NCC RADIO TEST REPORT

Equipment	:	**Network Security Gateway**
Brand Name	:	**FORTINET**
Model Name	:	**FG-80F,FG-81F,FG-80F-Bypass,FG-81F-Bypass,FG-80F-USG,FG-81F-USG,FG-80F-Bypass-USG,FG-81F-Bypass-USG**
Applicant	:	英屬蓋曼群島商防特往股份有限公司台灣分公司 臺北市內湖區行愛路 **176** 號 **2** 樓
Manufacturer	:	**Fortinet Inc.** **899 KIFER RD** **SUNNYVALE CA 94086-5301** **UNITED STATES**
Standard	:	**NCC LP0002 (2018-01-10)**

The product was received on Mar. 20, 2020 and testing was started from Apr. 30, 2020 and completed on May 11, 2020. 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 NCC LP0002 (2018-01-10) and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

History of this test report **3**
Summary of Test Result **4**
1 General Description **5**
1.1 Product Feature of Equipment Under Test 5
1.2 Modification of EUT 5
1.3 Testing Location 6
1.4 Applicable Standards 6
2 Test Configuration of Equipment Under Test **7**
2.1 Carrier Frequency Channel 7
2.2 Test Mode 8
2.3 Connection Diagram of Test System 9
2.4 EUT Operation Test Setup 10
2.5 Measurement Results Explanation Example 10
3 Test Result **11**
3.1 6dB and 99% Bandwidth Measurement 11
3.2 Output Power Measurement 20
3.3 Power Spectral Density Measurement 21
3.4 Conducted Band Edges and Spurious Emission Measurement 30
3.5 Radiated Band Edges and Spurious Emission Measurement 39
3.6 AC Conducted Emission Measurement 43
3.7 Antenna Requirements 45
4 List of Measuring Equipment **46**
5 Uncertainty of Evaluation **48**
Appendix A. Conducted Test Results
Appendix B. AC Conducted Emission Test Result
Appendix C. Radiated Spurious Emission
Appendix D. Radiated Spurious Emission Plots
Annex A. Receiver Radiated Emission
Appendix E. Duty Cycle Plots
Appendix F. Setup Photographs

History of this test report

Report No.	Version	Description	Issued Date
TR032024	01	Initial issue of report	Jun. 02, 2020
TR032024	02	Adding sample list in section 1.1	Jun. 19, 2020

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	LP0002 3.10.1.6 (2)(A)	6dB Bandwidth	Pass	-
3.1	-	99% Occupied Bandwidth	Reporting only	-
3.2	LP0002 3.10.1.2 (1)(C)	Output Power	Pass	-
3.3	LP0002 3.10.1.6 (2)(B)	Power Spectral Density	Pass	-
3.4	LP0002 3.10.1.5	Conducted Band Edges and Spurious Emission	Pass	-
3.5	LP0002 3.10.1.5	Radiated Band Edges and Spurious Emission	Pass	Under limit 0.41 dB at 4804.000 MHz
3.6	LP0002 2.3	AC Conducted Emission	Pass	Under limit 8.48 dB at 0.491 MHz
3.7	LP0002 2.2 3.10.1.3 3.10.1.4	Antenna Requirement	Pass	-
Annex A	LP0002 2.11	Receiver Radiated Emission	Pass	Please refer to Annex A

Remark: The difference of sample 1 to sample 8 can be referred Product Equality Declaration.

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: Wii Chang

Report Producer: Vivian Hsu

1 General Description

1.1 Product Feature of Equipment Under Test

Bluetooth - LE

Product Specification subjective to this standard	
Sample 1	FG-80F
Sample 2	FG-80F-USG
Sample 3	FG-80F-Bypass
Sample 4	FG-80F-Bypass-USG
Sample 5	FG-81F
Sample 6	FG-81F-USG
Sample 7	FG-81F-Bypass
Sample 8	FG-81F-Bypass-USG
Antenna Type	Bluetooth: PIFA Antenna

Specification of Accessory		
AC Adapter	**Brand Name**	全漢
	Model Name	FSP036-RHBN3

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, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978	
Test Site No.	**Sporton Site No.**	
	TH05-HY	CO05-HY

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

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	03CH13-HY

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

FCC designation No.: TW1190 and TW0007

1.4 Applicable Standards

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

- NCC LP0002 (2018-01-10)
- 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

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).

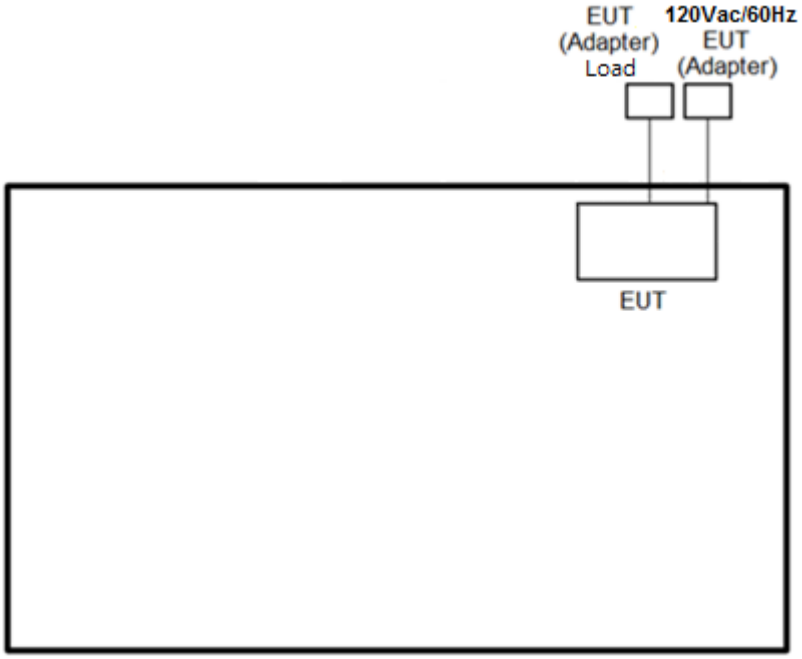
b. AC power line Conducted Emission was tested under maximum output power.

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

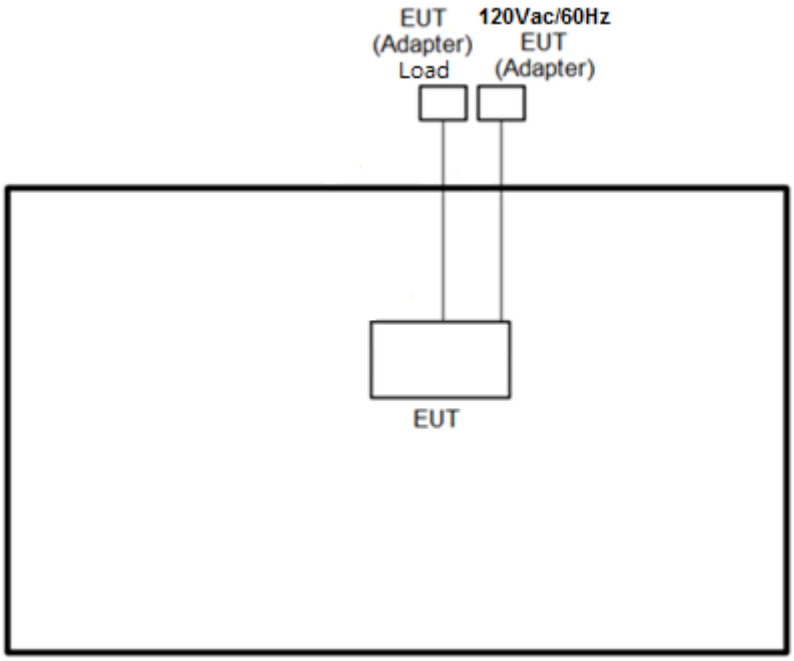
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
	Bluetooth – LE / GFSK
Conducted Test Cases	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps Mode 4: Bluetooth Tx CH00_2402 MHz_2Mbps Mode 5: Bluetooth Tx CH19_2440 MHz_2Mbps Mode 6: Bluetooth Tx CH39_2480 MHz_2Mbps
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-LE Tx_1Mbps + Adapter Port 1 + Adapter Port 2 (Load) Mode 2: Bluetooth-LE Tx_1Mbps + Adapter Port 1 (Load) + Adapter Port 2
Remark: 1. The worst case of conducted emission is mode 2; only the test data of it was reported. 2. All test items were performed with Sample 7.	

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 “Tera Term v4.89” 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 10dB attenuator.

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

= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

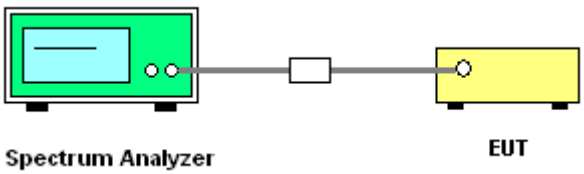
3.1.2 Measuring Instruments

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 to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 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

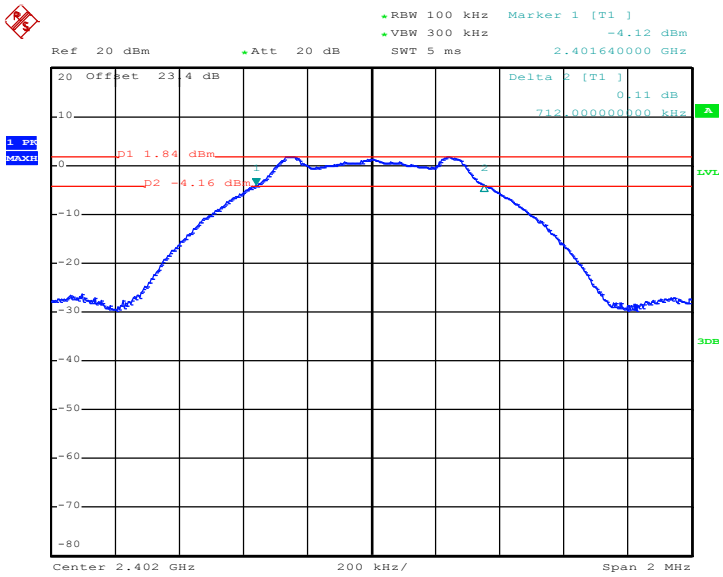


3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

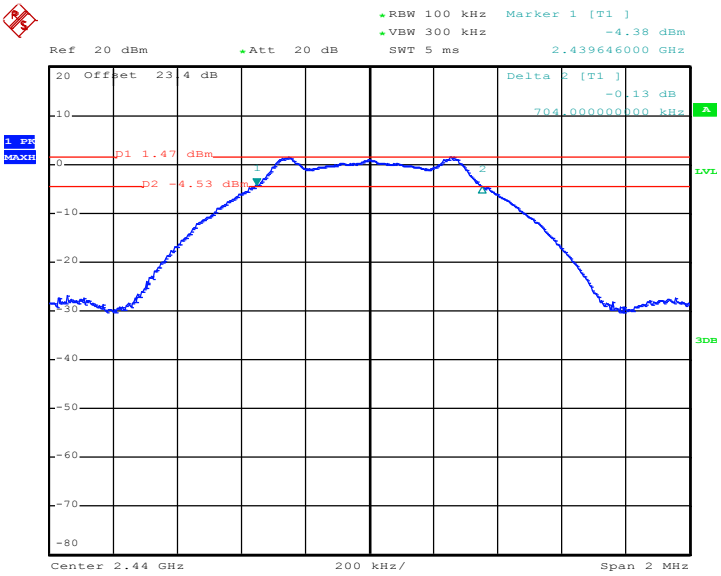
<1Mbps>

6 dB Bandwidth Plot on Channel 00



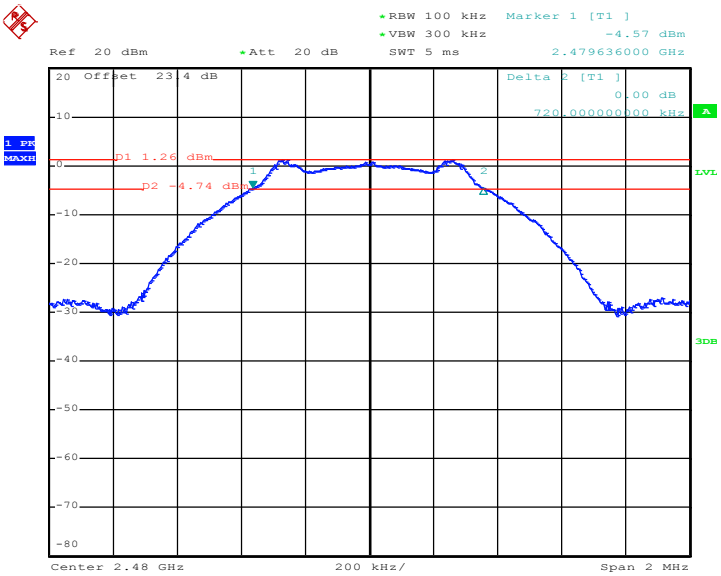
Date: 7.MAY.2020 09:21:24

6 dB Bandwidth Plot on Channel 19



Date: 7.MAY.2020 09:29:34

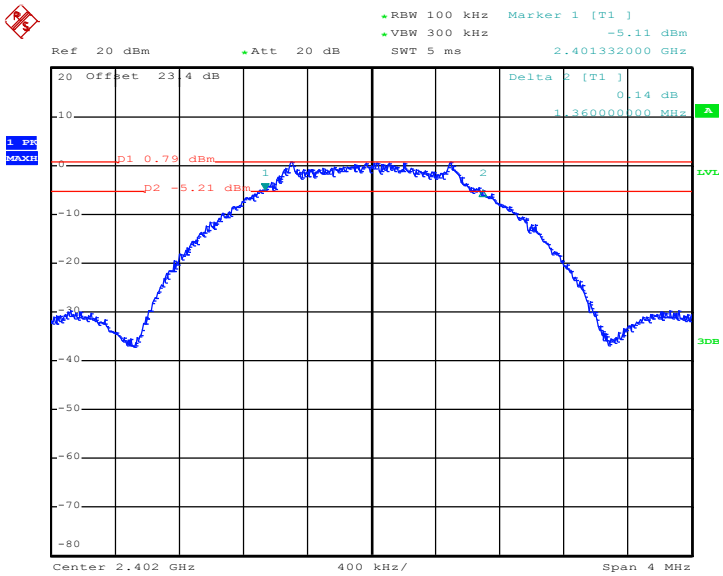
6 dB Bandwidth Plot on Channel 39



Date: 7.MAY.2020 09:35:52

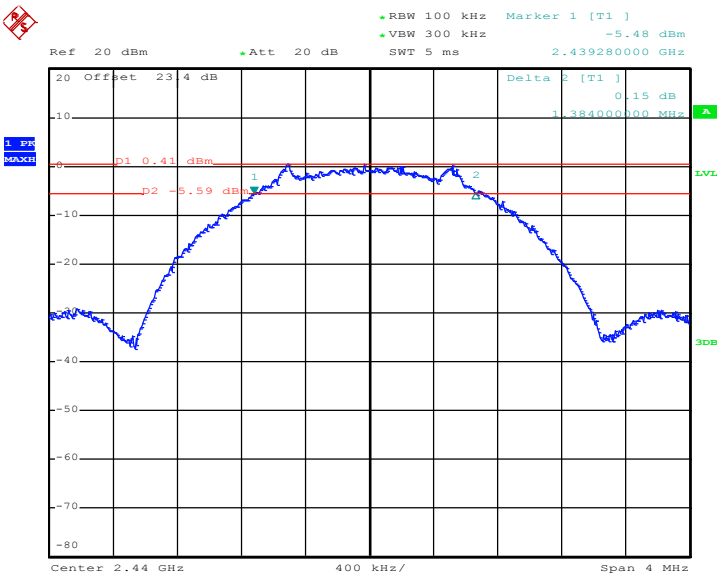
<2Mbps>

6 dB Bandwidth Plot on Channel 00



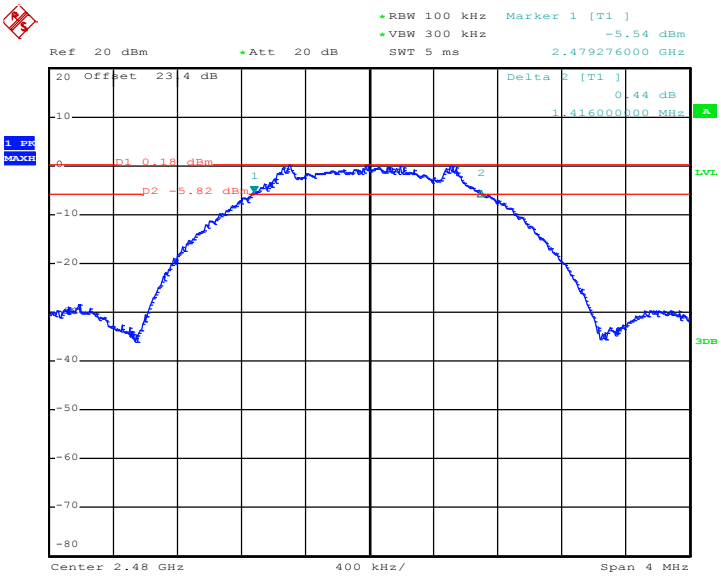
Date: 6.MAY.2020 17:48:49

6 dB Bandwidth Plot on Channel 19



Date: 6.MAY.2020 17:44:38

6 dB Bandwidth Plot on Channel 39



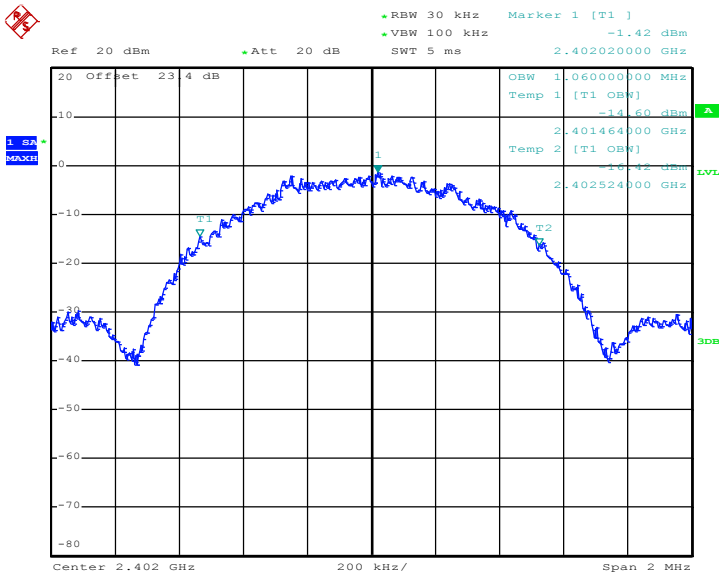
Date: 6.MAY.2020 17:29:08

3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

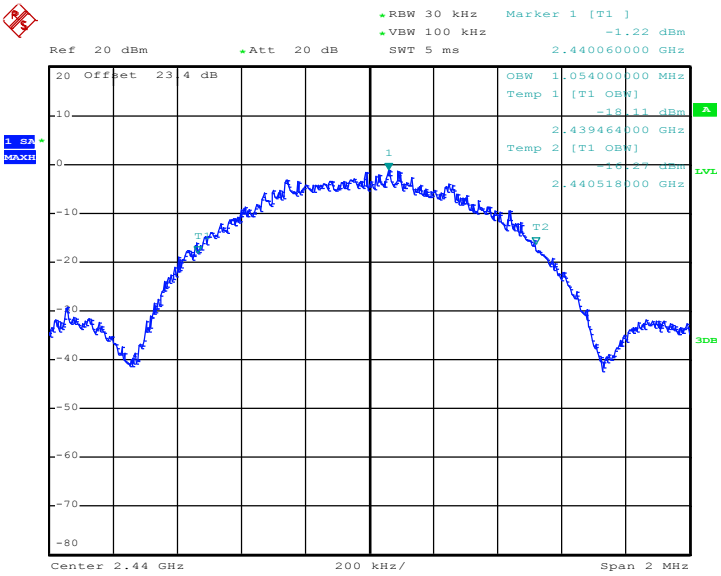
<1Mbps>

99% Bandwidth Plot on Channel 00



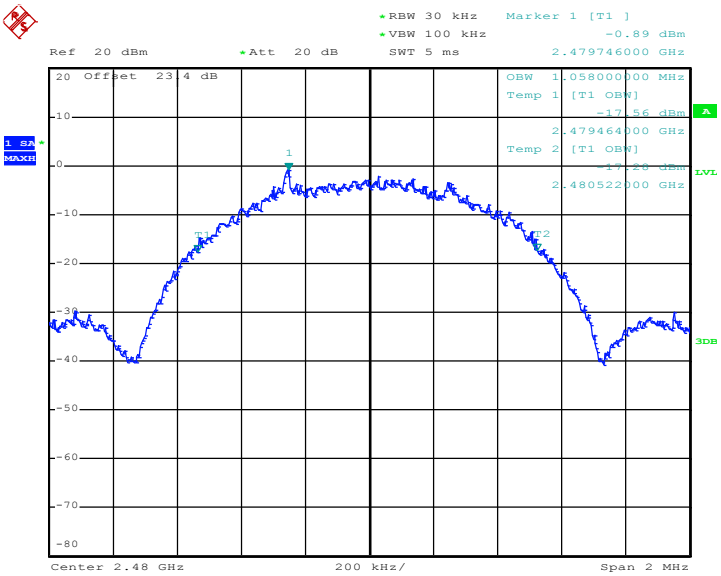
Date: 7.MAY.2020 09:24:49

99% Occupied Bandwidth Plot on Channel 19



Date: 7.MAY.2020 09:33:00

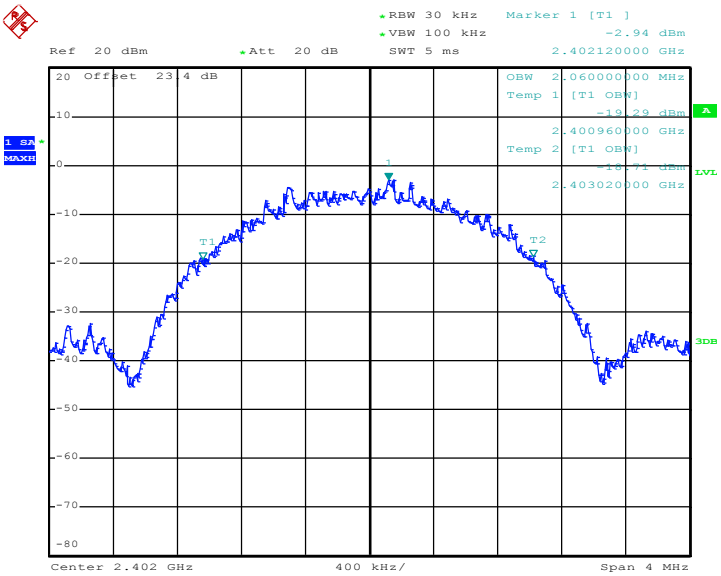
99% Occupied Bandwidth Plot on Channel 39



Date: 7.MAY.2020 09:37:55

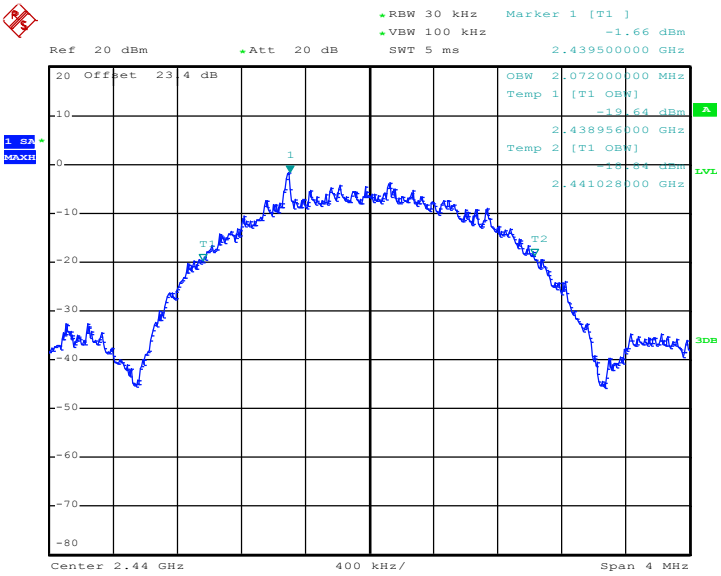
<2Mbps>

99% Bandwidth Plot on Channel 00



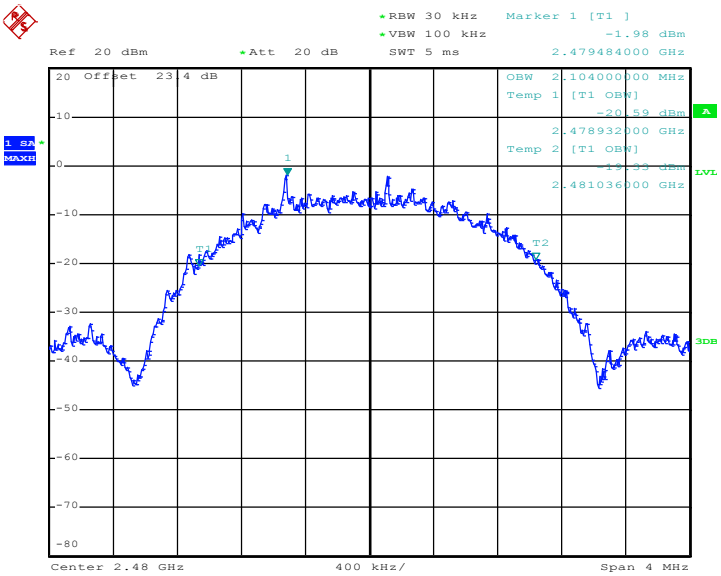
Date: 6.MAY.2020 17:52:37

99% Occupied Bandwidth Plot on Channel 19



Date: 6.MAY.2020 17:46:05

99% Occupied Bandwidth Plot on Channel 39



Date: 6.MAY.2020 17:41:41

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

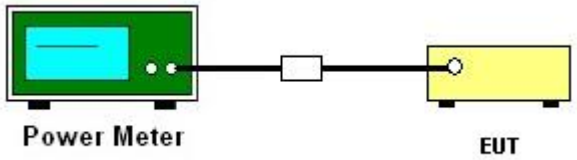
3.2.2 Measuring Instruments

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 to the maximum power setting and enable the EUT 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

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 8dBm in any 3kHz band at any time interval of continuous transmission.

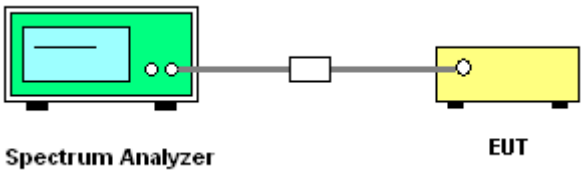
3.3.2 Measuring Instruments

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 to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup



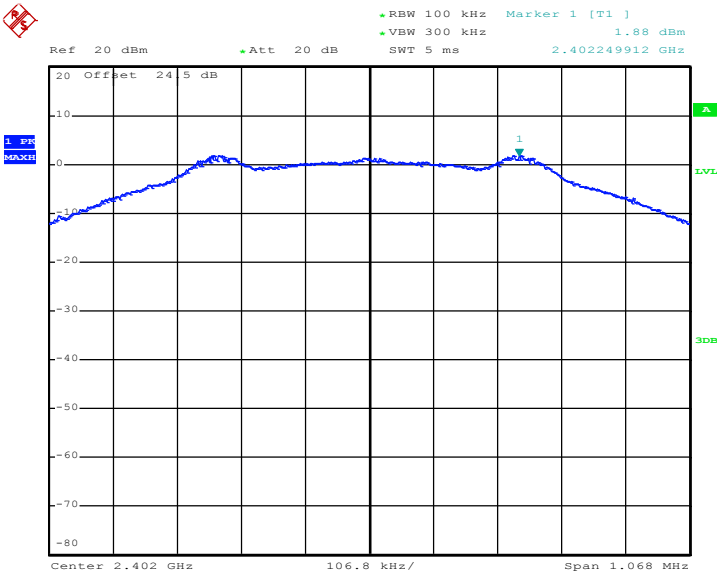
3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

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

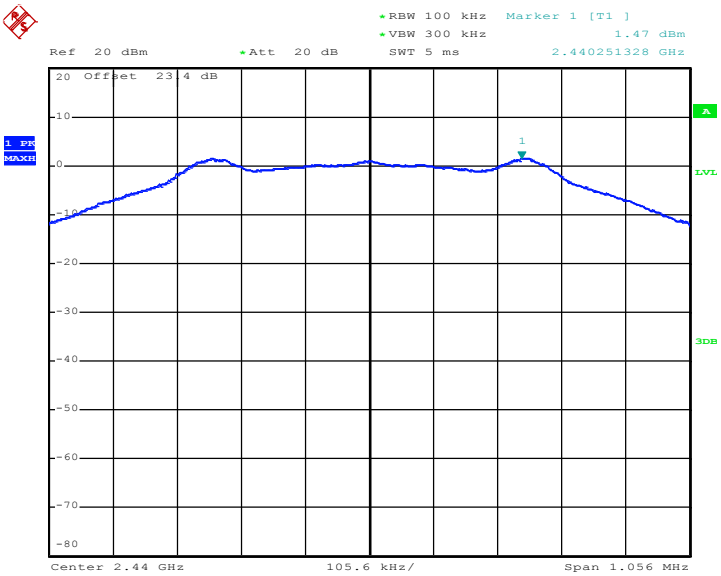
<1Mbps>

PSD 100kHz Plot on Channel 00



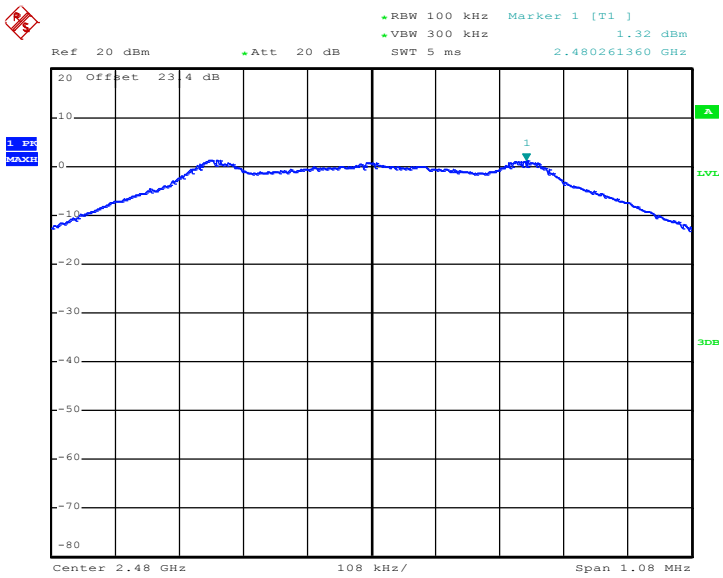
Date: 11.MAY.2020 14:49:25

PSD 100kHz Plot on Channel 19



Date: 7.MAY.2020 09:30:55

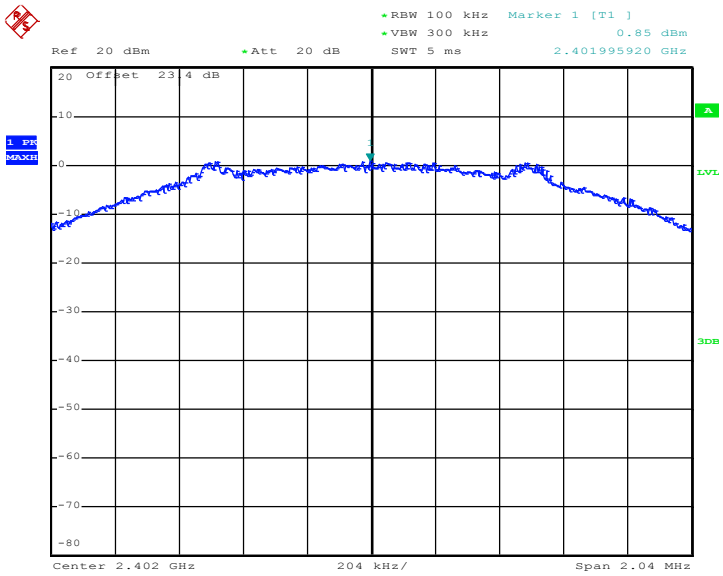
PSD 100kHz Plot on Channel 39



Date: 7.MAY.2020 09:36:32

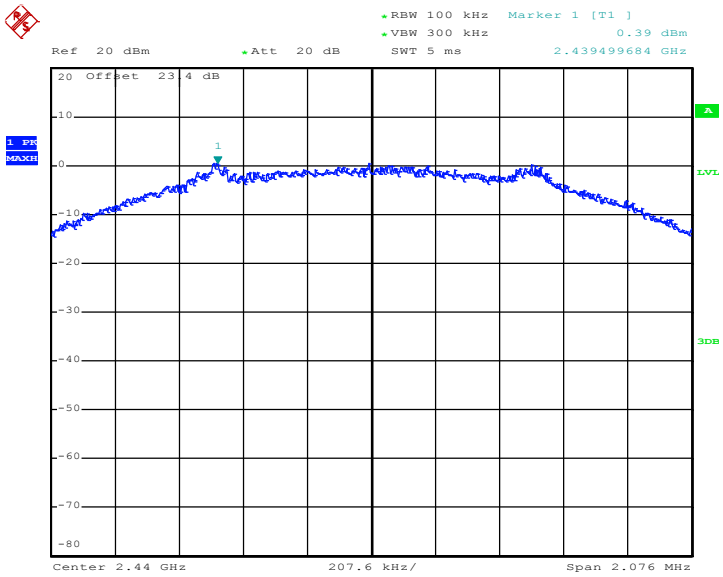
<2Mbps>

PSD 100kHz Plot on Channel 00



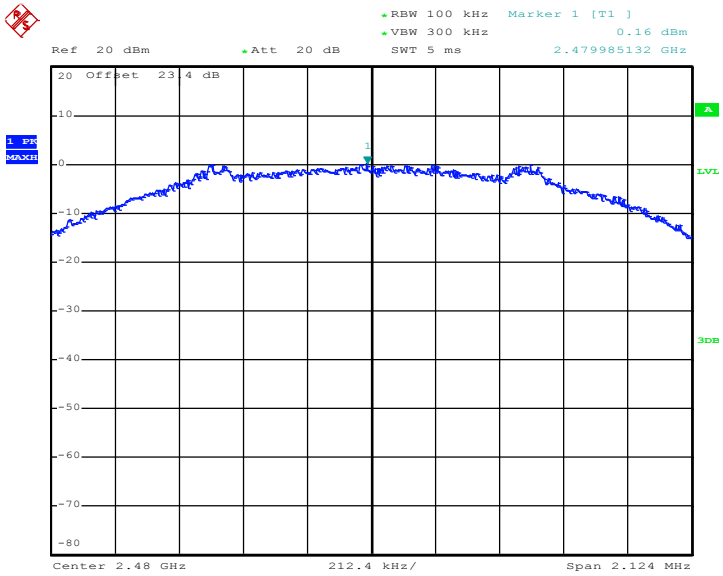
Date: 6.MAY.2020 17:50:19

PSD 100kHz Plot on Channel 19



Date: 6.MAY.2020 17:45:12

PSD 100kHz Plot on Channel 39

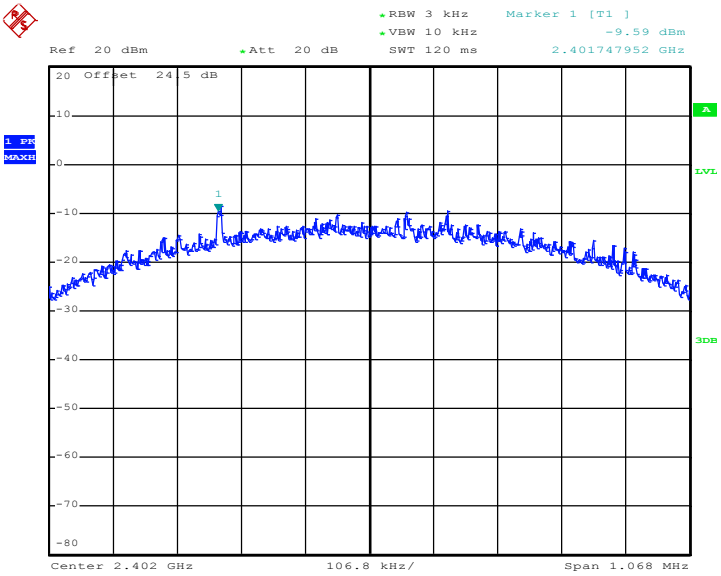


Date: 6.MAY.2020 17:30:05

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

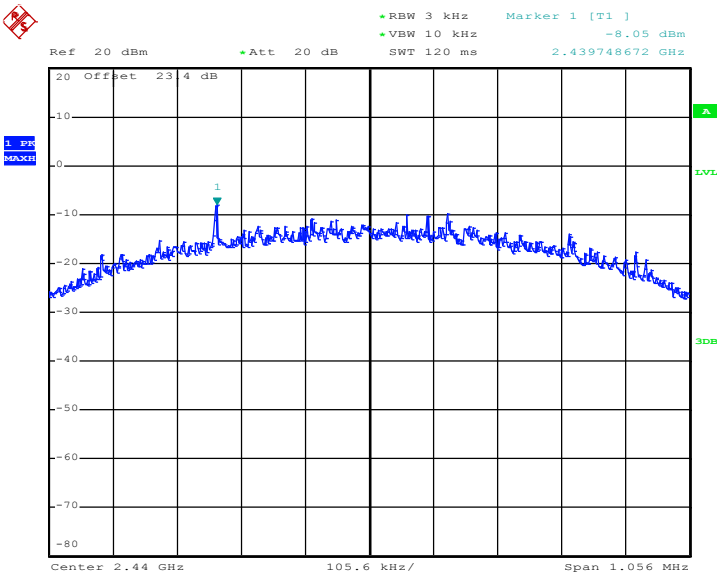
<1Mbps>

PSD 3kHz Plot on Channel 00



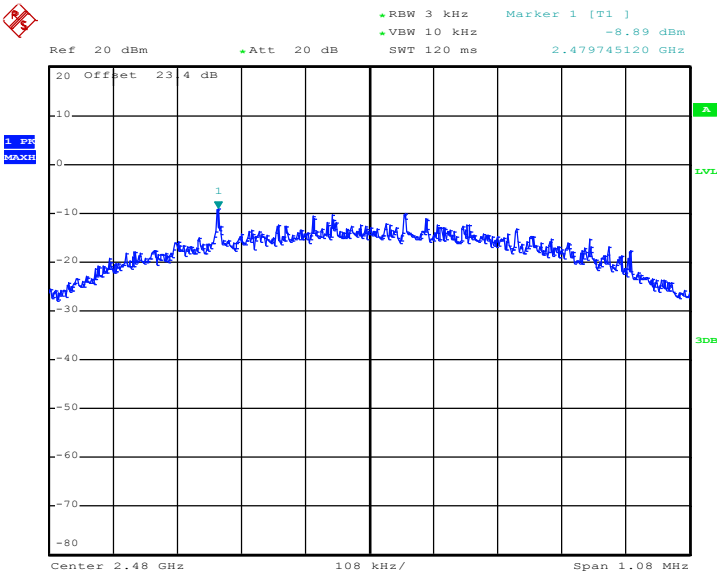
Date: 11.MAY.2020 14:49:08

PSD 3kHz Plot on Channel 19



Date: 7.MAY.2020 09:30:08

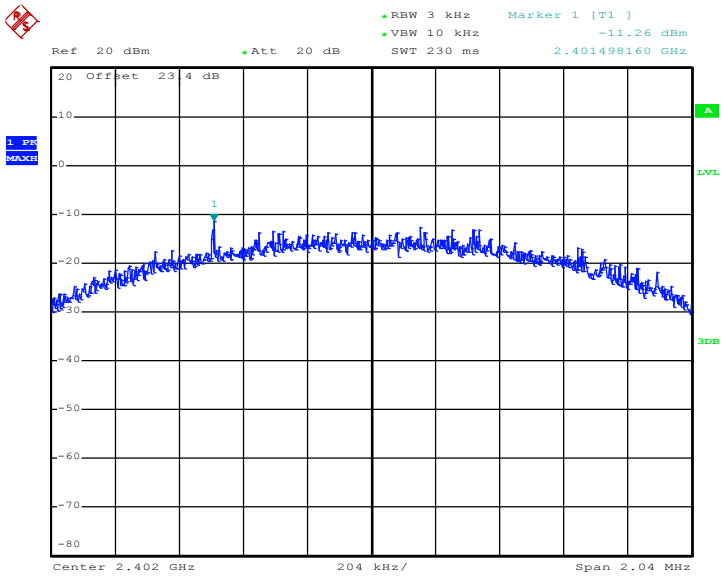
PSD 3kHz Plot on Channel 39



Date: 7.MAY.2020 09:36:18

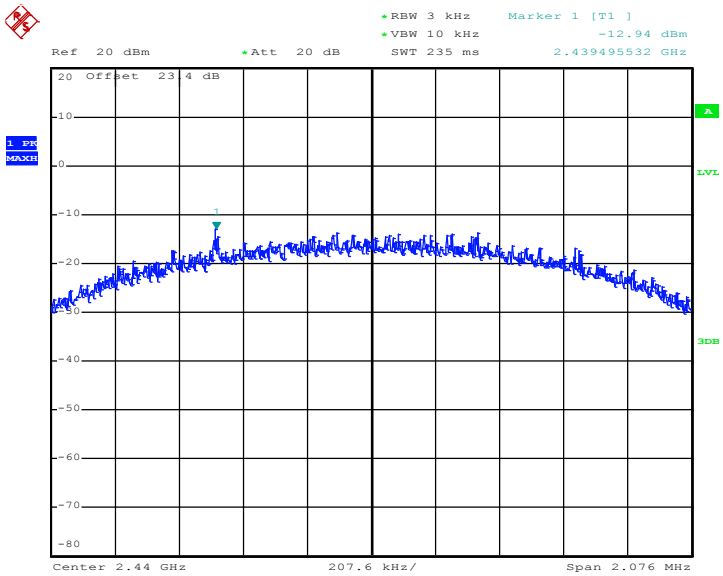
<2Mbps>

PSD 3kHz Plot on Channel 00



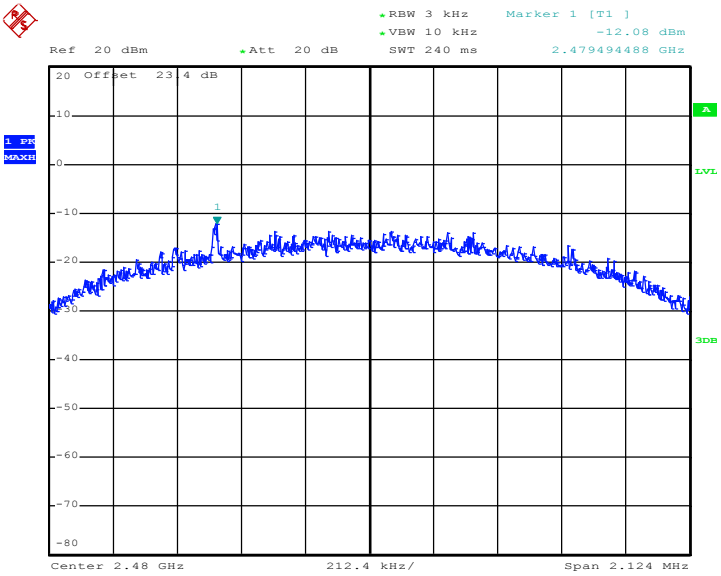
Date: 6.MAY.2020 17:49:19

PSD 3kHz Plot on Channel 19



Date: 6.MAY.2020 17:44:58

PSD 3kHz Plot on Channel 39



Date: 6.MAY.2020 17:29:47

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.

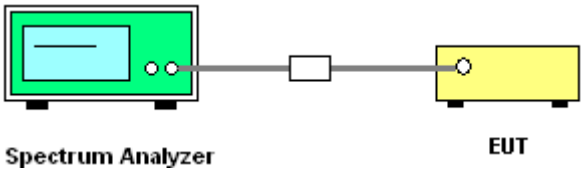
3.4.2 Measuring Instruments

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 to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
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.

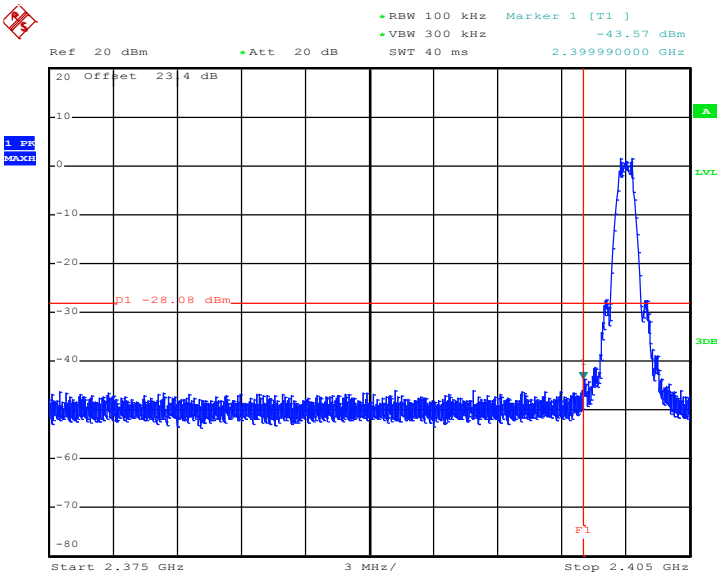
3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges Plots

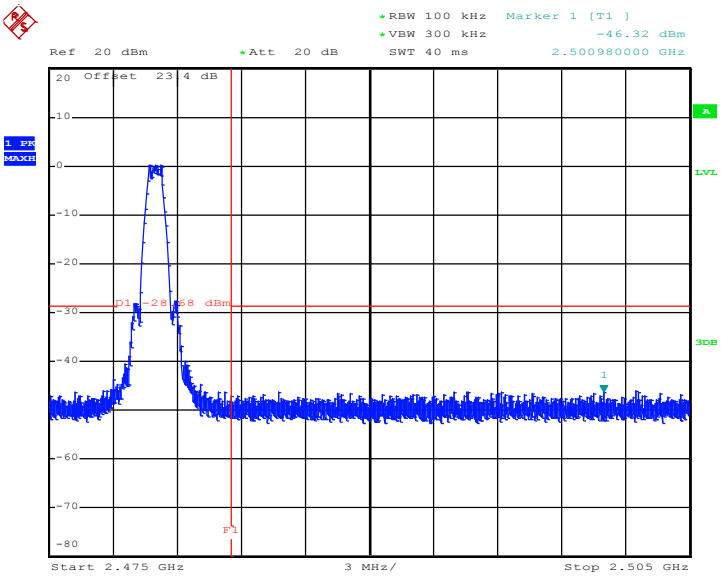
<1Mbps>

Low Band Edge Plot on Channel 00



Date: 7.MAY.2020 09:22:31

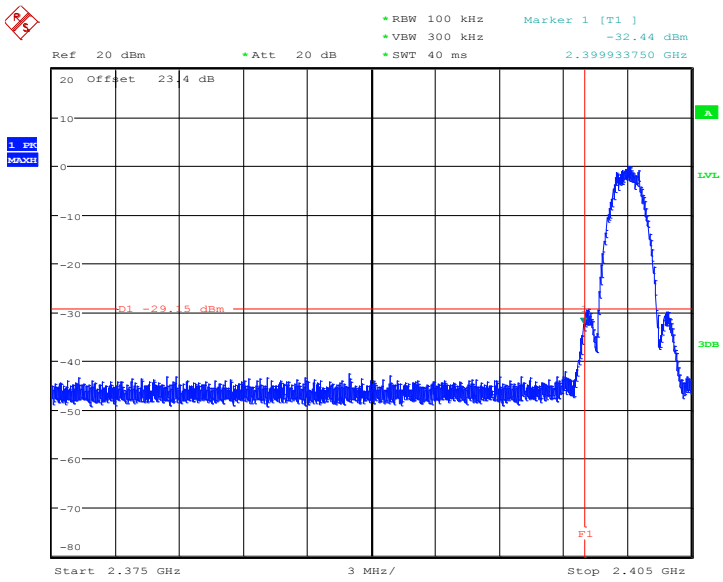
High Band Edge Plot on Channel 39



Date: 7.MAY.2020 09:37:00

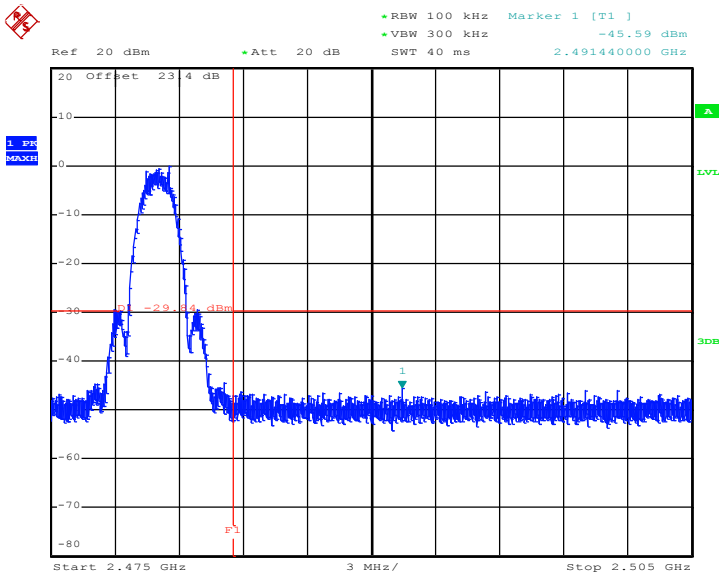
<2Mbps>

Low Band Edge Plot on Channel 00



Date: 8.MAY.2020 02:30:13

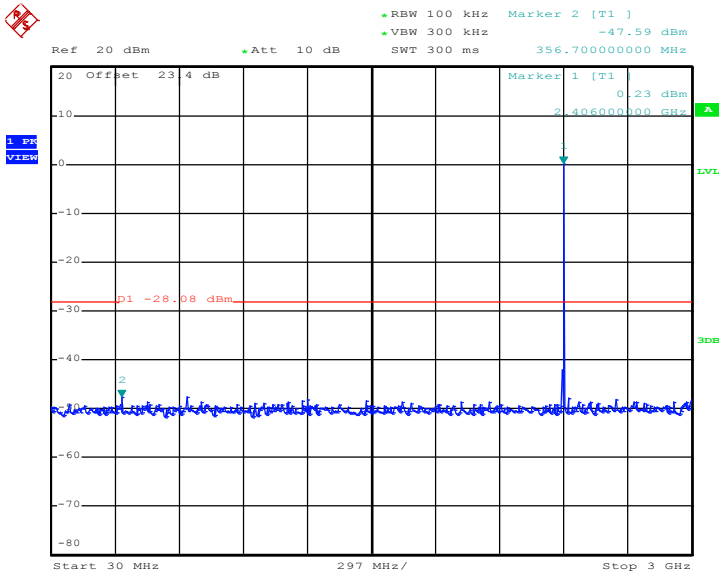
High Band Edge Plot on Channel 39



Date: 6.MAY.2020 17:30:19

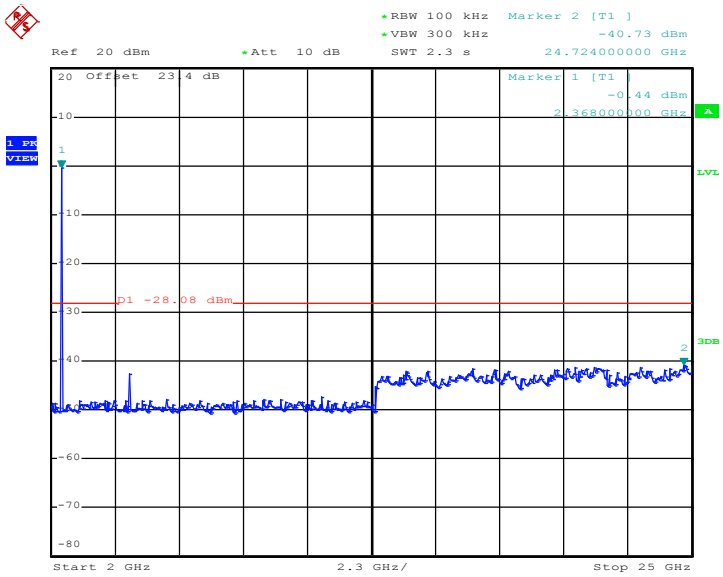
3.4.6 Test Result of Conducted Spurious Emission Plots

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



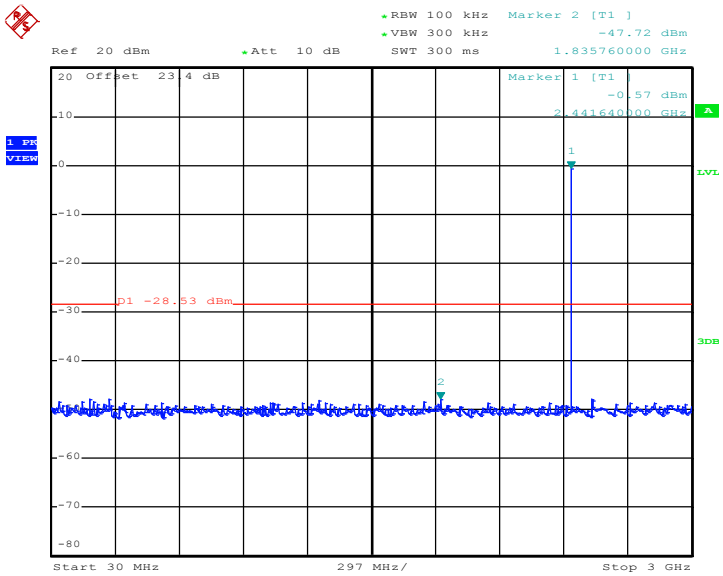
Date: 7.MAY.2020 09:23:23

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



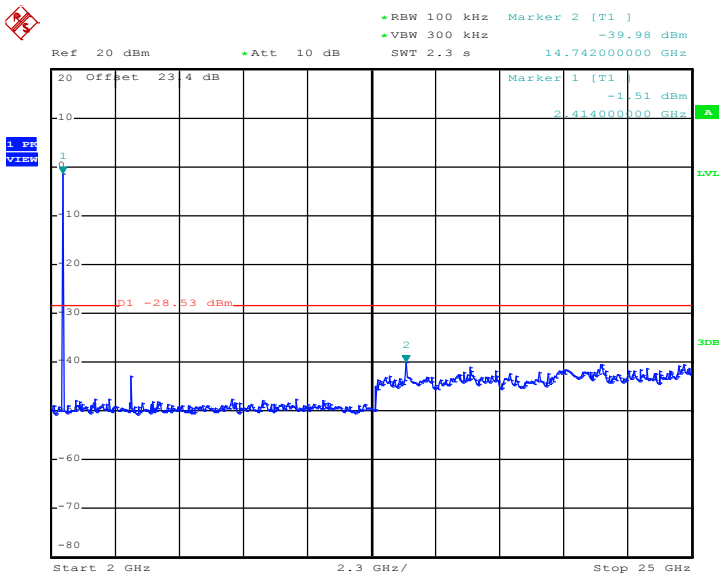
Date: 7.MAY.2020 09:23:41

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



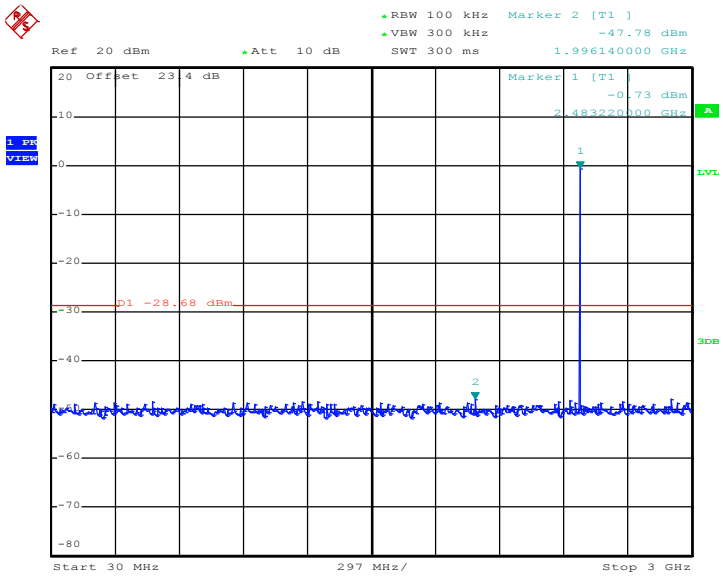
Date: 7.MAY.2020 09:32:31

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



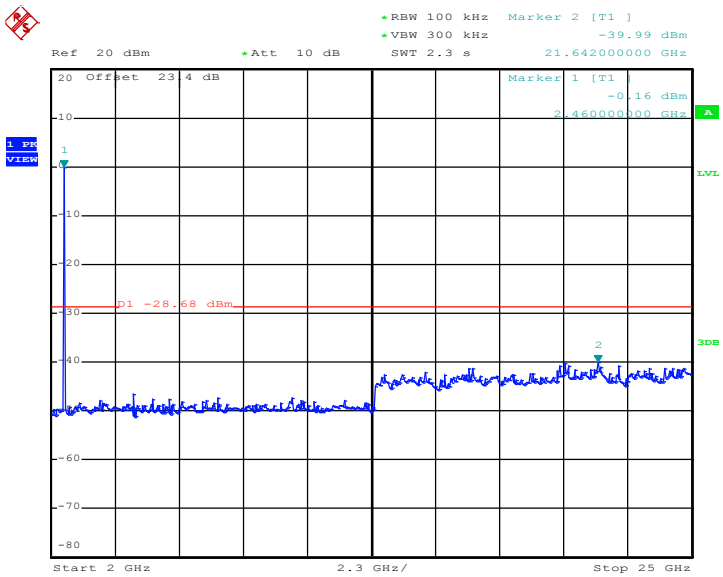
Date: 7.MAY.2020 09:32:46

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



Date: 7.MAY.2020 09:37:18

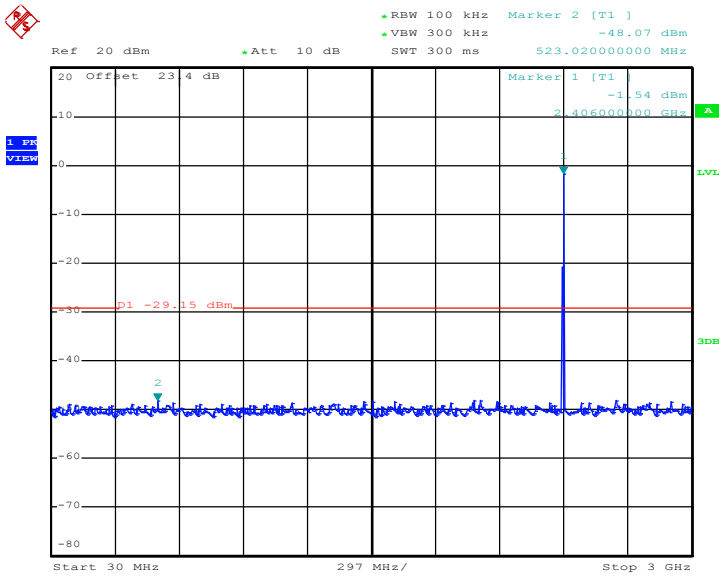
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 39



Date: 7.MAY.2020 09:37:33

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

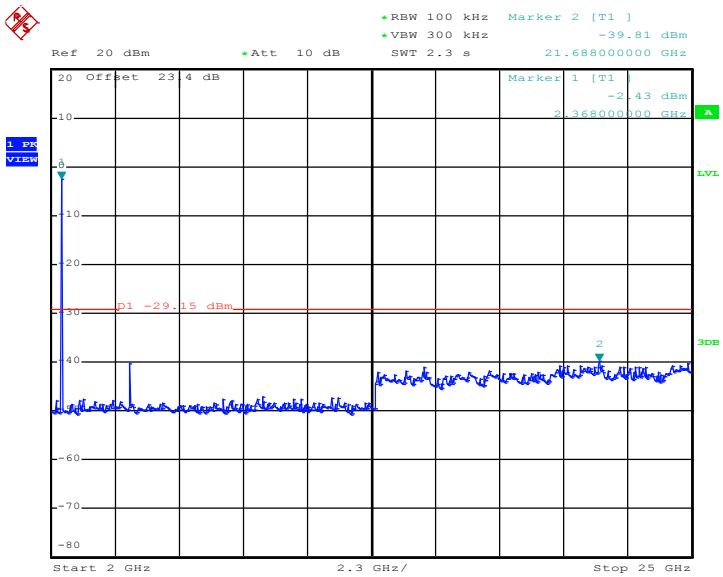
GFSK Channel 00



Date: 6.MAY.2020 17:51:53

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

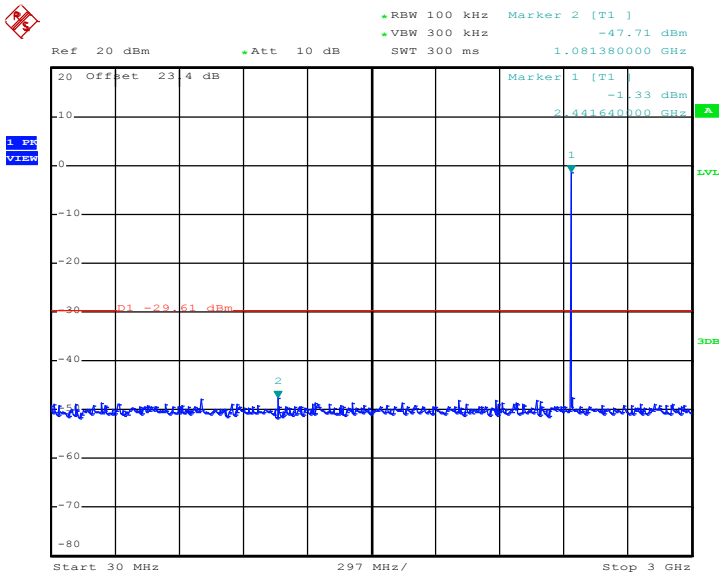
GFSK Channel 00



Date: 6.MAY.2020 17:52:13

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

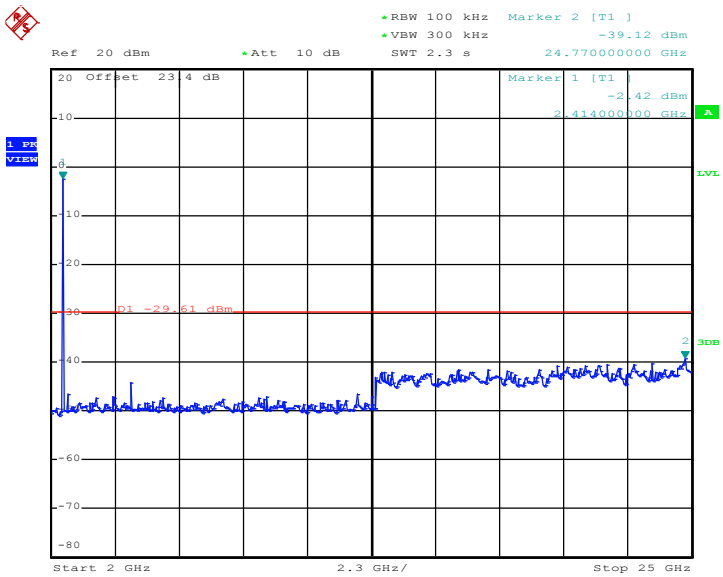
GFSK Channel 19



Date: 6.MAY.2020 17:45:32

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

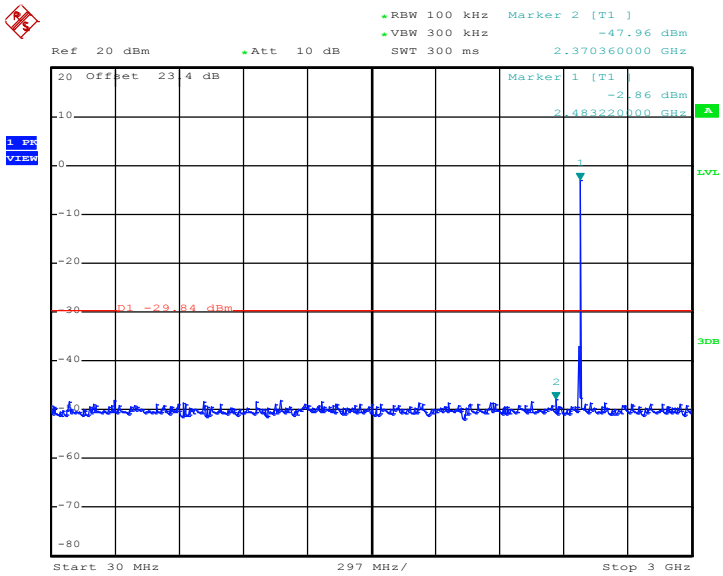
GFSK Channel 19



Date: 6.MAY.2020 17:45:48

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

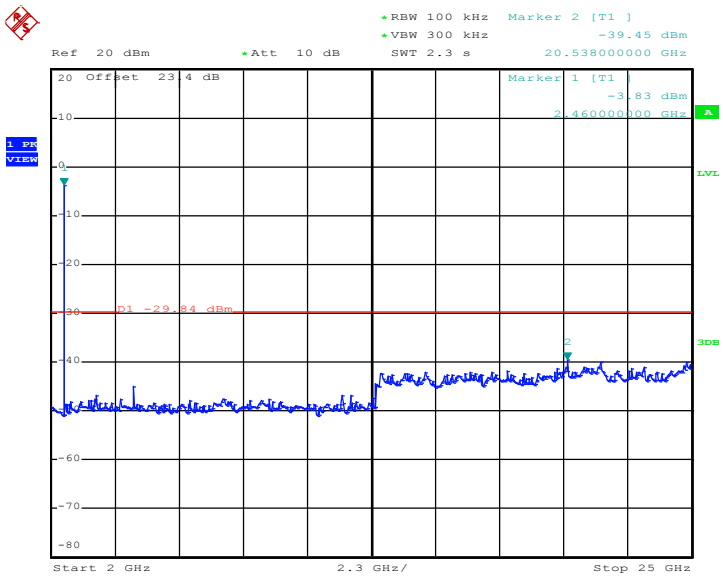
GFSK Channel 39



Date: 6.MAY.2020 17:41:14

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

GFSK Channel 39



Date: 6.MAY.2020 17:41:28

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 2.8 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

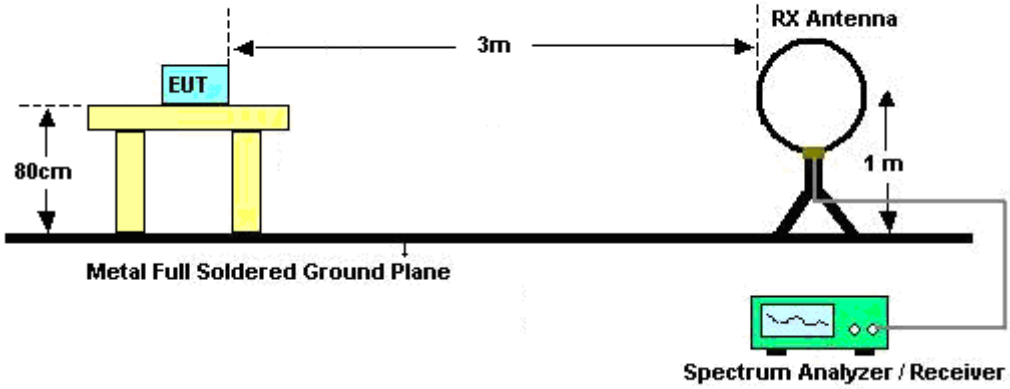
See list of measuring equipment of this test report.

3.5.3 Test Procedures

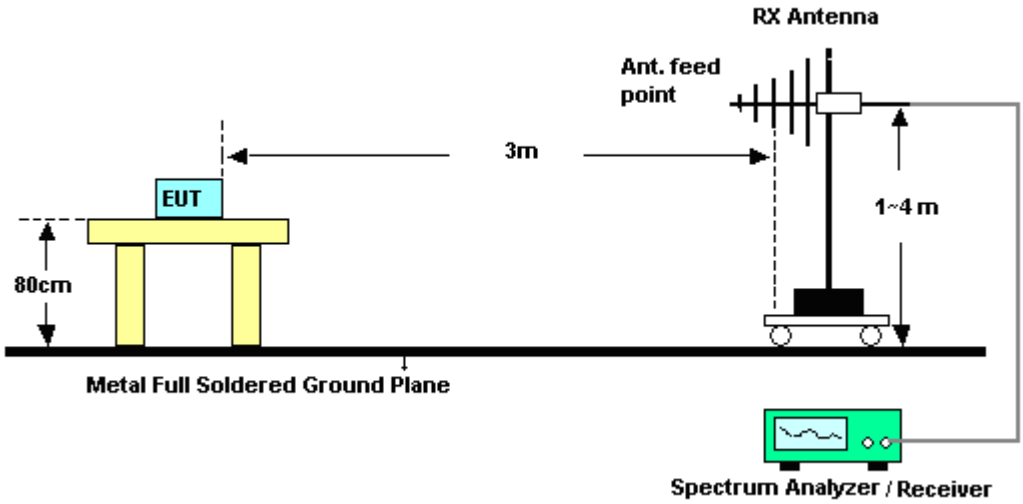
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

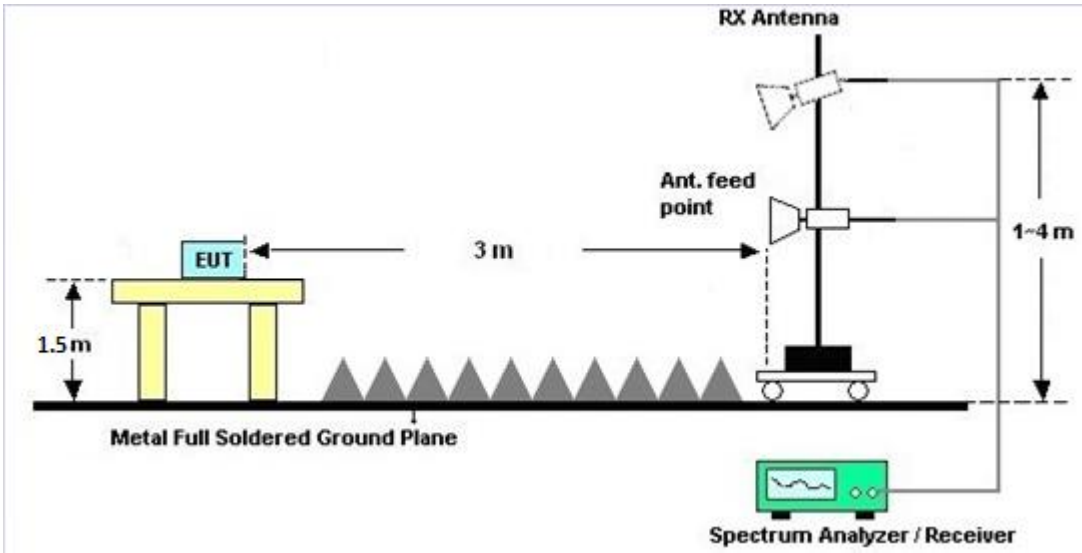
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per NCC LP0002 section 5.13 was not reported.

There is a comparison data 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 (30MHz ~ 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.

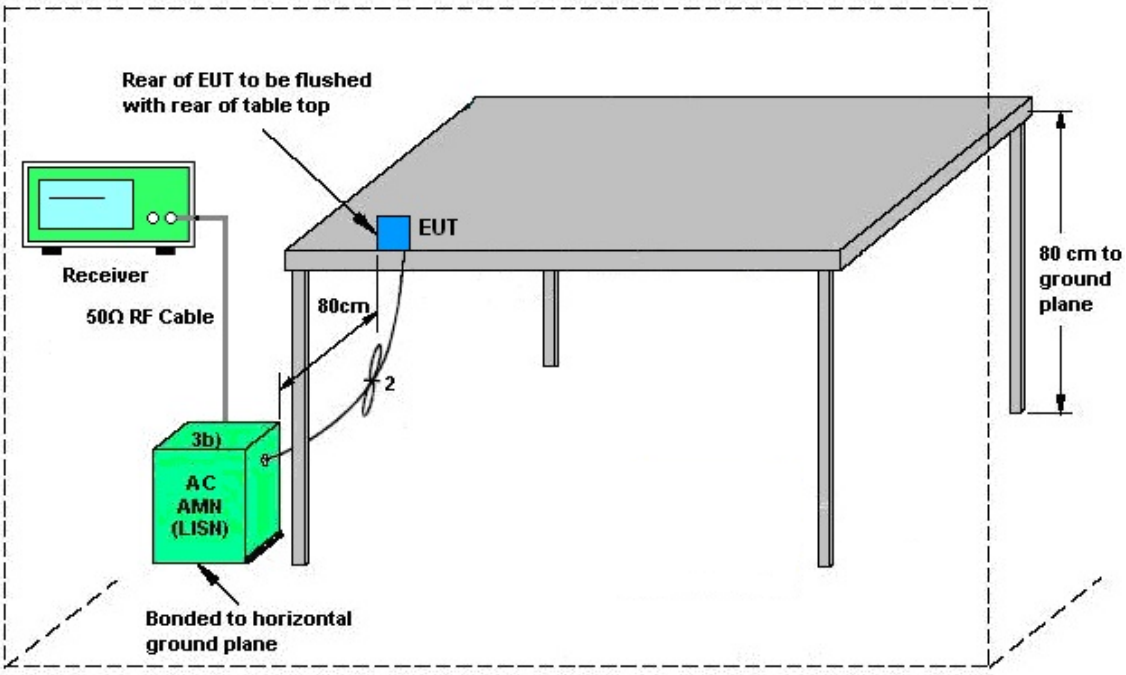
3.6.2 Measuring Instruments

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 should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



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

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the LP0002 Section 2.2, Section 3.10.1.3, and Section 3.10.1.4.

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	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	May 09, 2020	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Nov. 15, 2019	May 09, 2020	Nov. 14, 2020	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Nov. 07, 2019	May 09, 2020	Nov. 06, 2020	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Nov. 20, 2019	May 09, 2020	Nov. 19, 2020	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 15, 2019	May 09, 2020	Nov. 14, 2020	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	May 09, 2020	N/A	Conduction (CO05-HY)
LF Cable	HUBER + SUHNER	RG-214/U	LF01	N/A	Jan. 02, 2020	May 09, 2020	Jan. 01, 2021	Conduction (CO05-HY)
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100851	N/A	Jan. 02, 2020	May 09, 2020	Jan. 01, 2021	Conduction (CO05-HY)
Hygrometer	Testo	608-H2	41410069	N/A	Jun. 17, 2019	Apr. 30, 2020~ May 11. 2020	Jun. 16, 2020	Conducted (TH05-HY)
Power Sensor	DARE	RPR3006W	16I00054S NO10	10MHz~6GHz	Dec. 23, 2019	Apr. 30, 2020~ May 11. 2020	Dec. 22, 2020	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz~40GHz	Jul. 15, 2019	Apr. 30, 2020~ May 11. 2020	Jul. 14, 2020	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	100055	9kHz-40GHz	Aug. 14, 2019	Apr. 30, 2020~ May 11. 2020	Aug. 13, 2020	Conducted (TH05-HY)
Switch Box & RF Cable	Burgeon	ETF-058	EC130048 4	N/A	Aug. 22, 2019	Apr. 30, 2020~ May 11. 2020	Aug. 21, 2020	Conducted (TH05-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Jan. 09, 2020	May 08, 2020	Jan. 08, 2021	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-124 1	1GHz ~ 18GHz	Jul. 02, 2019	May 08, 2020	Jul. 01, 2020	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800 N1D01N-06	40103 & 07	30MHz~1GHz	Apr. 29, 2020	May 08, 2020	Apr. 28, 2021	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA9170 576	18GHz- 40GHz	May 14, 2019	May 08, 2020	May 13, 2020	Radiation (03CH13-HY)
Preamplifier	Keysight	83017A	MY532701 47	1GHz~26.5GHz	Oct. 28, 2019	May 08, 2020	Oct. 27, 2020	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590074	1GHz~18GHz	May 20, 2019	May 08, 2020	May 19, 2020	Radiation (03CH13-HY)
Amplifier	Sonoma-Instru ment	310 N	187282	9KHz~1GHz	Dec. 17, 2019	May 08, 2020	Dec. 16, 2020	Radiation (03CH13-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz ~ 40GHz	Dec. 13, 2019	May 08, 2020	Dec. 12, 2020	Radiation (03CH13-HY)
Hygrometer	TECPEL	DTM-303B	TP150115	N/A	Nov. 08, 2019	May 08, 2020	Nov. 07, 2020	Radiation (03CH13-HY)

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0030/126E	30M-18G	Feb. 12, 2020	May 08, 2020	Feb. 11, 2021	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	804793/4	30M-18G	Feb. 12, 2020	May 08, 2020	Feb. 11, 2021	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30M-18G	Feb. 12, 2020	May 08, 2020	Feb. 11, 2021	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30M~40GHz	Mar. 12, 2020	May 08, 2020	Mar. 11, 2021	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY4274/2	30M~40GHz	Mar. 12, 2020	May 08, 2020	Mar. 11, 2021	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200485	10Hz~44GHz	Feb. 10, 2020	May 08, 2020	Feb. 09, 2021	Radiation (03CH13-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	May 08, 2020	N/A	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	May 08, 2020	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	May 08, 2020	N/A	Radiation (03CH13-HY)
Software	AUDIX	E3 6.2009-8-24c	RK-001124	N/A	N/A	May 08, 2020	N/A	Radiation (03CH13-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY54130085	20Hz ~ 8.4GHz	Nov. 01, 2019	May 08, 2020	Oct. 31, 2020	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN2	3GHz High Pass Filter	Jul. 14, 2019	May 08, 2020	Jul. 13, 2020	Radiation (03CH13-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN12	1.53GHz Low Pass Filter	Sep. 16, 2019	May 08, 2020	Sep. 15, 2020	Radiation (03CH13-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))	2.3

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.4

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.5

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

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

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Owen Yang	Temperature:	21~25	°C
Test Date:	2020/4/30~2020/5/11	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.060	0.712	0.50	Pass
BLE	1Mbps	1	19	2440	1.054	0.704	0.50	Pass
BLE	1Mbps	1	39	2480	1.058	0.720	0.50	Pass

TEST RESULTS DATA
Average Power Table

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	1.50	30.00	0.78	2.28	36.00	Pass
BLE	1Mbps	1	19	2440	1.80	30.00	0.78	2.58	36.00	Pass
BLE	1Mbps	1	39	2480	1.70	30.00	0.78	2.48	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	1.88	-9.59	0.78	8.00	Pass
BLE	1Mbps	1	19	2440	1.47	-8.05	0.78	8.00	Pass
BLE	1Mbps	1	39	2480	1.32	-8.89	0.78	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

Report Number : TR032024

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	2.060	1.360	0.50	Pass
BLE	2Mbps	1	19	2440	2.072	1.384	0.50	Pass
BLE	2Mbps	1	39	2480	2.104	1.416	0.50	Pass

TEST RESULTS DATA
Average Power Table

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	1.90	30.00	0.78	2.68	36.00	Pass
BLE	2Mbps	1	19	2440	1.80	30.00	0.78	2.58	36.00	Pass
BLE	2Mbps	1	39	2480	1.60	30.00	0.78	2.38	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	0.85	-11.26	0.78	8.00	Pass
BLE	2Mbps	1	19	2440	0.39	-12.94	0.78	8.00	Pass
BLE	2Mbps	1	39	2480	0.16	-12.08	0.78	8.00	Pass

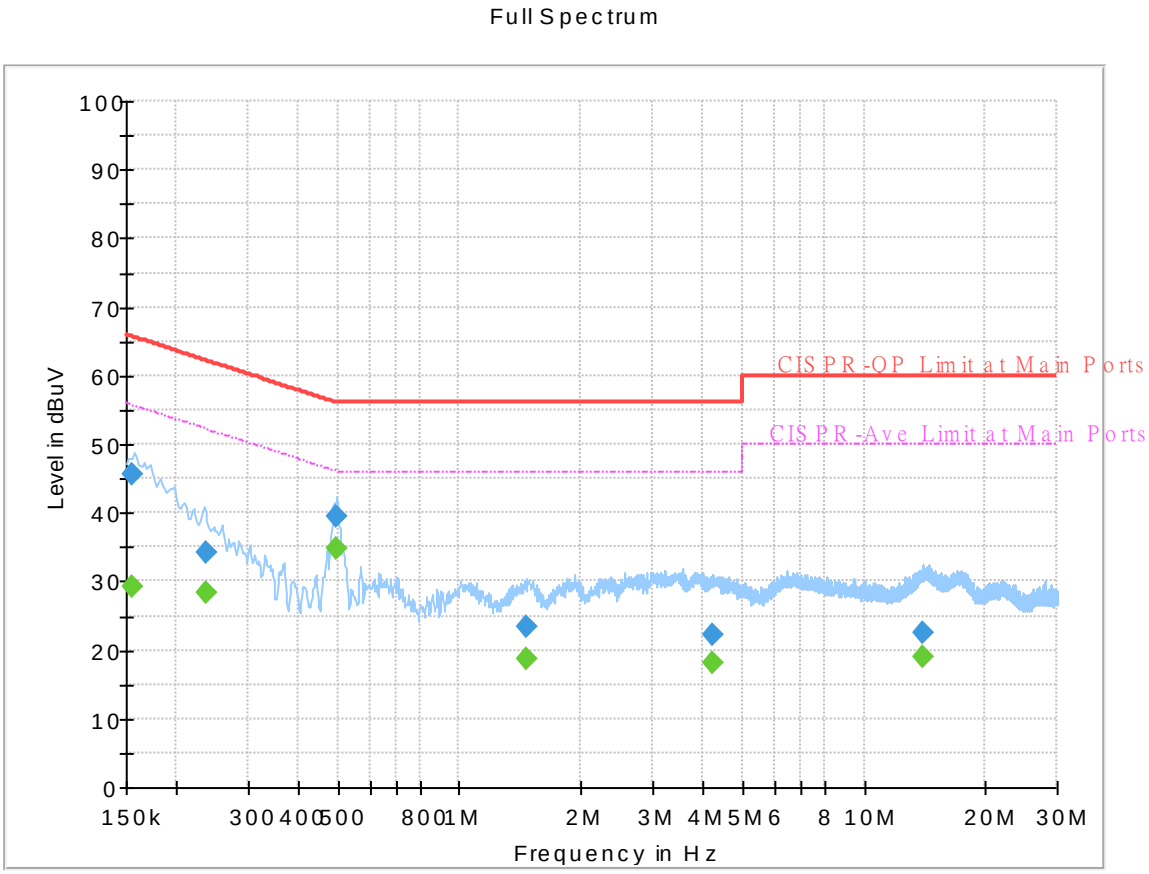
Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

Appendix B. AC Conducted Emission Test Results

Test Engineer :	Howard Huang	**Temperature :**	21~25℃
		Relative Humidity :	50~53%

EUT Information

Report NO :	032024
Test Mode :	Mode 2
Test Voltage :	120Vac/60Hz
Phase :	Line

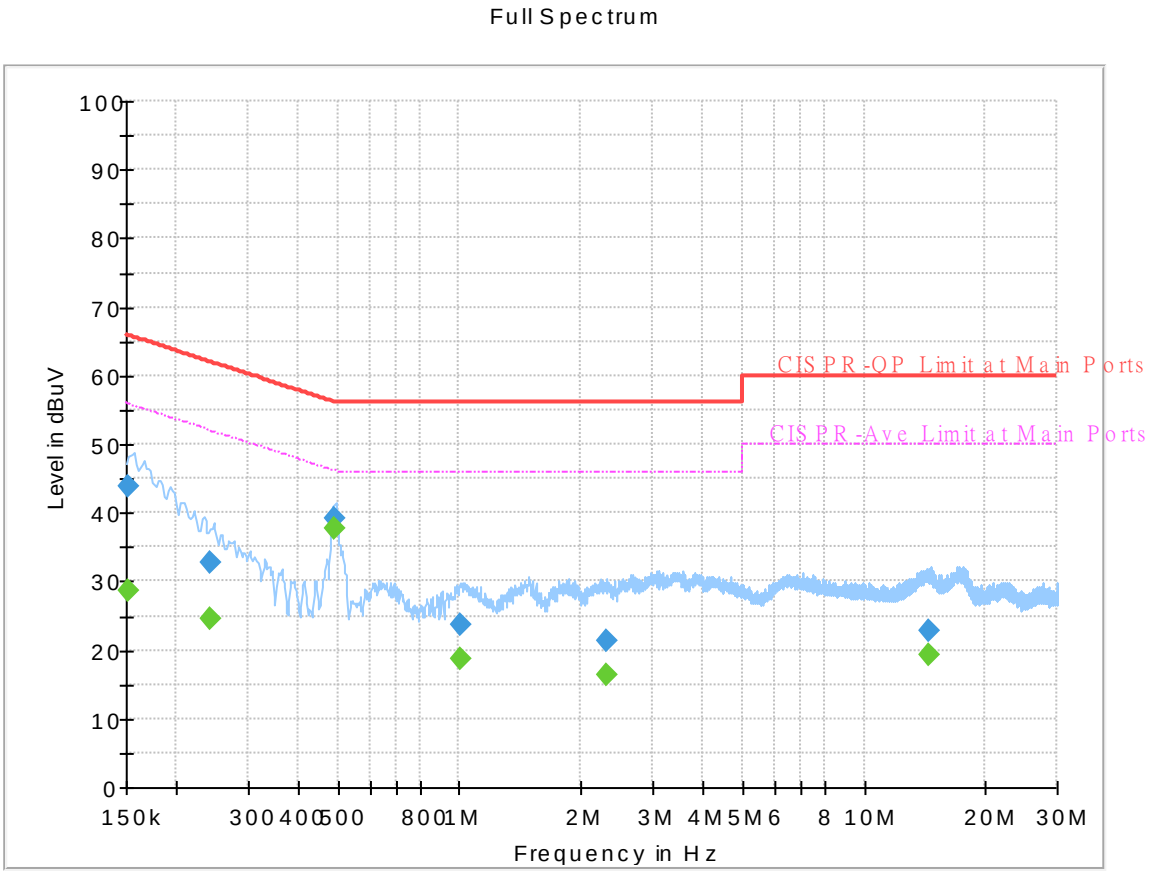


Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.154410	---	29.29	55.76	26.47	L1	OFF	19.5
0.154410	45.67	---	65.76	20.09	L1	OFF	19.5
0.235500	---	28.45	52.25	23.80	L1	OFF	19.5
0.235500	34.14	---	62.25	28.11	L1	OFF	19.5
0.495330	---	34.81	46.08	11.27	L1	OFF	19.5
0.495330	39.33	---	56.08	16.75	L1	OFF	19.5
1.471200	---	18.69	46.00	27.31	L1	OFF	19.6
1.471200	23.27	---	56.00	32.73	L1	OFF	19.6
4.223130	---	18.06	46.00	27.94	L1	OFF	19.6
4.223130	22.16	---	56.00	33.84	L1	OFF	19.6
13.958250	---	19.12	50.00	30.88	L1	OFF	19.8
13.958250	22.49	---	60.00	37.51	L1	OFF	19.8

EUT Information

Report NO :	032024
Test Mode :	Mode 2
Test Voltage :	120Vac/60Hz
Phase :	Neutral



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.152250	---	28.73	55.88	27.15	N	OFF	19.5
0.152250	43.79	---	65.88	22.09	N	OFF	19.5
0.242250	---	24.43	52.02	27.59	N	OFF	19.5
0.242250	32.78	---	62.02	29.24	N	OFF	19.5
0.491370	---	37.67	46.15	8.48	N	OFF	19.5
0.491370	39.30	---	56.15	16.85	N	OFF	19.5
1.000140	---	18.78	46.00	27.22	N	OFF	19.6
1.000140	23.78	---	56.00	32.22	N	OFF	19.6
2.316750	---	16.47	46.00	29.53	N	OFF	19.6
2.316750	21.41	---	56.00	34.59	N	OFF	19.6
14.437860	---	19.21	50.00	30.79	N	OFF	19.9
14.437860	22.71	---	60.00	37.29	N	OFF	19.9

Appendix C. Radiated Spurious Emission

Test Engineer :	Daniel Lee and Jacky Hong	Temperature :	21.5~23.5°C
		Relative Humidity :	49.5~55.5%

<1Mbps>

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		2321.025	56.22	-17.78	74	41.74	27.86	13.92	27.3	100	239	P	H
		2378.04	44.68	-9.32	54	30.3	27.69	13.98	27.29	100	239	A	H
	*	2402	96.99	-	-	82.68	27.6	14	27.29	100	239	P	H
	*	2402	96.42	-	-	82.11	27.6	14	27.29	100	239	A	H
													H
		2367.33	55.63	-18.37	74	41.22	27.73	13.97	27.29	100	177	P	V
		2378.04	44.75	-9.25	54	30.37	27.69	13.98	27.29	100	177	A	V
	*	2402	97.51	-	-	83.2	27.6	14	27.29	100	177	P	V
	*	2402	96.95	-	-	82.64	27.6	14	27.29	100	177	A	V
													V
BLE CH 19 2440MHz		2319.94	55.42	-18.58	74	40.94	27.86	13.92	27.3	124	240	P	H
		2367.82	44.23	-9.77	54	29.82	27.73	13.97	27.29	124	240	A	H
	*	2440	96.09	-	-	81.81	27.52	14.04	27.28	124	240	P	H
	*	2440	95.5	-	-	81.22	27.52	14.04	27.28	124	240	A	H
		2483.69	55.94	-18.06	74	41.63	27.5	14.08	27.27	124	240	P	H
		2488.24	44.14	-9.86	54	29.83	27.5	14.08	27.27	124	240	A	H
		2318.12	55.34	-18.66	74	40.86	27.86	13.92	27.3	151	194	P	V
		2349.62	44.24	-9.76	54	29.78	27.8	13.95	27.29	151	194	A	V
	*	2440	96.68	-	-	82.4	27.52	14.04	27.28	151	194	P	V
	*	2440	96.08	-	-	81.8	27.52	14.04	27.28	151	194	A	V
		2483.76	55.45	-18.55	74	41.14	27.5	14.08	27.27	151	194	P	V
		2500	44.24	-9.76	54	29.92	27.5	14.09	27.27	151	194	A	V

BLE CH 39 2480MHz	*	2480	91.73	-	-	77.43	27.5	14.07	27.27	100	241	P	H
	*	2480	91.12	-	-	76.82	27.5	14.07	27.27	100	241	A	H
		2496.16	55.11	-18.89	74	40.79	27.5	14.09	27.27	100	241	P	H
		2483.96	44.08	-9.92	54	29.77	27.5	14.08	27.27	100	241	A	H
													H
													H
	*	2480	93.73	-	-	79.43	27.5	14.07	27.27	100	174	P	V
	*	2480	93.15	-	-	78.85	27.5	14.07	27.27	100	174	A	V
		2496.72	55.15	-18.85	74	40.83	27.5	14.09	27.27	100	174	P	V
		2483.72	44.17	-9.83	54	29.86	27.5	14.08	27.27	100	174	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	56.09	-17.91	74	75.61	31.11	6.96	57.59	100	173	P	H
		4804	53.59	-0.41	54	73.11	31.11	6.96	57.59	100	173	A	H
													H
													H
		4804	51.44	-22.56	74	70.96	31.11	6.96	57.59	100	156	P	V
		4804	47.46	-6.54	54	66.98	31.11	6.96	57.59	100	156	A	V
													V
													V
BLE CH 19 2440MHz		4880	52.43	-21.57	74	71.71	31.2	6.96	57.44	100	175	P	H
		4880	48.76	-5.24	54	68.04	31.2	6.96	57.44	100	175	A	H
		7320	43.83	-30.17	74	56.08	36.76	8.27	57.28	100	0	P	H
													H
		4880	46.94	-27.06	74	66.22	31.2	6.96	57.44	100	0	P	V
		7320	42.91	-31.09	74	55.16	36.76	8.27	57.28	100	0	P	V
													V
													V
BLE CH 39 2480MHz		4960	47.84	-26.16	74	66.79	31.36	6.97	57.28	100	0	P	H
		7440	43.92	-30.08	74	56.45	36.68	8.22	57.43	100	0	P	H
													H
													H
		4960	42.19	-31.81	74	61.14	31.36	6.97	57.28	100	0	P	V
		7440	43.58	-30.42	74	56.11	36.68	8.22	57.43	100	0	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz BLE (LF)

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)
2.4GHz BLE LF		31.94	21.56	-18.44	40	29.66	23.64	0.49	32.23	-	-	P	H
		500.45	29.15	-16.85	46	36.13	23.61	1.93	32.52	-	-	P	H
		524.7	33.09	-12.91	46	39.9	23.7	1.95	32.46	-	-	P	H
		600.36	37.38	-8.62	46	42.39	25.21	2.07	32.29	-	-	P	H
		749.74	39.2	-6.8	46	40.84	27.8	2.35	31.79	100	0	P	H
		924.34	36.81	-9.19	46	36.15	29.29	2.69	31.32	-	-	P	H
													H
													H
													H
													H
													H
													H
		30.97	26.17	-13.83	40	33.61	24.31	0.48	32.23	-	-	P	V
		179.38	23.35	-20.15	43.5	39.77	14.66	1.19	32.27	-	-	P	V
		524.7	31.65	-14.35	46	38.46	23.7	1.95	32.46	-	-	P	V
		615.88	36.97	-9.03	46	41.53	25.54	2.09	32.19	100	0	P	V
		749.74	34.49	-11.51	46	36.13	27.8	2.35	31.79	-	-	P	V
		924.34	36.16	-9.84	46	35.5	29.29	2.69	31.32	-	-	P	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against 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		2343.075	55.47	-18.53	74	41.01	27.81	13.95	27.3	100	240	P	H
		2378.145	44.28	-9.72	54	29.9	27.69	13.98	27.29	100	240	A	H
	*	2402	97.24	-	-	82.93	27.6	14	27.29	100	240	P	H
	*	2402	95.77	-	-	81.46	27.6	14	27.29	100	240	A	H
													H
													H
		2347.905	55.57	-18.43	74	41.11	27.8	13.95	27.29	116	177	P	V
		2378.25	44.28	-9.72	54	29.9	27.69	13.98	27.29	116	177	A	V
	*	2402	97.93	-	-	83.62	27.6	14	27.29	116	177	P	V
	*	2402	96.5	-	-	82.19	27.6	14	27.29	116	177	A	V
													V
													V
BLE CH 19 2440MHz		2374.54	55.37	-18.63	74	40.98	27.7	13.98	27.29	124	240	P	H
		2350.74	44.15	-9.85	54	29.69	27.8	13.95	27.29	124	240	A	H
	*	2440	95.83	-	-	81.55	27.52	14.04	27.28	124	240	P	H
	*	2440	94.27	-	-	79.99	27.52	14.04	27.28	124	240	A	H
		2488.52	55.74	-18.26	74	41.43	27.5	14.08	27.27	124	240	P	H
		2488.59	44.11	-9.89	54	29.8	27.5	14.08	27.27	124	240	A	H
		2310.56	55.63	-18.37	74	41.13	27.88	13.92	27.3	112	172	P	V
		2316.86	44.17	-9.83	54	29.68	27.87	13.92	27.3	112	172	A	V
	*	2440	96.83	-	-	82.55	27.52	14.04	27.28	112	172	P	V
	*	2440	95.24	-	-	80.96	27.52	14.04	27.28	112	172	A	V
		2483.9	54.66	-19.34	74	40.35	27.5	14.08	27.27	112	172	P	V
		2488.24	44.17	-9.83	54	29.86	27.5	14.08	27.27	112	172	A	V

BLE CH 39 2480MHz	*	2480	91.65	-	-	77.35	27.5	14.07	27.27	100	240	P	H
	*	2480	90.09	-	-	75.79	27.5	14.07	27.27	100	240	A	H
		2489.08	56.01	-17.99	74	41.7	27.5	14.08	27.27	100	240	P	H
		2483.52	44.49	-9.51	54	30.18	27.5	14.08	27.27	100	240	A	H
													H
													H
	*	2480	93.65	-	-	79.35	27.5	14.07	27.27	100	174	P	V
	*	2480	92	-	-	77.7	27.5	14.07	27.27	100	174	A	V
		2486.44	55.12	-18.88	74	40.81	27.5	14.08	27.27	100	174	P	V
		2483.52	44.67	-9.33	54	30.36	27.5	14.08	27.27	100	174	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	57.32	-16.68	74	76.84	31.11	6.96	57.59	109	173	P	H
		4804	52.51	-1.49	54	72.03	31.11	6.96	57.59	100	179	A	H
													H
													H
		4804	52.43	-21.57	74	71.95	31.11	6.96	57.59	100	158	P	V
		4804	46.98	-7.02	54	66.5	31.11	6.96	57.59	100	158	A	V
													V
													V
BLE CH 19 2440MHz		4880	52.58	-21.42	74	71.86	31.2	6.96	57.44	100	173	P	H
		4880	46.83	-7.17	54	66.11	31.2	6.96	57.44	100	173	A	H
		7320	43.82	-30.18	74	56.07	36.76	8.27	57.28	100	0	P	H
													H
		4880	45.6	-28.4	74	64.88	31.2	6.96	57.44	100	0	P	V
		7320	43.17	-30.83	74	55.42	36.76	8.27	57.28	100	0	P	V
													V
													V
BLE CH 39 2480MHz		4960	47.85	-26.15	74	66.8	31.36	6.97	57.28	100	0	P	H
		7440	43.29	-30.71	74	55.82	36.68	8.22	57.43	100	0	P	H
													H
													H
		4960	40.98	-33.02	74	59.93	31.36	6.97	57.28	100	0	P	V
		7440	43.39	-30.61	74	55.92	36.68	8.22	57.43	100	0	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average 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 D. Radiated Spurious Emission Plots

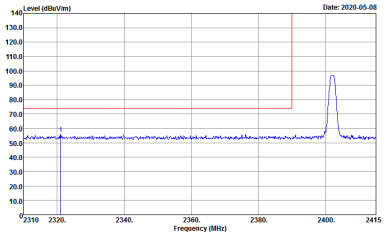
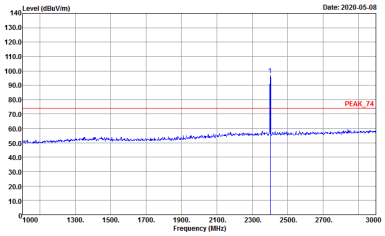
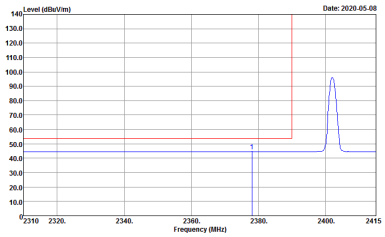
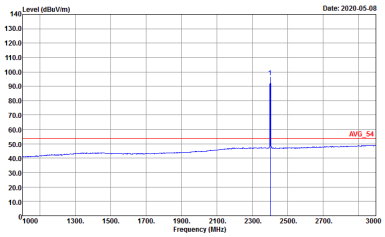
Test Engineer :	Daniel Lee and Jacky Hong	**Temperature :**	21.5~23.5°C
		Relative Humidity :	49.5~55.5%

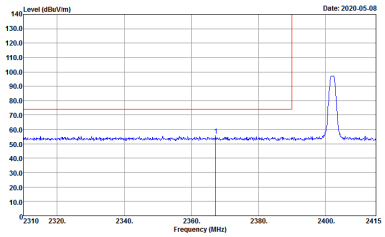
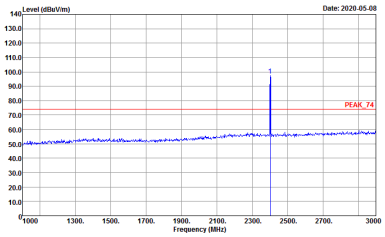
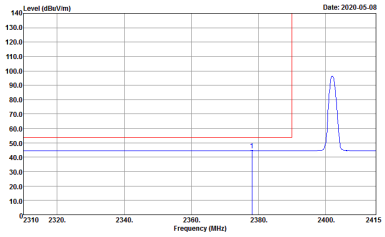
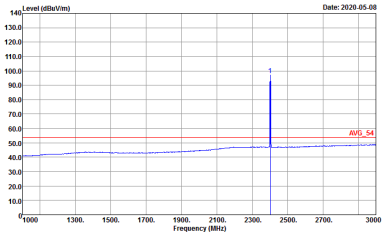
Note symbol

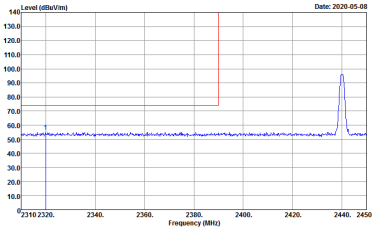
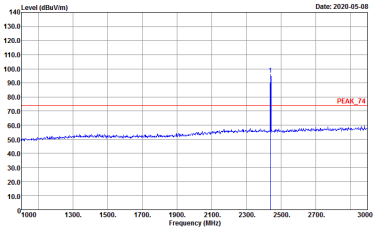
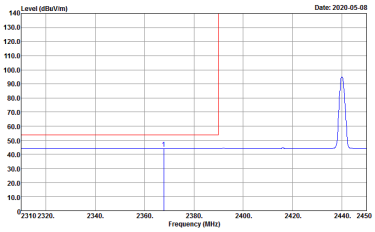
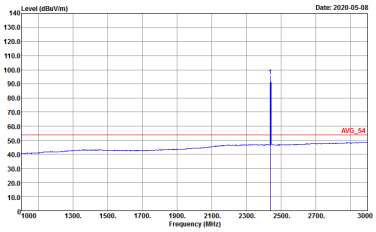
-L	**Low channel location**
-R	**High channel location**

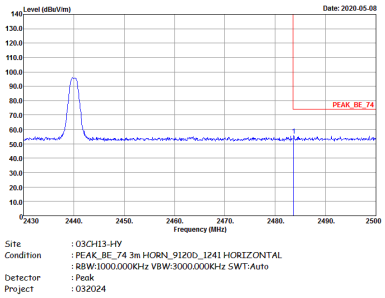
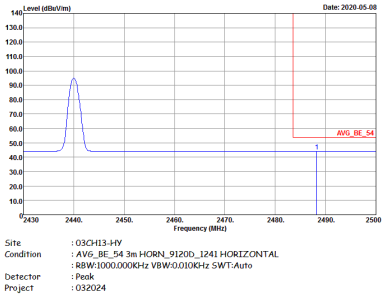
<1Mbps>

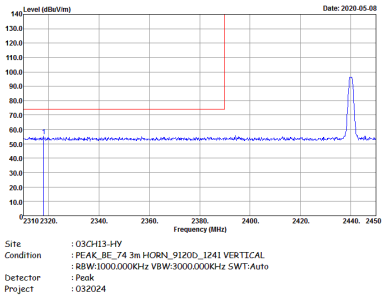
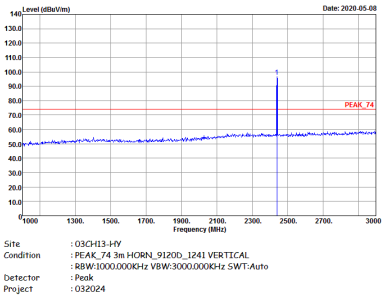
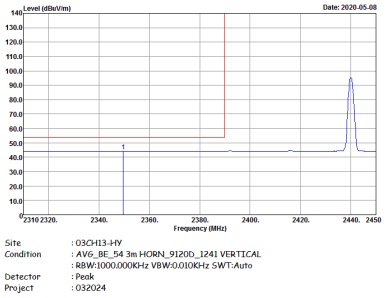
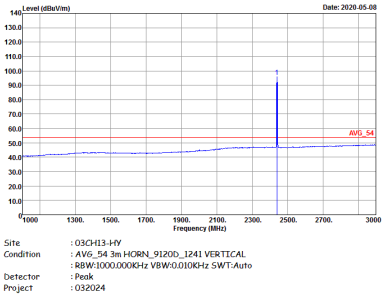
2.4GHz 2400~2483.5MHz
BLE (Band Edge @ 3m)

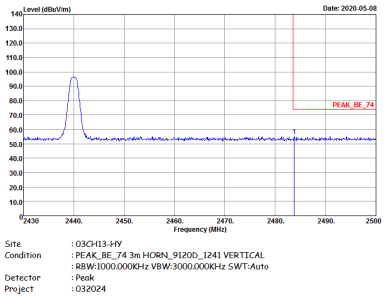
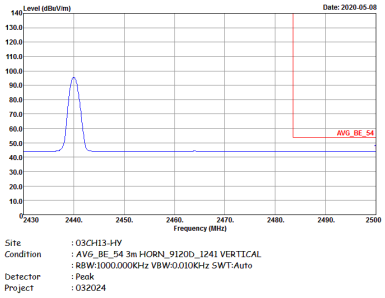
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11
Avg.	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11

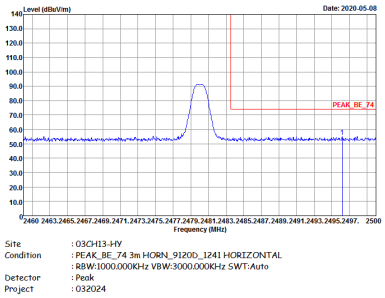
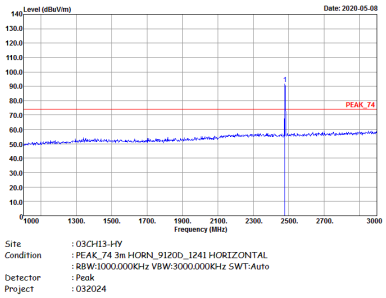
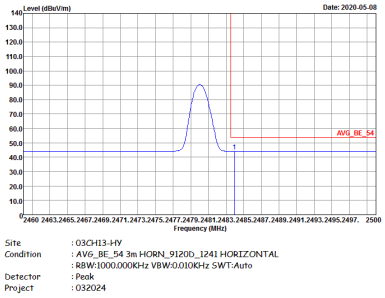
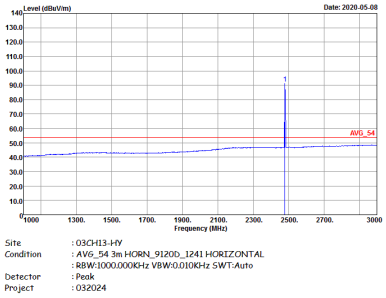
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11
Avg	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024 Setting : 11

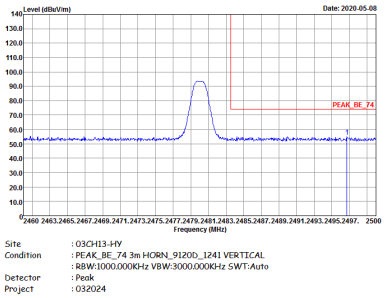
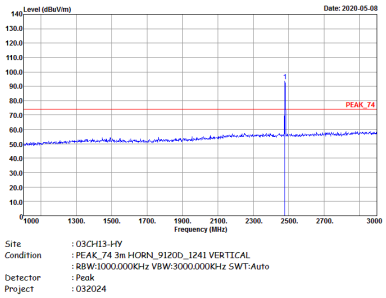
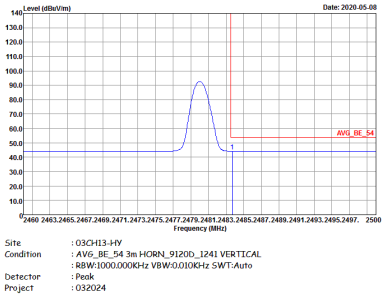
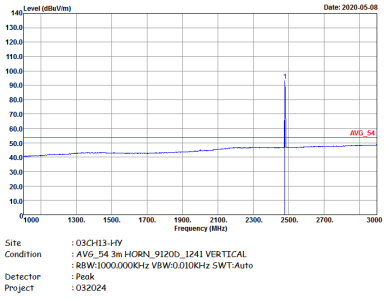
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024
Avg.	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024

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.		

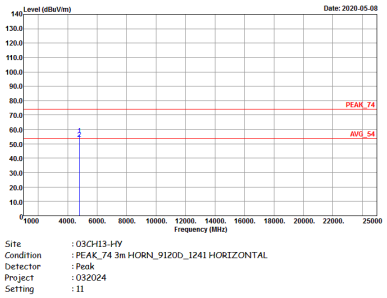
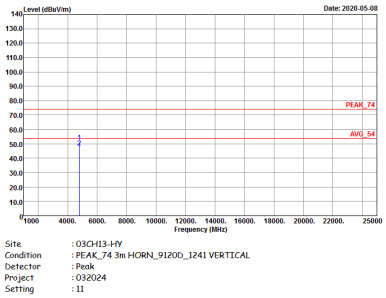
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

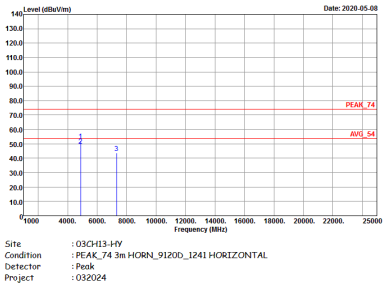
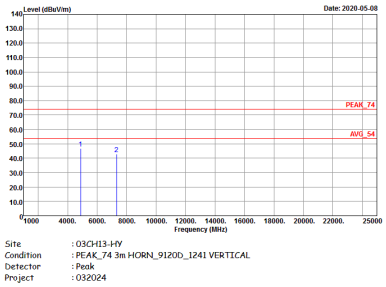
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak		
Avg.		

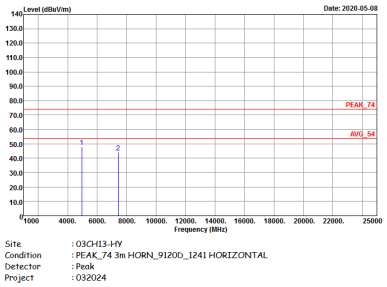
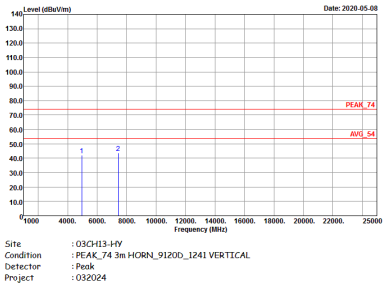
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak		
Avg.		

2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

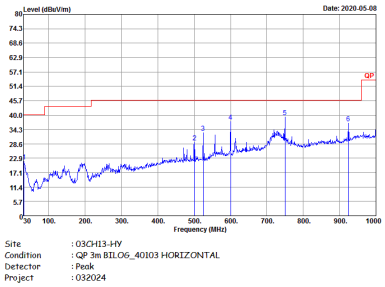
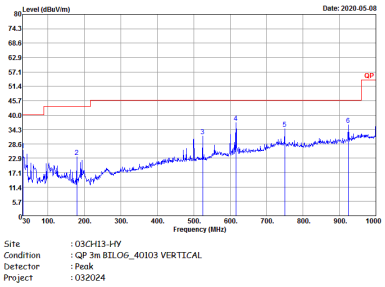
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 HORIZONTAL Detector : Peak Project : 032024 Setting : 11	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL Detector : Peak Project : 032024 Setting : 11

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		

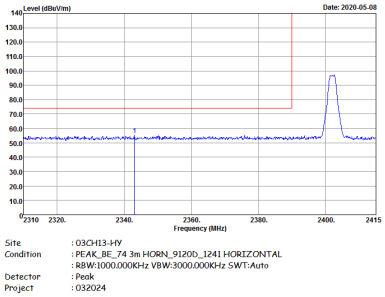
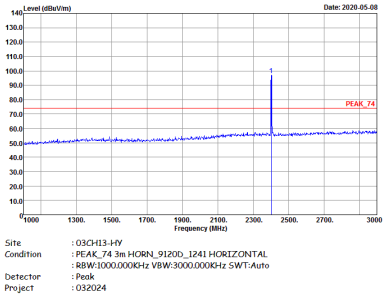
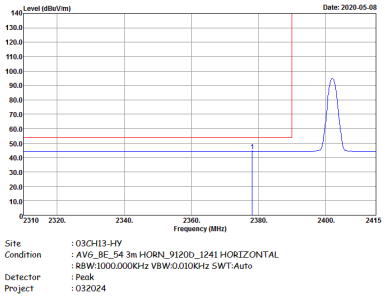
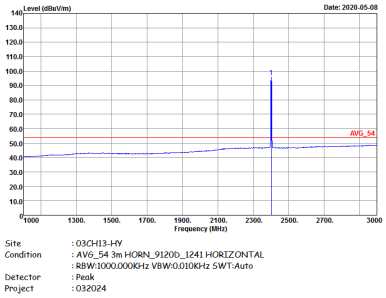
Emission below 1GHz

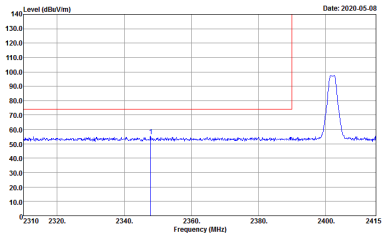
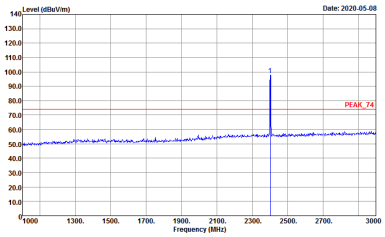
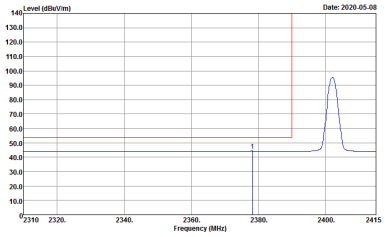
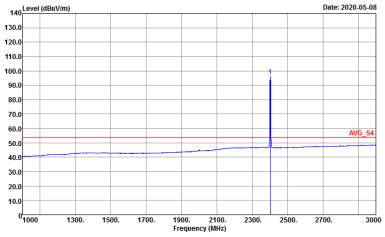
2.4GHz BLE (LF)

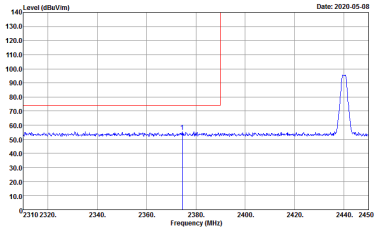
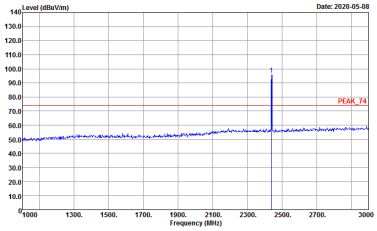
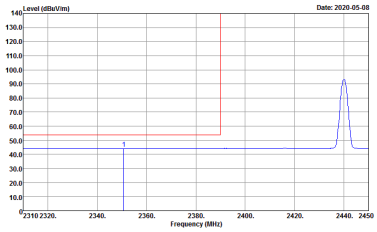
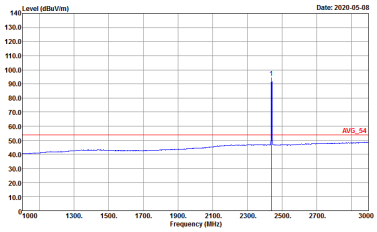
BLE	2.4GHz 2400~2483.5MHz	
	BLE LF	
	Horizontal	Vertical
QP / Peak		

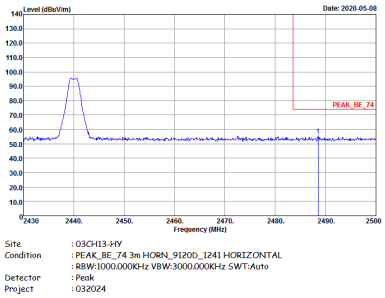
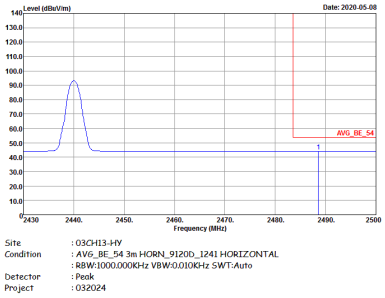
<2Mbps>

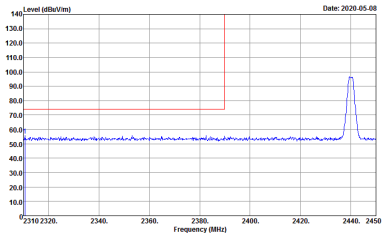
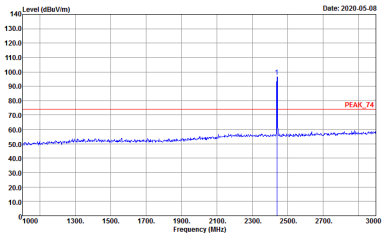
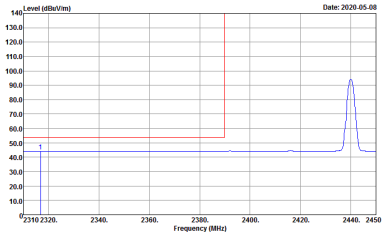
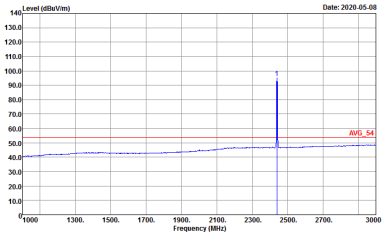
2.4GHz 2400~2483.5MHz
BLE (Band Edge @ 3m)

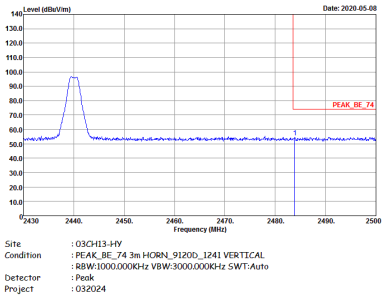
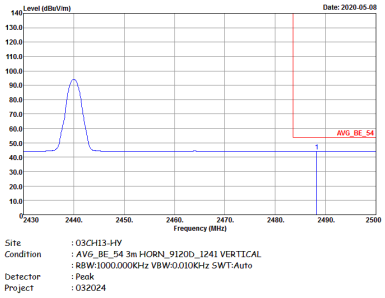
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak		
Avg.		

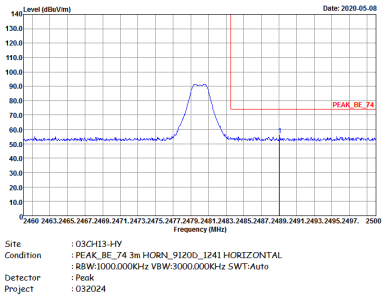
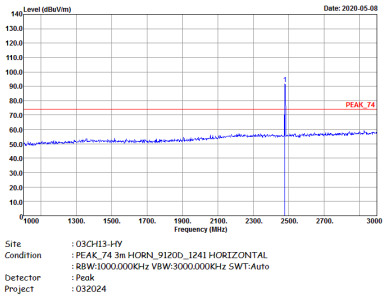
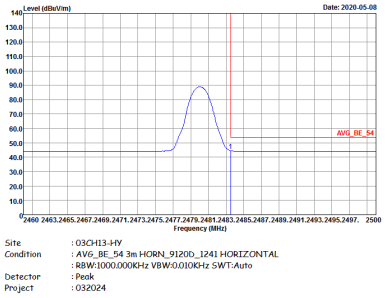
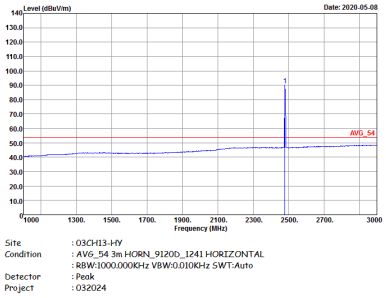
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024
Avg	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024

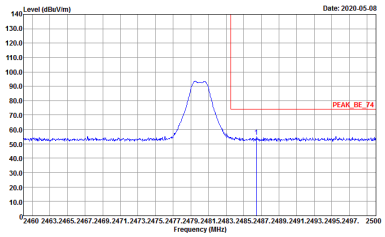
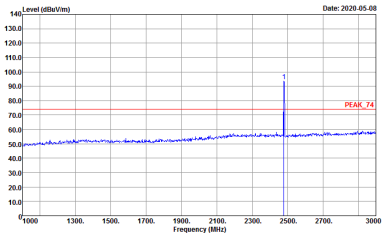
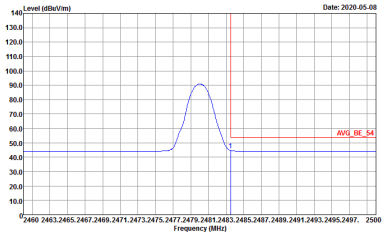
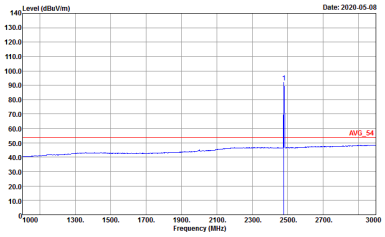
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024
Avg.	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024

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 : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024
Avg.	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024

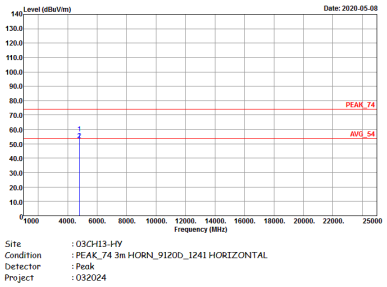
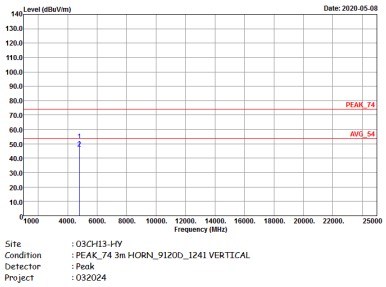
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

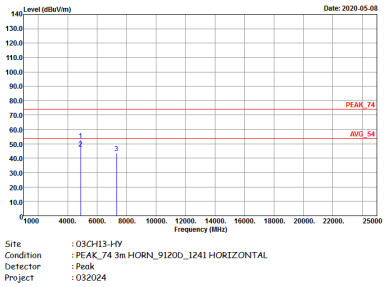
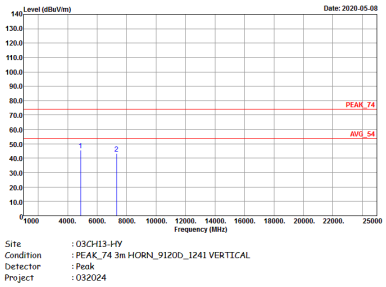
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak		
Avg.		

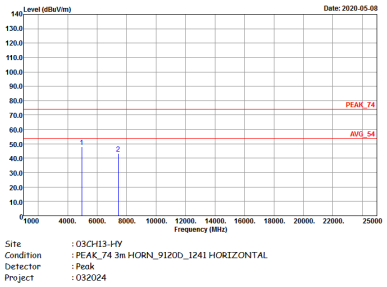
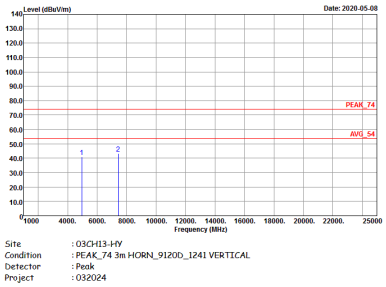
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak	 Site : 03CH13-HY Condition : PEAK_BE_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 032024
Avg.	 Site : 03CH13-HY Condition : AVG_BE_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024	 Site : 03CH13-HY Condition : AVG_54 3m HORN_9120D_1241 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto Detector : Peak Project : 032024

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		

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

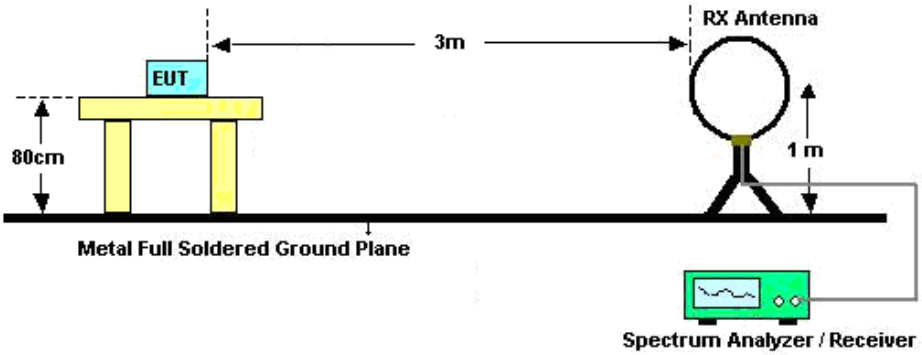
See list of measuring equipment of this test report.

A.3 Test Procedures

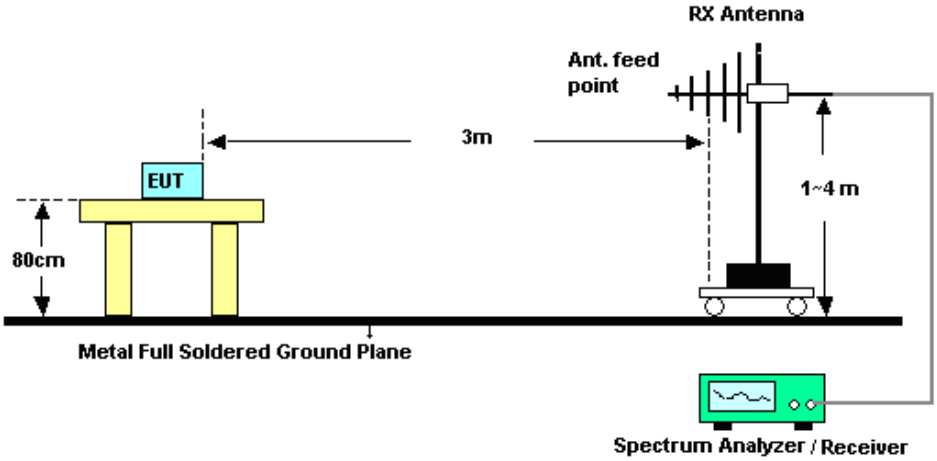
1. The EUT was placed on a turntable with 0.8 meter above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. The table was rotated 360 degrees to determine the position of the highest radiation.
4. The antenna 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

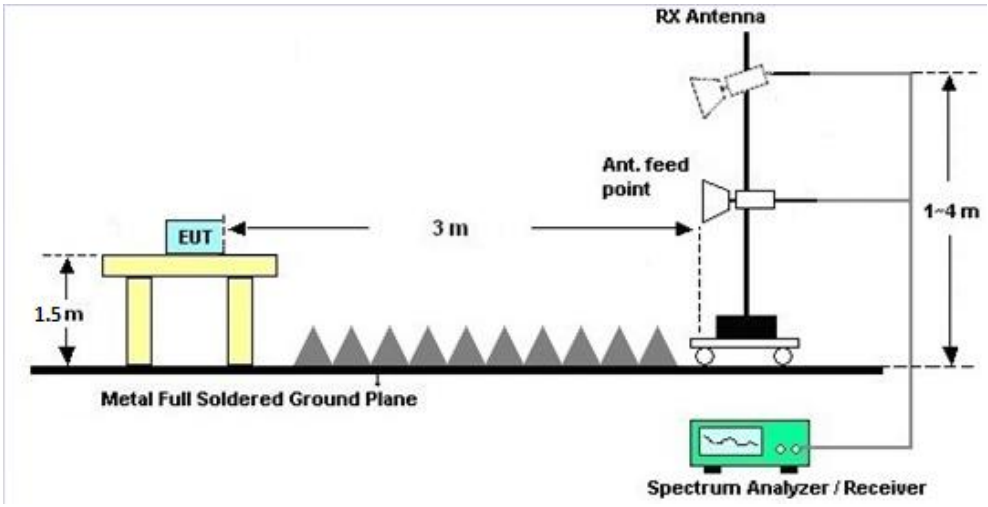
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz

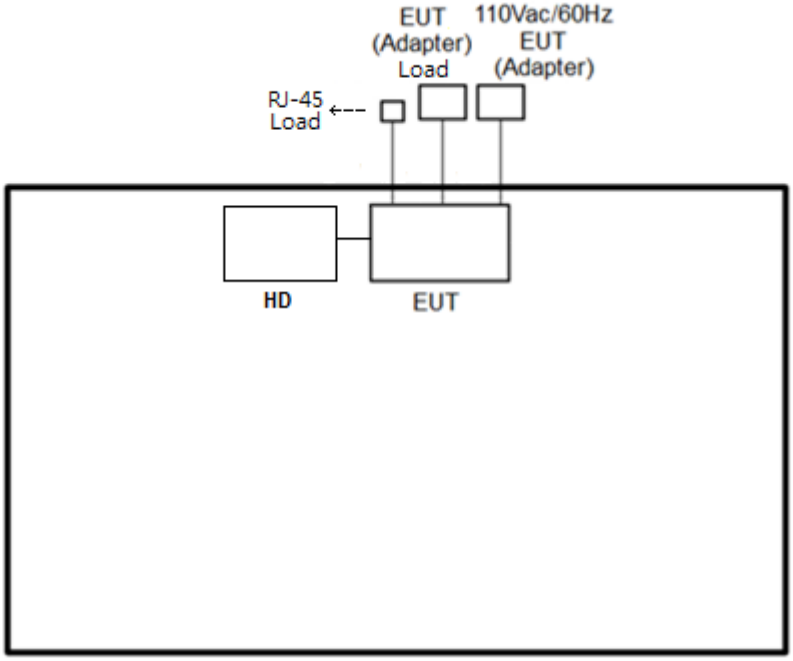


A.5 Test Result of Receiver Radiated Spurious Emissions (9kHz ~ 30MHz)

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 5.13 was not reported.

There is a comparison data 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



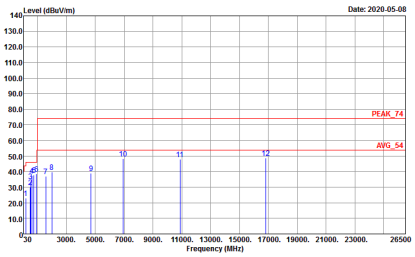
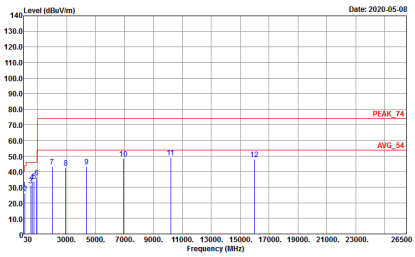
A.7 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	行動硬碟	WD	WDBGPU0010BBL	N/A	N/A	N/A

Remark: Applicant has ensured accessory would not be attached with the product on the market, accessory is provided by lab for testing.

A.8 Test Result of Receiver Radiated Spurious Emission (30MHz ~ 5th Harmonic)

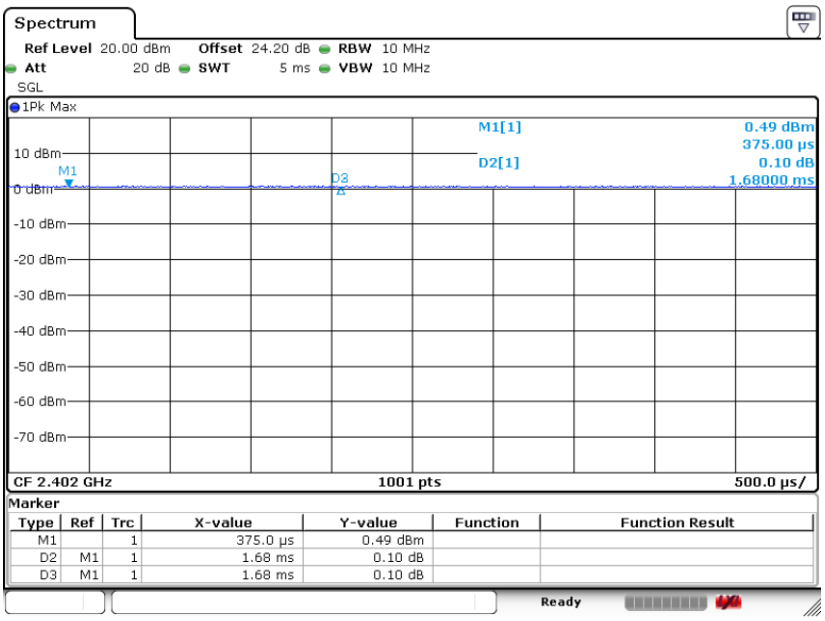
Test Engineer :	Daniel Lee and Jacky Hong	**Temperature :**	21.5~23.5°C
		Relative Humidity :	49.5~55.5%
Frequency	924.340 MHz	**Margin**	Under 7.47 dB
Test Mode	Bluetooth-LE Idle		

	Idle Mode	
	Horizontal	**Vertical**
Peak **Avg.**	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 HORIZONTAL Detector : Peak Project : 032024 1 197.81 23.08 -20.42 43.50 39.63 14.50 1.14 32.31 --- --- Peak 2 499.48 30.19 -15.81 46.00 37.19 23.59 1.85 32.52 --- --- Peak 3 524.70 33.78 -12.22 46.00 40.59 23.70 1.87 32.46 --- --- Peak 4 600.36 37.32 -8.68 46.00 42.33 25.21 1.97 32.29 --- --- Peak 5 749.74 37.76 -8.24 46.00 39.40 27.80 2.21 31.79 --- --- Peak 6 924.34 38.53 -7.47 46.00 37.87 29.29 2.50 31.32 100 0 Peak 7 1576.00 36.87 -37.13 74.00 65.99 25.25 3.47 57.84 --- --- Peak 8 2000.00 39.83 -34.17 74.00 67.30 26.10 3.93 57.50 --- --- Peak 9 4704.00 39.17 -34.83 74.00 59.49 31.11 6.36 57.79 --- --- Peak 10 6936.00 48.53 -25.47 74.00 62.34 35.34 7.62 56.77 --- --- Peak 11 10881.00 48.06 -25.94 74.00 54.42 40.66 9.58 56.60 --- --- Peak 12 16803.00 48.64 -25.36 74.00 51.98 40.39 12.21 55.94 100 0 Peak	 Site : 03CH13-HY Condition : PEAK_74 3m HORN_9120D_1241 VERTICAL Detector : Peak Project : 032024 1 32.91 28.39 -11.61 40.00 36.98 23.15 0.48 32.24 --- --- Peak 2 120.21 26.03 -17.47 43.50 40.11 17.10 0.90 32.15 --- --- Peak 3 524.70 31.03 -14.97 46.00 37.84 23.70 1.87 32.46 --- --- Peak 4 615.88 33.36 -12.64 46.00 37.92 25.54 1.99 32.19 --- --- Peak 5 749.74 33.96 -12.04 46.00 35.60 27.80 2.21 31.79 --- --- Peak 6 924.34 36.10 -9.90 46.00 35.44 29.29 2.50 31.32 100 0 Peak 7 2000.00 43.38 -30.62 74.00 69.34 26.10 5.44 57.50 --- --- Peak 8 2938.00 42.59 -31.41 74.00 64.91 28.60 6.62 57.54 --- --- Peak 9 4374.00 43.35 -30.65 74.00 62.97 30.40 8.31 58.33 --- --- Peak 10 6936.00 48.28 -25.72 74.00 59.69 35.34 10.02 56.77 --- --- Peak 11 10197.00 49.19 -24.81 74.00 55.17 39.29 11.75 57.02 100 0 Peak 12 15984.00 47.99 -26.01 74.00 52.33 37.70 14.08 56.12 --- --- Peak

Appendix E. Duty Cycle Plots

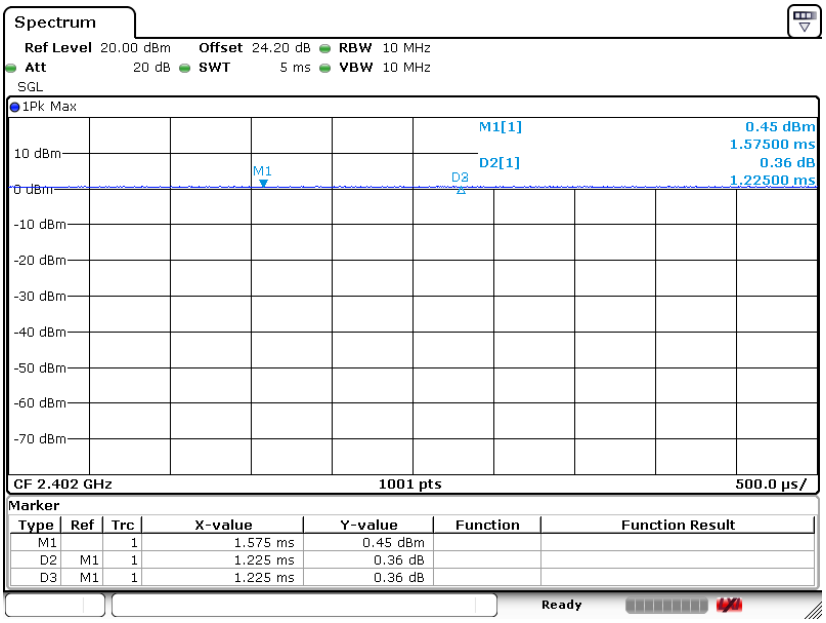
Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
Bluetooth - LE for 1Mbps	100	-	-	10Hz	0.00
Bluetooth - LE for 2Mbps	100	-	-	10Hz	0.00

Bluetooth - LE for 1Mbps



Date: 20.APR.2020 15:39:55

Bluetooth - LE for 2Mbps



Date: 20.APR.2020 15:35:00