

## FCC Test Report

**Report No.:** RFBHAT-WTW-P21061067

**FCC ID:** R68OQ610US

**Test Model:** Open-Q 610 uSOM

**Received Date:** Jun. 29, 2021

**Test Date:** Sep. 03 ~ Sep. 15, 2021

**Issued Date:** Jan. 10, 2022

**Applicant:** Lantronix, Inc.

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**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch  
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**Test Location (2):** No. 70, Wenming Rd., Guishan Dist., Taoyuan City 333, Taiwan

**FCC Registration /** 788550 / TW0003

**Designation Number:** 281270 / TW0032



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### Release Control Record

| Issue No.            | Description      | Date Issued   |
|----------------------|------------------|---------------|
| RFBHAT-WTW-P21061067 | Original Release | Jan. 10, 2022 |

## 1 Certificate of Conformity

**Product:** Open-Q 610 uSOM

**Brand:** Lantronix

**Test Model:** Open-Q 610 uSOM

**Sample Status:** Engineering Sample

**Applicant:** Lantronix, Inc.

**Test Date:** Sep. 03 ~ Sep. 15, 2021

**Standards:** 47 CFR FCC Part 15, Subpart C (Section 15.247)  
ANSI C63.10:2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Lena Wang , Date: Jan. 10, 2022  
Lena Wang / Specialist

Approved by : Jeremy Lin , Date: Jan. 10, 2022  
Jeremy Lin / Project Engineer

## 2 Summary of Test Results

| 47 CFR FCC Part 15, Subpart C (Section 15.247) |                                                                                                               |        |                                                                                       |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------------------------------------------------|
| FCC Clause                                     | Test Item                                                                                                     | Result | Remarks                                                                               |
| 15.207                                         | AC Power Conducted Emission                                                                                   | Pass   | Meet the requirement of limit.<br>Minimum passing margin is -25.40 dB at 0.40179 MHz. |
| 15.247(a)(1)(iii)                              | Number of Hopping Frequency Used                                                                              | Pass   | Meet the requirement of limit.                                                        |
| 15.247(a)(1)(iii)                              | Dwell Time on Each Channel                                                                                    | Pass   | Meet the requirement of limit.                                                        |
| 15.247(a)(1)                                   | 1. Hopping Channel Separation<br>2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System | Pass   | Meet the requirement of limit.                                                        |
| 15.247(a)(1)                                   | Maximum Peak Output Power                                                                                     | Pass   | Meet the requirement of limit.                                                        |
| ---                                            | Occupied Bandwidth Measurement                                                                                | Pass   | Reference only                                                                        |
| 15.205 & 209                                   | Radiated Emissions                                                                                            | Pass   | Meet the requirement of limit.<br>Minimum passing margin is -9.84 dB at 2390.00 MHz.  |
| 15.247(d)                                      | Band Edge Measurement                                                                                         | Pass   | Meet the requirement of limit.                                                        |
| 15.247(d)                                      | Antenna Port Emission                                                                                         | Pass   | Meet the requirement of limit.                                                        |
| 15.203                                         | Antenna Requirement                                                                                           | Pass   | Antenna connector is U.FL.                                                            |

### Note:

1. If the Frequency Hopping System operating in 2400-2483.5 MHz band and the output power less than 125 mW. The hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of hopping channel whichever is greater.
2. For 2.4G band compliance with rule 15.247(d) of the band-edge items, the test plots were recorded in Annex A. Test Procedures refer to report 4.1.3.
3. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

### 2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

| Measurement                        | Frequency          | Expanded Uncertainty (k=2) (±) |
|------------------------------------|--------------------|--------------------------------|
| Conducted Emissions at mains ports | 150 kHz ~ 30 MHz   | 2.79 dB                        |
| Radiated Emissions up to 1 GHz     | 9 kHz ~ 30 MHz     | 3.00 dB                        |
|                                    | 30 MHz ~ 200 MHz   | 2.91 dB                        |
|                                    | 200 MHz ~ 1000 MHz | 2.93 dB                        |
| Radiated Emissions above 1 GHz     | 1 GHz ~ 18 GHz     | 1.76 dB                        |
|                                    | 18 GHz ~ 40 GHz    | 1.77 dB                        |

## 2.2 Modification Record

There were no modifications required for compliance.

### 3 General Information

#### 3.1 General Description of EUT

|                            |                             |
|----------------------------|-----------------------------|
| <b>Product</b>             | Open-Q 610 uSOM             |
| <b>Brand</b>               | Lantronix                   |
| <b>Test Model</b>          | Open-Q 610 uSOM             |
| <b>Status of EUT</b>       | Engineering Sample          |
| <b>Power Supply Rating</b> | 12 Vdc (Adapter)            |
| <b>Modulation Type</b>     | GFSK, $\pi/4$ -DQPSK, 8DPSK |
| <b>Transfer Rate</b>       | 1/2/3 Mbps                  |
| <b>Operating Frequency</b> | 2402 ~ 2480 MHz             |
| <b>Number of Channel</b>   | 79                          |
| <b>Output Power</b>        | 19.543 mW                   |
| <b>Antenna Type</b>        | Refer to Note as below      |
| <b>Antenna Connector</b>   | Refer to Note as below      |
| <b>Accessory Device</b>    | N/A                         |
| <b>Data Cable Supplied</b> | N/A                         |

Note:

1. The following antennas were provided to the EUT.

|                    |                         |          |
|--------------------|-------------------------|----------|
| Ant. Type          | Flexible Dipole Antenna |          |
| Connector Type     | U.FL                    |          |
| Antenna Gain (dBi) |                         |          |
| 2.4~2.5G           |                         | 4.9~5.8G |
| 3.32               |                         | 6.11     |

2. The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.
3. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or User's Manual.
4. The BT could transmit simultaneously with WLAN 5GHz at the same time. The emission of the simultaneous operation has been evaluated and no non-compliance was found.

### 3.2 Description of Test Modes

79 channels are provided to this EUT:

| Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|---------|-------------|---------|-------------|---------|-------------|---------|-------------|
| 0       | 2402        | 20      | 2422        | 40      | 2442        | 60      | 2462        |
| 1       | 2403        | 21      | 2423        | 41      | 2443        | 61      | 2463        |
| 2       | 2404        | 22      | 2424        | 42      | 2444        | 62      | 2464        |
| 3       | 2405        | 23      | 2425        | 43      | 2445        | 63      | 2465        |
| 4       | 2406        | 24      | 2426        | 44      | 2446        | 64      | 2466        |
| 5       | 2407        | 25      | 2427        | 45      | 2447        | 65      | 2467        |
| 6       | 2408        | 26      | 2428        | 46      | 2448        | 66      | 2468        |
| 7       | 2409        | 27      | 2429        | 47      | 2449        | 67      | 2469        |
| 8       | 2410        | 28      | 2430        | 48      | 2450        | 68      | 2470        |
| 9       | 2411        | 29      | 2431        | 49      | 2451        | 69      | 2471        |
| 10      | 2412        | 30      | 2432        | 50      | 2452        | 70      | 2472        |
| 11      | 2413        | 31      | 2433        | 51      | 2453        | 71      | 2473        |
| 12      | 2414        | 32      | 2434        | 52      | 2454        | 72      | 2474        |
| 13      | 2415        | 33      | 2435        | 53      | 2455        | 73      | 2475        |
| 14      | 2416        | 34      | 2436        | 54      | 2456        | 74      | 2476        |
| 15      | 2417        | 35      | 2437        | 55      | 2457        | 75      | 2477        |
| 16      | 2418        | 36      | 2438        | 56      | 2458        | 76      | 2478        |
| 17      | 2419        | 37      | 2439        | 57      | 2459        | 77      | 2479        |
| 18      | 2420        | 38      | 2440        | 58      | 2460        | 78      | 2480        |
| 19      | 2421        | 39      | 2441        | 59      | 2461        |         |             |

### 3.2.1 Test Mode Applicability and Tested Channel Detail

| EUT Configure Mode | Applicable To |       |     |      | Description |
|--------------------|---------------|-------|-----|------|-------------|
|                    | RE $\geq$ 1G  | RE<1G | PLC | APCM |             |
| -                  | √             | √     | √   | √    | -           |

Where **RE $\geq$ 1G:** Radiated Emission above 1 GHz **RE<1G:** Radiated Emission below 1 GHz  
**PLC:** Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

**Note:**

1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Z-plane**.
2. "-" means no effect.
3. Radiated emission test (below 1GHz) and power line conducted emission test items chosen the worst fundamental frequency emission level.

#### **Radiated Emission Test (Above 1 GHz):**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|--------------------|-------------------|----------------|-----------------------|-----------------|-------------|
| -                  | 0 to 78           | 0, 39, 78      | FHSS                  | GFSK            | DH5         |
|                    | 0 to 78           | 0, 39, 78      | FHSS                  | 8DPSK           | 3DH5        |

#### **Radiated Emission Test (Below 1 GHz):**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|--------------------|-------------------|----------------|-----------------------|-----------------|-------------|
| -                  | 0 to 78           | 0              | FHSS                  | GFSK            | DH5         |

#### **Power Line Conducted Emission Test:**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|--------------------|-------------------|----------------|-----------------------|-----------------|-------------|
| -                  | 0 to 78           | 0              | FHSS                  | GFSK            | DH5         |

### Antenna Port Conducted Measurement:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

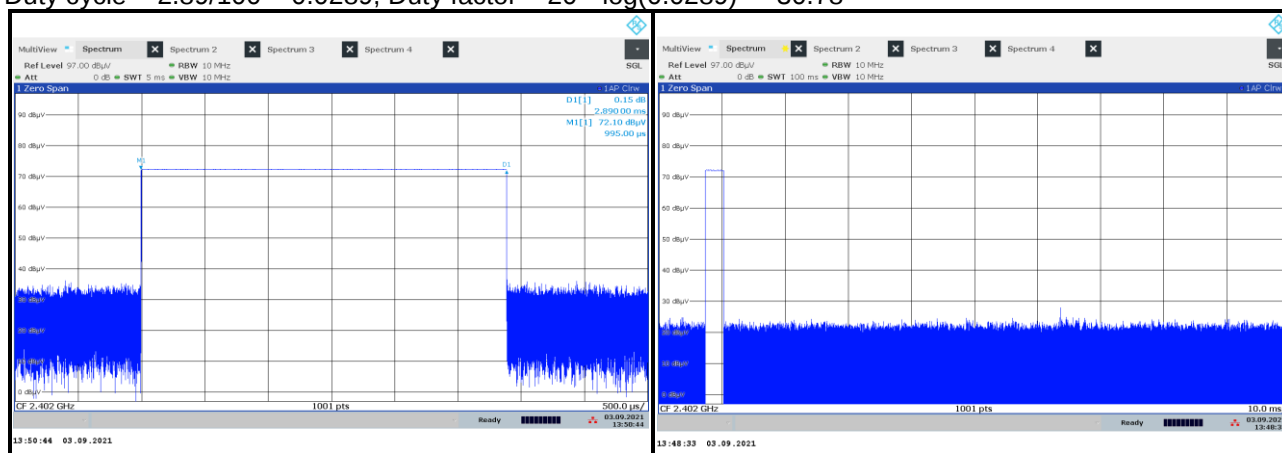
| EUT Configure Mode | Available Channel | Tested Channel | Modulation Technology | Modulation Type | Packet Type |
|--------------------|-------------------|----------------|-----------------------|-----------------|-------------|
| -                  | 0 to 78           | 0, 39, 78      | FHSS                  | GFSK            | DH5         |
| -                  | 0 to 78           | 0, 39, 78      | FHSS                  | 8DPSK           | 3DH5        |

### Test Condition:

| Applicable To | Environmental Conditions | Input Power    | Tested by  |
|---------------|--------------------------|----------------|------------|
| RE $\geq$ 1G  | 25 deg. C, 65 % RH       | 120 Vac, 60 Hz | Titan Hsu  |
| RE $<$ 1G     | 25 deg. C, 65 % RH       | 120 Vac, 60 Hz | Adair Peng |
| PLC           | 25 deg. C, 65 % RH       | 120 Vac, 60 Hz | Rex Wang   |
| APCM          | 25 deg. C, 65 % RH       | 120 Vac, 60 Hz | Ivan Tseng |

### 3.3 Duty Cycle of Test Signal

Duty cycle =  $2.89/100 = 0.0289$ , Duty factor =  $20 * \log(0.0289) = -30.78$



### 3.4 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

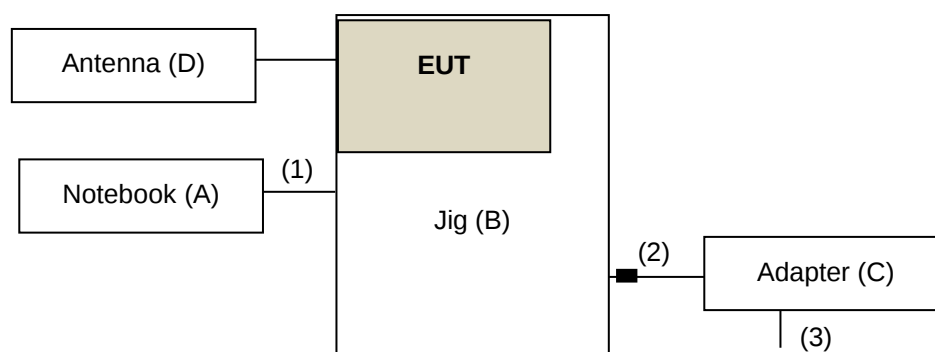
| ID | Product  | Brand       | Model No.        | Serial No. | FCC ID | Remarks            |
|----|----------|-------------|------------------|------------|--------|--------------------|
| A  | Notebook | Lenovo      | 20J4 MD A003TW   | PF-11H9AK  | N/A    | -                  |
| B  | Jig      | N/A         | N/A              | N/A        | N/A    | Provided by client |
| C  | Adapter  | YINGHUIYUAN | YHY-12003000     | N/A        | N/A    | Provided by client |
| D  | Antenna  | Taoglas     | FXP.830.07.0100C | N/A        | N/A    | Provided by client |

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as a communication partner to transfer data.

| ID | Cable Descriptions | Qty. | Length (m) | Shielding (Yes/No) | Cores (Qty.) | Remarks            |
|----|--------------------|------|------------|--------------------|--------------|--------------------|
| 1. | Type C USB Cable   | 1    | 1          | Y                  | 0            | Provided by client |
| 2. | Adapter Cable      | 1    | 1.2        | Y                  | 1            | Provided by client |
| 3. | Power Cable        | 1    | 1.15       | N                  | 0            | Provided by client |

#### 3.4.1 Configuration of System under Test



### 3.5 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and references:

#### Test Standard:

##### FCC Part 15, Subpart C (15.247)

ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

#### References Test Guidance:

##### KDB 558074 D01 15.247 Meas Guidance v05r02

All test items have been performed as a reference to the above KDB test guidance.

## 4 Test Types and Results

### 4.1 Radiated Emission and Bandedge Measurement

#### 4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|-------------------|-----------------------------------|-------------------------------|
| 0.009 ~ 0.490     | 2400/F (kHz)                      | 300                           |
| 0.490 ~ 1.705     | 24000/F (kHz)                     | 30                            |
| 1.705 ~ 30.0      | 30                                | 30                            |
| 30 ~ 88           | 100                               | 3                             |
| 88 ~ 216          | 150                               | 3                             |
| 216 ~ 960         | 200                               | 3                             |
| Above 960         | 500                               | 3                             |

**Note:**

- The lower limit shall apply at the transition frequencies.
- Emission level (dBuV/m) = 20 log Emission level (uV/m).
- For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

#### 4.1.2 Test Instruments

| Description & Manufacturer               | Model No.                              | Serial No.                                          | Date of Calibration | Due Date of Calibration |
|------------------------------------------|----------------------------------------|-----------------------------------------------------|---------------------|-------------------------|
| Test Receiver<br>Rohde & Schwarz         | N9038A                                 | MY55420137                                          | Apr. 09, 2021       | Apr. 08, 2022           |
| Spectrum Analyzer<br>KEYSIGHT            | N9020B                                 | MY60110440                                          | Dec. 18, 2020       | Dec. 17, 2021           |
| BILOG Antenna<br>SCHWARZBECK             | VULB9168                               | 1213                                                | Nov. 04, 2020       | Nov. 03, 2021           |
| HORN Antenna<br>SCHWARZBECK              | BBHA 9120 D                            | 9120D-563                                           | Nov. 22, 2020       | Nov. 21, 2021           |
| HORN Antenna<br>SCHWARZBECK              | BBHA 9170                              | 995                                                 | Nov. 22, 2020       | Nov. 21, 2021           |
| Loop Antenna<br>EMCI                     | EM-6879                                | 269                                                 | Sep. 17, 2020       | Sep. 16, 2021           |
| Loop Antenna<br>TESEQ                    | HLA 6121                               | 45745                                               | Jul. 21, 2021       | Jul. 20, 2022           |
| Preamplifier<br>EMCI                     | EMC330N                                | 980782                                              | Jan. 12, 2021       | Jan. 11, 2022           |
| Preamplifier<br>EMCI                     | EMC118A45SE                            | 980808                                              | Jan. 12, 2021       | Jan. 11, 2022           |
| Preamplifier<br>EMCI                     | EMC184045SE                            | 980788                                              | Jan. 12, 2021       | Jan. 11, 2022           |
| RF signal cable<br>EMCI                  | EMC104-SM-SM-<br>(9000+2000+1000)      | 201243+ 201231+<br>210102                           | Jan. 12, 2021       | Jan. 11, 2022           |
| RF signal cable<br>EMCI                  | EMCCFD400-NM-<br>NM-<br>(9000+300+500) | 201236+ 201235+<br>201233                           | Jan. 12, 2021       | Jan. 11, 2022           |
| RF signal cable<br>EMCI                  | EMC101G-KM-KM-<br>(5000+3000+2000)     | 201260+201257+2<br>01254                            | Jan. 12, 2021       | Jan. 11, 2022           |
| Software<br>BV ADT                       | ADT_Radiated_V7.<br>6.15.9.5           | NA                                                  | NA                  | NA                      |
| Antenna Tower<br>Max-Full                | MFT-151SS-0.5T                         | NA                                                  | NA                  | NA                      |
| Turn Table<br>Max-Full                   | MF-7802BS                              | NA                                                  | NA                  | NA                      |
| Turn Table Controller<br>Max-Full        | MF-7802BS                              | MF780208674                                         | NA                  | NA                      |
| USB Wideband Power<br>Sensor<br>KEYSIGHT | U2021XA                                | MY55050005/MY551<br>90004/MY55190007/<br>MY55210005 | Jul. 12, 2021       | Jul. 11, 2022           |

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.  
 2. The test was performed in WM Chamber 8.

#### 4.1.3 Test Procedures

##### **For Radiated Emission below 30 MHz**

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

##### **Note:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30 MHz.

##### **For Radiated Emission above 30 MHz**

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30 MHz ~ 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

##### **Note:**

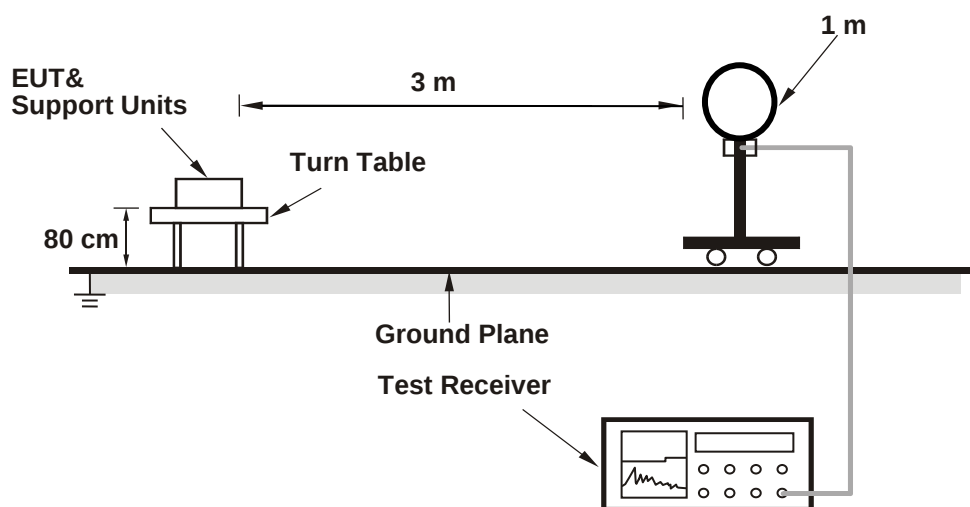
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) or Peak detection (PK) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
3. For fundamental and harmonic signal measurement, according to ANSI C63.10 section 7.5, the average value = peak value + duty cycle correction factor. The duty cycle correction factor refer to Chapter 3.3 of this report.
4. All modes of operation were investigated and the worst-case emissions are reported.

#### 4.1.4 Deviation from Test Standard

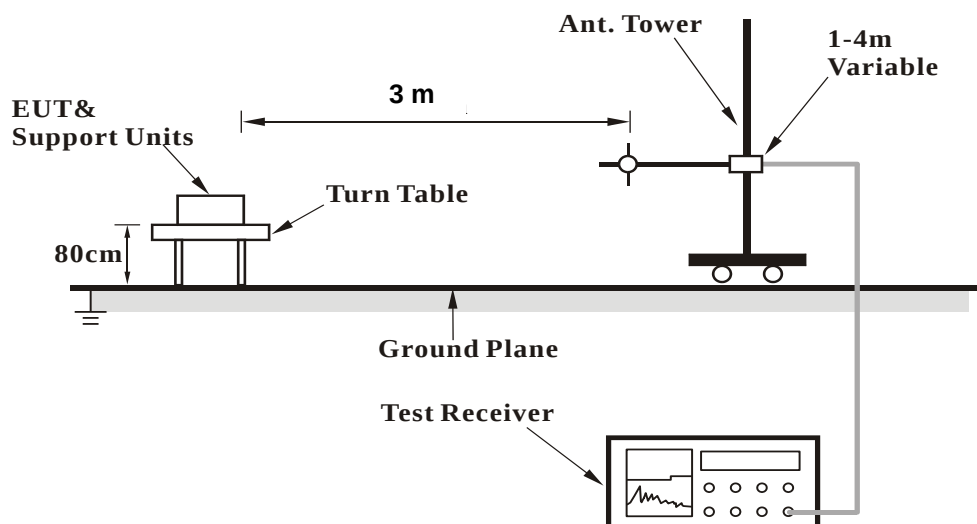
No deviation.

#### 4.1.5 Test Set Up

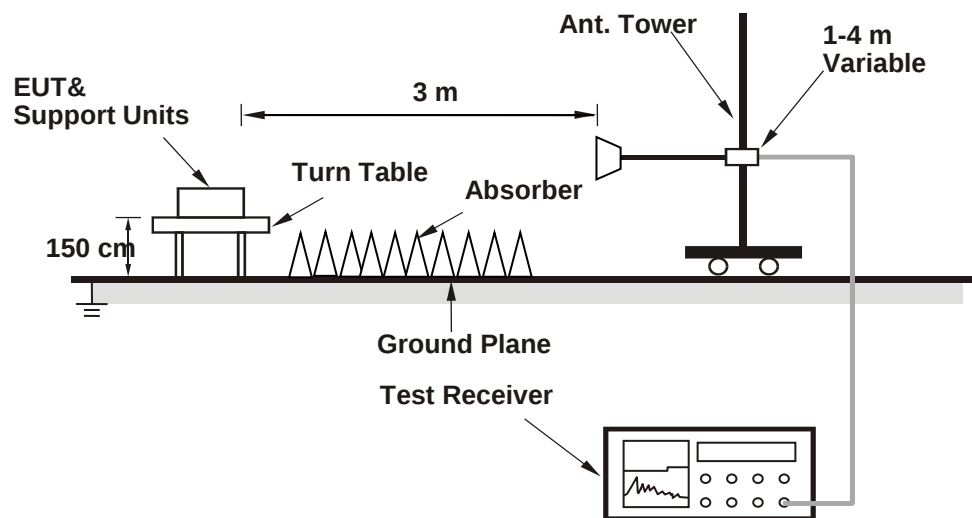
##### <Radiated Emission below 30 MHz>



##### <Radiated Emission 30 MHz to 1 GHz>



### <Radiated Emission above 1 GHz>



For the actual test configuration, please refer to the attached file (Test Setup Photo).

#### 4.1.6 EUT Operating Conditions

Set the EUT under transmission condition continuously at specific channel frequency.

#### 4.1.7 Test Results

##### Above 1 GHz Data:

##### GFSK

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_GFSK   | <b>Channel</b>           | CH 0 : 2402 MHz           |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | 2390.00         | 56.56 PK                | 74.00          | -17.44      | 1.00 H             | 296                  | 24.90            | 31.66                    |
| 2                                                    | 2390.00         | 43.46 AV                | 54.00          | -10.54      | 1.00 H             | 296                  | 11.80            | 31.66                    |
| 3                                                    | *2402.00        | 103.68 PK               |                |             | 1.00 H             | 296                  | 72.00            | 31.68                    |
| 4                                                    | *2402.00        | 72.90 AV                |                |             | 1.00 H             | 296                  | 41.22            | 31.68                    |
| 5                                                    | 4804.00         | 47.86 PK                | 74.00          | -26.14      | 2.25 H             | 66                   | 45.50            | 2.36                     |
| 6                                                    | 4804.00         | 17.08 AV                | 54.00          | -36.92      | 2.25 H             | 66                   | 14.72            | 2.36                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | 2390.00         | 56.26 PK                | 74.00          | -17.74      | 1.95 V             | 203                  | 24.60            | 31.66                    |
| 2                                                    | 2390.00         | 44.16 AV                | 54.00          | -9.84       | 1.95 V             | 203                  | 12.50            | 31.66                    |
| 3                                                    | *2402.00        | 107.28 PK               |                |             | 1.95 V             | 203                  | 75.60            | 31.68                    |
| 4                                                    | *2402.00        | 76.50 AV                |                |             | 1.95 V             | 203                  | 44.82            | 31.68                    |
| 5                                                    | 4804.00         | 49.66 PK                | 74.00          | -24.34      | 1.38 V             | 263                  | 47.30            | 2.36                     |
| 6                                                    | 4804.00         | 18.88 AV                | 54.00          | -35.12      | 1.38 V             | 263                  | 16.52            | 2.36                     |

##### Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_GFSK   | <b>Channel</b>           | CH 39 : 2441 MHz          |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2441.00        | 103.98 PK               |                |             | 1.05 H             | 293                  | 72.20            | 31.78                    |
| 2                                                    | *2441.00        | 73.20 AV                |                |             | 1.05 H             | 293                  | 41.42            | 31.78                    |
| 3                                                    | 4882.00         | 48.14 PK                | 74.00          | -25.86      | 2.28 H             | 69                   | 45.60            | 2.54                     |
| 4                                                    | 4882.00         | 17.36 AV                | 54.00          | -36.64      | 2.28 H             | 69                   | 14.82            | 2.54                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2441.00        | 108.38 PK               |                |             | 2.17 V             | 203                  | 76.60            | 31.78                    |
| 2                                                    | *2441.00        | 77.60 AV                |                |             | 2.17 V             | 203                  | 45.82            | 31.78                    |
| 3                                                    | 4882.00         | 48.34 PK                | 74.00          | -25.66      | 1.38 V             | 266                  | 45.80            | 2.54                     |
| 4                                                    | 4882.00         | 17.56 AV                | 54.00          | -36.44      | 1.38 V             | 266                  | 15.02            | 2.54                     |

**Remarks:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_GFSK   | <b>Channel</b>           | CH 78 : 2480 MHz          |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2480.00        | 104.08 PK               |                |             | 1.01 H             | 285                  | 72.20            | 31.88                    |
| 2                                                    | *2480.00        | 73.30 AV                |                |             | 1.01 H             | 285                  | 41.42            | 31.88                    |
| 3                                                    | 2483.50         | 50.25 PK                | 74.00          | -23.75      | 1.01 H             | 285                  | 54.60            | -4.35                    |
| 4                                                    | 2483.50         | 19.47 AV                | 54.00          | -34.53      | 1.01 H             | 285                  | 23.82            | -4.35                    |
| 5                                                    | 4960.00         | 48.29 PK                | 74.00          | -25.71      | 2.26 H             | 63                   | 45.60            | 2.69                     |
| 6                                                    | 4960.00         | 17.51 AV                | 54.00          | -36.49      | 2.26 H             | 63                   | 14.82            | 2.69                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2480.00        | 108.28 PK               |                |             | 1.88 V             | 201                  | 76.40            | 31.88                    |
| 2                                                    | *2480.00        | 77.50 AV                |                |             | 1.88 V             | 201                  | 45.62            | 31.88                    |
| 3                                                    | 2483.50         | 55.35 PK                | 74.00          | -18.65      | 1.88 V             | 201                  | 59.70            | -4.35                    |
| 4                                                    | 2483.50         | 24.57 AV                | 54.00          | -29.43      | 1.88 V             | 201                  | 28.92            | -4.35                    |
| 5                                                    | 4960.00         | 49.49 PK                | 74.00          | -24.51      | 1.42 V             | 266                  | 46.80            | 2.69                     |
| 6                                                    | 4960.00         | 18.71 AV                | 54.00          | -35.29      | 1.42 V             | 266                  | 16.02            | 2.69                     |

**Remarks:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

## 8DPSK

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_8DPSK  | <b>Channel</b>           | CH 0 : 2402 MHz           |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | 2390.00         | 56.36 PK                | 74.00          | -17.64      | 1.01 H             | 297                  | 24.70            | 31.66                    |
| 2                                                    | 2390.00         | 43.66 AV                | 54.00          | -10.34      | 1.01 H             | 297                  | 12.00            | 31.66                    |
| 3                                                    | *2402.00        | 104.28 PK               |                |             | 1.01 H             | 297                  | 72.60            | 31.68                    |
| 4                                                    | *2402.00        | 73.50 AV                |                |             | 1.01 H             | 297                  | 41.82            | 31.68                    |
| 5                                                    | 4804.00         | 47.96 PK                | 74.00          | -26.04      | 2.29 H             | 65                   | 45.60            | 2.36                     |
| 6                                                    | 4804.00         | 17.18 AV                | 54.00          | -36.82      | 2.29 H             | 65                   | 14.82            | 2.36                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | 2390.00         | 56.16 PK                | 74.00          | -17.84      | 1.69 V             | 202                  | 24.50            | 31.66                    |
| 2                                                    | 2390.00         | 43.76 AV                | 54.00          | -10.24      | 1.69 V             | 202                  | 12.10            | 31.66                    |
| 3                                                    | *2402.00        | 108.58 PK               |                |             | 1.69 V             | 202                  | 76.90            | 31.68                    |
| 4                                                    | *2402.00        | 62.46 AV                |                |             | 1.69 V             | 202                  | 30.78            | 31.68                    |
| 5                                                    | 4804.00         | 49.96 PK                | 74.00          | -24.04      | 1.42 V             | 265                  | 47.60            | 2.36                     |
| 6                                                    | 4804.00         | 19.18 AV                | 54.00          | -34.82      | 1.42 V             | 265                  | 16.82            | 2.36                     |

### Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_8DPSK  | <b>Channel</b>           | CH 39 : 2441 MHz          |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2441.00        | 105.28 PK               |                |             | 1.01 H             | 295                  | 73.50            | 31.78                    |
| 2                                                    | *2441.00        | 74.50 AV                |                |             | 1.01 H             | 295                  | 42.72            | 31.78                    |
| 3                                                    | 4882.00         | 48.24 PK                | 74.00          | -25.76      | 2.30 H             | 66                   | 45.70            | 2.54                     |
| 4                                                    | 4882.00         | 17.46 AV                | 54.00          | -36.54      | 2.30 H             | 66                   | 14.92            | 2.54                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2441.00        | 109.58 PK               |                |             | 1.74 V             | 222                  | 77.80            | 31.78                    |
| 2                                                    | *2441.00        | 78.80 AV                |                |             | 1.74 V             | 222                  | 47.02            | 31.78                    |
| 3                                                    | 4882.00         | 50.34 PK                | 74.00          | -23.66      | 1.45 V             | 263                  | 47.80            | 2.54                     |
| 4                                                    | 4882.00         | 19.56 AV                | 54.00          | -34.44      | 1.45 V             | 263                  | 17.02            | 2.54                     |

**Remarks:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

|                        |              |                          |                           |
|------------------------|--------------|--------------------------|---------------------------|
| <b>RF Mode</b>         | TX BT_8DPSK  | <b>Channel</b>           | CH 78 : 2480 MHz          |
| <b>Frequency Range</b> | 1GHz ~ 25GHz | <b>Detector Function</b> | Peak (PK)<br>Average (AV) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2480.00        | 105.28 PK               |                |             | 1.12 H             | 293                  | 73.40            | 31.88                    |
| 2                                                    | *2480.00        | 74.50 AV                |                |             | 1.12 H             | 293                  | 42.62            | 31.88                    |
| 3                                                    | 2483.50         | 54.05 PK                | 74.00          | -19.95      | 1.12 H             | 293                  | 58.40            | -4.35                    |
| 4                                                    | 2483.50         | 23.27 AV                | 54.00          | -30.73      | 1.12 H             | 293                  | 27.62            | -4.35                    |
| 5                                                    | 4960.00         | 48.39 PK                | 74.00          | -25.61      | 2.31 H             | 69                   | 45.70            | 2.69                     |
| 6                                                    | 4960.00         | 17.61 AV                | 54.00          | -36.39      | 2.31 H             | 69                   | 14.92            | 2.69                     |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | *2480.00        | 109.68 PK               |                |             | 1.81 V             | 228                  | 77.80            | 31.88                    |
| 2                                                    | *2480.00        | 78.90 AV                |                |             | 1.81 V             | 228                  | 47.02            | 31.88                    |
| 3                                                    | 2483.50         | 58.45 PK                | 74.00          | -15.55      | 1.81 V             | 228                  | 62.80            | -4.35                    |
| 4                                                    | 2483.50         | 27.67 AV                | 54.00          | -26.33      | 1.81 V             | 228                  | 32.02            | -4.35                    |
| 5                                                    | 4960.00         | 49.99 PK                | 74.00          | -24.01      | 1.45 V             | 269                  | 47.30            | 2.69                     |
| 6                                                    | 4960.00         | 19.21 AV                | 54.00          | -34.79      | 1.45 V             | 269                  | 16.52            | 2.69                     |

**Remarks:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency.
6. for Fundamental frequency and bandedge & harmonic:  
The average value of fundamental frequency is :average = peak value + 20log(Duty cycle)  
where the duty factor is calculated from following formula:  
 $20\text{Log}(\text{Duty cycle}) = 20 \log (2.89\text{ms} \times 1/100) = -30.78\text{dB}$  please refer to the plotted duty (see section 3.3)

### 9 kHz ~ 30 MHz Data:

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

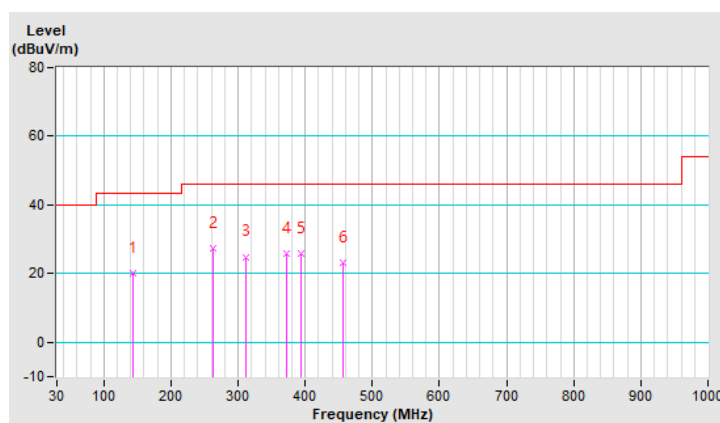
### 30 MHz ~ 1 GHz Worst-Case Data:

|                        |              |                          |                 |
|------------------------|--------------|--------------------------|-----------------|
| <b>RF Mode</b>         | TX BT_GFSK   | <b>Channel</b>           | CH 0 : 2402 MHz |
| <b>Frequency Range</b> | 30MHz ~ 1GHz | <b>Detector Function</b> | Quasi-Peak (QP) |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|------------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                    | 143.87          | 20.1 QP                 | 43.5           | -23.4       | 1.50 H             | 270                  | 38.4             | -18.3                    |
| 2                                                    | 263.36          | 27.4 QP                 | 46.0           | -18.6       | 1.00 H             | 153                  | 46.5             | -19.1                    |
| 3                                                    | 311.16          | 24.9 QP                 | 46.0           | -21.1       | 1.00 H             | 187                  | 42.2             | -17.3                    |
| 4                                                    | 371.61          | 25.7 QP                 | 46.0           | -20.3       | 1.00 H             | 46                   | 41.5             | -15.8                    |
| 5                                                    | 394.10          | 26.0 QP                 | 46.0           | -20.0       | 2.00 H             | 314                  | 41.4             | -15.4                    |
| 6                                                    | 455.96          | 23.2 QP                 | 46.0           | -22.8       | 1.00 H             | 63                   | 36.7             | -13.5                    |

### Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

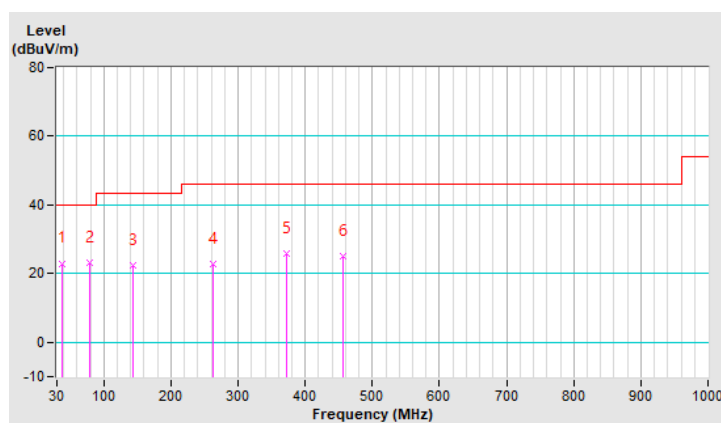


|                 |              |                   |                 |
|-----------------|--------------|-------------------|-----------------|
| RF Mode         | TX BT_GFSK   | Channel           | CH 0 : 2402 MHz |
| Frequency Range | 30MHz ~ 1GHz | Detector Function | Quasi-Peak (QP) |

| Antenna Polarity & Test Distance : Vertical at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|----------------------------------------------------|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No                                                 | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1                                                  | 37.03           | 23.0 QP                 | 40.0           | -17.0       | 1.00 V             | 12                   | 41.9             | -18.9                    |
| 2                                                  | 79.20           | 23.2 QP                 | 40.0           | -16.8       | 1.00 V             | 262                  | 46.1             | -22.9                    |
| 3                                                  | 142.46          | 22.4 QP                 | 43.5           | -21.1       | 1.49 V             | 18                   | 40.9             | -18.5                    |
| 4                                                  | 263.36          | 22.8 QP                 | 46.0           | -23.2       | 1.00 V             | 70                   | 41.9             | -19.1                    |
| 5                                                  | 371.61          | 26.0 QP                 | 46.0           | -20.0       | 1.00 V             | 175                  | 41.8             | -15.8                    |
| 6                                                  | 455.96          | 24.9 QP                 | 46.0           | -21.1       | 1.00 V             | 171                  | 38.4             | -13.5                    |

#### Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



## 4.2 Conducted Emission Measurement

### 4.2.1 Limits of Conducted Emission Measurement

| Frequency (MHz) | Conducted Limit (dBUV) |         |
|-----------------|------------------------|---------|
|                 | Quasi-Peak             | Average |
| 0.15 - 0.5      | 66 - 56                | 56 - 46 |
| 0.50 - 5.0      | 56                     | 46      |
| 5.0 - 30.0      | 60                     | 50      |

Note: 1. The lower limit shall apply at the transition frequencies.  
 2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.

### 4.2.2 Test Instruments

| Description & Manufacturer                  | Model No.                | Serial No.     | Date of Calibration | Due Date of Calibration |
|---------------------------------------------|--------------------------|----------------|---------------------|-------------------------|
| Test Receiver<br>ROHDE & SCHWARZ            | ESR3                     | 102783         | Dec. 21, 2020       | Dec. 20, 2021           |
| RF signal cable (with<br>10dB PAD)<br>Woken | 5D-FB                    | Cable-cond2-01 | Sep. 04, 2021       | Sep. 03, 2022           |
| LISN/AMN<br>ROHDE & SCHWARZ<br>(EUT)        | ESH2-Z5                  | 100100         | Jan. 28, 2021       | Jan. 27, 2022           |
| LISN/AMN<br>ROHDE & SCHWARZ<br>(Peripheral) | ENV216                   | 101196         | Apr. 26, 2021       | Apr. 25, 2022           |
| Software<br>ADT                             | BV ADT_Cond_<br>V7.3.7.4 | NA             | NA                  | NA                      |

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.  
 2. The test was performed in HwaYa Shielded Room 2. (Conduction 2).  
 3. The VCCI Site Registration No. is C-12047.

#### 4.2.3 Test Procedures

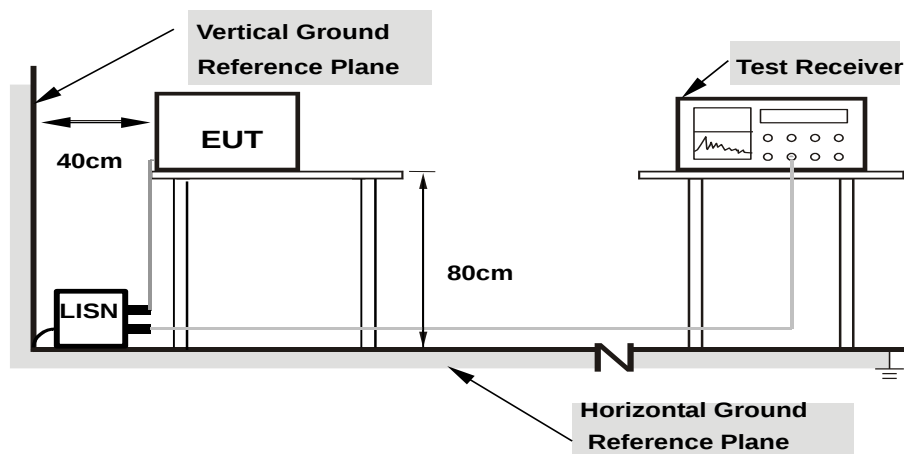
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50 uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20 dB) was not recorded.

**Note:** The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15 MHz - 30 MHz.

#### 4.2.4 Deviation from Test Standard

No deviation.

#### 4.2.5 Test Setup



**Note:** 1.Support units were connected to second LISN.  
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

For the actual test configuration, please refer to the attached file (Test Setup Photo).

#### 4.2.6 EUT Operating Condition

Set the EUT under transmission condition continuously at specific channel frequency.

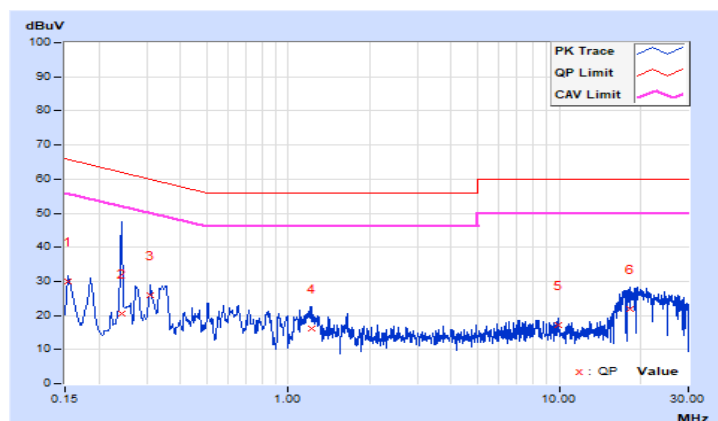
#### 4.2.7 Test Results

|                        |                |                                                     |                                      |
|------------------------|----------------|-----------------------------------------------------|--------------------------------------|
| <b>Frequency Range</b> | 150kHz ~ 30MHz | <b>Detector Function &amp; Resolution Bandwidth</b> | Quasi-Peak (QP) / Average (AV), 9kHz |
| <b>Input Power</b>     | 120Vac, 60Hz   | <b>Environmental Conditions</b>                     | 25 °C, 75% RH                        |
| <b>Tested by</b>       | Rex Wang       | <b>Test Date</b>                                    | 2021/9/11                            |

| Phase Of Power : Line (L) |                 |                        |                      |      |                       |       |              |       |             |        |
|---------------------------|-----------------|------------------------|----------------------|------|-----------------------|-------|--------------|-------|-------------|--------|
| No                        | Frequency (MHz) | Correction Factor (dB) | Reading Value (dBuV) |      | Emission Level (dBuV) |       | Limit (dBuV) |       | Margin (dB) |        |
|                           |                 |                        | Q.P.                 | AV.  | Q.P.                  | AV.   | Q.P.         | AV.   | Q.P.        | AV.    |
| 1                         | 0.15400         | 10.11                  | 19.88                | 5.19 | 29.99                 | 15.30 | 65.78        | 55.78 | -35.79      | -40.48 |
| 2                         | 0.24200         | 10.13                  | 10.30                | 5.01 | 20.43                 | 15.14 | 62.03        | 52.03 | -41.60      | -36.89 |
| 3                         | 0.31000         | 10.14                  | 15.65                | 3.72 | 25.79                 | 13.86 | 59.97        | 49.97 | -34.18      | -36.11 |
| 4                         | 1.22600         | 10.18                  | 6.14                 | 1.22 | 16.32                 | 11.40 | 56.00        | 46.00 | -39.68      | -34.60 |
| 5                         | 9.94200         | 10.33                  | 6.78                 | 2.19 | 17.11                 | 12.52 | 60.00        | 50.00 | -42.89      | -37.48 |
| 6                         | 18.39000        | 10.45                  | 11.30                | 4.34 | 21.75                 | 14.79 | 60.00        | 50.00 | -38.25      | -35.21 |

#### Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

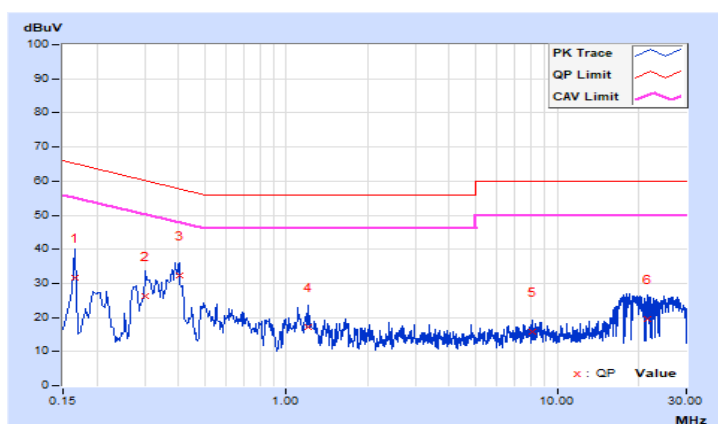


|                 |                |                                          |                                      |
|-----------------|----------------|------------------------------------------|--------------------------------------|
| Frequency Range | 150kHz ~ 30MHz | Detector Function & Resolution Bandwidth | Quasi-Peak (QP) / Average (AV), 9kHz |
| Input Power     | 120Vac, 60Hz   | Environmental Conditions                 | 25 °C, 75% RH                        |
| Tested by       | Rex Wang       | Test Date                                | 2021/9/11                            |

| Phase Of Power : Neutral (N) |                 |                        |                      |      |                       |       |              |       |             |        |
|------------------------------|-----------------|------------------------|----------------------|------|-----------------------|-------|--------------|-------|-------------|--------|
| No                           | Frequency (MHz) | Correction Factor (dB) | Reading Value (dBuV) |      | Emission Level (dBuV) |       | Limit (dBuV) |       | Margin (dB) |        |
|                              |                 |                        | Q.P.                 | AV.  | Q.P.                  | AV.   | Q.P.         | AV.   | Q.P.        | AV.    |
| 1                            | 0.16600         | 10.12                  | 21.41                | 1.28 | 31.53                 | 11.40 | 65.16        | 55.16 | -33.63      | -43.76 |
| 2                            | 0.30200         | 10.14                  | 15.97                | 2.05 | 26.11                 | 12.19 | 60.19        | 50.19 | -34.08      | -38.00 |
| 3                            | 0.40179         | 10.15                  | 22.27                | 6.70 | 32.42                 | 16.85 | 57.82        | 47.82 | -25.40      | -30.97 |
| 4                            | 1.21000         | 10.19                  | 7.11                 | 0.55 | 17.30                 | 10.74 | 56.00        | 46.00 | -38.70      | -35.26 |
| 5                            | 8.08200         | 10.38                  | 5.55                 | 2.18 | 15.93                 | 12.56 | 60.00        | 50.00 | -44.07      | -37.44 |
| 6                            | 21.60600        | 10.61                  | 9.05                 | 3.29 | 19.66                 | 13.90 | 60.00        | 50.00 | -40.34      | -36.10 |

#### Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

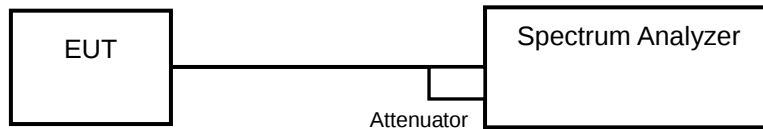


### 4.3 Number of Hopping Frequency Used

#### 4.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

#### 4.3.2 Test Setup



#### 4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

#### 4.3.4 Test Procedure

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
- Set the SA on View mode and then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

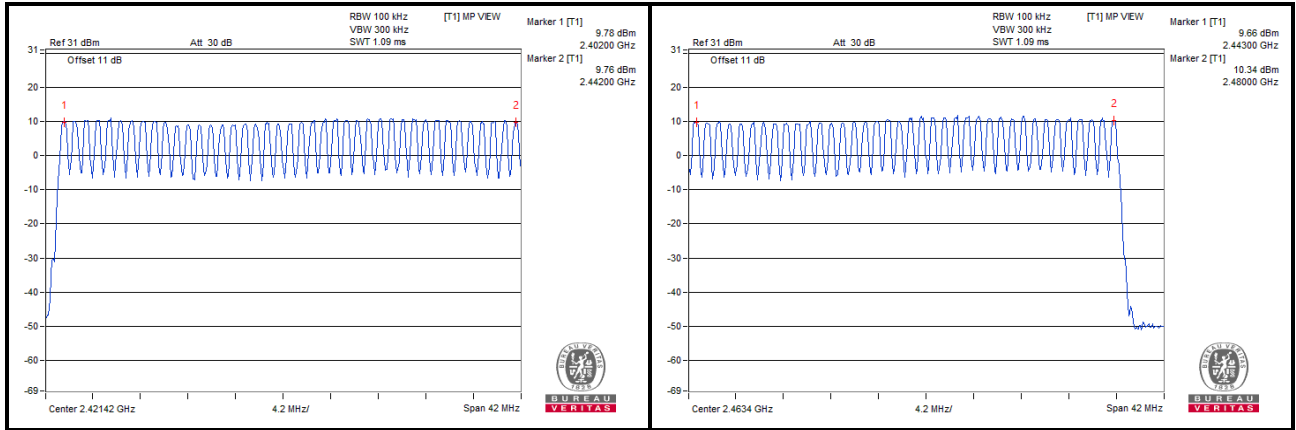
#### 4.3.5 Deviation from Test Standard

No deviation.

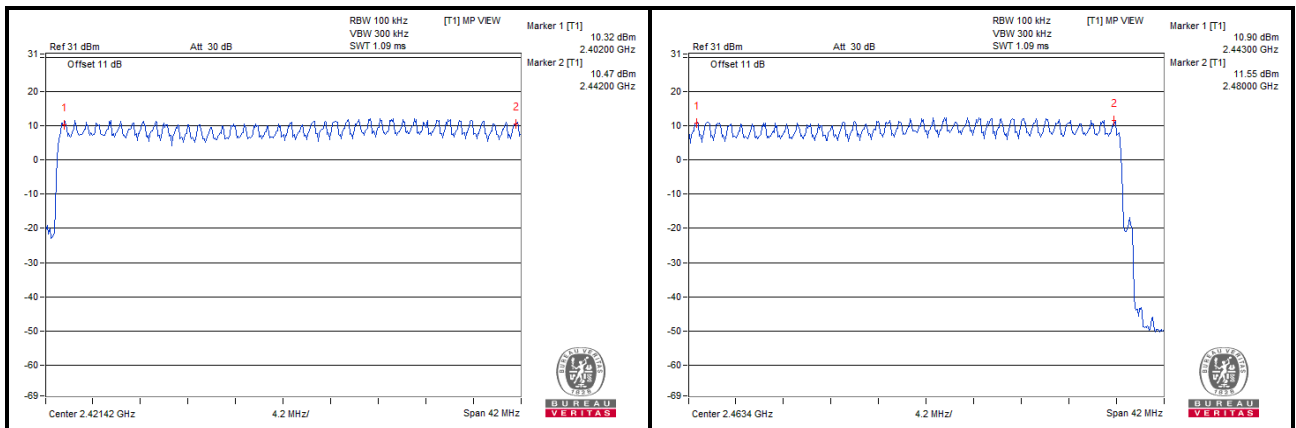
#### 4.3.6 Test Results

There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

##### <GFSK>



##### <8DPSK>

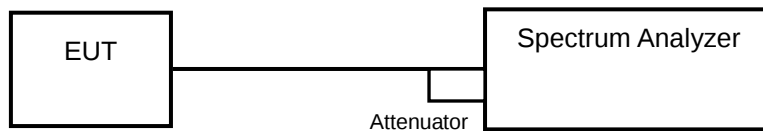


#### 4.4 Dwell Time on Each Channel

##### 4.4.1 Limits of Dwell Time on Each Channel Measurement

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

##### 4.4.2 Test Setup



##### 4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

##### 4.4.4 Test Procedures

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Adjust the center frequency of SA on any frequency to be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- Repeat above procedures until all different time-slot modes have been completed.

##### 4.4.5 Deviation from Test Standard

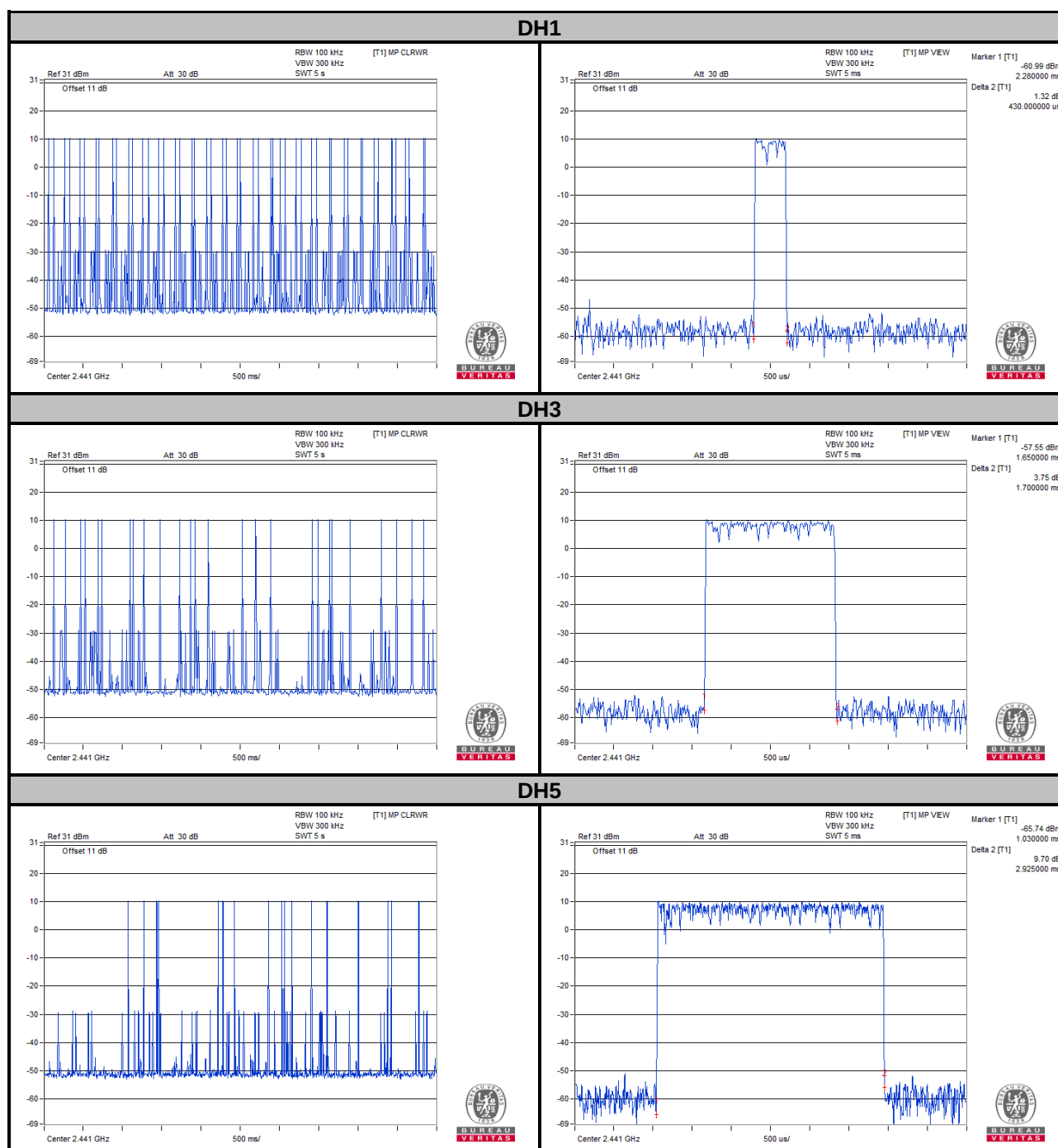
No deviation.

#### 4.4.6 Test Results

##### GFSK

| Mode | Number of Transmission in a 31.6 (79 Hopping*0.4) | Length of Transmission Time (msec) | Result (msec) | Limit (msec) |
|------|---------------------------------------------------|------------------------------------|---------------|--------------|
| DH1  | 50 (times / 5 sec) * 6.32 = 316 times             | 0.43                               | 135.88        | 400          |
| DH3  | 26 (times / 5 sec) * 6.32 = 165 times             | 1.7                                | 280.5         | 400          |
| DH5  | 17 (times / 5 sec) * 6.32 = 108 times             | 2.925                              | 315.9         | 400          |

**Note:** Test plots of the transmitting time slot are shown as below.



## 8DPSK

| Mode | Number of Transmission in a 31.6 (79 Hopping*0.4) | Length of Transmission Time (msec) | Result (msec) | Limit (msec) |
|------|---------------------------------------------------|------------------------------------|---------------|--------------|
| 3DH1 | 50 (times / 5 sec) * 6.32 = 323 times             | 0.48                               | 155.04        | 400          |
| 3DH3 | 26 (times / 5 sec) * 6.32 = 165 times             | 1.74                               | 287.1         | 400          |
| 3DH5 | 18 (times / 5 sec) * 6.32 = 114 times             | 2.94                               | 335.16        | 400          |

**Note:** Test plots of the transmitting time slot are shown as below.



## 4.5 Channel Bandwidth

### 4.5.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5 MHz, if the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

### 4.5.2 Test Setup



### 4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.5.4 Test Procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
- Repeat above procedures until all frequencies measured were complete.

### 4.5.5 Deviation from Test Standard

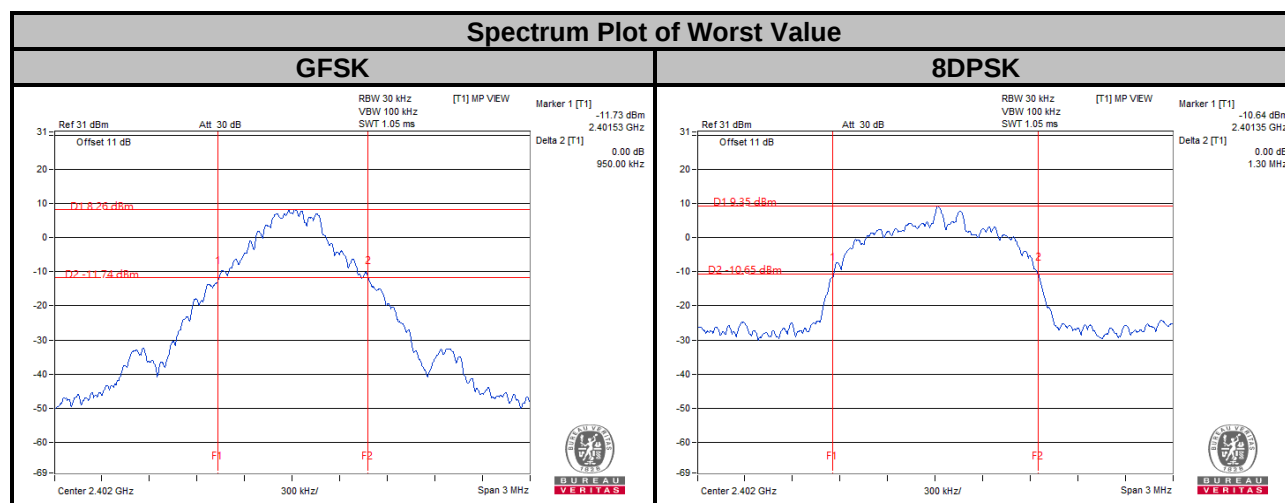
No deviation.

### 4.5.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

#### 4.5.7 Test Results

| Channel | Frequency (MHz) | 20 dB Bandwidth (MHz) |       |
|---------|-----------------|-----------------------|-------|
|         |                 | GFSK                  | 8DPSK |
| 0       | 2402            | 0.95                  | 1.30  |
| 39      | 2441            | 0.95                  | 1.29  |
| 78      | 2480            | 0.95                  | 1.30  |



## 4.6 Occupied Bandwidth Measurement

### 4.6.1 Test Setup



### 4.6.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument

### 4.6.3 Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1 % to 5 % of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to sampling. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

### 4.6.4 Deviation from Test Standard

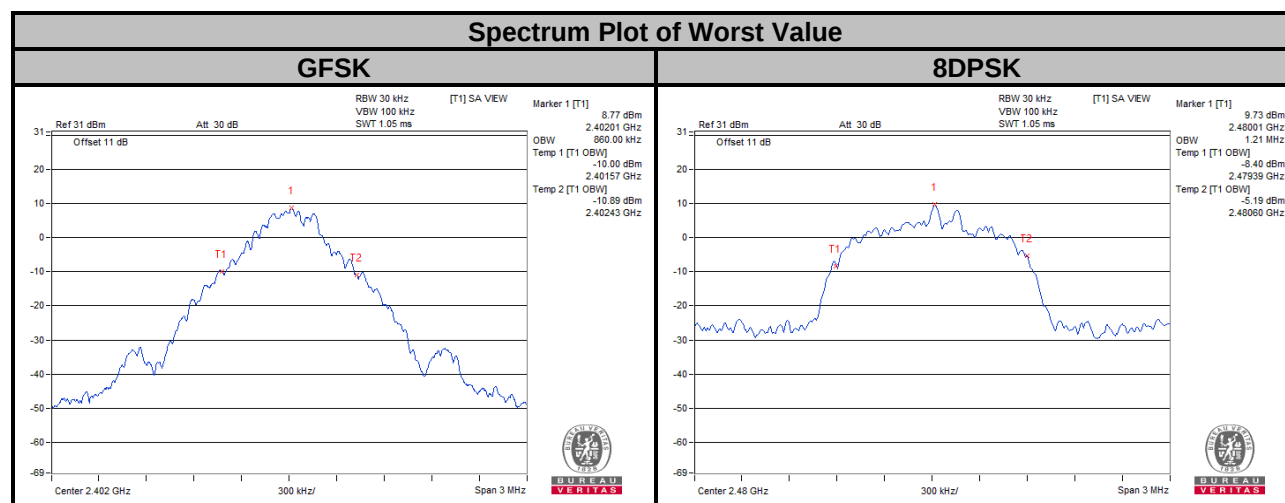
No deviation.

### 4.6.5 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

#### 4.6.6 Test Results

| Channel | Frequency (MHz) | Occupied Bandwidth (MHz) |       |
|---------|-----------------|--------------------------|-------|
|         |                 | GFSK                     | 8DPSK |
| 0       | 2402            | 0.86                     | 1.20  |
| 39      | 2441            | 0.85                     | 1.18  |
| 78      | 2480            | 0.85                     | 1.21  |

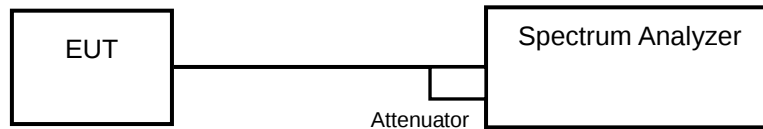


## 4.7 Hopping Channel Separation

### 4.7.1 Limits of Hopping Channel Separation Measurement

At least 25 kHz or two-third of 20 dB hopping channel bandwidth (whichever is greater).

### 4.7.2 Test Setup



### 4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.7.4 Test Procedure

Measurement Procedure REF

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
- By using the MaxHold function record the separation of two adjacent channels.
- Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

### 4.7.5 Deviation from Test Standard

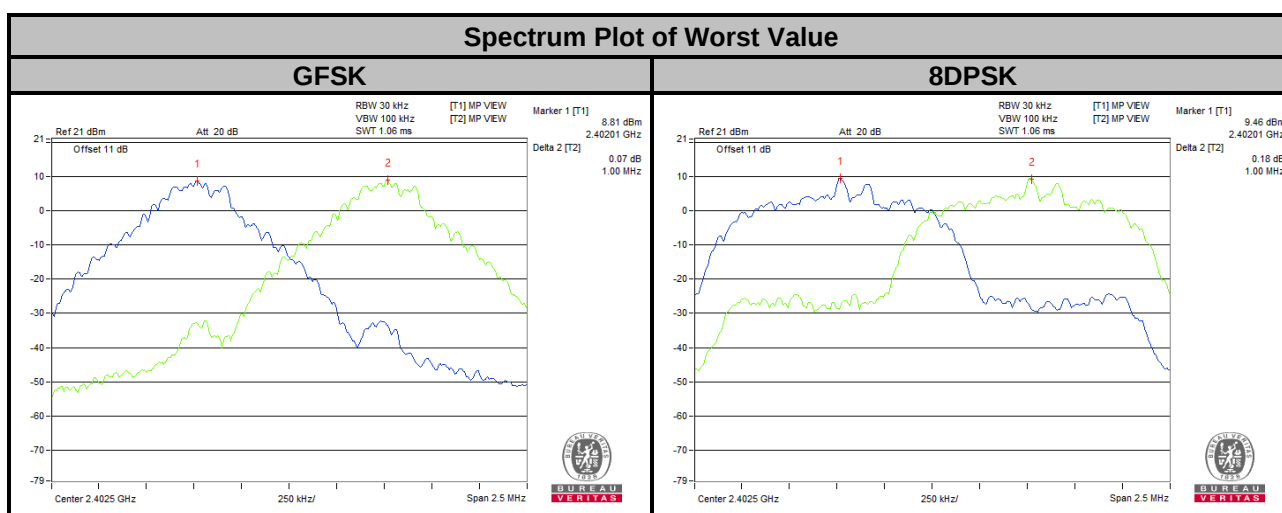
No deviation.

#### 4.7.6 Test Results

| Channel | Freq. (MHz) | Adjacent Channel Separation (MHz) |       | 20 dB Bandwidth (MHz) |       | Minimum Limit (MHz) |       | Pass / Fail |
|---------|-------------|-----------------------------------|-------|-----------------------|-------|---------------------|-------|-------------|
|         |             | GFSK                              | 8DPSK | GFSK                  | 8DPSK | GFSK                | 8DPSK |             |
| 0       | 2402        | 1.00                              | 1.00  | 0.95                  | 1.30  | 0.64                | 0.87  | Pass        |
| 39      | 2441        | 1.00                              | 1.00  | 0.95                  | 1.29  | 0.64                | 0.86  | Pass        |
| 78      | 2480        | 1.00                              | 1.00  | 0.95                  | 1.30  | 0.64                | 0.87  | Pass        |

#### Note:

- The minimum limit is two-third 20 dB bandwidth.



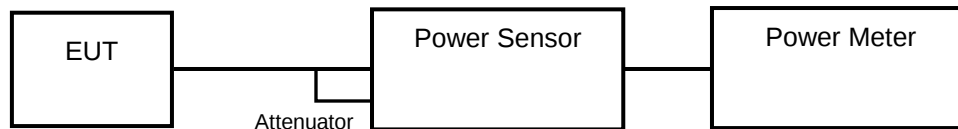
## 4.8 Maximum Output Power

### 4.8.1 Limits of Maximum Output Power Measurement

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.

For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

### 4.8.2 Test Setup



### 4.8.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.8.4 Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

### 4.8.5 Deviation from Test Standard

No deviation.

### 4.8.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

#### 4.8.7 Test Results

##### <GFSK>

| Channel | Freq. (MHz) | Peak Power |       | Average Power |       | Power Limit (mW)           | Pass / Fail |
|---------|-------------|------------|-------|---------------|-------|----------------------------|-------------|
|         |             | (mW)       | (dBm) | (mW)          | (dBm) |                            |             |
| 0       | 2402        | 11.508     | 10.61 | 11.22         | 10.50 | 125 / 1000 <sup>Note</sup> | Pass        |
| 39      | 2441        | 12.023     | 10.80 | 11.668        | 10.67 | 125 / 1000 <sup>Note</sup> | Pass        |
| 78      | 2480        | 12.677     | 11.03 | 12.331        | 10.91 | 125 / 1000 <sup>Note</sup> | Pass        |

Note: RF Output Power limit depends on the operating channel numbers, please refer to section 4.3 of the results.

##### <8DPSK>

| Channel | Freq. (MHz) | Peak Power |       | Average Power |       | Power Limit (mW)           | Pass / Fail |
|---------|-------------|------------|-------|---------------|-------|----------------------------|-------------|
|         |             | (mW)       | (dBm) | (mW)          | (dBm) |                            |             |
| 0       | 2402        | 16.52      | 12.18 | 11.298        | 10.53 | 125 / 1000 <sup>Note</sup> | Pass        |
| 39      | 2441        | 19.543     | 12.91 | 12.134        | 10.84 | 125 / 1000 <sup>Note</sup> | Pass        |
| 78      | 2480        | 17.742     | 12.49 | 12.218        | 10.87 | 125 / 1000 <sup>Note</sup> | Pass        |

Note: RF Output Power limit depends on the operating channel numbers, please refer to section 4.3 of the results.

#### **4.9 Conducted Out of Band Emission Measurement**

##### **4.9.1 Limits Of Conducted Out of Band Emission Measurement**

Below –20 dB of the highest emission level of operating band (in 100 kHz RBW).

##### **4.9.2 Test Instruments**

Refer to section 4.1.2 to get information of above instrument.

##### **4.9.3 Test Procedure**

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

##### **4.9.4 Deviation from Test Standard**

No deviation.

##### **4.9.5 EUT Operating Condition**

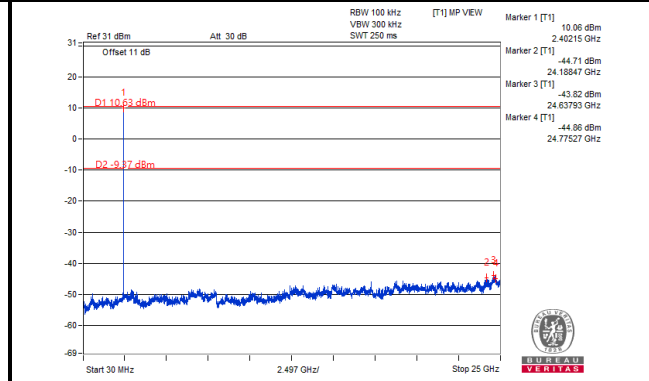
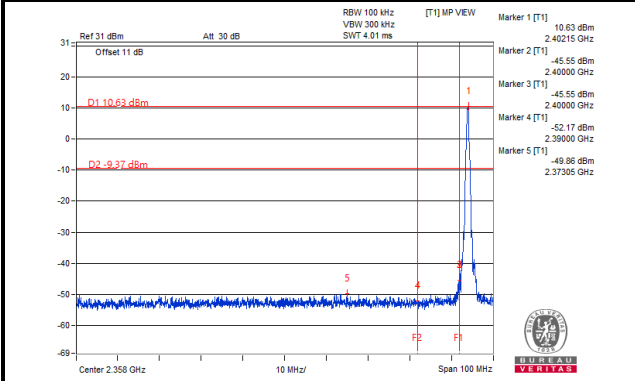
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

##### **4.9.6 Test Results**

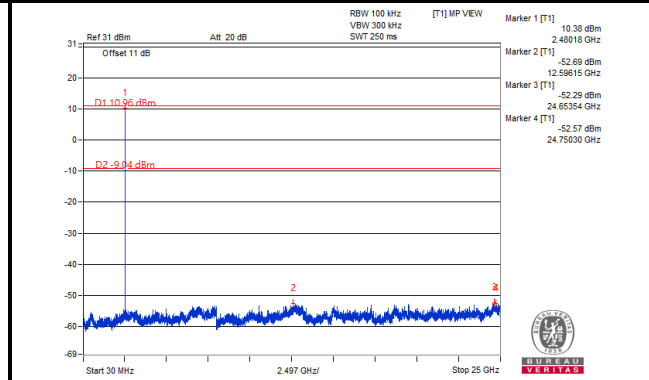
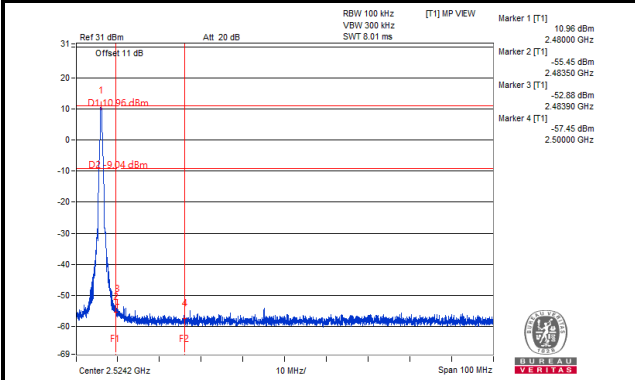
The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20 dB offset below D1. It shows compliance with the requirement.

# GFSK

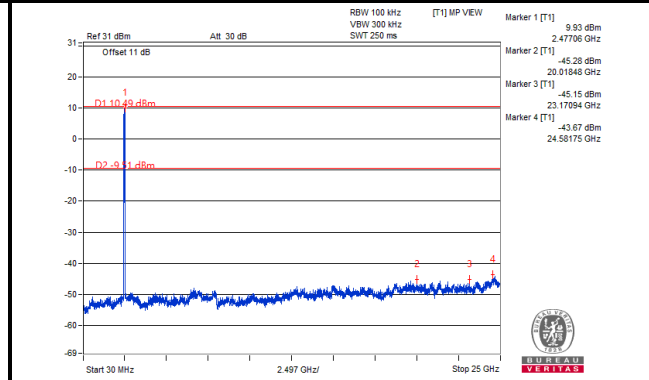
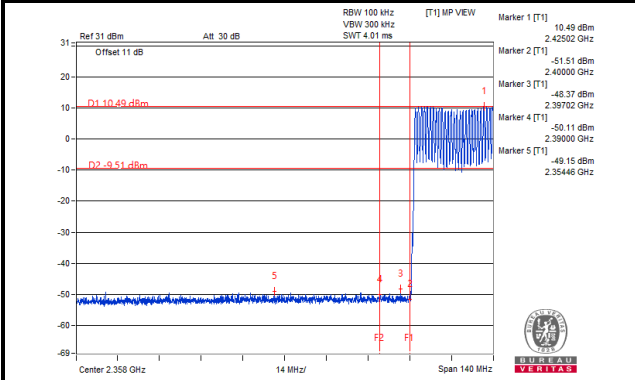
## Hopping Disabled\_Low Channel



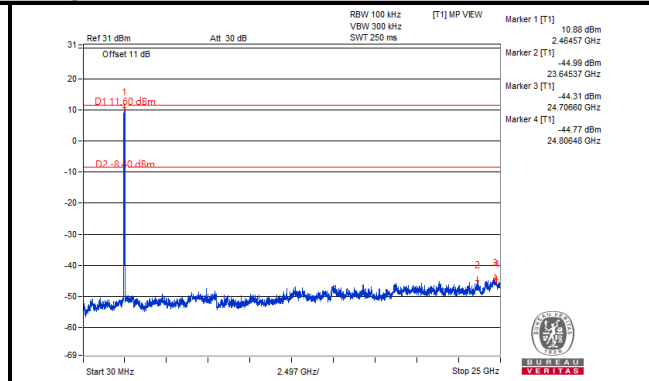
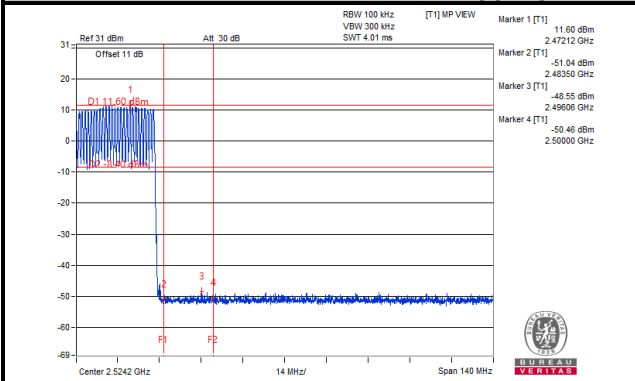
## Hopping Disabled\_High Channel



## Hopping Enabled\_Low Channel

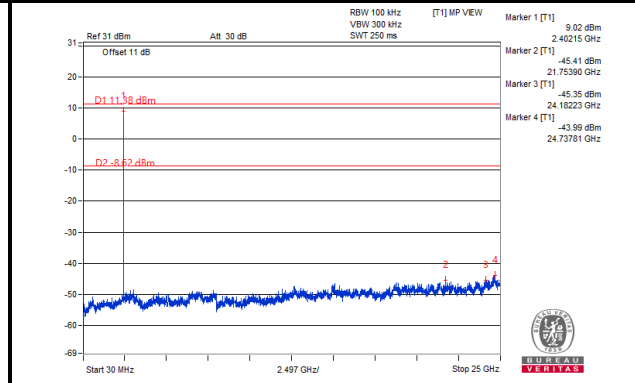
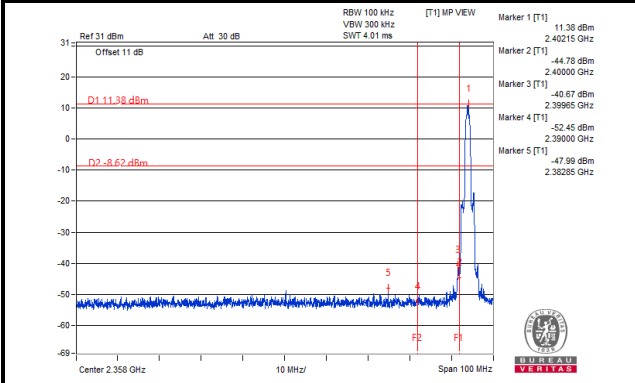


## Hopping Enabled\_High Channel

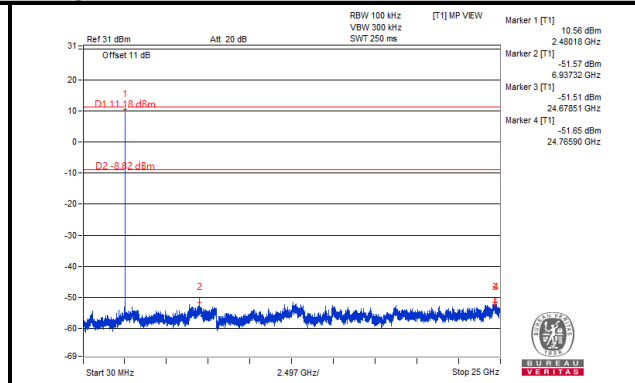
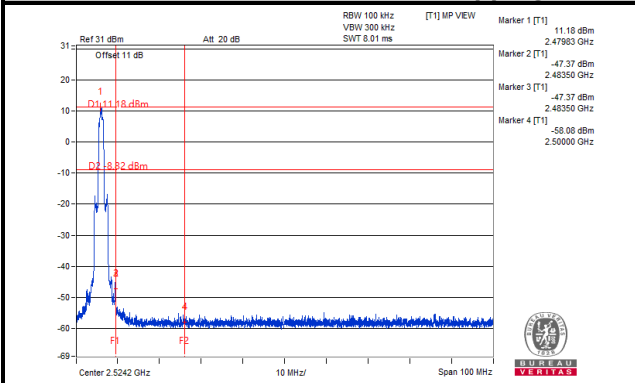


# 8DPSK

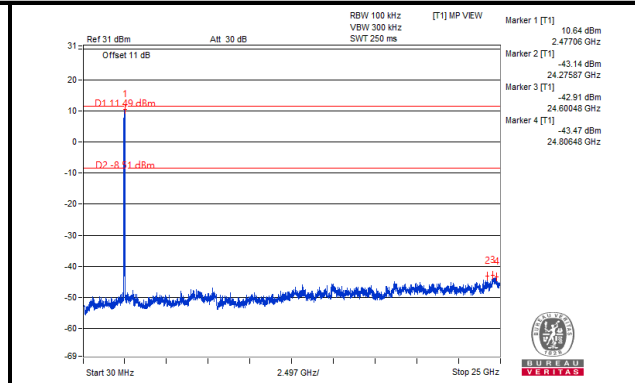
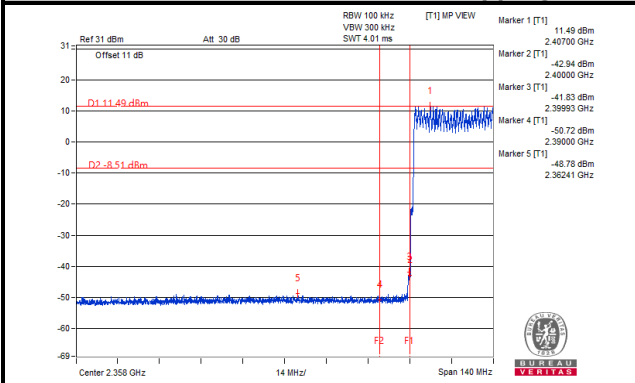
## Hopping Disabled\_Low Channel



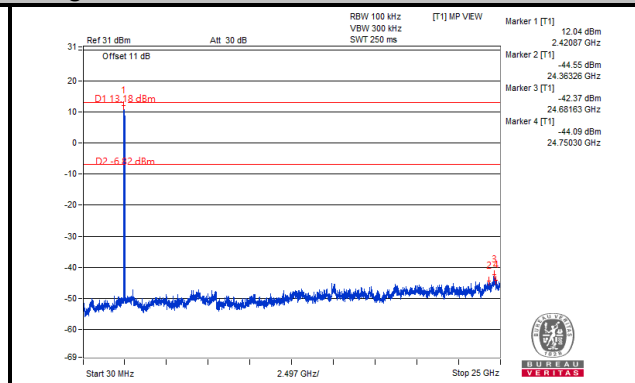
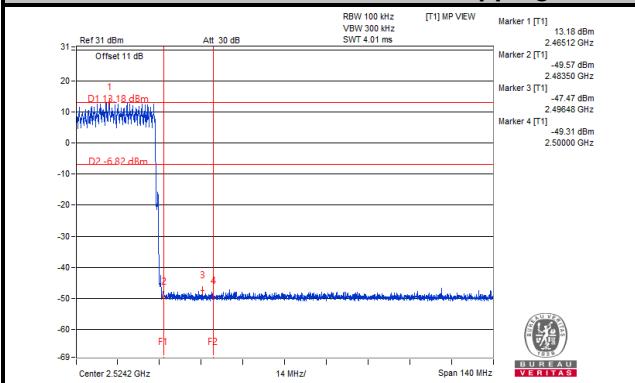
## Hopping Disabled\_High Channel



## Hopping Enabled\_Low Channel



## Hopping Enabled\_High Channel

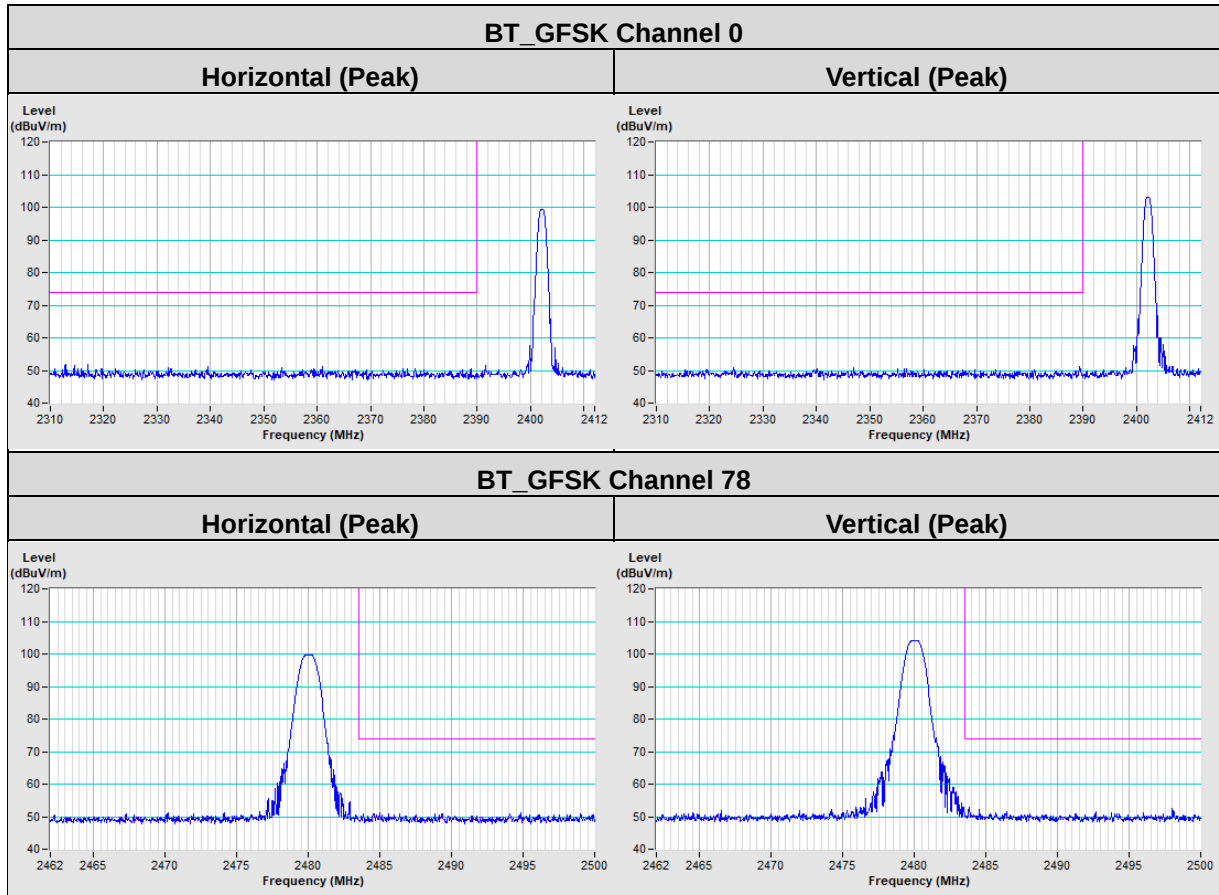


## 5 Pictures of Test Arrangements

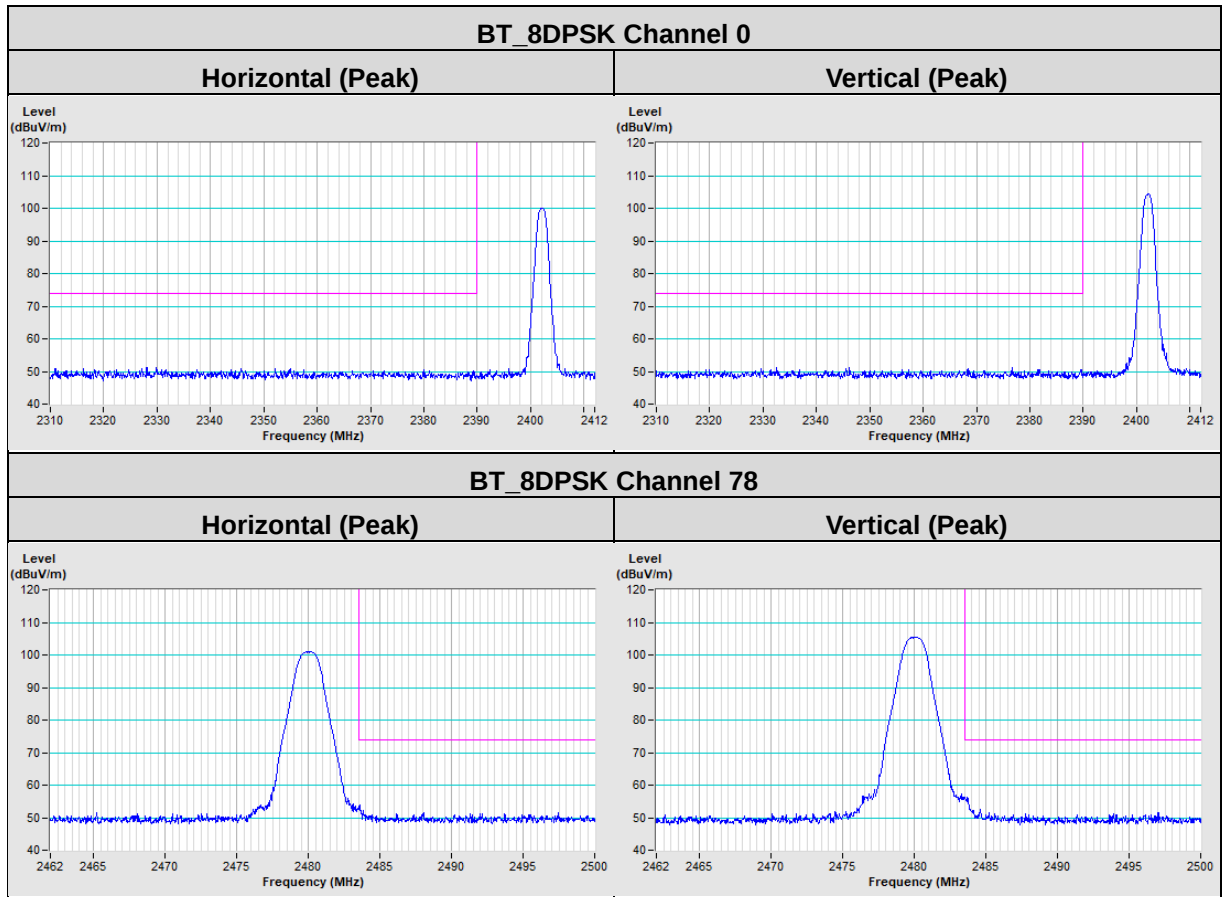
Please refer to the attached file (Test Setup Photo).

## Annex A- Band Edge Measurement

### GFSK



## 8DPSK



## Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

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The address and road map of all our labs can be found in our web site also.

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