# RADIO TEST REPORT

## FCC ID: 2AOQZ-ES11

**Product:** Wireless charging speaker

**Trade Name:** ESONSTYNE

**Model Name:** ES11

**Serial Model:** X8, X9N, ES11, ES12, ES21, ES26, ES28, ES29, ES30, ES35

**Report No.:** UNIA2018122602FR-01

### Prepared for

Shenzhen Eson Technology Co., Ltd.

3/F,No.1,Guanghui Science&Technology Park, MinQing Rd, LongHua New District, Shenzhen, China

### Prepared by

Shenzhen United Testing Technology Co., Ltd.

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# TEST RESULTCERTIFICATION

**Applicant's name** ..... : Shenzhen Eson Technology Co., Ltd.

Address ..... : 3/F,No.1,Guanghui Science&Technology Park, MinQing Rd, LongHua New District, Shenzhen, China

**Manufacture's Name** ..... : Shenzhen Eson Technology Co., Ltd.

Address ..... : 3/F,No.1,Guanghui Science&Technology Park, MinQing Rd, LongHua New District, Shenzhen, China

**Product description**

Product name..... : Wireless charging speaker

Trade Mark ..... : ESON STYNE

Model and/or type reference : ES11, X8, X9N, ES11, ES12, ES21, ES26, ES28, ES29, ES30, ES35

**Standards** ..... : FCC Rules and Regulations Part 15 Subpart C Section 15.247
ANSI C63.10: 2013
KDB558074 D01 V05: Guidance for Performing Compliance

This device described above has been tested by Shenzhen United Testing Technology Co., Ltd., and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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**Date of Test** ..... : Dec.25, 2018

Date (s) of performance of tests..... : Dec. 25, 2018--Jan. 03, 2019

Date of Issue..... : Jan. 03, 2019

Test Result..... : Pass

Prepared by: Kahn.Yang

Kahn yang/Editor

Reviewer: Sherwin Qian

Sherwin Qian/Supervisor

Approved & Authorized Signer: Liuze

Liuze/Manager

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# 1 TEST SUMMARY

## 1.1 Environment conditions

During the measurement the environment condition were within the listed ranges：

| | |
|---|---|
| Normal temperature | 25℃ |
| Relative humidity | 55% |
| Air pressure | 101KPa |

## 1.2 SUMMARY of TEST RESULTS

| **FCC PART 15.247** | | |
|---|---|---|
| FCC Part 15.207 | AC Power Conducted Emission | PASS |
| FCC Part 15.247(a)(1)(i) | 20dB Bandwidth | PASS |
| FCC Part 15.247(d) | Spurious RF Conducted Emission | PASS |
| FCC Part 15.247(b) | Maximum Peak Output Power | PASS |
| FCC Part 15.247(b) | Pseudorandom Frequency Hopping Sequence | PASS |
| FCC Part 15.247(a)(1)(iii) | Number of hopping frequency& Time of Occupancy | PASS |
| FCC Part 15.247(a)(1) | Frequency Separation | PASS |
| FCC Part 15.205/15.209 | Radiated Emissions | PASS |
| FCC Part 15.247(d) | Band Edge Compliance of RF Emission | PASS |
| FCC Part15.247(g)(h) | Pseudorandom Frequency Hopping Sequence | PASS |
| FCC Part 15.203/15.247 (b) | Antenna Requirement | PASS |

## 1.3 TEST FACILITY

Test Firm : Shenzhen United Testing Technology Co.,Ltd.

Address :2F, Annex Bldg, JiahuangyuanTechPark, #365 Baotian 1 Rd,TiegangCommunity, XixiangStr, Bao'an District, Shenzhen,China

The testing quality ability of our laboratory meet with "Quality Law of People's Republic of China" Clause 19.The testing quality system of our laboratory meets with ISO/IEC-17025 requirements, which is approved by CNAS. This approval result is accepted by MRA of APLAC.

Our test facility is recognized, certified, or accredited by the following organizations:

CNAS-LAB Code: L6494

The EMC Laboratory has been assessed and in compliance with CNAS-CL01 accreditation criteria for testing Laboratories (identical to ISO/IEC 17025:2017 General Requirements) for the Competence of testing Laboratories.

Designation Number: CN1227

Test Firm Registration Number: 674885

The EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications commission. The acceptance letter from the FCC is maintained in our files.

## 1.4 MEASUREMENT UNCERTAINTY

Measurement Uncertainty

| | | |
|---|---|---|
| Conducted Emission Expanded Uncertainty | = | 2.23dB, k=2 |
| Radiated emission expanded uncertainty(9kHz-30MHz) | = | 3.08dB, k=2 |
| Radiated emission expanded uncertainty(30MHz-1000MHz) | = | 4.42dB, k=2 |
| Radiated emission expanded uncertainty(Above 1GHz) | = | 4.06dB, k=2 |

# 2 GENERAL INFORMATION

## 2.1 GENERAL DESCRIPTION OF EUT

| | |
|---|---|
| Equipment | Wireless charging speaker |
| Trade Mark | ESONSTYNE |
| Model Name | ES11 |
| Serial No. | X8, X9N, ES11, ES12, ES21, ES26, ES28, ES29, ES30, ES35 |
| Model Difference | All models have the same functionality, software and electronics, only the color, front frame shape and model names may differ. Test sample model:ES11 |
| FCC ID | 2AOQZ-ES11 |
| Antenna Type | PCB Antenna |
| Antenna Gain | 0.0 dBi |
| Frequency Range | 2402MHz - 2480MHz |
| Number of Channels | 79 |
| Modulation Type | GFSK, pi/4DQPSK |
| Power Source | DC7.4V from battery |
| Adapter Model | N/A |

## 2.2 CARRIER FREQUENCY OF CHANNELS

| Channel | Frequency (MHz) |
|---|---|
| 00 | 2402 |
| 01 | 2403 |
| : | : |
| : | : |
| 77 | 2479 |
| 78 | 2480 |

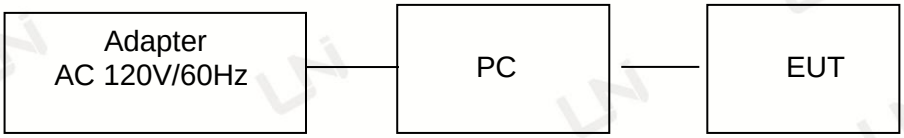
## 2.3 OPARATION OF EUT DURING TESTING

Operating Mode
The mode is used: Transmitting mode

| | |
|---|---|
| Low Channel | 2402MHz |
| Middle Channel | 2441MHz |
| High Channel | 2480MHz |

## 2.4 DESCRIPTION OF TEST SETUP

Operation of EUT during Conducted testing:




Operation of EUT duringRadiation and Above1GHz Radiation testing:

## 2.5 Special Accessories

| Manufacturer | Description | Model | Serial Number | Certificate |
|---|---|---|---|---|
| HP | notebook | HP-CQ45 | CNU1254XFC | FCC ID |
| --- | --- | --- | --- | --- |

## 2.6 MEASUREMENT INSTRUMENTS LIST

| Item | Equipment | Manufacturer | Model No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | AMN | Schwarzbeck | NNLK8121 | 8121370 | 2019.09.09 |
| 2 | AMN | ETS | 3810/2 | 00020199 | 2019.09.09 |
| 3 | EMI TEST RECEIVER | Rohde&Schwarz | ESCI | 101210 | 2019.09.09 |
| 4 | AAN | TESEQ | T8-Cat6 | 38888 | 2019.09.09 |
| 5 | Horn Antenna | Sunol | DRH-118 | A101415 | 2019.09.29 |
| 6 | BicoNILog Antenna | Sunol | JB1 Antenna | A090215 | 2019.09.29 |
| 7 | PREAMP | HP | 8449B | 3008A00160 | 2019.09.09 |
| 8 | PREAMP | HP | 8447D | 2944A07999 | 2019.09.09 |
| 9 | EMI TEST RECEIVER | Rohde&Schwarz | ESR3 | 101891 | 2019.09.09 |
| 10 | VECTOR Signal Generator | Rohde&Schwarz | SMU200A | 101521 | 2019.09.28 |
| 11 | Signal Generator | Agilent | E4421B | MY4335105 | 2019.09.28 |
| 12 | Spectrum Analyzer | Agilent | E4407B | MY41440676 | 2019.09.28 |
| 13 | MXA Signal Analyzer | Agilent | N9020A | MY50510140 | 2019.09.28 |
| 14 | MXA Signal Analyzer | Agilent | N9020A | MY51110104 | 2019.09.09 |
| 15 | ANT Tower&Turn table Controller | Champro | EM 1000 | 60764 | 2019.09.28 |
| 16 | Anechoic Chamber | Taihe Maorui | 9m*6m*6m | 966A0001 | 2019.09.09 |
| 17 | Shielding Room | Taihe Maorui | 6.4m*4m*3m | 643A0001 | 2019.09.09 |
| 18 | RF Power sensor | DARE | RPR3006W | 15I00041SNO88 | 2019.03.14 |
| 19 | RF Power sensor | DARE | RPR3006W | 15I00041SNO89 | 2019.03.14 |
| 20 | RF power divider | Anritsu | K241B | 992289 | 2019.09.28 |
| 21 | Wideband radio communication tester | Rohde&Schwarz | CMW500 | 154987 | 2019.09.28 |
| 22 | Biconical antenna | Schwarzbeck | VHA 9103 | 91032360 | 2019.09.08 |
| 23 | Biconical antenna | Schwarzbeck | VHA 9103 | 91032361 | 2019.09.08 |

| | | | | | |
|---|---|---|---|---|---|
| 24 | Broadband Hybrid Antennas | Schwarzbeck | VULB9163 | VULB9163#958 | 2019.09.08 |
| 25 | Horn Antenna | Schwarzbeck | BBHA9120D | 9120D-1680 | 2019.01.12 |
| 26 | Active Receive Loop Antenna | Schwarzbeck | FMZB 1919B | 00023 | 2019.11.02 |
| 27 | Horn Antenna | Schwarzbeck | BBHA 9170 | BBHA9170651 | 2019.03.14 |
| 28 | Microwave Broadband Preamplifier | Schwarzbeck | BBV 9721 | 100472 | 2019.10.24 |
| 29 | Active Loop Antenna | Com-Power | AL-130R | 10160009 | 2019.05.10 |
| 30 | Power Meter | KEYSIGHT | N1911A | MY50520168 | 2019.05.10 |
| 31 | EMI Test Software | FALA | EZ-EMC | FA-03A | 2019.05.10 |

Note: The calibration interval was one year

# 3 TEST CONDITIONS AND RESULTS

## 3.1 CONDUCTED EMISSIONS TEST

**Limit**

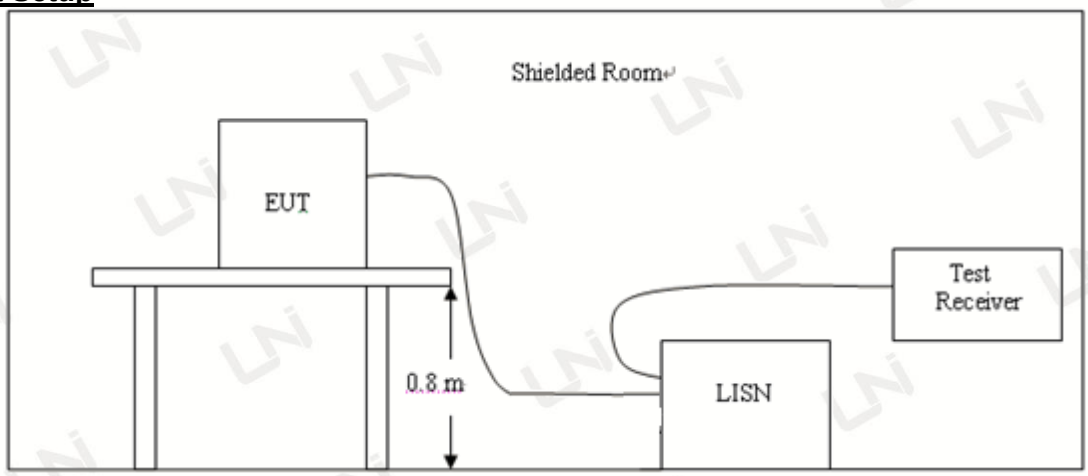
For unintentional device, according to § 15.107(a) Line Conducted Emission Limits is as following

| Frequency range (MHz) | Limit (dBuV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

* Decreasing linearly with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limit is same as above table.

**Test Setup**




**Test Procedure**

1,The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. A wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10.

2, Support equipment, if needed, was placed as per ANSI C63.10.

3, All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.

4, If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

5, All support equipments received AC power from a second LISN, if any.

6, The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.

7, Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.

**Test Result**

**---PASS---**

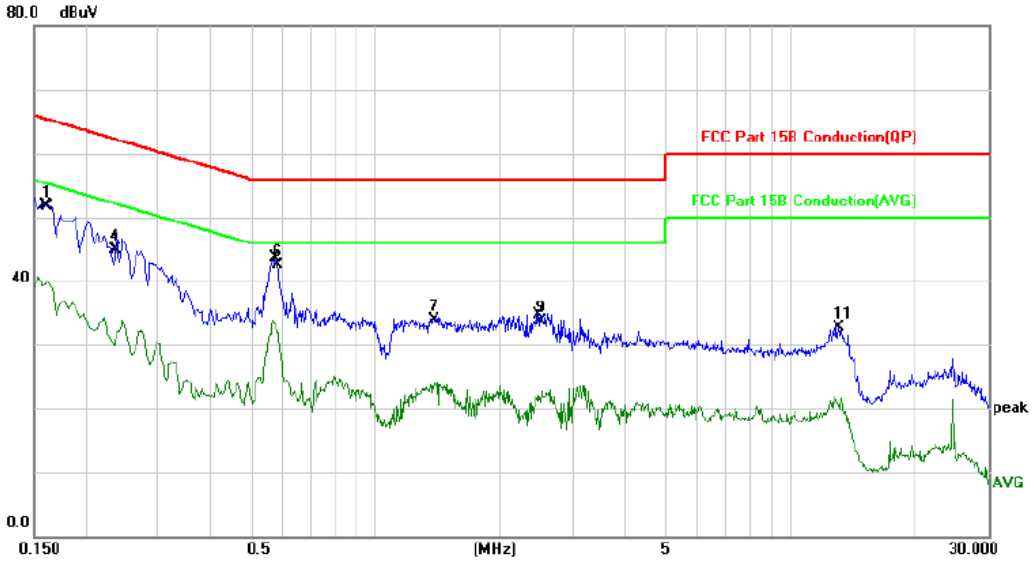
Remark:

1. All modes of GFSK, Pi/4 DQPSK, and 8DPSK were test at Low, Middle, and Highchannel; 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:.

Please refer to test data as follows:

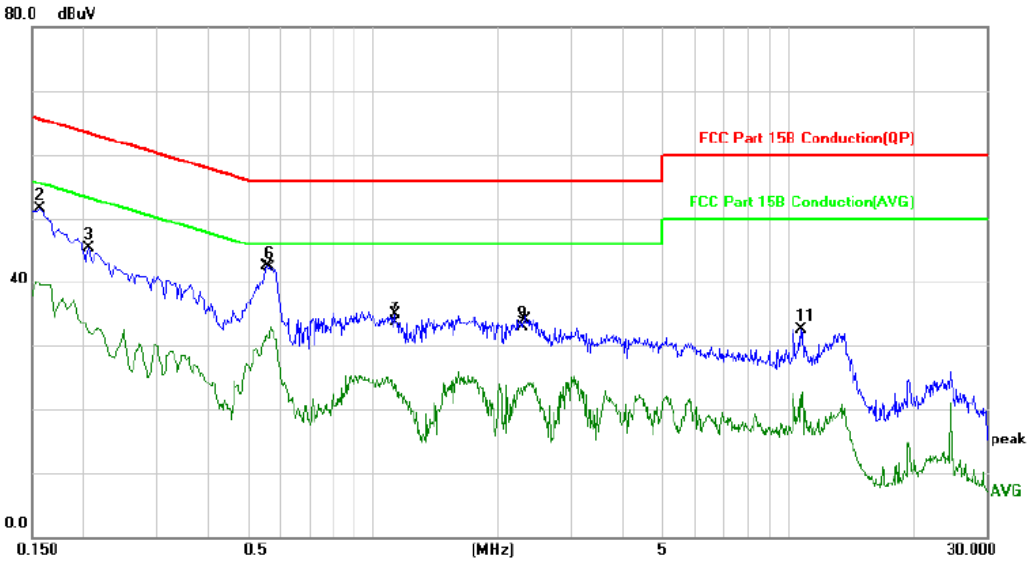
| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 48% |
| Test Date: | Dec. 28, 2018 | Pressure: | 1030hPa |
| Test Voltage: | AC 120V 60Hz | Polarization: | |

| Line | L |
|---|---|




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.1620 | 51.89 | -0.13 | 51.76 | 65.36 | -13.60 | peak | |
| 2 | | 0.1624 | 39.87 | -0.13 | 39.74 | 55.34 | -15.60 | AVG | |
| 3 | | 0.2340 | 29.98 | -0.12 | 29.86 | 52.30 | -22.44 | AVG | |
| 4 | | 0.2353 | 45.10 | -0.12 | 44.98 | 62.26 | -17.28 | peak | |
| 5 | * | 0.5780 | 33.02 | -0.04 | 32.98 | 46.00 | -13.02 | AVG | |
| 6 | | 0.5820 | 42.51 | -0.04 | 42.47 | 56.00 | -13.53 | peak | |
| 7 | | 1.3860 | 34.14 | -0.17 | 33.97 | 56.00 | -22.03 | peak | |
| 8 | | 1.3860 | 24.07 | -0.17 | 23.90 | 46.00 | -22.10 | AVG | |
| 9 | | 2.5100 | 33.89 | -0.16 | 33.73 | 56.00 | -22.27 | peak | |
| 10 | | 2.5100 | 21.05 | -0.16 | 20.89 | 46.00 | -25.11 | AVG | |
| 11 | | 13.0659 | 32.76 | -0.14 | 32.62 | 60.00 | -27.38 | peak | |
| 12 | | 13.0659 | 20.37 | -0.14 | 20.23 | 50.00 | -29.77 | AVG | |

| Line | N |
|---|---|




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.1556 | 39.98 | -0.13 | 39.85 | 55.69 | -15.84 | AVG | |
| 2 | | 0.1580 | 51.72 | -0.13 | 51.59 | 65.56 | -13.97 | peak | |
| 3 | | 0.2060 | 45.47 | -0.13 | 45.34 | 63.36 | -18.02 | peak | |
| 4 | | 0.2060 | 32.19 | -0.13 | 32.06 | 53.36 | -21.30 | AVG | |
| 5 | | 0.5580 | 31.38 | -0.04 | 31.34 | 46.00 | -14.66 | AVG | |
| 6 | * | 0.5620 | 42.37 | -0.04 | 42.33 | 56.00 | -13.67 | peak | |
| 7 | | 1.1300 | 33.75 | -0.14 | 33.61 | 56.00 | -22.39 | peak | |
| 8 | | 1.1380 | 23.84 | -0.14 | 23.70 | 46.00 | -22.30 | AVG | |
| 9 | | 2.2860 | 33.07 | -0.25 | 32.82 | 56.00 | -23.18 | peak | |
| 10 | | 2.2860 | 22.52 | -0.25 | 22.27 | 46.00 | -23.73 | AVG | |
| 11 | | 10.7900 | 32.55 | -0.11 | 32.44 | 60.00 | -27.56 | peak | |
| 12 | | 10.7940 | 22.83 | -0.11 | 22.72 | 50.00 | -27.28 | AVG | |

## 3.2 RADIATED EMISSION TEST

**Limit**

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

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)

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission

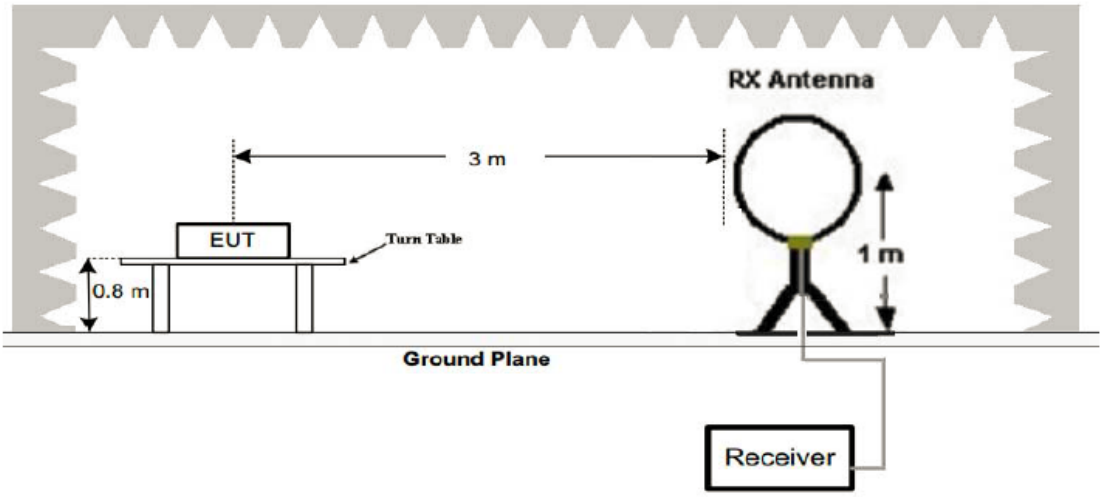
Unwanted emissions that fall into restricted bands shall comply with the limits specified in RSS-Gen; and Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Radiated emission limits

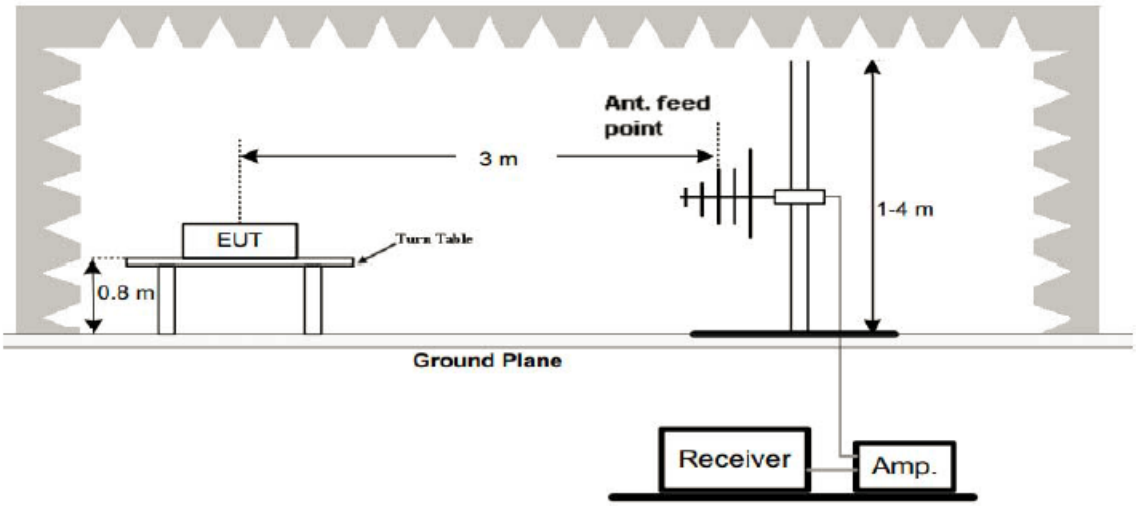
| Frequency(MHz) | Distance(Meters) | Radiated(dBμV/m) | Radiated(μV/m) |
|---|---|---|---|
| 0.009-0.49 | 3 | 20log(2400/F(KHz))+40log(300/3) | 2400/F(KHz) |
| 0.49-1.705 | 3 | 20log(24000/F(KHz))+ 40log(30/3) | 24000/F(KHz) |
| 1.705-30 | 3 | 20log(30)+ 40log(30/3) | 30 |
| 30-88 | 3 | 40.0 | 100 |
| 88-216 | 3 | 43.5 | 150 |
| 216-960 | 3 | 46.0 | 200 |
| Above 960 | 3 | 54.0 | 500 |

**Test Setup**

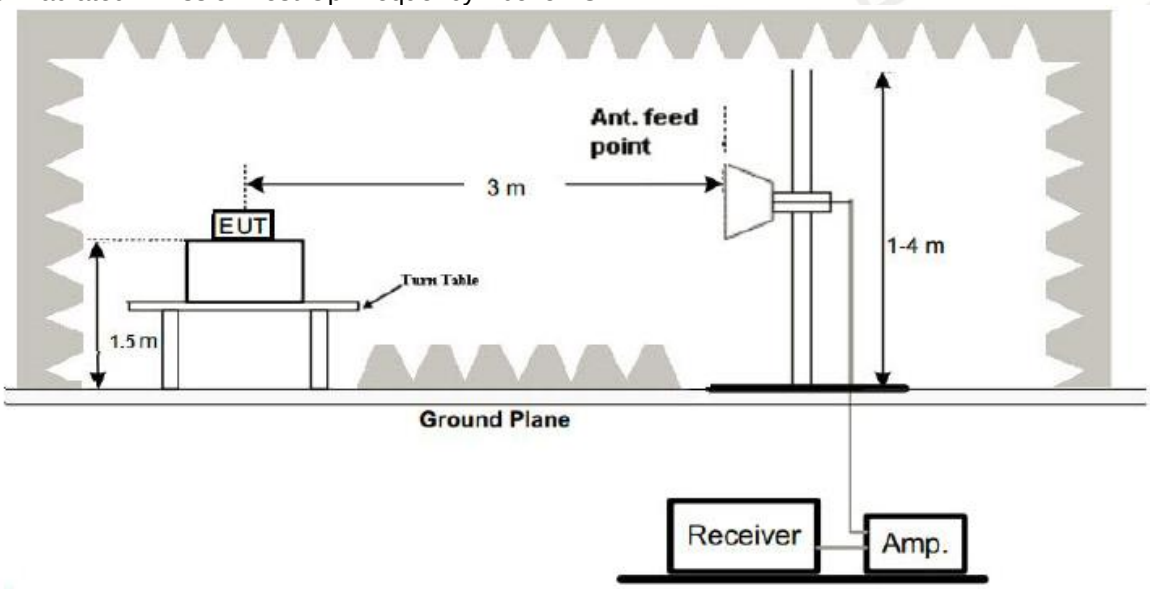
1. Radiated Emission Test-Up Frequency Below 30MHz



2. Radiated Emission Test-Up Frequency 30MHz~1GHz




3. Radiated Emission Test-Up Frequency Above 1GHz




**Test Procedure**

1. Below 1GHz measurement the EUT is placed on a turntablewhich is 0.8m above ground plane, and above 1GHz measurementEUT was placed on alow permittivity and low loss tangent 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. Radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

| Test Frequency range | Test Antenna Type | Test Distance |
|---|---|---|
| 9KHz-30MHz | Active Loop Antenna | 3 |
| 30MHz-1GHz | Bilog Antenna | 3 |
| 1GHz-18GHz | Horn Antenna | 3 |
| 18GHz-25GHz | HornAnternna | 1 |

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

| Test Frequency range | Test Receiver/Spectrum Setting | Detector |
|---|---|---|
| 9KHz-150KHz | RBW=200Hz/VBW=3KHz,Sweep time=Auto | QP |
| 150KHz-30MHz | RBW=9KHz/VBW=100KHz,Sweep time=Auto | QP |
| 30MHz-1GHz | RBW=120KHz/VBW=1000KHz,Sweep time=Auto | QP |
| 1GHz-40GHz | Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto<br>Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto | Peak |

**TEST RESULTS**

**---PASS---**

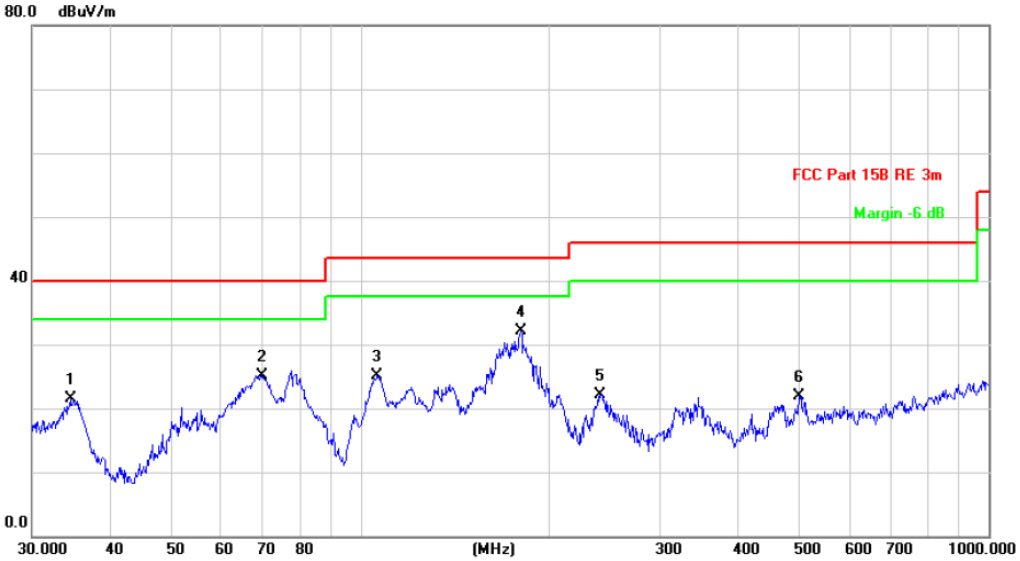
Remark:
1. All the test modes completed for test. Only the worst mode was reported.
2. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, and test data recorded in this report.
3. Radiated emission test from 9KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9KHz to 30MHz and not recorded in this report.

## Below 1GHz Test Results:

Note: For test below 1GHz all modes of GFSK, Pi/4 DQPSK, were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:

| | | | |
|---|---|---|---|
| Temperature: | 25℃ | Relative Humidity: | 48% |
| Test Date: | Dec. 28, 2018 | Pressure: | 1030hPa |
| Test Voltage: | DC 3.7V from battery | Polarization: | Horizontal/Vertical |

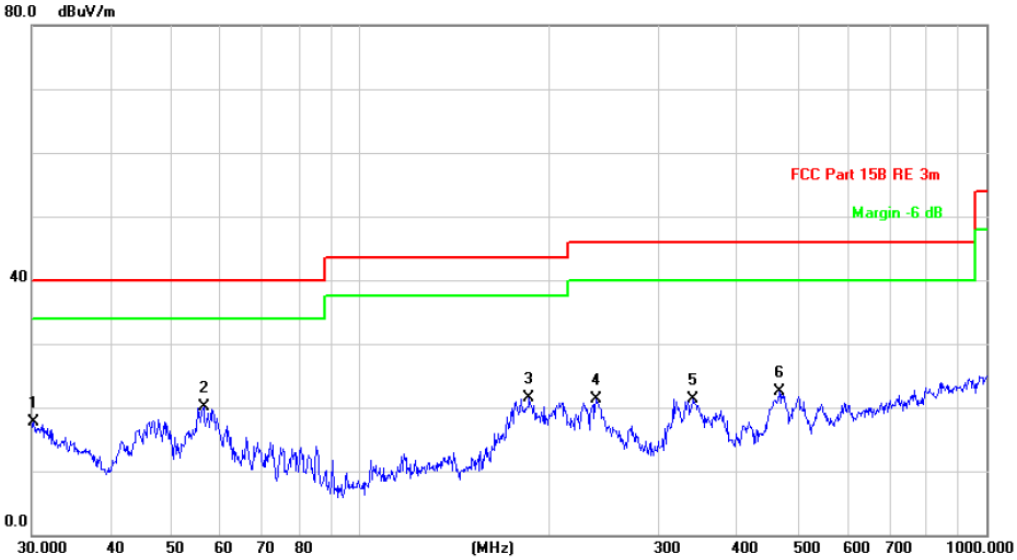
| Polarization: | Horizontal |
|---|---|




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | | 34.5173 | 30.19 | -8.67 | 21.52 | 40.00 | -18.48 | QP | | | |
| 2 | | 69.6005 | 43.97 | -18.81 | 25.16 | 40.00 | -14.84 | QP | | | |
| 3 | | 106.3850 | 38.98 | -13.87 | 25.11 | 43.50 | -18.39 | QP | | | |
| 4 | * | 180.0165 | 46.42 | -14.31 | 32.11 | 43.50 | -11.39 | QP | | | |
| 5 | | 240.8304 | 35.46 | -13.30 | 22.16 | 46.00 | -23.84 | QP | | | |
| 6 | | 499.4247 | 28.33 | -6.43 | 21.90 | 46.00 | -24.10 | QP | | | |

Remark: Absolute Level= Reading Level+ Factor, Margin= Absolute Level – Limit
Factor=Ant. Factor + Cable Loss – Pre-amplifier

| Polarization: | Vertical |
|---|---|




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB/m | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | | 30.2111 | 21.46 | -3.68 | 17.78 | 40.00 | -22.22 | QP | | | |
| 2 | * | 56.3948 | 39.04 | -18.88 | 20.16 | 40.00 | -19.84 | QP | | | |
| 3 | | 186.4409 | 35.98 | -14.43 | 21.55 | 43.50 | -21.95 | QP | | | |
| 4 | | 238.3102 | 34.66 | -13.38 | 21.28 | 46.00 | -24.72 | QP | | | |
| 5 | | 340.7817 | 31.48 | -10.14 | 21.34 | 46.00 | -24.66 | QP | | | |
| 6 | | 467.2349 | 29.38 | -6.83 | 22.55 | 46.00 | -23.45 | QP | | | |

Remark: Absolute Level= Reading Level+ Factor, Margin= Absolute Level – Limit
Factor=Ant. Factor + Cable Loss – Pre-amplifier

Remark：
(1) Measuring frequencies from 9 kHz to the 1 GHz, Radiated emission test from 9kHz to 30MHz was verified, and no any emission was found except system noise floor.
(2) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.
(3) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz.

## Above 1 GHz Test Results:

Note: Both GFSK, Pi/4 DQPSK have been tested; only worse case GFSK is reported.

**GFSK: CH Low (2402MHz)Horizontal:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4804.00 | 57.59 | -3.64 | 53.95 | 74 | 20.05 | PK |
| 4804.00 | 44.73 | -3.64 | 41.09 | 54 | 12.91 | AV |
| 7206.00 | 54.55 | -0.95 | 53.60 | 74 | 20.40 | PK |
| 7206.00 | 41.38 | -0.95 | 40.43 | 54 | 13.57 | AV |
| -- | -- | -- | -- | -- | -- | -- |

**GFSK: CH Low (2402MHz) Vertical:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4804.00 | 58.65 | -3.64 | 55.01 | 74 | 18.99 | PK |
| 4804.00 | 44.18 | -3.64 | 40.54 | 54 | 13.46 | AV |
| 7206.00 | 54.81 | -0.95 | 53.86 | 74 | 20.14 | PK |
| 7206.00 | 42.05 | -0.95 | 41.10 | 54 | 12.90 | AV |
| -- | -- | -- | -- | -- | -- | -- |

**GFSK: CH Middle (2441MHz) Horizontal:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4882.00 | 58.41 | -3.51 | 54.90 | 74 | 19.10 | PK |
| 4882.00 | 43.48 | -3.51 | 39.97 | 54 | 14.03 | AV |
| 7323.00 | 54.71 | -0.82 | 53.89 | 74 | 20.11 | PK |
| 7323.00 | 40.51 | -0.82 | 39.69 | 54 | 14.31 | AV |
| -- | -- | -- | -- | -- | -- | -- |

**GFSK: CH Middle (2441MHz) Vertical:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4882.00 | 57.26 | -3.51 | 53.75 | 74 | 20.25 | PK |
| 4882.00 | 45.73 | -3.51 | 42.22 | 54 | 11.78 | AV |
| 7323.00 | 54.93 | -0.82 | 54.11 | 74 | 19.89 | PK |
| 7323.00 | 40.83 | -0.82 | 40.01 | 54 | 13.99 | AV |
| -- | -- | -- | -- | -- | -- | -- |

**GFSK: CH High (2480MHz) Horizontal:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4960.00 | 58.11 | -3.43 | 54.68 | 74 | 19.32 | PK |
| 4960.00 | 45.39 | -3.43 | 41.96 | 54 | 12.04 | AV |
| 7440.00 | 55.17 | -0.75 | 54.42 | 74 | 19.58 | PK |
| 7440.00 | 42.26 | -0.75 | 41.51 | 54 | 12.49 | AV |
| -- | -- | -- | -- | -- | -- | -- |

**GFSK: CH High (2480MHz) Vertical:**

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4960.00 | 56.81 | -3.43 | 53.38 | 74 | 20.62 | PK |
| 4960.00 | 44.88 | -3.43 | 41.45 | 54 | 12.55 | AV |
| 7440.00 | 55.02 | -0.75 | 54.27 | 74 | 19.73 | PK |
| 7440.00 | 42.78 | -0.75 | 42.03 | 54 | 11.97 | AV |
| -- | -- | -- | -- | -- | -- | -- |

Remark：
(1) Measuring frequencies from 1 GHz to the 25 GHz.
(2) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
(3) Margin= Limits –Emission Level
(4) Data of measurement within this frequency range shown “--- ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
(5) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.
(6) All modes of operation were investigated and the worst-case emissions are reported.

## Radiated Band Edge Test:

Note: Both GFSK, Pi/4 DQPSK have been tested; only worse case GFSK is reported.

Operation Mode: GFSK TX CH Low (2402MHz)

Horizontal (Worst case):

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2335.00 | 52.99 | -5.78 | 47.21 | 74 | 26.79 | PK |
| 2335.00 | -- | -- | -- | 54 | -- | AV |
| 2390.00 | 56.10 | -5.84 | 50.26 | 74 | 23.74 | PK |
| 2390.00 | -- | -- | -- | 54 | -- | AV |
| 2400.00 | 57.08 | -5.84 | 51.24 | 74 | 22.76 | PK |
| 2400.00 | -- | -- | -- | 54 | -- | AV |

Vertical:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2335.00 | 54.03 | -5.78 | 48.25 | 74 | 25.75 | PK |
| 2335.00 | -- | -- | -- | 54 | -- | AV |
| 2390.00 | 56.43 | -5.84 | 50.59 | 74 | 23.41 | PK |
| 2390.00 | -- | -- | -- | 54 | -- | AV |
| 2400.00 | 57.52 | -5.84 | 51.68 | 74 | 22.32 | PK |
| 2400.00 | -- | -- | -- | 54 | -- | AV |

Operation Mode: GFSK TX CH High (2480MHz)

Horizontal (Worst case):

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 55.88 | -5.65 | 50.23 | 74 | 23.77 | PK |
| 2483.50 | -- | -- | -- | 54 | -- | AV |
| 2489.00 | 54.21 | -5.65 | 48.56 | 74 | 25.44 | PK |
| 2489.00 | -- | -- | -- | 54 | -- | AV |
| 2500.00 | 51.92 | -5.72 | 46.20 | 74 | 27.80 | PK |
| 2500.00 | -- | -- | -- | 54 | -- | AV |

Vertical:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 57.21 | -5.65 | 51.56 | 74 | 22.44 | PK |
| 2483.50 | -- | -- | -- | 54 | -- | AV |
| 2489.00 | 55.17 | -5.65 | 49.52 | 74 | 24.48 | PK |
| 2489.00 | -- | -- | -- | 54 | -- | AV |
| 2500.00 | 52.83 | -5.72 | 47.11 | 74 | 26.89 | PK |
| 2500.00 | -- | -- | -- | 54 | -- | AV |

Remark：

(1) Factor = Antenna Factor + Cable Loss – Pre-amplifier.

(2) Margin= Limits –Emission Level

(3) -- Mean the PK detector measured value is below average limit.

## 3.3 CONDUCTED OUTPUT POWER

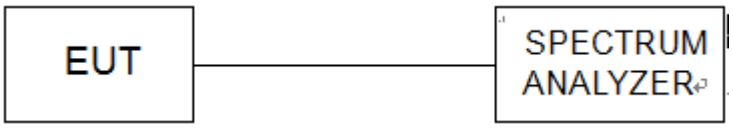
**Limit**

The Maximum Peak Output Power Measurement is 30dBm.

**Test Procedure**

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

**Test Configuration**



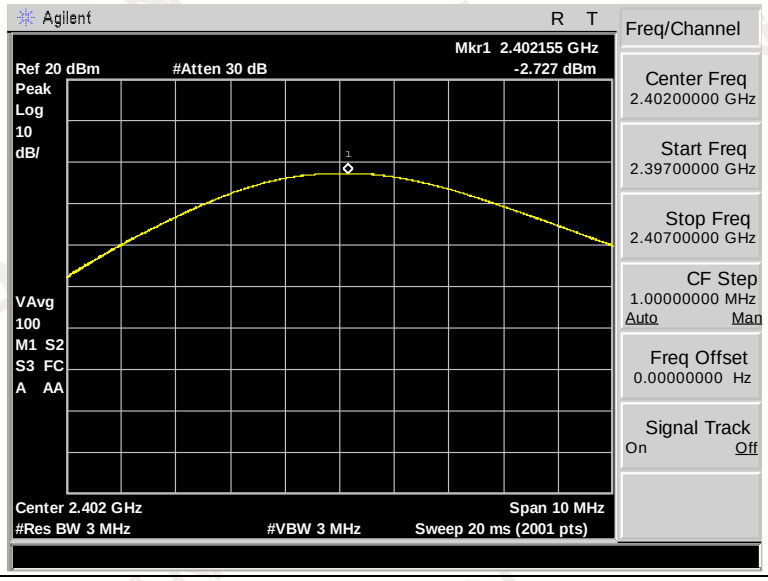

**Test Result**

| Type | Channel | Output power (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|
| GFSK | 00 | -2.727 | 30 | Pass |
| | 39 | -2.667 | | |
| | 78 | -3.456 | | |
| pi/4DQPSK | 00 | -1.625 | 30 | Pass |
| | 39 | -1.481 | | |
| | 78 | -2.349 | | |

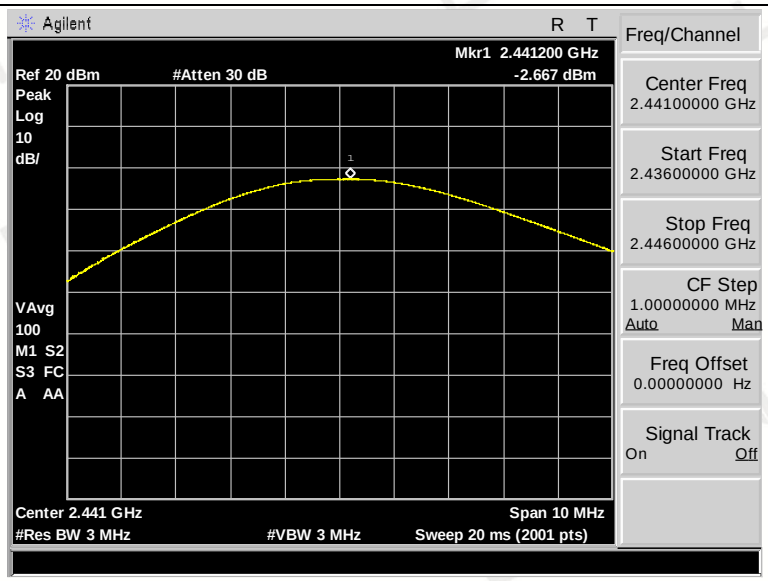
Note: 1.The test results including the cable lose.

## GFSK Modulation

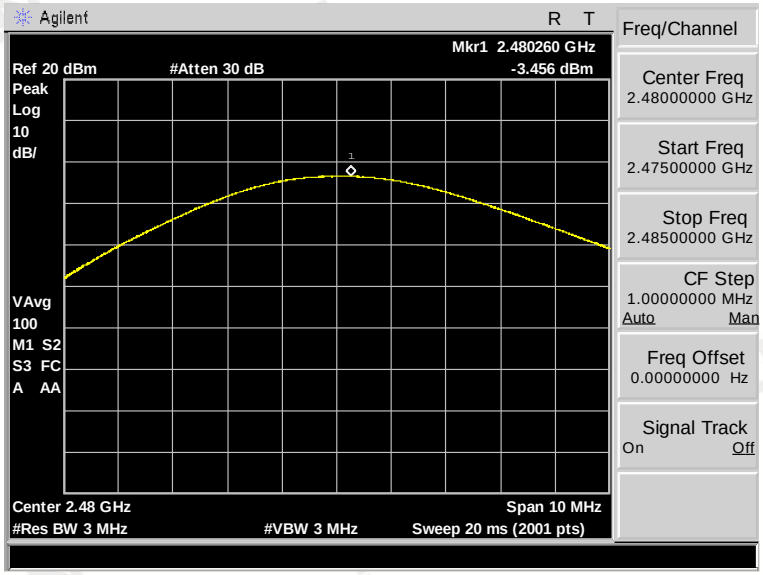
### CH00




### CH39

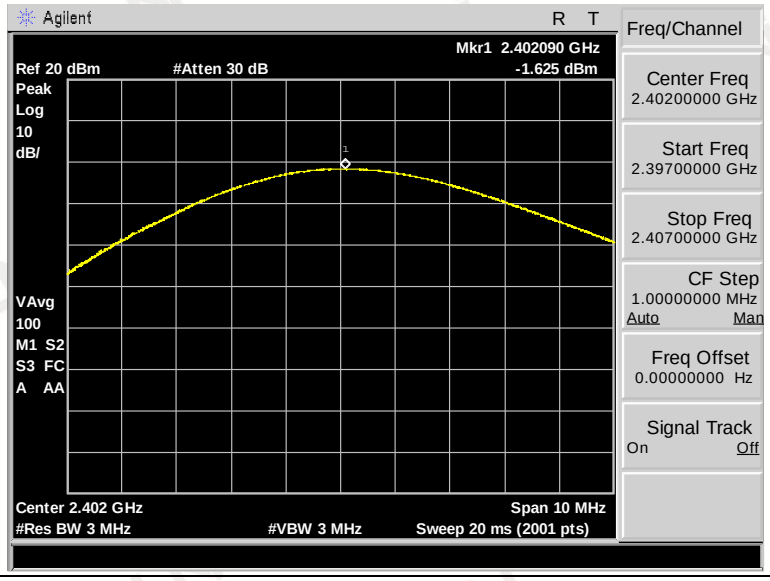



### CH78

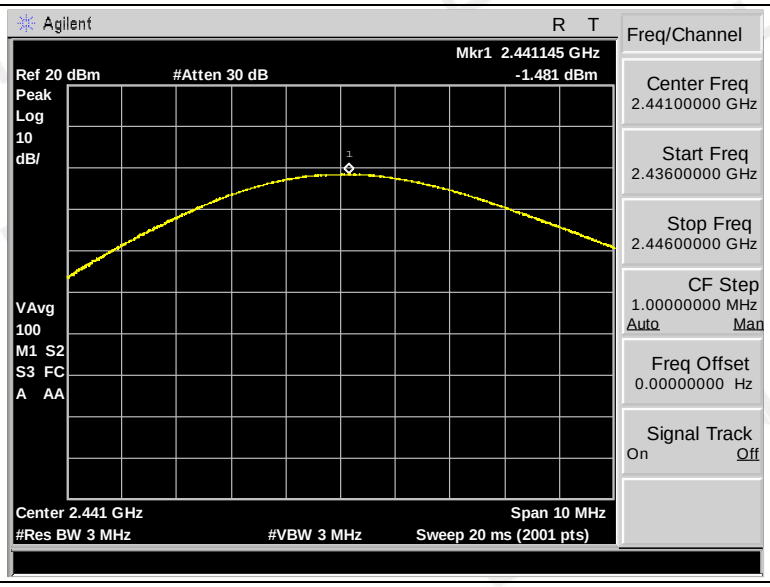


## pi/4DQPSK Modulation

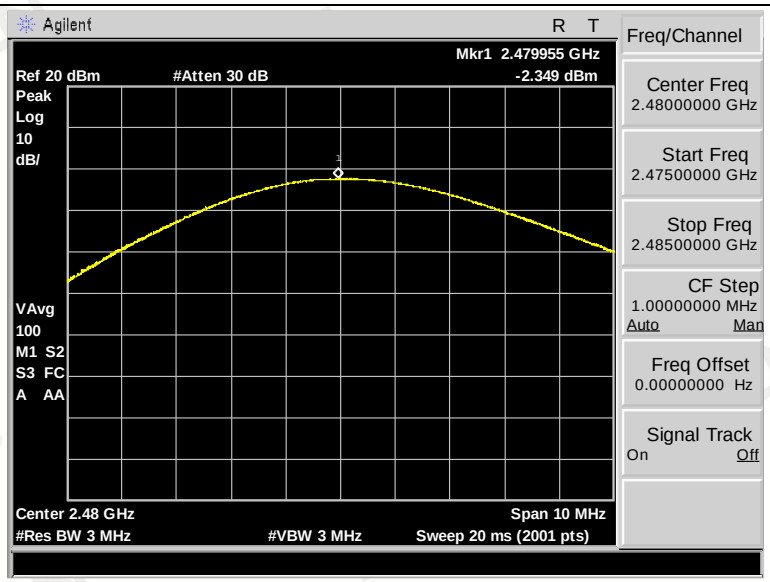
### CH00




### CH39




### CH78



## 3.4 OCCUPIED BANDWIDTH MEASUREMENT

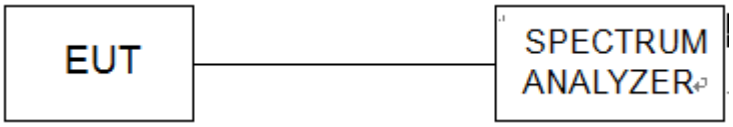
**Limit**

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

**Test Procedure**

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

**Test Configuration**



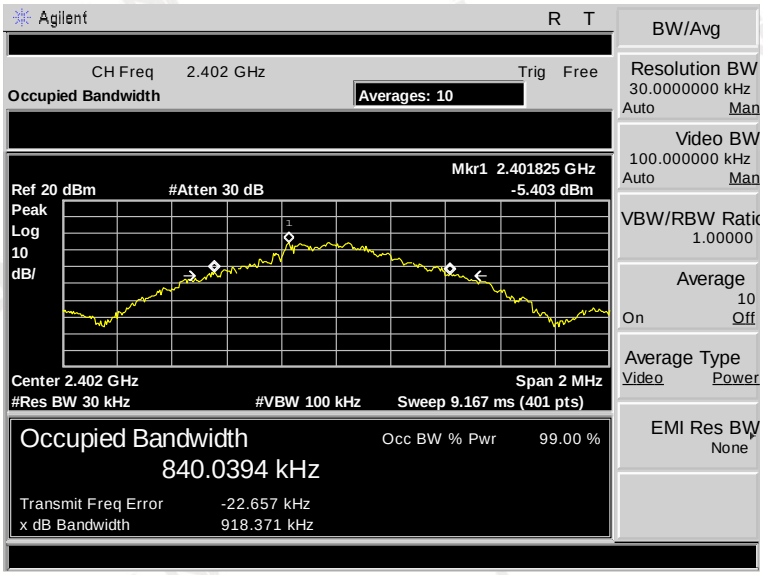

**Test Result**

**---PASS---**

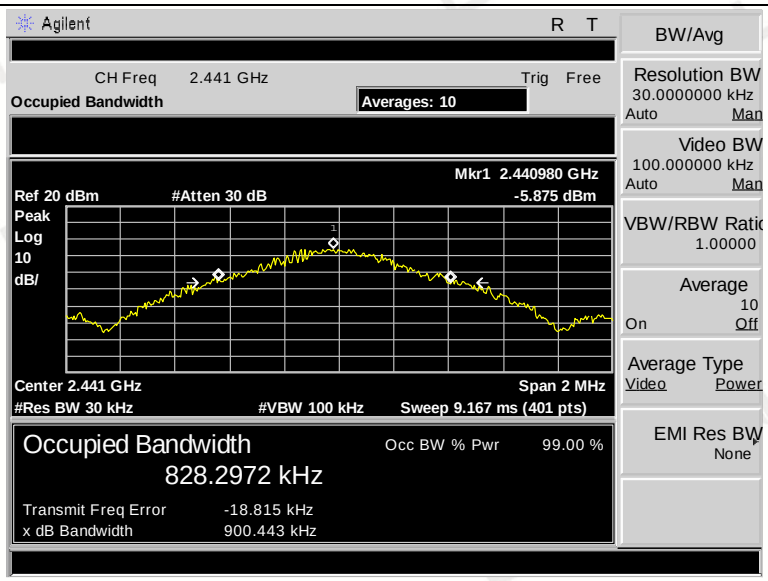
| Modulation | Channel | OBW (MHz) | 20dB bandwidth (MHz) 99% | Result |
|---|---|---|---|---|
| GFSK | CH00 | 0.8400 | 0.918 | Pass |
| | CH39 | 0.8283 | 0.900 | |
| | CH78 | 0.8327 | 0.842 | |
| pi/4DQPSK | CH00 | 1.1845 | 1.246 | |
| | CH39 | 1.1845 | 1.247 | |
| | CH78 | 1.2006 | 1.273 | |

## GFSK Modulation

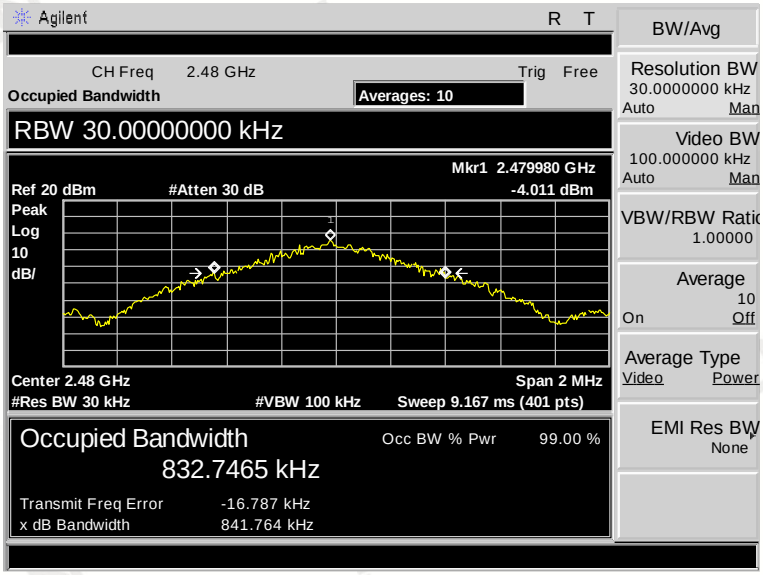
### CH00




### CH39

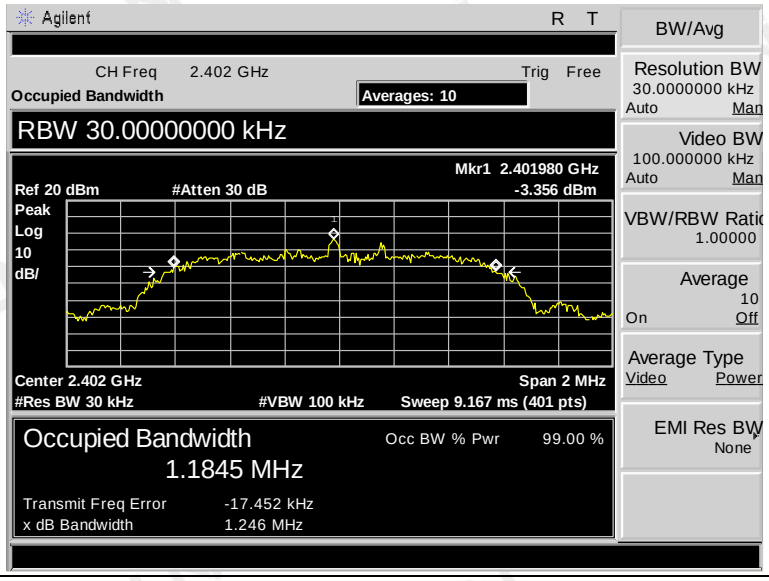



### CH78

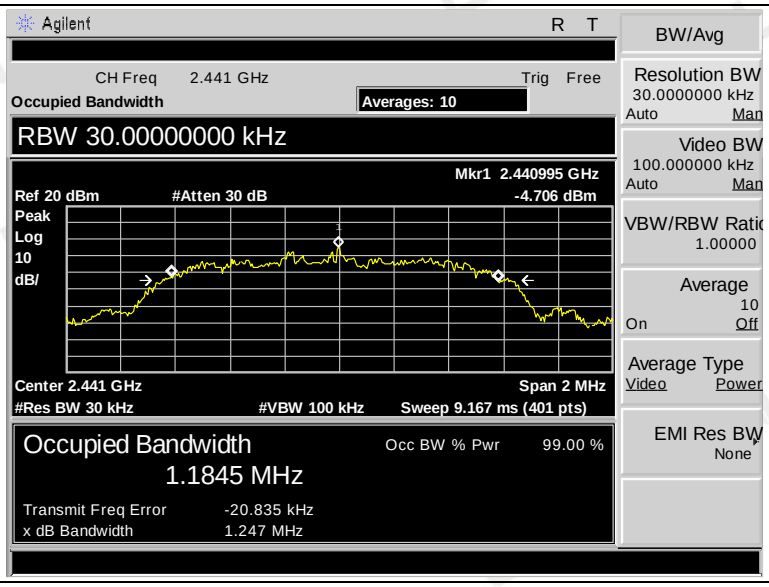


## pi/4DQPSK Modulation

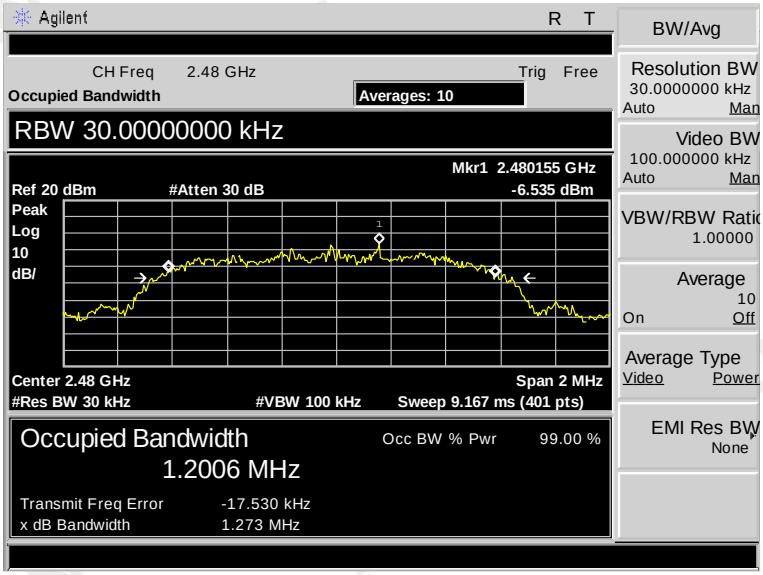
### CH00




### CH39




### CH78



## 3.5 Frequency Separation

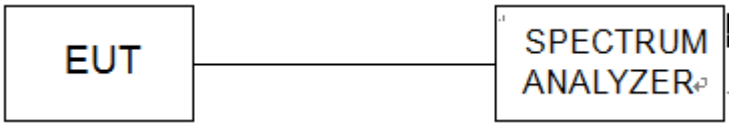
**LIMIT**

According to 15.247(a)(1),frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

**TEST PROCEDURE**

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with100KHz RBW and 300 KHz VBW.

**Test Configuration**



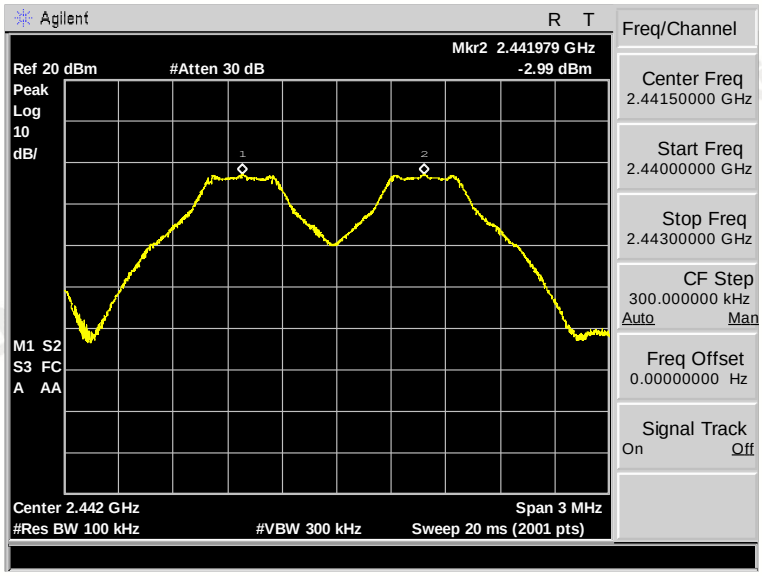

**TEST RESULTS**

| Modulation | Channel | Channel Separation (MHz) | Limit(MHz) | Result |
|---|---|---|---|---|
| GFSK | CH38 | 1.000 | 25KHz or 2/3*20dB bandwidth | Pass |
| | CH39 | | | |
| pi/4DQPSK | CH38 | 1.007 | 25KHz or 2/3*20dB bandwidth | Pass |
| | CH39 | | | |

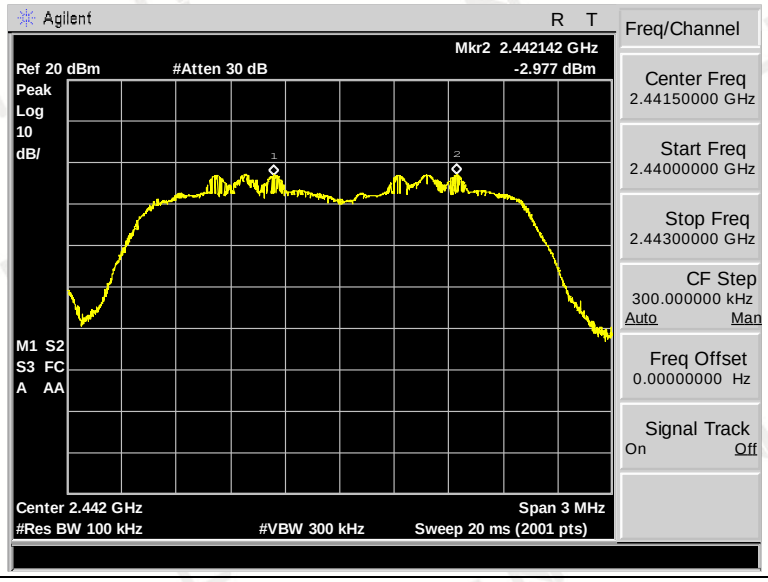
Note:

We have tested all mode at high, middle and low channel, and recorded worst case at middle

*GFSK Modulation*




*pi/4DQPSKModulation*



## 3.6 Number of hopping frequency

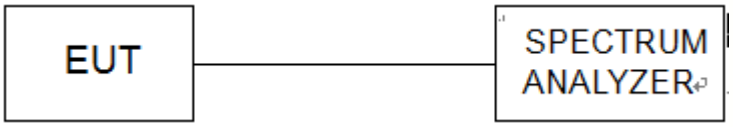
**Limit**

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

**Test Procedure**

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with 100 KHz RBW and 300 KHz VBW.

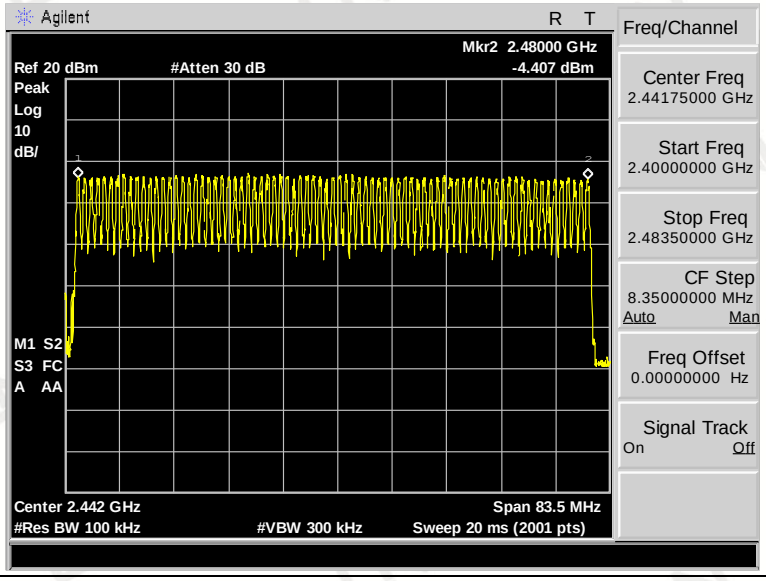
**Test Configuration**



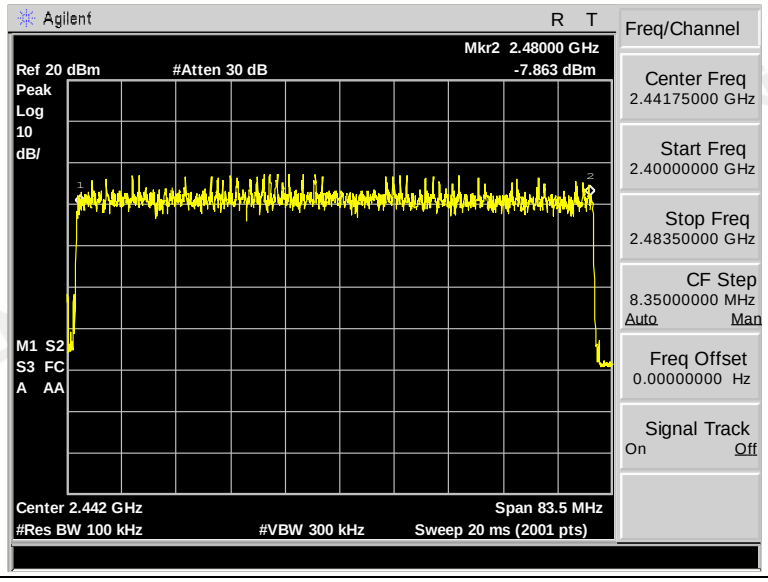

**Test Results**

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

*GFSK*



*pi/4DQPSK*


Agilent
R T
Mkr2 2.48000 GHz
Ref 20 dBm
#Atten 30 dB
-7.863 dBm
Peak
Log
10
dB/
M1 S2
S3 FC
A AA
Center 2.442 GHz
Span 83.5 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 20 ms (2001 pts)
Freq/Channel
Center Freq
2.44175000 GHz
Start Freq
2.40000000 GHz
Stop Freq
2.48350000 GHz
CF Step
8.35000000 MHz
Auto Man
Freq Offset
0.00000000 Hz
Signal Track
On Off

## 3.7 Time of Occupancy (Dwell Time)

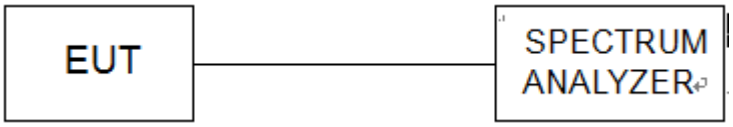
**Limit**

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.

**Test Procedure**

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 1MHz VBW, Span 0Hz.

**Test Configuration**




**Test Results**

| Modulation | Packet | Pulse time (ms) | Dwell time (ms) | Limit (s) | Result |
|---|---|---|---|---|---|
| GFSK | DH1 | 0.410 | 0.131 | 0.40 | Pass |
| | DH3 | 1.660 | 0.266 | | |
| | DH5 | 2.925 | 0.312 | | |
| π/4DQPSK | 2-DH1 | 0.400 | 0.128 | 0.40 | Pass |
| | 2-DH3 | 1.660 | 0.266 | | |
| | 2-DH5 | 2.925 | 0.312 | | |

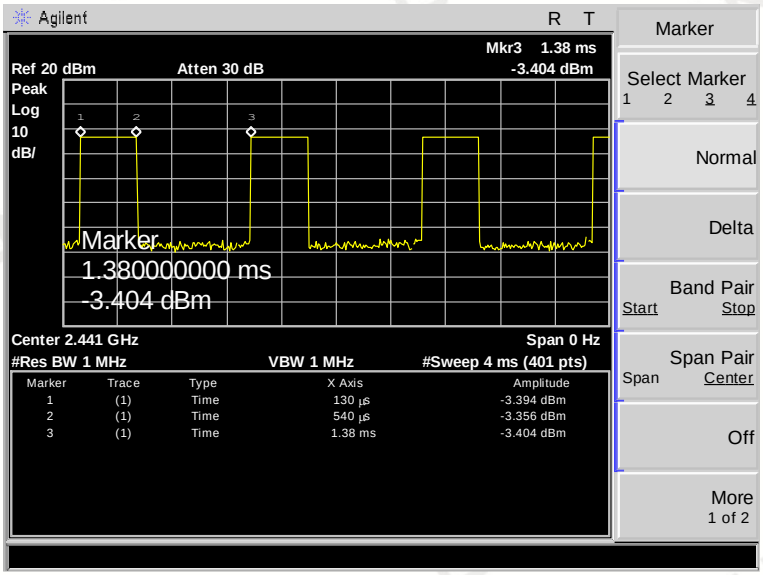
Note:

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

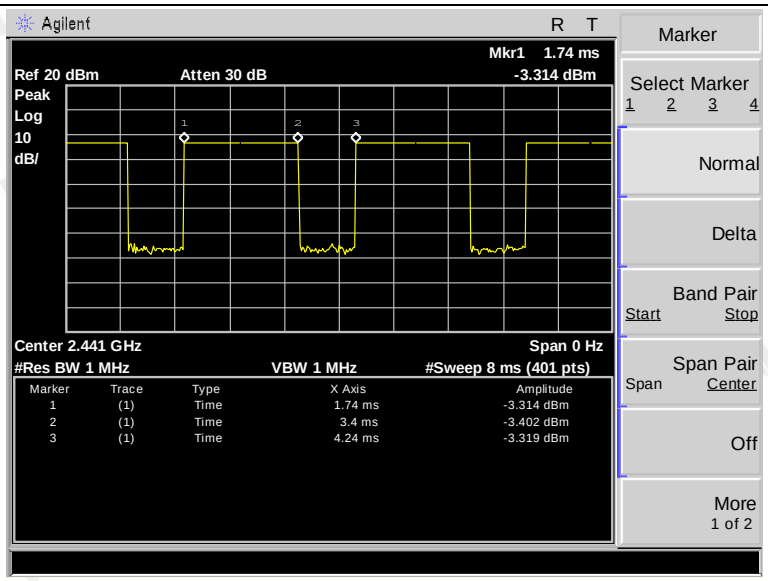
   Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3

## GFSK

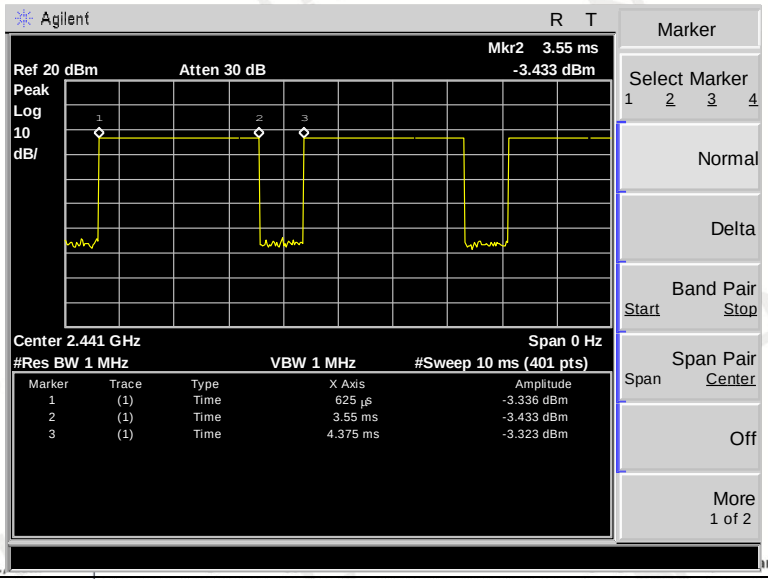
### DH1




### DH3

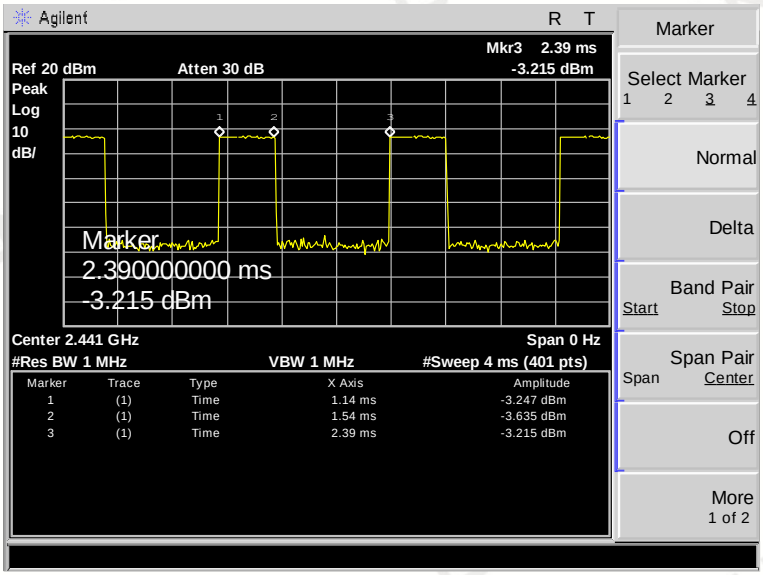



### DH5

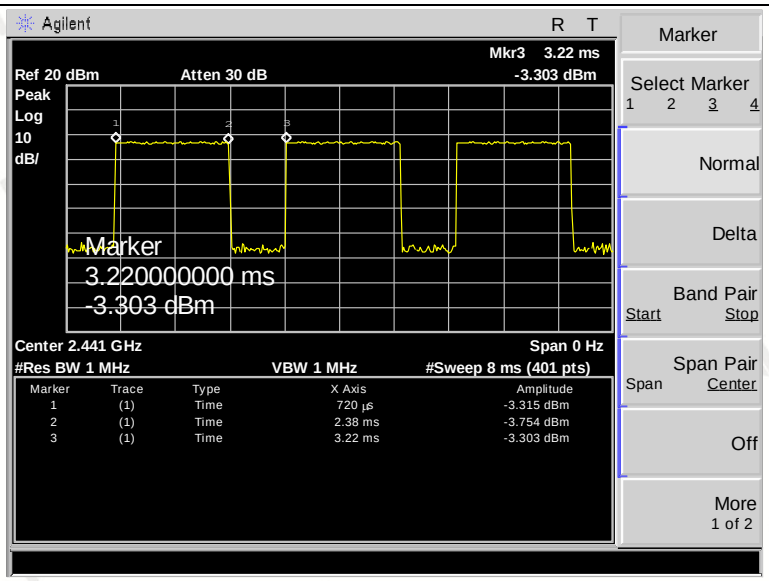


## π/4DQPSK

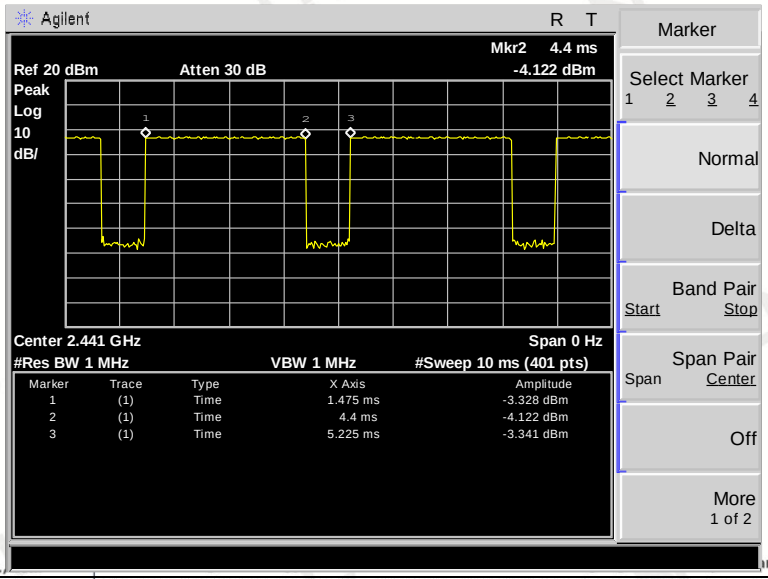
### 2-DH1




### 2-DH3




### 2-DH5



## 3.8 OUT-OF BAND EMISSIONS

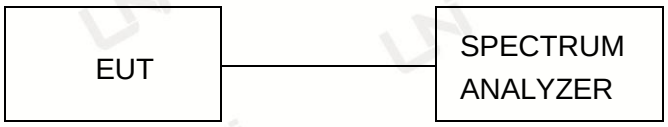
**Limit**

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 desiredpower, based on either an RF con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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.

**Test Procedure**

Connect the transmitter output to spectrumanalyzer using a low loss RF cable, and set the spectrumanalyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

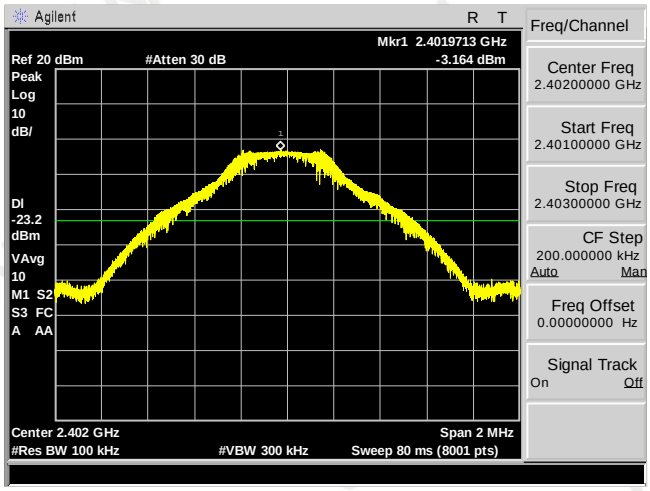
**Test Configuration**

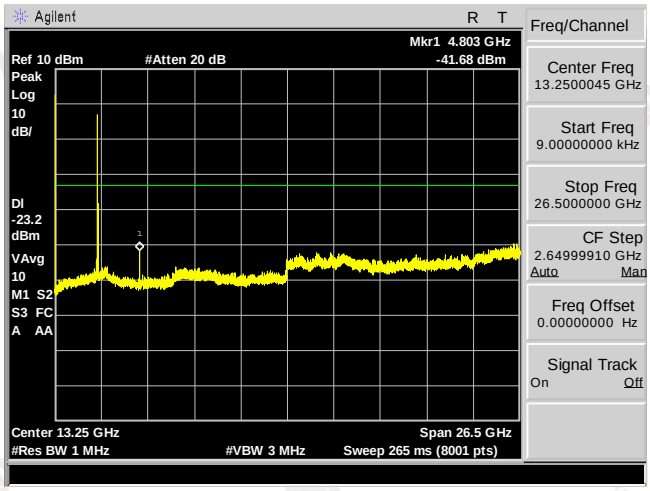



**Test Results**

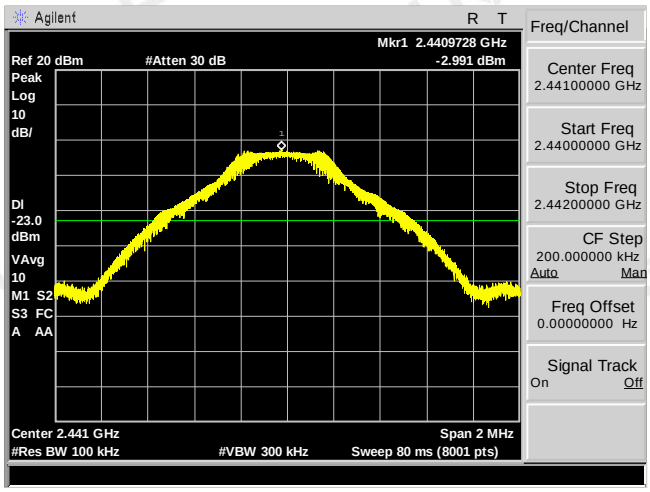
Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

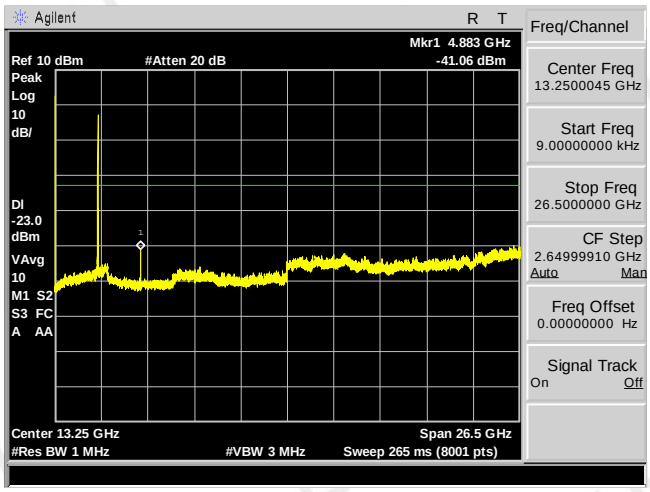
## GFSK CH00



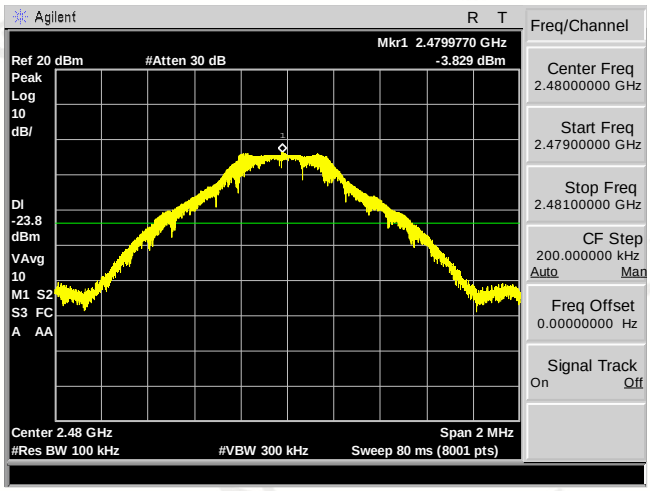



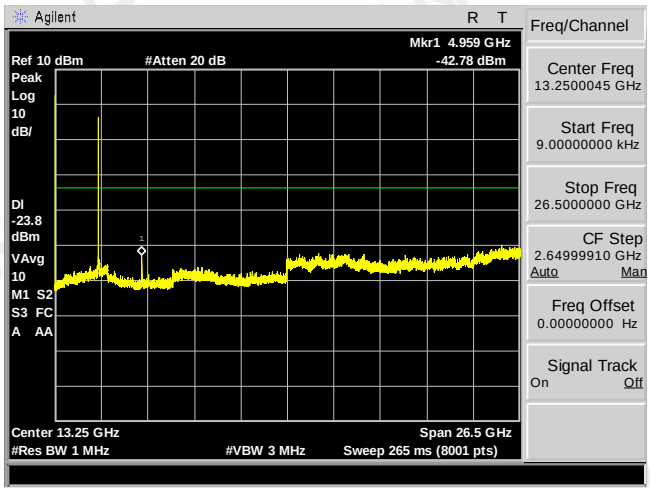

## GFSK CH39



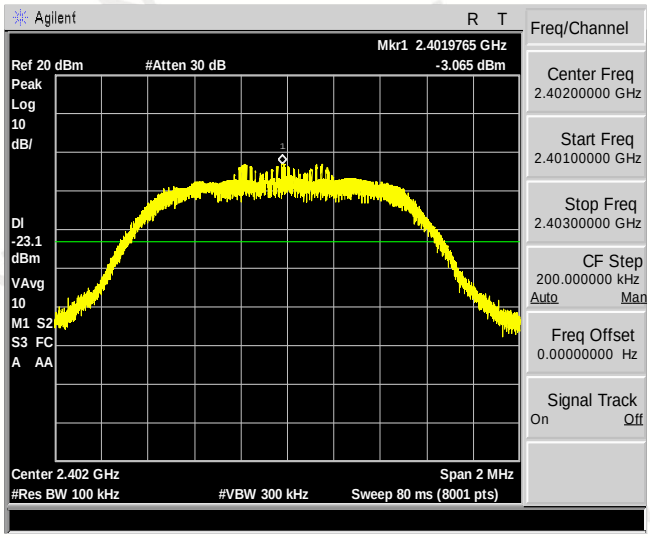



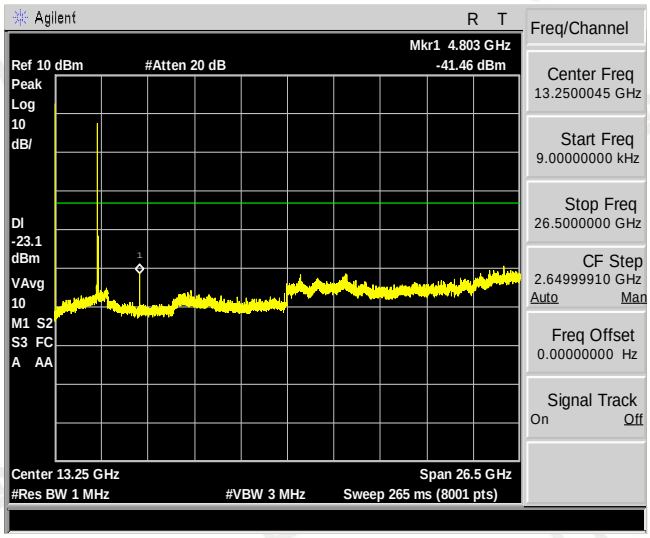

## GFSK CH78



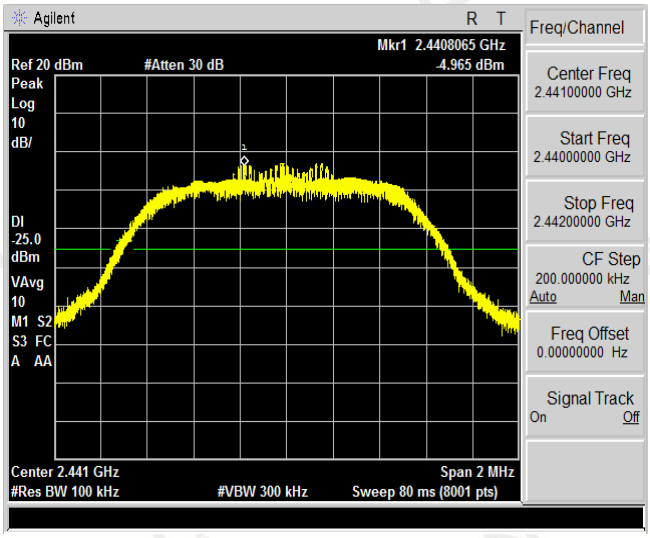



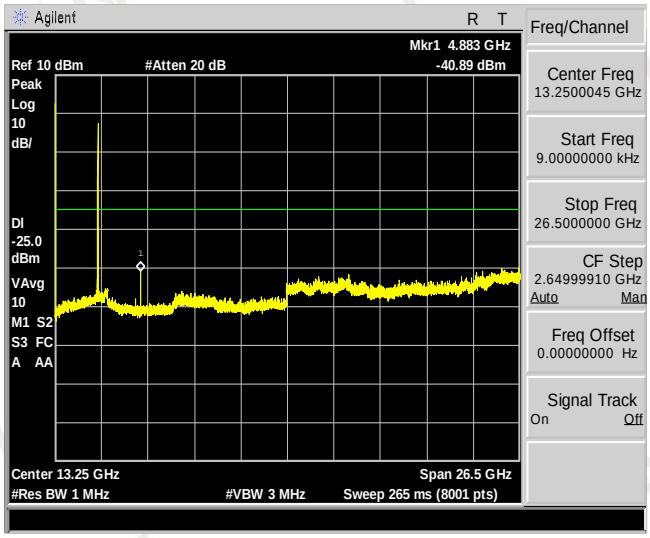
## π/4DQPSK CH00



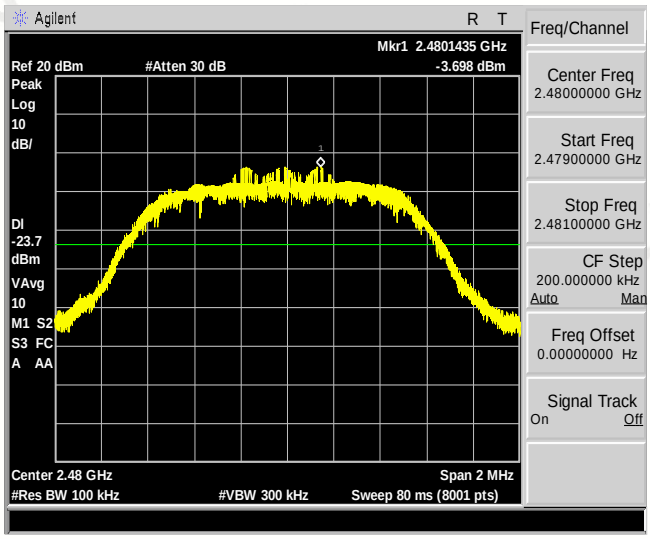



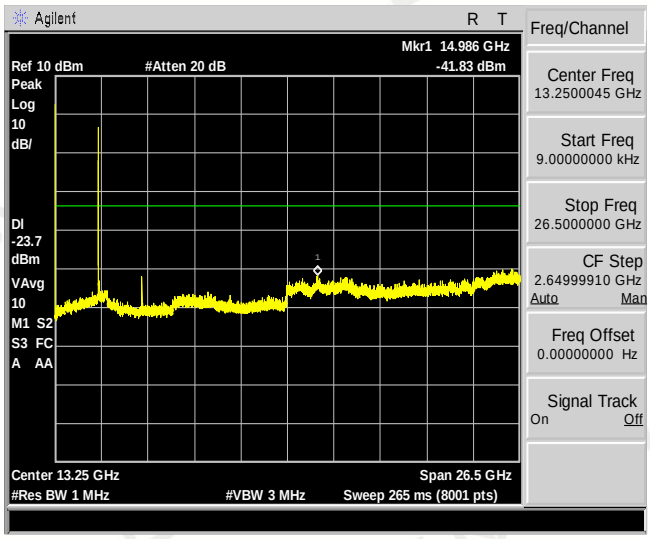

## π/4DQPSK CH39



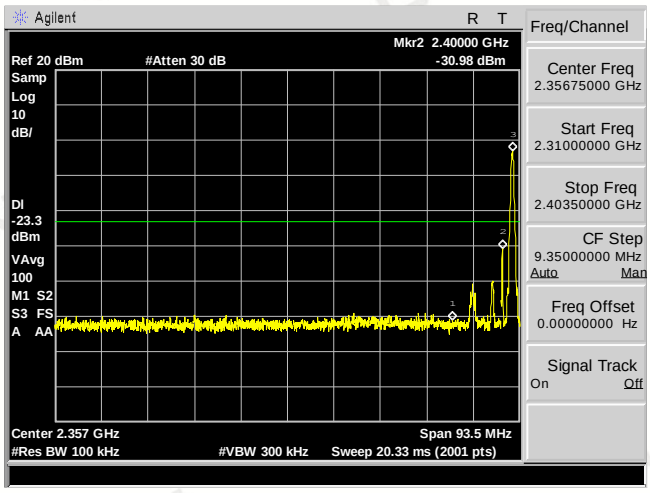

## π/4DQPSK CH78



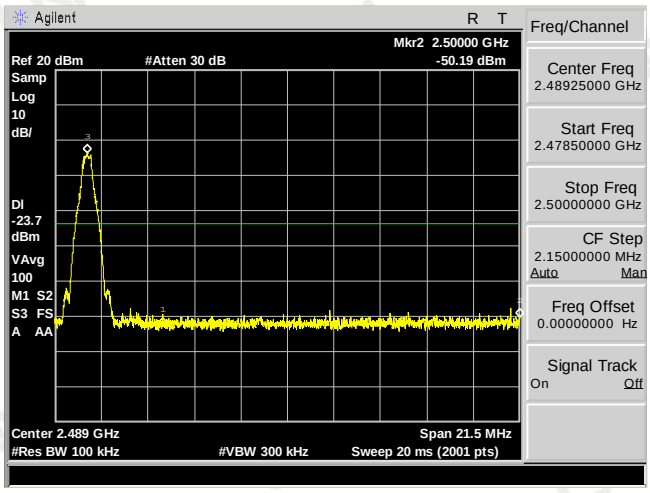



## Conducted Band EdgeTest:

### *GFSK*




Left Band edge hoping off

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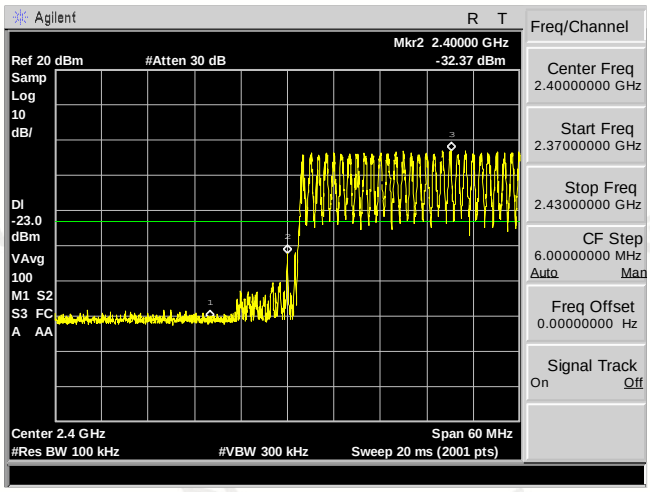
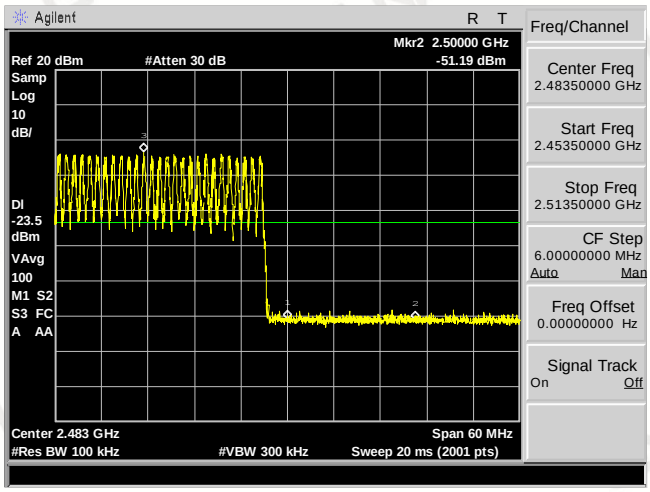
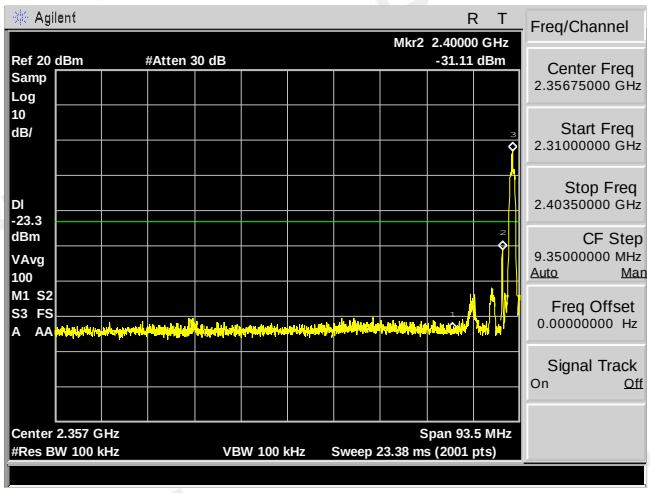



Left Band edge hoping on

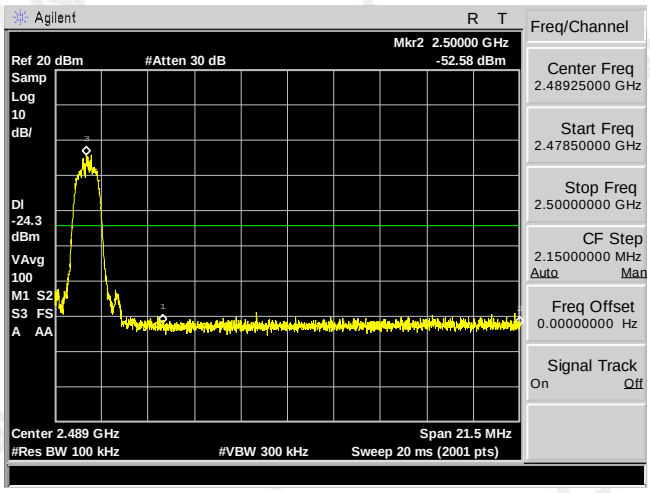



RightBand edge hoping on

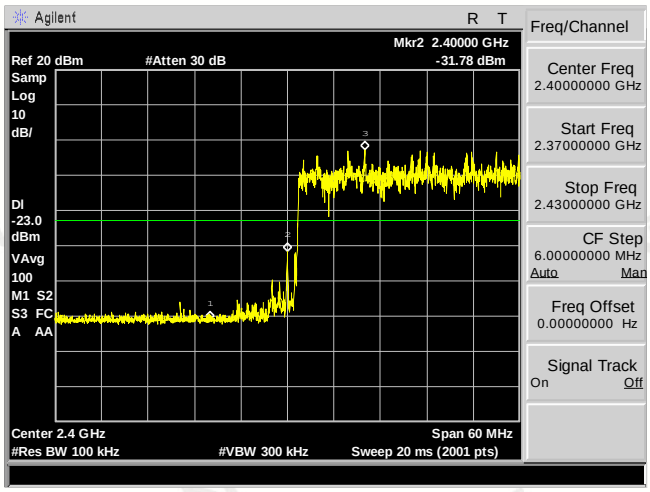
## π/4DQPSK



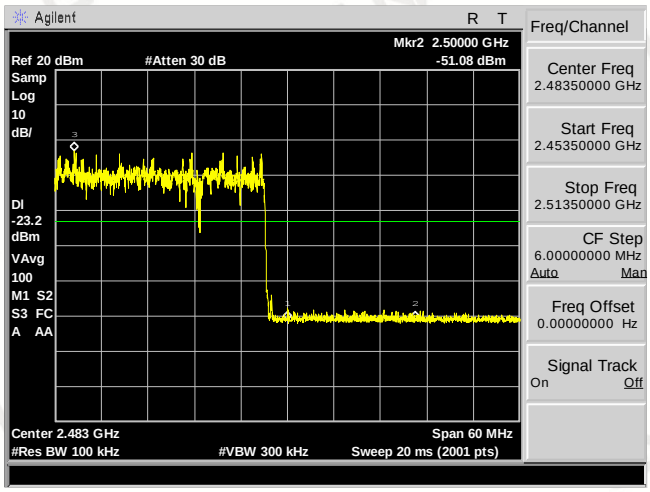

Left Band edge hoping off




RightBand edge hoping off




Left Band edge hoping on




RightBand edge hoping on

### 3.9 Pseudorandom Frequency Hopping Sequence

**TEST APPLICABLE**

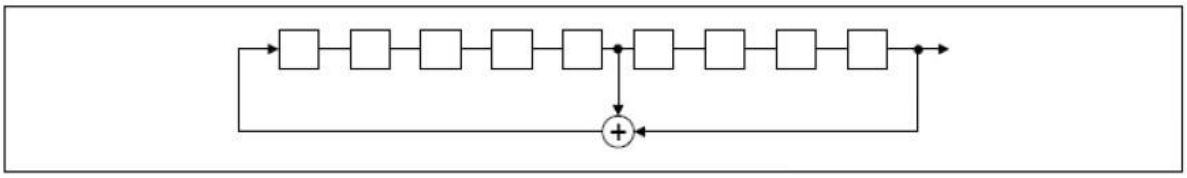
**For 47 CFR Part 15C section 15.247 (g) (h) requirement:**

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.

**EUT Pseudorandom Frequency Hopping Sequence Requirement**

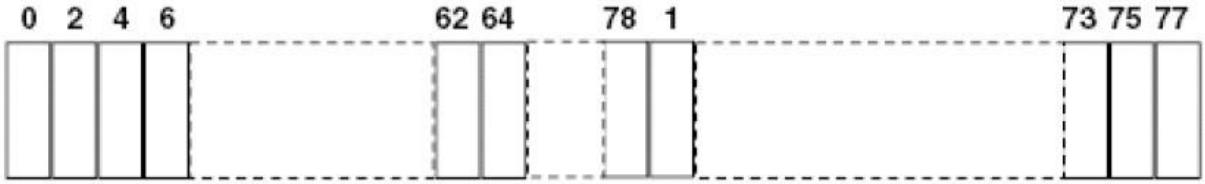
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the firststage. The sequence begins with the first one of 9 consecutive ones, forexample: the 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 on the average by each transmitter.

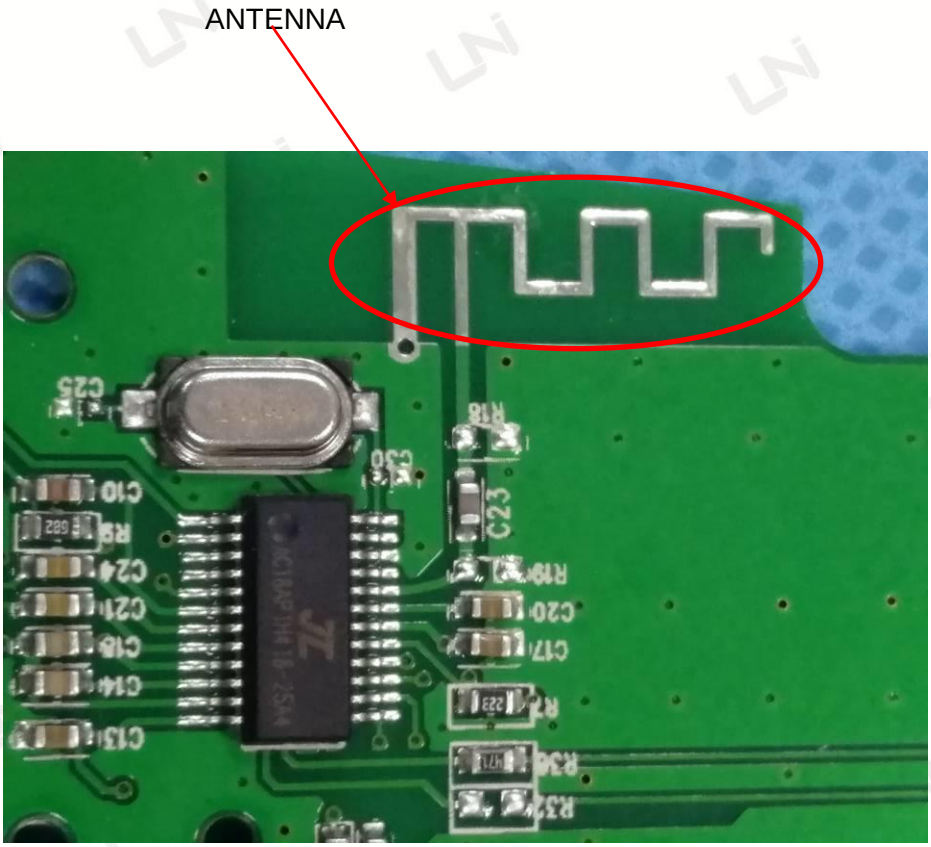
According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

| |
|---|
| Compliance for section 15.247(g) |
| According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system. |
| Compliance for section 15.247(h) |
| According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.<br>According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter. |

## 3.10 ANTENNA REQUIREMENT

Standard Applicable:
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.

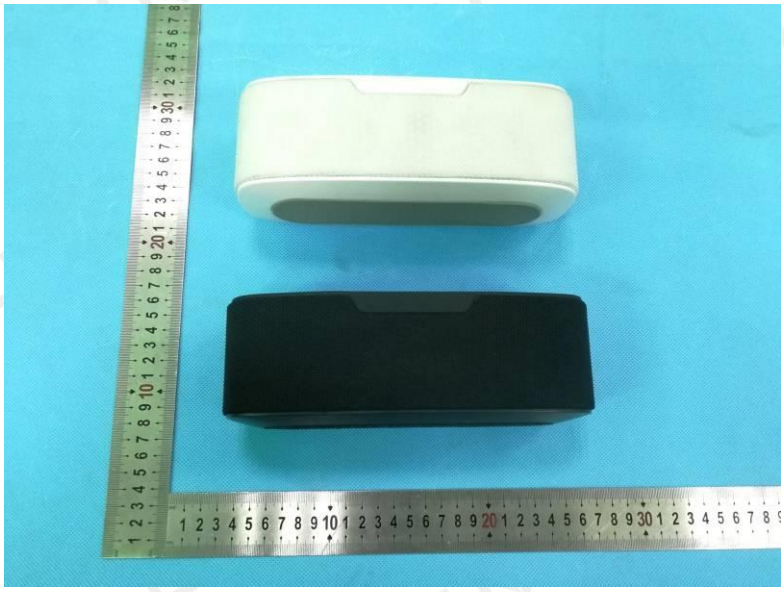
Antenna Connected Construction
The antenna used in this product is anIntegral Antenna, the directional gains of antenna used for transmitting is 0.0dBi.



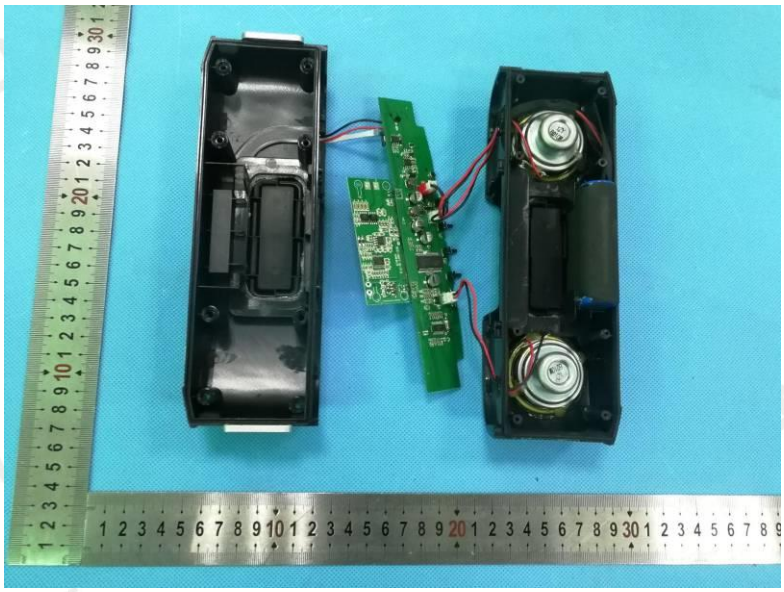
# 4 PHOTOGRAPH OF TEST

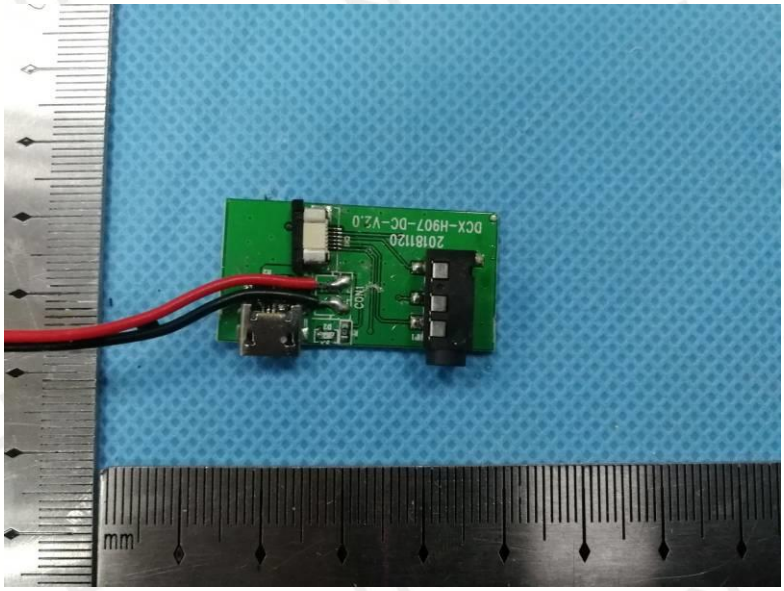
# 5 PHOTOGRAPH OF EUT

## External Photos



## Internal Photos

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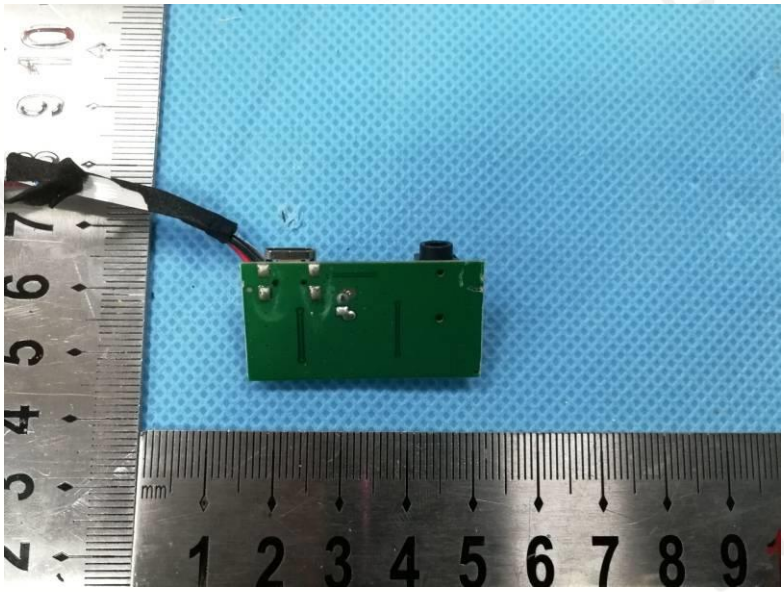
20181120
CON1
mm


mm
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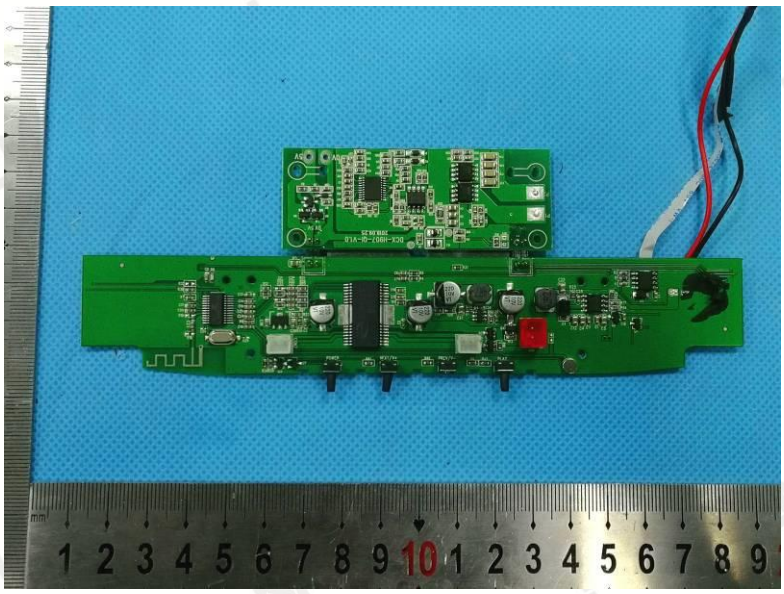
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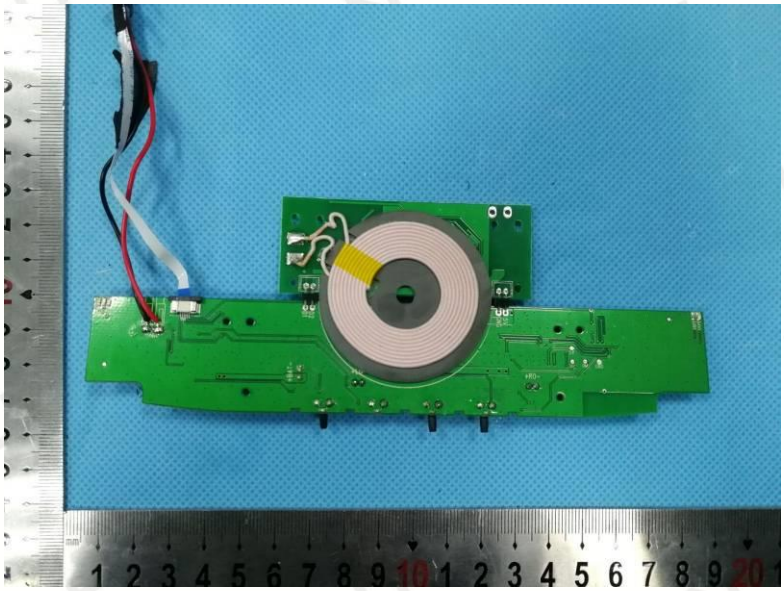

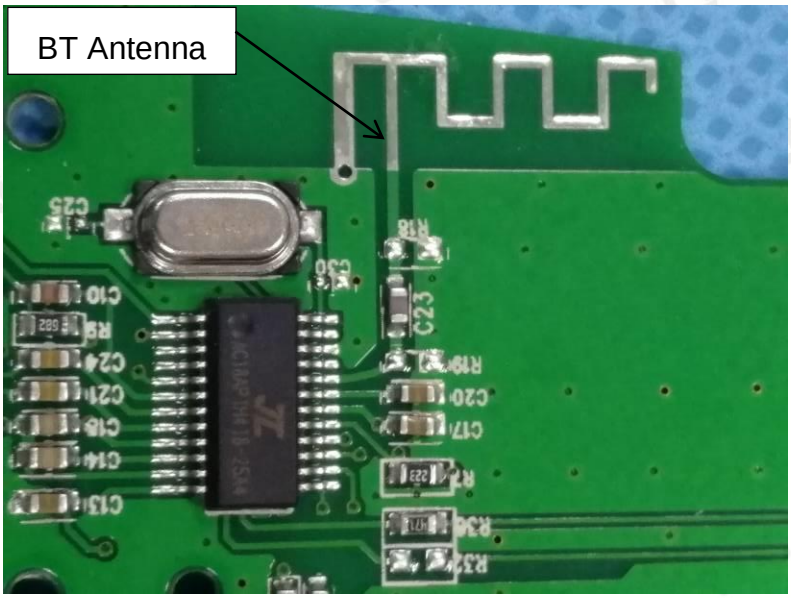


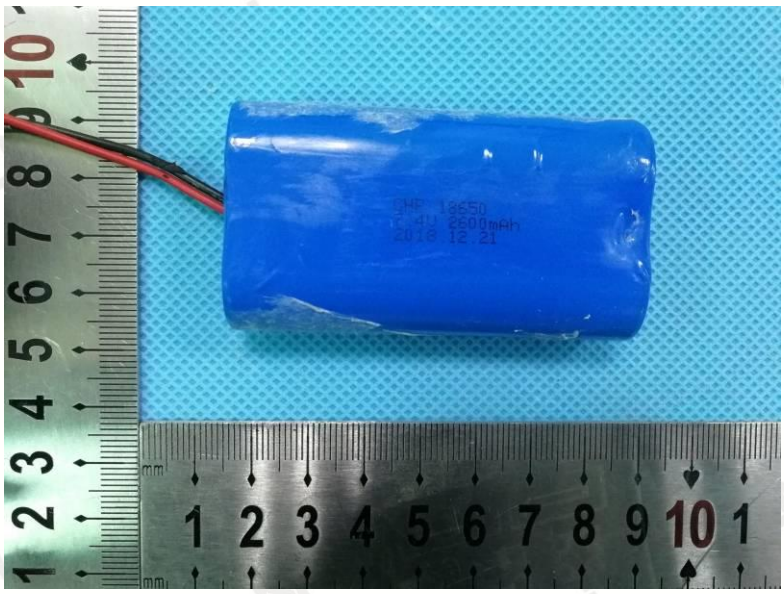

**********End of Report**********