# FCC TEST REPORT

**Test report**

**On Behalf of**

**ESI CASES&ACCESSORIES**

**For**

**WIRELESS SPEAKER**

**Model No: 91718, BB783,BB2428,BB2430,BB2431,BB2869**

**FCC ID:2AQBE91718**

**Prepared for :** **ESI CASES&ACCESSORIES**
**44 East 32nd Street,Floor 6,New York,New York 10016,USA**

**Prepared By :** **Shenzhen Tongzhou Testing Co.,Ltd**
**1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China**

**Date of Test:** **2020/5/7 - 2020/5/13**

**Date of Report:** **2020/5/14**

**Report Number:** **TZ200501347-E**

# TEST RESULT CERTIFICATION

| | |
|---|---|
| **Applicant's name** ..... : | **ESI CASES&ACCESSORIES** |
| Address ..... : | 44 East 32nd Street,Floor 6,New York,New York 10016,USA |
| **Manufacture's Name** ..... : | **Man shun union electronic technology (shenzhen) Co., Ltd.** |
| Address ..... : | 1-3/F, 23# Shengxin Road,Shengping, Longgang, Shenzhen, Guangdong, 518172 |
| **Product description** | |
| Trade Mark ..... : | N/A |
| Product name ..... : | WIRELESS SPEAKER |
| Model No ..... : | 91718, BB783,BB2428,BB2430,BB2431,BB2869 |
| **Standards** ..... : | FCC Rules and Regulations Part 15 Subpart C Section 15.247<br>ANSI C63.10: 2013 |

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| | |
|---|---|
| Date of Test ..... ..... : | |
| Date (s) of performance of tests ..... : | 2020/5/7 - 2020/5/14 |
| Date of Issue ..... : | 2020/5/15 |
| Test Result ..... : | **PASS** |

Testing Engineer : Nancy Li

(Nancy Li)

Technical Manager : Hugo Chen

(Hugo Chen)

Authorized Signatory : Andy Zhang

(Andy Zhang)

## Revision History

| Revision | Issue Date | Revisions | Revised By |
|---|---|---|---|
| 00 | 2020/5/15 | Initial Issue | Andy Zhang |
| | | | |
| | | | |

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# 1. GENERAL INFORMATION

## 1.1. Description of Device (EUT)

| | |
|---|---|
| EUT | : WIRELESS SPEAKER |
| Model Number | : 91718, BB783,BB2428,BB2430,BB2431,BB2869 |
| Test Model | : 91718 |
| Power Supply | : DC 3.7V by battery |
| Hardware version | : MC-BT450-V1.0 |
| Software version | : V1.0 |
| Sample ID | : TZ200501347-1#/ TZ200501347-2# |
| Bluetooth | |
| Bluetooth | : BR/EDR |
| Frequency Range | : 2402-2480MHz |
| Channel Number | : 79 Channels |
| Modulation Technology | : GFSK, π/4-DQPSK, 8DPSK |
| Data Rates | : 1~3Mbps |
| Antenna Type And Gain | : PCB Antenna 0.0dBi |

*Note: Antenna postion refer to EUT Photos.*

## 1.2 Support equipment List

| Manufacturer | Description | Model | Serial Number | Certificate |
|---|---|---|---|---|
| | | | | |

## 1.3 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

○ - supplied by the manufacturer

● - supplied by the lab

| | | |
|---|---|---|
| ● | Adapter | Mode:EP-TA20CBC<br>Input:AC100-240V-50/60Hz，0.5A<br>Output:DC 5V,2A |

## 1.4 External I/O Cable

| I/O Port Description | Quantity | Cable |
|---|---|---|
| | | |
| | | |

## 1.5 Description of Test Facility

Designation Number: CN1275

Test Firm Registration Number: 167722

The 3m-Semi anechoic test site fulfills CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010

## 1.6 Statement of the Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to CISPR 16 – 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the Tongzhou quality system according to To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 1.7 Measurement Uncertainty

| Test Item | | Frequency Range | Uncertainty | Note |
|---|---|---|---|---|
| Radiation Uncertainty | : | 9KHz~30MHz | ±3.08dB | (1) |
| | | 30MHz~1000MHz | ±4.42dB | (1) |
| | | 1GHz~40GHz | ±4.06dB | (1) |
| Conduction Uncertainty | : | 150kHz~30MHz | ±2.23dB | (1) |

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

## 1.8 Description of Test Modes

Bluetooth operates in the unlicensed ISM Band at 2.4GHz. The EUT works in the X-axis, Y-axis, Z-axis. The following operating modes were applied for the related test items. All test modes were tested, only the result of the worst case was recorded in the report.

| Mode of Operations | Frequency Range (MHz) | Data Rate (Mbps) |
|---|---|---|
| Bluetooth | 2402 | 1/2/3 |
| | 2441 | 1/2/3 |
| | 2480 | 1/2/3 |
| For Conducted Emission | | |
| Test Mode | TX Mode | |
| For Radiated Emission | | |
| Test Mode | TX Mode | |

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR PART 15C 15.207, 15.209, 15.247 and DA 00-705.

## 2.1 EUT Configuration

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

## 2.2 EUT Exercise

The EUT was operated in the normal operating mode for Hopping Numbers and Dwell Time test and a continuous transmits mode for other tests.

According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209, 15.247 under the FCC Rules Part 15 Subpart C.

## 2.3 General Test Procedures

### 2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane.According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

### 2.3.2 Radiated Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane.The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013

## 2.4. Test Sample

The application provides 2 samples to meet requirement;

| Sample Number | Description |
|---|---|
| TZ200501347-1# | Engineer sample – continuous transmit |
| TZ200501347-2# | Normal sample – Intermittent transmit |

# 3. SYSTEM TEST CONFIGURATION

## 3.1 Justification

The system was configured for testing in a continuous transmits condition.

## 3.2 EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (BT_Tool V1.0.9) provided by application.

## 3.3 Block Diagram/Schematics

Please refer to the related document.

## 3.4 Equipment Modifications

Shenzhen Tongzhou Testing Co.,Ltd has not done any modification on the EUT.

## 3.5 Test Setup

Please refer to the test setup photo.

# 4. SUMMARY OF TEST RESULTS

| Applied Standard: FCC Part 15 Subpart C | | | |
|---|---|---|---|
| **FCC Rules** | **Description of Test** | **Test Sample** | **Result** |
| §15.247(b)(1) | Maximum Conducted Output Power | TZ200501347-1# | Compliant |
| §15.247(c) | Frequency Separation And 20 dB Bandwidth | TZ200501347-1# | Compliant |
| §15.247(a)(1)(ii) | Number Of Hopping Frequency | TZ200501347-1# | Compliant |
| §15.247(a)(1)(iii) | Time Of Occupancy (Dwell Time) | TZ200501347-1# | Compliant |
| §15.209, §15.247(d) | Radiated and Conducted Spurious Emissions | TZ200501347-1#<br>TZ200501347-2# | Compliant |
| §15.205 | Emissions at Restricted Band | TZ200501347-1# | Compliant |
| §15.207(a) | Conducted Emissions | TZ200501347-2# | Compliant |
| §15.203 | Antenna Requirements | TZ200501347-1# | Compliant |
| §15.247(i)§2.1093 | RF Exposure | N/A | Compliant |

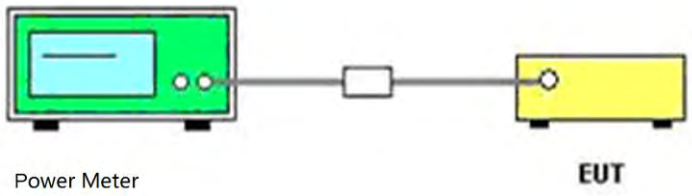
# 5. SUMMARY OF TEST EQUIPMENT

| Item | Test Equipment | Manufacturer | Model No. | Serial No. | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 1 | MXA Signal Analyzer | Keysight | N9020A | MY52091623 | 2020/1/2 | 2021/1/1 |
| 2 | Power Sensor | Agilent | U2021XA | MY5365004 | 2020/1/2 | 2021/1/1 |
| 3 | Power Meter | Agilent | U2531A | TW53323507 | 2020/1/2 | 2021/1/1 |
| 4 | Wideband Antenna | schwarzbeck | VULB 9163 | 958 | 2019/11/16 | 2022/11/15 |
| 5 | Horn Antenna | schwarzbeck | 9120D-1141 | 1574 | 2019/11/16 | 2022/11/15 |
| 6 | Horn Antenna | A-INFO | LB-180400-KF | J211020657 | 2019/11/16 | 2022/11/15 |
| 7 | EMI Test Receiver | R&S | ESCI | 100849/003 | 2020/1/2 | 2021/1/1 |
| 8 | Controller | MF | MF7802 | N/A | N/A | N/A |
| 9 | Amplifier | schwarzbeck | BBV 9743 | 209 | 2020/1/2 | 2021/1/1 |
| 10 | Amplifier | Tonscend | TSAMP-0518SE | -- | 2020/1/2 | 2021/1/1 |
| 11 | Amplifier | SKET | LNPA_1840-50 | SK2018101801 | 2019/10/22 | 2020/10/21 |
| 12 | RF Cable(below 1GHz) | HUBER+SUHNER | RG214 | N/A | 2020/1/2 | 2021/1/1 |
| 12 | RF Cable(above 1GHz) | HUBER+SUHNER | RG214 | N/A | 2020/1/2 | 2021/1/1 |
| 14 | Artificial Mains | ROHDE & SCHWARZ | ENV 216 | 101333-IP | 2020/1/2 | 2021/1/1 |
| 15 | EMI Test Software | ROHDE & SCHWARZ | ESK1 | V1.71 | N/A | N/A |
| 16 | RE test software | Tonscend | JS32-RE | V2.0.2.0 | N/A | N/A |
| 17 | Test Software | Tonscend | JS1120-3 | V2.5.77.0418 | N/A | N/A |

# 6. MEASUREMENT RESULTS

## 6.1 Peak Power

6.1.1 Block Diagram of Test Setup




6.1.2 Limit

According to §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.

6.1.3 Test Procedure

According to ANSI C63.10:2013 Maximum peak conducted output power for HFSS devices:

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the HFSS bandwidth and shall utilize a fast-responding diode detector.

6.1.4 Test Results

| Temperature | 22.8℃ | Humidity | 56% |
|---|---|---|---|
| Test Engineer | Nancy Li | Configurations | BT |

| Type | Channel | Output power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|
| GFSK | 00 | -0.437 | 20.97 | Pass |
| | 39 | -0.855 | | |
| | 78 | -1.467 | | |
| π/4DQPSK | 00 | 0.787 | 20.97 | Pass |
| | 39 | 0.327 | | |
| | 78 | -0.223 | | |
| 8DPSK | 00 | 0.733 | 20.97 | Pass |
| | 39 | 0.340 | | |
| | 78 | -0.214 | | |

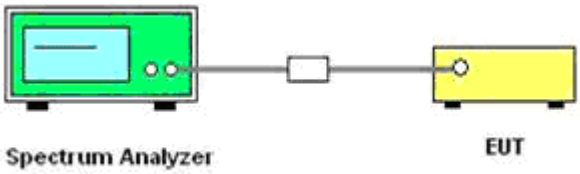
*Remark:*
1. *Test results including cable loss;*
2. *Measured output power at difference Packet Type for each mode and recorded worst case for each mode.*

## 6.2 Frequency Separation and 20 dB Bandwidth

6.2.1 Limit

According to §15.247(a) (1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

6.2.2 Block Diagram of Test Setup




6.2.3 Test Procedure

Frequency separation test procedure:

1). Place the EUT on the table and set it in transmitting mode.

2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.

3). Set center frequency of Spectrum Analyzer = middle of hopping channel.

4). Set the Spectrum Analyzer as RBW = 100 kHz, VBW = 300 kHz, Span = wide enough to capture the peaks of two adjacent channels, Sweep = auto.

5). Max hold, mark 2 peaks of hopping channel and record the 2 peaks frequency.

20dB bandwidth test procedure:

1). Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel.

2). RBW ≥1% of the 20 dB bandwidth, VBW ≥RBW.

3). Detector function = peak.

4). Trace = max hold.

6.2.4 Test Results

| Temperature | 22.8℃ | Humidity | 56% |
|---|---|---|---|

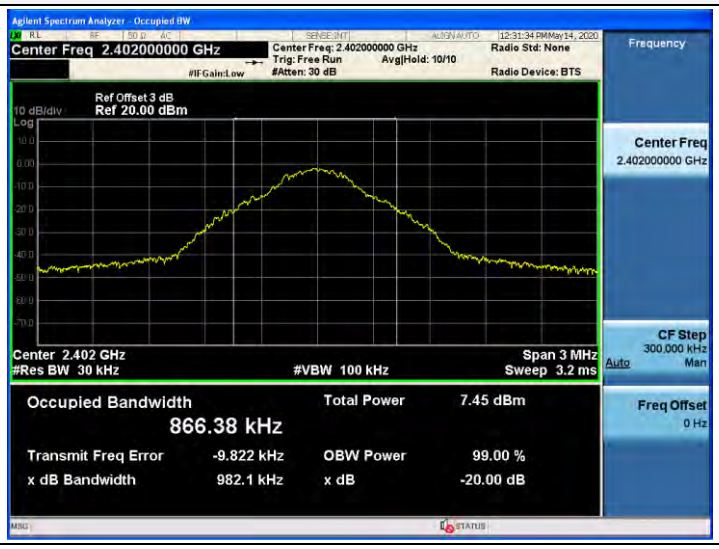
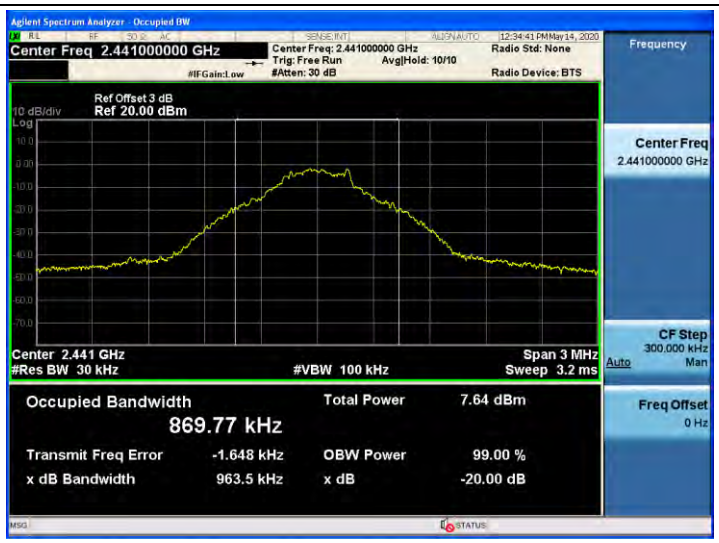
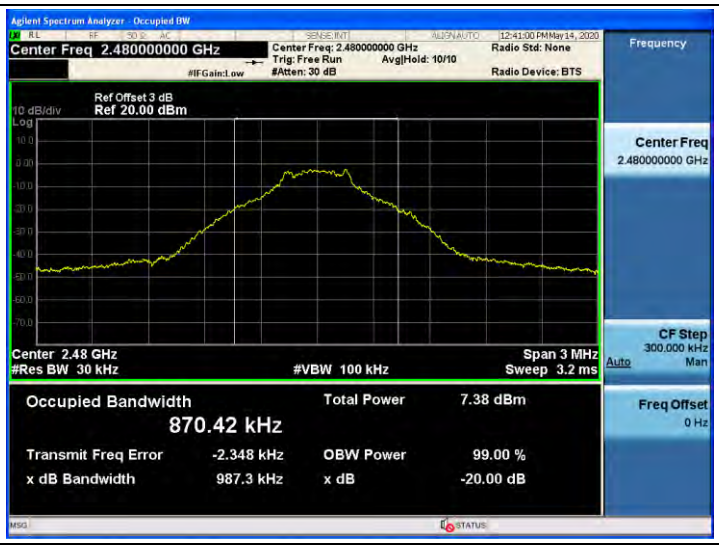
| Test Engineer | Nancy Li | Configurations | BT |
|---|---|---|---|

| Modulation | Channel | 20dB bandwidth (MHz) | Result |
|---|---|---|---|
| GFSK | CH00 | 0.9821 | Pass |
| | CH39 | 0.9635 | |
| | CH78 | 0.9873 | |
| π/4DQPSK | CH00 | 1.308 | Pass |
| | CH39 | 1.315 | |
| | CH78 | 1.325 | |
| 8DPSK | CH00 | 1.305 | Pass |
| | CH39 | 1.311 | |
| | CH78 | 1.303 | |

| Modulation | Channel | Channel Separation (MHz) | Limit(MHz) | Result |
|---|---|---|---|---|
| GFSK | CH39 | 0.999 | 2/3* 20dB BW or 20dB BW | Pass |
| | CH40 | | | |
| π/4DQPSK | CH39 | 0.998 | 2/3* 20dB BW or 20dB BW | Pass |
| | CH40 | | | |
| 8DPSK | CH39 | 1.007 | 2/3* 20dB BW or 20dB BW | Pass |
| | CH40 | | | |

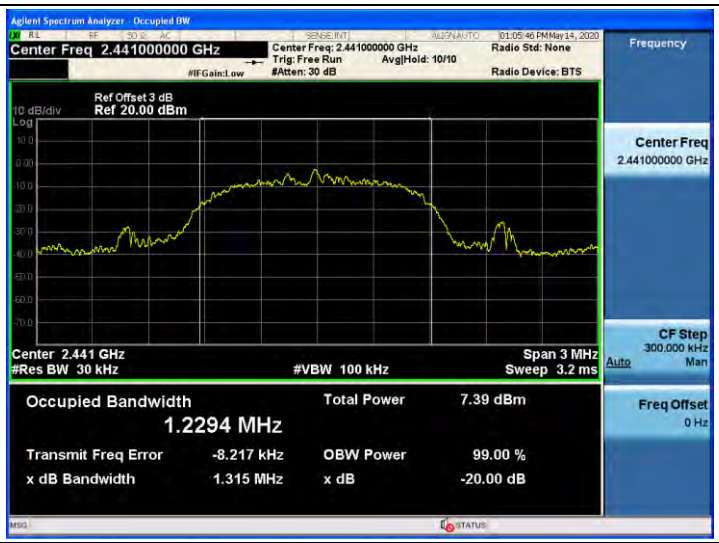
*Remark:*
1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*

**For 20dB bandwidth Test plots:**

| GFSK Modulation |
|---|
|  |
| CH00 |
|  |
| CH39 |
|  |
| CH78 |

*π/4DQPSK Modulation*

*CH00*




*CH39*

*CH78*

*8DPSK Modulation*

*CH00*

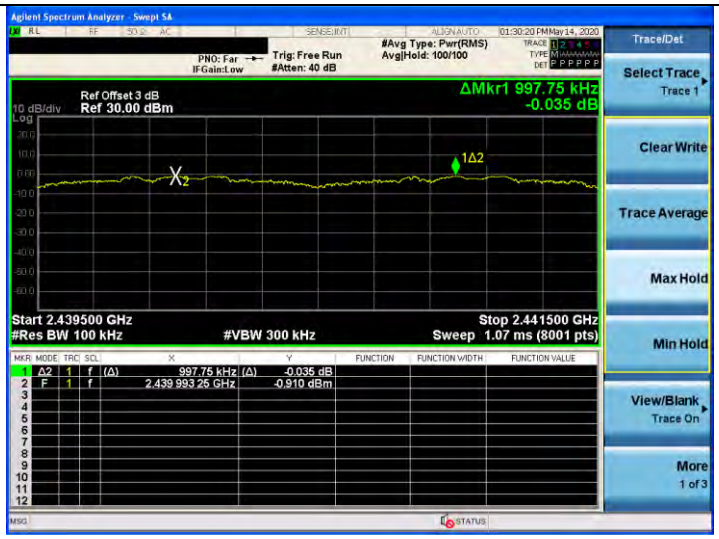
*CH39*

*CH78*

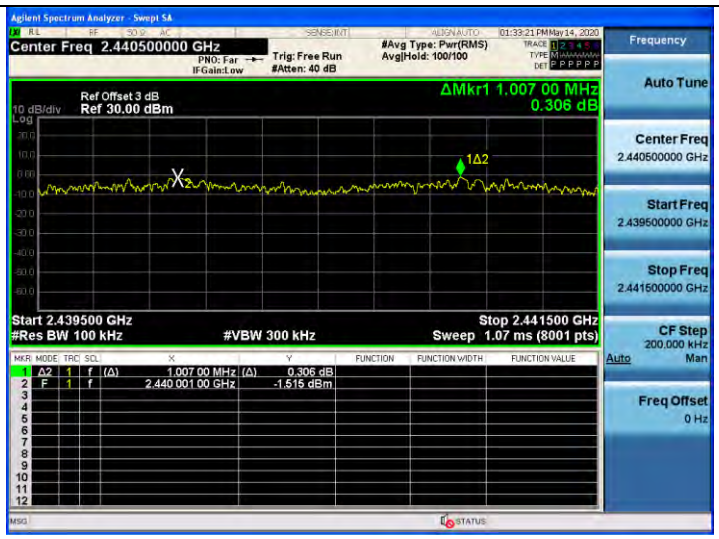
**For Channel Separation (MHz):**

*GFSK Modulation*

*π/4DQPSK Modulation*




*8DPSK Modulation*

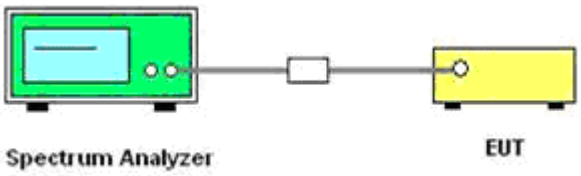


## 6.3 Number of Hopping Frequency

### 6.3.1 Limit

According to §15.247(a)(1)(ii) or A8.1 (d), Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

### 6.3.2 Block Diagram of Test Setup




### 6.3.3 Test Procedure

1). Place the EUT on the table and set it in transmitting mode.

2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.

3). Set Spectrum Analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.

4). Set the Spectrum Analyzer as RBW, VBW=1MHz.

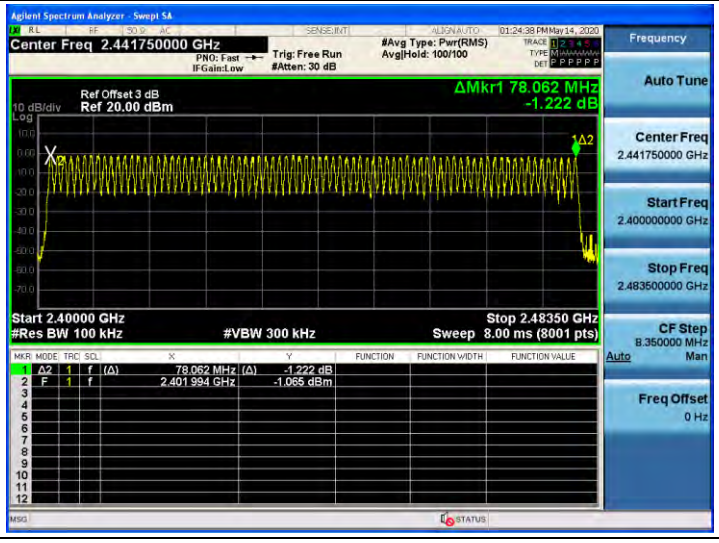
5). Max hold, view and count how many channel in the band.

### 6.3.4 Test Results

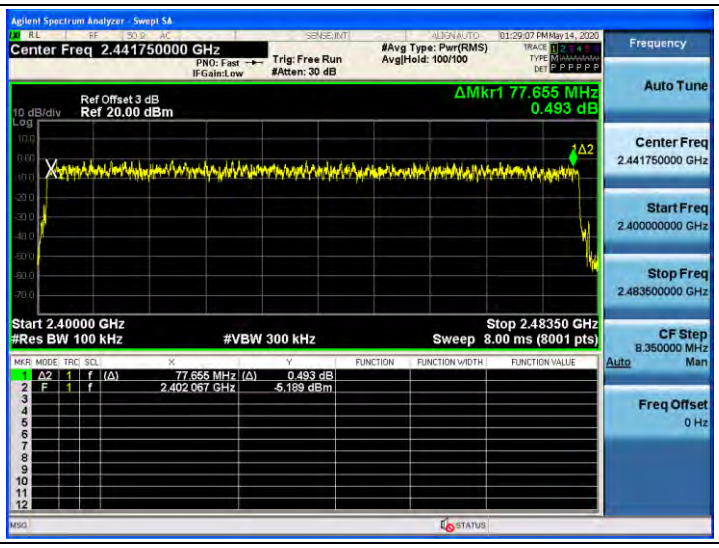
| Temperature | 22.8℃ | Humidity | 56% |
|---|---|---|---|
| Test Engineer | Nancy Li | Configurations | BT |

| Modulation | Number of Hopping Channel | Limit | Result |
|---|---|---|---|
| GFSK | 79 | ≥15 | Pass |
| π/4 DQPSK | 79 | | |
| 8DPSK | 79 | | |

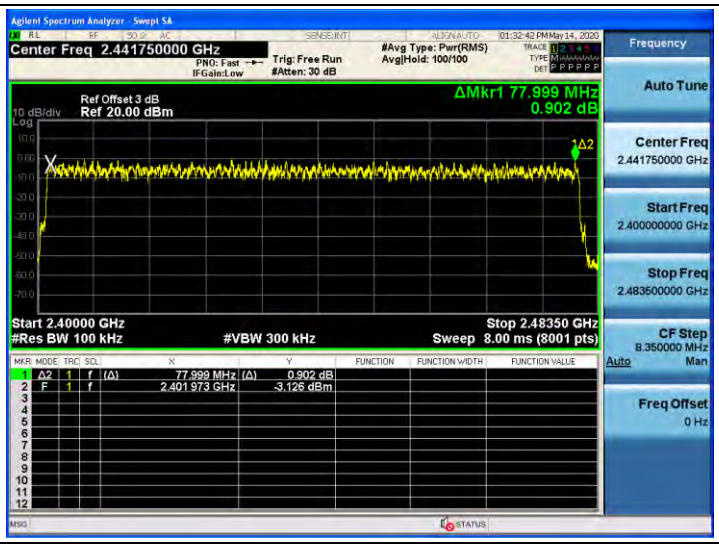
*GFSK Modulation*




*π/4DQPSK Modulation*




*8DPSK Modulation*

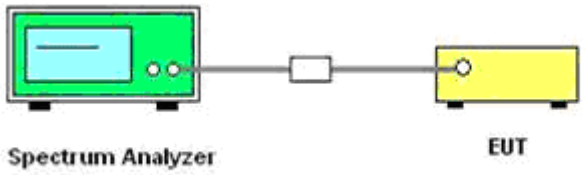


## 6.4 Time of Occupancy (Dwell Time)

### 6.4.1 Limit

According to §15.247(a)(1)(iii) or A8.1 (d), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

### 6.4.2 Block Diagram of Test Setup




### 6.4.3 Test Procedure

1). Place the EUT on the table and set it in transmitting mode.

2). Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Spectrum Analyzer.

3). Set center frequency of Spectrum Analyzer = operating frequency.

4). Set the Spectrum Analyzer as RBW, VBW=1MHz, Span = 0Hz, Sweep = auto.

5). Repeat above procedures until all frequency measured was complete.

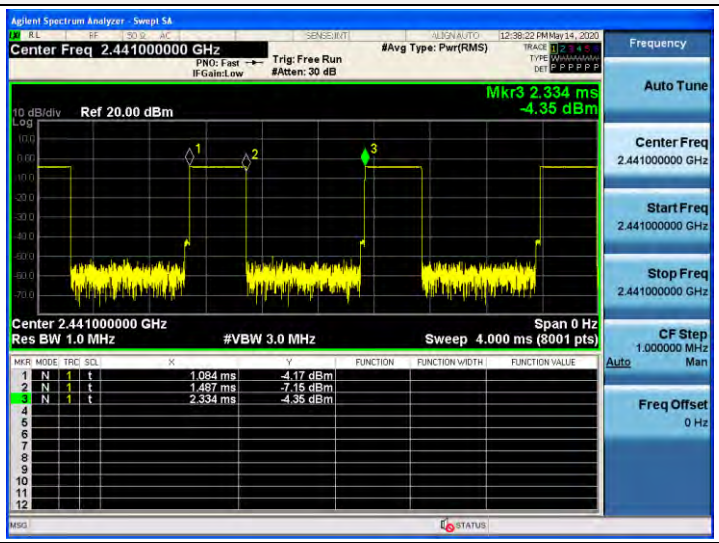
### 6.4.4 Test Result

| | | | |
|---|---|---|---|
| Temperature | 22.8℃ | Humidity | 56% |
| Test Engineer | Nancy Li | Configurations | BT |

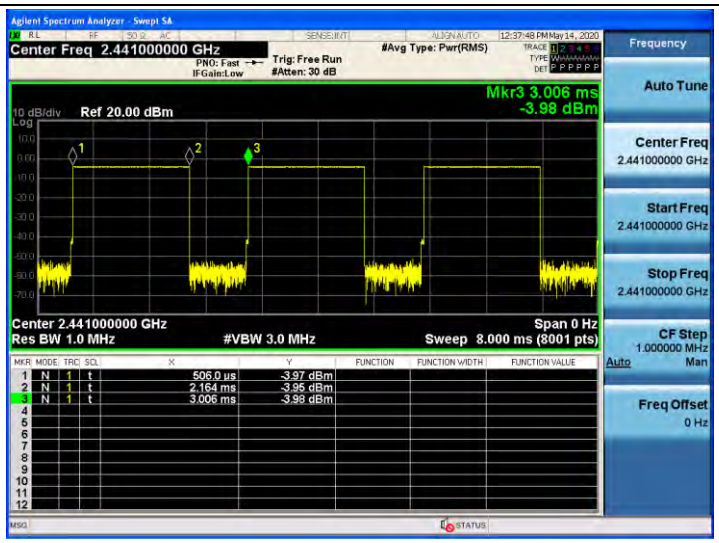
| Modulation | Packet | Pulse time (ms) | Dwell time (s) | Limit (s) | Result |
|---|---|---|---|---|---|
| GFSK | DH1 | 0.403 | 0.129 | 0.40 | Pass |
| | DH3 | 1.658 | 0.265 | | |
| | DH5 | 2.904 | 0.310 | | |
| π/4DQPSK | 2-DH1 | 0.414 | 0.132 | 0.40 | Pass |
| | 2-DH3 | 1.665 | 0.266 | | |
| | 2-DH5 | 2.913 | 0.311 | | |
| 8DPSK | 3-DH1 | 0.414 | 0.132 | 0.40 | Pass |
| | 3-DH3 | 1.662 | 0.266 | | |
| | 3-DH5 | 2.913 | 0.311 | | |

Note:
1. We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
2. Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1, 3-DH1
   Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3
   Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5, 3-DH5

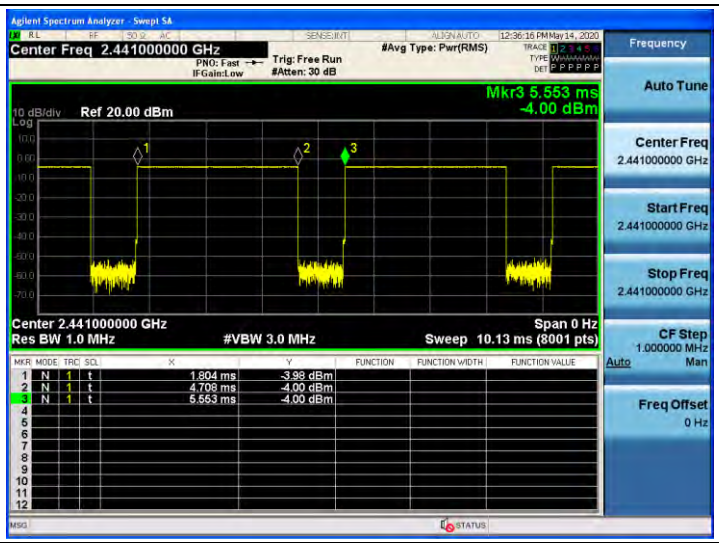
GFSK Modulation




DH1

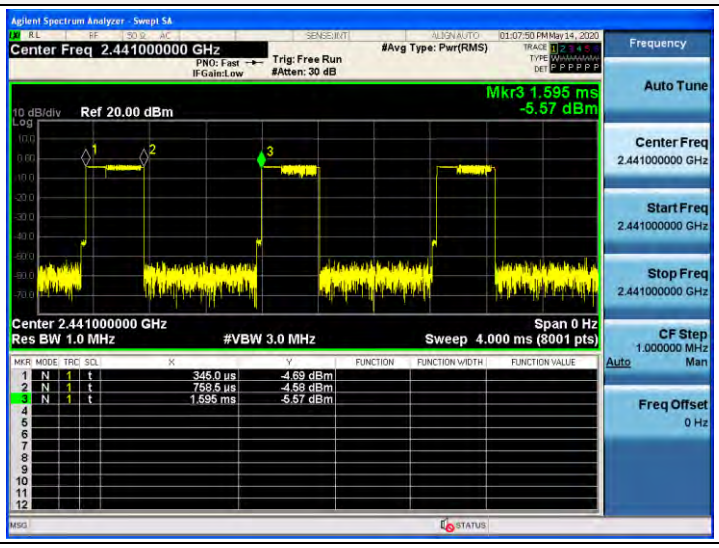



DH3

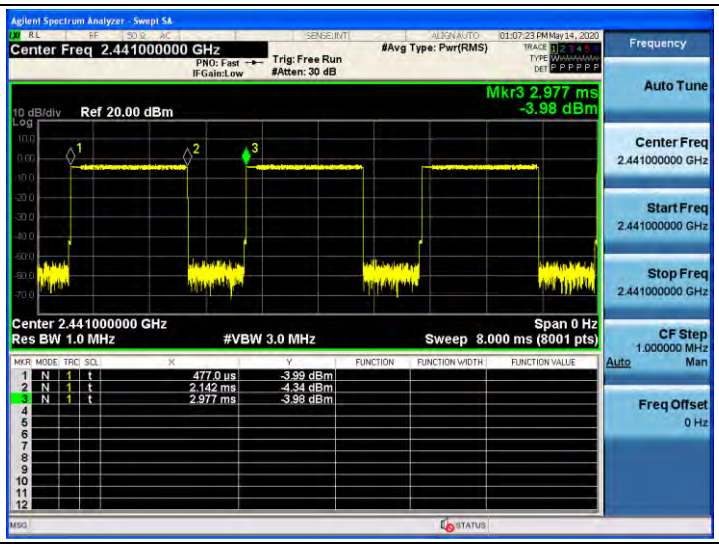



DH5

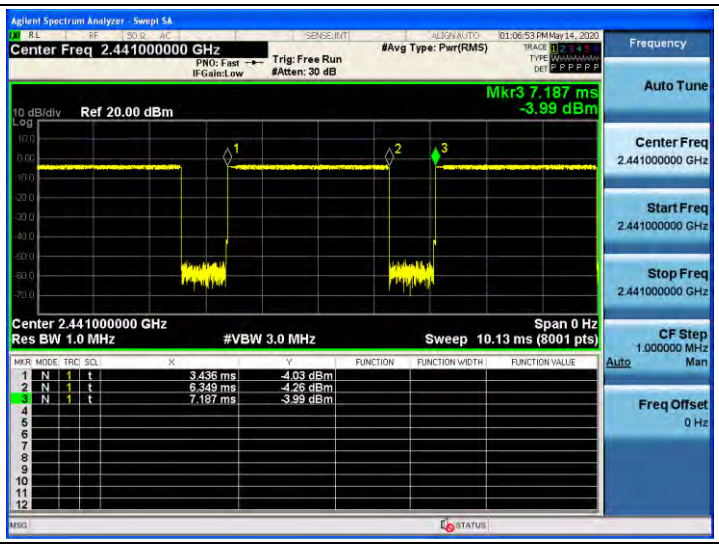
π/4DQPSK Modulation




2-DH1

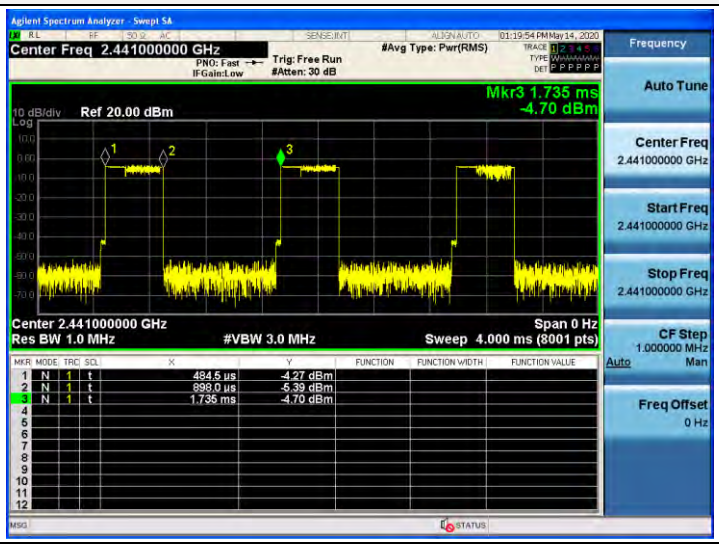



2-DH3

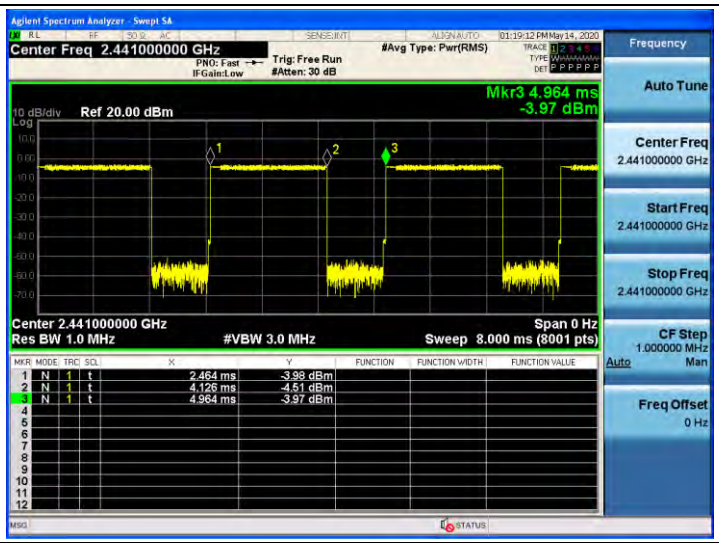



2-DH5

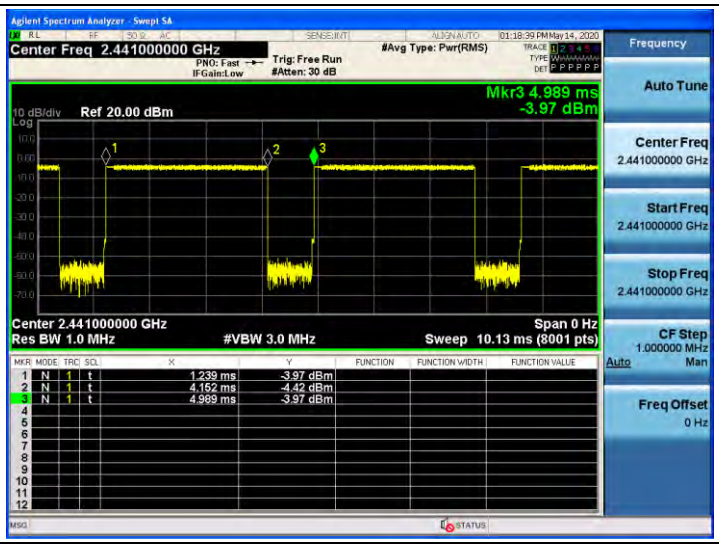
8DPSK Modulation




3-DH1




3-DH3



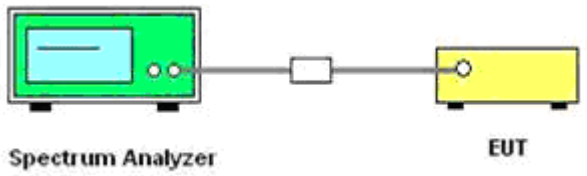

3-DH5

## 6.5 Conducted Spurious Emissions and Band Edges Test

### 6.5.1 Limit

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

### 6.5.2 Block Diagram of Test Setup




### 6.5.3 Test Procedure

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

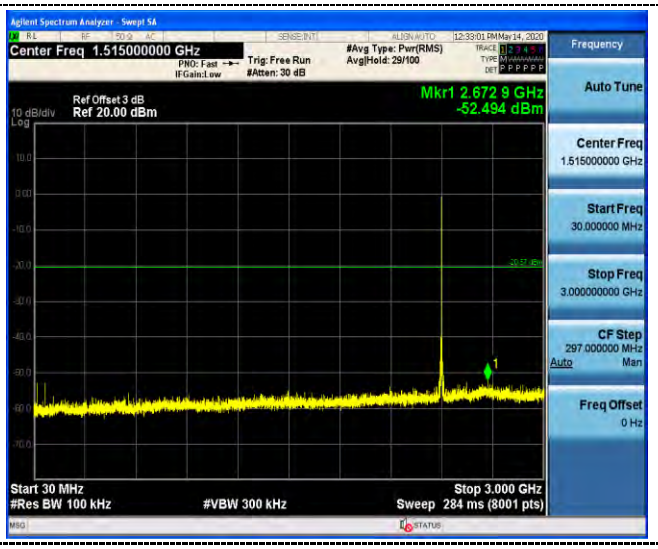
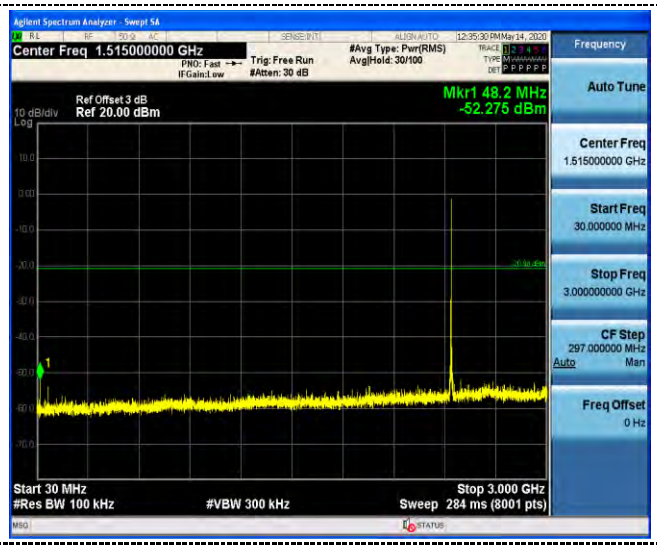
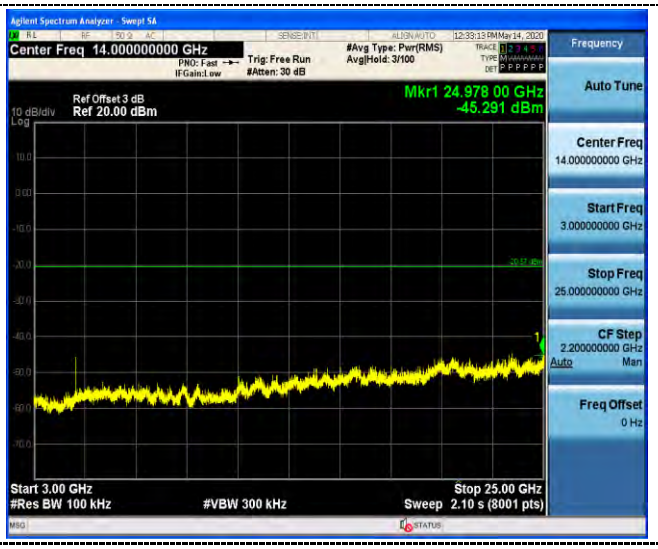
The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 100 KHz. The video bandwidth is set to 300 KHz.

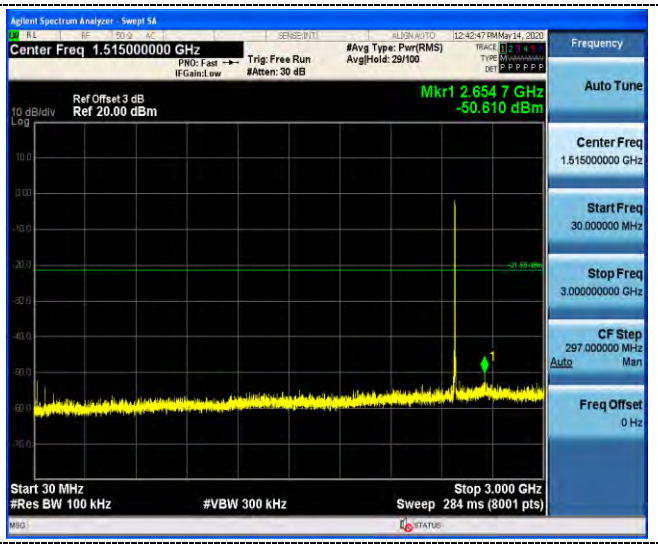
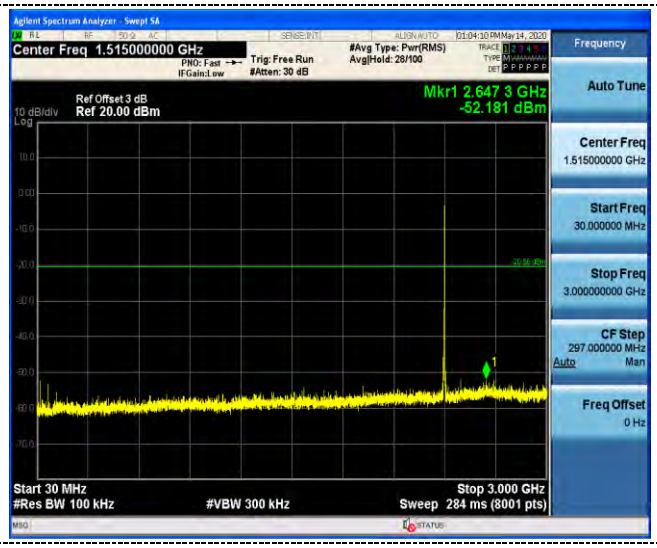
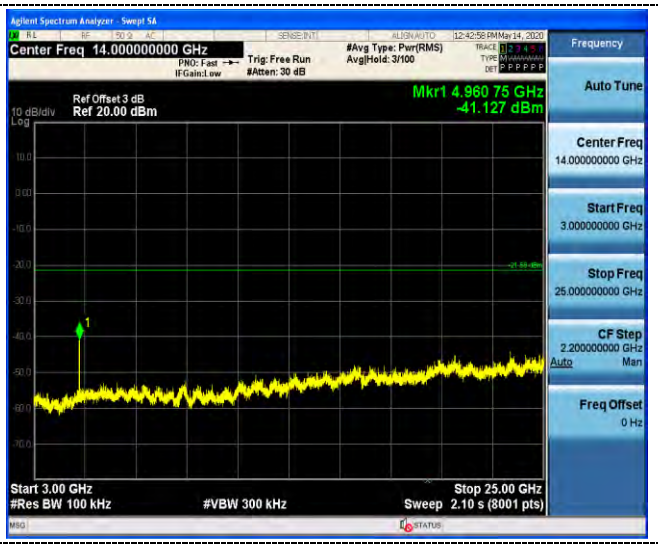
Measurements are made over the 9 kHz to 26.5GHz range with the transmitter set to the lowest, middle, and highest channels

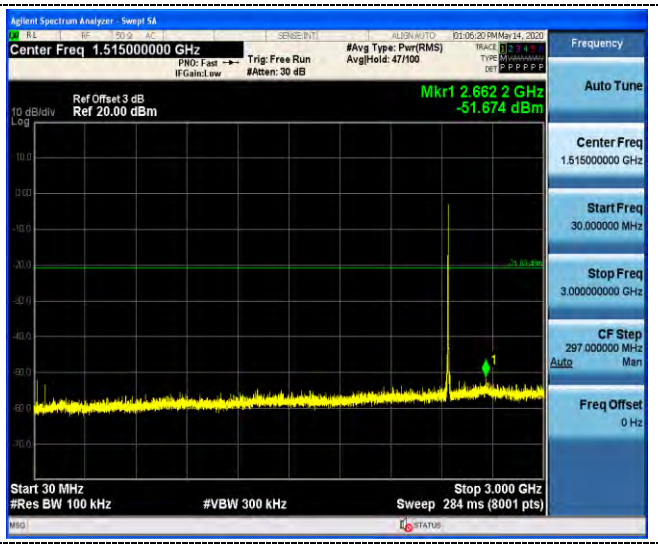
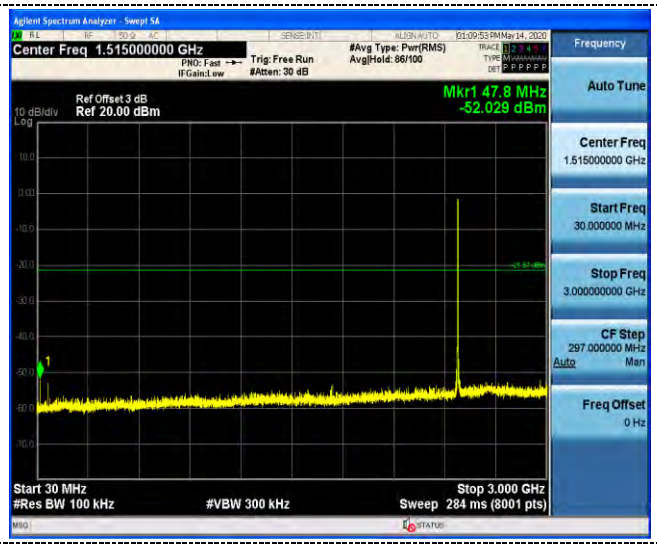
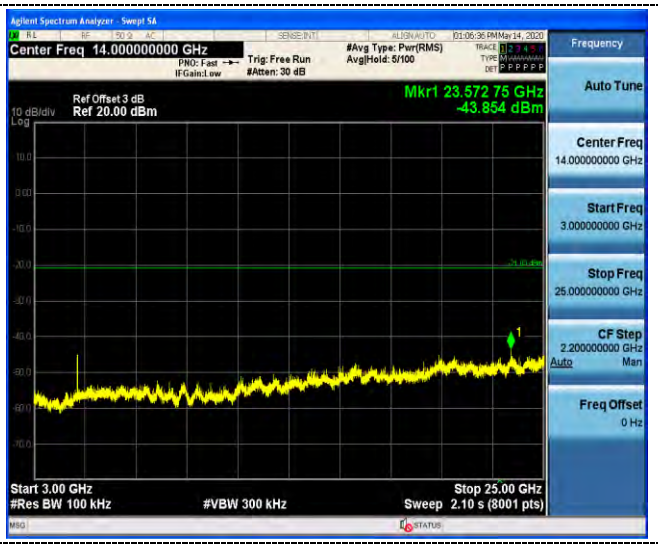
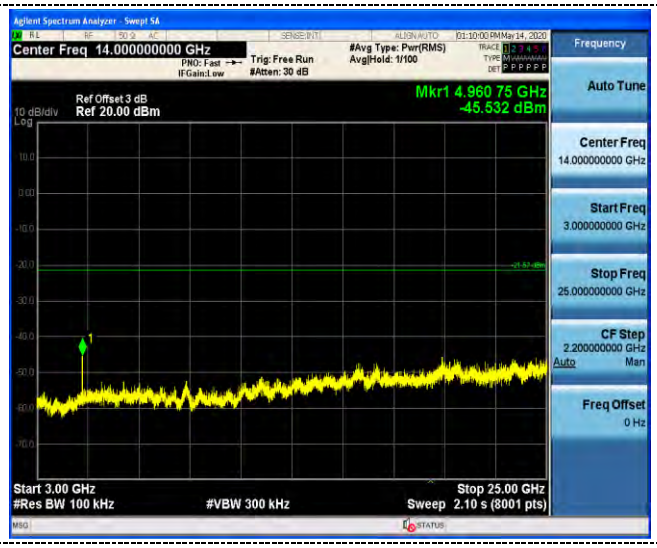
### 6.5.4 Test Results of Conducted Spurious Emissions

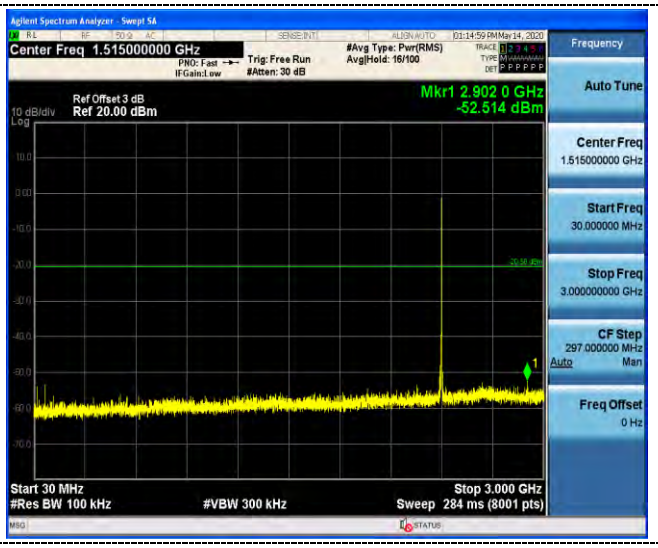
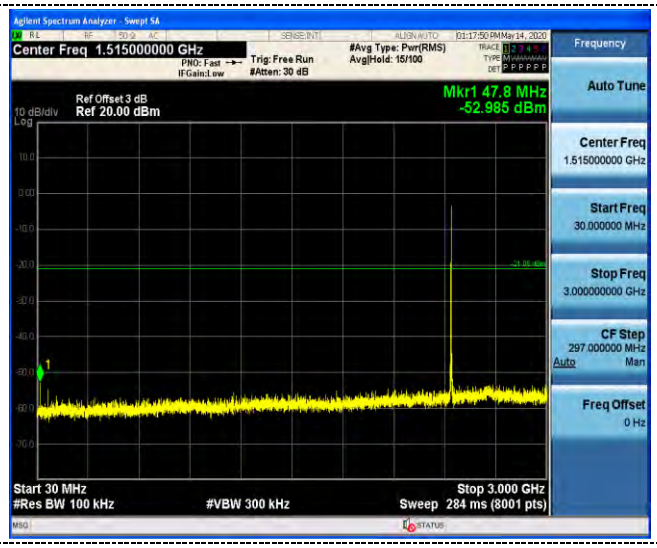
No non-compliance noted. Only record the worst test result in this report. The test data refer to the following page.

| | | | |
|---|---|---|---|
| Temperature | 22.8℃ | Humidity | 52% |
| Test Engineer | Nancy Li | Configurations | BT |

| GFSK CH00 | GFSK CH39 |
|---|---|
| | |
| Reference | Reference |
|  |  |
| 30MHz-3GHz | 30MHz-3GHz |
|  | |
| 3GHz-25GHz | 3GHz-25GHz |

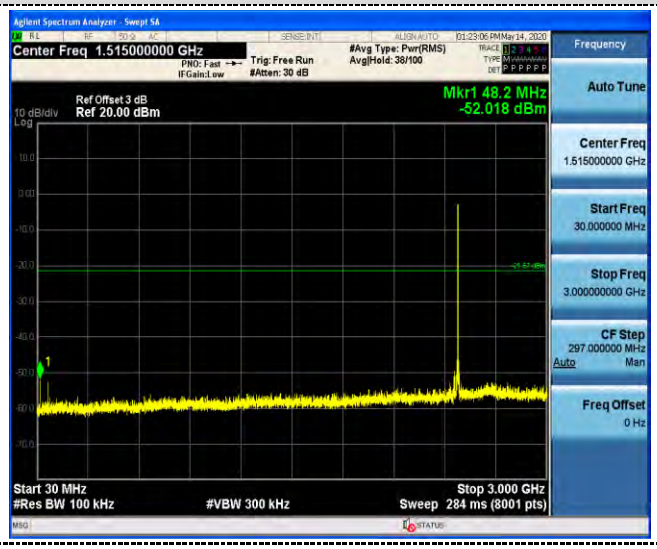
| GFSK CH78 | π/4DQPSK CH00 |
|---|---|
| | |
| Reference | Reference |
|   |   |
| 30MHz-3GHz | 30MHz-3GHz |
|   | |
| 3GHz-25GHz | 3GHz-25GHz |

| π/4DQPSK CH39 | π/4DQPSK CH78 |
|---|---|
| | |
| Reference | Reference |
|   |   |
| 30MHz-3GHz | 30MHz-3GHz |
|   |   |
| 3GHz-25GHz | 3GHz-25GHz |

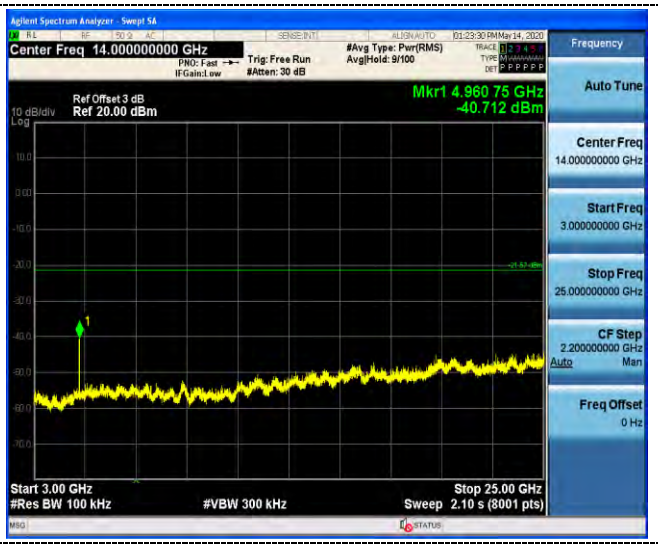
| 8DPSK CH00 | 8DPSK CH39 |
|---|---|
| | |
| Reference | Reference |
|  |  |
| 30MHz-3GHz | 30MHz-3GHz |
| | |
| 3GHz-25GHz | 3GHz-25GHz |

**8DPSK CH78**

Reference




30MHz-3GHz

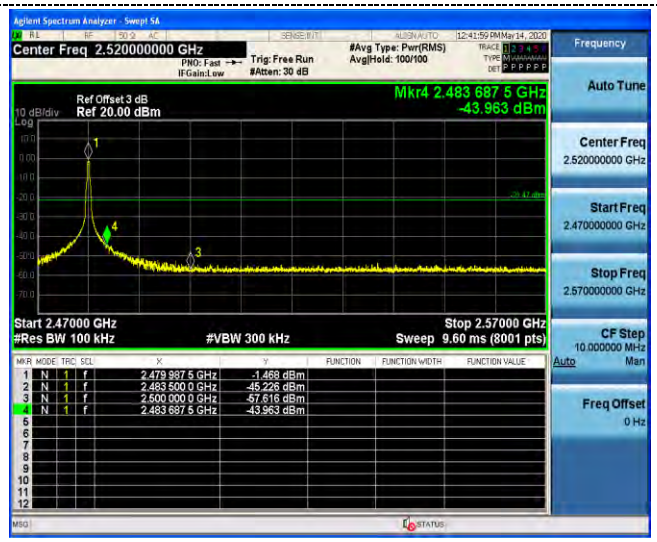



3GHz-25GHz

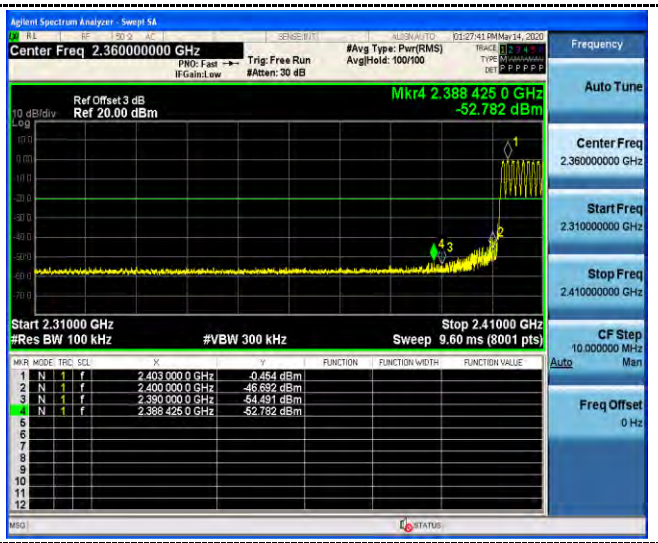
***Band-edge Measurements for RF Conducted Emissions:***

**GFSK**

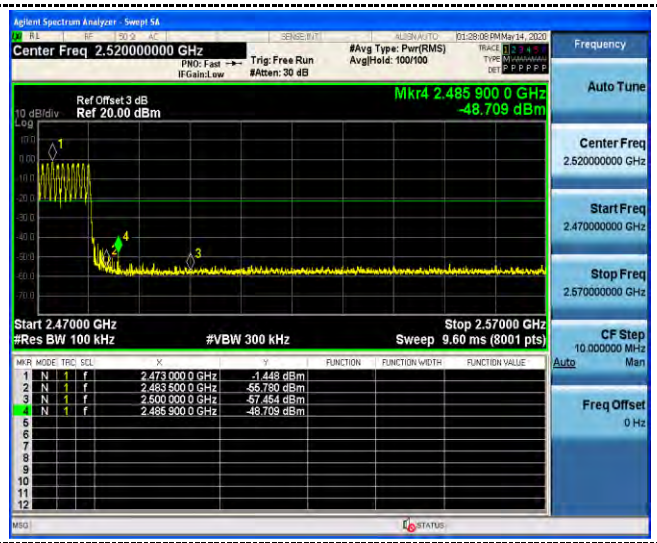
Left Band edge hoping off




Right Band edge hoping off

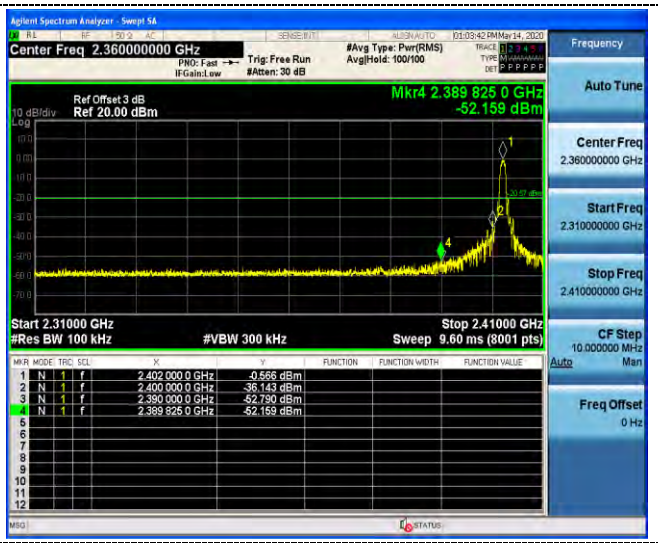



Left Band edge hoping on

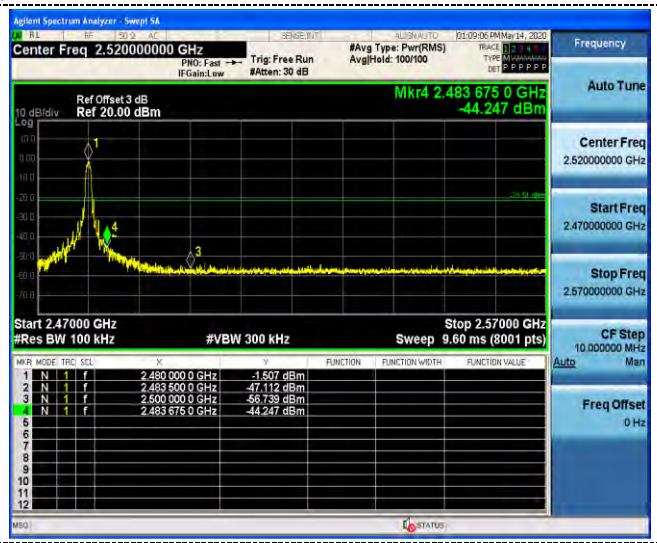



Right Band edge hoping on

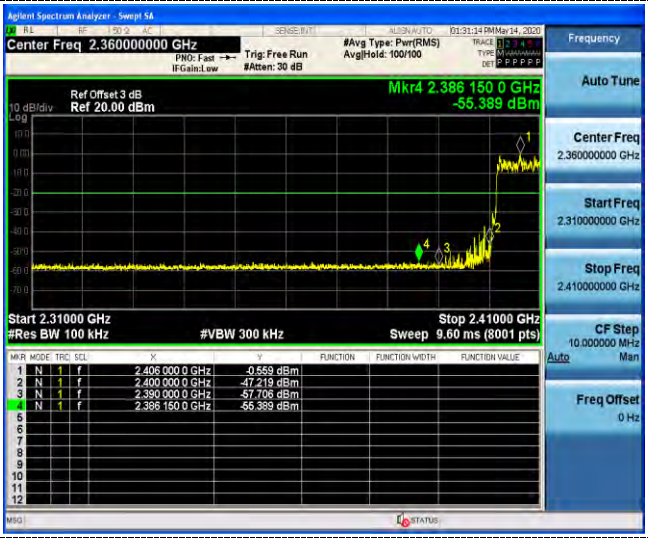
***π/4DQPSK***




Left Band edge hoping off



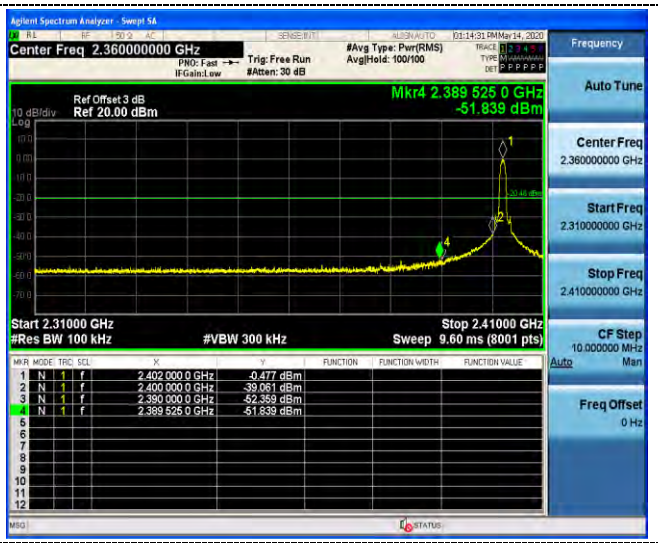

Right Band edge hoping off



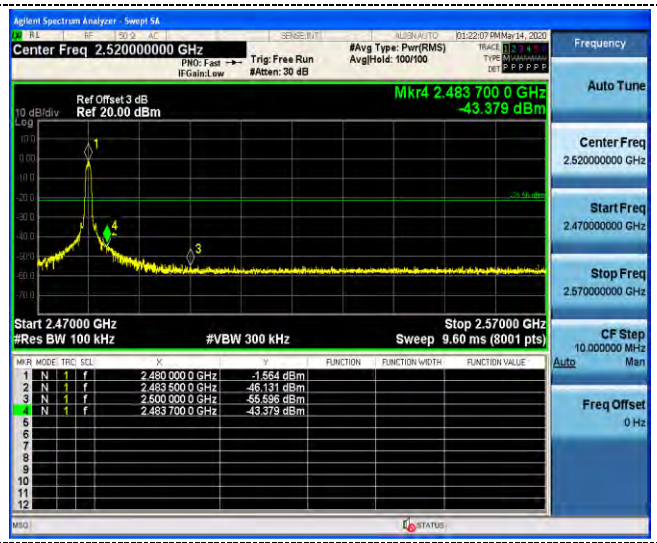

Left Band edge hoping on

Right Band edge hoping on

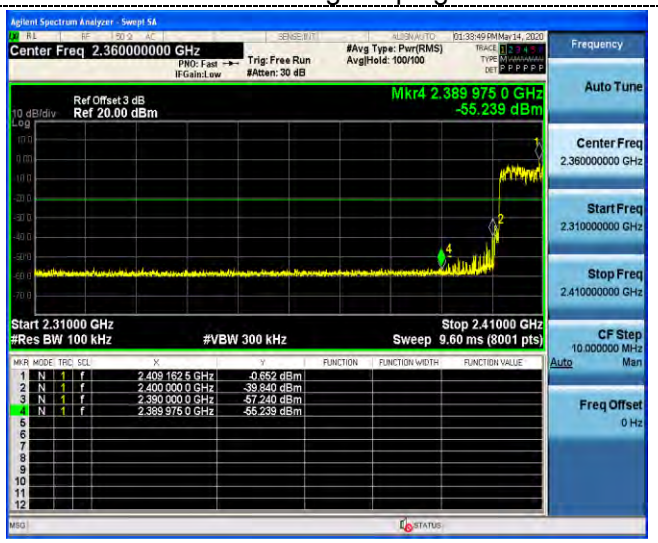
**8DPSK**




Left Band edge hoping off




Right Band edge hoping off




Left Band edge hoping on

Right Band edge hoping on

*Remark:*

1. *Test results including cable loss;*
2. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*

## 6.6 Restricted Band Emission Limit

### 6.6.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| \1\ 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 | (\2\) |
| 13.36-13.41 | | | |

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

| 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 |

### 6.6.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start Frequency | 1000 MHz |
| Stop Frequency | 10th carrier harmonic |
| RB / VB (Emission in restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average |
| RB / VB (Emission in non-restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average |

| Receiver Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG |
| Start ~ Stop Frequency | 150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB/VB 120kHz/1MHz for QP |

### 6.6.3. Test Procedures

**1) Sequence of testing 9 kHz to 30 MHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

**Final measurement:**

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

**2) Sequence of testing 30 MHz to 1 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

**Final measurement:**

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

**3) Sequence of testing 1 GHz to 18 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

**Final measurement:**

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

**4) Sequence of testing above 18 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

**Premeasurement:**

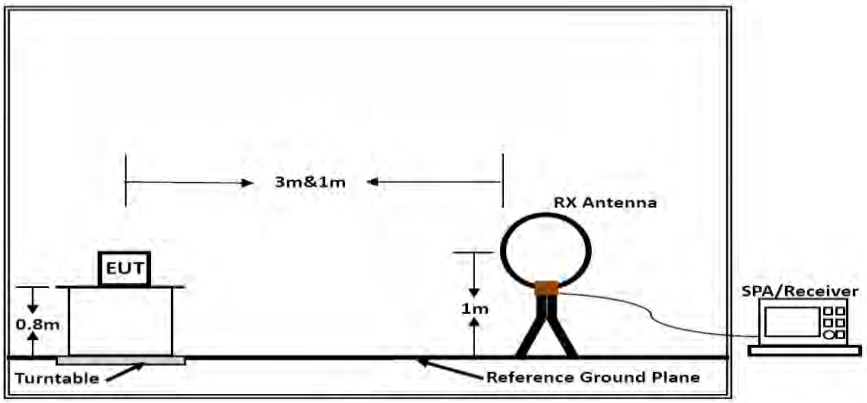
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

**Final measurement:**

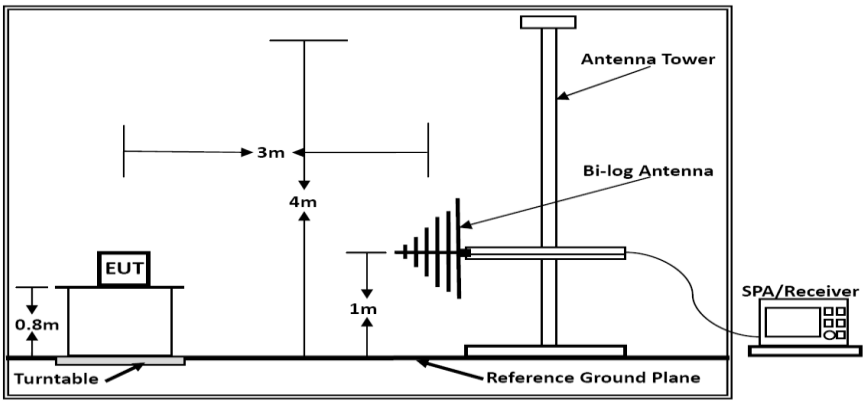
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

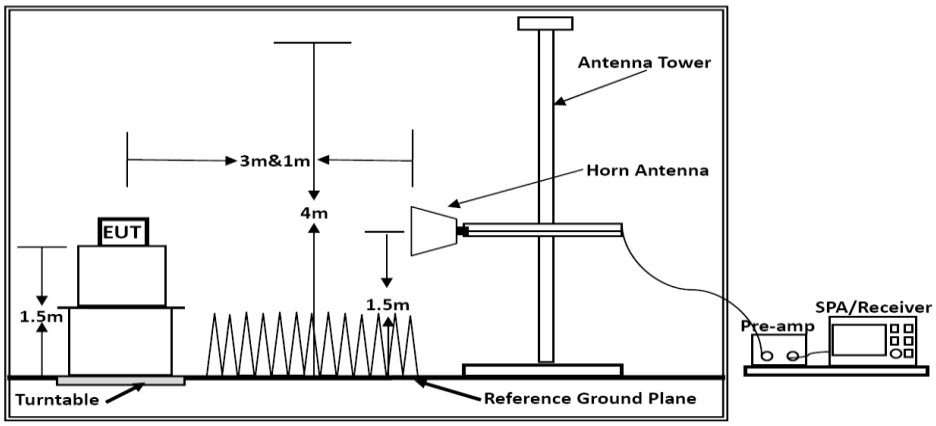
### 6.6.4. Test Setup Layout




Below 30MHz




Below 1GHz




Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1.5m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1.5m]) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

### 6.6.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

### 6.6.6. Results of Radiated Emissions (9 kHz~30MHz)

| Temperature | 22.8℃ | Humidity | 52% |
|---|---|---|---|
| Test Engineer | Nancy Li | Configurations | BT |

| Freq. (MHz) | Level (dBuV) | Over Limit (dB) | Over Limit (dBuV) | Remark |
|---|---|---|---|---|
| - | - | - | - | See Note |

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

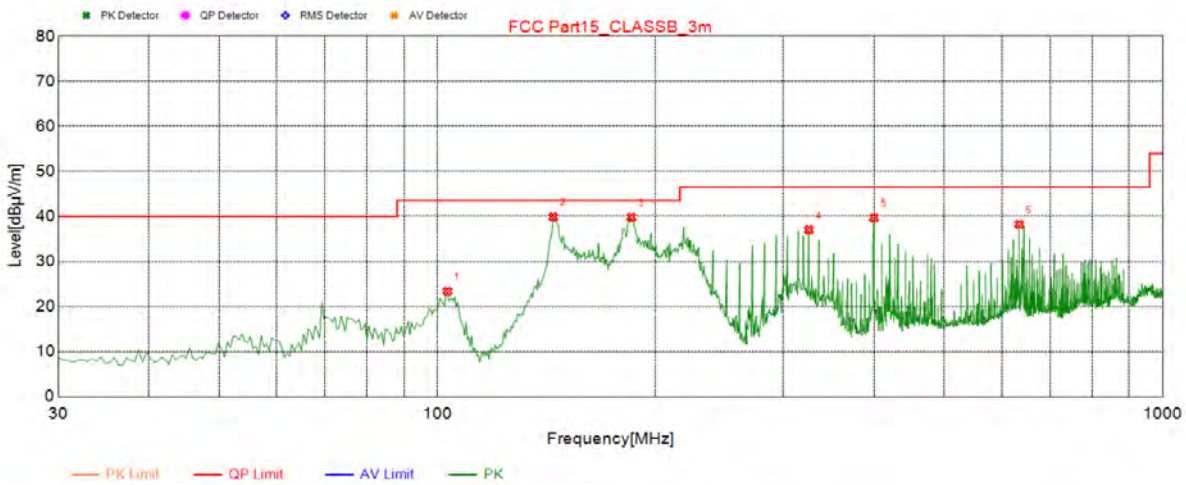
**PASS.**

Only record the worst test result in this report.

The test data please refer to following page.

***Below 1GHz (Worst case: 1Mbps, High Channel)***

*Horizontal*




| Suspected List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Result Level [dBµV/m] | Factor [dB/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle[°] | Polarity |
| 1 | 103.235 | 23.36 | -15.99 | 43.50 | 20.14 | 300 | 220 | Horizontal |
| 2 | 144.460 | 39.92 | -19.31 | 43.50 | 3.58 | 300 | 73 | Horizontal |
| 3 | 185.200 | 39.83 | -16.94 | 43.50 | 3.67 | 100 | 228 | Horizontal |
| 4 | 325.365 | 37.03 | -12.11 | 46.50 | 9.47 | 100 | 24 | Horizontal |
| 5 | 400.055 | 39.7 | -10.04 | 46.50 | 6.80 | 100 | 49 | Horizontal |
| 6 | 634.795 | 38.24 | -5.16 | 46.50 | 8.26 | 100 | 2 | Horizontal |

****Note:*

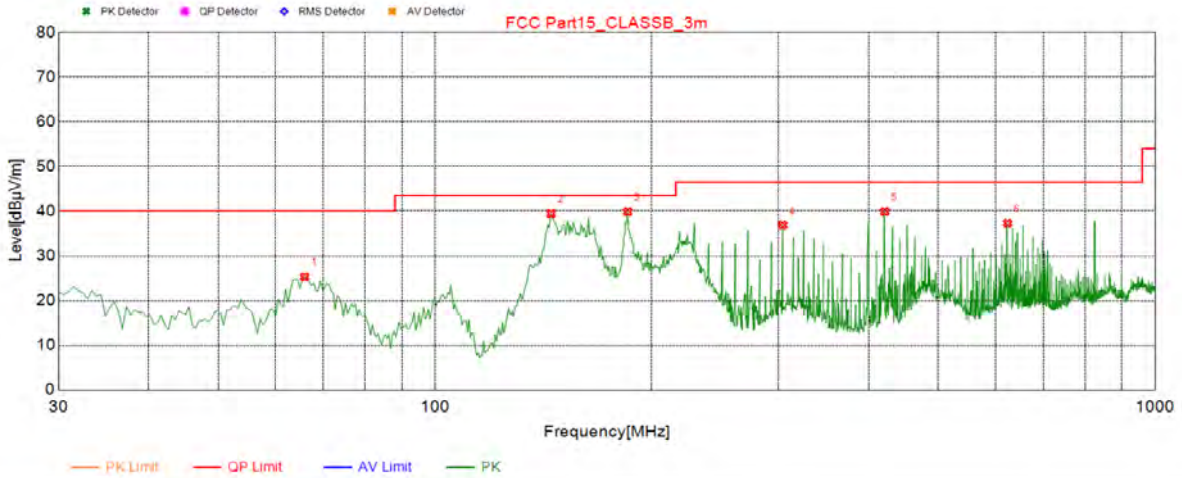
*Pre-scan all modes and recorded the worst case results in this report.*

*Emission level (dBuV/m) = 20 log Emission level (uV/m).*

*Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.*

*Margin=Limit-Result Level*

*Vertical*




| Suspected List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Result Level [dBµV/m] | Factor [dB/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle[°] | Polarity |
| 1 | 65.890 | 25.27 | -17.16 | 40.00 | 14.73 | 200 | 153 | Vertical |
| 2 | 144.945 | 39.42 | -19.30 | 43.50 | 4.08 | 100 | 271 | Vertical |
| 3 | 185.200 | 39.88 | -16.94 | 43.50 | 3.62 | 100 | 207 | Vertical |
| 4 | 304.025 | 36.88 | -12.69 | 46.50 | 9.62 | 100 | 330 | Vertical |
| 5 | 421.395 | 39.92 | -9.61 | 46.50 | 6.58 | 100 | 129 | Vertical |
| 6 | 624.125 | 37.28 | -5.29 | 46.50 | 9.22 | 100 | 353 | Vertical |

****Note:*

*Pre-scan all modes and recorded the worst case results in this report.*

*Emission level (dBuV/m) = 20 log Emission level (uV/m).*

*Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.*

*Margin=Limit-Result Level*

**Above 1GHz**

*The worst test result for GFSK, Channel 0 / 2402 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | 54.29 | 33.06 | 35.04 | 3.94 | 56.25 | 74 | 17.75 | Peak | Vertical |
| 4804.00 | 45.62 | 33.06 | 35.04 | 3.94 | 47.58 | 54 | 6.42 | Average | Vertical |
| 4804.00 | 53.73 | 33.06 | 35.04 | 3.94 | 55.69 | 74 | 18.31 | Peak | Horizontal |
| 4804.00 | 45.16 | 33.06 | 35.04 | 3.94 | 47.12 | 54 | 6.88 | Average | Horizontal |

*The worst test result for π/4-DQPSK, Channel 0 / 2402 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | 53.89 | 33.06 | 35.04 | 3.94 | 55.85 | 74 | 18.15 | Peak | Vertical |
| 4804.00 | 45.31 | 33.06 | 35.04 | 3.94 | 47.27 | 54 | 6.73 | Average | Vertical |
| 4804.00 | 53.33 | 33.06 | 35.04 | 3.94 | 55.29 | 74 | 18.71 | Peak | Horizontal |
| 4804.00 | 44.62 | 33.06 | 35.04 | 3.94 | 46.58 | 54 | 7.42 | Average | Horizontal |

*The worst test result for 8DPSK, Channel 0 / 2402 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | 54.01 | 33.06 | 35.04 | 3.94 | 55.97 | 74 | 18.03 | Peak | Vertical |
| 4804.00 | 45.34 | 33.06 | 35.04 | 3.94 | 47.30 | 54 | 6.7 | Average | Vertical |
| 4804.00 | 53.36 | 33.06 | 35.04 | 3.94 | 55.32 | 74 | 18.68 | Peak | Horizontal |
| 4804.00 | 44.65 | 33.06 | 35.04 | 3.94 | 46.61 | 54 | 7.39 | Average | Horizontal |

*The worst test result for GFSK, Channel 39 / 2441 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | 54.54 | 33.16 | 35.15 | 3.96 | 56.51 | 74 | 17.49 | Peak | Vertical |
| 4882.00 | 45.77 | 33.16 | 35.15 | 3.96 | 47.74 | 54 | 6.26 | Average | Vertical |
| 4882.00 | 53.87 | 33.16 | 35.15 | 3.96 | 55.84 | 74 | 18.16 | Peak | Horizontal |
| 4882.00 | 45.52 | 33.16 | 35.15 | 3.96 | 47.49 | 54 | 6.51 | Average | Horizontal |

*The worst test result for π/4-DQPSK, Channel 39 / 2441 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | 54.29 | 33.16 | 35.15 | 3.96 | 56.26 | 74 | 17.74 | Peak | Vertical |
| 4882.00 | 45.29 | 33.16 | 35.15 | 3.96 | 47.26 | 54 | 6.74 | Average | Vertical |
| 4882.00 | 53.45 | 33.16 | 35.15 | 3.96 | 55.42 | 74 | 18.58 | Peak | Horizontal |
| 4882.00 | 45.26 | 33.16 | 35.15 | 3.96 | 47.23 | 54 | 6.77 | Average | Horizontal |

*The worst test result for 8DPSK, Channel 39 / 2441 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | 54.36 | 33.16 | 35.15 | 3.96 | 56.33 | 74 | 17.67 | Peak | Vertical |
| 4882.00 | 45.51 | 33.16 | 35.15 | 3.96 | 47.48 | 54 | 6.52 | Average | Vertical |
| 4882.00 | 53.65 | 33.16 | 35.15 | 3.96 | 55.62 | 74 | 18.38 | Peak | Horizontal |
| 4882.00 | 44.98 | 33.16 | 35.15 | 3.96 | 46.95 | 54 | 7.05 | Average | Horizontal |

*The worst test result for GFSK, Channel 78 / 2480 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | 53.62 | 33.26 | 35.14 | 3.98 | 55.72 | 74 | 18.28 | Peak | Vertical |
| 4960.00 | 45.14 | 33.26 | 35.14 | 3.98 | 47.24 | 54 | 6.76 | Average | Vertical |
| 4960.00 | 53.37 | 33.26 | 35.14 | 3.98 | 55.47 | 74 | 18.53 | Peak | Horizontal |
| 4960.00 | 44.60 | 33.26 | 35.14 | 3.98 | 46.70 | 54 | 7.3 | Average | Horizontal |

*The worst test result for π/4-DQPSK, Channel 78 / 2480 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | 53.11 | 33.26 | 35.14 | 3.98 | 55.21 | 74 | 18.79 | Peak | Vertical |
| 4960.00 | 44.78 | 33.26 | 35.14 | 3.98 | 46.88 | 54 | 7.12 | Average | Vertical |
| 4960.00 | 52.84 | 33.26 | 35.14 | 3.98 | 54.94 | 74 | 19.06 | Peak | Horizontal |
| 4960.00 | 44.05 | 33.26 | 35.14 | 3.98 | 46.15 | 54 | 7.85 | Average | Horizontal |

*The worst test result for 8DPSK, Channel 78 / 2480 MHz*

| Freq. (MHz) | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | 53.10 | 33.26 | 35.14 | 3.98 | 55.20 | 74 | 18.8 | Peak | Vertical |
| 4960.00 | 44.64 | 33.26 | 35.14 | 3.98 | 46.74 | 54 | 7.26 | Average | Vertical |
| 4960.00 | 52.99 | 33.26 | 35.14 | 3.98 | 55.09 | 74 | 18.91 | Peak | Horizontal |
| 4960.00 | 44.41 | 33.26 | 35.14 | 3.98 | 46.51 | 54 | 7.49 | Average | Horizontal |

*Notes:*

1). Measuring frequencies from 9k~10th harmonic (ex. 26GHz), No emission found between lowest internal used/generated frequency to 30 MHz.
2). Radiated emissions measured in frequency range from 9k~10th harmonic (ex. 26GHz) were made with an instrument using Peak detector mode.
3). 18~25GHz at least have 20dB margin. No recording in the test report.
4). Measured (dBuV/m) = Reading (dBuV)+ Ant. Fac (dB/m)+ Cab. Loss (dB)- Pre. Fac.( dB)
6). Margin = Limit(dBuV/m)- Measured (dBuV/m)

## 6.7. AC Power line conducted emissions

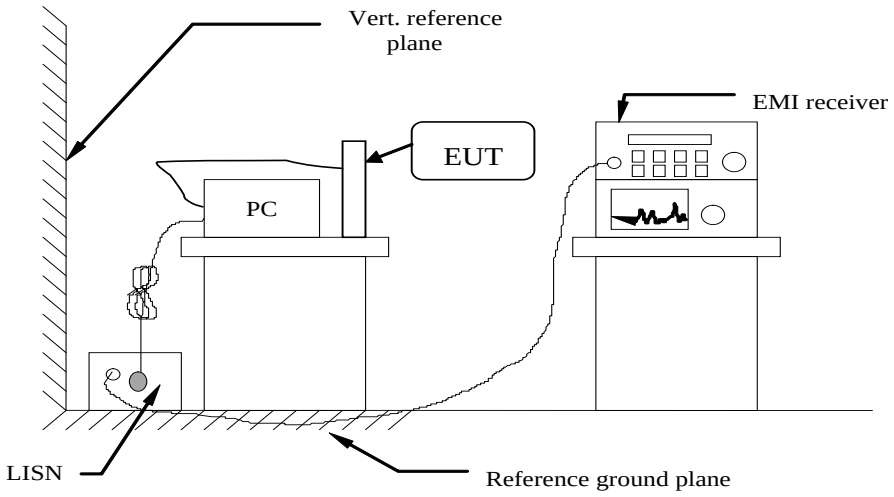
### 6.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

| Frequency Range (MHz) | Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

* Decreasing linearly with the logarithm of the frequency

### 6.7.2 Block Diagram of Test Setup




### 6.7.3 Test Results

Remark:

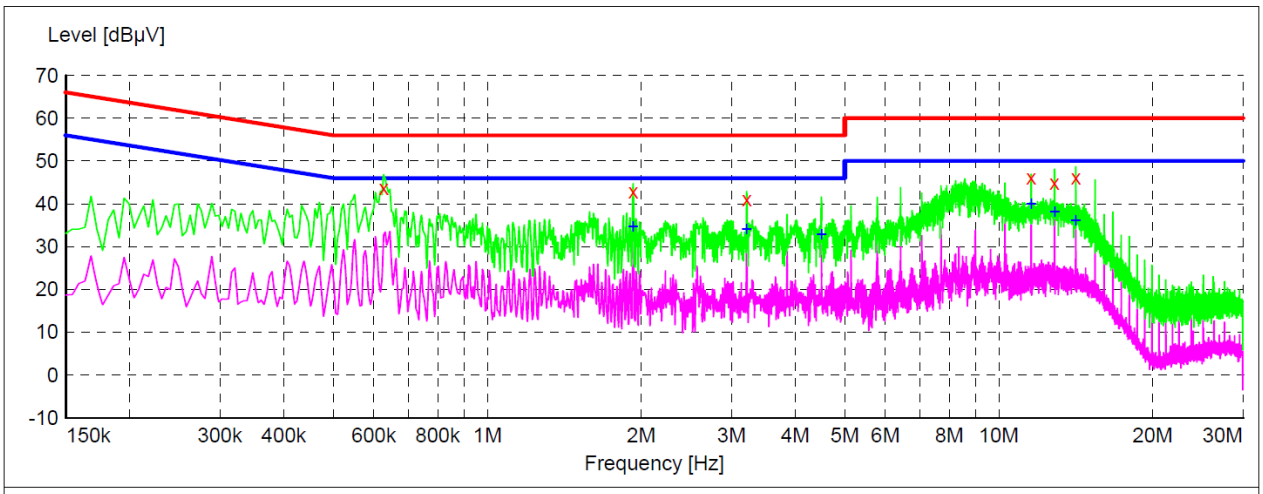
1. All modes of GFSK, Pi/4 DQPSK and 8DPSKwere test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:
2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:

| Temperature | 22.8℃ | Humidity | 52% |
|---|---|---|---|
| Test Engineer | Nancy Li | Configurations | BT |

| Power supply: | DC 5V from Adapter<br>AC 120V/60Hz | Polarization | L |
|---|---|---|---|

***SCAN TABLE: "Voltage (9K-30M)FIN"***

Short Description: 150K-30M Voltage




x x x MES TZ200512109_fin

***MEASUREMENT RESULT: "TZ200512109_fin"***

5/12/2020 10:19AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.627000 | 43.60 | 9.9 | 56 | 12.4 | QP | L1 | GND |
| 1.927500 | 42.80 | 9.7 | 56 | 13.2 | QP | L1 | GND |
| 3.214500 | 41.10 | 9.7 | 56 | 14.9 | QP | L1 | GND |
| 11.571000 | 46.10 | 9.8 | 60 | 13.9 | QP | L1 | GND |
| 12.853500 | 44.80 | 9.8 | 60 | 15.2 | QP | L1 | GND |
| 14.140500 | 46.00 | 9.9 | 60 | 14.0 | QP | L1 | GND |

***MEASUREMENT RESULT: "TZ200512109_fin2"***

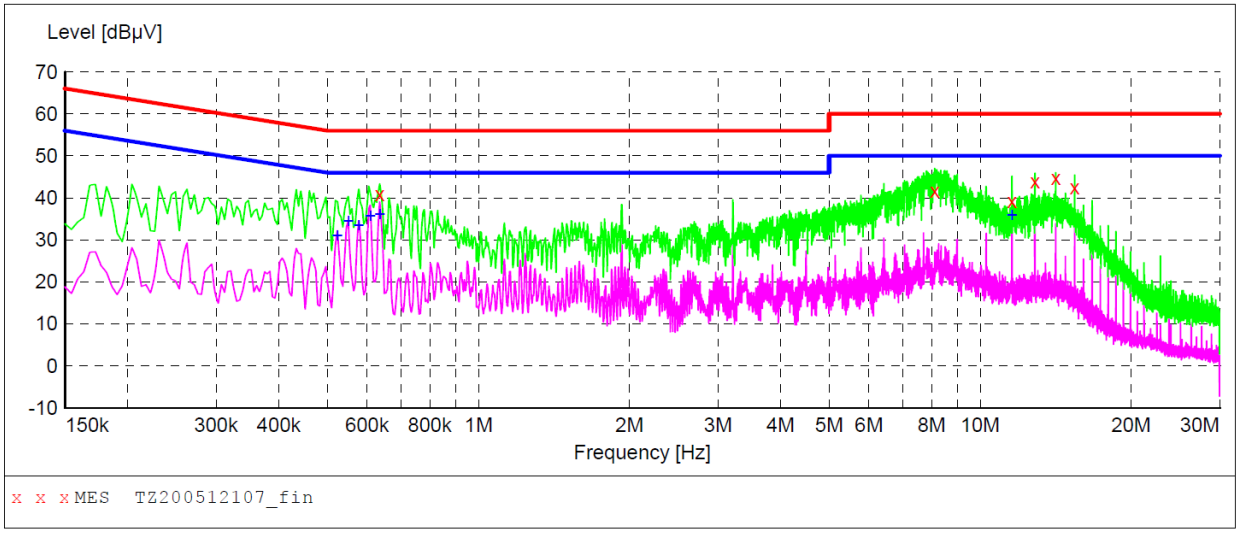
5/12/2020 10:19AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 1.927500 | 34.70 | 9.7 | 46 | 11.3 | AV | L1 | GND |
| 3.214500 | 34.20 | 9.7 | 46 | 11.8 | AV | L1 | GND |
| 4.501500 | 32.90 | 9.8 | 46 | 13.1 | AV | L1 | GND |
| 11.571000 | 40.00 | 9.8 | 50 | 10.0 | AV | L1 | GND |
| 12.853500 | 38.20 | 9.8 | 50 | 11.8 | AV | L1 | GND |
| 14.145000 | 36.10 | 9.9 | 50 | 13.9 | AV | L1 | GND |

| Power supply: | DC 5V from Adapter AC 120V/60Hz | Polarization | N |
|---|---|---|---|

***SCAN TABLE: "Voltage (9K-30M)FIN"***

Short Description: 150K-30M Voltage




***MEASUREMENT RESULT: "TZ200512107_fin"***

5/12/2020 10:15AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.636000 | 40.80 | 9.9 | 56 | 15.2 | QP | N | GND |
| 8.119500 | 41.60 | 9.8 | 60 | 18.4 | QP | N | GND |
| 11.566500 | 39.10 | 9.8 | 60 | 20.9 | QP | N | GND |
| 12.858000 | 43.90 | 9.8 | 60 | 16.1 | QP | N | GND |
| 14.140500 | 44.70 | 9.9 | 60 | 15.3 | QP | N | GND |
| 15.427500 | 42.50 | 9.9 | 60 | 17.5 | QP | N | GND |

***MEASUREMENT RESULT: "TZ200512107_fin2"***

5/12/2020 10:15AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.523500 | 31.00 | 9.9 | 46 | 15.0 | AV | N | GND |
| 0.550500 | 34.50 | 9.9 | 46 | 11.5 | AV | N | GND |
| 0.577500 | 33.50 | 9.9 | 46 | 12.5 | AV | N | GND |
| 0.609000 | 35.80 | 9.9 | 46 | 10.2 | AV | N | GND |
| 0.636000 | 36.20 | 9.9 | 46 | 9.8 | AV | N | GND |
| 11.571000 | 35.90 | 9.8 | 50 | 14.1 | AV | N | GND |

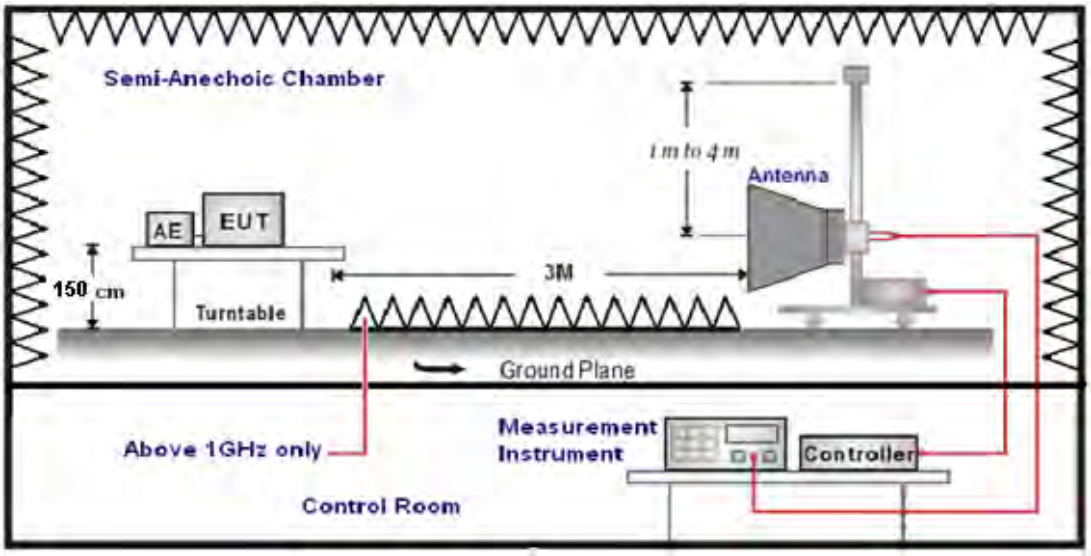
Note:
1. Level(dBµV) = Reading (dBµV) + Transd (dB).
2. Transd (dB). = Cable loss (dB) + LISN Factor (dB).
3. Margin(dB)=Limit-Level

## 6.8. Band-edge measurements for radiated emissions

### 6.8.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### 6.8.2. Test Setup Layout




### 6.8.3. Test Procedures

According to KDB 412172 section 1.1 Field Strength Approach (linear terms):

1.The EUT was placed on a turn table which is 1.5m above ground plane.

2.Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.

3.And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

4.Repeat above procedures until all frequency measurements have been completed..

5.The distance between test antenna and EUT was 3 meter:

6.Setting test receiver/spectrum as following table states:

| Test Frequency range | Test Receiver/Spectrum Setting | Detector |
|---|---|---|
| 1GHz-40GHz | Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto<br>Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto | Peak |

### 6.8.4. Test Results

| Temperature | 22.8℃ | Humidity | 55% |
|---|---|---|---|
| Test Engineer | Nancy Li | Configurations | BT |

Remark: GFSK, Pi/4 DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.

Operation Mode: GFSK TX Low channel(2402MHz)

Horizontal (Worst case)

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2390 | 62.54 | -5.68 | 56.86 | 74 | 17.14 | peak |
| 2390 | 52.97 | -5.68 | 47.29 | 54 | 6.71 | AVG |

Vertical:

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2390 | 61.37 | -5.68 | 55.69 | 74 | 18.31 | peak |
| 2390 | 52.39 | -5.68 | 46.71 | 54 | 7.29 | AVG |

Operation Mode: GFSK TX High channel (2480MHz)

Horizontal (Worst case)

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.5 | 59.11 | -5.42 | 53.69 | 74 | 20.31 | peak |
| 2483.5 | 50.81 | -5.42 | 45.39 | 54 | 8.61 | AVG |

Vertical:

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.5 | 58.56 | -5.42 | 53.14 | 74 | 20.86 | peak |
| 2483.5 | 50.49 | -5.42 | 45.07 | 54 | 8.93 | AVG |

Remark:
Emission Level (dBuV/m) = Meter Reading(dBuV)+Factor(dB)
Factor(dB) = Antenna Factor + Cable Loss – Pre-amplifier.
Margin = Limit(dBuV/m)- Measured (dBuV/m)

*Remark:*

1. *Measured at difference Packet Type for each mode and recorded worst case for each mode.*
2. *Worst case data at DH5 for GFSK, 2DH5 for π/4DQPSK, 3DH5 for 8DPSK,modulation type;*

3. *Measured at Hopping and Non-Hopping mode, recorded worst at Non-Hopping mode.*
4. *The other emission levels were very low against the limit.*
5. *The average measurement was not performed when the peak measured data under the limit of average detection.*
6. *Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;*

## 6.9. Pseudorandom frequency hopping sequence

### 6.9.1 Standard Applicable

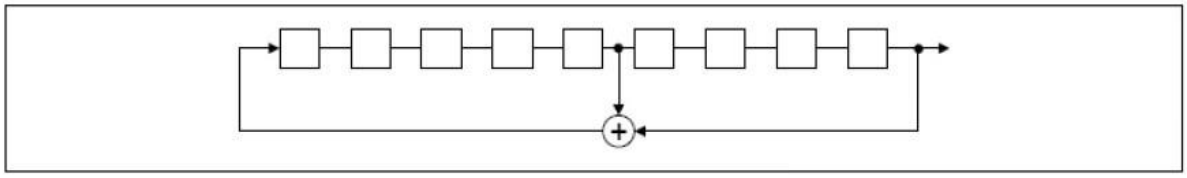
For 47 CFR Part 15C sections 15.247 (a) (1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### 6.9.2 EUT Pseudorandom Frequency Hopping Sequence Requirement

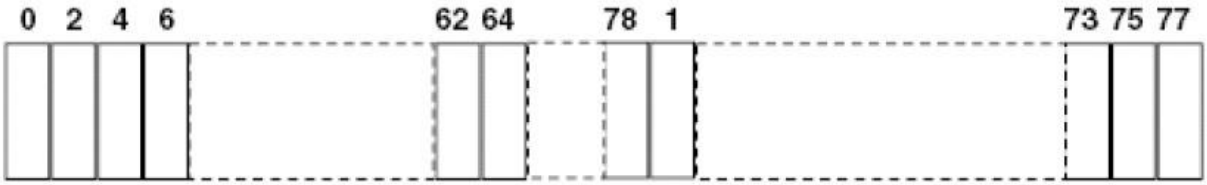
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



*Linear Feedback Shift Register for Generation of the PRBS sequence*

An example of pseudorandom frequency hopping sequence as follows:




Each frequency used equally one the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

## 6.10. Antenna requirement

### 6.10.1 Standard Applicable

According to antenna requirement of §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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

### 6.10.2 Antenna Connected Construction

#### 6.10.2.1. Standard Applicable

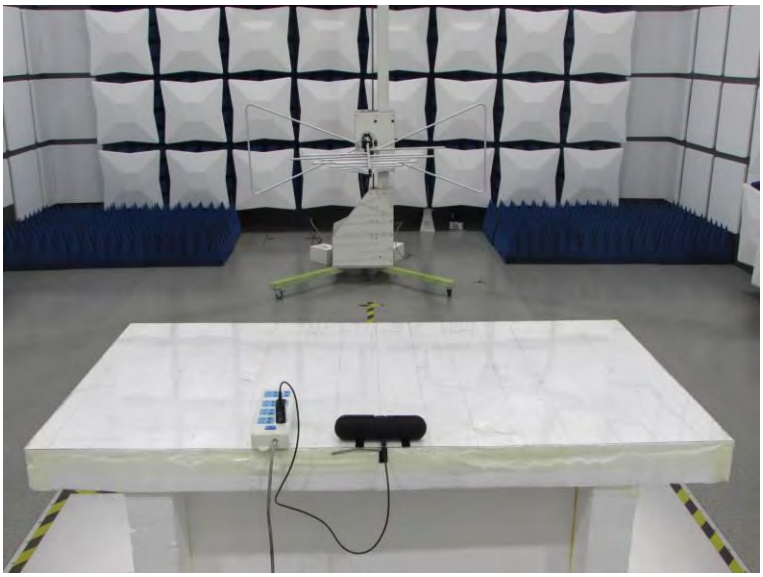
According to § 15.203 & RSS-Gen, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

#### 6.10.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 0.00dBi, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

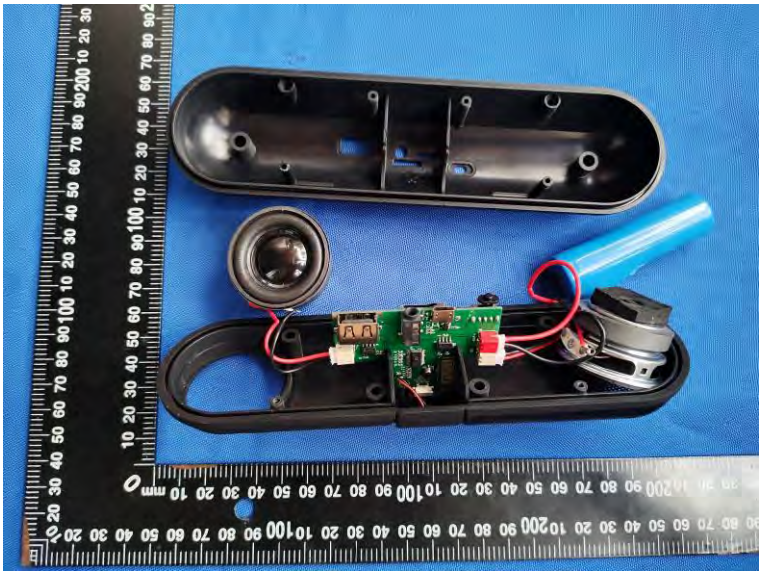
#### 6.10.2.3. Results: Compliance.

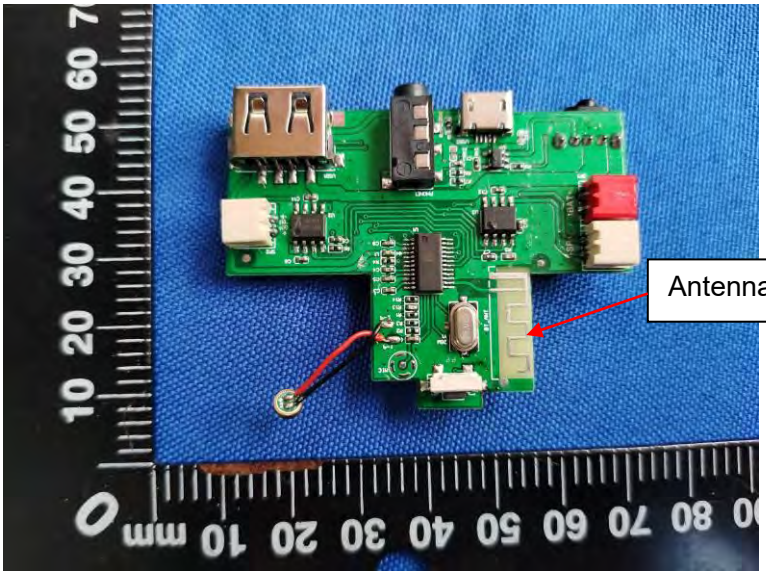
## 7. TEST SETUP PHOTOGRAPHS

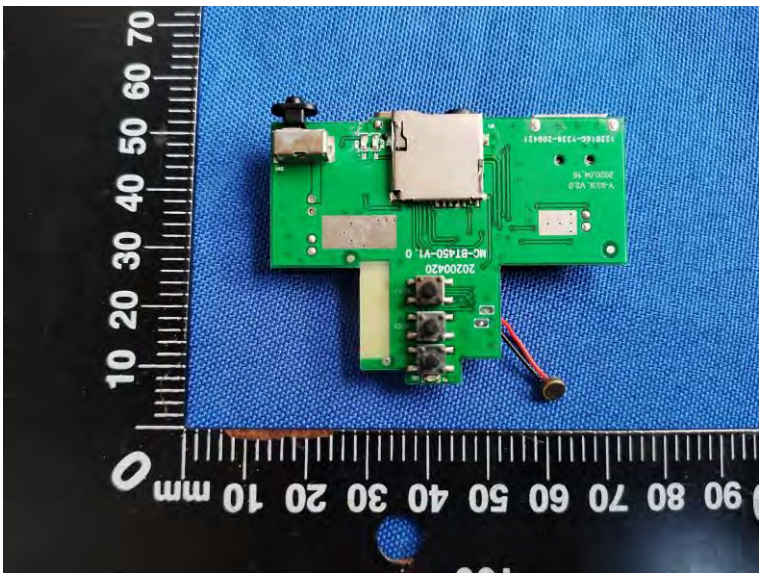


## 8.EXTERNAL PHOTOS OF THE EUT

## 9.INTERIOR PHOTOS OF THE EUT





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