

# FCC TEST REPORT(Bluetooth)

for

OMATE LIMITED

Bluetooth wrist watch

Model Number: OMATE X

FCC ID: 2ABF5-OMX1

Prepared for : OMATE LIMITED

Address : Room 1101,11/F San Toi Building, No.139 Connaught  
Road, Central District, HongKong

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Report No. : 14KWE10199506F

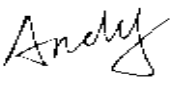
Date of Test : Oct. 17~23, 2014

Date of Report : Oct. 23, 2014

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## Keyway Testing Technology Co., Ltd.

|                                                                                                                                                                                                                     |                                                                                                                                    |                                                                                                                                      |                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Applicant:<br/>Address:</b>                                                                                                                                                                                      | OMATE LIMITED<br>Room 1101,11/F San Toi Building,No.139 Connaught Road,<br>Central District, HongKong                              |                                                                                                                                      |                  |
| <b>Manufacturer:<br/>Address:</b>                                                                                                                                                                                   | OMATE LIMITED<br>Room 1101,11/F San Toi Building,No.139 Connaught Road,<br>Central District, HongKong                              |                                                                                                                                      |                  |
| <b>E.U.T:</b>                                                                                                                                                                                                       | Bluetooth wrist watch                                                                                                              |                                                                                                                                      |                  |
| <b>Model Number:</b>                                                                                                                                                                                                | OMATE X                                                                                                                            |                                                                                                                                      |                  |
| <b>Trade Name:</b>                                                                                                                                                                                                  | OMATE                                                                                                                              | <b>Serial No.:</b>                                                                                                                   | -----            |
| <b>Date of Receipt:</b>                                                                                                                                                                                             | Oct. 17, 2014                                                                                                                      | <b>Date of Test:</b>                                                                                                                 | Oct. 17~23, 2014 |
| <b>Test Specification:</b>                                                                                                                                                                                          | FCC Part 15, Subpart C: 2014<br>ANSI C63.4:2009                                                                                    |                                                                                                                                      |                  |
| <b>Test Result:</b>                                                                                                                                                                                                 | The equipment under test was found to be compliance with the requirements of the standards applied.                                |                                                                                                                                      |                  |
| <b>Issue Date: Oct. 23, 2014</b>                                                                                                                                                                                    |                                                                                                                                    |                                                                                                                                      |                  |
| <b>Tested by:</b>                                                                                                                                                                                                   | <b>Reviewed by:</b>                                                                                                                | <b>Approved by:</b>                                                                                                                  |                  |
| <br><hr style="width: 100px; margin: 0 auto;"/>                                                                                  | <br><hr style="width: 100px; margin: 0 auto;"/> | <br><hr style="width: 100px; margin: 0 auto;"/> |                  |
| <div style="display: flex; justify-content: space-between;"> <span>Cissy Song / Engineer</span> <span>Andy Gao / Supervisor</span> <span>Jade Yang / Supervisor</span> </div>                                       |                                                                                                                                    |                                                                                                                                      |                  |
| <b>Other Aspects:</b>                                                                                                                                                                                               | None.                                                                                                                              |                                                                                                                                      |                  |
| <i>Abbreviations: OK/P=passed    fail/F=failed    n.a/N=not applicable    E.U.T=equipment under tested</i>                                                                                                          |                                                                                                                                    |                                                                                                                                      |                  |
| <i>This test report is based on a single evaluation of one sample of above mentioned products. It is not permitted to be duplicated in extracts without written approval of Keyway Testing Technology Co., Ltd.</i> |                                                                                                                                    |                                                                                                                                      |                  |

## 1.TEST SUMMARY

| Test Items                  | Test Requirement              | Result |
|-----------------------------|-------------------------------|--------|
| Conducted Emissions         | 15.207                        | PASS   |
| Radiated Emissions          | 15.205(a)/15.209<br>15.247(d) | PASS   |
| 20dB Bandwidth              | 15.247(a)(1)                  | PASS   |
| Frequency Separation        | 15.247(a)(1)                  | PASS   |
| Maximum Peak Output Power   | 15.247(b)(1)                  | PASS   |
| Number of Hopping Frequency | 15.247(a)(1)(iii)             | PASS   |
| Dwell time                  | 15.247(a)(1)(iii)             | PASS   |
| Emissions from out of band  | 15.247(d)                     | PASS   |
| Antenna Requirement         | 15.203                        | PASS   |

## 2.GENERAL PRODUCT INFORMATION

### 2.1. Product Function

Refer to Technical Construction Form and User Manual.

### 2.2. Description of Device (EUT)

|                        |                                         |
|------------------------|-----------------------------------------|
| Product Name:          | Bluetooth wrist watch                   |
| Model No.:             | OMATE X                                 |
| Operation Frequency:   | 2402~2480 MHz                           |
| Modulation technology: | FHSS GFSK, Pi/4 QPSK, 8DPSK<br>BLE:GFSK |
| Channel numbers:       | FHSS:79<br>BLE:40                       |
| Channel separation:    | FHSS:1MHz<br>BLE: 2MHz                  |
| Antenna Type:          | Integral Antenna                        |
| Antenna gain:          | 0dBi (declare by Applicant)             |
| Power supply:          | DC 3.7V<br>DC 5V from adapter           |

### 2.3. Difference between Model Numbers

None.

### 2.4. Independent Operation Modes

The basic operation modes are:

#### 2.4.1. EUT work continues TX mode and frequency as below:

| Modulation                  | Channel | Frequency |
|-----------------------------|---------|-----------|
| FHSS, Pi/4DQPSK,<br>8-DQPSK | Low     | 2402MHz   |
|                             | Middle  | 2441MHz   |
|                             | High    | 2480MHz   |

Note: Bluetooth signal has 9 packages DH1, DH3, DH5, 2DH1, 2DH3, 2DH5, 3DH1, 3DH3, 3DH5, DH5 package is largest; we are testing DH5 in the report.

### 2.5. Test Supporting System

|          |                                                                                 |
|----------|---------------------------------------------------------------------------------|
| Adapter: | Provide: Keyway<br>M/N:KW005<br>Input :AC 100~240V 50-60Hz;<br>Output: DC 5V 1A |
|----------|---------------------------------------------------------------------------------|

### 3. TEST SITES

#### 3.1. Test Facilities

Lab Qualifications : 944 Shielded Room built by ETS-Lindgren, USA  
Date of completion: March 28, 2011

966 Chamber built by ETS-Lindgren, USA  
Date of completion: March 28, 2011

Certificated by TUV Rheinland, Germany.  
Registration No.: UA 50207153  
Date of registration: July 13, 2011

Certificated by UL, USA  
Registration No.: 100567-237  
Date of registration: September 1, 2011

Certificated by Intertek  
Registration No.: 2011-RTL-L1-31  
Date of registration: October 11, 2011

Certificated by Industry Canada  
Registration No.: 9868A  
Date of registration: December 8, 2011

Certificated by FCC, USA  
Registration No.: 370994  
Date of registration: February 21, 2012

Certificated by CNAS China  
Registration No.: CNAS L5783  
Date of registration: August 8, 2012

Name of Firm : Keyway Testing Technology Co., Ltd.

Site Location : Building 1, Baishun Industrial Zone, Zhangmotou  
Town, Dongguan, Guangdong, China

### 3.2. List of Test and Measurement Instruments

#### 3.2.1. For conducted emission at the mains terminals test

| Equipment                      | Manufacturer  | Model No. | Serial No. | Last Cal.  | Next Cal.  |
|--------------------------------|---------------|-----------|------------|------------|------------|
| EMI Test Receiver              | Rohde&Schwarz | ESCI      | 101156     | Apr. 27,14 | Apr. 27,15 |
| Artificial Mains Network       | Rohde&Schwarz | ENV216    | 101315     | Apr. 27,14 | Apr. 27,15 |
| Artificial Mains Network (AUX) | Rohde&Schwarz | ENV216    | 101314     | Apr. 27,14 | Apr. 27,15 |
| RF Cable                       | FUJIKURA      | 3D-2W     | 944 Cable  | Apr. 27,14 | Apr. 27,15 |

#### 3.2.2. For radiated emission test

| Equipment                             | Manufacturer  | Model No.          | Serial No.   | Last Cal.  | Next Cal.  |
|---------------------------------------|---------------|--------------------|--------------|------------|------------|
| EMI Test Receiver                     | Rohde&Schwarz | ESCI               | 101156       | Apr. 27,14 | Apr. 27,15 |
| System Simulator                      | Agilent       | E5515C             | GB43130245   | Apr. 30,14 | Apr. 30,15 |
| Power Splitter                        | Weinschel     | 1506A              | NW425        | Apr. 30,14 | Apr. 30,15 |
| Bilog Antenna                         | ETS-LINDGREEN | 3142D              | 135452       | Apr. 27,14 | Apr. 27,15 |
| Spectrum Analyzer                     | Agilent       | E4411B             | MY4511304    | Apr. 27,14 | Apr. 27,15 |
| 3m Semi-anechoic Chamber              | ETS-LINDGREEN | 966                | KW01         | Apr. 27,14 | Apr. 27,15 |
| Signal Amplifier                      | SONOMA        | 310                | 187016       | Apr. 27,14 | Apr. 27,15 |
| Signal Amplifier                      | Agilent       | 8449B              | 3008A00251   | Apr. 27,14 | Apr. 27,15 |
| RF Cable                              | IMRO          | IMRO-400           | 966 Cable 1# | N/A        | N/A        |
| MULTI-DEVICE Controller               | ETS-LINDGREEN | 2090               | 126913       | N/A        | N/A        |
| Horn Antenna                          | DAZE          | ZN30701            | 11003        | Apr. 27,14 | Apr. 27,15 |
| Horn Antenna                          | SCHWARZBECK   | BBHA9170           | 9170-068     | Apr. 27,14 | Apr. 27,15 |
| Spectrum Analyzer                     | Agilent       | 8593E              | 3911A04271   | Apr. 27,14 | Apr. 27,15 |
| Spectrum Analyzer                     | Agilent       | E4408B             | MY44211125   | Apr. 30,14 | Apr. 30,15 |
| Signal Amplifier                      | DAZE          | ZN3380C            | 11001        | Apr. 27,14 | Apr. 27,15 |
| High Pass filter                      | Micro         | HPM50111           | 324216       | Apr. 30,14 | Apr. 30,15 |
| Filter                                | COM-MW        | ZBSF-C836.5-25-X   | KW032        | Apr. 30,14 | Apr. 30,15 |
| Filter                                | COM-MW        | ZBSF-C1747.5-75-X2 | KW035        | Apr. 30,14 | Apr. 30,15 |
| Filter                                | COM-MW        | ZBSF-C1880-60-X2   | KW037        | Apr. 30,14 | Apr. 30,15 |
| DC Power Supply                       | LongWei       | PS-305D            | 010964729    | Apr. 27,14 | Apr. 27,15 |
| Constant temperature and humidity box | GF            | GTH-800-40-1P      | MAA9906-005  | Apr. 27,14 | Apr. 27,15 |
| Universal radio communication tester  | Rohde&Schwarz | CMU200             | 3215420      | Apr. 27,14 | Apr. 27,15 |
| Splitter                              | Agilent       | 11636B             | 0025164      | Apr. 27,14 | Apr. 27,15 |

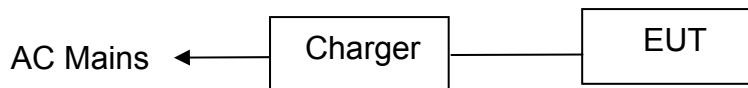
## 4. TEST SET-UP AND OPERATION MODES

### 4.1. Principle of Configuration Selection

**Emission:** The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the Operating Instructions.

### 4.2. Block Diagram of Test Set-up

System Diagram of Connections between EUT and Simulators



*(EUT: Bluetooth wrist watch)*

### 4.3. Test Operation Mode and Test Software

None.

### 4.4. Special Accessories and Auxiliary Equipment

None.

### 4.5. Countermeasures to Achieve EMC Compliance

None.

## 5. EMISSION TEST RESULTS

### 5.1. Conducted Emission at the Mains Terminals Test

#### 5.1.1. Limit 15.207 limits

| FREQUENCY OF EMISSION (MHz) | CONDUCTED LIMIT (dB $\mu$ V) |          |
|-----------------------------|------------------------------|----------|
|                             | Quasi-peak                   | Average  |
| 0.15-0.5                    | 66 to 56                     | 56 to 46 |
| 0.5-5                       | 56                           | 46       |
| 5-30                        | 60                           | 50       |

#### 5.1.2. Test Setup

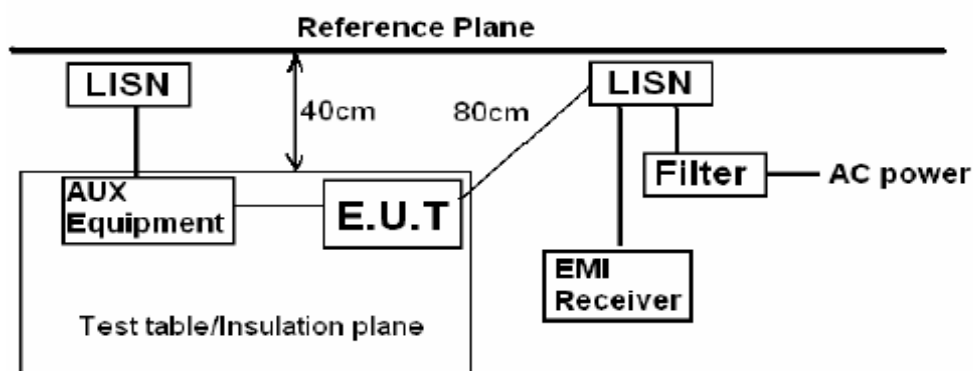
The EUT was put on a wooden table which was 0.8 m high above the ground and connected to the AC mains through the Artificial Mains Network (AMN). Where the mains cable supplied by the manufacture was longer than 0.8 m, the excess was folded back and forth parallel to the cable at the centre so as to form a bundle no longer than 0.4 m.

The EUT was kept 0.4 m from any other earthed conducting surface. Both sides of AC line were checked to find out the maximum conducted emission levels according to the test procedure during the conducted emission test.

The frequency range from 150 kHz to 30 MHz was investigated.

The bandwidth of the test receiver was set at 9 kHz.

Pretest for all mode, The test data of the worst case condition(s) was reported on the following page.

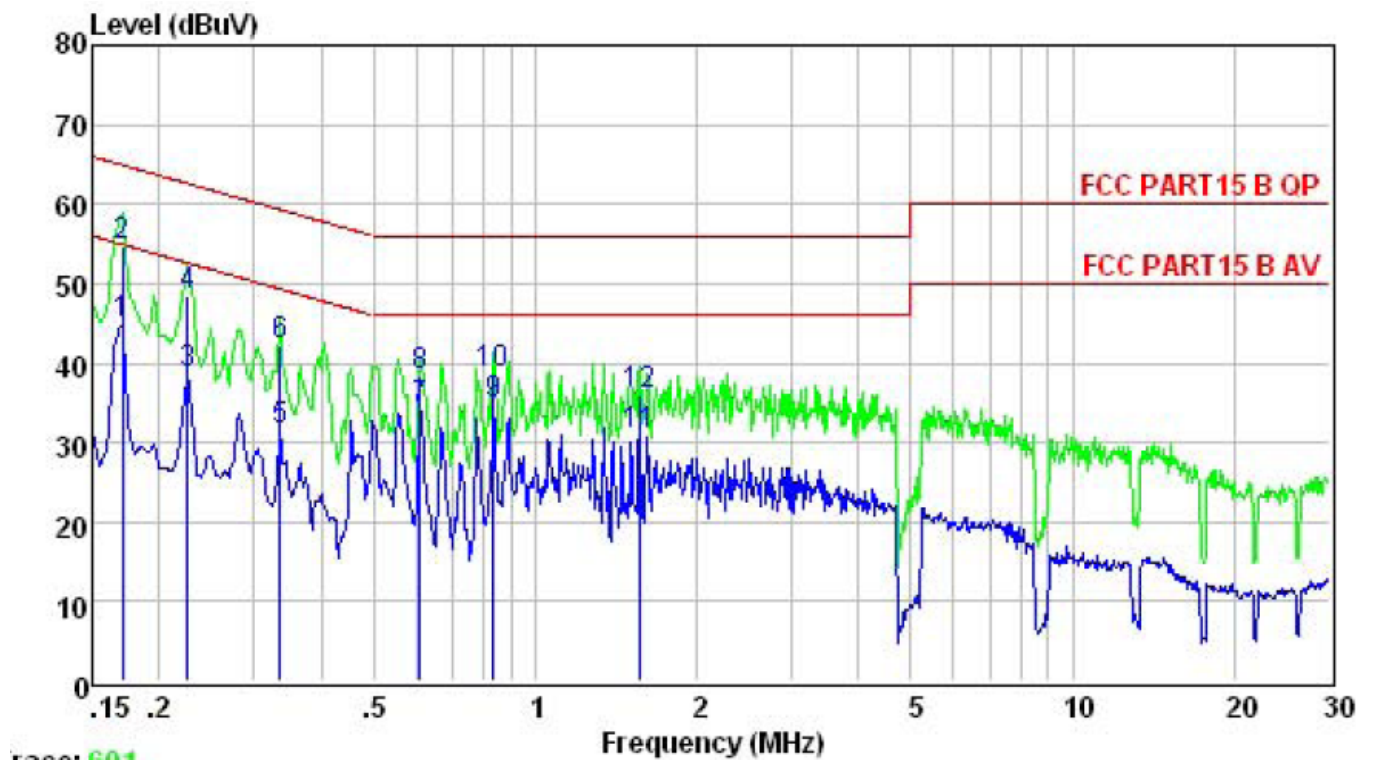


*Remark:*  
*E.U.T: Equipment Under Test*  
*LISN: Line Impedance Stabilization Network*  
*Test table height=0.8m*

#### 5.1.3. Test Mode

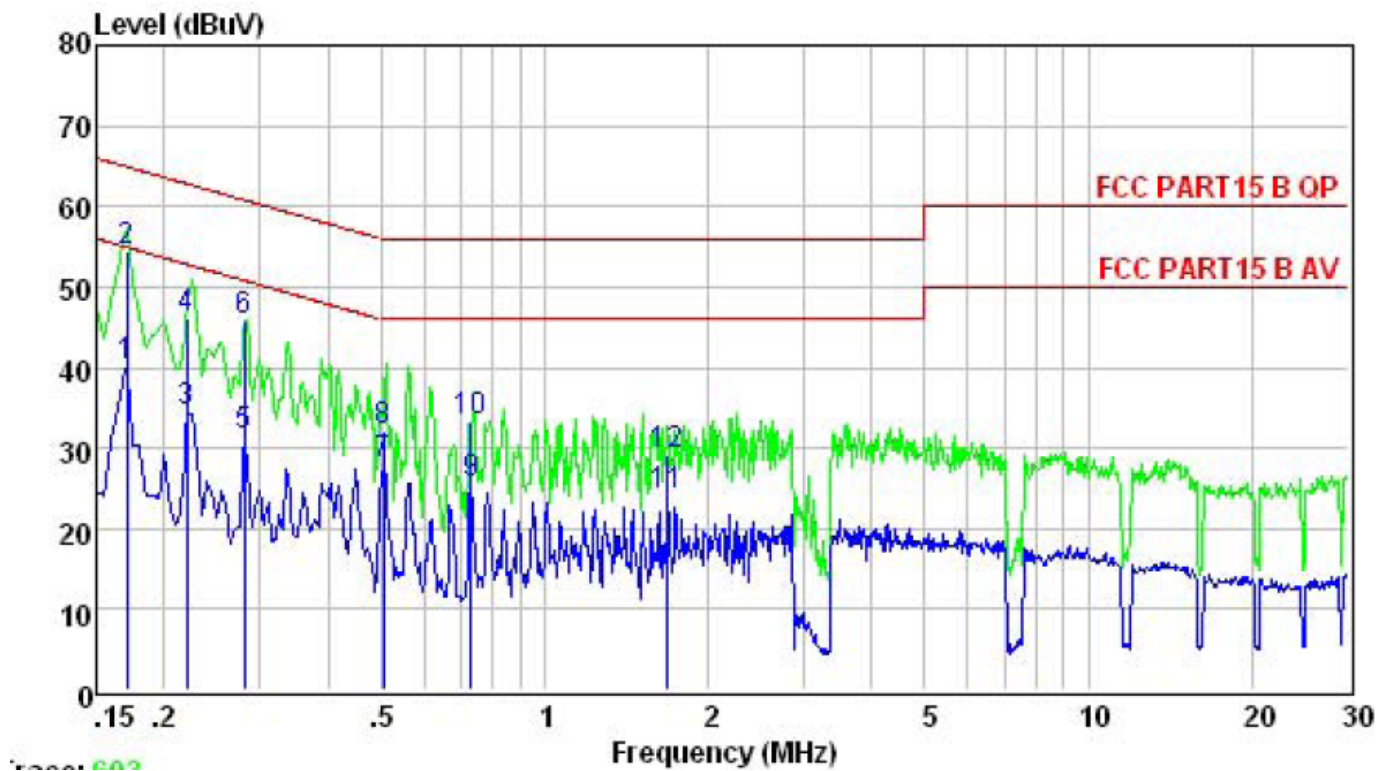
Set EUT in TX mode.

## Line



|    | Freq  | Level | Limit | Over   | Remark  |
|----|-------|-------|-------|--------|---------|
|    | MHz   | dBuV  | dBuV  | Limit  |         |
| 1  | 0.170 | 45.05 | 54.94 | -9.89  | Average |
| 2  | 0.170 | 54.60 | 64.94 | -10.34 | QP      |
| 3  | 0.226 | 38.70 | 52.61 | -13.91 | Average |
| 4  | 0.226 | 48.60 | 62.61 | -14.01 | QP      |
| 5  | 0.336 | 31.60 | 49.31 | -17.71 | Average |
| 6  | 0.336 | 42.10 | 59.31 | -17.21 | QP      |
| 7  | 0.611 | 34.17 | 46.00 | -11.83 | Average |
| 8  | 0.611 | 38.30 | 56.00 | -17.70 | QP      |
| 9  | 0.835 | 34.73 | 46.00 | -11.27 | Average |
| 10 | 0.835 | 38.60 | 56.00 | -17.40 | QP      |
| 11 | 1.560 | 30.92 | 46.00 | -15.08 | Average |
| 12 | 1.560 | 35.90 | 56.00 | -20.10 | QP      |

## Neutral



|    | Freq  | Level | Limit | Over   |         |
|----|-------|-------|-------|--------|---------|
|    | MHz   | dBuV  | Line  | Limit  | Remark  |
|    | MHz   | dBuV  | dBuV  | dB     |         |
| 1  | 0.170 | 40.28 | 54.94 | -14.66 | Average |
| 2  | 0.170 | 54.30 | 64.94 | -10.64 | QP      |
| 3  | 0.220 | 34.46 | 52.83 | -18.37 | Average |
| 4  | 0.220 | 45.98 | 62.83 | -16.85 | QP      |
| 5  | 0.280 | 31.42 | 50.81 | -19.39 | Average |
| 6  | 0.280 | 45.67 | 60.81 | -15.14 | QP      |
| 7  | 0.505 | 27.89 | 46.00 | -18.11 | Average |
| 8  | 0.505 | 32.12 | 56.00 | -23.88 | QP      |
| 9  | 0.731 | 25.43 | 46.00 | -20.57 | Average |
| 10 | 0.731 | 33.24 | 56.00 | -22.76 | QP      |
| 11 | 1.680 | 24.11 | 46.00 | -21.89 | Average |
| 12 | 1.680 | 29.25 | 56.00 | -26.75 | QP      |

## 5.2. Radiated Emission Test

### 5.2.1. Limit 15.209 limits

| FREQUENCY<br>MHz | DISTANCE<br>Meters | FIELD STRENGTHS LIMIT                                                                             |                                   |
|------------------|--------------------|---------------------------------------------------------------------------------------------------|-----------------------------------|
|                  |                    | $\mu\text{V}/\text{m}$                                                                            | $\text{dB}(\mu\text{V})/\text{m}$ |
| 30 ~ 88          | 3                  | 100                                                                                               | 40.0                              |
| 88 ~ 216         | 3                  | 150                                                                                               | 43.5                              |
| 216 ~ 960        | 3                  | 200                                                                                               | 46.0                              |
| 960 ~ 1000       | 3                  | 500                                                                                               | 54.0                              |
| Above 1000       | 3                  | 74.0 $\text{dB}(\mu\text{V})/\text{m}$ (Peak)<br>54.0 $\text{dB}(\mu\text{V})/\text{m}$ (Average) |                                   |

### 5.2.2. Restricted bands of operation

| MHz                        | MHz                   | MHz             | GHz              |
|----------------------------|-----------------------|-----------------|------------------|
| 0.090 - 0.110              | 16.42 - 16.423        | 399.9 - 410     | 4.5 - 5.15       |
| <sup>1</sup> 0.495 - 0.505 | 16.69475 - 16.69525   | 608 - 614       | 5.35 - 5.46      |
| 2.1735 - 2.1905            | 16.80425 - 16.80475   | 960 - 1240      | 7.25 - 7.75      |
| 4.125 - 4.128              | 25.5 - 25.67          | 1300 - 1427     | 8.025 - 8.5      |
| 4.17725 - 4.17775          | 37.5 - 38.25          | 1435 - 1626.5   | 9.0 - 9.2        |
| 4.20725 - 4.20775          | 73 - 74.6             | 1645.5 - 1646.5 | 9.3 - 9.5        |
| 6.215 - 6.218              | 74.8 - 75.2           | 1660 - 1710     | 10.6 - 12.7      |
| 6.26775 - 6.26825          | 108 - 121.94          | 1718.8 - 1722.2 | 13.25 - 13.4     |
| 6.31175 - 6.31225          | 123 - 138             | 2200 - 2300     | 14.47 - 14.5     |
| 8.291 - 8.294              | 149.9 - 150.05        | 2310 - 2390     | 15.35 - 16.2     |
| 8.362 - 8.366              | 156.52475 - 156.52525 | 2483.5 - 2500   | 17.7 - 21.4      |
| 8.37625 - 8.38675          | 156.7 - 156.9         | 2690 - 2900     | 22.01 - 23.12    |
| 8.41425 - 8.41475          | 162.0125 - 167.17     | 3260 - 3267     | 23.6 - 24.0      |
| 12.29 - 12.293             | 167.72 - 173.2        | 3332 - 3339     | 31.2 - 31.8      |
| 12.51975 - 12.52025        | 240 - 285             | 3345.8 - 3358   | 36.43 - 36.5     |
| 12.57675 - 12.57725        | 322 - 335.4           | 3600 - 4400     | ( <sup>2</sup> ) |

All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

### 5.2.3. Test setup

The EUT was placed on a turn table which was 0.8 m above the ground. The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT was set 3 m away from the receiving antenna which was mounted on an antenna tower. The measuring antenna moved up and down to find out the maximum emission level. It moved from 1 m to 4 m for both horizontal and vertical polarizations.

The EUT was tested in the Chamber Site. It was pre-scanned with a Peak detector from the spectrum, and all the final readings from the test receiver were measured with the Quasi-Peak detector.

The bandwidth of the EMI test receiver is set at 120kHz for frequency range from 30MHz to 1000 MHz.

The bandwidth of the Spectrum's VBW is set at 3MHz and RBW is set at 1MHz for peak emissions measurement above 1GHz and 1MHz RBW, 10Hz VBW for average emissions measure above 1GHz.

The frequency range from 30MHz to 10<sup>th</sup> harmonic (25GHz) are checked. and no any emissions were found from 18GHz to 25 GHz, So the radiated emissions from 18GHz to 25GHz were not record.

Notes: 1. Emission Level = Antenna Factor + Cable Loss + Meter Reading-Preamp Factor.

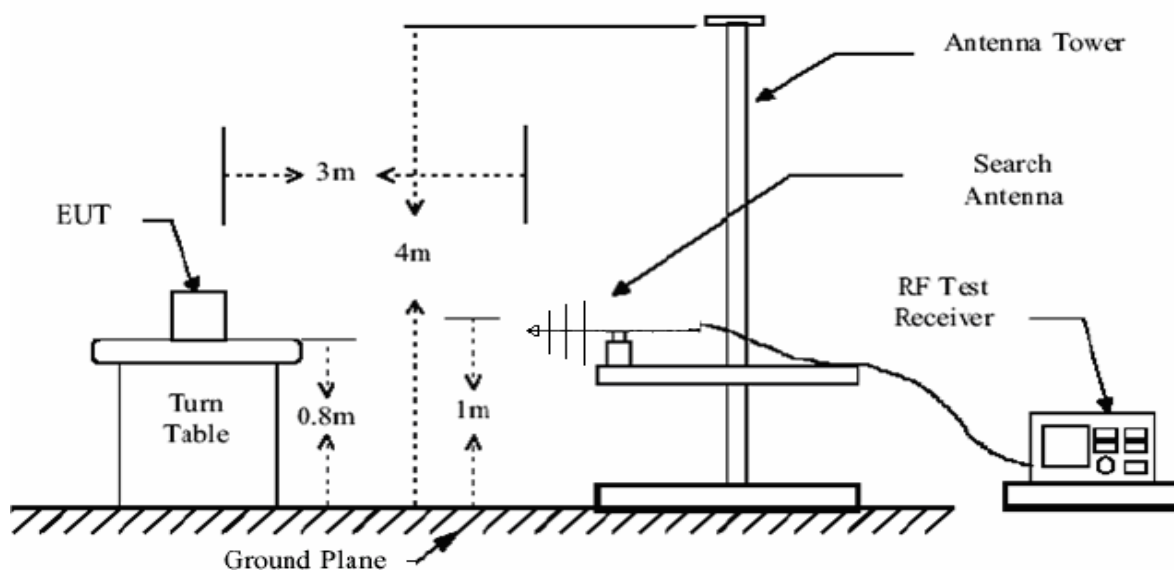
2. Measurement Uncertainty:  $\pm 3.2$  dB at a level of confidence of 95%.

3. For emissions above 1GHz, if peak level comply with average limit, then the average level is deemed to comply with average limit.

4. For emissions below 1GHz, pretest for all mode, The test data of the worst case condition(s) was reported on the following pages.

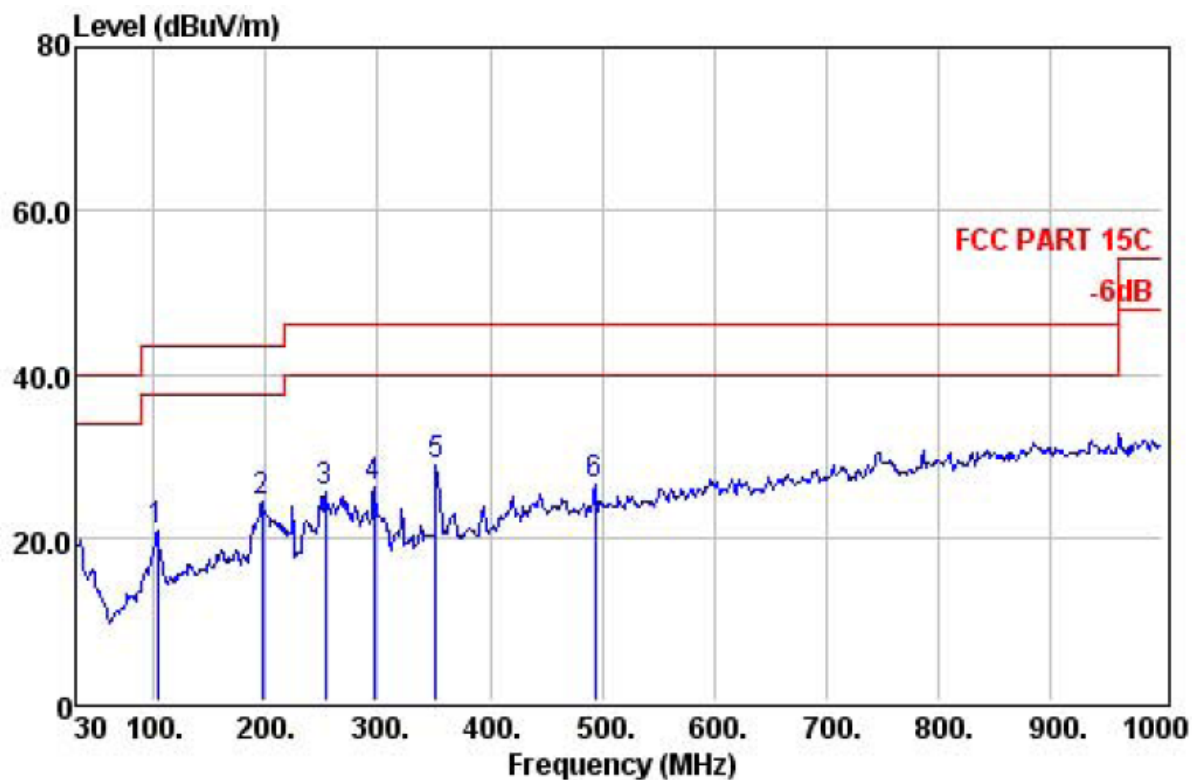
5: During the test, pre-scan the GFSK, Pi/4DQPSK, 8DPSK modulation, and found the GFSK modulation which it is worse case.

6:Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis which it is worse case.



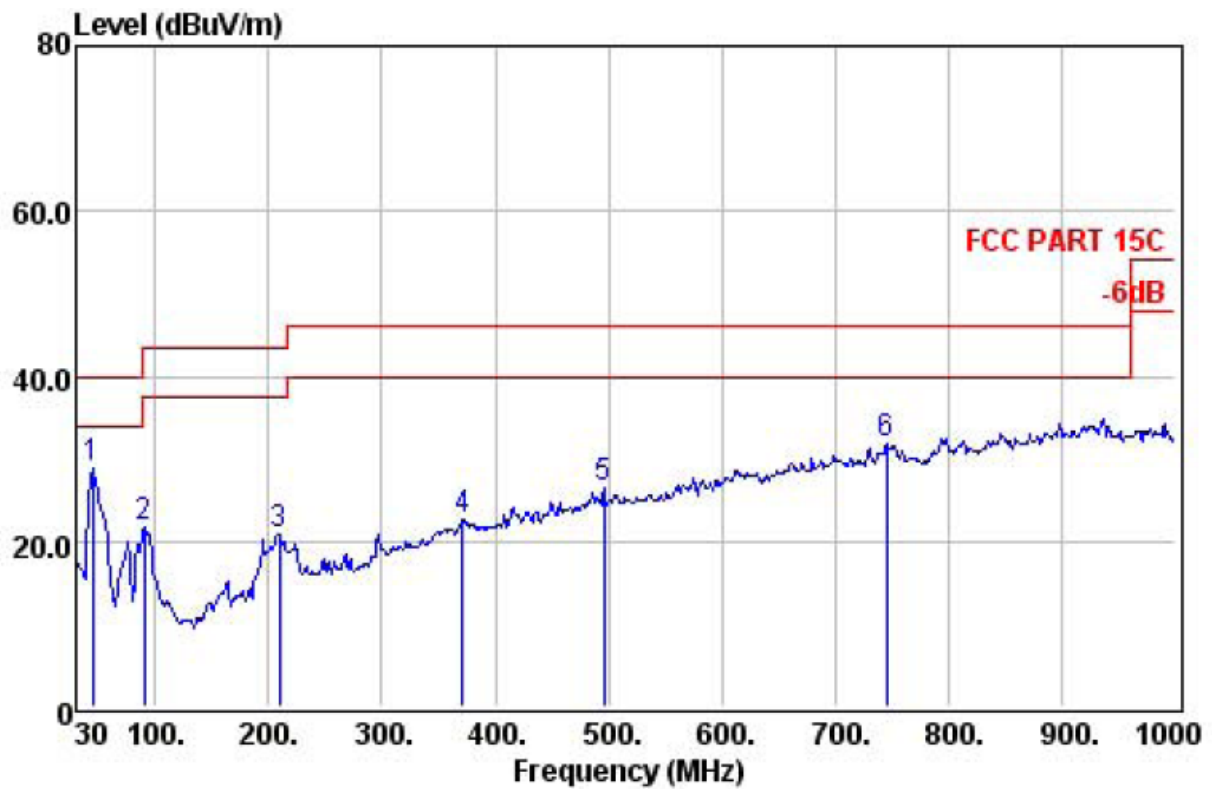
Below 1GHz

BT Mode Horizontal polarizations



|   | Preamp<br>Freq | Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------------|--------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz            | dB     | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 102.75         | 31.35  | 41.75         | 1.03                 | 9.52   | 20.95  | 43.50         | -22.55        | QP     |
| 2 | 196.84         | 31.11  | 43.22         | 1.46                 | 10.72  | 24.29  | 43.50         | -19.21        | QP     |
| 3 | 253.10         | 30.97  | 41.87         | 1.70                 | 12.91  | 25.51  | 46.00         | -20.49        | QP     |
| 4 | 296.75         | 30.93  | 41.62         | 1.87                 | 13.70  | 26.26  | 46.00         | -19.74        | QP     |
| 5 | 352.04         | 30.66  | 41.66         | 2.10                 | 15.67  | 28.77  | 46.00         | -17.23        | QP     |
| 6 | 493.66         | 30.59  | 35.72         | 2.77                 | 18.60  | 26.50  | 46.00         | -19.50        | QP     |

BT Mode Vertical polarizations



|   |        | Preamp | Read  | CableAntenna |        |        | Limit  | Over   |        |
|---|--------|--------|-------|--------------|--------|--------|--------|--------|--------|
|   | Freq   | Factor | Level | Loss         | Factor | Level  | Line   | Limit  | Remark |
|   | MHz    | dB     | dBuV  | dB           | dB/m   | dBuV/m | dBuV/m | dB     |        |
| 1 | 44.55  | 31.40  | 48.64 | 0.56         | 11.03  | 28.83  | 40.00  | -11.17 | QP     |
| 2 | 90.14  | 31.35  | 43.13 | 0.94         | 9.11   | 21.83  | 43.50  | -21.67 | QP     |
| 3 | 209.45 | 31.08  | 38.99 | 1.53         | 11.45  | 20.89  | 43.50  | -22.61 | QP     |
| 4 | 371.44 | 30.62  | 34.92 | 2.27         | 16.17  | 22.74  | 46.00  | -23.26 | QP     |
| 5 | 495.60 | 30.59  | 35.54 | 2.77         | 18.63  | 26.35  | 46.00  | -19.65 | QP     |
| 6 | 745.86 | 30.67  | 35.61 | 4.04         | 22.77  | 31.75  | 46.00  | -14.25 | QP     |

## Above 1GHz

## GFSK 2402MHz Horizontal polarizations

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4804.00  | 27.49            | 32.11         | 11.96                | 32.94  | 49.52  | 74.00         | -24.48        | Peak   |
| 2 | 6967.00  | 27.89            | 18.41         | 16.60                | 37.11  | 44.23  | 74.00         | -29.77        | Peak   |
| 3 | 8599.00  | 28.28            | 15.56         | 16.79                | 36.92  | 40.99  | 74.00         | -33.01        | Peak   |
| 4 | 10588.00 | 28.86            | 14.96         | 17.08                | 39.25  | 42.43  | 74.00         | -31.57        | Peak   |
| 5 | 12679.00 | 29.14            | 13.40         | 17.94                | 39.94  | 42.14  | 74.00         | -31.86        | Peak   |
| 6 | 15535.00 | 29.63            | 9.89          | 20.34                | 38.53  | 39.13  | 74.00         | -34.87        | Peak   |

## GFSK 2402MHz Vertical polarizations

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4804.00  | 27.49            | 31.96         | 11.96                | 32.94  | 49.37  | 74.00         | -24.63        | Peak   |
| 2 | 7307.00  | 27.96            | 14.74         | 16.61                | 37.32  | 40.71  | 74.00         | -33.29        | Peak   |
| 3 | 8973.00  | 28.39            | 16.72         | 16.87                | 37.36  | 42.56  | 74.00         | -31.44        | Peak   |
| 4 | 11081.00 | 28.91            | 13.36         | 17.18                | 39.57  | 41.20  | 74.00         | -32.80        | Peak   |
| 5 | 13291.00 | 29.26            | 11.00         | 18.54                | 42.05  | 42.33  | 74.00         | -31.67        | Peak   |
| 6 | 15688.00 | 29.65            | 13.11         | 20.43                | 39.12  | 43.01  | 74.00         | -30.99        | Peak   |

## GFSK 2441MHz Horizontal polarizations

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4882.00  | 27.53            | 31.57         | 12.14                | 33.11  | 49.29  | 74.00         | -24.71        | Peak   |
| 2 | 7035.00  | 27.91            | 16.33         | 16.60                | 37.21  | 42.23  | 74.00         | -31.77        | Peak   |
| 3 | 8667.00  | 28.30            | 16.12         | 16.81                | 37.00  | 41.63  | 74.00         | -32.37        | Peak   |
| 4 | 10078.00 | 28.81            | 16.78         | 16.98                | 38.53  | 43.48  | 74.00         | -30.52        | Peak   |
| 5 | 11880.00 | 28.99            | 16.13         | 17.34                | 39.52  | 44.00  | 74.00         | -30.00        | Peak   |
| 6 | 13393.00 | 29.28            | 13.37         | 18.67                | 42.52  | 45.28  | 74.00         | -28.72        | Peak   |

**GFSK 2441MHz Vertical polarizations**

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4882.00  | 27.53            | 31.65         | 12.14                | 33.11  | 49.37  | 74.00         | -24.63        | Peak   |
| 2 | 6967.00  | 27.89            | 14.53         | 16.60                | 37.11  | 40.35  | 74.00         | -33.65        | Peak   |
| 3 | 9517.00  | 28.61            | 18.65         | 16.92                | 38.01  | 44.97  | 74.00         | -29.03        | Peak   |
| 4 | 12067.00 | 29.01            | 16.00         | 17.43                | 39.41  | 43.83  | 74.00         | -30.17        | Peak   |
| 5 | 14430.00 | 29.46            | 14.25         | 19.63                | 41.00  | 45.42  | 74.00         | -28.58        | Peak   |
| 6 | 15348.00 | 29.60            | 18.04         | 20.23                | 38.43  | 47.10  | 74.00         | -26.90        | Peak   |

**GFSK 2480MHz Horizontal polarizations**

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4960.00  | 27.58            | 31.07         | 12.36                | 33.32  | 49.17  | 74.00         | -24.83        | Peak   |
| 2 | 6780.00  | 27.86            | 14.14         | 16.60                | 36.62  | 39.50  | 74.00         | -34.50        | Peak   |
| 3 | 8735.00  | 28.32            | 14.67         | 16.82                | 37.08  | 40.25  | 74.00         | -33.75        | Peak   |
| 4 | 11761.00 | 28.98            | 12.86         | 17.32                | 39.64  | 40.84  | 74.00         | -33.16        | Peak   |
| 5 | 13971.00 | 29.39            | 8.53          | 19.33                | 43.47  | 41.94  | 74.00         | -32.06        | Peak   |
| 6 | 16113.00 | 29.75            | 12.85         | 20.71                | 41.02  | 44.83  | 74.00         | -29.17        | Peak   |

**GFSK 2480MHz Vertical polarizations**

|   | Freq     | Preamp<br>Factor | Read<br>Level | CableAntenna<br>Loss | Factor | Level  | Limit<br>Line | Over<br>Limit | Remark |
|---|----------|------------------|---------------|----------------------|--------|--------|---------------|---------------|--------|
|   | MHz      | dB               | dBuV          | dB                   | dB/m   | dBuV/m | dBuV/m        | dB            |        |
| 1 | 4960.00  | 27.58            | 31.53         | 12.36                | 33.32  | 49.63  | 74.00         | -24.37        | Peak   |
| 2 | 7477.00  | 27.99            | 17.52         | 16.63                | 37.39  | 43.55  | 74.00         | -30.45        | Peak   |
| 3 | 9007.00  | 28.40            | 14.83         | 16.88                | 37.40  | 40.71  | 74.00         | -33.29        | Peak   |
| 4 | 10622.00 | 28.86            | 14.82         | 17.09                | 39.27  | 42.32  | 74.00         | -31.68        | Peak   |
| 5 | 13359.00 | 29.27            | 10.44         | 18.63                | 42.37  | 42.17  | 74.00         | -31.83        | Peak   |
| 6 | 14974.00 | 29.55            | 13.77         | 19.99                | 38.64  | 42.85  | 74.00         | -31.15        | Peak   |

## 6. 20DB OCCUPY BANDWIDTH

### 6.1. Limits

According to FCC Section 15.247(a)(1), the 20dB bandtidth is known as the 99% emission bandwidth, or 20dB bandwidth( $10 \cdot \log 1\% = 20\text{dB}$ )taking the RF output power

### 6.2. Test setup

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, During the measurement, the Bluetooth module of the EUT is activated and controlled by the software, and is set to operate under test mode transmitting 339 bytes DH5 packages at maximum power.

2. Set the spectrum analyzer:

Span: approximately 2 to 3 times the 20dB bandwidth, centered on a hopping channel

RBW  $\geq 1\%$  of the 20dB bandwidth

VBW  $\geq$  RBW

Sweep=auto

Detector function=peak

Trace=max hold

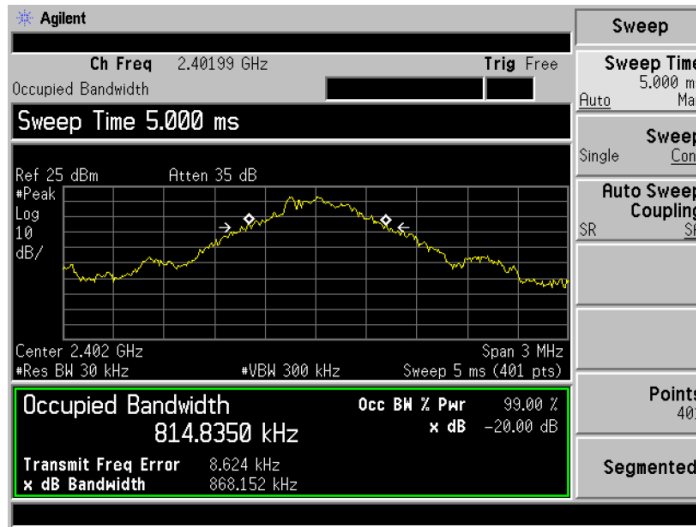
Test data:

|           | Channel Frequency<br>(MHz) | 20dB Bandwidth<br>(MHz) |
|-----------|----------------------------|-------------------------|
| GFSK      | 2402                       | 0.868                   |
|           | 2441                       | 0.845                   |
|           | 2480                       | 0.845                   |
| Pi/4DQPSK | 2402                       | 1.105                   |
|           | 2441                       | 1.136                   |
|           | 2480                       | 1.084                   |
| 8-DPSK    | 2402                       | 1.171                   |
|           | 2441                       | 1.155                   |
|           | 2480                       | 1.167                   |

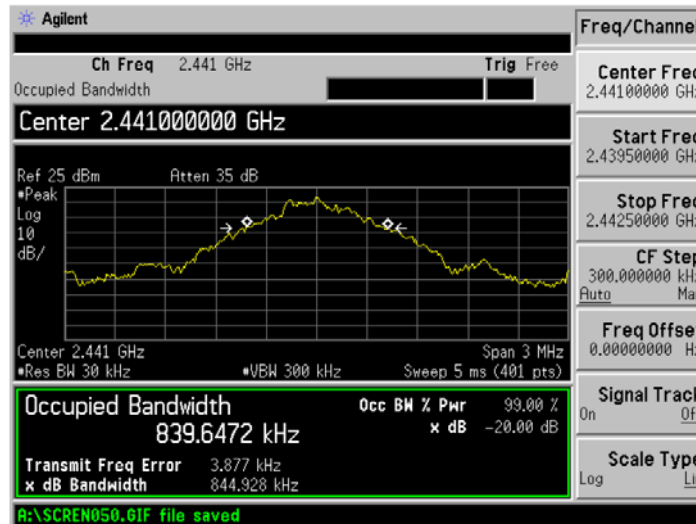
Test plot as follows:

## GFSK

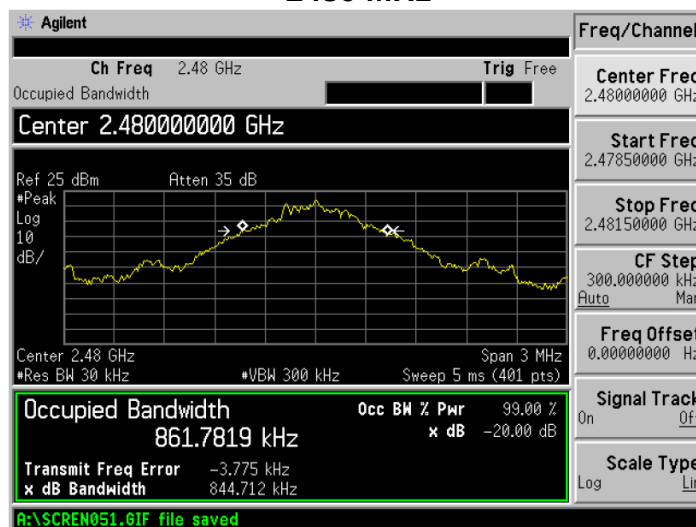
## 2402MHz



## 2441 MHz

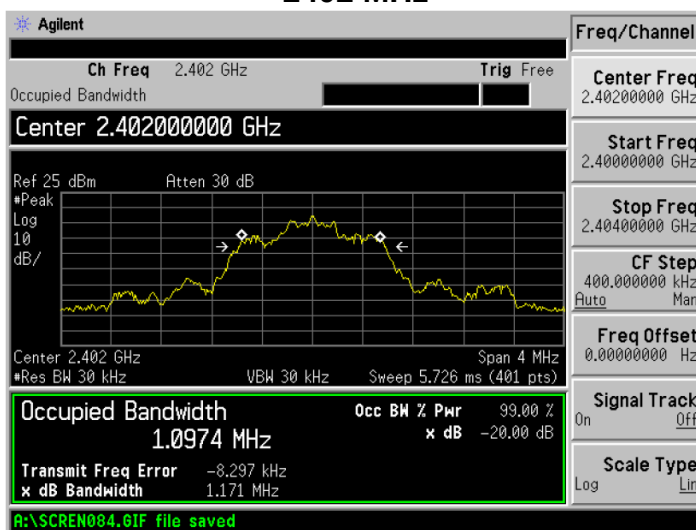


## 2480 MHz



## 8-DPSK

## 2402 MHz



## 2441 MHz



## 2480 MHz



## 7. FREQUENCY SEPARATION

### 7.1. Limits

According to FCC Section 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

### 7.2. Test setup

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, During the measurement, the Bluetooth module of the EUT is activated and controlled by the software, and is set to operate under test mode transmitting 339 bytes DH5 packages at maximum power.

2. Set the spectrum analyzer:

Span: wide enough to capture the peaks of two adjacent channels

RBW  $\geq 1\%$  of the span

VBW  $\geq$  RBW

Sweep=auto

Detector function=peak

Trace=max hold

Test data:

|           | Separation (MHz) | Limit (MHz) | Result |
|-----------|------------------|-------------|--------|
| GFSK      | 1.002            | 868         | PASS   |
| Pi/4DQPSK | 1.006            | 757         | PASS   |
| 8-DPSK    | 1.002            | 781         | PASS   |

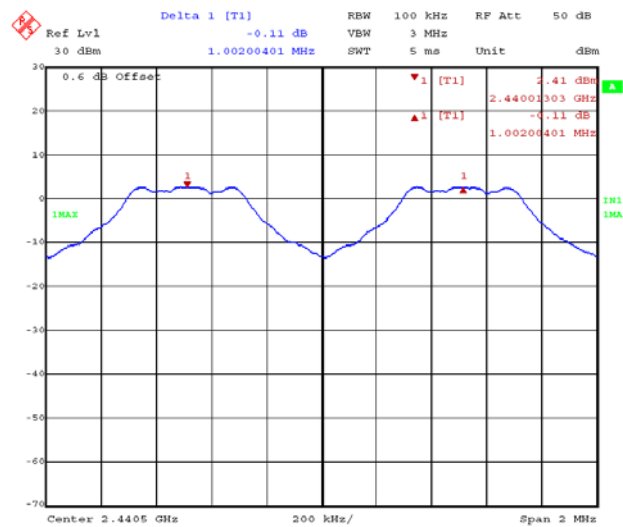
Note: we pretest low, middle, high channel. The middle channel's data record in the report.

Note: Limit according to section 6

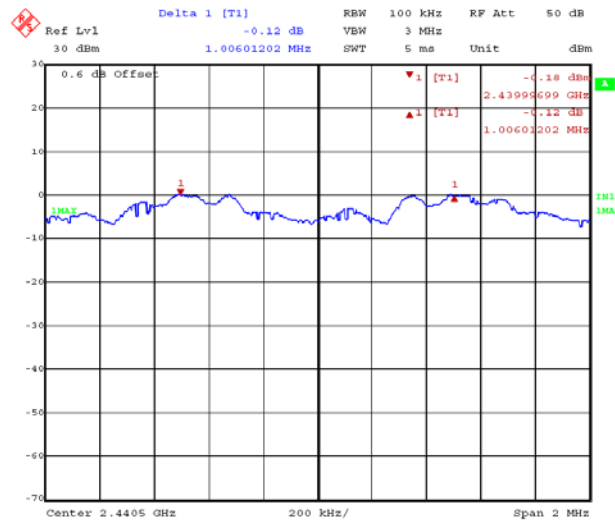
| Mode     | 20dB bandwidth (kHz)<br>(worse case) | Limit (kHz)<br>(Carrier Frequencies Separation) |
|----------|--------------------------------------|-------------------------------------------------|
| GFSK     | 868                                  | 868                                             |
| Pi/4QPSK | 1136                                 | 757                                             |
| 8DPSK    | 1171                                 | 781                                             |

Test plot as follows:

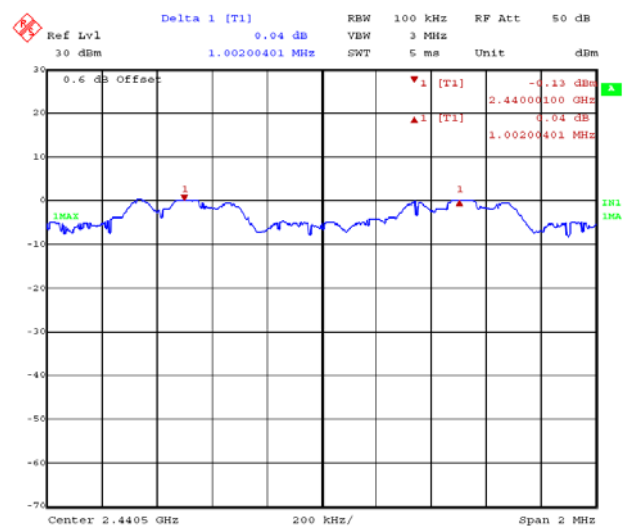
## GFSK



## Pi/4DQPSK



## 8-DPSK



## 8. MAXIMUM PEAK OUTPUT POWER

### 8.1. Limits

According to FCC Section 15.247(b)(1), For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

### 8.2. Test setup

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the power meter, during the measurement, the Bluetooth module of the EUT is activated and controlled by the software, and is set to operate under test mode transmitting 339 bytes DH5 packages at maximum power.

Test data:

|           | Channel<br>Frequency (MHz) | Peak output Power |         | Limit<br>W | Result |
|-----------|----------------------------|-------------------|---------|------------|--------|
|           |                            | dBm               | W       |            |        |
| GFSK      | 2402                       | 1.18              | 0.00132 | 1.000      | Pass   |
|           | 2441                       | 1.07              | 0.00128 | 1.000      | Pass   |
|           | 2480                       | 1.14              | 0.00130 | 1.000      | Pass   |
| Pi/4DQPSK | 2402                       | 1.02              | 0.00126 | 0.125      | Pass   |
|           | 2441                       | 0.92              | 0.00124 | 0.125      | Pass   |
|           | 2480                       | 0.98              | 0.00125 | 0.125      | Pass   |
| 8-DPSK    | 2402                       | 1.07              | 0.00128 | 0.125      | Pass   |
|           | 2441                       | 0.93              | 0.00124 | 0.125      | Pass   |
|           | 2480                       | 0.98              | 0.00125 | 0.125      | Pass   |

## 9. NUMBER OF HOPPING FREQUENCY

### 9.1. Limits

According to FCC Section 15.247(a)(1)(iii), Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

### 9.2. Test setup

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, During the measurement, the Bluetooth module of the EUT is activated and controlled by the software, and is set to operate under test mode transmitting 339 bytes DH5 packages at maximum power.

2. Set the spectrum analyzer:

Span: the frequency band of operation

RBW  $\geq 1\%$  of the span

VBW  $\geq$  RBW

Sweep=auto

Detector function=peak

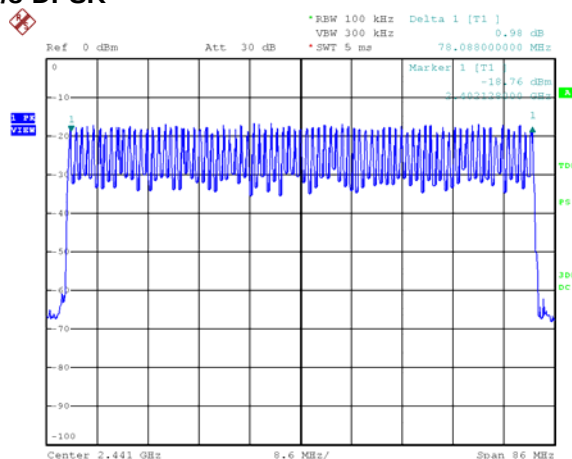
Trace=max hold

Test data:

|           | Measured channel numbers | Limit | Result |
|-----------|--------------------------|-------|--------|
| GFSK      | 79                       | >15   | PASS   |
| Pi/4DQPSK |                          |       | PASS   |
| 8-DPSK    |                          |       | PASS   |

Test plot as follows:

GFSK/ Pi/4DQPSK/8-DPSK



## 10.DWELL TIME

### 10.1. Limits

According to FCC Section 15.247(a)(1)(iii), Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### 10.2. Test setup

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, During the measurement, the Bluetooth module of the EUT is activated and controlled by the software, and is set to operate under test mode transmitting 339 bytes DH5 packages at maximum power.

2. Set the spectrum analyzer:

Span= 0Hz

RBW =100 kHz

VBW = 300 kHz

Sweep=auto

Detector function=peak

Test data:

| Frequency                     | Packet          | Dwell time(ms) | Limit(ms) | Result |
|-------------------------------|-----------------|----------------|-----------|--------|
| 2402MHz<br>2441MHz<br>2480MHz | DH1/2-DH1/3-DH1 | 117.12         | 400       | Pass   |
|                               | DH3/2-DH3/3-DH3 | 259.20         | 400       | Pass   |
|                               | DH5/2-DH5/3-DH5 | 307.20         | 400       | Pass   |

The test period:  $T = 0.4 \text{ Second/Channel} \times 79 \text{ Channel} = 31.6 \text{ s}$

Test channel: 2402MHz/2441MHz/2480MHz as blow

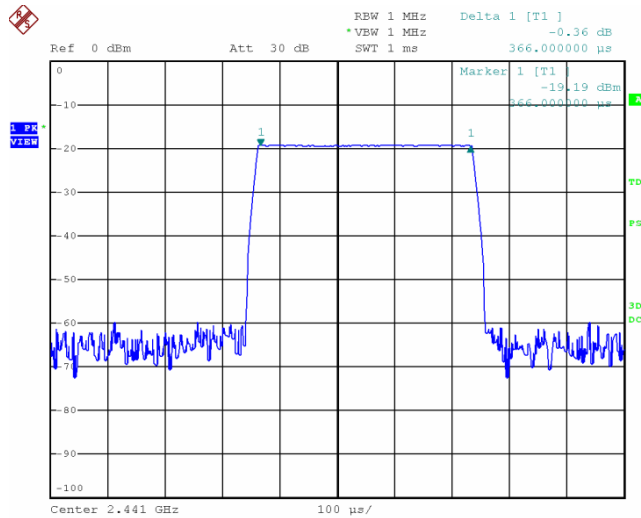
DH1/2-DH1/3-DH1 time slot= $0.366(\text{ms}) \times (1600 / (2 \times 79)) \times 31.6 = 117.12 \text{ ms}$

DH3/2-DH3/3-DH3 time slot= $1.62(\text{ms}) \times (1600 / (4 \times 79)) \times 31.6 = 259.20 \text{ ms}$

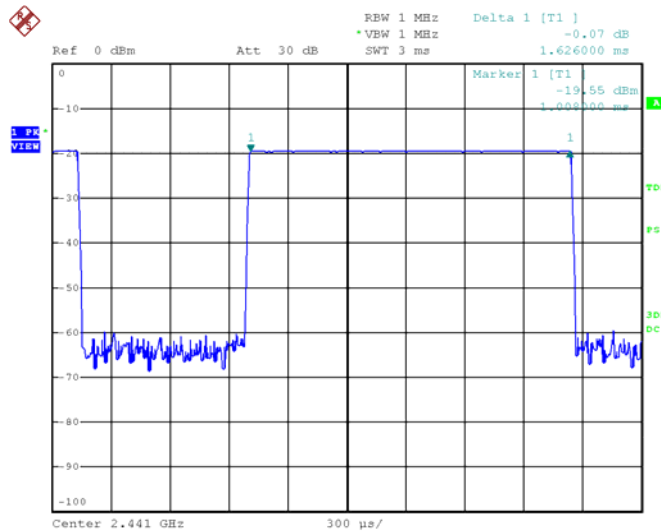
DH5/2-DH5/3-DH5 time slot= $2.88(\text{ms}) \times (1600 / (6 \times 79)) \times 31.6 = 307.20 \text{ ms}$

Test plot as follows:

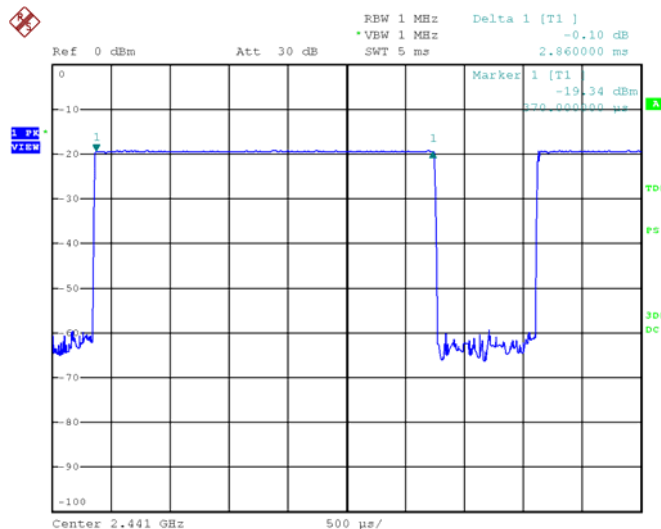
GFSK/ Pi/4DQPSK  
DH1/2-DH1



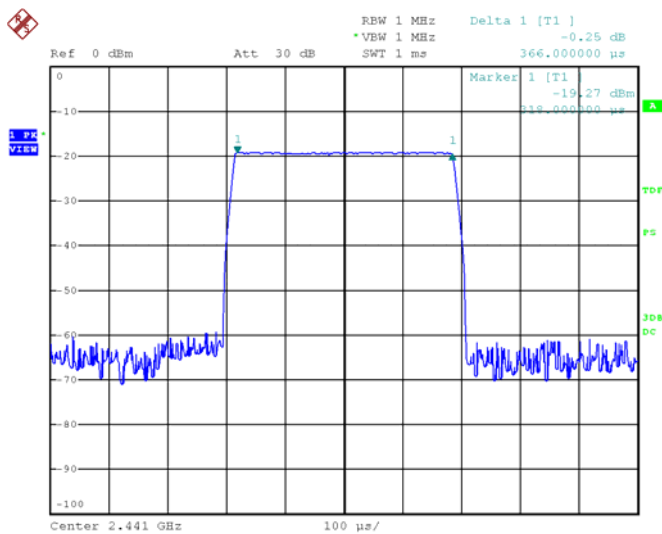
DH3/2-DH3



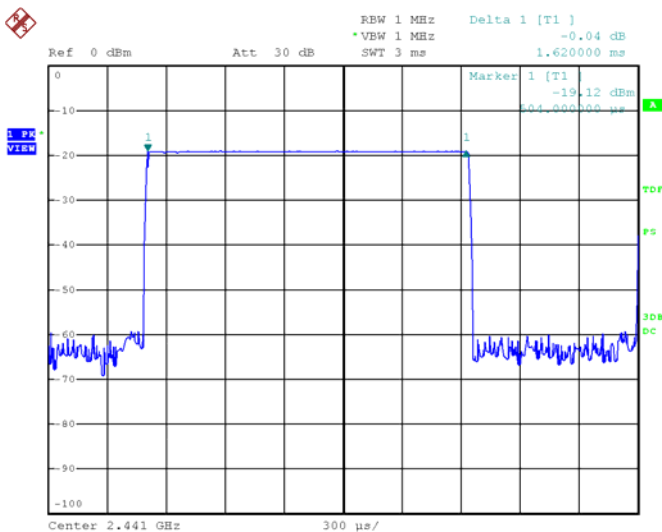
DH5/2-DH5



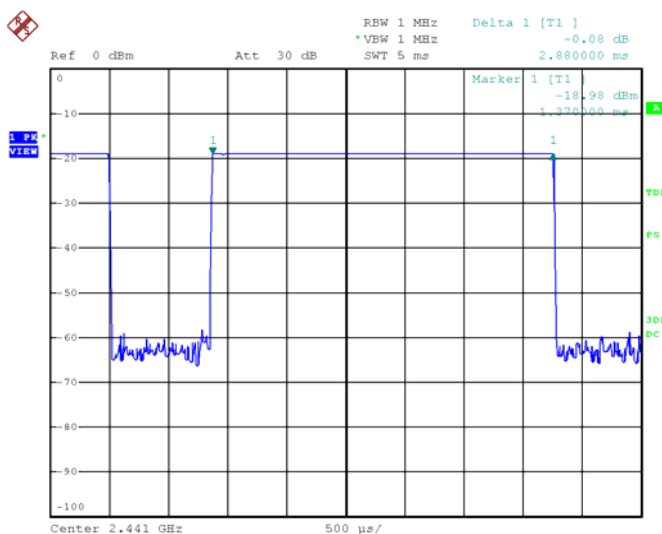
8-DPSK  
3-DH1



3-DH3



3-DH5



## 11. BAND EDGE COMPLIANCE TEST

### 11.1. Limits

According to FCC Section 15.247(d), 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

### 11.2. Test setup

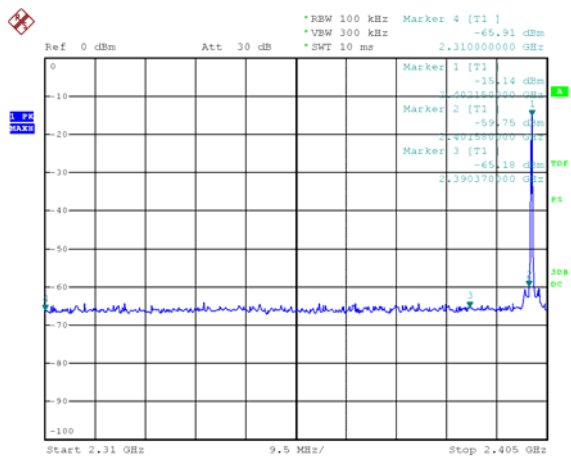
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set to span from the lowest frequency generated in the device up to and including the tenth harmonic of the highest fundamental frequency

The bandwidth of the Spectrum's VBW is set at 3MHz and RBW is set at 1MHz for peak emissions measurement above 1GHz and 1MHz RBW, 10Hz VBW for average emissions measure.

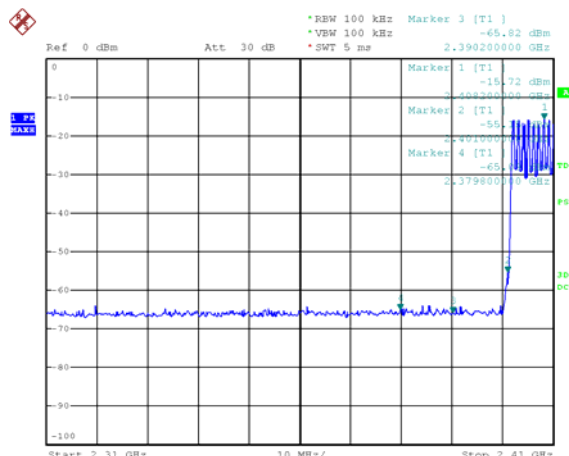
Note: If the PK measured levels comply with average limit, then the average level were deemed to comply with average limit.

Test plot as follows:

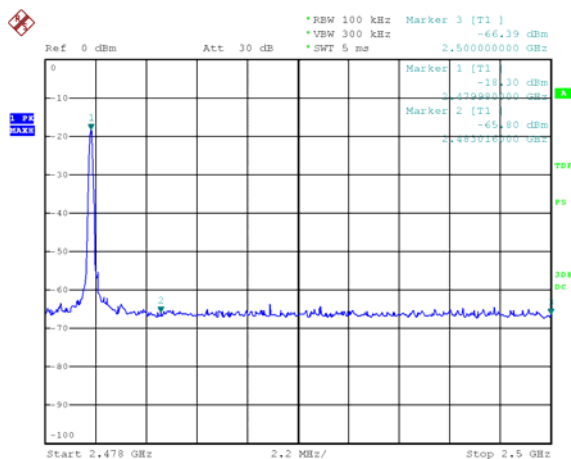
# GFSK



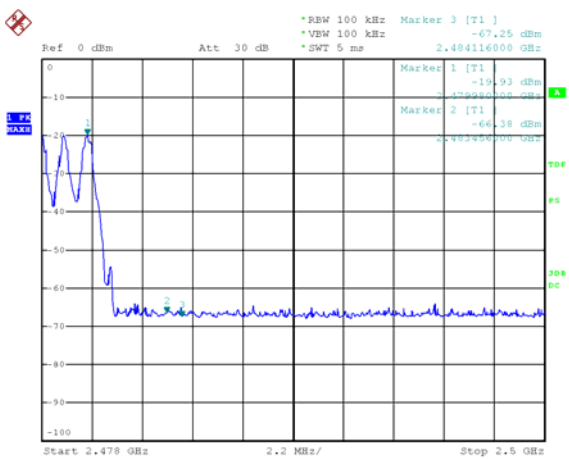
No-hopping mode



Hopping mode

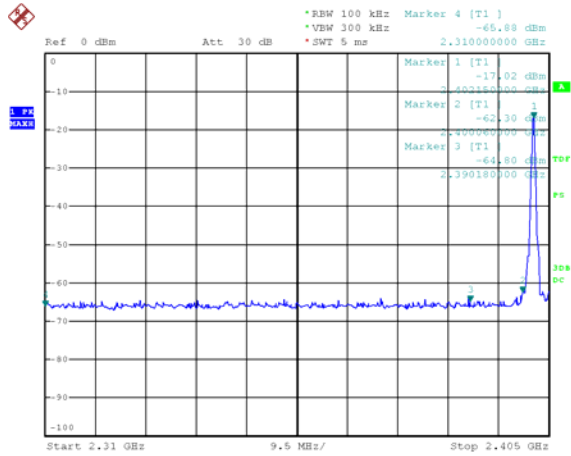


No-hopping mode

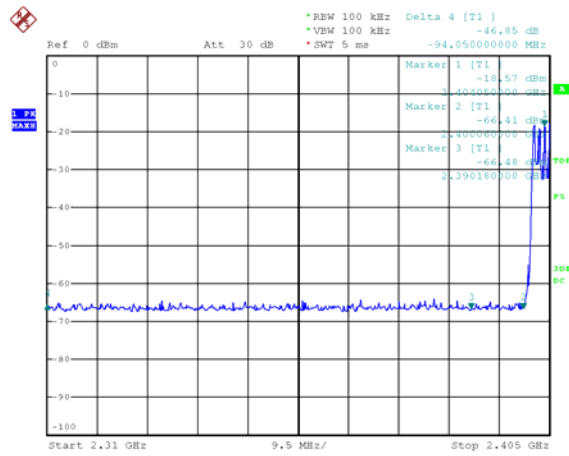


Hopping mode

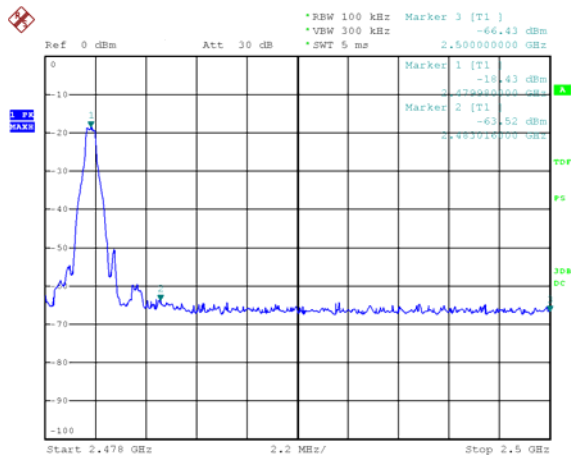
# Pi/4DQPSK



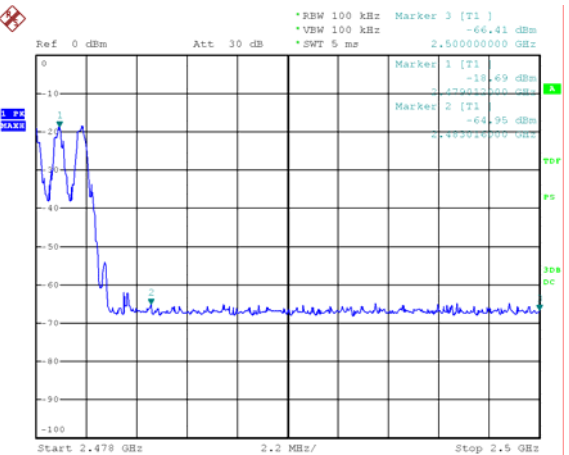
No-hopping mode



Hopping mode

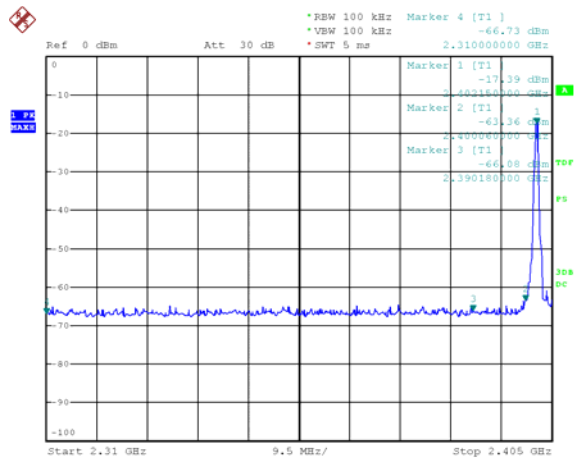


No-hopping mode

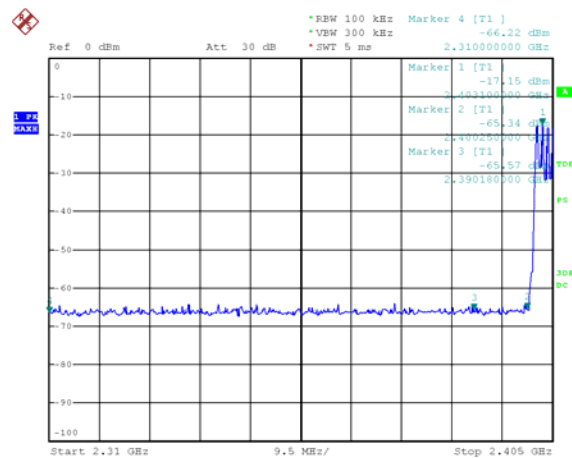


Hopping mode

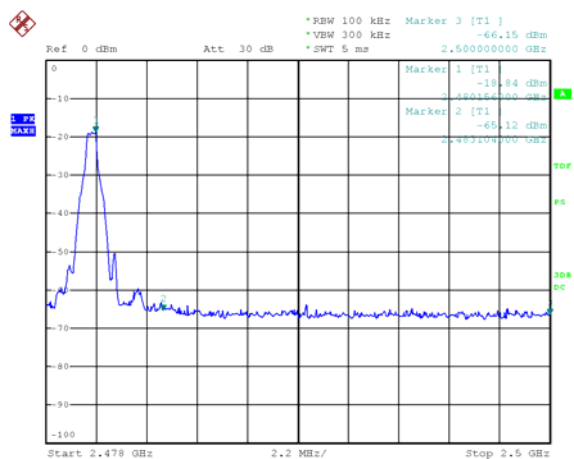
## 8-DPSK



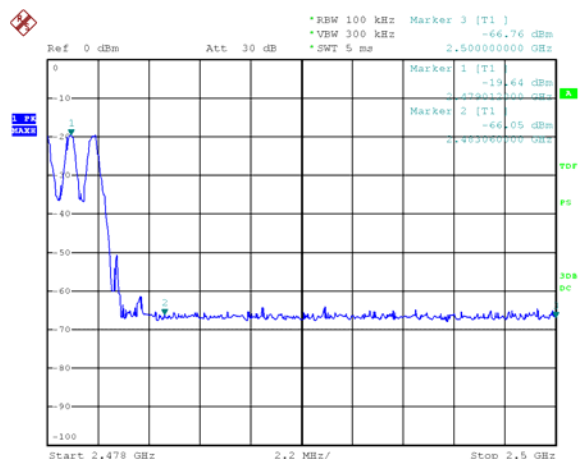
No-hopping mode



Hopping mode



No-hopping mode



Hopping mode

For radiated test as follows:

|           | Frequency<br>(MHz) | Antenna<br>polarization<br>(H/V) | Emission<br>(dBuV/m) | Band edge Limit<br>(dBuV/m) |       | Result |
|-----------|--------------------|----------------------------------|----------------------|-----------------------------|-------|--------|
|           |                    |                                  | PK                   | PK                          | AV    |        |
| GFSK      | <2400              | H                                | 46.02                | 74.00                       | 54.00 | Pass   |
|           | <2400              | V                                | 45.31                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | H                                | 45.29                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | V                                | 45.06                | 74.00                       | 54.00 | Pass   |
| Pi/4DQPSK | <2400              | H                                | 44.87                | 74.00                       | 54.00 | Pass   |
|           | <2400              | V                                | 44.19                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | H                                | 43.61                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | V                                | 43.91                | 74.00                       | 54.00 | Pass   |
| 8-DPSK    | <2400              | H                                | 44.27                | 74.00                       | 54.00 | Pass   |
|           | <2400              | V                                | 44.69                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | H                                | 46.08                | 74.00                       | 54.00 | Pass   |
|           | >2483.5            | V                                | 45.63                | 74.00                       | 54.00 | Pass   |

If the PK measured levels comply with average limit, then the average level were deemed to comply with average limit.

## 12. ANTENNA REQUIREMENTS

### 12.1.Limits

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

### 12.2. Result

The antennas used for this product are integral Antenna and that no antenna other than that furnished by the responsible party shall be used with the device, the maximum peak gain of the transmit antenna is only 0dBi.

### 13. PHOTOGRAPHS OF TEST SET-UP

Conducted



Radiated



## 14. PHOTOGRAPHS OF THE EUT

Please see annex.

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