# FCC RADIO TEST REPORT

| | | |
|---|---|---|
| **FCC ID** | : | **UZ7CR8178ASC** |
| **Equipment** | : | **Standard Cradle** |
| **Brand Name** | : | **Zebra** |
| **Model Name** | : | **CR8178A-SC** |
| **Applicant** | : | **Zebra Technologies Corporation<br>1 Zebra Plaza, Holtsville, NY 11742** |
| **Manufacturer** | : | **Zebra Technologies Corporation<br>1 Zebra Plaza, Holtsville, NY 11742** |
| **Standard** | : | **FCC Part 15 Subpart C §15.247** |

**The product was received on Feb. 03, 2023 and testing was performed from Feb. 17, 2023 to Feb. 24, 2023. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.**

**The test results in this report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.**

Louis Wu

**Approved by: Louis Wu**

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

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# History of this test report

| Report No. | Version | Description | Issue Date |
|---|---|---|---|
| FR320320-01 | 01 | Initial issue of report | Mar. 22, 2023 |
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# Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---|---|---|---|---|
| 3.1 | 15.247(a)(2) | 6dB Bandwidth | Pass | - |
| 3.1 | 2.1049 | 99% Occupied Bandwidth | Reporting only | - |
| 3.2 | 15.247(b)(3)<br>15.247(b)(4) | Output Power | Pass | - |
| 3.3 | 15.247(e) | Power Spectral Density | Pass | - |
| 3.4 | 15.247(d) | Conducted Band Edges and Spurious Emission | Pass | - |
| 3.5 | 15.247(d) | Radiated Band Edges and Spurious Emission | Pass | 6.75 dB under the limit at 716.760 MHz |
| 3.6 | 15.207 | AC Conducted Emission | Pass | 15.34 dB under the limit at 0.526 MHz |
| 3.7 | 15.203 | Antenna Requirement | Pass | - |

| **Declaration of Conformity:** |
|---|
| 1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.<br>It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.<br>2. The measurement uncertainty please refer to report "Uncertainty of Evaluation". |
| **Comments and Explanations:** |
| The product specifications of the EUT presented in the report are declared by the manufacturer who shall take full responsibility for the authenticity. |

**Reviewed by: Wei Chen**

**Report Producer: Clio Lo**

# 1 General Description

## 1.1 Product Feature of Equipment Under Test

| Product Feature | |
|---|---|
| **Equipment** | Standard Cradle |
| **Brand Name** | Zebra |
| **Model Name** | CR8178A-SC |
| **FCC ID** | UZ7CR8178ASC |
| **EUT supports Radios application** | Bluetooth-LE |
| **HW Version** | DV |
| **MFD** | 28DEC22 |
| **EUT Stage** | Identical Prototype |

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

| Specification of Accessories | | | | |
|---|---|---|---|---|
| **5V Adapter** | **Brand Name** | Zebra | **Part Number** | PWR-WUA5V4W0US |
| **RJ-50-RS232 Cable** | **Brand Name** | Zebra | **Model Name** | CBA-R01-S07PBR |
| **RJ-50 to USB Cable** | **Brand Name** | Zebra | **Model Name** | CBA-U21-S07ZBR |

| Support Unit used in test configuration and system | | | | |
|---|---|---|---|---|
| **Digital Scanner** | **Brand Name** | Zebra | **Model Name** | DS8178A |

## 1.2 Product Specification of Equipment Under Test

| Product Specification is subject to this standard | |
|---|---|
| **Tx/Rx Frequency Range** | 2402 MHz ~ 2480 MHz |
| **Number of Channels** | 40 |
| **Carrier Frequency of Each Channel** | 40 Channel (37 hopping + 3 advertising channel) |
| **Maximum Output Power to Antenna** | Bluetooth – LE (1Mbps): 4.18 dBm / 0.0026 W |
| **99% Occupied Bandwidth** | Bluetooth – LE (1Mbps): 1.051 MHz |
| **Antenna Type / Gain** | Chip Antenna with gain 1.20 dBi |
| **Type of Modulation** | Bluetooth - LE: GFSK |

**Remark:** The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

## 1.3 Modification of EUT

No modifications made to the EUT during the testing.

## 1.4 Testing Location

| | |
|---|---|
| **Test Site** | Sporton International Inc. EMC & Wireless Communications Laboratory |
| **Test Site Location** | No.52, Huaya 1st Rd., Guishan Dist.,<br>Taoyuan City 333, Taiwan (R.O.C.)<br>TEL: +886-3-327-3456<br>FAX: +886-3-328-4978 |
| **Test Site No.** | **Sporton Site No.** |
| | CO05-HY (TAF Code: 1190) |
| **Remark** | The Conducted Emission test item subcontracted to Sporton International Inc. EMC & Wireless Communications Laboratory. |

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

| | |
|---|---|
| **Test Site** | Sporton International Inc. Wensan Laboratory |
| **Test Site Location** | No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist.,<br>Taoyuan City 333010, Taiwan (R.O.C.)<br>TEL: +886-3-327-0868<br>FAX: +886-3-327-0855 |
| **Test Site No.** | **Sporton Site No.** |
| | TH05-HY, 03CH15-HY |

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

FCC designation No.: TW1190 and TW3786

## 1.5 Applicable Standards

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

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013

**Remark:**

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

# 2 Test Configuration of Equipment Under Test

## 2.1 Carrier Frequency Channel

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

## 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, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.

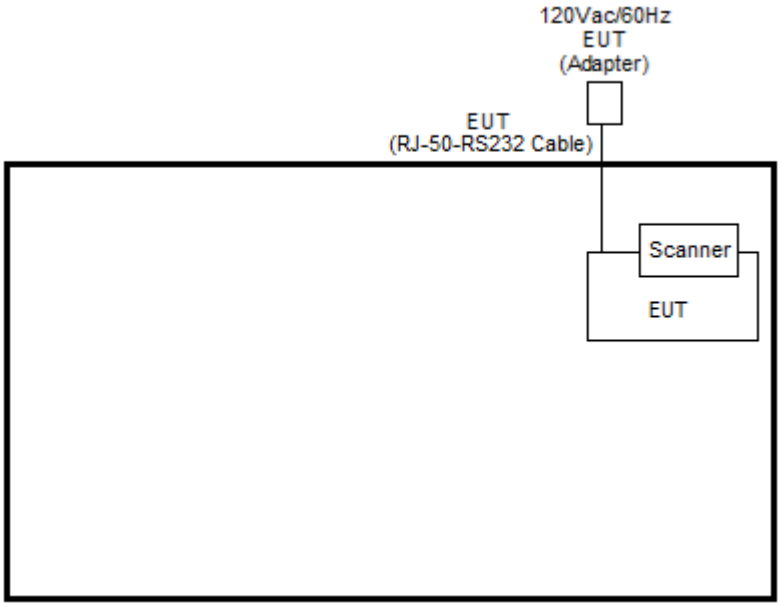
b. AC power line Conducted Emission was tested under maximum output power.

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

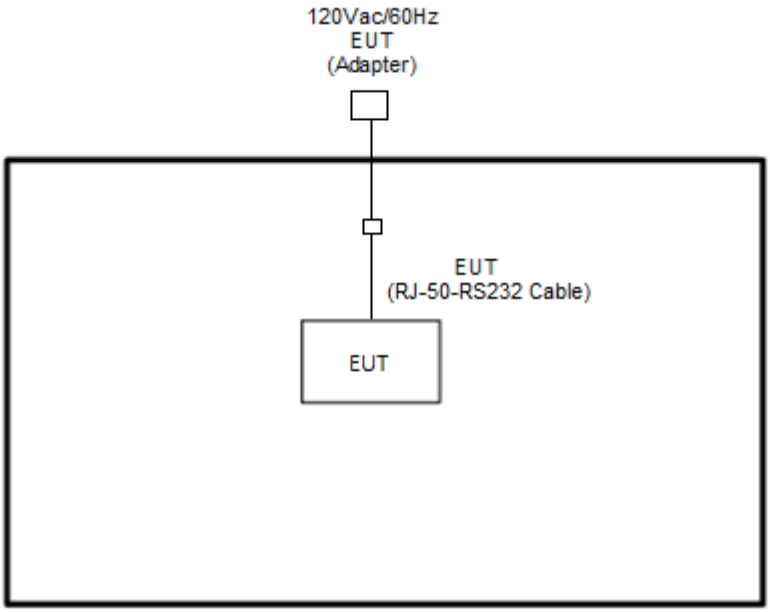
| Summary table of Test Cases | |
|---|---|
| **Test Item** | **Data Rate / Modulation** |
| **Conducted Test Cases** | **Bluetooth – LE / GFSK** |
| | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps<br>Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps<br>Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps |
| **Radiated Test Cases** | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps<br>Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps<br>Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps |
| **AC Conducted Emission** | Mode 1: Digital Scanner Charging with EUT + RJ-50-RS232 cable + 5V Adapter |
| **Remark:** For radiation spurious emission, the modulation and the data rate picked for testing are determined by the Max. RF conducted power. | |

## 2.3 Connection Diagram of Test System

**<AC Conducted Emission Mode>**




**<Bluetooth – LE Tx Mode>**



## 2.4 Support Unit used in test configuration and system

| Item | Equipment | Brand Name | Model Name | FCC ID | Data Cable | Power Cord |
|---|---|---|---|---|---|---|
| 1. | Notebook | DELL | Latitude 3400 | FCC DoC | N/A | AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m |

## 2.5 EUT Operation Test Setup

The RF test items, utility “BT Regulatory Test App 2.2.0.0” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

## 2.6 Measurement Results Explanation Example

**For all conducted test items:**

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

Example :

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

*Offset = RF cable loss + attenuator factor.*

Following shows an offset computation example with cable loss 4.2 dB and 10 dB attenuator.

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

= 4.2 + 10 = 14.2 (dB)

# 3 Test Result

## 3.1 6dB and 99% Bandwidth Measurement

### 3.1.1 Limit of 6dB and 99% Bandwidth

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

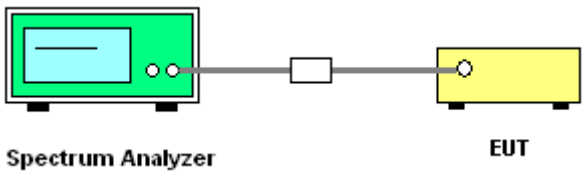
### 3.1.2 Measuring Instruments

Please refer to the measuring equipment list in 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 is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW) ≥ 3 * RBW.
6. Measure and record the results in the test report.

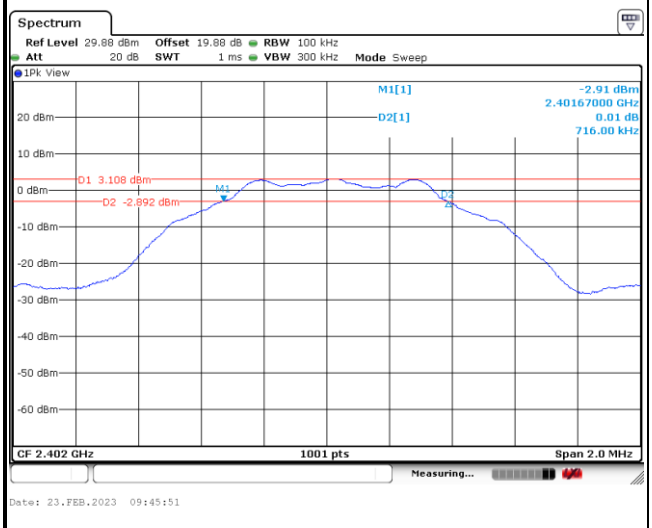
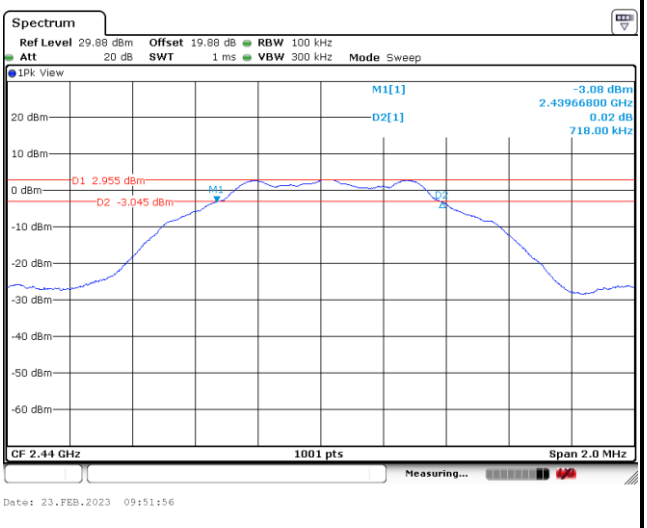
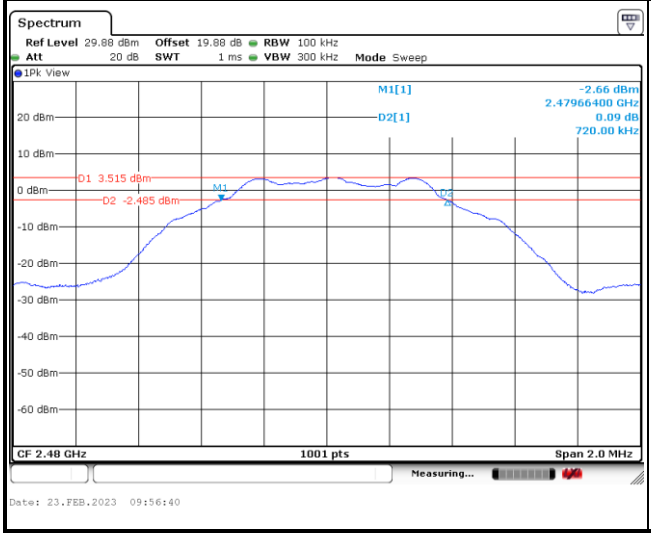
### 3.1.4 Test Setup



### 3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

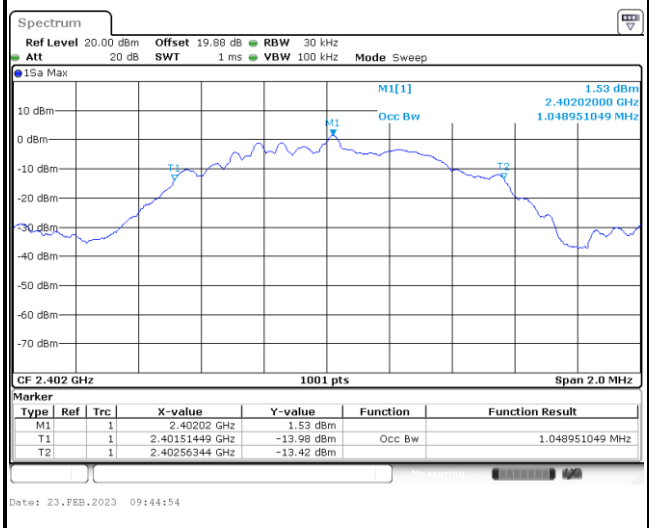
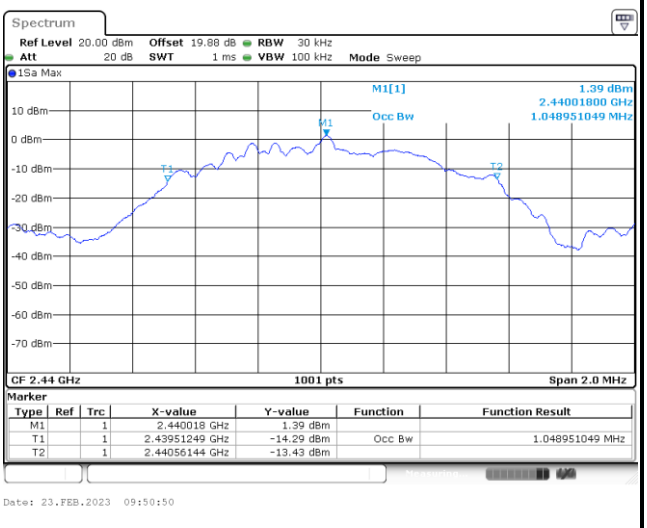
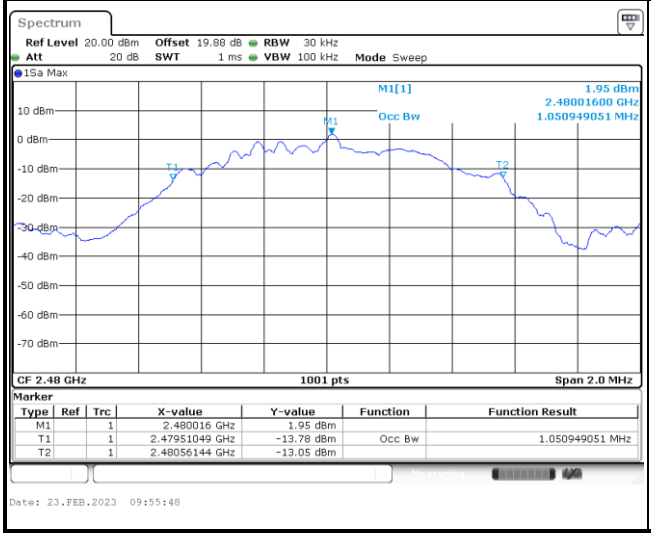
**<1Mbps>**

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

### 3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

**<1Mbps>**

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







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

## 3.2 Output Power Measurement

### 3.2.1 Limit of Output Power

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

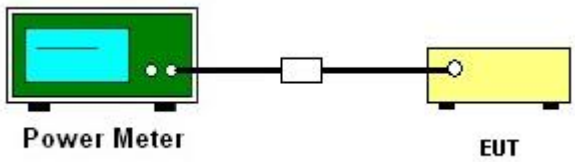
### 3.2.2 Measuring Instruments

Please refer to the measuring equipment list in 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 is connected to the power meter by RF cable and attenuator.
3. The path loss is compensated to the results for each measurement.
4. Set the maximum power setting and enable the EUT to transmit continuously.
5. Measure the conducted output power and record the results in the test report.

### 3.2.4 Test Setup




### 3.2.5 Test Result of Average Output Power

Please refer to Appendix A.

# 3.3 Power Spectral Density Measurement

## 3.3.1 Limit of Power Spectral Density

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

## 3.3.2 Measuring Instruments

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

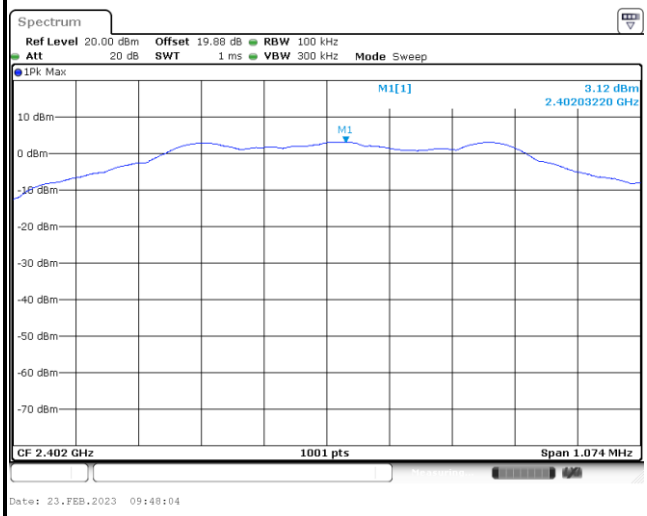
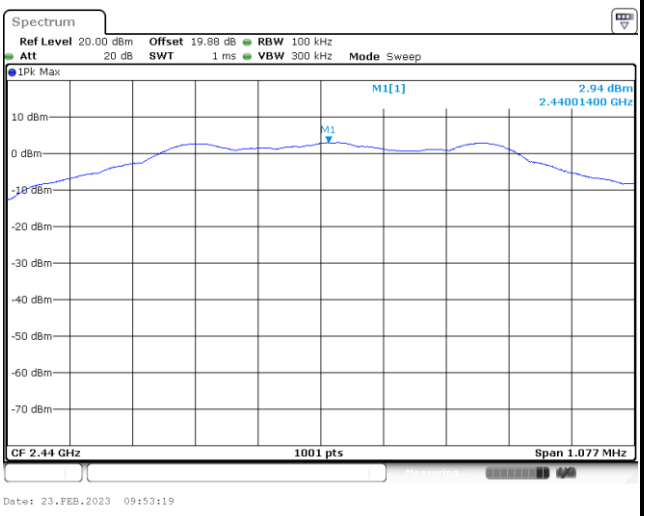
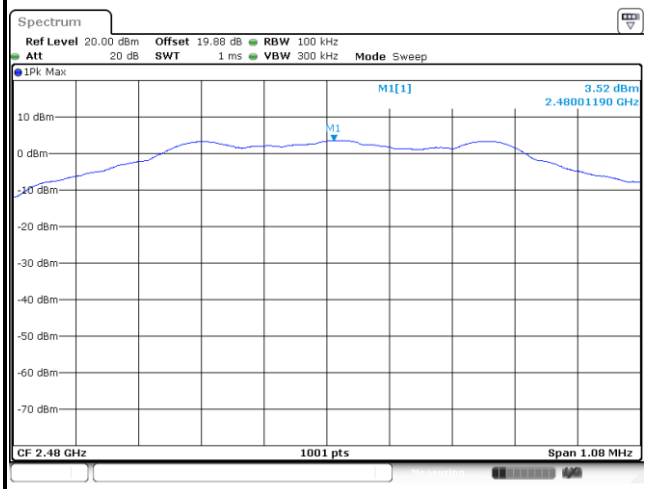
## 3.3.4 Test Setup


## 3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

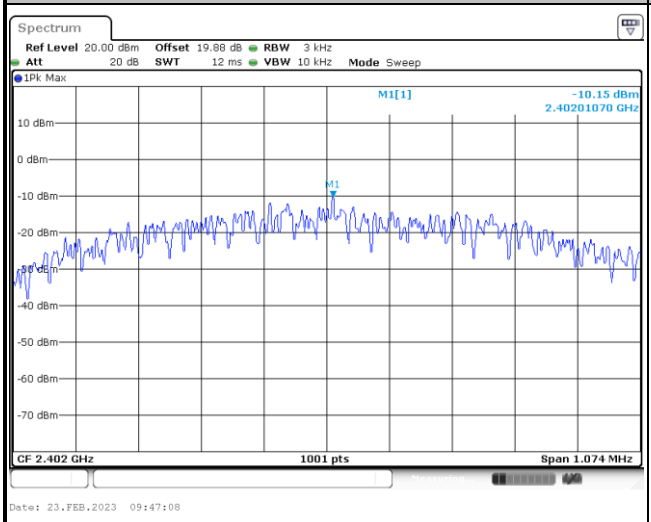
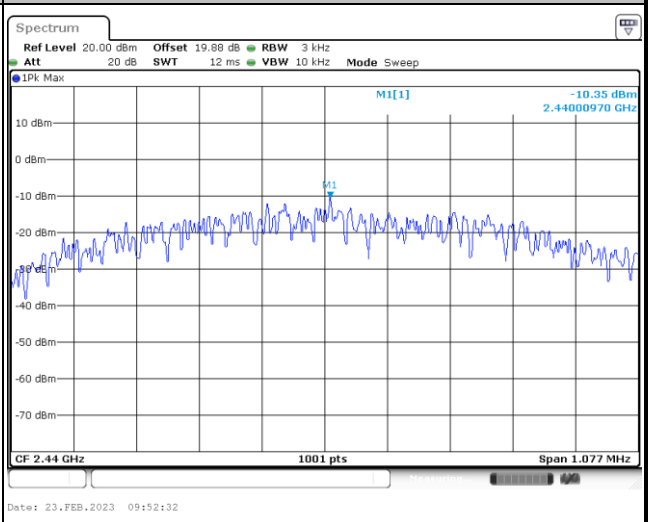
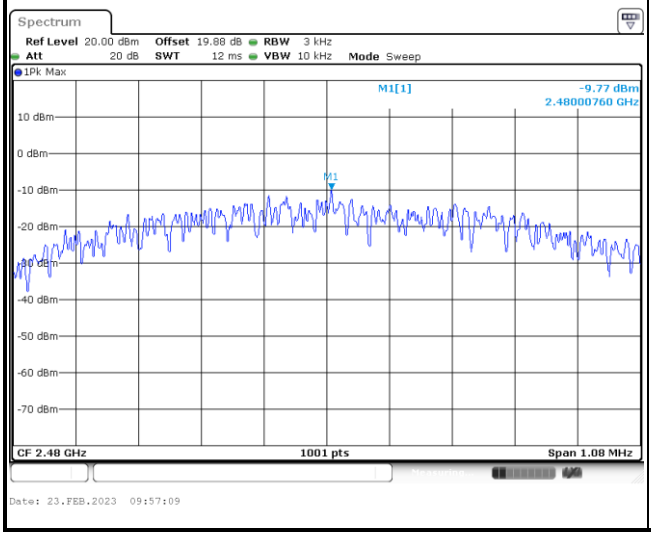
## 3.3.6 Test Result of Power Spectral Density Plots (100kHz)

**<1Mbps>**

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

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

**<1Mbps>**

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

# 3.4 Conducted Band Edges and Spurious Emission Measurement

## 3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 30 dB down from the highest emission level within the authorized band.

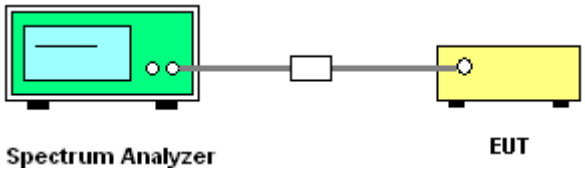
## 3.4.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

## 3.4.3 Test Procedure

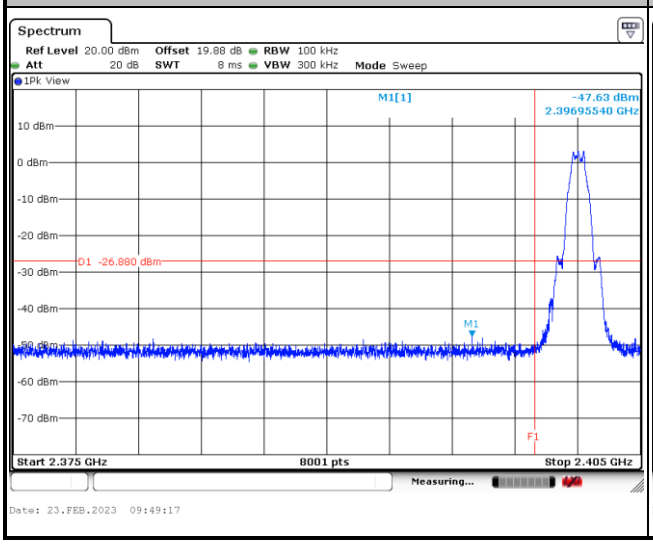
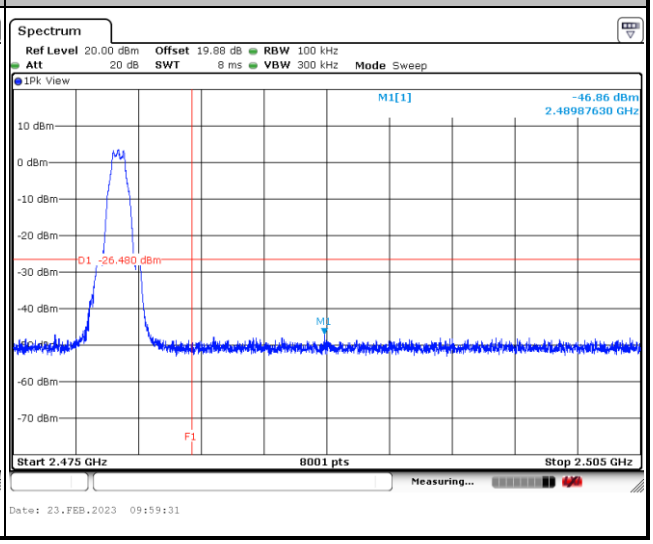
1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW = 300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

## 3.4.4 Test Setup



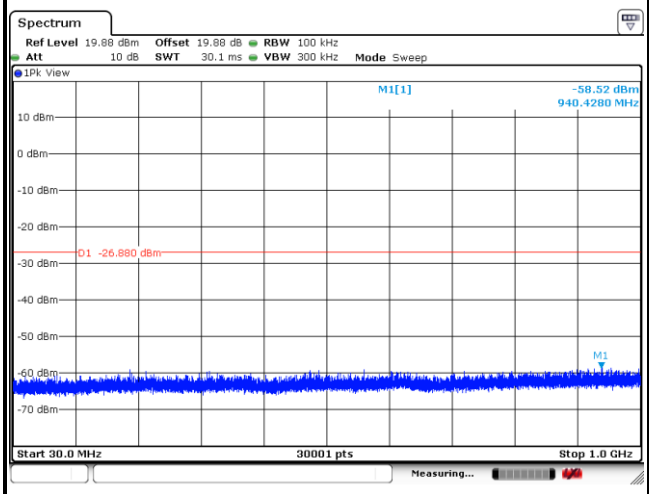
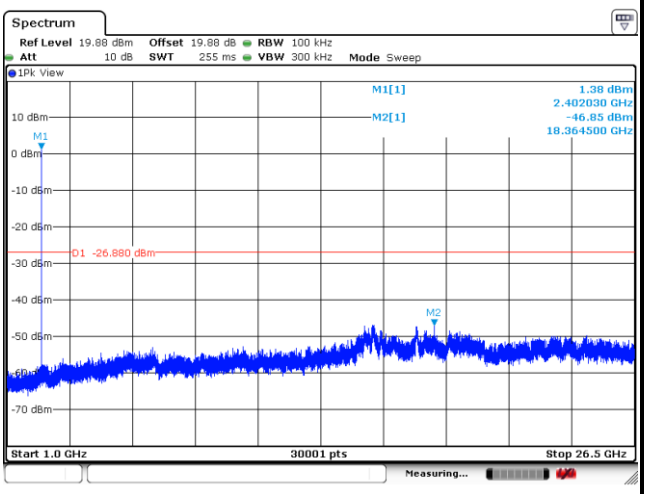
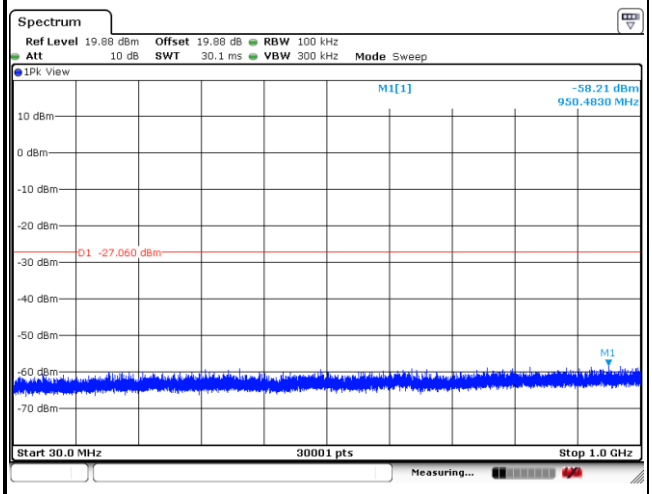
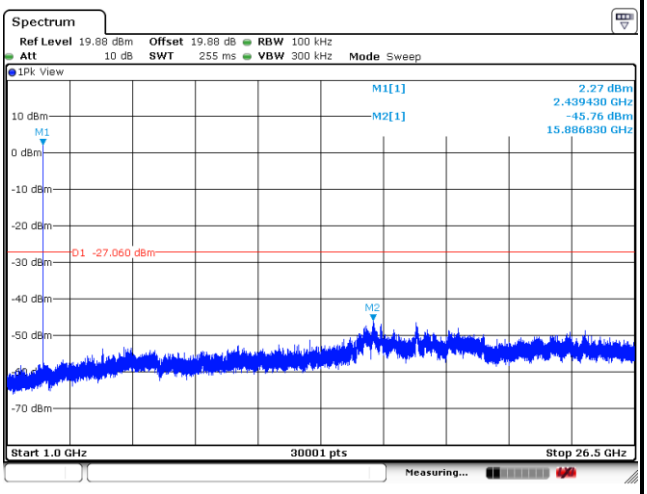
## 3.4.5 Test Result of Conducted Band Edges Plots

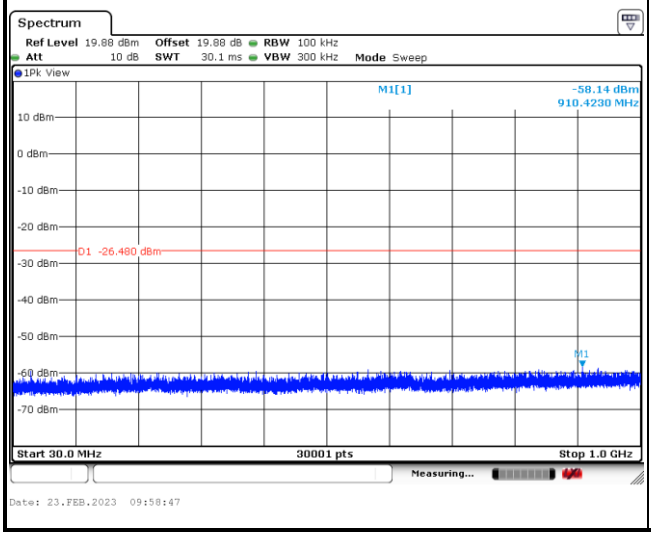
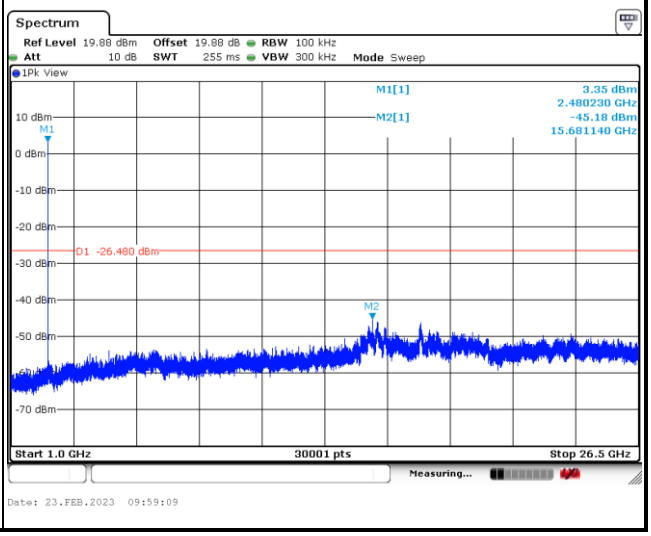
**<1Mbps>**

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

## 3.4.6 Test Result of Conducted Spurious Emission Plots

**<1Mbps>**

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

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

# 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 is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

## 3.5.2 Measuring Instruments

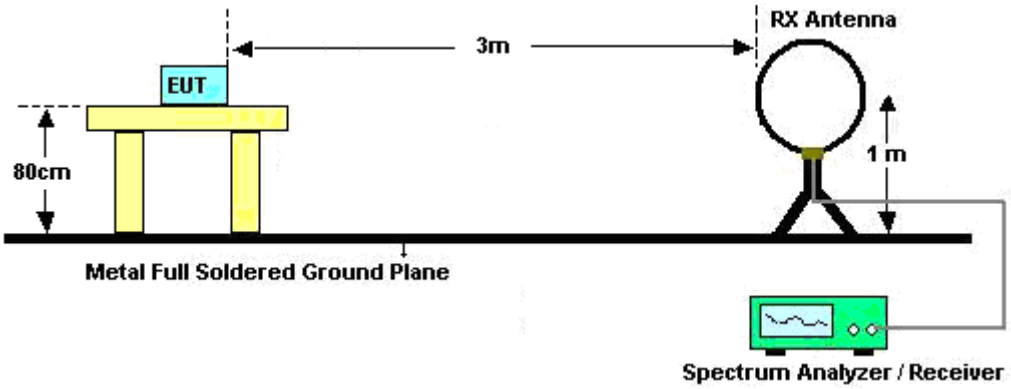
Please refer to the measuring equipment list in this test report.

### 3.5.3 Test Procedures

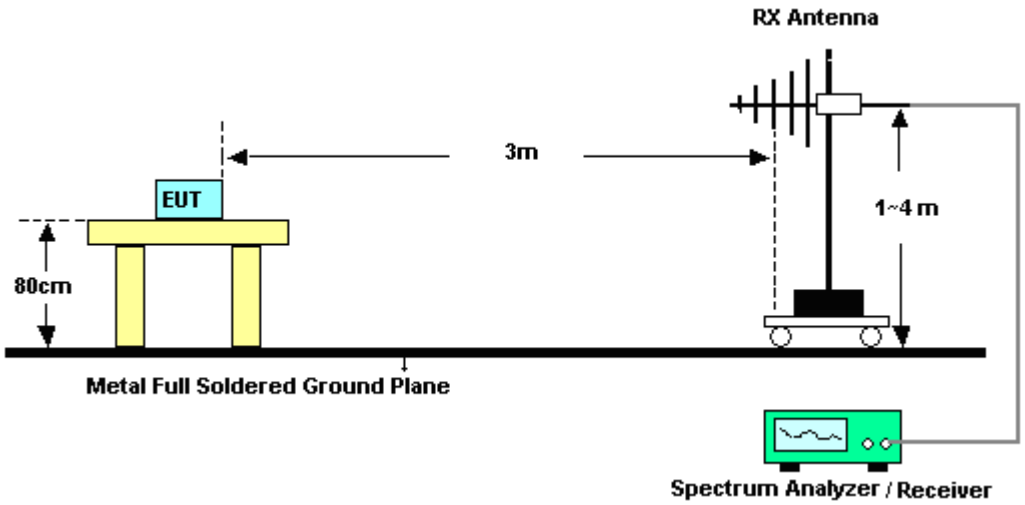
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT is arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
4. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as "-".
7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as "-".
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW = 100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW = 3 MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

## 3.5.4 Test Setup

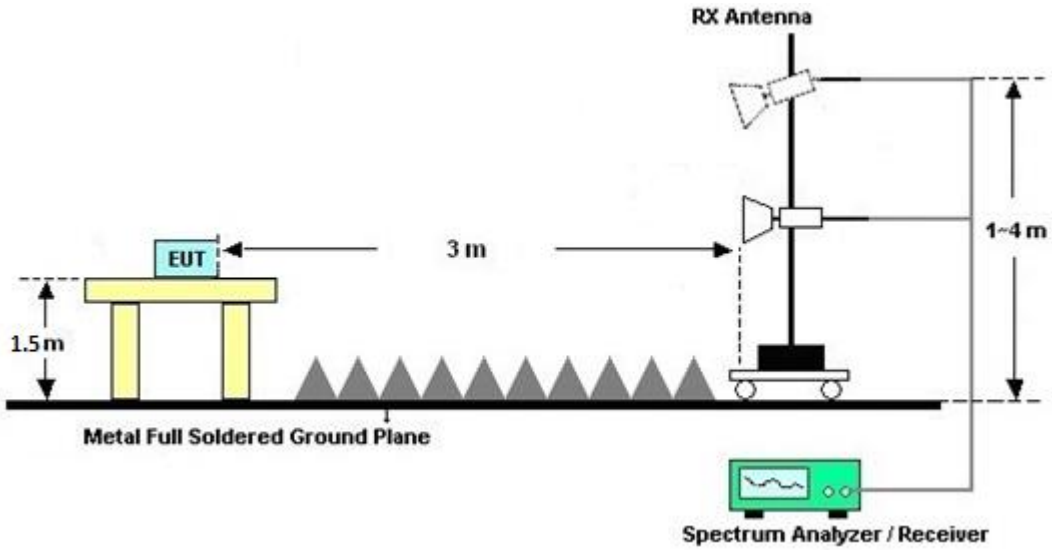
**For radiated test below 30MHz**



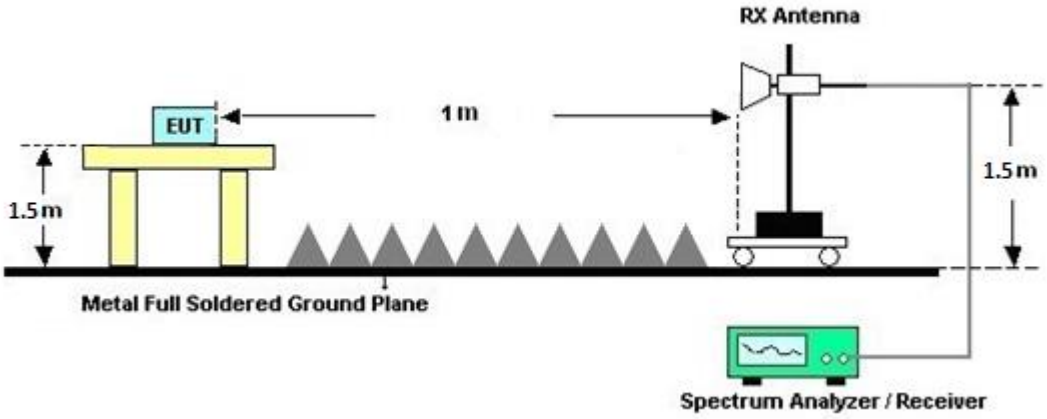

**For radiated test from 30MHz to 1GHz**




**For radiated test from 1GHz to 18GHz**



**For radiated test above 18GHz**




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

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

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

### 3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

### 3.5.7 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

# 3.6 AC Conducted Emission Measurement

## 3.6.1 Limit of AC Conducted Emission

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

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

*Decreases with the logarithm of the frequency.

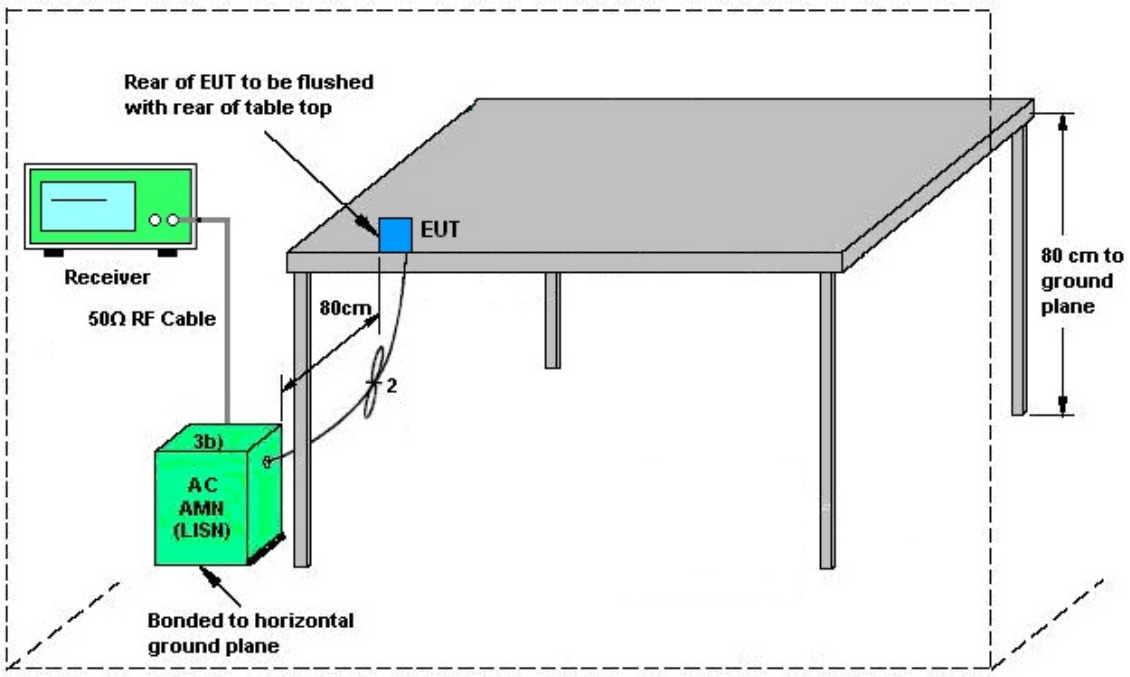
## 3.6.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

## 3.6.3 Test Procedures

1. The EUT is placed 0.4 meter away from the conducting wall of the shielding room, and is kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN shall be used.
6. Both Line and Neutral shall be tested in order to find out the maximum conducted emission.
7. The frequency range from 150 kHz to 30 MHz is scanned.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9 kHz) 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

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

An embedded-in antenna design is used.

# 4 List of Measuring Equipment

| Instrument | Brand Name | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---|---|---|---|---|---|---|---|---|
| Loop Antenna | TESEQ | HLA 6120 | 31244 | 9 kHz~30 MHz | Mar. 18, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Mar. 17, 2023 | Radiation (03CH15-HY) |
| Bilog Antenna | TESEQ | CBL 6111D & 00800N1D01N-06 | 40103 & 07 | 30MHz~1GHz | Apr. 24, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Apr. 23, 2023 | Radiation (03CH15-HY) |
| Horn Antenna | SCHWARZBECK | BBHA 9120 D | 9120D-02294 | 1GHz~18GHz | Jun. 23, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Jun. 22, 2023 | Radiation (03CH15-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK | BBHA 9170 | 00994 | 18GHz~40GHz | Nov. 04, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Nov. 03, 2023 | Radiation (03CH15-HY) |
| Amplifier | SONOMA | 310N | 363440 | 9kHz~1GHz | Dec. 26, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Dec. 25, 2023 | Radiation (03CH15-HY) |
| Preamplifier | Jet-Power | JPA0118-55-303K | 171000180005400 2 | 1GHz~18GHz | Sep. 28, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Sep. 27, 2023 | Radiation (03CH15-HY) |
| Preamplifier | EM Electronics | EM01G18G | 060802 | 1GHz~18GHz | Mar. 08, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Mar. 07, 2023 | Radiation (03CH15-HY) |
| Preamplifier | EMEC | EM18G40G | 060801 | 18GHz~40GHz | Jun. 28, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Jun. 27, 2023 | Radiation (03CH15-HY) |
| EMI Test Receiver | Keysight | N9038A(MXE) | MY54130085 | 20MHz~8.4GHz | Oct. 18, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Oct. 17, 2023 | Radiation (03CH15-HY |
| Spectrum Analyzer | Agilent | E4446A | MY50180136 | 3Hz~44GHz | May 11, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | May 10, 2023 | Radiation (03CH15-HY) |
| Antenna Mast | ChainTek | MBS-520-1 | N/A | 1m~4m | N/A | Feb. 21, 2023~ Feb. 24, 2023 | N/A | Radiation (03CH15-HY) |
| Turn Table | ChainTek | T-200-S-1 | N/A | 0~360 Degree | N/A | Feb. 21, 2023~ Feb. 24, 2023 | N/A | Radiation (03CH15-HY) |
| Software | Audix | E3 6.2009-8-24 (k5) | RK-000451 | N/A | N/A | Feb. 21, 2023~ Feb. 24, 2023 | N/A | Radiation (03CH15-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104, 102E | MY582185/4, MY9838/4PE, 519228/2 | 30MHz~18G | Jun. 21, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Jun. 20, 2023 | Radiation (03CH15-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 804011/2,804012/2 | 30MHz-40GHz | Jan. 03, 2023 | Feb. 21, 2023~ Feb. 24, 2023 | Jan. 02, 2024 | Radiation (03CH15-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY9837/4PE | 9kHz~30MHz | Mar. 10, 2022 | Feb. 21, 2023~ Feb. 24, 2023 | Mar. 09, 2023 | Radiation (03CH15-HY) |
| AC Power Source | ChainTek | APC-1000W | N/A | N/A | N/A | Feb. 17, 2023 | N/A | Conduction (CO05-HY) |
| EMI Test Receiver | Rohde & Schwarz | ESR3 | 102388 | 9kHz~3.6GHz | Dec. 01, 2022 | Feb. 17, 2023 | Nov. 30, 2023 | Conduction (CO05-HY) |
| Hygrometer | Testo | 608-H1 | 34913912 | N/A | Nov. 17, 2022 | Feb. 17, 2023 | Nov. 16, 2023 | Conduction (CO05-HY) |
| LISN | Rohde & Schwarz | ENV216 | 100081 | 9kHz~30MHz | Nov. 17, 2022 | Feb. 17, 2023 | Nov. 16, 2023 | Conduction (CO05-HY) |
| Software | Rohde & Schwarz | EMC32 | N/A | N/A | N/A | Feb. 17, 2023 | N/A | Conduction (CO05-HY) |
| Pulse Limiter | SCHWARZBECK | VTSD 9561-F N | 00691 | N/A | Aug. 01, 2022 | Feb. 17, 2023 | Jul. 31, 2023 | Conduction (CO05-HY) |
| LISN Cable | MVE | RG-400 | 260260 | N/A | Dec. 29, 2022 | Feb. 17, 2023 | Dec. 28, 2023 | Conduction (CO05-HY) |
| Hygrometer | TECPEL | DTM-303A | TP201996 | N/A | Nov. 17, 2022 | Feb. 21, 2023~ Feb. 23, 2023 | Nov. 16, 2023 | Conducted (TH05-HY) |
| Power Sensor | DARE | RPR3006W | 16I00054SNO12 (NO:113) | 10MHz~6GHz | Dec. 13, 2022 | Feb. 21, 2023~ Feb. 23, 2023 | Dec. 12, 2023 | Conducted (TH05-HY) |
| Signal Analyzer | Rohde & Schwarz | FSV40 | 101905 | 10Hz - 40GHz | Aug. 03, 2022 | Feb. 21, 2023~ Feb. 23, 2023 | Aug. 02, 2023 | Conducted (TH05-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))** | **3.5 dB** |

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **6.30 dB** |

**Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)**

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **4.20 dB** |

**Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)**

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **5.40 dB** |

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **5.20 dB** |

# Appendix A. Test Result of Conducted Test Items

| Test Engineer: | Henry Ke | Temperature: | 21~25 | °C |
|---|---|---|---|---|
| Test Date: | 2023/2/21~2023/2/23 | 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 | 1.049 | 0.716 | 0.50 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 1.049 | 0.718 | 0.50 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 1.051 | 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 | 4.18 | 30.00 | 1.20 | 5.38 | 36.00 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 4.08 | 30.00 | 1.20 | 5.28 | 36.00 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 3.88 | 30.00 | 1.20 | 5.08 | 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 | 3.12 | -10.15 | 1.20 | 8.00 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 2.94 | -10.35 | 1.20 | 8.00 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 3.52 | -9.77 | 1.20 | 8.00 | Pass |

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

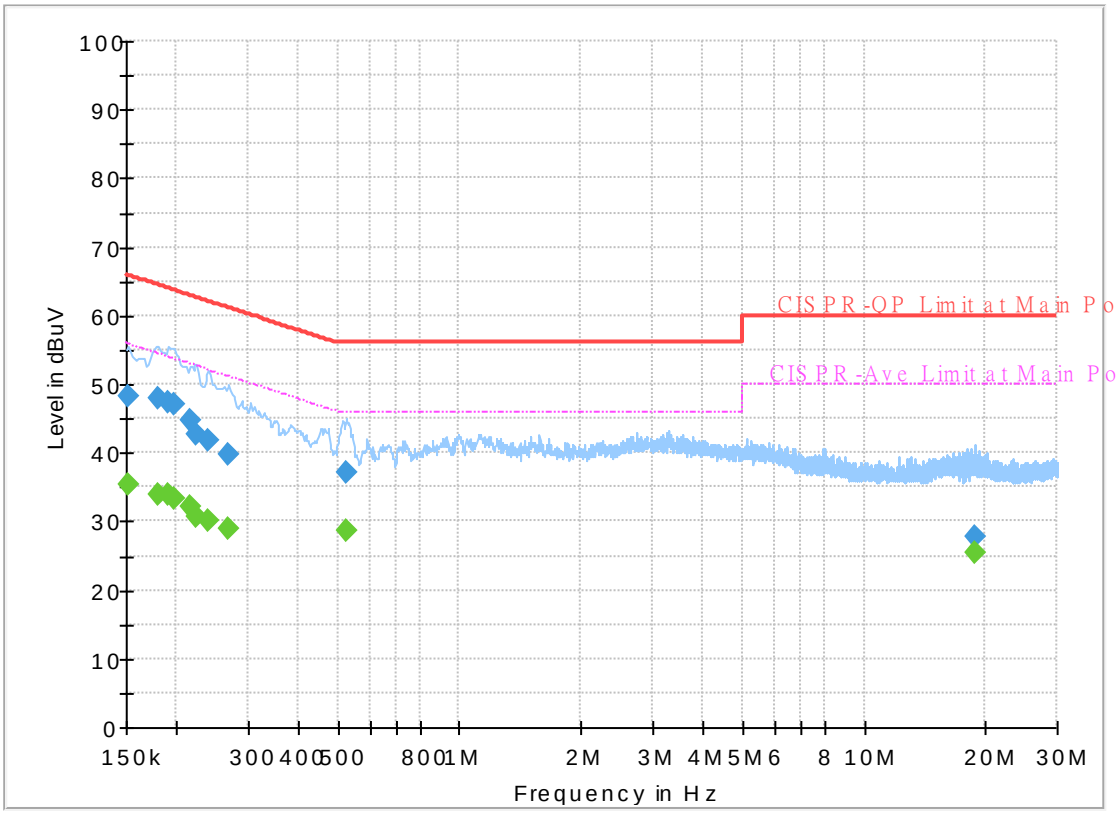
# Appendix B. AC Conducted Emission Test Results

| | | | |
|---|---|---|---|
| **Test Engineer :** | Tom Lee | **Temperature :** | 23~26℃ |
| | | **Relative Humidity :** | 45~55% |

# EUT Information

| | |
|---|---|
| Report NO : | 320320-01 |
| Test Mode : | Mode 1 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Line |

Full Spectrum



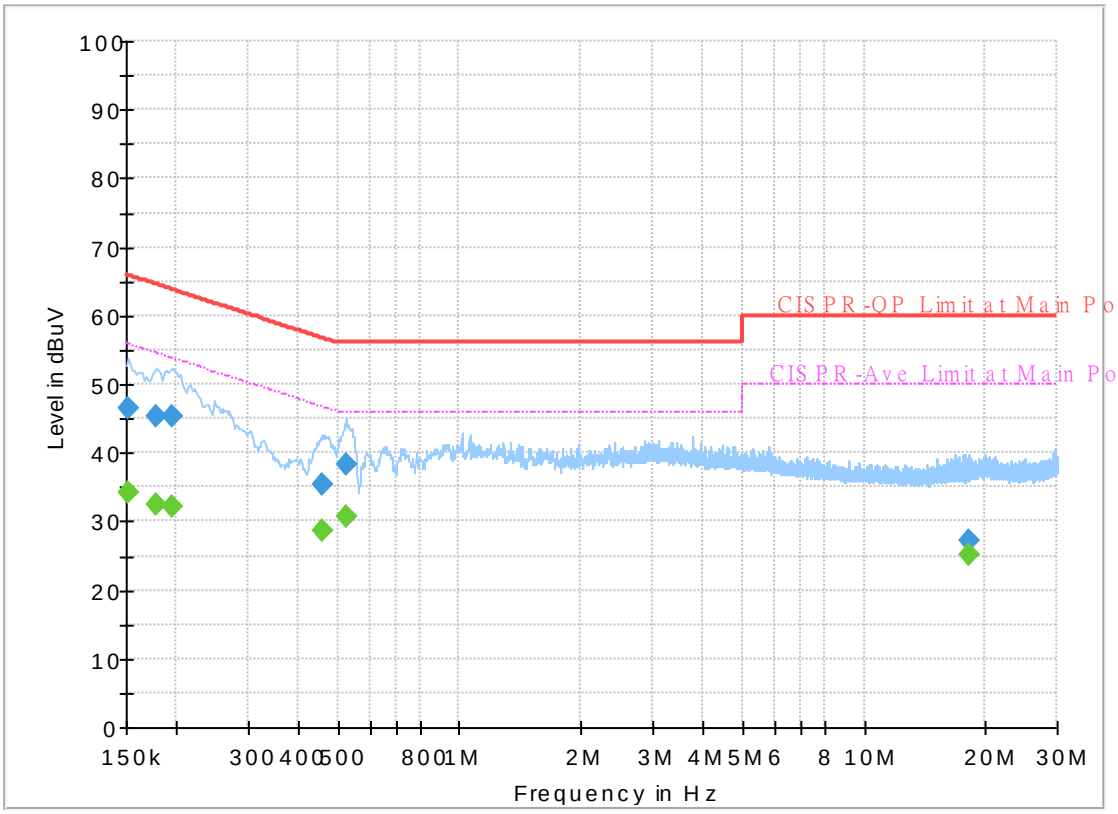

# Final_Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.152250 | --- | 35.41 | 55.88 | 20.47 | L1 | OFF | 19.9 |
| 0.152250 | 48.36 | --- | 65.88 | 17.52 | L1 | OFF | 19.9 |
| 0.179250 | --- | 34.02 | 54.52 | 20.50 | L1 | OFF | 19.9 |
| 0.179250 | 47.84 | --- | 64.52 | 16.68 | L1 | OFF | 19.9 |
| 0.190500 | --- | 34.02 | 54.02 | 20.00 | L1 | OFF | 19.9 |
| 0.190500 | 47.39 | --- | 64.02 | 16.63 | L1 | OFF | 19.9 |
| 0.197250 | --- | 33.34 | 53.73 | 20.39 | L1 | OFF | 19.9 |
| 0.197250 | 46.94 | --- | 63.73 | 16.79 | L1 | OFF | 19.9 |
| 0.215250 | --- | 32.09 | 53.00 | 20.91 | L1 | OFF | 19.9 |
| 0.215250 | 44.70 | --- | 63.00 | 18.30 | L1 | OFF | 19.9 |
| 0.224250 | --- | 30.62 | 52.66 | 22.04 | L1 | OFF | 19.9 |
| 0.224250 | 42.78 | --- | 62.66 | 19.88 | L1 | OFF | 19.9 |
| 0.240000 | --- | 30.08 | 52.10 | 22.02 | L1 | OFF | 19.9 |
| 0.240000 | 41.82 | --- | 62.10 | 20.28 | L1 | OFF | 19.9 |
| 0.269250 | --- | 28.82 | 51.14 | 22.32 | L1 | OFF | 19.9 |
| 0.269250 | 39.81 | --- | 61.14 | 21.33 | L1 | OFF | 19.9 |
| 0.525750 | --- | 28.78 | 46.00 | 17.22 | L1 | OFF | 19.9 |
| 0.525750 | 37.21 | --- | 56.00 | 18.79 | L1 | OFF | 19.9 |
| 18.820500 | --- | 25.48 | 50.00 | 24.52 | L1 | OFF | 20.5 |
| 18.820500 | 27.85 | --- | 60.00 | 32.15 | L1 | OFF | 20.5 |

# EUT Information

| | |
|---|---|
| Report NO : | 320320-01 |
| Test Mode : | Mode 1 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Neutral |

Full Spectrum




# Final_Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.152250 | --- | 34.28 | 55.88 | 21.60 | N | OFF | 19.9 |
| 0.152250 | 46.51 | --- | 65.88 | 19.37 | N | OFF | 19.9 |
| 0.177000 | --- | 32.34 | 54.63 | 22.29 | N | OFF | 19.9 |
| 0.177000 | 45.28 | --- | 64.63 | 19.35 | N | OFF | 19.9 |
| 0.195000 | --- | 32.23 | 53.82 | 21.59 | N | OFF | 19.9 |
| 0.195000 | 45.26 | --- | 63.82 | 18.56 | N | OFF | 19.9 |
| 0.456000 | --- | 28.56 | 46.77 | 18.21 | N | OFF | 19.9 |
| 0.456000 | 35.34 | --- | 56.77 | 21.43 | N | OFF | 19.9 |
| 0.525750 | --- | 30.66 | 46.00 | 15.34 | N | OFF | 19.9 |
| 0.525750 | 38.35 | --- | 56.00 | 17.65 | N | OFF | 19.9 |
| 18.172500 | --- | 25.23 | 50.00 | 24.77 | N | OFF | 20.6 |
| 18.172500 | 27.26 | --- | 60.00 | 32.74 | N | OFF | 20.6 |

# Appendix C. Radiated Spurious Emission

| Test Engineer : | Eric Xiao, Quentin Liu and Bigshow Wang | Temperature : | 21~23.2°C |
|---|---|---|---|
| | | Relative Humidity : | 45~60% |

**2.4GHz 2400~2483.5MHz**

**BLE (Band Edge @ 3m)**

| BLE | Note | Frequency | Level | Margin | Limit Line | Read Level | Antenna Factor | Path Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| BLE CH 00 2402MHz | | 2382.726 | 50.9 | -23.1 | 74 | 44.48 | 27.26 | 16.02 | 36.86 | 352 | 130 | P | H |
| | | 2389.662 | 41.43 | -12.57 | 54 | 34.94 | 27.32 | 16.03 | 36.86 | 352 | 130 | A | H |
| | * | 2402 | 101.5 | - | - | 94.9 | 27.41 | 16.05 | 36.86 | 352 | 130 | P | H |
| | * | 2402 | 101.03 | - | - | 94.43 | 27.41 | 16.05 | 36.86 | 352 | 130 | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 2340.804 | 50.5 | -23.5 | 74 | 44.42 | 27 | 15.94 | 36.86 | 356 | 297 | P | V |
| | | 2384.562 | 41.33 | -12.67 | 54 | 34.89 | 27.28 | 16.02 | 36.86 | 356 | 297 | A | V |
| | * | 2402 | 99.03 | - | - | 92.43 | 27.41 | 16.05 | 36.86 | 356 | 297 | P | V |
| | * | 2402 | 98.54 | - | - | 91.94 | 27.41 | 16.05 | 36.86 | 356 | 297 | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| BLE CH 19 2440MHz | | 2346.4 | 50.51 | -23.49 | 74 | 44.42 | 27 | 15.95 | 36.86 | 302 | 145 | P | H |
| | | 2386.02 | 41.2 | -12.8 | 54 | 34.75 | 27.29 | 16.02 | 36.86 | 302 | 145 | A | H |
| | * | 2440 | 99.52 | - | - | 92.62 | 27.64 | 16.11 | 36.85 | 302 | 145 | P | H |
| | * | 2440 | 98.92 | - | - | 92.02 | 27.64 | 16.11 | 36.85 | 302 | 145 | A | H |
| | | 2495.24 | 51.1 | -22.9 | 74 | 43.87 | 27.88 | 16.2 | 36.85 | 302 | 145 | P | H |
| | | 2487.54 | 42.1 | -11.9 | 54 | 34.91 | 27.85 | 16.19 | 36.85 | 302 | 145 | A | H |
| | | 2372.3 | 50.76 | -23.24 | 74 | 44.44 | 27.18 | 16 | 36.86 | 300 | 283 | P | V |
| | | 2387.84 | 41.19 | -12.81 | 54 | 34.72 | 27.3 | 16.03 | 36.86 | 300 | 283 | A | V |
| | * | 2440 | 96.05 | - | - | 89.15 | 27.64 | 16.11 | 36.85 | 300 | 283 | P | V |
| | * | 2440 | 95.55 | - | - | 88.65 | 27.64 | 16.11 | 36.85 | 300 | 283 | A | V |
| | | 2494.47 | 51.17 | -22.83 | 74 | 43.94 | 27.88 | 16.2 | 36.85 | 300 | 283 | P | V |
| | | 2495.94 | 42.02 | -11.98 | 54 | 34.79 | 27.88 | 16.2 | 36.85 | 300 | 283 | A | V |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BLE CH 39 2480MHz** | * | 2480 | 97.74 | - | - | 90.6 | 27.82 | 16.17 | 36.85 | 298 | 134 | P | H |
| | * | 2480 | 97.19 | - | - | 90.05 | 27.82 | 16.17 | 36.85 | 298 | 134 | A | H |
| | | 2497.48 | 51.74 | -22.26 | 74 | 44.5 | 27.89 | 16.2 | 36.85 | 298 | 134 | P | H |
| | | 2483.8 | 42.48 | -11.52 | 54 | 35.31 | 27.84 | 16.18 | 36.85 | 298 | 134 | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | * | 2480 | 94.6 | - | - | 87.46 | 27.82 | 16.17 | 36.85 | 296 | 271 | P | V |
| | * | 2480 | 93.94 | - | - | 86.8 | 27.82 | 16.17 | 36.85 | 296 | 271 | A | V |
| | | 2496.37 | 52 | -22 | 74 | 44.76 | 27.89 | 16.2 | 36.85 | 296 | 271 | P | V |
| | | 2492.35 | 42.07 | -11.93 | 54 | 34.86 | 27.87 | 16.19 | 36.85 | 296 | 271 | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| **Remark** | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |

## 2.4GHz 2400~2483.5MHz

## BLE (Harmonic @ 3m)

| BLE | Note | Frequency ( MHz ) | Level ( dBµV/m ) | Margin ( dB ) | Limit Line ( dBµV/m ) | Read Level ( dBµV ) | Antenna Factor ( dB/m ) | Path Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BLE CH 00 2402MHz | | 4804 | 48.16 | -25.84 | 74 | 56.78 | 32.32 | 9.42 | 50.36 | - | - | P | H |
| | | 4804 | 39.37 | -14.63 | 54 | 47.99 | 32.32 | 9.42 | 50.36 | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4804 | 47.15 | -26.85 | 74 | 55.77 | 32.32 | 9.42 | 50.36 | - | - | P | V |
| | | 4804 | 38.36 | -15.64 | 54 | 46.98 | 32.32 | 9.42 | 50.36 | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

| BLE | Note | Frequency ( MHz ) | Level ( dBµV/m ) | Margin ( dB ) | Limit Line ( dBµV/m ) | Read Level ( dBµV ) | Antenna Factor ( dB/m ) | Path Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 4880 | 48.19 | -25.81 | 74 | 56.57 | 32.6 | 9.4 | 50.38 | - | - | P | H |
| | | 4880 | 39.4 | -14.6 | 54 | 47.78 | 32.6 | 9.4 | 50.38 | - | - | A | H |
| | | 7320 | 50.86 | -23.14 | 74 | 55.63 | 36.62 | 10.85 | 52.24 | - | - | P | H |
| | | 7320 | 42.07 | -11.93 | 54 | 46.84 | 36.62 | 10.85 | 52.24 | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| BLE CH 19 2440MHz | | | | | | | | | | | | | H |
| | | 4880 | 47.42 | -26.58 | 74 | 55.8 | 32.6 | 9.4 | 50.38 | - | - | P | V |
| | | 4880 | 38.63 | -15.37 | 54 | 47.01 | 32.6 | 9.4 | 50.38 | - | - | A | V |
| | | 7320 | 51.07 | -22.93 | 74 | 55.84 | 36.62 | 10.85 | 52.24 | - | - | P | V |
| | | 7320 | 42.28 | -11.72 | 54 | 47.05 | 36.62 | 10.85 | 52.24 | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

| BLE | Note | Frequency ( MHz ) | Level ( dBµV/m ) | Margin ( dB ) | Limit Line ( dBµV/m ) | Read Level ( dBµV ) | Antenna Factor ( dB/m ) | Path Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BLE CH 39 2480MHz | | 4960 | 48.41 | -25.59 | 74 | 56.49 | 32.94 | 9.37 | 50.39 | - | - | P | H |
| | | 4960 | 39.62 | -14.38 | 54 | 47.7 | 32.94 | 9.37 | 50.39 | - | - | A | H |
| | | 7440 | 51.41 | -22.59 | 74 | 56.32 | 36.34 | 10.96 | 52.21 | - | - | P | H |
| | | 7440 | 42.62 | -11.38 | 54 | 47.53 | 36.34 | 10.96 | 52.21 | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4960 | 48.86 | -25.14 | 74 | 56.94 | 32.94 | 9.37 | 50.39 | - | - | P | V |
| | | 4960 | 40.07 | -13.93 | 54 | 48.15 | 32.94 | 9.37 | 50.39 | - | - | A | V |
| | | 7440 | 51.24 | -22.76 | 74 | 56.15 | 36.34 | 10.96 | 52.21 | - | - | P | V |
| | | 7440 | 42.45 | -11.55 | 54 | 47.36 | 36.34 | 10.96 | 52.21 | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

## Emission above 18GHz

## 2.4GHz BLE (SHF)

| BLE | Note | Frequency | Level | Over | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | (dBµV) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 2.4GHz BLE SHF | | 23038 | 43.43 | -30.57 | 74 | 61.71 | 38.9 | -2.9 | 54.28 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 22708 | 44.2 | -29.8 | 74 | 63.72 | 38.47 | -3.51 | 54.48 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against limit line.
3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

## Emission below 1GHz

## 2.4GHz BLE (LF)

| BLE | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | (dBμV) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 2.4GHz BLE LF | | 65.89 | 25.6 | -14.4 | 40 | 44.95 | 12.07 | 44.95 | 32.42 | - | - | P | H |
| | | 131.85 | 24.82 | -18.68 | 43.5 | 38.41 | 17.46 | 38.41 | 32.42 | - | - | P | H |
| | | 263.77 | 30.79 | -15.21 | 46 | 41.16 | 20.03 | 41.16 | 32.39 | - | - | P | H |
| | | 312.27 | 31 | -15 | 46 | 41.65 | 19.55 | 41.65 | 32.34 | - | - | P | H |
| | | 419.94 | 37.17 | -8.83 | 46 | 44.35 | 22.8 | 44.35 | 32.4 | - | - | P | H |
| | | 720.64 | 38.85 | -7.15 | 46 | 40.88 | 27.02 | 40.88 | 32.28 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 30 | 22.66 | -17.34 | 40 | 29.88 | 24.53 | 29.88 | 32.39 | - | - | P | V |
| | | 94.02 | 13.73 | -29.77 | 43.5 | 29.69 | 15.25 | 29.69 | 32.42 | - | - | P | V |
| | | 128.94 | 20.71 | -22.79 | 43.5 | 34.33 | 17.46 | 34.33 | 32.43 | - | - | P | V |
| | | 263.77 | 23.37 | -22.63 | 46 | 33.74 | 20.03 | 33.74 | 32.39 | - | - | P | V |
| | | 419.94 | 29.47 | -16.53 | 46 | 36.65 | 22.8 | 36.65 | 32.4 | - | - | P | V |
| | | 716.76 | 39.25 | -6.75 | 46 | 41.5 | 26.82 | 41.5 | 32.29 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

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

## Note symbol

| | |
|---|---|
| * | **Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. |
| ! | Test result is **Margin** line. |
| P/A | **P**eak or **A**verage |
| H/V | **H**orizontal or **V**ertical |

## A calculation example for radiated spurious emission is shown as below:

| BLE | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| BLE CH 00 2402MHz | | 2390 | 55.45 | -18.55 | 74 | 54.51 | 32.22 | 4.58 | 35.86 | 103 | 308 | P | H |
| | | 2390 | 43.54 | -10.46 | 54 | 42.6 | 32.22 | 4.58 | 35.86 | 103 | 308 | A | H |

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

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

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

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)

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

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)

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

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

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

# Appendix D. Radiated Spurious Emission Plots

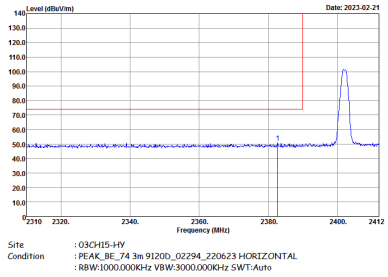
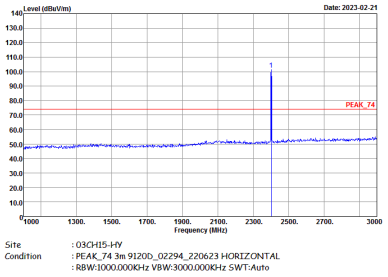
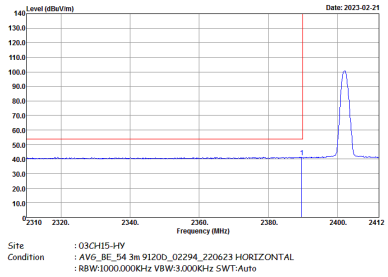
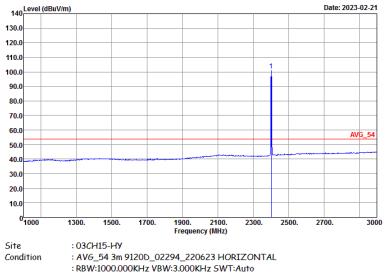
| | | | |
|---|---|---|---|
| **Test Engineer :** | Eric Xiao, Quentin Liu and Bigshow Wang | **Temperature :** | 21~23.2°C |
| | | **Relative Humidity :** | 45~60% |

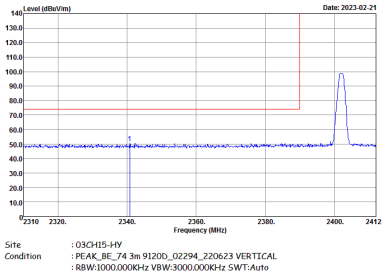
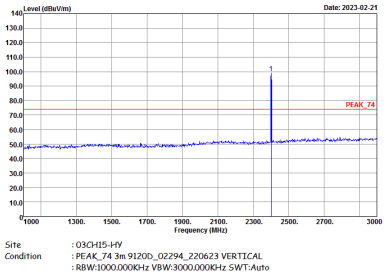
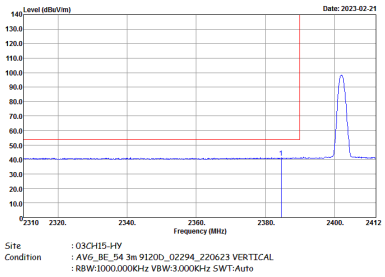
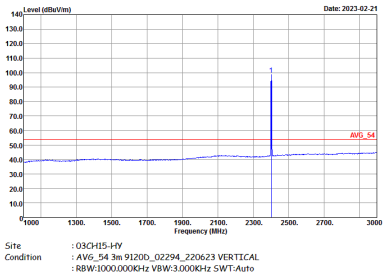
## Note symbol

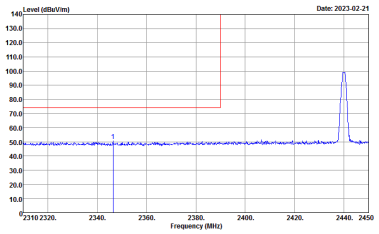
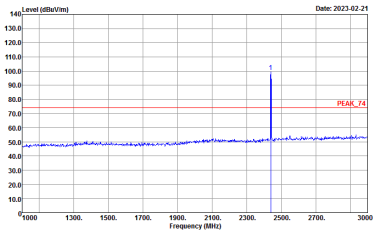
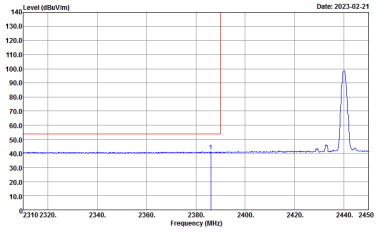
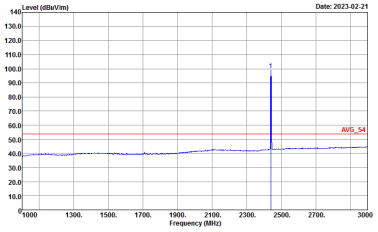
| | |
|---|---|
| -L | **Low channel location** |
| -R | **High channel location** |

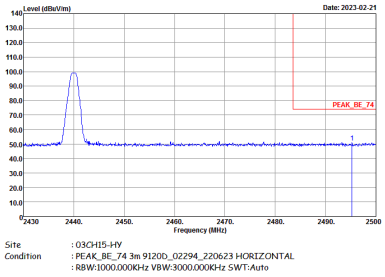
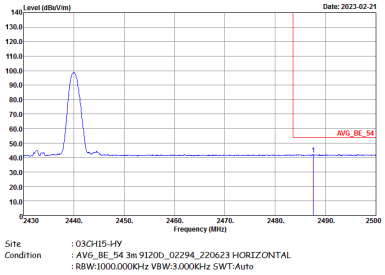
## 2.4GHz 2400~2483.5MHz

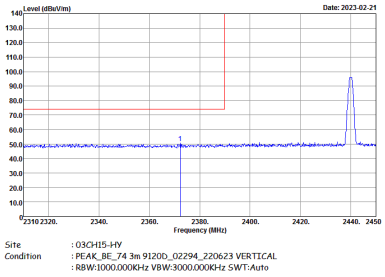
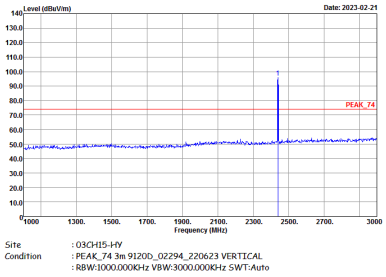
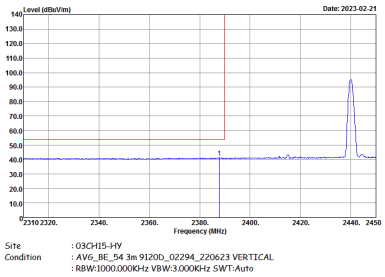
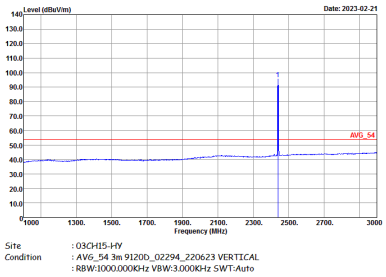
## BLE (Band Edge @ 3m)

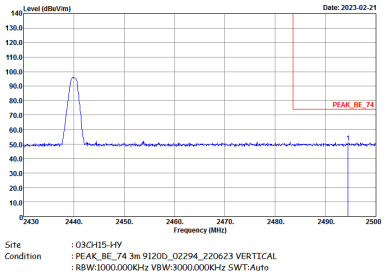
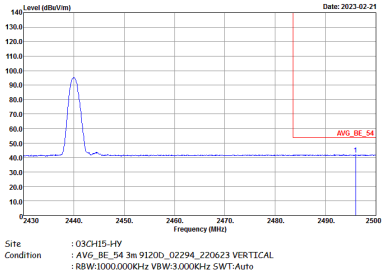
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

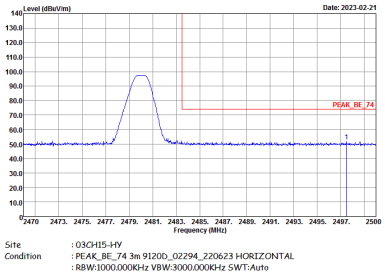
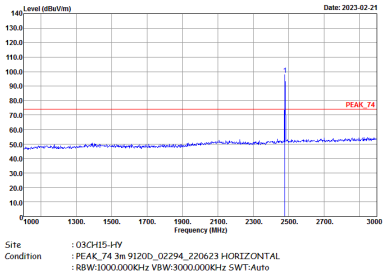
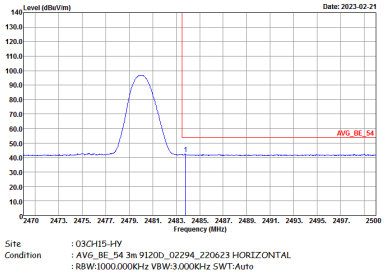
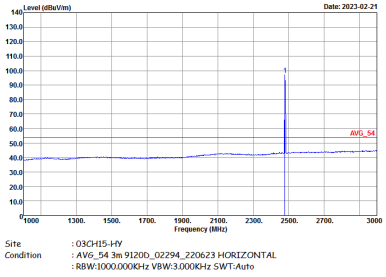
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Vertical | Fundamental |
| Peak |  |  |
| Avg. |  |  |

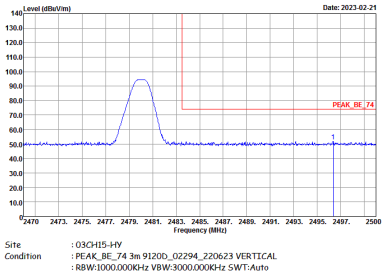
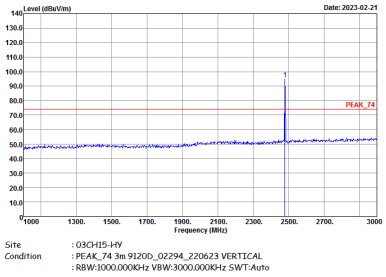
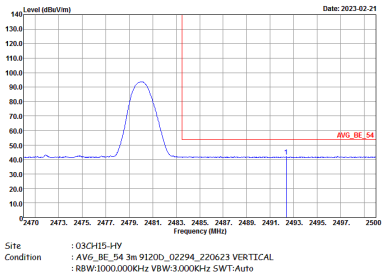
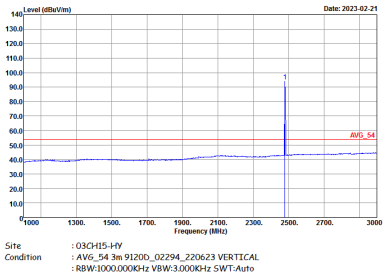
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - L | |
| | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH15-HY<br>Condition : PEAK_BE_74 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto |  <br>Site : 03CH15-HY<br>Condition : PEAK_74 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto |
| Avg. |  <br>Site : 03CH15-HY<br>Condition : AVG_BE_54 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto |  <br>Site : 03CH15-HY<br>Condition : AVG_54 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto |

| 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. |  |  |

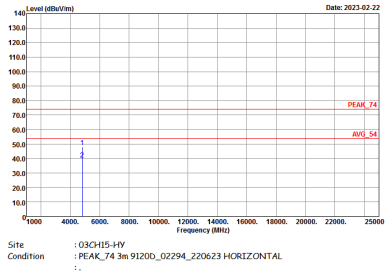
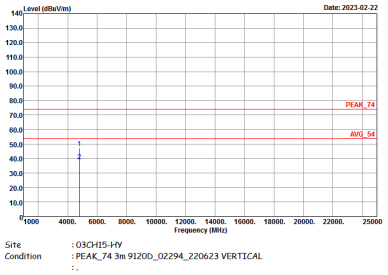
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - R | |
| | Vertical | Fundamental |
| Peak |  | Left blank |
| Avg. |  | Left blank |

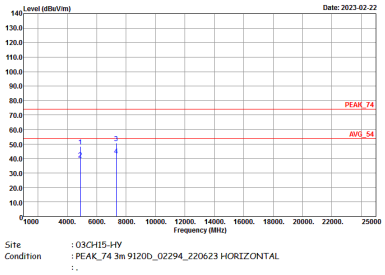
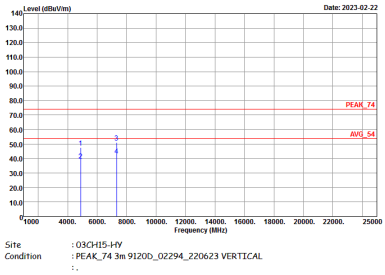
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH39 2480MHz | |
| | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH15-HY<br>Condition : PEAK_BE_74 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto |  <br>Site : 03CH15-HY<br>Condition : PEAK_74 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3000.000KHz SWT:Auto |
| Avg. |  <br>Site : 03CH15-HY<br>Condition : AVG_BE_54 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto |  <br>Site : 03CH15-HY<br>Condition : AVG_54 3m 9120D_02294_220623 HORIZONTAL<br>: RBW:1000.000KHz VBW:3.000KHz SWT:Auto |

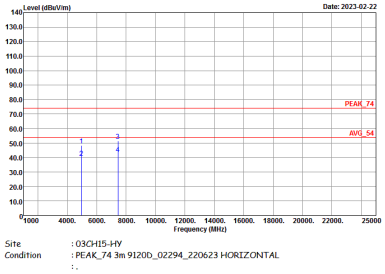
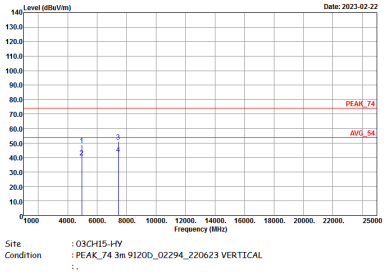
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH39 2480MHz | |
| | Vertical | Fundamental |
| Peak |  |  |
| Avg. |  |  |

## 2.4GHz 2400~2483.5MHz

## BLE (Harmonic @ 3m)

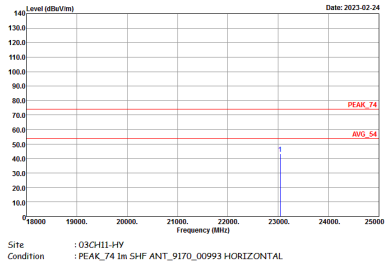
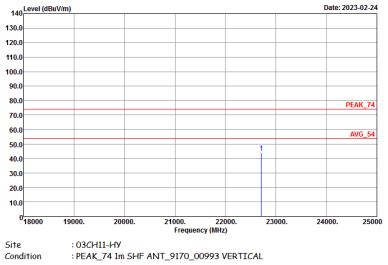
| BLE | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |

| BLE | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |

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

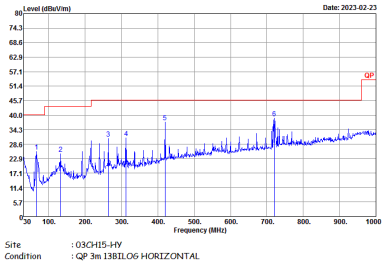
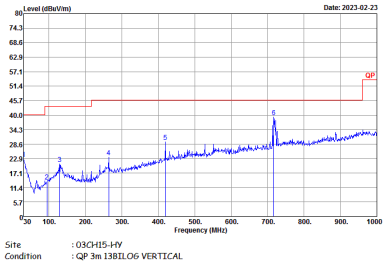
## Emission above 18GHz

## 2.4GHz BLE (SHF @ 1m)

| BLE | 2.4GHz 2400~2483.5MHz | |
|---|---|---|
| | BLE SHF | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |

## Emission below 1GHz

## 2.4GHz BLE (LF)

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

# Appendix E. Duty Cycle Plots

| Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---|---|---|---|---|
| Bluetooth -LE | 62.50 | 390 | 2.56 | 3kHz |

**Bluetooth – LE**