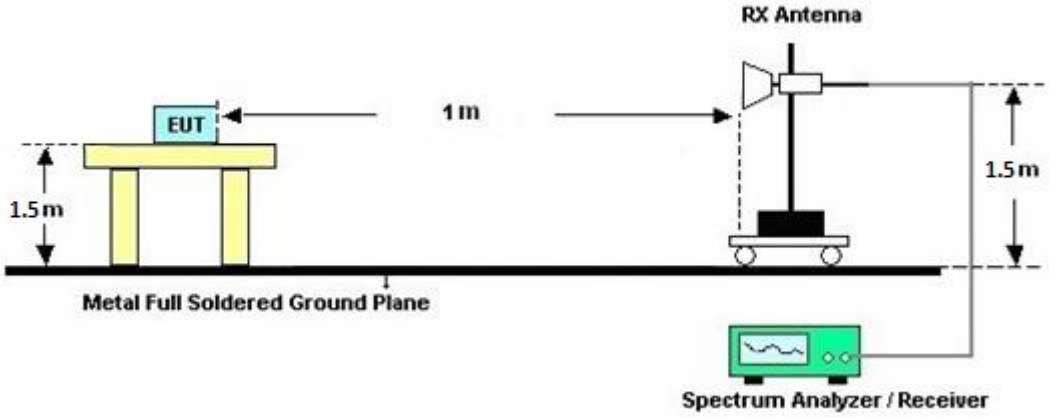
For radiated test from 30MHz to 1GHz



For radiated test from 1GHz to 18GHz



For radiated test above 18GHz



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

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

There is 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 C and D.

3.5.7 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

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.

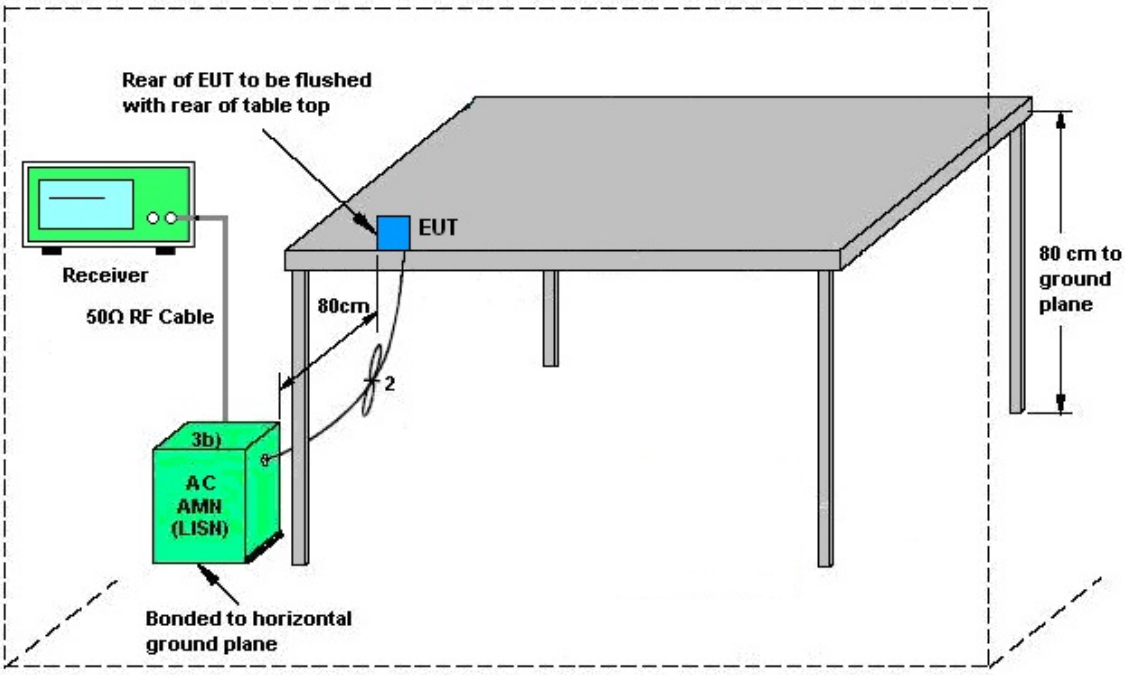
3.6.2 Measuring Instruments

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 B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. 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 provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

3.7.2 Antenna Anti-Replacement Construction

Antenna permanently attached.

4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N -06	35419 & 03	30MHz~1GHz	Apr. 28, 2021	Aug. 17, 2021~ Aug. 18, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Double Ridge Horn Antenna	ESCO	3117	00075962	1GHz ~ 18GHz	Dec. 01, 2020	Aug. 17, 2021~ Aug. 18, 2021	Nov. 30, 2021	Radiation (03CH07-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 04, 2021	Aug. 17, 2021~ Aug. 18, 2021	Jan. 03, 2022	Radiation (03CH07-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590075	1GHz~18GHz	Apr. 22, 2021	Aug. 17, 2021~ Aug. 18, 2021	Apr. 21, 2022	Radiation (03CH07-HY)
Preamplifier	COM-POWER	PA-103A	161241	10MHz~1GHz	May 18, 2021	Aug. 17, 2021~ Aug. 18, 2021	May 17, 2022	Radiation (03CH07-HY)
Preamplifier	Agilent	8449B	3008A02362	1GHz~26.5GHz	Oct. 31, 2020	Aug. 17, 2021~ Aug. 18, 2021	Oct. 30, 2021	Radiation (03CH07-HY)
Preamplifier	EMEC	EM18G40G	0600789	18-40GHz	Jul. 23, 2021	Aug. 17, 2021~ Aug. 18, 2021	Jul. 22, 2022	Radiation (03CH07-HY)
Spectrum Analyzer	Agilent	N9030A	MY52350276	3Hz~44GHz	Jul. 22, 2021	Aug. 17, 2021~ Aug. 18, 2021	Jul. 21, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY15682-4	30MHz to 18GHz	Feb. 24, 2021	Aug. 17, 2021~ Aug. 18, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24971-4	9kHz to 18GHz	Feb. 24, 2021	Aug. 17, 2021~ Aug. 18, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655-4	9kHz to 18GHz	Feb. 24, 2021	Aug. 17, 2021~ Aug. 18, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2858/2,801 606/2	18GHz~40GHz	Feb. 24, 2021	Aug. 17, 2021~ Aug. 18, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126	532078/126E	30MHz~18GHz	Sep. 18, 2020	Aug. 17, 2021~ Aug. 18, 2021	Sep. 17, 2021	Radiation (03CH07-HY)
Controller	EMEC	EM1000	N/A	Control Ant Mast	Apr. 28, 2021	Aug. 17, 2021~ Aug. 18, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Controller	MF	MF-7802	N/A	Control Turn table	N/A	Aug. 17, 2021~ Aug. 18, 2021	N/A	Radiation (03CH07-HY)
Antenna Mast	EMEC	AM-BS-4500E	N/A	Boresight mast 1M~4M	Apr. 28, 2021	Aug. 17, 2021~ Aug. 18, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Turn Table	ChainTek	Chaintek 3000	N/A	0~360 Degree	N/A	Aug. 17, 2021~ Aug. 18, 2021	N/A	Radiation (03CH07-HY)
Software	Audix	E3 6.2009-8-24	N/A	N/A	N/A	Aug. 17, 2021~ Aug. 18, 2021	N/A	Radiation (03CH07-HY)
USB Data Logger	TECPEL	TR-32	HE17XB2495	N/A	Mar. 09, 2021	Aug. 17, 2021~ Aug. 18, 2021	Mar. 08, 2022	Radiation (03CH07-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170251	18GHz~40GHz	Dec. 02, 2020	Aug. 17, 2021~ Aug. 18, 2021	Dec. 01, 2021	Radiation (03CH07-HY)

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Hygrometer	Testo	608-H1	34893241	N/A	Mar. 01, 2021	Aug. 10, 2021~ Aug. 24, 2021	Feb. 28, 2022	Conducted (TH02-HY)
Power Meter	Agilent	E4416A	GB41292344	N/A	Jan. 14, 2021	Aug. 10, 2021~ Aug. 24, 2021	Jan. 13, 2022	Conducted (TH02-HY)
Power Sensor	Agilent	E9327A	US40441548	50MHz~18GHz	Jan. 14, 2021	Aug. 10, 2021~ Aug. 24, 2021	Jan. 13, 2022	Conducted (TH02-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101565	10Hz ~ 40GHz	Nov. 13, 2020	Aug. 10, 2021~ Aug. 24, 2021	Nov. 12, 2021	Conducted (TH02-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2021	Aug. 10, 2021~ Aug. 24, 2021	Mar. 16, 2022	Conducted (TH02-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Sep. 24, 2024~ Sep. 27, 2024	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Dec. 06, 2023	Sep. 24, 2024~ Sep. 27, 2024	Dec. 05, 2024	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Oct. 26, 2023	Sep. 24, 2024~ Sep. 27, 2024	Oct. 25, 2024	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Dec. 08, 2023	Sep. 24, 2024~ Sep. 27, 2024	Dec. 07, 2024	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 22, 2023	Sep. 24, 2024~ Sep. 27, 2024	Nov. 21, 2024	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32	N/A	N/A	N/A	Sep. 24, 2024~ Sep. 27, 2024	N/A	Conduction (CO05-HY)
Pulse Limiter	SCHWARZBECK	VTSD 9561-F N	00691	N/A	Jul. 30, 2024	Sep. 24, 2024~ Sep. 27, 2024	Jul. 29, 2025	Conduction (CO05-HY)
RF Cable	HUBER + SUHNER	RG 214/U	1358175	9kHz~30MHz	Mar. 14, 2024	Sep. 24, 2024~ Sep. 27, 2024	Mar. 13, 2025	Conduction (CO05-HY)

5 Measurement Uncertainty

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**3.5 dB**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.9 dB**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**6.1 dB**

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

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

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Tommy Lee and Shiming Liu	Temperature:	24.4~24.9	°C
Test Date:	2021/8/10~2021/8/24	Relative Humidity:	45.9~51.5	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.057	0.744	0.50	Pass
BLE	1Mbps	1	19	2440	1.057	0.744	0.50	Pass
BLE	1Mbps	1	39	2480	1.061	0.756	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	1	0	2402	0.07	30.00	-2.10	-2.03	36.00	Pass
BLE	1Mbps	1	19	2440	0.08	30.00	-2.10	-2.02	36.00	Pass
BLE	1Mbps	1	39	2480	0.04	30.00	-2.10	-2.06	36.00	Pass

TEST RESULTS DATA
Average Power Table (Reporting Only)

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
BLE	1Mbps	1	0	2402	-0.01	30.00	-2.10	-2.11	36.00	Pass
BLE	1Mbps	1	19	2440	0.00	30.00	-2.10	-2.10	36.00	Pass
BLE	1Mbps	1	39	2480	-0.01	30.00	-2.10	-2.11	36.00	Pass

TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
BLE	1Mbps	1	0	2402	-1.44	-15.88	-2.10	8.00	Pass
BLE	1Mbps	1	19	2440	-1.44	-15.87	-2.10	8.00	Pass
BLE	1Mbps	1	39	2480	-1.52	-15.87	-2.10	8.00	Pass

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

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	2Mbps	1	0	2402	2.118	1.267	0.50	Pass
BLE	2Mbps	1	19	2440	2.118	1.271	0.50	Pass
BLE	2Mbps	1	39	2480	2.114	1.271	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	1	0	2402	0.05	30.00	-2.10	-2.05	36.00	Pass
BLE	2Mbps	1	19	2440	0.06	30.00	-2.10	-2.04	36.00	Pass
BLE	2Mbps	1	39	2480	-0.08	30.00	-2.10	-2.18	36.00	Pass

TEST RESULTS DATA
Average Power Table (Reporting Only)

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
BLE	2Mbps	1	0	2402	-0.10	30.00	-2.10	-2.20	36.00	Pass
BLE	2Mbps	1	19	2440	0.00	30.00	-2.10	-2.10	36.00	Pass
BLE	2Mbps	1	39	2480	-0.10	30.00	-2.10	-2.20	36.00	Pass

TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
BLE	2Mbps	1	0	2402	-1.56	-18.44	-2.10	8.00	Pass
BLE	2Mbps	1	19	2440	-1.11	-18.05	-2.10	8.00	Pass
BLE	2Mbps	1	39	2480	-1.16	-18.00	-2.10	8.00	Pass

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

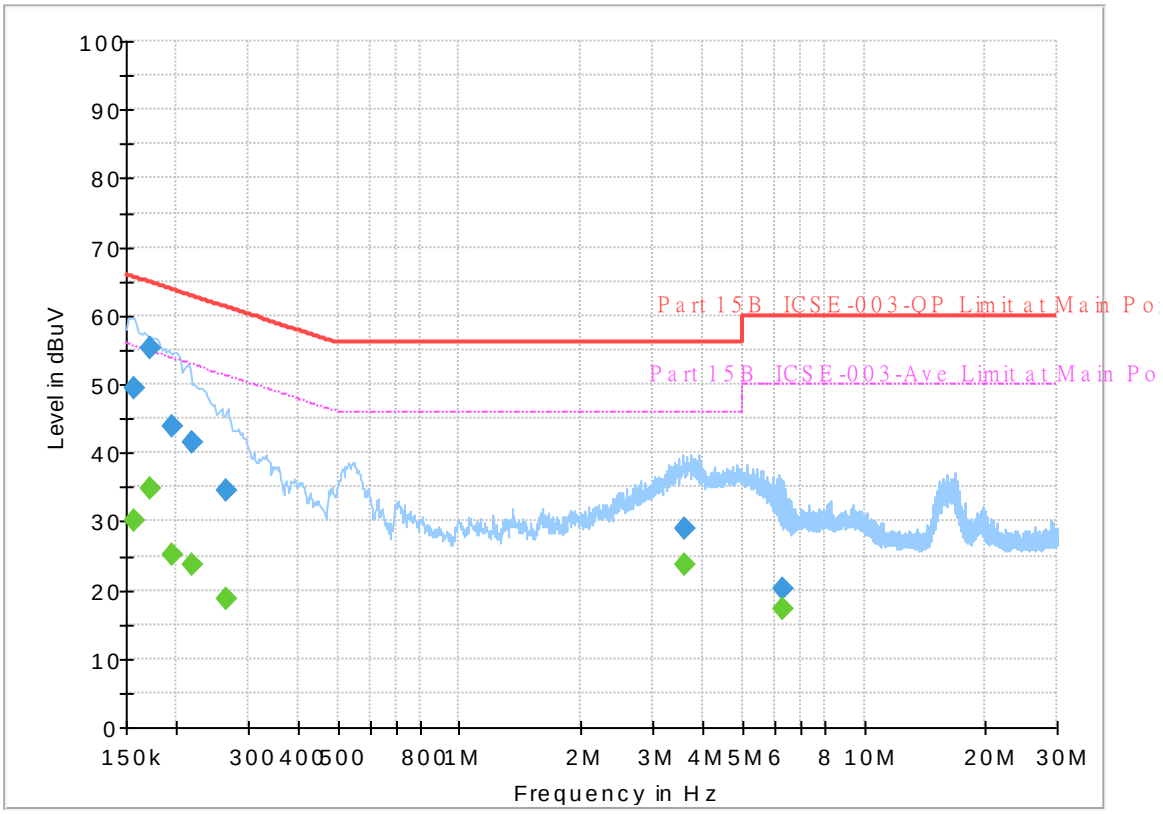
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Calvin Wang	**Temperature :**	23~26℃
		Relative Humidity :	45~55%

EUT Information

Report NO :	490411
Test Mode :	Mode 1
Test Voltage :	Power From System
Phase :	Line

Full Spectrum



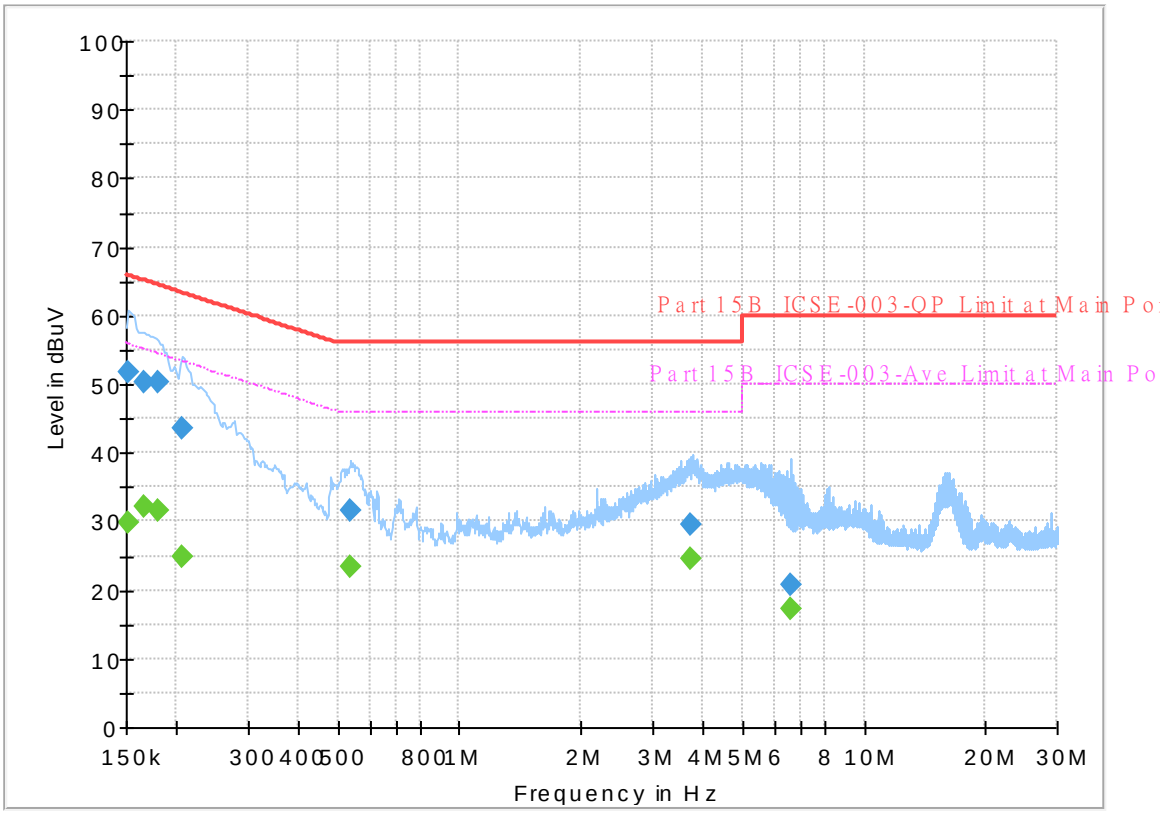
Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.156750	---	30.01	55.63	25.62	L1	OFF	19.8
0.156750	49.29	---	65.63	16.34	L1	OFF	19.8
0.172500	---	34.74	54.84	20.10	L1	OFF	19.8
0.172500	55.19	---	64.84	9.65	L1	OFF	19.8
0.195000	---	25.27	53.82	28.55	L1	OFF	19.8
0.195000	43.74	---	63.82	20.08	L1	OFF	19.8
0.217500	---	23.63	52.91	29.28	L1	OFF	19.8
0.217500	41.43	---	62.91	21.48	L1	OFF	19.8
0.264750	---	18.76	51.28	32.52	L1	OFF	19.8
0.264750	34.60	---	61.28	26.68	L1	OFF	19.8
3.615000	---	23.57	46.00	22.43	L1	OFF	19.8
3.615000	28.89	---	56.00	27.11	L1	OFF	19.8
6.279000	---	17.29	50.00	32.71	L1	OFF	19.9
6.279000	20.23	---	60.00	39.77	L1	OFF	19.9

EUT Information

Report NO :	490411
Test Mode :	Mode 1
Test Voltage :	Power From System
Phase :	Neutral

Full Spectrum



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.152250	---	29.68	55.88	26.20	N	OFF	19.8
0.152250	51.67	---	65.88	14.21	N	OFF	19.8
0.165750	---	32.10	55.17	23.07	N	OFF	19.8
0.165750	50.19	---	65.17	14.98	N	OFF	19.8
0.179250	---	31.47	54.52	23.05	N	OFF	19.8
0.179250	50.41	---	64.52	14.11	N	OFF	19.8
0.206250	---	24.95	53.36	28.41	N	OFF	19.8
0.206250	43.62	---	63.36	19.74	N	OFF	19.8
0.534750	---	23.33	46.00	22.67	N	OFF	19.8
0.534750	31.67	---	56.00	24.33	N	OFF	19.8
3.738750	---	24.52	46.00	21.48	N	OFF	19.8
3.738750	29.44	---	56.00	26.56	N	OFF	19.8
6.596250	---	17.37	50.00	32.63	N	OFF	19.9
6.596250	20.64	---	60.00	39.36	N	OFF	19.9

Appendix C. Radiated Spurious Emission

Test Engineer :	Jesse Wang and Stan Hsieh	Temperature :	23.5~24.1°C
		Relative Humidity :	54.3~54.9%

<1Mbps>

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Margin	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		2368.59	53.66	-20.34	74	39.18	31.87	18.02	35.41	358	281	P	H
		2390	45.12	-8.88	54	30.53	31.9	18.11	35.42	358	281	A	H
	*	2402	86.74	-	-	72.11	31.9	18.15	35.42	358	281	P	H
	*	2402	86.05	-	-	71.42	31.9	18.15	35.42	358	281	A	H
													H
													H
		2376.255	53.93	-20.07	74	39.41	31.87	18.06	35.41	353	48	P	V
		2389.59	45.01	-8.99	54	30.41	31.9	18.11	35.41	353	48	A	V
	*	2402	86.93	-	-	72.3	31.9	18.15	35.42	353	48	P	V
	*	2402	86.27	-	-	71.64	31.9	18.15	35.42	353	48	A	V
													V
													V
BLE CH 19 2440MHz		2380	53.95	-20.05	74	39.42	31.87	18.07	35.41	305	280	P	H
		2387.7	45.15	-8.85	54	30.56	31.9	18.1	35.41	305	280	A	H
	*	2440	85.86	-	-	70.9	32.2	18.19	35.43	305	280	P	H
	*	2440	85.3	-	-	70.34	32.2	18.19	35.43	305	280	A	H
		2492.02	54.49	-19.51	74	39.11	32.6	18.24	35.46	305	280	P	H
		2498.46	45.65	-8.35	54	30.26	32.6	18.25	35.46	305	280	A	H
		2348.78	54.08	-19.92	74	39.74	31.8	17.94	35.4	388	48	P	V
		2368.94	44.93	-9.07	54	30.45	31.87	18.02	35.41	388	48	A	V
	*	2440	86.98	-	-	72.02	32.2	18.19	35.43	388	48	P	V
	*	2440	86.4	-	-	71.44	32.2	18.19	35.43	388	48	A	V
		2486.56	55.18	-18.82	74	39.93	32.47	18.23	35.45	388	48	P	V
		2494.05	45.72	-8.28	54	30.34	32.6	18.24	35.46	388	48	A	V

BLE CH 39 2480MHz	*	2480	87.84	-	-	72.59	32.47	18.23	35.45	317	185	P	H
	*	2480	87.13	-	-	71.88	32.47	18.23	35.45	317	185	A	H
		2483.76	56.01	-17.99	74	40.76	32.47	18.23	35.45	317	185	P	H
		2483.52	46.32	-7.68	54	31.07	32.47	18.23	35.45	317	185	A	H
													H
													H
	*	2480	87.55	-	-	72.3	32.47	18.23	35.45	339	61	P	V
	*	2480	86.98	-	-	71.73	32.47	18.23	35.45	339	61	A	V
		2498.28	55.61	-18.39	74	40.22	32.6	18.25	35.46	339	61	P	V
		2483.72	46.34	-7.66	54	31.09	32.47	18.23	35.45	339	61	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)	Margin (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	45.47	-28.53	74	57.13	34	12.33	57.99	100	0	P	H
													H
													H
													H
		4804	46.23	-27.77	74	57.89	34	12.33	57.99	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	43.61	-30.39	74	55	34.1	12.41	57.9	100	0	P	H
		7320	41.81	-32.19	74	49.43	35.6	14.7	57.92	100	0	P	H
													H
													H
		4880	47.2	-26.8	74	58.59	34.1	12.41	57.9	100	0	P	V
		7320	41.64	-32.36	74	49.26	35.6	14.7	57.92	100	0	P	V
													V
													V
BLE CH 39 2480MHz		4960	43.23	-30.77	74	54.34	34.2	12.5	57.81	100	0	P	H
		7440	41.28	-32.72	74	48.82	35.6	14.9	58.04	100	0	P	H
													H
													H
		4960	46.56	-27.44	74	57.67	34.2	12.5	57.81	100	0	P	V
		7440	41.56	-32.44	74	49.1	35.6	14.9	58.04	100	0	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission above 18GHz

2.4GHz BLE (SHF)

BT	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
					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 SHF		21927	48.9	-25.1	74	64.93	38.1	5.95	60.08	100	0	P	H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
		24195	48.77	-25.23	74	61.54	38.85	6.6	58.22	100	0	P	V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.

Emission below 1GHz

2.4GHz BLE (LF)

BLE	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
					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		30	22.55	-17.45	40	27.11	24.57	0.9	30.03	-	-	P	H
		49.71	16.47	-23.53	40	30.73	14.47	1.28	30.01	-	-	P	H
		106.95	20.05	-23.45	43.5	31.7	16.57	1.77	29.99	-	-	P	H
		763.4	30.06	-15.94	46	27.7	27.73	4.29	29.66	-	-	P	H
		872.6	31.37	-14.63	46	27.06	28.78	4.63	29.1	-	-	P	H
		951.7	33.34	-12.66	46	26.77	30.39	4.88	28.7	100	0	P	H
													H
													H
													H
													H
													H
													H
		30	32.75	-7.25	40	37.31	24.57	0.9	30.03	100	0	P	V
		44.85	30.12	-9.88	40	41.96	16.97	1.2	30.01	-	-	P	V
		106.95	27.97	-15.53	43.5	39.62	16.57	1.77	29.99	-	-	P	V
		559.7	26.92	-19.08	46	27.21	25.86	3.74	29.89	-	-	P	V
		777.4	30.12	-15.88	46	27.64	27.78	4.33	29.63	-	-	P	V
		951	33.53	-12.47	46	27	30.36	4.87	28.7	-	-	P	V
													V
													V
													V
													V
													V
													V
Remark	3. No other spurious found. 4. All results are PASS against limit line.												

<2Mbps>

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Margin	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		2380.56	54.64	-19.36	74	40.11	31.87	18.07	35.41	315	278	P	H
		2386.755	46.62	-7.38	54	32.03	31.9	18.1	35.41	315	278	A	H
	*	2402	88.08	-	-	73.45	31.9	18.15	35.42	315	278	P	H
	*	2402	86.79	-	-	72.16	31.9	18.15	35.42	315	278	A	H
													H
													H
		2377.41	54.01	-19.99	74	39.49	31.87	18.06	35.41	312	315	P	V
		2312.415	46.66	-7.34	54	32.53	31.73	17.78	35.38	312	315	A	V
	*	2402	84.71	-	-	70.08	31.9	18.15	35.42	312	315	P	V
	*	2402	83.44	-	-	68.81	31.9	18.15	35.42	312	315	A	V
													V
													V
BLE CH 19 2440MHz		2348.22	54.15	-19.85	74	39.81	31.8	17.94	35.4	303	282	P	H
		2354.38	46.76	-7.24	54	32.37	31.83	17.96	35.4	303	282	A	H
	*	2440	87.33	-	-	72.37	32.2	18.19	35.43	303	282	P	H
	*	2440	85.96	-	-	71	32.2	18.19	35.43	303	282	A	H
		2492.65	55.06	-18.94	74	39.68	32.6	18.24	35.46	303	282	P	H
		2492.37	47.9	-6.1	54	32.52	32.6	18.24	35.46	303	282	A	H
		2342.34	54.67	-19.33	74	40.36	31.8	17.91	35.4	346	316	P	V
		2328.76	46.72	-7.28	54	32.49	31.77	17.85	35.39	346	316	A	V
	*	2440	85.16	-	-	70.2	32.2	18.19	35.43	346	316	P	V
	*	2440	83.65	-	-	68.69	32.2	18.19	35.43	346	316	A	V
		2489.99	54.83	-19.17	74	39.44	32.6	18.24	35.45	346	316	P	V
		2491.46	47.39	-6.61	54	32	32.6	18.24	35.45	346	316	A	V

BLE CH 39 2480MHz	*	2480	89.11	-	-	73.86	32.47	18.23	35.45	360	173	P	H
	*	2480	87.84	-	-	72.59	32.47	18.23	35.45	360	173	A	H
		2483.76	57.13	-16.87	74	41.88	32.47	18.23	35.45	360	173	P	H
		2483.64	49.53	-4.47	54	34.28	32.47	18.23	35.45	360	173	A	H
													H
													H
	*	2480	84.89	-	-	69.64	32.47	18.23	35.45	341	329	P	V
	*	2480	83.55	-	-	68.3	32.47	18.23	35.45	341	329	A	V
		2484.44	55.8	-18.2	74	40.55	32.47	18.23	35.45	341	329	P	V
		2483.56	48.17	-5.83	54	32.92	32.47	18.23	35.45	341	329	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)	Margin (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	42.84	-31.16	74	54.5	34	12.33	57.99	100	0	P	H
													H
													H
													H
		4804	45.51	-28.49	74	57.17	34	12.33	57.99	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz		4880	43.01	-30.99	74	54.4	34.1	12.41	57.9	100	0	P	H
		7320	41.35	-32.65	74	48.97	35.6	14.7	57.92	100	0	P	H
													H
													H
		4880	46.63	-27.37	74	58.02	34.1	12.41	57.9	100	0	P	V
		7320	41.93	-32.07	74	49.55	35.6	14.7	57.92	100	0	P	V
													V
													V
BLE CH 39 2480MHz		4960	41.87	-32.13	74	52.98	34.2	12.5	57.81	100	0	P	H
		7440	41.18	-32.82	74	48.72	35.6	14.9	58.04	100	0	P	H
													H
													H
		4960	44.27	-29.73	74	55.38	34.2	12.5	57.81	100	0	P	V
		7440	41.22	-32.78	74	48.76	35.6	14.9	58.04	100	0	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission above 18GHz

2.4GHz BLE (SHF)

BT	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
					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 SHF		22564	48.56	-25.44	74	63.75	38.15	6.13	59.47	100	0	P	H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
		24860	48.93	-25.07	74	60.77	38.89	6.93	57.66	100	0	P	V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Emission below 1GHz

2.4GHz BLE (LF)

BLE	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
					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		30	23.13	-16.87	40	27.69	24.57	0.9	30.03	-	-	P	H
		47.01	16.84	-23.16	40	30.05	15.57	1.23	30.01	-	-	P	H
		106.95	20.44	-23.06	43.5	32.09	16.57	1.77	29.99	-	-	P	H
		687.1	28.12	-17.88	46	27.64	26.15	4.12	29.79	-	-	P	H
		766.9	31.37	-14.63	46	28.98	27.74	4.3	29.65	-	-	P	H
		954.5	33.47	-12.53	46	26.75	30.52	4.89	28.69	100	0	P	H
													H
													H
													H
													H
													H
													H
		30	30.58	-9.42	40	35.14	24.57	0.9	30.03	100	0	P	V
		45.66	22.47	-17.53	40	34.73	16.54	1.21	30.01	-	-	P	V
		106.95	25.89	-17.61	43.5	37.54	16.57	1.77	29.99	-	-	P	V
		648.6	27.55	-18.45	46	27.32	26.06	4.02	29.85	-	-	P	V
		840.4	30.1	-15.9	46	26.41	28.43	4.57	29.31	-	-	P	V
		955.9	34.3	-11.7	46	27.51	30.59	4.89	28.69	-	-	P	V
													V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. The emission position marked as “-” means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.

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	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
					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. Margin(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. Margin(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. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.

Appendix D. Radiated Spurious Emission Plots

Test Engineer :	Jesse Wang and Stan Hsieh	**Temperature :**	23.5~24.1°C
		Relative Humidity :	54.3~54.9%

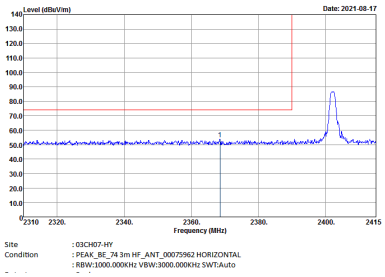
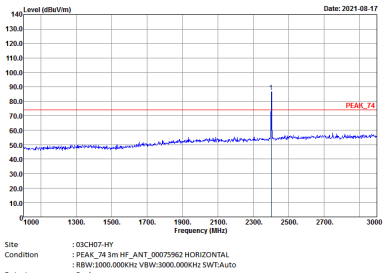
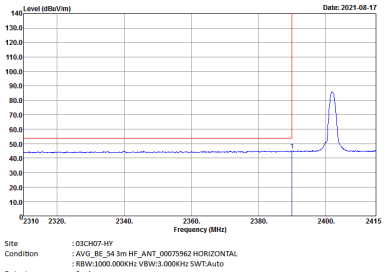
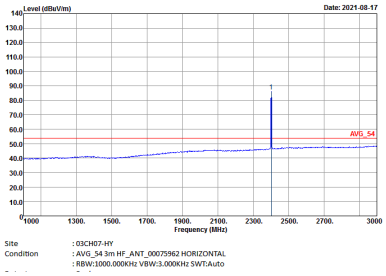
Note symbol

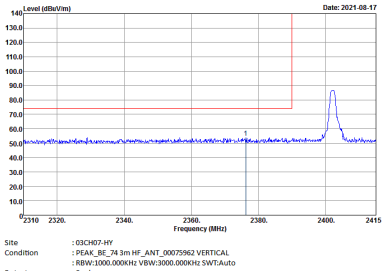
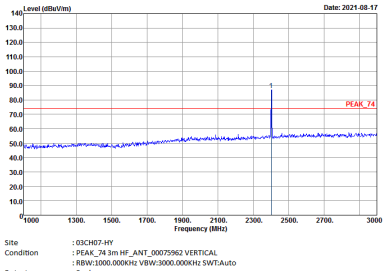
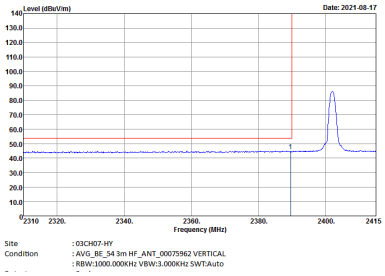
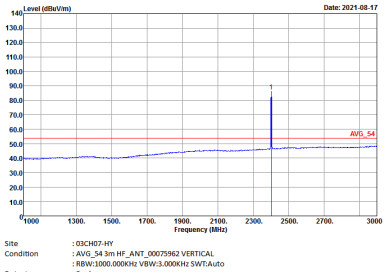
-L	**Low channel location**
-R	**High channel location**

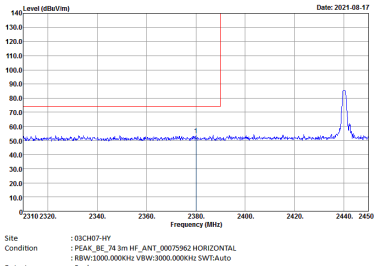
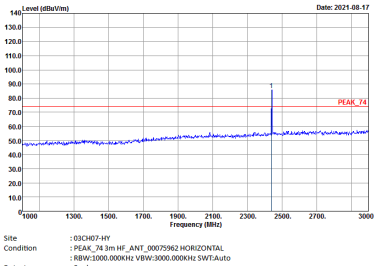
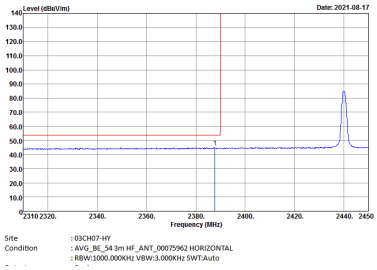
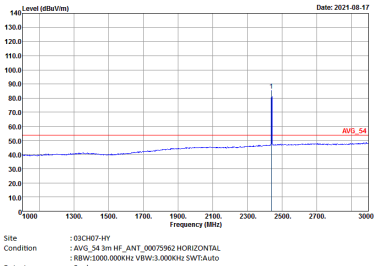
<1Mbps>

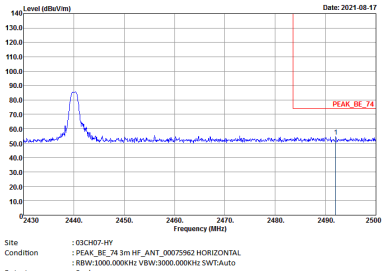
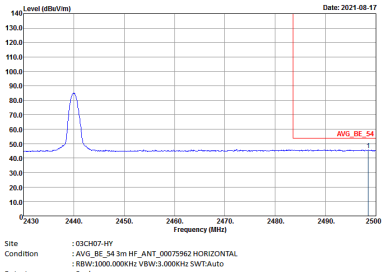
2.4GHz 2400~2483.5MHz

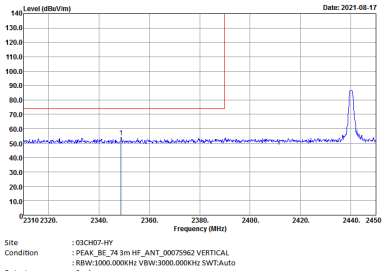
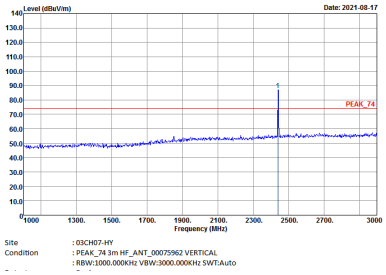
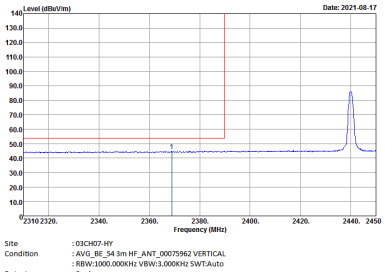
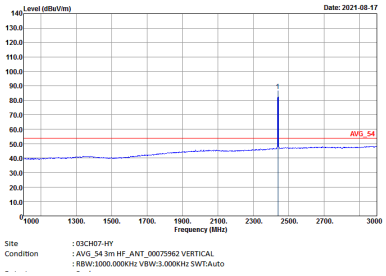
BLE (Band Edge @ 3m)

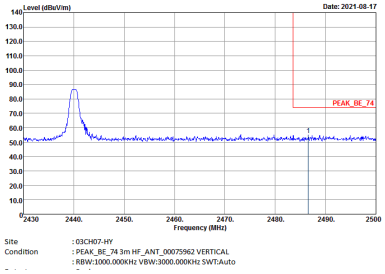
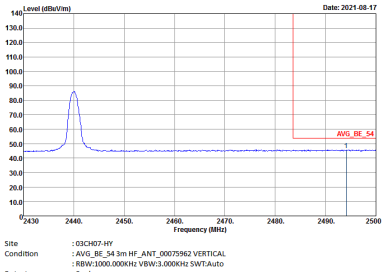
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak		
Avg.		

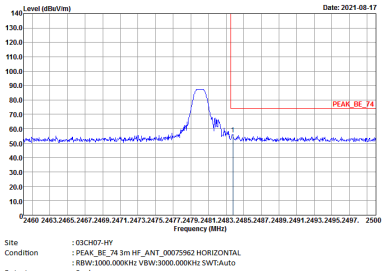
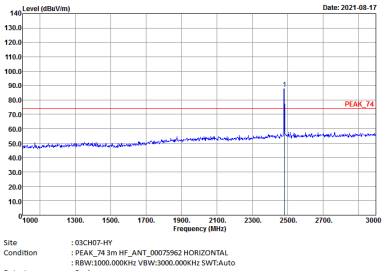
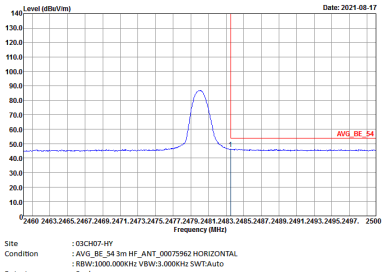
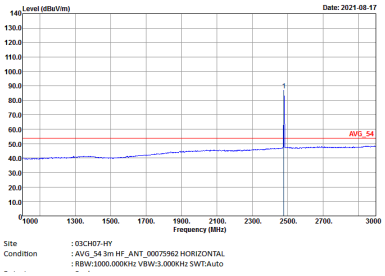
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak		
Avg.		

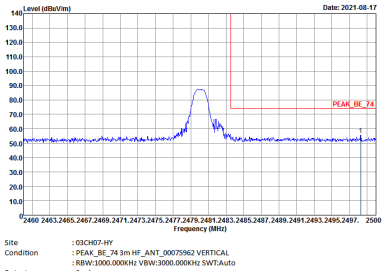
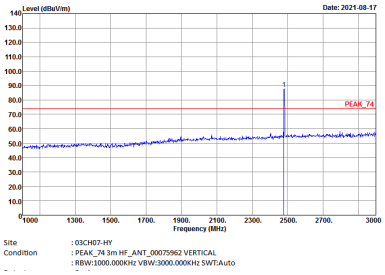
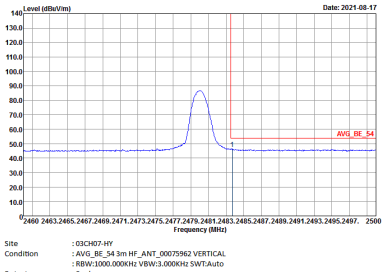
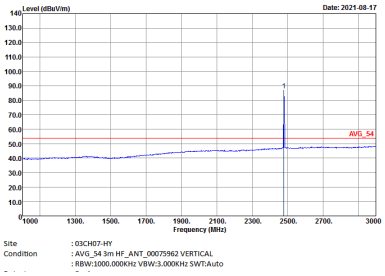
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak		
Avg.		

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		
Avg.		

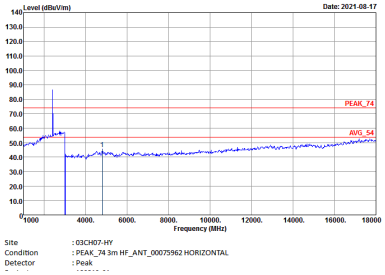
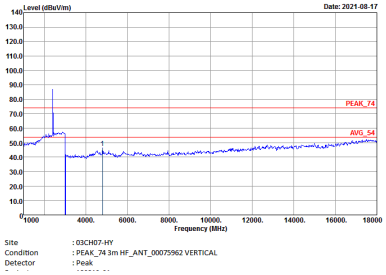
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

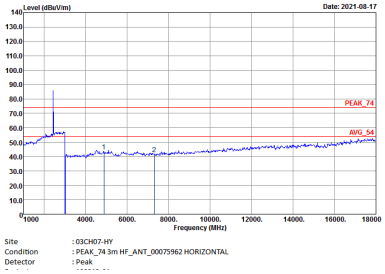
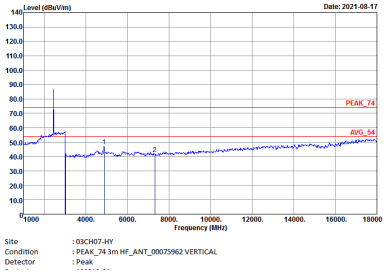
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak		
Avg.		

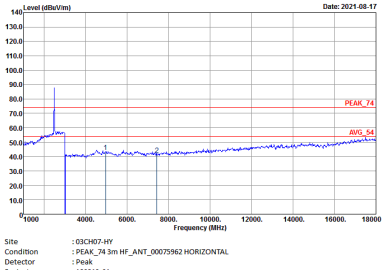
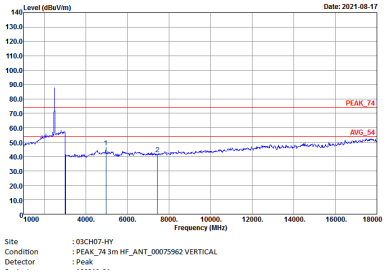
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak		
Avg.		

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

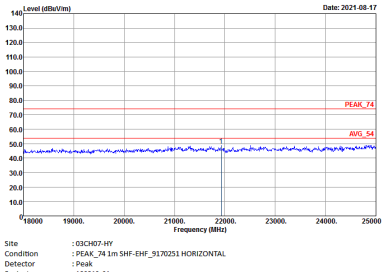
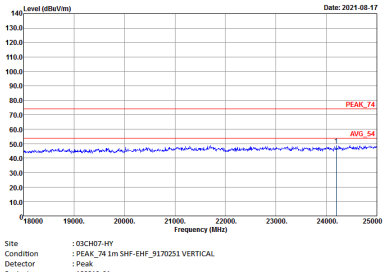
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.		

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 Avg.		

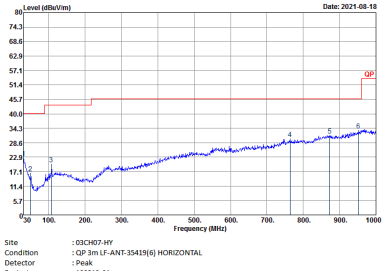
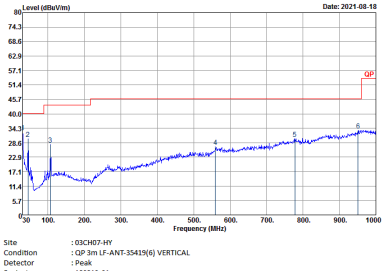
Emission above 18GHz

2.4GHz BLE (SHF @ 1m)

BLE	2.4GHz 2400~2483.5MHz	
	BLE SHF	
	Horizontal	Vertical
Peak Avg.		

Emission below 1GHz

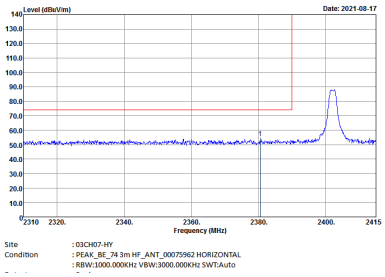
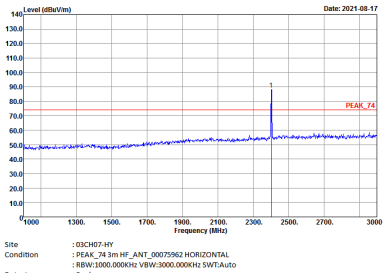
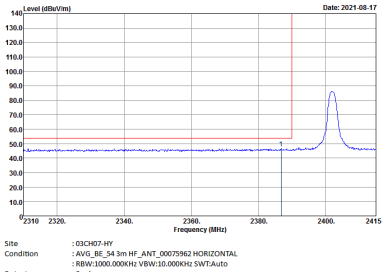
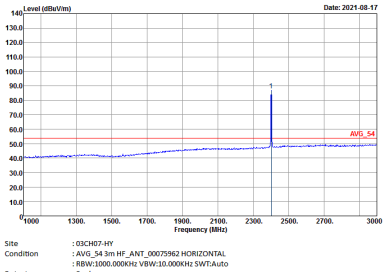
2.4GHz BLE (LF)

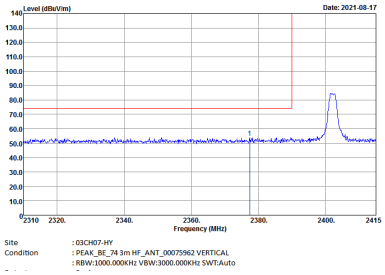
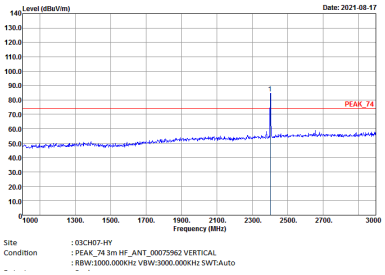
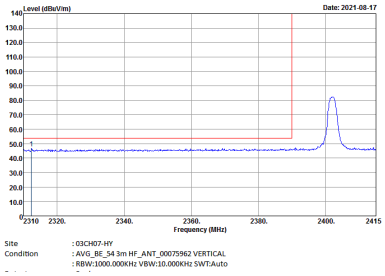
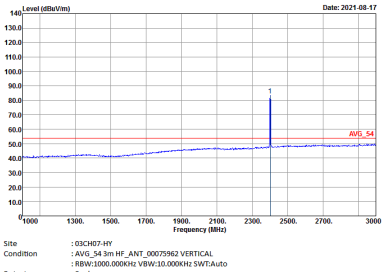
BLE	2.4GHz 2400~2483.5MHz	
	BLE LF	
	Horizontal	Vertical
QP / Peak		

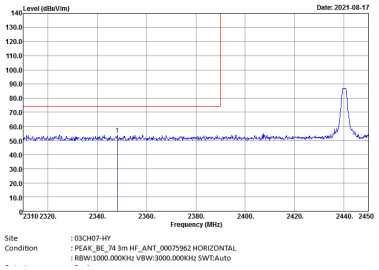
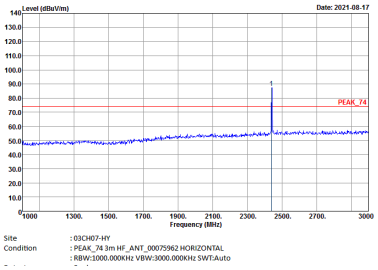
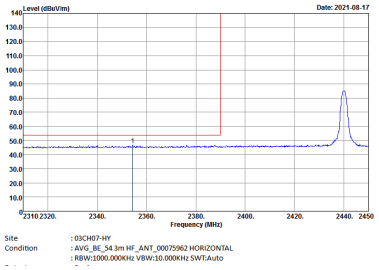
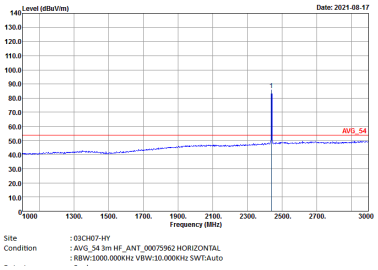
<2Mbps>

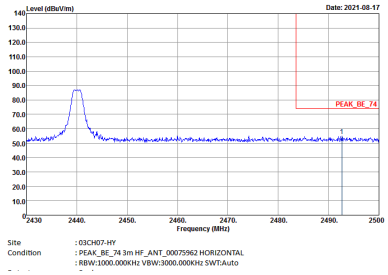
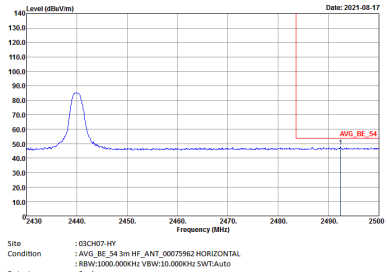
2.4GHz 2400~2483.5MHz

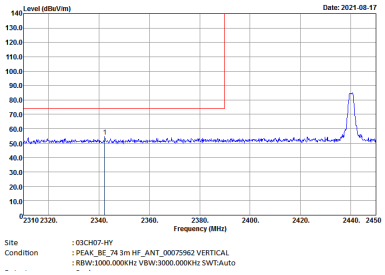
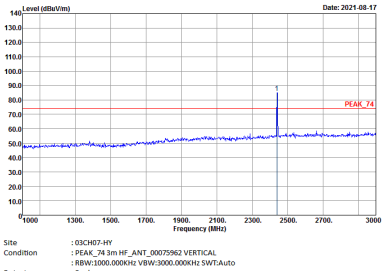
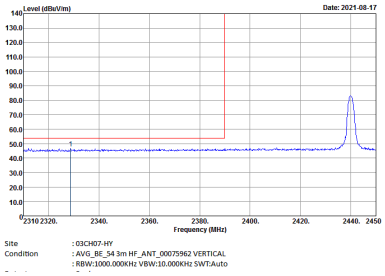
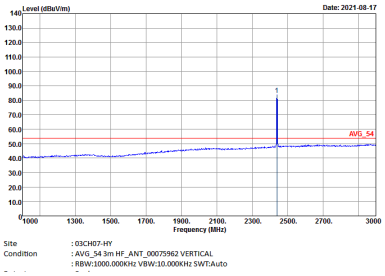
BLE (Band Edge @ 3m)

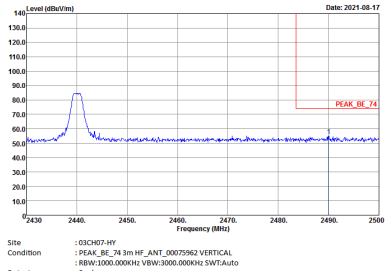
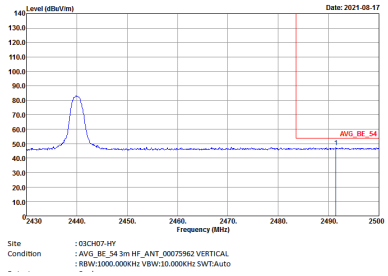
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak		
Avg.		

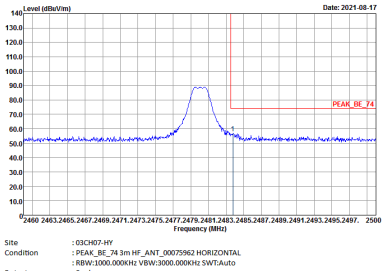
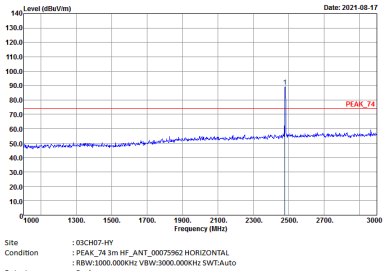
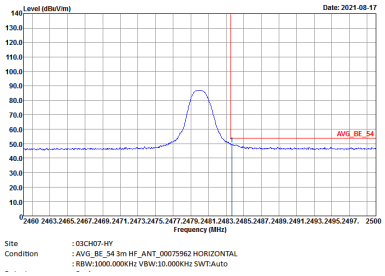
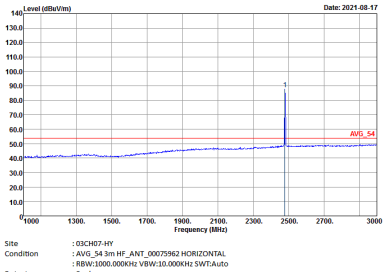
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak		
Avg.		

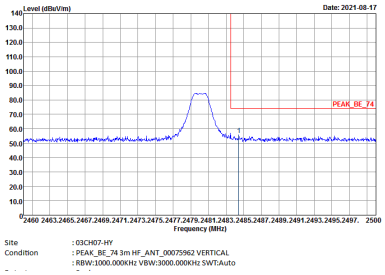
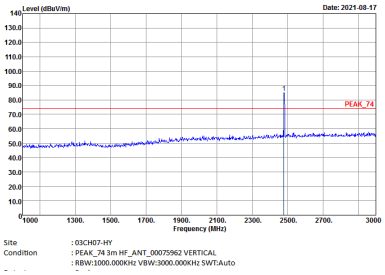
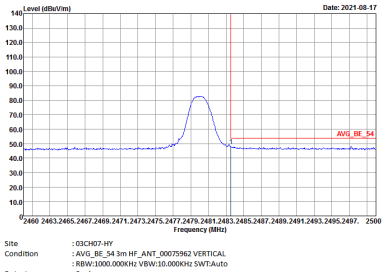
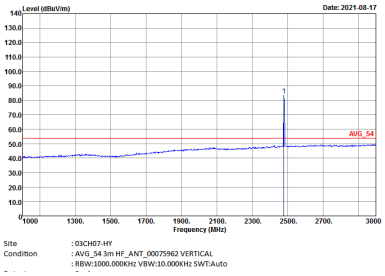
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak		
Avg.		

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		
Avg.		

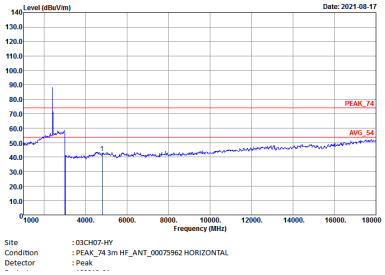
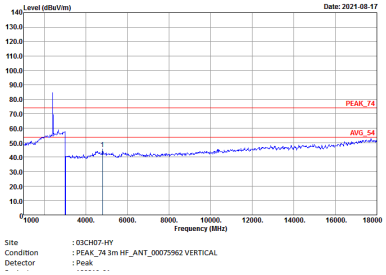
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

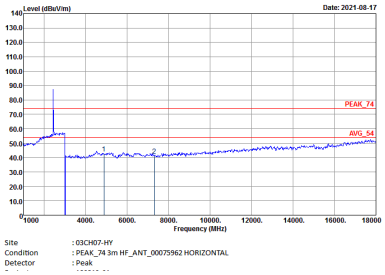
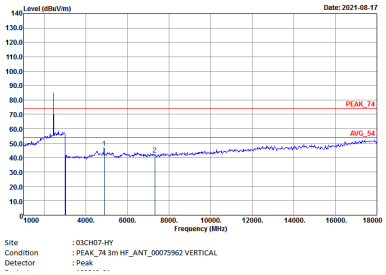
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak		
Avg.		

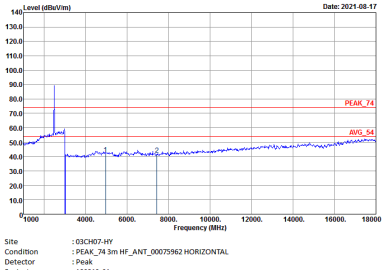
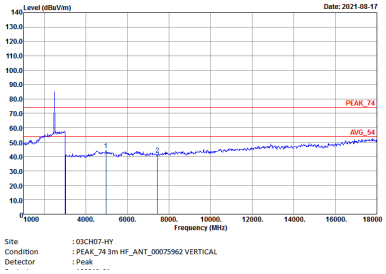
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak		
Avg.		

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

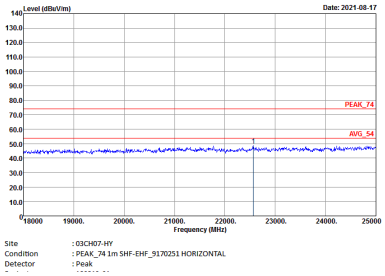
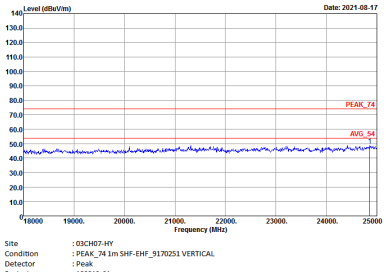
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.		

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 Avg.		

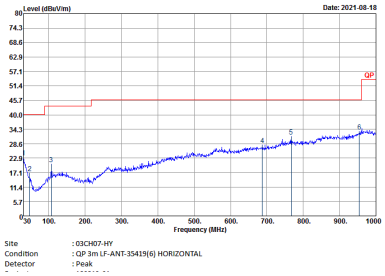
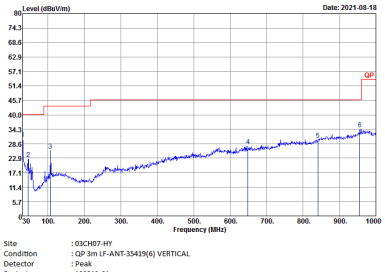
Emission above 18GHz

2.4GHz BLE (SHF @ 1m)

BLE	2.4GHz 2400~2483.5MHz	
	BLE SHF	
	Horizontal	Vertical
Peak Avg.		

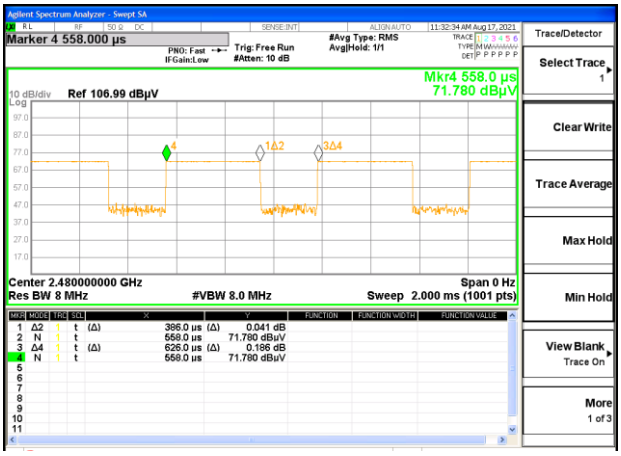
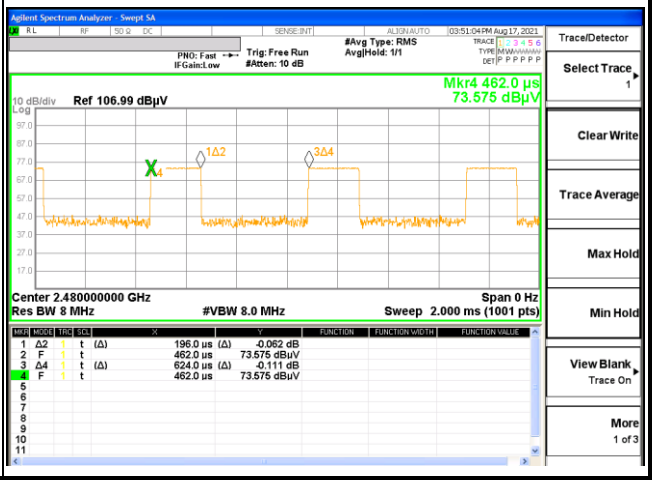
Emission below 1GHz

2.4GHz BLE (LF)

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

Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth -LE for 1Mbps	61.66	386	2.59	3kHz
Bluetooth –LE for 2Mbps	31.41	196	5.10	10kHz

Bluetooth – LE for 1Mbps	Bluetooth – LE for 2Mbps
	

————THE END————