

# RF Test Report

**Applicant:** Quectel Wireless Solutions Company Limited

**Address:** Building 5, Shanghai Business Park Phase III (Area B), No.1016  
Tianlin Road, Minhang District, Shanghai, 200233 China

**Product:** Wi-Fi & Bluetooth Module

**Model No.:** FCS960K-E

**Brand Name:** QUECTEL

**FCC ID:** XMR25FCS960KE

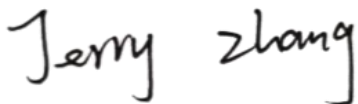
**Standards:** FCC CFR47 Part 15C

**Report No.:** PD20240165-R3B

**Issue Date:** 2025/03/25

**Test Result:** PASS \*

\* Testing performed at Hefei Panwin Technology Co., Ltd. on the above equipment indicates the product meets the requirements of the relevant standards.



**Reviewed By:** Jerry Zhang



**Approved By:** Alec Yang

## Hefei Panwin Technology Co., Ltd.

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# Test Report

Report No.: PD20240165-R3B

Report Version: 01

## Revision History

| Report No.     | Version | Description    | Issue Date | Note  |
|----------------|---------|----------------|------------|-------|
| PD20240165-R3B | 1       | Initial Report | 2025/03/25 | Valid |

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## Test Summary

| No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Test Case                                              | FCC Rules          | Verdict |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------|---------|
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Output Power Measurement                               | 15.247(b)          | PASS    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 6dB and 99% Bandwidth Measurement                      | 15.247(a)(2)       | PASS    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Power Spectral Density Measurement                     | 15.247(e)          | PASS    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Conducted Band Edges and Spurious Emission Measurement | 15.247(d)          | PASS    |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Radiated Band Edges and Spurious Emission Measurement  | 15.247(d)          | PASS    |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | AC Conducted Emission Measurement                      | 15.207             | NA      |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Antenna Requirements                                   | 15.203 & 15.247(b) | PASS    |
| <p>Date of Testing: 2024/12/09 to 2025/03/24</p> <p>Date of Sample Received: 2024/12/09</p> <ul style="list-style-type: none"> <li>We, Hefei Panwin Technology Co., Ltd., would like to declare that the tested sample has been evaluated in accordance with the procedures given in applied standard(s) in <b>Section 2.3</b> of this report and shown compliance with the applicable technical standards.</li> <li>All indications of PASS/FAIL in this report are based on interpretations and/or observations of test results.</li> </ul> <p>Measurement Uncertainties were not taken into account and are published for informational purposes only.</p> |                                                        |                    |         |

## 1 General Information

### 1.1 Notes of the Test Report

This report is invalid without signature of auditor and approver or with any alterations. The report shall not be partially reproduced without written approval of the testing company. Entrusted test results are only responsible for incoming samples. If there is any objection to the testing report, it shall be raised to the testing company within 15 days from the date of receiving the report. In the test results, "NA" means "not applicable", and the test items marked with "Δ" are subcontracted projects.

### 1.2 Test Facility

#### A2LA (Certificate Number: 6849.01)

Hefei Panwin Technology Co., Ltd. has been accredited by American Association for Laboratory Accreditation to perform measurement.

#### FCC (Designation Number: CN1361, Test Firm Registration Number: 473156)

Hefei Panwin Technology Co., Ltd. has been accredited on the US Federal Communications Commission list of test facilities recognized to perform measurements.

### 1.3 Testing Laboratory

|              |                                                                                                                                |
|--------------|--------------------------------------------------------------------------------------------------------------------------------|
| Company Name | Hefei Panwin Technology Co., Ltd.                                                                                              |
| Address      | Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province, China |
| Telephone    | +86-0551-63811775                                                                                                              |
| Post Code    | 230031                                                                                                                         |

## 2 General Description of Equipment under Test

### 2.1 Details of Application

|                      |                                                                                                                       |
|----------------------|-----------------------------------------------------------------------------------------------------------------------|
| Applicant            | Quectel Wireless Solutions Company Limited                                                                            |
| Applicant Address    | Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, 200233 China |
| Manufacturer         | Quectel Wireless Solutions Company Limited                                                                            |
| Manufacturer Address | Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, 200233 China |

### 2.2 General Information

|                              |                                                         |
|------------------------------|---------------------------------------------------------|
| Product                      | Wi-Fi & Bluetooth Module                                |
| Model                        | FCS960K-E                                               |
| SN                           | Conducted: E1M24EN08000121<br>Radiated: E1M24EN08000176 |
| Hardware Version             | R1.0                                                    |
| Software Version             | /                                                       |
| Antenna Type                 | External Antenna                                        |
| Antenna Gain                 | 0.20dBi                                                 |
| Additional Beamforming Gain  | NA                                                      |
| Max. Conducted Power         | BLE: 5.36dBm                                            |
| Operating voltage            | Typical 3.3Vdc                                          |
| Type of Modulation           | Bluetooth LE 5.4: GFSK                                  |
| Operating Frequency Range(s) | Bluetooth LE: 2402 to 2480MHz                           |

**Note:** The declared of product specification for EUT and/or Antenna presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

## 2.3 Application Standards

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

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

### Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

## 3 Test Condition

### 3.1 Test Configuration

#### Test mode

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The worst cases were recorded in this report.

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes (Z, X, Y axis), receiver antenna polarization (horizontal and vertical), the worst emission was found in Z position and the worst case was recorded.

| Test Mode    | Data Rate |
|--------------|-----------|
| Bluetooth LE | 1Mbps     |
|              | 2Mbps     |



## 3.2 Carrier Frequency and 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       | -       | -          |

## 3.3 Equipment List

### Conducted

| Instrument        | Manufacturer | Model               | Asset No. | Cal. Interval | Cal. Due Date |
|-------------------|--------------|---------------------|-----------|---------------|---------------|
| Spectrum Analyzer | KEYSIGHT     | N9020B              | PWC0048   | 1 Year        | 2025/09/11    |
| RF Control Unit   | Tonseced     | JS0806-2            | PWC0055   | /             | /             |
| Shielded Chamber  | Maorui       | MR543               | PWC0041   | 3 Years       | 2026/08/26    |
| Test Software     | Tonseced     | JS1120-3<br>V3.2.22 | /         | /             | /             |

### Radiated

| Instrument                  | Manufacturer      | Model                 | Asset No. | Cal. Interval | Cal. Due Date |
|-----------------------------|-------------------|-----------------------|-----------|---------------|---------------|
| EMI Test Receiver           | R&S               | ESR7                  | PWB0023   | 1 Year        | 2025/09/11    |
| Spectrum Analyzer           | R&S               | FSV3044               | PWB0024   | 1 Year        | 2025/09/11    |
| Loop Antenna                | R&S               | HFH2-Z2E              | PWB0026   | 1 Year        | 2025/09/13    |
| TRILOG Broadband            | Schwarzbeck       | VULB9162              | PWB0029   | 1 Year        | 2025/09/09    |
| Double-Ridged Guide Antenna | ETS-Lindgren      | 3117                  | PWB0031   | 1 Year        | 2025/09/26    |
| k Type Horn Antenna         | Steatite Antennas | QMS-00880             | PWB0035   | 1 Year        | 2025/09/08    |
| Pre-Amplifier               | R&S               | SCU40F1               | PWB0036   | 1 Year        | 2025/09/11    |
| Pre-Amplifier               | COM-MW            | DLNA8                 | PWB0094   | 1 Year        | 2025/09/11    |
| Pre-Amplifier               | R&S               | SCU18F                | PWB0034   | 1 Year        | 2025/09/11    |
| Pre-Amplifier               | R&S               | OSP220<br>(OSP-B155G) | PWB0042   | 1 Year        | 2025/09/11    |
| Anechoic Chamber            | ETS.LINDGREN      | Fact 3-2m             | PWB0003   | 3 Years       | 2026/06/05    |
| Test Software               | Tonscend          | JS36                  | /         | /             | /             |

## 3.4 Support Equipment List

| Equipment | Manufacturer | Description                  | Model       | Serial Number                       |
|-----------|--------------|------------------------------|-------------|-------------------------------------|
| EVB       | Quectel      | /                            | Q1-C1950    | E1C24A21H000109;<br>E1C23H816000098 |
| Adapter   | STH          | AC to DC power supply to EVB | P60EB120500 | /                                   |

## 3.5 Test Uncertainty

| No. | Parameter                                            | Uncertainty                                |
|-----|------------------------------------------------------|--------------------------------------------|
| 1   | DTS Bandwidth                                        | 1.9 %                                      |
| 2   | Occupied channel bandwidth                           | 1.9 %                                      |
| 3   | Duty Cycle                                           | 0.11 %                                     |
| 4   | Maximum Conducted Output Power                       | 1.18 dB                                    |
| 5   | Maximum Power Spectral Density Level                 | 0.98 dB                                    |
| 6   | Band-edge Compliance                                 | 1.21 dB                                    |
| 7   | Unwanted Emissions In Non-restricted Frequency Bands | 9kHz-7GHz: 1.21 dB<br>7GHz-40GHz: 3.31 dB  |
| 8   | Radiated Band Edges and Spurious Emission            | Below 1GHz: 4.88 dB<br>Above 1GHz: 5.06 dB |
| 9   | Temperature                                          | 3 °C                                       |
| 10  | Humidity                                             | 1.3 %                                      |
| 11  | Supply Voltages                                      | 0.006 V                                    |

## 4 Test Items Description

### Ambient condition

Shielded Chamber

|                  |                |
|------------------|----------------|
| Temperature [°C] | 20.0 to 24.2   |
| Humidity [%RH]   | 26 to 36       |
| Pressure [kPa]   | 101.7 to 103.1 |

Anechoic Chamber

|                  |                |
|------------------|----------------|
| Temperature [°C] | 20.2 to 24.8   |
| Humidity [%RH]   | 30 to 49       |
| Pressure [kPa]   | 101.0 to 102.9 |

## 4.1 Output Power Measurement

### 4.1.1 Limit of Output Power

Rule Part 15.247 (b) (3) specifies that “For systems using digital modulation in the 902-928 MHz 2400-2483.5 MHz: 1 Watt.”

|                      |                                |
|----------------------|--------------------------------|
| Average Output Power | $\leq 1\text{W}(30\text{dBm})$ |
|----------------------|--------------------------------|

### 4.1.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

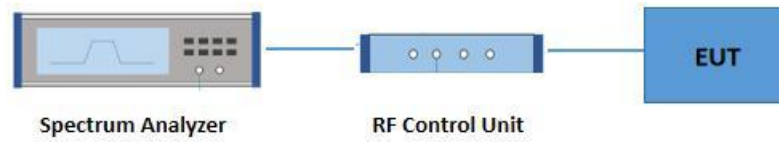
### 4.1.3 Test Procedures

The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.1.

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

- 1) Set the RBW  $\geq$  DTS bandwidth.
- 2) Set VBW  $\geq [3 \times \text{RBW}]$ .
- 3) Set span  $\geq [3 \times \text{RBW}]$ .
- 4) Sweep time = auto couple.
- 5) Detector = peak.
- 6) Trace mode = max hold.
- 7) Allow trace to fully stabilize.
- 8) Use peak marker function to determine the peak amplitude level.

## 4.1.4 Test Setup



## 4.1.5 Test Results

See ANNEX A.1.

## 4.2 6dB and 99% Bandwidth Measurement

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

The minimum 6 dB bandwidth shall be at least 500 kHz

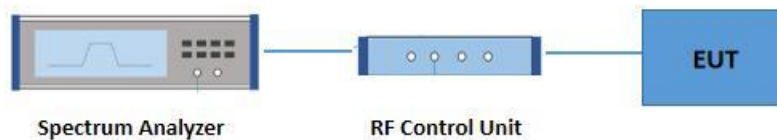
### 4.2.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

### 4.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8 & 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1% to 5% of the 99% OBW and the VBW is set to 3 times of the RBW.
6. Measure and record the results in the test report.

### 4.2.4 Test Setup



### 4.2.5 Test Results

See ANNEX A.2.

## 4.3 Power Spectral Density Measurement

### 4.3.1 Limit of Power Spectral Density

Rule Part 15.247(e) specifies that" 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.

### 4.3.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

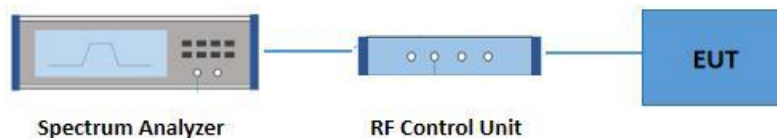
### 4.3.3 Test Procedures

The testing follows ANSI C63.10-2013 clause 11.10.2

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- 1) Set analyzer center frequency to DTS channel center frequency.
- 2) Set the span to 1.5 times the DTS bandwidth.
- 3) Set the RBW to  $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
- 4) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- 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 amplitude level within the RBW.
- 10) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

### 4.3.4 Test Setup



### 4.3.5 Test Result of Power Spectral Density

Please refer to ANNEX A.3.

## 4.4 Conducted Band Edges and Spurious Emission Measurement

### 4.4.1 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, In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

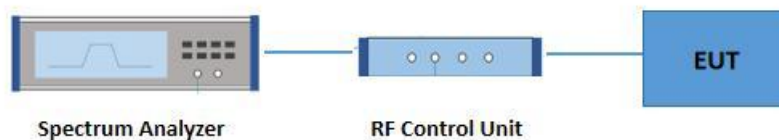
### 4.4.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test

### 4.4.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 11.13.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

### 4.4.4 Test Setup



### 4.4.5 Test Result

Please refer to ANNEX A.4.



## 4.5 Radiated Band Edges and Spurious Emission Measurement

### 4.5.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

| Frequency<br>(MHz) | Field Strength<br>(microvolts/meter) | Measurement Distance<br>(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                                |

### 4.5.2 Measuring Instruments

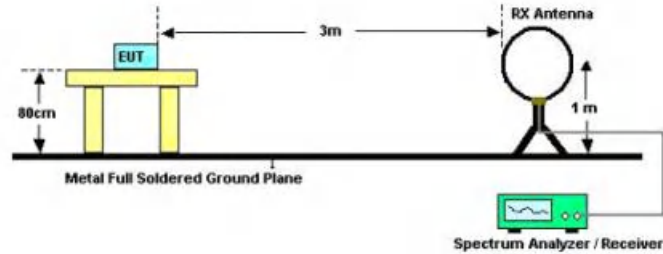
The section 3.3 of List of Measuring Equipment of this test report is used for test.

## 4.5.3 Test Procedures

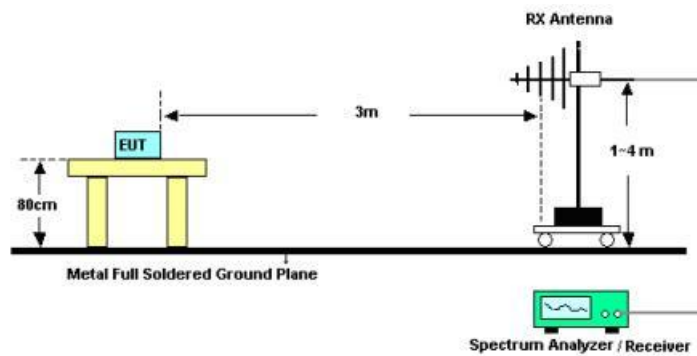
1. The testing follows ANSI C63.10-2013 clause 11.12.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level -Preamplifier Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
  - (1) Span shall wide enough to fully capture the emission being measured.
  - (2) Set RBW=100 kHz for  $f < 1 \text{ GHz}$ ; VBW  $\geq$  RBW; Sweep = auto; Detector function = peak; Trace = max hold.
  - (3) Set RBW = 1 MHz, VBW= 3MHz for  $\geq 1 \text{ GHz}$  for peak measurement  
 For average measurement:  
 VBW= 10 Hz, when duty cycle is no less than 98 percent.  
 VBW  $\geq 1/T$ , 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.

#### 4.5.4 Test Setup

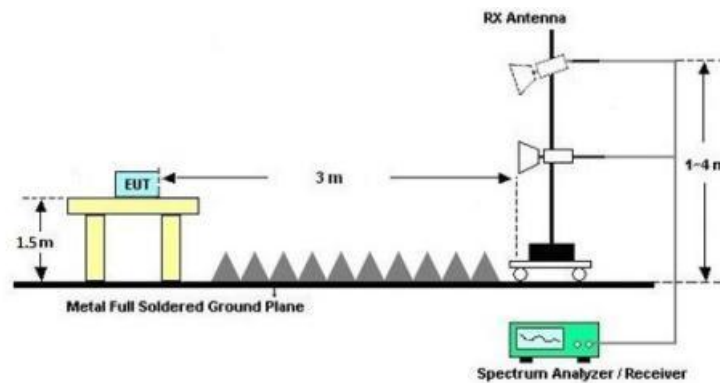
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

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

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

similar.

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

Please refer to ANNEX B.1.

#### 4.5.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHzwhichever is lower)

Please refer to ANNEX B.1.

#### 4.5.8 Duty Cycle

Please refer to ANNEX A.5.

## 4.6 AC Conducted Emission Measurement

### 4.6.1 Limit of AC Conducted Emission

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

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

Decreases with the logarithm of the frequency.

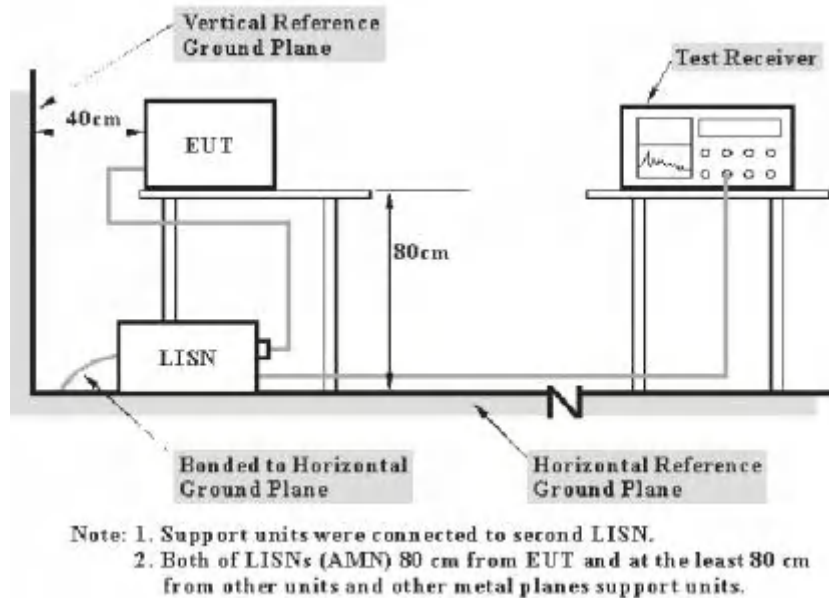
### 4.6.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

### 4.6.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.2.
2. The mains terminal disturbance voltage test was conducted in a shielded room.
3. The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a  $50\Omega/50\mu\text{H} + 5\Omega$  linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
4. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane.
5. The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
6. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10-2013 on conducted measurement.

#### 4.6.4 Test Setup



#### 4.9.5 Uncertainty Measurement

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT. The listed uncertainties are the worst case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

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

| CASE                          | Uncertainty |
|-------------------------------|-------------|
| Continuous Emission (AC port) | 2.92 dB     |

#### 4.9.6 Test Result

**Remark:** The product is DC powered, this test item is not applicable.

## 4.7 Antenna Requirements

### 4.7.1 Standard Applicable

15.203 requirement: 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.

15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and(b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6dBi.

### 4.7.2 Antenna Anti-Replacement Construction

The antenna is External on the main PCB and no consideration of replacement. The best case gain of the antenna is 0.20dBi.

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

## ANNEX A: Test Results of Conducted Test

## A.1 Conducted Output Power

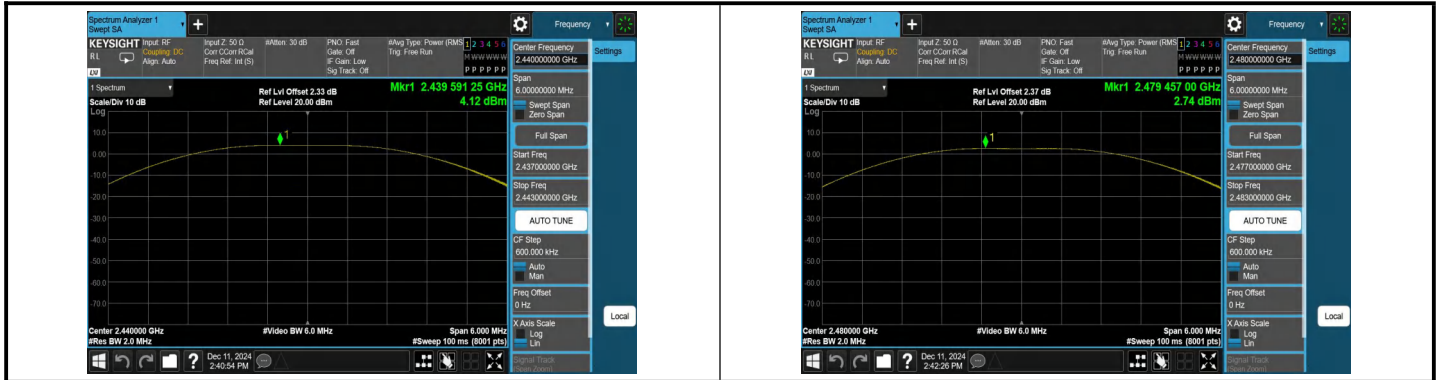
## Test Result Peak

| Test Mode | Antenna | Frequency [MHz] | Conducted Peak Power[dBm] | Conducted Limit[dBm] | EIRP[dBm] | EIRP Limit[dBm] | Verdict |
|-----------|---------|-----------------|---------------------------|----------------------|-----------|-----------------|---------|
| BLE_1M    | Ant1    | 2402            | 5.36                      | ≤30                  | 5.56      | ≤36             | PASS    |
| BLE_1M    | Ant1    | 2440            | 4.15                      | ≤30                  | 4.35      | ≤36             | PASS    |
| BLE_1M    | Ant1    | 2480            | 2.79                      | ≤30                  | 2.99      | ≤36             | PASS    |
| BLE_2M    | Ant1    | 2402            | 5.29                      | ≤30                  | 5.49      | ≤36             | PASS    |
| BLE_2M    | Ant1    | 2440            | 4.12                      | ≤30                  | 4.32      | ≤36             | PASS    |
| BLE_2M    | Ant1    | 2480            | 2.74                      | ≤30                  | 2.94      | ≤36             | PASS    |

## Test Graphs







## A.2 6dB and 99% Bandwidth

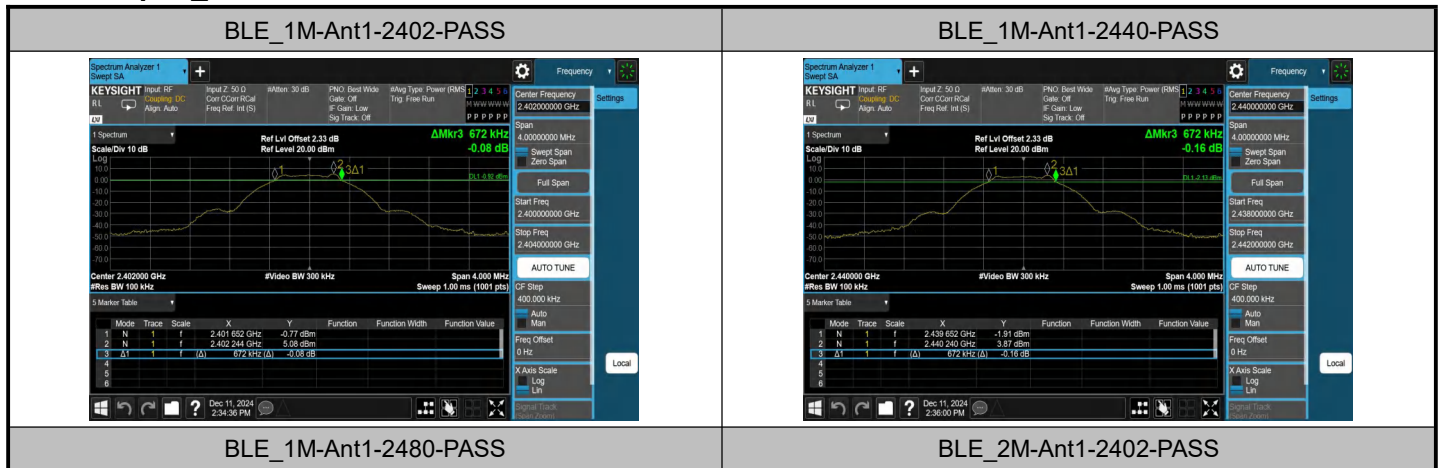
### Test Result 6dB Bandwidth

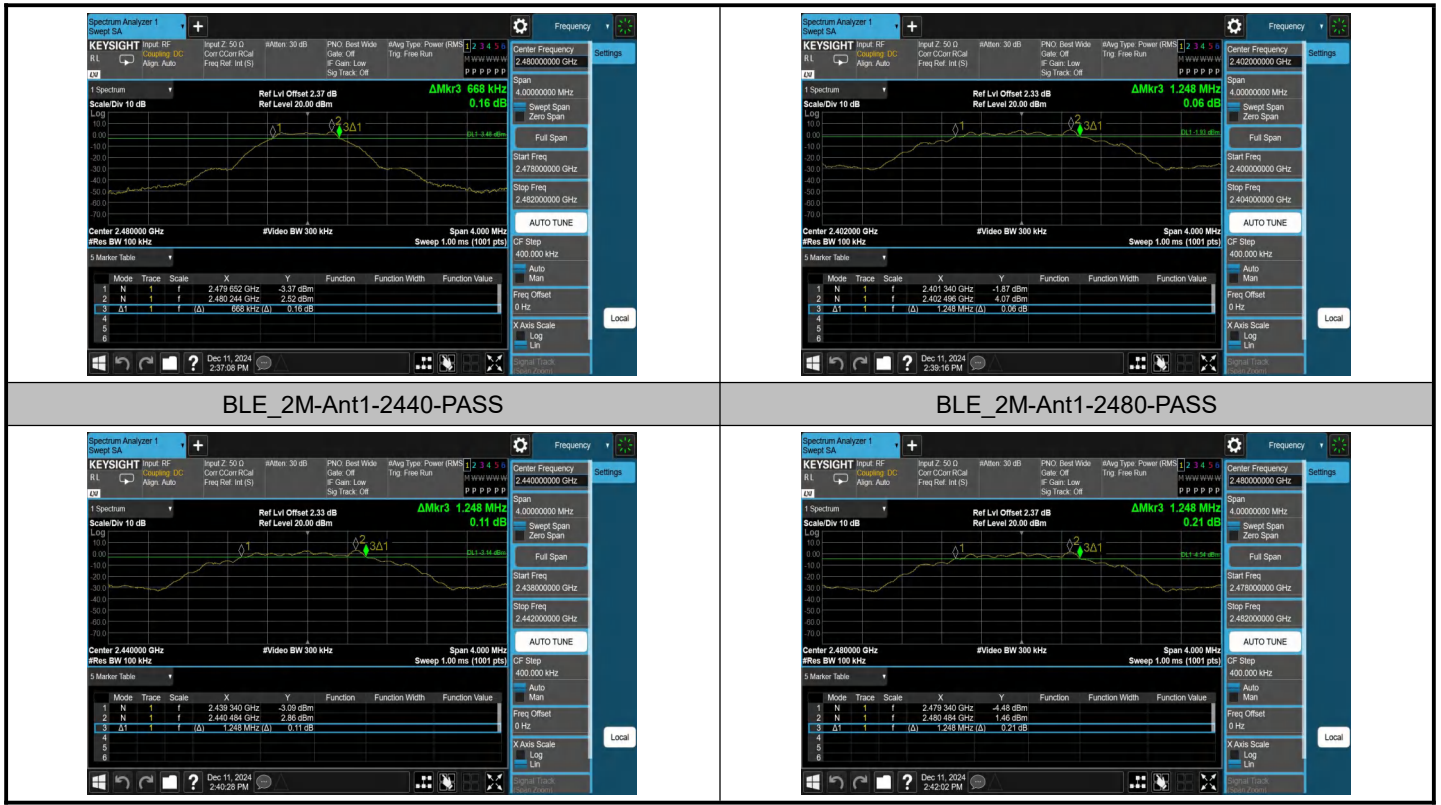
| Test Mode | Antenna | Frequency[MHz] | DTS BW[MHz] | FL[MHz]  | FH[MHz]  | Limit[MHz] | Verdict |
|-----------|---------|----------------|-------------|----------|----------|------------|---------|
| BLE_1M    | Ant1    | 2402           | 0.672       | 2401.652 | 2402.324 | 0.5        | PASS    |
| BLE_1M    | Ant1    | 2440           | 0.672       | 2439.652 | 2440.324 | 0.5        | PASS    |
| BLE_1M    | Ant1    | 2480           | 0.668       | 2479.652 | 2480.320 | 0.5        | PASS    |
| BLE_2M    | Ant1    | 2402           | 1.248       | 2401.340 | 2402.588 | 0.5        | PASS    |
| BLE_2M    | Ant1    | 2440           | 1.248       | 2439.340 | 2440.588 | 0.5        | PASS    |
| BLE_2M    | Ant1    | 2480           | 1.248       | 2479.340 | 2480.588 | 0.5        | PASS    |

### Test Result 99% Bandwidth

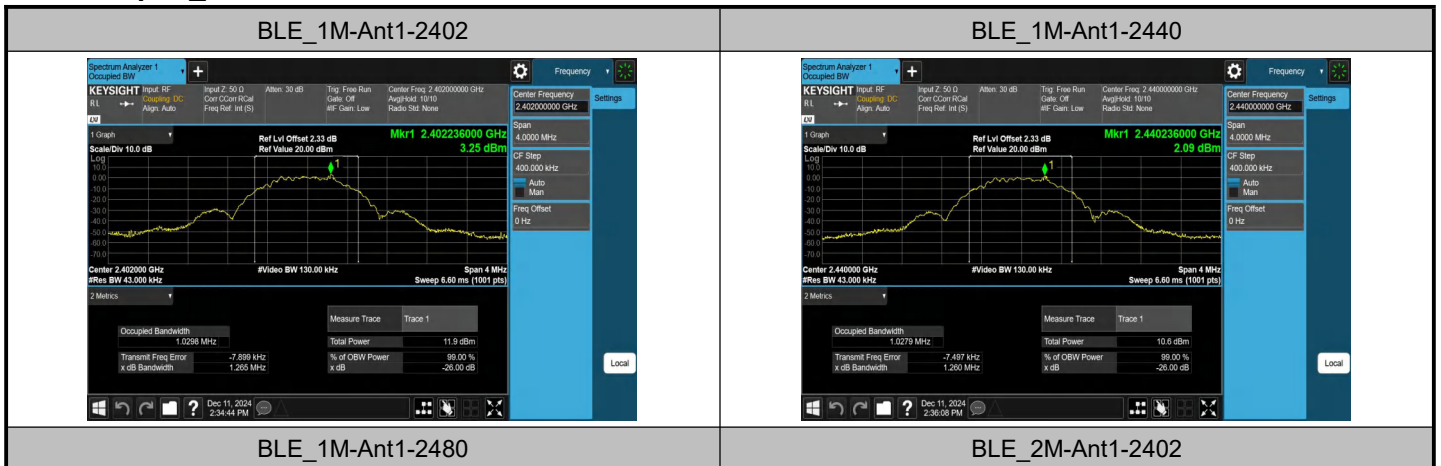
| Test Mode | Antenna | Frequency[MHz] | OCB [MHz] | FL[MHz]   | FH[MHz]   | Limit[MHz] | Verdict |
|-----------|---------|----------------|-----------|-----------|-----------|------------|---------|
| BLE_1M    | Ant1    | 2402           | 1.0298    | 2401.4772 | 2402.5070 | ---        | ---     |
| BLE_1M    | Ant1    | 2440           | 1.0279    | 2439.4786 | 2440.5065 | ---        | ---     |
| BLE_1M    | Ant1    | 2480           | 1.0278    | 2479.4786 | 2480.5064 | ---        | ---     |
| BLE_2M    | Ant1    | 2402           | 2.0878    | 2400.9604 | 2403.0482 | ---        | ---     |
| BLE_2M    | Ant1    | 2440           | 2.0992    | 2438.9549 | 2441.0541 | ---        | ---     |
| BLE_2M    | Ant1    | 2480           | 2.0998    | 2478.9551 | 2481.0549 | ---        | ---     |

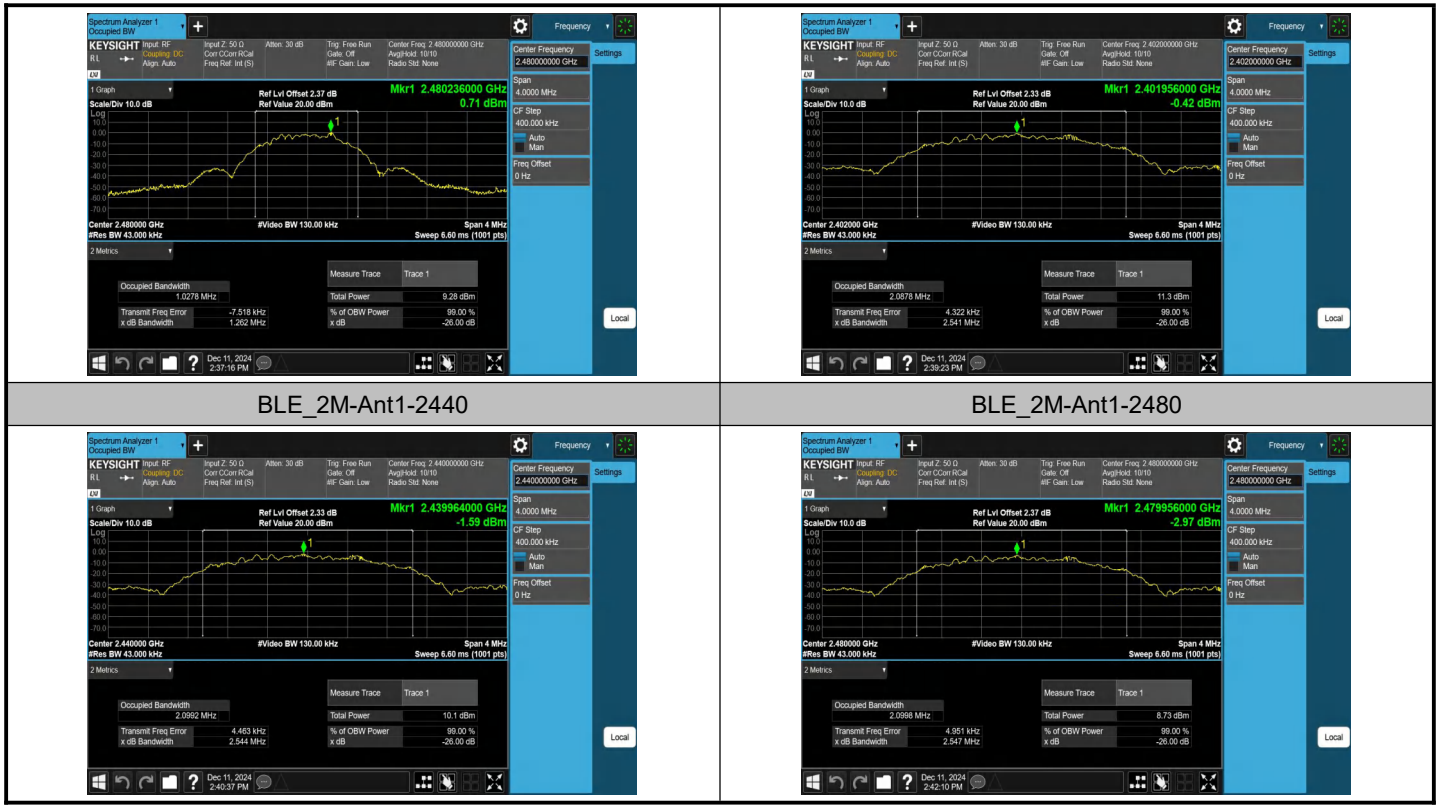
### Test Graphs\_6dB Bandwidth





## Test Graphs\_99% Bandwidth



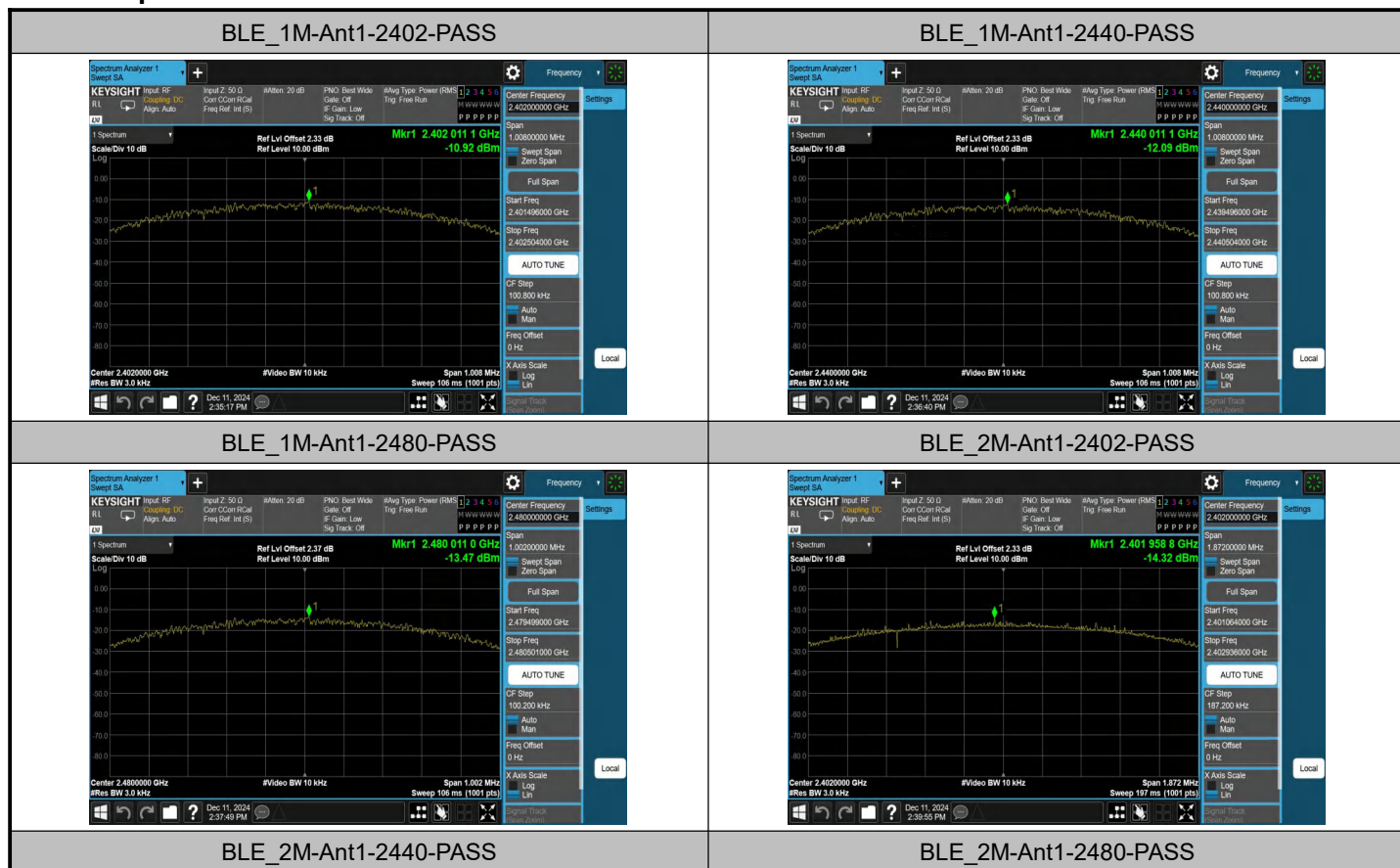


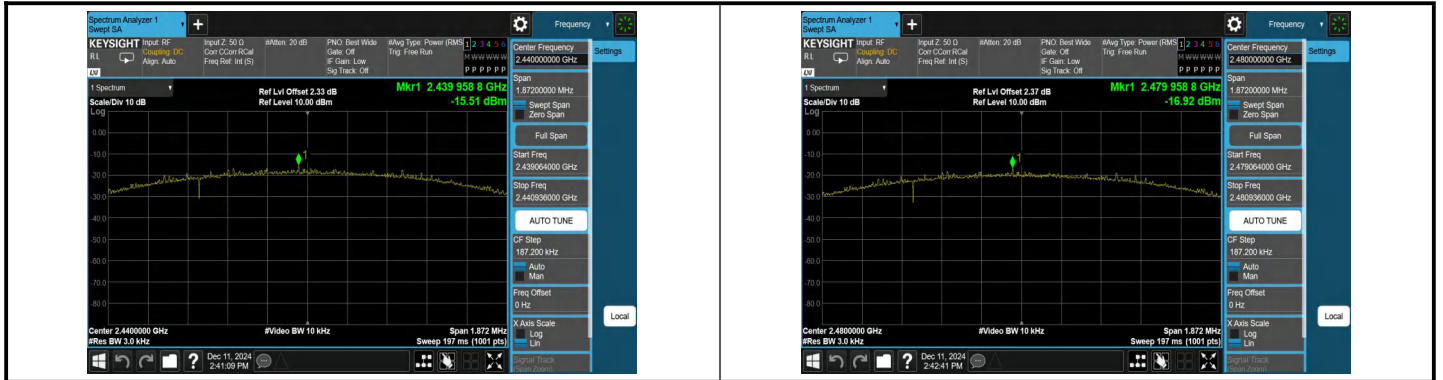
## A.3 Power Spectral Density

### Test Result

| Test Mode | Antenna | Frequency[MHz] | Result[dBm/3kHz] | Limit[dBm/3kHz] | Verdict |
|-----------|---------|----------------|------------------|-----------------|---------|
| BLE_1M    | Ant1    | 2402           | -10.92           | ≤8.00           | PASS    |
| BLE_1M    | Ant1    | 2440           | -12.09           | ≤8.00           | PASS    |
| BLE_1M    | Ant1    | 2480           | -13.47           | ≤8.00           | PASS    |
| BLE_2M    | Ant1    | 2402           | -14.32           | ≤8.00           | PASS    |
| BLE_2M    | Ant1    | 2440           | -15.51           | ≤8.00           | PASS    |
| BLE_2M    | Ant1    | 2480           | -16.92           | ≤8.00           | PASS    |

### Test Graphs







## A.4 Conducted Band Edges and Spurious Emission

### Test Result

#### Band Edges

| Test Mode | Antenna | Ch Name | Frequency[MHz] | Ref Level[dBm] | Result[dBm] | Limit[dBm] | Verdict |
|-----------|---------|---------|----------------|----------------|-------------|------------|---------|
| BLE_1M    | Ant1    | Low     | 2402           | 1.55           | -54.65      | ≤-18.45    | PASS    |
| BLE_1M    | Ant1    | High    | 2480           | -0.89          | -56.04      | ≤-20.89    | PASS    |
| BLE_2M    | Ant1    | Low     | 2402           | 0.41           | -31.98      | ≤-19.59    | PASS    |
| BLE_2M    | Ant1    | High    | 2480           | -2.01          | -55.64      | ≤-22.01    | PASS    |

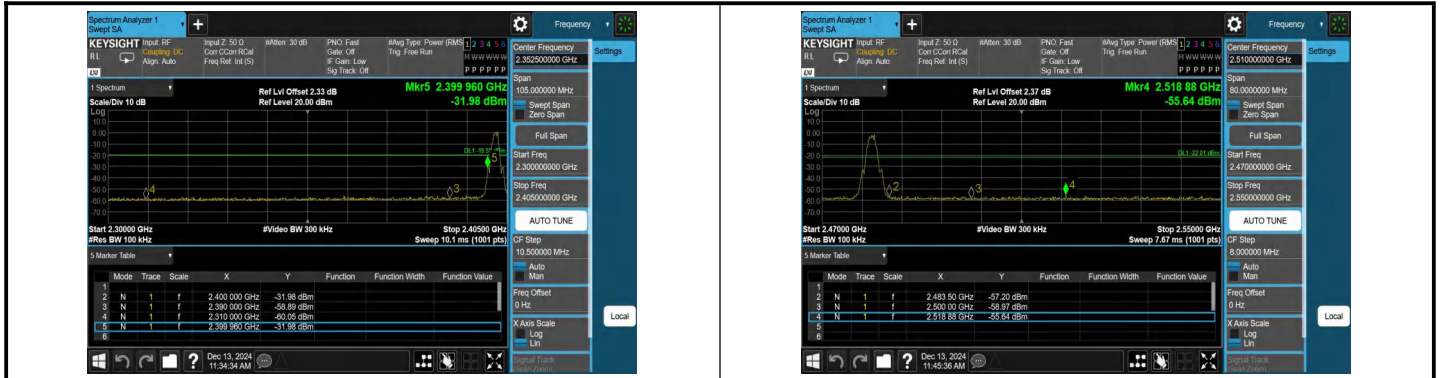
### Spurious Emission

| Test Mode | Antenna | Frequency[MHz] | Freq Range[MHz] | Ref Level[dBm] | Result[dBm] | Limit[dBm] | Verdict |
|-----------|---------|----------------|-----------------|----------------|-------------|------------|---------|
| BLE_1M    | Ant1    | 2402           | 30~1000         | 1.55           | -69.34      | ≤-18.45    | PASS    |
| BLE_1M    | Ant1    | 2402           | 1000~26500      | 1.55           | -55.09      | ≤-18.45    | PASS    |
| BLE_1M    | Ant1    | 2440           | 30~1000         | 0.43           | -68.49      | ≤-19.57    | PASS    |
| BLE_1M    | Ant1    | 2440           | 1000~26500      | 0.43           | -53.17      | ≤-19.57    | PASS    |
| BLE_1M    | Ant1    | 2480           | 30~1000         | -0.89          | -69.08      | ≤-20.89    | PASS    |
| BLE_1M    | Ant1    | 2480           | 1000~26500      | -0.89          | -51.67      | ≤-20.89    | PASS    |
| BLE_2M    | Ant1    | 2402           | 30~1000         | 0.41           | -69.18      | ≤-19.59    | PASS    |
| BLE_2M    | Ant1    | 2402           | 1000~26500      | 0.41           | -54.74      | ≤-19.59    | PASS    |
| BLE_2M    | Ant1    | 2440           | 30~1000         | -0.68          | -68.8       | ≤-20.68    | PASS    |
| BLE_2M    | Ant1    | 2440           | 1000~26500      | -0.68          | -47.57      | ≤-20.68    | PASS    |
| BLE_2M    | Ant1    | 2480           | 30~1000         | -2.01          | -69.16      | ≤-22.01    | PASS    |
| BLE_2M    | Ant1    | 2480           | 1000~26500      | -2.01          | -53.74      | ≤-22.01    | PASS    |

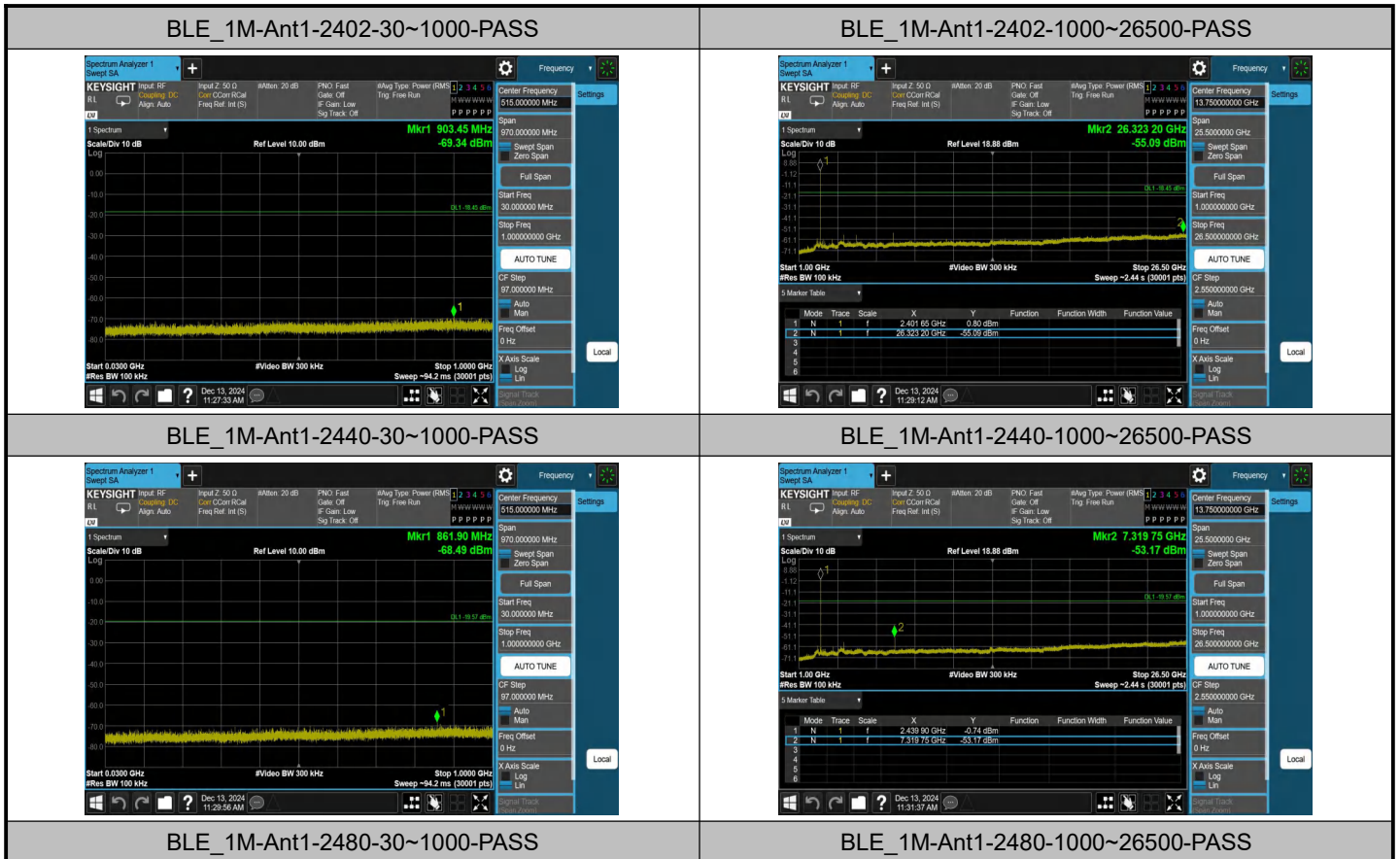
### Test Graphs

#### Band Edges

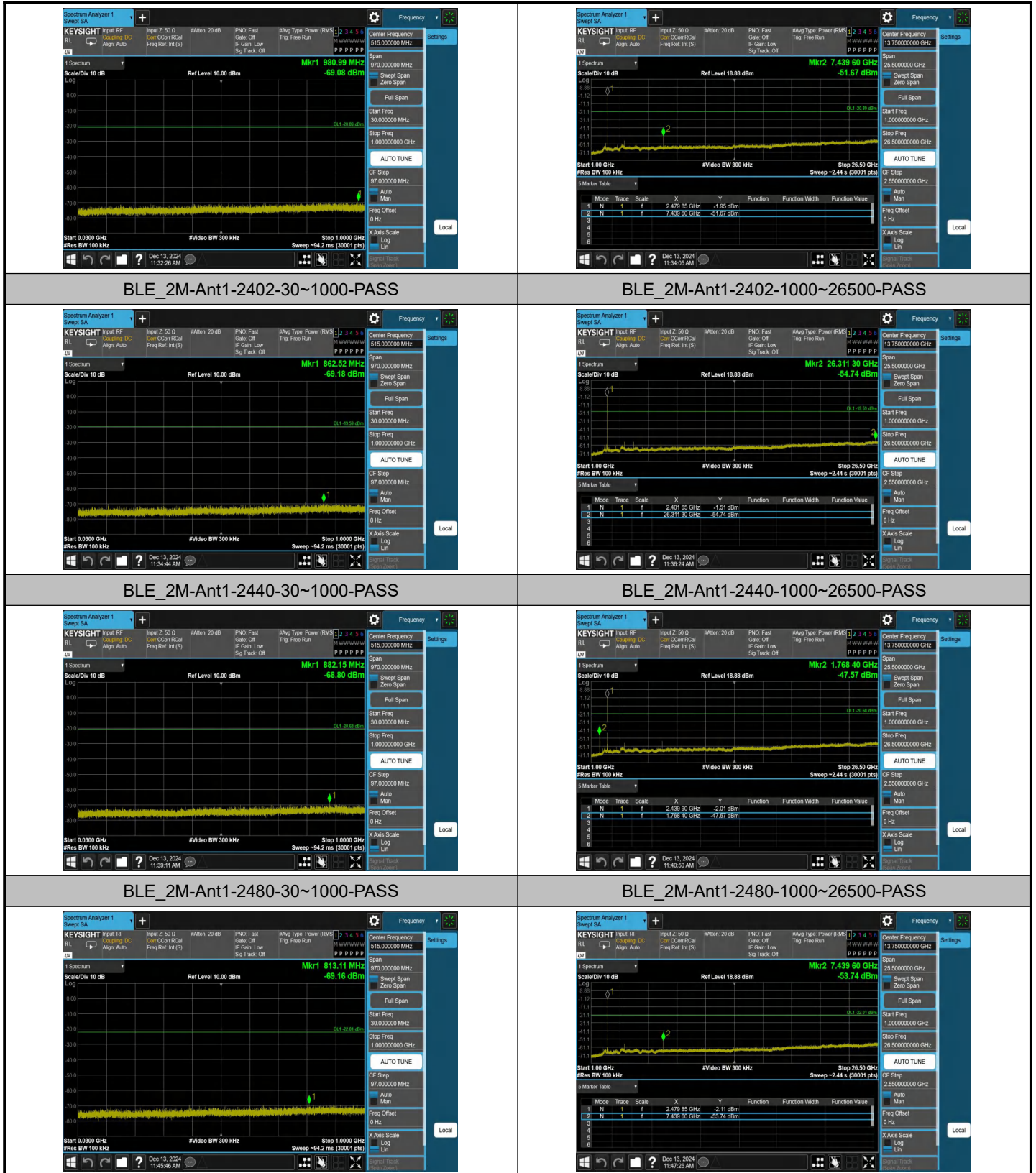
|                              |                              |
|------------------------------|------------------------------|
| <p>BLE_1M-Ant1-2402-PASS</p> | <p>BLE_1M-Ant1-2480-PASS</p> |
| <p>BLE_2M-Ant1-2402-PASS</p> | <p>BLE_2M-Ant1-2480-PASS</p> |



## Spurious Emission







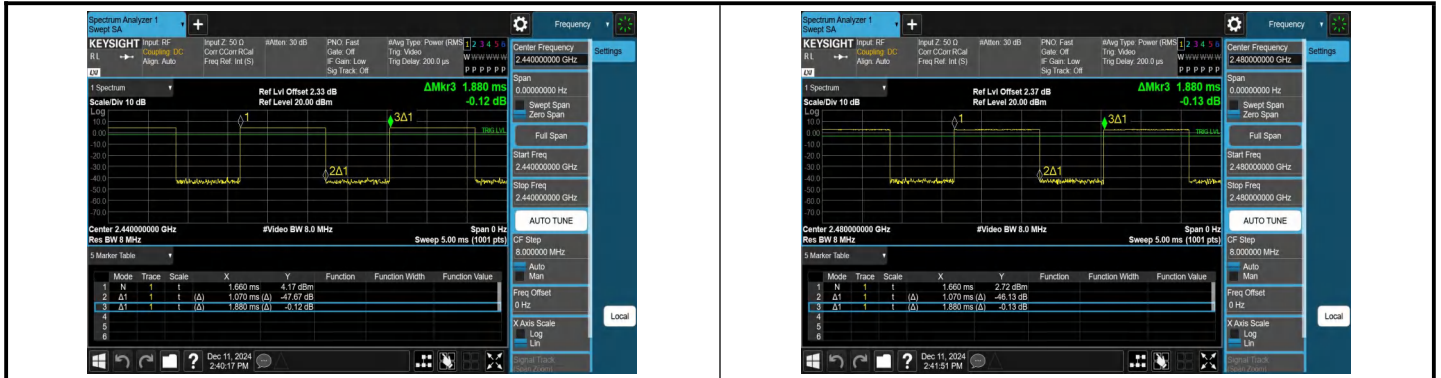
## A.5 Duty Cycle

### Test Result

| Test Mode | Antenna | Frequency[MHz] | ON Time[ms] | Period[ms] | Duty Cycle[%] | Duty Cycle Factor[dB] |
|-----------|---------|----------------|-------------|------------|---------------|-----------------------|
| BLE_1M    | Ant1    | 2402           | 2.12        | 2.50       | 84.80         | 0.72                  |
| BLE_1M    | Ant1    | 2440           | 2.12        | 2.50       | 84.80         | 0.72                  |
| BLE_1M    | Ant1    | 2480           | 2.12        | 2.50       | 84.80         | 0.72                  |
| BLE_2M    | Ant1    | 2402           | 1.07        | 1.88       | 56.91         | 2.45                  |
| BLE_2M    | Ant1    | 2440           | 1.07        | 1.88       | 56.91         | 2.45                  |
| BLE_2M    | Ant1    | 2480           | 1.07        | 1.88       | 56.91         | 2.45                  |

### Test Graphs





## ANNEX B: Test Results of Radiated Test

### B.1 Radiated Band Edges and Spurious Emission

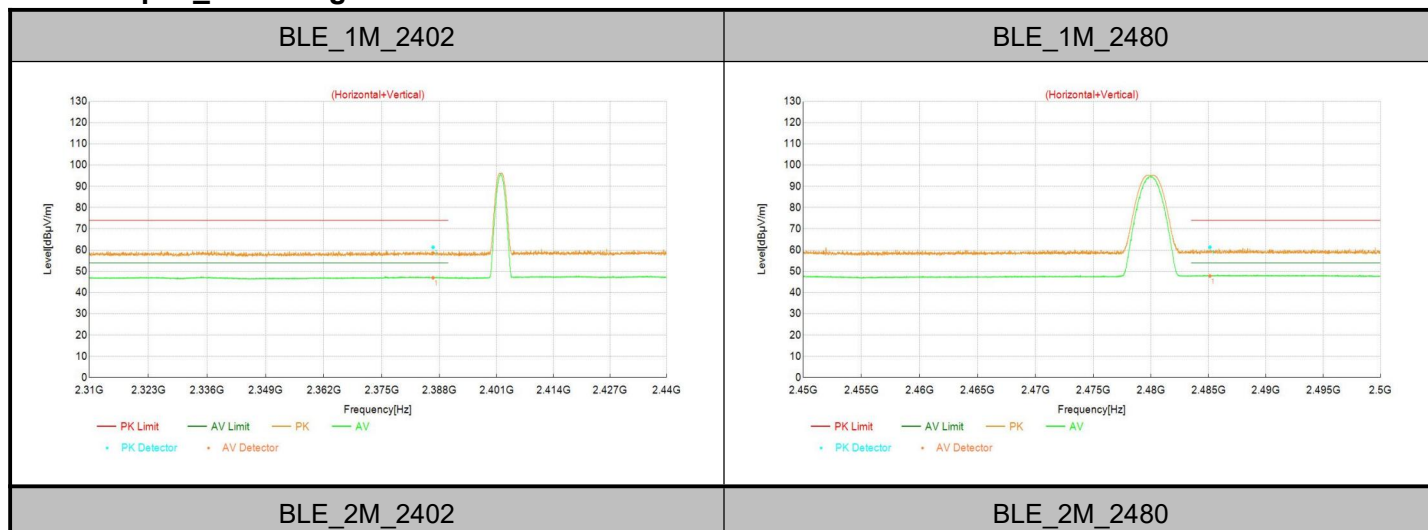
#### Test Result\_Band Edges

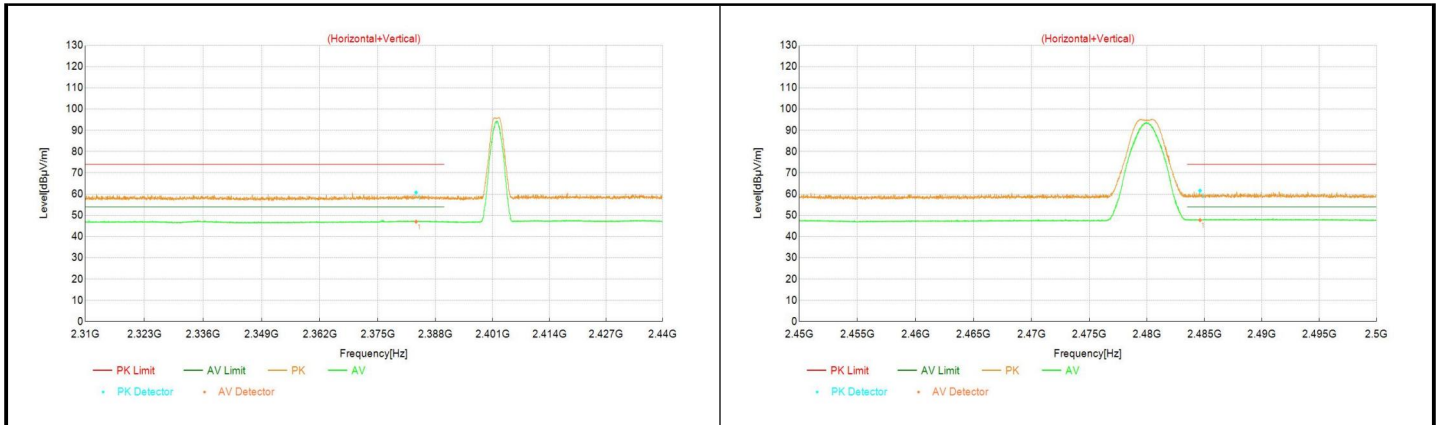
Note:Both vertical and horizontal polarities have been evaluated, and the test data only shows the worst-case.  
Level=Reading+Factor; Margin=Limit-Level; V=Vertical , H=Horizontal.

#### Data List

| Test Mode   | Frequency [MHz] | Reading [dBμV] | Level [dBμV/m] | Factor [dB/m] | Limit [dBμV/m] | Margin [dB] | Pol. | Det |
|-------------|-----------------|----------------|----------------|---------------|----------------|-------------|------|-----|
| BLE_1M_2402 | 2386.59567      | 49.18          | 61.32          | 12.14         | 74.00          | 12.68       | H    | PK  |
|             | 2386.59567      | 34.84          | 46.98          | 12.14         | 54.00          | 7.02        | H    | AV  |
| BLE_1M_2480 | 2485.13063      | 48.58          | 61.37          | 12.79         | 74.00          | 12.63       | V    | PK  |
|             | 2485.13063      | 35.02          | 47.81          | 12.79         | 54.00          | 6.19        | V    | AV  |
| BLE_2M_2402 | 2383.65772      | 48.57          | 60.77          | 12.20         | 74.00          | 13.23       | H    | PK  |
|             | 2383.65772      | 34.84          | 47.04          | 12.20         | 54.00          | 6.96        | H    | AV  |
| BLE_2M_2480 | 2484.61546      | 48.87          | 61.62          | 12.75         | 74.00          | 12.38       | H    | PK  |
|             | 2484.61546      | 35.01          | 47.76          | 12.75         | 54.00          | 6.24        | H    | AV  |

#### Test Graphs\_Band Edges





## Test Result\_Spurious Emission

Note1: Test result Sweep the whole frequency band through the range from 9kHz to the 10th harmonic of the carrier the Emissions in the frequency band 9kHz-30MHz and 18GHz-26.5GHz are more than 20dB below the limit are not reported.

Note2: Both vertical and horizontal polarities have been evaluated, and the test data only shows the worst-case. Level=Reading+Factor; Margin=Limit-Level; V=Vertical , H=Horizontal.

### Data List

| Test Mode   | Frequency [MHz] | Reading [dBμV] | Level [dBμV/m] | Factor [dB/m] | Limit [dBμV/m] | Margin [dB] | Pol. | Det |
|-------------|-----------------|----------------|----------------|---------------|----------------|-------------|------|-----|
| BLE_1M_2402 | 4804            | 47.13          | 54.47          | 7.34          | 74.00          | 19.53       | V    | PK  |
|             | 7206            | 43.85          | 57.53          | 13.68         | 74.00          | 16.47       | V    | PK  |
|             | 9608            | 33.70          | 48.41          | 14.71         | 74.00          | 25.59       | V    | PK  |
|             | 12010           | 33.46          | 49.29          | 15.83         | 74.00          | 24.71       | H    | PK  |
|             | 14412           | 32.60          | 50.95          | 18.35         | 74.00          | 23.05       | V    | PK  |
|             | 16814           | 30.77          | 54.01          | 23.24         | 74.00          | 19.99       | V    | PK  |
|             | 4804            | 40.72          | 48.06          | 7.34          | 54.00          | 5.94        | V    | AV  |
|             | 7206            | 33.18          | 46.86          | 13.68         | 54.00          | 7.14        | V    | AV  |
|             | 9608            | 22.70          | 37.41          | 14.71         | 54.00          | 16.59       | V    | AV  |
|             | 12010           | 23.01          | 38.84          | 15.83         | 54.00          | 15.16       | V    | AV  |
|             | 14412           | 21.64          | 39.99          | 18.35         | 54.00          | 14.01       | V    | AV  |
|             | 16814           | 20.22          | 43.46          | 23.24         | 54.00          | 10.54       | V    | AV  |
| BLE_1M_2440 | 4880            | 45.98          | 53.43          | 7.45          | 74.00          | 20.57       | V    | PK  |
|             | 7320            | 42.58          | 57.00          | 14.42         | 74.00          | 17.00       | H    | PK  |
|             | 9760            | 33.80          | 48.80          | 15.00         | 74.00          | 25.20       | V    | PK  |
|             | 12200           | 33.48          | 49.01          | 15.53         | 74.00          | 24.99       | V    | PK  |
|             | 14640           | 31.97          | 50.42          | 18.45         | 74.00          | 23.58       | V    | PK  |
|             | 17080           | 29.89          | 54.41          | 24.52         | 74.00          | 19.59       | H    | PK  |
|             | 4880            | 36.28          | 43.73          | 7.45          | 54.00          | 10.27       | V    | AV  |
|             | 7320            | 33.43          | 47.85          | 14.42         | 54.00          | 6.15        | V    | AV  |
|             | 9760            | 23.18          | 38.18          | 15.00         | 54.00          | 15.82       | V    | AV  |
|             | 12200           | 23.73          | 39.26          | 15.53         | 54.00          | 14.74       | V    | AV  |



|             |       |       |       |       |       |       |   |    |
|-------------|-------|-------|-------|-------|-------|-------|---|----|
|             | 14640 | 21.45 | 39.90 | 18.45 | 54.00 | 14.10 | V | AV |
|             | 17080 | 18.85 | 43.37 | 24.52 | 54.00 | 10.63 | V | AV |
| BLE_1M_2480 | 4960  | 45.33 | 52.72 | 7.39  | 74.00 | 21.28 | H | PK |
|             | 7440  | 42.32 | 56.79 | 14.47 | 74.00 | 17.21 | V | PK |
|             | 9920  | 33.43 | 48.47 | 15.04 | 74.00 | 25.53 | V | PK |
|             | 12400 | 33.05 | 49.52 | 16.47 | 74.00 | 24.48 | V | PK |
|             | 14880 | 32.79 | 51.31 | 18.52 | 74.00 | 22.69 | H | PK |
|             | 17360 | 29.95 | 54.77 | 24.82 | 74.00 | 19.23 | V | PK |
|             | 4960  | 33.84 | 41.23 | 7.39  | 54.00 | 12.77 | V | AV |
|             | 7440  | 32.61 | 47.08 | 14.47 | 54.00 | 6.92  | V | AV |
|             | 9920  | 23.26 | 38.30 | 15.04 | 54.00 | 15.70 | V | AV |
|             | 12400 | 22.55 | 39.02 | 16.47 | 54.00 | 14.98 | V | AV |
|             | 14880 | 21.71 | 40.23 | 18.52 | 54.00 | 13.77 | V | AV |
|             | 17360 | 18.72 | 43.54 | 24.82 | 54.00 | 10.46 | V | AV |
| BLE_2M_2402 | 4804  | 46.47 | 53.81 | 7.34  | 74.00 | 20.19 | V | PK |
|             | 7206  | 42.43 | 56.11 | 13.68 | 74.00 | 17.89 | H | PK |
|             | 9608  | 33.45 | 48.16 | 14.71 | 74.00 | 25.84 | V | PK |
|             | 12010 | 34.06 | 49.89 | 15.83 | 74.00 | 24.11 | V | PK |
|             | 14412 | 32.59 | 50.94 | 18.35 | 74.00 | 23.06 | V | PK |
|             | 16814 | 31.15 | 54.39 | 23.24 | 74.00 | 19.61 | H | PK |
|             | 4804  | 38.28 | 45.62 | 7.34  | 54.00 | 8.38  | V | AV |
|             | 7206  | 32.94 | 46.62 | 13.68 | 54.00 | 7.38  | V | AV |
|             | 9608  | 23.05 | 37.76 | 14.71 | 54.00 | 16.24 | H | AV |
|             | 12010 | 22.53 | 38.36 | 15.83 | 54.00 | 15.64 | V | AV |
|             | 14412 | 21.64 | 39.99 | 18.35 | 54.00 | 14.01 | H | AV |
|             | 16814 | 20.30 | 43.54 | 23.24 | 54.00 | 10.46 | H | AV |
| BLE_2M_2440 | 4880  | 44.20 | 51.65 | 7.45  | 74.00 | 22.35 | V | PK |
|             | 7320  | 42.43 | 56.85 | 14.42 | 74.00 | 17.15 | H | PK |
|             | 9760  | 33.53 | 48.53 | 15.00 | 74.00 | 25.47 | V | PK |

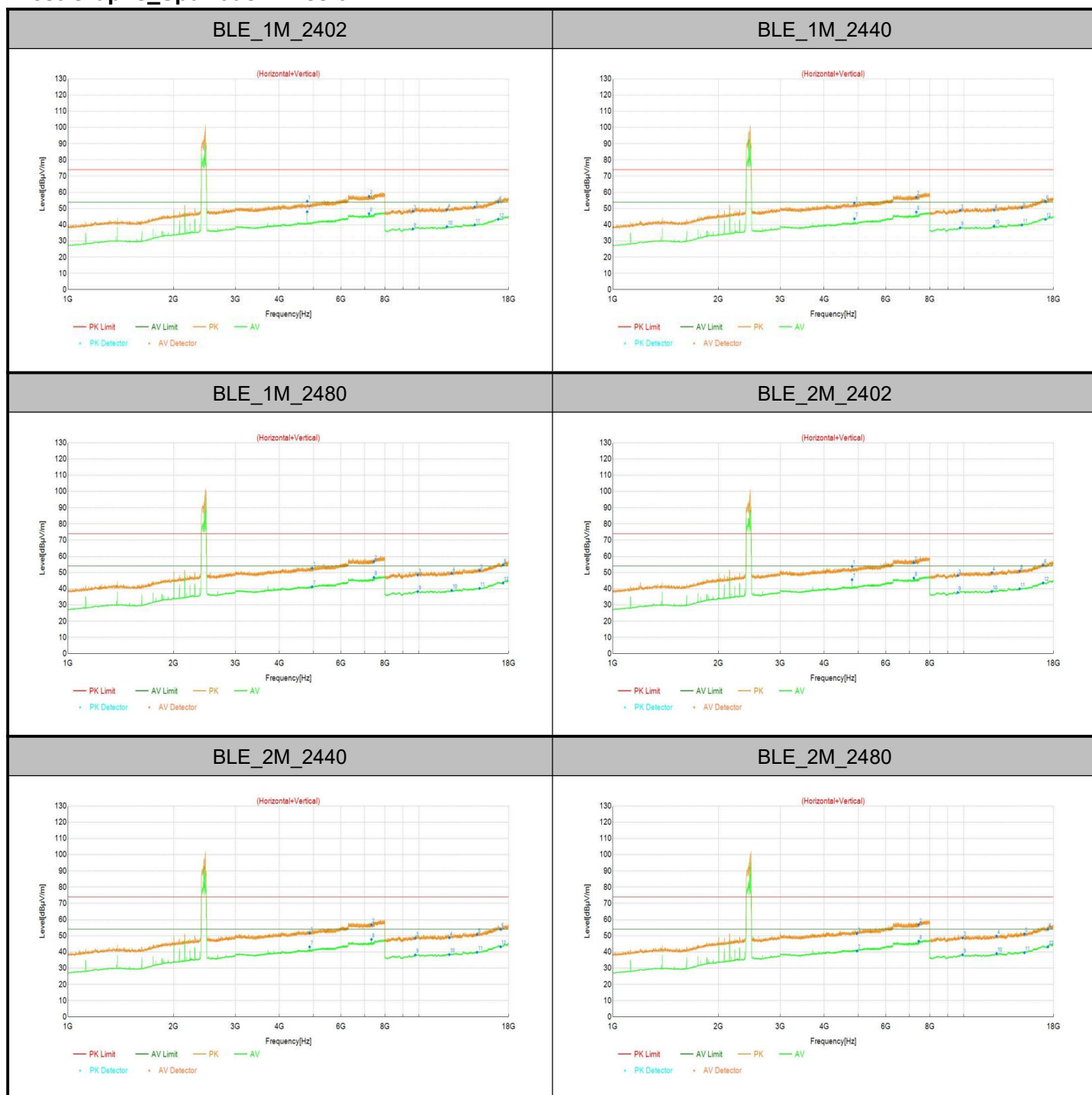
|             |       |       |       |       |       |       |   |    |
|-------------|-------|-------|-------|-------|-------|-------|---|----|
|             | 12200 | 33.24 | 48.77 | 15.53 | 74.00 | 25.23 | V | PK |
|             | 14640 | 32.33 | 50.78 | 18.45 | 74.00 | 23.22 | V | PK |
|             | 17080 | 29.61 | 54.13 | 24.52 | 74.00 | 19.87 | V | PK |
|             | 4880  | 35.72 | 43.17 | 7.45  | 54.00 | 10.83 | V | AV |
|             | 7320  | 33.32 | 47.74 | 14.42 | 54.00 | 6.26  | V | AV |
|             | 9760  | 23.18 | 38.18 | 15.00 | 54.00 | 15.82 | V | AV |
|             | 12200 | 22.89 | 38.42 | 15.53 | 54.00 | 15.58 | H | AV |
|             | 14640 | 21.37 | 39.82 | 18.45 | 54.00 | 14.18 | H | AV |
|             | 17080 | 18.74 | 43.26 | 24.52 | 54.00 | 10.74 | H | AV |
| BLE_2M_2480 | 4960  | 44.07 | 51.46 | 7.39  | 74.00 | 22.54 | H | PK |
|             | 7440  | 42.40 | 56.87 | 14.47 | 74.00 | 17.13 | V | PK |
|             | 9920  | 33.63 | 48.67 | 15.04 | 74.00 | 25.33 | V | PK |
|             | 12400 | 33.31 | 49.78 | 16.47 | 74.00 | 24.22 | V | PK |
|             | 14880 | 32.59 | 51.11 | 18.52 | 74.00 | 22.89 | H | PK |
|             | 17360 | 29.15 | 53.97 | 24.82 | 74.00 | 20.03 | H | PK |
|             | 4960  | 33.24 | 40.63 | 7.39  | 54.00 | 13.37 | V | AV |
|             | 7440  | 32.14 | 46.61 | 14.47 | 54.00 | 7.39  | V | AV |
|             | 9920  | 23.29 | 38.33 | 15.04 | 54.00 | 15.67 | V | AV |
|             | 12400 | 22.64 | 39.11 | 16.47 | 54.00 | 14.89 | V | AV |
|             | 14880 | 21.04 | 39.56 | 18.52 | 54.00 | 14.44 | V | AV |
|             | 17360 | 18.34 | 43.16 | 24.82 | 54.00 | 10.84 | V | AV |

| Data List   |                 |                |                |               |                |             |      |     |
|-------------|-----------------|----------------|----------------|---------------|----------------|-------------|------|-----|
| Test Mode   | Frequency [MHz] | Reading [dBμV] | Level [dBμV/m] | Factor [dB/m] | Limit [dBμV/m] | Margin [dB] | Pol. | Det |
| BLE_1M_2402 | 44.188171       | 44.61          | 29.26          | -15.35        | 40.00          | 10.74       | V    | QP  |
|             | 108.777138      | 30.15          | 12.50          | -17.65        | 43.50          | 31.00       | V    | QP  |
|             | 197.422355      | 26.15          | 10.62          | -15.53        | 43.50          | 32.88       | H    | QP  |
|             | 500.003732      | 50.82          | 40.67          | -10.15        | 46.00          | 5.33        | V    | QP  |



|  |            |       |       |       |       |      |   |    |
|--|------------|-------|-------|-------|-------|------|---|----|
|  | 593.987138 | 48.52 | 39.91 | -8.61 | 46.00 | 6.09 | V | QP |
|  | 875.001558 | 45.21 | 41.39 | -3.82 | 46.00 | 4.61 | H | QP |

## Test Graphs\_Spurious Emission



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| BLE_1M_2402                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | / |
| <div><p>(Horizontal+Vertical)</p><p>The spectrum plot displays the signal level in dBμV/m against frequency in Hz. The y-axis ranges from 0 to 130 dBμV/m, and the x-axis ranges from 30M to 1G Hz. A yellow line represents the QP Limit, which is stepped at various frequencies. A blue line represents the PK (Peak) signal, showing several peaks. Red dots indicate the QP Detector results. The legend at the bottom identifies the QP Limit, PK, and QP Detector.</p></div> | / |

## ANNEX C: The EUT Appearance

The EUT Appearance (internal and external photographs) are submitted separately.

## ANNEX D: Test Setup Photograph

The Test Setup Photographs are submitted separately.