# FCC RADIO TEST REPORT

| | | |
|---|---|---|
| **FCC ID** | : | **2A7ZY-M811-TX** |
| **Equipment** | : | **Minder 811** |
| **Brand Name** | : | **Two-Commas** |
| **Model Name** | : | **M811** |
| **Applicant** | : | **Two Commas llc<br>2576 Barona Street, West Sacramento<br>CA 95691** |
| **Manufacturer** | : | **Two Commas llc<br>2576 Barona Street, West Sacramento<br>CA 95691** |
| **Standard** | : | **FCC Part 15 Subpart C §15.247** |

**The product was received on Jul. 08, 2022 and testing was performed from Jul. 19, 2022 to Jul. 27, 2022. We, Sporton International (USA) Inc., 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 (USA) Inc., the test report shall not be reproduced except in full.**

Neil Kao

**Approved by: Neil Kao**

***Sporton International (USA) Inc.***
*1175 Montague Expressway, Milpitas, CA 95035*

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# History of this test report

| Report No. | Version | Description | Issue Date |
|---|---|---|---|
| FR220714005 | 01 | Initial issue of report | Aug. 15, 2022 |
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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) | 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 | 7.89 dB under the limit at 7440.000 MHz |
| - | 15.207 | AC Conducted Emission | Not Required | See Note 2 |
| 3.6 | 15.203 & 15.247(b) | Antenna Requirement | Pass | - |

**Note:**

**1.** Not required means after assessing, test items are not necessary to carry out.

**2.** The EUT is powered by batteries which is deemed DC power source, it does not operate from the AC power lines or contain provisions for operation while connected to the AC power lines, according to 47 CFR §15.207(c), the conducted emission limits are not applicable to the device hence the test is not performed.

| **Conformity Assessment Condition:** |
|---|
| 1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.<br>2. Please refer to the section " Uncertainty of Evaluation " for measurement uncertainty. |
| **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. |

# 1 General Description

## 1.1 Product Feature of Equipment Under Test

Bluetooth-LE

| Product Feature | |
|---|---|
| **EUT Stage** | Identical Prototype |
| **Antenna Type** | Bluetooth-LE: Ceramic Antenna |

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

## 1.2 Modification of EUT

No modifications made to the EUT during the testing.

## 1.3 Testing Location

| | |
|---|---|
| **Test Site** | Sporton International (USA) Inc. |
| **Test Site Location** | 1175 Montague Expressway, Milpitas, CA 95035<br>TEL : 408 9043300 |
| **Test Site No.** | **Sporton Site No.** |
| | TH01-CA, 03CH02-CA |

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

FCC Designation No.: US 1250

## 1.4 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 DTS 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. 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

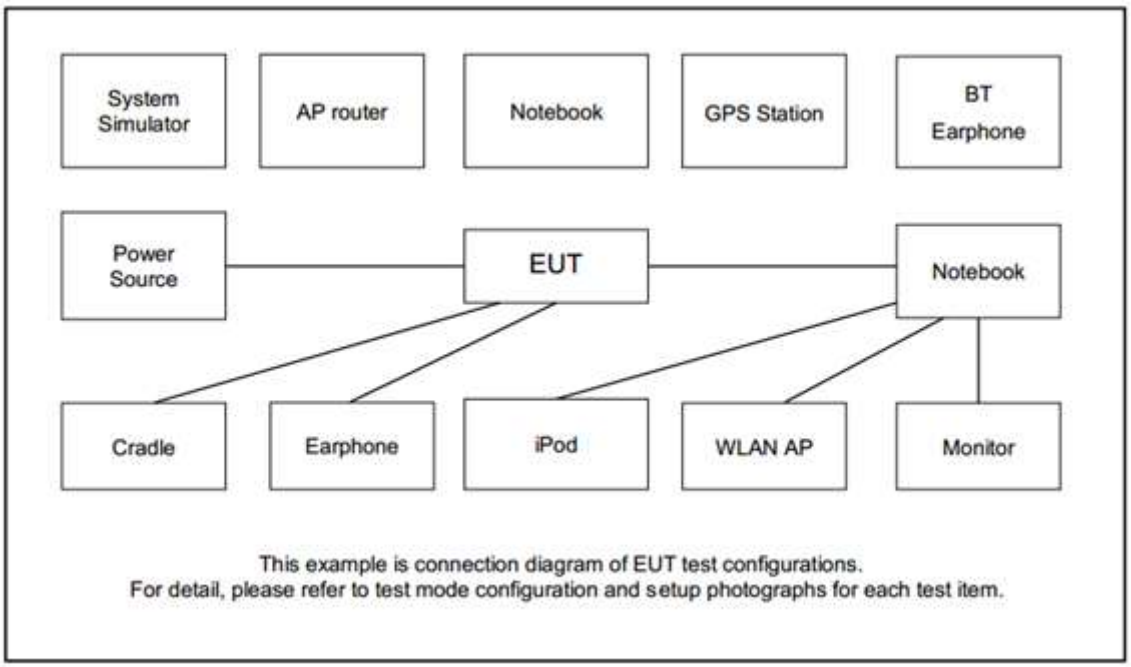
a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is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

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

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

| Summary table of Test Cases | |
|---|---|
| **Test Item** | **Data Rate / Modulation** |
| **Conducted Test Cases** | **Bluetooth – LE / GFSK** |
| | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps |
| | Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps |
| | Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps |
| **Radiated Test Cases** | Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps |
| | Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps |
| | Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps |

## 2.3 Connection Diagram of Test System




## 2.4 Support Unit used in test configuration and system

| Item | Equipment | Brand Name | Model Name | FCC ID | Data Cable | Power Cord |
|---|---|---|---|---|---|---|
| 1. | Notebook | ACER | Altos PS548-G1 | N/A | N/A | AC I/P: Unshielded, 1.2 m<br>DC O/P: Shielded, 1.8 m |

## 2.5 EUT Operation Test Setup

The RF test items, utility “nRF connect for Desktop V3.11.1” 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.

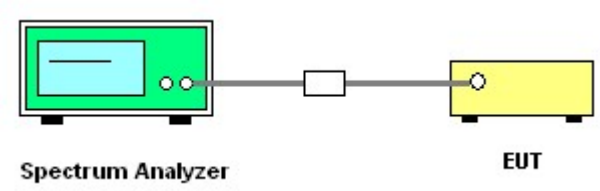
### 3.1.2 Measuring Instruments

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.

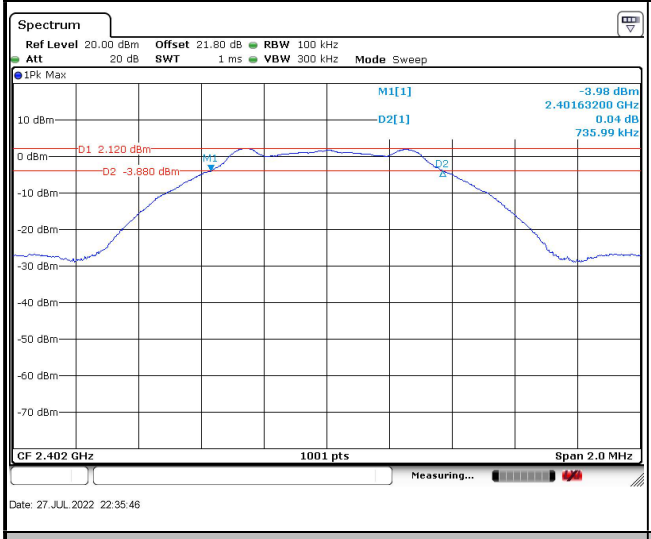
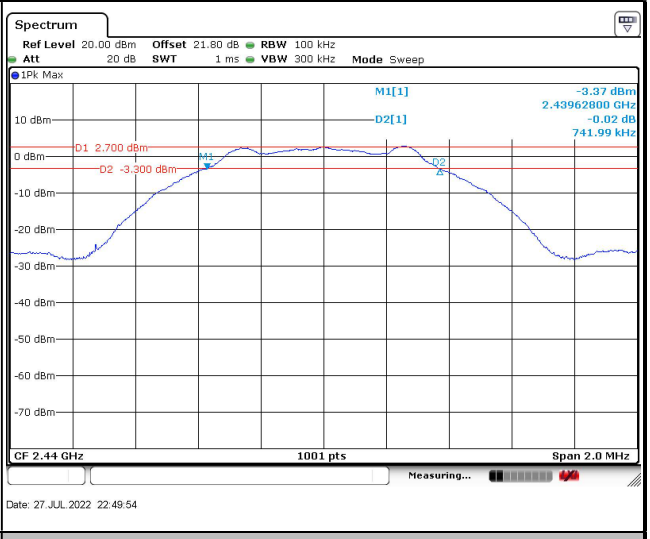
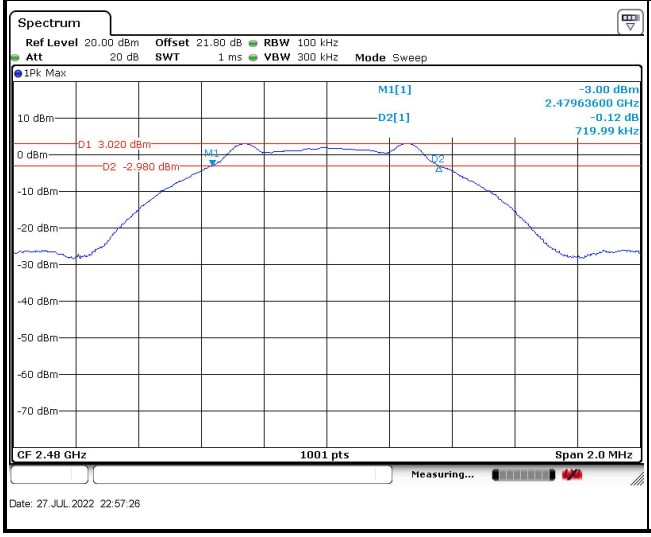
### 3.1.4 Test Setup



## 3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

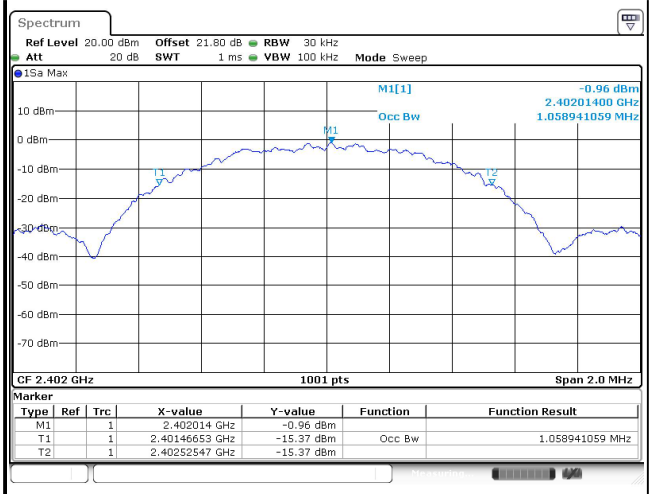
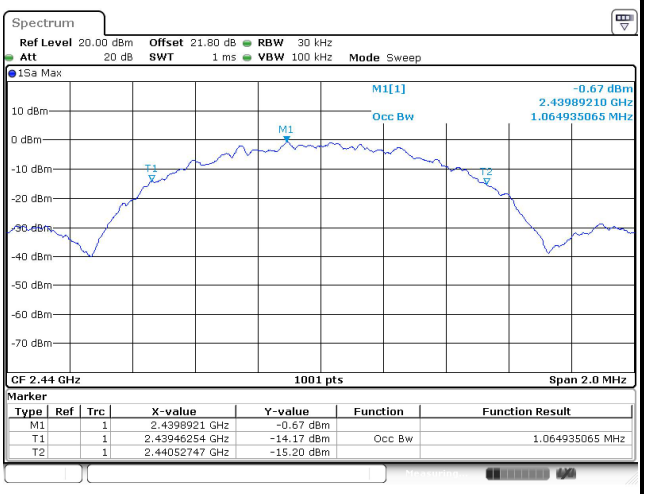
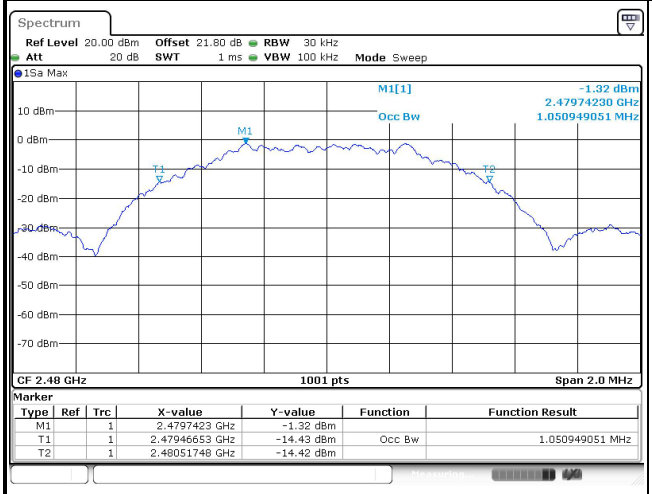
**<1Mbps>**

| 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.

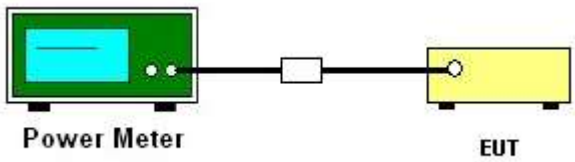
### 3.2.2 Measuring Instruments

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.

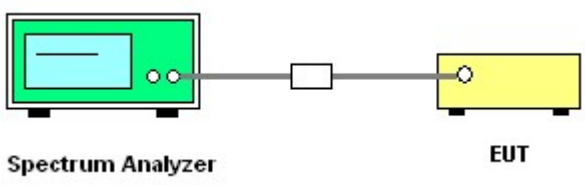
### 3.3.2 Measuring Instruments

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

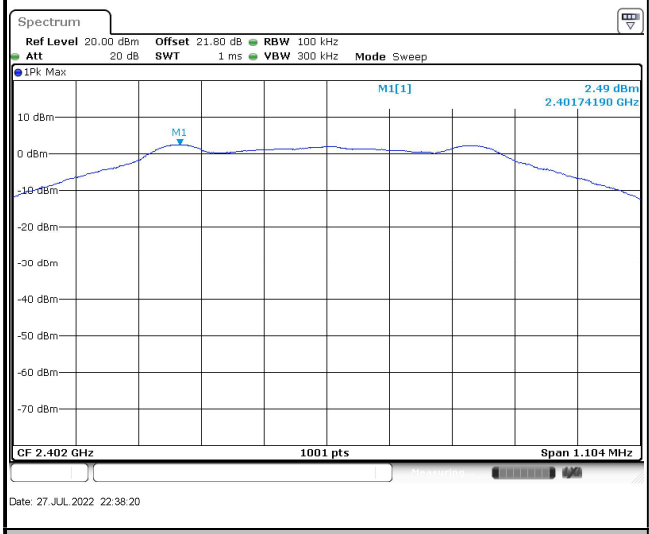
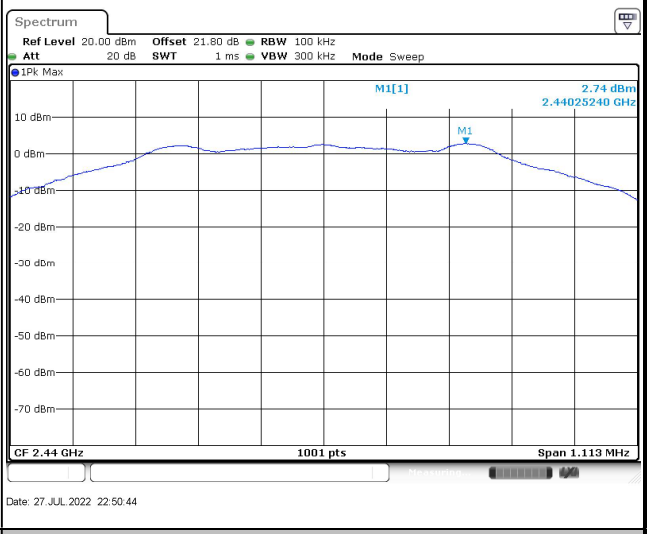
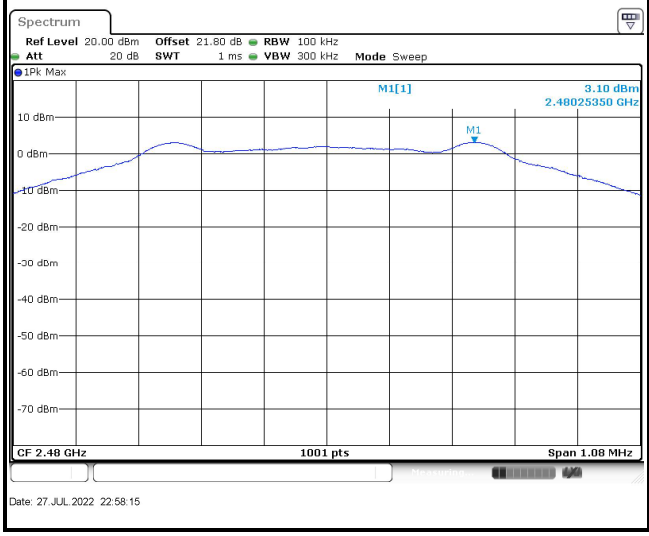



### 3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

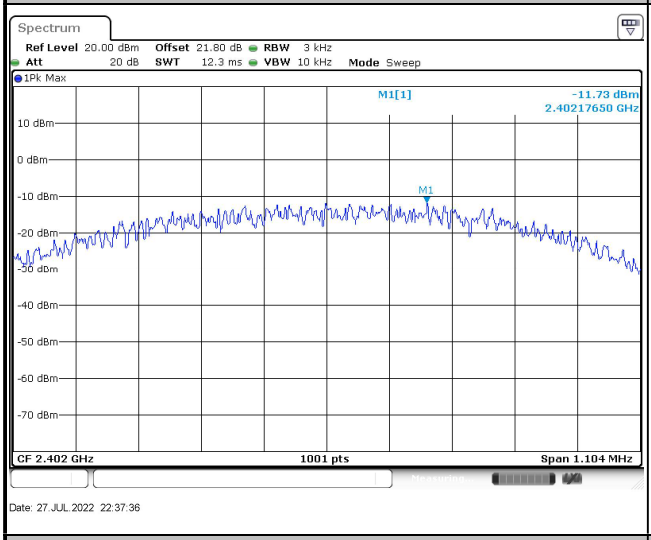
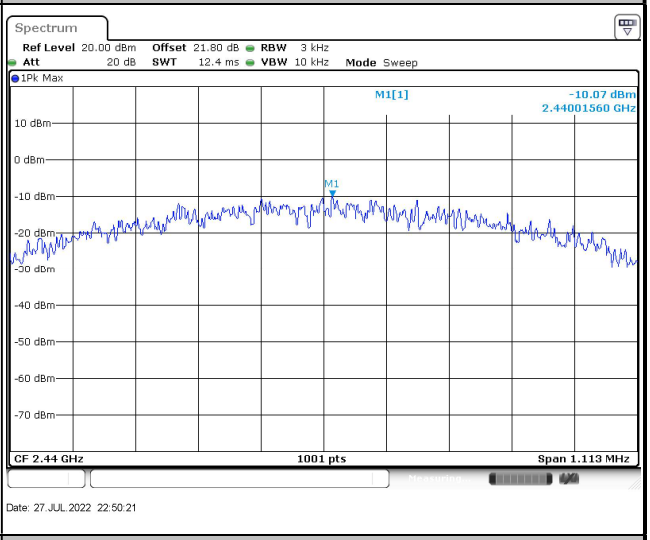
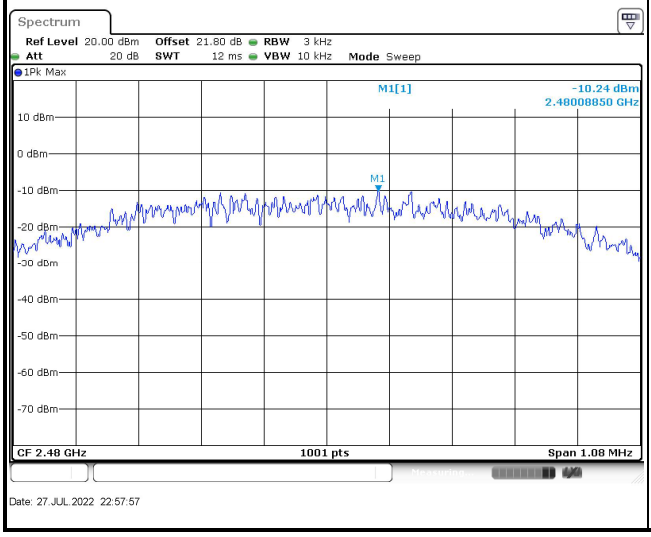
## 3.3.6 Test Result of Power Spectral Density Plots (100kHz)

**<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 20 dB down from the highest emission level within the authorized band.

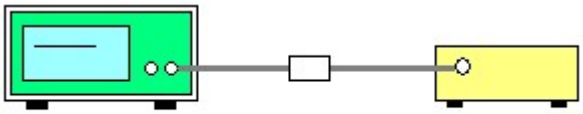
## 3.4.2 Measuring Instruments

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

## 3.4.3 Test Procedure

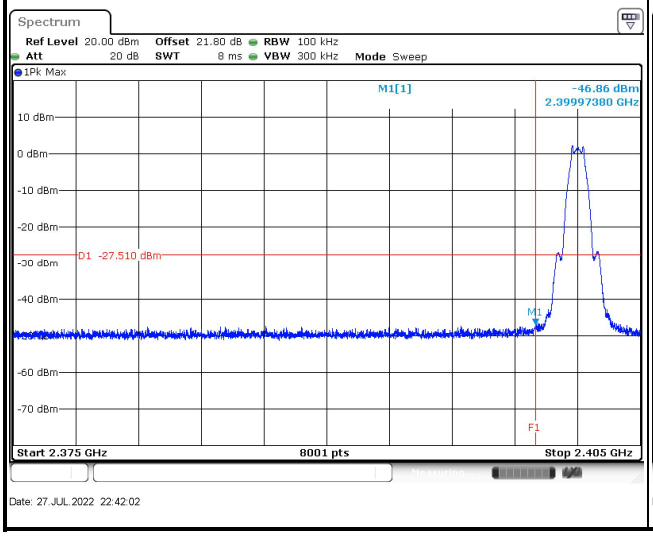
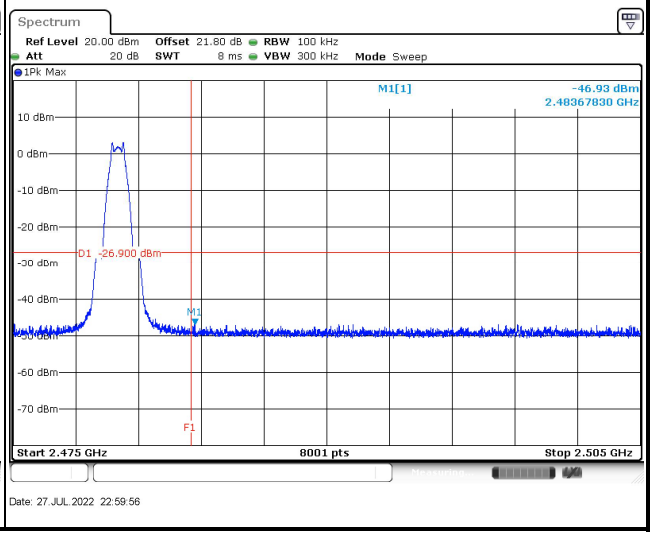
1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit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



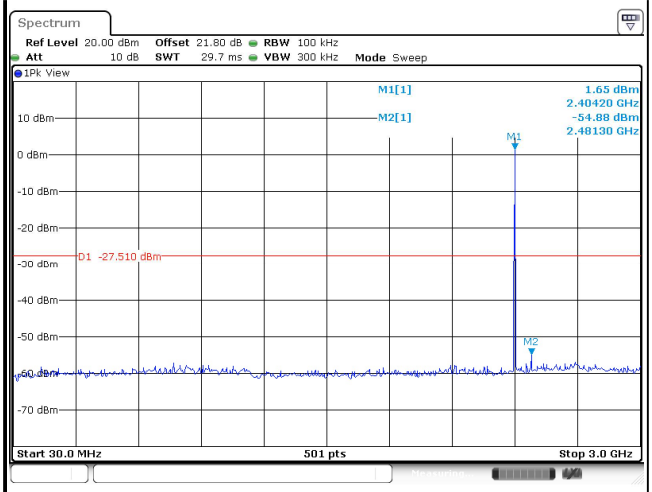
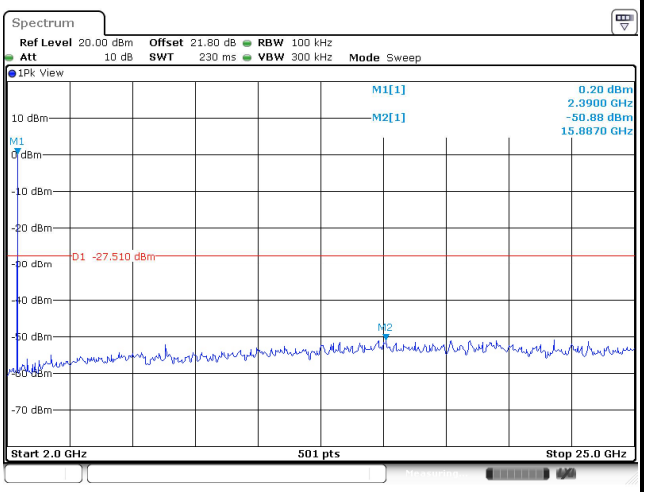
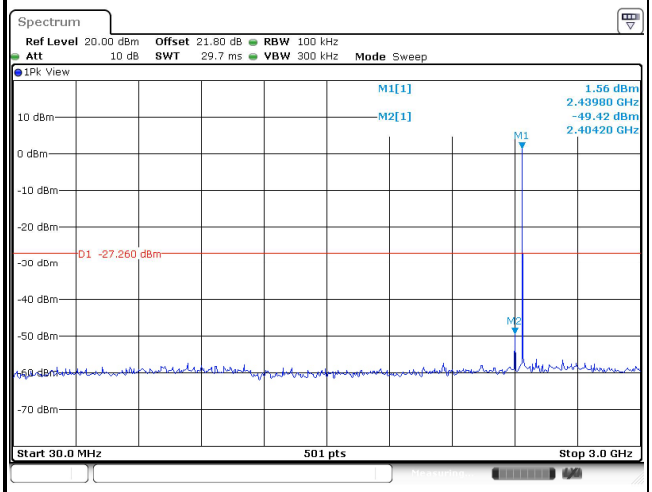
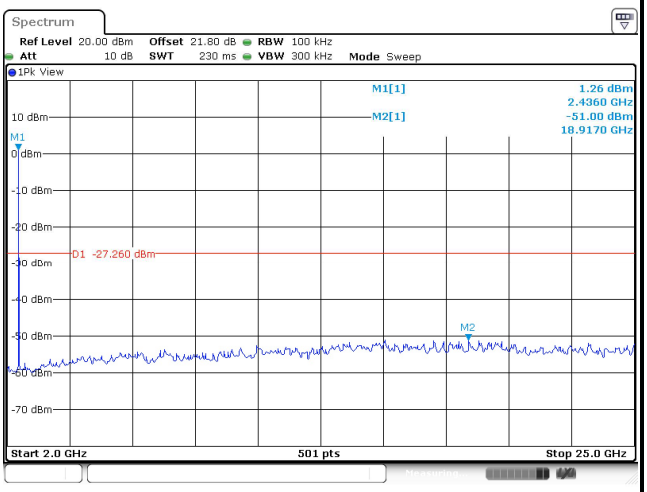
## 3.4.5 Test Result of Conducted Band Edges Plots

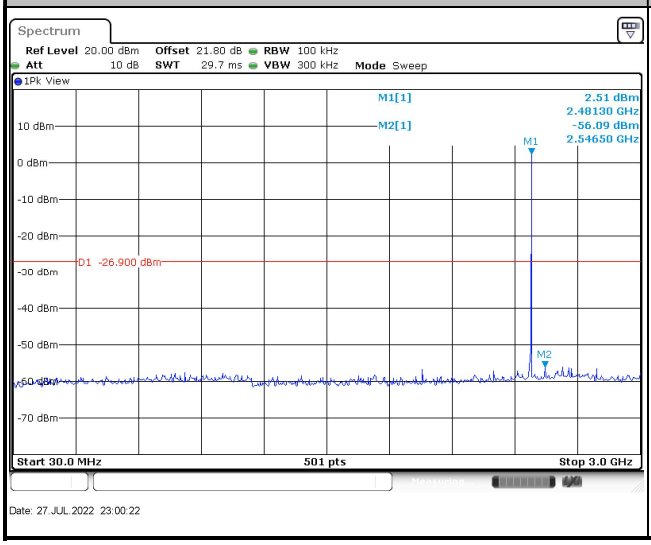
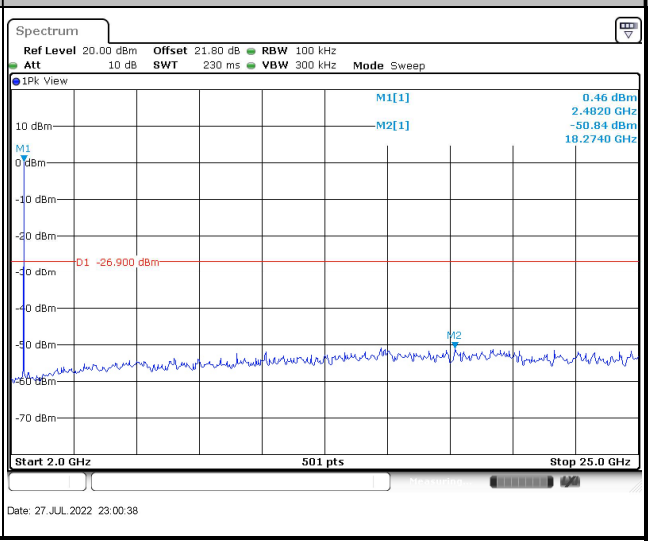
**<1Mbps>**

| 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

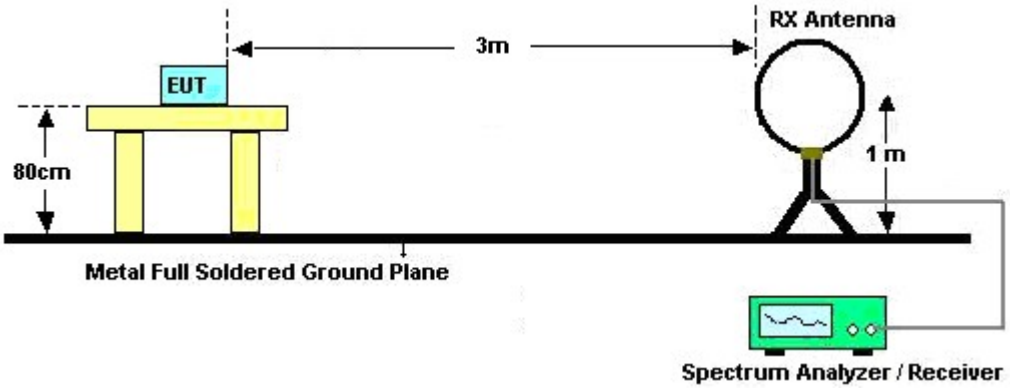
Please refer to the measuring equipment list in this test report.

### 3.5.3 Test Procedures

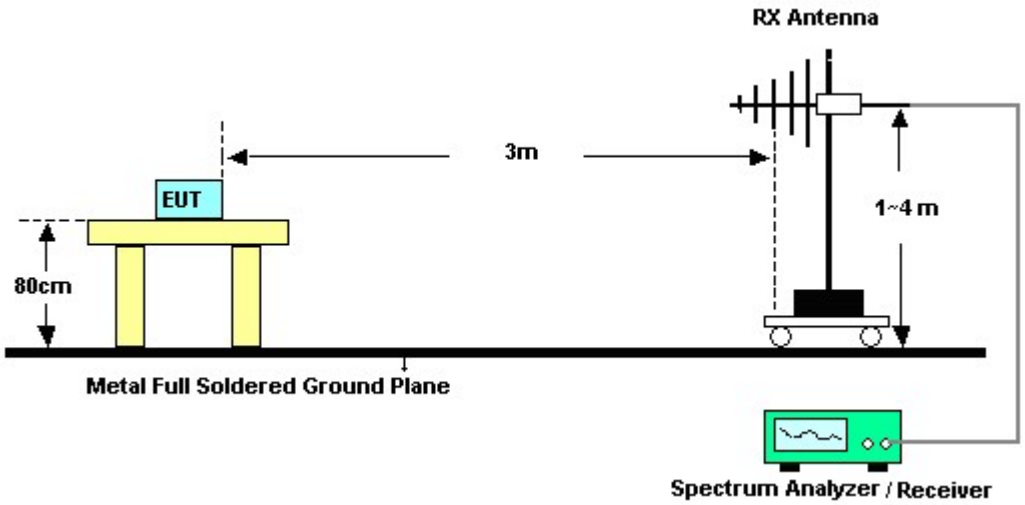
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT is arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the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

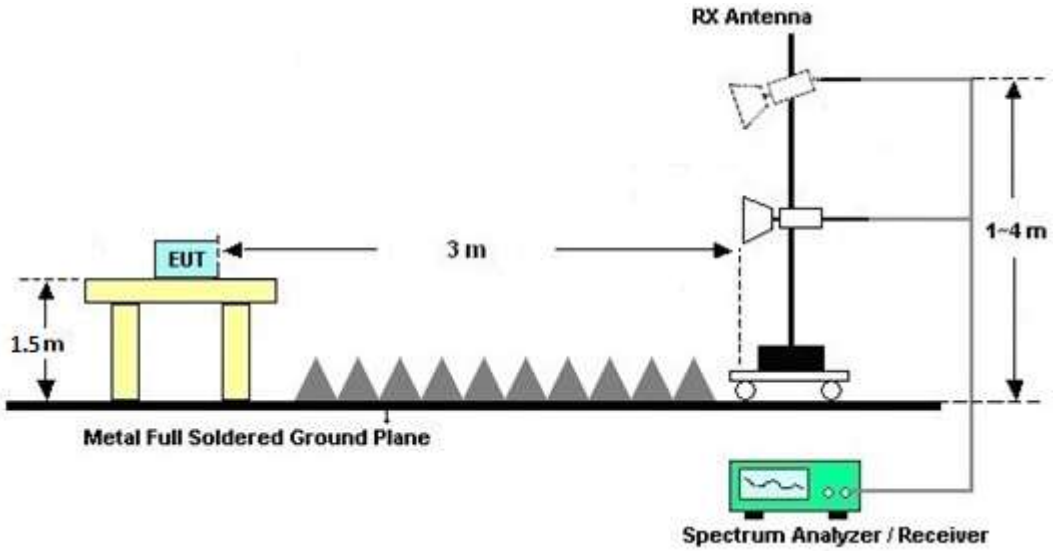
**For radiated test below 30MHz**



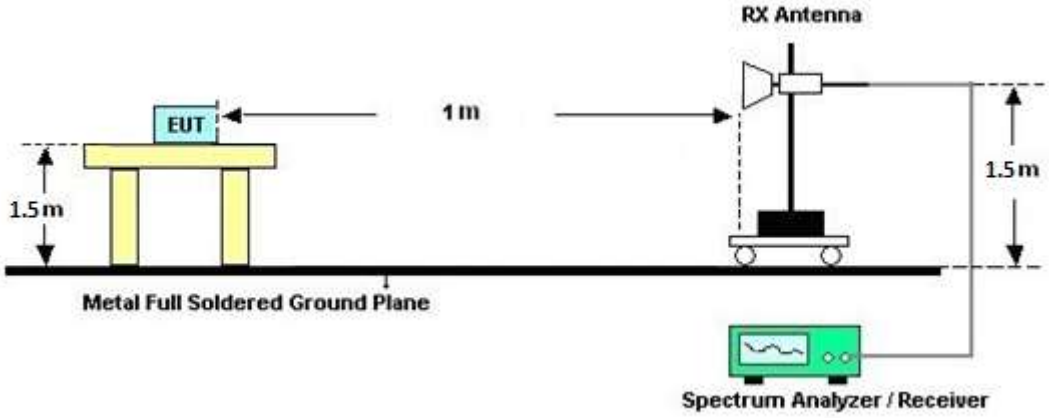

**For radiated test from 30MHz to 1GHz**




**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 B and C.

### 3.5.7 Duty Cycle

Please refer to Appendix D.

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

Please refer to Appendix B and C.

# 3.6 Antenna Requirements

## 3.6.1 Standard Applicable

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

## 3.6.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

## 3.6.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

# 4 List of Measuring Equipment

| Instrument | Brand Name | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---|---|---|---|---|---|---|---|---|
| Hygrometer | Testo | 608-H1 | 45142595 | N/A | Aug. 30. 2021 | Jul. 27, 2022 | Aug. 29, 2022 | Conducted (TH01-CA) |
| Power Sensor | DARE!! | RPR3006W | RPR6W-1901026 | 10MHz-6GHz | May 10, 2022 | Jul. 27, 2022 | May 09, 2023 | Conducted (TH01-CA) |
| Switch Box& RF Cable | EM Electronics | EMSW26 | 1090304 | N/A | Mar. 30, 2022 | Jul. 27, 2022 | Mar. 29, 2023 | Conducted (TH01-CA) |
| Spectrum Analyzer | Rohde & Schwarz | FSV40 | 101089 | 10Hz-40GHz | Jun. 01, 2022 | Jul. 27, 2022 | May 31, 2023 | Conducted (TH01-CA) |
| Loop Antenna | Rohde & Schwarz | HFH2-Z2 | 100315 | 9kHz~30MHz | Jan. 07, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | Jan. 06, 2023 | Radiation (03CH02-CA) |
| Bilog Antenna | TESEQ | 6111D | 54683 | 30MHz~1GHz | Oct. 15, 2021 | Jul. 20, 2022~ Jul. 21, 2022 | Oct. 14, 2022 | Radiation (03CH02-CA) |
| Horn Antenna | SCHWARZBECK | BBHA 9120D | 01895 | 1GHz~18GHz | Aug. 25, 2021 | Jul. 20, 2022~ Jul. 21, 2022 | Aug. 24, 2022 | Radiation (03CH02-CA) |
| Horn Antenna | SCHWARZBECK | BBHA 9170D | 00841 | 18GHz~40GHz | Aug. 26, 2021 | Jul. 20, 2022~ Jul. 21, 2022 | Aug. 25, 2022 | Radiation (03CH02-CA) |
| Amplifier | SONOMA | 310N | 372240 | N/A | May 10, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | May 09, 2023 | Radiation (03CH02-CA) |
| Preamplifier | Keysight | 83017A | MY53270323 | 1GHz~26.5GHz | May 11, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | May 10, 2023 | Radiation (03CH02-CA) |
| Preamplifier | E-instrument | ERA-100M-18G-56-01-A70 | EC1900251 | 1GHz~18GHz | May 10, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | May 09, 2023 | Radiation (03CH02-CA) |
| Preamplifier | EMEC | EMC18G40G | 060725 | 18GHz-40GHz | May 10, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | May 09, 2023 | Radiation (03CH02-CA) |
| RF Cable | HUBER+SUHNER | SUCOFLEX 102 | 8024032/2, 802406/2, 802875/2 | N/A | Jun. 22, 2022 | Jul. 20, 2022~ Jul. 21, 2022 | Jun. 21, 2023 | Radiation (03CH02-CA) |
| Spectrum Analyzer | Keysight | N9010A | MY57420221 | 10Hz~44GHz | Sep. 22, 2021 | Jul. 20, 2022~ Jul. 21, 2022 | Sep. 21, 2022 | Radiation (03CH02-CA) |
| Filter | Wainwright | WHKX12-2700-3000-18000-60ST | SN10 | 3GHz High Pass Filter | Jul. 22, 2021 | Jul. 19, 2022~ Jul. 20, 2022 | Jul. 21, 2022 | Radiation (03CH02-CA) |
| Filter | Wainwright | WLK12-1200-1272-11000-40SS | SN1 | 1.2GHz Low Pass Filter | Jul. 22, 2021 | Jul. 19, 2022~ Jul. 20, 2022 | Jul. 21, 2022 | Radiation (03CH02-CA) |
| Hygrometer | TESEO | 608-H1 | 45142602 | N/A | Aug. 04, 2021 | Jul. 20, 2022~ Jul. 21, 2022 | Aug. 03, 2022 | Radiation (03CH02-CA) |
| Controller | ChainTek | EM-1000 | 060876 | NA | N/A | Jul. 20, 2022~ Jul. 21, 2022 | N/A | Radiation (03CH02-CA) |
| Antenna Mast | ChainTek | MBS-520-1 | N/A | 1m~4m | N/A | Jul. 20, 2022~ Jul. 21, 2022 | N/A | Radiation (03CH02-CA) |
| Turn Table | ChainTek | T-200-S-1 | N/A | 0~360 Degree | N/A | Jul. 20, 2022~ Jul. 21, 2022 | N/A | Radiation (03CH02-CA) |
| Software | Audix | E3 | N/A | N/A | N/A | Jul. 20, 2022~ Jul. 21, 2022 | N/A | Radiation (03CH02-CA) |

# 5 Uncertainty of Evaluation

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

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

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **6.2 dB** |

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

| | |
|---|---|
| **Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))** | **6.4 dB** |

# Appendix A. Test Result of Conducted Test Items

| Test Engineer: | Venkata Kondepudi | Temperature: | 21~24.4 | °C |
|---|---|---|---|---|
| Test Date: | 2022/7/27 | Relative Humidity: | 48.9~50.8 | % |

## 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 | 1.058 | 0.736 | 0.50 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 1.065 | 0.742 | 0.50 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 1.050 | 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 | 3.21 | 30.00 | 0.00 | 3.21 | 36.00 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 3.34 | 30.00 | 0.00 | 3.34 | 36.00 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 3.23 | 30.00 | 0.00 | 3.23 | 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 | 2.49 | -11.73 | 0.00 | 8.00 | Pass |
| BLE | 1Mbps | 1 | 19 | 2440 | 2.74 | -10.07 | 0.00 | 8.00 | Pass |
| BLE | 1Mbps | 1 | 39 | 2480 | 3.10 | -10.24 | 0.00 | 8.00 | Pass |

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

# Appendix B. Radiated Spurious Emission

| | | | |
|---|---|---|---|
| **Test Engineer :** | Fu Chen | **Temperature :** | 20~24°C |
| | | **Relative Humidity :** | 42~49% |

**2.4GHz 2400~2483.5MHz**

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

| 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 | | 2360.715 | 55.69 | -18.31 | 74 | 42.09 | 27.75 | 17.38 | 31.53 | 100 | 117 | P | H |
| | | 2338.035 | 44.4 | -9.6 | 54 | 30.76 | 27.84 | 17.33 | 31.53 | 100 | 117 | A | H |
| | * | 2402 | 100.72 | - | - | 87.11 | 27.66 | 17.44 | 31.49 | 100 | 117 | P | H |
| | * | 2402 | 100.42 | - | - | 86.81 | 27.66 | 17.44 | 31.49 | 100 | 117 | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 2337.3 | 56.13 | -17.87 | 74 | 42.41 | 27.92 | 17.33 | 31.53 | 375 | 51 | P | V |
| | | 2337.93 | 43.93 | -10.07 | 54 | 30.21 | 27.92 | 17.33 | 31.53 | 375 | 51 | A | V |
| | * | 2402 | 96.42 | - | - | 82.73 | 27.74 | 17.44 | 31.49 | 375 | 51 | P | V |
| | * | 2402 | 96.06 | - | - | 82.37 | 27.74 | 17.44 | 31.49 | 375 | 51 | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| BLE CH 19 2440MHz | | 2383.6 | 55.28 | -18.72 | 74 | 41.68 | 27.7 | 17.41 | 31.51 | 115 | 115 | P | H |
| | | 2376.08 | 44.37 | -9.63 | 54 | 30.78 | 27.71 | 17.4 | 31.52 | 115 | 115 | A | H |
| | * | 2440 | 100.63 | - | - | 86.94 | 27.66 | 17.5 | 31.47 | 115 | 115 | P | H |
| | * | 2440 | 100.31 | - | - | 86.62 | 27.66 | 17.5 | 31.47 | 115 | 115 | A | H |
| | | 2488 | 55.5 | -18.5 | 74 | 41.75 | 27.62 | 17.59 | 31.46 | 115 | 115 | P | H |
| | | 2499.68 | 43.95 | -10.05 | 54 | 30.18 | 27.61 | 17.61 | 31.45 | 115 | 115 | A | H |
| | | 2325.04 | 55.41 | -18.59 | 74 | 41.71 | 27.92 | 17.31 | 31.53 | 399 | 40 | P | V |
| | | 2376.08 | 43.92 | -10.08 | 54 | 30.21 | 27.83 | 17.4 | 31.52 | 399 | 40 | A | V |
| | * | 2440 | 95.16 | - | - | 81.54 | 27.59 | 17.5 | 31.47 | 399 | 40 | P | V |
| | * | 2440 | 94.83 | - | - | 81.21 | 27.59 | 17.5 | 31.47 | 399 | 40 | A | V |
| | | 2494.48 | 54.54 | -19.46 | 74 | 40.91 | 27.49 | 17.6 | 31.46 | 399 | 40 | P | V |
| | | 2499.04 | 43.83 | -10.17 | 54 | 30.18 | 27.49 | 17.61 | 31.45 | 399 | 40 | A | V |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BLE CH 39 2480MHz | * | 2480 | 99.41 | - | - | 85.66 | 27.63 | 17.58 | 31.46 | 104 | 114 | P | H |
| | * | 2480 | 99.1 | - | - | 85.35 | 27.63 | 17.58 | 31.46 | 104 | 114 | A | H |
| | | 2485.08 | 55.52 | -18.48 | 74 | 41.77 | 27.62 | 17.59 | 31.46 | 104 | 114 | P | H |
| | | 2483.52 | 44.46 | -9.54 | 54 | 30.72 | 27.62 | 17.58 | 31.46 | 104 | 114 | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | * | 2480 | 94.14 | - | - | 80.51 | 27.51 | 17.58 | 31.46 | 392 | 54 | P | V |
| | * | 2480 | 93.78 | - | - | 80.15 | 27.51 | 17.58 | 31.46 | 392 | 54 | A | V |
| | | 2499.08 | 56.01 | -17.99 | 74 | 42.36 | 27.49 | 17.61 | 31.45 | 392 | 54 | P | V |
| | | 2483.52 | 43.91 | -10.09 | 54 | 30.28 | 27.51 | 17.58 | 31.46 | 392 | 54 | 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 | 46.51 | -27.49 | 74 | 71.44 | 31.51 | 11.44 | 67.88 | 100 | 264 | P | H |
| | | 4804 | 41.39 | -12.61 | 54 | 66.32 | 31.51 | 11.44 | 67.88 | 100 | 264 | A | H |
| | | 11325 | 49.65 | -24.35 | 74 | 60.49 | 39.83 | 17.59 | 68.26 | - | - | P | H |
| | | 11325 | 37.95 | -16.05 | 54 | 48.79 | 39.83 | 17.59 | 68.26 | - | - | A | H |
| | | 14490 | 50.88 | -23.12 | 74 | 56.72 | 41.94 | 20.2 | 67.98 | - | - | P | H |
| | | 14490 | 41.87 | -12.13 | 54 | 47.71 | 41.94 | 20.2 | 67.98 | - | - | A | H |
| | | 18000 | 58.6 | -15.4 | 74 | 57.59 | 48.82 | 21.91 | 69.72 | - | - | P | H |
| | | 18000 | 48.92 | -5.08 | 54 | 47.91 | 48.82 | 21.91 | 69.72 | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4804 | 42.43 | -31.57 | 74 | 67.33 | 31.54 | 11.44 | 67.88 | 383 | 304 | P | V |
| | | 4804 | 34.16 | -19.84 | 54 | 59.06 | 31.54 | 11.44 | 67.88 | 383 | 304 | A | V |
| | | 11400 | 49.32 | -24.68 | 74 | 59.8 | 39.92 | 17.66 | 68.06 | - | - | P | V |
| | | 11400 | 38.52 | -15.48 | 54 | 49 | 39.92 | 17.66 | 68.06 | - | - | A | V |
| | | 14490 | 51.07 | -22.93 | 74 | 56.91 | 41.94 | 20.2 | 67.98 | - | - | P | V |
| | | 14490 | 41.75 | -12.25 | 54 | 47.59 | 41.94 | 20.2 | 67.98 | - | - | A | V |
| | | 17985 | 58.22 | -15.78 | 74 | 57.52 | 48.7 | 21.9 | 69.9 | - | - | P | V |
| | | 17985 | 48.52 | -5.48 | 54 | 47.82 | 48.7 | 21.9 | 69.9 | - | - | A | 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 | 46.58 | -27.42 | 74 | 71.57 | 31.45 | 11.48 | 67.92 | 100 | 270 | P | H |
| | | 4880 | 41.03 | -12.97 | 54 | 66.02 | 31.45 | 11.48 | 67.92 | 100 | 270 | A | H |
| | | 7320 | 51.28 | -22.72 | 74 | 68.1 | 36.33 | 13.92 | 67.07 | 100 | 273 | P | H |
| | | 7320 | 44.59 | -9.41 | 54 | 61.41 | 36.33 | 13.92 | 67.07 | 100 | 273 | A | H |
| | | 11355 | 50.02 | -23.98 | 74 | 60.69 | 39.91 | 17.62 | 68.2 | - | - | P | H |
| | | 11355 | 38.3 | -15.7 | 54 | 48.97 | 39.91 | 17.62 | 68.2 | - | - | A | H |
| | | 14490 | 51.69 | -22.31 | 74 | 57.53 | 41.94 | 20.2 | 67.98 | - | - | P | H |
| | | 14490 | 41.77 | -12.23 | 54 | 47.61 | 41.94 | 20.2 | 67.98 | - | - | A | H |
| | | 18000 | 58.57 | -15.43 | 74 | 57.56 | 48.82 | 21.91 | 69.72 | - | - | P | H |
| | | 18000 | 49 | -5 | 54 | 47.99 | 48.82 | 21.91 | 69.72 | - | - | A | H |
| | | | | | | | | | | | | | H |
| BLE CH 19 2440MHz | | | | | | | | | | | | | H |
| | | 4880 | 43.32 | -30.68 | 74 | 68.38 | 31.38 | 11.48 | 67.92 | 399 | 301 | P | V |
| | | 4880 | 35.5 | -18.5 | 54 | 60.56 | 31.38 | 11.48 | 67.92 | 399 | 301 | A | V |
| | | 7320 | 48.95 | -25.05 | 74 | 65.7 | 36.4 | 13.92 | 67.07 | 101 | 71 | P | V |
| | | 7320 | 39.89 | -14.11 | 54 | 56.64 | 36.4 | 13.92 | 67.07 | 101 | 71 | A | V |
| | | 11280 | 49.5 | -24.5 | 74 | 60.6 | 39.67 | 17.55 | 68.32 | - | - | P | V |
| | | 11280 | 37.51 | -16.49 | 54 | 48.61 | 39.67 | 17.55 | 68.32 | - | - | A | V |
| | | 14490 | 50.68 | -23.32 | 74 | 56.52 | 41.94 | 20.2 | 67.98 | - | - | P | V |
| | | 14490 | 41.73 | -12.27 | 54 | 47.57 | 41.94 | 20.2 | 67.98 | - | - | A | V |
| | | 18000 | 58.57 | -15.43 | 74 | 57.34 | 49.04 | 21.91 | 69.72 | - | - | P | V |
| | | 18000 | 49.12 | -4.88 | 54 | 47.89 | 49.04 | 21.91 | 69.72 | - | - | A | 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 | 48.13 | -25.87 | 74 | 73.17 | 31.51 | 11.51 | 68.06 | 100 | 298 | P | H |
| | | 4960 | 43.9 | -10.1 | 54 | 68.94 | 31.51 | 11.51 | 68.06 | 100 | 298 | A | H |
| | | 7440 | 52.43 | -21.57 | 74 | 69.1 | 36.49 | 14.07 | 67.23 | 100 | 300 | P | H |
| | | 7440 | 46.11 | -7.89 | 54 | 62.78 | 36.49 | 14.07 | 67.23 | 100 | 300 | A | H |
| | | 11595 | 50.58 | -23.42 | 74 | 60.3 | 40 | 17.86 | 67.58 | - | - | P | H |
| | | 11595 | 39.11 | -14.89 | 54 | 48.83 | 40 | 17.86 | 67.58 | - | - | A | H |
| | | 14490 | 50.77 | -23.23 | 74 | 56.61 | 41.94 | 20.2 | 67.98 | - | - | P | H |
| | | 14490 | 41.91 | -12.09 | 54 | 47.75 | 41.94 | 20.2 | 67.98 | - | - | A | H |
| | | 17970 | 58.38 | -15.62 | 74 | 58.51 | 48.04 | 21.9 | 70.07 | - | - | P | H |
| | | 17970 | 47.87 | -6.13 | 54 | 48 | 48.04 | 21.9 | 70.07 | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4960 | 44.33 | -29.67 | 74 | 69.42 | 31.46 | 11.51 | 68.06 | 380 | 324 | P | V |
| | | 4960 | 37.46 | -16.54 | 54 | 62.55 | 31.46 | 11.51 | 68.06 | 380 | 324 | A | V |
| | | 7440 | 49.17 | -24.83 | 74 | 65.86 | 36.47 | 14.07 | 67.23 | 107 | 297 | P | V |
| | | 7440 | 41.22 | -12.78 | 54 | 57.91 | 36.47 | 14.07 | 67.23 | 107 | 297 | A | V |
| | | 11550 | 49.57 | -24.43 | 74 | 59.37 | 40.04 | 17.81 | 67.65 | - | - | P | V |
| | | 11550 | 39.17 | -14.83 | 54 | 48.97 | 40.04 | 17.81 | 67.65 | - | - | A | V |
| | | 14490 | 50.89 | -23.11 | 74 | 56.73 | 41.94 | 20.2 | 67.98 | - | - | P | V |
| | | 14490 | 41.85 | -12.15 | 54 | 47.69 | 41.94 | 20.2 | 67.98 | - | - | A | V |
| | | 18000 | 58.54 | -15.46 | 74 | 57.31 | 49.04 | 21.91 | 69.72 | - | - | P | V |
| | | 18000 | 49.11 | -4.89 | 54 | 47.88 | 49.04 | 21.91 | 69.72 | - | - | A | 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.
4. The emission level close to 18GHz is checked that the average emission level is noise floor only.

**Emission above 18GHz**

**2.4GHz BLE (SHF)**

| BT | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | (dBμV) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 2.4GHz BLE SHF | | 23894 | 39.29 | -34.71 | 74 | 36.93 | 38.94 | 15.24 | 51.82 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 22914 | 39.58 | -34.42 | 74 | 38.23 | 38.77 | 14.52 | 51.94 | - | - | P | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |

**Remark**

1. No other spurious found.
2. All results are PASS against 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 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 | | 170.65 | 19.48 | -24.02 | 43.5 | 34.04 | 15.73 | 2.11 | 32.4 | - | - | P | H |
| | | 260.86 | 20.06 | -25.94 | 46 | 29.64 | 20.2 | 2.63 | 32.41 | - | - | P | H |
| | | 411.21 | 23.07 | -22.93 | 46 | 29.77 | 22.52 | 3.29 | 32.51 | - | - | P | H |
| | | 636.25 | 29.83 | -16.17 | 46 | 31.96 | 26.45 | 4.03 | 32.61 | - | - | P | H |
| | | 748.77 | 30.42 | -15.58 | 46 | 30.26 | 28.1 | 4.46 | 32.4 | - | - | P | H |
| | | 944.71 | 34.45 | -11.55 | 46 | 29.74 | 30.98 | 4.99 | 31.26 | - | - | P | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 173.56 | 20.32 | -23.18 | 43.5 | 35.06 | 15.54 | 2.13 | 32.41 | - | - | P | V |
| | | 260.86 | 19.79 | -26.21 | 46 | 29.37 | 20.2 | 2.63 | 32.41 | - | - | P | V |
| | | 401.51 | 21.92 | -24.08 | 46 | 29.01 | 22.16 | 3.25 | 32.5 | - | - | P | V |
| | | 675.05 | 27.45 | -18.55 | 46 | 29.32 | 26.5 | 4.19 | 32.56 | - | - | P | V |
| | | 753.62 | 31.88 | -14.12 | 46 | 31.64 | 28.17 | 4.47 | 32.4 | - | - | P | V |
| | | 954.41 | 33.74 | -12.26 | 46 | 28.5 | 31.38 | 5.04 | 31.18 | - | - | P | 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 and emission level has at least 6dB margin against limit or noise floor only.

**Note symbol**

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

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

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

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

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

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

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)

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

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

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)

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

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

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

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

# Appendix C. Radiated Spurious Emission Plots

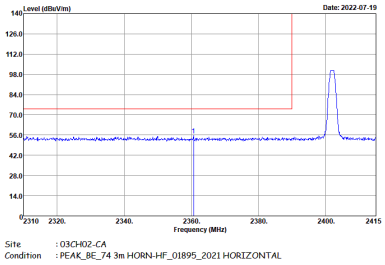
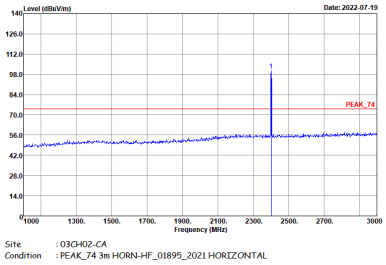
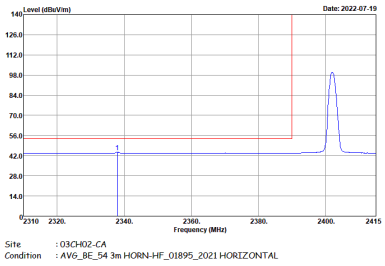
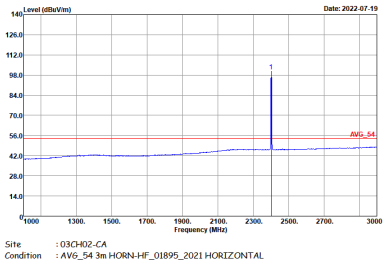
| | | | |
|---|---|---|---|
| **Test Engineer :** | Fu Chen | **Temperature :** | 20~24°C |
| | | **Relative Humidity :** | 42~49% |

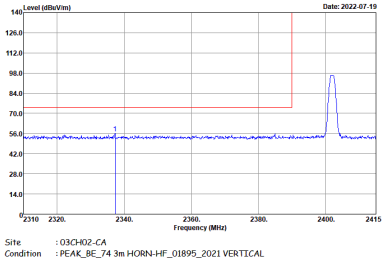
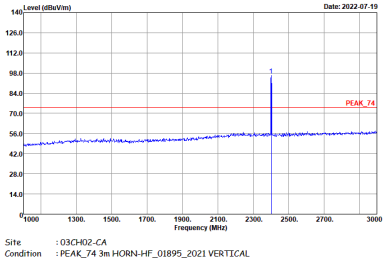
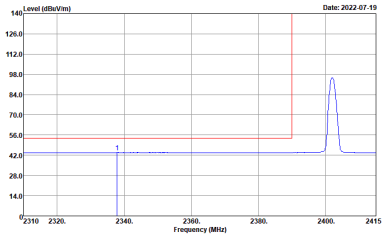
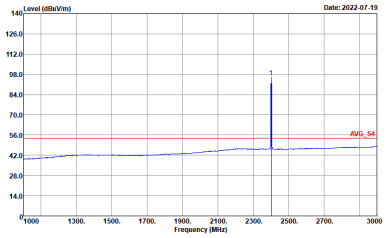
## Note symbol

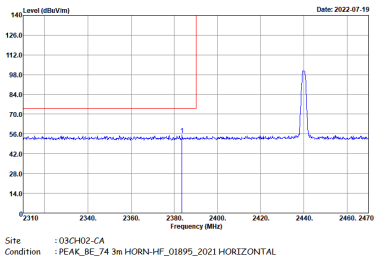
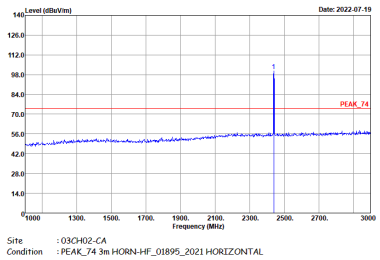
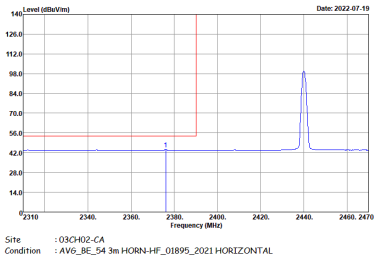
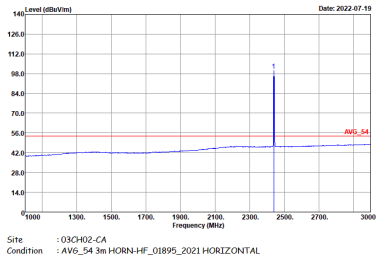
| | |
|---|---|
| -L | **Low channel location** |
| -R | **High channel location** |

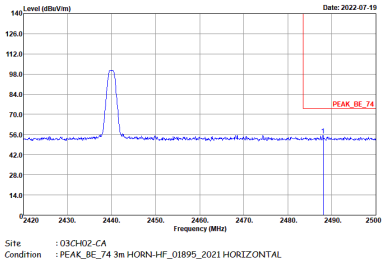
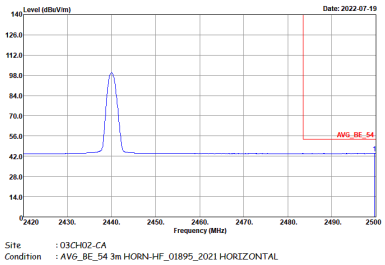
## 2.4GHz 2400~2483.5MHz

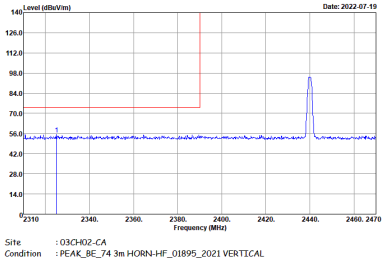
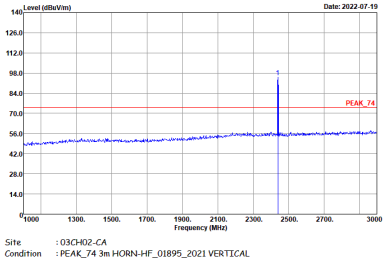
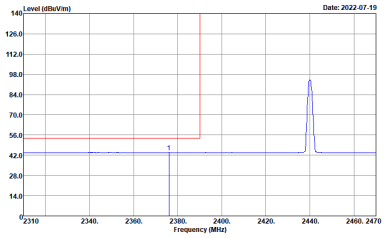
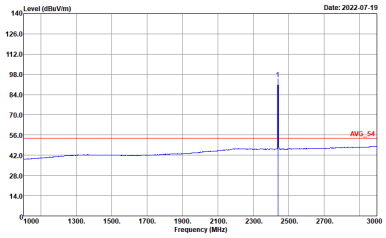
## BLE (Band Edge @ 3m)

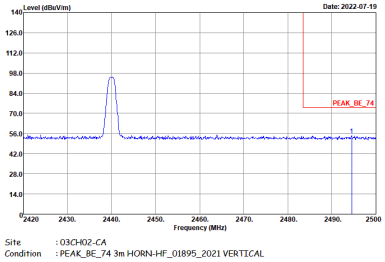
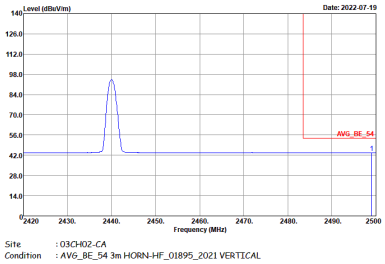
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

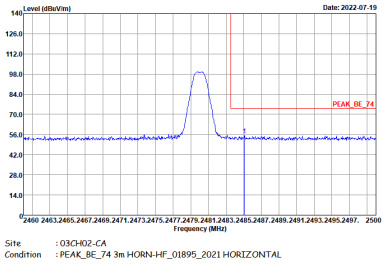
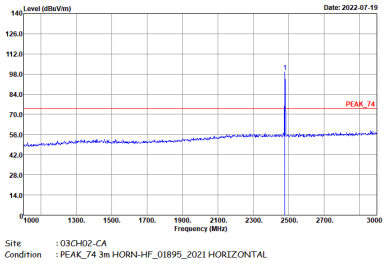
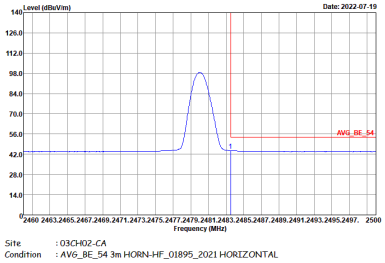
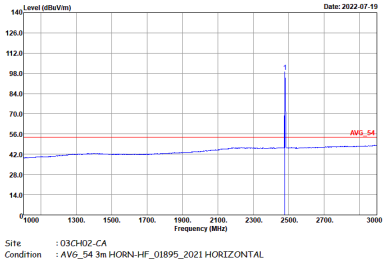
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Vertical | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : PEAK_74 3m HORN-HF_01895_2021 VERTICAL |
| Avg |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : AVG_54 3m HORN-HF_01895_2021 VERTICAL |

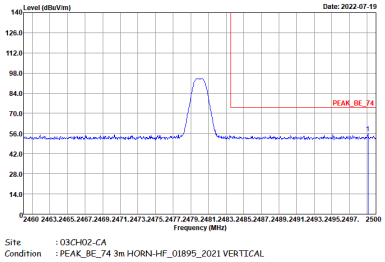
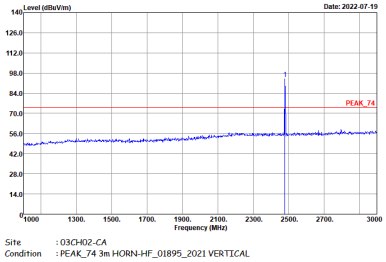
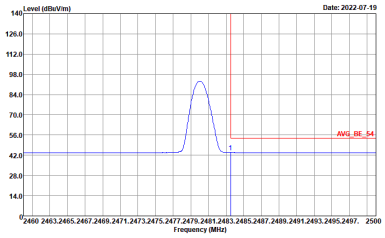
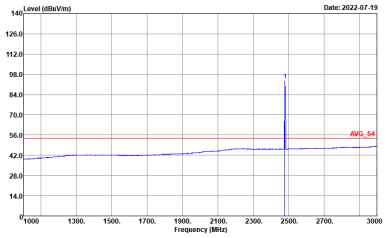
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - L | |
| | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 HORIZONTAL |  <br>Site : 03CH02-CA<br>Condition : PEAK_74 3m HORN-HF_01895_2021 HORIZONTAL |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 HORIZONTAL |  <br>Site : 03CH02-CA<br>Condition : AVG_54 3m HORN-HF_01895_2021 HORIZONTAL |

| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - R | |
| | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 HORIZONTAL | Left blank |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 HORIZONTAL | Left blank |

| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - L | |
| | Vertical | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : PEAK_74 3m HORN-HF_01895_2021 VERTICAL |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : AVG_54 3m HORN-HF_01895_2021 VERTICAL |

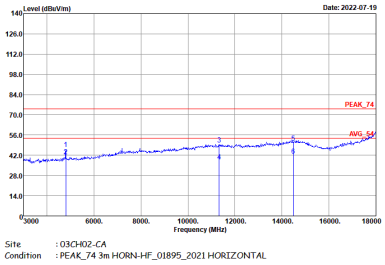
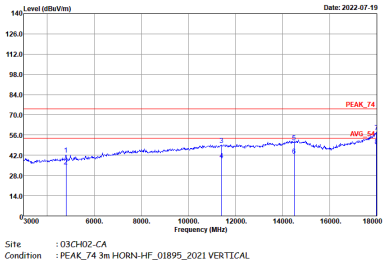
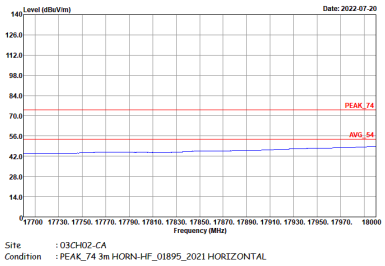
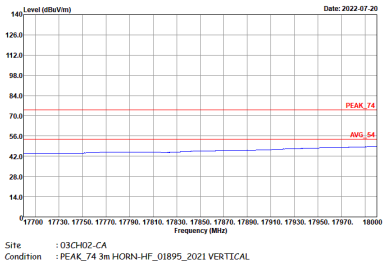
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH19 2440MHz - R | |
| | Vertical | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 VERTICAL | Left blank |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 VERTICAL | Left blank |

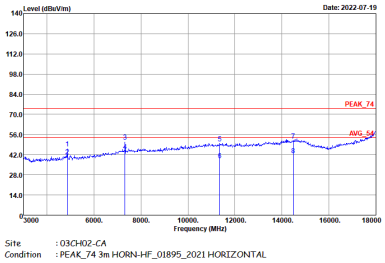
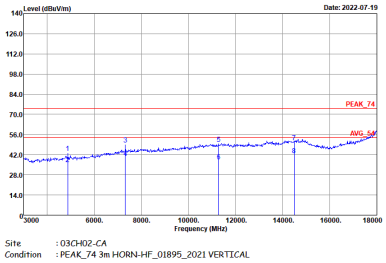
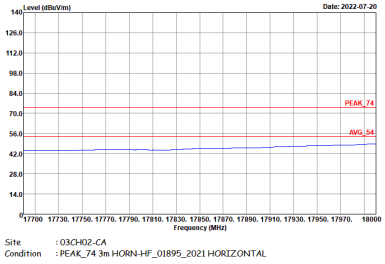
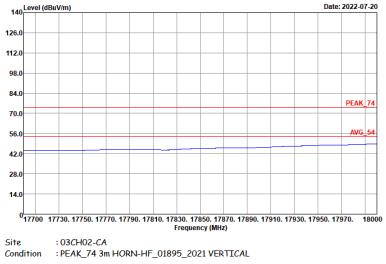
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH39 2480MHz | |
| | Horizontal | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 HORIZONTAL |  <br>Site : 03CH02-CA<br>Condition : PEAK_74 3m HORN-HF_01895_2021 HORIZONTAL |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 HORIZONTAL |  <br>Site : 03CH02-CA<br>Condition : AVG_54 3m HORN-HF_01895_2021 HORIZONTAL |

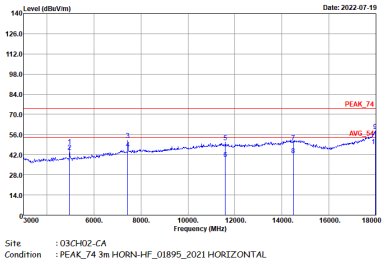
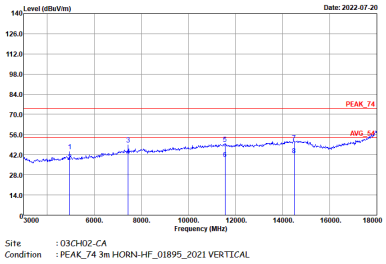
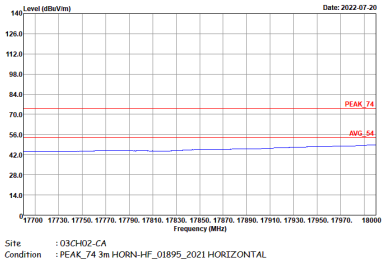
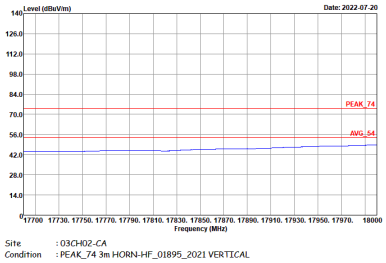
| BLE | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| | BLE CH39 2480MHz | |
| | Vertical | Fundamental |
| Peak |  <br>Site : 03CH02-CA<br>Condition : PEAK_BE_74 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : PEAK_74 3m HORN-HF_01895_2021 VERTICAL |
| Avg. |  <br>Site : 03CH02-CA<br>Condition : AVG_BE_54 3m HORN-HF_01895_2021 VERTICAL |  <br>Site : 03CH02-CA<br>Condition : AVG_54 3m HORN-HF_01895_2021 VERTICAL |

## 2.4GHz 2400~2483.5MHz

## BLE (Harmonic @ 3m)

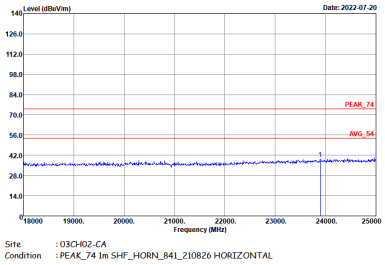
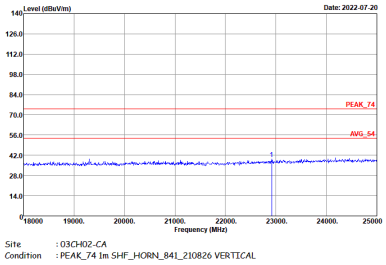
| BLE | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| | BLE CH00 2402MHz | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |
| Avg. |  |  |

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

| BLE | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| | BLE CH39 2480MHz | |
| | Horizontal | Vertical |
| Peak<br>Avg. |  |  |
| Avg. |  |  |

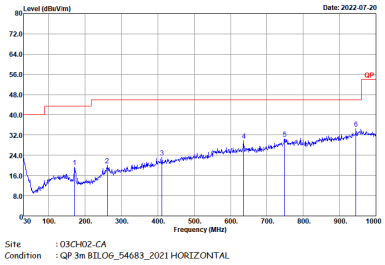
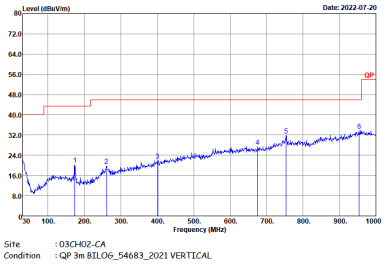
## Emission above 18GHz

## 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 D. Duty Cycle Plots

| Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting |
|---|---|---|---|---|
| Bluetooth - LE for 1Mbps | 100.00 | - | - | 10Hz |

**Bluetooth –LE for 1Mbps**