# FCC Part 15C

## Measurement And Test Report

For

## Beijing Infomedia Electronic Technology Co., Ltd.

**Floor 4, B Building, Printing Academy, No.2 Cuiwei Road, Haidian District, Beijing, China**

**FCC ID: 2AFA5PAW5000**

**Jul. 06, 2015**

| **This Report Concerns:** | **Equipment Type:** |
|---|---|
| ☒ Original Report | Digital Audio Player |

| | |
|---|---|
| **Report Number:** | MTI150603006RF-1 |
| **Test Engineer:** | David Chen |
| **Reviewed By:** | Tim Zhang |
| **Approved & Authorized By:** | Hebe Lee |
| **Test Date:** | Jun. 17, 2015 - Jul. 06, 2015 |
| **Prepared By:** | **Shenzhen Microtest Technology Co.,Ltd**<br>6F, Zhongbao Building, Gushu, Bao'an District, Shenzhen, P.R.China<br>Tel: +86-755-8885 0135<br>Fax: +86-755-8885 0136 |

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# 1. Test Certification

| | |
|---|---|
| **Product:** | Digital Audio Player |
| **Model No.:** | PAW5000 |
| **Additional Model:** | N/A |
| **Applicant:** | Beijing Infomedia Electronic Technology Co., Ltd |
| **Address:** | Floor 4, B Building, Printing Academy, No.2 Cuiwei Road, Haidian District, Beijing, China |
| **Manufacturer:** | Beijing Infomedia Electronic Technology Co., Ltd |
| **Address:** | Floor 4, B Building, Printing Academy, No.2 Cuiwei Road, Haidian District, Beijing, China |
| **Date of Test:** | Jun. 17, 2015 - Jul. 06, 2015 |
| **Applicable Standards:** | FCC CFR Title 47 Part 15 Subpart C Section 15.247 |

*The above equipment has been tested by Shenzhen Microtest Testing Lab. and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.*



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# 2. Test Result Summary

| Requirement | CFR 47 Section | Result |
|---|---|---|
| Antenna Requirement | §15.203/§15.247 (c) | PASS |
| AC Power Line Conducted Emission | §15.207 | PASS |
| Conducted Peak Output Power | §15.247 (b)(1) | PASS |
| 20dB Occupied Bandwidth | §15.247 (a)(1) | PASS |
| Carrier Frequencies Separation | §15.247 (a)(1) | PASS |
| Hopping Channel Number | §15.247 (a)(1) | PASS |
| Dwell Time | §15.247 (a)(1) | PASS |
| Radiated Emission | §15.205/§15.209 | PASS |
| Band Edge | §15.247(d) | PASS |

***Note:***

*1. PASS: Test item meets the requirement.*

*2. Fail: Test item does not meet the requirement.*

*3. N/A: Test case does not apply to the test object.*

*4. The test result judgment is decided by the limit of test standard.*



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# 3. EUT Description

| | |
|---|---|
| **Product Name:** | Digital Audio Player |
| **Model :** | PAW5000 |
| **Additional Model:** | N/A |
| **Trade Mark:** | **lotoo** |
| **BT Version:** | 6.1.0.3 |
| **Operation Frequency:** | 2402MHz~2480MHz |
| **Transfer Rate:** | 1/2/3 Mbits/s |
| **Number of Channel:** | 79 |
| **Modulation Type:** | GFSK, π/4-DQPSK, 8DPSK |
| **Modulation Technology:** | FHSS |
| **Antenna Type:** | Internal Antenna |
| **Antenna Gain:** | 0 dBi |
| **Power Supply:** | Rechargeable Li-ion Battery DC3.7V |
| **Remark:** | N/A |



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**Operation Frequency each of channel for GFSK, π/4-DQPSK, 8DPSK**

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| 0 | 2402MHz | 20 | 2422MHz | 40 | 2442MHz | 60 | 2462MHz |
| 1 | 2403MHz | 21 | 2423MHz | 41 | 2443MHz | 61 | 2463MHz |
| … | … | … | … | … | … | … | … |
| 10 | 2412MHz | 30 | 2432MHz | 50 | 2452MHz | 70 | 2472MHz |
| 11 | 2413MHz | 31 | 2433MHz | 51 | 2453MHz | 71 | 2473MHz |
| … | … | … | … | … | … | … | … |
| 18 | 2420MHz | 38 | 2440MHz | 58 | 2460MHz | 78 | 2480MHz |
| 19 | 2421MHz | 39 | 2441MHz | 59 | 2461MHz | - | |
| Remark: Channel 0, 39 &78 have been tested for GFSK, π/4-DQPSK, 8DPSK modulation mode. | | | | | | | |



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# 4. Genera Information

## 4.1. Test environment and mode

| Operating Environment: | |
|---|---|
| Temperature: | 25.0 °C |
| Humidity: | 56 % RH |
| Atmospheric Pressure: | 1010 mbar |
| **Test Mode:** | |
| Engineering mode: | Keep the EUT in continuous transmitting by select channel and modulations |
| The sample was placed 0.8m above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. | |

## 4.2. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| Equipment | Model No. | Serial No. | FCC ID | Trade Name |
|---|---|---|---|---|
| / | / | / | / | / |

***Note:***

1. *The adapter is provided by Testing Lab.*
2. *All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.*
3. *Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.*
4. *For conducted measurements (Output Power, 20dB Occupied Bandwidth, Carrier Frequencies Separation, Hopping Channel Number, Dwell Time, Spurious Emissions), the antenna of EUT is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.*



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# 5. Facilities and Accreditations

## 5.1. Facilities

Shenzhen Toby Technology Co., Ltd.
Add.: 10/F.,A Block,Jiada R&D Bldg.,No.5 Songpingshan, Road, Science&Technology Park,
Shenzhen, 518057
FCC Registration No.:811562

## 5.2. Measurement Uncertainty

The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

| No. | Item | MU |
|---|---|---|
| 1 | Conducted Emission | ±2.56dB |
| 2 | RF power, conducted | ±0.12dB |
| 3 | Spurious emissions, conducted | ±0.11dB |
| 4 | All emissions, radiated(<1G) | ±3.92dB |
| 5 | All emissions, radiated(>1G) | ±4.28dB |
| 6 | Temperature | ±0.1°C |
| 7 | Humidity | ±1.0% |



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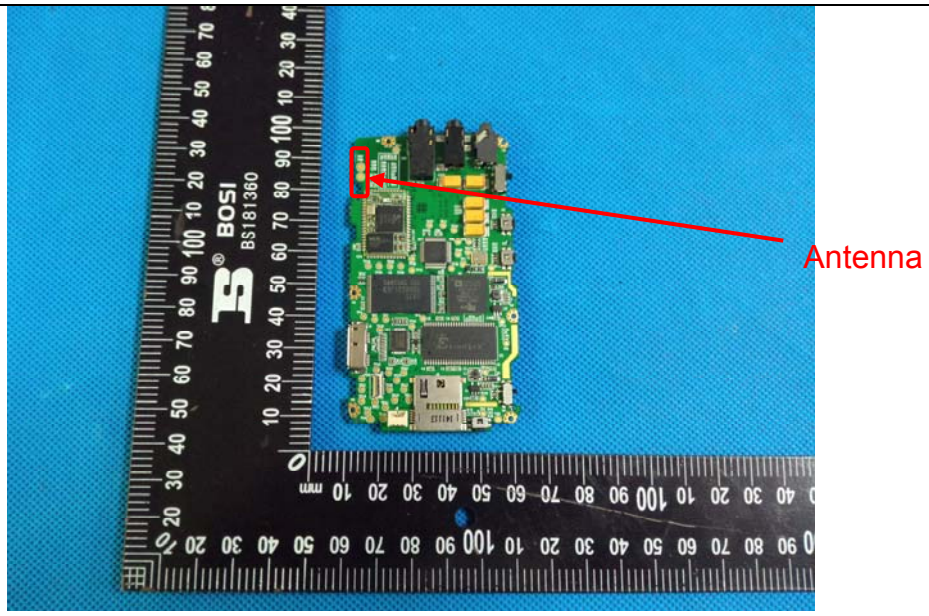
# 6. Test Results and Measurement Data

## 6.1. Antenna requirement

| **Standard requirement:** | FCC Part15 C Section 15.203 /247(c) |
|---|---|
| 15.203 requirement:<br>An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.<br>15.247(c) (1)(i) requirement:<br>(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi. | |
| **E.U.T Antenna:** | |
| The Bluetooth antenna is an internal antenna which permanently attached, and the best case gain of the antenna is 0dBi. | |



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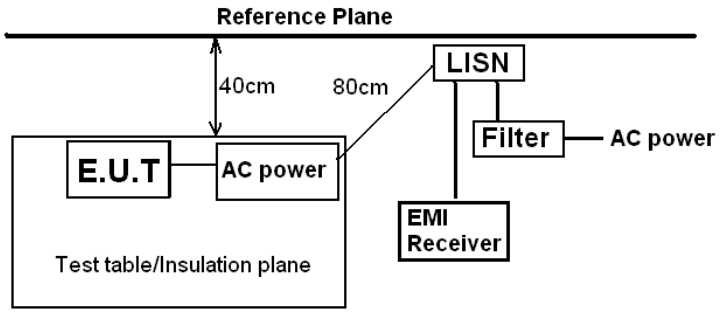
## 6.2. Conducted Emission

### 6.2.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.207 |
| **Test Method:** | ANSI C63.4:2009 |
| **Frequency Range:** | 150 kHz to 30 MHz |
| **Receiver setup:** | RBW=9 kHz, VBW=30 kHz, Sweep time=auto |
| **Limits:** | |

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

**Test Setup:**




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

**Test Mode:** Reference to item 4.1

**Test Procedure:**

1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment.
2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs).
3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2009 on conducted measurement.

**Test Result:** PASS



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### 6.2.2. Test Instruments

| Conducted Emission Shielding Room Test Site (843) | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| EMI Test Receiver | R&S | ESCS30 | 100139 | Sep. 16, 2015 |
| LISN | Schwarzbeck | NSLK 8126 | 8126453 | Sep. 29, 2015 |
| Coax cable | TOBY | CE-05 | N/A | Sep.15 , 2015 |
| EMI Test Software | Shurple Technology | EZ-EMC | N/A | N/A |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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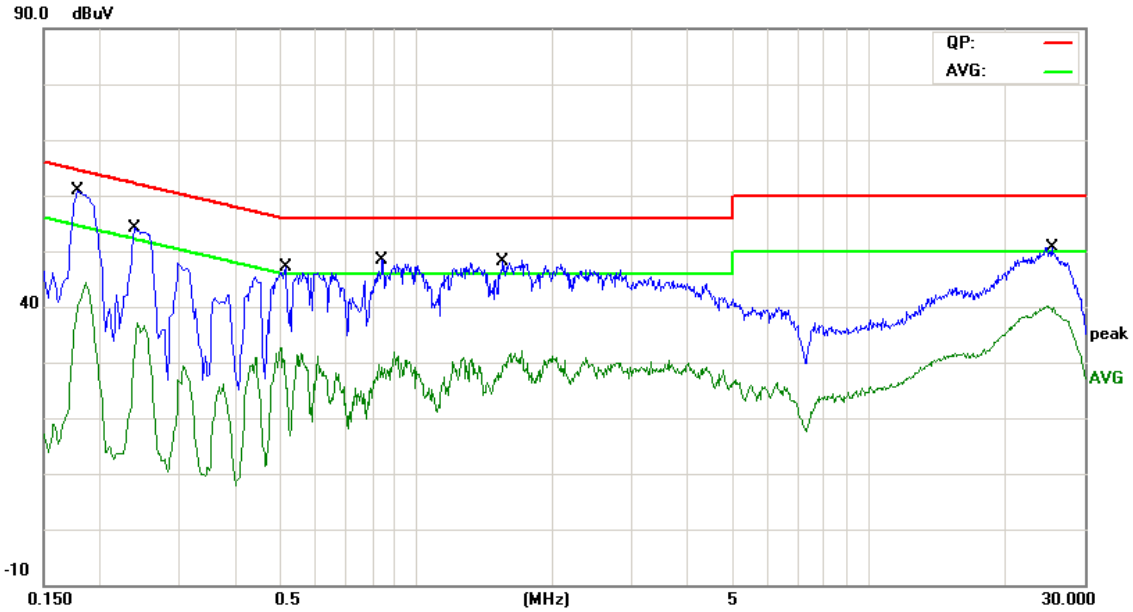
### 6.2.3. Test data

**Please refer to following diagram for individual**

**Conducted Emission on Line Terminal of the power line (150 kHz to 30MHz)**




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | * | 0.1780 | 45.77 | 9.98 | 55.75 | 64.57 | -8.82 | QP | |
| 2 | | 0.1780 | 26.29 | 9.98 | 36.27 | 54.57 | -18.30 | AVG | |
| 3 | | 0.2380 | 39.24 | 10.02 | 49.26 | 62.16 | -12.90 | QP | |
| 4 | | 0.2380 | 21.20 | 10.02 | 31.22 | 52.16 | -20.94 | AVG | |
| 5 | | 0.5140 | 34.09 | 10.03 | 44.12 | 56.00 | -11.88 | QP | |
| 6 | | 0.5140 | 18.49 | 10.03 | 28.52 | 46.00 | -17.48 | AVG | |
| 7 | | 0.8420 | 32.41 | 10.09 | 42.50 | 56.00 | -13.50 | QP | |
| 8 | | 0.8420 | 18.68 | 10.09 | 28.77 | 46.00 | -17.23 | AVG | |
| 9 | | 1.5580 | 31.77 | 10.06 | 41.83 | 56.00 | -14.17 | QP | |
| 10 | | 1.5580 | 18.50 | 10.06 | 28.56 | 46.00 | -17.44 | AVG | |
| 11 | | 25.3860 | 34.70 | 10.17 | 44.87 | 60.00 | -15.13 | QP | |
| 12 | | 25.3860 | 29.16 | 10.17 | 39.33 | 50.00 | -10.67 | AVG | |

***Note:***

*Freq. = Emission frequency in MHz*
*Reading level (dBμV) = Receiver reading*
*Corr. Factor (dB) = Antenna factor + Cable loss*
*Measurement (dBμV) = Reading level (dBμV) + Corr. Factor (dB)*
*Limit (dBμV) = Limit stated in standard*
*Margin (dB) = Measurement (dBμV) – Limits (dBμV)*
*Q.P. =Quasi-Peak*
*AVG =average*
** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz*



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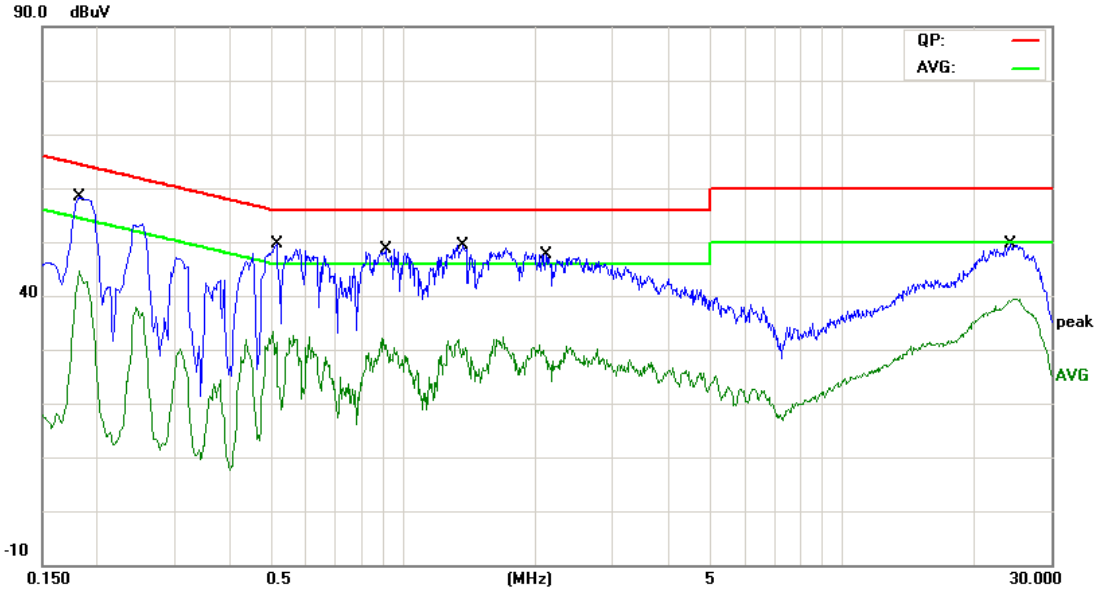
## Conducted Emission on Neutral Terminal of the power line (150 kHz to 30MHz)




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | * | 0.1835 | 45.85 | 9.99 | 55.84 | 64.32 | -8.48 | QP | |
| 2 | | 0.1835 | 33.38 | 9.99 | 43.37 | 54.32 | -10.95 | AVG | |
| 3 | | 0.5140 | 35.26 | 10.03 | 45.29 | 56.00 | -10.71 | QP | |
| 4 | | 0.5140 | 19.58 | 10.03 | 29.61 | 46.00 | -16.39 | AVG | |
| 5 | | 0.9100 | 34.30 | 10.08 | 44.38 | 56.00 | -11.62 | QP | |
| 6 | | 0.9100 | 20.63 | 10.08 | 30.71 | 46.00 | -15.29 | AVG | |
| 7 | | 1.3700 | 34.65 | 10.06 | 44.71 | 56.00 | -11.29 | QP | |
| 8 | | 1.3700 | 19.61 | 10.06 | 29.67 | 46.00 | -16.33 | AVG | |
| 9 | | 2.1140 | 31.67 | 10.06 | 41.73 | 56.00 | -14.27 | QP | |
| 10 | | 2.1140 | 17.80 | 10.06 | 27.86 | 46.00 | -18.14 | AVG | |
| 11 | | 24.1940 | 33.61 | 10.16 | 43.77 | 60.00 | -16.23 | QP | |
| 12 | | 24.1940 | 27.96 | 10.16 | 38.12 | 50.00 | -11.88 | AVG | |

***Note1:***

*Freq. = Emission frequency in MHz*

*Reading level (dBμV) = Receiver reading*

*Corr. Factor (dB) = Antenna factor + Cable loss*

*Measurement (dBμV) = Reading level (dBμV) + Corr. Factor (dB)*

*Limit (dBμV) = Limit stated in standard*

*Margin (dB) = Measurement (dBμV) – Limits (dBμV)*

*Q.P. =Quasi-Peak*

*AVG =average*

** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz.*



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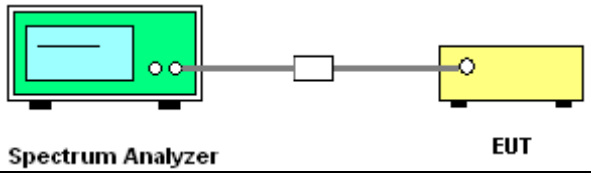
## 6.3. Conducted Output Power

### 6.3.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (b)(3) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (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. |
| **Test Setup:** |  |
| **Test Mode:** | Transmitting mode with modulation |
| **Test Procedure:** | Use the following spectrum analyzer settings:<br><br>Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel<br>RBW > the 20 dB bandwidth of the emission being measured VBW ≥ RBW<br>Sweep = auto<br>Detector function = peak<br>Trace = max hold<br>Allow the trace to stabilize.<br>Use the marker-to-peak function to set the marker to the peak of the emission. |
| **Test Result:** | PASS |

### 6.3.2. Test Instruments

| Equipment | Manufacturer | Model | Serial Number | Calibration Due |
|---|---|---|---|---|
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF Cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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### 6.3.3. Test Data

| GFSK mode | | | |
|---|---|---|---|
| Test channel | Peak Output Power (dBm) | Limit (dBm) | Result |
| Lowest | -3.057 | 21.00 | PASS |
| Middle | -2.794 | 21.00 | PASS |
| Highest | -1.612 | 21.00 | PASS |

| Pi/4DQPSK mode | | | |
|---|---|---|---|
| Test channel | Peak Output Power (dBm) | Limit (dBm) | Result |
| Lowest | -2.138 | 21.00 | PASS |
| Middle | -1.859 | 21.00 | PASS |
| Highest | -1.468 | 21.00 | PASS |

| 8DPSK mode | | | |
|---|---|---|---|
| Test channel | Peak Output Power (dBm) | Limit (dBm) | Result |
| Lowest | -1.883 | 21.00 | PASS |
| Middle | -0.932 | 21.00 | PASS |
| Highest | -1.176 | 21.00 | PASS |

**Test plots as follows:**



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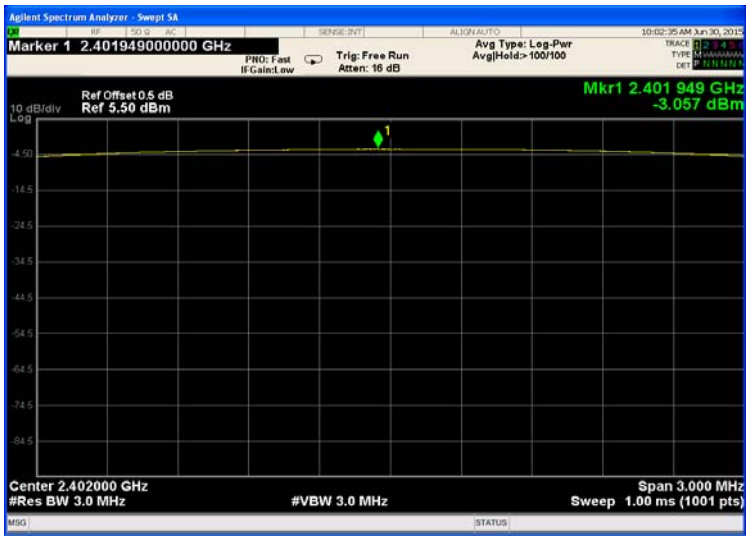
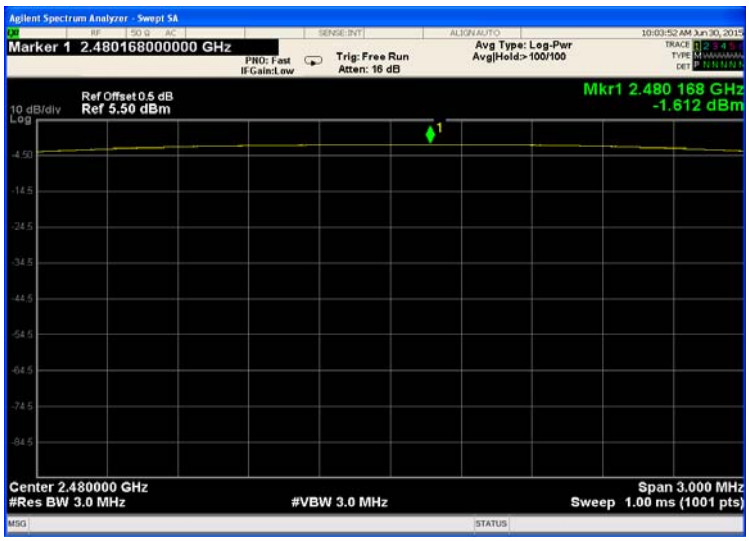
**GFSK Modulation**

Lowest channel




Middle channel

Highest channel



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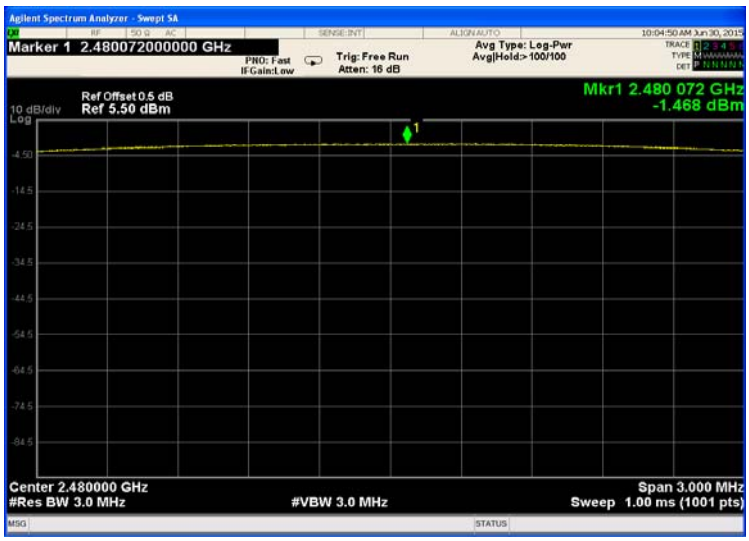
**Pi/4DQPSK Modulation**

Lowest channel

Middle channel

Highest channel



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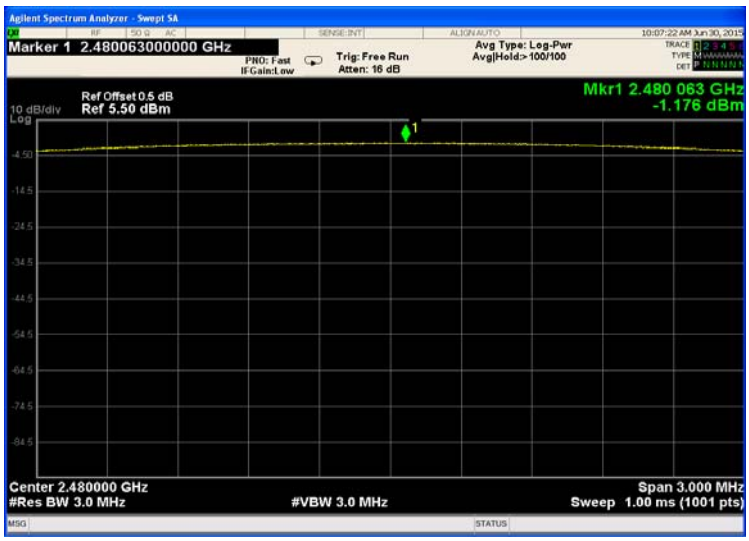
**8DPSK Modulation**

Lowest channel

Middle channel

Highest channel



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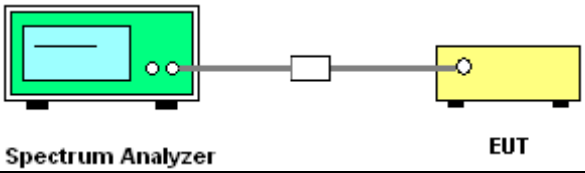
## 6.4. 20dB Occupy Bandwidth

### 6.4.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (a)(1) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | N/A |
| **Test Setup:** |  |
| **Test Mode:** | Transmitting mode with modulation |
| **Test Procedure:** | 1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.<br>Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a<br>hopping channel; RBW≥1% of the 20 dB bandwidth; VBW≥RBW;<br>Sweep = auto; Detector function = peak; Trace = max hold.<br>5. Measure and record the results in the test report. |
| **Test Result:** | PASS |



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### 6.4.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

### 6.4.3. Test data

| Test channel | 20dB Occupy Bandwidth (kHz) | | | |
|---|---|---|---|---|
| | GFSK | π/4-DQPSK | 8DPSK | Conclusion |
| Lowest | 922.7 | 1216 | 1239 | PASS |
| Middle | 880.2 | 1194 | 1225 | PASS |
| Highest | 879.7 | 1195 | 1225 | PASS |

**Test plots as follows:**



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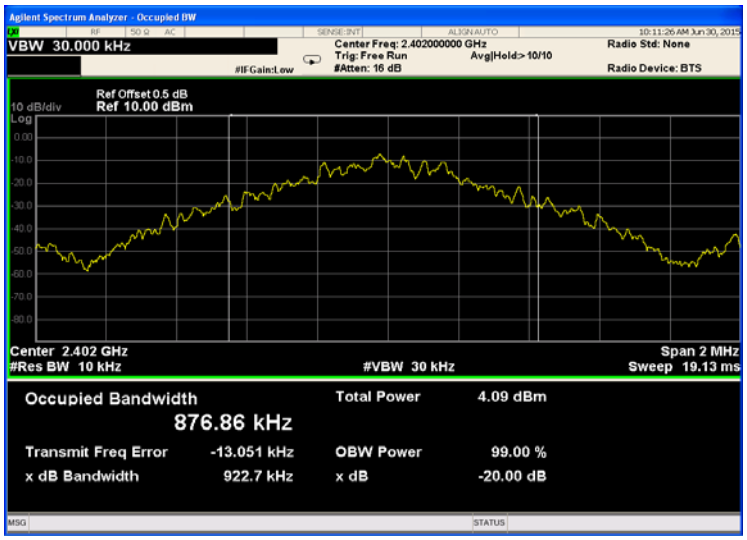
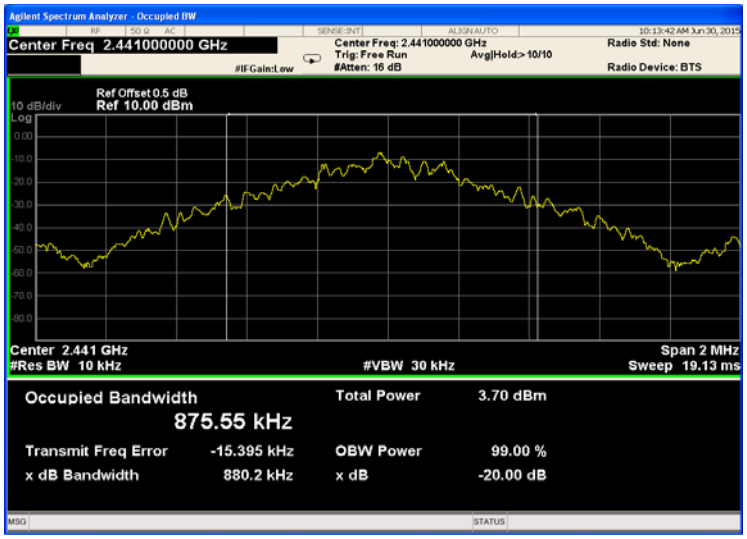
**GFSK Modulation**

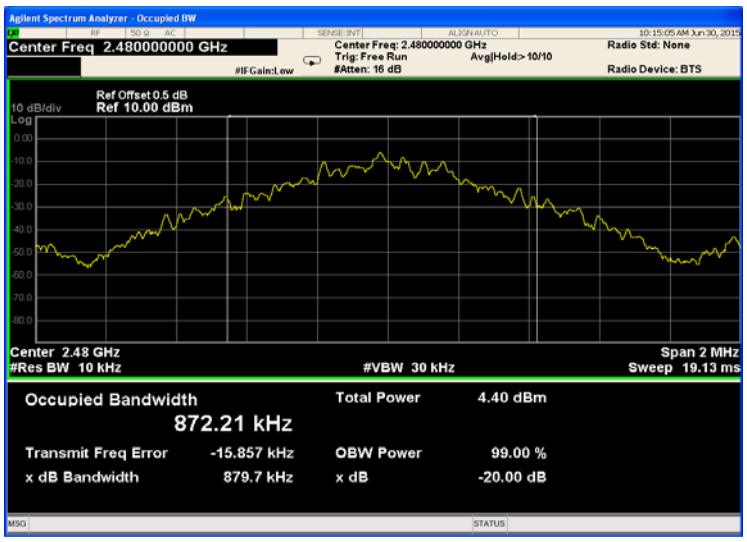
Lowest channel




Middle channel




Highest channel



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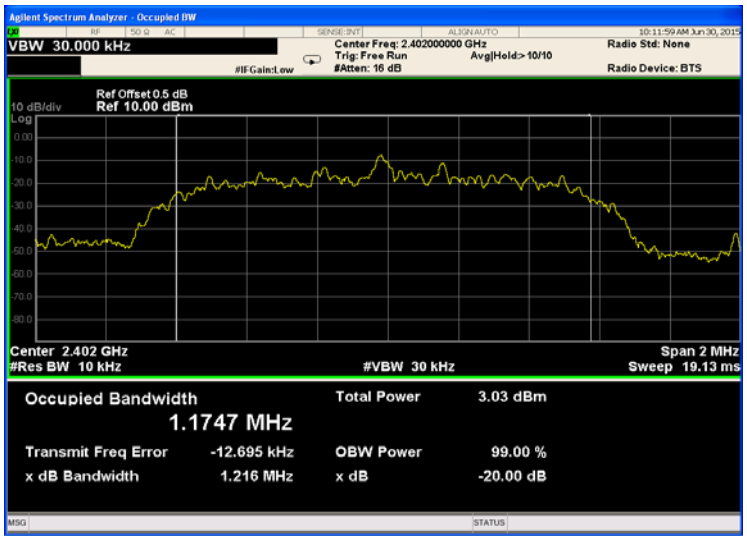
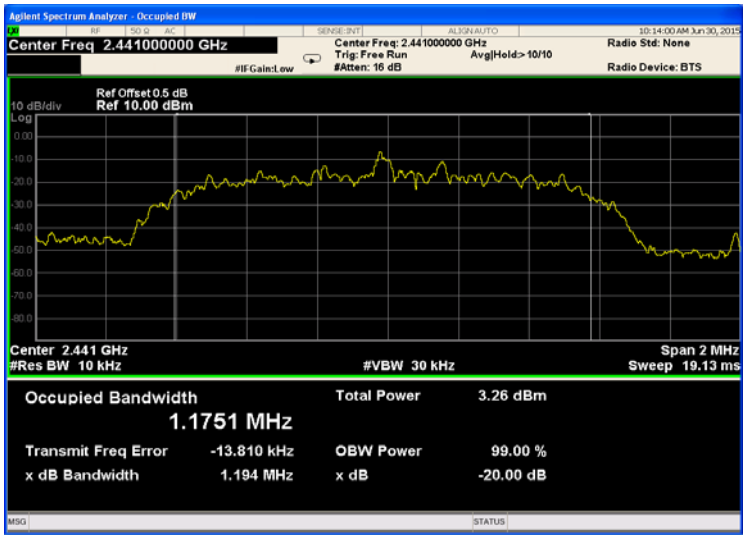
**Pi/4DQPSK Modulation**

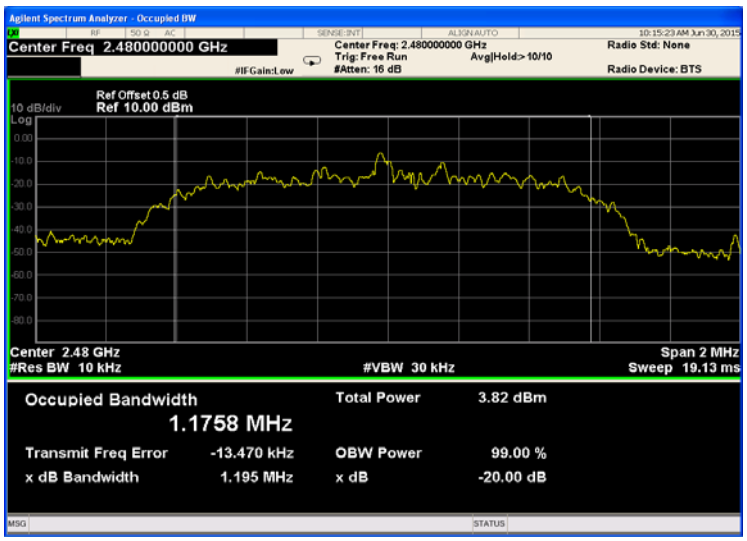
Lowest channel




Middle channel




Highest channel



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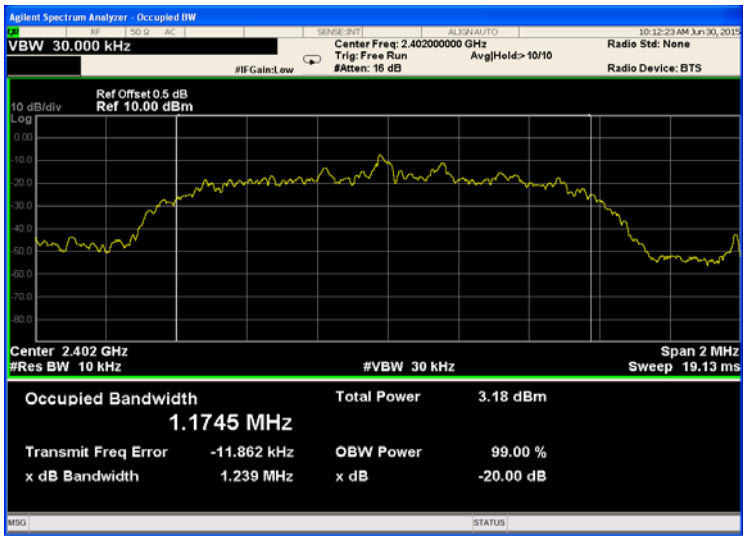
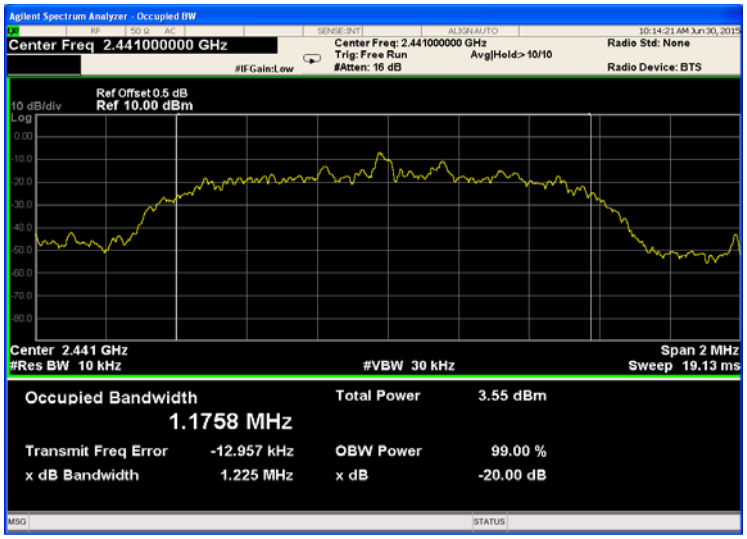
**8DPSK Modulation**

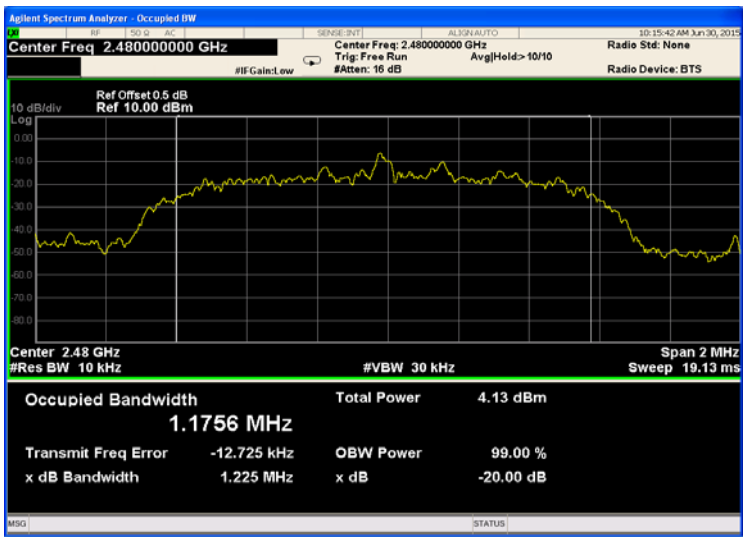
Lowest channel




Middle channel




Highest channel



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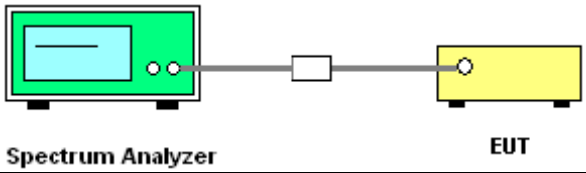
## 6.5. Carrier Frequencies Separation

### 6.5.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (a)(1) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | 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. |
| **Test Setup:** |  |
| **Test Mode:** | Hopping mode |
| **Test Procedure:** | 1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Enable the EUT hopping function.<br>5. Use the following spectrum analyzer settings:<br>Span = wide enough to capture the peaks of two adjacent channels;<br>RBW≥1% of the span; VBW≥RBW; Sweep = auto;<br>Detector function = peak; Trace = max hold.<br>6. Measure and record the results in the test report. |
| **Test Result:** | PASS |

### 6.5.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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### 6.5.3. Test data

| GFSK mode | | | |
|---|---|---|---|
| Test channel | Carrier Frequencies Separation (kHz) | Limit (kHz) | Result |
| Lowest | 1000 | *615.13* | PASS |
| Middle | 1000 | *615.13* | PASS |
| Highest | 1000 | *615.13* | PASS |

| Pi/4 DQPSK mode | | | |
|---|---|---|---|
| Test channel | Carrier Frequencies Separation (kHz) | Limit (kHz) | Result |
| Lowest | 1000 | *810.67* | PASS |
| Middle | 1000 | *810.67* | PASS |
| Highest | 1000 | *810.67* | PASS |

| 8DPSK mode | | | |
|---|---|---|---|
| Test channel | Carrier Frequencies Separation (kHz) | Limit (kHz) | Result |
| Lowest | 1000 | *826* | PASS |
| Middle | 1000 | *826* | PASS |
| Highest | 1000 | *826* | PASS |

***Note: According to section 6.4***

| *Mode* | *20dB bandwidth (kHz) (worse case)* | *Limit (kHz) (Carrier Frequencies Separation)* |
|---|---|---|
| *GFSK* | 922.7 | *615.13* |
| *π/4-DQPSK* | 1216 | *810.67* |
| *8DPSK* | 1239 | *826* |

**Test plots as follows:**



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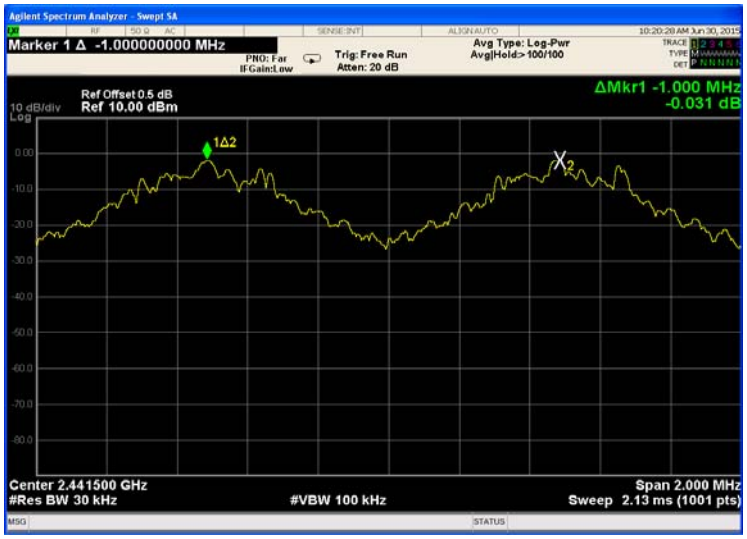
**GFSK Modulation**

Lowest channel

Middle channel




Highest channel

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**Pi/4DQPSK Modulation**

Lowest channel

Middle channel

Highest channel

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**8DPSK Modulation**

Lowest channel

Middle channel

Highest channel

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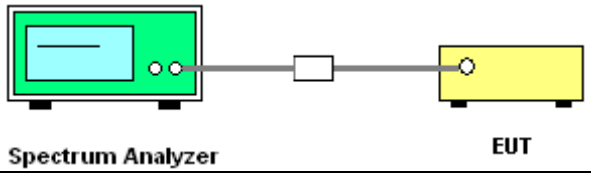
## 6.6. Hopping Channel Number

### 6.6.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (a)(1) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. |
| **Test Setup:** |  |
| **Test Mode:** | Hopping mode |
| **Test Procedure:** | 1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Enable the EUT hopping function.<br>5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW ≥1% of the span; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold.<br>6. The number of hopping frequency used is defined as the number of total channel.<br>7. Record the measurement data derived from spectrum analyzer. |
| **Test Result:** | PASS |

### 6.6.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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### 6.6.3. Test data

| Mode | Hopping channel numbers | Limit | Result |
|---|---|---|---|
| GFSK, P/4-DQPSK,8DPSK | 79 | 15 | PASS |

**Test plots as follows:**



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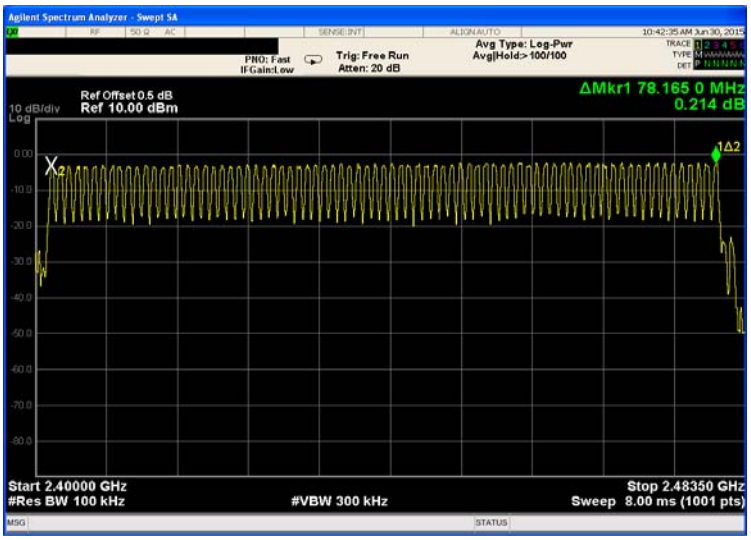
GFSK




Pi/4DQPSK

8DPSK

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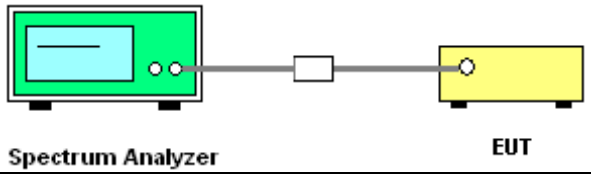
## 6.7. Dwell Time

### 6.7.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (a)(1) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. |
| **Test Setup:** |  |
| **Test Mode:** | Hopping mode |
| **Test Procedure:** | 1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Enable the EUT hopping function.<br>5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 1 MHz; VBW≥RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.<br>6. Measure and record the results in the test report. |
| **Test Result:** | PASS |

### 6.7.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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### 6.7.3. Test Data

| Mode | Packet | Hops Over Occupancy Time (hops) | Package Transfer Time (ms) | Dwell time (second) | Limit (second) | Result |
|---|---|---|---|---|---|---|
| GFSK | DH5 | 106.67 | 2.976 | 0.317 | 0.4 | PASS |
| Pi/4 DQPSK | 2-DH5 | 106.67 | 2.956 | 0.315 | 0.4 | PASS |
| 8DPSK | 3-DH5 | 106.67 | 2.948 | 0.314 | 0.4 | PASS |

***Note:*** *1. In normal mode, hopping rate is 1600 hops/s with 6 slots in 79 hopping channels.*

*With channel hopping rate (1600 / 6 / 79) in Occupancy Time Limit (0.4 x 79) (s), Hops Over Occupancy Time comes to (1600 / 6 / 79) x (0.4 x 79) = 106.67 hops*

*2. Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time*

**Test plots as follows:**



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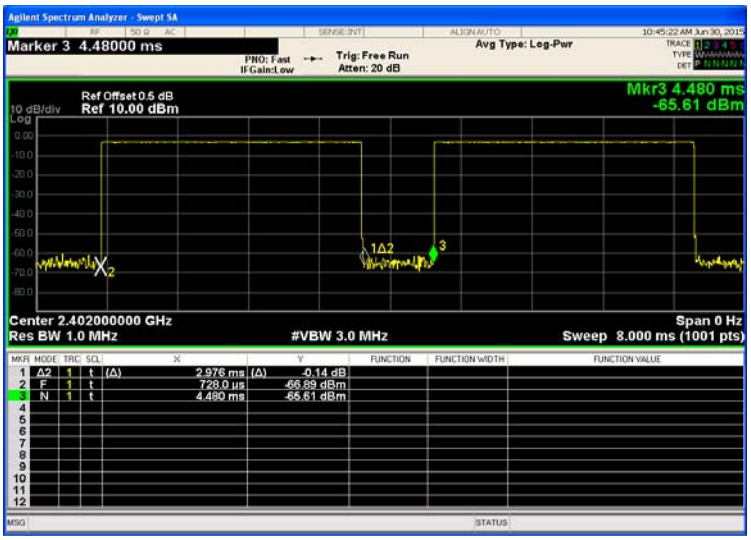
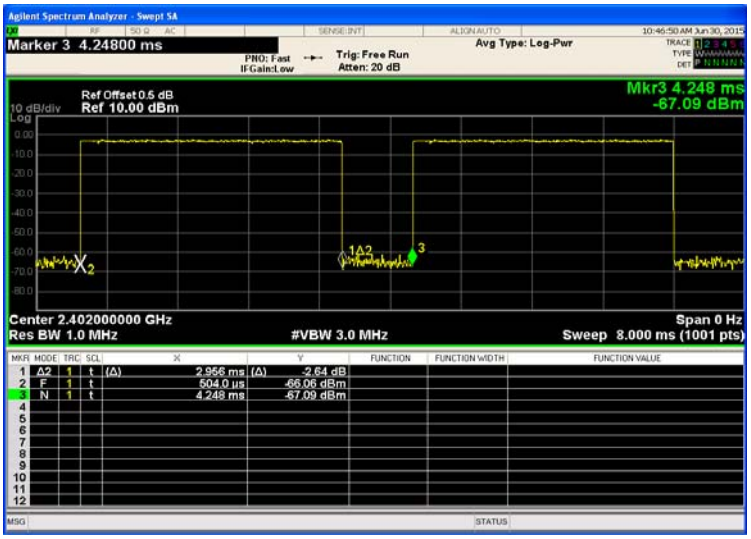
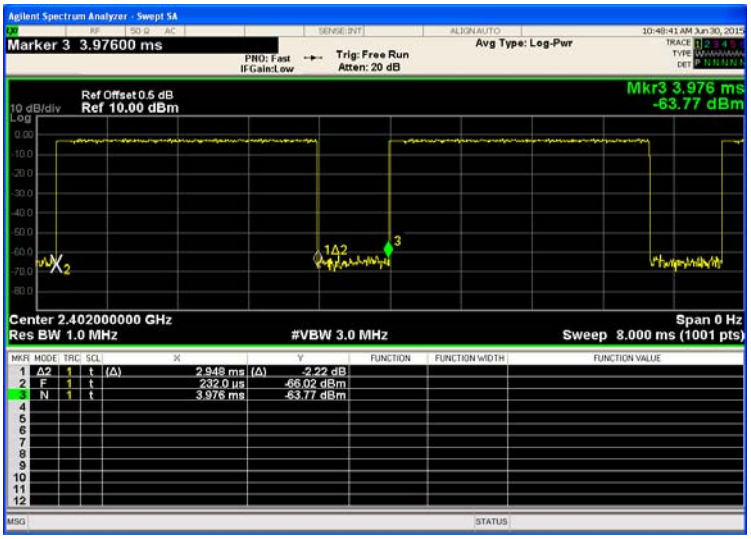
GFSK




Pi/4DQPSK




8DPSK



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## 6.8. Pseudorandom Frequency Hopping Sequence

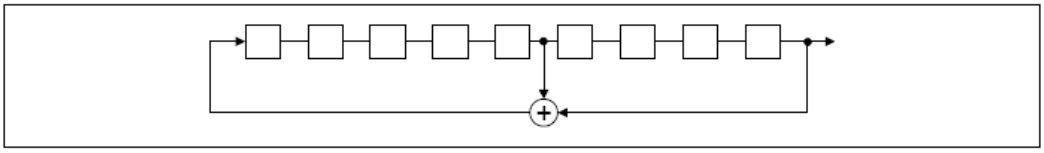
| Test Requirement: | FCC Part15 C Section 15.247 (a)(1) requirement: |
|---|---|

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

**EUT Pseudorandom Frequency Hopping Sequence**

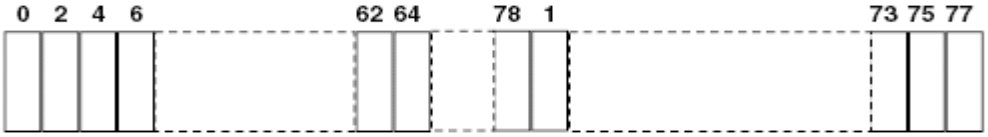
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9$ -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



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

An example of Pseudorandom Frequency Hopping Sequence as follow:




Each frequency used equally on the average by each transmitter.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.



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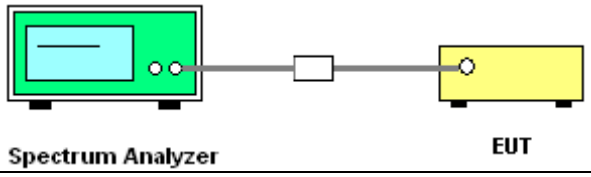
## 6.9. Conducted Band Edge Measurement

### 6.9.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (d) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits. |
| **Test Setup:** |  |
| **Test Mode:** | Transmitting mode with modulation |
| **Test Procedure:** | 1. The testing follows the guidelines in Band-edge Compliance of RF Conducted Emissions of FCC Public Notice DA 00-705 Measurement Guidelines.<br>2. Set to the maximum power setting and enable the EUT transmit continuously.<br>3. Set RBW = 100 kHz (≥1% span=10MHz), VBW = 300 kHz (≥RBW). Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.<br>4. Enable hopping function of the EUT and then repeat step 2 and 3.<br>5. Measure and record the results in the test report. |
| **Test Result:** | PASS |

### 6.9.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |



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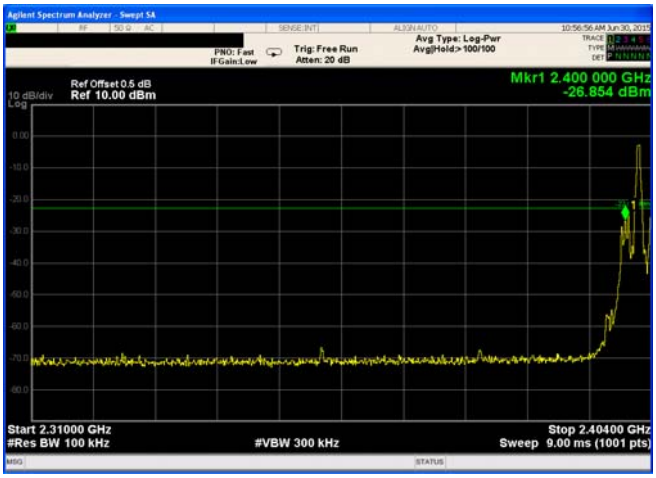
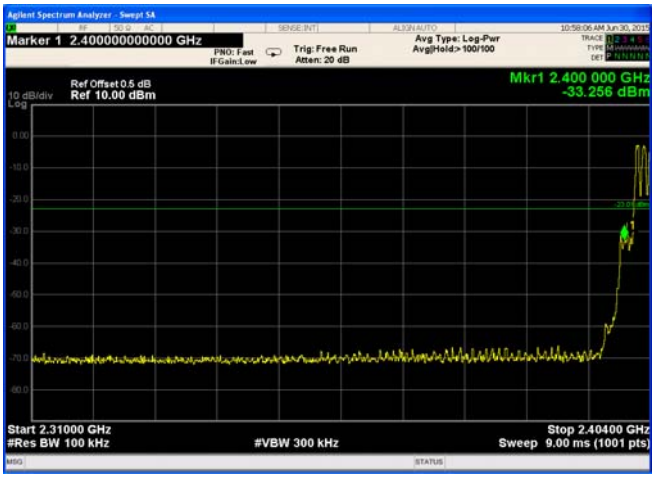
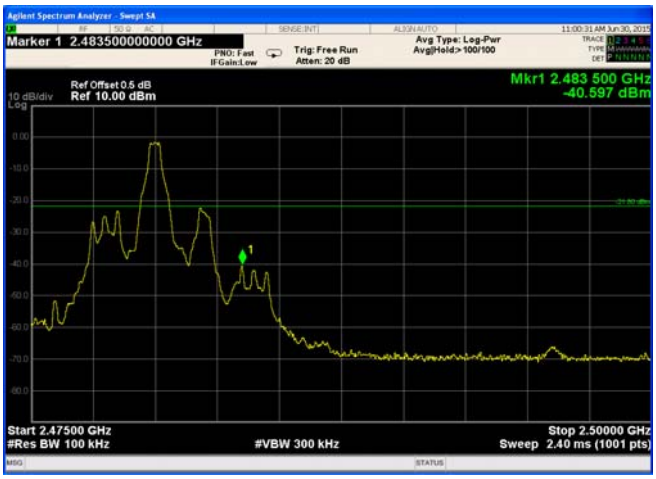
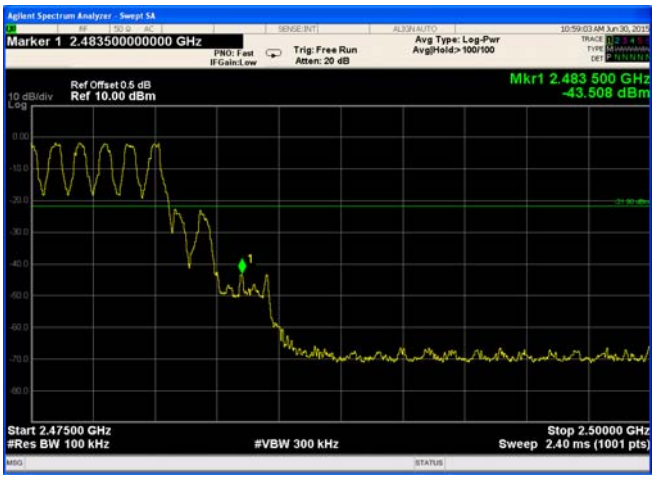
***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

## 6.9.3. Test Data

### GFSK Modulation

| Test channel: | Lowest channel |
|---|---|
|   |   |
| No-hopping mode | Hopping mode |
| Test channel: | Highest channel |
|   |   |
| No-hopping mode | Hopping mode |



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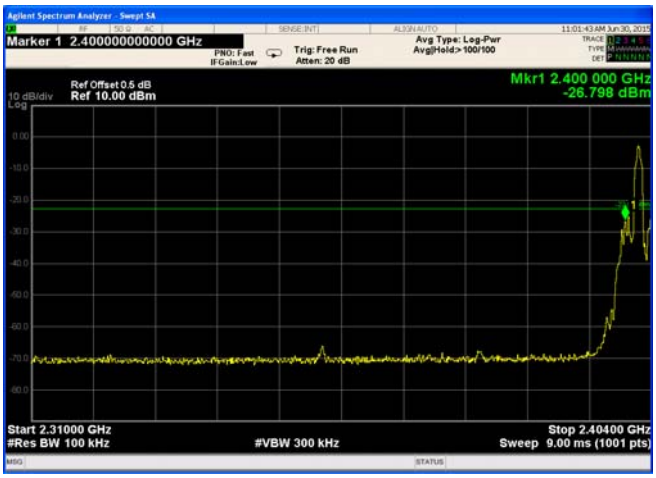
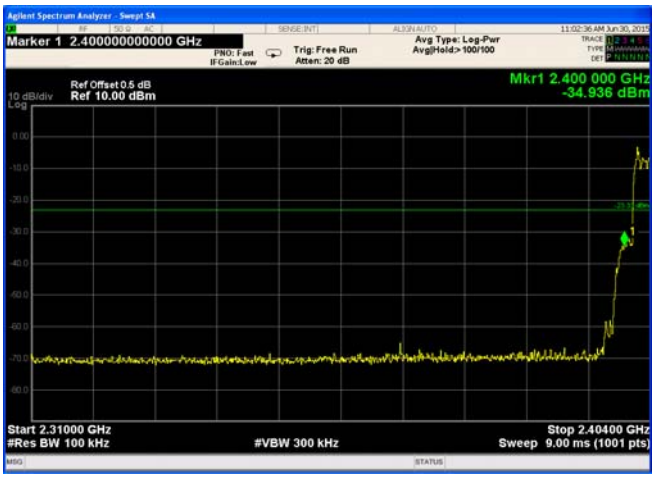
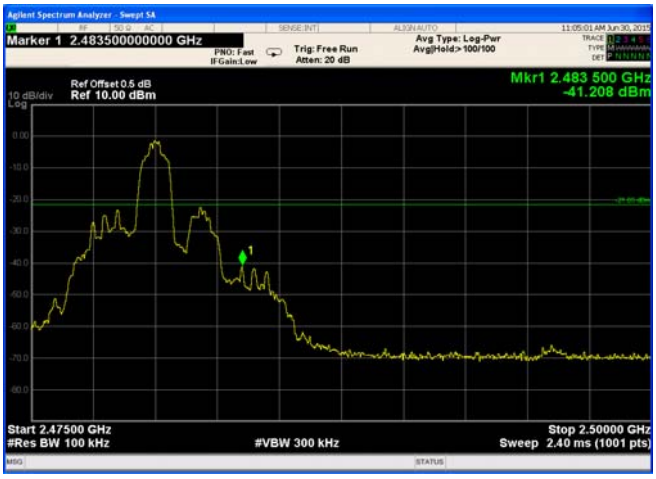
**Pi/4DQPSK Modulation**

| Test channel: | Lowest channel |
|---|---|
|  |  |
| No-hopping mode | Hopping mode |
| Test channel: | Highest channel |
|  | |
| No-hopping mode | Hopping mode |



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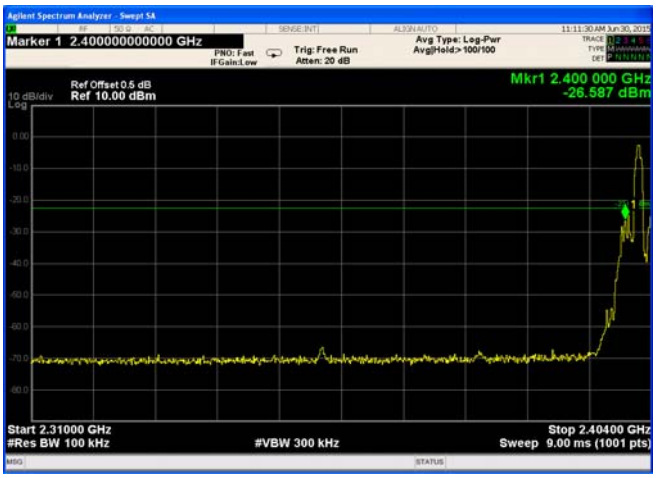
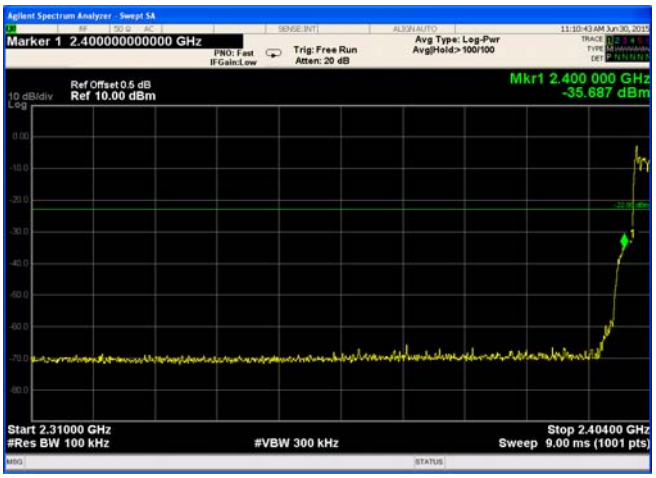
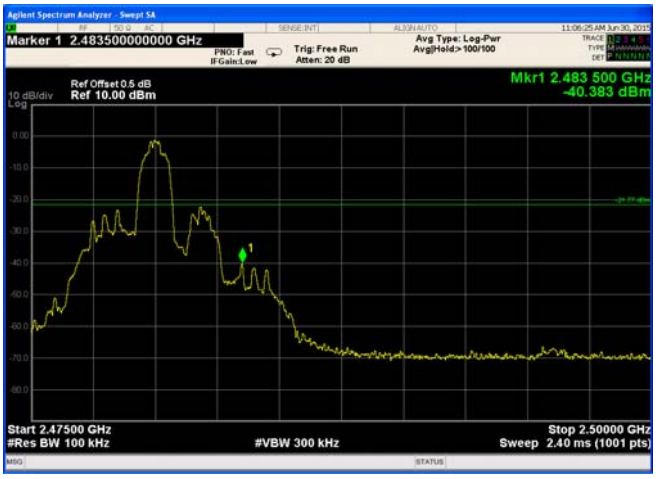
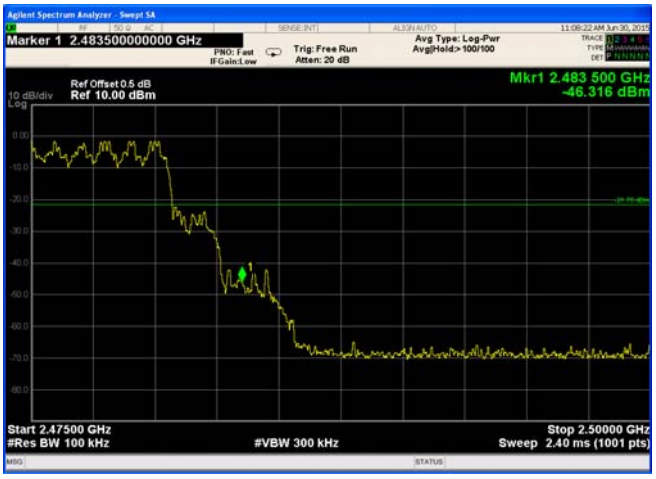
**8DPSK Modulation**

| Test channel: | Lowest channel |
|---|---|
|   |   |
| No-hopping mode | Hopping mode |
| **Test channel:** | **Highest channel** |
|   |   |
| No-hopping mode | Hopping mode |



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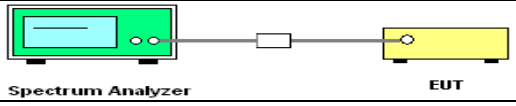
## 6.10. Conducted Spurious Emission Measurement

### 6.10.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.247 (d) |
| **Test Method:** | ANSI C63.4:2009 and DA00-705 |
| **Limit:** | In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits. |
| **Test Setup:** |   |
| **Test Mode:** | Transmitting mode with modulation |
| **Test Procedure:** | 1. The testing follows the guidelines in Spurious RF Conducted Emissions of FCC Public Notice DA 00-705 Measurement Guidelines<br>2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.<br>5. Measure and record the results in the test report.<br>6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band. |
| **Test Result:** | PASS |

### 6.10.2. Test Instruments

| RF Test Room | | | | |
|---|---|---|---|---|
| **Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| RF cable | TOBY | RE-06 | N/A | Sep.15 , 2015 |
| Antenna Connector | TOBY | RFC-01 | N/A | Sep.15 , 2015 |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to*



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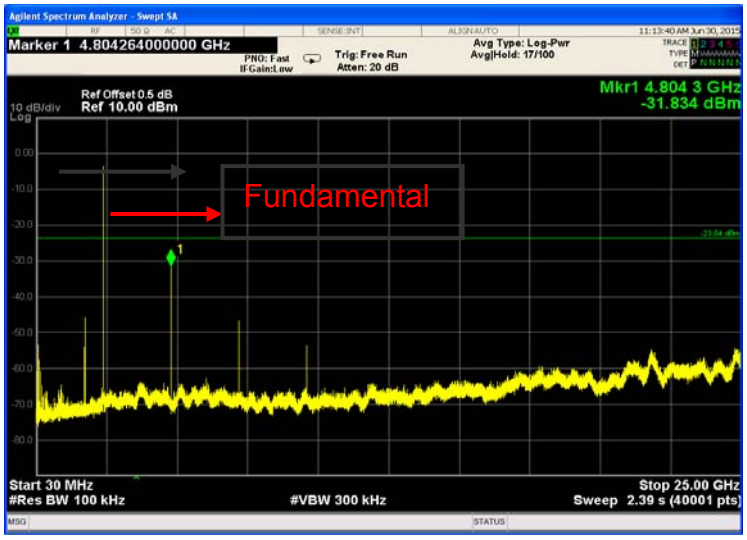
*international system unit (SI).*

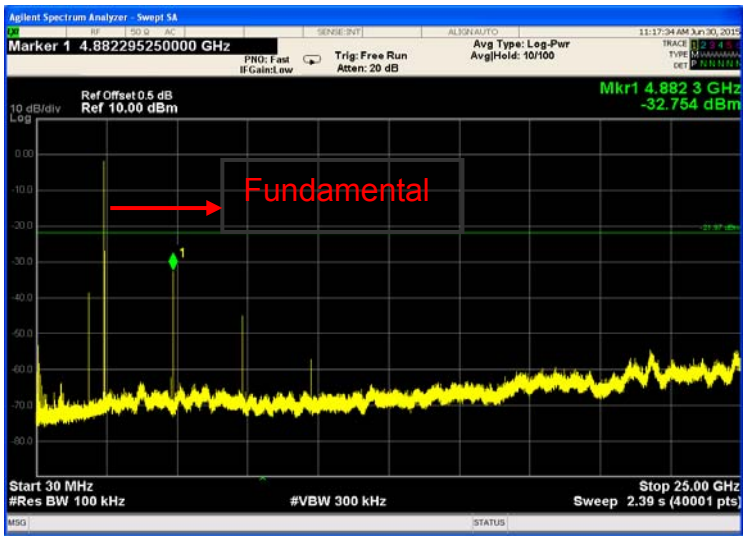
### 6.10.3. Test Data

GFSK mode

Lowest Channel




Middle Channel




Highest Channel



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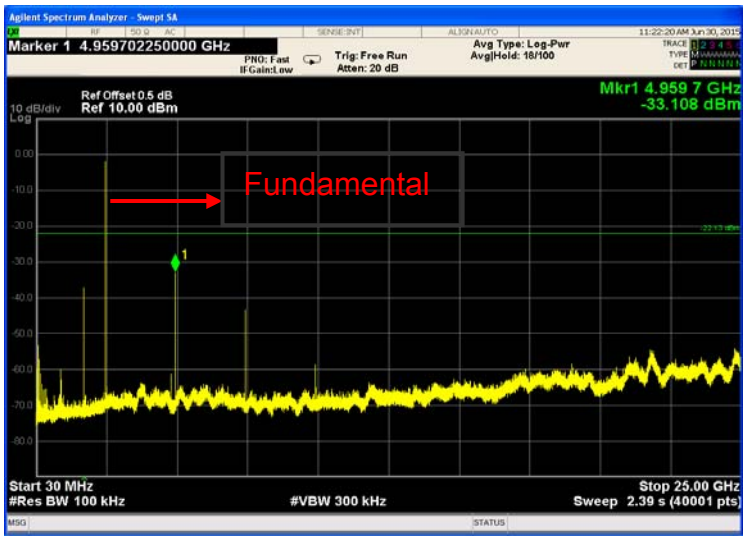
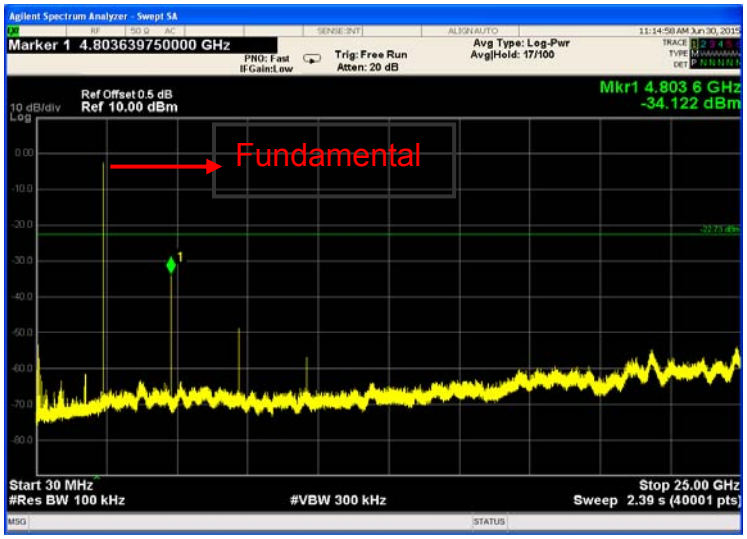
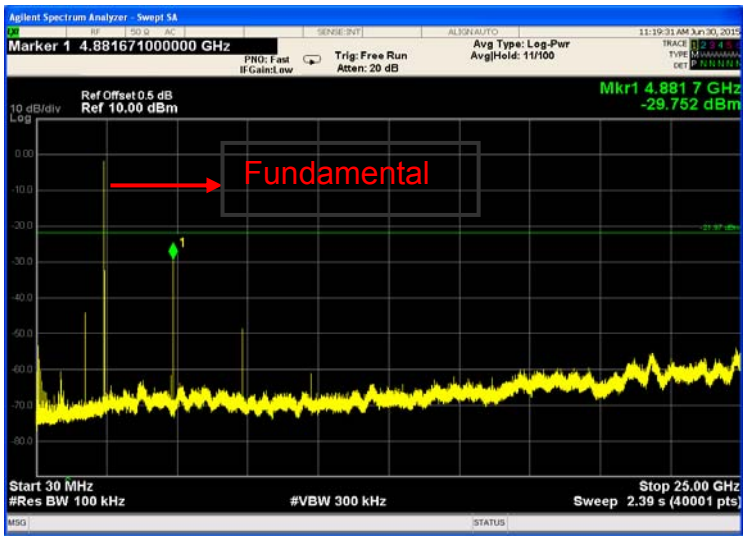



Pi/4DQPSK mode Lowest Channel




Middle Channel




Highest Channel



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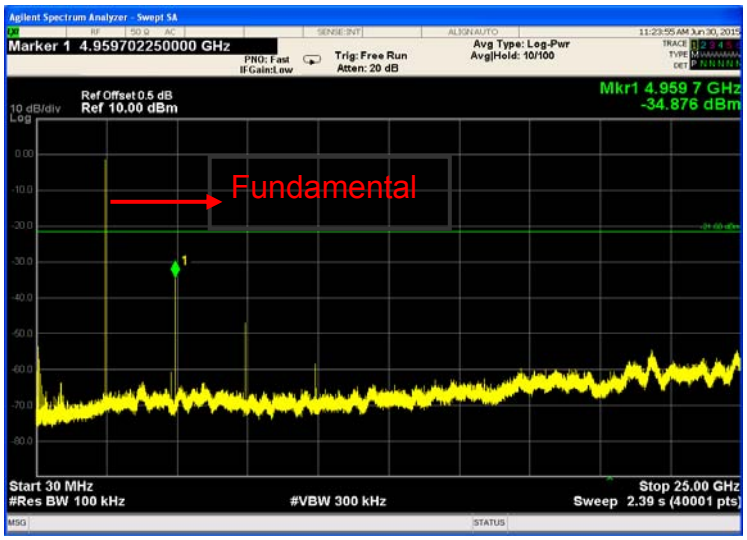




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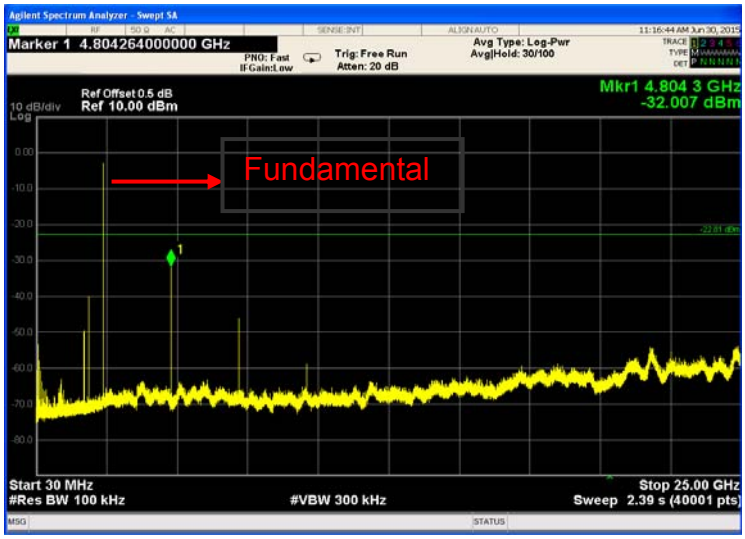
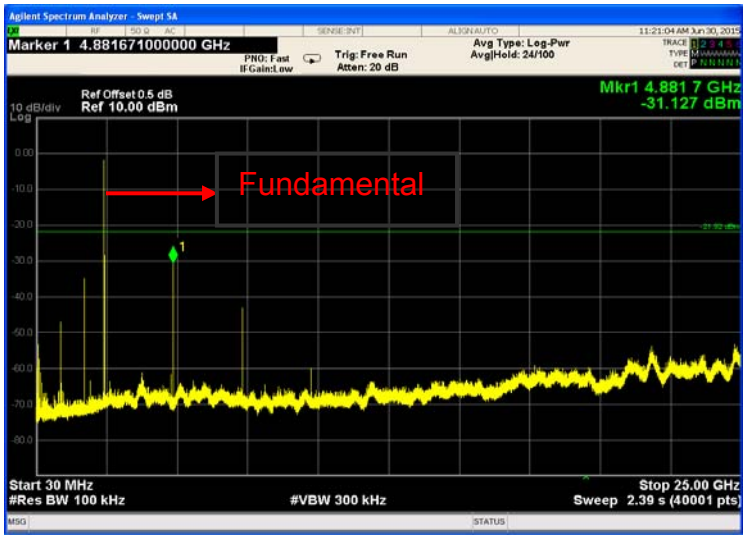
8DPSK mode

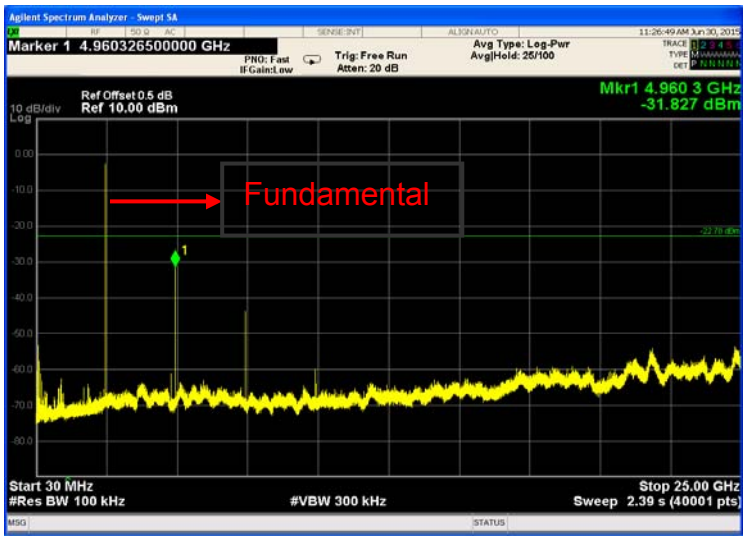
Lowest Channel




Middle Channel




Highest Channel



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## 6.11. Radiated Spurious Emission Measurement

### 6.11.1. Test Specification

| | |
|---|---|
| **Test Requirement:** | FCC Part15 C Section 15.209 |
| **Test Method:** | ANSI C63.4: 2009 and ANSI C63.10: 2009 |
| **Frequency Range:** | 9 kHz to 25 GHz |
| **Measurement Distance:** | 3 m |
| **Antenna Polarization:** | Horizontal & Vertical |

**Receiver Setup:**

| Frequency | Detector | RBW | VBW | Remark |
|---|---|---|---|---|
| 9kHz- 150kHz | Quasi-peak | 200Hz | 1kHz | Quasi-peak Value |
| 150kHz-30MHz | Quasi-peak | 9kHz | 30kHz | Quasi-peak Value |
| 30MHz-1GHz | Quasi-peak | 100KHz | 300KHz | Quasi-peak Value |
| Above 1GHz | Peak | 1MHz | 3MHz | Peak Value |
| | Peak | 1MHz | 10Hz | Average Value |

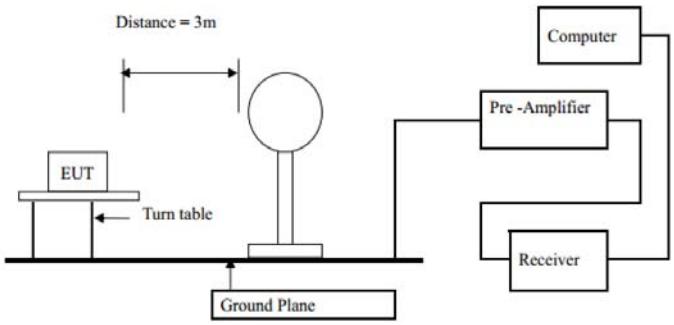
**Limit:**

| Frequency | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009-0.490 | 2400/F(KHz) | 300 |
| 0.490-1.705 | 24000/F(KHz) | 30 |
| 1.705-30 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

| Frequency | Field Strength (microvolts/meter) | Measurement Distance (meters) | Detector |
|---|---|---|---|
| Above 1GHz | 500 | 3 | Average |
| | 5000 | 3 | Peak |

**Test setup:**

For radiated emissions below 30MHz




30MHz to 1GHz



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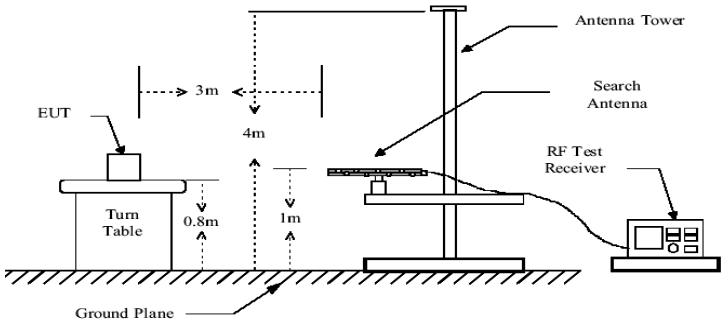
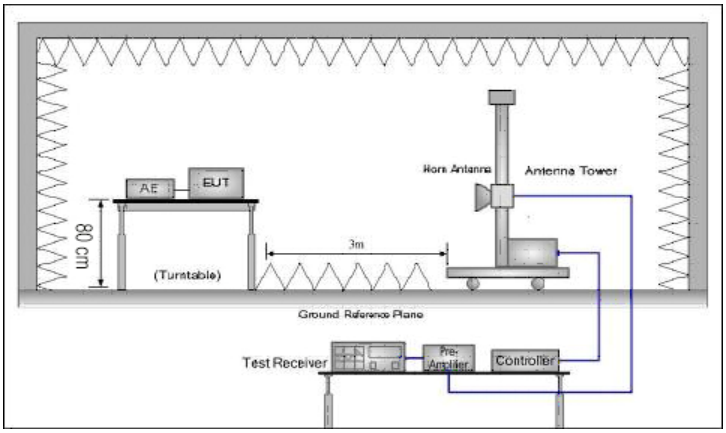
<table>
<tr><td></td><td>


Above 1GHz


</td></tr>
<tr><td>Test Mode:</td><td>Transmitting mode with modulation</td></tr>
<tr><td>Test Procedure:</td><td>
1. The testing follows the guidelines in Spurious Radiated Emissions of FCC Public Notice DA 00-705 Measurement Guidelines.<br>
2. For the radiated emission test below 1GHz:<br>
The EUT was placed on a turntable with 0.8 meter above ground. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) 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.<br>
For the radiated emission test above 1GHz:<br>
Place the measurement antenna on a turntable with 0.8 meter above ground, which is away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission
</td></tr>
</table>



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| | |
|---|---|
| | and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.<br>3. Set to the maximum power setting and enable the EUT transmit continuously.<br>4. Use the following spectrum analyzer settings:<br>(1) Span shall wide enough to fully capture the emission being measured;<br>(2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW≥RBW;<br>Sweep = auto; Detector function = peak; Trace = max hold for peak<br>(3) For average measurement: use duty cycle correction factor method per<br>15.35(c). Duty cycle = On time/100 milliseconds<br>On time =N1*L1+N2*L2+...+Nn-1*LNn-1+Nn*Ln<br>Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc.<br>Average Emission Level = Peak Emission Level + 20*log(Duty cycle)<br>Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level |
| **Test results:** | PASS |



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### 6.11.2. Test Instruments

| Radiated Emission Test Site (966) | | | | |
|---|---|---|---|---|
| **Name of Equipment** | **Manufacturer** | **Model** | **Serial Number** | **Calibration Due** |
| ESPI Test Receiver | ROHDE&SCHWARZ | ESVD | 100008 | Sep.16 , 2015 |
| Spectrum Analyzer | ROHDE&SCHWARZ | FSEM | 848597/001 | Sep.16 , 2015 |
| Spectrum Analyzer | Agilent | N9020A | MY49100060 | Oct. 21, 2015 |
| Pre-amplifier | EM Electronics Corporation CO.,LTD | EM30265 | 07032613 | Sep.16 , 2015 |
| Pre-amplifier | HP | 8447D | 2727A05017 | Sep.16 , 2015 |
| Loop antenna | ZHINAN | ZN30900A | 12024 | Dec.14 , 2015 |
| Broadband Antenna | Schwarzbeck | VULB9163 | 340 | Sep.16 , 2015 |
| Horn Antenna | Schwarzbeck | BBHA 9120D | 631 | Sep.16 , 2015 |
| Horn Antenna | Schwarzbeck | BBHA 9170 | 373 | Sep.16 , 2015 |
| Antenna Mast | CCS | CC-A-4M | N/A | N/A |
| Coax cable | TOBY | RE-low-01 | N/A | Sep.15 , 2015 |
| Coax cable | TOBY | RE-high-02 | N/A | Sep.15 , 2015 |
| Coax cable | TOBY | RE-low-03 | N/A | Sep.15 , 2015 |
| Coax cable | TOBY | RE-high-04 | N/A | Sep.15 , 2015 |
| EMI Test Software | Shurple Technology | EZ-EMC | N/A | N/A |

***Note:*** *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*



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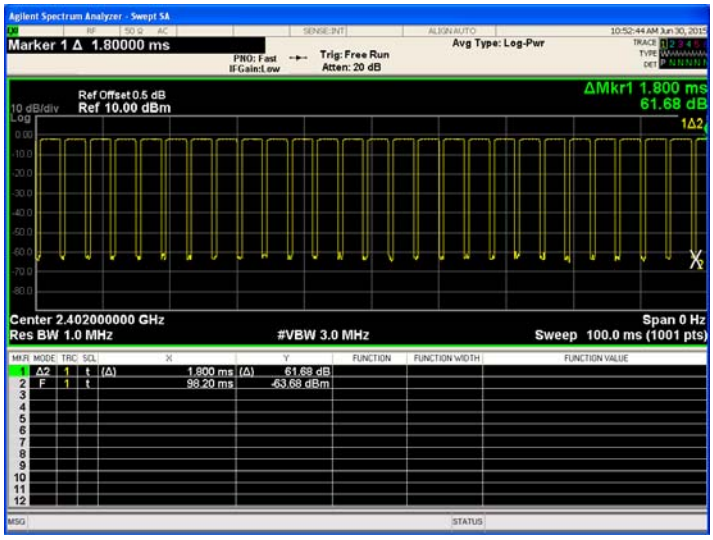
### 6.11.3. Test Data

**Duty cycle correction factor for average measurement**

DH5 on time (One Pulse) Plot on Channel 00

DH5 on time (Count Pulses) Plot on Channel 00




***Note:***

1. *Worst case Duty cycle = on time/100 milliseconds = (2.976*26+1.800)/ 100 = 0.79176*
2. *Worst case Duty cycle correction factor = 20*log (Duty cycle) = -2.03dB*
3. *DH5 has the highest duty cycle worst case and is reported.*
4. *The average levels were calculated from the peak level corrected with duty cycle correction factor (-2.34dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.*



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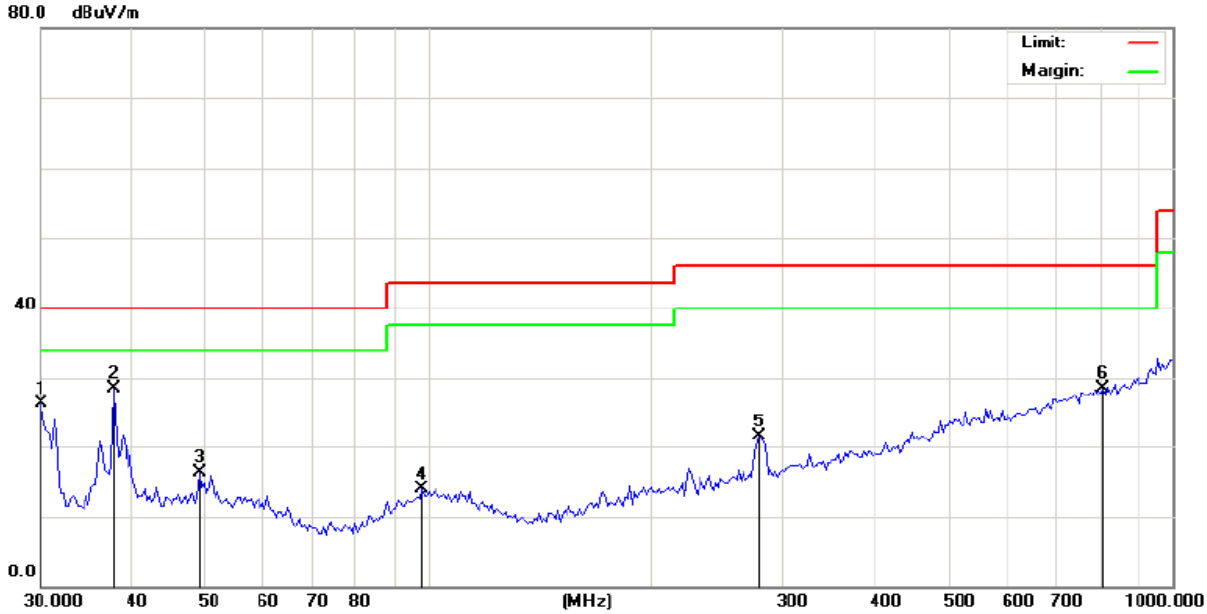
**Please refer to following diagram for individual**

**Below 1GHz**

Horizontal:




| | | | |
|---|---|---|---|
| Site | Polarization: ***Horizontal*** | Temperature: | 25 |
| Limit: FCC Part 15B Class B RE_3 m | Power: AC 120V/60Hz | Humidity: | 56 % |

| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | | 30.0000 | 40.07 | -13.72 | 26.35 | 40.00 | -13.65 | peak | | 0 | |
| 2 | * | 37.5647 | 41.19 | -12.78 | 28.41 | 40.00 | -11.59 | peak | | 0 | |
| 3 | | 49.0626 | 28.48 | -12.08 | 16.40 | 40.00 | -23.60 | peak | | 0 | |
| 4 | | 97.6864 | 25.71 | -11.79 | 13.92 | 43.50 | -29.58 | peak | | 0 | |
| 5 | | 278.3308 | 30.59 | -8.99 | 21.60 | 46.00 | -24.40 | peak | | 0 | |
| 6 | | 809.9238 | 26.92 | 1.58 | 28.50 | 46.00 | -17.50 | peak | | 0 | |



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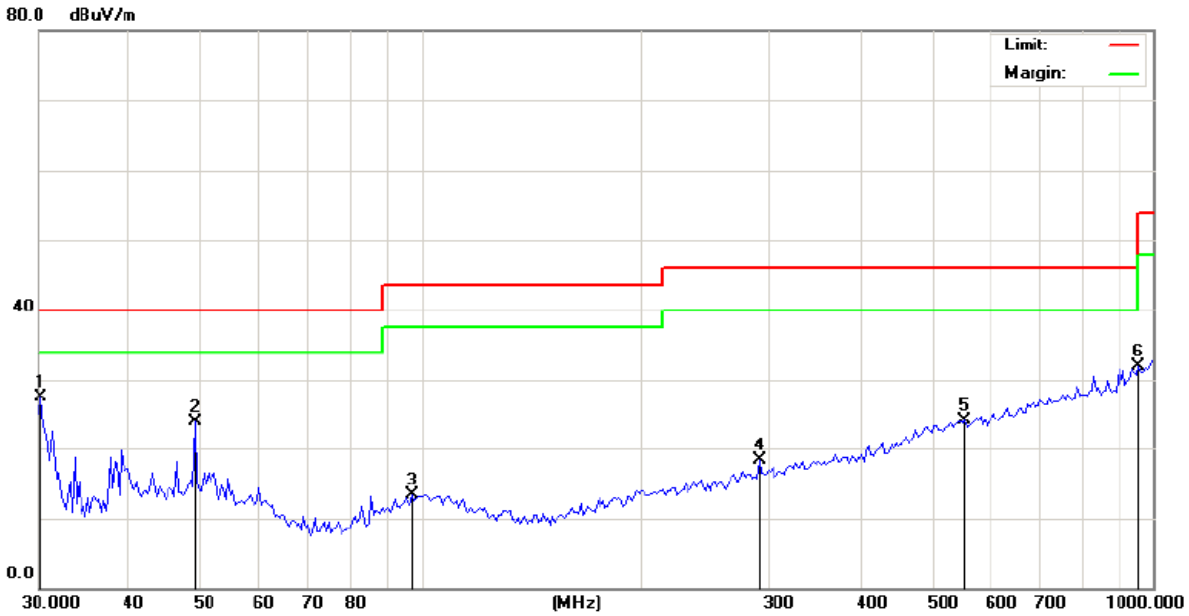
Vertical:




| | | | |
|---|---|---|---|
| Site | Polarization: ***Vertical*** | Temperature: | 25 |
| Limit: FCC Part 15B Class B RE_3 m | Power: AC 120V/60Hz | Humidity: | 56 % |

| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | Antenna Height | Table Degree | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | Detector | cm | degree | Comment |
| 1 | * | 30.2116 | 41.17 | -13.69 | 27.48 | 40.00 | -12.52 | peak | | 0 | |
| 2 | | 49.0626 | 35.91 | -12.08 | 23.83 | 40.00 | -16.17 | peak | | 0 | |
| 3 | | 97.0023 | 25.29 | -11.90 | 13.39 | 43.50 | -30.11 | peak | | 0 | |
| 4 | | 290.3170 | 26.92 | -8.58 | 18.34 | 46.00 | -27.66 | peak | | 0 | |
| 5 | | 554.1707 | 26.44 | -2.41 | 24.03 | 46.00 | -21.97 | peak | | 0 | |
| 6 | | 958.7133 | 27.17 | 4.66 | 31.83 | 46.00 | -14.17 | peak | | 0 | |

**Note:** *1.The low frequency, which started from 9KHz~30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported*

*2. Measurements were conducted in all three channels (high, middle, low) and three modulation(GFSK, Pi/4 DQPSK, 8DPSK), and the worst case Mode (Middle channel and 8DPSK) was submitted only.*



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## Above 1GHz

| Modulation Type: 8DPSK | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Low channel: 2402 MHz | | | | | | | | | |
| Frequency (MHz) | Ant. Pol. H/V | Peak reading (dBμV) | AV reading (dBuV) | Correction Factor (dB/m) | Emission Level Peak (dBμV/m) | Emission Level AV (dBμV/m) | Peak limit (dBμV/m) | AV limit (dBμV/m) | Margin (dB) |
| 2390 | H | 47.58 | --- | -8.27 | 39.31 | --- | 74 | 54 | -14.69 |
| 4804 | H | 46.36 | --- | 0.66 | 47.02 | --- | 74 | 54 | -6.98 |
| 7206 | H | 41.29 | --- | 9.5 | 50.79 | --- | 74 | 54 | -3.21 |
| --- | H | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | | | | | |
| 2390 | V | 48.29 | --- | -8.27 | 40.02 | --- | 74 | 54 | -13.98 |
| 4804 | V | 46.58 | --- | 0.66 | 47.24 | --- | 74 | 54 | -6.76 |
| 7206 | V | 40.35 | --- | 9.5 | 49.85 | --- | 74 | 54 | -4.15 |
| --- | V | --- | --- | --- | --- | --- | --- | --- | --- |

| Middle channel: 2441 MHz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Ant. Pol. H/V | Peak reading (dBμV) | AV reading (dBμV) | Correction Factor (dB/m) | Emission Level Peak (dBμV/m) | Emission Level AV (dBμV/m) | Peak limit (dBμV/m) | AV limit (dBμV/m) | Margin (dB) |
| 4882 | H | 46.46 | --- | 0.99 | 47.45 | --- | 74 | 54 | -6.55 |
| 7323 | H | 40.57 | --- | 9.87 | 50.44 | --- | 74 | 54 | -3.56 |
| --- | H | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | | | | | |
| 4882 | V | 45.59 | --- | 0.99 | 46.58 | --- | 74 | 54 | -7.42 |
| 7323 | V | 40.26 | --- | 9.87 | 50.13 | --- | 74 | 54 | -3.87 |
| --- | V | --- | --- | --- | --- | ---- | --- | --- | --- |

| High channel: 2480 MHz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Ant. Pol. H/V | Peak reading (dBμV) | AV reading (dBμV) | Correction Factor (dB/m) | Emission Level Peak (dBμV/m) | Emission Level AV (dBμV/m) | Peak limit (dBμV/m) | AV limit (dBμV/m) | Margin (dB) |
| 2483.5 | H | 45.65 | --- | -7.83 | 37.82 | --- | 74 | 54 | -16.18 |
| 4960 | H | 48.36 | --- | 1.33 | 49.69 | --- | 74 | 54 | -4.31 |
| 7440 | H | 40.56 | --- | 10.22 | 50.78 | --- | 74 | 54 | -3.22 |
| --- | H | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | | | | | |
| 2483.5 | V | 45.98 | --- | -7.83 | 38.15 | --- | 74 | 54 | -15.85 |
| 4960 | V | 49.58 | --- | 1.33 | 50.91 | --- | 74 | 54 | -3.09 |
| 7440 | V | 40.36 | --- | 10.22 | 50.58 | --- | 74 | 54 | -3.42 |
| --- | V | --- | --- | --- | --- | --- | --- | --- | --- |

***Note:***

1. *Emission Level=Peak Reading + Correction Factor; Correction Factor= Antenna Factor + Cable loss – Pre-amplifier*
2. *Margin (dB) = Emission Level (Peak) (dBμV/m)-Average limit (dBμV/m)*
3. *The emission levels of other frequencies are very lower than the limit and not show in test report.*
4. *Measurements were conducted from 1 GHz to the 10th harmonic of highest fundamental frequency.*
5. *Data of measurement shown "---"in the above table mean that the reading of emissions is attenuated more than 20 dB below the limits or the field strength is too small to be measured.*
6. *Measurements were conducted in all three modulation(GFSK, Pi/4 DQPSK, 8DPSK), and the worst case Mode (8DPSK) was submitted only.*

********END OF REPORT********



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