# FCC TEST REPORT

| | | |
|---|---|---|
| **Reference No.** | : | WTS14S1119871E |
| **FCC ID** | : | PB4-TDKA28 |
| **Applicant** | : | Imation Corp. |
| **Address** | : | 1 Imation Way, Oakdale, MN 55128 USA |
| **Manufacturer** | : | Imation Corp. |
| **Address** | : | 1 Imation Way, Oakdale, MN 55128 USA |
| **Product Name** | : | Wireless Speaker |
| **Model No.** | : | A28 |
| **Trademark** | : | TDK Life on Record |
| **Standards** | : | FCC CFR47 Part 15 Subpart C: 2014 |
| **Date of Receipt sample** | : | Nov.06, 2014 |
| **Date of Test** | : | Nov.11-14, 2014 |
| **Date of Issue** | : | Nov.25, 2014 |
| **Test Result** | : | **Pass** |

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.


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Compiled by: Approved by:

Maikou Zhang / Project Engineer

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# 2 Test Summary

| Test Items | Test Requirement | Result |
|---|---|---|
| Spurious Radiated Emissions | 15.205(a)<br>15.209<br>15.247(d) | PASS |
| Band edge Emissions | 15.247(d) | PASS |
| Duty Cycle | 15.35 | PASS |
| Conducted Emissions | 15.207 | PASS |
| 20dB Bandwidth | 15.215c<br>15.247(a)(1) | PASS |
| Maximum Peak Output Power | 15.247(b)(1) | PASS |
| Frequency Separation | 15.247(a)(1) | PASS |
| Number of Hopping Frequency | 15.247(a)(1)(iii) | PASS |
| Dwell time | 15.247(a)(1)(iii) | PASS |
| Maximum Permissible Exposure<br>(Exposure of Humans to RF Fields) | 1.1307(b)(1) | PASS |

# 3 Contents

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# 4 General Information

## 4.1 General Description of E.U.T.

| | |
|---|---|
| **Product Name** | : Wireless Speaker |
| **Model No.** | : A28 |
| **Brand Name** | : TDK Life on Record |
| **Remark** | : The model No. A28 has two colors (black and grey), black model sample was tested . |
| **Operation Frequency** | : 2402MHz ~ 2480MHz,79 channels in total, separated by 1MHz |
| **Type of Modulation** | : GFSK, Pi/4DQPSK, 8DPSK |
| **Oscillator** | : Crystal 12.88MHz for CPU, 26MHz for RF module |
| **Antenna installation** | : Copper foil Antenna |
| **Antenna Gain** | : 2.11dBi |

## 4.2 Details of E.U.T.

| | |
|---|---|
| **Technical Data** | (1)DC 5V, 1A |
| | (2)DC 3.6V, 2000mAh by battery |

## 4.3 Channel List

| Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 1 | 2402 | 2 | 2403 | 3 | 2404 | 4 | 2405 |
| 5 | 2406 | 6 | 2407 | 7 | 2408 | 8 | 2409 |
| 9 | 2410 | 10 | 2411 | 11 | 2412 | 12 | 2413 |
| 13 | 2414 | 14 | 2415 | 15 | 2416 | 16 | 2417 |
| 17 | 2418 | 18 | 2419 | 19 | 2420 | 20 | 2421 |
| 21 | 2422 | 22 | 2423 | 23 | 2424 | 24 | 2425 |
| 25 | 2426 | 26 | 2427 | 27 | 2428 | 28 | 2429 |
| 29 | 2430 | 30 | 2431 | 31 | 2432 | 32 | 2433 |
| 33 | 2434 | 34 | 2435 | 35 | 2436 | 36 | 2437 |
| 37 | 2438 | 38 | 2439 | 39 | 2440 | 40 | 2441 |
| 41 | 2442 | 42 | 2443 | 43 | 2444 | 44 | 2445 |
| 45 | 2446 | 46 | 2447 | 47 | 2448 | 48 | 2449 |
| 49 | 2450 | 50 | 2451 | 51 | 2452 | 52 | 2453 |
| 53 | 2454 | 54 | 2455 | 55 | 2456 | 56 | 2457 |
| 57 | 2458 | 58 | 2459 | 59 | 2460 | 60 | 2461 |
| 61 | 2462 | 62 | 2463 | 63 | 2464 | 64 | 2465 |
| 65 | 2466 | 66 | 2467 | 67 | 2468 | 68 | 2469 |
| 69 | 2470 | 70 | 2471 | 71 | 2472 | 72 | 2473 |
| 73 | 2474 | 74 | 2475 | 75 | 2476 | 76 | 2477 |
| 77 | 2478 | 78 | 2479 | 79 | 2480 | - | - |

## 4.4 Description of Support Units

| No. | Equipment | Manufacturer | Model No. | Serial No. |
|---|---|---|---|---|
| 1. | Notebook | LENOVO | X201i | 75Y4408 |

## 4.5 Test Facility

The test facility has a test site registered with the following organizations:

- **IC – Registration No.: 7760A-1**

  Waltek Services(Shenzhen) Co., Ltd. has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files.

  Registration 7760A-1, July 12, 2012.

- **FCC – Registration No.: 880581**

  Waltek Services(Shenzhen) Co., Ltd. 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. Registration 880581, April 29, 2014.

## 4.6 Test Location

All the tests were performed at:
Waltek Services(Shenzhen) Co., Ltd. at 1/F, Fukangtai Building, West Baima Rd.,Songgang Street, Baoan District, Shenzhen, China

# 5 Equipment Used during Test

## 5.1 Equipments List

| Conducted Emissions | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMI Test Receiver | R&S | ESCI | 100947 | Sep.21,2014 | Sep.20,2015 |
| 2. | LISN | R&S | ENV216 | 101215 | Sep.21,2014 | Sep.20,2015 |
| 3. | Cable | Top | TYPE16(3.5M) | - | Sep.21,2014 | Sep.20,2015 |
| **3m Semi-anechoic Chamber for Radiation Emissions** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMC Analyzer | Agilent | E7405A | MY45114943 | Sep.18,2014 | Sep.17,2015 |
| 2. | Active Loop Antenna | Beijing Dazhi | ZN30900A | - | Sep.18,2014 | Sep.17,2015 |
| 3. | Trilog Broadband Antenna | SCHWARZBECK | VULB9163 | 336 | Apr.19,2014 | Apr.18,2015 |
| 4. | Coaxial Cable (below 1GHz) | Top | TYPE16(13M) | - | Sep.18,2014 | Sep.17,2015 |
| 5. | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9120 D | 667 | Apr.19,2014 | Apr.18,2015 |
| 6. | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9170 | 335 | Apr.19,2014 | Apr.18,2015 |
| 7. | Broadband Preamplifier | COMPLIANCE DIRECTION | PAP-1G18 | 2004 | Mar.17,2014 | Mar.16,2015 |
| 8. | Coaxial Cable (above 1GHz) | Top | 1GHz-25GHz | EW02014-7 | Apr.10,2014 | Apr.09,2015 |
| **RF Conducted Testing** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMC Analyzer | R&S | ESCI | 101155 | Sep.18,2014 | Sep.17,2015 |
| 2. | Humidity Chamber | GF | GTH-225-40-1P | IAA061213 | May 16,2014 | May 15,2015 |
| 3. | DC Power Supply | EVERFINE | WY305 | 1004002 | Apr.11,2014 | Apr.10,2015 |

## 5.2 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| Radio Frequency | ± 1 x $10^{-6}$ |
| Bandwidth | ± 1.5 x $10^{-6}$ |
| RF Power | ± 1.0 dB |
| RF Power Density | ± 2.2 dB |
| Temperature | ± 1 °C |
| DC Source | ±0.05% |
| Radiated Emissions test | ± 5.03 dB<br>(Bilog antenna 30M~1000MHz) |
| | ± 4.74 dB<br>(Horn antenna 1000M~25000MHz) |
| Conducted Emissions test | 3.64dB (150kHz~30MHz) |

## 5.3 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Don guan Zhuang RD. Guangzhou, P.R.China.

# 6 Conducted Emission

| | |
|---|---|
| Test Requirement: | FCC CFR 47 Part 15 Section 15.207 |
| Test Method: | ANSI C63.4:2003 |
| Test Result: | PASS |
| Frequency Range: | 150kHz to 30MHz |
| Class: | Class B |
| Limit: | 66-56 dBμV between 0.15MHz & 0.5MHz<br>56 dBμV between 0.5MHz & 5MHz<br>60 dBμV between 5MHz & 30MHz |
| Detector: | Peak for pre-scan (9kHz Resolution Bandwidth) Quasi-Peak & Average if maximised peak within 6dB of Average Limit |

## 6.1 E.U.T. Operation

**Operating Environment:**

Temperature: 25.5 °C

Humidity: 51 % RH

Atmospheric Pressure: 1012 mbar

**EUT Operation:**

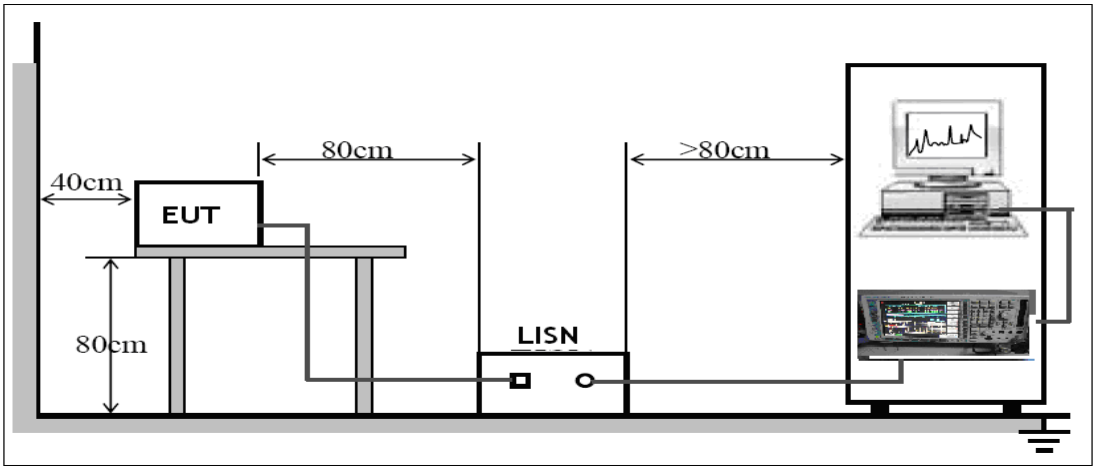
The pre-test was performed in Bluetooth linking, and the data were shown as follow.

The EUT was tested according to ANSI C63.4:2003. The frequency spectrum from 150kHz to 30MHz was investigated.

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

## 6.2 EUT Setup

The EUT was placed on the test table in shielding room.

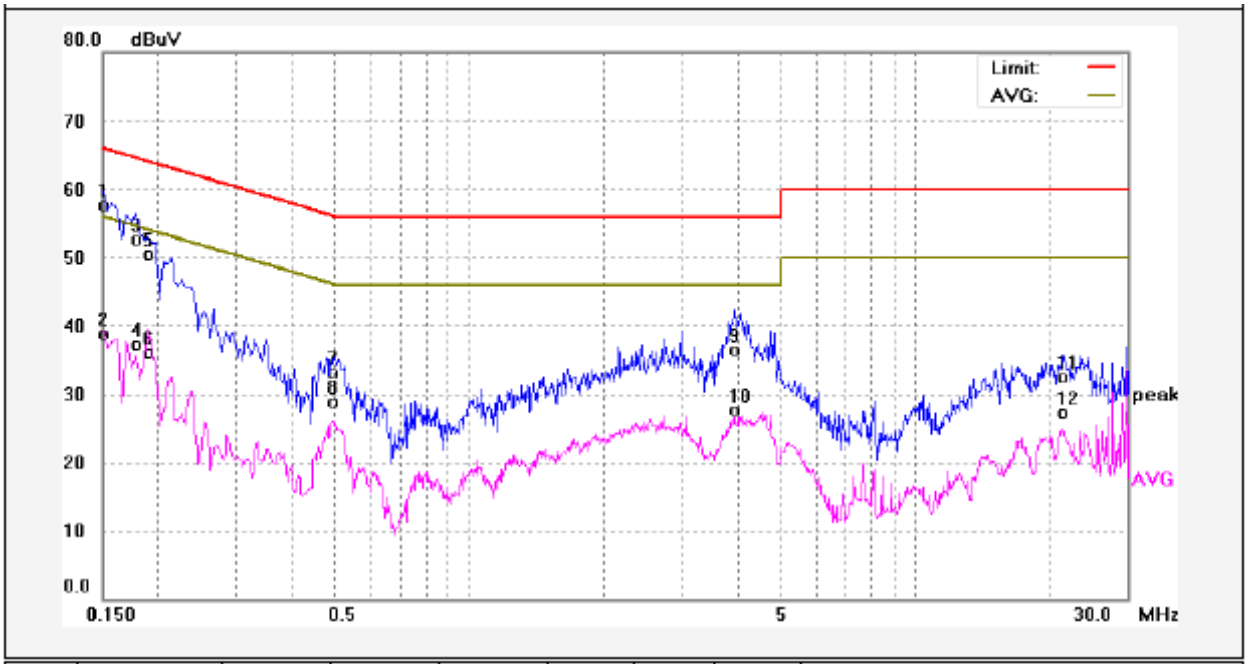


## 6.3 Conducted Emission Test Result

An initial pre-scan was performed on the live and neutral lines.

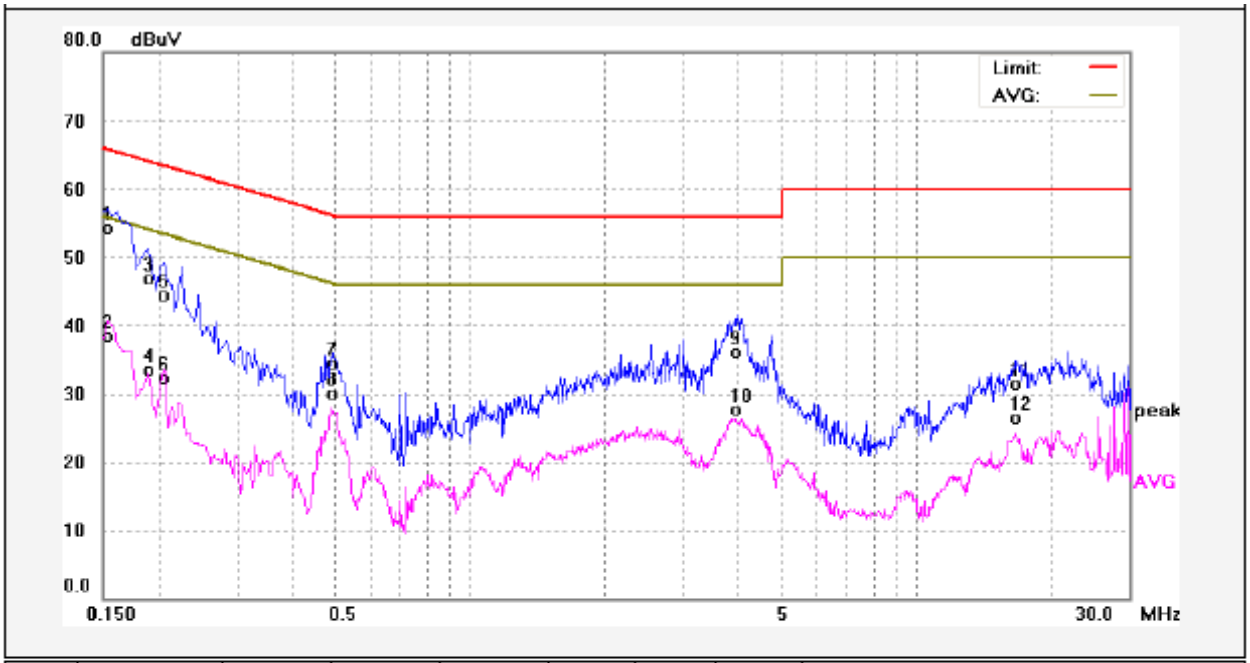
Test Mode: Bluetooth linking

Live line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1500 | 47.92 | 9.80 | 57.72 | 65.99 | -8.27 | QP | |
| 2 | 0.1500 | 29.04 | 9.80 | 38.84 | 55.99 | -17.15 | AVG | |
| 3 | 0.1780 | 42.93 | 9.82 | 52.75 | 64.57 | -11.82 | QP | |
| 4 | 0.1780 | 27.44 | 9.82 | 37.26 | 54.57 | -17.31 | AVG | |
| 5 | 0.1900 | 40.67 | 9.83 | 50.50 | 64.03 | -13.53 | QP | |
| 6 | 0.1900 | 26.19 | 9.83 | 36.02 | 54.03 | -18.01 | AVG | |
| 7 | 0.4980 | 23.26 | 9.93 | 33.19 | 56.03 | -22.84 | QP | |
| 8 | 0.4980 | 18.96 | 9.93 | 28.89 | 46.03 | -17.14 | AVG | |
| 9 | 3.9620 | 26.48 | 10.07 | 36.55 | 56.00 | -19.45 | QP | |
| 10 | 3.9620 | 17.72 | 10.07 | 27.79 | 46.00 | -18.21 | AVG | |
| 11 | 21.4020 | 21.13 | 11.31 | 32.44 | 60.00 | -27.56 | QP | |
| 12 | 21.4020 | 16.07 | 11.31 | 27.38 | 50.00 | -22.62 | AVG | |

Neutral line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1539 | 44.50 | 9.80 | 54.30 | 65.78 | -11.48 | QP | |
| 2 | 0.1539 | 28.73 | 9.80 | 38.53 | 55.78 | -17.25 | AVG | |
| 3 | 0.1900 | 37.05 | 9.83 | 46.88 | 64.03 | -17.15 | QP | |
| 4 | 0.1900 | 23.62 | 9.83 | 33.45 | 54.03 | -20.58 | AVG | |
| 5 | 0.2060 | 34.64 | 9.84 | 44.48 | 63.36 | -18.88 | QP | |
| 6 | 0.2060 | 22.43 | 9.84 | 32.27 | 53.36 | -21.09 | AVG | |
| 7 | 0.4940 | 24.53 | 9.93 | 34.46 | 56.10 | -21.64 | QP | |
| 8 | 0.4940 | 20.21 | 9.93 | 30.14 | 46.10 | -15.96 | AVG | |
| 9 | 3.9940 | 26.07 | 10.07 | 36.14 | 56.00 | -19.86 | QP | |
| 10 | 3.9940 | 17.62 | 10.07 | 27.69 | 46.00 | -18.31 | AVG | |
| 11 | 16.6660 | 20.53 | 11.00 | 31.53 | 60.00 | -28.47 | QP | |
| 12 | 16.6660 | 15.47 | 11.00 | 26.47 | 50.00 | -23.53 | AVG | |

# 7 Spurious Radiated Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method: DA 00-705

Test Result: PASS

Measurement Distance: 3m

Limit:

| Frequency (MHz) | Field Strength | | Field Strength Limit at 3m Measurement Dist | |
|---|---|---|---|---|
| | uV/m | Distance (m) | uV/m | dBuV/m |
| 0.009 ~ 0.490 | 2400/F(kHz) | 300 | 10000 * 2400/F(kHz) | $20\log^{(2400/F(kHz))} + 80$ |
| 0.490 ~ 1.705 | 24000/F(kHz) | 30 | 100 * 24000/F(kHz) | $20\log^{(24000/F(kHz))} + 40$ |
| 1.705 ~ 30 | 30 | 30 | 100 * 30 | $20\log^{(30)} + 40$ |
| 30 ~ 88 | 100 | 3 | 100 | $20\log^{(100)}$ |
| 88 ~ 216 | 150 | 3 | 150 | $20\log^{(150)}$ |
| 216 ~ 960 | 200 | 3 | 200 | $20\log^{(200)}$ |
| Above 960 | 500 | 3 | 500 | $20\log^{(500)}$ |

## 7.1 EUT Operation :

Operating Environment:

Temperature: 25.5 °C

Humidity: 51 % RH

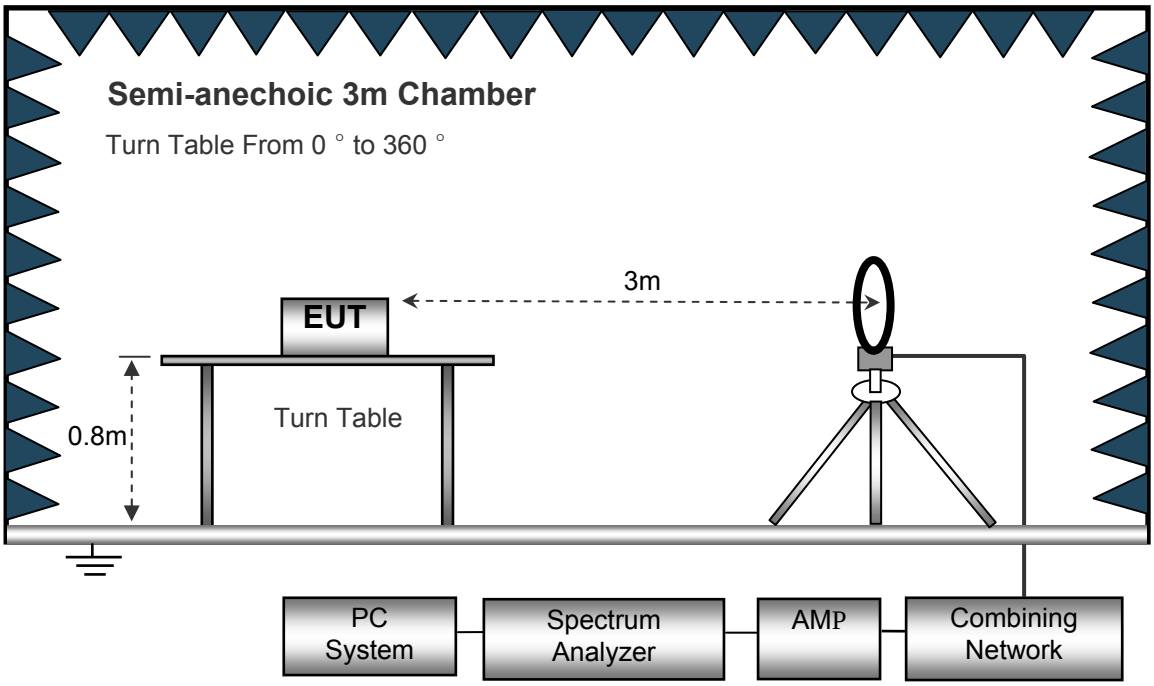
Atmospheric Pressure:1010 mbar

**Operation Mode:**

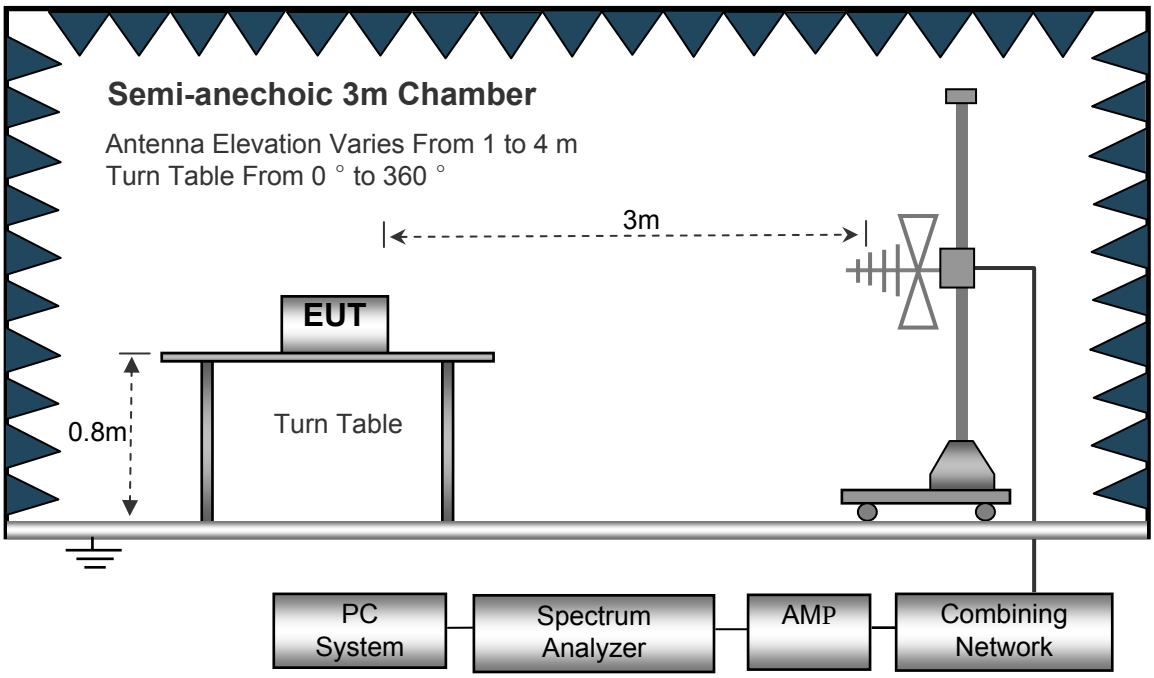
The EUT was tested in transmitting mode, and the data were shown as follow.

## 7.2 Test Setup

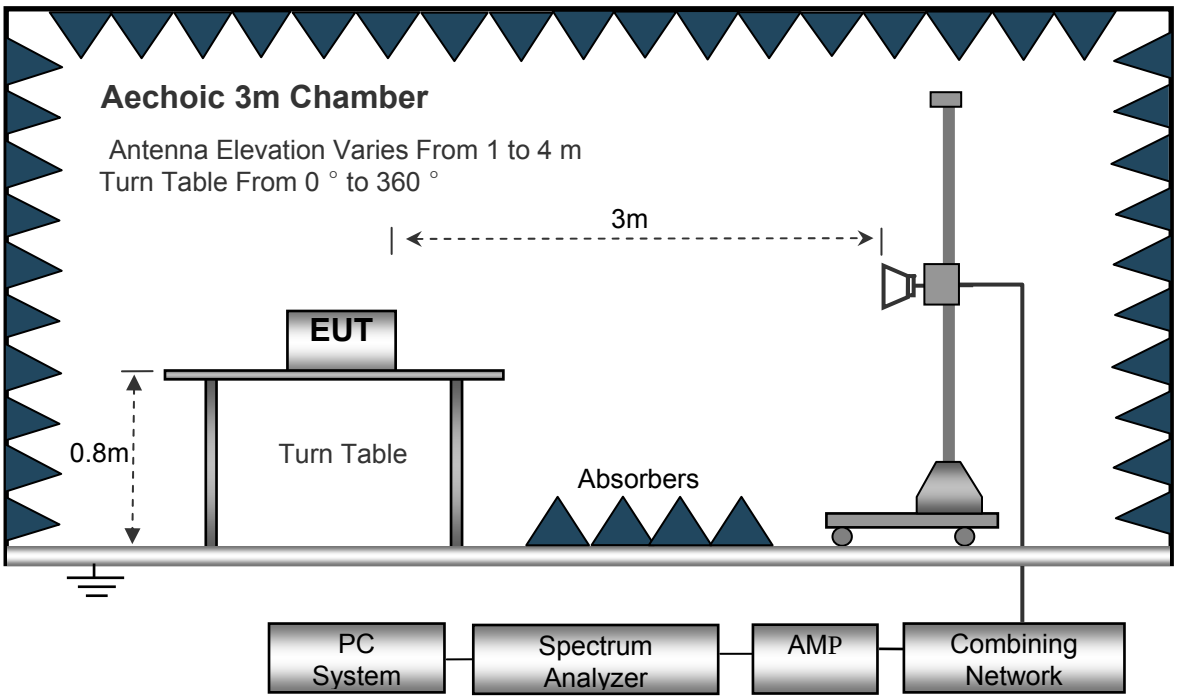
The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.4: 2003.
The test setup for emission measurement below 30MHz.




The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.




## 7.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz

Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 100kHz
Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 3MHz
Detector ..... Ave.
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 10Hz

## 7.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.

## 7.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

## 7.6 Summary of Test Results

**Test Frequency :12.88MHz-30MHz**

The measurements were more than 20 dB below the limit and not reported.

**Test Frequency : 30MHz ~ 18GHz**

Test mode: transmitting

All the modulation modes were tested, the data of the worst mode (GFSK) were recorded in the following pages.

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| **GFSK Lower Channel 2402MHz** | | | | | | | | | |
| 452.64 | 16.50 | PK | 280 | 1.9 | H | 20.49 | 36.99 | 46.00 | -9.01 |
| 452.64 | 15.20 | PK | 332 | 1.8 | V | 20.49 | 35.69 | 46.00 | -10.31 |
| 4804.00 | 64.35 | PK | 335 | 1.6 | V | -2.36 | 61.99 | 74.00 | -12.01 |
| 4804.00 | 44.28 | Ave | 335 | 1.6 | V | -2.36 | 41.92 | 54.00 | -12.08 |
| 7206.00 | 63.47 | PK | 224 | 1.1 | H | 1.33 | 64.80 | 74.00 | -9.20 |
| 7206.00 | 42.69 | Ave | 224 | 1.1 | H | 1.33 | 44.02 | 54.00 | -9.98 |
| 2337.85 | 46.79 | PK | 152 | 1.2 | V | -13.19 | 33.60 | 74.00 | -40.40 |
| 2337.85 | 39.62 | Ave | 152 | 1.2 | V | -13.19 | 26.43 | 54.00 | -27.57 |
| 2385.81 | 44.53 | PK | 290 | 1.4 | H | -13.14 | 31.39 | 74.00 | -42.61 |
| 2385.81 | 36.17 | Ave | 290 | 1.4 | H | -13.14 | 23.03 | 54.00 | -30.97 |
| 2485.63 | 42.56 | PK | 47 | 1.0 | V | -13.08 | 29.48 | 74.00 | -44.52 |
| 2485.63 | 36.40 | Ave | 47 | 1.0 | V | -13.08 | 23.32 | 54.00 | -30.68 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| **GFSK Center Channel 2441MHz** | | | | | | | | | |
| 452.64 | 17.29 | PK | 353 | 1.6 | H | 20.49 | 37.78 | 46.00 | -8.22 |
| 452.64 | 15.24 | PK | 116 | 1.5 | V | 20.49 | 35.73 | 46.00 | -10.27 |
| 4882.00 | 65.17 | PK | 279 | 1.8 | V | -2.30 | 62.87 | 74.00 | -11.13 |
| 4882.00 | 43.36 | Ave | 279 | 1.8 | V | -2.30 | 41.06 | 54.00 | -12.94 |
| 7323.00 | 63.48 | PK | 185 | 1.5 | H | 2.21 | 65.69 | 74.00 | -8.31 |
| 7323.00 | 40.29 | Ave | 185 | 1.5 | H | 2.21 | 42.50 | 54.00 | -11.50 |
| 2338.43 | 45.10 | PK | 139 | 1.9 | V | -13.19 | 31.91 | 74.00 | -42.09 |
| 2338.43 | 39.54 | Ave | 139 | 1.9 | V | -13.19 | 26.35 | 54.00 | -27.65 |
| 2369.02 | 43.18 | PK | 243 | 1.3 | H | -13.14 | 30.04 | 74.00 | -43.96 |
| 2369.02 | 38.43 | Ave | 243 | 1.3 | H | -13.14 | 25.29 | 54.00 | -28.71 |
| 2493.54 | 42.11 | PK | 88 | 1.3 | V | -13.08 | 29.03 | 74.00 | -44.97 |
| 2493.54 | 37.03 | Ave | 88 | 1.3 | V | -13.08 | 23.95 | 54.00 | -30.05 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK Upper Channel 2480MHz | | | | | | | | | |
| 452.64 | 17.13 | PK | 115 | 1.0 | H | 20.49 | 37.62 | 46.00 | -8.38 |
| 452.64 | 16.21 | PK | 326 | 1.3 | V | 20.49 | 36.70 | 46.00 | -9.30 |
| 4960.00 | 66.18 | PK | 312 | 1.0 | V | 0.05 | 66.23 | 74.00 | -7.77 |
| 4960.00 | 45.63 | Ave | 312 | 1.0 | V | 0.05 | 45.68 | 54.00 | -8.32 |
| 7440.00 | 62.61 | PK | 116 | 1.7 | H | 2.84 | 65.45 | 74.00 | -8.55 |
| 7440.00 | 41.23 | Ave | 116 | 1.7 | H | 2.84 | 44.07 | 54.00 | -9.93 |
| 2338.06 | 46.08 | PK | 348 | 1.4 | V | -13.19 | 32.89 | 74.00 | -41.11 |
| 2338.06 | 38.73 | Ave | 348 | 1.4 | V | -13.19 | 25.54 | 54.00 | -28.46 |
| 2352.52 | 44.37 | PK | 179 | 1.7 | H | -13.14 | 31.23 | 74.00 | -42.77 |
| 2352.52 | 36.21 | Ave | 179 | 1.7 | H | -13.14 | 23.07 | 54.00 | -30.93 |
| 2492.73 | 44.85 | PK | 188 | 1.2 | V | -13.08 | 31.77 | 74.00 | -42.23 |
| 2492.73 | 37.23 | Ave | 188 | 1.2 | V | -13.08 | 24.15 | 54.00 | -29.85 |

**Test Frequency : 18-25GHz**
The measurements were more than 20 dB below the limit and not reported.

# 8 Band Edge Measurement

| | |
|---|---|
| Test Requirement: | Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)). |
| Test Method: | DA 00-705 |
| Limit: | 40.0 dBuV/m between 30MHz & 88MHz;<br>43.5 dBuV/m between 88MHz & 216MHz;<br>46.0 dBuV/m between 216MHz & 960MHz;<br>54.0 dBuV/m above 960MHz.<br>74.0 dBuV/m for peak above 1GHz<br>54.0 dBuV/m for AVG above 1GHz |

## 8.1 Test Procedure

1. The EUT was placed on a turntable which is 0.8m above ground plane

2. Measurement Distance is 3m

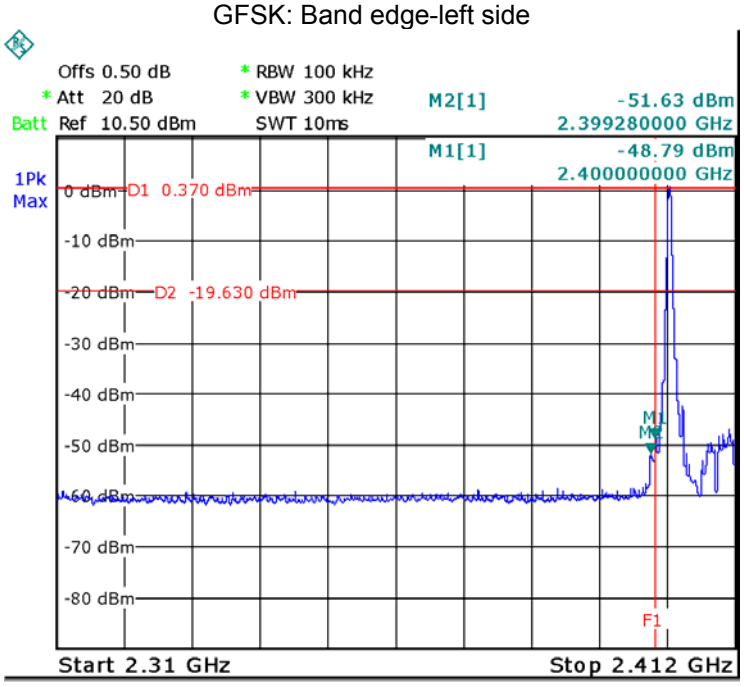
3. Detector: For Peak value:
RBW = 1 MHz for f ≥ 1 GHz
VBW ≥ RBW; Sweep = auto
Detector function = peak
Trace = max hold
For AVG value:
RBW = 1 MHz for f ≥ 1 GHz
VBW = 10Hz; Sweep = auto
Detector function = AVG
Trace = max hold

4.continuous transmitting

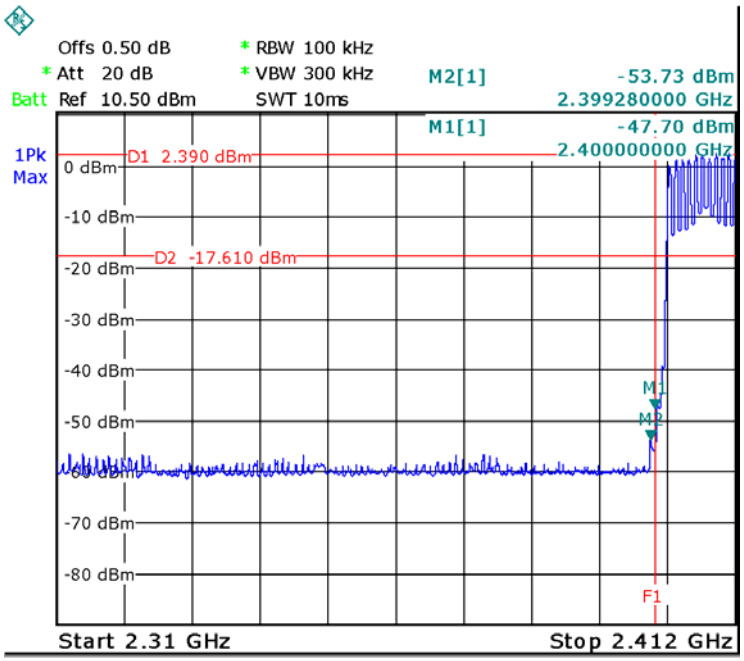
## 8.2 Test Result:

Test result plots shown as follows:

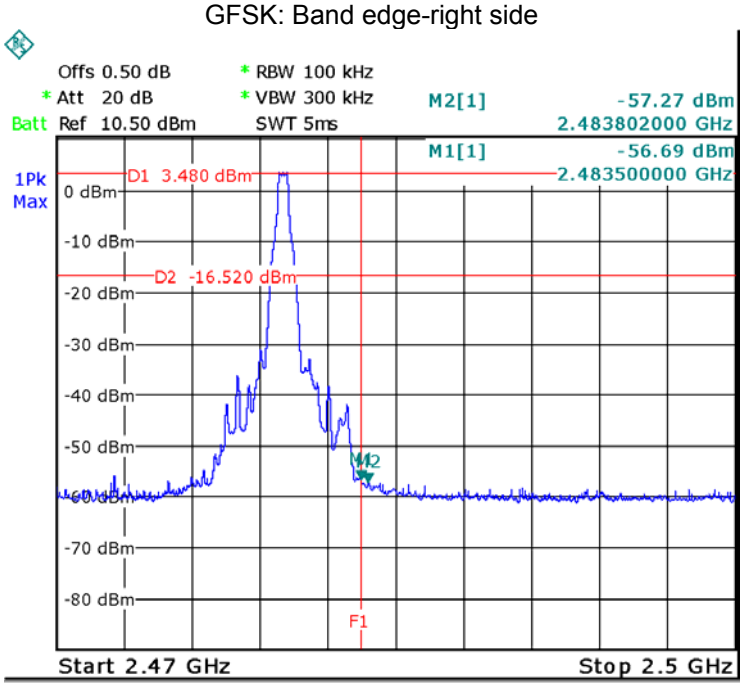
GFSK: Band edge-left side



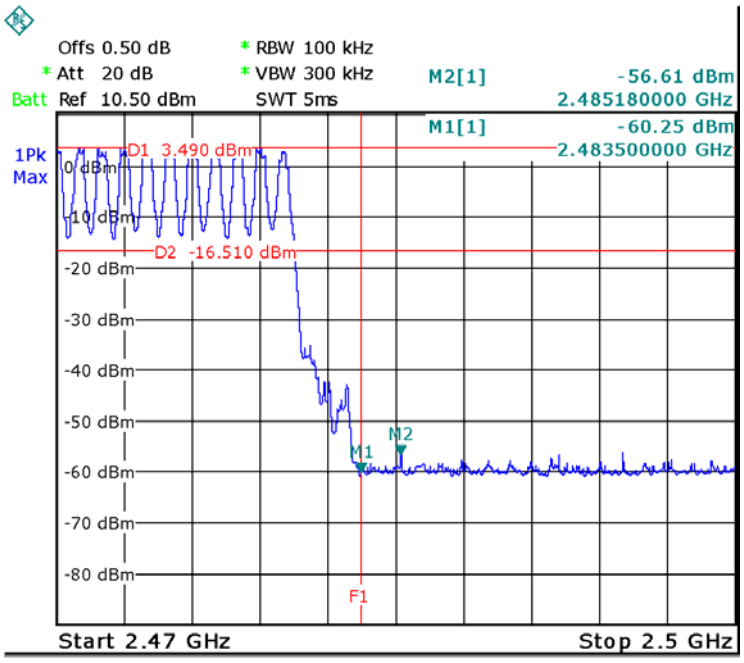

GFSK Hopping Band edge-left side



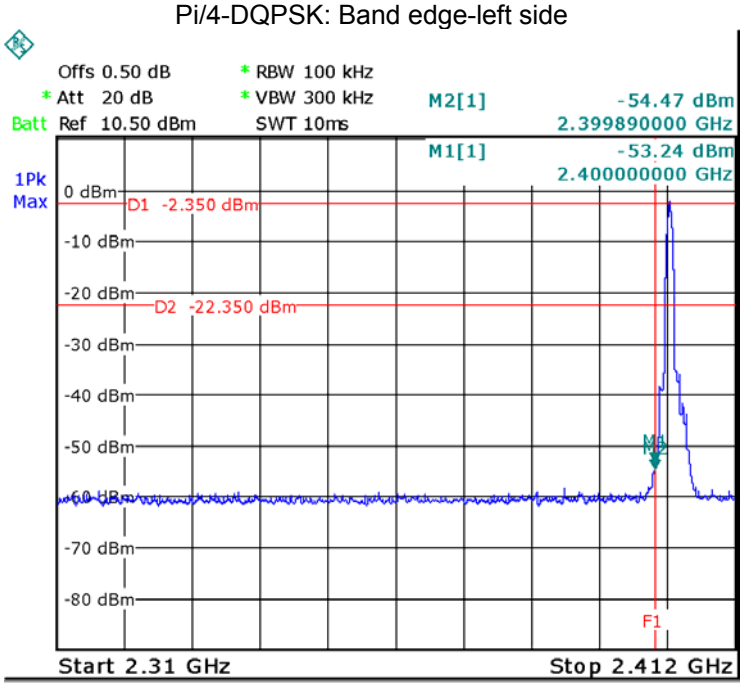
GFSK: Band edge-right side



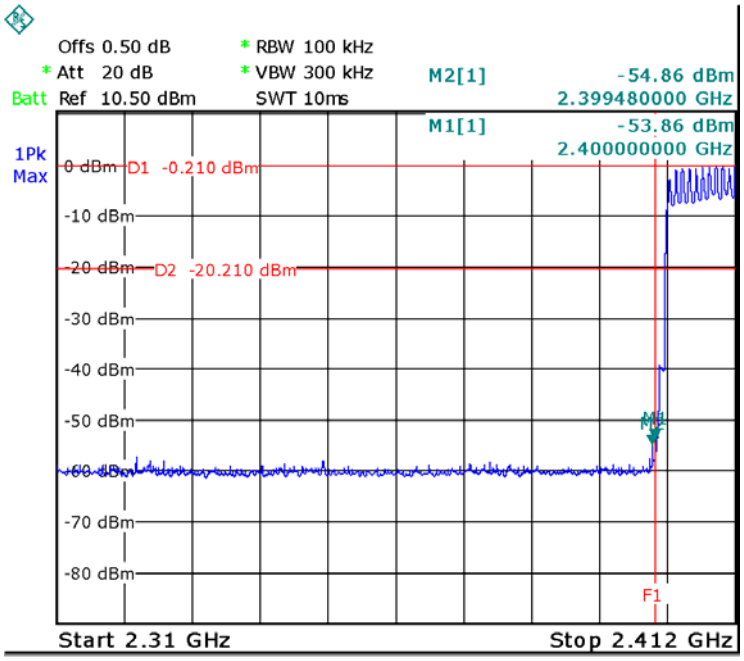

GFSK Hopping Band edge-right side



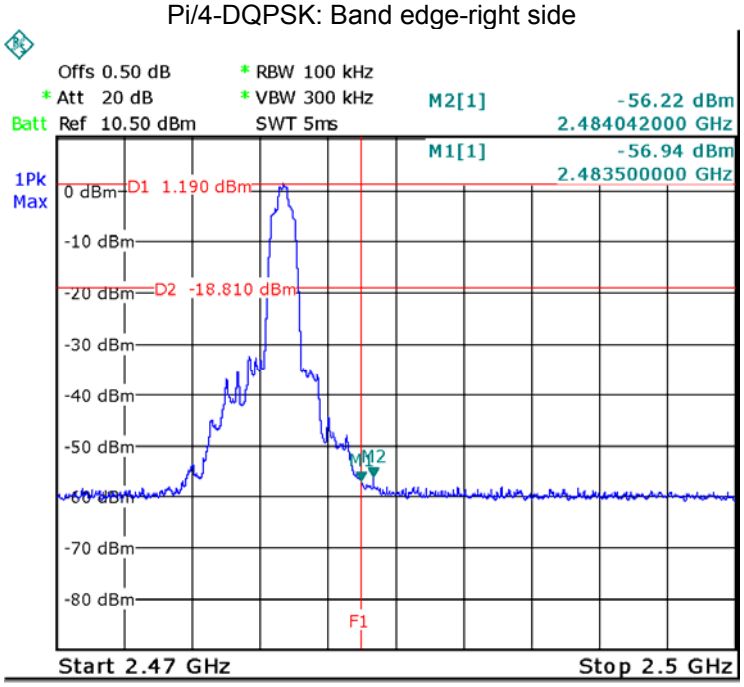
Pi/4-DQPSK: Band edge-left side



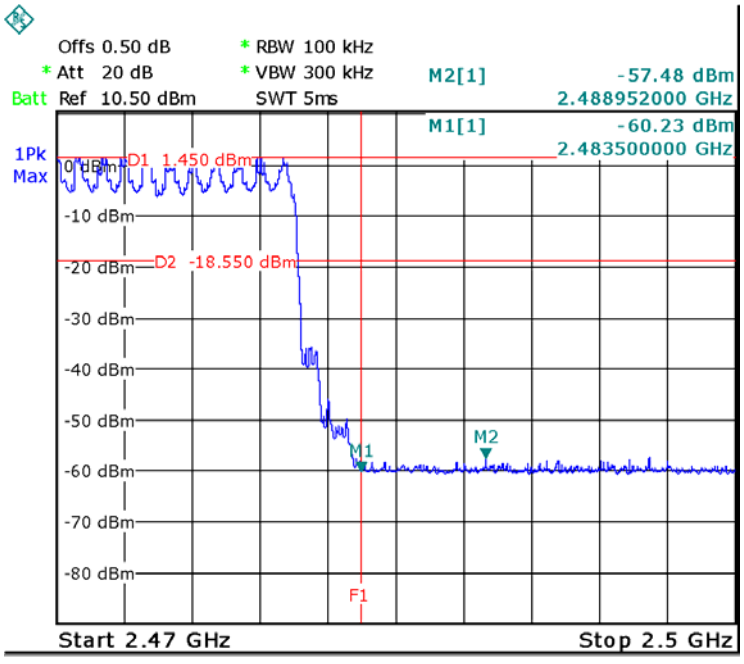

Pi/4 DQPSK Hopping Band edge-left side



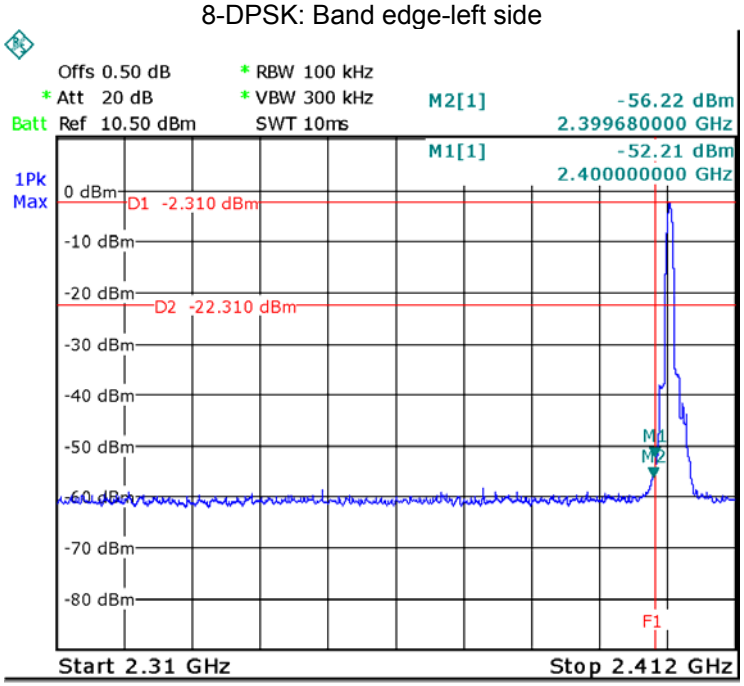
Pi/4-DQPSK: Band edge-right side



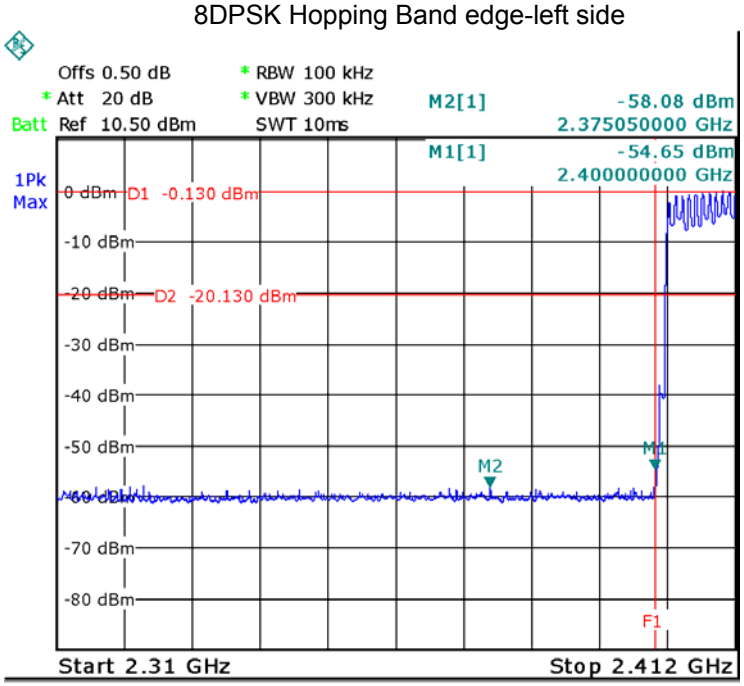

Pi/4 DQPSK Hopping Band edge-right side



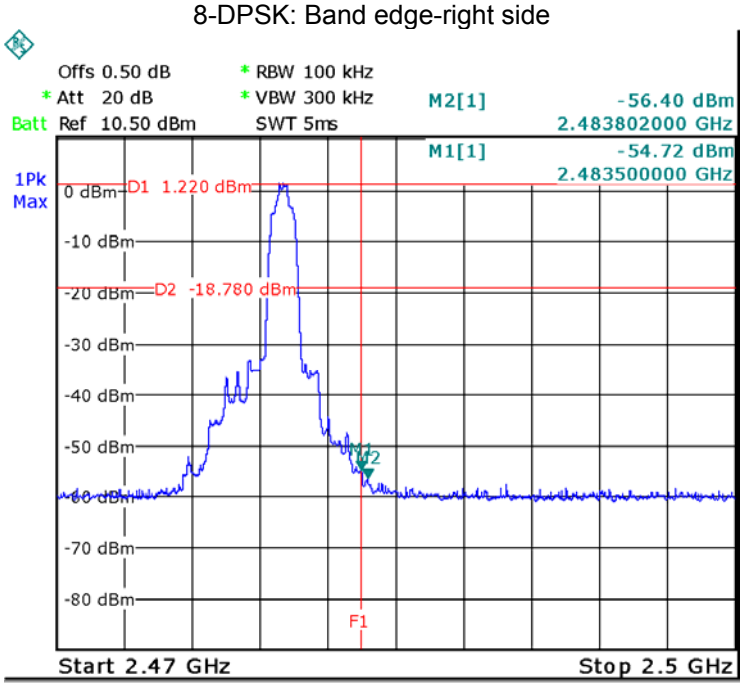
8-DPSK: Band edge-left side



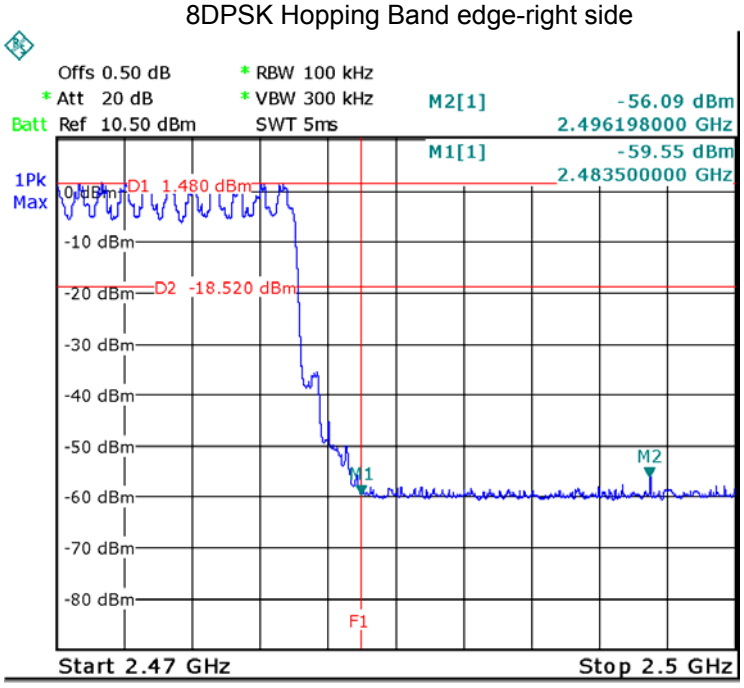

8DPSK Hopping Band edge-left side



8-DPSK: Band edge-right side




8DPSK Hopping Band edge-right side



# 9 20 dB Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Mode: Test in fixing operating frequency at low, Middle, high channel.

## 9.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

2. Set the spectrum analyzer: RBW = 100kHz, VBW = 100kHz

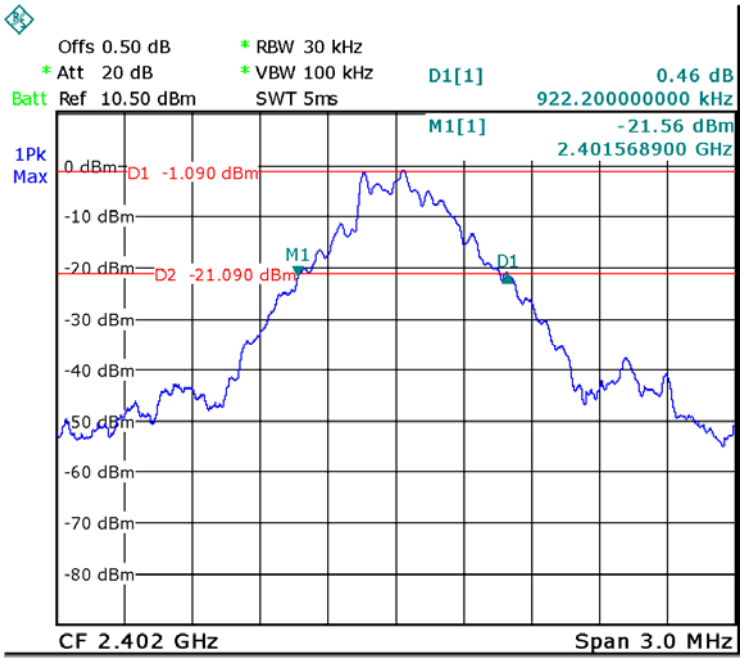
## 9.2 Test Result:

| Modulation | Test Channel | Bandwidth(MHz) |
|---|---|---|
| GFSK | Lower | 0.922 |
| | Middle | 0.922 |
| | Upper | 0.922 |
| Pi/4DQPSK | Lower | 1.222 |
| | Middle | 1.222 |
| | Upper | 1.222 |
| 8DPSK | Lower | 1.216 |
| | Middle | 1.216 |
| | Upper | 1.216 |

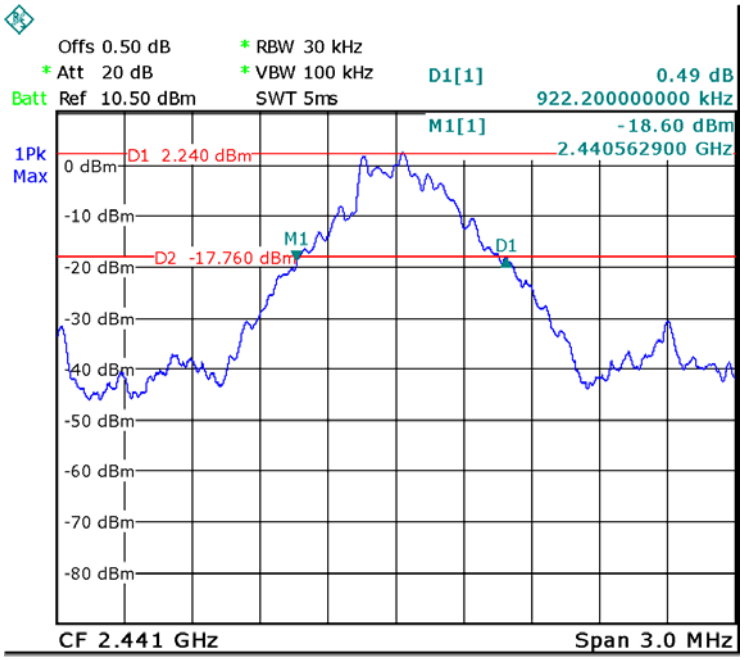
Test result plot as follows:

Modulation:GFSK

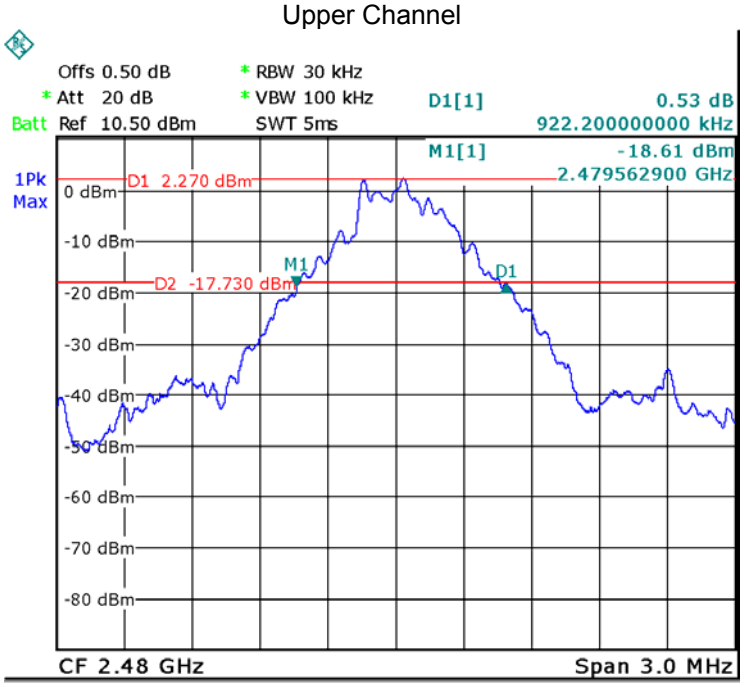
Lower Channel




Middle Channel

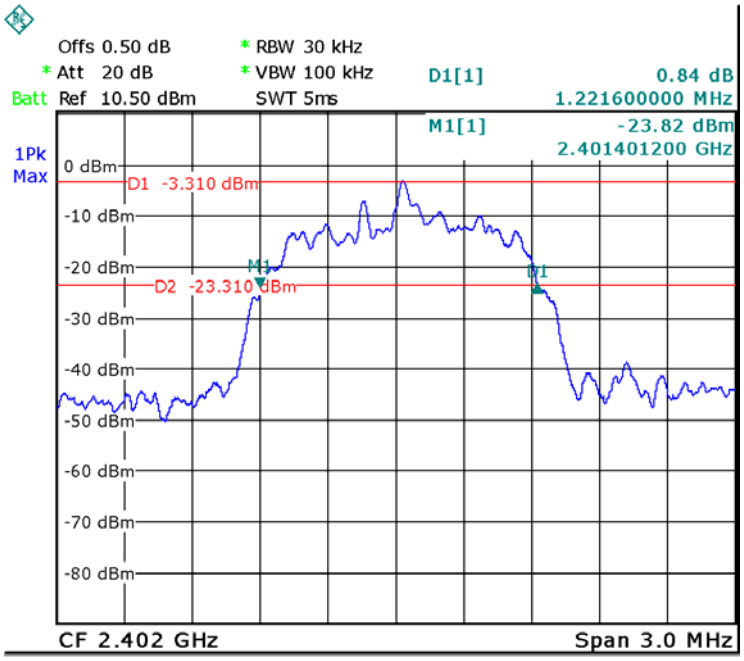


Upper Channel

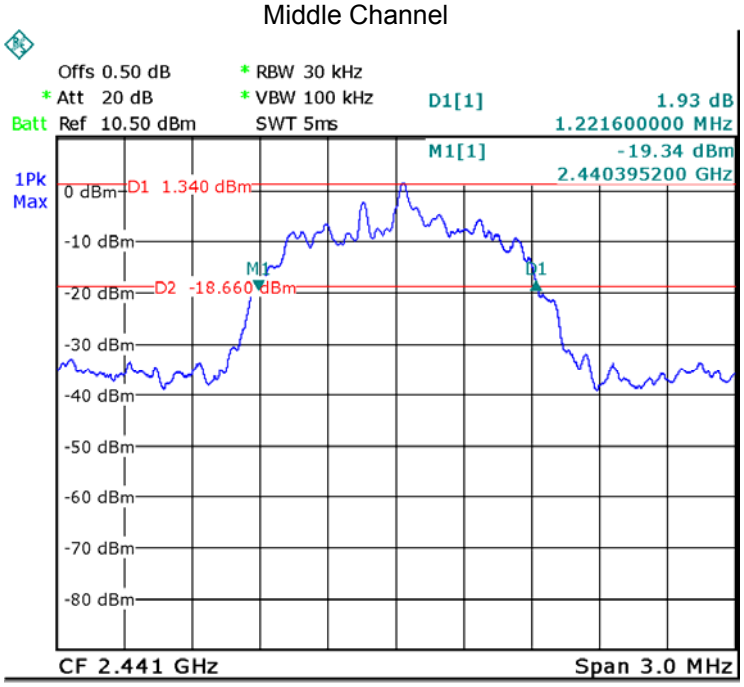



Modulation: Pi/4DQPSK

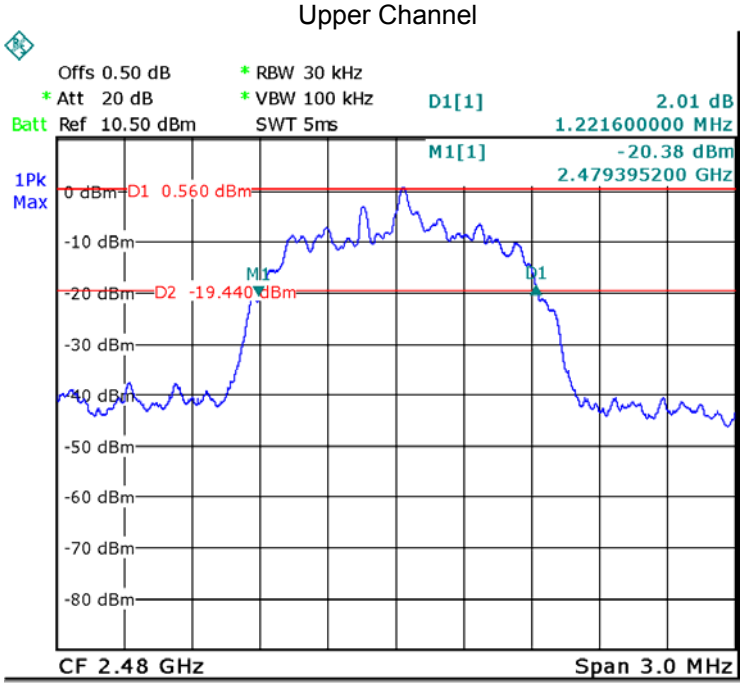
Lower Channel



Middle Channel

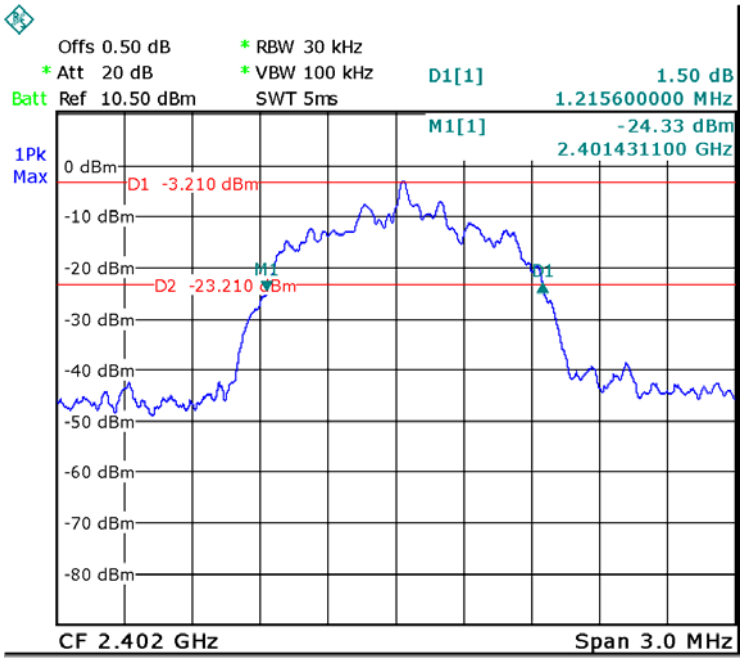



Upper Channel

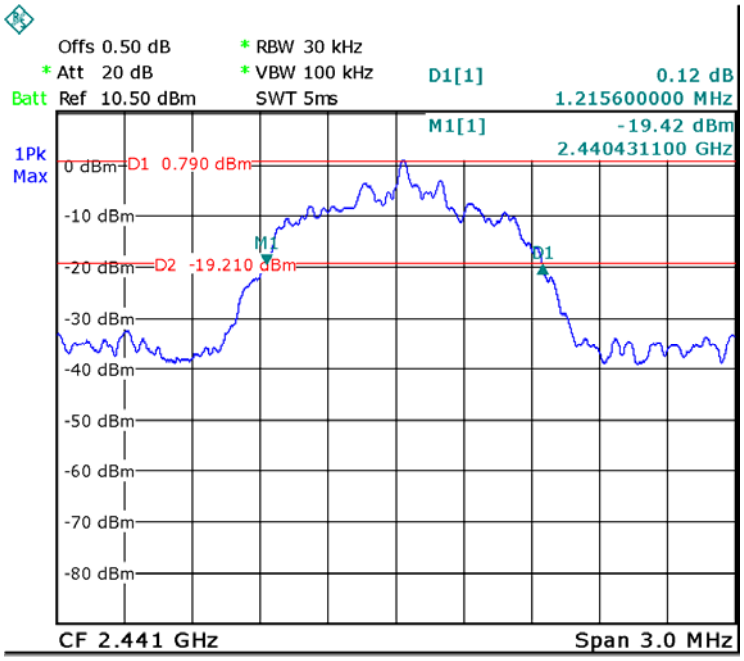


Modulation: 8DPSK

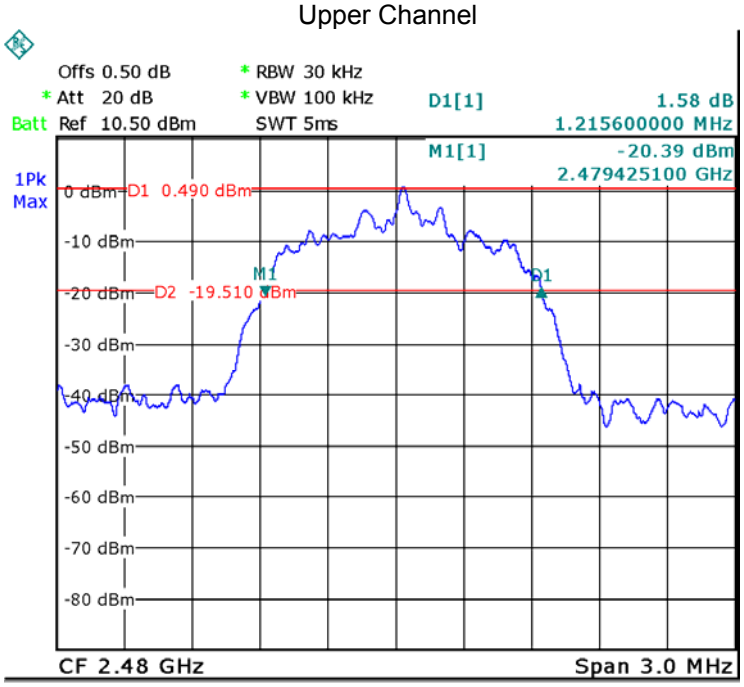
Lower Channel




Middle Channel



Upper Channel



# 10 Maximum Peak Output Power

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 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.

Refer to the result “Number of Hopping Frequency” of this document. The 1watts (30 dBm) limit applies.

Test mode: Test in fixing frequency transmitting mode.

## 10.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 3 MHz. VBW =3 MHz. Sweep = auto; Detector Function = Peak.

3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

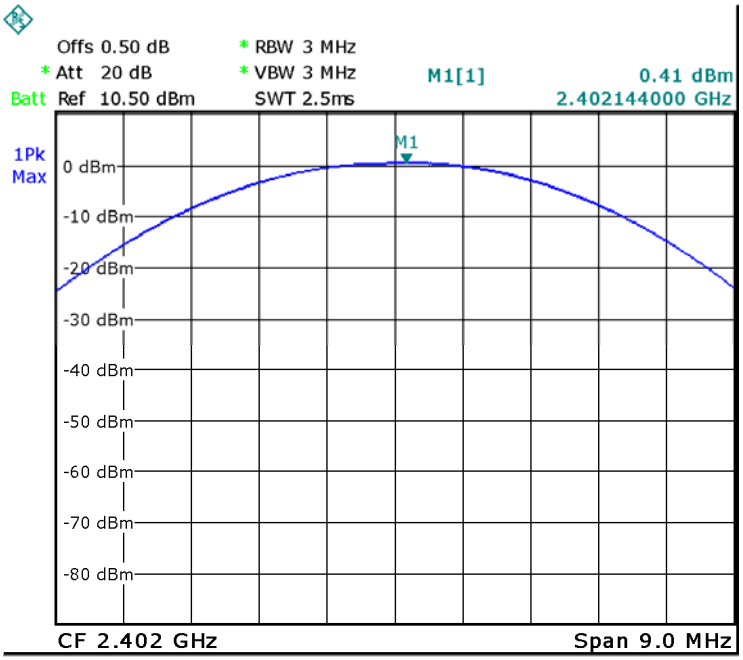
## 10.2 Test Result:

| Modulation | Test Channel | Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | Lower | 0.41 | 30 |
| | Middle | 3.29 | 30 |
| | Upper | 3.64 | 30 |
| Pi/4DQPSK | Lower | -1.2 | 30 |
| | Middle | 2.56 | 30 |
| | Upper | 2.3 | 30 |
| 8DPSK | Lower | -0.61 | 30 |
| | Middle | 2.8 | 30 |
| | Upper | 2.66 | 30 |

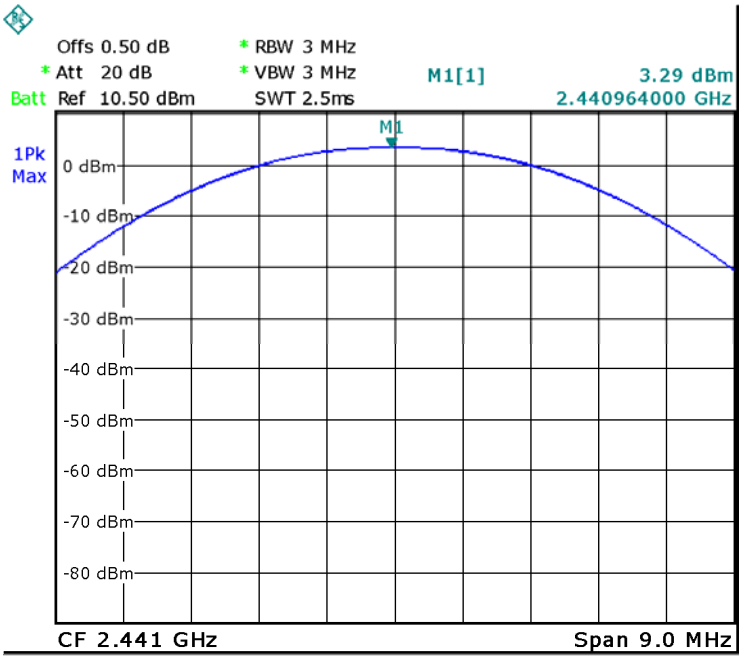
Test result plot as follows:

Modulation:GFSK

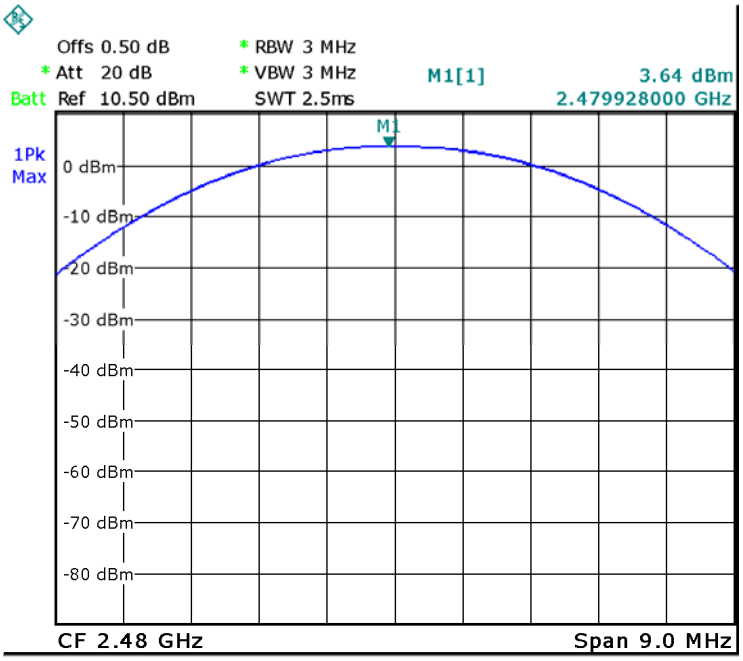
Lower Channel




Middle Channel

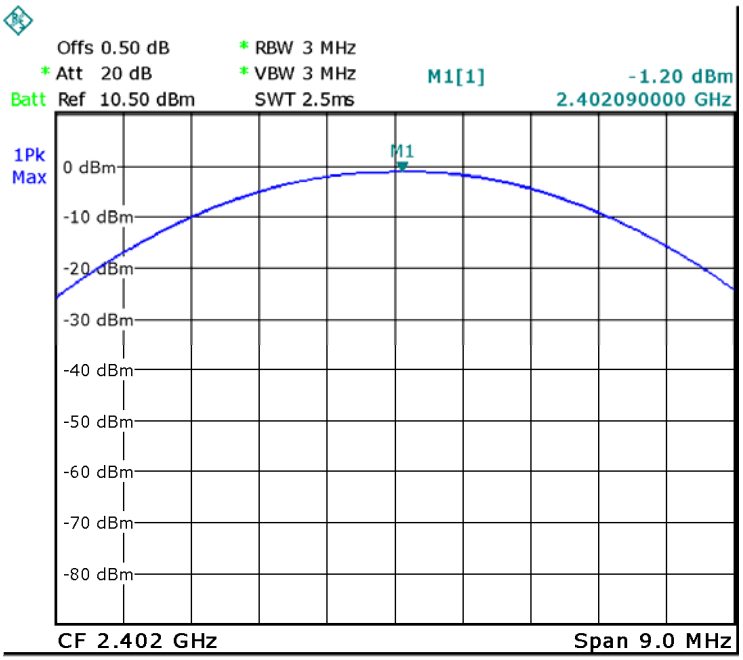



Upper Channel

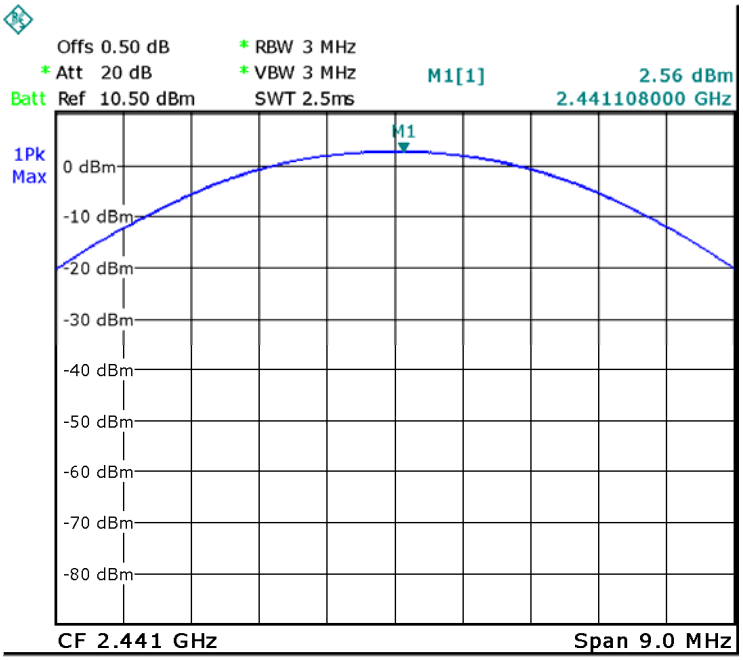



Modulation: Pi/4DQPSK

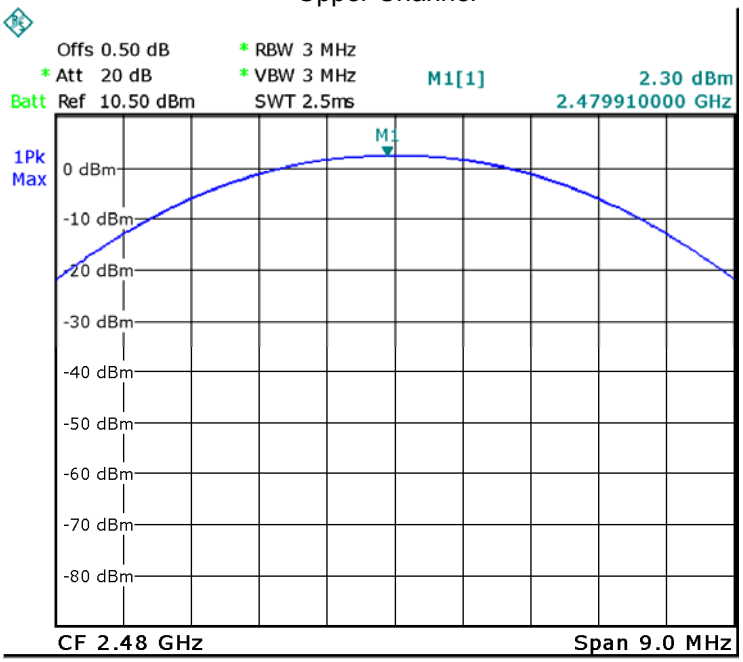
Lower Channel



Middle Channel

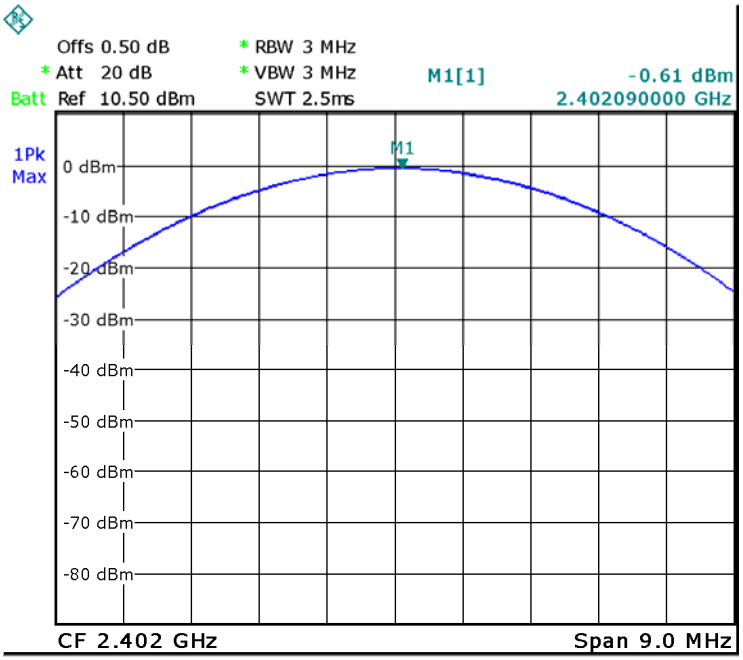



Upper Channel

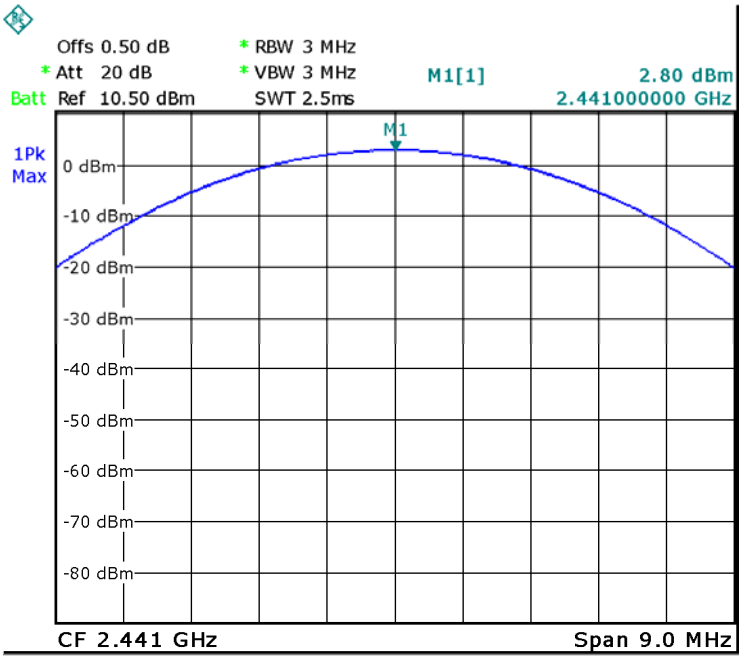


Modulation: 8DPSK

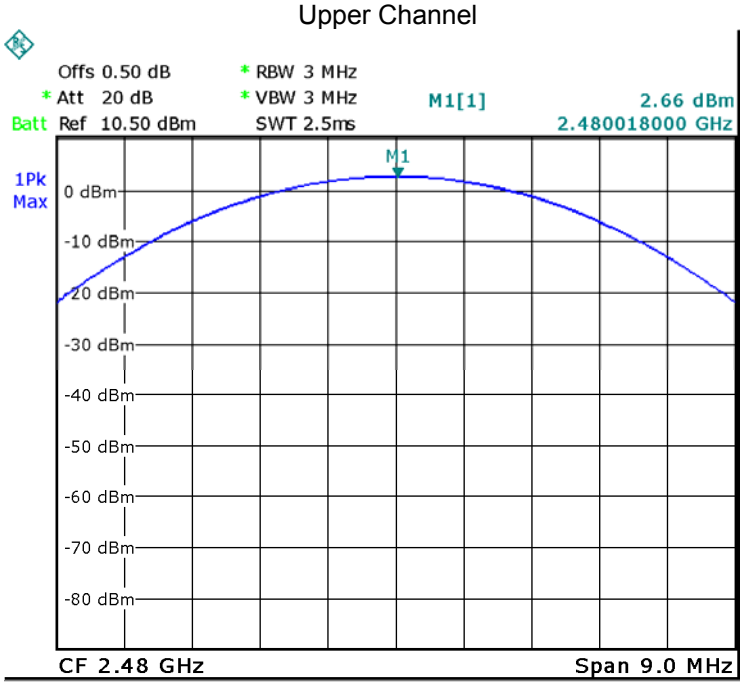
Lower Channel




Middle Channel



Upper Channel



# 11 Hopping Channel Separation

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 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 1W.

Test Mode: Test in hopping transmitting operating mode.

## 11.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 100KHz. VBW = 100KHz , Span = 6MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

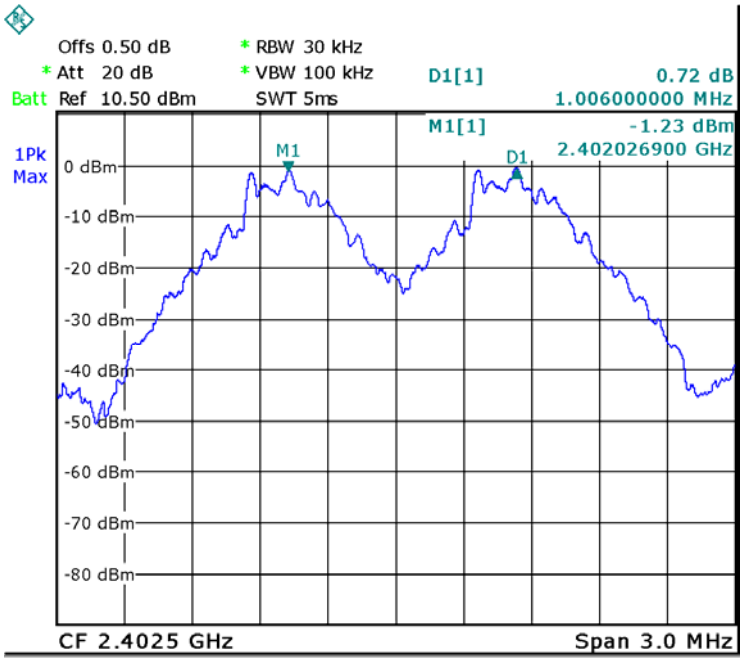
## 11.2 Test Result:

| Modulation | Test Channel | Separation (MHz) |
|---|---|---|
| GFSK | Lower | 1.006 |
| | Middle | 1.006 |
| | Upper | 1.006 |
| Pi/4DQPSK | Lower | 1.006 |
| | Middle | 1.006 |
| | Upper | 1.006 |
| 8DPSK | Lower | 1.006 |
| | Middle | 1.006 |
| | Upper | 1.006 |

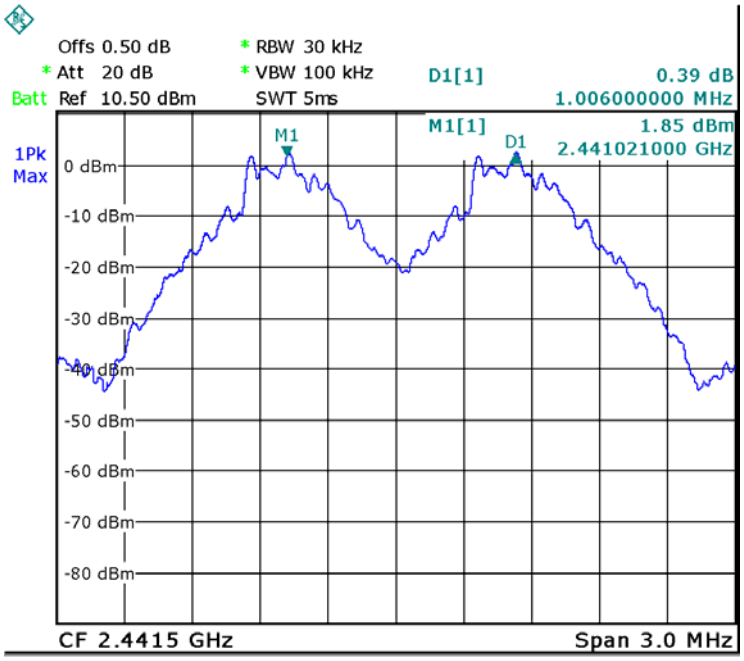
Test result plot as follows:

Modulation: GFSK

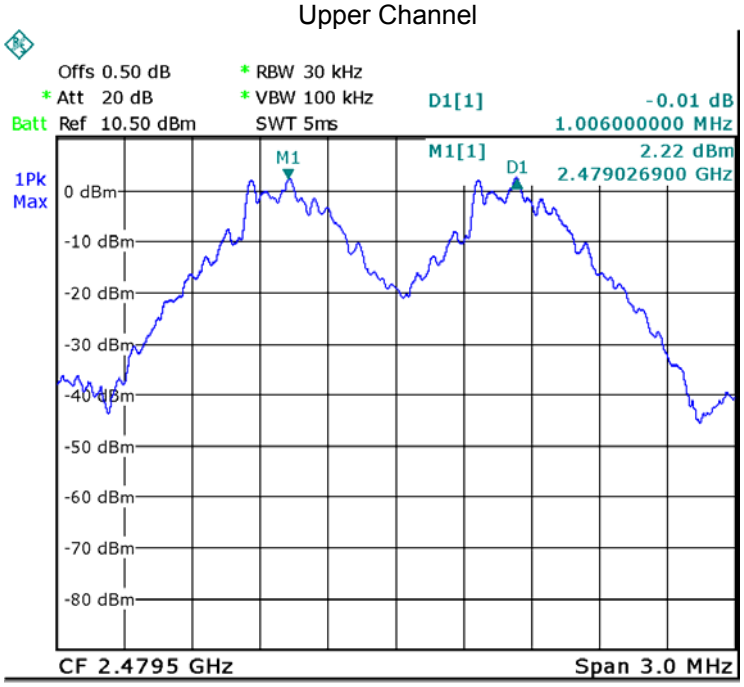
Lower Channel




Middle Channel

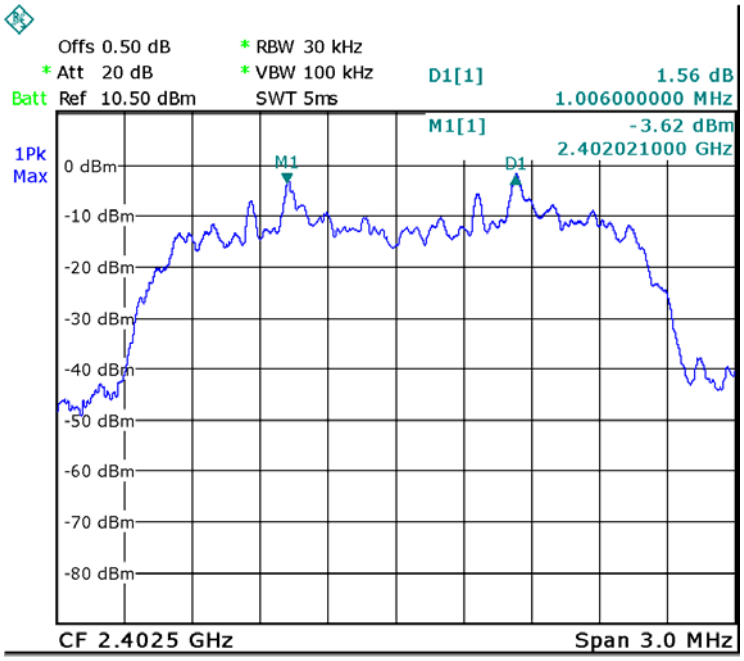


Upper Channel

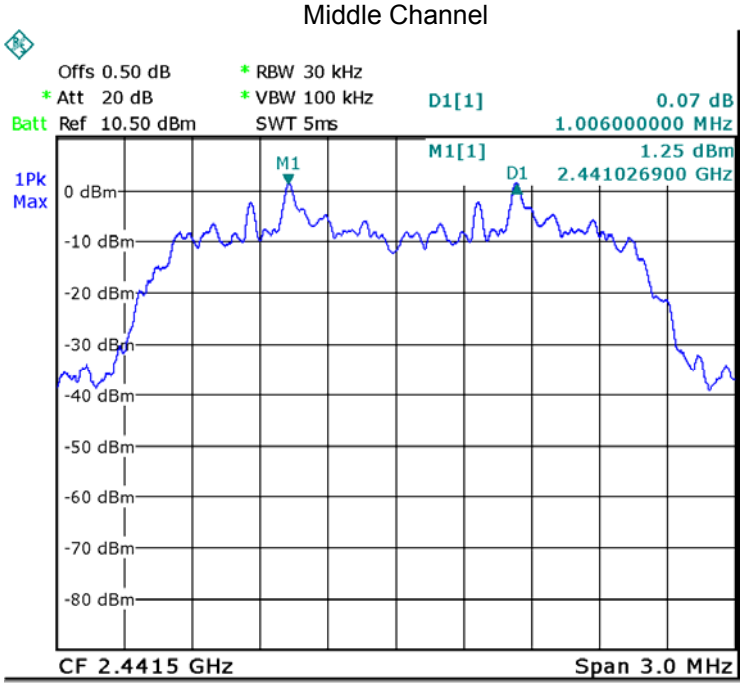



Modulation: Pi/4DQPSK

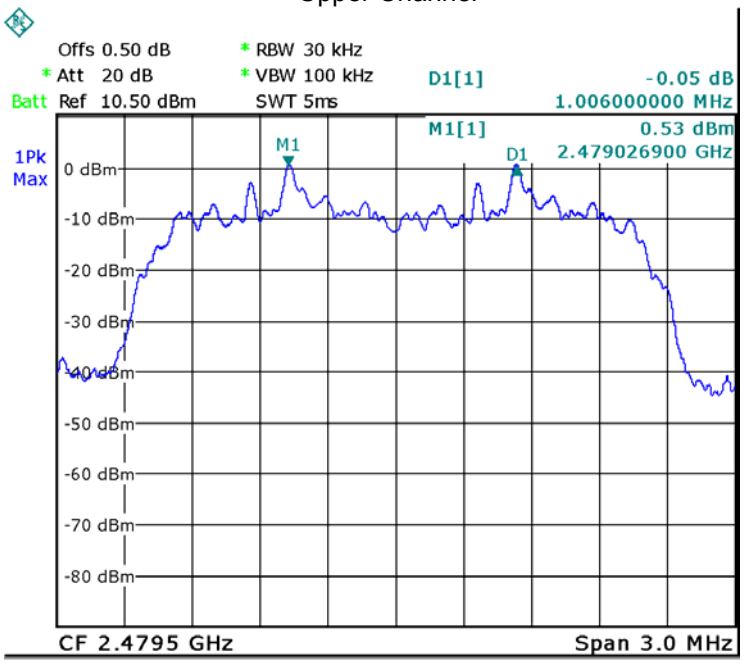
Lower Channel



Middle Channel

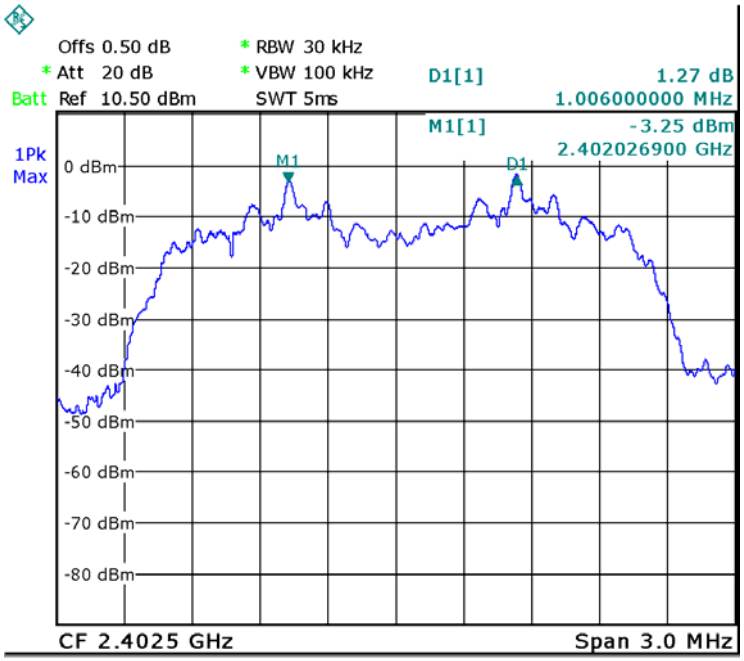



Upper Channel

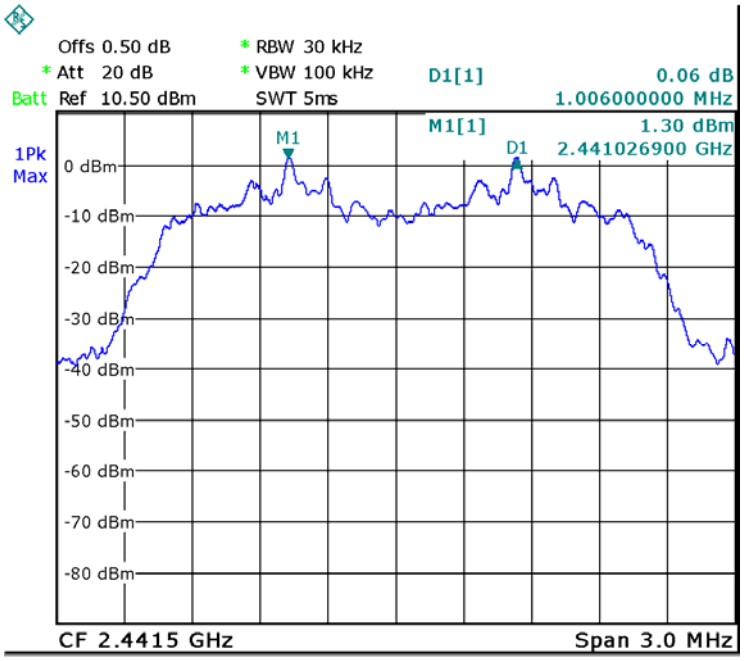


Modulation: 8DPSK

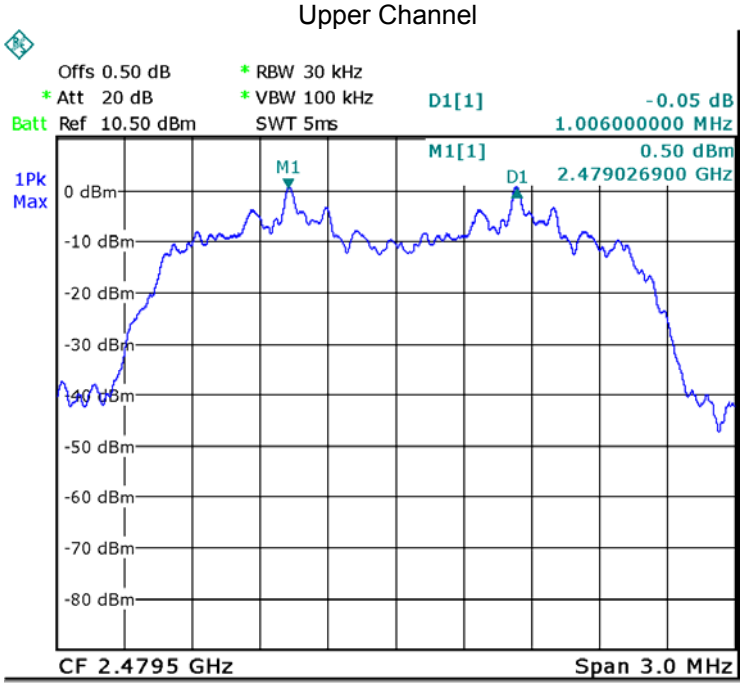
Lower Channel




Middle Channel



Upper Channel



# 12 Number of Hopping Frequency

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: DA 00-705

Test Limit: Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Mode: Test in hopping transmitting operating mode.

## 12.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 1MHz. VBW = 1MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

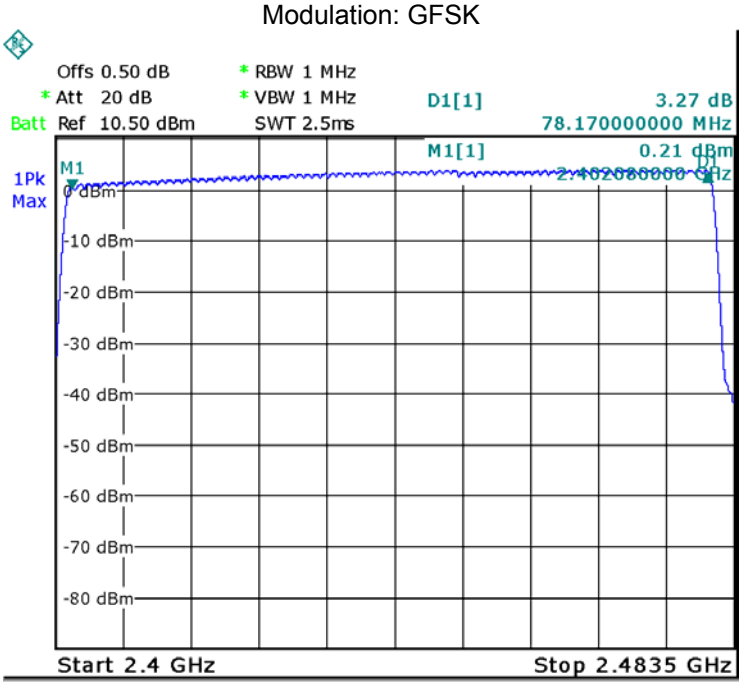
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

4. Set the spectrum analyzer: Centre Frequency = 2.441GHz, Span = 86MHz. Sweep=auto;

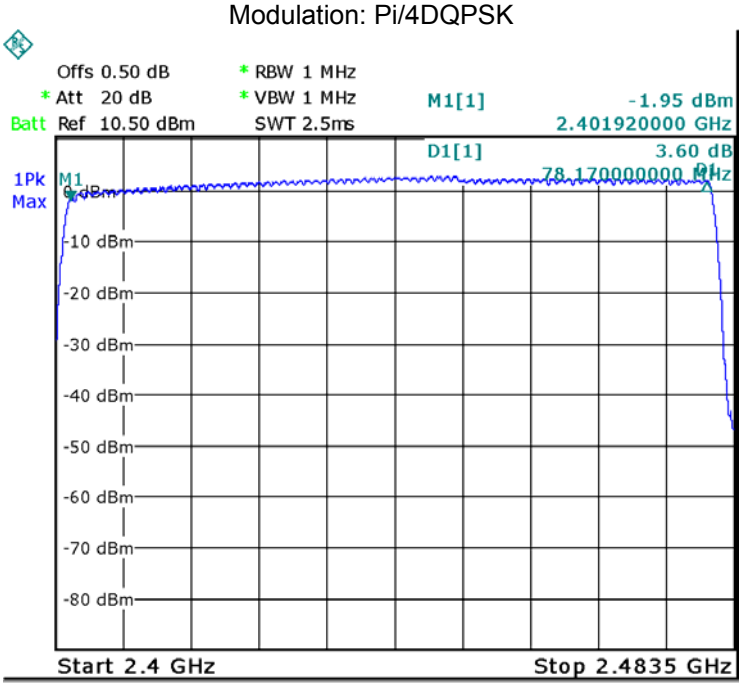
## 12.2 Test Result:

**Total Channels are 79 Channels.**

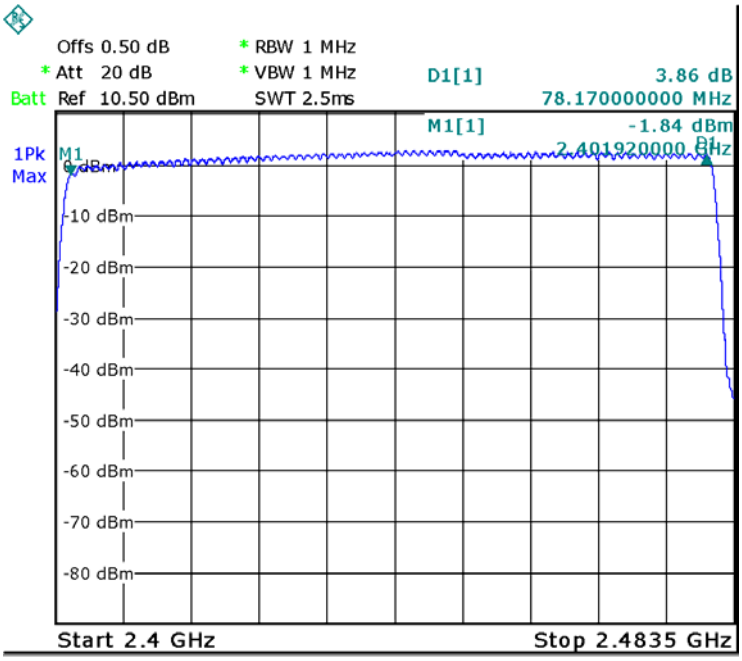
Modulation: GFSK



Modulation: Pi/4DQPSK




Modulation: 8DPSK



# 13 Dwell Time

| | |
|---|---|
| Test Requirement: | FCC CFR47 Part 15 Section 15.247 |
| Test Method: | DA 00-705 |
| Test Limit: | Regulation 15.247(a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used. |
| Test Mode: | Test in hopping transmitting operating mode. |

## 13.1 Test Procedure:

1.Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2.Set spectrum analyzer span = 0. centred on a hopping channel;

3.Set RBW = 1MHz and VBW = 1MHz. Sweep = as necessary to capture the entire dwell time per hopping channel.

4.Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

## 13.2 Test Result:

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period
The test period: T= 0.4(s) * 79 = 31.6 (s)
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

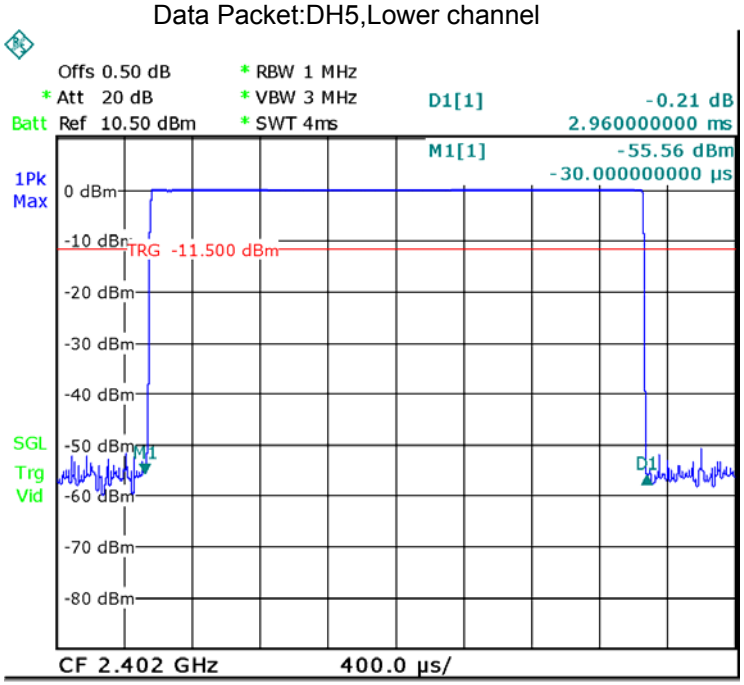
DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

| Data Packet | Dwell Time(s) |
|---|---|
| DH5 | 1600/79/6*31.6*(MkrDelta)/1000 |
| DH3 | 1600/79/4*31.6*(MkrDelta)/1000 |
| DH1 | 1600/79/2*31.6*(MkrDelta)/1000 |
| Remark | Mkr Delta is once pulse time. Only the worst data(DH5) were show as follow. |

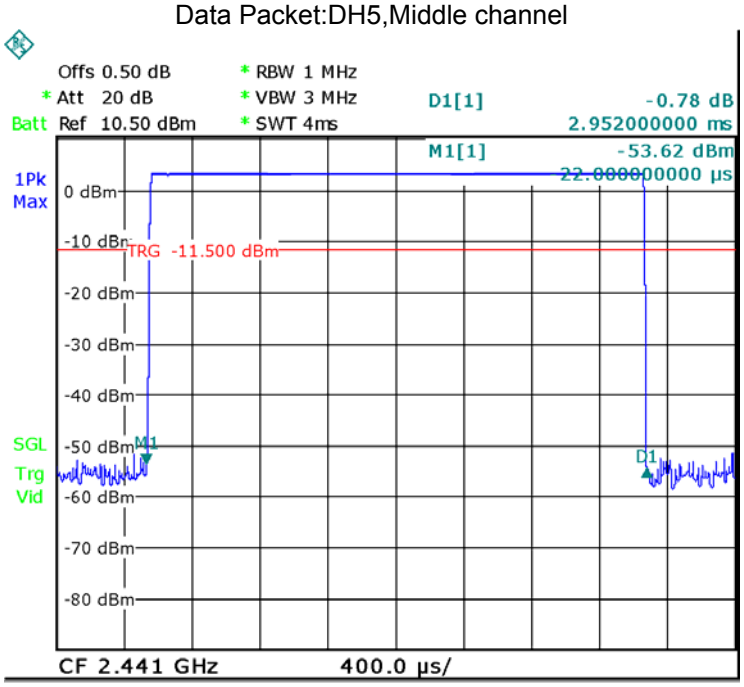
| Modulation | Frequency | Data Packet | Mkr Delta(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|---|
| GFSK | Lower channel | DH5 | 2.960 | 0.316 | 0.400 |
| | Middle channel | | 2.952 | 0.315 | 0.400 |
| | Upper channel | | 2.950 | 0.315 | 0.400 |
| Pi/4DQPSK | Lower channel | DH5 | 2.950 | 0.315 | 0.400 |
| | Middle channel | | 2.960 | 0.316 | 0.400 |
| | Upper channel | | 2.960 | 0.316 | 0.400 |
| 8DPSK | Lower channel | DH5 | 2.960 | 0.316 | 0.400 |
| | Middle channel | | 2.964 | 0.316 | 0.400 |
| | Upper channel | | 2.972 | 0.317 | 0.400 |

Modulation: GFSK

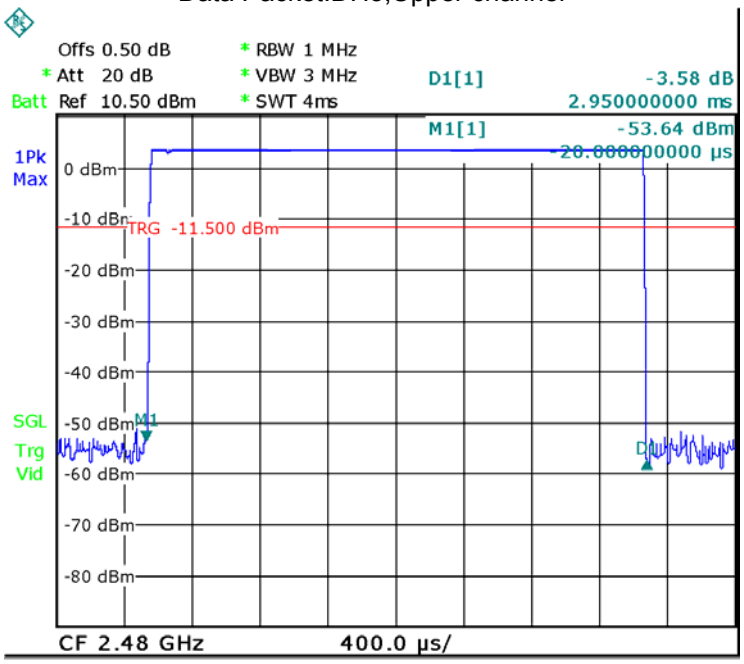
Data Packet:DH5,Lower channel



Data Packet:DH5,Middle channel

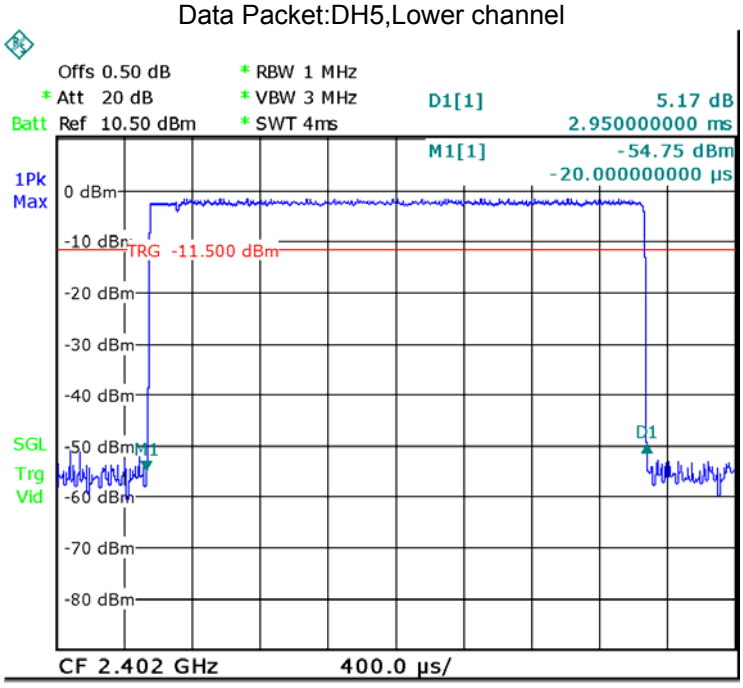



Data Packet:DH5,Upper channel

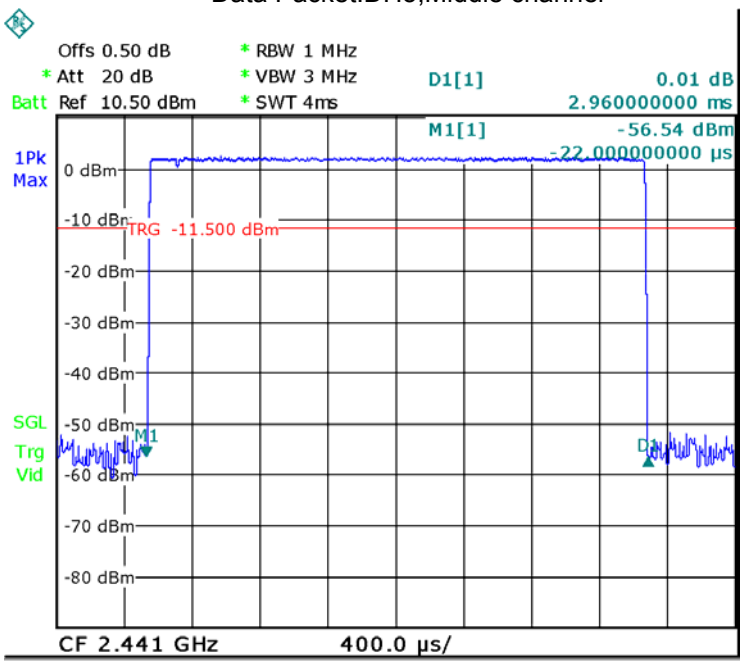


Modulation: Pi/4DQPSK

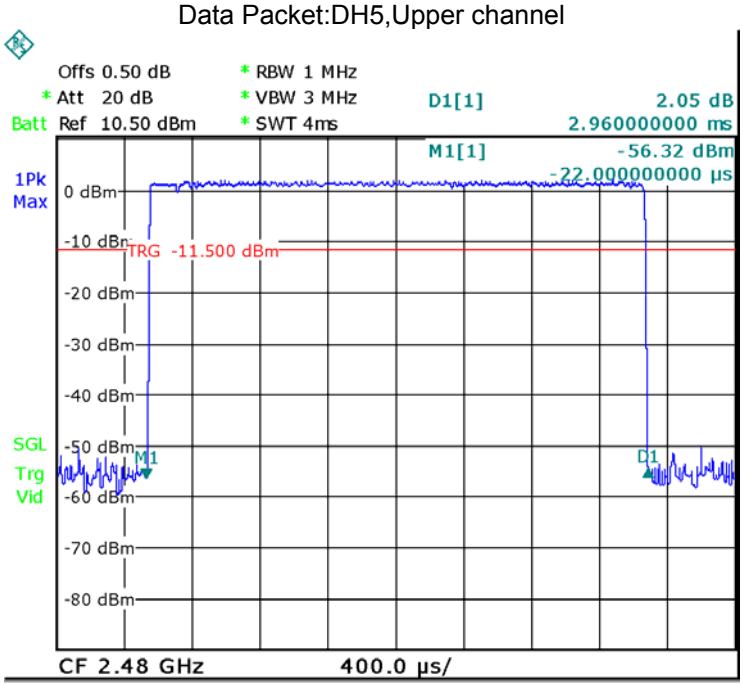
Data Packet:DH5,Lower channel




Data Packet:DH5,Middle channel

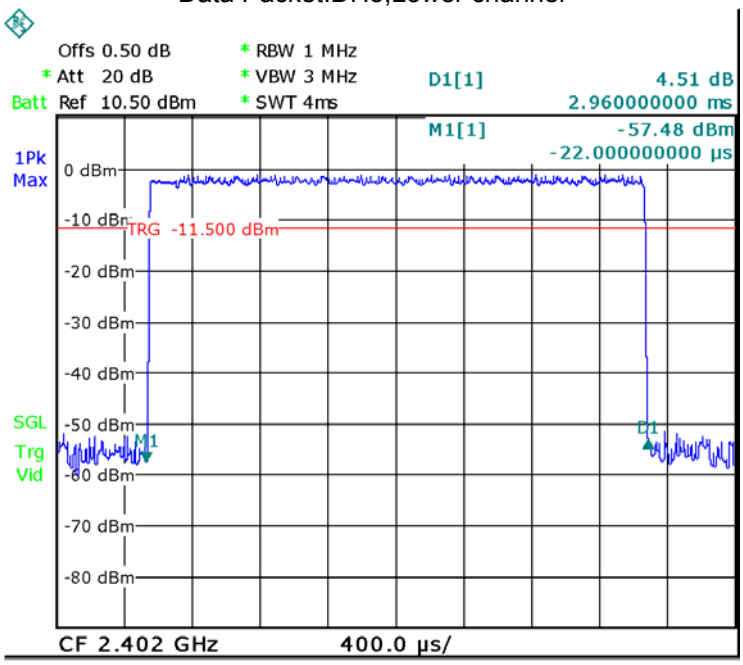


Data Packet:DH5,Upper channel

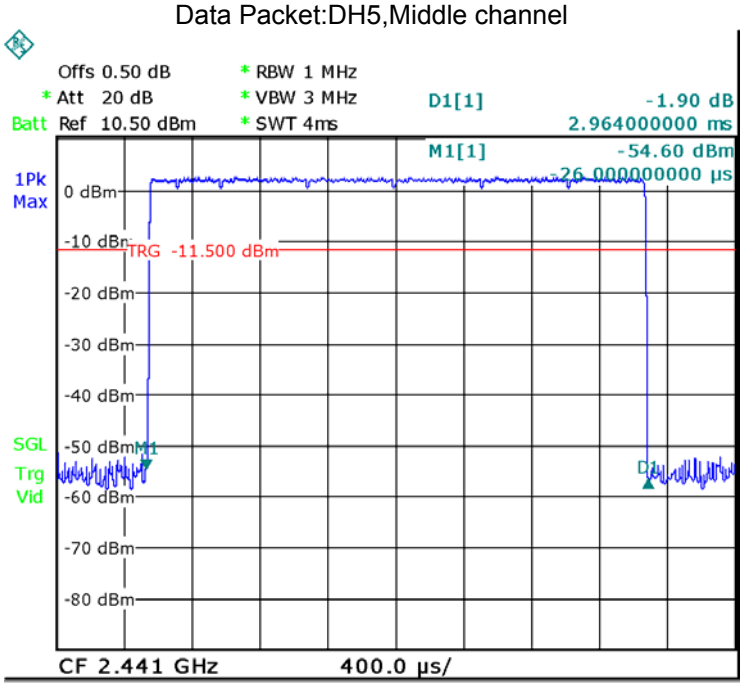



Modulation: 8DPSK

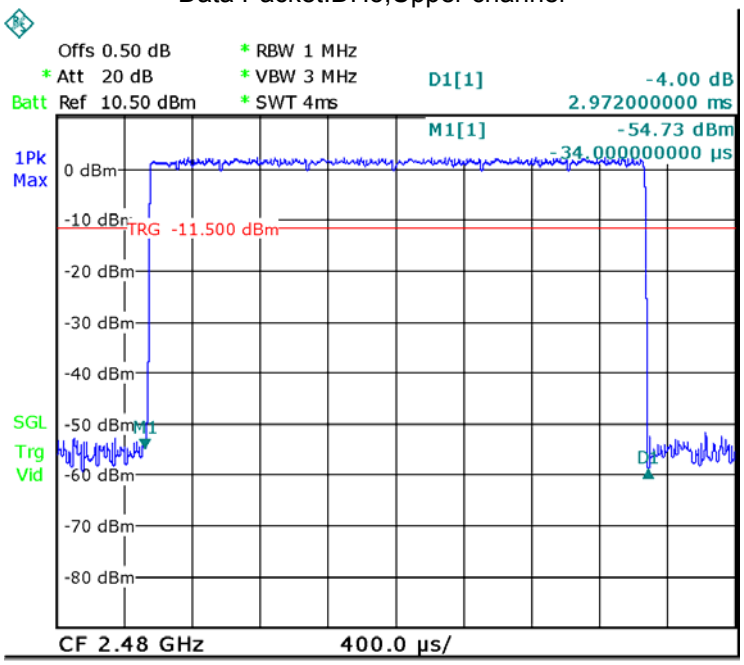
Data Packet:DH5,Lower channel



Data Packet:DH5,Middle channel




Data Packet:DH5,Upper channel



# 14 Antenna Requirement

According to the FCC Part 15 Paragraph 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. This product has a Copper foil antenna, fulfill the requirement of this section.

# 15 RF Exposure

Test Requirement: FCC Part 1.1307

Test Mode: The EUT work in test mode(Tx).

## 15.1 Requirements:

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 0.2 m normally can be maintained between the user and the device.

## 15.2 The procedures / limit

(A) Limits for Occupational / Controlled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/ $cm^2$) | Averaging Time $\|E\|^2$,$\|H\|^2$or S (minutes) |
|---|---|---|---|---|
| 0.3-3.0 | 614 | 1.63 | (100)* | 6 |
| 3.0-30 | 1842 / f | 4.89 / f | (900 / f)* | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | | | F/300 | 6 |
| 1500-100,000 | | | 5 | 6 |

(B) Limits for General Population / Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/ $cm^2$) | Averaging Time $\|E\|^2$,$\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | (180/f)* | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | | | F/1500 | 30 |
| 1500-100,000 | | | 1.0 | 30 |

Note: f = frequency in MHz ; *Plane-wave equivalent power density

## 15.3 MPE Calculation Method

$$\text{E (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \qquad \text{Power Density: } Pd \text{ (W/m²)} = \frac{E^2}{377}$$

**E** = Electric field (V/m)
**P** = Peak RF output power (W)
**G** = EUT Antenna numeric gain (numeric) ,$Gain_{numeric}=10^{(dBi/10)}$
**d** = Separation distance between radiator and human body (m)
The formula can be changed to

$$\boldsymbol{Pd} = \frac{30 \times P \times G}{377 \times d^2}$$

From the peak EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the gain of the used antenna, the RF power density can be obtained

| Modulation | Antenna Gain (dBi) | Antenna Gain (numeric) | Max. Output Power (dBm) | Peak Output Power (mW) | Power Density (S) ($mW/cm^2$) | Limit of Power Density (S) ($mW/cm^2$) |
|---|---|---|---|---|---|---|
| GFSK | 2.11 | 1.626 | 3.64 | 2.312 | 0.000748 | 1 |
| Pi/4DQPSK | 2.11 | 1.626 | 2.56 | 1.803 | 0.000583 | 1 |
| 8DPSK | 2.11 | 1.626 | 2.8 | 1.905 | 0.000616 | 1 |

# 16 Photographs – Test Setup

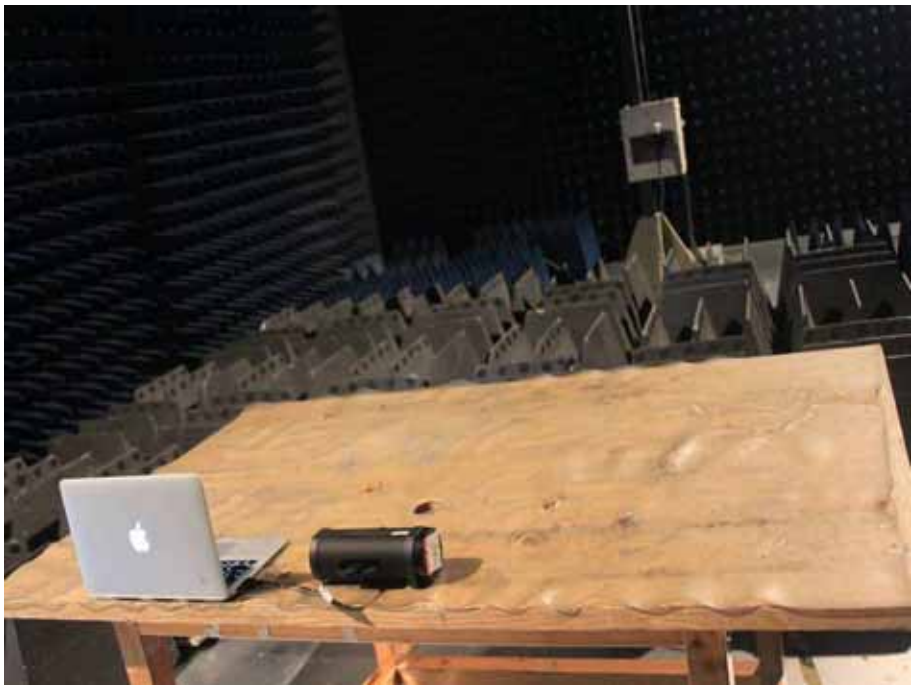
## 16.1 Conducted Emissions

## 16.2 Radiated Emissions

Below 30MHz

From 30-1000MHz

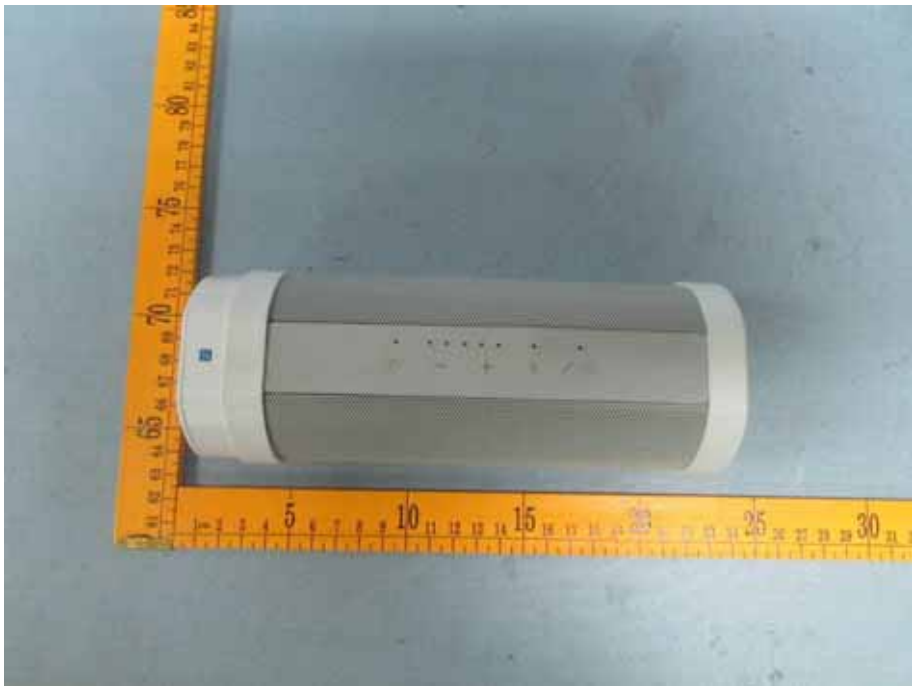
Above 1GHz



# 17 Photographs - Constructional Details

## 17.1 EUT –Black Sample Appearance View


## 17.2 EUT –Grey Sample Appearance View

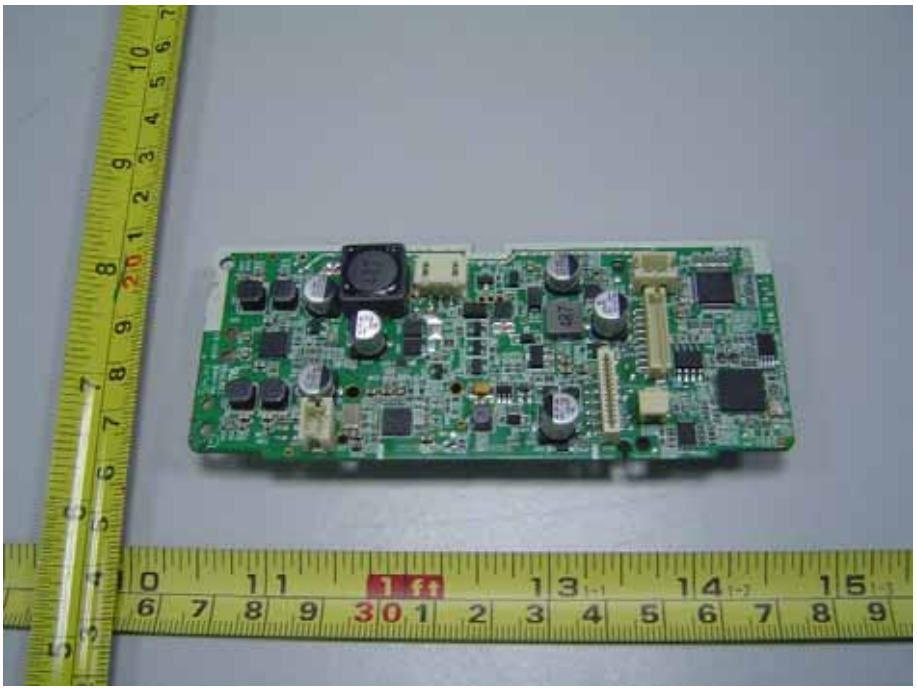


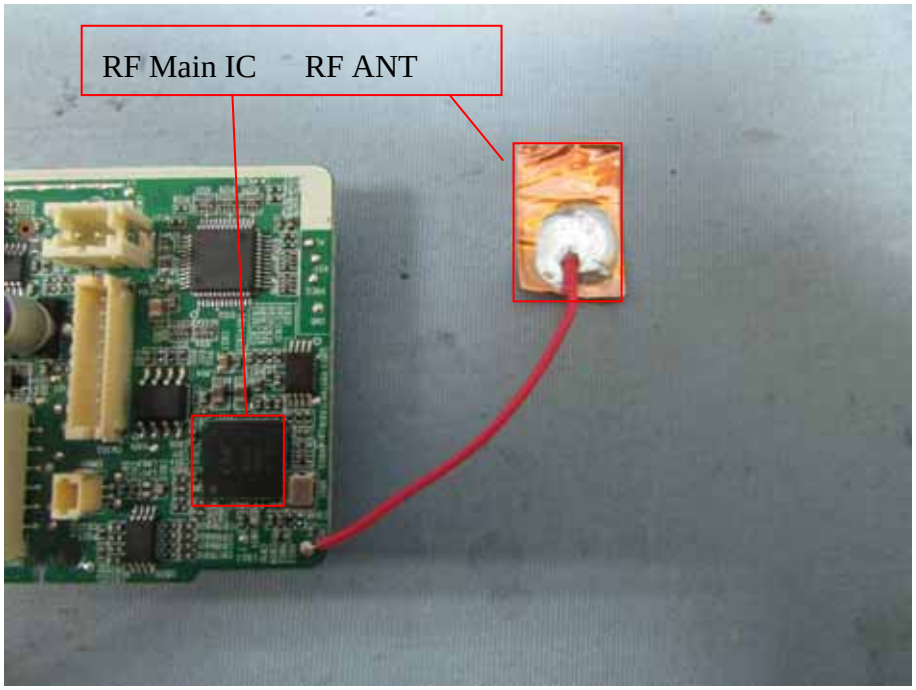

TDK

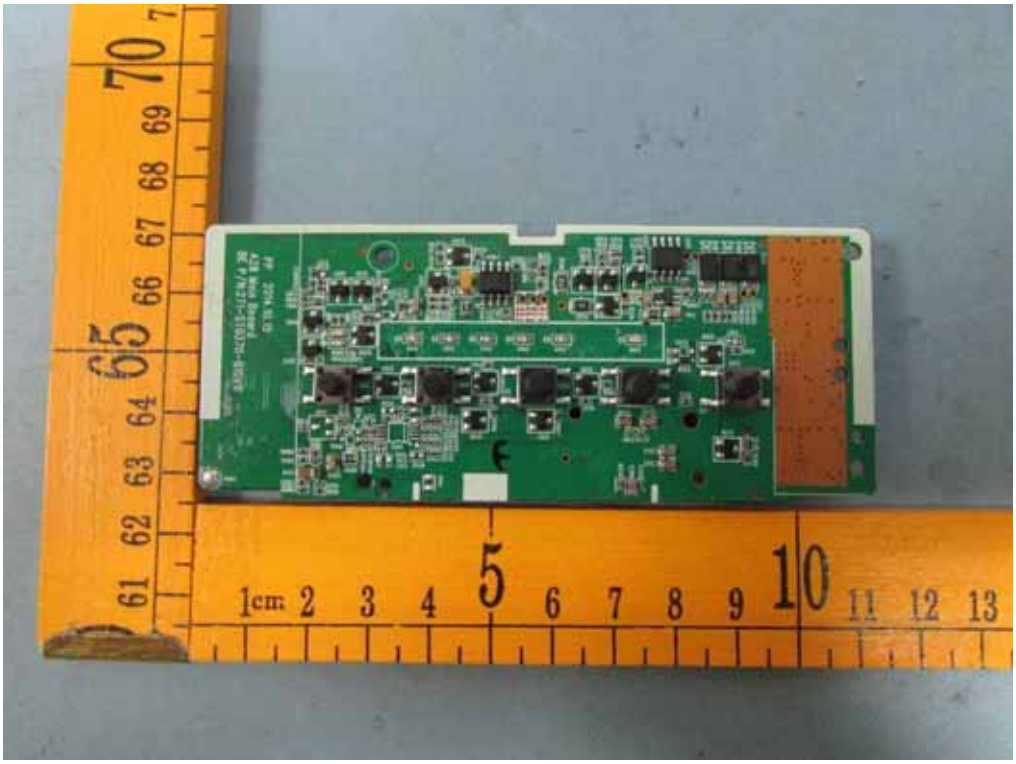
## 17.3 EUT –Open View

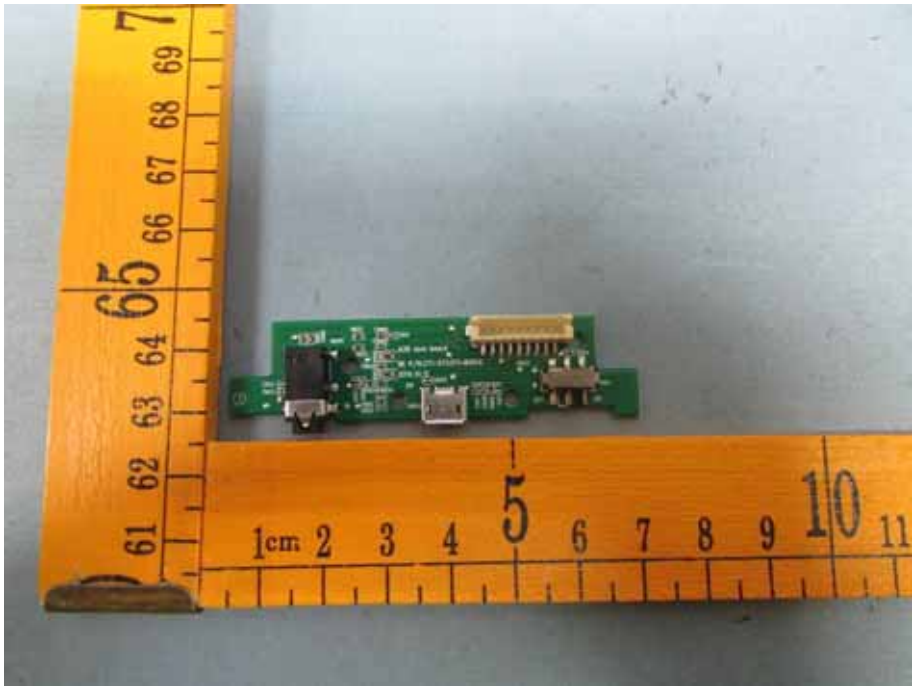
Black

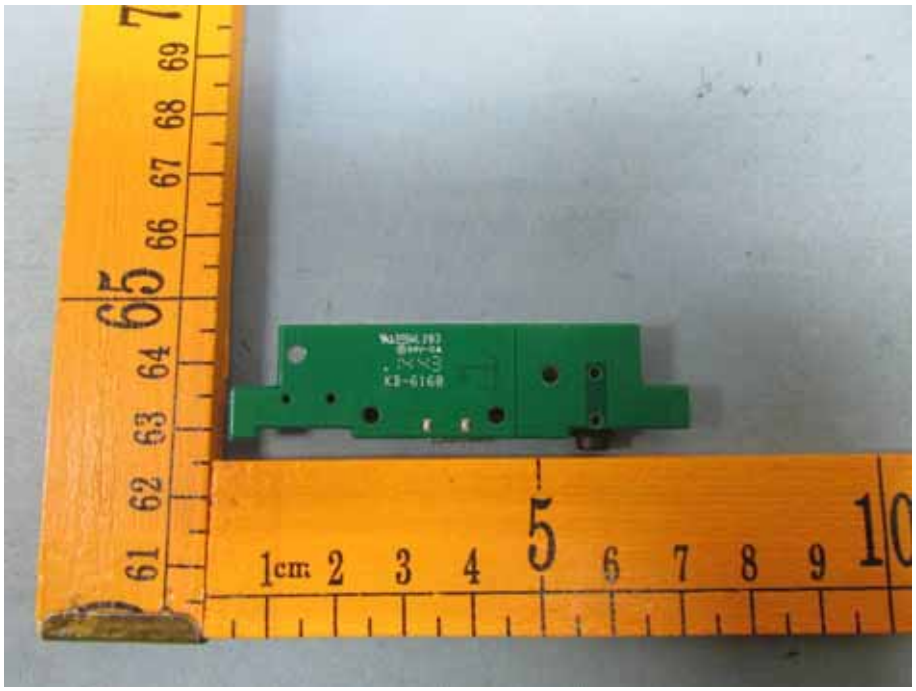
Grey

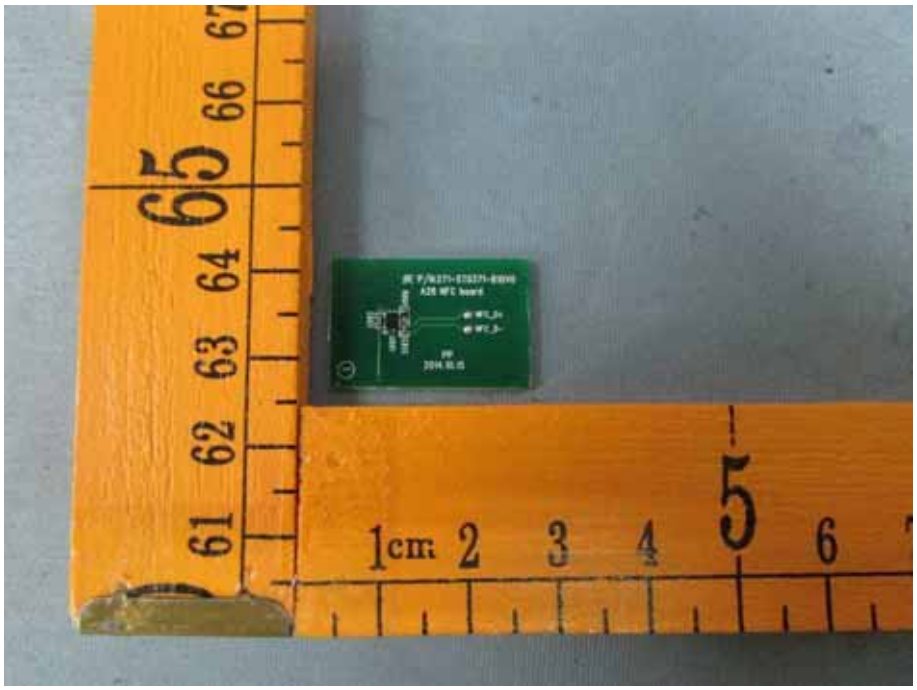


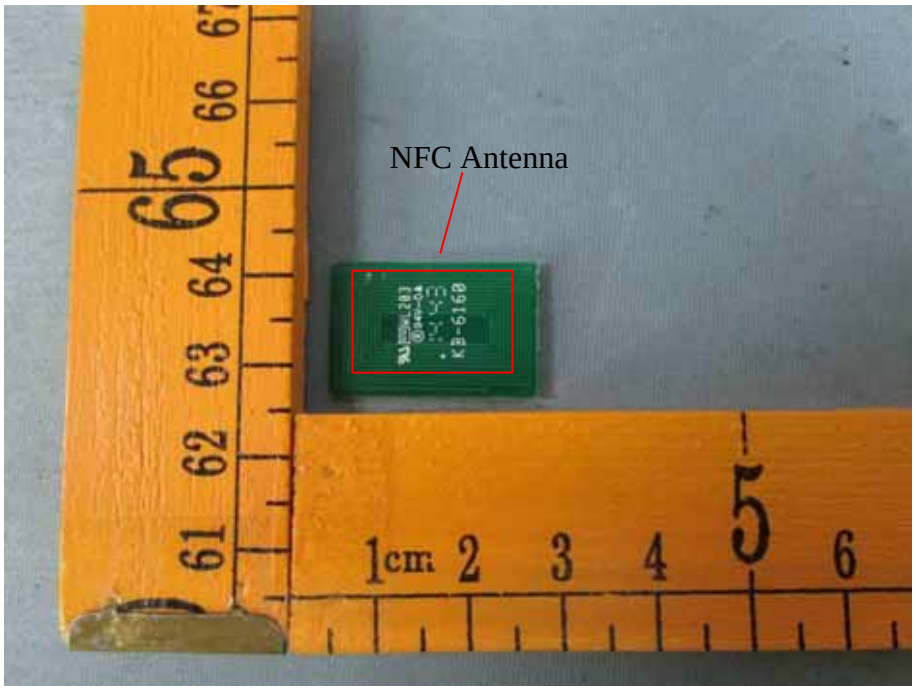

RF Main IC
RF ANT












======End of Report======