# FCC TEST REPORT

# FCC ID: 2AVMA-BY3090

| | | |
|---|---|---|
| Product Name | : | Wireless speaker |
| Model Name | : | BY-3090/nby18/nby6670/BY6660/nby8820/nby4070/nby8890/nby6690/nby8810/nby2290/nby003/BY3070/BY6630/BY6650/BY1050/nby5540/nby5510/nby5590/nby008/nby360/nby8891/BY1040/nby5530/BY2280/BY3010/BY4030/BY4080/BY3020/nby3320/nby3330/nby3340 |
| Brand Name | : | N/A |
| Report No. | : | PTC19122703301E-FC01 |

**Prepared for**

Dongguan Xianghe Xin Industrial Co.,Ltd

The third floor of Building A,Chang yin ke chuang Park,No.10,Binnong First Road ,Meitang,Huangjiang Town,Dongguan city

**Prepared by**

Dongguan Precise Testing & Certification Co., Ltd.

Building D, Baoding Technology Park, Guangming Road 2, Guangming Community, Dongcheng District, Dongguan, Guangdong, China

# 1TEST RESULT CERTIFICATION

| | | |
|---|---|---|
| Applicant's name | : | Dongguan Xianghe Xin Industrial Co.,Ltd |
| Address | : | The third floor of Building A,Chang yin ke chuang Park,No.10,Binnong First Road ,Meitang,Huangjiang Town,Dongguan city |
| Manufacture's name | : | Dongguan Xianghe Xin Industrial Co.,Ltd |
| Address | : | The third floor of Building A,Chang yin ke chuang Park,No.10,Binnong First Road ,Meitang,Huangjiang Town,Dongguan city |
| Product name | : | Wireless speaker |
| Model name | : | BY-3090/nby18/nby6670/BY6660/nby8820/nby4070 /nby8890/nby6690/nby8810/nby2290/nby003/BY3070/BY6630/ BY6650/BY1050/nby5540/nby5510/nby5590/nby008/nby360/nby8891/BY1040/nby5530/BY2280/BY3010/BY4030/BY4080/BY3020/nby3320/nby3330/nby3340 |
| Standards | : | FCC CFR47 Part 15 Section 15.247 |
| Test procedure | : | ANSI C63.10:2013 |
| Test Date | : | Dec. 10, 2019 to Jan. 13, 2020 |
| Date of Issue | : | Jan. 14, 2020 |
| Test Result | : | Pass |

This device described above has been tested by PTC, 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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Test Engineer:

Leo Yang

Leo Yang / Engineer

Technical Manager:

Chris Du / Manager

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## 2 Test Summary

| Test Items | Test Requirement | Result |
|---|---|---|
| Radiated Spurious Emissions | 15.205(a)<br>15.209<br>15.247(d) | PASS |
| Band edge | 15.247(d)<br>15.205(a) | PASS |
| Conduct Emission | 15.207 | PASS |
| 20dB Bandwidth | 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 |
| Antenna Requirement | 15.203 | PASS |

# 3 TEST FACILITY

Dongguan Precise Testing & Certification Corp., Ltd.

Address: Building D, Baoding Technology Park, Guangming Road2, Dongcheng District, Dongguan, Guangdong, China

FCC Registration Number: 790290

A2LA Certificate No.: 4408.01

IC Registration Number: 12191A-1

# 4 General Information

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

| | | |
|---|---|---|
| Product Name | : | Wireless speaker |
| Model Name | : | BY-3090/nby18/nby6670/BY6660/nby8820/nby4070 /nby8890/nby6690/nby8810/nby2290/nby003/BY3070/BY6630/ BY6650/BY1050/nby5540/nby5510/nby5590/nby008/nby360/n by8891/BY1040/nby5530/BY2280/BY3010/BY4030/BY4080/BY3 020/nby3320/nby3330/nby3340 |
| Bluetooth Version | : | BT 5.0 |
| Operating frequency | : | 2402-2480MHz |
| Numbers of Channel | : | 79 channels |
| Antenna Type | : | PCB Antenna |
| Antenna Gain | : | 0 dBi |
| Type of Modulation | : | GFSK, Π/4-DQPSK, 8DPSK |
| Hardware Version | : | V1.0 |
| Software Version | : | V1.0 |

## 4.2 Test Mode

The EUT has been tested under its typical operating condition. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst case data were reported.

The EUT has been associated with peripherals pursuant to ANSI C63.10-2013 and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation (9 KHz to the 10th harmonics of the highest fundamental frequency or to 40 GHz, whichever is lower).

The EUT has been tested under TX operating condition.

This EUT is a FHSS system, were conducted to determine the final configuration from all possible combinations. We use software control the EUT, Let EUT hopping on and transmit with highest power, all the modes GFSK, Π/4-DQPSK, 8DPSK , have been tested. 79 Channels are provided by EUT. The 3 channels of lower, medium and higher were chosen for test.

| Pretest Mode | Description |
|---|---|
| Mode 1 | CH00 |
| Mode 2 | CH39 |
| Mode 3 | CH78 |
| Mode 4 | Link BT |

| For Conducted Emission | |
|---|---|
| Final Test Mode | Description |
| Mode 4 | Link BT |

| For Radiated Emission | |
|---|---|
| Final Test Mode | Description |
| Mode 1 | CH00 |
| Mode 2 | CH39 |
| Mode 3 | CH78 |

Note:

(1) The measurements are performed at the highest, middle, lowest available channels.

(2) Measurements are performed according to the Public Notice-DA 00-705.

(3) Test perform on all mode(BDR and EDR), only records worse cases in the test report.

Channel List:

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

| **Channel** | **Frequency(MHz)** |
|---|---|
| 0 | 2402 |
| 39 | 2441 |
| 78 | 2480 |

# 5 Equipment During Test

## 5.1 Equipments List

RF Conducted Test

| Name of Equipment | Manufacturer | Model | Serial No. | Characteristics | Calibration Due |
|---|---|---|---|---|---|
| MXG Signal Analyzer | Agilent | N9020A | MY56070279 | 10Hz-30GHz | Sep.18, 2020 |
| Coaxial Cable | CDS | 79254 | 46107086 | 10Hz-30GHz | Sep.18, 2020 |
| Antenna Connector | Florida RF Labs | N/A | RF01# | N/A | Sep.18, 2020 |
| Power Meter | Anritsu | ML2495A | N/A | 100k-65GHz | Sep.18, 2020 |
| Power sensor | Anritsu | MA2411B | N/A | 300MHz-40GHz | Sep.18, 2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

Radiated Emissions

| Name of Equipment | Manufacturer | Model | Serial No. | Characteristics | Calibration Due |
|---|---|---|---|---|---|
| EMI Test Receiver | Rohde&Schwarz | ESCI | 101417 | 9KHz-3GHz | Sep.18, 2020 |
| Loop Antenna | Schwarzbeck | FMZB 1519 | 012 | 9 KHz -30MHz | Sep.18, 2020 |
| Bilog Antenna | SCHWARZBECK | VULB9160 | 9160-3355 | 25MHz-2GHz | Sep.18, 2020 |
| Preamplifier (low frequency) | SCHWARZBECK | BBV 9475 | 9745-0013 | 1MHz-1GHz | Sep.18, 2020 |
| Cable | Schwarzbeck | PLF-100 | 549489 | 9KHz-3GHz | Sep.18, 2020 |
| Spectrum Analyzer | Agilent | E4407B | MY45109572 | 9KHz-40GHz | Sep.18, 2020 |
| Horn Antenna | SCHWARZBECK | 9120D | 9120D-1246 | 1GHz-18GHz | Sep.18, 2020 |
| Power Amplifier | LUNAR EM | LNA1G18-40 | J10100000081 | 1GHz-26.5GHz | Sep.18, 2020 |
| Horn Antenna | SCHWARZBECK | BBHA 9170 | 9170-181 | 14GHz-40GHz | Sep.18, 2020 |
| Amplifier | SCHWARZBECK | BBV 9721 | 9721-205 | 18GHz-40GHz | Sep.18, 2020 |
| Cable | H+S | CBL-26 | N/A | 1GHz-26.5GHz | Sep.18, 2020 |
| RF Cable | R&S | R204 | R21X | 1GHz-40GHz | Sep.18, 2020 |

Conducted Emissions

| Name of Equipment | Manufacturer | Model | Serial No. | Characteristics | Calibration Due |
|---|---|---|---|---|---|
| EMI Test Receiver | Rohde&Schwarz | ESCI | 101417 | 9KHz-3GHz | Sep.18, 2020 |
| Artificial Mains Network | Rohde&Schwarz | L2-16B | 000WX31025 | 9KHz-300MHz | Sep.18, 2020 |
| Artificial Mains Network | Rohde&Schwarz | ENV216 | 101342 | 9KHz-300MHz | Sep.18, 2020 |

## 5.2 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| RF output power, conducted | ±1.0dB |
| Power Spectral Density, conducted | ±2.2dB |
| Radio Frequency | ± 1 x $10^{-6}$ |
| Bandwidth | ± 1.5 x $10^{-6}$ |
| Time | ±2% |
| Duty Cycle | ±2% |
| Temperature | ±1°C |
| Humidity | ±5% |
| DC and low frequency voltages | ±3% |
| Conducted Emissions (150kHz~30MHz) | ±3.64dB |
| Radiated Emission(30MHz~1GHz) | ±5.03dB |
| Radiated Emission(1GHz~25GHz) | ±4.74dB |
| Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95% | |

## 5.3 Description of Support Units

| Equipment | Model No. | Series No. |
|---|---|---|
| Adapter | Model: PS65B150Y3000S<br>Input: AC100-240V, 50/60Hz, 1.5A<br>Output: DC 5V, 3000mA | N/A |

# 6 Conducted Emission

| | | |
|---|---|---|
| Test Requirement: | : | FCC CFR 47 Part 15 Section 15.207 |
| Test Method: | : | ANSI C63.10:2013 |
| Test Result: | : | PASS |
| Frequency Range: | : | 150kHz to 30MHz |
| Class/Severity: | : | Class B |
| Detector: | : | Peak for pre-scan (9kHz Resolution Bandwidth) |

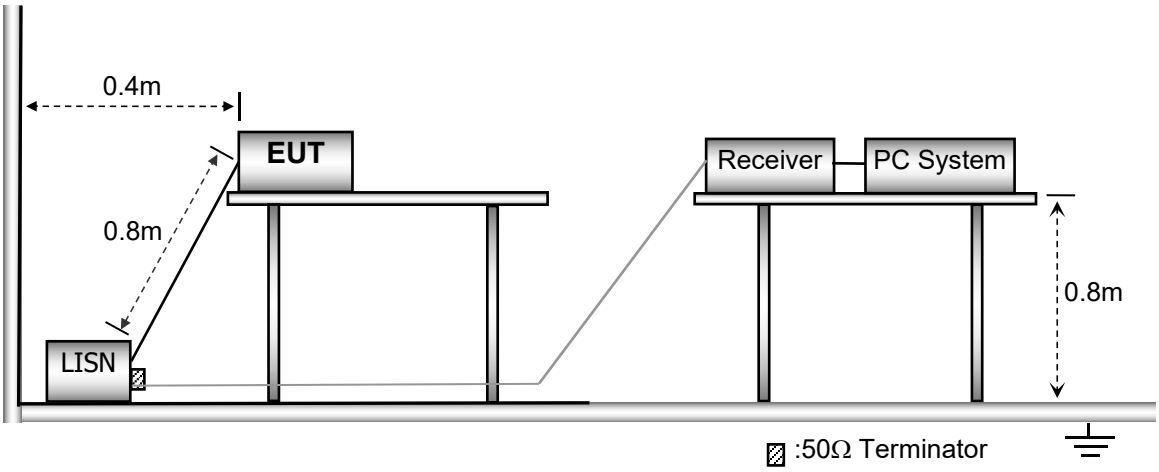
## 6.1 E.U.T. Operation

Operating Environment **:**

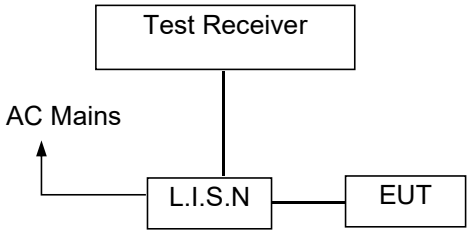
| | | |
|---|---|---|
| Temperature: | : | 25.5 °C |
| Humidity: | : | 51 % RH |
| Atmospheric Pressure: | : | 101.2kPa |

## 6.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10: 2013



## 6.3 Test SET-UP (Block Diagram of Configuration)




## 6.4 Measurement Procedure:

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured was complete.

## 6.5 Conducted Emission Limit

**Conducted Emission**

| Frequency(MHz) | Quasi-peak | Average |
|---|---|---|
| 0.15-0.5 | 66-56 | 56-46 |
| 0.5-5.0 | 56 | 46 |
| 5.0-30.0 | 60 | 50 |

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

## 6.6 Measurement Description

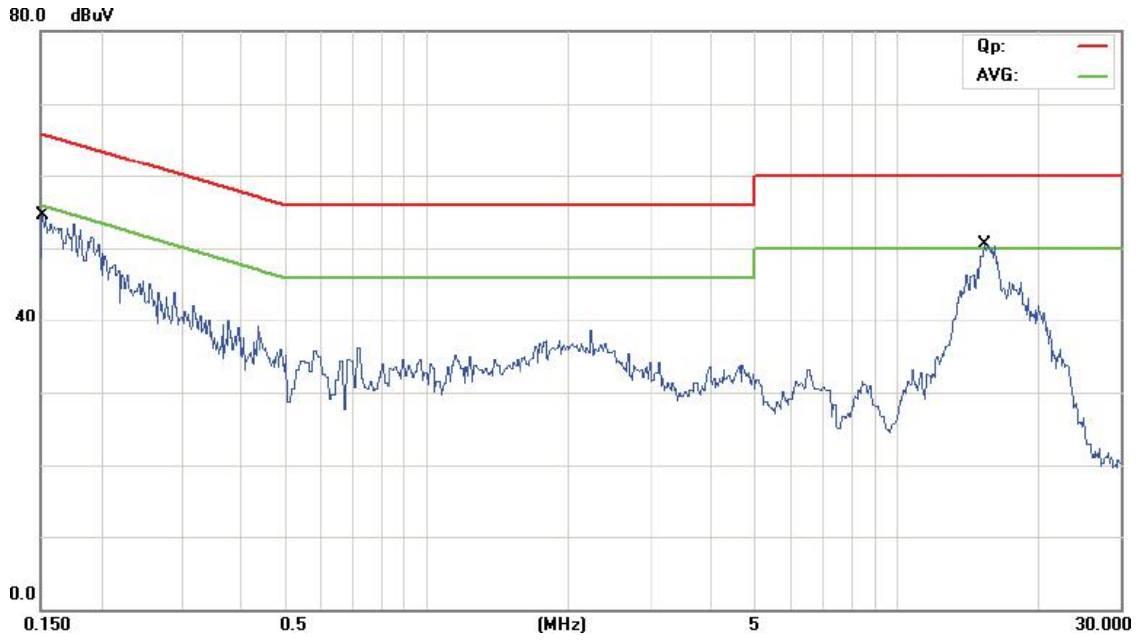
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

## 6.7 Conducted Emission Test Result

Pass.

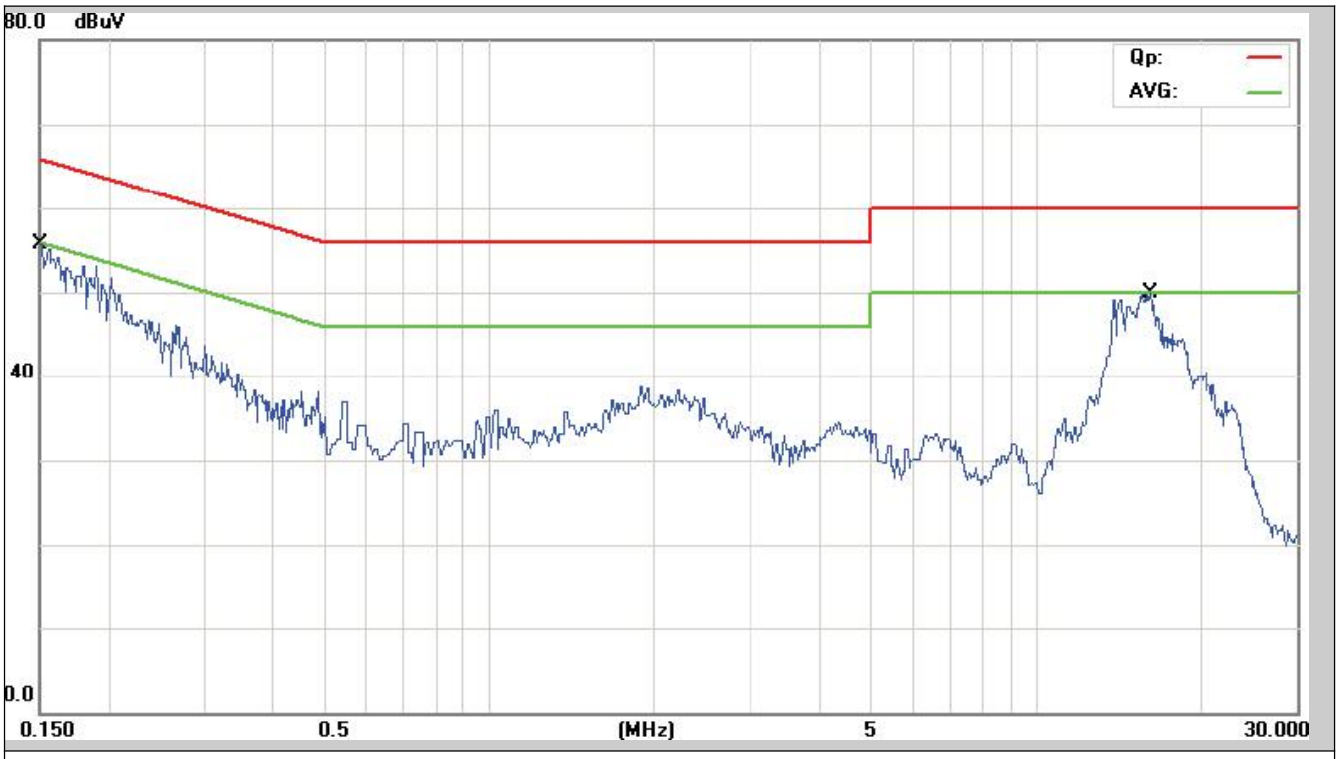
All the modulation modes were tested the data of the worst mode (AC 120V/60Hz, GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Line -120V/60Hz:




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.1500 | 33.70 | 11.00 | 44.70 | 66.00 | -21.30 | QP | |
| 2 | | 0.1500 | 1.40 | 11.00 | 12.40 | 56.00 | -43.60 | AVG | |
| 3 | * | 15.3573 | 33.50 | 11.29 | 44.79 | 60.00 | -15.21 | QP | |
| 4 | | 15.3573 | 10.50 | 11.29 | 21.79 | 50.00 | -28.21 | AVG | |

Neutral -120V/60Hz:




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | | 0.1505 | 33.70 | 11.00 | 44.70 | 65.97 | -21.27 | QP | |
| 2 | | 0.1505 | 0.90 | 11.00 | 11.90 | 55.97 | -44.07 | AVG | |
| 3 | * | 16.1027 | 32.40 | 11.26 | 43.66 | 60.00 | -16.34 | QP | |
| 4 | | 16.1027 | 9.30 | 11.26 | 20.56 | 50.00 | -29.44 | AVG | |

# 7 Radiated Spurious Emissions

Test Requirement : FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method : ANSI C63.10:2013

Test Result : PASS

Measurement Distance : 3m

Limit : See the follow table

| 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 : 23.5 °C

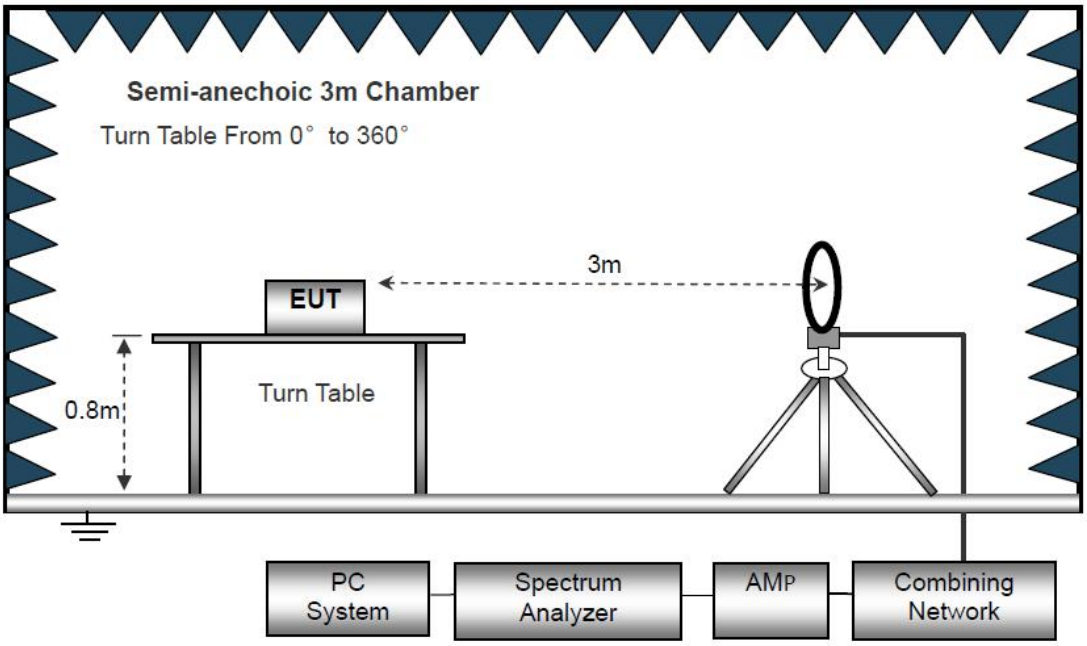
Humidity : 51.1 % RH

Atmospheric Pressure : 101.2kPa

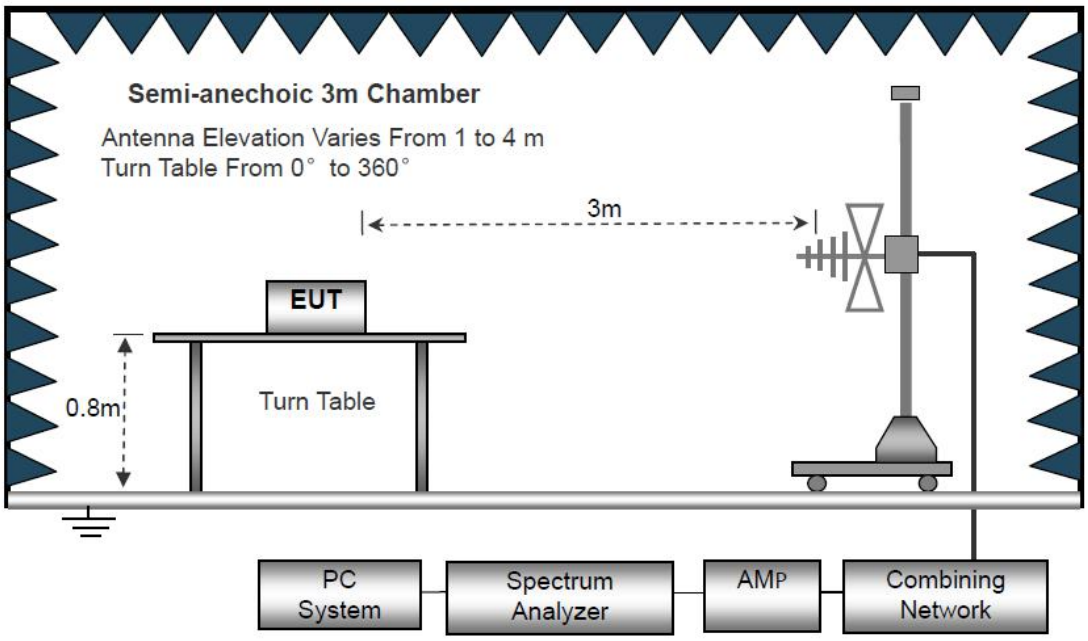
## 7.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site

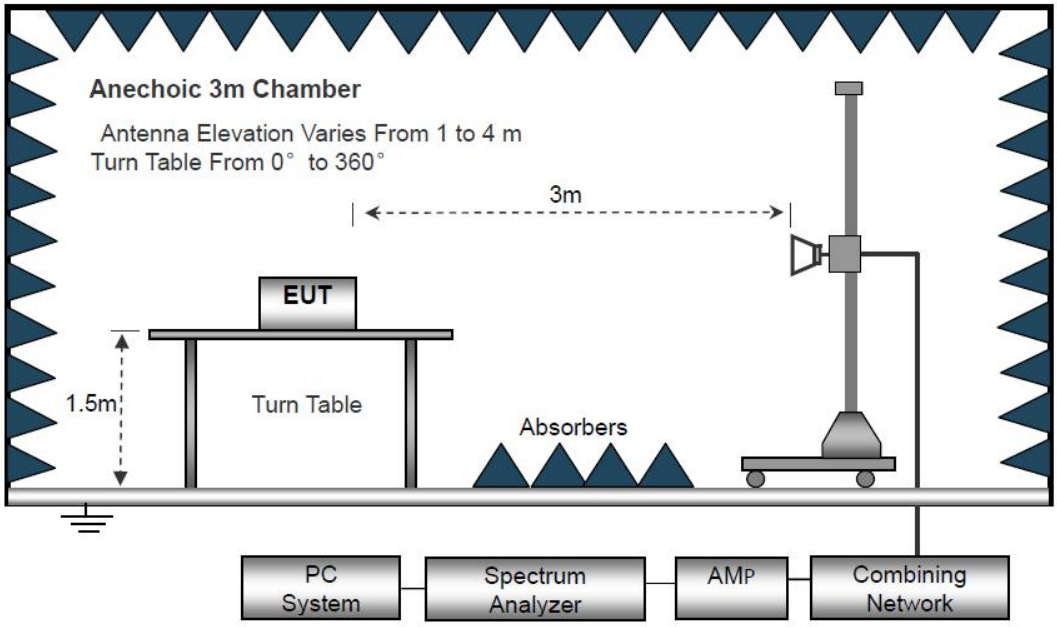
The test setup for emission measurement below 30MHz.




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

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

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

## 7.4 Test Procedure

1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.

2. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.

3. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (From 1m to 4m) and turntable (from 0 degree to 360 degree) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.

5. Set to the maximum power setting and enable the EUT transmit continuously.

6. Final measurement (Above 1GHz): The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 degree to 360 degree in order to have the antenna inside the cone of radiation.

7. Test Procedure of measurement (For Above 1GHz):

1) Monitor the frequency range at horizontal polarization and move the antenna over all sides of the EUT(if necessary move the EUT to another orthogonal axis).

2) Change the antenna polarization and repeat 1) with vertical polarization.

3) Make a hardcopy of the spectrum.

4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

5) Change the analyser mode to Clear/ Write and found the cone of emission.

6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3m and the antenna will be still inside the cone of emission.

7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarization and azimuth and the peak and average detector, which causes the maximum emission.

8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

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 Summary of Test Results

**Test Frequency: 9KHz-30MHz**

| Freq. (MHz) | Ant.Pol. H/V | Emission Level (dBuV/m) | Limit 3m (dBuV/m) | Over (dB) |
|---|---|---|---|---|
| -- | -- | -- | -- | >20 |

Note:

The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

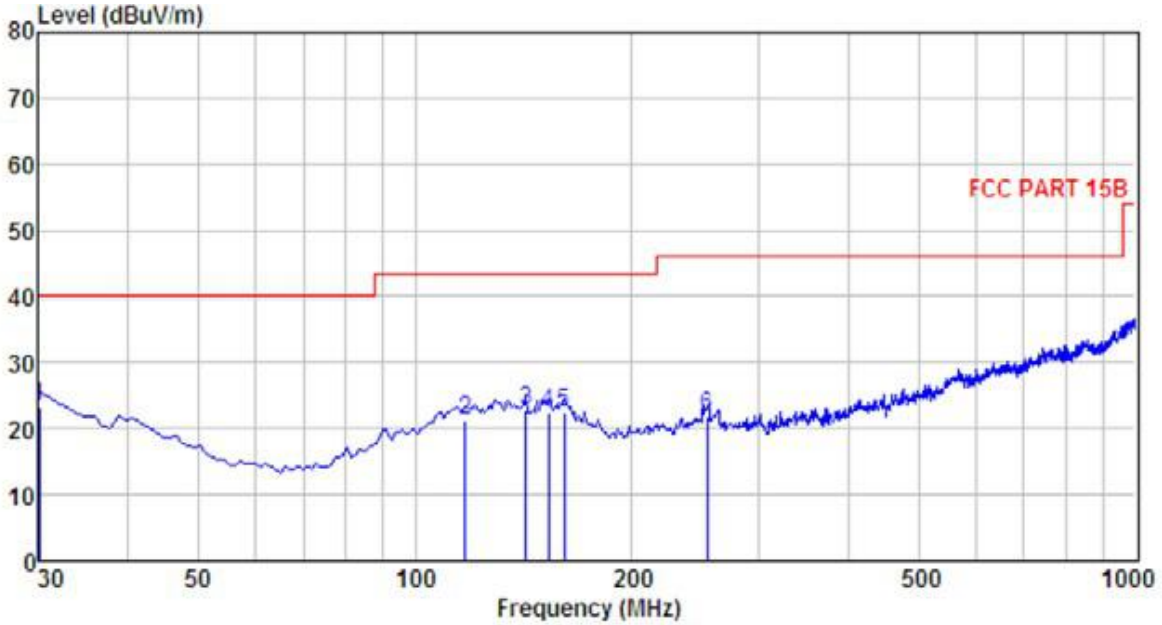
Distance extrapolation factor =40log(Specific distance/ test distance)( dB);
Limit line=Specific limits(dBuV) + distance extrapolation factor.

**Test Frequency: 30MHz ~ 1GHz**

Please refer to the following test plots:

All the modulation modes were tested the data of the worst mode (AC 120V/60Hz, GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Test plot for Horizontal: GFSK(2402MHz)

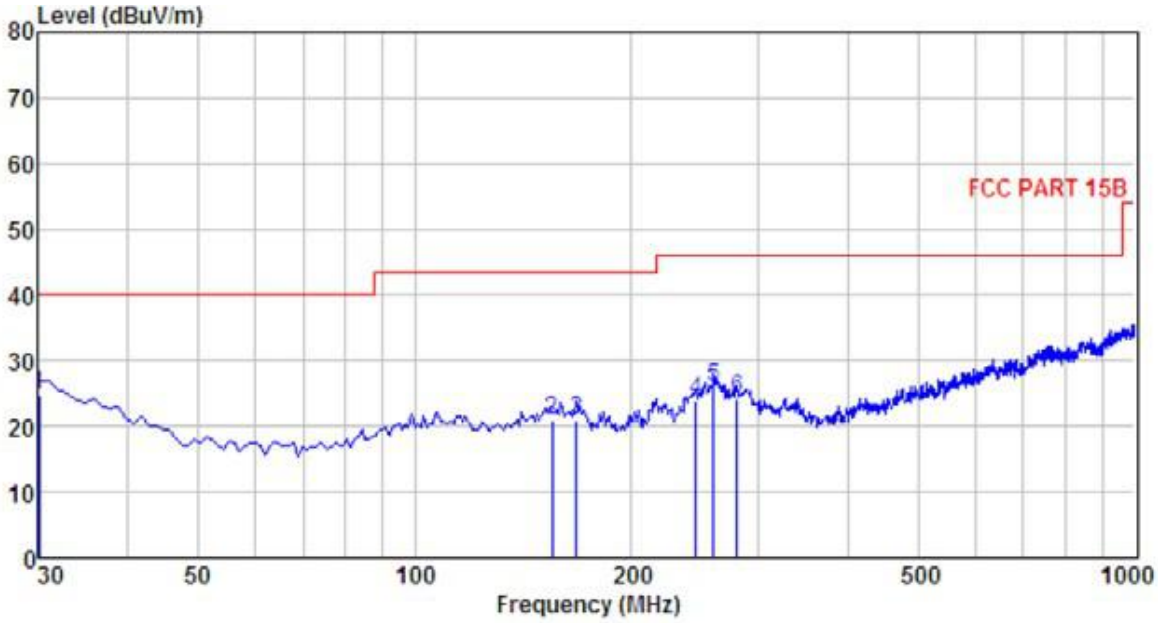



pol: HORIZONTAL

| | Freq | Reading | CabLos | Antfac | Measured | Limit | Over | Remark |
|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dB/m | dBuV/m | dBuV/m | dB | |
| 1 | 30.00 | 10.68 | 0.39 | 12.33 | 23.40 | 40.00 | -16.60 | QP |
| 2 | 117.30 | 9.76 | 0.68 | 10.96 | 21.40 | 43.50 | -22.10 | QP |
| 3 | 142.52 | 13.87 | 0.71 | 8.21 | 22.79 | 43.50 | -20.71 | QP |
| 4 | 153.19 | 13.36 | 0.73 | 8.39 | 22.48 | 43.50 | -21.02 | QP |
| 5 | 160.95 | 12.91 | 0.75 | 8.70 | 22.36 | 43.50 | -21.14 | QP |
| 6 | 254.07 | 8.75 | 0.90 | 12.06 | 21.71 | 46.00 | -24.29 | QP |

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Test plot for Vertical: GFSK(2402MHz)




pol: VERTICAL

| | Freq MHz | Reading dBuV | CabLos dB | Antfac dB/m | Measured dBuV/m | Limit dBuV/m | Over dB | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 30.00 | 12.10 | 0.39 | 12.33 | 24.82 | 40.00 | -15.18 | QP |
| 2 | 155.13 | 11.87 | 0.76 | 8.47 | 21.10 | 43.50 | -22.40 | QP |
| 3 | 167.74 | 11.15 | 0.77 | 8.90 | 20.82 | 43.50 | -22.68 | QP |
| 4 | 245.34 | 10.74 | 0.97 | 12.08 | 23.79 | 46.00 | -22.21 | QP |
| 5 | 259.89 | 12.88 | 1.01 | 12.05 | 25.94 | 46.00 | -20.06 | QP |
| 6 | 280.26 | 10.60 | 1.01 | 12.68 | 24.29 | 46.00 | -21.71 | QP |

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

**Test Frequency 1GHz-25GHz**

| Frequency | Read Level | Cable loss | Antenna Factor | Preamp Factor | Emission Level | Limits | Margin | Remark | Comment |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBμV) | (dB) | dB/m | (dB) | (dBμV/m) | (dBμV/m) | (dB) | | |
| Low Channel (2402 MHz)(GFSK)--Above 1G | | | | | | | | | |
| 4804.03 | 63.95 | 5.21 | 35.59 | 44.30 | 60.45 | 74.00 | -13.55 | Pk | Vertical |
| 4804.03 | 41.66 | 5.21 | 35.59 | 44.30 | 38.16 | 54.00 | -15.84 | AV | Vertical |
| 7206.27 | 61.54 | 6.48 | 36.27 | 44.60 | 59.69 | 74.00 | -14.31 | Pk | Vertical |
| 7206.27 | 44.81 | 6.48 | 36.27 | 44.60 | 42.96 | 54.00 | -11.04 | AV | Vertical |
| 4804.11 | 61.94 | 5.21 | 35.55 | 44.30 | 58.40 | 74.00 | -15.60 | Pk | Horizontal |
| 4804.11 | 42.85 | 5.21 | 35.55 | 44.30 | 39.31 | 54.00 | -14.69 | AV | Horizontal |
| 7206.22 | 63.58 | 6.48 | 36.27 | 44.52 | 61.81 | 74.00 | -12.19 | Pk | Horizontal |
| 7206.22 | 47.75 | 6.48 | 36.27 | 44.52 | 45.98 | 54.00 | -8.02 | AV | Horizontal |
| Mid Channel (2441 MHz)(GFSK)--Above 1G | | | | | | | | | |
| 4882.4 | 63.06 | 5.21 | 35.66 | 44.20 | 59.73 | 74.00 | -14.27 | Pk | Vertical |
| 4882.4 | 42.28 | 5.21 | 35.66 | 44.20 | 38.95 | 54.00 | -15.05 | AV | Vertical |
| 7323.24 | 60.39 | 7.10 | 36.50 | 44.43 | 59.56 | 74.00 | -14.44 | Pk | Vertical |
| 7323.24 | 48.48 | 7.10 | 36.50 | 44.43 | 47.65 | 54.00 | -6.35 | AV | Vertical |
| 4882.11 | 61.21 | 5.21 | 35.66 | 44.20 | 57.88 | 74.00 | -16.12 | Pk | Horizontal |
| 4882.11 | 47.80 | 5.21 | 35.66 | 44.20 | 44.47 | 54.00 | -9.53 | AV | Horizontal |
| 7323.13 | 59.86 | 7.10 | 36.50 | 44.43 | 59.03 | 74.00 | -14.97 | Pk | Horizontal |
| 7323.13 | 42.05 | 7.10 | 36.50 | 44.43 | 41.22 | 54.00 | -12.78 | AV | Horizontal |
| High Channel (2480 MHz)(GFSK)-- Above 1G | | | | | | | | | |
| 4960.4 | 66.15 | 5.21 | 35.52 | 44.21 | 62.67 | 74.00 | -11.33 | Pk | Vertical |
| 4960.4 | 42.49 | 5.21 | 35.52 | 44.21 | 39.01 | 54.00 | -14.99 | AV | Vertical |
| 7440.2 | 62.44 | 7.10 | 36.53 | 44.60 | 61.47 | 74.00 | -12.53 | Pk | Vertical |
| 7440.2 | 45.48 | 7.10 | 36.53 | 44.60 | 44.51 | 54.00 | -9.49 | AV | Vertical |
| 4960.23 | 67.30 | 5.21 | 35.52 | 44.21 | 63.82 | 74.00 | -10.18 | Pk | Horizontal |
| 4960.23 | 47.23 | 5.21 | 35.52 | 44.21 | 43.75 | 54.00 | -10.25 | AV | Horizontal |
| 7440.3 | 61.31 | 7.10 | 36.53 | 44.60 | 60.34 | 74.00 | -13.66 | Pk | Horizontal |
| 7440.3 | 45.65 | 7.10 | 36.53 | 44.60 | 44.68 | 54.00 | -9.32 | AV | Horizontal |

Note: 1. The testing has been conformed to 10*2480MHz=24800MHz.

2. All other emissions more than 30dB below the limit.

3. Emission Level= Antenna Factor + Cable Loss + Read Level - Preamp Factor

Margin=Emission Level-Limit

## Spurious Emission in Restricted Band 2310-2390MHz and 2483.5-2500MHz

All the modulation modes have been tested, and the worst result was report as below:

| Frequency | Meter Reading | Cable Loss | Antenna Factor | Preamp Factor | Emission Level | Limits | Margin | Detector | Comment |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dBμV) | (dB) | dB/m | (dB) | (dBμV/m) | (dBμV/m) | (dB) | Type | |
| 2Mbps (π/4-DQPSK)-hopping | | | | | | | | | |
| 2310.00 | 61.59 | 2.97 | 27.80 | 43.80 | 48.56 | 74 | -25.44 | Pk | Horizontal |
| 2310.00 | 42.65 | 2.97 | 27.80 | 43.80 | 29.62 | 54 | -24.38 | AV | Horizontal |
| 2310.00 | 64.99 | 2.97 | 27.80 | 43.80 | 51.96 | 74 | -22.04 | Pk | Vertical |
| 2310.00 | 43.87 | 2.97 | 27.80 | 43.80 | 30.84 | 54 | -23.16 | AV | Vertical |
| 2390.00 | 62.99 | 3.14 | 27.21 | 43.80 | 49.54 | 74 | -24.46 | Pk | Vertical |
| 2390.00 | 41.71 | 3.14 | 27.21 | 43.80 | 28.26 | 54 | -25.74 | AV | Vertical |
| 2390.00 | 64.66 | 3.14 | 27.21 | 43.80 | 51.21 | 74 | -22.79 | Pk | Horizontal |
| 2390.00 | 45.69 | 3.14 | 27.21 | 43.80 | 32.24 | 54 | -21.76 | AV | Horizontal |
| 2483.50 | 65.42 | 3.58 | 27.70 | 44.00 | 52.70 | 74 | -21.30 | Pk | Vertical |
| 2483.50 | 45.44 | 3.58 | 27.70 | 44.00 | 32.72 | 54 | -21.28 | AV | Vertical |
| 2483.50 | 65.99 | 3.58 | 27.70 | 44.00 | 53.27 | 74 | -20.73 | Pk | Horizontal |
| 2483.50 | 47.52 | 3.58 | 27.70 | 44.00 | 34.80 | 54 | -19.20 | AV | Horizontal |
| 2Mbps(π/4-DQPSK)- Non-hopping | | | | | | | | | |
| 2310.00 | 64.59 | 2.97 | 27.80 | 43.80 | 51.56 | 74 | -22.44 | Pk | Horizontal |
| 2310.00 | 42.59 | 2.97 | 27.80 | 43.80 | 29.56 | 54 | -24.44 | AV | Horizontal |
| 2310.00 | 62.74 | 2.97 | 27.80 | 43.80 | 49.71 | 74 | -24.29 | Pk | Vertical |
| 2310.00 | 45.61 | 2.97 | 27.80 | 43.80 | 32.58 | 54 | -21.42 | AV | Vertical |
| 2390.00 | 65.37 | 3.14 | 27.21 | 43.80 | 51.92 | 74 | -22.08 | Pk | Vertical |
| 2390.00 | 42.61 | 3.14 | 27.21 | 43.80 | 29.16 | 54 | -24.84 | AV | Vertical |
| 2390.00 | 64.85 | 3.14 | 27.21 | 43.80 | 51.40 | 74 | -22.60 | Pk | Horizontal |
| 2390.00 | 45.02 | 3.14 | 27.21 | 43.80 | 31.57 | 54 | -22.43 | AV | Horizontal |
| 2483.50 | 62.63 | 3.58 | 27.70 | 44.00 | 49.91 | 74 | -24.09 | Pk | Vertical |
| 2483.50 | 44.29 | 3.58 | 27.70 | 44.00 | 31.57 | 54 | -22.43 | AV | Vertical |
| 2483.50 | 63.91 | 3.58 | 27.70 | 44.00 | 51.19 | 74 | -22.81 | Pk | Horizontal |
| 2483.50 | 44.52 | 3.58 | 27.70 | 44.00 | 31.80 | 54 | -22.20 | AV | Horizontal |

Note: (1) All other emissions more than 20dB below the limit.

# 8 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGE

## 8.1 REQUIREMENT

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

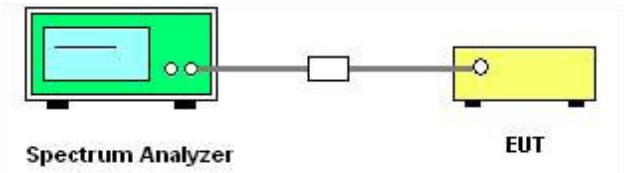
## 8.2 TEST PROCEDURE

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | 30 MHz to 10th carrier harmonic |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

. For Band edge

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | Lower Band Edge: 2300 – 2403 MHz<br>Upper Band Edge: 2479 – 2500 MHz |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

## 8.3 TEST SETUP




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

2. The spectrum from 30MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

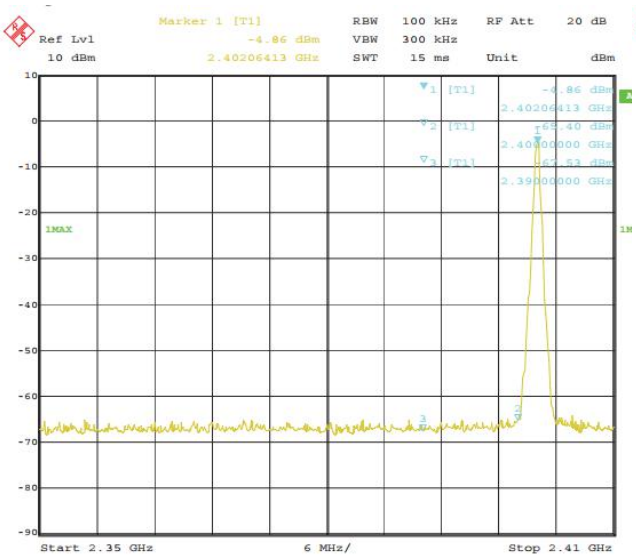
## 8.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.GFSK , was tested and record.

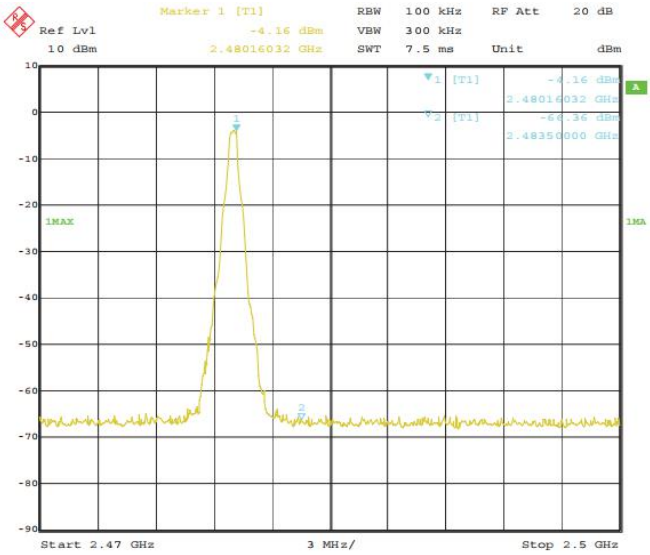
## 8.5 TEST RESULTS

**Test Plot**

GFSK: Band Edge-Low Channel

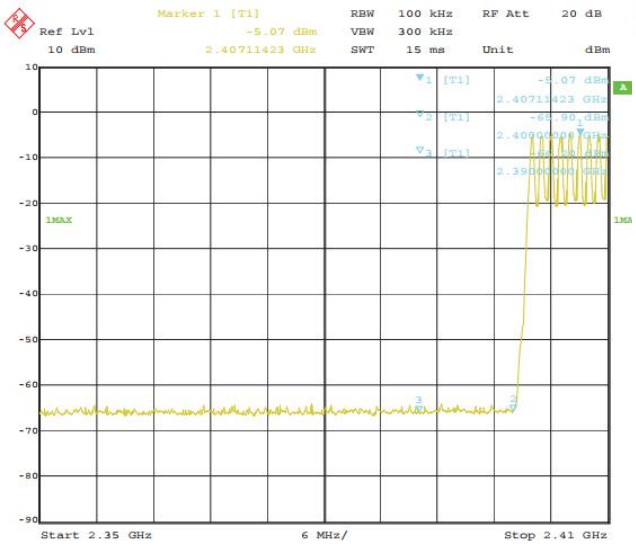


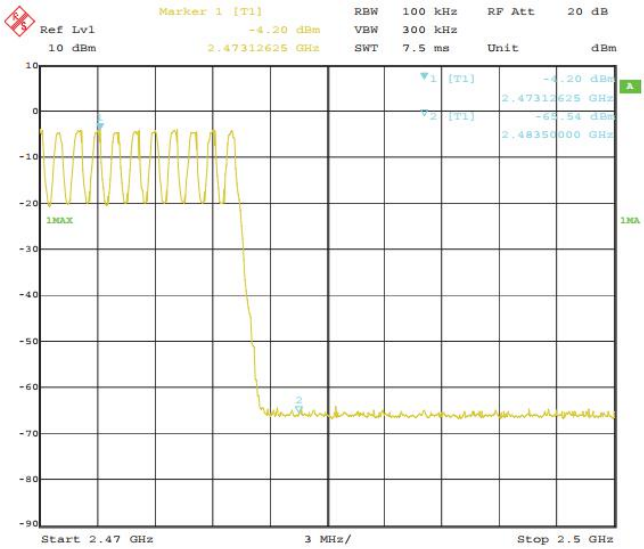

GFSK: Band Edge-High Channel




GFSK: Band Edge-Low Channel (Hopping Mode)

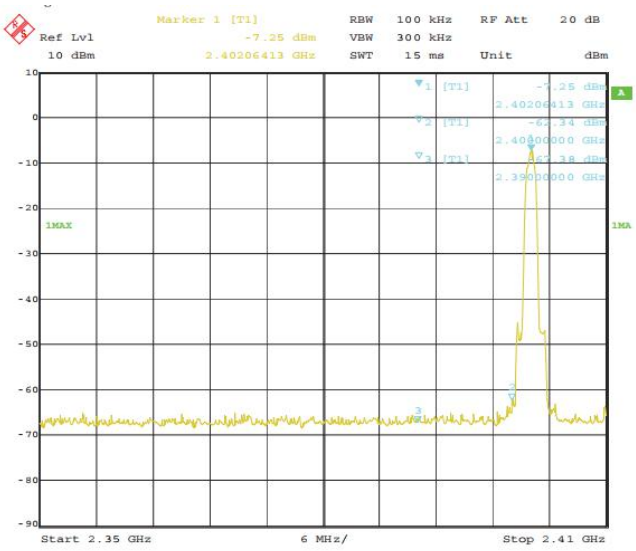
GFSK: Band Edge-High Channel (Hopping Mode)



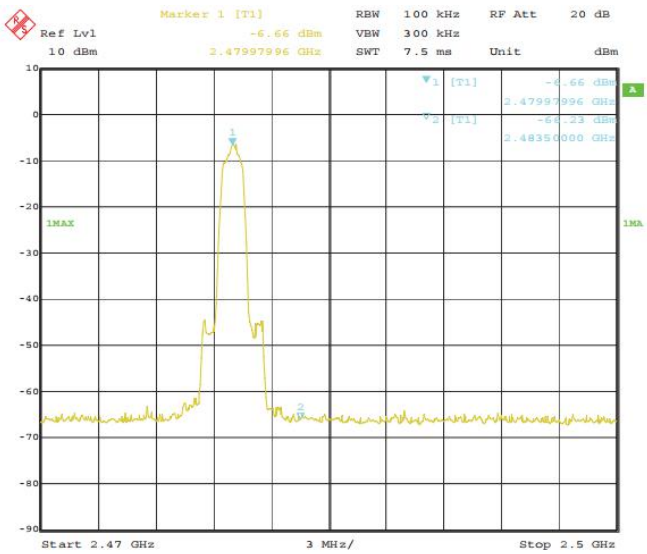




**Test Plot**

π /4-DQPSK: Band Edge-Low Channel

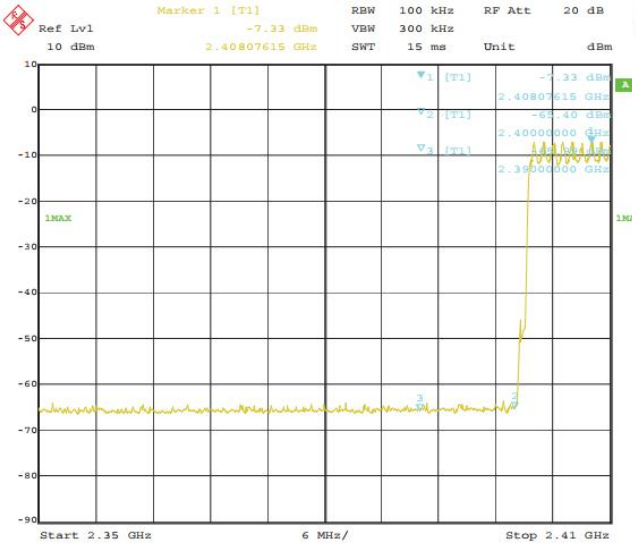



π /4-DQPSK: Band Edge-High Channel



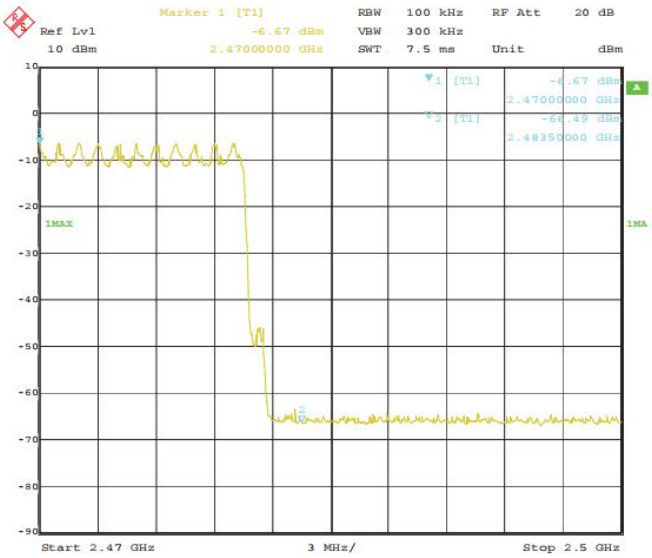
π /4-DQPSK: Band Edge-Low Channel

(Hopping Mode)



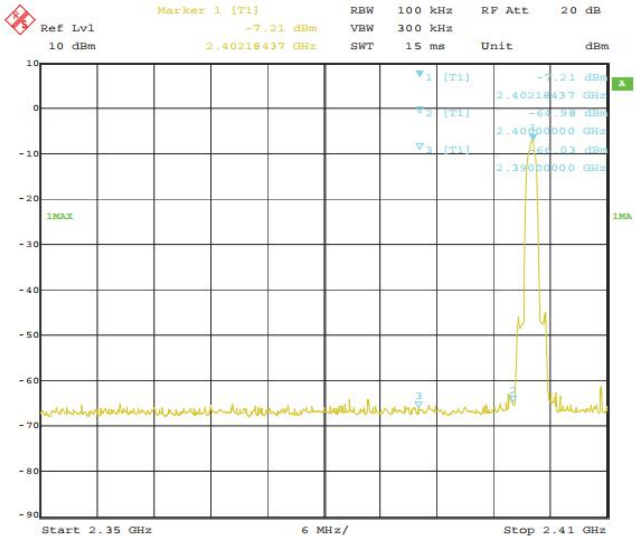

π /4-DQPSK: Band Edge-High Channel

(Hopping Mode)

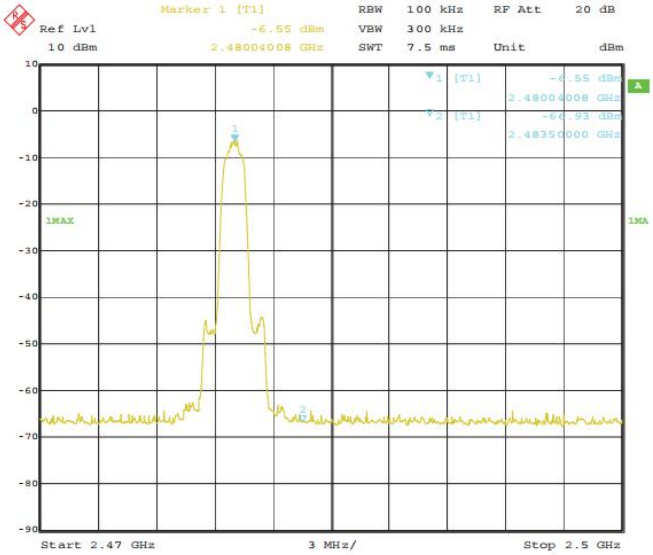



**Test Plot**

8DQPSK: Band Edge-Low Channel

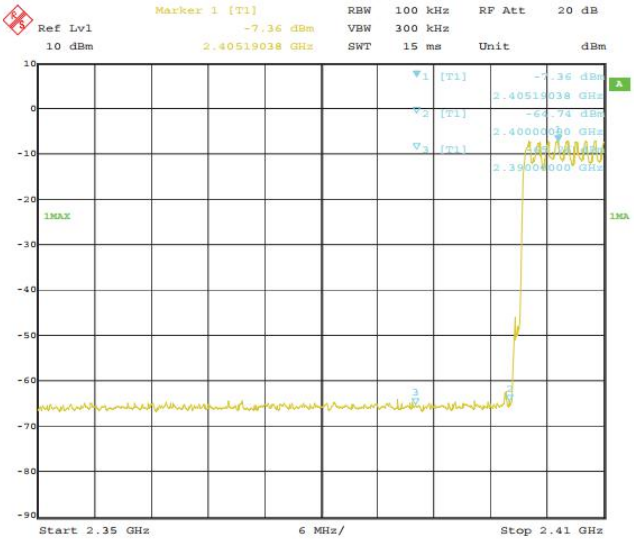



8DQPSK: Band Edge-High Channel



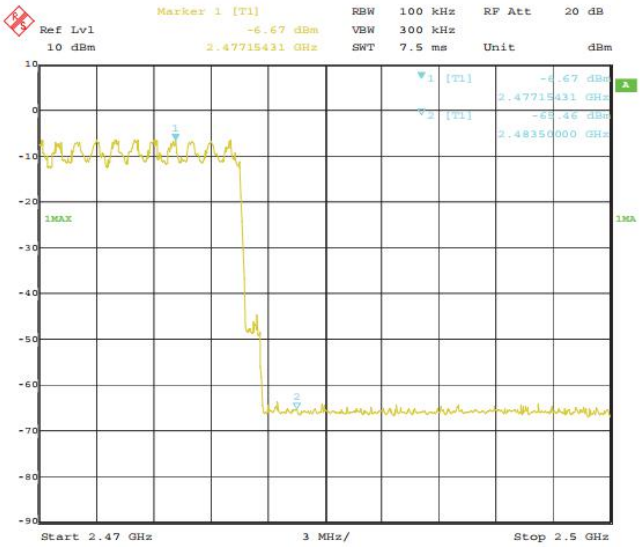
8DQPSK: Band Edge-Low Channel

(Hopping Mode)




8DQPSK: Band Edge-High Channel

(Hopping Mode)



# 9 20 dB Bandwidth Measurement

Test Requirement : FCC CFR47 Part 15 Section 15.247

Test Method : ANSI C63.10:2013

## 9.1 Test Procedure

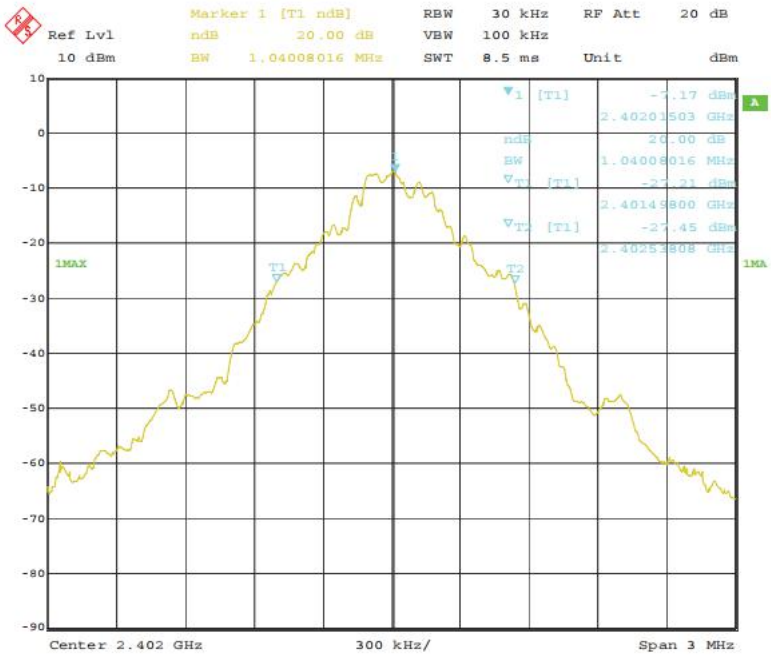
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

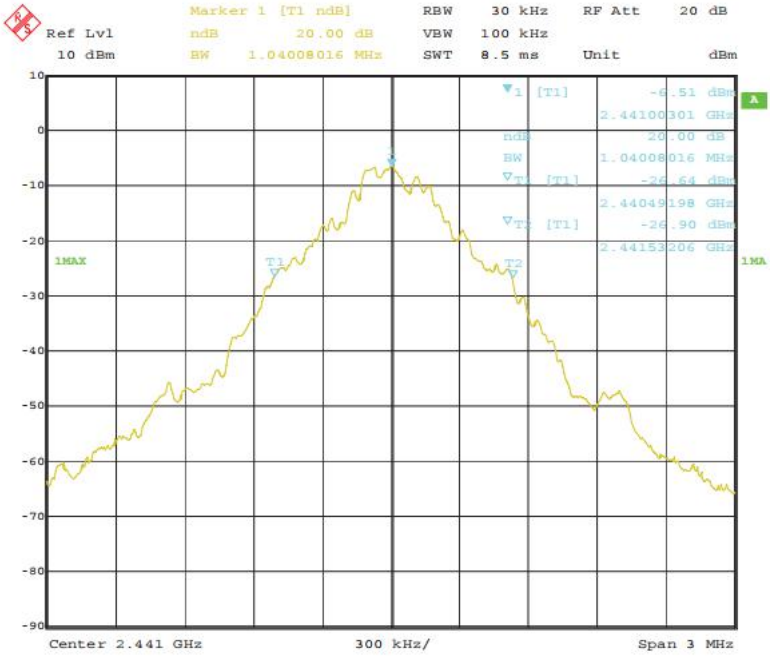
2. Set the spectrum analyzer: RBW =30kHz, VBW = 100kHz

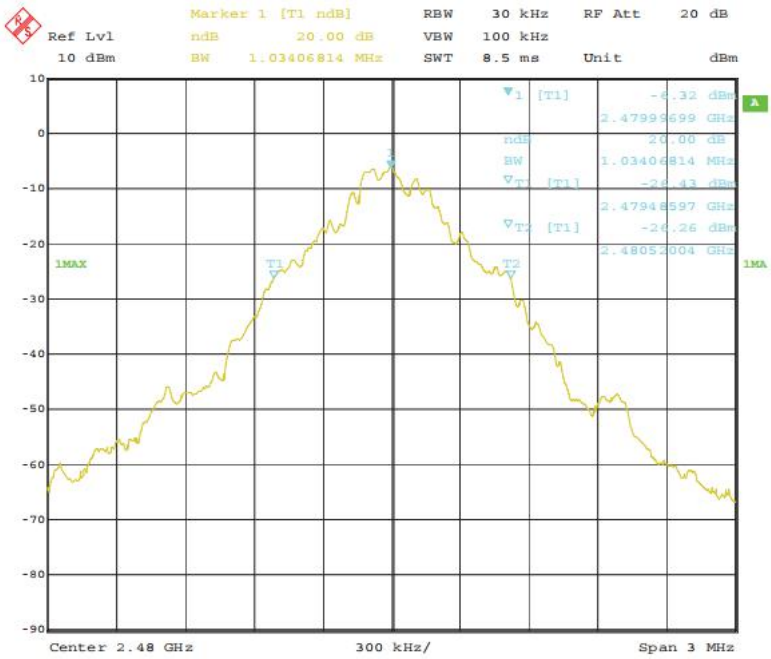
## 9.2 Test Result

| Test Channel | Frequency (MHz) | Measured Bandwidth (KHz) | Limit (kHz) | Verdict |
|---|---|---|---|---|
| **GFSK** | | | | |
| 0 | 2402 | 1040 | N/A | PASS |
| 39 | 2441 | 1040 | N/A | PASS |
| 78 | 2480 | 1034 | N/A | PASS |
| **Æ/4DQPSK** | | | | |
| 0 | 2402 | 1329 | N/A | PASS |
| 39 | 2441 | 1347 | N/A | PASS |
| 78 | 2480 | 1347 | N/A | PASS |
| **8DPSK** | | | | |
| 0 | 2402 | 1287 | N/A | PASS |
| 39 | 2441 | 1287 | N/A | PASS |
| 78 | 2480 | 1287 | N/A | PASS |

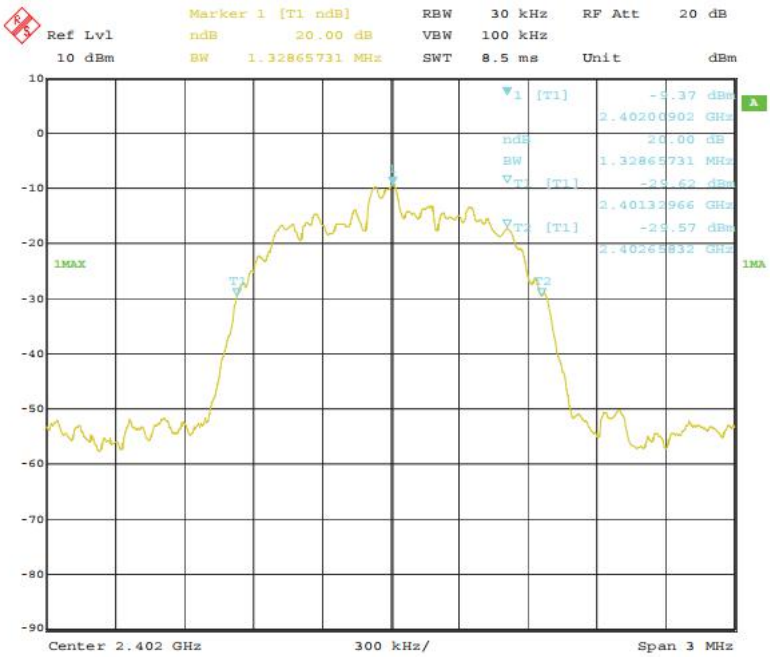
Test Mode: CH00 / CH39 / CH78 (GFSK Mode)

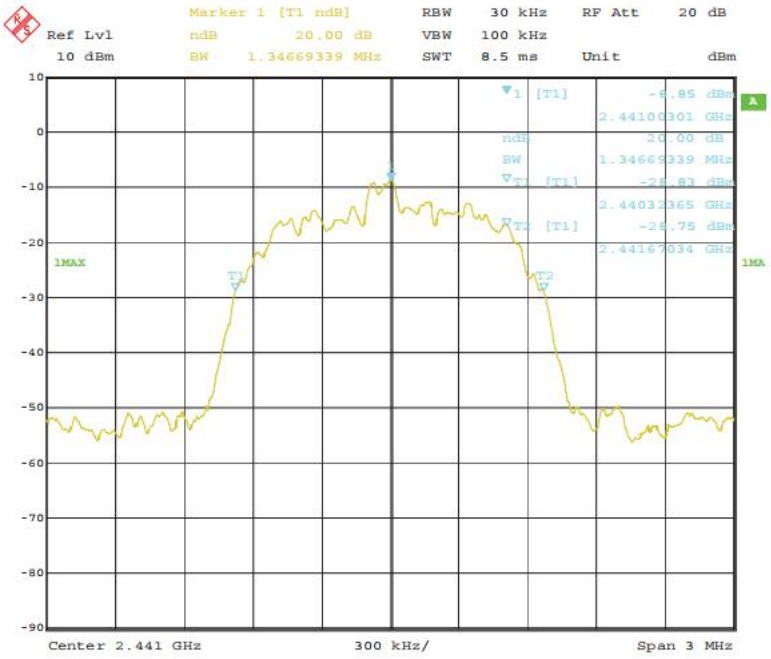


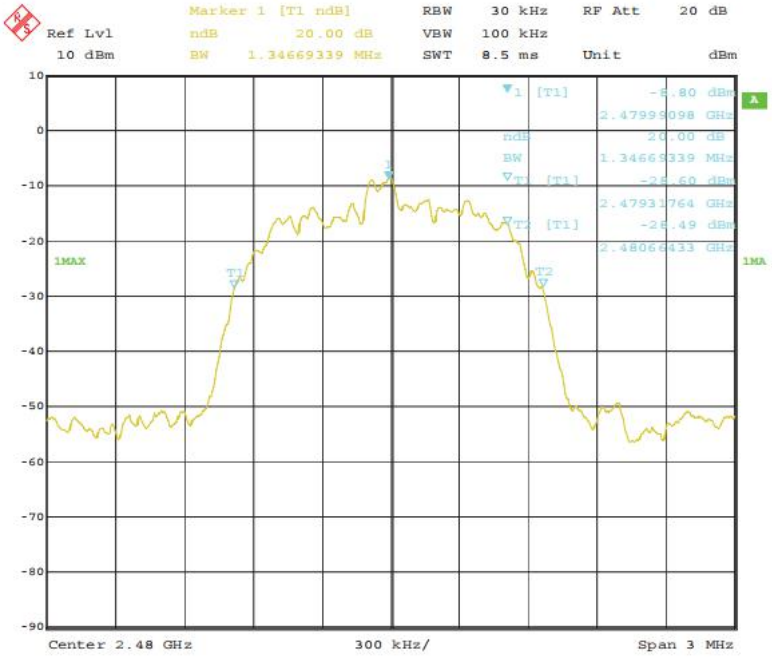





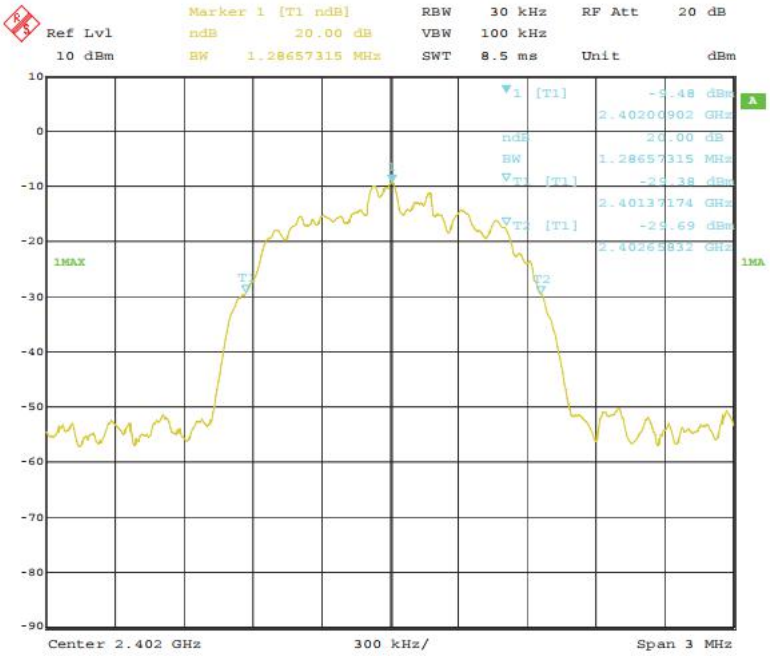

Test Mode: CH00 / CH39 / CH78 (Æ/4DQPSK Mode)

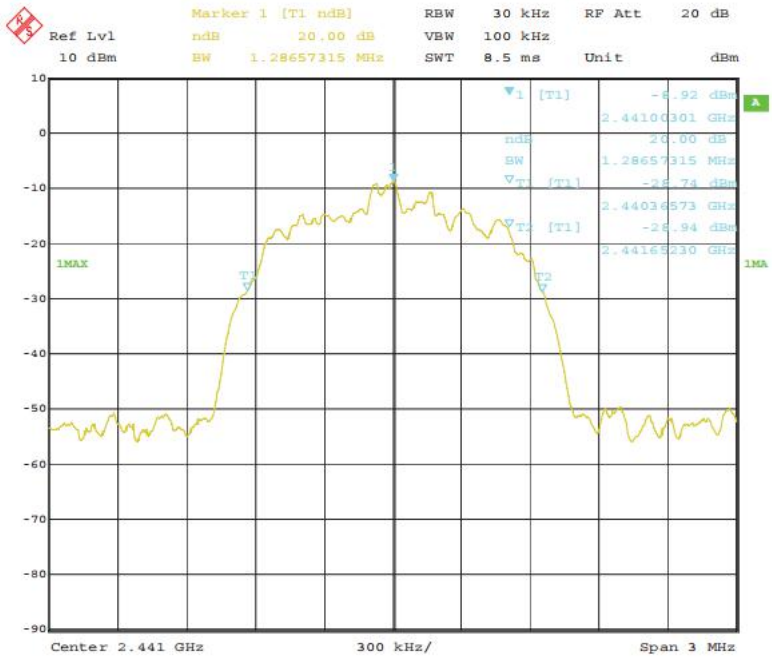


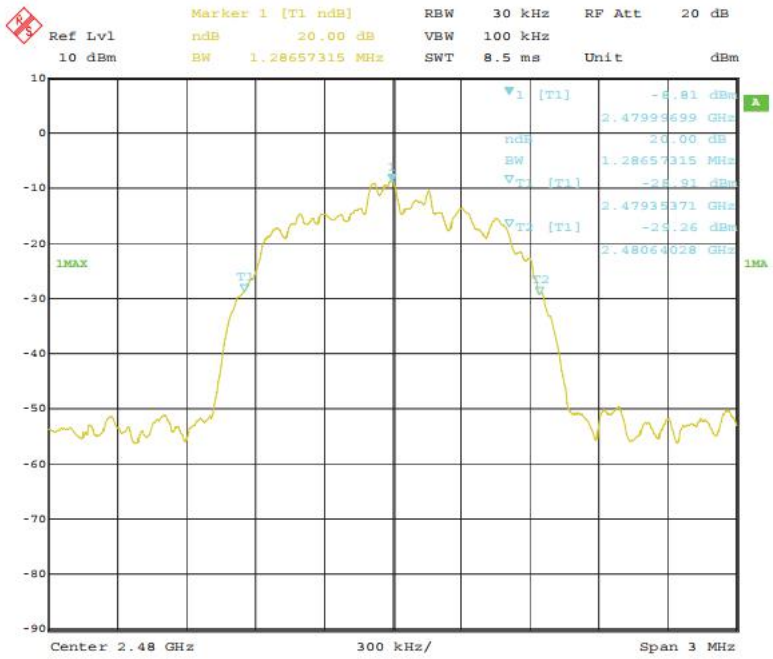

Marker 1 [T1 ndB]
ndB 20.00 dB
BW 1.34669339 MHz
RBW 30 kHz
VBW 100 kHz
SWT 8.5 ms
RF Att 20 dB
Unit dBm
Ref Lvl
10 dBm
1 [T1] -6.85 dBm
2.44100301 GHz
ndB 20.00 dB
BW 1.34669339 MHz
T1 [T1] -28.83 dBm
2.44032365 GHz
T2 [T1] -28.75 dBm
2.44167034 GHz
1MAX
1MA
Center 2.441 GHz
300 kHz/
Span 3 MHz


Marker 1 [T1 ndB]
ndB 20.00 dB
BW 1.34669339 MHz
RBW 30 kHz
VBW 100 kHz
SWT 8.5 ms
RF Att 20 dB
Unit dBm
Ref Lvl
10 dBm
1 [T1] -6.80 dBm
2.47999098 GHz
ndB 20.00 dB
BW 1.34669339 MHz
T1 [T1] -28.60 dBm
2.47931764 GHz
T2 [T1] -28.49 dBm
2.48066433 GHz
1MAX
1MA
Center 2.48 GHz
300 kHz/
Span 3 MHz

Test Mode: CH00 / CH39 / CH78 ( 8DPSK Mode)




Marker 1 [T1 ndB]
RBW 30 kHz
RF Att 20 dB
Ref Lvl
ndB 20.00 dB
VBW 100 kHz
10 dBm
BW 1.28657315 MHz
SWT 8.5 ms
Unit dBm
1 [T1] -6.81 dBm
2.47999699 GHz
ndB 20.00 dB
BW 1.28657315 MHz
T1 [T1] -26.91 dBm
2.47935371 GHz
T2 [T1] -26.26 dBm
2.48064028 GHz
1MAX
A
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
300 kHz/
Span 3 MHz

# 10 Maximum Peak Output Power

Test Requirement : FCC CFR47 Part 15 Section 15.247

Test Method : ANSI C63.10:2013

Test Limit : Regulation 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band eploying at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt (30dBm). 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 0.125watts (20.97 dBm) limit applies.

## 10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power Meter.GFSK, was tested and record.

## 10.2 Test Result

| Test Channel | Frequenc y (MHz) | Power Setting | Peak Output Power (dBm) | LIMIT (dBm) | Verdict |
|---|---|---|---|---|---|
| 1Mbps | | | | | |
| 0 | 2402 | Default | -4.22 | 30 | PASS |
| 39 | 2441 | Default | -3.93 | 30 | PASS |
| 78 | 2480 | Default | -3.81 | 30 | PASS |
| 2Mbps | | | | | |
| 0 | 2402 | Default | -4.87 | 30 | PASS |
| 39 | 2441 | Default | -4.24 | 30 | PASS |
| 78 | 2480 | Default | -4.07 | 30 | PASS |
| 3Mbps | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 0 | 2402 | Default | -4.69 | 30 | PASS |
| 39 | 2441 | Default | -4.21 | 30 | PASS |
| 78 | 2480 | Default | -4.18 | 30 | PASS |

# 11 Hopping Channel Separation

| | | |
|---|---|---|
| Test Requirement | : | FCC CFR47 Part 15 Section 15.247 |
| Test Method | : | ANSI C63.10:2013 |
| 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 2400-2483.5MHz 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 | : | Hopping |

## 11.1 Test Procedure

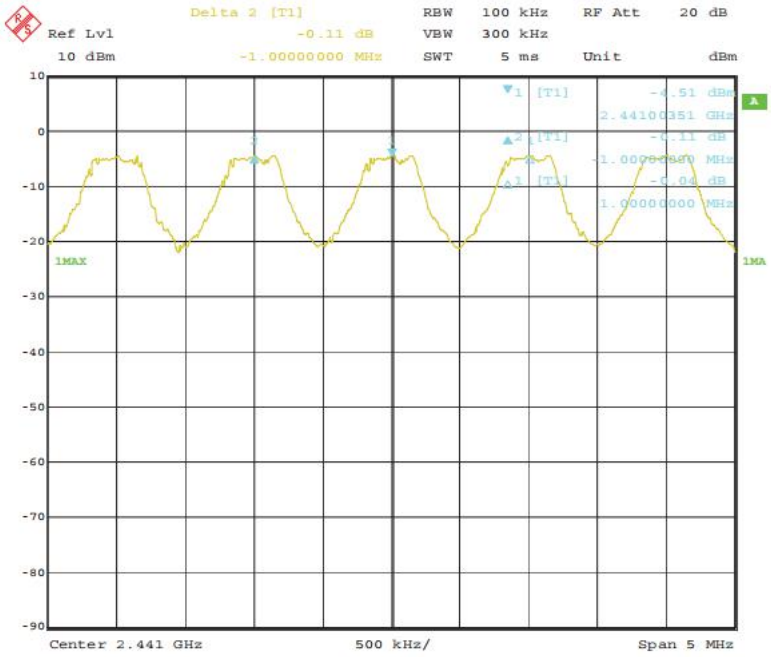
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW =100KHz. VBW =300KHz, Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

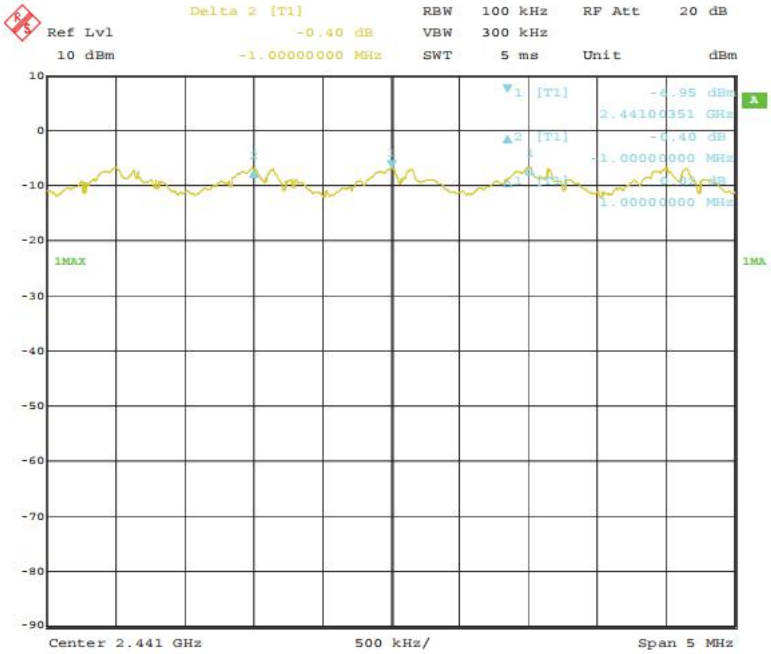
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

## 11.2 Test Result

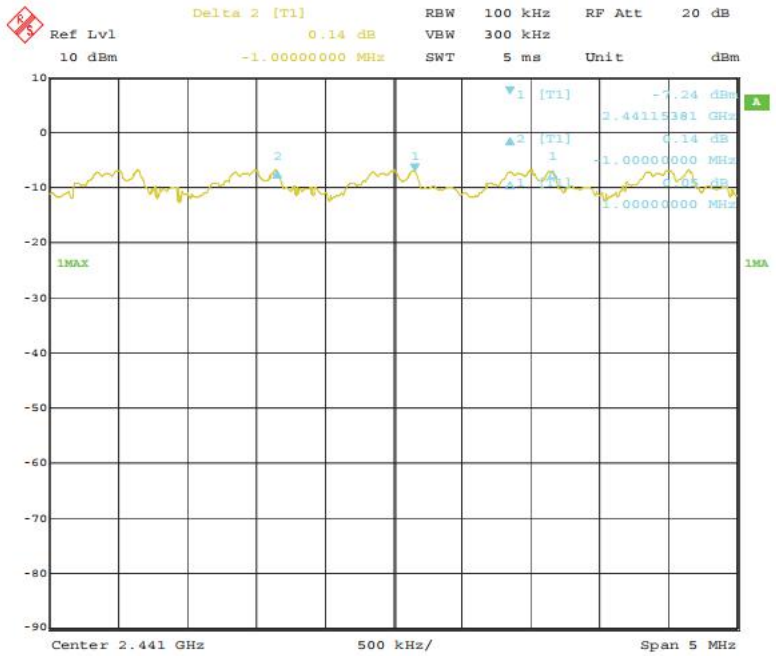
(GFSK) Channel Separation plot




( Æ/4DQPSK) Channel Separation plot



( 8DPSK) Channel Separation plot



# 12 Number of Hopping Frequency

| | | |
|---|---|---|
| Test Requirement | : | FCC CFR47 Part 15 Section 15.247 |
| Test Method | : | ANSI C63.10:2013 |
| 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 | : | Hopping(GFSK) |

## 12.1 Test Procedure

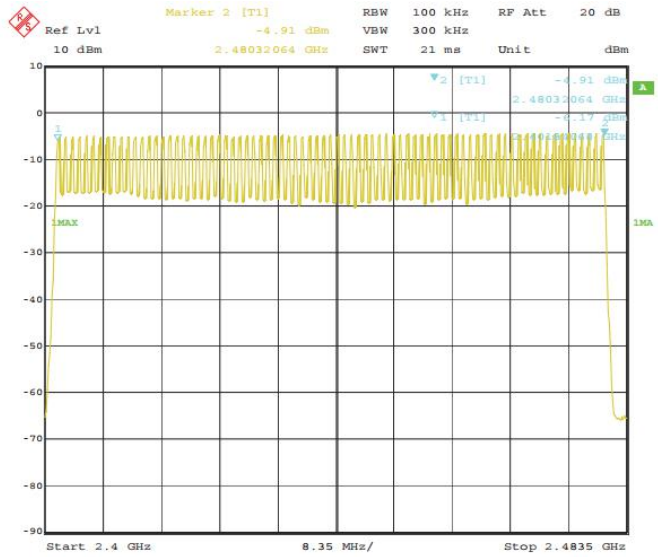
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100KHz. VBW = 300KHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to 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: Start Frequency = 2.4GHz, Stop Frequency = 2.483GHz. Sweep=auto;

## 12.2 Test Result

| Quantity of Hopping Channel | Limit | Results |
|---|---|---|
| 79 | >15 | Pass |

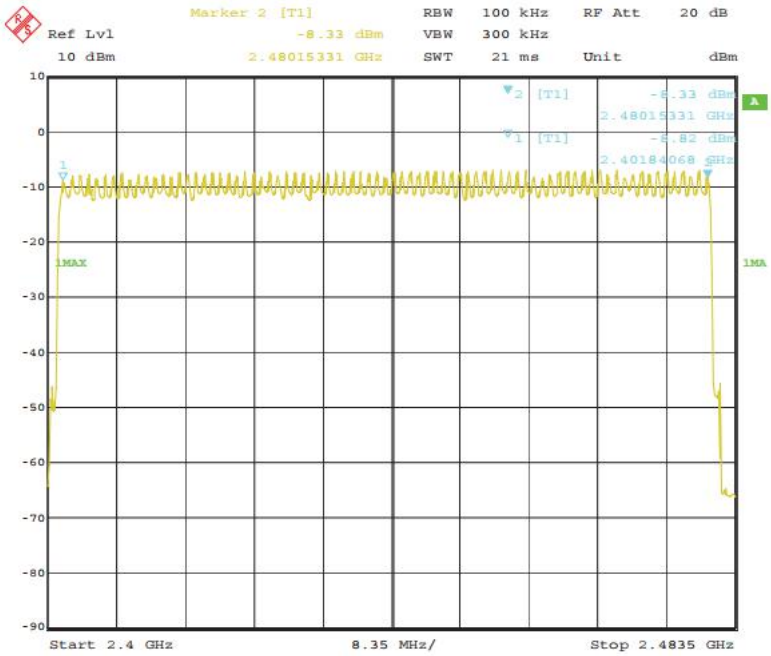
Test plots

GFSK



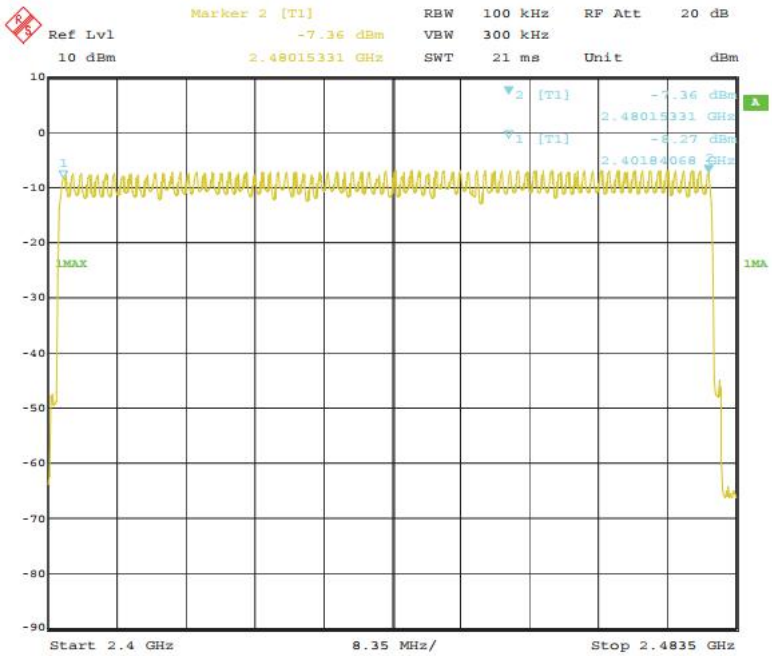
Test plots

Æ/4DQPSK




Test plots

8DPSK



# 13 Dwell Time

| | | |
|---|---|---|
| Test Requirement | : | FCC CFR47 Part 15 Section 15.247 |
| Test Method | : | ANSI C63.10:2013 |
| 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. |
| Test Mode | : | The test model GFSK and was recorded. |

## 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. Set the EUT for DH5, DH3 and DH1 packet transmitting.

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).DH5 was worse case.

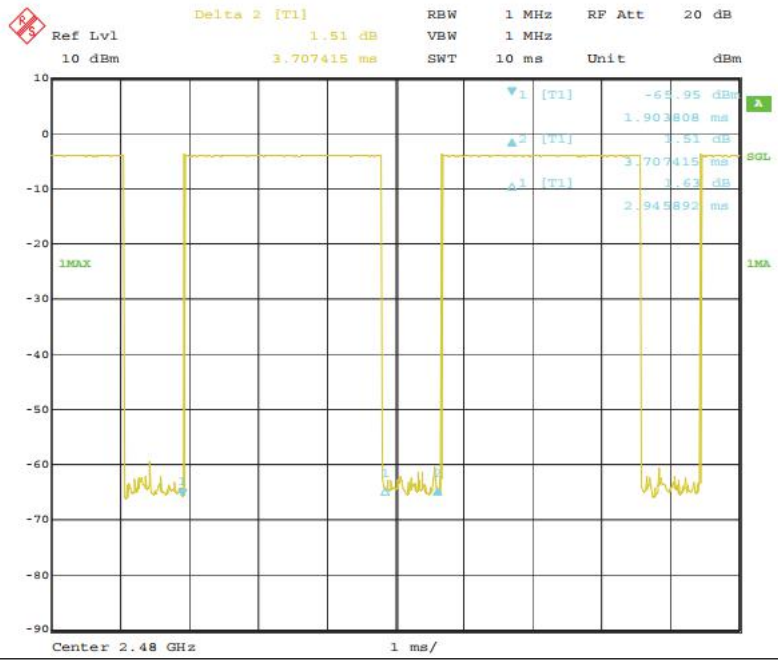
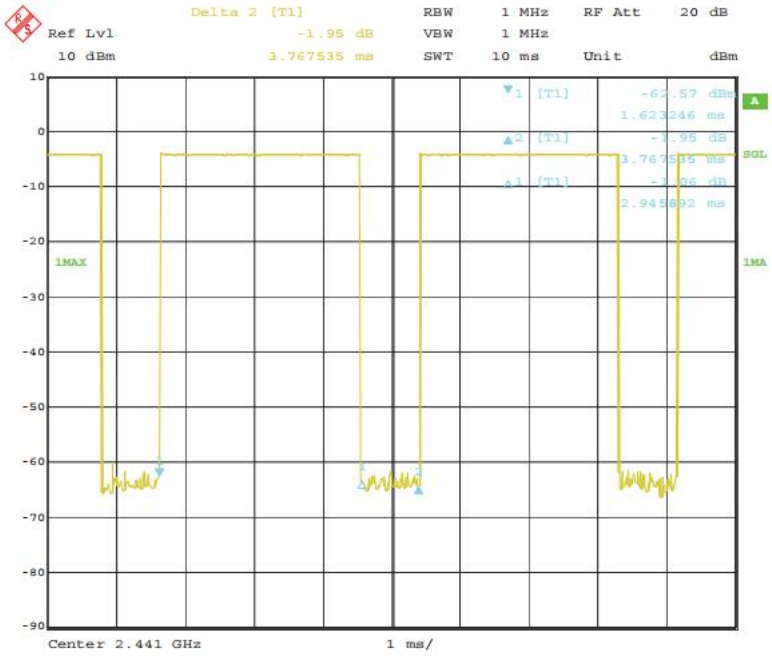
## 13.2 Test Result

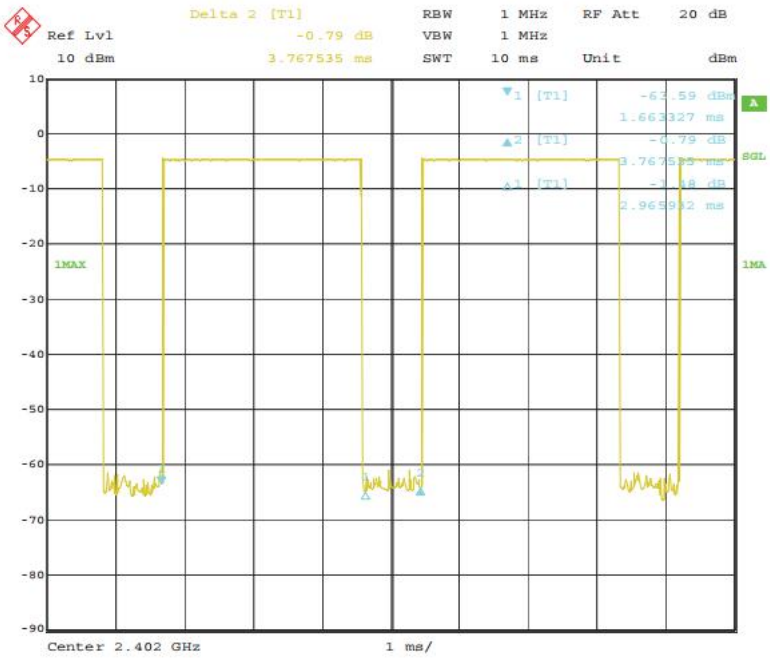
GFSK

| Channel | Reading | Hoping Rate | Actual | Limit |
|---|---|---|---|---|
| High | 2.946ms | 266.667 hop/s | 0.314s | 0.4s |
| Middle | 2.946ms | 266.667 hop/s | 0.314s | 0.4s |
| Low | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |

Actual = Reading × (Hopping rate / Number of channels) × Test period, Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds] NOTE: The EUT makes worst case 1600 hops per second or 1 time slot has a length of 625μs with 79 channels.

**Note: DH5 was the wore case**

| Modulation mode | GFSK mode |
|---|---|
| High |  |
| | |
| Mid |  |

| | |
|---|---|
| Low |  |

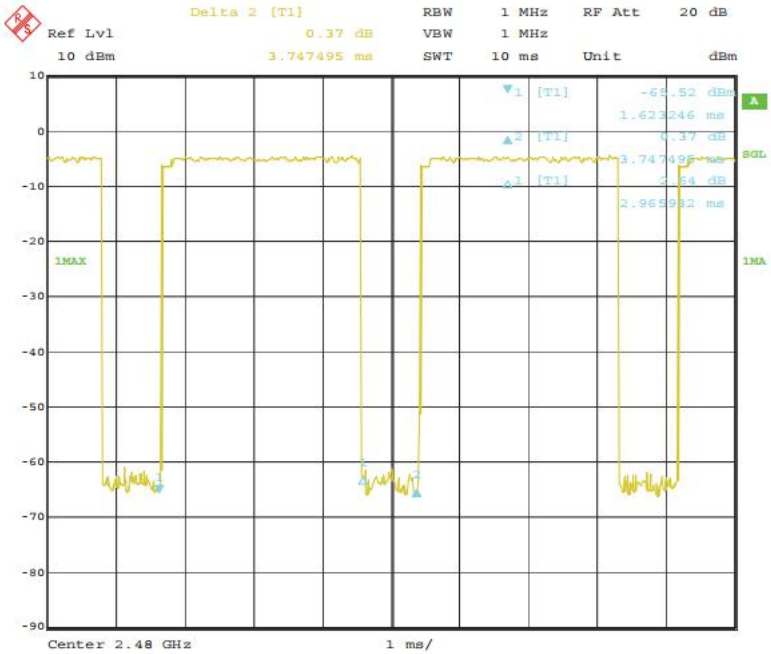
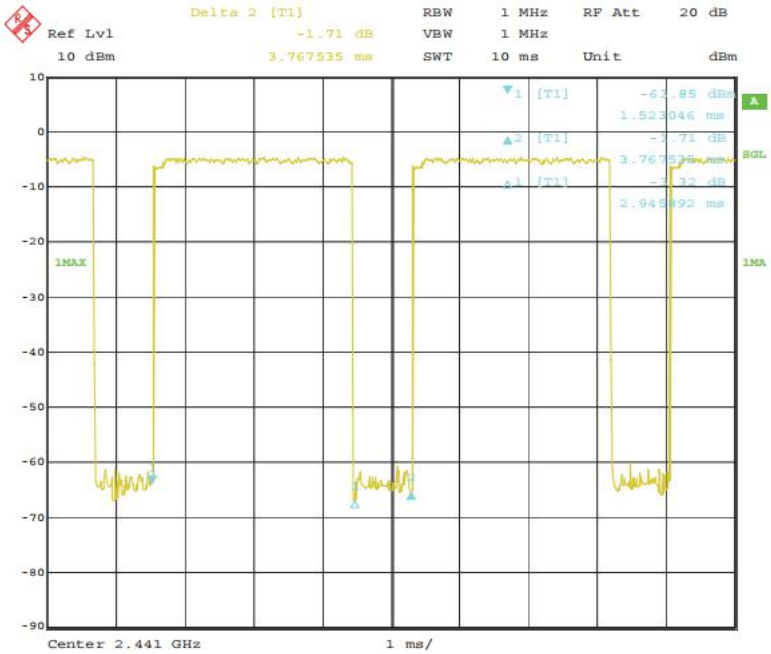


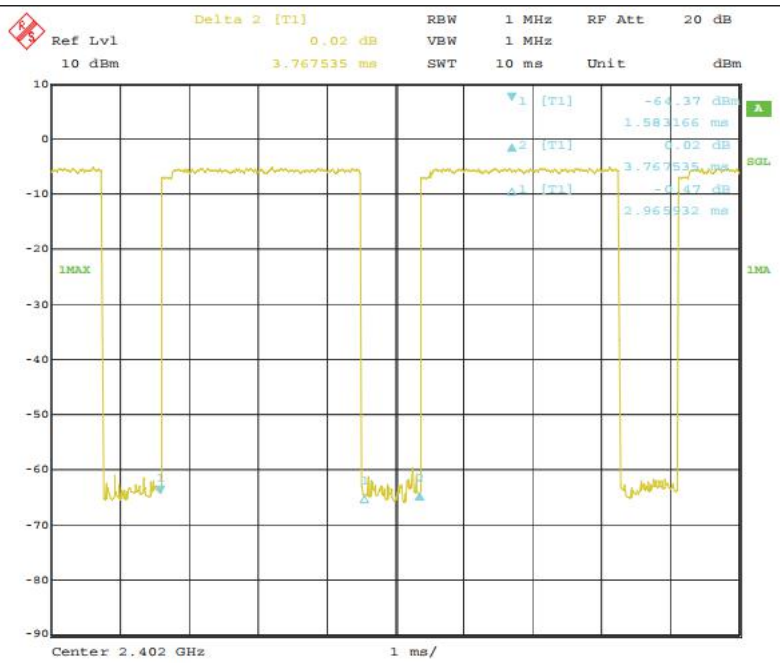
**Type of Modulation: Æ/4DQPSK**

| Channel | Reading | Hoping Rate | Actual | Limit |
|---|---|---|---|---|
| High | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |
| Middle | 2.946ms | 266.667 hop/s | 0.314s | 0.4s |
| Low | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |

Actual = Reading × (Hopping rate / Number of channels) × Test period, Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds] NOTE: The EUT makes worst case 1600 hops per second or 1 time slot has a length of 625μs with 79 channels.

**Note: DH5 was the wore case**

| Modulation mode | Æ/4DQPSK |
|---|---|
| High |  |
| | |
| Mid |  |

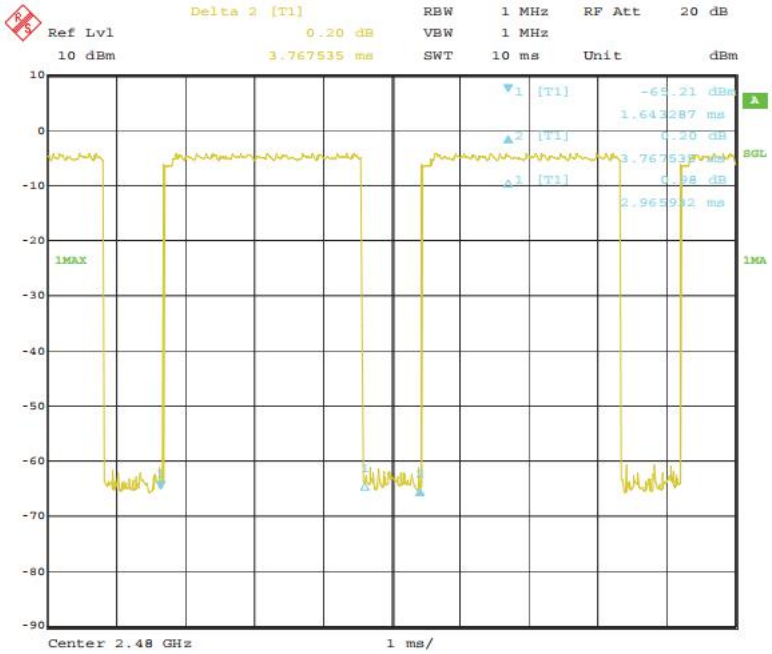
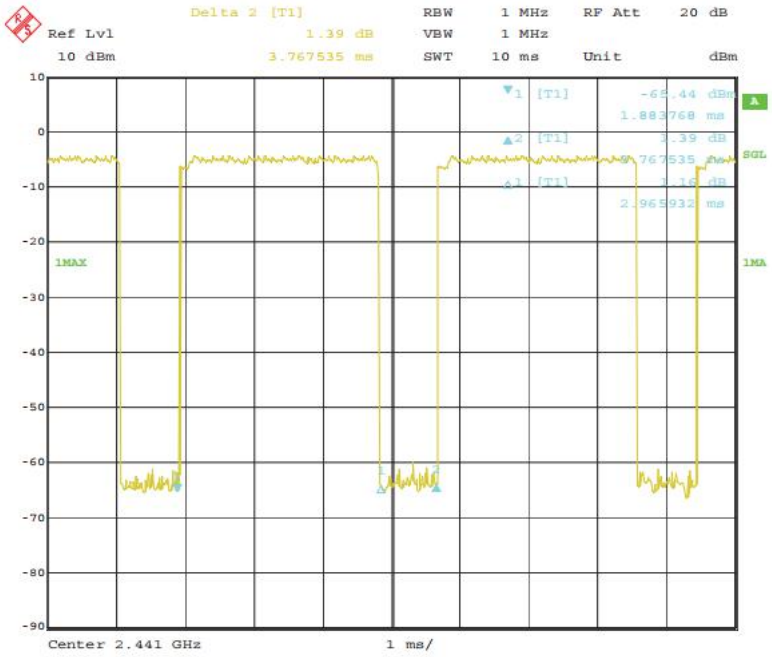
| | |
|---|---|
| Low |  |

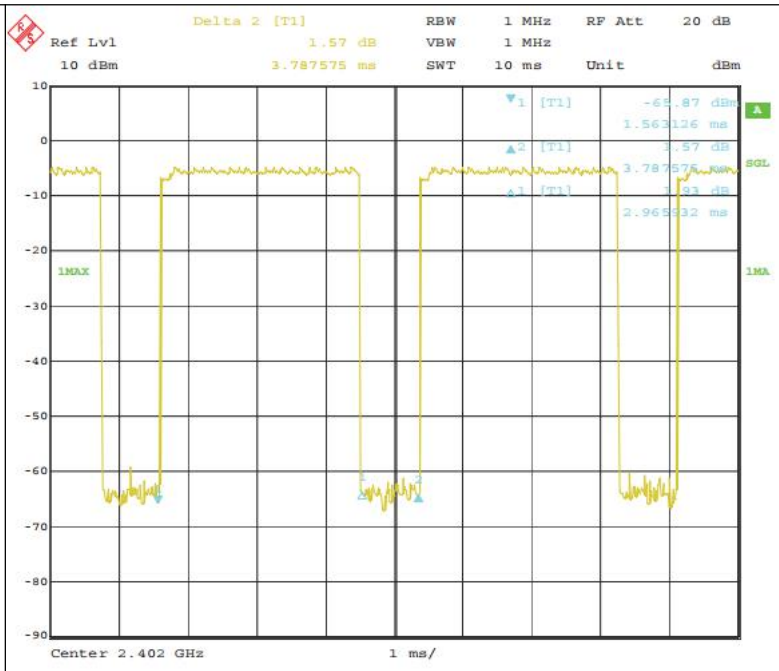
**Type of Modulation: 8DPSK**

| Channel | Reading | Hoping Rate | Actual | Limit |
|---|---|---|---|---|
| High | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |
| Middle | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |
| Low | 2.966ms | 266.667 hop/s | 0.316s | 0.4s |

Actual = Reading × (Hopping rate / Number of channels) × Test period, Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds] NOTE: The EUT makes worst case 1600 hops per second or 1 time slot has a length of 625μs with 79 channels.

**Note: DH5 was the wore case**

| Modulation mode | 8DPSK |
|---|---|
| High |  |
| | |
| Mid |  |

| | |
|---|---|
| Low |  Delta 2 [T1]<br>1.57 dB<br>3.787575 ms<br>Ref Lvl<br>10 dBm<br>RBW 1 MHz<br>VBW 1 MHz<br>SWT 10 ms<br>RF Att 20 dB<br>Unit dBm<br>1 [T1] -62.87 dBm<br>1.563126 ms<br>2 [T1] 1.57 dB<br>3.787575 ms<br>3 [T1] 2.93 dB<br>2.965932 ms<br>1MAX<br>A<br>SGL<br>1MA<br>10<br>0<br>-10<br>-20<br>-30<br>-40<br>-50<br>-60<br>-70<br>-80<br>-90<br>Center 2.402 GHz<br>1 ms/ |

# 14 Antenna Requirement

## 14.1 Antenna Requirement

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

## 14.2 Result

The EUT’S antenna, permanent attached antenna, is Internal PCB Antenna. The antenna’s gain is 0dBi and meets the requirement.

********THE END REPORT********