

FCC RF Test Report

| APPLICANT | : | Espressif Systems (Shanghai) Co.,Ltd. |
|----------------|---|---------------------------------------|
| EQUIPMENT | : | 2.4GHz Wi-Fi & BT IoT Module |
| BRAND NAME | : | ESPRESSIF |
| MODEL NAME | : | ESP8684-WROOM-02UC |
| FCC ID | : | 2AC7Z-ESP868402UC |
| STANDARD | : | FCC Part 15 Subpart C §15.247 |
| CLASSIFICATION | : | (DTS) Digital Transmission System |
| TEST DATE(S) | : | Feb. 25, 2023 ~ Mar. 16, 2023 |

We, Sporton International Inc. (Kunshan), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

JasonJia

Approved by: Jason Jia



Sporton International Inc. (Kunshan) No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China



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APPENDIX E. SETUP PHOTOGRAPHS



REVISION HISTORY

| REPORT NO. | VERSION | DESCRIPTION | ISSUED DATE |
|------------|---------|-------------------------|---------------|
| FR310905A | Rev. 01 | Initial issue of report | Mar. 08, 2023 |
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| Report Section | FCC Rule | Description | Limit | Result | Remark |
|-------------------|-----------------------|---|--------------------------|-------------|---|
| 3.1 | 15.247(a)(2) | 6dB Bandwidth | ≥ 0.5MHz | Pass | - |
| 3.1 | - | 99% Bandwidth | - | Report only | - |
| 3.2 | 15.247(b)(3) | Peak Output Power | ≤ 30dBm | Pass | - |
| 3.3 | 15.247(e) | Power Spectral Density | ≤ 8dBm/3kHz | Pass | - |
| 3.4 | 15.247(d) | Conducted Band Edges and Spurious Emission | ≤ 20dBc | Pass | - |
| 3.5 | 15.247(d) | Radiated Band Edges and Spurious Emission | 15.209(a) & 15.247(d) | Pass | Under limit 1.97 dB at 2483.620 MHz |
| 3.6 | 15.207 | AC Conducted Emission | 15.207(a) | Pass | Under limit 7.83 dB at 0.171 MHz |
| 3.7 | 15.203 & 15.247(b) | Antenna Requirement | 15.203 & 15.247(b) | Pass | - |

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.



1 General Description

1.1 Applicant

Espressif Systems (Shanghai) Co.,Ltd. Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

1.2 Manufacturer

Espressif Systems (Shanghai) Co.,Ltd.

Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

1.3 Product Feature of Equipment Under Test

| Product Feature | | |
|-----------------|------------------------------|--|
| Equipment | 2.4GHz Wi-Fi & BT IoT Module | |
| Brand Name | ESPRESSIF | |
| Model Name | ESP8684-WROOM-02UC | |
| FCC ID | 2AC7Z-ESP868402UC | |
| HW Version | V1.0 | |
| SW Version | v1.1.3.4 | |
| EUT Stage | Identical Prototype | |

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

| Standards-related Product Specification | | | |
|---|--|--|--|
| Tx/Rx Frequency Range | 2402 MHz ~ 2480 MHz | | |
| Number of Channels | 40 | | |
| Carrier Frequency of Each Channel | 40 Channel(37 hopping + 3 advertising channel) | | |
| | BLE 1Mbps: 15.74 dBm (0.0375 W) | | |
| Maximum Quinut Dowar to Antonno | BLE 2Mbps: 15.93 dBm (0.0392 W) | | |
| Maximum Output Power to Antenna | BLE 500kbps: 15.47 dBm (0.0352 W) | | |
| | BLE 125kbps: 15.47 dBm (0.0352 W) | | |
| 99% Occupied Bandwidth | BLE 1Mbps: 1.083MHz | | |
| | BLE 2Mbps: 2.106MHz | | |
| Antenna Type / Gain | Glue stick antenna with gain 1.57 dBi | | |
| Type of Modulation | Bluetooth LE : GFSK | | |

Remark: For BLE 1Mbps/500kbps/125kbps mode, the whole testing has assessed BLE 1Mbps by referring to their higher conducted power.

1.5 Modification of EUT

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



1.6 Testing Location

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for

| Laboratory Accreditation with Certificate Number 5145.02. |
|---|
|---|

| Test Firm | Sporton International Inc. (Kunshan) | | | |
|--------------------|--|---------------------|-----------------------------------|--|
| Test Site Location | No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958 | | | |
| | Sporton Site No. | FCC Designation No. | FCC Test Firm Registration No. | |
| Test Site No. | CO01-KS 03CH05-KS TH01-KS | CN1257 | 314309 | |

1.7 Test Software

| ſ | ltem | Site | Manufacturer | Name | Version |
|---|------|-----------|--------------|------|-------------|
| I | 1. | 03CH05-KS | AUDIX | E3 | 6.2009-8-24 |
| | 2. | CO01-KS | AUDIX | E3 | 6.2009-8-24 |

1.8 Applicable Standards

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

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013

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



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|-----------------|---------|----------------|---------|----------------|
| | 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 |
| 2400-2483.5 MHz | 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). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

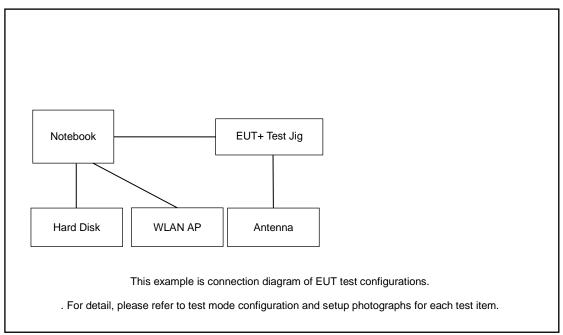
The following summary table is showing all test modes to demonstrate in compliance with the standard.

| | Summary table of Test Cases | | | | |
|-------------|--|--|--|--|--|
| Test Item | Data Rate / Modulation | | | | |
| Test item | Bluetooth – LE / GFSK | | | | |
| | Mode 1: Bluetooth Tx CH00_2402 MHz | | | | |
| Conducted | Mode 2: Bluetooth Tx CH19_2440 MHz | | | | |
| TCs | Mode 3: Bluetooth Tx CH38_2478 MHz | | | | |
| | Mode 4: Bluetooth Tx CH39_2480 MHz | | | | |
| | Mode 1: Bluetooth Tx CH00_2402 MHz | | | | |
| Radiated | Mode 2: Bluetooth Tx CH19_2440 MHz | | | | |
| TCs | Mode 3: Bluetooth Tx CH38_2478 MHz | | | | |
| | Mode 4: Bluetooth Tx CH39_2480 MHz | | | | |
| AC | | | | | |
| Conducted | Mode 1: Bluetooth Tx + Powered from test Jig | | | | |
| Emission | | | | | |
| Remark: For | Remark: For Radiated Test Cases, The tests were performance with Test Jig. | | | | |

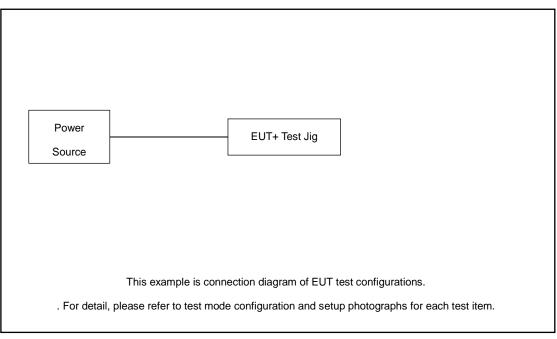


2.3 Connection Diagram of Test System

AC Conducted Emission:



Radiated Emission:





2.4 Support Unit used in test configuration and system

| Item | Equipment | Trade Name | Model Name | FCC ID | Data Cable | Power Cord |
|------|-----------|------------|---------------|------------|----------------|--|
| 1. | WLAN AP | D-link | DIR-655 | KA21R655B1 | N/A | Unshielded,1.8m |
| 2. | Notebook | Lenovo | V130-14IKB004 | N/A | N/A | AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m |
| 3. | Hard Disk | Lenovo | F310 | DoC | Shielded, 1.2m | N/A |
| 4. | Test Jig | N/A | N/A | N/A | N/A | N/A |
| 5. | Antenna | N/A | N/A | N/A | N/A | N/A |

2.5 EUT Operation Test Setup

For BLE RF test items, use the test program " EspRFTestTool" to make the EUT transmit continuously.

For AC power line conducted emissions, use the test program "EspRFTestTool" to make the EUT continuous transmit

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 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

Offset = RF cable loss

Following shows an offset computation example with cable loss 5.50 dB.

 $Offset(dB) = RF \ cable \ loss(dB)$ = 5.50 (dB)



3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

3.1.2 Measuring Instruments

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

3.1.3 Test Procedures

- 1. The testing follows ANSI C63.10-2013 clause 11.8
- 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.
- 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% to 5% of the 99% OBW and the VBW is set to 3 times of the RBW.
- 6. Measure and record the results in the test report.

3.1.4 Test Setup



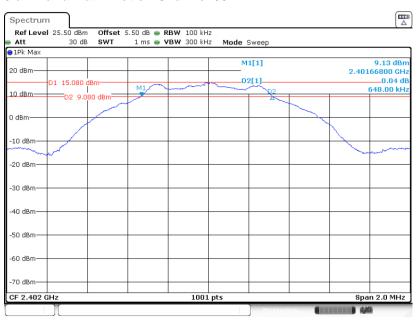
Spectrum Analyzer



3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

BLE 1Mbps:



6 dB Bandwidth Plot on Channel 00

Date: 13.MAR.2023 17:06:43

6 dB Bandwidth Plot on Channel 19



Date: 13.MAR.2023 17:09:30

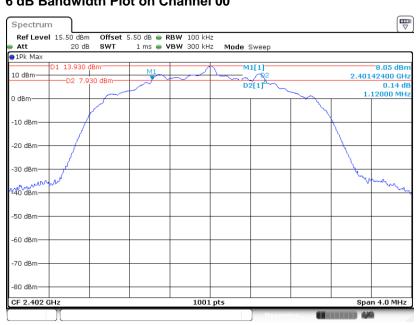




6 dB Bandwidth Plot on Channel 39

Date: 13.MAR.2023 17:11:49

BLE 2Mbps:



6 dB Bandwidth Plot on Channel 00

Date: 25.FEB.2023 00:57:52

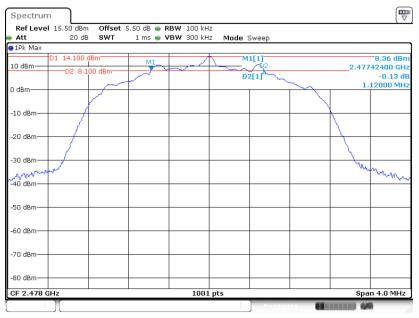




6 dB Bandwidth Plot on Channel 19

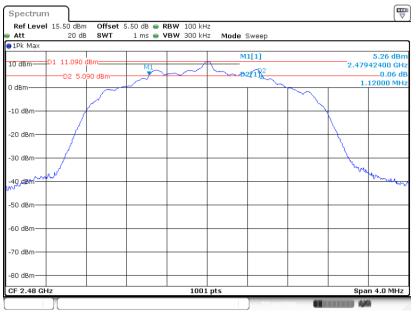
Date: 25.FEB.2023 01:17:53

6 dB Bandwidth Plot on Channel 38



Date: 25.FEB.2023 01:36:44





6 dB Bandwidth Plot on Channel 39

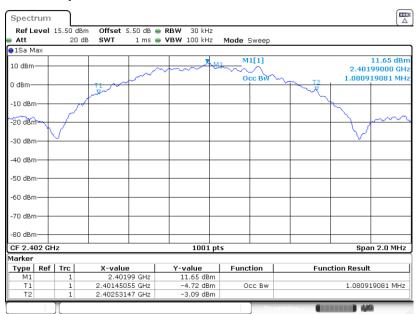
Date: 25.FEB.2023 01:31:00



3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

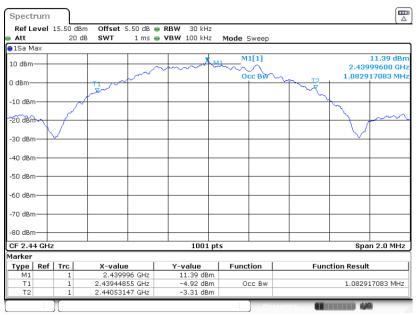
BLE 1Mbps:



99% Occupied Bandwidth Plot on Channel 00

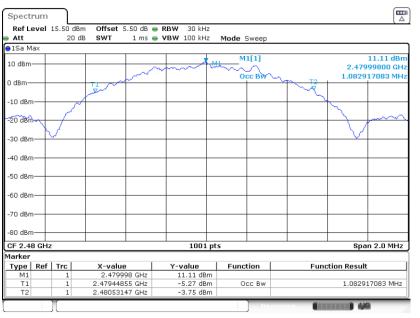
Date: 13.MAR.2023 17:07:35

99% Occupied Bandwidth Plot on Channel 19



Date: 13.MAR.2023 17:10:01





99% Occupied Bandwidth Plot on Channel 39

Date: 13.MAR.2023 17:12:20

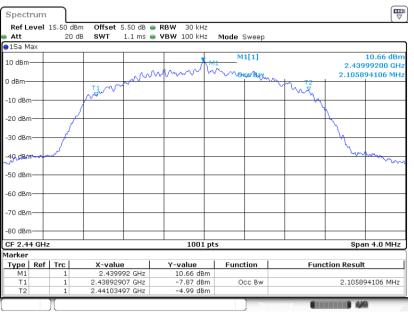
BLE 2Mbps:

99% Occupied Bandwidth Plot on Channel 00



Date: 25.FEB.2023 00:59:38

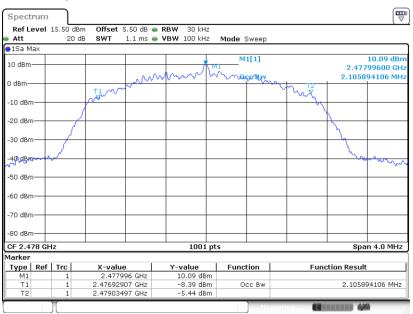




99% Occupied Bandwidth Plot on Channel 19

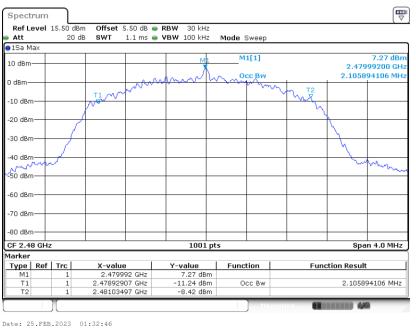
Date: 25.FEB.2023 01:19:21

99% Occupied Bandwidth Plot on Channel 38



Date: 25.FEB.2023 01:38:31





99% Occupied Bandwidth Plot on Channel 39

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

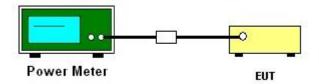
3.2.2 Measuring Instruments

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

3.2.3 Test Procedures

- The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.3 PKPM1 Peak power meter or ANSI C63.10-2013 clause 11.9.2.3.1 Method AVGPM method.
- 2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
- 3. Set to the maximum power setting and enable the EUT transmit continuously.
- 4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

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

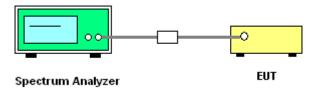
3.3.2 Measuring Instruments

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

3.3.3 Test Procedures

- 1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 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.
- 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



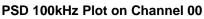
3.3.5 Test Result of Power Spectral Density

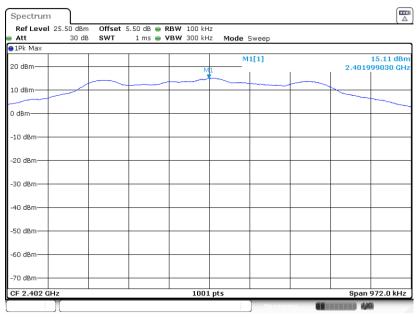
Please refer to Appendix A.



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

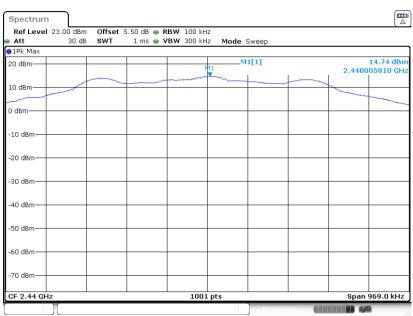
BLE 1Mbps:





Date: 13.MAR.2023 17:08:01

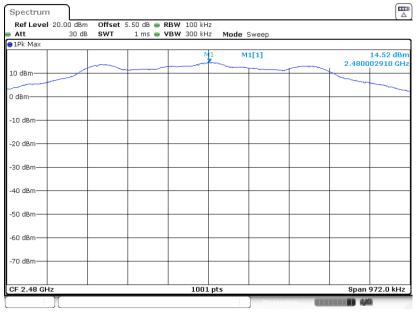
PSD 100kHz Plot on Channel 19



Date: 13.MAR.2023 17:10:50



PSD 100kHz Plot on Channel 39



Date: 13.MAR.2023 17:12:43

BLE 2Mbps:

PSD 100kHz Plot on Channel 00 Spectrum Ref Level 15.50 dBm Offset 5.50 dB 🖷 RBW 100 kHz Att 20 dB SWT 1 ms 👄 **VBW** 300 kHz Mode Sweep ●1Pk Max M1[1] 13.86 dBn 2.40200000 GH м1 10 dBm 0 dBm--10 dBm -20 dBm -30 dBm -40 dBm -50 dBn -60 dBm -70 dBm -80 dBm 1001 pts Span 1.68 MHz CF 2.402 GHz 140

Date: 25.FEB.2023 00:58:30

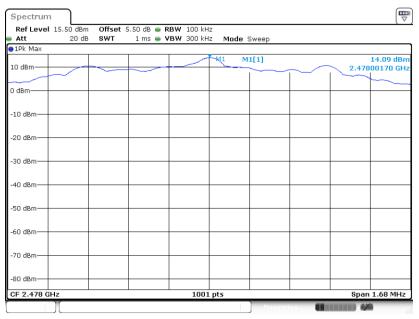


PSD 100kHz Plot on Channel 19

| 14.60 dBr 2.44000170 GH | | M1[1] | THE . | | | 1Pk Max |
|----------------------------|---|-------|-------|--|--|---------|
| | 2 | M1[1] | - MI | | | |
| | | | | | | 10 dBm |
| | | | | | |) dBm |
| | | | _ | | | 10 dBm |
| | | | _ | | | 20 dBm— |
| | | | _ | | | 30 dBm— |
| | | | | | | 40 dBm— |
| | | | _ | | | 50 dBm— |
| | | | | | | 60 dBm |
| | | | | | | 70 dBm— |
| | | | _ | | | 80 dBm— |
| | | | | | | -60 dBm |

Date: 25.FEB.2023 01:18:31

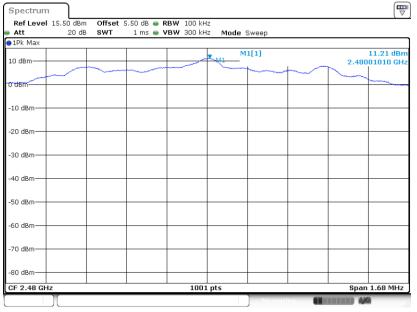
PSD 100kHz Plot on Channel 38



Date: 25.FEB.2023 01:37:22



PSD 100kHz Plot on Channel 39

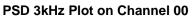


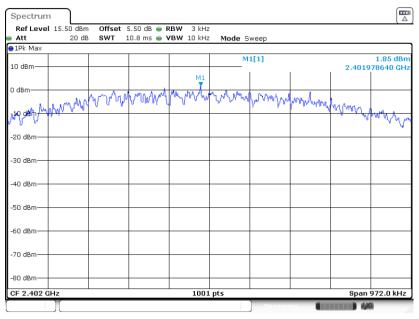
Date: 25.FEB.2023 01:31:38



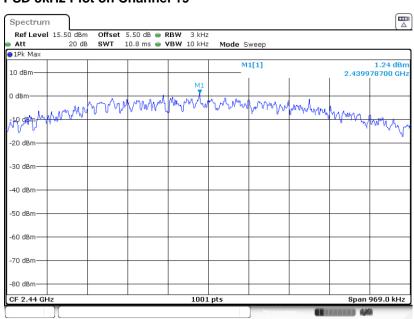
3.3.7 Test Result of Power Spectral Density Plots (3kHz)

BLE 1Mbps:





Date: 13.MAR.2023 17:07:04

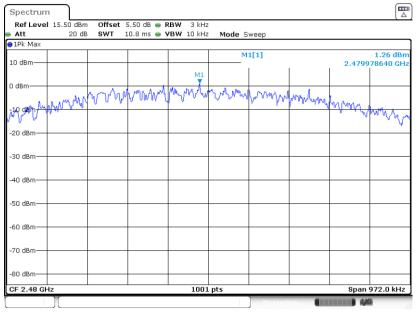


PSD 3kHz Plot on Channel 19

Date: 13.MAR.2023 17:09:50

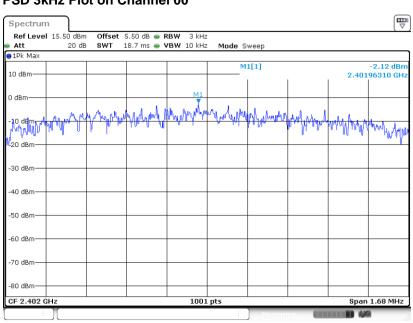


PSD 3kHz Plot on Channel 39



Date: 13.MAR.2023 17:12:09

BLE 2Mbps:

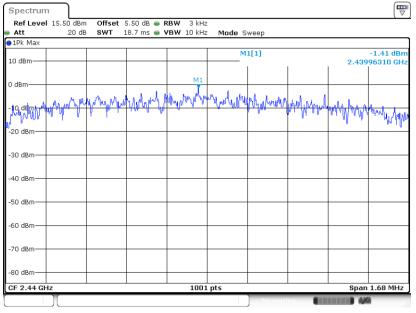


PSD 3kHz Plot on Channel 00

Date: 25.FEB.2023 00:58:11

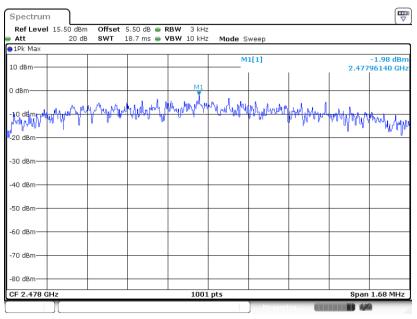


PSD 3kHz Plot on Channel 19



Date: 25.FEB.2023 01:18:12

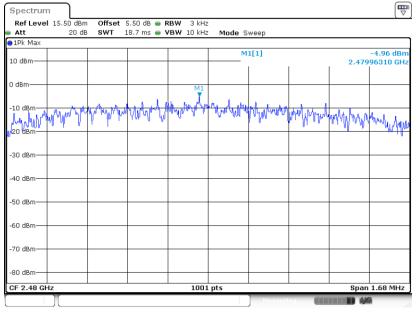
PSD 3kHz Plot on Channel 38



Date: 25.FEB.2023 01:37:03



PSD 3kHz Plot on Channel 39



Date: 25.FEB.2023 01:31:19



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

3.4.2 Measuring Instruments

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

3.4.3 Test Procedure

- 1. The testing follows ANSI C63.10-2013 clause 11.13
- 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

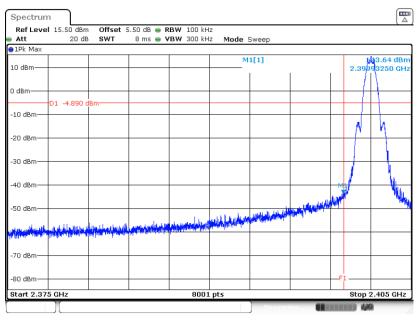




3.4.5 Test Result of Conducted Band Edges Plots

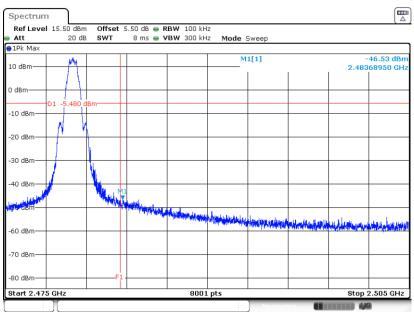
BLE 1Mbps:





Date: 13.MAR.2023 17:08:15



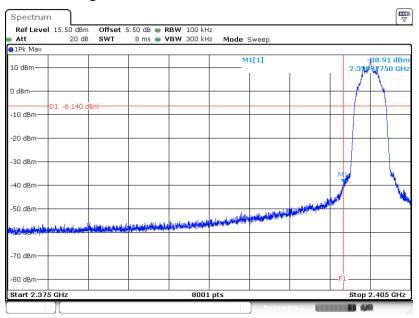


Date: 13.MAR.2023 17:12:56





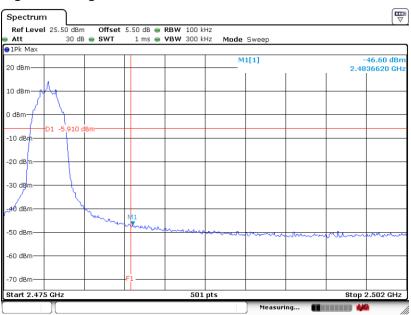
BLE 2Mbps:



Low Band Edge Plot on Channel 00

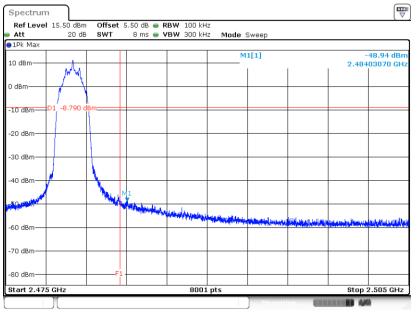
Date: 25.FEB.2023 00:58:49





Date: 27.FEB.2023 15:58:36





High Band Edge Plot on Channel 39

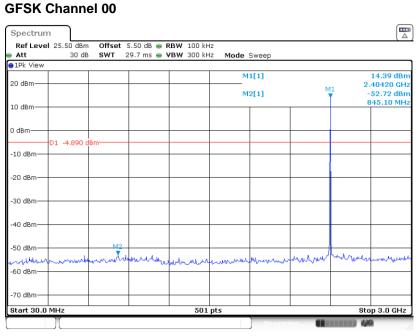
Date: 25.FEB.2023 01:31:56



3.4.6 Test Result of Conducted Spurious Emission Plots

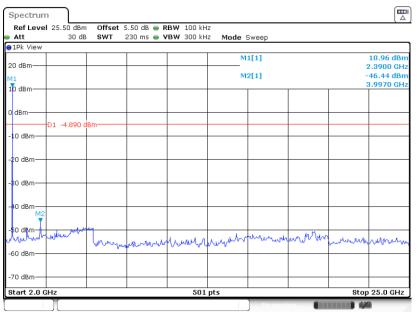
BLE 1Mbps:

Conducted Spurious Emission Plot on Bluetooth LE 1Mbps



Date: 13.MAR.2023 17:08:32

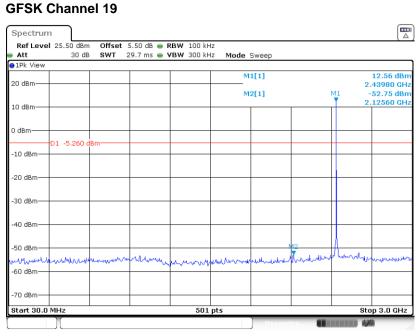
Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00



Date: 13.MAR.2023 17:08:50

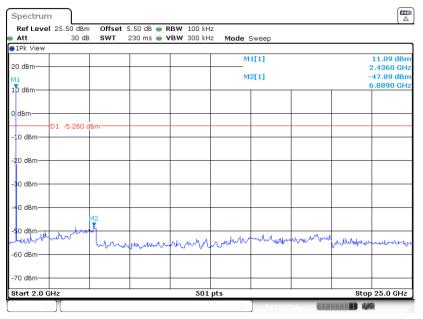


Conducted Spurious Emission Plot on Bluetooth LE 1Mbps



Date: 13.MAR.2023 17:11:06

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



Date: 13.MAR.2023 17:11:18

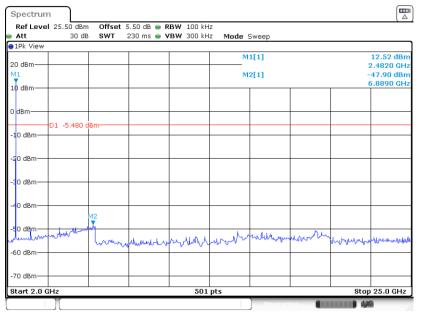


Conducted Spurious Emission Plot on Bluetooth LE 1Mbps

| Spectrum | | | | | |
|-----------------------|----------------|-------------------------|------------|-------------------|--------------|
| Ref Level 25.50 dBm | Offset 5.50 dB | | | | |
| Att 30 dB 1Pk View | SWT 29.7 ms 🛛 | ● VBW 300 kHz 🛛 № | lode Sweep | | |
| | | | M1[1] | | 12.54 dB |
| 20 dBm | | | M2[1] | N | 2.48130 GH |
| 10 dBm | | | mz[1] | | 436.10 MH |
| TO OBIII | | | | | |
| 0 dBm | | | | | |
| D1 -5.480 dl | Bm | | | | |
| -10 dBm | | | | | |
| | | | | | |
| -20 dBm | | | | | |
| | | | | | |
| -30 dBm | | | | | |
| | | | | | |
| -40 dBm | | | | | |
| -50 dBm M2 | | | | | |
| T | when my when | he more way much | welling | and when the work | Widentily mm |
| -60 dBm | | a and a second a second | | | |
| | | | | | |
| -70 dBm | | | | | |
| Start 30.0 MHz | | 501 pts | | | Stop 3.0 GHz |

Date: 13.MAR.2023 17:13:09

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



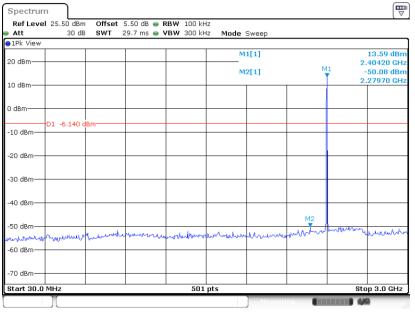
Date: 13.MAR.2023 17:13:23



BLE 2Mbps:

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

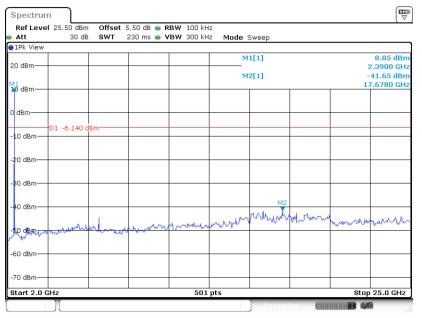
GFSK Channel 00



Date: 25.FEB.2023 00:59:10

Conducted Spurious Emission Plot on Bluetooth LE 2Mbps

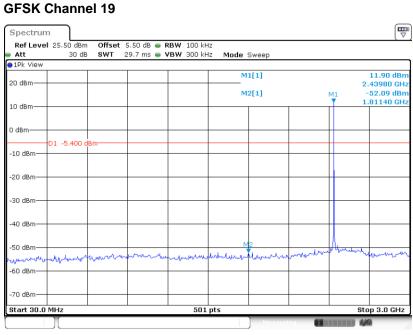
GFSK Channel 00



Date: 25.FEB.2023 00:59:29

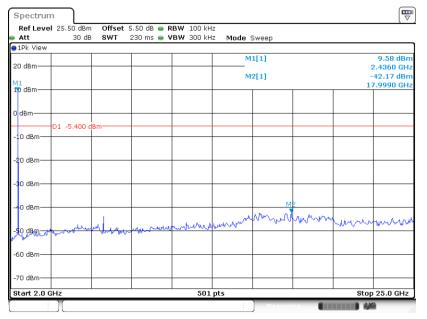


Conducted Spurious Emission Plot on Bluetooth LE 2Mbps



Date: 25.FEB.2023 01:18:52

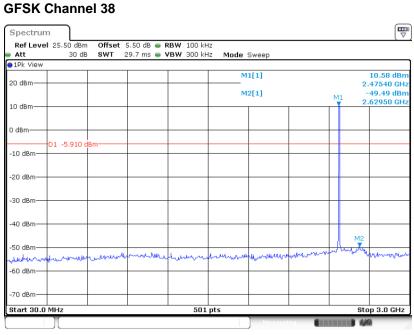
Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 19



Date: 25.FEB.2023 01:19:12

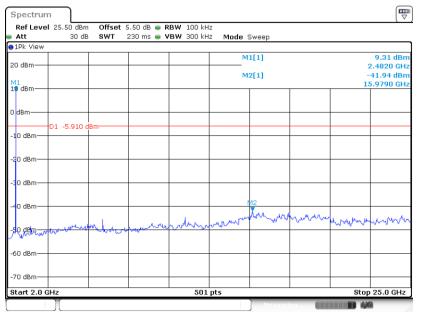


Conducted Spurious Emission Plot on Bluetooth LE 2Mbps



Date: 25.FEB.2023 01:38:02

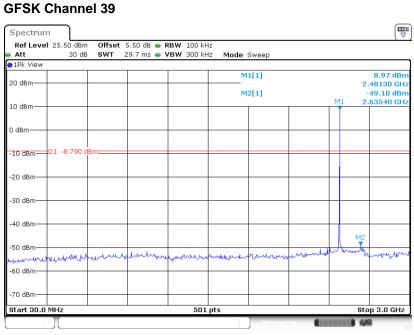
Conducted Spurious Emission Plot on Bluetooth LE 2Mbps GFSK Channel 38



Date: 25.FEB.2023 01:38:22

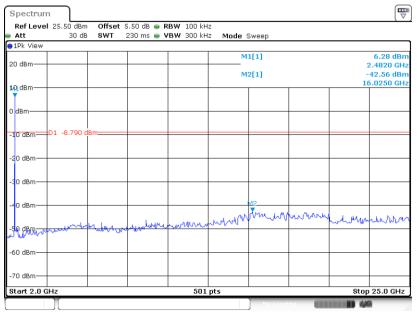


Conducted Spurious Emission Plot on Bluetooth LE 2Mbps



Date: 25.FEB.2023 01:32:17

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



Date: 25.FEB.2023 01:32:37



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

3.5.2 Measuring Instruments

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



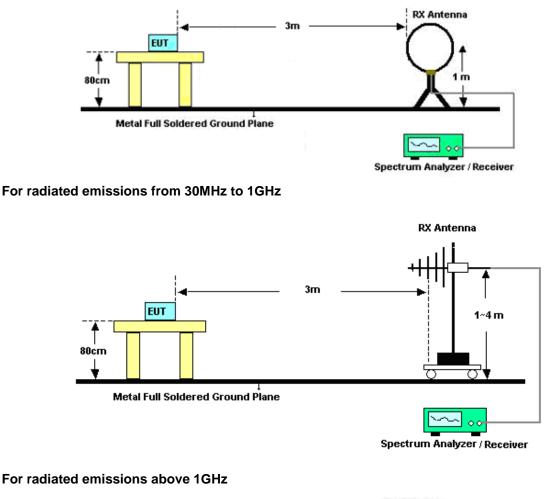
3.5.3 Test Procedures

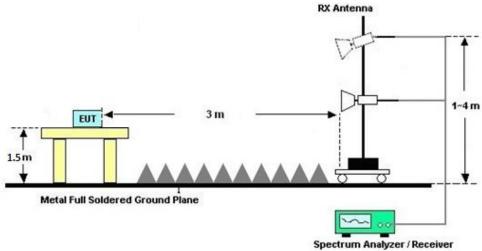
- 1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
- 2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get 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 peak 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 $f \ge 1$ 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





Sporton International Inc. (Kunshan) TEL : +86-512-57900158 FAX : +86-512-57900958 FCC ID: 2AC7Z-ESP868402UC



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

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

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

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.5.7 Duty Cycle

Please refer to Appendix D.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.



3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

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

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

*Decreases with the logarithm of the frequency.

3.6.2 Measuring Instruments

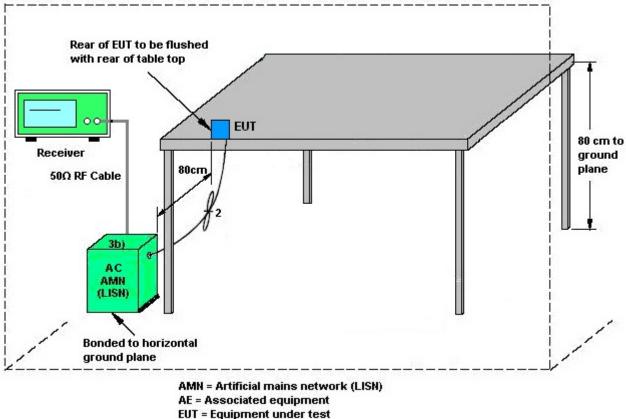
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.6.3 Test Procedures

- 1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
- 2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
- 3. All the support units are connecting to the other LISN.
- 4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
- 5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
- 6. Both sides of AC line were checked for maximum conducted interference.
- 7. The frequency range from 150 kHz to 30 MHz was searched.
- 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



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 rule.

3.7.2 Antenna Anti-Replacement Construction

Non-standard antenna connector 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 |
|---|--|-----------|-------------------------------------|---------------------------------|---------------------|---------------------------------|---------------|--------------------------|
| Spectrum Analyzer | R&S | FSV40 | 101040 | 10Hz~40GHz | Oct. 12, 2022 | Feb. 25, 2023~ Mar. 13, 2023 | Oct. 11, 2023 | Conducted (TH01-KS) |
| Pulse Power Senor | Anritsu | MA2411B | 0917070 300MHz~40GH z Jan. 05, 2 | | Jan. 05, 2023 | Feb. 25, 2023~ Mar. 13, 2023 | Jan. 04, 2024 | Conducted (TH01-KS) |
| Power Meter | Anritsu | ML2495A | 1005002 | 50MHz Bandwidth | Jan. 05, 2023 | Feb. 25, 2023~ Mar. 13, 2023 | Jan. 04, 2024 | Conducted (TH01-KS) |
| EMI Test Receiver | Keysight | N9038A | MY564000 04 | 3Hz~8.5GHz;M ax 30dBm | Oct. 13, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Oct. 12, 2023 | Radiation (03CH05-KS) |
| EXA Spectrum Analyzer | Keysight | N9010A | MY551502 44 | 10Hz-44G,MAX 30dB | Mar. 24, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Mar. 23, 2023 | Radiation (03CH05-KS) |
| Loop Antenna | R&S | HFH2-Z2 | 100321 | 9kHz~30MHz | Oct. 16, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Oct. 15, 2023 | Radiation (03CH05-KS) |
| Bilog Antenna | TeseQ | CBL6111D | 49922 | 30MHz-1GHz | 2022, May 24 | Feb. 27, 2023~ Mar. 16, 2023 | May 23, 2023 | Radiation (03CH05-KS) |
| Double Ridge Horn Antenna | ETS-Lindgren | 3117 | 00218642 | 1GHz~18GHz | Apr. 18, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Apr. 17, 2023 | Radiation (03CH05-KS) |
| SHF-EHF Horn | Com-power | AH-840 | 101093 | 18GHz~40GHz | Jan. 08, 2023 | Feb. 27, 2023~ Mar. 16, 2023 | Jan. 07, 2024 | Radiation (03CH05-KS) |
| Amplifier | SONOMA | 310N | 380826 | 9KHz-1GHz | Jul. 11, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Jul. 10, 2023 | Radiation (03CH05-KS) |
| Amplifier | EM | EM18G40GA | 060852 | 18~40GHz | Jan. 05, 2023 | Feb. 27, 2023~ Mar. 16, 2023 | Jan. 04, 2024 | Radiation (03CH05-KS) |
| high gain Amplifier | EM | EM01G18GA | 060839 | 1Ghz-18Ghz | Oct. 12, 2022 | Feb. 27, 2023~ Mar. 16, 2023 | Oct. 11, 2023 | Radiation (03CH05-KS) |
| Amplifier | EM | EM01G18GA | 060833 | 1Ghz-18Ghz | Jan. 05, 2023 | Feb. 27, 2023~ Mar. 16, 2023 | Jan. 04, 2024 | Radiation (03CH05-KS) |
| AC Power Source | Chroma | 61601 | F1040900 04 | N/A | NCR | Feb. 27, 2023~ Mar. 16, 2023 | NCR | Radiation (03CH05-KS) |
| Turn Table | ChamPro | EM 1000-T | 060762-T | 0~360 degree | NCR | Feb. 27, 2023~ Mar. 16, 2023 | NCR | Radiation (03CH05-KS) |
| Antenna Mast | ast ChamPro EM 1000-A 060762-A 1 m~4 m NCR | | NCR | Feb. 27, 2023~ Mar. 16, 2023 | NCR | Radiation (03CH05-KS) | | |
| EMI Receiver | iver R&S ESCI7 100768 9kHz~7GHz; May 2 | | May 24, 2022 | Mar. 01, 2023 | May 23, 2023 | Conduction (CO01-KS) | | |
| AC LISN (for auxiliary equipment) | MessTec | AN3016 | 060103 | 9kHz~30MHz | Oct. 13, 2022 | Mar. 01, 2023 | Oct. 12, 2023 | Conduction (CO01-KS) |
| AC LISN | MessTec | AN3016 | 060105 | 9kHz~30MHz | May 24, 2022 | Mar. 01, 2023 | May 23, 2023 | Conduction (CO01-KS) |
| AC Power Source | Chroma | 61602 | ABP00000 0811 | AC 0V~300V, 45Hz~1000Hz | Oct. 12, 2022 | Mar. 01, 2023 | Oct. 11, 2023 | Conduction (CO01-KS) |

NCR: No Calibration Required



5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Measurement

| Test Item | Uncertainty | | | |
|----------------------------------|-------------|--|--|--|
| Conducted Power | ±0.46 dB | | | |
| Conducted Emissions | ±0.48 dB | | | |
| Occupied Channel Bandwidth | ±0.1 % | | | |
| Conducted Power Spectral Density | ±0.40 dB | | | |

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

| Measuring Uncertainty for a Level of Confidence | 2.78dB |
|---|--------|
| of 95% (U = 2Uc(y)) | 2.7608 |

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

| Measuring Uncertainty for a Level of Confidence | 5.0dB |
|---|-------|
| of 95% (U = 2Uc(y)) | 3.00B |

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

| Measuring Uncertainty for a Level of Confidence | 5.0dB | |
|---|-------|--|
| of 95% (U = 2Uc(y)) | 5.008 | |

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

| Measuring Uncertainty for a Level of Confidence | 5.0dB |
|---|-------|
| of 95% (U = 2Uc(y)) | 5.008 |

----- THE END ------



Appendix A. Conducted Test Results

Report Number : FR310905A

Bluetooth Low Energy

| Test Engineer: | Jiang Jun | Temperature: | 20~26 | °C |
|----------------|---------------------|--------------------|-------|----|
| Test Date: | 2023/2/25~2023/3/13 | Relative Humidity: | 40~51 | % |

| BLE1M-Ant1 <u>TEST RESULTS DATA</u> <u>6dB and 99% Occupied Bandwidth</u> | | | | | | | | | | |
|---|--------------|-----|-----|----------------|--------------------------------|-----------------|--------------------------|-----------|--|--|
| 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 | 1.08 | 0.65 | 0.50 | Pass | | |
| BLE | 1Mbps | 1 | 19 | 2440 | 1.08 | 0.65 | 0.50 | Pass | | |
| BLE | 1Mbps | 1 | 39 | 2480 | 1.08 | 0.65 | 0.50 | Pass | | |

| <u>TEST RESULTS DATA</u> <u>Peak Power Table</u> | | | | | | | | | | | |
|---|--------------|-----|-----|----------------|-------------------------------------|--------------------------------------|-------------|------------------------|---------------------------------|---------------|--|
| 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 | 15.74 | 30.00 | 1.57 | 17.31 | 36.00 | Pass | |
| BLE | 1Mbps | 1 | 19 | 2440 | 15.65 | 30.00 | 1.57 | 17.22 | 36.00 | Pass | |
| BLE | 1Mbps | 1 | 39 | 2480 | 15.69 | 30.00 | 1.57 | 17.26 | 36.00 | Pass | |

| TEST RESULTS DATA |
|---------------------|
| Average Power Table |
| (Reporting Only) |

| Mod. | Data Rate | Ντx | CH. | Freq. (MHz) | Duty Factor (dB) | Average Conducted Power (dBm) |
|------|--------------|-----|-----|----------------|------------------------|--|
| BLE | 1Mbps | 1 | 0 | 2402 | 0.21 | 15.08 |
| BLE | 1Mbps | 1 | 19 | 2440 | 0.21 | 14.89 |
| BLE | 1Mbps | 1 | 39 | 2480 | 0.21 | 14.92 |

| | <u>TEST RESULTS DATA</u> <u>Peak Power Density</u> | | | | | | | | | | | |
|-------|---|--------|----------|----------------|------------------------------|----------------------------|-------------|-------------------------------------|---------------|--------------------------|--|--|
| 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 | 15.11 | 1.85 | 1.57 | 8.00 | Pass | | | |
| BLE | 1Mbps | 1 | 19 | 2440 | 14.74 | 1.24 | 1.57 | 8.00 | Pass | | | |
| BLE | 1Mbps | 1 | 39 | 2480 | 14.52 | 1.26 | 1.57 | 8.00 | Pass | | | |
| Note: | PSD (dBm | n/ 100 | 0kHz) is | a referer | nce level use | d for Conduc | ted Band Ed | ges and Cond | ducted Spuric | us Emission 20dBc limit. | | |



Bluetooth Low Energy

| Test Engineer: | Jiang Jun | Temperature: | 20~26 | °C |
|----------------|---------------------|--------------------|-------|----|
| Test Date: | 2023/2/25~2023/3/13 | Relative Humidity: | 40~51 | % |

| | | | | | <u>6d</u> | TEST | E2M-Ant1 RESULTS 6 Occupie | |
|------|--------------|-----|-----|----------------|--------------------------------|-----------------|----------------------------------|-----------|
| 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 | 2.102 | 1.120 | 0.50 | Pass |
| BLE | 2Mbps | 1 | 19 | 2440 | 2.106 | 1.120 | 0.50 | Pass |
| BLE | 2Mbps | 1 | 38 | 2478 | 2.106 | 1.120 | 0.50 | Pass |
| BLE | 2Mbps | 1 | 39 | 2480 | 2.106 | 1.120 | 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 | 15.92 | 30.00 | 1.57 | 17.49 | 36.00 | Pass |
| BLE | 2Mbps | 1 | 19 | 2440 | 15.93 | 30.00 | 1.57 | 17.50 | 36.00 | Pass |
| BLE | 2Mbps | 1 | 38 | 2478 | 14.94 | 30.00 | 1.57 | 16.51 | 36.00 | Pass |
| BLE | 2Mbps | 1 | 39 | 2480 | 12.88 | 30.00 | 1.57 | 14.45 | 36.00 | Pass |

| <u>TEST RESULTS DATA</u> <u>Average Power Table</u> <u>(Reporting Only)</u> | | | | | | | | |
|---|--------------|-----|-----|----------------|------------------------|--|--|--|
| Mod. | Data Rate | NTX | CH. | Freq. (MHz) | Duty Factor (dB) | Average Conducted Power (dBm) | | |
| BLE | 2Mbps | 1 | 0 | 2402 | 0.41 | 14.71 | | |
| BLE | 2Mbps | 1 | 19 | 2440 | 0.41 | 14.63 | | |
| BLE | 2Mbps | 1 | 38 | 2478 | 0.41 | 13.48 | | |
| BLE | 2Mbps | 1 | 39 | 2480 | 0.41 | 11.58 | | |

| | <u>TEST RESULTS DATA</u> <u>Peak Power Density</u> | | | | | | | | | |
|----|---|-----|-----|----------------|------------------------------|----------------------------|-------------|-------------------------------------|-----------|--|
| | | | | | | | | | | |
| Mo | d. Data Rate | Ntx | CH. | Freq. (MHz) | Peak PSD (dBm /100kHz) | Peak PSD (dBm /3kHz) | DG (dBi) | Peak PSD Limit (dBm /3kHz) | Pass/Fail | |
| BL | E 2Mbps | 1 | 0 | 2402 | 13.86 | -2.12 | 1.57 | 8.00 | Pass | |
| BL | E 2Mbps | 1 | 19 | 2440 | 14.60 | -1.41 | 1.57 | 8.00 | Pass | |
| BL | E 2Mbps | 1 | 38 | 2478 | 14.09 | -1.98 | 1.57 | 8.00 | Pass | |
| BL | E 2Mbps | 1 | 39 | 2480 | 11.21 | -4.96 | 1.57 | 8.00 | Pass | |

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

Report Number : FR310905A

| | | | | | | | <u>TEST I</u> | E125k(S=8 RESULTS & Power Ta | DATA | | |
|---|-------|--------------|-----|-----|----------------|-------------------------------------|--------------------------------------|------------------------------------|------------------------|---------------------------------|---------------|
| | | | | | | | <u>rear</u> | rower to | | | |
| r | /lod. | 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 | 125kbps | 1 | 0 | 2402 | 15.47 | 30.00 | 1.57 | 17.04 | 36.00 | Pass |
| | BLE | 125kbps | 1 | 19 | 2440 | 13.25 | 30.00 | 1.57 | 14.82 | 36.00 | Pass |
| | BLE | 125kbps | 1 | 39 | 2480 | 13.54 | 30.00 | 1.57 | 15.11 | 36.00 | Pass |

TEST RESULTS DATA Average Power Table (Reporting Only)

| Mod. | Data Rate | NTX | CH. | Freq. (MHz) | Duty Factor (dB) | Average Conducted Power (dBm) |
|------|--------------|-----|-----|----------------|------------------------|--|
| BLE | 125kbps | 1 | 0 | 2402 | 0.03 | 14.58 |
| BLE | 125kbps | 1 | 19 | 2440 | 0.03 | 12.52 |
| BLE | 125kbps | 1 | 39 | 2480 | 0.03 | 12.71 |

| | | | | | | <u>TEST I</u> | E500k(S=2 RESULTS & Power Ta | DATA | | |
|------|--------------|-----|-----|----------------|-------------------------------------|--------------------------------------|------------------------------------|------------------------|---------------------------------|---------------|
| 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 | 500kbps | 1 | 0 | 2402 | 15.47 | 30.00 | 1.57 | 17.04 | 36.00 | Pass |
| BLE | 500kbps | 1 | 19 | 2440 | 13.26 | 30.00 | 1.57 | 14.83 | 36.00 | Pass |
| BLE | 500kbps | 1 | 39 | 2480 | 13.64 | 30.00 | 1.57 | 15.21 | 36.00 | Pass |

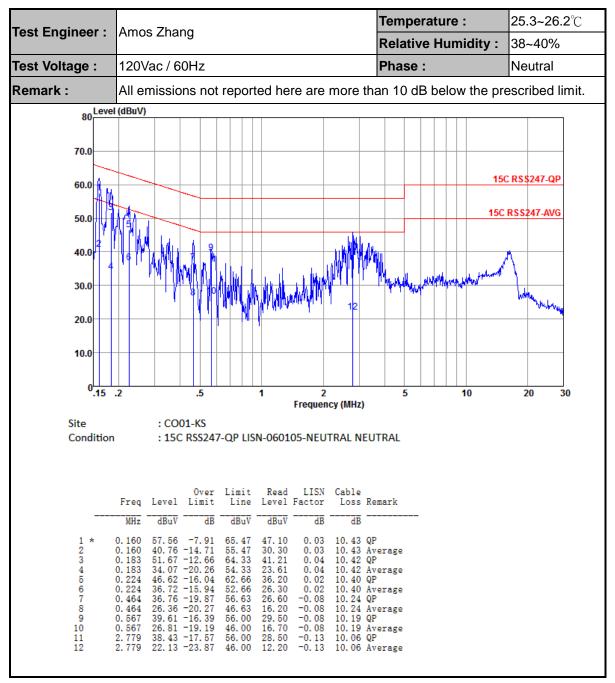
| | <u>TEST RESULTS DATA</u> <u>Average Power Table</u> <u>(Reporting Only)</u> | | | | | | | | | | |
|------|---|-----|-----|----------------|------------------------|--|--|--|--|--|--|
| Mod. | Data Rate | NTX | CH. | Freq. (MHz) | Duty Factor (dB) | Average Conducted Power (dBm) | | | | | |
| BLE | 500kbps | 1 | 0 | 2402 | 0.11 | 14.69 | | | | | |
| BLE | 500kbps | 1 | 19 | 2440 | 0.11 | 12.44 | | | | | |
| BLE | 500kbps | 1 | 39 | 2480 | 0.11 | 12.79 | | | | | |



Appendix B. AC Conducted Emission Test Results

| | A second Theorem | Temperature : | 25.3~26.2° ∁ |
|-----------------|--|------------------------|---------------------|
| Test Engineer : | Amos Zhang | Relative Humidity : | 38~40% |
| Test Voltage : | 120Vac / 60Hz | Phase : | Line |
| Remark : | All emissions not reported here are more that | an 10 dB below the pre | escribed limit. |
| 80 Level | (dBuV) | | |
| 70.0 | | | |
| 70.0 | | | |
| 60.0 | | 150 | RS\$247-QP |
| 50.0 | | 15C | RSS247-AVG |
| 24 | | + | |
| 40.0 | | 1 | N |
| 30.0 | The Anthen and Anthen anthen anthen anthen anthen and Anthen and Anthen and Anthen and A | Mapalahurman | <u>\</u> |
| 20.0 | 12 | | Mandandan |
| 20.0 | | | |
| 10.0 | | | |
| | | | |
| 0.15 | 2 .5 1 2 Frequency (MHz) | 5 10 | 20 30 |
| Site | : CO01-KS | | |
| Condition | : 15C RSS247-QP LISN-060105-LINE LINE | | |
| | | | |
| | Over Limit Read LISN Cable Freq Level Limit Line Level Factor Loss Rem | mark | |
| | MHz dBuV dB dBuV dB dBu - dBu - dBu - dB | | |
| 2 | 0.163 57.28 -8.02 65.30 46.79 0.06 10.43 QP 0.163 44.08 -11.22 55.30 33.59 0.06 10.43 Ave | erage | |
| 3 * | 0.171 57.07 -7.83 64.90 46.59 0.05 10.43 QP 0.171 42.57 -12.33 54.90 32.09 0.05 10.43 Ave 0.194 53.75 -10.09 63.84 43.31 0.02 10.42 QP | erage | |
| 6 7 | 0.194 40.75 -13.09 53.84 30.31 0.02 10.42 Ave 0.233 49.23 -13.12 62.35 38.80 0.04 10.39 QP | erage | |
| 9 | 0.233 42.33 -10.02 52.35 31.90 0.04 10.39 Ave 0.535 39.06 -16.94 56.00 28.90 -0.04 10.20 QP | - | |
| 11 | 0.535 26.46 -19.54 46.00 16.30 -0.04 10.20 Ave 2.779 36.55 -19.45 56.00 26.59 -0.10 10.06 QP 2.779 22.15 -23.85 46.00 12.19 -0.10 10.06 Ave | | |
| | | . . | |





Note:

- 1. Level(dB μ V) = Read Level(dB μ V) + LISN Factor(dB) + Cable Loss(dB)
- 2. Over Limit(dB) = Level(dB μ V) Limit Line(dB μ V)



Appendix C. Radiated Spurious Emission

| Test Engineer : | Carry Xu | Relative Humidity : | 41~42% |
|-----------------|----------|---------------------|----------------|
| Test Engineer . | Carry Xu | Temperature : | 22~23 ℃ |

| Power setting | | | | | |
|----------------|----|--|--|--|--|
| BLE 1Mbps CH00 | 13 | | | | |
| BLE 1Mbps CH19 | 13 | | | | |
| BLE 1Mbps CH39 | 13 | | | | |
| BLE 2Mbps CH00 | 13 | | | | |
| BLE 2Mbps CH19 | 13 | | | | |
| BLE 2Mbps CH38 | 13 | | | | |
| BLE 2Mbps CH39 | 12 | | | | |



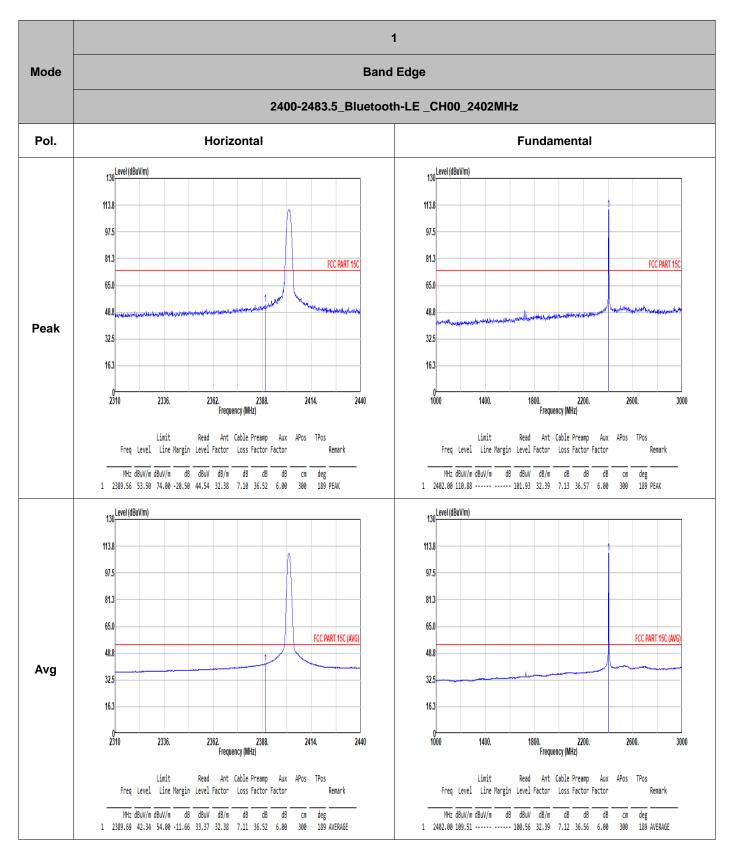
Radiated Spurious Emission Test Modes

| Mode | Band (MHz) | Modulation | Channel | Frequency | Data Rate | Remark |
|--------|---------------|--------------|---------|-----------|--------------|--------|
| Mode 1 | 2400-2483.5 | Bluetooth-LE | 00 | 2402 | 1Mbps | - |
| Mode 2 | 2400-2483.5 | Bluetooth-LE | 19 | 2440 | 1Mbps | - |
| Mode 3 | 2400-2483.5 | Bluetooth-LE | 39 | 2480 | 1Mbps | - |
| Mode 4 | 2400-2483.5 | Bluetooth-LE | 00 | 2402 | 2Mbps | - |
| Mode 5 | 2400-2483.5 | Bluetooth-LE | 19 | 2440 | 2Mbps | - |
| Mode 6 | 2400-2483.5 | Bluetooth-LE | 38 | 2478 | 2Mbps | - |
| Mode 7 | 2400-2483.5 | Bluetooth-LE | 39 | 2480 | 2Mbps | - |
| Mode 8 | 2400-2483.5 | Bluetooth-LE | 38 | 2478 | 2Mbps | LF |

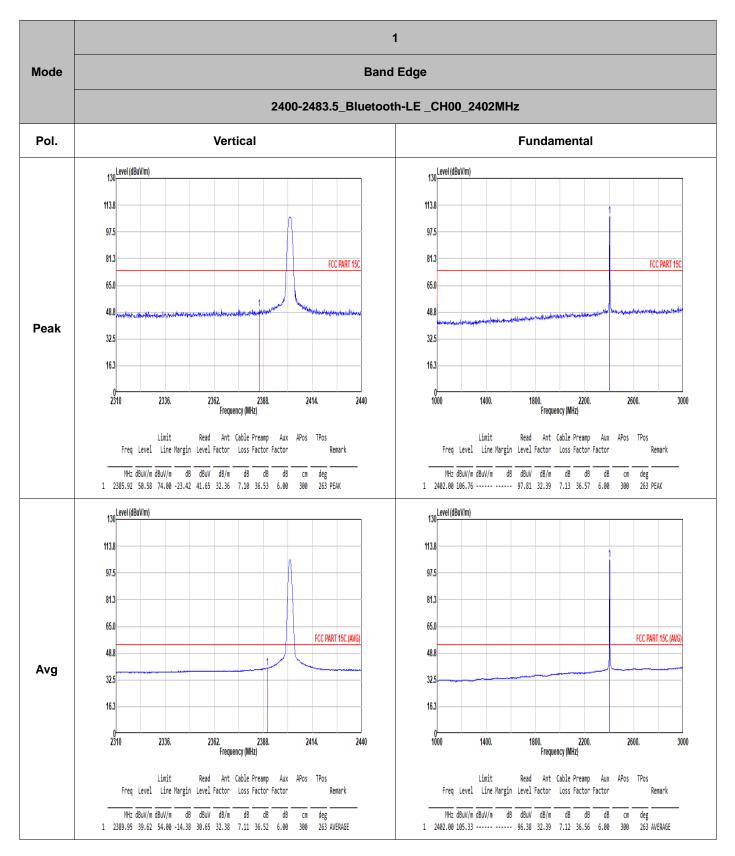
Summary of each worse mode

| Mode | Modulation | Ch. | Freq. (MHz) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Pol. | Peak Avg. | Result | Remark |
|------|--------------|-----|----------------|-------------------|-------------------|----------------|------|--------------|--------|-----------|
| 1 | Bluetooth-LE | 00 | 2389.69 | 42.34 | 54.00 | -11.66 | Н | AVERAGE | Pass | Band Edge |
| | Bluetooth-LE | 00 | 4804.00 | 48.58 | 54.00 | -5.42 | Н | AVERAGE | Pass | Harmonic |
| 2 | Bluetooth-LE | 19 | 4880.00 | 49.90 | 54.00 | -4.10 | Н | AVERAGE | Pass | Harmonic |
| 3 | Bluetooth-LE | 39 | 2483.50 | 50.04 | 54.00 | -3.96 | Н | AVERAGE | Pass | Band Edge |
| 3 | Bluetooth-LE | 39 | 4960.00 | 49.77 | 54.00 | -4.23 | Н | AVERAGE | Pass | Harmonic |
| 4 | Bluetooth-LE | 00 | 2389.95 | 42.64 | 54.00 | -11.36 | Н | AVERAGE | Pass | Band Edge |
| 4 | Bluetooth-LE | 00 | 4804.00 | 48.07 | 54.00 | -5.93 | V | AVERAGE | Pass | Harmonic |
| 5 | Bluetooth-LE | 19 | 4880.00 | 46.73 | 54.00 | -7.27 | Н | AVERAGE | Pass | Harmonic |
| 6 | Bluetooth-LE | 38 | 2483.62 | 52.03 | 54.00 | -1.97 | Н | AVERAGE | Pass | Band Edge |
| 0 | Bluetooth-LE | 38 | 3304.50 | 48.71 | 74.00 | -25.29 | Н | Peak | Pass | Harmonic |
| 7 | Bluetooth-LE | 39 | 2483.50 | 50.57 | 54.00 | -3.43 | н | AVERAGE | Pass | Band Edge |
| | Bluetooth-LE | 39 | 3307.50 | 48.22 | 74.00 | -25.78 | н | Peak | Pass | Harmonic |
| 8 | Bluetooth-LE | 38 | 71.71 | 28.85 | 40 | -11.15 | Н | Peak | Pass | LF |

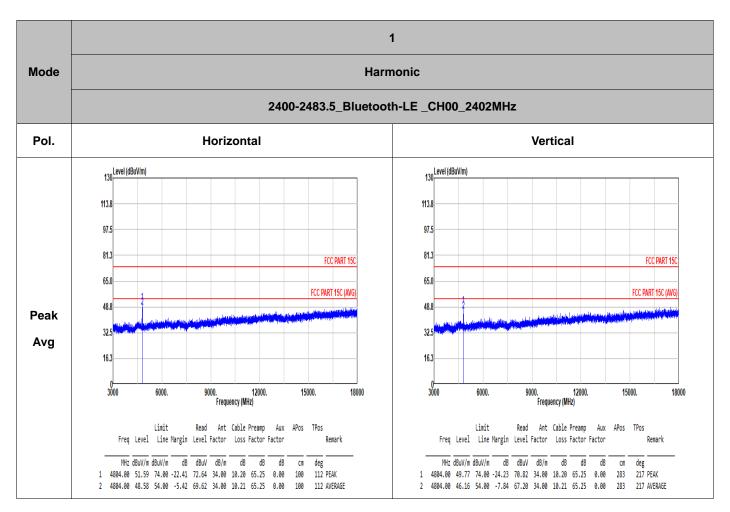




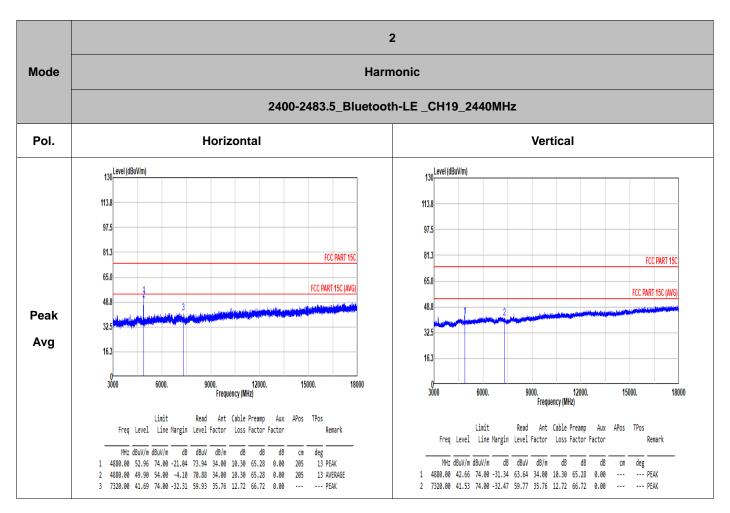




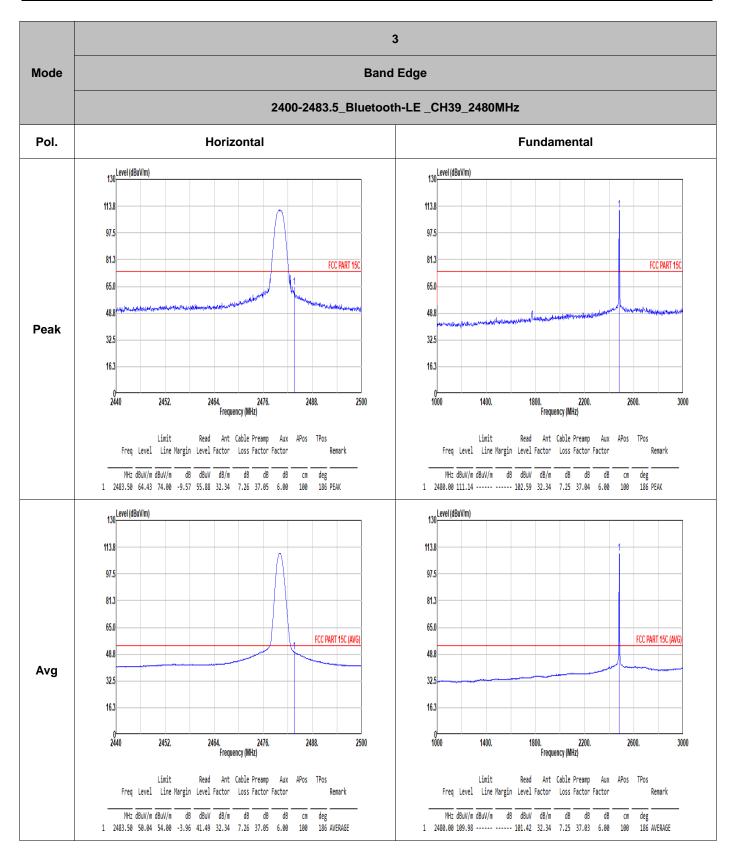




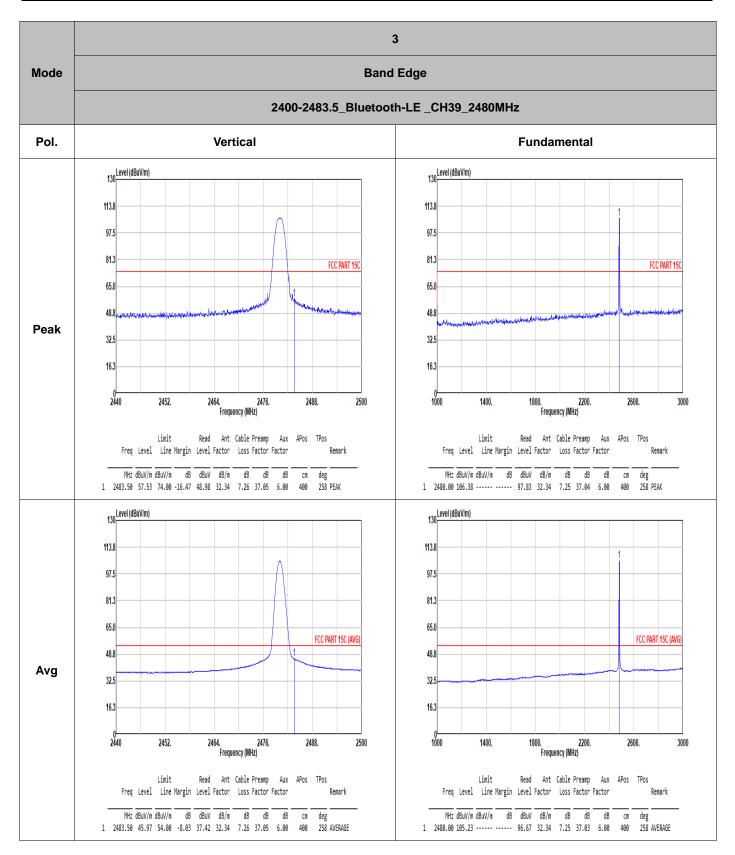




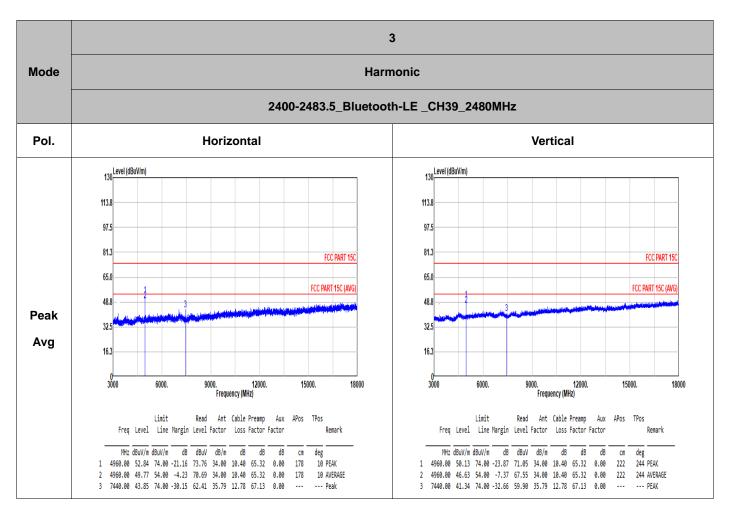




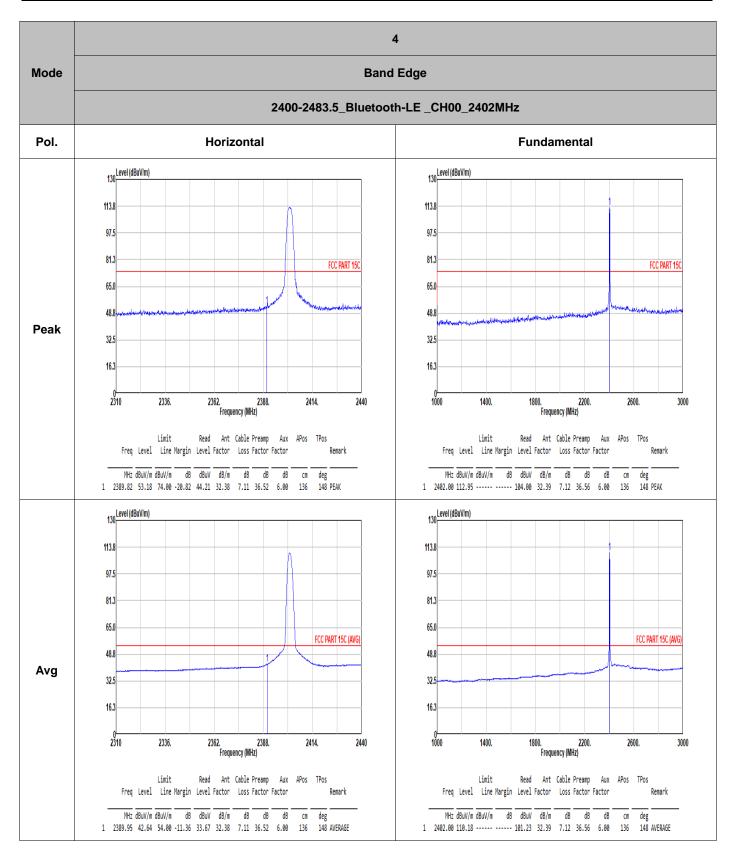




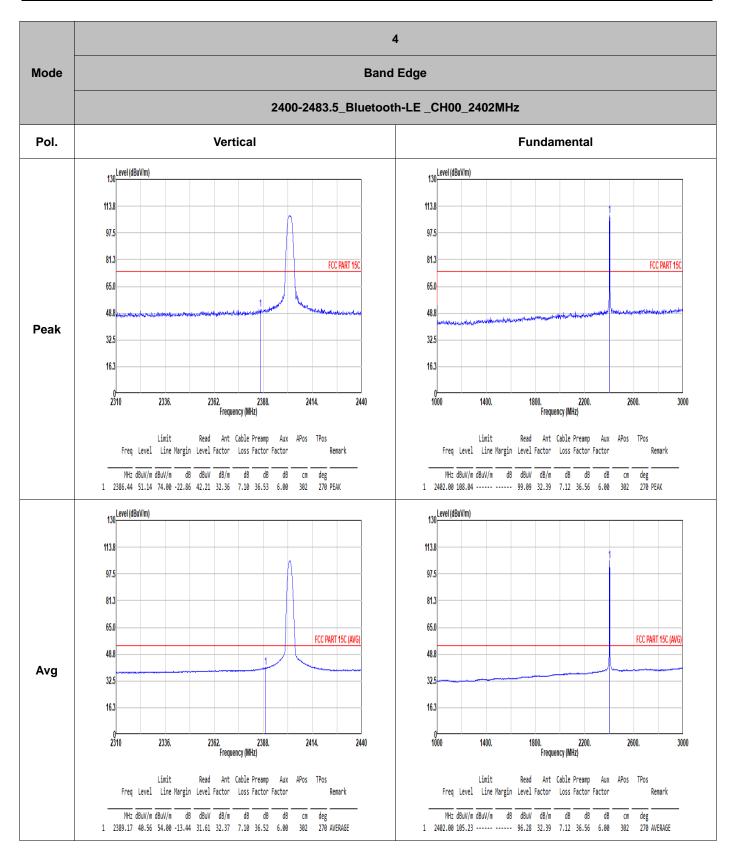




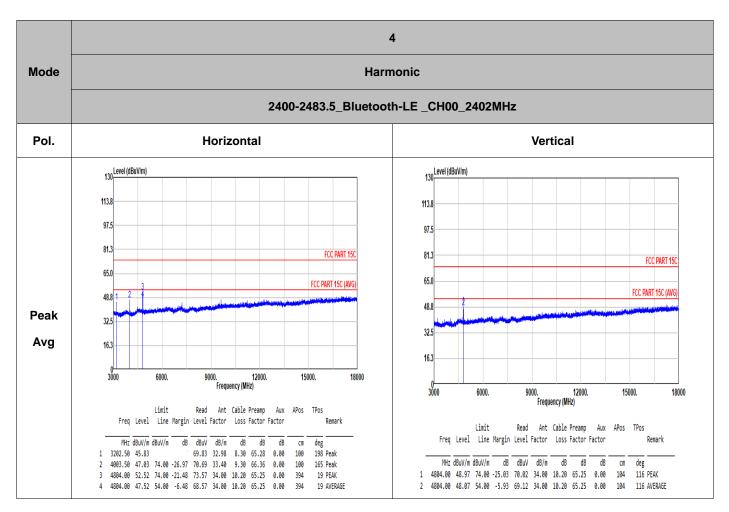




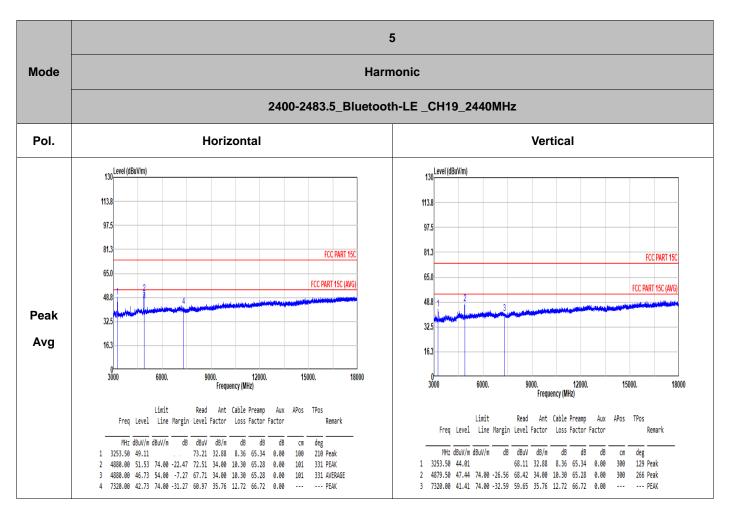




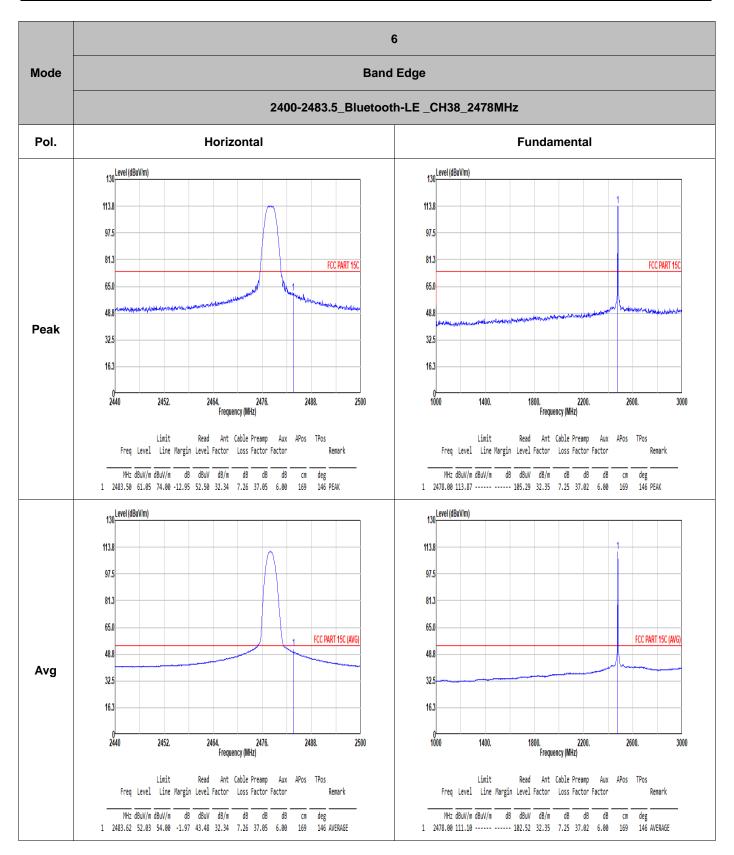




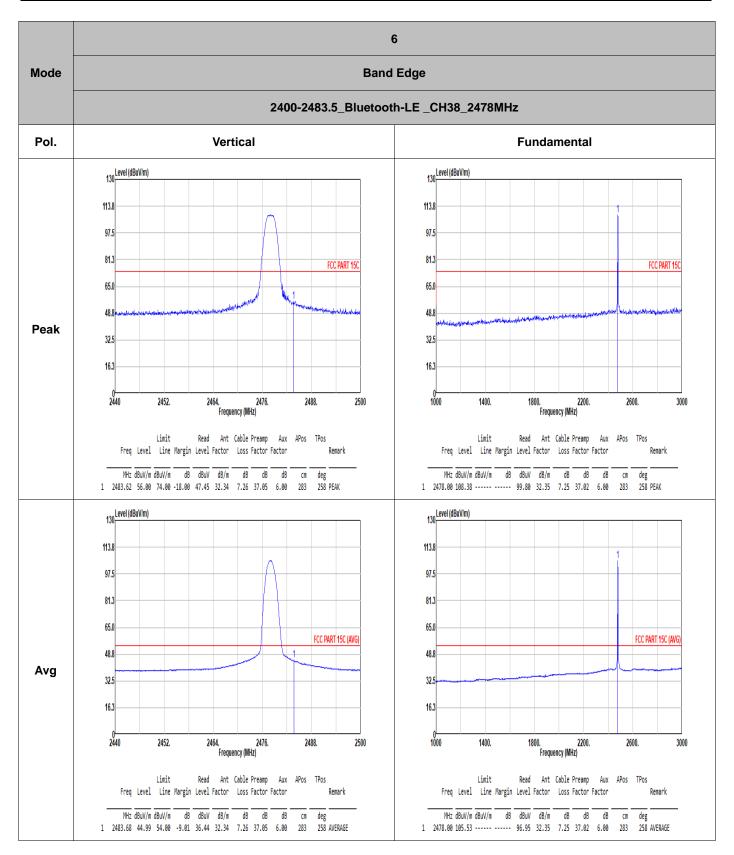




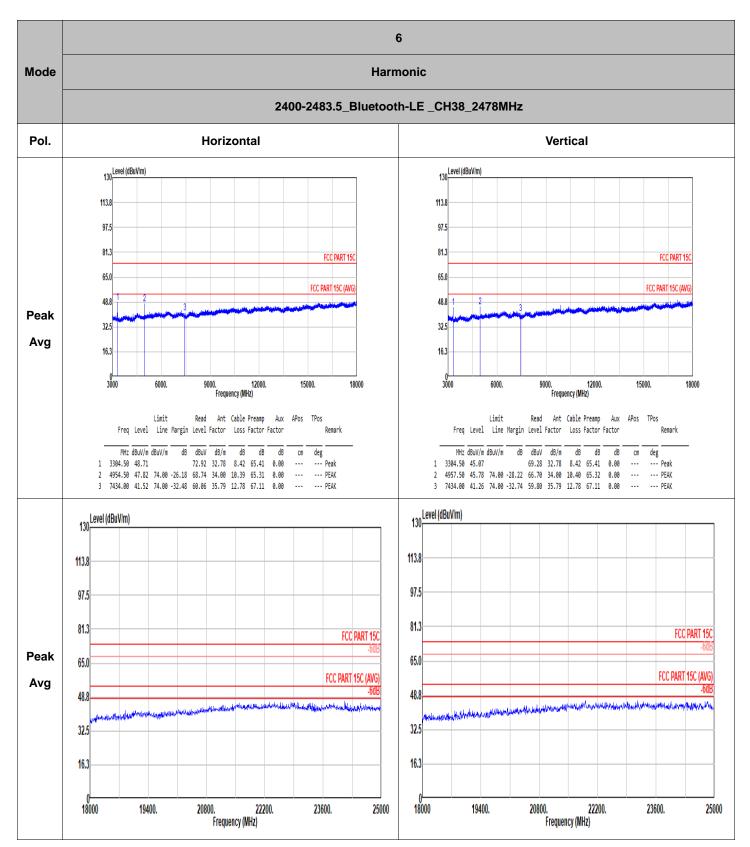




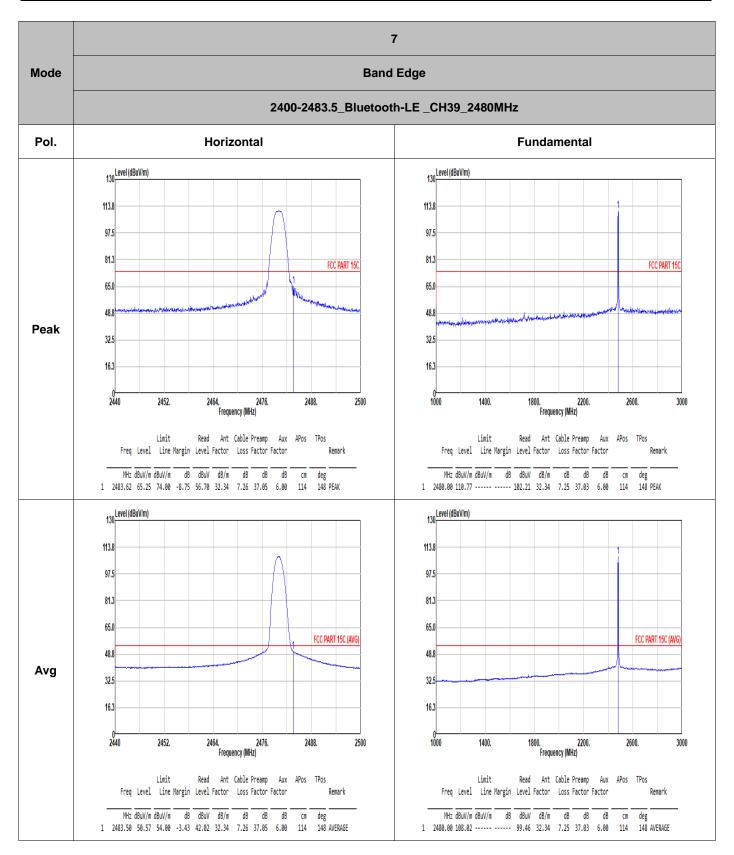




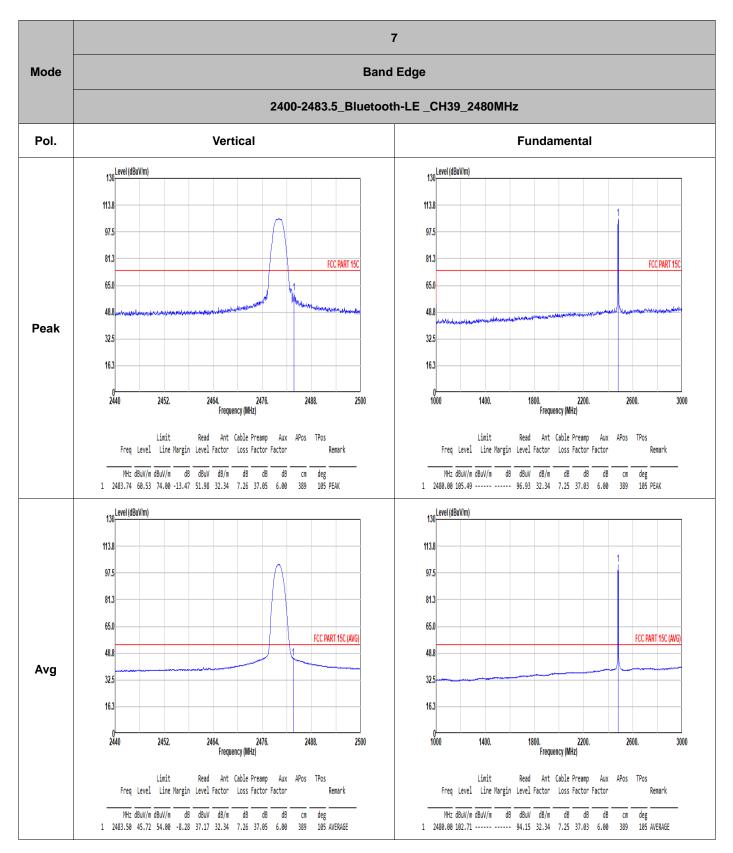




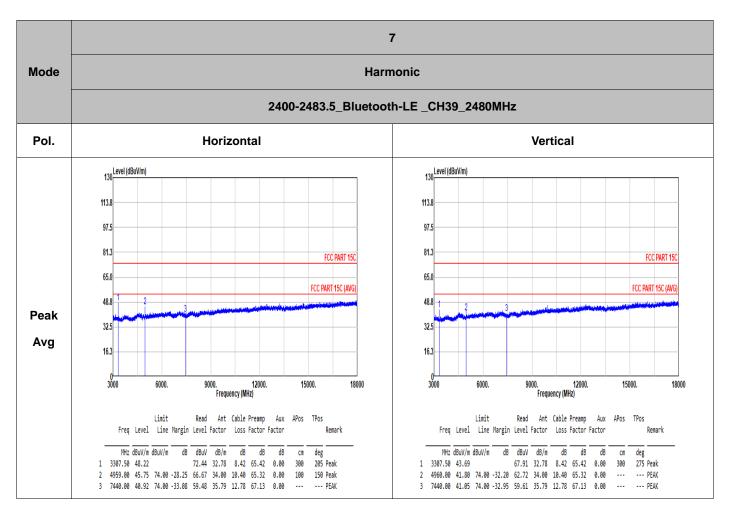




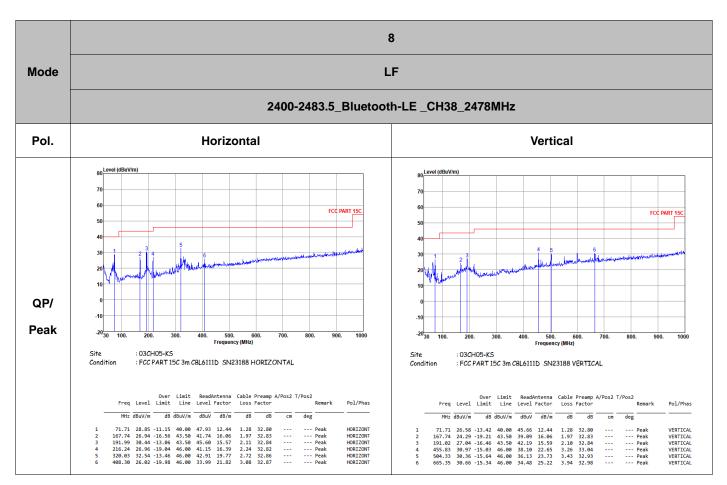














Appendix D. Duty Cycle Plots

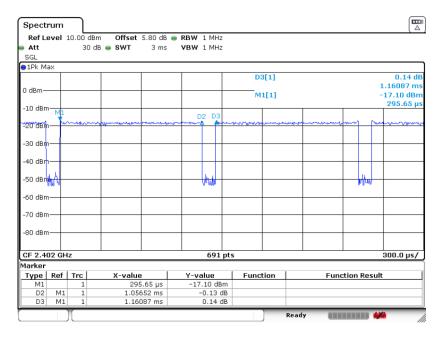
| Band | Duty Cycle(%) | T(ms) | 1/T(kHz) | VBW Setting |
|----------------------|---------------|-------|----------|----------------|
| Bluetooth LE 1Mbps | 95.25 | 2.093 | 0.478 | 1KHz |
| Bluetooth LE 2Mbps | 91.01 | 1.057 | 0.947 | 1.1KHz |
| Bluetooth LE 500kbps | 97.47 | 4.463 | 0.224 | 1KHz |
| Bluetooth LE 125kbps | 99.31 | - | - | 10Hz |

Spectrum Ref Level 35.80 dBm Offset 5.80 dB RBW 1 MHz Att 50 dB SWT 5 ms VBW 1 MHz SGL ●1Pk Max D3[1] -0.09 d 30 dBm 2.19710 m 13.13 dBr 389.86 μ M1[1] 20 dBm; 10 dBr 0 dBr -10 dB -20 dB -30 dB -40 dB -50 dBn -60 dBm 691 pts 500.0 μs/ CF 2.402 GHz Marker Type Ref Trc Y-value 13.13 dBm -0.17 dB -0.09 dB Function Function Result X-value 389.86 µs 2.09275 ms 2.1971 ms D2 D3 M1 M1 Ready

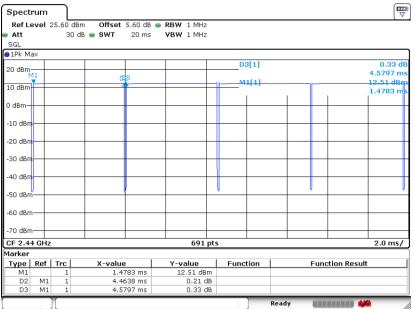
Bluetooth LE 1Mbps



Bluetooth LE 2Mbps



Bluetooth LE 500kbps





Bluetooth LE 125kbps

| Ref L | evel : | 25.60 dB | m Offset 5.60 dB (| RBW 1 MHz | | | (. |
|----------|-------------|----------|--------------------------|----------------------|----------|-------|------------------------|
| Att | | 30 0 | dB 😑 SWT 40 ms | VBW 1 MHz | | | |
| SGL | | | | | | | |
| 1Pk M | ах | | | | | | |
| 20 dBm | 41 | | | | D3[1] | | -0.40 dE |
| | ₹+ | | | | M1[1] | | 16.8696 m 15.90 dBn |
| 10 dBm | | | | | milti | | 3.0725 m |
| | | | | | 1 | 1 1 | 1 |
| 0 dBm— | | | | | | | |
| -10 dBrr | | | | | | | |
| -10 ubii | | | | | | | |
| -20 dBm | | | | | | _ | |
| | | | | | | | |
| -30 dBrr | ⊢ +- | | | | | | |
| | | | | | | | |
| -40 dBm | דדי | | | | | | |
| -50 dBrr | <u> </u> | | | | | | |
| -50 abii | ' | | | | | | |
| -60 dBm | <u> </u> | | | | | | |
| | | | | | | | |
| -70 dBrr | ∩+- | | | | | | |
| CF 2.4 | 4 GHz | | | 691 pts | | | 4.0 ms/ |
| 1arker | | | | | | | |
| Туре | Ref | | X-value | Y-value | Function | Funct | ion Result |
| M1 | | 1 | 3.0725 ms | 15.90 dBm | | | |
| D2 D3 | M1 M1 | 1 | 16.7536 ms 16.8696 ms | -0.51 dB -0.40 dB | | | |
| 03 | TIM | 1 | 10.8090 IIIS | -J.40 UB | | | |