

**ELECTROMAGNETIC EMISSIONS  
COMPLIANCE REPORT**

**Applicant:** Murata Manufacturing Co., Ltd.  
1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Ja-  
pan

**Manufacturer:** Murata Manufacturing Co., Ltd.  
1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Ja-  
pan

**Product Name:** Communication Module

**Brand Name:** muRata

**Model No.:** LBEE5ZZ1XL, LBEE5ZZ2XS

**Model Difference:** Refer to section 1.8

**Report Number:** TERF2305001164E2

**FCC ID** VPYLBEE5ZZ1XL

**Date of EUT Received:** N/A, the test results are fully leveraged from test report num-  
ber: TERF2211002150E2

**Date of Test:** N/A, the test results are fully leveraged from test report num-  
ber: TERF2211002150E2

**Issue Date:** May 08, 2023

Approved By

Jay Lin

**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.

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

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## Revision History

| Report Number    | Revision | Description | Issue Date   | Revised By | Remark |
|------------------|----------|-------------|--------------|------------|--------|
| TERF2305001164E2 | 00       | Initial     | May 08, 2023 | Yami Kuo   |        |
|                  |          |             |              |            |        |
|                  |          |             |              |            |        |
|                  |          |             |              |            |        |
|                  |          |             |              |            |        |
|                  |          |             |              |            |        |
|                  |          |             |              |            |        |

**Note:**

- 1、The remark "\*" indicates modification of the report upon requests from certification body.
- 2、Variant information of model numbers is provided by the applicant, please refer to section 1.8 of this report for details.  
Test results of this report are applicable to the sample EUT(s) received and variant models are assessed as electrically identical, no further tests are required for the variant.

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## 1 GENERAL INFORMATION

### 1.1 Product Description

|                              |  |
|------------------------------|--|
| Product Name:                | Communication Module                     |
| Brand Name:                  | muRata                                   |
| Model No.:                   | LBEE5ZZ1XL, LBEE5ZZ2XS                   |
| Model Difference:            | Refer to section 1.8                     |
| Hardware Version:            | 1  |
| Firmware Version:            | 1.1.1.1                                  |
| EUT Series No.:              | 1XL: Sample. No2                         |
| Power Supply:                | 3.3Vdc, 1.8Vdc                           |
| Test Software (Name/Version) | Tera Term V4.105 / Dut labtool v2.0.0.85 |

### 1.2 RF Specification

#### WLAN 2.4GHz

| Wi-Fi            | Frequency Range | Channels  | Rated Power (dBm) |       | Modulation Technology |
|------------------|-----------------|---|-------------------|-------|-----------------------|
|                  |                 |   | Peak              | Avg.  |                       |
| 802.11ax40       | 2422~2452       | 7   | 20.47             | 10.89 | OFDMA                 |
| Modulation type: |                 | CCK, DQPSK, DBPSK for DSSS                            |                   |       |                       |
|                  |                 | 256 QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM            |                   |       |                       |
|                  |                 | 1024 QAM, 256 QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA |                   |       |                       |
| Data Rate:       |                 | 802.11 b: 1/2/5.5/11 Mbps                             |                   |       |                       |
|                  |                 | 802.11 g: 6/9/12/18/24/36/48/54 Mbps                  |                   |       |                       |
|                  |                 | 802.11 n_20MHz: up to 144.4Mbps                       |                   |       |                       |
|                  |                 | 802.11 n_40MHz: up to 300Mbps                         |                   |       |                       |
|                  |                 | 802.11 ax_20MHz: up to 286.8Mbps                      |                   |       |                       |
|                  |                 | 802.11 ax_40MHz: up to 573.6Mbps                      |                   |       |                       |

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### 1.3 Antenna Designation

| Antenna Type | Freq. (MHz) | Peak Antenna Gain (dBi) | Directional Gain (dBi) |
|--------------|-------------|-------------------------|------------------------|
| Dipole       | 2412-2462   | 3.2                     | 6.21                   |

**Note:**

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
2. Antenna information is provided by the applicant.

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#### 1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

ANSI C63.10:2013

#### 1.5 Test Facility

| Laboratory  | Test Site Address   | Test Site Name | FCC Designa-<br>tion number | IC CAB<br>identifier |
|---|---|----------------|-----------------------------|----------------------|
| SGS Taiwan Ltd.<br>Central RF Lab.<br>(TAF code 3702) | No.134, Wu Kung Road, New Taipei<br>Industrial Park, Wuku District, New<br>Taipei City, Taiwan. | SAC 1          | TW0027                      | TW3702               |
|   |   | SAC 2          |                             |                      |
|   |   | SAC 3          |                             |                      |
|   |   | Conduction 1   |                             |                      |
|   |   | Conducted 1    |                             |                      |
|   |   | Conducted 2    |                             |                      |
|   |   | Conducted 3    |                             |                      |
|   |   | Conducted 4    |                             |                      |
|   |   | Conducted 5    |                             |                      |
|   |   | Conducted 6    |                             |                      |
|   | No.2, Keji 1st Rd., Guishan District,<br>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.

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## 1.8 Model Difference

LBEE5ZZ1XL has a dedicated antenna port for BT.

LBEE5ZZ2XS BT shares same antenna port with WLAN.

Some passive components are different between models as below.

| LBEE5ZZ1XL       | LBEE5ZZ2XS      |
|------------------|-----------------|
| C 336 No mounted | C336 mounted    |
| C337 mounted     | C337 No mounted |
| L310 mounted     | L310 No mounted |

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## 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 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 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.

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## 2.4 Measurement Results Explanation Example

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

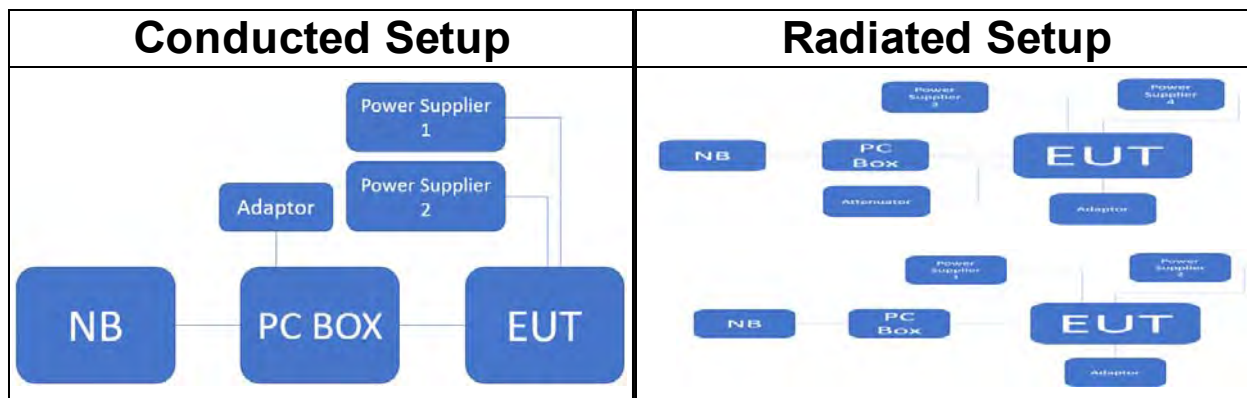
Radiated emission below 30MHz is measured in a 9m\*6m\*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

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



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## 2.6 Control Unit(s)

| Conducted Emission Test Site: Conducted D |        |              |               |           |          |
|---|--------|--------------|---------------|-----------|----------|
| EQUIPMENT TYPE                            | MFR    | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| Notebook                                  | Lenovo | T420         | S0012599      | N/A       | N/A      |
| Notebook                                  | Lenovo | L420         | S0011721      | N/A       | N/A      |

| Radiated Emission Test Site: SAC D |        |              |               |           |          |
|------------------------------------|--------|--------------|---------------|-----------|----------|
| EQUIPMENT TYPE                     | MFR    | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| LAN Cable                          | 向聯     | VPH-02       | 1500021123    | N.C.R     | N.C.R    |
| LAN Cable                          | INVAX  | IVX011       | N/A           | N.C.R     | N.C.R    |
| Notebook                           | Lenovo | T470         | P0001293      | N/A       | N/A      |
| Notebook                           | Lenovo | T420         | S0012599      | N/A       | N/A      |
| Adapter                            | APD    | NB-65B19     | N/A           | N/A       | N/A      |
| Adapter                            | FSP    | FSP065-REBN2 | H6081012364   | N.C.R     | N.C.R    |

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### 3 SUMMARY OF TEST RESULTS

| FCC Rules                        | Description Of Test                         | Result    | Note |
|----------------------------------|---|-----------|------|
| §15.247(b) (3)                   | Peak Output Power                           | Compliant |      |
| §15.205<br>§15.209<br>§15.247(d) | Radiated Band Edge<br>and Spurious Emission | Compliant |      |

#### Note

1. N/S Indicates whether item(s) being newly tested [N] or spot checked [S].
2. Items other than newly tested [N] are leveraged from test report TERF2211002150E2.

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## 4 DESCRIPTION OF TEST MODES

### 4.1 Operatin Frequencies

| Modulation of BW 20MHz |                 | Modulation of BW 40MHz |                 |
|------------------------|-----------------|------------------------|-----------------|
| CHANNEL                | FREQUENCY (MHz) | CHANNEL                | FREQUENCY (MHz) |
| 1                      | 2412            | 3                      | 2422            |
| 2                      | 2417            | 4                      | 2427            |
| 3                      | 2422            | 5                      | 2432            |
| 4                      | 2427            | 6                      | 2437            |
| 5                      | 2432            | 7                      | 2442            |
| 6                      | 2437            | 8                      | 2447            |
| 7                      | 2442            | 9                      | 2452            |
| 8                      | 2447            |                        |                 |
| 9                      | 2452            |                        |                 |
| 10                     | 2457            |                        |                 |
| 11                     | 2462            |                        |                 |

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## 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. Investigation has been done on all the possible configurations for searching the worst case.

The gevin UE is pre-scanned among below modes.

| Modulation |           | Transmission Chain |     |   |     |  |     |  |     | Single<br>Transmission<br>Spatial |      | Multi<br>Transmission<br>Spatial |      |
|------------|-----------|--------------------|-----|---|-----|--|-----|--|-----|-----------------------------------|------|----------------------------------|------|
| v          | 802.11 b  | v                  | Ch0 | v | Ch1 |  | Ch2 |  | Ch3 |                                   | 1TX  | v                                | 2TX  |
| v          | 802.11 g  | v                  | Ch0 | v | Ch1 |  | Ch2 |  | Ch3 |                                   | 1TX  | v                                | 2TX  |
| v          | 802.11 n  | v                  | Ch0 | v | Ch1 |  | Ch2 |  | Ch3 |                                   | SISO | v                                | MIMO |
| v          | 802.11 ax | v                  | Ch0 | v | Ch1 |  | Ch2 |  | Ch3 |                                   | SISO | v                                | MIMO |

4. Therefore, below summary is the modes of test configuration that yield the highest reading and generate the highest emission chosen to carry out the relevantly mandatory test items.
5. Observations have been done for 802.11 ax available RU configurations below and found that the lowest, heighest and Full RU results higher emissions.  
Only one RU can be enabled at any given time.

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| 802.11ax                      | 20MHz      |                  |             |                    | 802.11ax                      | 40MHz      |              |             |                    |
|-------------------------------|------------|------------------|-------------|--------------------|-------------------------------|------------|--------------|-------------|--------------------|
| RU type                       | 26-tone RU |                  | 52-tone RU  |                    | RU type                       | 26-tone RU |              | 52-tone RU  |                    |
| RU index and subcarrier range | RU0        | [-121: -96]      | RU37        | [-121: -70]        | RU index and subcarrier range | RU0        | [-243: -218] | RU37        | [-243: -192]       |
|                               | RU1        | [-95: -70]       | RU38        | [-68: -17]         |                               | RU1        | [-217: -192] | RU38        | [-189: -138]       |
|                               | RU2        | [-68: -43]       | RU39        | [17: 68]           |                               | RU2        | [-189: -164] | RU39        | [-109: -58]        |
|                               | RU3        | [-42: -17]       | RU40        | [70: 121]          |                               | RU3        | [-163: -138] | RU40        | [-55: -4]          |
|                               | RU4        | [-16: -4, 4: 16] | RU41        | N/A                |                               | RU4        | [-136: -111] | RU41        | [4: 55]            |
|                               | RU5        | [17: 42]         | RU42        | N/A                |                               | RU5        | [-109: -84]  | RU42        | [58: 109]          |
|                               | RU6        | [43: 68]         | RU43        | N/A                |                               | RU6        | [-83: -58]   | RU43        | [138: 189]         |
|                               | RU7        | [70: 95]         | RU44        | N/A                |                               | RU7        | [-55: -30]   | RU44        | [192: 243]         |
|                               | RU8        | [96: 121]        | RU45        | N/A                |                               | RU8        | [-29: -4]    | RU45        | N/A                |
|                               | RU9        | N/A              | RU46        | N/A                |                               | RU9        | [4: 29]      | RU46        | N/A                |
|                               | RU10       | N/A              | RU47        | N/A                |                               | RU10       | [30: 55]     | RU47        | N/A                |
|                               | RU11       | N/A              | RU48        | N/A                |                               | RU11       | [58: 83]     | RU48        | N/A                |
|                               | RU12       | N/A              | RU49        | N/A                |                               | RU12       | [84: 109]    | RU49        | N/A                |
|                               | RU13       | N/A              | RU50        | N/A                |                               | RU13       | [111: 136]   | RU50        | N/A                |
|                               | RU14       | N/A              | RU51        | N/A                |                               | RU14       | [138: 163]   | RU51        | N/A                |
|                               | RU15       | N/A              | RU52        | N/A                |                               | RU15       | [164: 189]   | RU52        | N/A                |
|                               | RU16       | N/A              |             |                    |                               | RU16       | [192: 217]   |             |                    |
|                               | RU17       | N/A              | 106-tone RU |                    |                               | RU17       | [218: 243]   | 106-tone RU |                    |
|                               | RU18       | N/A              | RU53        | [-122: -17]        |                               | RU18       | N/A          | RU53        | [-243: -138]       |
|                               | RU19       | N/A              | RU54        | [17: 122]          |                               | RU19       | N/A          | RU54        | [-109: -4]         |
|                               | RU20       | N/A              | RU55        | N/A                |                               | RU20       | N/A          | RU55        | [4: 109]           |
|                               | RU21       | N/A              | RU56        | N/A                |                               | RU21       | N/A          | RU56        | [138: 243]         |
|                               | RU22       | N/A              | RU57        | N/A                |                               | RU22       | N/A          | RU57        | N/A                |
|                               | RU23       | N/A              | RU58        | N/A                |                               | RU23       | N/A          | RU58        | N/A                |
|                               | RU24       | N/A              | RU59        | N/A                |                               | RU24       | N/A          | RU59        | N/A                |
|                               | RU25       | N/A              | RU60        | N/A                |                               | RU25       | N/A          | RU60        | N/A                |
|                               | RU26       | N/A              |             |                    |                               | RU26       | N/A          |             |                    |
|                               | RU27       | N/A              | 242-tone RU |                    |                               | RU27       | N/A          | 242-tone RU |                    |
|                               | RU28       | N/A              | RU61        | [-122: -2, 2: 122] |                               | RU28       | N/A          | RU61        | [-244: -3]         |
|                               | RU29       | N/A              | RU62        | N/A                |                               | RU29       | N/A          | RU62        | [3: 244]           |
|                               | RU30       | N/A              | RU63        | N/A                |                               | RU30       | N/A          | RU63        | N/A                |
|                               | RU31       | N/A              | RU64        | N/A                |                               | RU31       | N/A          | RU64        | N/A                |
|                               | RU32       | N/A              |             |                    |                               | RU32       | N/A          |             |                    |
|                               | RU33       | N/A              |             |                    |                               | RU33       | N/A          | 484-tone RU |                    |
|                               | RU34       | N/A              |             |                    |                               | RU34       | N/A          | RU65        | [-244: -3, 3: 244] |
|                               | RU35       | N/A              |             |                    |                               | RU35       | N/A          | RU66        | N/A                |
| RU36                          | N/A        |                  |             | RU36               | N/A                           |            |              |             |                    |

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| Conducted       |                   |                |            |                  |              |
|-----------------|-------------------|----------------|------------|------------------|--------------|
| MODE            | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | DATA RATE (Mbps) | ANTENNA PORT |
| 802.11ax (HE40) | 3 to 9            | 9              | OFDMA      | MCS0             | 2TX          |

| RADIATED EMISSION TEST (ABOVE 1 GHz) |                   |                |            |                  |              |
|--------------------------------------|-------------------|----------------|------------|------------------|--------------|
| MODE                                 | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | DATA RATE (Mbps) | ANTENNA PORT |
| 802.11ax (HE40)                      | 3 to 9            | 9              | OFDMA      | MCS0             | 2TX          |

### Note:

The field strength of radiated 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.

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## 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.

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## 6 MEASUREMENT EQUIPMENT USED

### 6.1 Conducted Measurement

| Conducted Emission Test Site: Conducted D |              |                     |  |            |            |
|---|--------------|---------------------|--|------------|------------|
| EQUIPMENT TYPE                            | MFR          | MODEL NUMBER        | SERIAL NUMBER                          | LAST CAL.  | CAL DUE.   |
| Spectrum Analyzer                         | KEYSIGHT     | N9010B              | MY59071574                             | 06/20/2022 | 06/19/2023 |
| Power Meter                               | Anritsu      | ML2496A             | 1512003                                | 07/26/2022 | 07/25/2023 |
| Power Sensor                              | Anritsu      | MA2411B             | 1339378                                | 07/26/2022 | 07/25/2023 |
| Power Sensor                              | Anritsu      | MA2411B             | 1339379                                | 07/26/2022 | 07/25/2023 |
| DC Power Supply                           | Agilent      | E3640A              | MY53130054                             | 09/29/2022 | 09/28/2023 |
| DC Power Supply                           | Agilent      | E3640A              | MY53140006                             | 05/16/2022 | 05/15/2023 |
| DC Power Supply                           | HOLA         | DP-3003             | D7070035                               | 06/09/2022 | 06/08/2023 |
| DC Power Supply                           | Gwinstek     | SPS-3610            | GEV856767                              | 09/29/2022 | 09/28/2023 |
| Test Software                             | SGS Taiwan   | Radio Test Software | Ver.21                                 | N.C.R      | N.C.R      |
| Attenuator                                | Marvelous    | MVE2213-10          | RF13                                   | 11/16/2022 | 11/15/2023 |
| Attenuator                                | Woken        | WATT-218FS-10       | RF15                                   | 11/16/2022 | 11/15/2023 |
| Attenuator                                | KEYSIGHT     | 11716C              | 8494B<br>TH60075424+8496B<br>TH6075262 | 11/16/2022 | 11/15/2023 |
| Coupler                                   | MIDISCO52335 | MDC2044-20          | RF36                                   | 11/16/2022 | 11/15/2023 |
| DC Block                                  | PASTERNAK    | PE8210              | RF158                                  | 11/16/2022 | 11/15/2023 |
| Splitter                                  | Marvelous    | MVE8576             | RF256                                  | 11/16/2022 | 11/15/2023 |
| Switch E-Channel                          | E-Channel    | ETF-1801 RF Switch  | EC2100175                              | 11/16/2022 | 11/15/2023 |
| Coaxial Cables                            | Woken        | 00100A1F2A196C      | RF62                                   | 11/16/2022 | 11/15/2023 |
| Coaxial Cables                            | Woken        | 00100A1F2A196C      | RF64                                   | 11/16/2022 | 11/15/2023 |
| Coaxial Cables                            | Woken        | 00100A1F1A185C      | RF71                                   | 11/16/2022 | 11/15/2023 |

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## 6.2 Radiated Measurement

| Radiated Emission Test Site: SAC D |                 |                   |                          |            |            |
|------------------------------------|-----------------|-------------------|--------------------------|------------|------------|
| EQUIPMENT TYPE                     | MFR             | MODEL NUMBER      | SERIAL NUMBER            | LAST CAL.  | CAL DUE.   |
| Broadband Antenna                  | SCHWARZBECK     | VULB 9168         | 9168-300                 | 11/11/2022 | 11/10/2023 |
| Horn Antenna                       | Schwarzbeck     | BBHA9170          | 185                      | 08/22/2022 | 08/21/2023 |
| Horn Antenna                       | Schwarzbeck     | BBHA9120D         | 1341                     | 05/31/2022 | 05/30/2023 |
| Loop Antenna                       | ETS.LINDGREN    | 6502              | 143303                   | 05/14/2022 | 05/13/2023 |
| 3m Site NSA                        | SGS             | 966 chamber D     | N/A                      | 04/30/2022 | 04/29/2023 |
| Spectrum Analyzer                  | KEYSIGHT        | N9010A            | MY57120200               | 03/24/2022 | 03/23/2023 |
| Test Software                      | audix           | e3                | E3 20923 SGS Ver.9 ( C ) | N.C.R      | N.C.R      |
| DC Power Supply                    | Agilent         | E3640A            | MY53130054               | 09/29/2022 | 09/28/2023 |
| DC Power Supply                    | Agilent         | E3640A            | MY53140006               | 05/16/2022 | 05/15/2023 |
| DC Power Supply                    | Gwinstek        | SPS-3610          | GEV856769                | 09/29/2022 | 09/28/2023 |
| DC Power Supply                    | Gwinstek        | SPS-3610          | GEV856767                | 09/29/2022 | 09/28/2023 |
| Pre-Amplifier                      | EMC Instruments | EM26400           | 971576                   | 10/02/2022 | 10/01/2023 |
| Pre-Amplifier                      | EMC Instruments | EMC9135           | 980234                   | 11/16/2022 | 11/15/2023 |
| Pre-Amplifier                      | EMC Instruments | EMC12630SE        | 980273                   | 11/16/2022 | 11/15/2023 |
| Attenuator                         | Woken           | WATT-218FS-10     | RF17                     | 11/16/2022 | 11/15/2023 |
| Coaxial Cable                      | Huber+Suhner    | RG 214/U          | W21.01                   | 11/16/2022 | 11/15/2023 |
| Coaxial Cable                      | Huber Suhner    | EMC106-SM-SM-7200 | 150703                   | 11/16/2022 | 11/15/2023 |
| Coaxial Cable                      | Huber Suhner    | SUCOFLEX 104      | MY17413/4                | 11/16/2022 | 11/15/2023 |

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

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## 7 PEAK OUTPUT POWER MEASUREMENT

### 7.1 Standard Applicable

### 7.2 Duty Cycle

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.

### 7.3 Output Power

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 from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 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.

#### Note:

As per section F. 2). e). (ii) of FCC KDB 662911 D01

If antenna gains are not equal and each transmit antenna is driven by only one spatial stream, directional gain may be calculated by either of the following formulas.

$$DirectionalGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

where

Each antenna is driven by no more than one spatial stream;

NSS = the number of independent spatial streams of data;

NANT = the total number of antennas

$g_{j,k} = 10^{G_k/20}$  if the kth antenna is being fed by spatial stream j, or zero if it is not;

$G_k$  is the gain in dBi of the kth antenna.

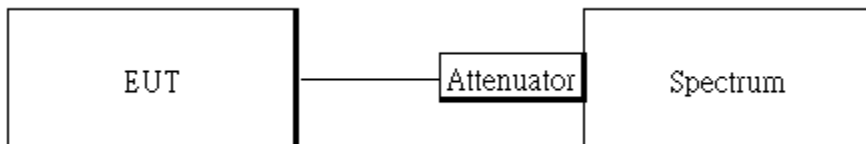
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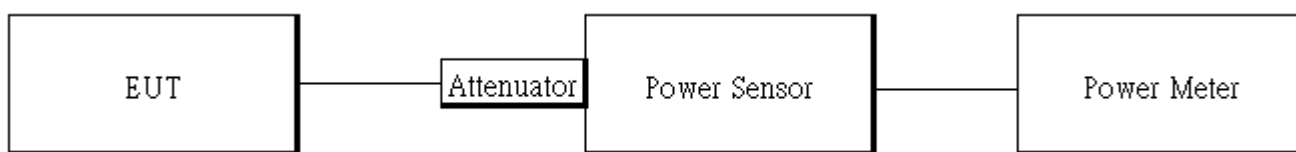
The antenna gain is greater than 6 dBi, therefore the power limit attenuation has been applied in the test results.

## 7.4 Test Setup

### 7.4.1 Duty Cycle



### 7.4.2 Output Power:



## 7.5 Measurement Procedure

### 7.5.1 Duty Cycle:

1. Set span = Zero
2. RBW = 8MHz
3. VBW = 8MHz,
4. Detector = Peak

### 7.5.2 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.

#### Power Meter:

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Spectrum or Power Meter.
5. MIMO mode: offset is set with "measure and add 10 Log (N)" to measurement for MIMO mode. Offset = cable loss + 10 log (N), where N is number of transmitting antenna, cable loss is specified below.

**\* Note: The duty cycle factor and below is compensated to obtain the maximum value of measurement in average.**

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台灣檢驗科技股份有限公司

t (886-2) 2299-3279

f (886-2) 2298-0488

www.sgs.com.tw

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## 7.6 Measurement Result

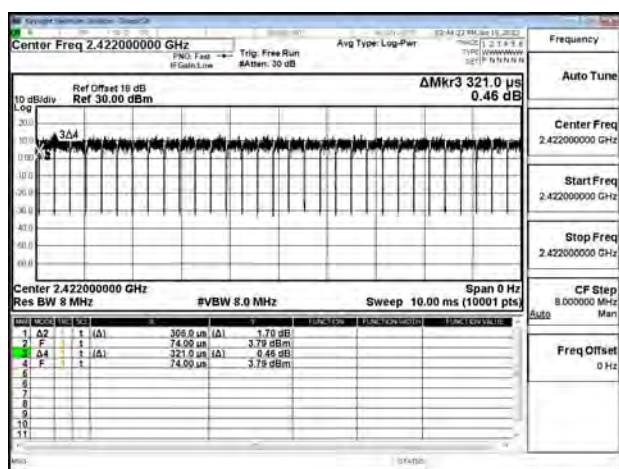
### 7.6.1 Duty Cycle:

#### Duty Cycle

|             | Duty Cycle (%)<br>= Ton / (Ton+Toff) | Duty Factor (dB)<br>=10*log ( 1/Duty Cycle ) | 1/T<br>(kHz) | VBW setting<br>(kHz) |
|-------------|--------------------------------------|--|--------------|----------------------|
| 802.11ax_40 | 95.33                                | 0.21   | 3.27         | 4.00                 |

### 7.6.2 Duty Cycle test plots

802.11ax\_40MHz\_Chain0\_2422MHz



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## 7.6.3 Output Power

| 802.11ax_HE_40M Ch0 |             |           |           |           |                         |             |        |
|---------------------|-------------|-----------|-----------|-----------|-------------------------|-------------|--------|
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Peak Output Power (dBm) | Limit (dBm) | RESULT |
| 9                   | 2452        | MCS0      | 242/62    | 10        | 17.46                   | 30.00       | PASS   |
| 802.11ax_HE_40M Ch0 |             |           |           |           |                         |             |        |
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Avg. Output Power (dBm) | Limit (dBm) | RESULT |
| 9                   | 2452        | MCS0      | 242/62    | 10        | 7.82                    | 30.00       | PASS   |
| 802.11ax_HE_40M Ch1 |             |           |           |           |                         |             |        |
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Peak Output Power (dBm) | Limit (dBm) | RESULT |
| 9                   | 2452        | MCS0      | 242/62    | 10        | 17.39                   | 30.00       | PASS   |
| 802.11ax_HE_40M Ch1 |             |           |           |           |                         |             |        |
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Avg. Output Power (dBm) | Limit (dBm) | RESULT |
| 9                   | 2452        | MCS0      | 242/62    | 10        | 7.74                    | 30.00       | PASS   |

| 802.11ax_HE_40M_2TX |             |           |           |           |                   |       |                               |             |        |
|---------------------|-------------|-----------|-----------|-----------|-------------------|-------|-------------------------------|-------------|--------|
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Peak Output Power |       | Total Peak Output Power (dBm) | Limit (dBm) | RESULT |
|                     |             |           |           |           | Ch0               | Ch1   |                               |             |        |
| 9                   | 2452        | MCS0      | 242/6     | 11        | 17.57             | 17.35 | 20.47                         | 29.79       | PASS   |
| 802.11ax_HE_40M_2TX |             |           |           |           |                   |       |                               |             |        |
| CH                  | Freq. (MHz) | Data Rate | RU Config | Power set | Avg. Output Power |       | Total Avg. Output Power (dBm) | Limit (dBm) | RESULT |
|                     |             |           |           |           | Ch0               | Ch1   |                               |             |        |
| 9                   | 2452        | MCS0      | 242/6     | 11        | 8.03              | 7.73  | 10.89                         | 29.79       | PASS   |

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## 8 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

### 8.1 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:**

1. The lower limit shall apply at the transition frequencies.

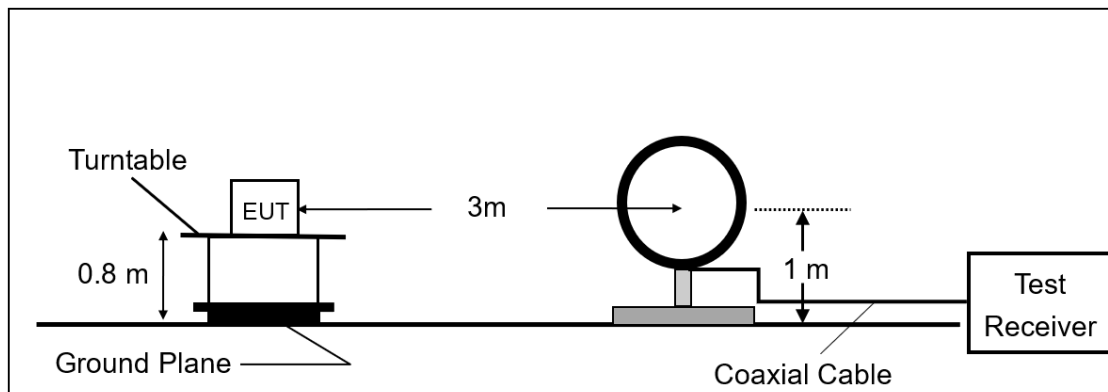
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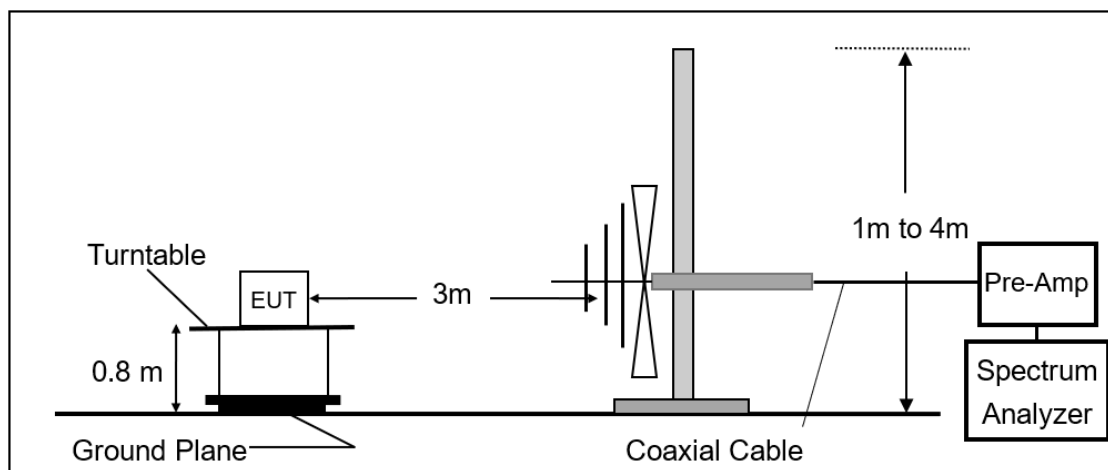


## 8.2 Test Setup

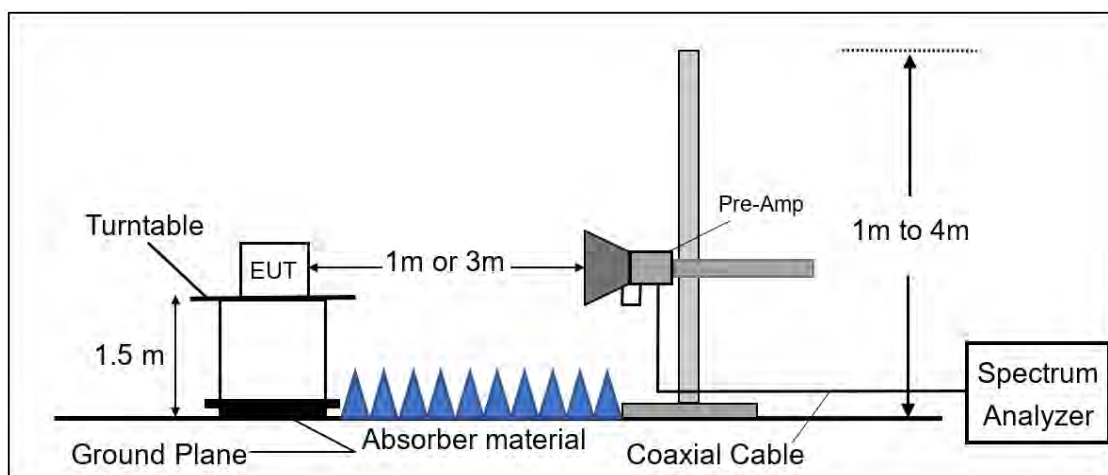
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



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



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



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### 8.3 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.

### 8.4 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)*

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

*Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre\_Amplifier Gain(dB)*

## 8.5 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.

## 8.6 Measurement Result

### Note:

1. *Refer to next page spectrum analyzer data chart and tabular data sheets.*
2. *Measurements are completed at peak and average level, the mark of average is the highest emission in restricted bands*

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f (886-2) 2298-0488

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## 8.6.1 Radiated Band Edge Measurement Result

Report Number :TERF2211002150E2

Test Site :SAC D

Operation Mode :802.11ax40

Test Date :2022-11-24

Test Frequency :2452 MHz

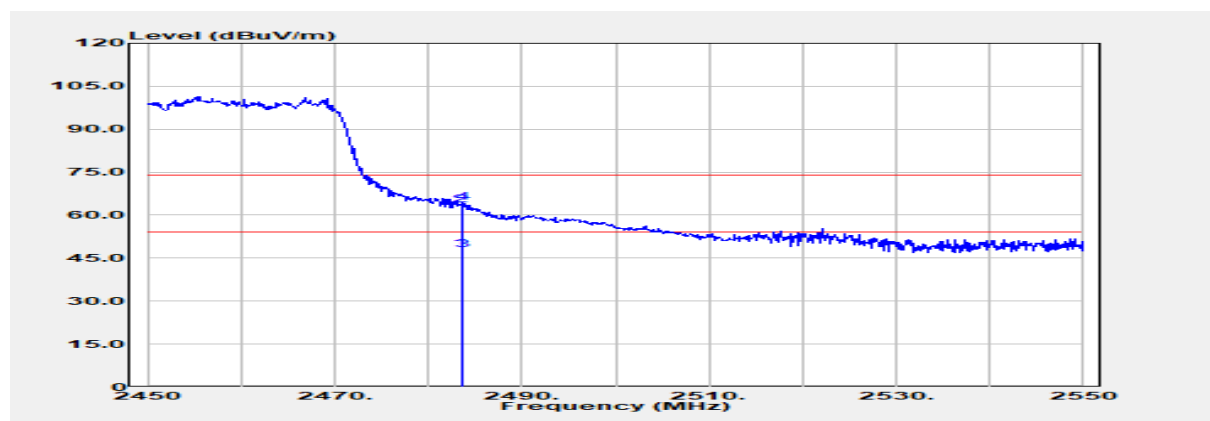
Temp./Humi. :22.5/60

Test Mode :Bandedge RU 242/62

Antenna Pol. :Vertical

EUT Pol :E2 Plane

Engineer :Howard Huang



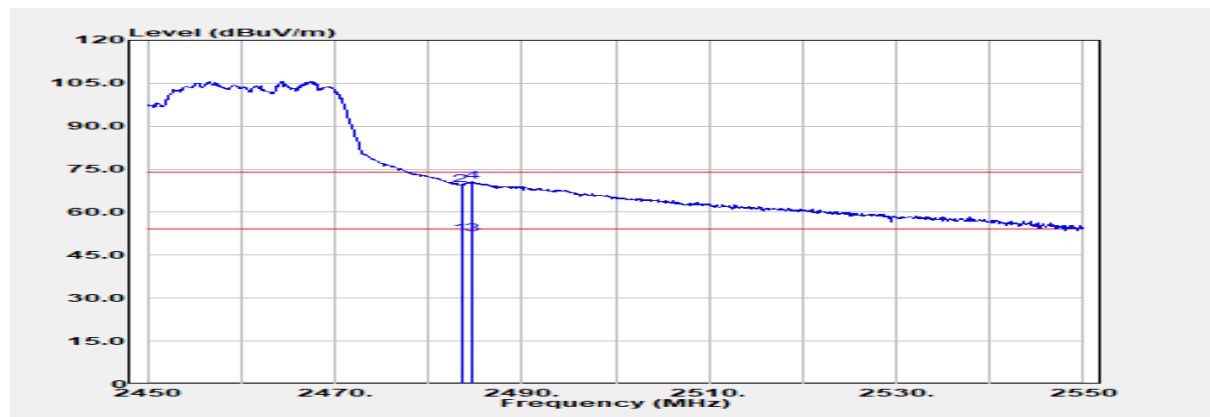
| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
| MHz      | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 2483.500 | Average  | 54.08         | -5.91  | 48.18        | 54.00        | -5.82  |
| 2483.500 | Peak     | 69.45         | -5.91  | 63.54        | 74.00        | -10.46 |
| 2483.700 | Average  | 53.81         | -5.91  | 47.91        | 54.00        | -6.09  |
| 2483.700 | Peak     | 70.28         | -5.91  | 64.37        | 74.00        | -9.63  |

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Report Number :TERF2211002150E2  
Operation Mode :802.11ax40  
Test Frequency :2452 MHz  
Test Mode :Bandedge RU 242/62  
EUT Pol :E2 Plane

Test Site :SAC D  
Test Date :2022-11-24  
Temp./Humi. :22.5/60  
Antenna Pol. :Horizontal  
Engineer :Howard Huang



| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
|          | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 2483.500 | Average  | 58.11         | -5.91  | 52.20        | 54.00        | -1.80  |
| 2483.500 | Peak     | 75.47         | -5.91  | 69.56        | 74.00        | -4.44  |
| 2484.600 | Average  | 58.25         | -5.91  | 52.33        | 54.00        | -1.67  |
| 2484.600 | Peak     | 76.56         | -5.91  | 70.65        | 74.00        | -3.35  |

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## 8.6.1 Spurious Emission:

Report Number :E2/2022/10038

Test Site :SAC D

Operation Mode :802.11ax40

Test Date :2022-03-07

Test Frequency :2422 MHz

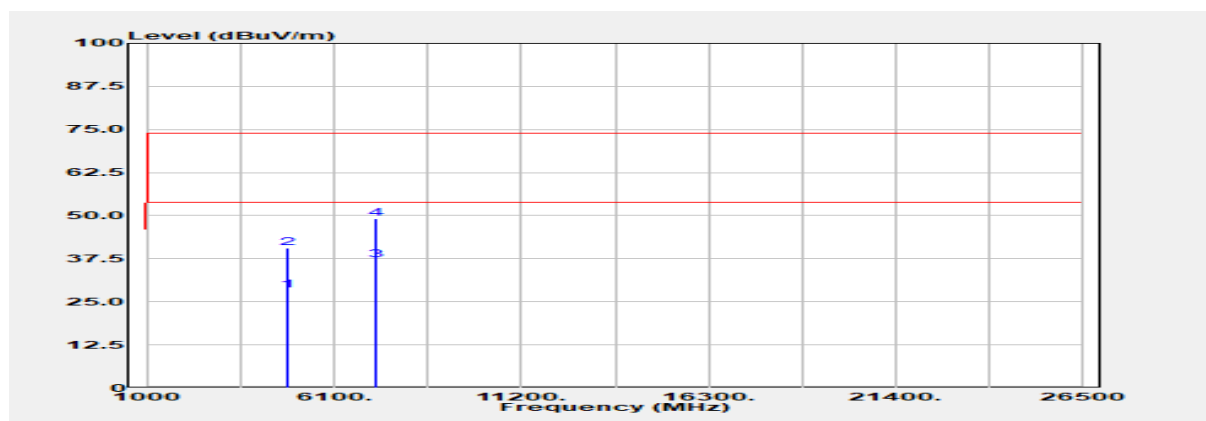
Temp./Humi. :18.8/64

Test Mode :TX CH LOW FULL RU

Antenna Pol. :Vertical

EUT Pol :E2 Plane

Engineer :Jack Tseng



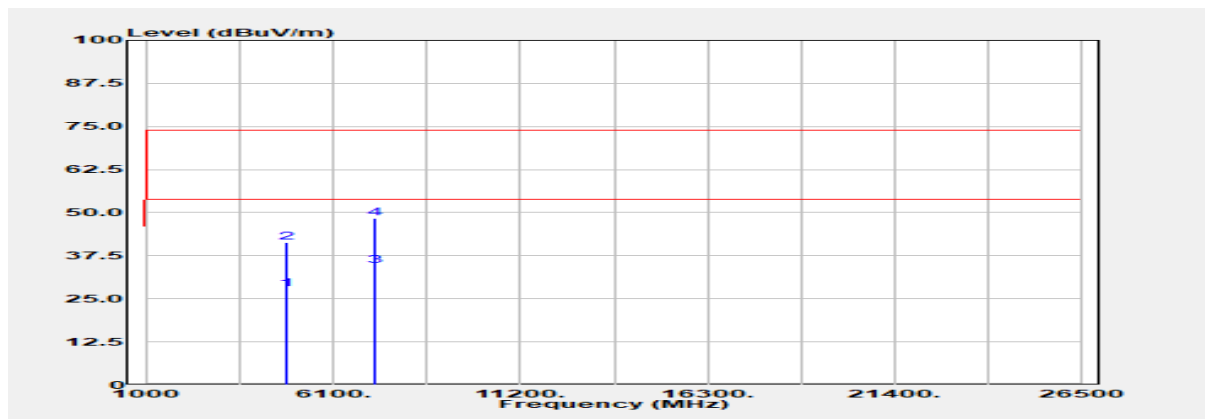
| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
| MHz      | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4844.000 | Average  | 28.26         | 0.08   | 28.34        | 54.00        | -25.66 |
| 4844.000 | Peak     | 40.56         | 0.08   | 40.65        | 74.00        | -33.35 |
| 7266.000 | Average  | 29.45         | 7.53   | 36.98        | 54.00        | -17.02 |
| 7266.000 | Peak     | 41.67         | 7.53   | 49.20        | 74.00        | -24.80 |

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Report Number :E2/2022/10038  
 Operation Mode :802.11ax40  
 Test Frequency :2422 MHz  
 Test Mode :TX CH LOW FULL RU  
 EUT Pol :E2 Plane

Test Site :SAC D  
 Test Date :2022-03-07  
 Temp./Humi. :18.8/64  
 Antenna Pol. :Horizontal  
 Engineer :Jack Tseng



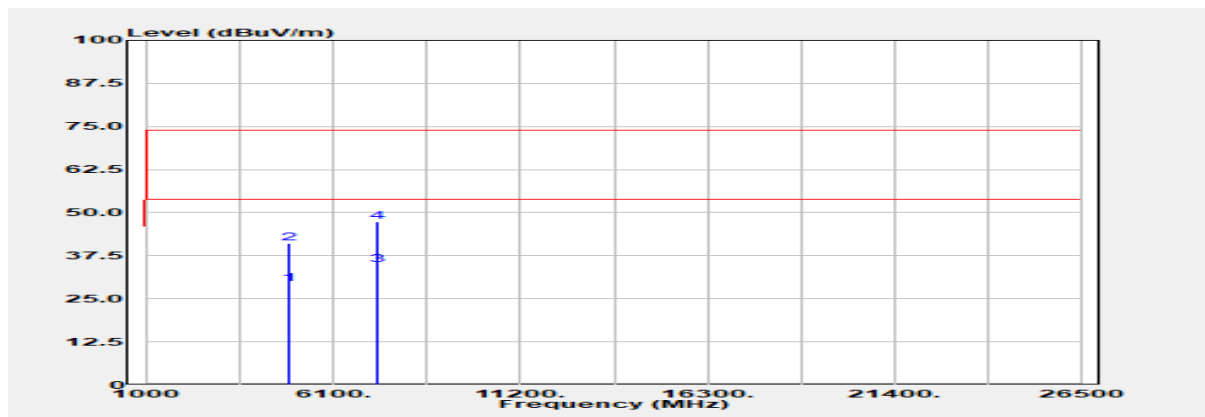
| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
|          | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4844.000 | Average  | 27.85         | 0.08   | 27.93        | 54.00        | -26.07 |
| 4844.000 | Peak     | 41.18         | 0.08   | 41.27        | 74.00        | -32.73 |
| 7266.000 | Average  | 26.98         | 7.53   | 34.51        | 54.00        | -19.49 |
| 7266.000 | Peak     | 40.83         | 7.53   | 48.36        | 74.00        | -25.64 |

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Report Number :E2/2022/10038  
 Operation Mode :802.11ax40  
 Test Frequency :2437 MHz  
 Test Mode :TX CH MID FULL RU  
 EUT Pol :E2 Plane

Test Site :SAC D  
 Test Date :2022-03-07  
 Temp./Humi. :18.8/64  
 Antenna Pol. :Vertical  
 Engineer :Jack Tseng



| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
|          | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4874.000 | Average  | 29.53         | -0.26  | 29.27        | 54.00        | -24.73 |
| 4874.000 | Peak     | 41.38         | -0.26  | 41.11        | 74.00        | -32.89 |
| 7311.000 | Average  | 28.13         | 6.68   | 34.81        | 54.00        | -19.19 |
| 7311.000 | Peak     | 40.63         | 6.68   | 47.31        | 74.00        | -26.69 |

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Report Number :E2/2022/10038

Test Site :SAC D

Operation Mode :802.11ax40

Test Date :2022-03-07

Test Frequency :2437 MHz

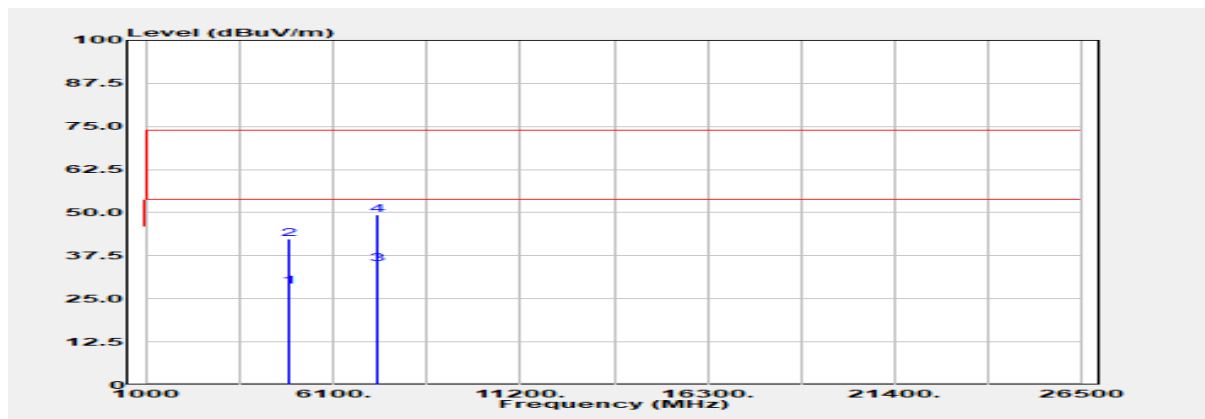
Temp./Humi. :18.8/64

Test Mode :TX CH MID FULL RU

Antenna Pol. :Horizontal

EUT Pol :E2 Plane

Engineer :Jack Tseng



| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| Mode     | Mode     | Reading Level |        | FS           | @3m          |        |
| MHz      | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4874.000 | Average  | 28.75         | -0.26  | 28.49        | 54.00        | -25.51 |
| 4874.000 | Peak     | 42.54         | -0.26  | 42.27        | 74.00        | -31.73 |
| 7311.000 | Average  | 28.37         | 6.68   | 35.05        | 54.00        | -18.95 |
| 7311.000 | Peak     | 42.66         | 6.68   | 49.34        | 74.00        | -24.66 |

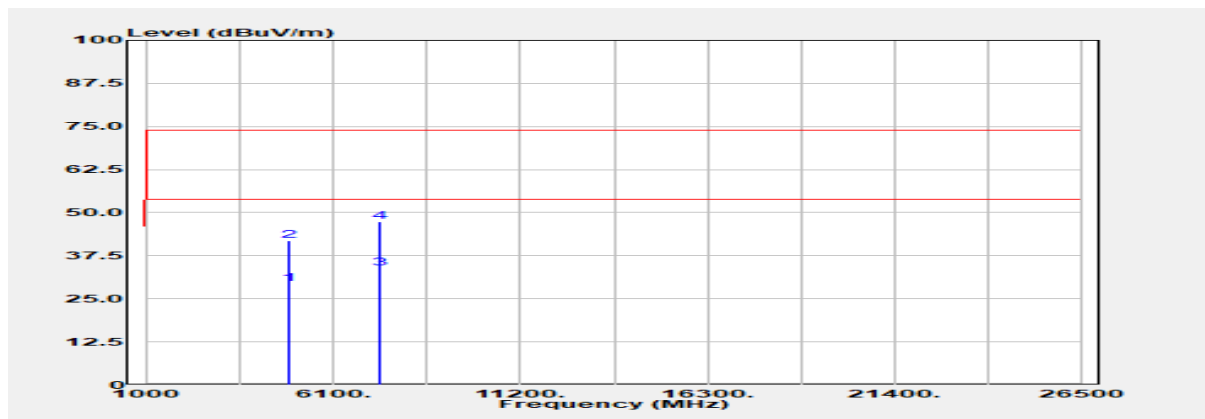
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Report Number :E2/2022/10038  
 Operation Mode :802.11ax40  
 Test Frequency :2452 MHz  
 Test Mode :TX CH HIGH FULL RU  
 EUT Pol :E2 Plane

Test Site :SAC D  
 Test Date :2022-03-07  
 Temp./Humi. :18.8/64  
 Antenna Pol. :Vertical  
 Engineer :Jack Tseng



| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
|          | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4904.000 | Average  | 29.82         | -0.60  | 29.21        | 54.00        | -24.79 |
| 4904.000 | Peak     | 42.54         | -0.60  | 41.93        | 74.00        | -32.07 |
| 7356.000 | Average  | 26.28         | 7.53   | 33.81        | 54.00        | -20.19 |
| 7356.000 | Peak     | 39.94         | 7.53   | 47.46        | 74.00        | -26.54 |

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Report Number :E2/2022/10038

Test Site :SAC D

Operation Mode :802.11ax40

Test Date :2022-03-07

Test Frequency :2452 MHz

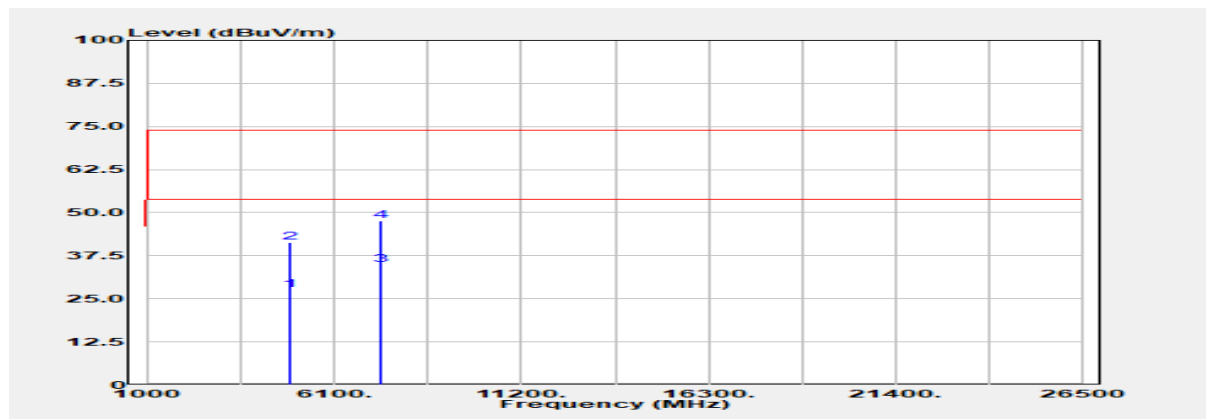
Temp./Humi. :18.8/64

Test Mode :TX CH HIGH FULL RU

Antenna Pol. :Horizontal

EUT Pol :E2 Plane

Engineer :Jack Tseng



| Freq.    | Detector | Spectrum      | Factor | Actual       | Limit        | Margin |
|----------|----------|---------------|--------|--------------|--------------|--------|
| MHz      | Mode     | Reading Level |        | FS           | @3m          |        |
|          | PK/QP/AV | dB $\mu$ V    | dB     | dB $\mu$ V/m | dB $\mu$ V/m | dB     |
| 4904.000 | Average  | 28.19         | -0.60  | 27.59        | 54.00        | -26.41 |
| 4904.000 | Peak     | 42.02         | -0.60  | 41.42        | 74.00        | -32.58 |
| 7356.000 | Average  | 27.22         | 7.53   | 34.75        | 54.00        | -19.25 |
| 7356.000 | Peak     | 40.07         | 7.53   | 47.59        | 74.00        | -26.41 |

~ End of Report ~

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