# FCC PART 15 SUBPART C TEST REPORT

## FCC PART 15.247

| | |
|---|---|
| **Report Reference No.....** | **: BSL24070197P01-R01** |
| **FCC ID.....** | **: 2BH6Z-F30** |
| Compiled by ( position+printed name+signature).. | : Engineer/ Cindy Zheng Cindy zheng |
| Supervised by ( position+printed name+signature).. | : Manager/Haley Wen Haley wen |
| Approved by ( position+printed name+signature).. | : RF Manager/ Vivian Jiang Vivian Jiang |
| Date of issue..... | : August 19, 2024 |
| **Testing Laboratory Name.....** | **: BSL Testing Co., Ltd.** |
| Address..... | : 1/F, Building B, Xinshidai GR Park,Shiyan Street, Bao'an District, Shenzhen,Guangdong, 518052, People's Republic of China |
| **Applicant's name.....** | **: HOLOFAN CO LLC** |
| Address..... | : 12755 BROOKHURST ST STE 206 GARDEN GROVE California States 92840 |
| **Test specification.....** | **:** |
| Standard..... | : **FCC Part 15.247** |

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| | |
|---|---|
| **Equipment description.....** | **: Hologram Fan** |
| Trade Mark..... | : Holofan |
| Manufacturer..... | : Shenzhen Eno Optoelectronics Technology Co., LTD. |
| Model/Type reference..... | : F30 |
| Listed Models ..... | : F65, F80, F100, S6, S9, S10, S15, S20, P65, HDMI65, HDMI70 |
| Modulation ..... | : GFSK |
| Frequency..... | From 2402MHz to 2480MHz |
| Ratings..... | : Input : AC100~ 240V/50~ 60Hz<br>Output: DC24V, 96W |
| Result..... | : **PASS** |

# TEST REPORT

| | | |
|---|---|---|
| **Equipment under Test** | : | **Hologram Fan** |
| Model /Type | : | F30 |
| Listed Models | : | F65, F80, F100, S6, S9, S10, S15, S20, P65, HDMI65, HDMI70 |
| Model Declaration | : | All the models are electrical identical including the same software parameter and hardware design, same mechanical structure and design, the only difference is the model named different. |
| **Applicant** | : | **HOLOFAN CO LLC** |
| Address | : | 12755 BROOKHURST ST STE 206 GARDEN GROVE California United States 92840 |
| **Manufacturer** | : | **Shenzhen Eno Optoelectronics Technology Co., LTD.** |
| Address | : | 201, Jinggongfang, No.4 Tenglian Road, Xixiang Sub-district, Baoan District, Shenzhen |

| | |
|---|---|
| **Test Result**: | **PASS** |

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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# 1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
KDB558074 D01 V05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

# 2 SUMMARY

## 2.1 General Remarks

| | | |
|---|---|---|
| Date of receipt of test sample | : | August 6, 2024 |
| | | |
| Testing commenced on | : | August 6, 2024 |
| | | |
| Testing concluded on | : | August 19, 2024 |

## 2.2 Product Description

| | |
|---|---|
| Product Description: | Hologram Fan |
| Model/Type reference: | F30 |
| Power supply: | Input : AC100~ 240V/50~ 60Hz<br>Output: DC24V, 96W |
| Testing sample ID： | BSL24070197P01-R01-1# (Engineer sample),<br>BSL24070197P01-R01-2# (Normal sample) |
| **Bluetooth BLE** | |
| Supported type: | Bluetooth low Energy |
| Modulation: | GFSK |
| Operation frequency: | 2402MHz to 2480MHz |
| Channel number: | 40 |
| Channel separation: | 2 MHz |
| Antenna type: | PCB antenna |
| Antenna gain: | -0.58 dBi |

## 2.3 Equipment Under Test

### Power supply system utilised

| | | | | | |
|---|---|---|---|---|---|
| Power supply voltage | : | ○ | 230V / 50 Hz | ● | 120V / 60Hz |
| | | ○ | 12 V DC | ○ | 24 V DC |
| | | ○ | Other (specified in blank below) | | |

## 2.4 Short description of the Equipment under Test (EUT)

This is a Hologram Fan.
For more details, refer to the user’s manual of the EUT.

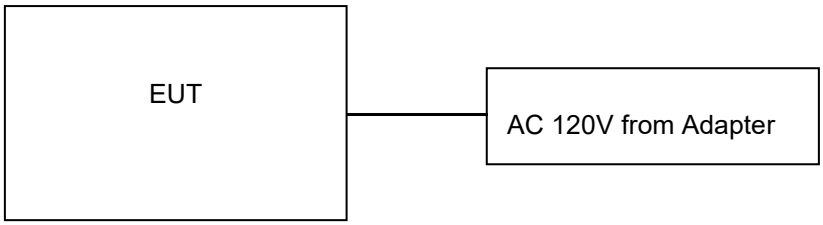
## 2.5 EUT operation mode

The Applicant provides communication tools software(Engineer mode) to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 40 channels provided to the EUT and Channel 00/19/39 were selected to test.

**Operation Frequency：**

| Channel | Frequency (MHz) |
|---|---|
| **00** | **2402** |
| 01 | 2404 |
| 02 | 2406 |
| ⋮ | ⋮ |
| **19** | **2440** |
| ⋮ | ⋮ |
| 37 | 2476 |
| 38 | 2478 |
| **39** | **2480** |

## 2.6 Block Diagram of Test Setup




## 2.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

## 2.8 Modifications

No modifications were implemented to meet testing criteria.

# 3 TEST ENVIRONMENT

## 3.1 Address of the test laboratory

**BSL Testing Co., Ltd.**
1/F, Building B, Xinshidai GR Park,Shiyan Street, Bao'an District, Shenzhen,Guangdong, 518052, People's Republic of China

## 3.2 Test Facility

**FCC-Registration No.: 562200 Designation Number: CN1338**
BSL Testing Co.,Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

**Industry Canada Registration Number. Is: 11093A CAB identifier: CN0019**
The Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing.

**A2LA-Lab Cert. No.: 4707.01**
BSL Testing Co.,Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

## 3.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:
Radiated Emission:

| | |
|---|---|
| Temperature: | 23 ° C |
| | |
| Humidity: | 44 % |
| | |
| Atmospheric pressure: | 950-1050mbar |

AC Main Conducted testing：

| | |
|---|---|
| Temperature: | 24 ° C |
| | |
| Humidity: | 47 % |
| | |
| Atmospheric pressure: | 950-1050mbar |

Conducted testing：

| | |
|---|---|
| Temperature: | 24 ° C |
| | |
| Humidity: | 46 % |
| | |
| Atmospheric pressure: | 950-1050mbar |

## 3.4 Summary of measurement results

| Test Specification clause | Test case | Test Mode | Test Channel | Recorded In Report | | Test result |
|---|---|---|---|---|---|---|
| §15.247(e) | Power spectral density | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | complies |
| §15.247(a)(2) | Spectrum bandwidth – 6 dB bandwidth | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | complies |
| §15.247(b)(3) | Maximum output Peak power | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | complies |
| §15.247(d) | Band edge compliance conducted | BLE 1Mpbs | ☒ Lowest<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Highest | complies |
| §15.205 | Band edge compliance radiated | BLE 1Mpbs | ☒ Lowest<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Highest | complies |
| §15.247(d) | TX spurious emissions conducted | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | complies |
| §15.247(d) | TX spurious emissions radiated | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | BLE 1Mpbs | ☒ Lowest<br>☒ Middle<br>☒ Highest | complies |
| §15.209(a) | TX spurious Emissions radiated Below 1GHz | BLE 1Mpbs | -/- | BLE 1Mpbs | -/- | complies |
| §15.107(a)<br>§15.207 | Conducted Emissions < 30 MHz | BLE 1Mpbs | -/- | BLE 1Mpbs | -/- | complies |

Remark:
1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report

## 3.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the BSL Testing Co., Ltd.quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for BSL Testing Co., Ltd.:

| Test | Range | Measurement Uncertainty | Notes |
|---|---|---|---|
| Radiated Emission | 9KHz~30MHz | 3.82 dB | (1) |
| Radiated Emission | 30~1000MHz | 4.06 dB | (1) |
| Radiated Emission | 1~18GHz | 5.14 dB | (1) |
| Radiated Emission | 18-40GHz | 5.38 dB | (1) |
| Conducted Disturbance | 0.15~30MHz | 2.14 dB | (1) |
| Transmitter power conducted | 1~40GHz | 0.57 dB | (1) |
| Conducted spurious emission | 1~40GHz | 1.60 dB | (1) |
| OBW | 1~40GHz | 25 Hz | (1) |
| PSD | 1~40GHz | 0.01 dBm/3KHz | (1) |

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

## 3.6 Equipments Used during the Test

| Conducted Emission | | | | | |
|---|---|---|---|---|---|
| **Test Equipment** | **Manufacturer** | **Model** | **Serial No.** | **Date of Cal.** | **Due Date** |
| Shielding Room | ZhongYu Electron | 7.3(L)x3.1(W)x2.9(H) | BSL252 | 2023-10-28 | 2024-10-27 |
| EMI Test Receiver | R&S | ESCI 7 | BSL552 | 2023-10-28 | 2024-10-27 |
| Coaxial Switch | ANRITSU CORP | MP59B | BSL225 | 2023-10-28 | 2024-10-27 |
| ENV216 2-L-V-NETZNACHB.DE | ROHDE&SCHWARZ | ENV216 | BSL226 | 2023-10-28 | 2024-10-27 |
| Coaxial Cable | BSL | N/A | BSL227 | N/A | N/A |
| EMI Test Software | AUDIX | E3 | N/A | N/A | N/A |
| Thermo meter | KTJ | TA328 | BSL233 | 2023-10-28 | 2024-10-27 |
| Absorbing clamp | Elektronik-Feinmechanik | MDS21 | BSL229 | 2023-10-28 | 2024-10-27 |
| LISN | R&S | ENV216 | 308 | 2023-10-28 | 2024-10-27 |
| LISN | R&S | ENV216 | 314 | 2023-10-28 | 2024-10-27 |

| Radiation Test equipment | | | | | |
|---|---|---|---|---|---|
| **Test Equipment** | **Manufacturer** | **Model** | **Serial No.** | **Date of Cal.** | **Due Date** |
| 3m Semi- Anechoic Chamber | ZhongYu Electron | 9.2(L)*6.2(W)* 6.4(H) | BSL250 | 2023-10-28 | 2024-10-27 |
| Control Room | ZhongYu Electron | 6.2(L)*2.5(W)* 2.4(H) | BSL251 | N/A | N/A |
| EMI Test Receiver | Rohde & Schwarz | ESU26 | BSL203 | 2023-10-28 | 2024-10-27 |
| BiConiLog Antenna | SCHWARZBECK MESS-ELEKTRONIK | VULB9163 | BSL214 | 2023-10-28 | 2024-10-27 |
| Double -ridged waveguide horn | SCHWARZBECK MESS-ELEKTRONIK | BBHA 9120 D | BSL208 | 2023-10-28 | 2024-10-27 |
| Horn Antenna | ETS-LINDGREN | 3160 | BSL217 | 2023-10-28 | 2024-10-27 |
| EMI Test Software | AUDIX | E3 | N/A | N/A | N/A |
| Coaxial Cable | BSL | N/A | BSL213 | 2023-10-28 | 2024-10-27 |
| Coaxial Cable | BSL | N/A | BSL211 | 2023-10-28 | 2024-10-27 |
| Coaxial cable | BSL | N/A | BSL210 | 2023-10-28 | 2024-10-27 |
| Coaxial Cable | BSL | N/A | BSL212 | 2023-10-28 | 2024-10-27 |
| Amplifier(100kHz-3GHz) | HP | 8347A | BSL204 | 2023-10-28 | 2024-10-27 |
| Amplifier(2GHz-20GHz) | HP | 84722A | BSL206 | 2023-10-28 | 2024-10-27 |
| Amplifier (18-26GHz) | Rohde & Schwarz | AFS33-18002 650-30-8P-44 | BSL218 | 2023-10-28 | 2024-10-27 |
| Band filter | Amindeon | 82346 | BSL219 | 2023-10-28 | 2024-10-27 |
| Power Meter | Anritsu | ML2495A | BSL540 | 2023-10-28 | 2024-10-27 |
| Power Sensor | Anritsu | MA2411B | BSL541 | 2023-10-28 | 2024-10-27 |
| Wideband Radio Communication Tester | Rohde & Schwarz | CMW500 | BSL575 | 2023-10-28 | 2024-10-27 |
| Splitter | Agilent | 11636B | BSL237 | 2023-10-28 | 2024-10-27 |
| Loop Antenna | ZHINAN | ZN30900A | BSL534 | 2023-10-28 | 2024-10-27 |

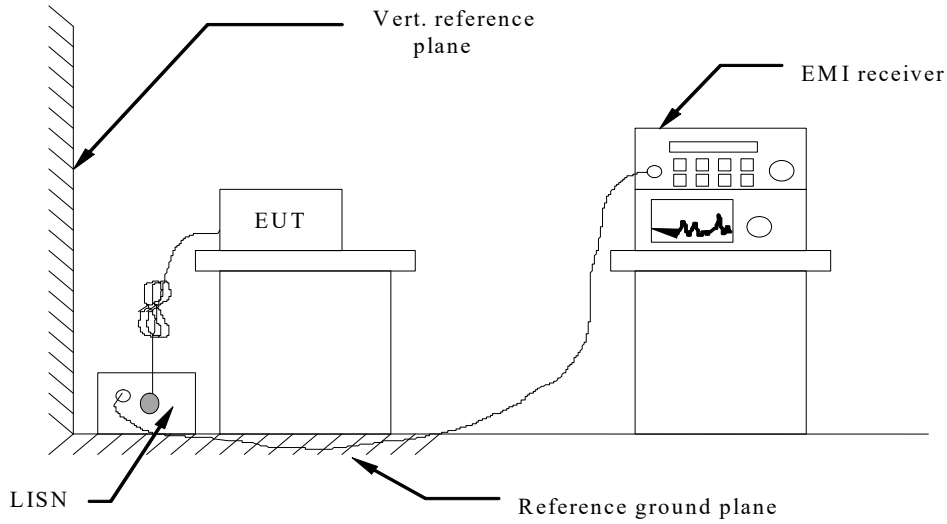
| | | | | | |
|---|---|---|---|---|---|
| Breitband hornantenne | SCHWARZBECK | BBHA 9170 | BSL579 | 2023-10-28 | 2024-10-27 |
| Amplifier | TDK | PA-02-02 | BSL574 | 2023-10-28 | 2024-10-27 |
| Amplifier | TDK | PA-02-03 | BSL576 | 2023-10-28 | 2024-10-27 |
| PSA Series Spectrum Analyzer | Rohde & Schwarz | FSP | BSL578 | 2023-10-28 | 2024-10-27 |

| **RF Conducted Test:** | | | | | |
|---|---|---|---|---|---|
| **Test Equipment** | **Manufacturer** | **Model** | **Serial No.** | **Date of Cal.** | **Due Date** |
| MXA Signal Analyzer | Agilent | N9020A | BSL566 | 2023-10-28 | 2024-10-27 |
| EMI Test Receiver | R&S | ESCI 7 | BSL552 | 2023-10-28 | 2024-10-27 |
| Spectrum Analyzer | Agilent | E4440A | BSL533 | 2023-10-28 | 2024-10-27 |
| MXG vector Signal Generator | Agilent | N5182A | BSL567 | 2023-10-28 | 2024-10-27 |
| ESG Analog Signal Generator | Agilent | E4428C | BSL568 | 2023-10-28 | 2024-10-27 |
| USB RF Power Sensor | DARE | RPR3006W | BSL569 | 2023-10-28 | 2024-10-27 |
| RF Switch Box | Shongyi | RFSW3003328 | BSL571 | 2023-10-28 | 2024-10-27 |
| Programmable Constant Temp & Humi Test Chamber | WEWON | WHTH-150L-40-880 | BSL572 | 2023-10-28 | 2024-10-27 |

# 4 TEST CONDITIONS AND RESULTS

## 4.1 AC Power Conducted Emission

**TEST CONFIGURATION**




**TEST PROCEDURE**

1 The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
2 Support equipment, if needed, was placed as per ANSI C63.10-2013
3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
4 The EUT received power from adapter, the adapter received AC120V/60Hz and AC 240V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5 All support equipments received AC power from a second LISN, if any.
6 The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT.The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8 During the above scans, the emissions were maximized by cable manipulation.

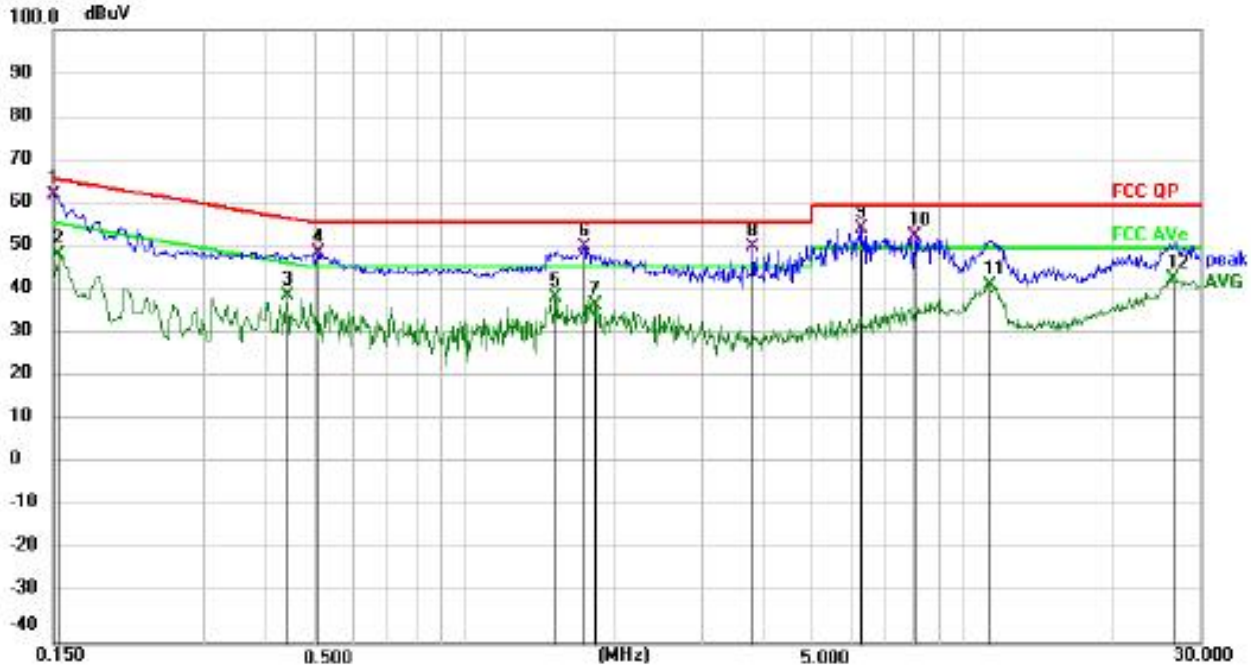
**AC Power Conducted Emission Limit**

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

| Frequency range (MHz) | Limit (dBuV) | |
|---|---|---|
| | 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. | | |

**TEST RESULTS**

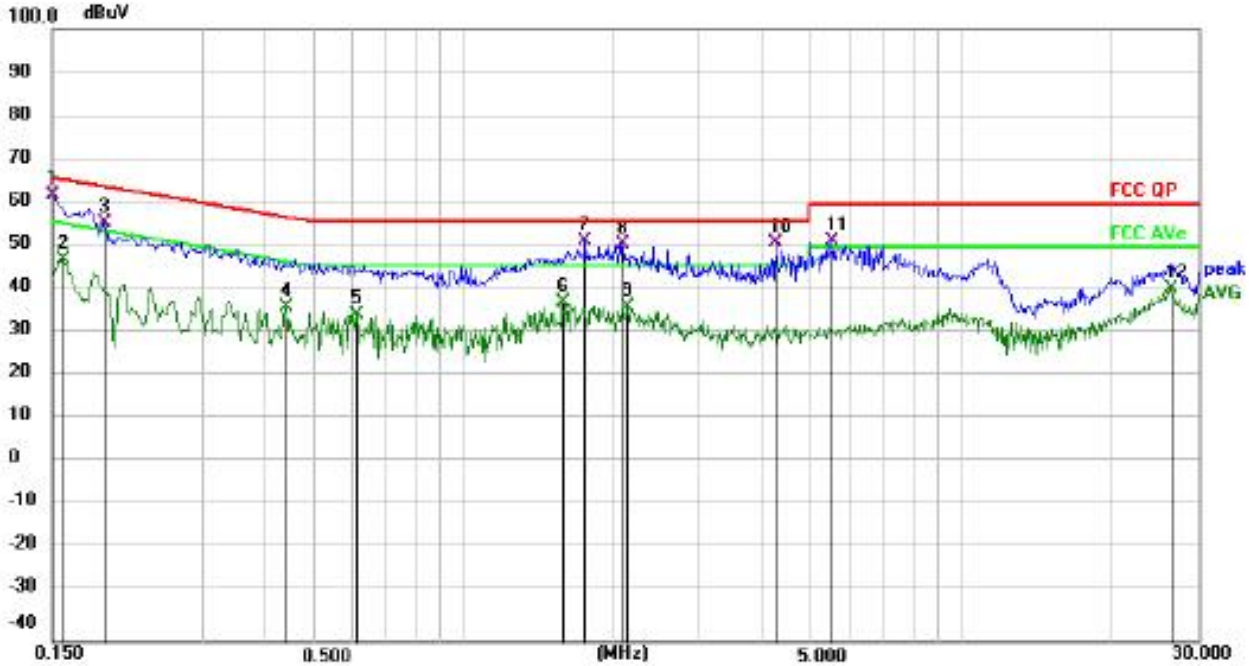
| Power supply: | AC 120V/60Hz | Polarization | L |
|---|---|---|---|




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F |
|---|---|---|---|---|---|---|---|---|
| 1 * | 0.1507 | 45.77 | 16.59 | 62.36 | 65.96 | -3.60 | QP | P |
| 2 | 0.1539 | 32.07 | 16.61 | 48.68 | 55.79 | -7.11 | AVG | P |
| 3 | 0.4420 | 22.71 | 16.69 | 39.40 | 47.02 | -7.62 | AVG | P |
| 4 | 0.5100 | 32.23 | 16.68 | 48.91 | 56.00 | -7.09 | QP | P |
| 5 | 1.5222 | 22.53 | 16.55 | 39.08 | 46.00 | -6.92 | AVG | P |
| 6 | 1.7382 | 33.80 | 16.52 | 50.32 | 56.00 | -5.68 | QP | P |
| 7 | 1.8327 | 20.61 | 16.51 | 37.12 | 46.00 | -8.88 | AVG | P |
| 8 | 3.8083 | 34.38 | 16.24 | 50.62 | 56.00 | -5.38 | QP | P |
| 9 | 6.3105 | 38.73 | 15.85 | 54.58 | 60.00 | -5.42 | QP | P |
| 10 | 8.0518 | 37.32 | 15.52 | 52.84 | 60.00 | -7.16 | QP | P |
| 11 | 11.3682 | 26.76 | 14.96 | 41.72 | 50.00 | -8.28 | AVG | P |
| 12 | 26.3037 | 29.27 | 14.01 | 43.28 | 50.00 | -6.72 | AVG | P |

Note:1).Level (dBμV)= Reading (dBμV)+ Factor (dB)
2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)
3). Margin(dB) = Limit (dBμV) - Level (dBμV)

| Power supply: | AC 120V/60Hz | Polarization | N |
|---|---|---|---|



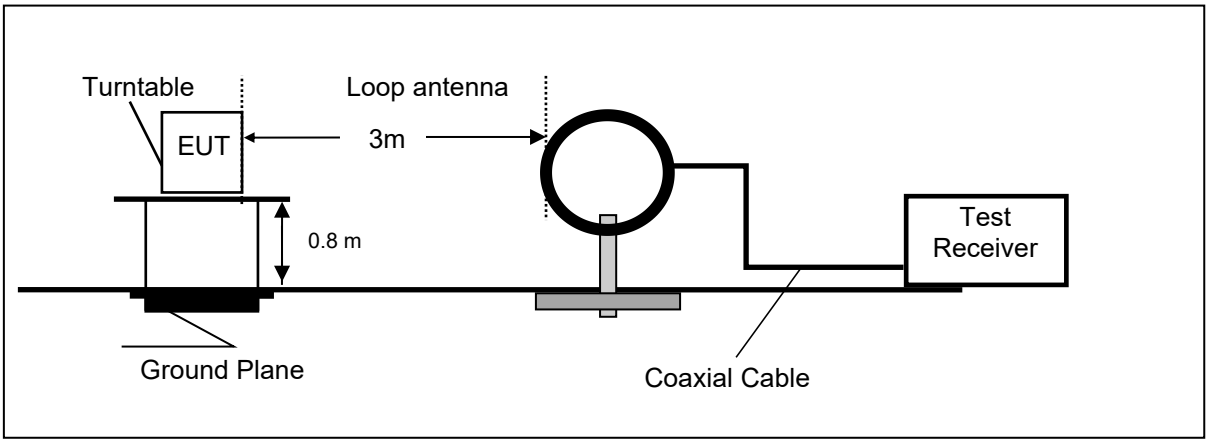

| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F |
|---|---|---|---|---|---|---|---|---|
| 1 * | 0.1500 | 44.34 | 17.53 | 61.87 | 66.00 | -4.13 | QP | P |
| 2 | 0.1580 | 29.70 | 17.53 | 47.23 | 55.57 | -8.34 | AVG | P |
| 3 | 0.1905 | 38.22 | 17.53 | 55.75 | 64.01 | -8.26 | QP | P |
| 4 | 0.4420 | 18.91 | 17.52 | 36.43 | 47.02 | -10.59 | AVG | P |
| 5 | 0.6134 | 17.36 | 17.51 | 34.87 | 46.00 | -11.13 | AVG | P |
| 6 | 1.5852 | 20.03 | 17.49 | 37.52 | 46.00 | -8.48 | AVG | P |
| 7 | 1.7655 | 33.95 | 17.48 | 51.43 | 56.00 | -4.57 | QP | P |
| 8 | 2.1074 | 33.30 | 17.47 | 50.77 | 56.00 | -5.23 | QP | P |
| 9 | 2.1480 | 19.15 | 17.47 | 36.62 | 46.00 | -9.38 | AVG | P |
| 10 | 4.2538 | 33.78 | 17.42 | 51.20 | 56.00 | -4.80 | QP | P |
| 11 | 5.5590 | 34.12 | 17.30 | 51.42 | 60.00 | -8.58 | QP | P |
| 12 | 26.3217 | 26.39 | 14.29 | 40.68 | 50.00 | -9.32 | AVG | P |

Note:1).Level (dBμV)= Reading (dBμV)+ Factor (dB)
2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)
3). Margin(dB) = Limit (dBμV) - Level (dBμV)

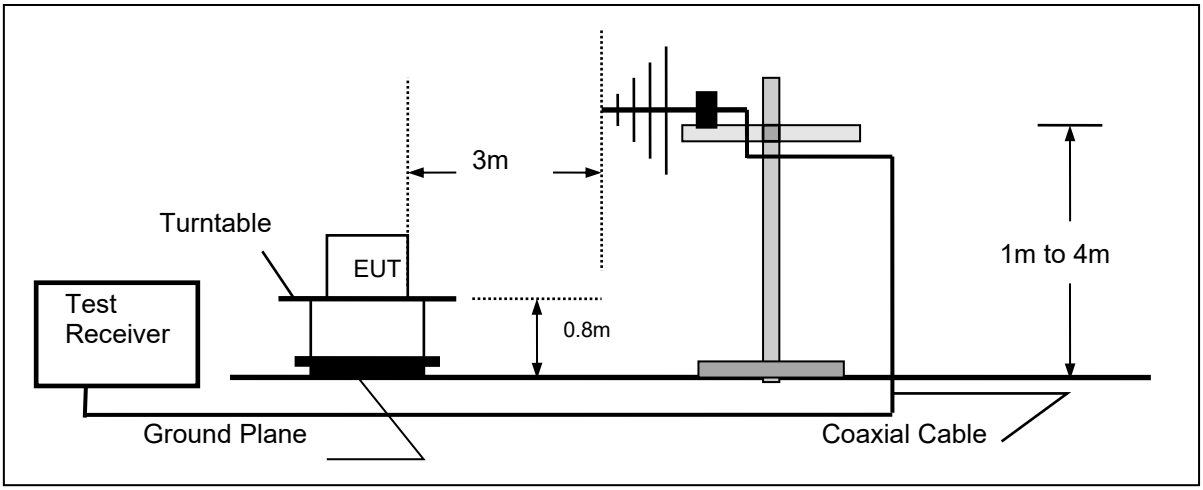
## 4.2 Radiated Emissions and Band Edge

**TEST CONFIGURATION**

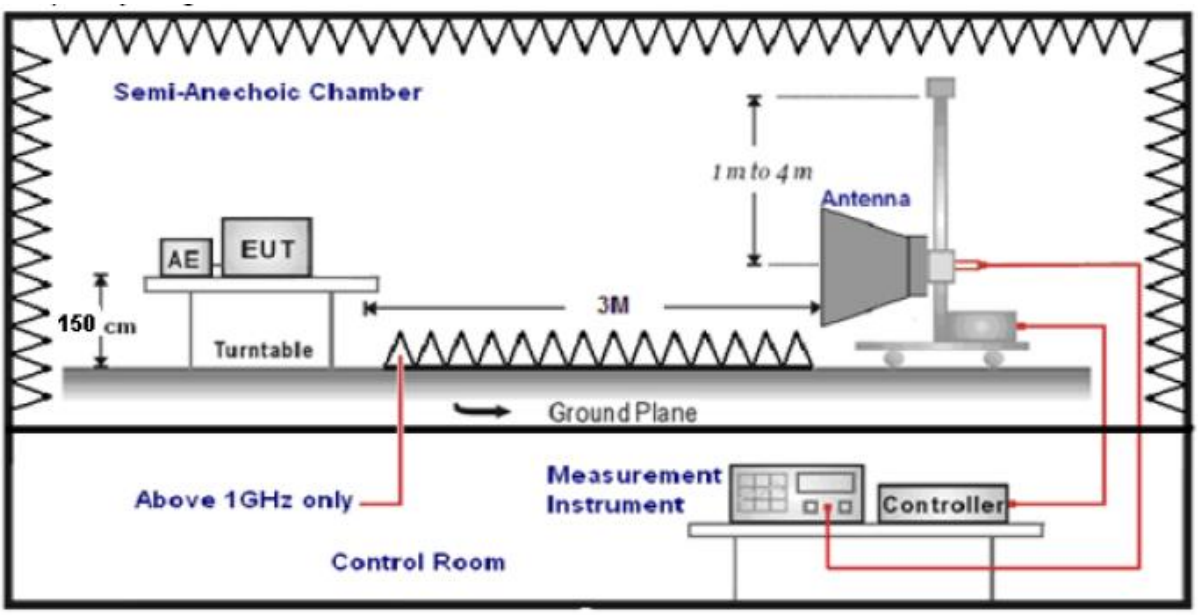
Frequency range 9 KHz – 30MHz




Frequency range 30MHz – 1000MHz




Frequency range above 1GHz-25GHz



## TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

| Test Frequency range | Test Antenna Type | Test Distance |
|---|---|---|
| 9KHz-30MHz | Active Loop Antenna | 3 |
| 30MHz-1GHz | Ultra-Broadband Antenna | 3 |
| 1GHz-18GHz | Double Ridged Horn Antenna | 3 |
| 18GHz-25GHz | Horn Anternna | 1 |

7. Setting test receiver/spectrum as following table states:

| Test Frequency range | Test Receiver/Spectrum Setting | Detector |
|---|---|---|
| 9KHz-150KHz | RBW=200Hz/VBW=3KHz,Sweep time=Auto | QP |
| 150KHz-30MHz | RBW=9KHz/VBW=100KHz,Sweep time=Auto | QP |
| 30MHz-1GHz | RBW=120KHz/VBW=1000KHz,Sweep time=Auto | QP |
| 1GHz-40GHz | Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto<br>Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto | Peak |

## Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

**FS = RA + AF + CL - AG**

| | |
|---|---|
| Where FS = Field Strength | CL = Cable Attenuation Factor (Cable Loss) |
| RA = Reading Amplitude | AG = Amplifier Gain |
| AF = Antenna Factor | |

Transd=AF +CL-AG

## RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

| Frequency (MHz) | Distance (Meters) | Radiated (dBμV/m) | Radiated (μV/m) |
|---|---|---|---|
| 0.009-0.49 | 3 | 20log(2400/F(KHz))+40log(300/3) | 2400/F(KHz) |
| 0.49-1.705 | 3 | 20log(24000/F(KHz))+ 40log(30/3) | 24000/F(KHz) |
| 1.705-30 | 3 | 20log(30)+ 40log(30/3) | 30 |
| 30-88 | 3 | 40.0 | 100 |
| 88-216 | 3 | 43.5 | 150 |
| 216-960 | 3 | 46.0 | 200 |
| Above 960 | 3 | 54.0 | 500 |

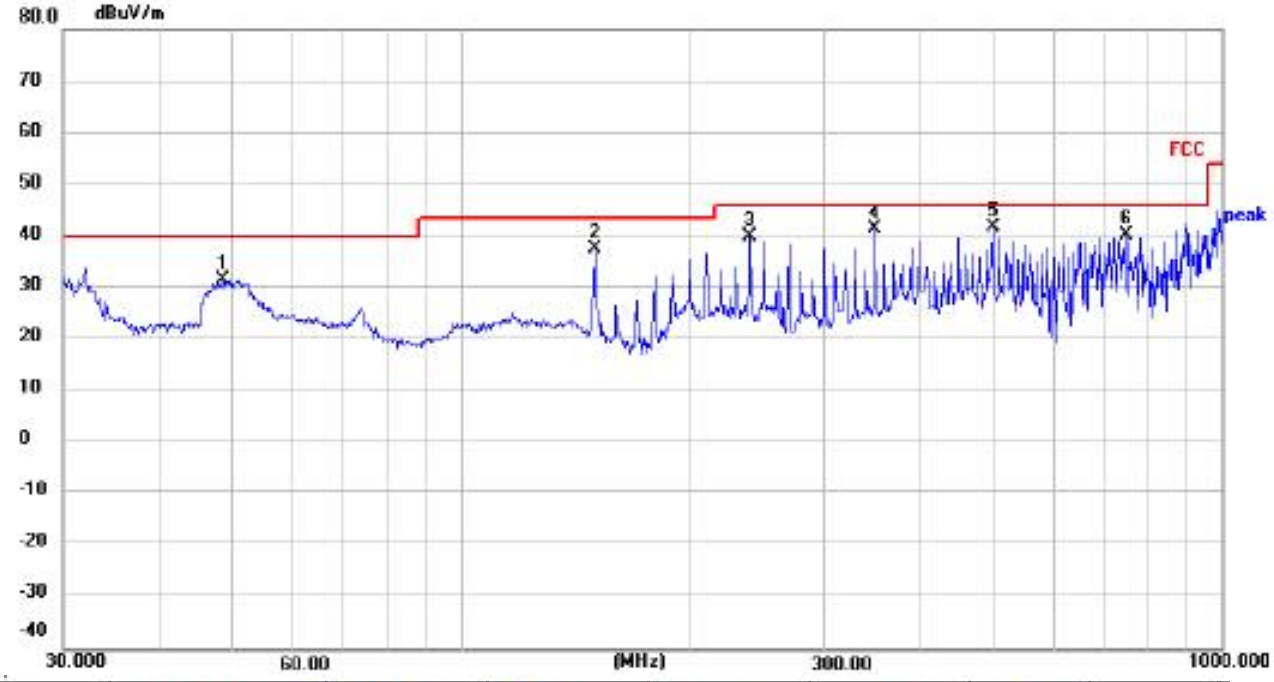
**TEST RESULTS**

Remark:

1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. BLE 1Mpbs were tested at Low, Middle, and High channel and recorded worst mode at BLE 1Mpbs.
3. Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.

**For 30MHz-1GHz**

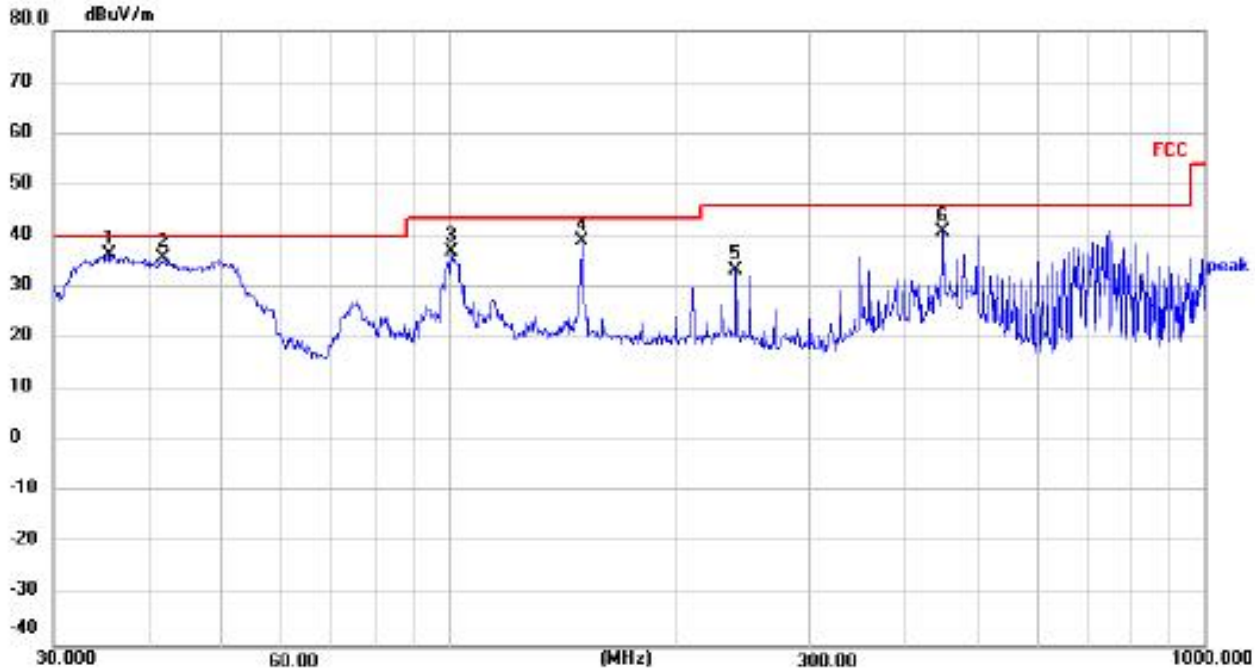
Horizontal




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB/m) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 48.6719 | 48.08 | -16.43 | 31.65 | 40.00 | -8.35 | peak |
| 2 | 150.0107 | 53.38 | -15.92 | 37.46 | 43.50 | -6.04 | peak |
| 3 | 239.9873 | 57.71 | -17.75 | 39.96 | 46.00 | -6.04 | peak |
| 4 | 350.4766 | 55.64 | -14.33 | 41.31 | 46.00 | -4.69 | peak |
| 5 * | 501.1788 | 52.53 | -10.66 | 41.87 | 46.00 | -4.13 | peak |
| 6 | 750.1082 | 45.45 | -5.31 | 40.14 | 46.00 | -5.86 | peak |

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)
2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)
3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

Vertical




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB/m) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 * | 35.4992 | 53.41 | -16.99 | 36.42 | 40.00 | -3.58 | peak |
| 2 | 41.8594 | 52.11 | -16.36 | 35.75 | 40.00 | -4.25 | peak |
| 3 | 100.9338 | 56.89 | -19.80 | 37.09 | 43.50 | -6.41 | peak |
| 4 | 150.0107 | 54.95 | -15.92 | 39.03 | 43.50 | -4.47 | peak |
| 5 | 239.9873 | 51.21 | -17.75 | 33.46 | 46.00 | -12.54 | peak |
| 6 | 451.1349 | 52.57 | -11.63 | 40.94 | 46.00 | -5.06 | peak |

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)
2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)
3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

**For 1GHz to 25GHz**

***GFSK (above 1GHz)***

| Frequency(MHz): | | | 2402 | | Polarity: | | HORIZONTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4804.00 | 56.09 | PK | 74 | 17.91 | 60.45 | 32.40 | 5.11 | 41.87 | -4.36 |
| 4804.00 | 45.90 | AV | 54 | 8.10 | 50.26 | 32.40 | 5.11 | 41.87 | -4.36 |
| 7206.00 | 54.51 | PK | 74 | 19.49 | 55.14 | 36.58 | 6.43 | 43.64 | -0.63 |
| 7206.00 | 44.72 | AV | 54 | 9.28 | 45.35 | 36.58 | 6.43 | 43.64 | -0.63 |

| Frequency(MHz): | | | 2402 | | Polarity: | | VERTICAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4804.00 | 56.49 | PK | 74 | 17.51 | 60.85 | 32.40 | 5.11 | 41.87 | -4.36 |
| 4804.00 | 46.38 | AV | 54 | 7.62 | 50.74 | 32.40 | 5.11 | 41.87 | -4.36 |
| 7206.00 | 54.75 | PK | 74 | 19.25 | 55.38 | 36.58 | 6.43 | 43.64 | -0.63 |
| 7206.00 | 45.33 | AV | 54 | 8.67 | 45.96 | 36.58 | 6.43 | 43.64 | -0.63 |

| Frequency(MHz): | | | 2440 | | Polarity: | | HORIZONTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4880.00 | 56.52 | PK | 74 | 17.48 | 60.47 | 32.56 | 5.34 | 41.85 | -3.95 |
| 4880.00 | 46.94 | AV | 54 | 7.06 | 50.89 | 32.56 | 5.34 | 41.85 | -3.95 |
| 7320.00 | 55.00 | PK | 74 | 19.00 | 55.36 | 36.54 | 6.81 | 43.71 | -0.36 |
| 7320.00 | 45.49 | AV | 54 | 8.51 | 45.85 | 36.54 | 6.81 | 43.71 | -0.36 |

| Frequency(MHz): | | | 2440 | | Polarity: | | VERTICAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4880.00 | 56.29 | PK | 74 | 17.71 | 60.24 | 32.56 | 5.34 | 41.85 | -3.95 |
| 4880.00 | 46.50 | AV | 54 | 7.50 | 50.45 | 32.56 | 5.34 | 41.85 | -3.95 |
| 7320.00 | 55.29 | PK | 74 | 18.71 | 55.65 | 36.54 | 6.81 | 43.71 | -0.36 |
| 7320.00 | 45.22 | AV | 54 | 8.78 | 45.58 | 36.54 | 6.81 | 43.71 | -0.36 |

| Frequency(MHz): | | | 2480 | | Polarity: | | HORIZONTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4960.00 | 56.79 | PK | 74 | 17.21 | 60.25 | 32.73 | 5.64 | 41.83 | -3.46 |
| 4960.00 | 46.98 | AV | 54 | 7.02 | 50.44 | 32.73 | 5.64 | 41.83 | -3.46 |
| 7440.00 | 55.68 | PK | 74 | 18.32 | 55.74 | 36.50 | 7.23 | 43.79 | -0.06 |
| 7440.00 | 45.59 | AV | 54 | 8.41 | 45.65 | 36.50 | 7.23 | 43.79 | -0.06 |

| Frequency(MHz): | | | 2480 | | Polarity: | | VERTICAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 4960.00 | 56.79 | PK | 74 | 17.21 | 60.25 | 32.73 | 5.64 | 41.83 | -3.46 |
| 4960.00 | 47.02 | AV | 54 | 6.98 | 50.48 | 32.73 | 5.64 | 41.83 | -3.46 |
| 7440.00 | 55.68 | PK | 74 | 18.32 | 55.74 | 36.50 | 7.23 | 43.79 | -0.06 |
| 7440.00 | 45.50 | AV | 54 | 8.50 | 45.56 | 36.50 | 7.23 | 43.79 | -0.06 |

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

***Results of Band Edges Test (Radiated)***

***GFSK***

| Test Frequency(MHz): | | | Lowest channel | | Polarity: | | HORIZONTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 2310.00 | 50.13 | PK | 74 | 23.87 | 60.55 | 27.42 | 4.31 | 42.15 | -10.42 |
| 2310.00 | 39.84 | AV | 54 | 14.16 | 50.26 | 27.42 | 4.31 | 42.15 | -10.42 |
| 2390.00 | 47.67 | PK | 74 | 26.33 | 57.96 | 27.55 | 4.35 | 42.19 | -10.29 |
| 2390.00 | 37.97 | AV | 54 | 16.03 | 48.26 | 27.55 | 4.35 | 42.19 | -10.29 |
| 2400.00 | 45.33 | PK | 74 | 28.67 | 55.52 | 27.70 | 4.39 | 42.28 | -10.19 |
| 2400.00 | 35.44 | AV | 54 | 18.56 | 45.63 | 27.70 | 4.39 | 42.28 | -10.19 |

| Test Frequency(MHz): | | | Lowest channel | | Polarity: | | VERTICAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 2310.00 | 46.16 | PK | 74 | 27.84 | 56.58 | 27.42 | 4.31 | 42.15 | -10.42 |
| 2310.00 | 35.93 | AV | 54 | 18.07 | 46.35 | 27.42 | 4.31 | 42.15 | -10.42 |
| 2390.00 | 43.97 | PK | 74 | 30.03 | 54.26 | 27.55 | 4.35 | 42.19 | -10.29 |
| 2390.00 | 34.06 | AV | 54 | 19.94 | 44.35 | 27.55 | 4.35 | 42.19 | -10.29 |
| 2400.00 | 41.93 | PK | 74 | 32.07 | 52.12 | 27.70 | 4.39 | 42.28 | -10.19 |
| 2400.00 | 32.33 | AV | 54 | 21.67 | 42.52 | 27.70 | 4.39 | 42.28 | -10.19 |

| Test Frequency(MHz): | | | Highest channel | | Polarity: | | HORIZONTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 2483.50 | 44.63 | PK | 74 | 29.37 | 55.26 | 27.55 | 4.38 | 42.56 | -10.63 |
| 2483.50 | 34.71 | AV | 54 | 19.29 | 45.34 | 27.55 | 4.38 | 42.56 | -10.63 |
| 2500.00 | 40.51 | PK | 74 | 33.49 | 51.24 | 27.69 | 4.46 | 42.88 | -10.73 |
| 2500.00 | 32.25 | AV | 54 | 21.75 | 42.98 | 27.69 | 4.46 | 42.88 | -10.73 |

| Test Frequency(MHz): | | | Highest channel | | Polarity: | | VERTICAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 2483.50 | 42.62 | PK | 74 | 31.38 | 53.25 | 27.55 | 4.38 | 42.56 | -10.63 |
| 2483.50 | 32.83 | AV | 54 | 21.17 | 43.46 | 27.55 | 4.38 | 42.56 | -10.63 |
| 2500.00 | 38.95 | PK | 74 | 35.05 | 49.68 | 27.69 | 4.46 | 42.88 | -10.73 |
| 2500.00 | 29.32 | AV | 54 | 24.68 | 40.05 | 27.69 | 4.46 | 42.88 | -10.73 |

REMARKS:
1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

## 4.3 Maximum Peak Output Power

**Limit**

The Maximum Peak Output Power Measurement is 30dBm.

**Test Procedure**

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

**Test Configuration**

**Test Results**

| Type | Channel | Output power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|
| GFSK 1Mbps | 00 | 0.828 | 30.00 | Pass |
| | 19 | 1.385 | | |
| | 39 | 1.962 | | |

Note: 1.The test results including the cable lose.S

## 4.4 Power Spectral Density

**Limit**

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

**Test Procedure**

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW ≥ 3 kHz.
3. Set the VBW ≥ 3× RBW.
4. Set the span to 1.5 times the DTS channel bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
11. The resulting peak PSD level must be 8dBm.

**Test Configuration**

**Test Results**

| Type | Channel | Power Spectral Density (dBm/3KHz) | Limit (dBm/3KHz) | Result |
|---|---|---|---|---|
| GFSK 1Mbps | 00 | -23.226 | 8.00 | Pass |
| | 19 | -22.938 | | |
| | 39 | -23.865 | | |

Test plot as follows:

BLE GFSK 1Mpbs

CH00

CH19

CH39

## 4.5 6dB Bandwidth

**Limit**

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz

**Test Procedure**

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW. The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB.

**Test Configuration**

**Test Results**

| Type | Channel | 6dB Bandwidth (MHz) | Limit (KHz) | Result |
|---|---|---|---|---|
| GFSK 1Mbps | 00 | 0.5037 | ≥500 | Pass |
| | 19 | 0.5026 | | |
| | 39 | 0.5130 | | |

Test plot as follows:

*BLE GFSK 1Mpbs*

*CH00*

*CH19*

*CH39*

## 4.6 Out-of-band Emissions

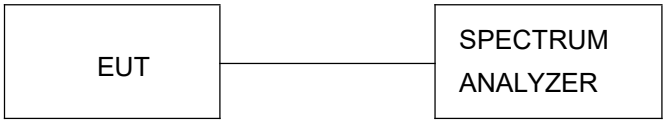
**Limit**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

**Test Procedure**

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

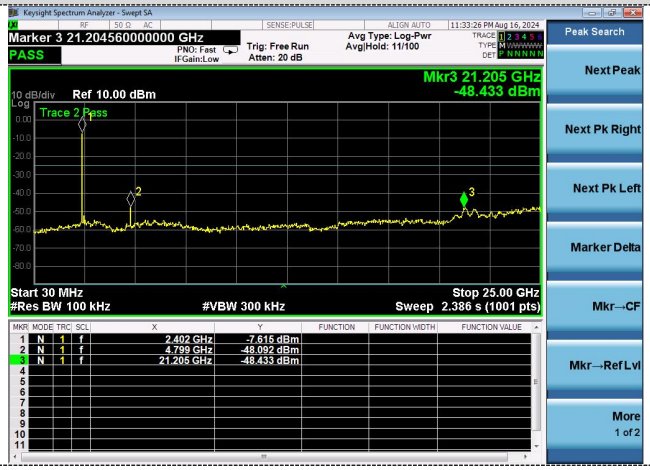
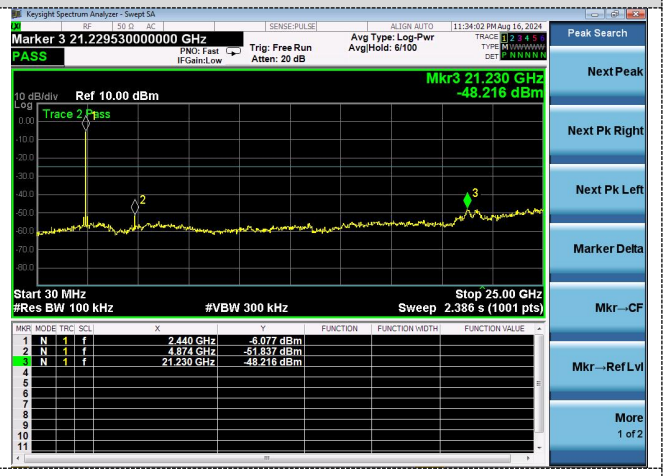
**Test Configuration**

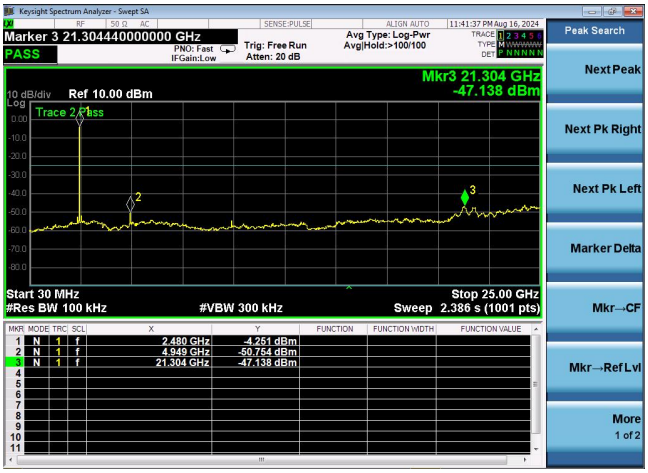



**Test Results**

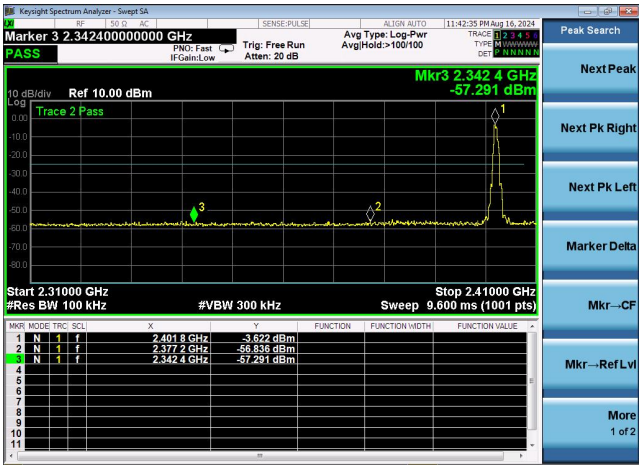
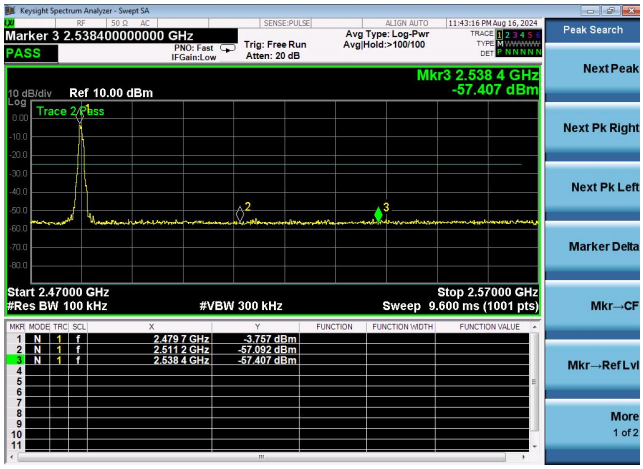
Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

Test plot as follows:

| GFSK 1Mbps (CH00) | GFSK 1Mbps (CH19) |
|---|---|
|  |  |
| 30MHz-25G | 30MHz-25G |

| GFSK 1Mbps (CH39) | |
|---|---|
|  | |
| 30MHz-25G | |

## Band-edge Measurements for RF Conducted Emissions:

| BLE GFSK 1Mpbs | |
|---|---|
|  |  |
| Left bandedge | Right bandedge |

## 4.7 Antenna Requirement

**Standard Applicable**

**For intentional device, according to FCC 47 CFR Section 15.203:**

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited

**FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):**

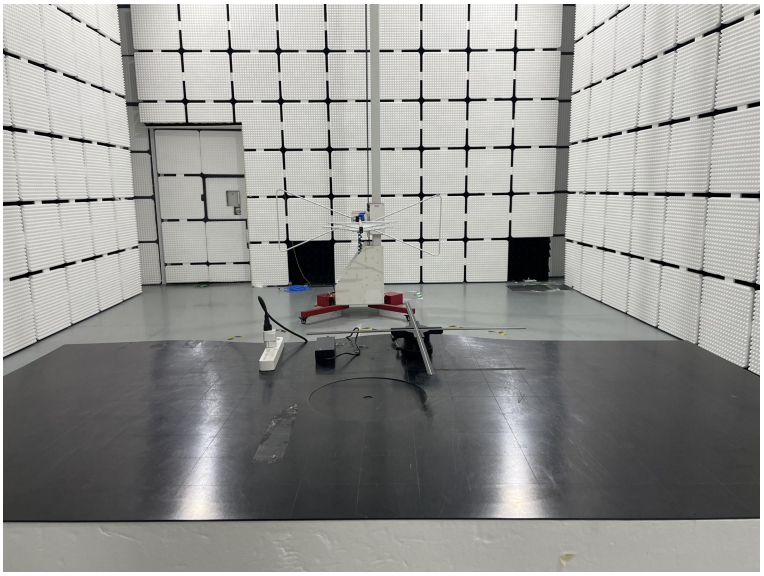
(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

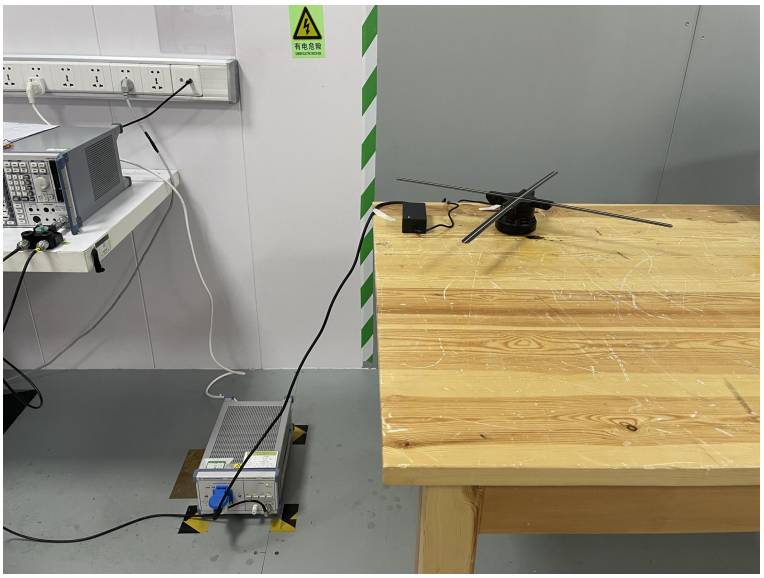
### Antenna Connected Construction

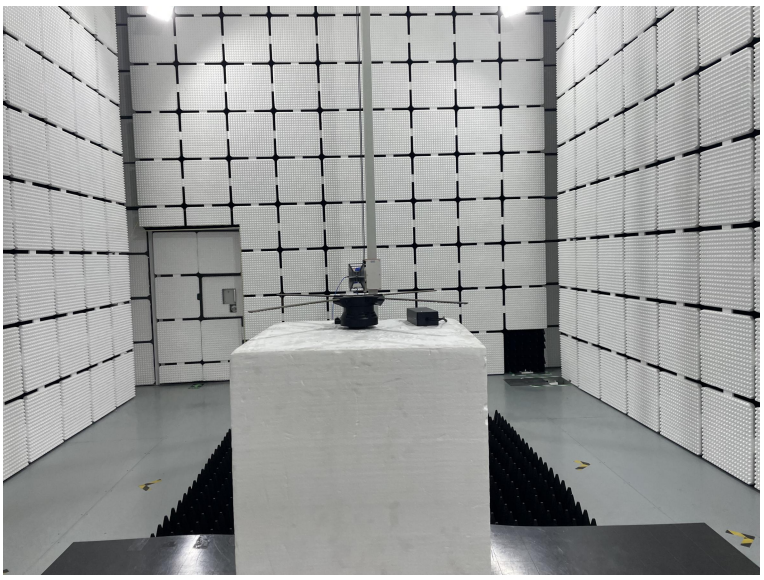
The maximum gain of antenna was -0.58 dBi.

Remark:The antenna gain is provided by the customer , if the data provided by the customer is not accurate, BSL Testing Co., Ltd. does not assume any responsibility.

# 5 Test Setup Photos of the EUT







# 6 Photos of the EUT

**Reference to the report ANNEX A of external photos and ANNEX B of internal photos.**

**********  End of Report  **********