# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

| | |
|---|---|
| **Applicant:** | Axon Enterprise, Inc.<br>17800 N 85th St, Scottsdale, AZ 85255, United States |
| **Manufacturer:** | Axon Enterprise, Inc.<br>17800 N 85th St, Scottsdale, AZ 85255, United States |
| **Product Name:** | Fleet Hub |
| **Brand Name:** | Axon |
| **Model No.:** | AX1033 |
| **HVIN:** | S01405B |
| **Model Difference:** | N/A |
| **Report Number:** | ER/2022/30024 |
| **FCC ID** | X4GS01405B |
| **IC:** | 8803A-S01405B |
| **Date of EUT Received:** | March 7, 2022 |
| **Date of Test:** | March 16, 2022 ~ March 25, 2022 |
| **Issue Date:** | April 18, 2022 |

***Approved By*** _____
***Jim Chang***

**We hereby certify that:**

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISED RSS-247.

The results of this report relate only to the sample identified in this report.

| Revision History | | | | | |
|---|---|---|---|---|---|
| **Report Number** | **Revision** | **Description** | **Issue Date** | **Revised By** | **Remark** |
| ER/2022/30024 | 00 | Original | April 18, 2022 | Yuri Tsai | |
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**Note:**

1、The remark "*" indicates modification of the report upon requests from certification body.

# Table of Contents

# 1 GENERAL INFORMATION

## 1.1 Product Description

| | |
|---|---|
| Product Name: | Fleet Hub |
| Brand Name: | Axon |
| Model No.: | AX1033 |
| HVIN: | S01405B |
| Model Difference: | N/A |
| Hardware Version: | X3 |
| Firmware Version: | IG2.DVT.1.2s |
| EUT Series No.: | X704322CM |
| Power Supply: | 12Vdc from Car battery |
| Test Software (Name/Version) | Tera Term 4.105 |

## 1.2 RF Specification

| | |
|---|---|
| Radio Technology: | BLE |
| Frequency Range: | 2402 – 2480MHz |
| Channel number: | 40 channels |
| Modulation type: | GFSK |
| Transmit Power: | 4.98 dBm |

## 1.3 Antenna Designation

| Antenna Type | Supplier | Antenna Part No. | Freq. (MHz) | Peak Antenna Gain (dBi) |
|---|---|---|---|---|
| Dipole | Airgain | AP-AXONF3-GL-WWG-BL-3M | 2.4GHz | 2.50 |

Note: Antenna information is provided by the applicant.

## 1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
FCC KDB 558074 D01 15.247 Meas Guidance v05r02
RSS-247 issue 2 Feb. 2017
RSS-Gen, Issue 5 (Amendment 2, February 2021)
ANSI C63.10:2013

## 1.5 Test Facility

| Laboratory | Test Site Address | Test Site Name | FCC Designation number | IC CAB identifier |
|---|---|---|---|---|
| SGS Taiwan Ltd. Central RF Lab. (TAF code 3702) | No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan. | SAC 1 | TW0027 | TW3702 |
| | | SAC 3 | | |
| | | Conduction 1 | | |
| | | Conducted 1 | | |
| | | Conducted 2 | | |
| | | Conducted 3 | | |
| | | Conducted 4 | | |
| | | Conducted 5 | | |
| | | Conducted 6 | | |
| | No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333 | Conduction C | TW0028 | |
| | | SAC C | | |
| | | SAC D | | |
| | | SAC G | | |
| | | Conducted A | | |
| | | Conducted B | | |
| | | Conducted C | | |
| | | Conducted D | | |
| | | Conducted E | | |
| | | Conducted F | | |
| | | Conducted G | | |
| **Note:** Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address. | | | | |

## 1.6 Special Accessories

There are no special accessories used while test was conducted.

## 1.7 Equipment Modifications

There was no modification incorporated into the EUT.

# 2 SYSTEM TEST CONFIGURATION

## 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

## 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

## 2.3 Test Procedure

### 2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

### 2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

### 2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

## 2.4 Measurement Results Explanation Example

### 2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

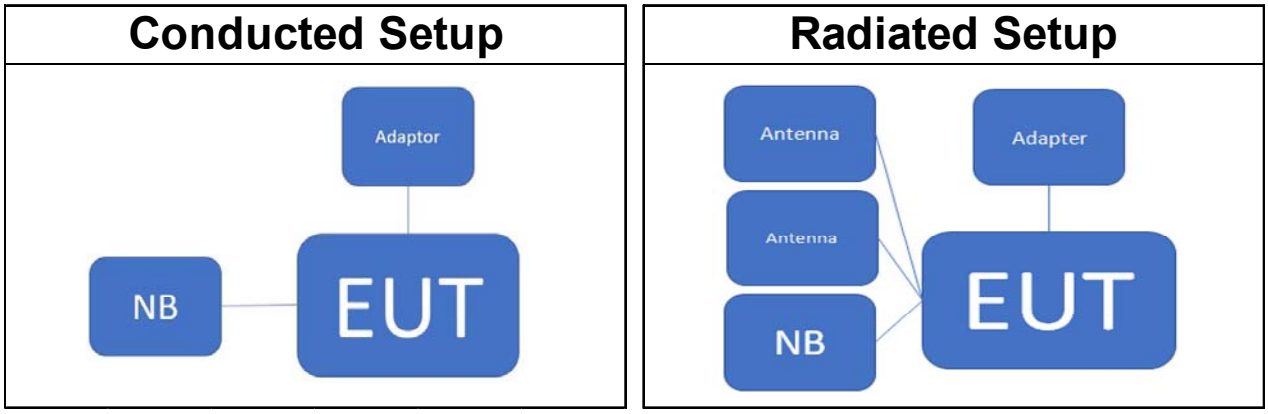
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

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

### 2.4.2 For all conducted test items:

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

## 2.5 Test Configuration




## 2.6 Control Unit(s)

| Conducted Emission Test Site: Conducted 1 | | | | | |
|---|---|---|---|---|---|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| Test Software | SGS | Radio Test Software | Ver. 21 | N.C.R | N.C.R |
| Adapter | FSP Technology Inc. | FSP120-AHAN3 | H00000084 | N/A | N/A |
| Notebook | Lenovo | T430s | R9-WW5EG | N/A | N/A |

| Radiated Emission Test Site: SAC 1 | | | | | |
|---|---|---|---|---|---|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| Test Software | Audix | e3 | Ver. 9.210322 | N.C.R | N.C.R |

# 3 SUMMARY OF TEST RESULTS

| FCC Rules | ISED Rules | Description Of Test | Result |
|---|---|---|---|
| §15.207(a) | RSS-Gen §8.8 | AC Power Line Conducted Emission | N/A |
| §15.247(b) (3) | RSS-247 §5.4 d | Peak Output Power | Compliant |
| §15.247(a)(2) | RSS-247 §5.2 a<br>RSS-Gen §6.7 | Emission Bandwidth | Compliant |
| §15.247(d)<br>§15.205<br>§15.209 | RSS-247 §5.5<br>RSS-Gen §8.9<br>RSS-Gen §8.10 | Radiated & Conducted Band Edge and Spurious Emission | Compliant |
| §15.247(e) | RSS-247 §5.2 b | Peak Power Density | Compliant |
| §15.203 | N/A | Antenna Requirement | Compliant |

# 4 DESCRIPTION OF TEST MODES

## 4.1 Operating Frequencies

| ITEM | FREQUENCY | ITEM | FREQUENCY | ITEM | FREQUENCY |
|---|---|---|---|---|---|
| 1 | 2402 MHz | 15 | 2430 MHz | 29 | 2458 MHz |
| 2 | 2404 MHz | 16 | 2432 MHz | 30 | 2460 MHz |
| 3 | 2406 MHz | 17 | 2434 MHz | 31 | 2462 MHz |
| 4 | 2408 MHz | 18 | 2436 MHz | 32 | 2464 MHz |
| 5 | 2410 MHz | 19 | 2438 MHz | 33 | 2466 MHz |
| 6 | 2412 MHz | 20 | 2440 MHz | 34 | 2468 MHz |
| 7 | 2414 MHz | 21 | 2442 MHz | 35 | 2470 MHz |
| 8 | 2416MHz | 22 | 2444 MHz | 36 | 2472 MHz |
| 9 | 2418 MHz | 23 | 2446 MHz | 37 | 2474 MHz |
| 10 | 2420 MHz | 24 | 2448 MHz | 38 | 2476 MHz |
| 11 | 2422 MHz | 25 | 2450 MHz | 39 | 2478 MHz |
| 12 | 2424 MHz | 26 | 2452 MHz | 40 | 2480 MHz |
| 13 | 2426 MHz | 27 | 2454 MHz | | |
| 14 | 2428 MHz | 28 | 2456 MHz | | |

## 4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. The field strength of radiation emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.
4. Investigation has been done on all the possible configurations for searching the worst case.

| RADIATED EMISSION TEST (BELOW 1 GHz) | | | | |
|---|---|---|---|---|
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | DATA RATE (Mbps) |
| Bluetooth LE | 0 to 39 | 20 | GFSK | 1 |

| RADIATED EMISSION TEST (ABOVE 1 GHz) | | | | |
|---|---|---|---|---|
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | DATA RATE (Mbps) |
| Bluetooth LE | 0 to 39 | 0,20,39 | GFSK | 1 |

| CONDUCTED TEST | | | | |
|---|---|---|---|---|
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | DATA RATE (Mbps) |
| Bluetooth LE | 0 to 39 | 0,20,39 | GFSK | 1 |

# 5 MEASUREMENT UNCERTAINTY

| Test Items | Uncertainty | | |
|---|---|---|---|
| AC Power Line Conducted Emission | +/- | 2.34 | dB |
| Output Power measurement | +/- | 1 | dB |
| Emission Bandwidth | +/- | 1.53 | Hz |
| Undesignable radiated emission measurement | +/- | 1.68 | dB |
| Peak Power Density | +/- | 1.62 | dB |
| Temperature | +/- | 0.4 | °C |
| Humidity | +/- | 3.5 | % |
| DC / AC Power Source | +/- | 1 | % |

| Radiated Spurious Emission Measurement Uncertainty | | | | |
|---|---|---|---|---|
| **Polarization: Vertical** | **+/-** | **2.57** | **dB** | 9kHz~30MHz |
| | **+/-** | **4.85** | **dB** | 30MHz - 1000MHz |
| | **+/-** | **4.45** | **dB** | 1GHz - 18GHz |
| | **+/-** | **4.24** | **dB** | 18GHz - 40GHz |
| **Polarization: Horizontal** | **+/-** | **2.57** | **dB** | 9kHz~30MHz |
| | **+/-** | **4.37** | **dB** | 30MHz - 1000MHz |
| | **+/-** | **4.45** | **dB** | 1GHz - 18GHz |
| | **+/-** | **4.24** | **dB** | 18GHz - 40GHz |

***Note:***

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

# 6 MEASUREMENT EQUIPMENT USED

## 6.1 Emission from AC power line

N/A

## 6.2 Conducted Measurement

| Conducted Emission Test Site: Conducted 1 | | | | | |
|---|---|---|---|---|---|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| EXA Spectrum Analyzer | KEYSIGHT | N9010B | MY59071571 | 05/26/2021 | 05/25/2022 |
| Power Meter | Anritsu | ML2496A | 1242004 | 11/02/2021 | 11/01/2022 |
| Power Sensor | Anritsu | MA2411B | 1207365 | 11/02/2021 | 11/01/2022 |
| Power Sensor | Anritsu | MA2411B | 1207368 | 11/02/2021 | 11/01/2022 |
| Attenuator | Mini-Circuit | BW-S10W2+ | 2 | 12/14/2021 | 12/13/2022 |
| DC Block | Mini-Circuits | BLK-18-S+ | 1 | 12/14/2021 | 12/13/2022 |

## 6.3 Radiated Measurement

| Radiated Emission Test Site: SAC 1 | | | | | |
|---|---|---|---|---|---|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| Horn Antenna | SCHWARZBECK | BBHA9120D | D803 | 12/20/2021 | 12/19/2022 |
| Bi-log Antenna | TESEO | CBL 6112D | 35242 & AT-N0555 | 01/03/2022 | 01/02/2023 |
| Horn Antenna | SCHWARZBECK | BBHA9170 | 184 | 12/16/2021 | 12/15/2022 |
| Loop Antenna | ETS.LINDGREN | 6502 | 148045 | 09/29/2021 | 09/28/2022 |
| Site Cal | SGS | SAC I chamber | N/A | 01/01/2022 | 12/31/2022 |
| EXA Spectrum Analyzer | Agilent | N9010A | MY50420195 | 05/12/2021 | 05/11/2022 |
| EMI Test Receiver | R&S | ESCI 7 | 100759 | 08/26/2021 | 08/25/2022 |
| Pre-Amplifier | EMC Instruments | EMC184045B | 980135 | 10/27/2021 | 10/26/2022 |
| Pre-Amplifier | HP | 8449B | 3008A01973 | 12/16/2021 | 12/15/2022 |
| Pre-Amplifier | HP | 8447D | 2944A09469 | 12/16/2021 | 12/15/2022 |
| Attenuator | Mini-Circuit | BW-S10W2+ | 4 | 12/14/2021 | 12/13/2022 |
| Bandreject Filter 2400-2483.5 | EWT | EWT-14-0166 | M1 | 12/14/2021 | 12/13/2022 |
| 3.2GHz High Pass Filter | WI | WHKX10-2624-80SS | 3 | 12/14/2021 | 12/13/2022 |
| Coaxial Cable | Huber Suhner | succoflex 102 | MY2622/2 | 12/16/2021 | 12/15/2022 |
| Coaxial Cable | Huber Suhner | succoflex 104A | 800086/4a | 12/16/2021 | 12/15/2022 |
| Coaxial Cable | Huber Suhner | EMC 104-SM-SM-2000 | 160123 | 12/16/2021 | 12/15/2022 |
| Coaxial Cable | Huber Suhner | SUCOFLEX 102 | MY2630/2 | 12/16/2021 | 12/15/2022 |
| Coaxial Cable | Huber Suhner | SUCOFLEX 102 | MY22962/2 | 12/16/2021 | 12/15/2022 |

***NOTE:*** *N.C.R refers to Not Calibrated Required.*

# 7 CONDUCTED EMISSION TEST

## 7.1 Standard Applicable:

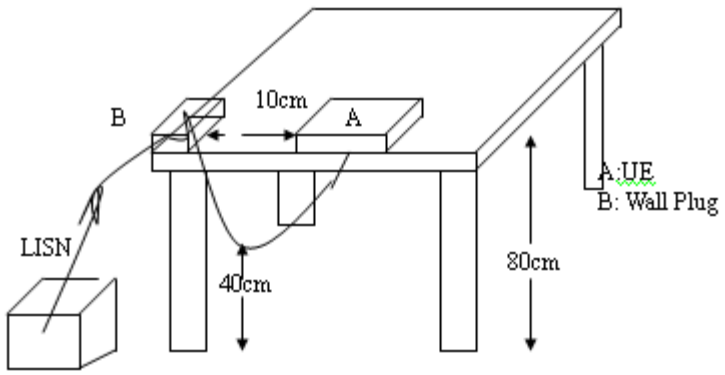
Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

| Frequency range MHz | Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |
| Note<br>1.The lower limit shall apply at the transition frequencies<br>2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz. | | |

## 7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

## 7.3 Test Setup




## 7.4 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.

2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

## 7.5 Measurement Result:

N/A; Powered from Car battery.

# 8 PEAK OUTPUT POWER MEASUREMENT

## 8.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

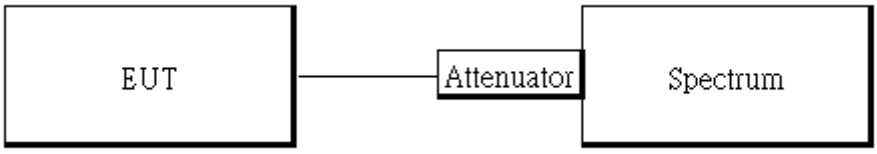
In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

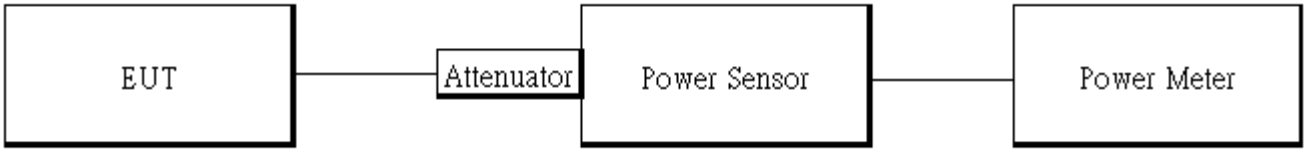
All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

## 8.2 Test Setup

### 8.2.1 Duty Cycle




### 8.2.2 Output Power




## 8.3 Measurement Procedure:

### 8.3.1 Duty Cycle

1. Place the EUT on the table and set it in transmitting mode.
2. Set span = Zero

3. RBW = 8MHz, VBW = 8MHz,
4. Detector = Peak

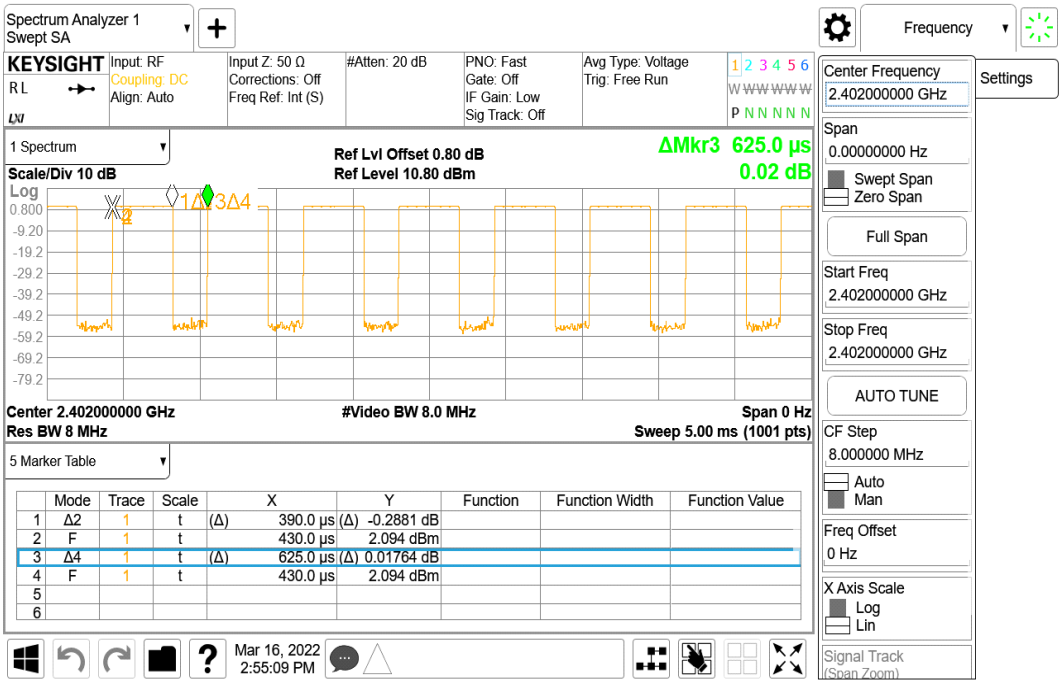
### 8.3.2 Output Power

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

## 8.4 Duty Factor:

| | Duty Cycle (%) = Ton / (Ton+Toff) | Duty Factor (dB) =10*log ( 1/Duty Cycle ) | 1/T (kHz) | VBW setting (kHz) |
|---|---|---|---|---|
| BLE 1M | 62.40 | 2.05 | 2.56 | 3.00 |

BLE_1M_LowCH00-2402



## 8.5 Output Power:

### 8.5.1 Peak & Avg

**BLE 1M mode:**

| CH | Frequency (MHz) | Power set | Peak Power Output (dBm) | Required Limit (dBm) |
|---|---|---|---|---|
| Low | 2402 | default | 3.15 | 30 |
| Mid | 2442 | default | **4.98** | 30 |
| High | 2480 | default | 3.09 | 30 |
| **CH** | **Frequency (MHz)** | **Power set** | **Max. Avg. Output include tune up tolerance Power (dBm)** | **Required Limit (dBm)** |
| Low | 2402 | default | 3.00 | 30 |
| Mid | 2442 | default | 4.81 | 30 |
| High | 2480 | default | 2.96 | 30 |

**Note: Measured by power meter, cable loss dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.*

### 8.5.2 EIRP

**EIRP BLE 1M mode**

| CH | Frequency (MHz) | Power set | Max. Avg. Output include tune up tolerance Power (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Limit |
|---|---|---|---|---|---|---|
| Low | 2402 | default | 3.00 | 2.50 | 5.50 | 4W= 36 dBm |
| Mid | 2442 | default | 4.81 | 2.50 | 7.31 | 4W= 36 dBm |
| High | 2480 | default | 2.96 | 2.50 | 5.46 | 4W= 36 dBm |

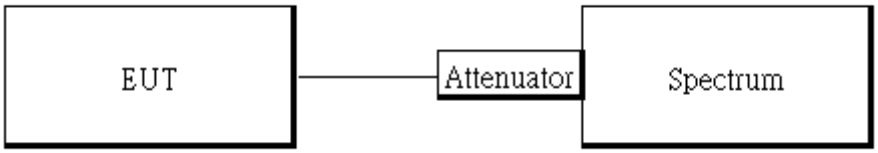
***Note:** EIRP = Average Power + Gain

# 9 EMISSION BANDWIDTH MEASUREMENT

## 9.1 Standard Applicable

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

## 9.2 Test Setup




## 9.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set the spectrum analyzer as
   RBW= 100 kHz ,
   VBW = 3 X RBW,
   Span= 2 to 5 times of the OBW,
   Sweep=auto,
   Detector = Peak, and Max hold for -6dB Bandwidth test.
5. Set the spectrum analyzer as
   RBW= 1 % to 5% of 99% Bandwidth ,
   VBW ≥ 3 X RBW,
   Span= large enough to capture all products of the modulation process,
   Sweep=auto,
   Detector = Peak, and Max hold for 99% Bandwidth test.
6. Mark the peak frequency and 99%dB (upper and lower) frequency
7. Repeat above procedures until all test default channel is completed

## 9.4 Measurement Result:

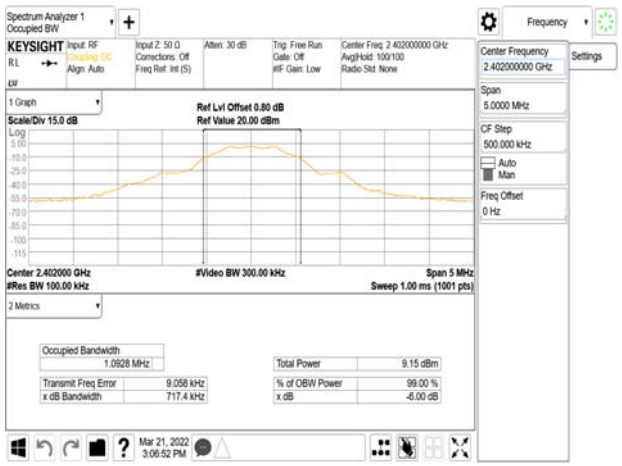
**BLE 1M mode**

| Frequency (MHz) | 6dB BW (MHz) | Required BW (MHz) | Result |
|---|---|---|---|
| 2402 | 1.0928 | ≧ 0.5 | PASS |
| 2442 | 1.0924 | ≧ 0.5 | PASS |
| 2480 | 1.0972 | ≧ 0.5 | PASS |

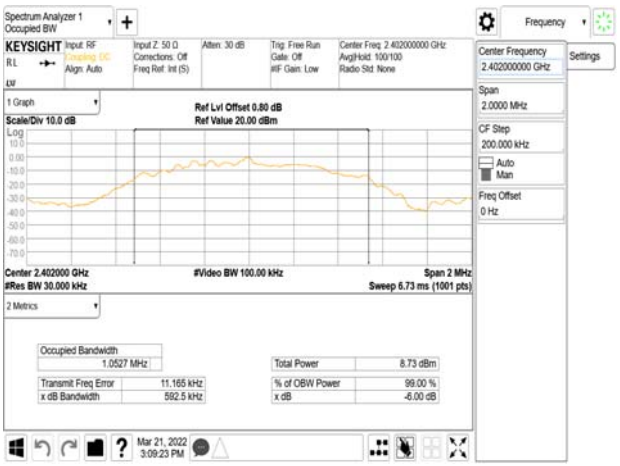
**BLE 1M mode**

| Frequency (MHz) | 99%Bandwidth (MHz) |
|---|---|
| 2402 | 1.0527 |
| 2442 | 1.0532 |
| 2480 | 1.0550 |

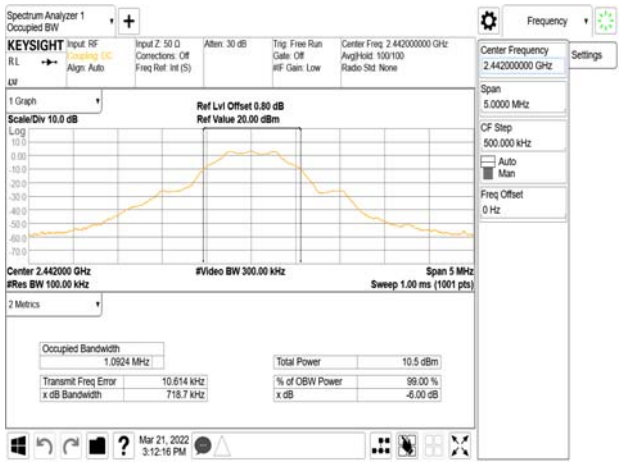
OBW_BLE 1M_LowCH00-2402MHz



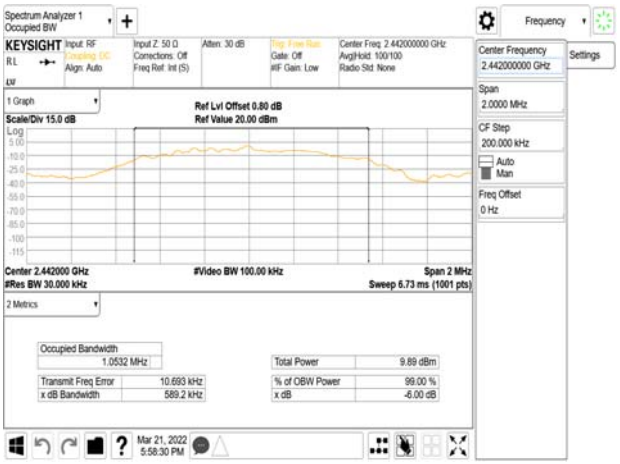

IC OBW_BLE 1M_LowCH00-2402MHz




OBW_BLE 1M_MidCH20-2442MHz

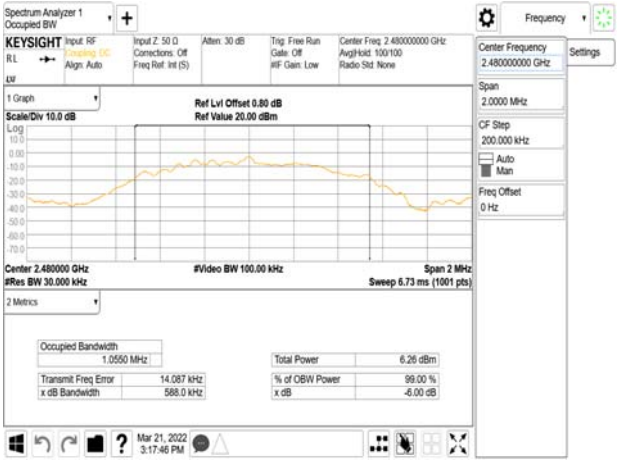



IC OBW_BLE 1M_MidCH20-2442MHz




OBW_BLE 1M_HighCH39-2480MHz


IC OBW_BLE 1M_HighCH39-2480MHz

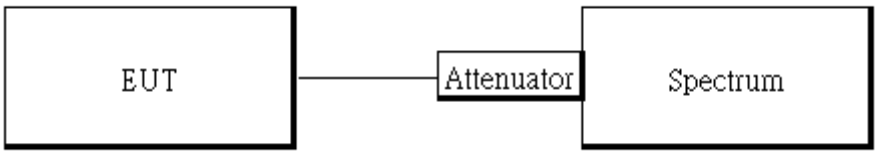


# 10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

## 10.1 Standard Applicable

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 conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

## 10.2 Test Setup




## 10.3 Measurement Procedure

### 10.3.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
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.

### 10.3.2 Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Set DL as the limit = reading on marker of reference level measurement – 20dBm
7. Mark the highest readings of the emissions outside of 2400MHz~2483.5MHz.
8. Repeat above procedures until all default test channel (low and high) was complete.

### 10.3.3 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

## 10.4 Measurement Result

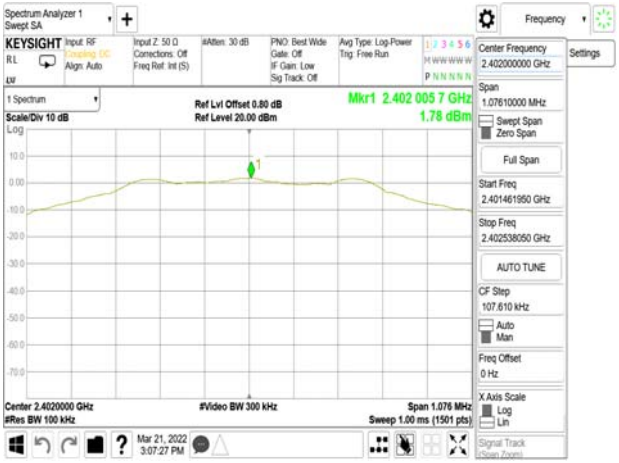
**BLE 1M_Reference Level of Limit**

| Frequency (MHz) | RF Power Density (dBm) | Reference Level of Limit = PSD - 20dB (dBm) |
|---|---|---|
| 2402 | 1.78 | -18.22 |
| 2442 | 3.18 | -16.82 |
| 2480 | -0.41 | -20.41 |

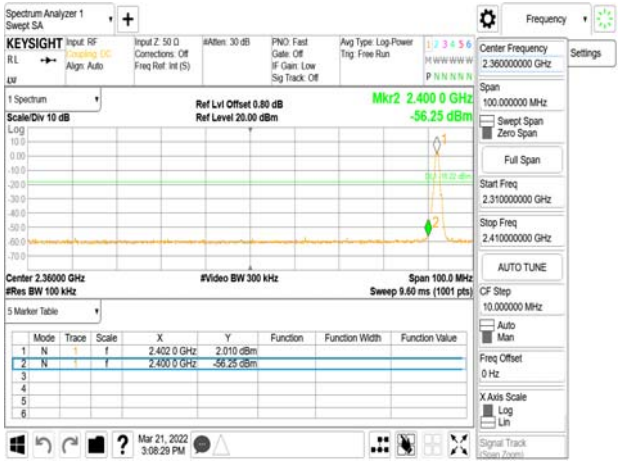
*NOTE: cable loss as dB that offsets in the spectrum*

*NOTE: Refer to next page for plots.*

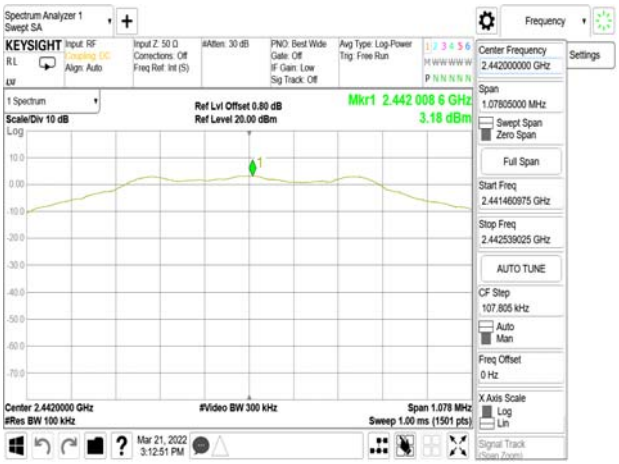
Reference Level_BLE 1M_LowCH00-2402MHz



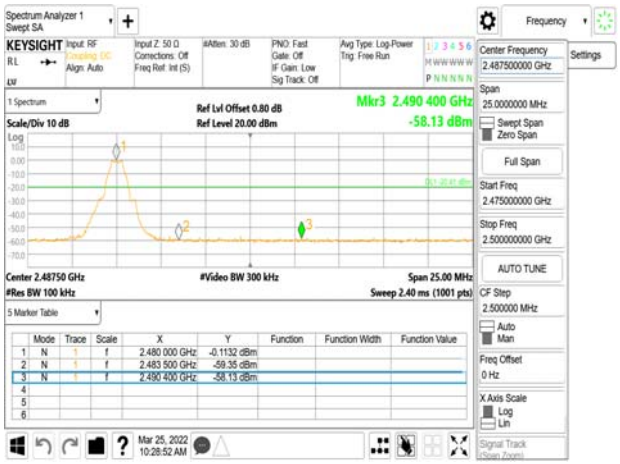

Band Edge_BLE 1M_LowCH00-2402MHz



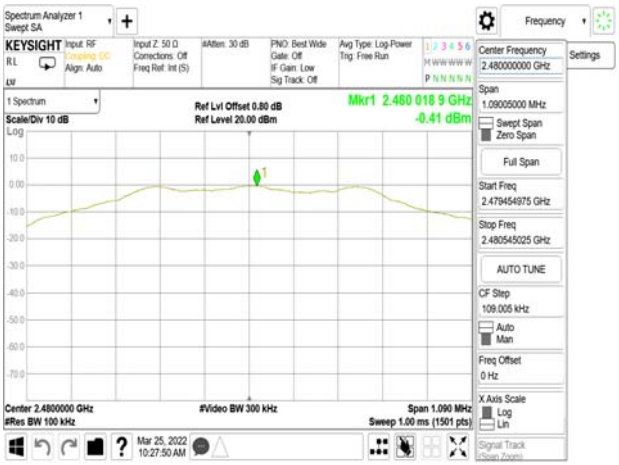

Reference Level_BLE 1M_MidCH20-2442MHz




Band Edge_BLE 1M_HighCH39-2480MHz

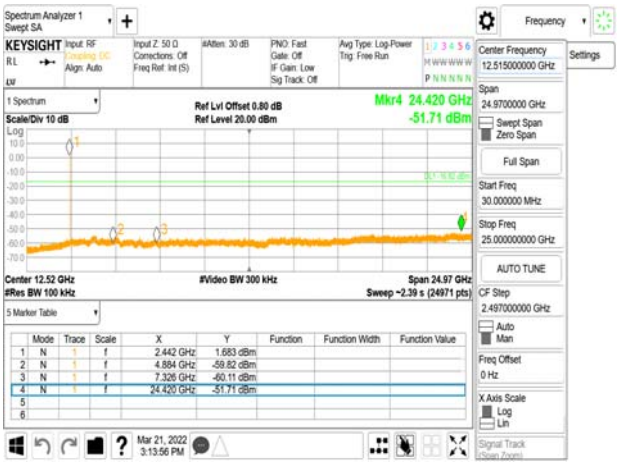



Reference Level_BLE 1M_HighCH39-2480MHz



Spurious Emission_BLE 1M_LowCH00-2402MHz


Spurious Emission_BLE 1M_MidCH20-2442MHz




Spurious Emission_BLE 1M_HighCH39-2480MHz

# 11 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

## 11.1 Standard Applicable

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 conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 and RSS-Gen §8.9 Table 5 and 6 limit as below.

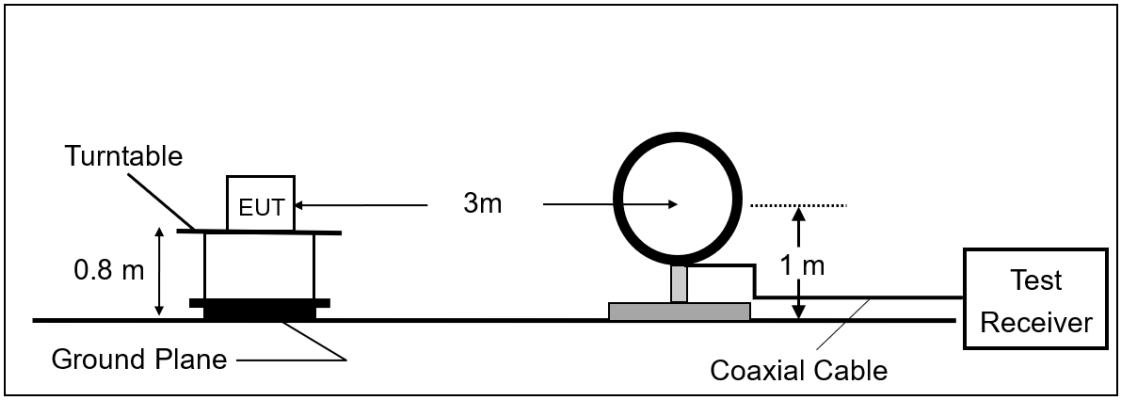
And according to §15.33(a) (1) & RSS-Gen §6.13.2.a for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

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

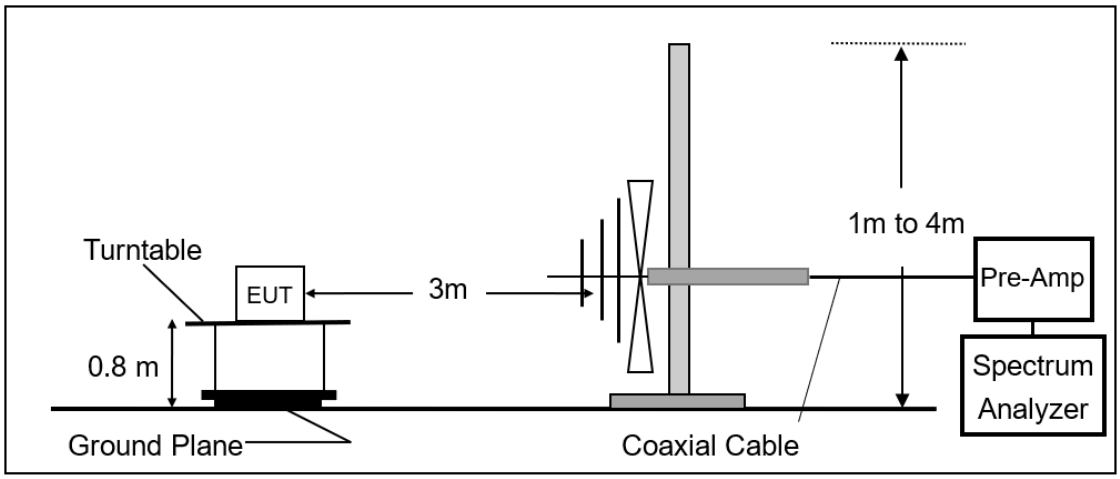
**Note:** The lower limit shall apply at the transition frequencies.

## 11.2 Test Setup

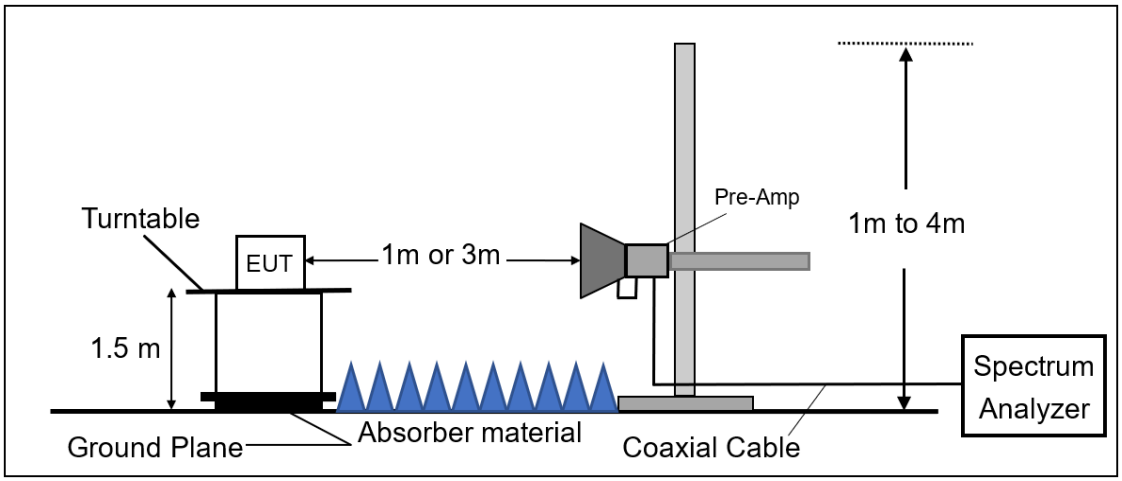
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.




(C) Radiated Emission Test Set-Up, Frequency Above 1GHz.




## 11.3 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
6. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.

7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Maximum Emission Measurements at frequency above 1 GHz.
8. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Emission Measurements at frequency above 1 GHz.
9. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
12. Repeat above procedures until all default test channel measured were complete.

## 11.4 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*

*The limit of the emission level is expressed in dBuV/m, which converts 20*log(uV/m)*

*Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)*

*Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)*

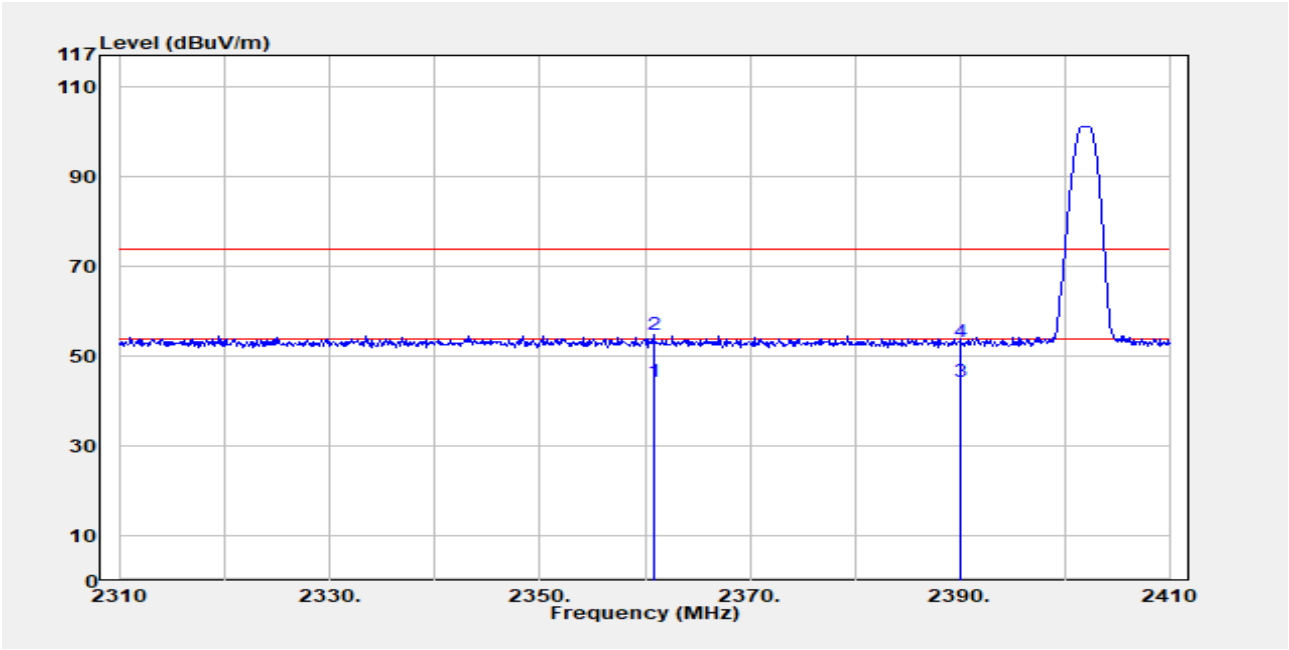
## 11.5 Test Results of Radiated Spurious Emissions from 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) & RSS-GEN §6.13.2 was not reported.

## 11.6 Measurement Result:

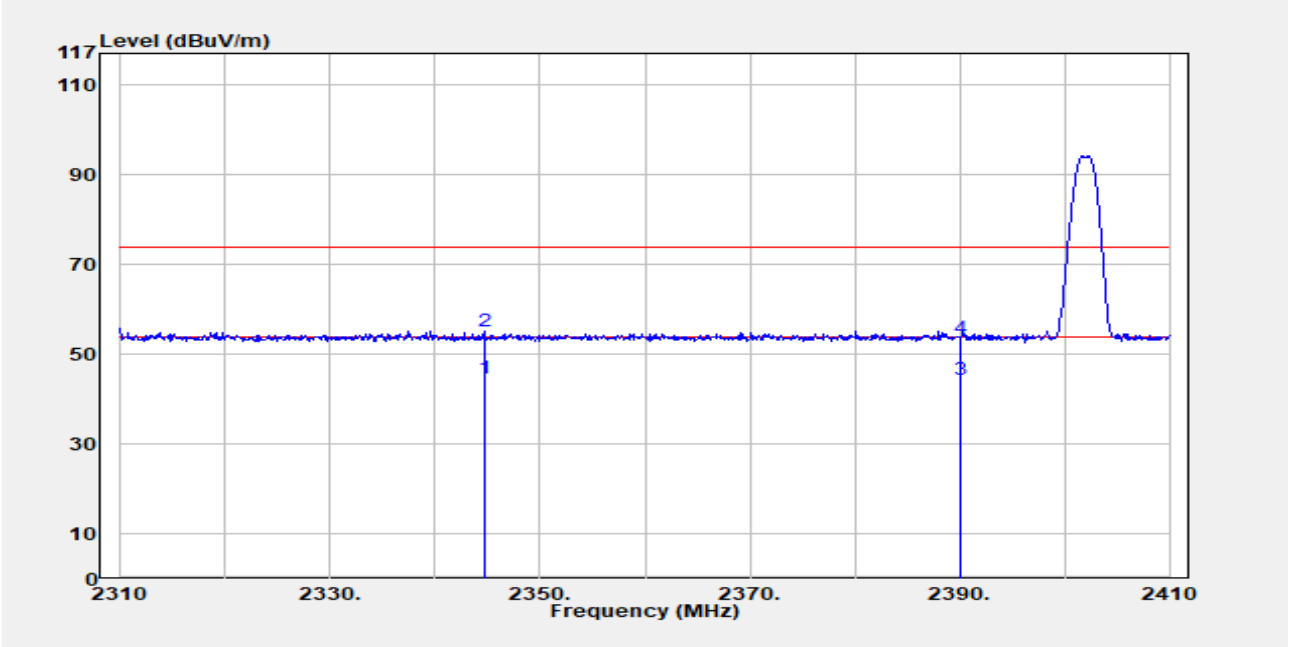
### 11.6.1 Radiated Band Edge Measurement Result

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2402 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Bandedge CH Low | Antenna Pol. | :Vertical |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



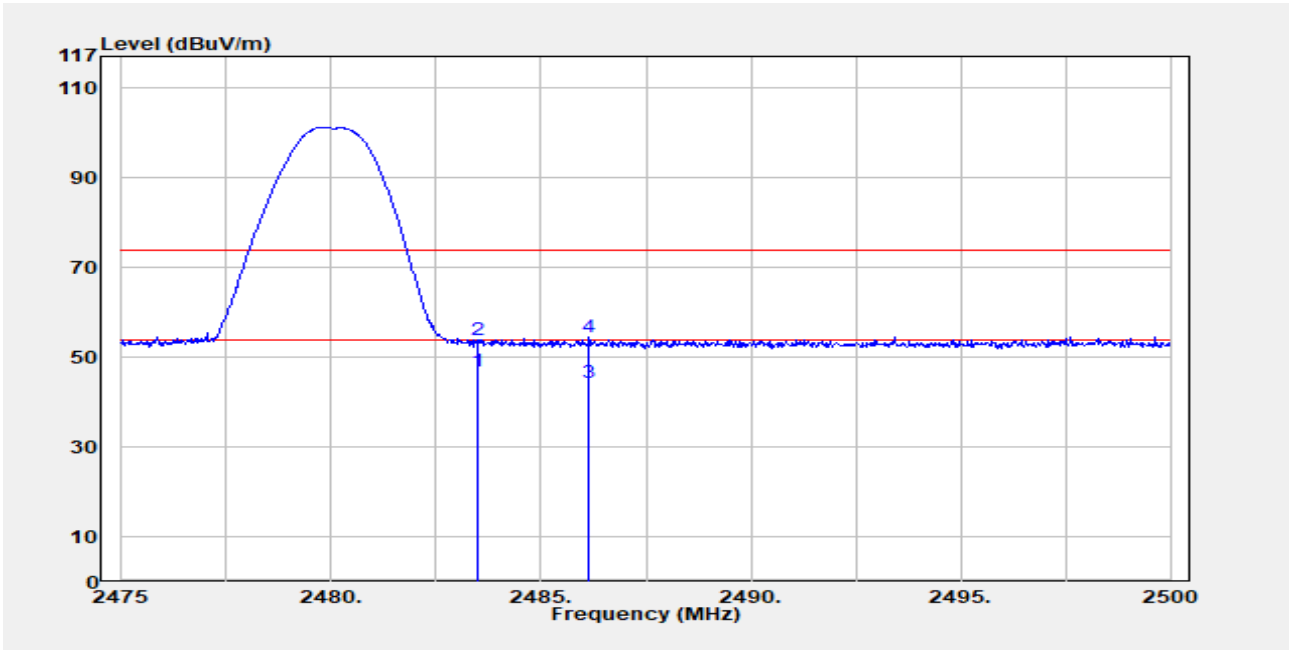

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 2360.80 | Average | 44.29 | -0.02 | 44.27 | 54.00 | -9.73 |
| 2360.80 | Peak | 55.00 | -0.02 | 54.98 | 74.00 | -19.02 |
| 2390.00 | Average | 44.43 | -0.12 | 44.31 | 54.00 | -9.69 |
| 2390.00 | Peak | 53.28 | -0.12 | 53.16 | 74.00 | -20.84 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2402 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Bandedge CH Low | Antenna Pol. | :Horizontal |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



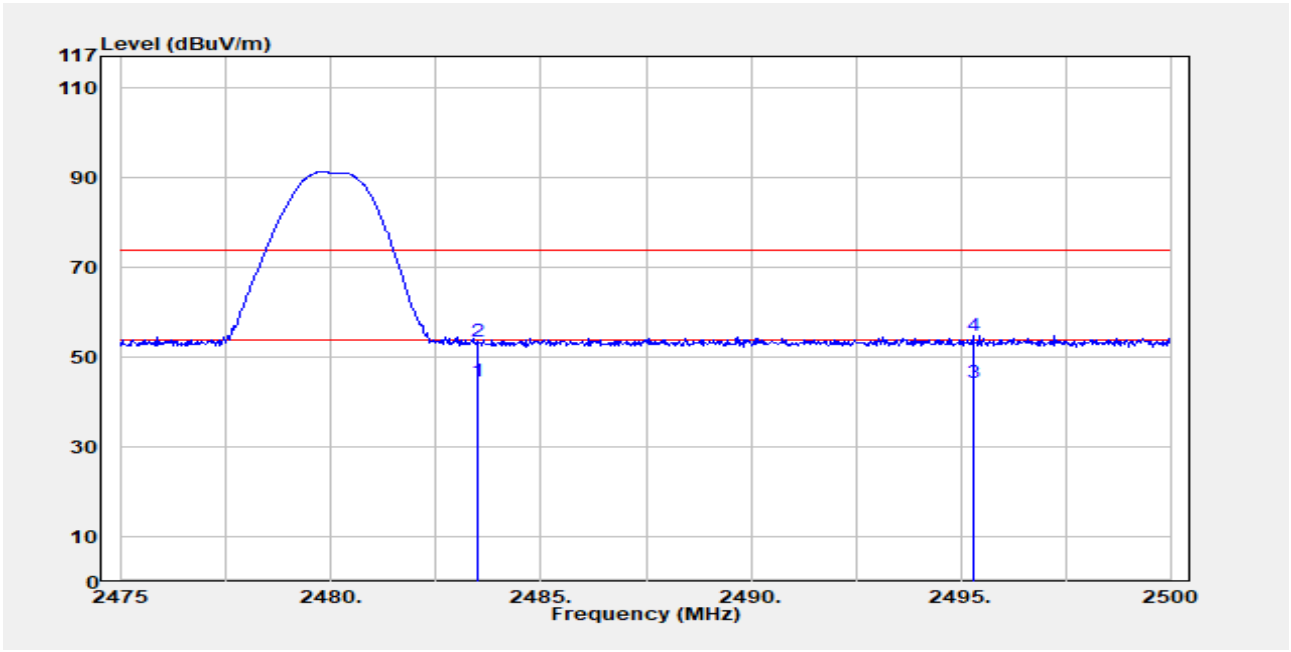

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 2344.70 | Average | 44.60 | 0.02 | 44.62 | 54.00 | -9.38 |
| 2344.70 | Peak | 55.10 | 0.02 | 55.12 | 74.00 | -18.88 |
| 2390.00 | Average | 44.67 | -0.12 | 44.55 | 54.00 | -9.45 |
| 2390.00 | Peak | 53.72 | -0.12 | 53.60 | 74.00 | -20.40 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2480 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Bandedge CH High | Antenna Pol. | :Vertical |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |




| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 2483.50 | Average | 46.96 | -0.16 | 46.80 | 54.00 | -7.20 |
| 2483.50 | Peak | 54.18 | -0.16 | 54.02 | 74.00 | -19.98 |
| 2486.15 | Average | 44.69 | -0.16 | 44.53 | 54.00 | -9.47 |
| 2486.15 | Peak | 54.67 | -0.16 | 54.51 | 74.00 | -19.49 |

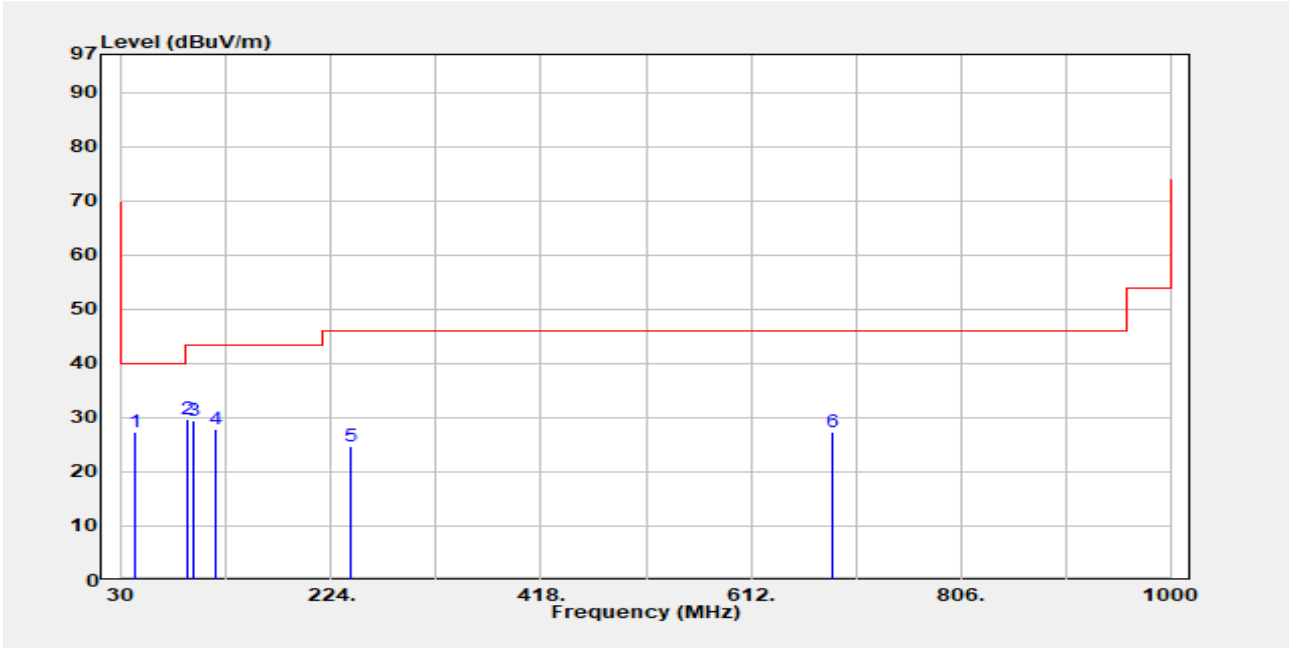
| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2480 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Bandedge CH High | Antenna Pol. | :Horizontal |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |




| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 2483.50 | Average | 44.77 | -0.16 | 44.60 | 54.00 | -9.40 |
| 2483.50 | Peak | 53.70 | -0.16 | 53.54 | 74.00 | -20.46 |
| 2495.30 | Average | 44.43 | -0.15 | 44.28 | 54.00 | -9.72 |
| 2495.30 | Peak | 54.91 | -0.15 | 54.77 | 74.00 | -19.23 |

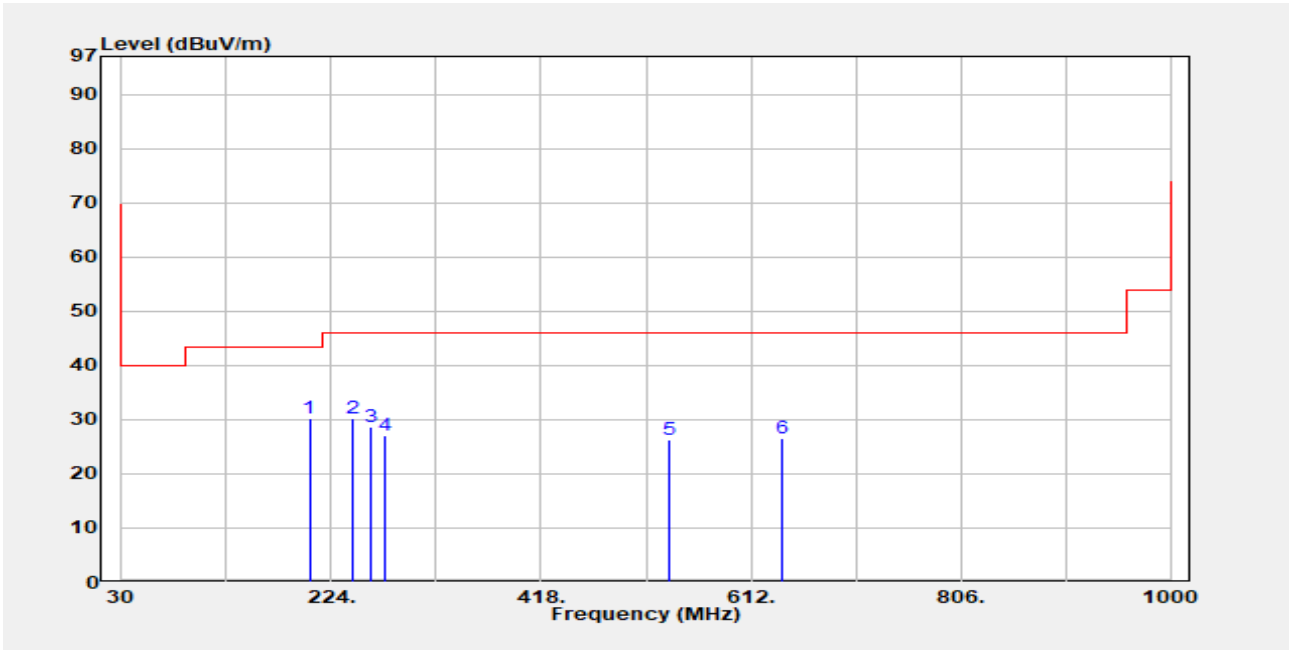
## 11.6.2 Radiated Spurious Emission

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2442 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Mid | Antenna Pol. | :VERTICAL |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



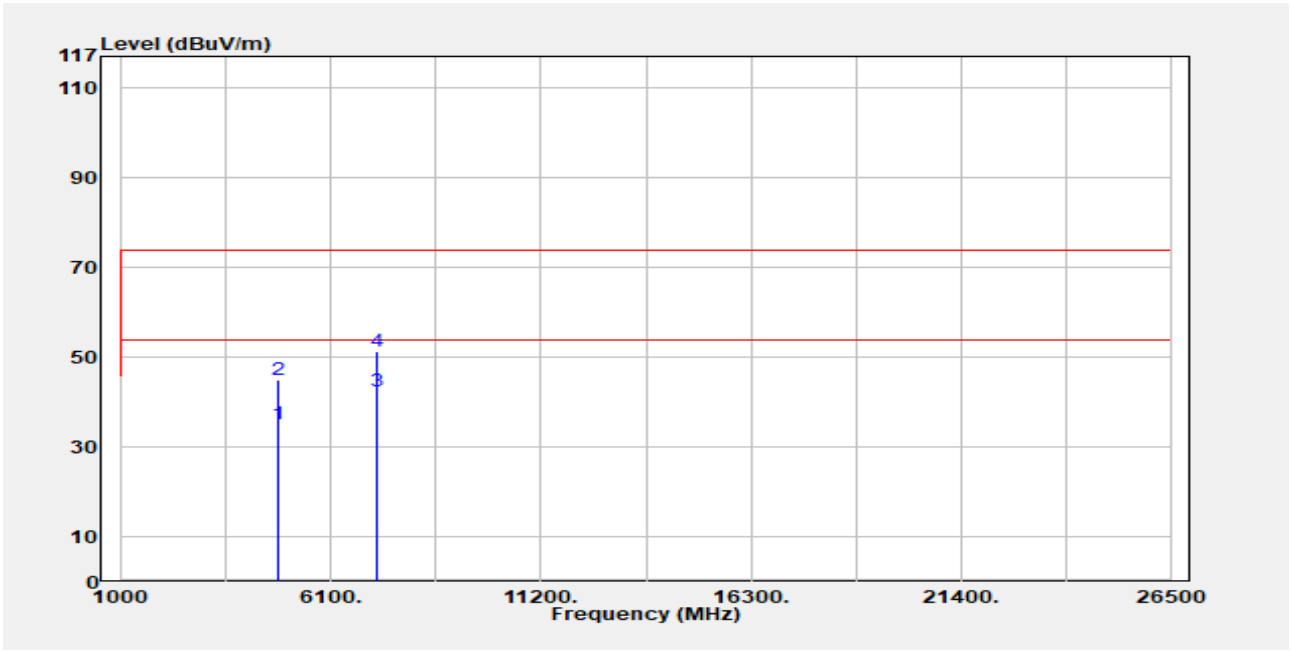

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 42.61 | Peak | 39.03 | -11.57 | 27.46 | 40.00 | -12.54 |
| 90.14 | Peak | 44.88 | -15.16 | 29.72 | 43.50 | -13.78 |
| 96.93 | Peak | 43.34 | -13.82 | 29.52 | 43.50 | -13.98 |
| 117.30 | Peak | 39.66 | -11.74 | 27.93 | 43.50 | -15.57 |
| 241.46 | Peak | 35.73 | -11.08 | 24.65 | 46.00 | -21.35 |
| 687.66 | Peak | 30.52 | -3.23 | 27.29 | 46.00 | -18.71 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2442 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Mid | Antenna Pol. | :HORIZONTAL |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



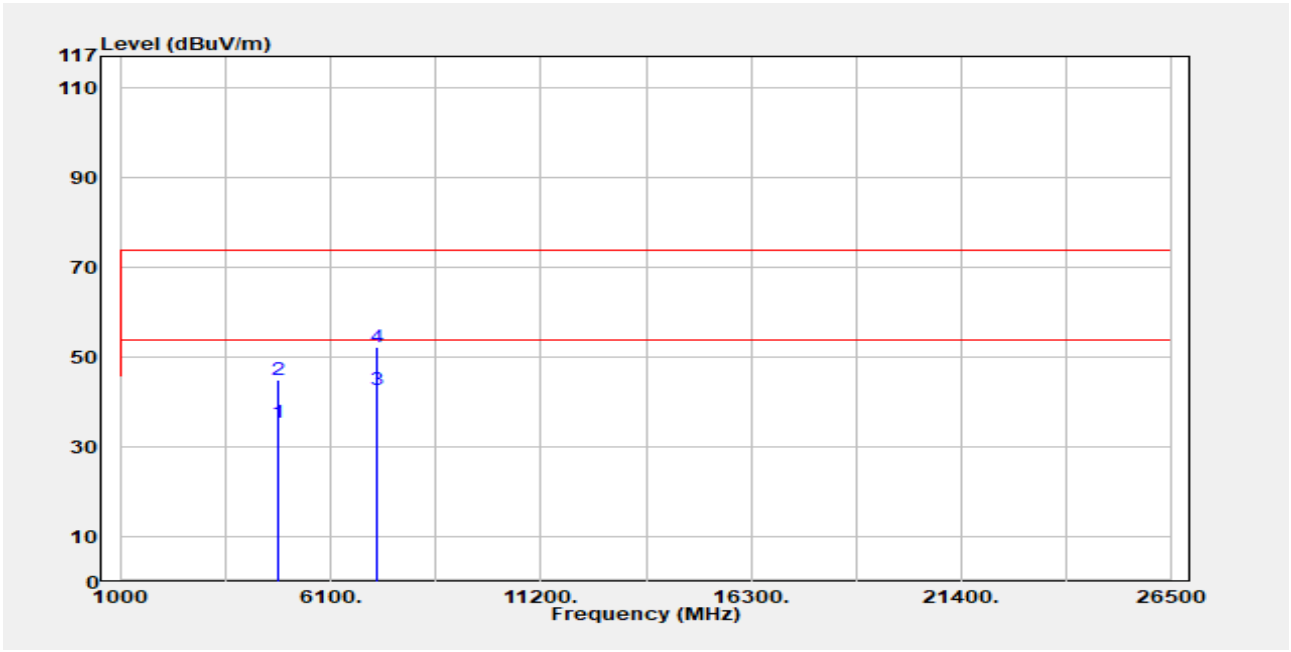

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 203.63 | Peak | 43.57 | -13.42 | 30.15 | 43.50 | -13.35 |
| 244.37 | Peak | 40.96 | -10.76 | 30.19 | 46.00 | -15.81 |
| 259.89 | Peak | 37.35 | -8.74 | 28.62 | 46.00 | -17.38 |
| 274.44 | Peak | 36.72 | -9.74 | 26.98 | 46.00 | -19.02 |
| 537.31 | Peak | 30.28 | -4.04 | 26.24 | 46.00 | -19.76 |
| 641.10 | Peak | 30.05 | -3.43 | 26.63 | 46.00 | -19.37 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2402 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Low | Antenna Pol. | :Vertical |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



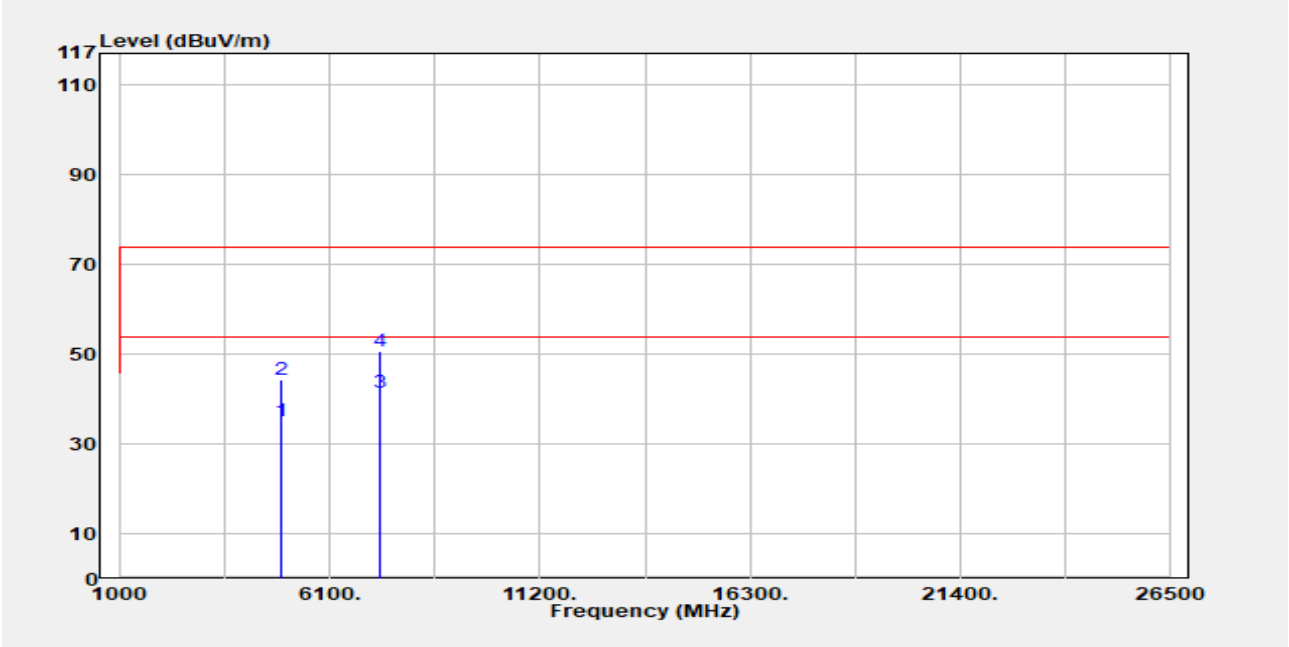

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4804.00 | Average | 28.32 | 7.01 | 35.33 | 54.00 | -18.67 |
| 4804.00 | Peak | 38.14 | 7.01 | 45.16 | 74.00 | -28.84 |
| 7206.00 | Average | 26.92 | 15.64 | 42.56 | 54.00 | -11.44 |
| 7206.00 | Peak | 35.70 | 15.64 | 51.35 | 74.00 | -22.65 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2402 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Low | Antenna Pol. | :Horizontal |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



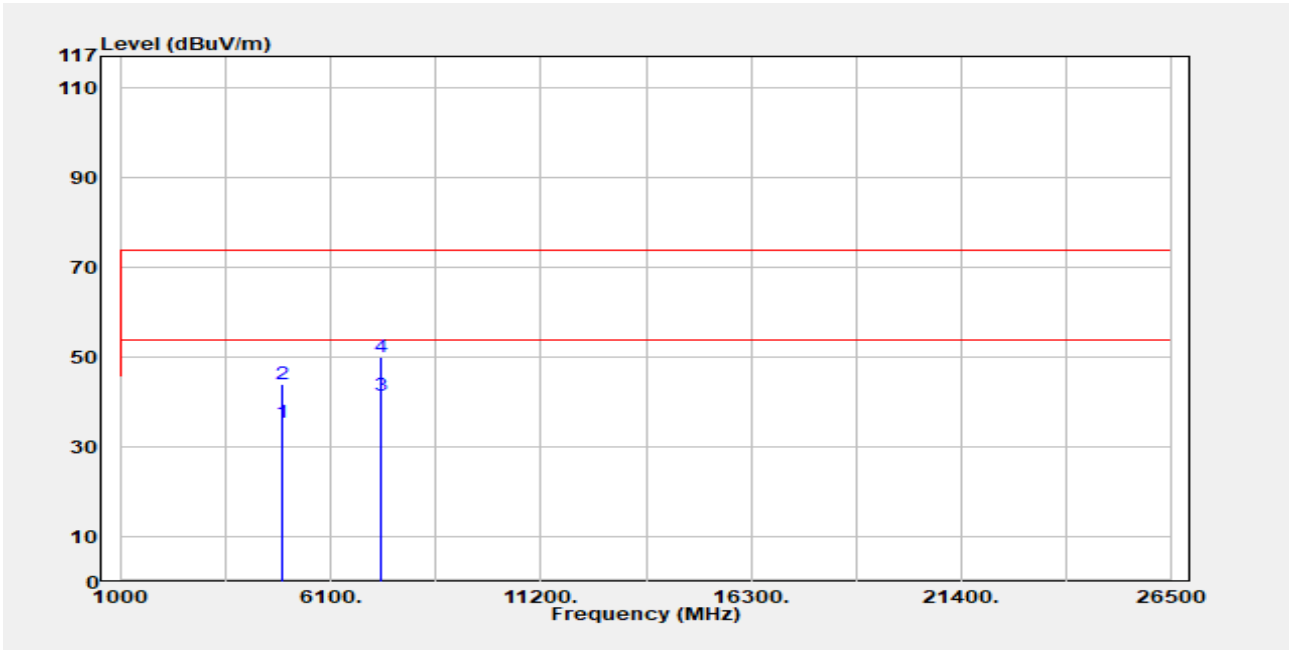

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4804.00 | Average | 28.41 | 7.01 | 35.42 | 54.00 | -18.58 |
| 4804.00 | Peak | 38.10 | 7.01 | 45.11 | 74.00 | -28.89 |
| 7206.00 | Average | 27.26 | 15.64 | 42.90 | 54.00 | -11.10 |
| 7206.00 | Peak | 36.79 | 15.64 | 52.43 | 74.00 | -21.57 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2442 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Mid | Antenna Pol. | :Vertical |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



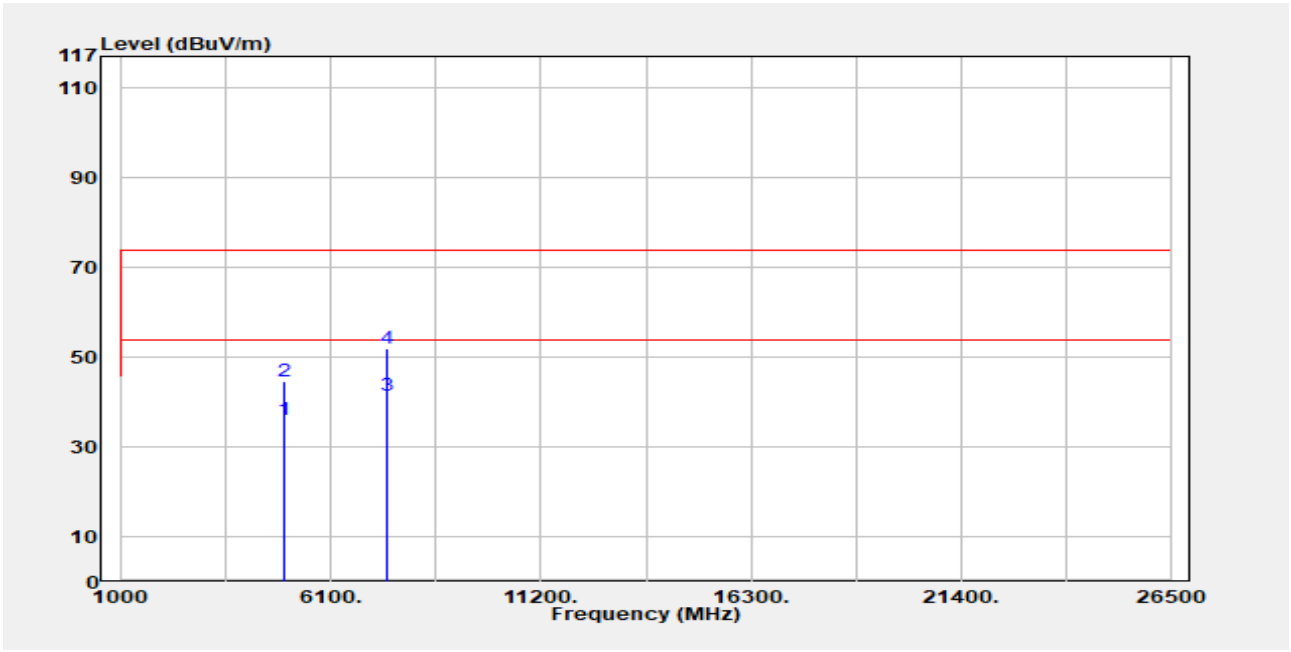

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4884.00 | Average | 28.26 | 6.93 | 35.19 | 54.00 | -18.81 |
| 4884.00 | Peak | 37.53 | 6.93 | 44.47 | 74.00 | -29.53 |
| 7326.00 | Average | 26.89 | 14.76 | 41.65 | 54.00 | -12.35 |
| 7326.00 | Peak | 36.03 | 14.76 | 50.79 | 74.00 | -23.21 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2442 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH Mid | Antenna Pol. | :Horizontal |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



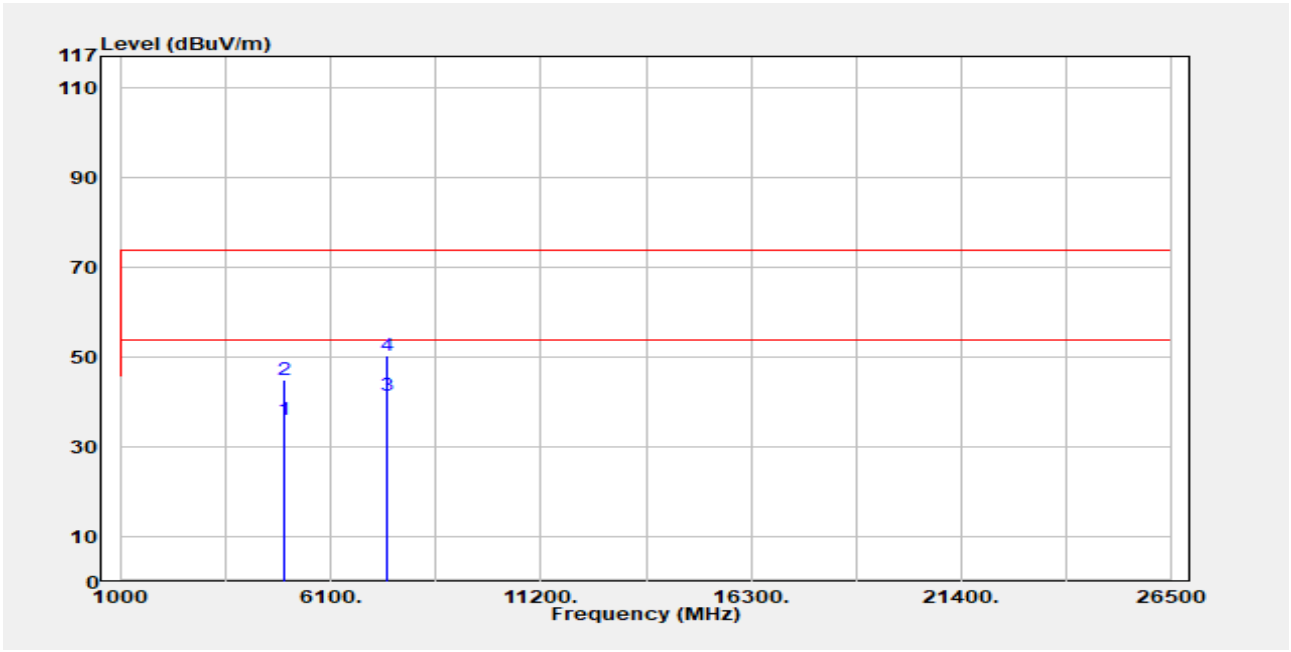

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4884.00 | Average | 28.54 | 6.93 | 35.47 | 54.00 | -18.53 |
| 4884.00 | Peak | 37.17 | 6.93 | 44.11 | 74.00 | -29.89 |
| 7326.00 | Average | 26.86 | 14.76 | 41.62 | 54.00 | -12.38 |
| 7326.00 | Peak | 35.45 | 14.76 | 50.22 | 74.00 | -23.78 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2480 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH High | Antenna Pol. | :Vertical |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |




| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4960.00 | Average | 28.54 | 7.56 | 36.10 | 54.00 | -17.90 |
| 4960.00 | Peak | 37.24 | 7.56 | 44.80 | 74.00 | -29.20 |
| 7440.00 | Average | 26.98 | 14.62 | 41.60 | 54.00 | -12.40 |
| 7440.00 | Peak | 37.35 | 14.62 | 51.97 | 74.00 | -22.03 |

| | | | |
|---|---|---|---|
| Report Number | :ER/2022/30024 | Test Site | :SAC 1 |
| Operation Mode | :BLE 1M | Test Date | :2022-03-23 |
| Test Frequency | :2480 MHz | Temp./Humi. | :24.0/61 |
| Test Mode | :Tx CH High | Antenna Pol. | :Horizontal |
| EUT Pol | :E2 Plane | Engineer | :GN Lin |



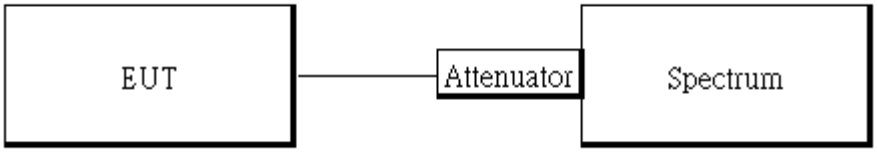

| Freq. MHz | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|---|---|---|---|---|---|---|
| 4960.00 | Average | 28.69 | 7.56 | 36.25 | 54.00 | -17.75 |
| 4960.00 | Peak | 37.36 | 7.56 | 44.92 | 74.00 | -29.08 |
| 7440.00 | Average | 26.94 | 14.62 | 41.56 | 54.00 | -12.44 |
| 7440.00 | Peak | 35.85 | 14.62 | 50.47 | 74.00 | -23.53 |

# 12 POWER SPECTRAL DENSITY

## 12.1 Standard Applicable:

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

## 12.2 Test Setup




## 12.3 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz. & the VBW = 10 kHz
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.

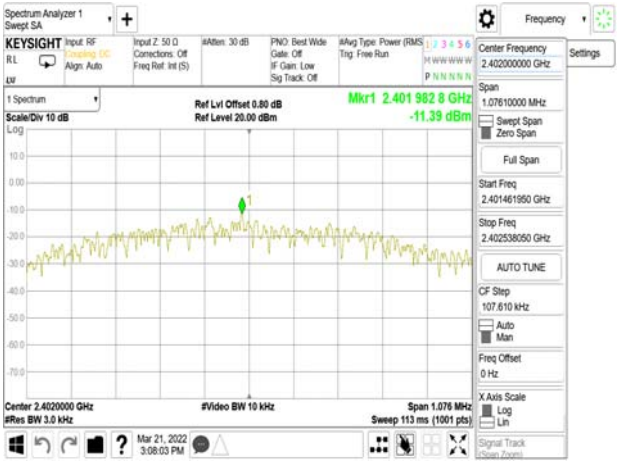
## 12.4 Measurement Result:

**BLE 1M mode**

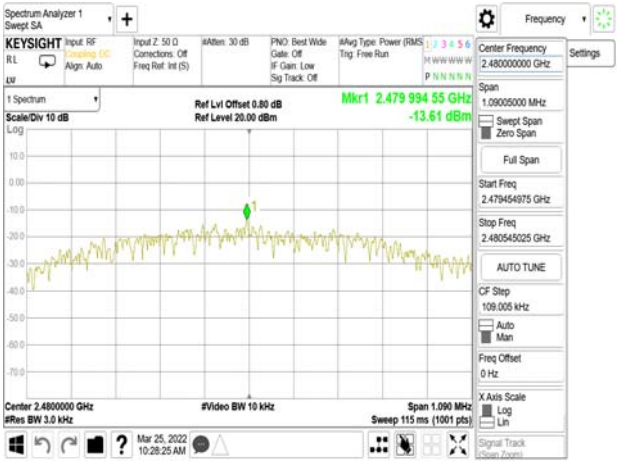
| Frequency (MHz) | RF Power Density (dBm/3kHz) | Maximum Limit (dBm/3kHz) | Result |
|---|---|---|---|
| 2402 | -11.39 | 8 | PASS |
| 2442 | -9.98 | 8 | PASS |
| 2480 | -13.61 | 8 | PASS |

*NOTE: cable loss as dB that offsets in the spectrum*

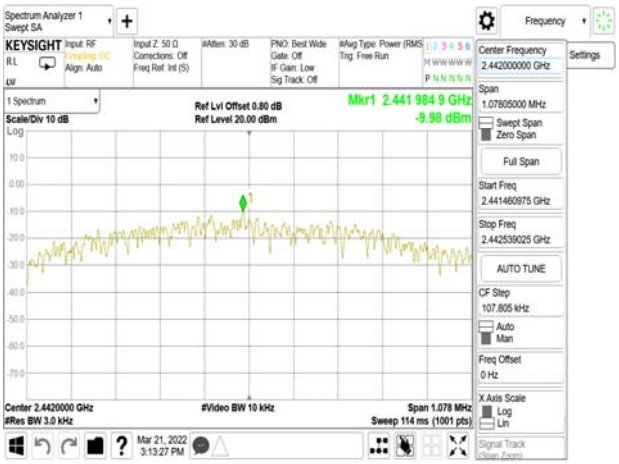
PSD_BLE 1M_LowCH00-2402MHz




PSD_BLE 1M_HighCH39-2480MHz




PSD_BLE 1M_MidCH20-2442MHz



# 13 ANTENNA REQUIREMENT

## 13.1 Standard Applicable:

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 shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

## 13.2 Antenna Connected Construction:

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

***~ End of Report ~***