

# **FCC Certification Test Report**

**Miragii, LLC**  
**Miragii Necklace**  
**Model: MIRAGII-N-A**

**FCC ID:2AEUB-M1**

**REPORT# 15WB0430004F-01 Rev 0**  
**20 June, 2015**

Prepared for:

**Miragii, LLC**  
**16885 West Bernardo Drive, Suite 320, San Diego, CA USA**

Prepared by:

**WASHINGTON TECHNOLOGY INTERNATIONAL LIMITED**

This report applies only to the sample evaluated prior to the preparation date stated above.

This report must be copied in its entirety, including all technical documents.

# FCC Certification Test Report

For the  
**Miragii, LLC**  
**Miragii Necklace**  
**Model: MIRAGII-N-A**

FCC ID:2AEUB-M1

WLL REPORT# 15WB0430004F-01 Rev 0  
20 June, 2015

Prepared by:



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Henry guo

Reviewed by:



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Steven yang

## Abstract

This report has been prepared on behalf of Miragii, LLC to support the attached Application for Equipment Authorization. The test report and application are submitted for a Spread Spectrum Transceiver under Part 15.247 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for Miragii, LLC

The above equipment was tested by A Test Lab Techno Corp. Taiwan Accreditation Foundation accreditation number: 1330

And the tested by Shenzhen Academy of Metrology and Quality Inspection. The FCC Registration Number is 806614

The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10: 2009 and KDB 558074, and the energy emitted by the sample tested as described in this report is in compliance with the requirements of FCC Rules Part 15.207, 15.209, 15.247. The test results of this report relate only to the tested sample identified in this report.

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Miragii Necklace is a Bluetooth V3.0 compliant device and complies with the limits for a Direct Sequence Spread Spectrum Transmitter device under Part 15.247 of the FCC Rules and Regulations.

| Revision History | Reason          | Date          |
|------------------|-----------------|---------------|
| Rev 0            | Initial Release | June 20, 2015 |
|                  |                 |               |

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## 1 Introduction

### 1.1 Compliance Statement

After the modifications listed in Section 2.5 were installed:

Miragii, LLC MiragiiNecklace complies with the limits for a Spread Spectrum Transceiver device under Part 15.247 of the FCC Rules and Regulations.

### 1.2 Test Scope Summary

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2009 version of ANSI C63.10

| Standard             | Item                                    | Result | Remark |
|----------------------|-----------------------------------------|--------|--------|
| FCC 15.207&FCC15.247 |                                         |        |        |
| 15.207               | AC Power Conducted Emission             | PASS   | -----  |
| 15.247(b)(1)         | Max. Output Power                       | PASS   | -----  |
| 15.247(c)            | Transmitter Radiated Emissions          | PASS   | -----  |
| 15.247(a)(1)         | 20dB RF Bandwidth                       | PASS   | -----  |
| 15.247(a)(1)(iii)    | Carrier Frequency Separation            | PASS   | -----  |
| 15.247(a)(1)(iii)    | Number of Hopping                       | PASS   | -----  |
| 15.247(a)(1)(iii)    | Time of Occupancy (Dwell Time)          | PASS   | -----  |
| 15.247(c)            | Out of Band Conducted Spurious Emission | PASS   | -----  |
| 15.247(c)            | Band Edge Measurement                   | PASS   | -----  |
| 15.247(c)            | Occupied Bandwidth Measurement          | PASS   | -----  |
| 15.203               | Antenna Requirement                     | PASS   | -----  |

The test results of this report relate only to the tested sample(s) identified in this report. Manufacturer or whom it may concern should recognize the pass or fail of the test result.

NOTE: The EUT is also considered as a kind of other class B digital device it has been verified to comply with the requirements of FCC Part 15B Class B (Verification) the test report has been issued by WTIL.

### **1.3 Contract Information**

Customer: Miragii, LLC

16885 West Bernardo Drive, Suite 320, San Diego,  
CA USA

### **1.4 Test and Support Personnel**

Murphy WangA Test Lab Techno Corp.

No. 140-1, Changan Street, Bade City,  
Taoyuan County 334, Taiwan R.O.C.

Peter LinShenzhen Academy of Metrology and Quality Inspection

No.4 TongFa Road, Xili Town Nanshan  
District, Shenzhen, China

## 1.5 Abbreviations

|             |                                                                      |
|-------------|----------------------------------------------------------------------|
| <b>A</b>    | <b>A</b> mpere                                                       |
| <b>ac</b>   | <b>a</b> lternating <b>c</b> urrent                                  |
| <b>AM</b>   | <b>A</b> mplitude <b>M</b> odulation                                 |
| <b>Amps</b> | <b>A</b> mp <b>e</b> res                                             |
| <b>b/s</b>  | <b>b</b> its per second                                              |
| <b>BW</b>   | <b>B</b> and <b>W</b> idth                                           |
| <b>CE</b>   | <b>C</b> onducted <b>E</b> mission                                   |
| <b>cm</b>   | <b>c</b> ent <b>m</b> eter                                           |
| <b>CW</b>   | <b>C</b> ontinuous <b>W</b> ave                                      |
| <b>dB</b>   | <b>d</b> eci <b>B</b> el                                             |
| <b>dc</b>   | <b>d</b> irect <b>c</b> urrent                                       |
| <b>EMI</b>  | <b>E</b> lectro <b>m</b> agnetic <b>I</b> nterference                |
| <b>EUT</b>  | <b>E</b> quipment <b>U</b> nder <b>T</b> est                         |
| <b>FM</b>   | <b>F</b> requency <b>M</b> odulation                                 |
| <b>G</b>    | <b>g</b> iga - prefix for $10^9$ multiplier                          |
| <b>Hz</b>   | <b>H</b> ertz                                                        |
| <b>IF</b>   | <b>I</b> ntermediate <b>F</b> requency                               |
| <b>k</b>    | <b>k</b> ilo - prefix for $10^3$ multiplier                          |
| <b>LISN</b> | <b>L</b> ine <b>I</b> mpedance <b>S</b> tabilization <b>N</b> etwork |
| <b>M</b>    | <b>M</b> ega - prefix for $10^6$ multiplier                          |
| <b>m</b>    | <b>m</b> eter                                                        |
| <b>μ</b>    | <b>μ</b> icro - prefix for $10^{-6}$ multiplier                      |
| <b>NB</b>   | <b>N</b> arrow <b>b</b> and                                          |
| <b>QP</b>   | <b>Q</b> uasi- <b>P</b> eak                                          |
| <b>RE</b>   | <b>R</b> adiated <b>E</b> missions                                   |
| <b>RF</b>   | <b>R</b> adio <b>F</b> requency                                      |
| <b>rms</b>  | <b>r</b> oot- <b>m</b> ean- <b>s</b> quare                           |
| <b>SN</b>   | <b>S</b> erial <b>N</b> umber                                        |
| <b>S/A</b>  | <b>S</b> pectrum <b>A</b> nalyzer                                    |
| <b>V</b>    | <b>V</b> olt                                                         |

## 2 Equipment Under Test

### 2.1 EUT Identification

The results obtained relate only to the item(s) tested.

**Table 1: Overview of Miragii Necklace, Equipment Under Test**

|                 |                                                                         |                 |       |       |    |
|-----------------|-------------------------------------------------------------------------|-----------------|-------|-------|----|
| Product         | Miragii Necklace                                                        |                 |       |       |    |
| Trade Name      | Miragii                                                                 |                 |       |       |    |
| Model Number    | Miragii-N-A                                                             |                 |       |       |    |
| Applicant       | Miragii, LLC<br>16885 West Bernardo Drive, Suite 320, San Diego, CA USA |                 |       |       |    |
| FCC ID          | 2AEUB-M1                                                                |                 |       |       |    |
| Frequency Range | 2402 ~ 2480 MHz                                                         |                 |       |       |    |
| Modulation Type | Bluetooth 3.0+EDR                                                       | GFSK for 1Mbps  |       |       |    |
|                 |                                                                         | 8DPSK for 3Mbps |       |       |    |
| Antenna Type    | Sheet Metal Antenna                                                     |                 |       |       |    |
| Antenna Gain    | 0.5dBi                                                                  |                 |       |       |    |
| RF Output Power | BT3.0 GFSK for 1Mbps                                                    | 2.523           | dBm / | 1.786 | mW |
| (Conducted)     | BT3.0 8DPSK for 3Mbps                                                   | 0.583           | dBm / | 1.143 | mW |
| 20dB Bandwidth  | BT 3.0 GFSK: 1.242MHz                                                   |                 |       |       |    |
|                 | BT3.0 8DPSK: 1.384MHz                                                   |                 |       |       |    |

## 2.2 Test Methodology

### 2.2.1 Mode of Operation

Decision of Test ATL has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation, which was shown in this test report and defined as:

| Test Mode                        |
|----------------------------------|
| Mode 1: Normal Working Mode      |
| Mode 2: GFSK Link Mode           |
| Mode 3: $\pi/4$ -DQPSK Link Mode |
| Mode 4: 8DPSK Link Mode          |
| --                               |

By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "X axis" position was the worst, then the final test was executed the worst condition and test data were recorded in this report.

Note: We only show worse data with GFSK Link Mode and 8DPSK Link Mode in this report.

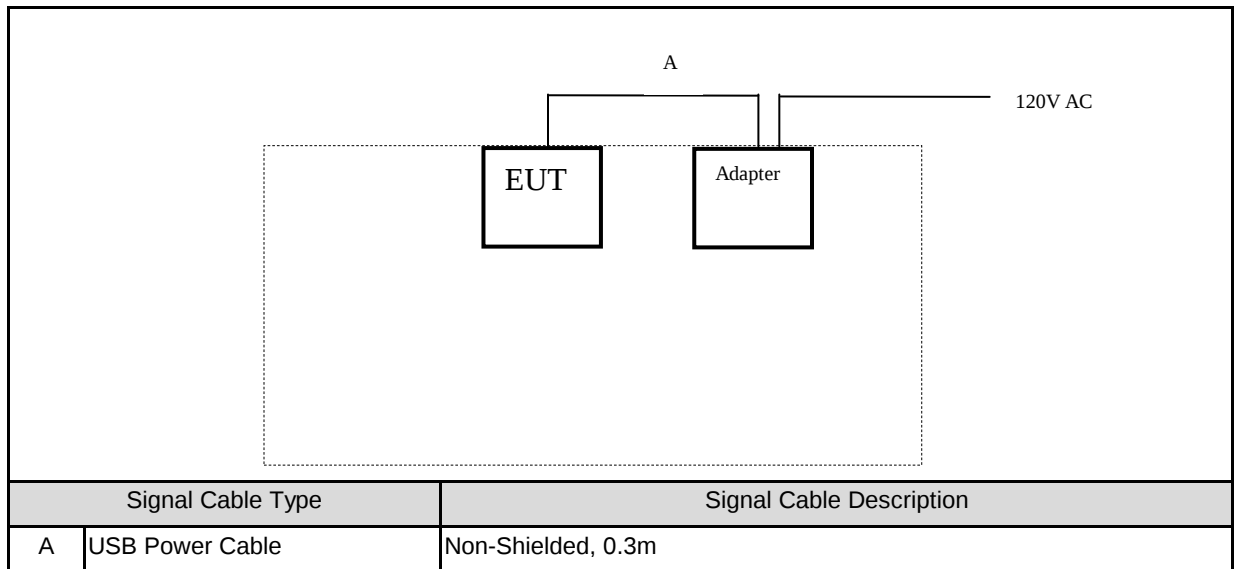
### 2.2.2 EUT Exercise Software

|   |                                                                                  |
|---|----------------------------------------------------------------------------------|
| 1 | Setup the EUT as shown on 2.3                                                    |
| 2 | Turn on the power of all EUT.                                                    |
| 3 | Keep EUT in continuous transmitting under the help of PC software CSR BlueTest3. |

### 2.3 Test Configuration

Miragii, LLC Miragii Necklace, Equipment Under Test (EUT), was operated from 5VDC from adapter.

The EUT firmware/software was set up to control power, bit rate, and channel selection.



**Figure 1: Test Configuration**

| Auxiliary equipmentdescription |               |              |              |               |
|--------------------------------|---------------|--------------|--------------|---------------|
| Product                        |               | Manufacturer | Model Number | S/N           |
| (1)                            | Power Adapter | Sony         | --           | 3513W51304150 |
| --                             | --            | --           | --           | --            |

### 2.4 Test Site Environment

| Items                      | Required (IEC 68-1) | Actual |
|----------------------------|---------------------|--------|
| Temperature (°C)           | 15-35               | 26     |
| Humidity (%RH)             | 25-75               | 60     |
| Barometric pressure (mbar) | 860-1060            | 950    |

### 2.5 EUT Modifications

N/A

## 2.6 Test Location

Site 1:

A Test Lab Techno Corp.

No. 140-1, Changan Street, Bade City,

Taoyuan County 334, Taiwan R.O.C.

Tel: +886-3-2710188 / Fax: +886-3-2710190

Taiwan Accreditation Foundation accreditation number: 1330

<http://www.atl-lab.com.tw/e-index.htm>

Site 2:

Shenzhen Academy of Metrology and Quality Inspection

No.4 TongFa Road, Xili Town Nanshan District, Shenzhen, China

## 2.7 Measurements

### 2.7.1 Measurement Method

All measurements were performed according to the 2009 version of ANSI C63.10 for testing compliance of a wide variety of unlicensed wireless devices

### 2.7.2 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

**Equation 1: Standard Uncertainty**

$$u_c = \pm \sqrt{\frac{a^2}{div_a^2} + \frac{b^2}{div_b^2} + \frac{c^2}{div_c^2} + \dots}$$

where  $u_c$  = standard uncertainty  
 $a, b, c, \dots$  = individual uncertainty elements  
 $\text{div}_{a, b, c}$  = the individual uncertainty element  
divisor based on the probability  
distribution  
divisor = 1.732 for rectangular distribution  
divisor = 2 for normal distribution  
divisor = 1.414 for trapezoid distribution

#### Equation 2: Expanded Uncertainty

$$U = ku_c$$

where  $U$  = expanded uncertainty  
 $k$  = coverage factor  
 $k \leq 2$  for 95% coverage (ANSI/NCSL Z540-2  
Annex G)  
 $u_c$  = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

**Table 2: Expanded Uncertainty List**

| Test Item          | Frequency Range     | Uncertainty (dB) |
|--------------------|---------------------|------------------|
| Conducted Emission | 9kHz ~ 30MHz        | 3.50             |
| Radiated Emission  | 30MHz ~ 1000MHz     | 4.50             |
|                    | 1000MHz ~ 18000MHz  | 4.60             |
|                    | 18000MHz ~ 40000MHz | 5.12             |

### 3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

**Table 3: Test Equipment List**

#### Conducted Emission

| Describe | Manufacturer      | Model Number    | Serial Number | Cal. Date   | Remark |
|----------|-------------------|-----------------|---------------|-------------|--------|
| SB3319   | EMI Test Receiver | Rohde & Schwarz | ESCS30        | Jan.20,2015 | 1 Year |
| SB4357   | AMN               | Rohde & Schwarz | ENV216        | Jan.20,2015 | 1 Year |

#### Radiated Emission

| 3 Meter Chamber |                          |                    |               |              |         |
|-----------------|--------------------------|--------------------|---------------|--------------|---------|
| Model No.       | Equipment                | Manufacturer       | Serial Number | Cal. Date    | Remark  |
| ESU40           | EMI Test Receiver        | R&S                | SB8501/09     | Jan.20, 2015 | 1 Year  |
| VULB9163        | Bilog Antenna            | Schwarzbeck        | SB8501/04     | Jan.20, 2015 | 1 Year  |
| HF906           | Horn Antenna             | R&S                | SB3435        | Jan.20, 2015 | 1 Year  |
| --              | Amplifier(1-18GHz)       | R&S                | SB3435/01     | Jan.20, 2015 | 1 Year  |
| --              | Amplifier(18-40GHz)      | R&S                | SB3435/02     | Jan.20, 2015 | 1 Year  |
| AT4560          | Horn Antenna             | Amplifier Research | SB5392/02     | Jan.20, 2015 | 1 Year  |
| 9X6X6           | 3m Semi-anechoic chamber | Albatross Projects | SB3450/01     | Oct.12, 2013 | 2 Years |
| ESI26           | EMI Test Receiver        | Rohde & Schwarz    | SB3436        | Jan.20,2015  | 1 Year  |
| VULB9163        | Broadband antenna        | SCHWARZBECK        | SB3955        | Jan.20,2015  | 1 Year  |
| HF907           | Horn Antenna             | R&S                | SB8501/01     | Aug.15,2014  | 1 Year  |

Remark: (1) Calibration period 1 year. (2) Calibration period 2 years. (3) Calibration period 3 years.

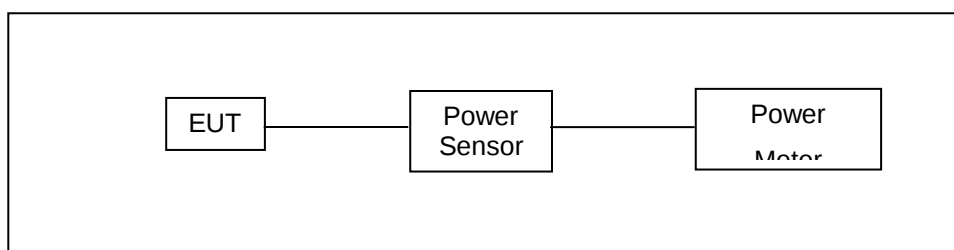
Note: N.C.R. = No Calibration Request

## 4 Maximum Conducted Output Power Measurement

### 4.1 Limit

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.

### 4.2 Test Setup



### 4.3 Test Instruments

| Describe                       | Manufacturer | Model Number | Serial Number | Cal. Date    | Remark |
|--------------------------------|--------------|--------------|---------------|--------------|--------|
| Single Channel PK Power Sensor | Agilent      | N1911A       | MY45101619    | Dec.21, 2014 | 1Year  |
| Wideband Power Meter           | Agilent      | N1921A       | MY45241957    | Dec.21, 2014 | 1Year  |

### 4.4 Test Procedure

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The tests below are run with the EUT's transmitter set at high power in TX mode. The EUT is needed to force selection of output power level and channel number. While testing, EUT was set to transmit continuously. Remove the Subjective device's antenna and connect the RF output port to power sensor. The maximum peak output power shall not exceed 1 watt.

Use a direct connection between the antenna port of transmitter and the power sensor, for prevent the power sensor input attenuation 40-50 dB. Set the RBW Bandwidth of the emission or use a channel power meter mode.

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt (+30 dBm). For antennas with gains greater than 6 dBi, transmitter output level must be decreased by an amount equal to (GAIN - 6)/3 dBm.

The antenna port of the EUT was connected to the input of a power sensor. Power was read directly and cable loss correction was added to the reading to obtain power at the EUT antenna terminals.

## 4.5 Test Result

| Model Number          | MIRAGII-N-A                    |            |       |            |
|-----------------------|--------------------------------|------------|-------|------------|
| Test Item             | Maximum Conducted Output Power |            |       |            |
| Test Mode             | Mode 2 Link Mode               |            |       |            |
| Date of Test          | 2015/05/26                     |            |       |            |
| Modulation technology | Frequency (MHz)                | Peak Power |       | Limit (mW) |
|                       |                                | (dBm)      | (mW)  |            |
| GFSK                  | 2402                           | -0.563     | 0.879 | <1000      |
|                       | 2441                           | 2.523      | 1.786 |            |
|                       | 2480                           | 2.047      | 1.603 |            |

| Model Number          | MIRAGII-N-A                     |            |       |            |
|-----------------------|---------------------------------|------------|-------|------------|
| Test Item             | Maximum Conducted Output Power0 |            |       |            |
| Test Mode             | Mode 4Link Mode                 |            |       |            |
| Date of Test          | 2015/05/26                      |            |       |            |
| Modulation technology | Frequency (MHz)                 | Peak Power |       | Limit (mW) |
|                       |                                 | (dBm)      | (mW)  |            |
| 8DPSK                 | 2402                            | -2.011     | 0.630 | <125       |
|                       | 2441                            | 0.583      | 1.143 |            |
|                       | 2480                            | 0.124      | 1.028 |            |

## 5 Conducted Emission Measurement

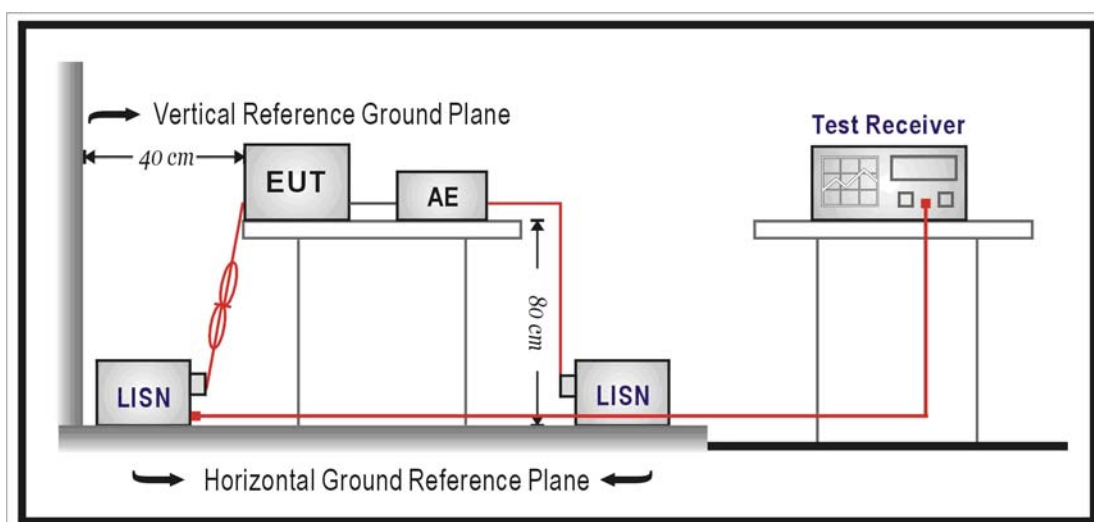
### 5.1 Limit

| Frequency (MHz) | Quasi-peak | Average  |
|-----------------|------------|----------|
| 0.15 - 0.5      | 66 to 56   | 56 to 46 |
| 0.50 - 5.0      | 56         | 46       |
| 5.0 - 30.0      | 60         | 50       |

### 5.2 Test Instruments

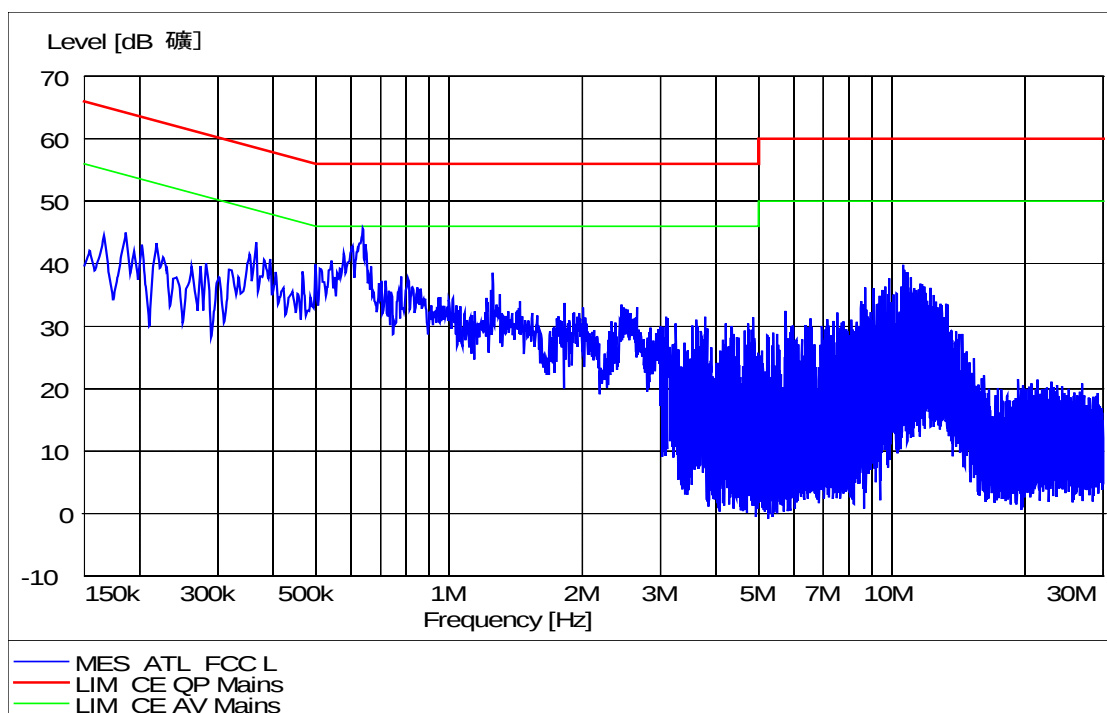
| Describe | Manufacturer      | Model Number    | Serial Number | Cal. Date   | Remark |
|----------|-------------------|-----------------|---------------|-------------|--------|
| SB3319   | EMI Test Receiver | Rohde & Schwarz | ESCS30        | Jan.20,2015 | 1 Year |
| SB4357   | AMN               | Rohde & Schwarz | ENV216        | Jan.20,2015 | 1 Year |

### 5.3 Test Setup



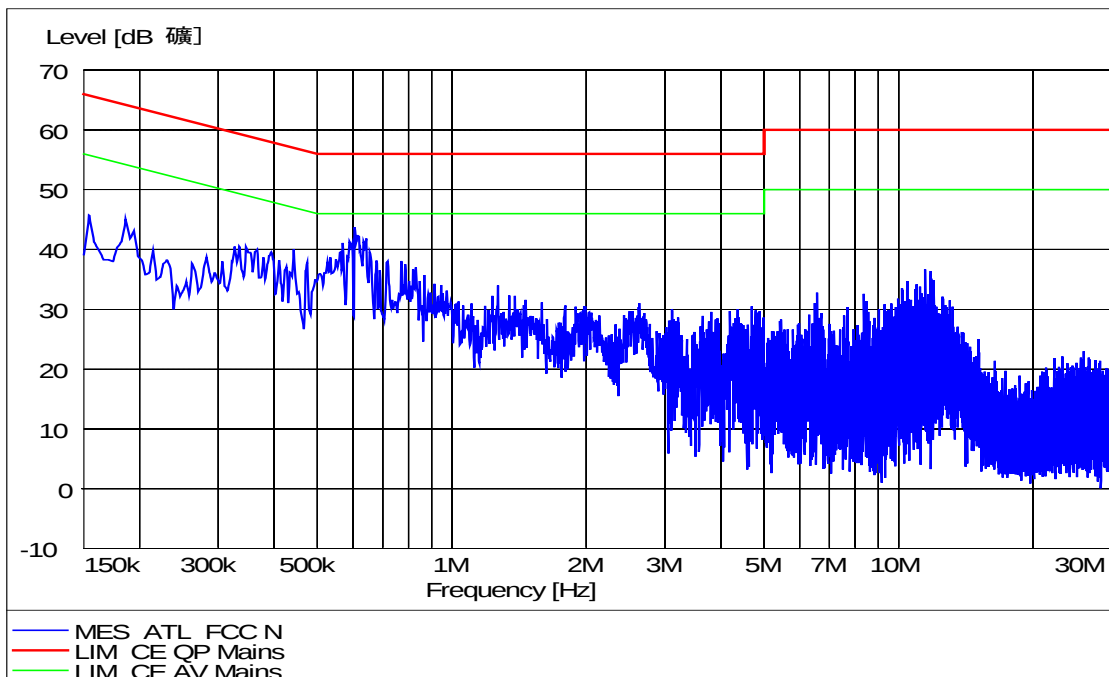
## 5.4 Test Result

|               |                    |                      |              |
|---------------|--------------------|----------------------|--------------|
| Standard:     | FCC 15.107         | Line:                | L1           |
| Test item:    | Conducted Emission | Power:               | AC 120V/60Hz |
| Model Number: | MIRAGII-N-A        | Temp.(°C)/Hum.(%RH): | 18(°C)/50%RH |
| Mode:         | 2                  | Date:                | 2015/06/10   |
|               |                    | Test By:             | Fly Lu       |
| Description:  | L line             |                      |              |



| Frequency<br>(MHz) | QP(dBμV) |       | Ave.( dBμV) |       |
|--------------------|----------|-------|-------------|-------|
|                    | Level    | Limit | Level       | Limit |
| 0.186              | 35.2     | 64.2  | 18.3        | 54.2  |
| 0.218              | 34.1     | 62.9  | 21.6        | 52.9  |
| 0.366              | 34.4     | 58.6  | 19.3        | 48.6  |
| 0.606              | 36.7     | 56.0  | 20.8        | 46.0  |
| 0.638              | 38.4     | 56.0  | 22.5        | 46.0  |
| 1.254              | 27.9     | 56.0  | 16.8        | 46.0  |

|               |                    |                      |              |
|---------------|--------------------|----------------------|--------------|
| Standard:     | FCC 15.207         | Line:                | N            |
| Test item:    | Conducted Emission | Power:               | AC 120V/60Hz |
| Model Number: | MIRAGII-N-A        | Temp.(°C)/Hum.(%RH): | 18(°C)/50%RH |
| Mode:         | 2                  | Date:                | 2015/06/10   |
|               |                    | Test By:             | Fly Lu       |
| Description:  | N line             |                      |              |



| Frequency<br>(MHz) | QP(dBμV) |       | Ave.( dBμV) |       |
|--------------------|----------|-------|-------------|-------|
|                    | Level    | Limit | Level       | Limit |
| 0.154              | 36.2     | 65.8  | 17.3        | 55.8  |
| 0.186              | 34.6     | 64.2  | 18.3        | 54.2  |
| 0.442              | 29.3     | 57.0  | 16.8        | 47.0  |
| 0.570              | 34.7     | 56.0  | 18.7        | 46.0  |
| 0.606              | 35.4     | 56.0  | 21.3        | 46.0  |
| 0.770              | 29.5     | 56.0  | 18.1        | 46.0  |

## 6 Radiated Interference Measurement

### 6.1 Limit

According to §15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency<br>(MHz) | Field Strength<br>( $\mu\text{V/m}$ at meter) | Measurement Distance<br>(meters) |
|--------------------|-----------------------------------------------|----------------------------------|
| 0.009 – 0.490      | 2400 / F (kHz)                                | 300                              |
| 0.490 – 1.705      | 24000 / F (kHz)                               | 30                               |
| 1.705 – 30.0       | 30                                            | 30                               |
| 30 - 88            | 100**                                         | 3                                |
| 88-216             | 150**                                         | 3                                |
| 216-960            | 200**                                         | 3                                |
| Above 960          | 500                                           | 3                                |

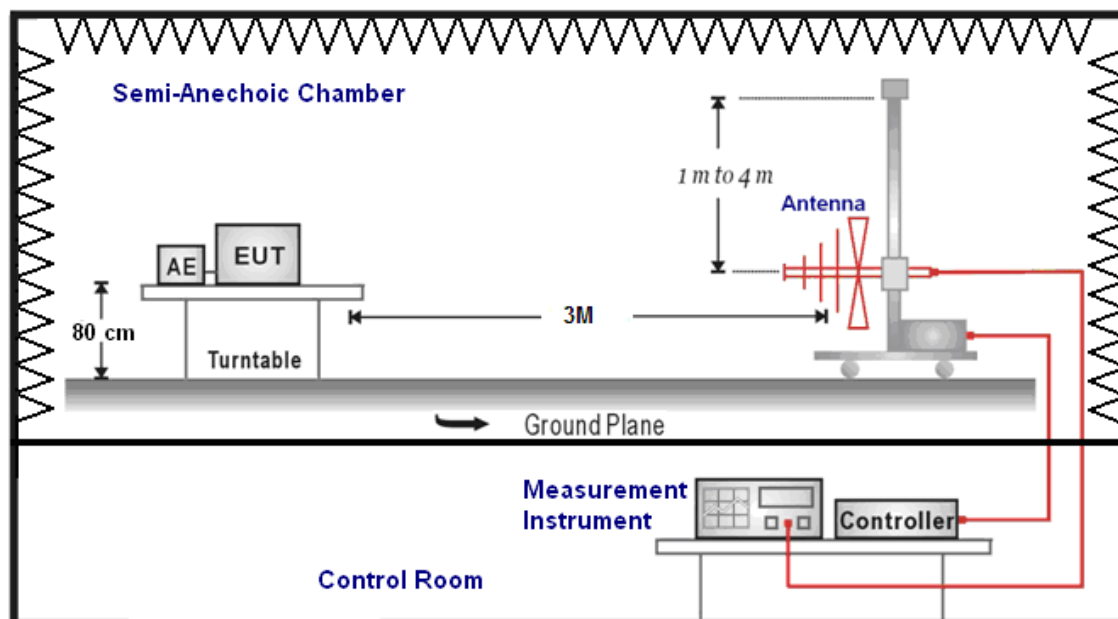
\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

### 6.2 Test Instruments

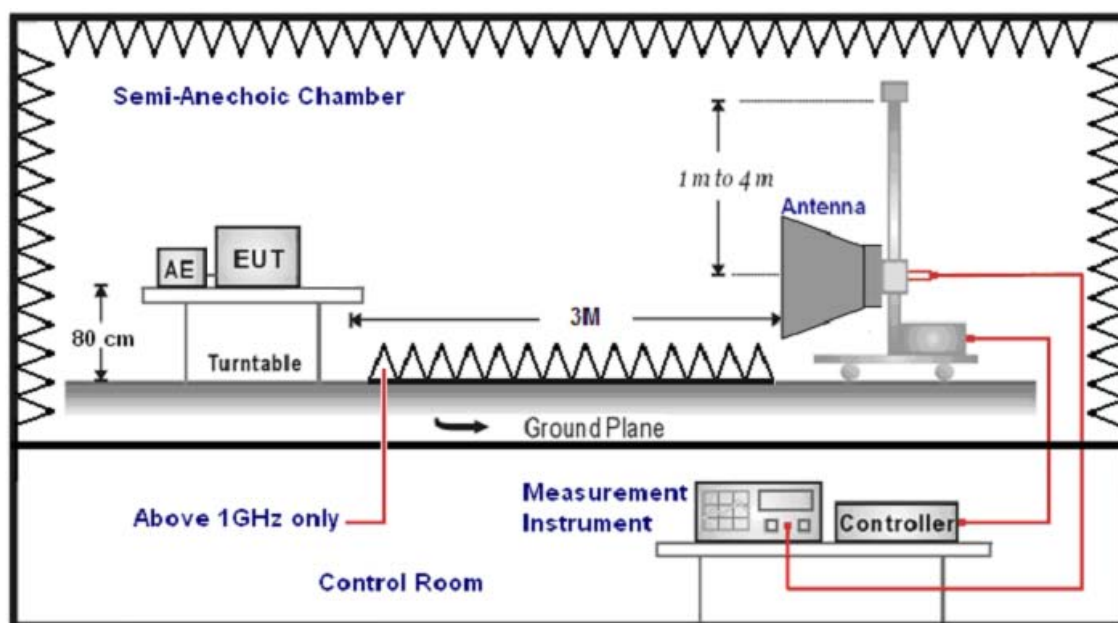
| 3 Meter Chamber   |                          |                    |               |              |         |
|-------------------|--------------------------|--------------------|---------------|--------------|---------|
| Model No.         | Equipment                | Manufacturer       | Serial Number | Cal. Date    | Remark  |
| ESU40             | EMI Test Receiver        | R&S                | SB8501/09     | Jan.20, 2015 | 1 Year  |
| VULB9163          | Bilog Antenna            | Schwarzbeck        | SB8501/04     | Jan.20, 2015 | 1 Year  |
| HF906             | Horn Antenna             | R&S                | SB3435        | Jan.20, 2015 | 1 Year  |
| --                | Amplifier(1-18GHz)       | R&S                | SB3435/01     | Jan.20, 2015 | 1 Year  |
| --                | Amplifier(18-40GHz)      | R&S                | SB3435/02     | Jan.20, 2015 | 1 Year  |
| AT4560            | Horn Antenna             | Amplifier Research | SB5392/02     | Jan.20, 2015 | 1 Year  |
| 9X6X6             | 3m Semi-anechoic chamber | Albatross Projects | SB3450/01     | Oct.12, 2013 | 2 Years |
| ESI26             | EMI Test Receiver        | Rohde & Schwarz    | SB3436        | Jan.20,2015  | 1 Year  |
| VULB9163          | Broadband antenna        | SCHWARZBECK        | SB3955        | Jan.20,2015  | 1 Year  |
| HF907             | Horn Antenna             | R&S                | SB8501/01     | Aug.15,2014  | 1 Year  |
| Spectrum Analyzer | Agilent                  | N9039A             | MY46520256    | Jan.10, 2015 | 2 Years |

## 6.3 Setup

Below 1GHz



Above 1GHz



## 6.4 Test Procedure

Final radiation measurements were made on a three-meter, Semi Anechoic Chamber. The EUT system was placed on a nonconductive turntable which is 0.8 meters height, top surface 1.0 x 1.5 meter. The spectrum was examined from 250 MHz to 2.5 GHz in order to cover the whole spectrum below 10th harmonic which could generate from the EUT. During the test, EUT was set to transmit continuously & Measurement spectrum range from 9kHz to 26.5 GHz is investigated.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

A nonconductive material surrounded the EUT to supporting the EUT for standing on three orthogonal planes. At each condition, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters to find the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarization.

Biconilog Antenna (mode VULB9163) at 3 Meter and Horn antenna was used in frequencies 1 – 18 GHz at a distance of 3 meter while 18-40GHz at distance of 1 meter. All test results were extrapolated to equivalent signal at 3 meters utilizing an inverse linear distance extrapolation Factor (20dB/decade).

For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

Appropriate preamplifiers were used for improving sensitivity and precautions were taken to avoid overloading or desensitizing the spectrum analyzer. No post – detector video filters were used in the test.

The spectrum analyzer's 6 dB bandwidth was set to 1 MHz, and the analyzer was operated in the peak detection mode, for frequencies both below and up 1 GHz. The average levels were obtained by subtracting the duty cycle correction factor from the peak readings.

The following procedures were used to convert the emission levels measured in decibels referenced to 1 microvolt (dBuV) into field intensity in micro volts per meter (uV/m).

The actual field intensity in decibels referenced to 1 microvolt in to field intensity in micro volts per meter (dBuV/m).

The actual field intensity in referenced to 1 microvolt per meter (dBuV/m) is determined by algebraically adding the measured reading in dBuV, the antenna factor (dB), and cable loss (dB) and Subtracting the gain of preamplifier (dB) is auto calculate in spectrum analyzer.

$$(1) \text{ Amplitude (dBuV/m) = FI (dBuV) + AF (dBuV) + CL (dBuV) - Gain (dB)}$$

FI= Reading of the field intensity.

AF= Antenna factor.

CL= Cable loss.

P.S Amplitude is auto calculate in spectrum analyzer.

$$(2) \text{ Actual Amplitude (dBuV/m) = Amplitude (dBuV) - Dis(dB)}$$

The FCC specified emission limits were calculated according the EUT operating frequency and by following linear interpolation equations:

(a) For fundamental frequency : Transmitter Output < +30dBm

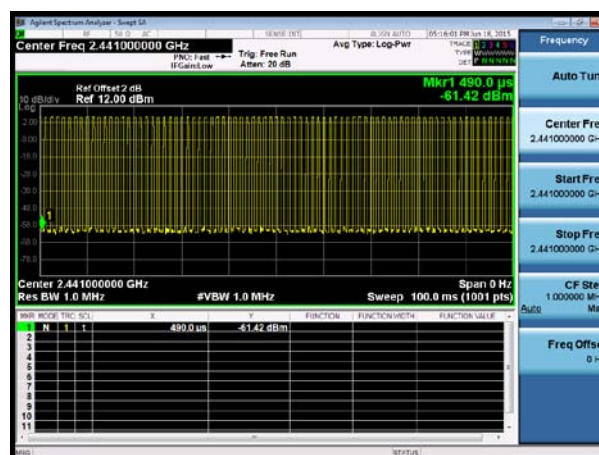
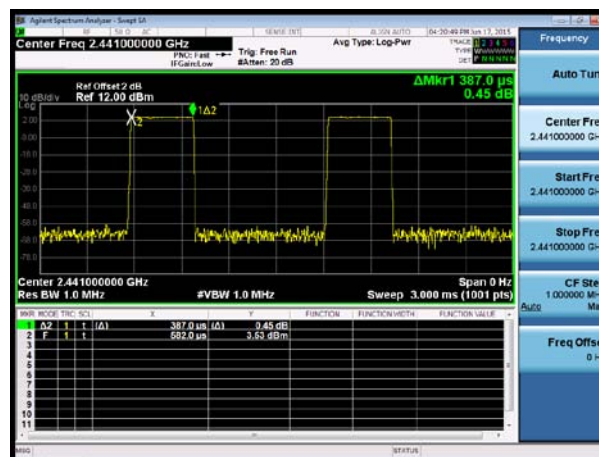
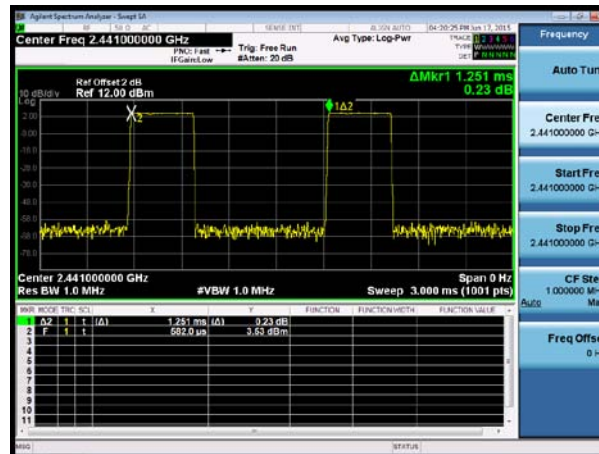
(b) For spurious frequency : Spurious emission limits = fundamental emission limit /10

Data of measurement within this frequency range without mark in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

**Note:** The duty cycle factor for calculate average level is 10.19 dB, and average limit is 20 dB blowe peak limit, so if peak measured level comply with average limit, the average level was deemed to comply with average limit.

Duty cycle(ms)=Ton/T=0.387/1.251\*100%=30.94%

Duty cycle factor=20log (1/duty cycle)=10.19



## 6.5 Test Result

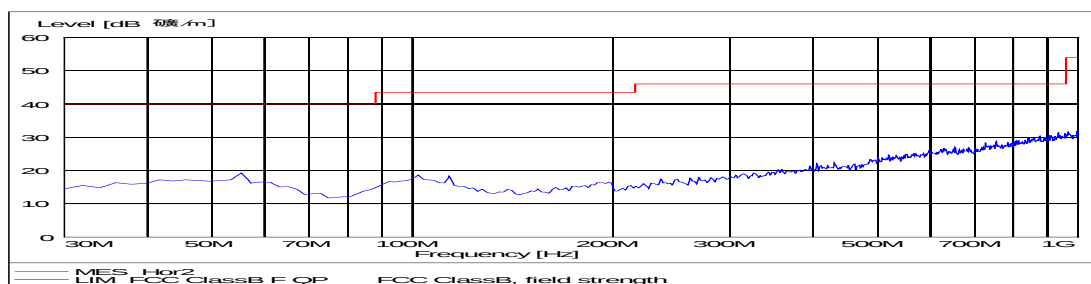
### Below 1GHz

|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 2            | Date:                | 2015/05/21   |
|               |                   | Test By:             | Fly Lu       |

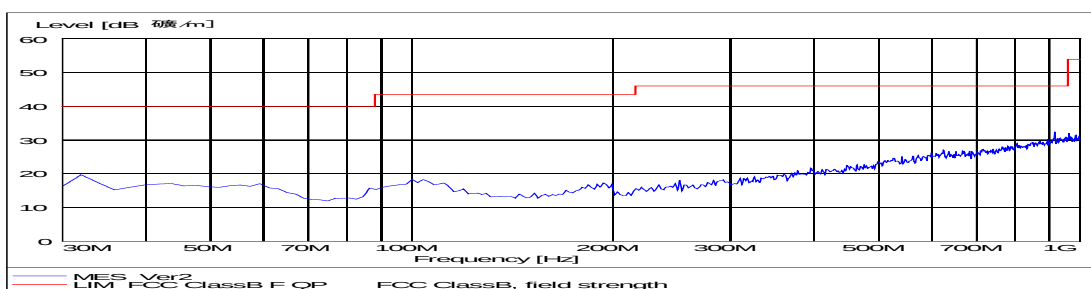
| Frequency<br>(MHz) | Reading<br>(dBuV) | Correct Factor<br>(dB/m) | Result<br>(dB) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark | Ant.Polar.<br>H / V |
|--------------------|-------------------|--------------------------|----------------|-------------------|----------------|--------|---------------------|
| 148.40             | 3.83              | 13.07                    | 16.9           | 43.5              | 26.6           | QP     | H                   |
| 457.04             | 7.09              | 12.53                    | 19.62          | 43.5              | 23.88          | QP     | H                   |
| 192.81             | 9.56              | 11.51                    | 21.07          | 43.5              | 22.43          | QP     | H                   |
| 205.22             | 5.05              | 12.44                    | 17.49          | 43.5              | 26.01          | QP     | H                   |
| 537.69             | 2.76              | 21.08                    | 23.84          | 46.0              | 22.16          | QP     | H                   |
| 667.80             | 3.73              | 22.93                    | 26.66          | 46.0              | 19.34          | QP     | H                   |
| 42 F               |                   |                          |                |                   |                |        |                     |
| 37.69              | 9.43              | 16.41                    | 25.84          | 40.0              | 14.16          | QP     | V                   |
| 108.21             | 7.21              | 13.70                    | 20.91          | 43.5              | 22.59          | QP     | V                   |
| 132.79             | 5.86              | 14.24                    | 20.1           | 43.5              | 23.4           | QP     | V                   |
| 166.63             | 8.71              | 12.17                    | 20.88          | 43.5              | 22.62          | QP     | V                   |
| 174.45             | 8.09              | 11.71                    | 19.8           | 43.5              | 23.7           | QP     | V                   |
| 255.59             | 4.86              | 15.14                    | 20             | 46.0              | 26             | QP     | V                   |

Note: No emission found between lowest internal used/generated frequencies to 30MHz (9 kHz~30MHz).

### Horizontal



### Vertical



## Above 1GHz

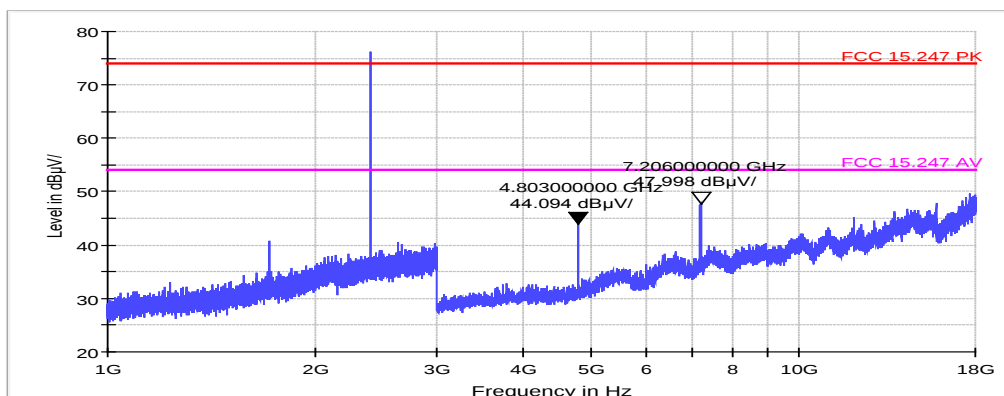
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 2            | Date:                | 2015/05/21   |
| Frequency:    | 2402 MHz          | Test By:             | Fly Lu       |

| Frequency<br>(MHz) | Reading<br>(dBuV) | Correct Factor<br>(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark | Ant.Polar.<br>H / V |
|--------------------|-------------------|--------------------------|--------------------|-------------------|----------------|--------|---------------------|
| 4803               | 38.29             | 5.8                      | 44.09              | 74.0              | 29.91          | peak   | H                   |
| 7206               | 41.20             | 6.8                      | 48.00              | 74.0              | 26.00          | peak   | H                   |
| 4803               | 36.35             | 5.8                      | 42.15              | 74.0              | 31.85          | peak   | V                   |
| 7206               | 42.30             | 6.8                      | 49.10              | 74.0              | 24.90          | peak   | V                   |

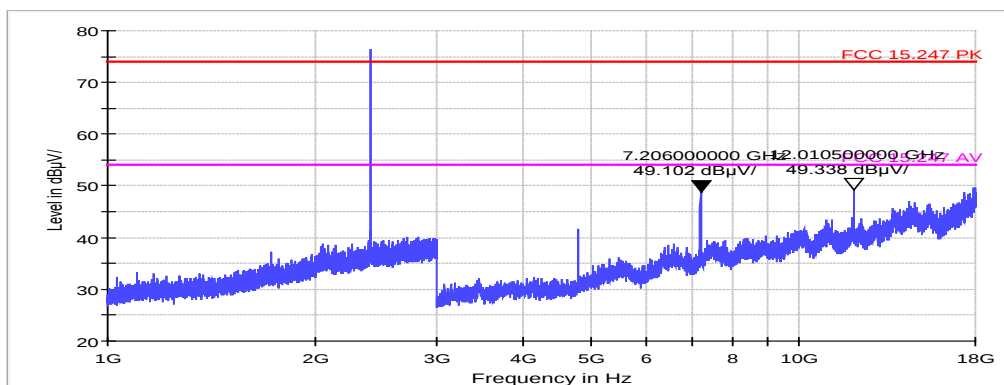
## Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



## Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



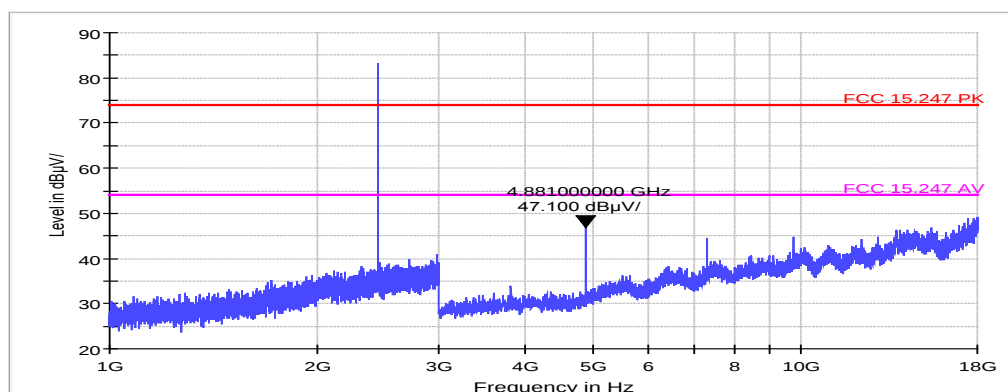
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 2            | Date:                | 2015/05/21   |
| Frequency:    | 2441 MHz          | Test By:             | Fly Lu       |

| Frequency (MHz) | Reading (dBuV) | Correct Factor (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark | Ant.Polar. H / V |
|-----------------|----------------|-----------------------|-----------------|----------------|-------------|--------|------------------|
| 4881            | 41.20          | 5.9                   | 47.10           | 74.0           | 26.90       | peak   | H                |
| 7323            | 38.12          | 6.8                   | 44.92           | 74.0           | 29.08       | peak   | H                |
| 4881            | 46.48          | 5.9                   | 52.38           | 74.0           | 21.62       | peak   | V                |
| 7323            | 42.95          | 6.8                   | 49.75           | 74.0           | 24.25       | peak   | V                |

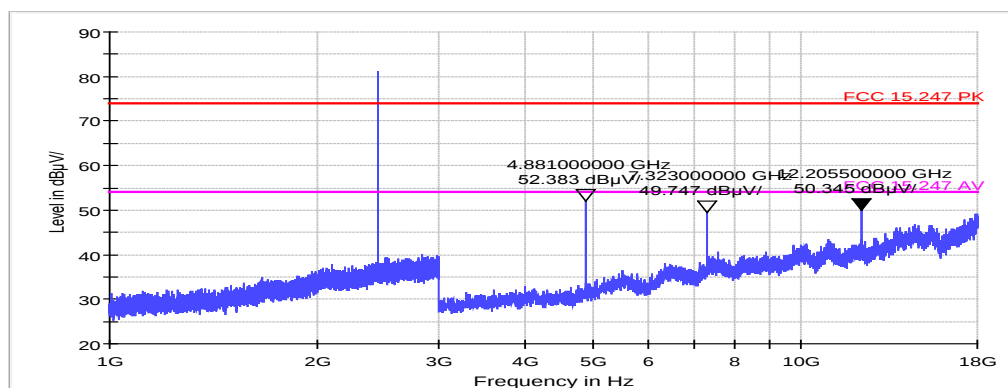
### Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



### Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



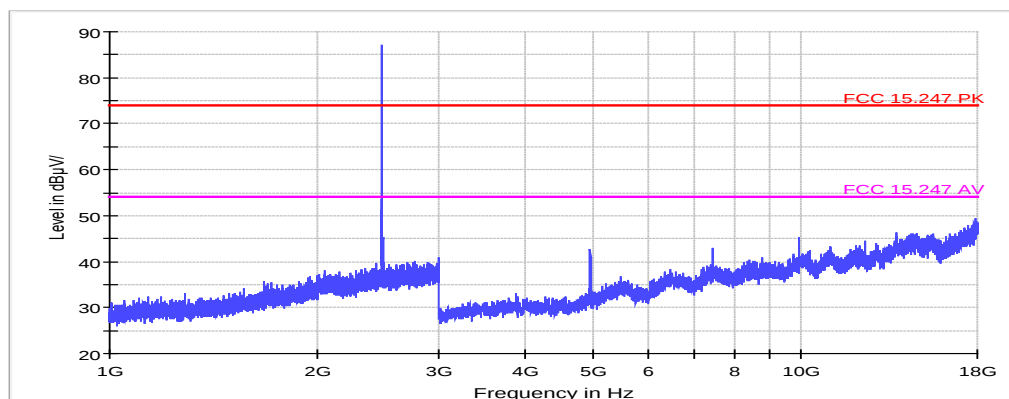
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 2            | Date:                | 2015/05/21   |
| Frequency:    | 2480 MHz          | Test By:             | Fly Lu       |

| Frequency<br>(MHz) | Reading<br>(dBuV) | Correct Factor<br>(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark | Ant.Polar.<br>H / V |
|--------------------|-------------------|--------------------------|--------------------|-------------------|----------------|--------|---------------------|
| 4960               | 37.99             | 5.9                      | 43.89              | 74.0              | 30.11          | peak   | H                   |
| 7440               | 35.75             | 6.8                      | 42.55              | 74.0              | 31.45          | peak   | H                   |
| 4960               | 38.04             | 5.9                      | 43.94              | 74.0              | 30.06          | peak   | V                   |
| 7440               | 35.46             | 6.8                      | 42.26              | 74.0              | 31.74          | peak   | V                   |

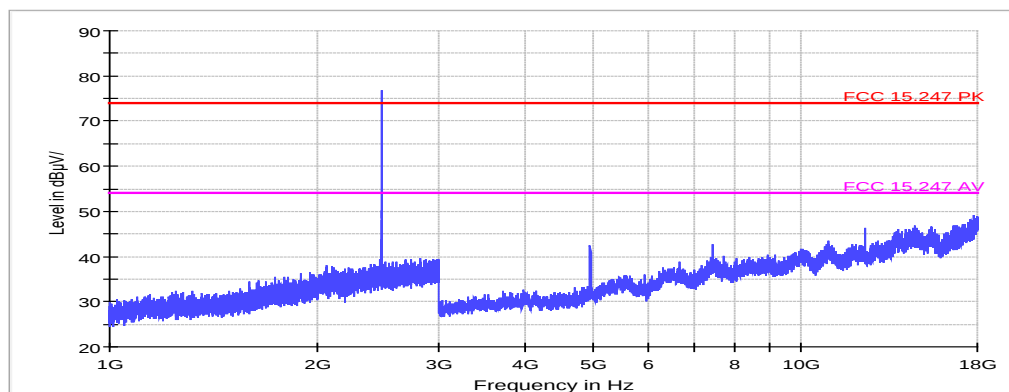
### Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



### Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



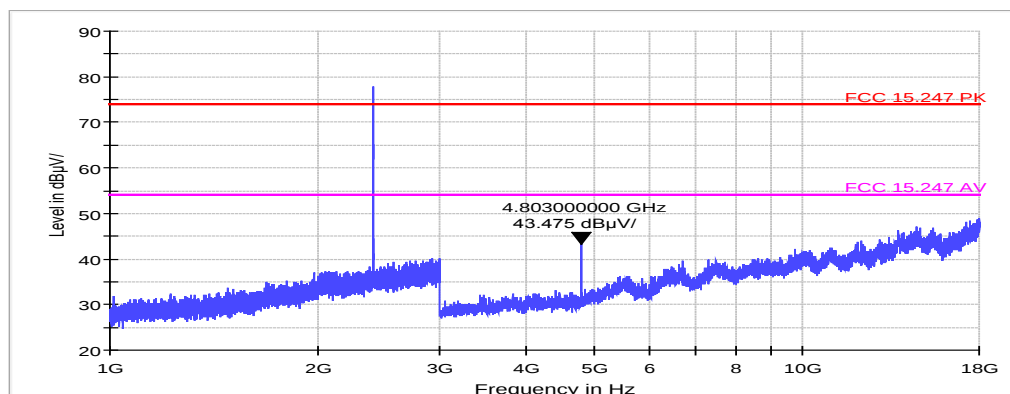
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 4            | Date:                | 2015/05/21   |
| Frequency:    | 2402 MHz          | Test By:             | Fly Lu       |

| Frequency<br>(MHz) | Reading<br>(dBuV) | Correct Factor<br>(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark | Ant.Polar.<br>H / V |
|--------------------|-------------------|--------------------------|--------------------|-------------------|----------------|--------|---------------------|
| 4803               | 37.68             | 5.8                      | 43.48              | 74.0              | 30.52          | peak   | H                   |
| 7206               | 32.25             | 6.8                      | 39.05              | 74.0              | 34.95          | peak   | H                   |
| 4803               | 38.80             | 5.8                      | 44.60              | 74.0              | 29.40          | peak   | V                   |
| 7206               | 31.89             | 6.8                      | 38.69              | 74.0              | 35.31          | peak   | V                   |

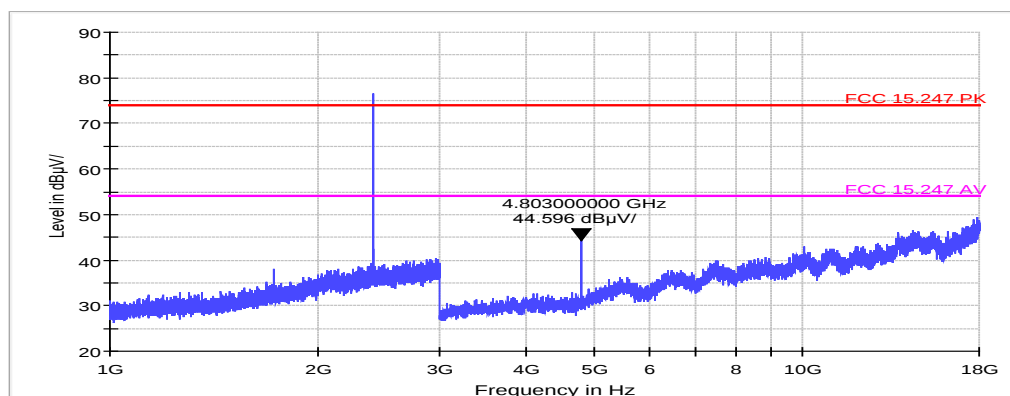
### Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



### Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



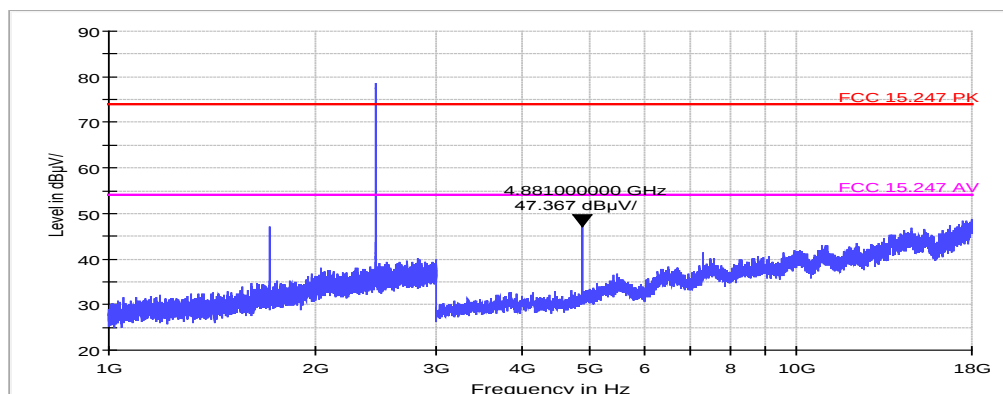
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 4            | Date:                | 2015/05/21   |
| Frequency:    | 2441 MHz          | Test By:             | Fly Lu       |

| Frequency (MHz) | Reading (dBuV) | Correct Factor (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark | Ant.Polar. H / V |
|-----------------|----------------|-----------------------|-----------------|----------------|-------------|--------|------------------|
| 4881            | 41.58          | 5.9                   | 47.38           | 74.0           | 26.62       | peak   | H                |
| 7323            | 35.86          | 6.8                   | 42.66           | 74.0           | 31.34       | peak   | H                |
| 4882            | 43.79          | 5.9                   | 49.59           | 74.0           | 24.41       | peak   | V                |
| 7323            | 32.46          | 6.8                   | 39.26           | 74.0           | 34.74       | peak   | V                |

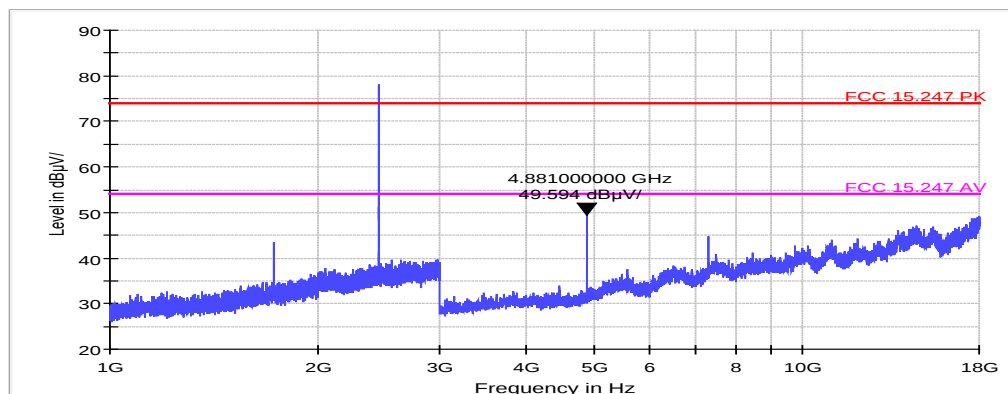
### Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



### Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



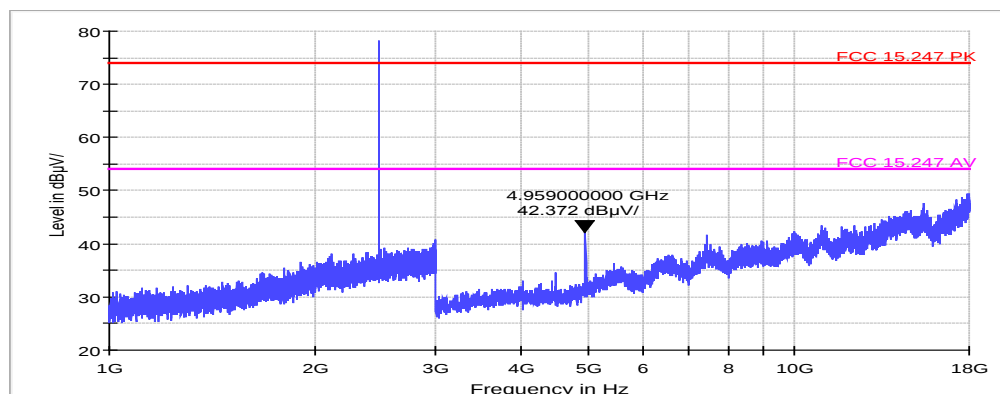
|               |                   |                      |              |
|---------------|-------------------|----------------------|--------------|
| Standard:     | FCC Part 15C      | Test Distance:       | 3m           |
| Test item:    | Radiated Emission | Power:               | AC 120V/60HZ |
| Model Number: | MIRAGII-N-A       | Temp.(°C)/Hum.(%RH): | 26(°C)/60%RH |
| Mode:         | Mode 4            | Date:                | 2015/05/21   |
| Frequency:    | 2480 MHz          | Test By:             | Fly Lu       |

| Frequency (MHz) | Reading (dBuV) | Correct Factor (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark | Ant.Polar. H / V |
|-----------------|----------------|-----------------------|-----------------|----------------|-------------|--------|------------------|
| 4959            | 36.47          | 5.9                   | 42.37           | 74.0           | 31.63       | peak   | H                |
| 7438            | 35.37          | 6.8                   | 42.17           | 74.0           | 31.83       | peak   | H                |
| 4959            | 30.57          | 5.9                   | 36.47           | 74.0           | 37.53       | peak   | V                |
| 7438            | 38.89          | 6.8                   | 45.69           | 74.0           | 28.31       | peak   | V                |

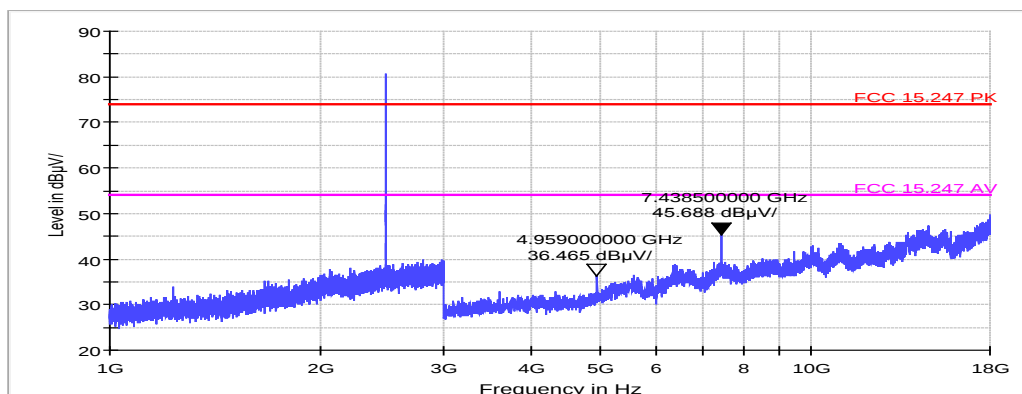
### Horizontal

FCC Electric Field Strength 1-18GHz operate on 2.4GHz



### Vertical

FCC Electric Field Strength 1-18GHz operate on 2.4GHz

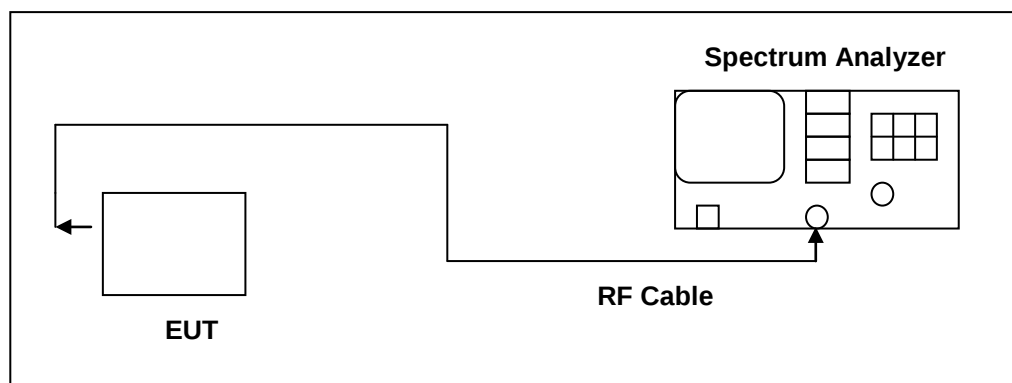


## 7 20dB RF Bandwidth Measurement

### 7.1 Limit

N/A

### 7.2 Test Setup



### 7.3 Test Instruments

| Equipment         | Manufacturer | Model Number | Serial Number | Cal. Date  | Remark  |
|-------------------|--------------|--------------|---------------|------------|---------|
| Spectrum Analyzer | Agilent      | N9039A       | MY46520256    | 01/10/2015 | 2 Years |
| Test Site         | ATL          | TE02         | TE02          | N.C.R.     | -----   |

### 7.4 Test Procedure

#### 20dB RF Bandwidth

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The RF output port of the Equipment-Under-Test is directly coupled to the input of the EMC analyzer through a specialized RF connector and a 10dB passive attenuator. A fully charged battery was used for the supply voltage. The Bluetooth frequency hopping function of the EUT was enabled. The spectrum analyzer used the following settings:

1. Span = approx. 2 to 3 times the 20dB bandwidth, centered on a hopping frequency
2. RBW  $\geq$  1% of the 20dB span
3. VBW  $\geq$  RBW
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

The trace was allowed to stabilize. The EUT was transmitting at its maximum data rate. The marker-to-peak function was used to set the marker to the peak of the emission. The marker-delta function was used to measure 20dB down on one side of the emission. The marker-delta function and marker was moved to the other side of the

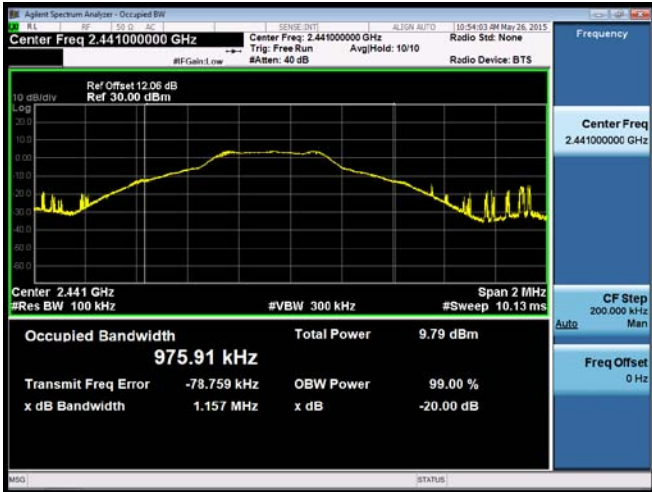
emission until it was even with the reference marker. The marker-delta reading at this point was the 20dB bandwidth of the emission.

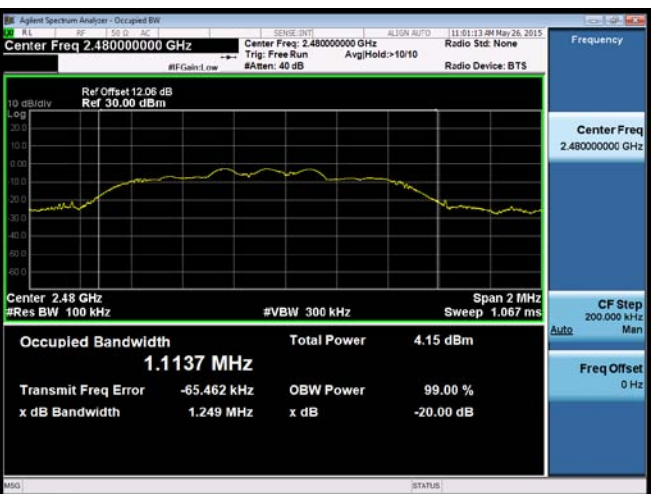
## 7.5 Test Result

|                    |                                               |                |
|--------------------|-----------------------------------------------|----------------|
| Model Number       | MIRAGII-N-A                                   |                |
| Test Item          | 20dB RF Bandwidth and 99 % Occupied Bandwidth |                |
| Test Mode          | Mode 2: GFSK Link Mode                        |                |
| Date of Test       | 2015/05/26                                    |                |
| Frequency<br>(MHz) | 20dB RF Bandwidth<br>(MHz)                    | Limit<br>(MHz) |
| 2402               | 1.123                                         | -----          |
| 2441               | 1.157                                         | -----          |
| 2480               | 1.242                                         | -----          |

|                    |                                               |                |
|--------------------|-----------------------------------------------|----------------|
| Model Number       | MIRAGII-N-A                                   |                |
| Test Item          | 20dB RF Bandwidth and 99 % Occupied Bandwidth |                |
| Test Mode          | Mode 4: 8DPSK Link Mode                       |                |
| Date of Test       | 2015/05/26                                    |                |
| Frequency<br>(MHz) | 20dB RF Bandwidth<br>(MHz)                    | Limit<br>(MHz) |
| 2402               | 1.324                                         | -----          |
| 2441               | 1.384                                         | -----          |
| 2480               | 1.249                                         | -----          |

## 7.6 Test Graphs

| Mode 2: GFSK Link Mode |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2402                   |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.40200000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Center 2.402 GHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Span 2 MHz<br/>Sweep 1.067 ms</p> <p>Occupied Bandwidth 983.72 kHz</p> <p>Total Power 6.47 dBm</p> <p>Transmit Freq Error -57.460 kHz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 1.123 MHz</p> <p>x dB -20.00 dB</p>   |
| 2441                   |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.441000000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Center 2.441 GHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Span 2 MHz<br/>Sweep 10.13 ms</p> <p>Occupied Bandwidth 975.91 kHz</p> <p>Total Power 9.79 dBm</p> <p>Transmit Freq Error -78.759 kHz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 1.157 MHz</p> <p>x dB -20.00 dB</p> |
| 2480                   |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.480000000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Center 2.48 GHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Span 2 MHz<br/>Sweep 1.067 ms</p> <p>Occupied Bandwidth 995.02 kHz</p> <p>Total Power 9.81 dBm</p> <p>Transmit Freq Error -84.446 kHz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 1.242 MHz</p> <p>x dB -20.00 dB</p> |

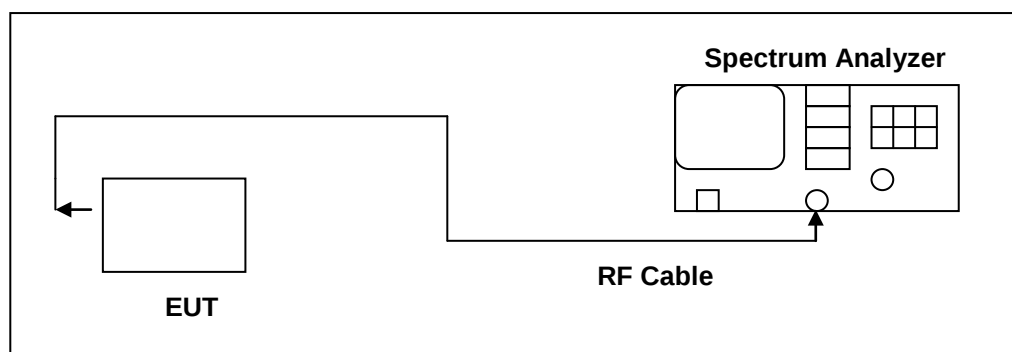
| Mode 4: 8DPSK Link Mode |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2402                    |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.40200000 GHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 10/10</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset: 12.06 dB</p> <p>Ref: 30.00 dBm</p> <p>Center: 2.402 GHz</p> <p>#Res BW: 100 kHz</p> <p>#VBW: 300 kHz</p> <p>Span: 2 MHz</p> <p>Sweep: 1.067 ms</p> <p>Occupied Bandwidth: 1.2346 MHz</p> <p>Total Power: 0.51 dBm</p> <p>Transmit Freq Error: -54.969 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.324 MHz</p> <p>x dB: -20.00 dB</p>  |
| 2441                    |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.44100000 GHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 10/10</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset: 12.06 dB</p> <p>Ref: 30.00 dBm</p> <p>Center: 2.441 GHz</p> <p>#Res BW: 100 kHz</p> <p>#VBW: 300 kHz</p> <p>Span: 2 MHz</p> <p>Sweep: 1.067 ms</p> <p>Occupied Bandwidth: 1.2973 MHz</p> <p>Total Power: 4.53 dBm</p> <p>Transmit Freq Error: -64.751 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.384 MHz</p> <p>x dB: -20.00 dB</p> |
| 2480                    |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq: 2.48000000 GHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 10/10</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset: 12.06 dB</p> <p>Ref: 30.00 dBm</p> <p>Center: 2.48 GHz</p> <p>#Res BW: 100 kHz</p> <p>#VBW: 300 kHz</p> <p>Span: 2 MHz</p> <p>Sweep: 1.067 ms</p> <p>Occupied Bandwidth: 1.1137 MHz</p> <p>Total Power: 4.15 dBm</p> <p>Transmit Freq Error: -65.462 kHz</p> <p>OBW Power: 99.00 %</p> <p>x dB Bandwidth: 1.249 MHz</p> <p>x dB: -20.00 dB</p> |

## 8 Carrier Frequency Separation Measurement

### 8.1 Limit

Title 47 of the CFR, Part 15 Subpart (c) 15.247(a)(1)(i) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for channel spacing. The channel spacing shall be a minimum of 25 kHz or the 20 dB bandwidth.

### 8.2 Test Setup



### 8.3 Test Instruments

| Equipment       | Manufacturer | Model Number | Serial Number | Cal. Date  | Remark |
|-----------------|--------------|--------------|---------------|------------|--------|
| Signal Analyzer | Agilent      | N9020A       | MY53420615    | 12/19/2014 | 1Year  |

### 8.4 Test Procedure

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The RF output port of the Equipment-Under-Test is directly coupled to the input of the EMC analyzer through a specialized RF connector and a 10dB passive attenuator. A fully charged battery was used for the supply voltage. The Bluetooth transmitter of the V6 had its hopping function enabled. The following spectrum analyzer settings were used:

1. Span = wide enough to capture the peaks of two adjacent channels
2. Resolution (or IF) Bandwidth (RBW)  $\geq$  1% of the span
3. Video (or Average) Bandwidth (VBW)  $\geq$  RBW
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

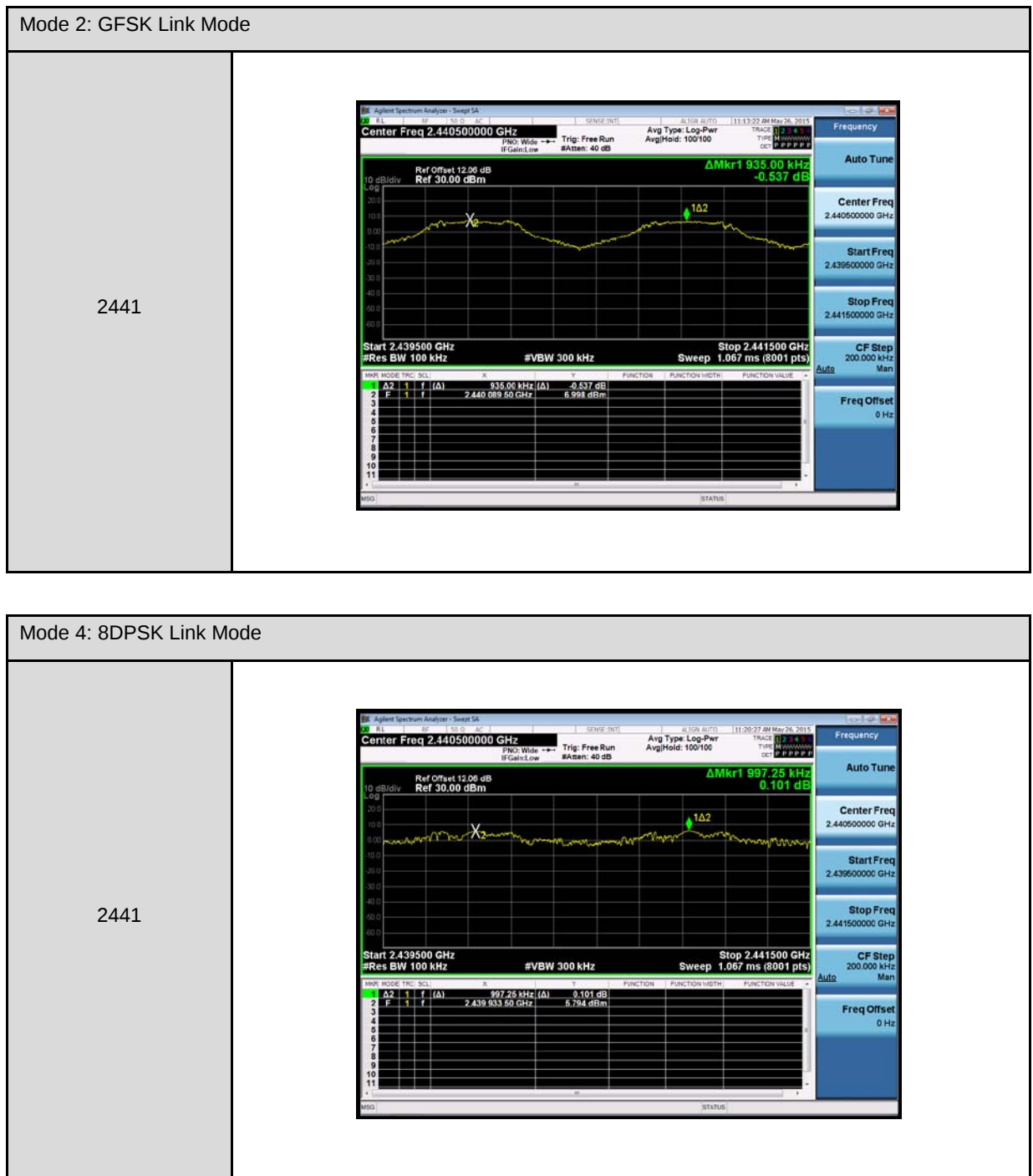
The trace was allowed to stabilize. The marker-delta function was used to determine the separation between the peaks of the adjacent channels.

## 8.5 Test Result

|                    |                              |                |  |
|--------------------|------------------------------|----------------|--|
| Model Number       | MIRAGII-N-A                  |                |  |
| Test Item          | Carrier Frequency Separation |                |  |
| Test Mode          | Mode 2: GFSK Link Mode       |                |  |
| Date of Test       | 2015/05/26                   |                |  |
| Frequency<br>(MHz) | Measurement<br>(MHz)         | Limit<br>(MHz) |  |
| 2441               | 0.935                        | >0.832         |  |

|                    |                              |                |  |
|--------------------|------------------------------|----------------|--|
| Model Number       | MIRAGII-N-A                  |                |  |
| Test Item          | Carrier Frequency Separation |                |  |
| Test Mode          | Mode 4: 8DPSK Link Mode      |                |  |
| Date of Test       | 2015/05/26                   |                |  |
| Frequency<br>(MHz) | Measurement<br>(MHz)         | Limit<br>(MHz) |  |
| 2441               | 0.997                        | >0.927         |  |

## 8.6 Test Graphs

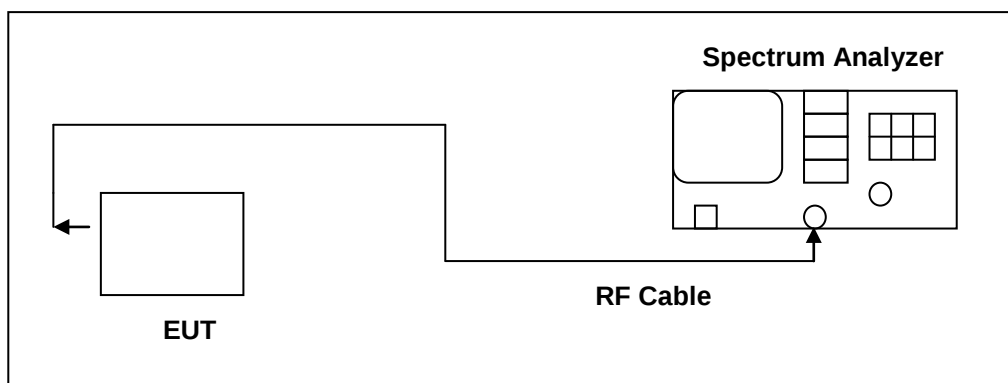


## 9 Number of Hopping Measurement

### 9.1 Limit

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

### 9.2 Test Setup



### 9.3 Test Instruments

| Equipment         | Manufacturer | Model Number | Serial Number | Cal. Date  | Remark  |
|-------------------|--------------|--------------|---------------|------------|---------|
| Spectrum Analyzer | Agilent      | N9039A       | MY46520256    | 01/10/2015 | 2 Years |
| Test Site         | ATL          | TE02         | TE02          | N.C.R.     | -----   |

### 9.4 Test Procedure

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The RF output port of the Equipment-Under-Test is directly coupled to the input of the EMC analyzer through a specialized RF connector and a 10dB passive attenuator. A fully charged battery was used for the supply voltage. The Bluetooth frequency hopping function of the EUT was enabled. The spectrum analyzer used the following settings:

1. Span = the frequency band of operation
2. RBW  $\geq$  1% of the span
3. VBW  $\geq$  RBW
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

The trace was allowed to stabilize.

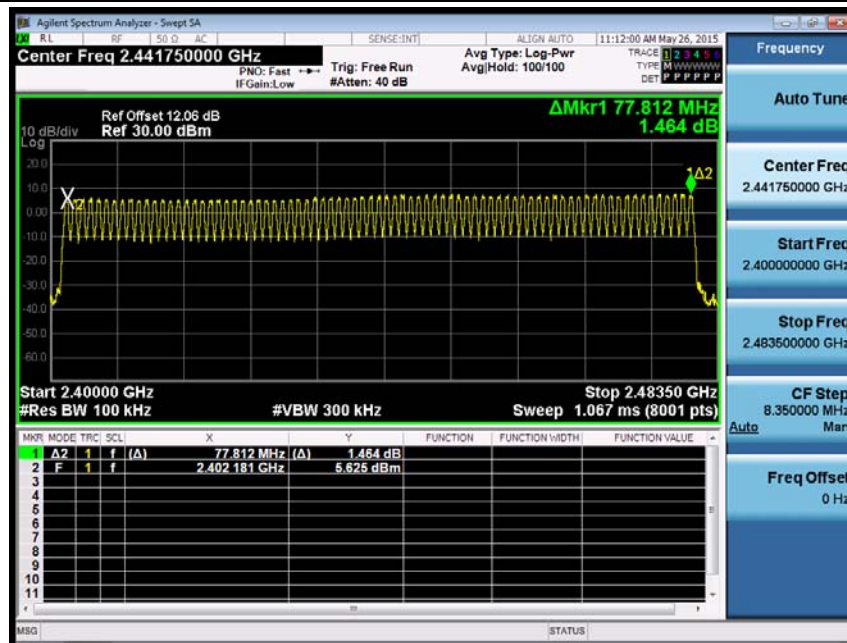
## 9.5 Test Result

|                          |                        |               |  |
|--------------------------|------------------------|---------------|--|
| Model Number             | MIRAGII-N-A            |               |  |
| Test Item                | Number of Hopping      |               |  |
| Test Mode                | Mode 2: GFSK Link Mode |               |  |
| Date of Test             | 2015/05/26             |               |  |
| Frequency Range<br>(MHz) | Measurement<br>(ch)    | Limit<br>(ch) |  |
| 2402 - 2480              | 79                     | > 15          |  |

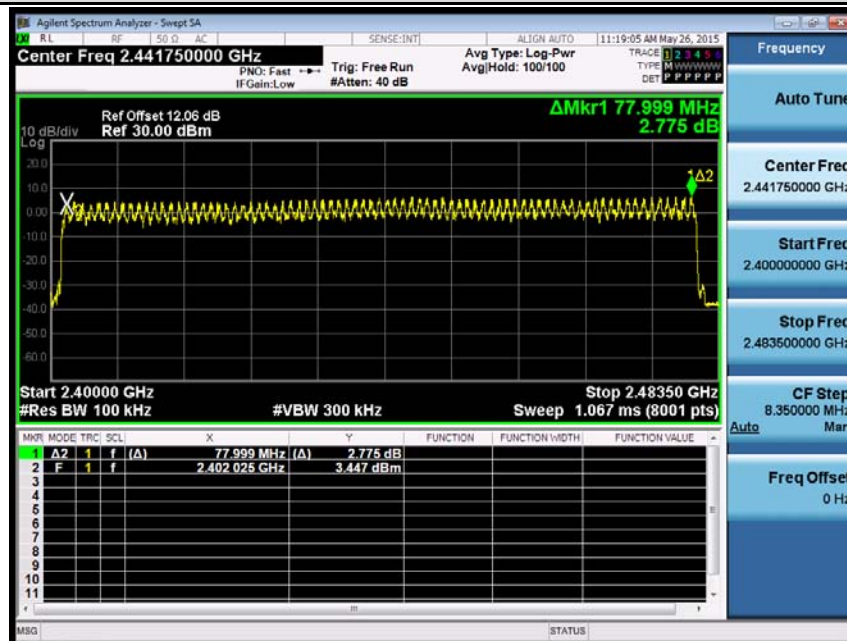
|                          |                         |               |  |
|--------------------------|-------------------------|---------------|--|
| Model Number             | MIRAGII-N-A             |               |  |
| Test Item                | Number of Hopping       |               |  |
| Test Mode                | Mode 4: 8DPSK Link Mode |               |  |
| Date of Test             | 2015/05/26              |               |  |
| Frequency Range<br>(MHz) | Measurement<br>(ch)     | Limit<br>(ch) |  |
| 2402 - 2480              | 79                      | > 15          |  |

## 9.6 Test Graphs

Mode 2: GFSK Link Mode



Mode 4: 8DPSK Link Mode

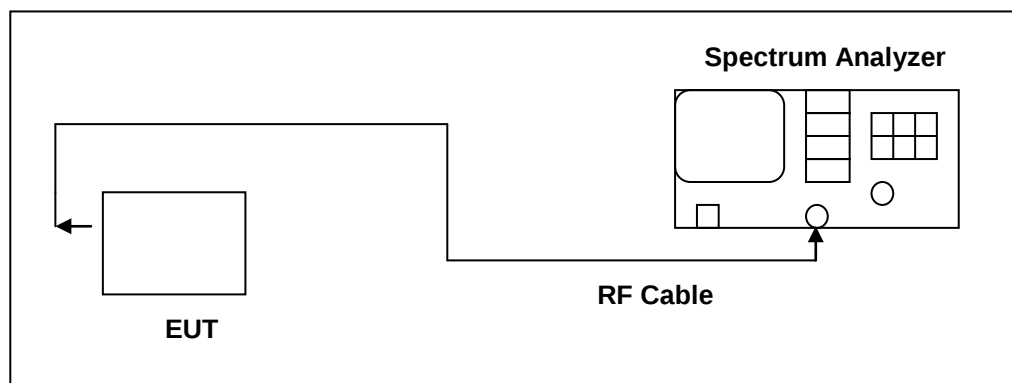


## 10 Time of Occupancy (Dwell Time) Measurement

### 10.1 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.

### 10.2 Test Setup



### 10.3 Test Instruments

| Equipment         | Manufacturer | Model Number | Serial Number | Cal. Date  | Remark  |
|-------------------|--------------|--------------|---------------|------------|---------|
| Spectrum Analyzer | Agilent      | N9039A       | MY46520256    | 01/10/2015 | 2 Years |
| Test Site         | ATL          | TE02         | TE02          | N.C.R.     | -----   |

### 10.4 Test Procedure

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The RF output port of the Equipment-Under-Test is directly coupled to the input of the EMC analyzer through a specialized RF connector and a 10dB passive attenuator. A fully charged battery was used for the supply voltage. The Bluetooth hopping function of the EUT was enabled. The following spectrum analyzer settings were used:

1. Span = zero span, centered on a hopping channel
2. RBW = 1 MHz
3. VBW  $\geq$  RBW
4. Sweep = as necessary to capture the entire dwell time per hopping channel
5. Detector function = peak
6. Trace = max hold

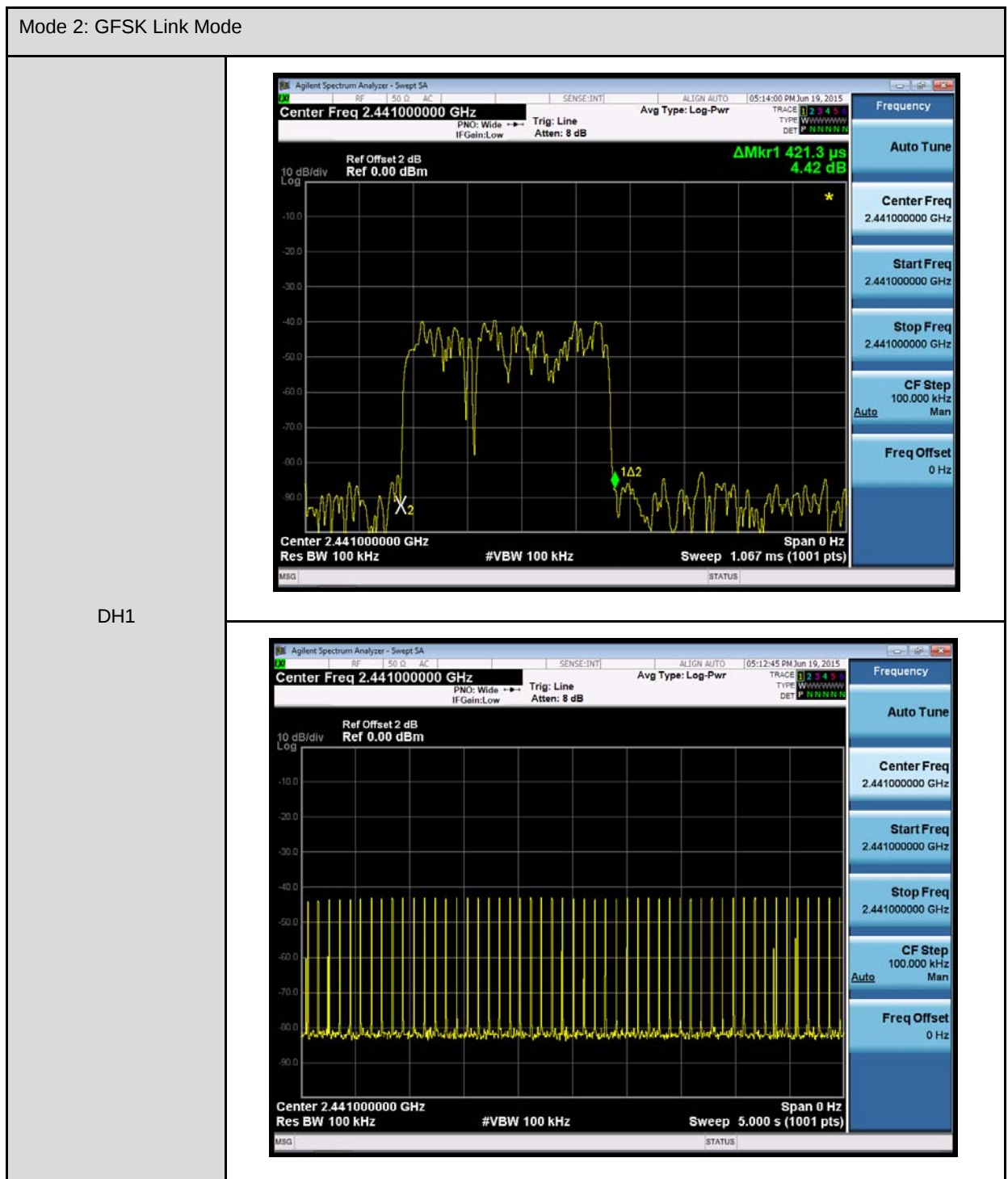
The marker-delta function was used to determine the dwell time.

## 10.5 Test Result

|                              |                                |  |
|------------------------------|--------------------------------|--|
| Model Number                 | MIRAGII-N-A                    |  |
| Test Item                    | Time of Occupancy (Dwell Time) |  |
| Test Mode                    | Mode 2: GFSK Link Mode         |  |
| Date of Test                 | 2015/06/19                     |  |
| DH1                          |                                |  |
| Length of per burst(ms)      | 0.4213                         |  |
| Number of burst in 5 seconds | 51                             |  |
| Cycle Calculate              | 79CH * 0.4 = 31.6 (sec)        |  |
| Dwell Times                  | 31.6/5*51*0.4213 =135.793      |  |
| LIMIT(msec)                  | < = 400                        |  |
| DH3                          |                                |  |
| Length of per burst(ms)      | 1.707                          |  |
| Number of burst in 5 seconds | 27                             |  |
| Cycle Calculate              | 79CH * 0.4 = 31.6 (sec)        |  |
| Dwell Times                  | 31.6/5*25*1.707 =269.706       |  |
| LIMIT(msec)                  | < = 400                        |  |
| DH5                          |                                |  |
| Length of per burst(ms)      | 2.955                          |  |
| Number of burst in 5 seconds | 18                             |  |
| Cycle Calculate              | 79CH * 0.4 = 31.6 (sec)        |  |
| Dwell Times                  | 31.6/5*17*2.955 =336.161       |  |
| LIMIT(msec)                  | < = 400                        |  |

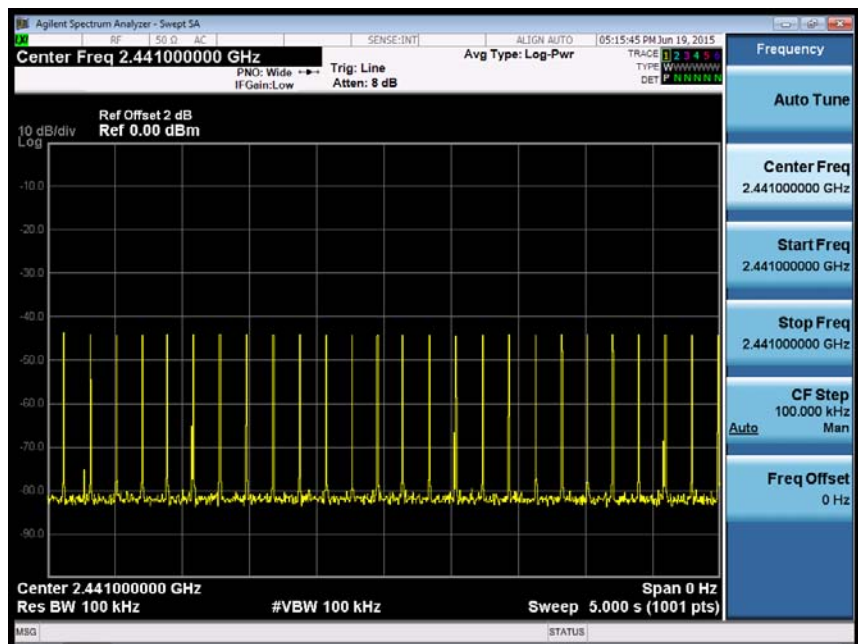
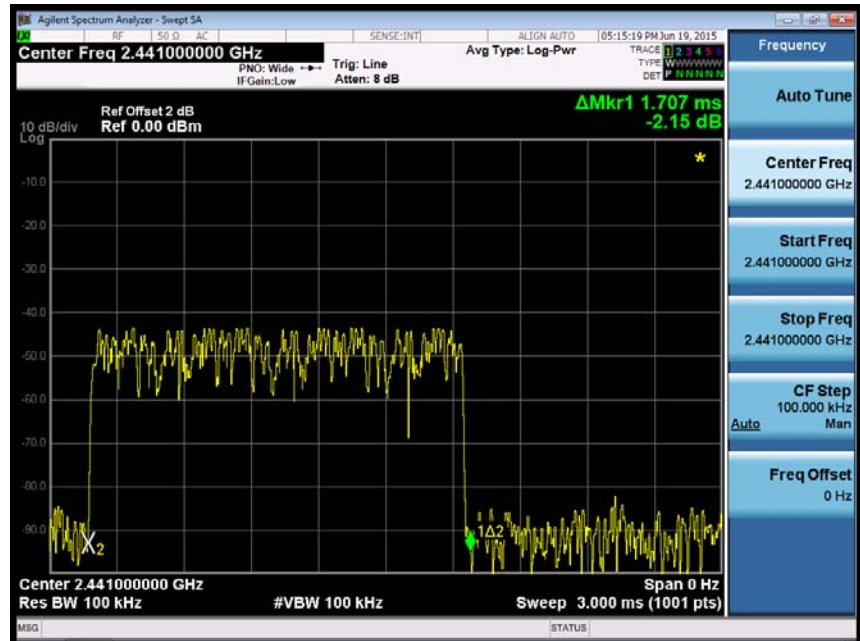
|                              |                                          |
|------------------------------|------------------------------------------|
| Model Number                 | MIRAGII-N-A                              |
| Test Item                    | Time of Occupancy (Dwell Time)           |
| Test Mode                    | Mode 4: 8DPSK Link Mode                  |
| Date of Test                 | 2015/06/19                               |
| DH1                          |                                          |
| Length of per burst(ms)      | 0.438                                    |
| Number of burst in 5 seconds | 51                                       |
| Cycle Calculate              | $79\text{CH} * 0.4 = 31.6 \text{ (sec)}$ |
| Dwell Times                  | $31.6/5 * 51 * 0.438 = 141.176$          |
| LIMIT(msec)                  | $\leq 400$                               |
| DH3                          |                                          |
| Length of per burst(ms)      | 1.695                                    |
| Number of burst in 5 seconds | 26                                       |
| Cycle Calculate              | $79\text{CH} * 0.4 = 31.6 \text{ (sec)}$ |
| Dwell Times                  | $31.6/5 * 26 * 1.695 = 278.522$          |
| LIMIT(msec)                  | $\leq 400$                               |
| DH5                          |                                          |
| Length of per burst(ms)      | 2.970                                    |
| Number of burst in 5 seconds | 18                                       |
| Cycle Calculate              | $79\text{CH} * 0.4 = 31.6 \text{ (sec)}$ |
| Dwell Times                  | $31.6/5 * 18 * 2.970 = 337.867$          |
| LIMIT(msec)                  | $\leq 400$                               |

## 10.6 Test Graphs



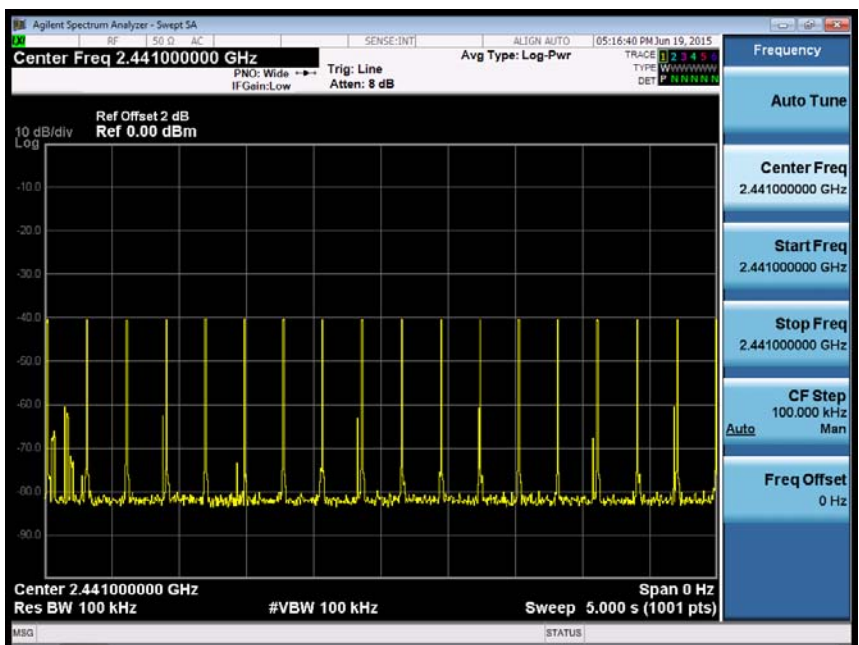
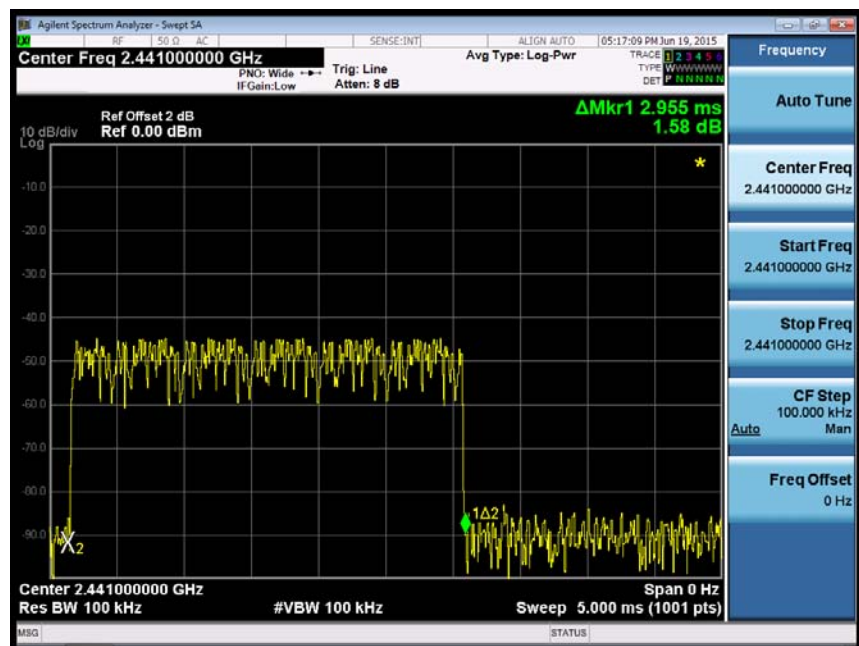
Mode 2: GFSK Link Mode

DH3



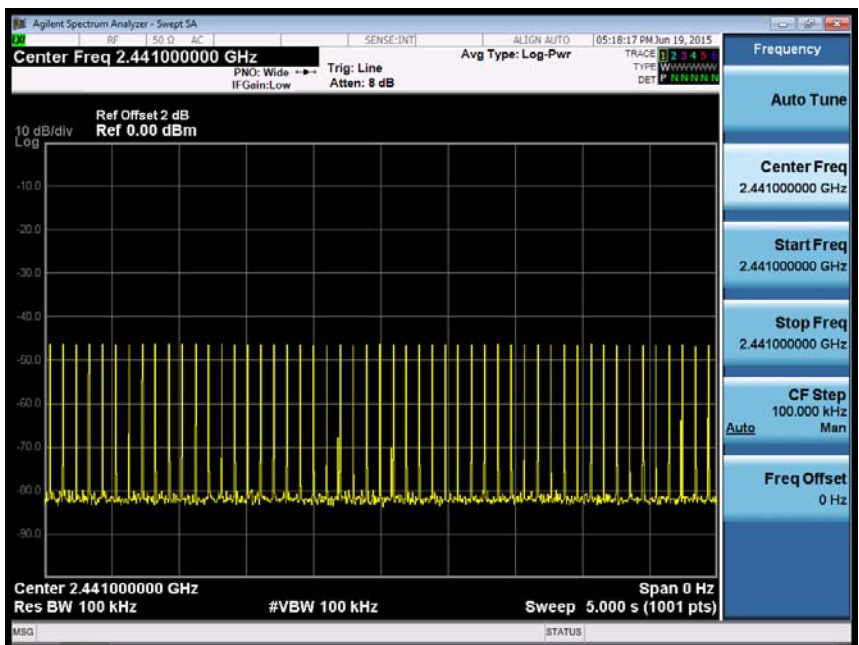
Mode 2: GFSK Link Mode

DH5



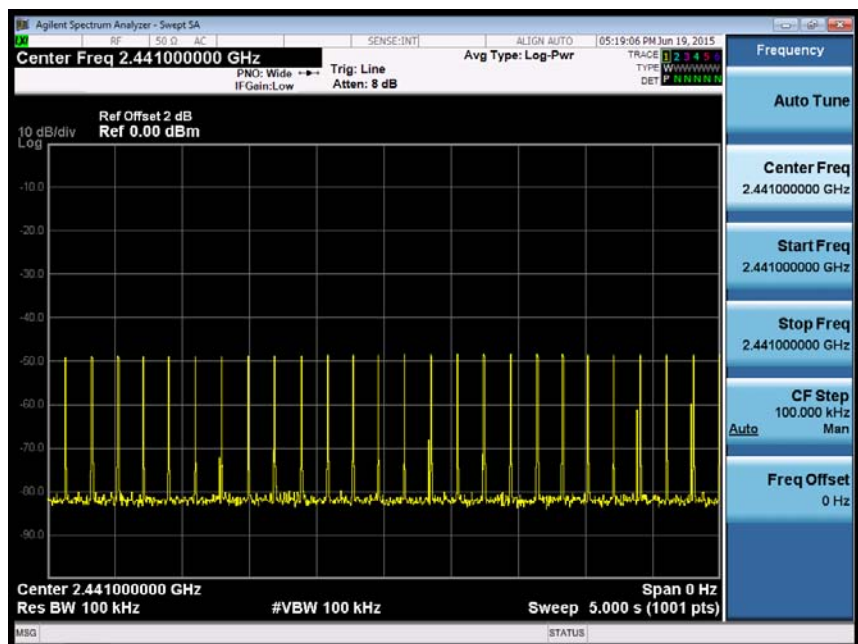
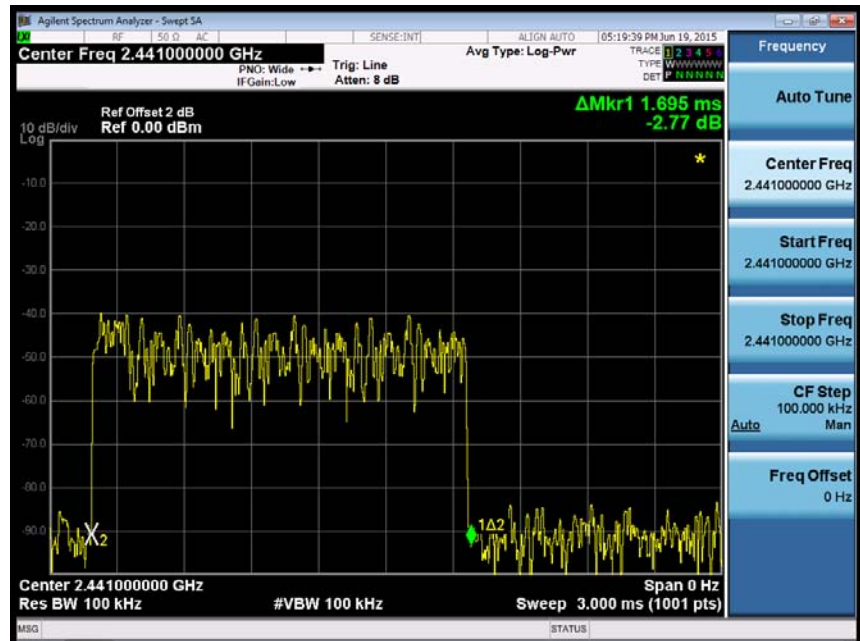
Mode 4: 8DPSK Link Mode

3-DH1



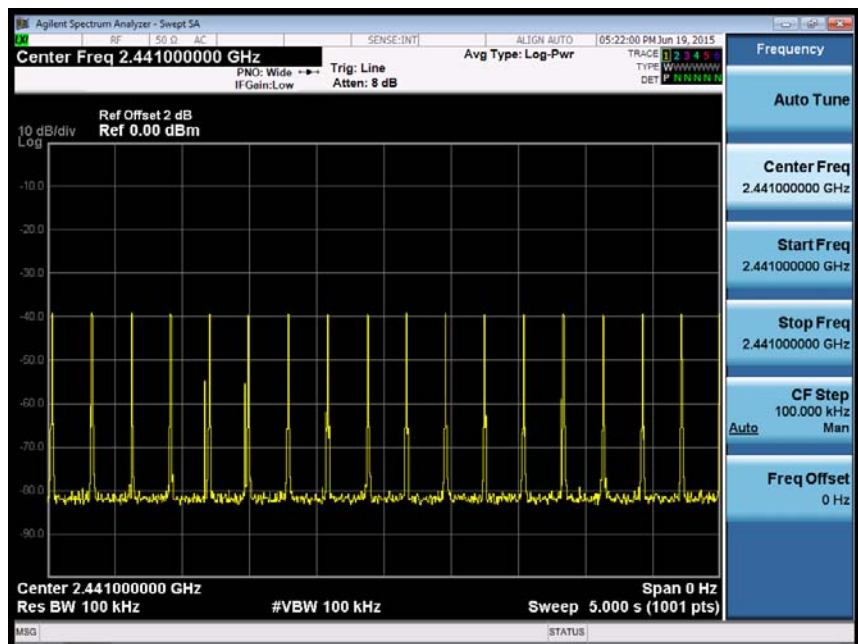
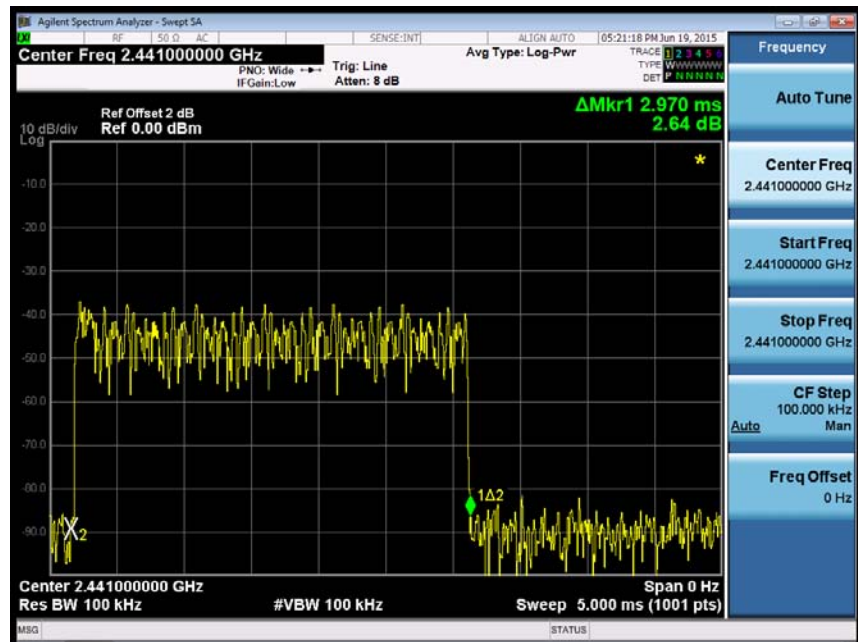
Mode 4: 8DPSK Link Mode

3-DH3



Mode 4: 8DPSK Link Mode

3-DH5

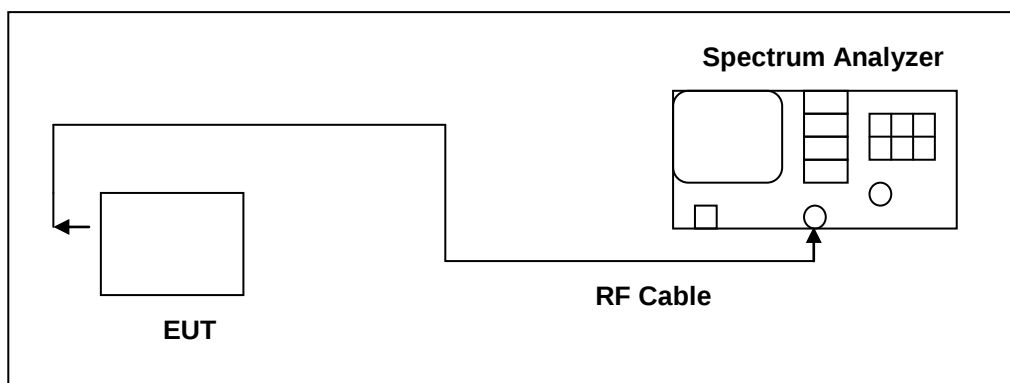


## 11 Out of Band Conducted Emissions Measurement

### 11.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

### 11.2 Test Setup



### 11.3 Test Instruments

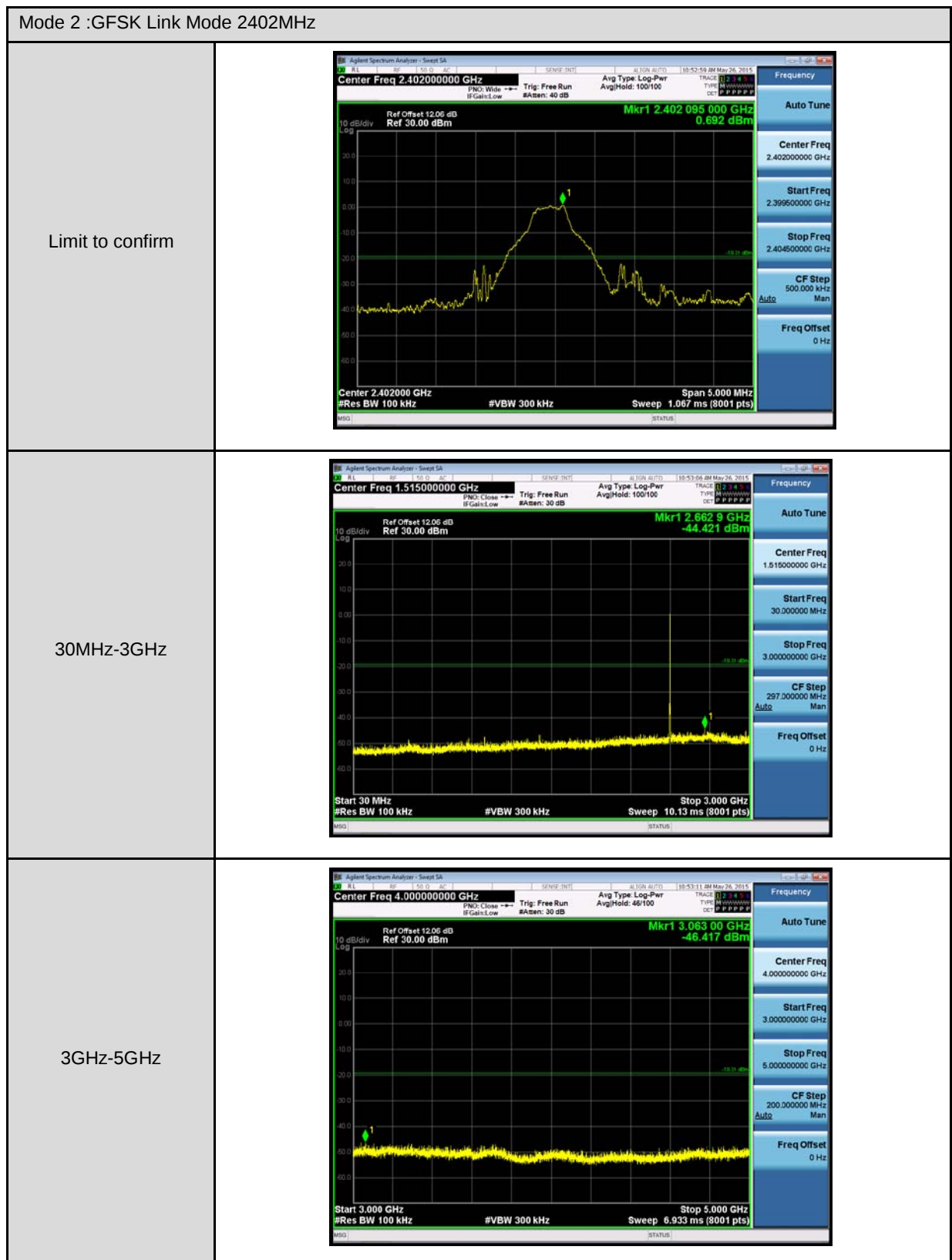
| Equipment         | Manufacturer | Model Number | Serial Number | Cal. Date  | Remark  |
|-------------------|--------------|--------------|---------------|------------|---------|
| Spectrum Analyzer | Agilent      | N9039A       | MY46520256    | 01/10/2015 | 2 Years |
| Test Site         | ATL          | TE02         | TE02          | N.C.R.     | -----   |

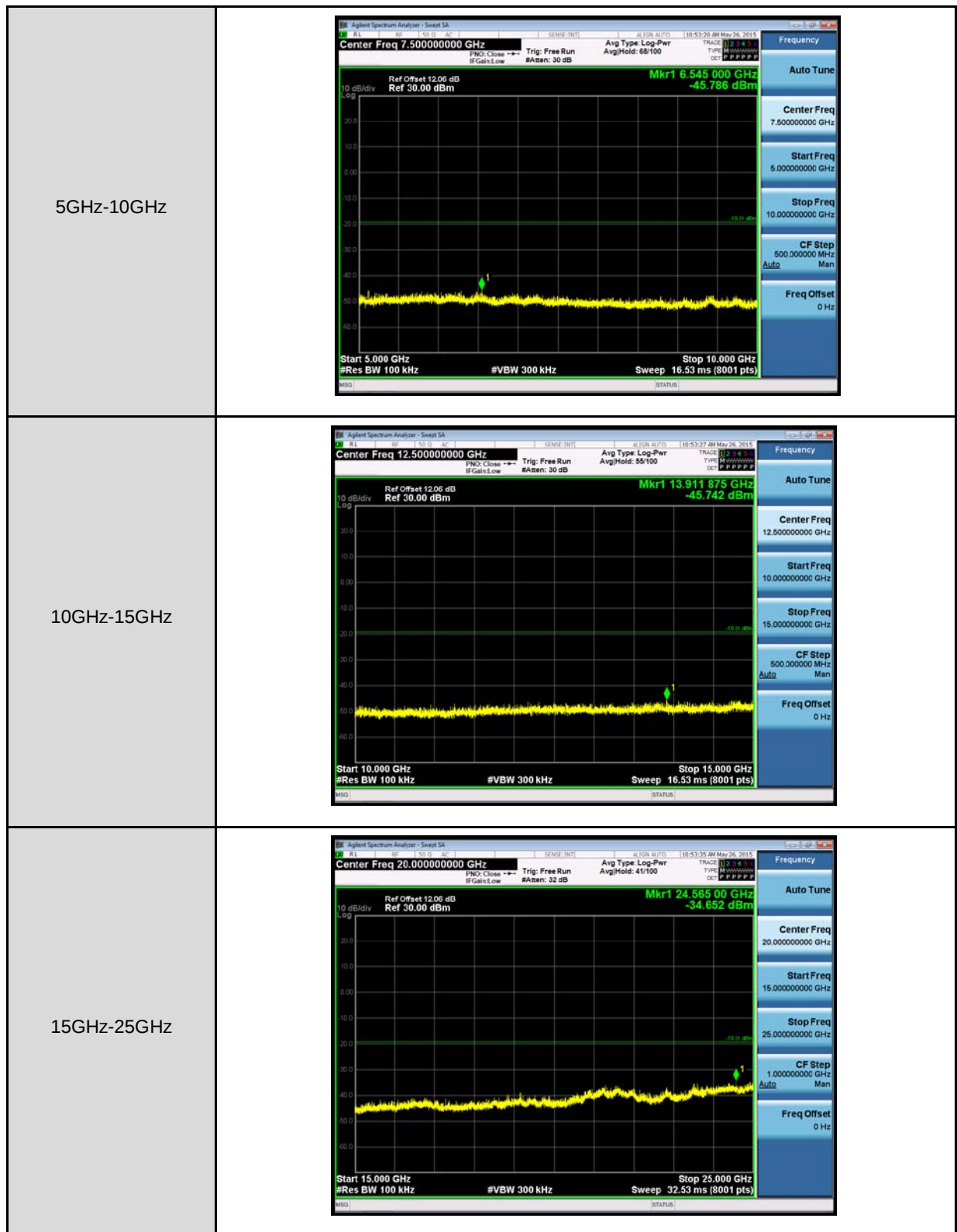
### 11.4 Test Procedure

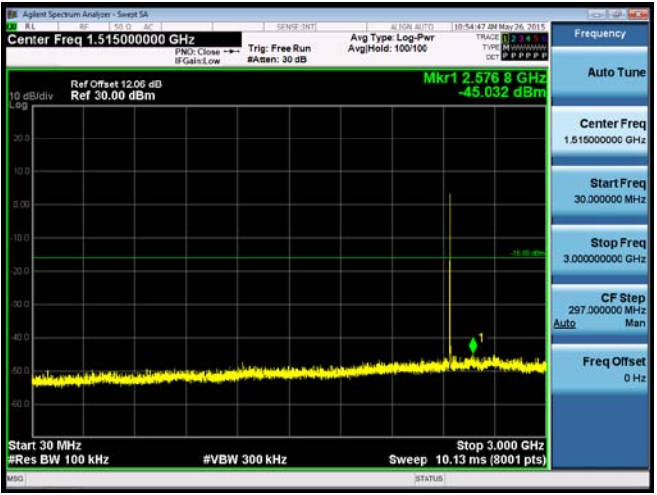
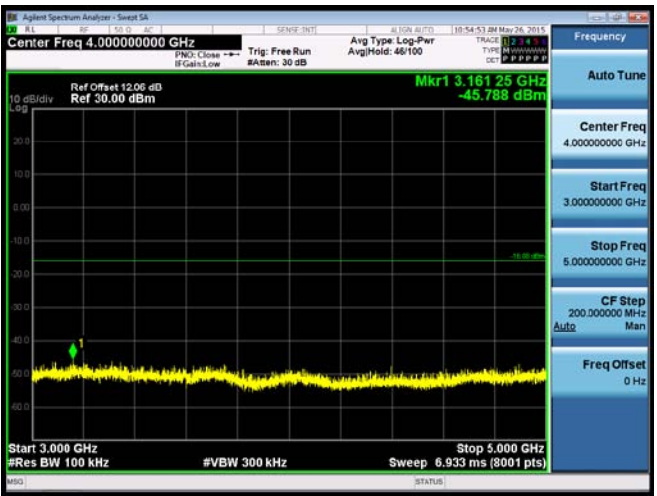
Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. In any 100 kHz bandwidth outside the EUT pass band, the RF power produced by the modulation products of the spreading sequence, the information sequence, and the carrier frequency shall be at least 20 dB below that of the maximum in-band 100 kHz emission, antenna output of the EUT was coupled directly to spectrum analyzer; if an external attenuator and/or cable was used, these losses are compensated for with the analyzer OFFSET function.

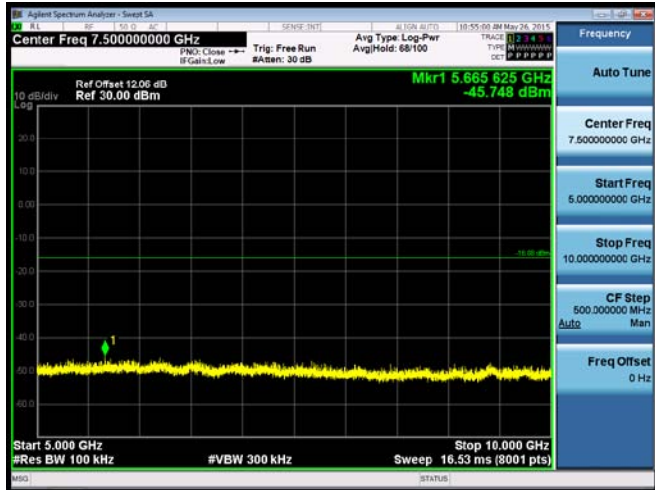
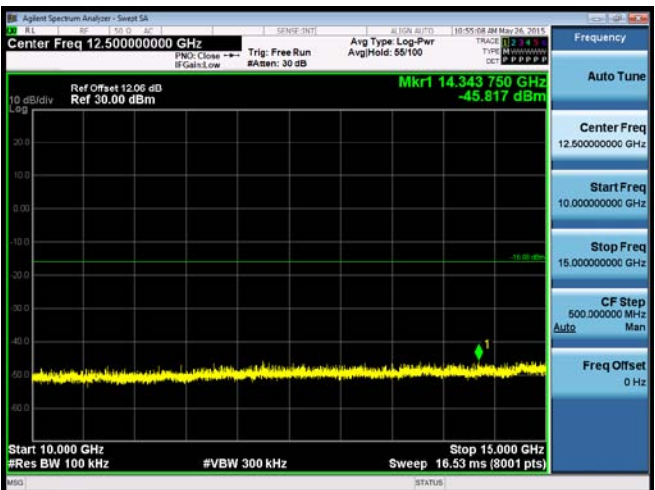
All other types of emissions from the EUT shall meet the general limits for radiated frequencies outside the pass band. The test was performed at 3 channels (Channel 0, 39, 78)

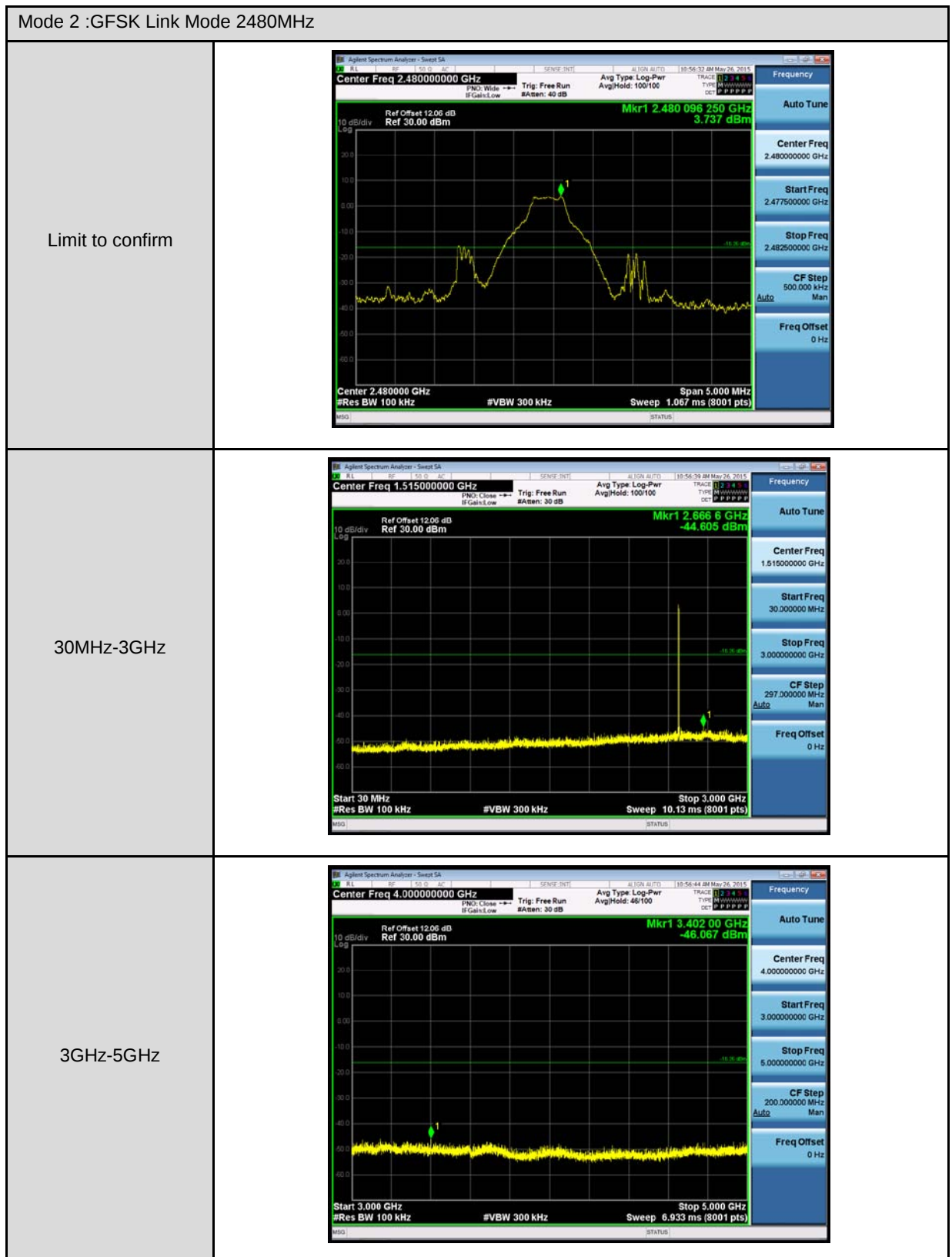
## 11.5 Test Graphs

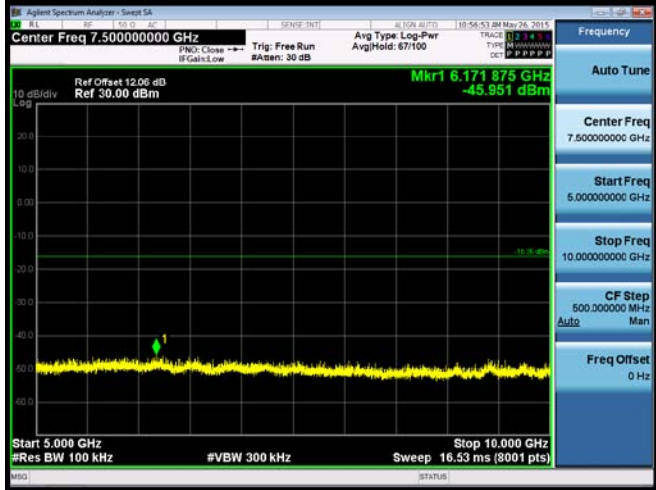
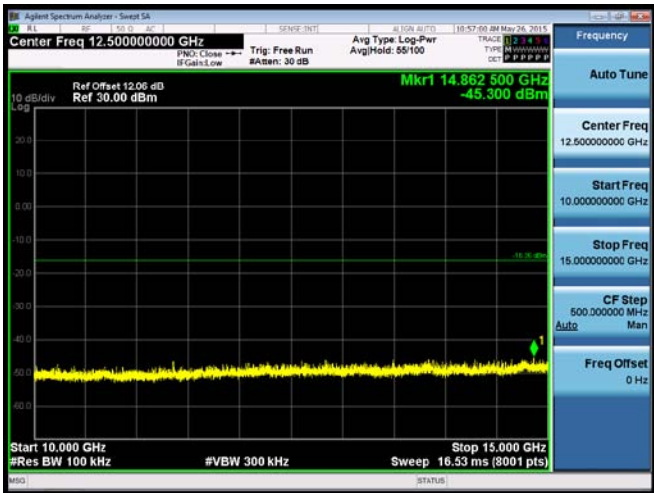


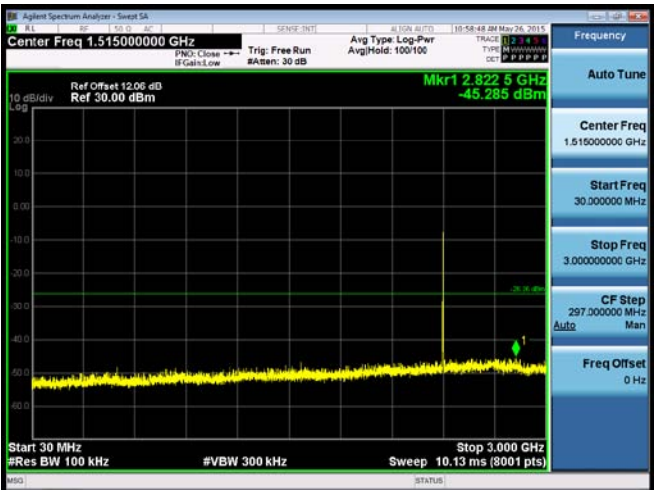
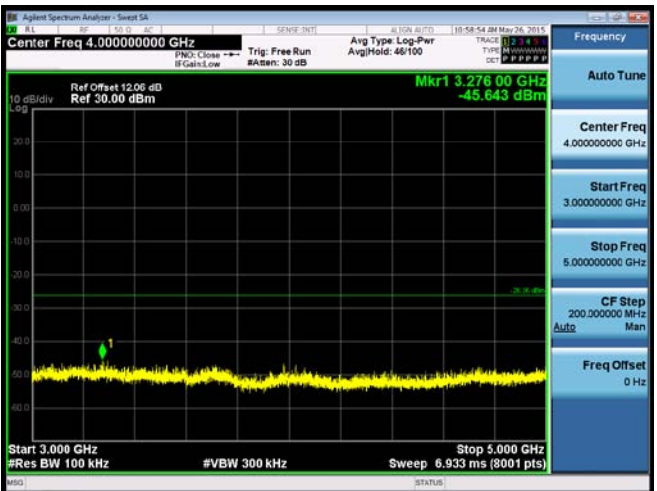


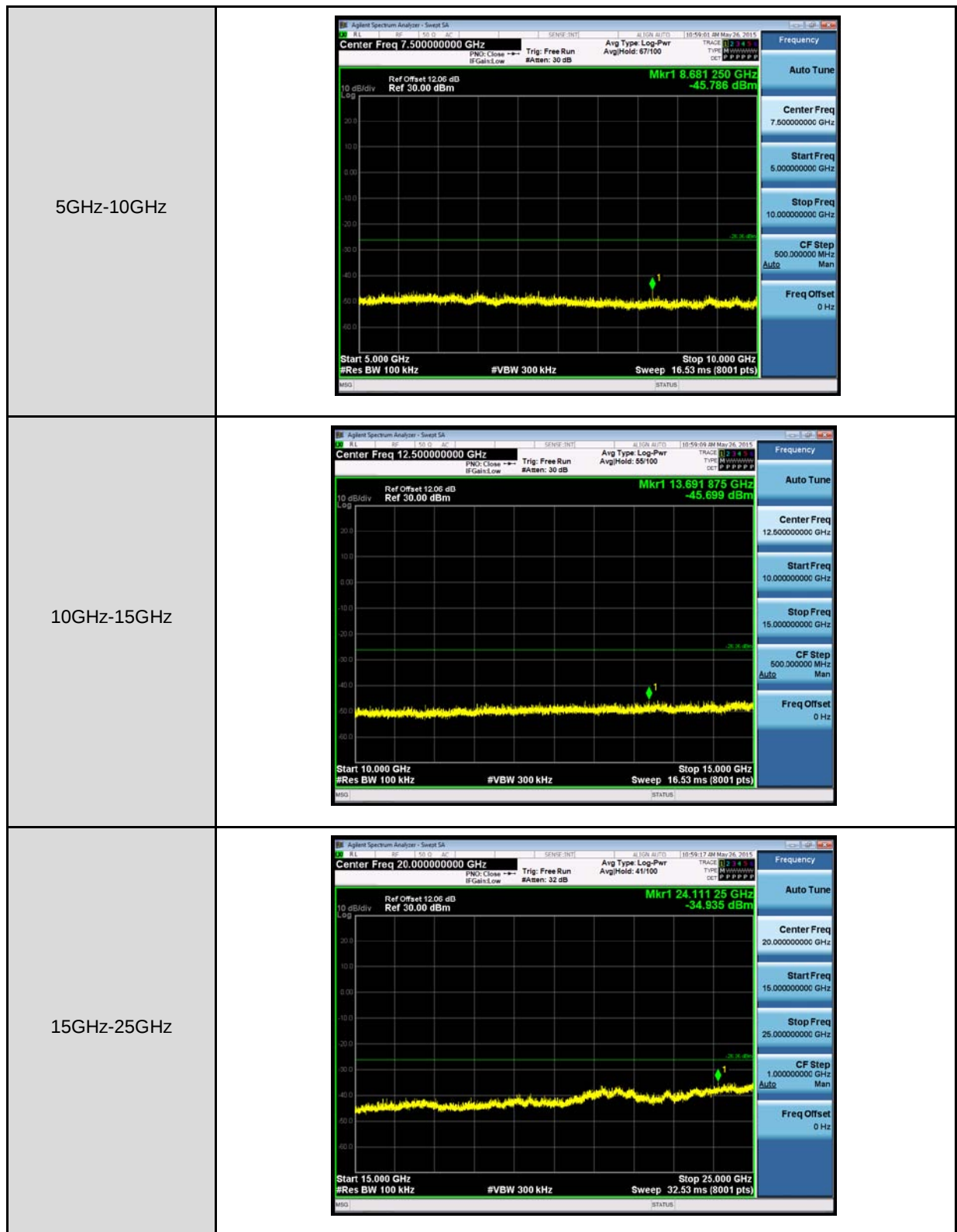
|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mode 2 :GFSK Link Mode 2441MHz |  <p>Agilent Spectrum Analyzer - Sweep SA</p> <p>Center Freq 2.441000000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Mkr1 2.440 933 125 GHz<br/>-3.924 dBm</p> <p>Center 2.441000 GHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Sweep 1.067 ms (8001 pts)</p> <p>Span 5.000 MHz</p> <p>Frequency</p> <p>Auto Tune</p> <p>Center Freq<br/>2.441000000 GHz</p> <p>Start Freq<br/>2.438500000 GHz</p> <p>Stop Freq<br/>2.443500000 GHz</p> <p>CF Step<br/>500.000 kHz<br/>Auto Man</p> <p>Freq Offset<br/>0 Hz</p> |
| 30MHz-3GHz                     |  <p>Agilent Spectrum Analyzer - Sweep SA</p> <p>Center Freq 1.515000000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Mkr1 1.515 768 GHz<br/>-45.032 dBm</p> <p>Start 30 MHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Sweep 10.13 ms (8001 pts)</p> <p>Stop 3.000 GHz</p> <p>Frequency</p> <p>Auto Tune</p> <p>Center Freq<br/>1.515000000 GHz</p> <p>Start Freq<br/>30.000000 MHz</p> <p>Stop Freq<br/>3.000000000 GHz</p> <p>CF Step<br/>297.000000 MHz<br/>Auto Man</p> <p>Freq Offset<br/>0 Hz</p>         |
| 3GHz-5GHz                      |  <p>Agilent Spectrum Analyzer - Sweep SA</p> <p>Center Freq 4.000000000 GHz</p> <p>Ref Offset 12.06 dB<br/>Ref 30.00 dBm</p> <p>Mkr1 3.161 25 GHz<br/>-45.788 dBm</p> <p>Start 3.000 GHz<br/>#Res BW 100 kHz<br/>#VBW 300 kHz<br/>Sweep 6.933 ms (8001 pts)</p> <p>Stop 5.000 GHz</p> <p>Frequency</p> <p>Auto Tune</p> <p>Center Freq<br/>4.000000000 GHz</p> <p>Start Freq<br/>3.000000000 GHz</p> <p>Stop Freq<br/>5.000000000 GHz</p> <p>CF Step<br/>200.000000 MHz<br/>Auto Man</p> <p>Freq Offset<br/>0 Hz</p>    |

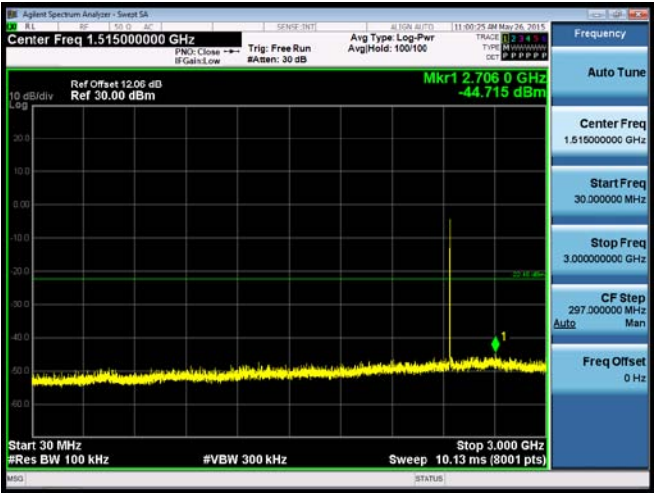
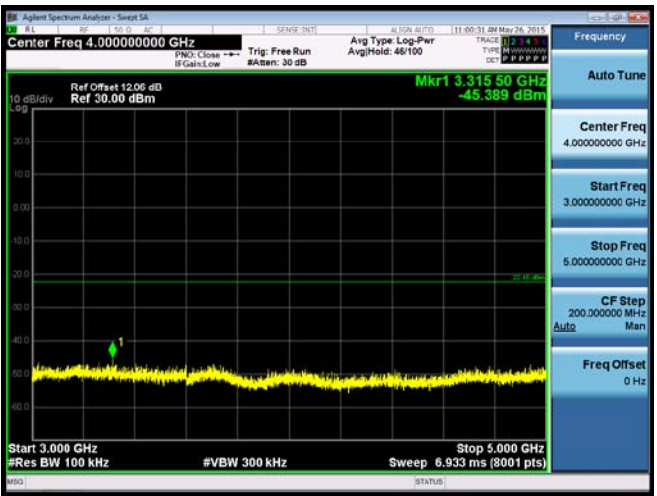
|                    |                                                                                      |
|--------------------|--------------------------------------------------------------------------------------|
| <p>5GHz-10GHz</p>  |    |
| <p>10GHz-15GHz</p> |   |
| <p>15GHz-25GHz</p> |  |

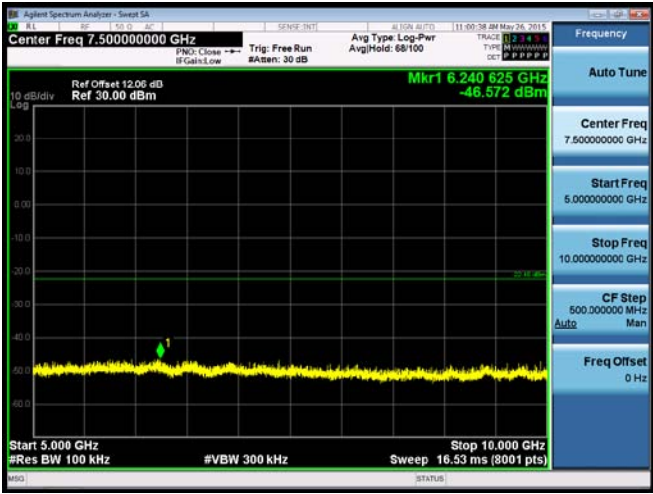
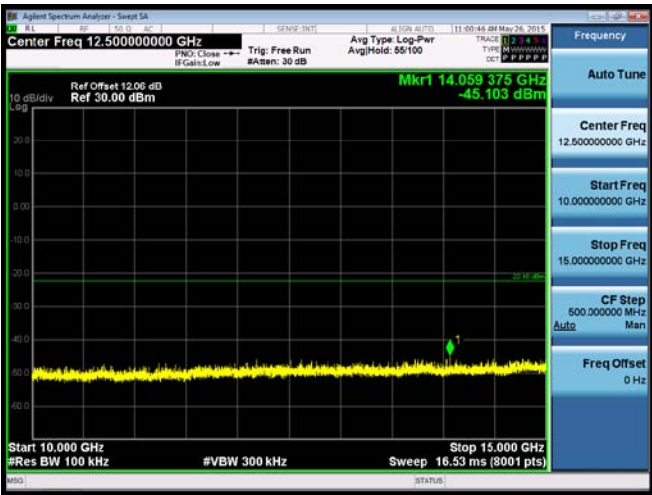


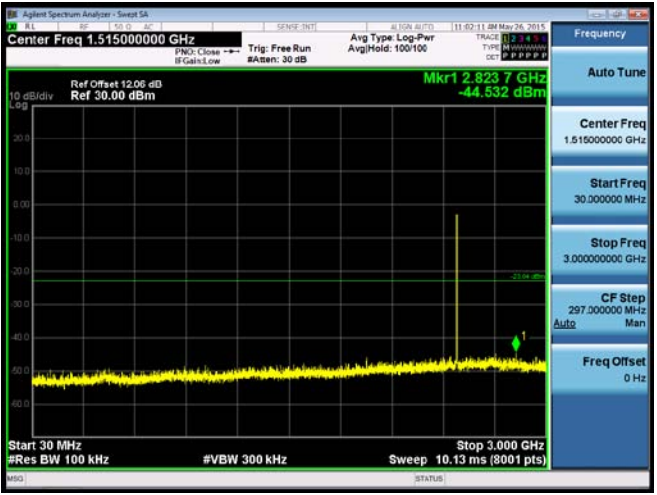
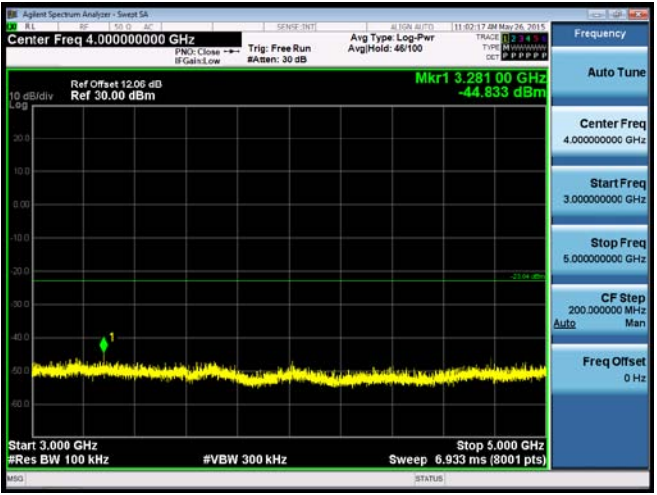
|                    |                                                                                      |
|--------------------|--------------------------------------------------------------------------------------|
| <p>5GHz-10GHz</p>  |    |
| <p>10GHz-15GHz</p> |   |
| <p>15GHz-25GHz</p> |  |

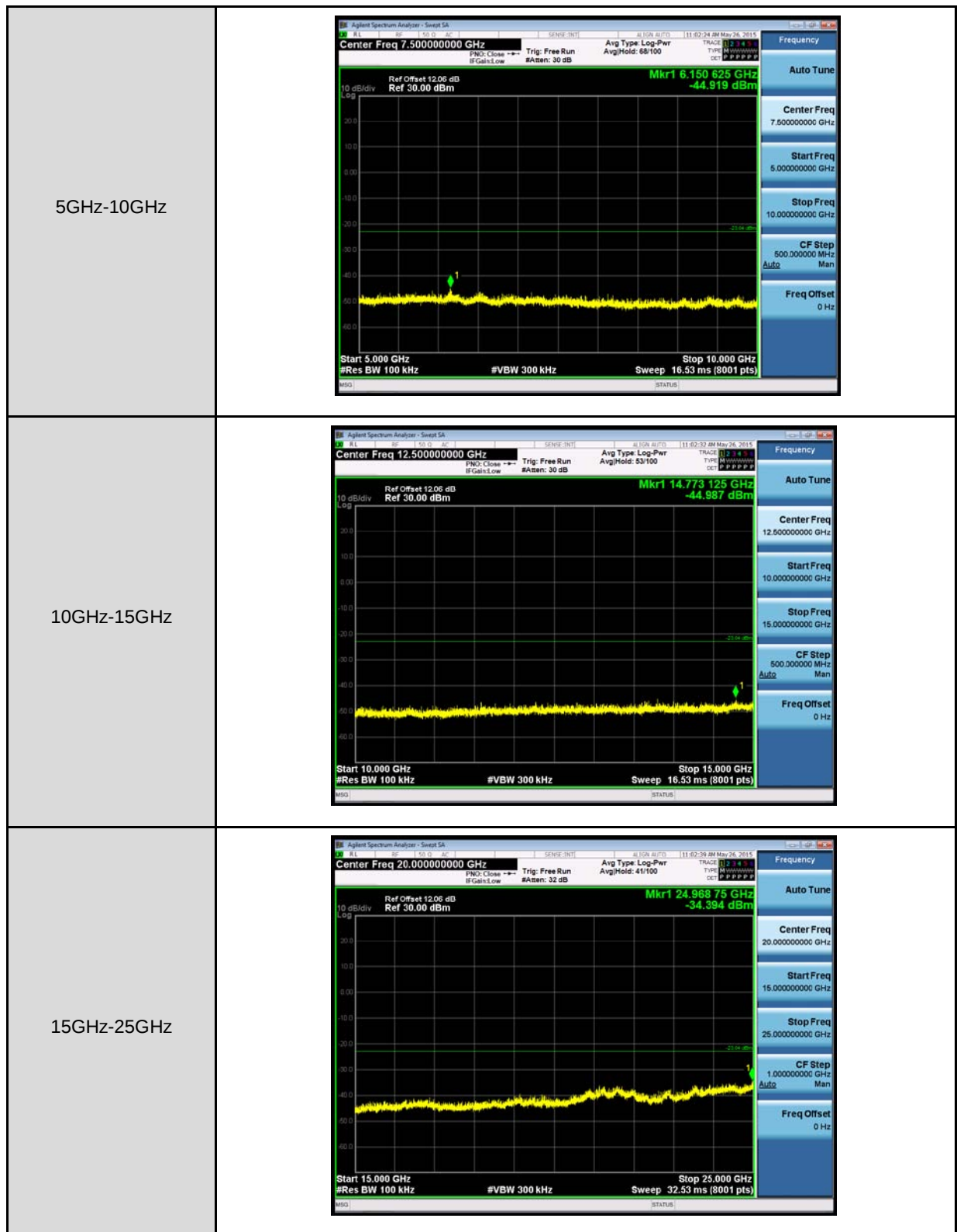
| Mode 4 :8DPSK Link Mode 2402MHz |                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------|
| Limit to confirm                |    |
| 30MHz-3GHz                      |   |
| 3GHz-5GHz                       |  |



|                                 |                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------|
| Mode 4 :8DPSK Link Mode 2441MHz |    |
| 30MHz-3GHz                      |   |
| 3GHz-5GHz                       |  |

|             |                                                                                      |
|-------------|--------------------------------------------------------------------------------------|
| 5GHz-10GHz  |    |
| 10GHz-15GHz |   |
| 15GHz-25GHz |  |

| Mode 4 :8DPSK Link Mode 2480MHz |                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------|
| Limit to confirm                |    |
| 30MHz-3GHz                      |   |
| 3GHz-5GHz                       |  |



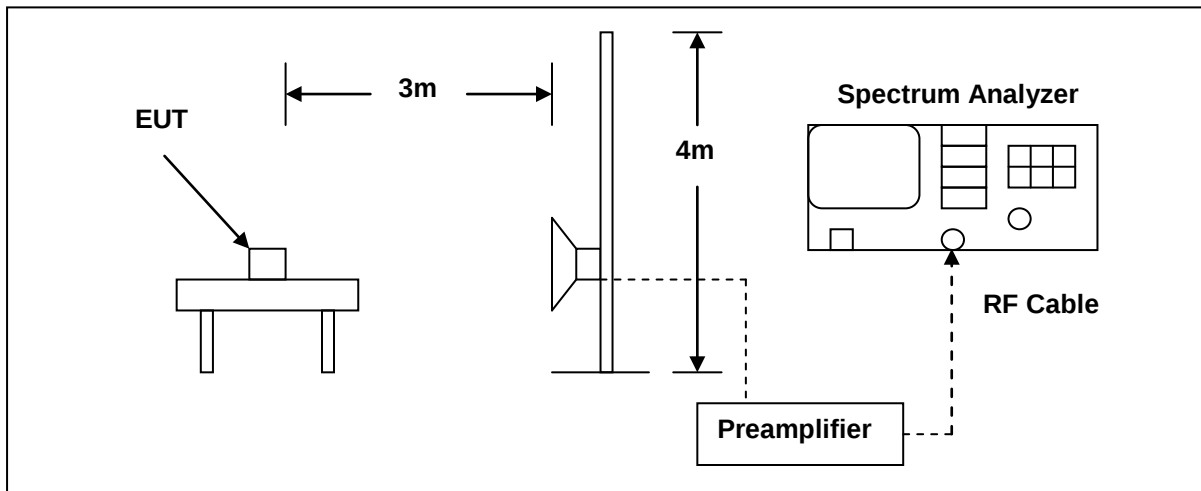
Note: No emission found between lowest internal used/generated frequencies to 30MHz (9 kHz~30MHz).

## 12 Band Edges Measurement

### 12.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

### 12.2 Test Setup



### 12.3 Test Instruments

| 3 Meter Chamber |                          |                    |               |              |         |
|-----------------|--------------------------|--------------------|---------------|--------------|---------|
| Model No.       | Equipment                | Manufacturer       | Serial Number | Cal. Date    | Remark  |
| ESU40           | EMI Test Receiver        | R&S                | SB8501/09     | May.16, 2015 | 1 Year  |
| VULB9163        | Bilog Antenna            | Schwarzbeck        | SB8501/04     | Jan.20, 2015 | 1 Year  |
| HF906           | Horn Antenna             | R&S                | SB3435        | Jan.20, 2015 | 1 Year  |
| --              | Amplifier(1-18GHz)       | R&S                | SB3435/01     | Jan.20, 2015 | 1 Year  |
| --              | Amplifier(18-40GHz)      | R&S                | SB3435/02     | May.16, 2015 | 1 Year  |
| AT4560          | Horn Antenna             | Amplifier Research | SB5392/02     | May.16, 2015 | 1 Year  |
| 9X6X6           | 3m Semi-anechoic chamber | Albatross Projects | SB3450/01     | Oct.12, 2013 | 2 Years |
| ESI26           | EMI Test Receiver        | Rohde & Schwarz    | SB3436        | Jan.20,2015  | 1 Year  |
| VULB9163        | Broadband antenna        | SCHWARZBECK        | SB3955        | Jan.20,2015  | 1 Year  |

|                   |              |        |            |              |         |
|-------------------|--------------|--------|------------|--------------|---------|
| HF907             | Horn Antenna | R&S    | SB8501/01  | Aug.15,2014  | 1 Year  |
| Spectrum Analyzer | Agilent      | N9039A | MY46520256 | Jan.10, 2015 | 2 Years |

## 12.4 Test Procedure

Testing must be done according to this procedure, FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. This is the only method recognized by the FCC. The emissions on the harmonics frequencies, the limits, and the margin of compliance are presented. These tests were made when the transmitter was in full radiated power. The additional test was performed to show compliance with the requirement at the band-edge frequency 2483.5 MHz and up to 2500 MHz and at 2390.0 MHz

The transmitter was configured with the worst case antenna and setup to transmit at the highest channel. Then the field strength was measured at 2483.5 MHz

The transmitter was then configured with the worst case antenna and setup to transmit at the lowest channel. Then the field strength was measured at 2390.0 MHz these tests were performed at 4 different bit rates.

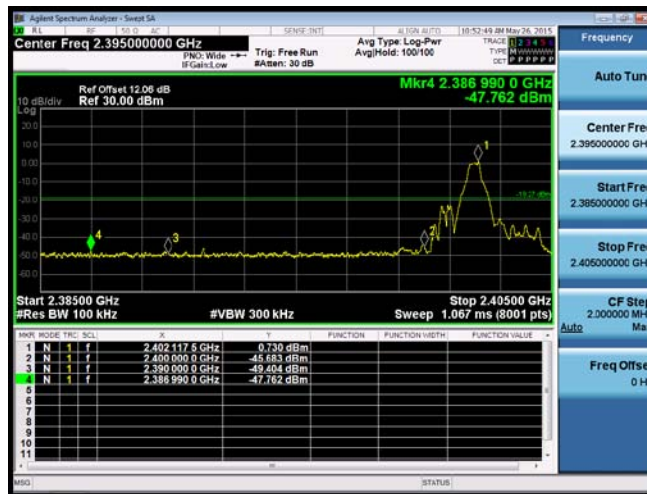
For measurements the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

## 12.5 Test Result

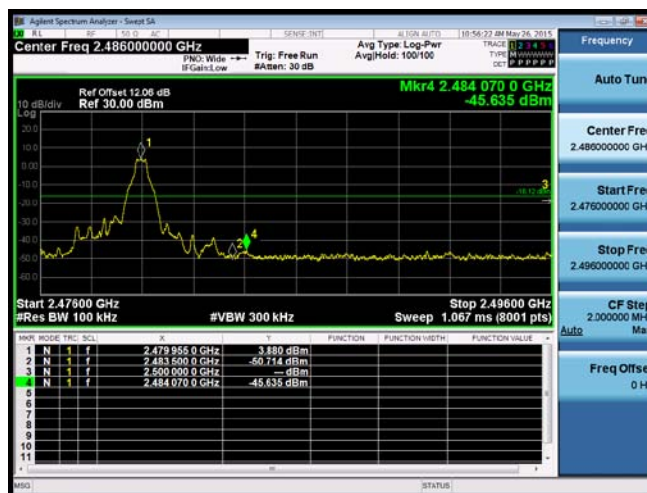
### Conducted Band Edge

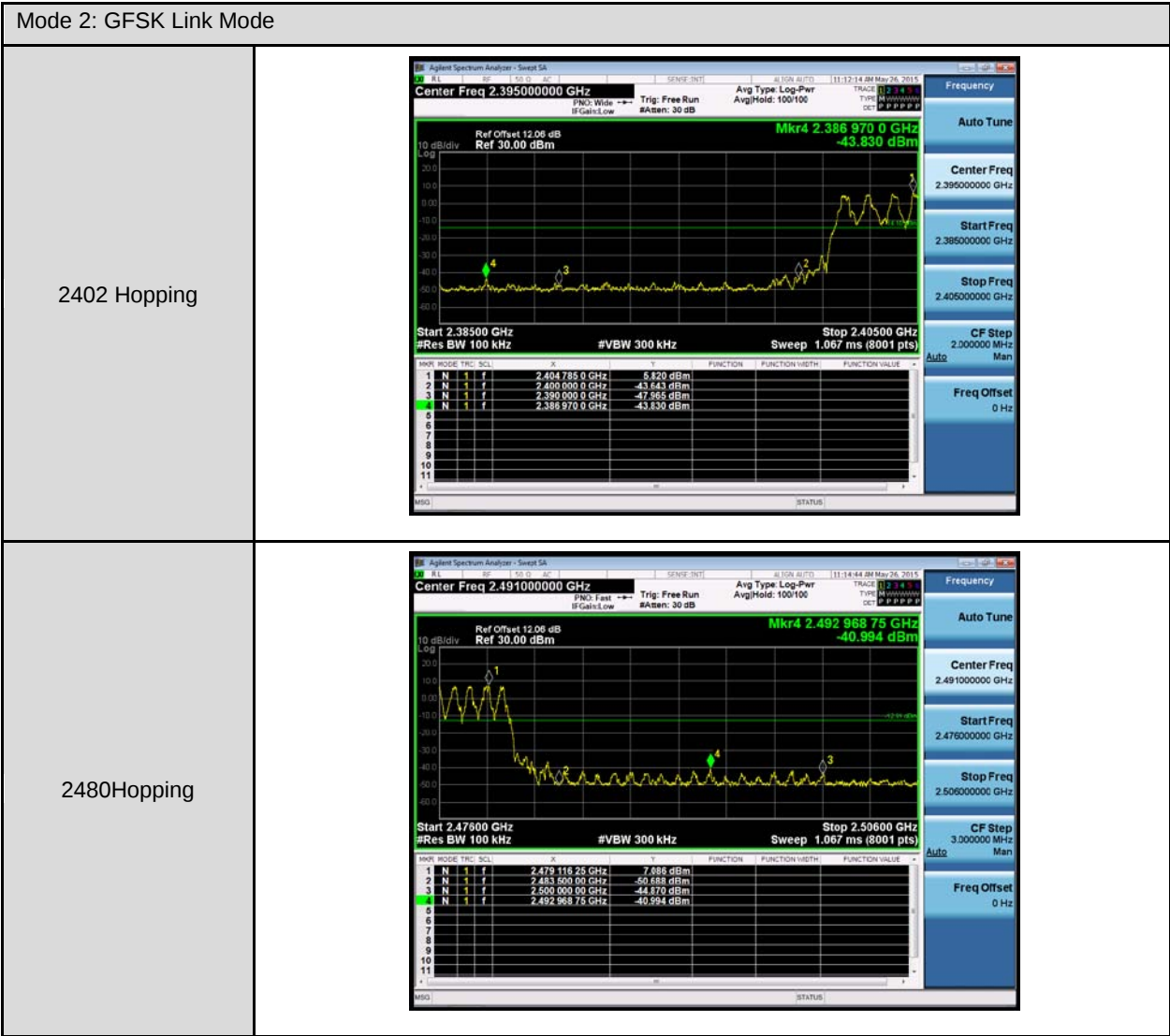
Mode 2: GFSK Link Mode

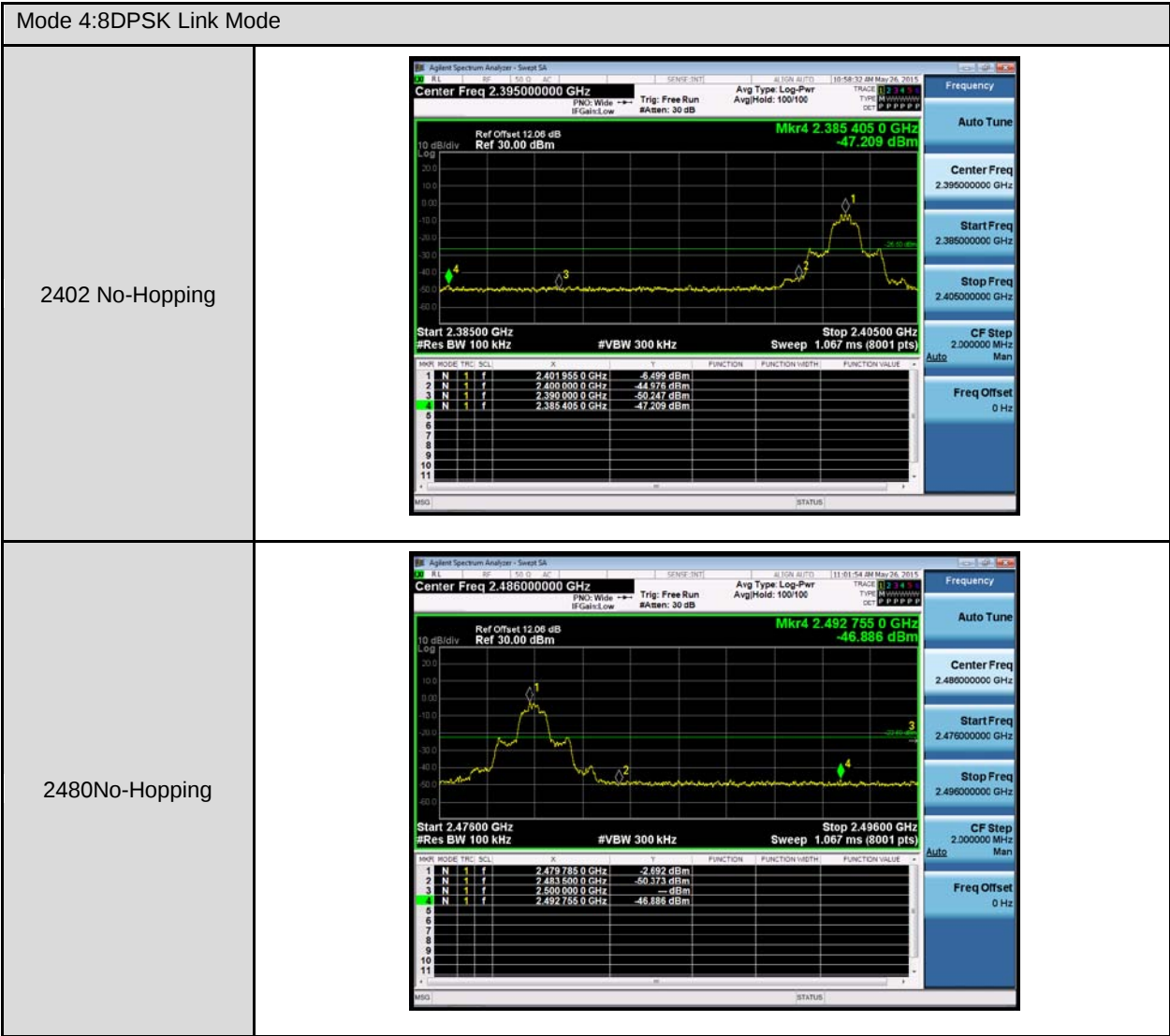
2402 No-Hopping

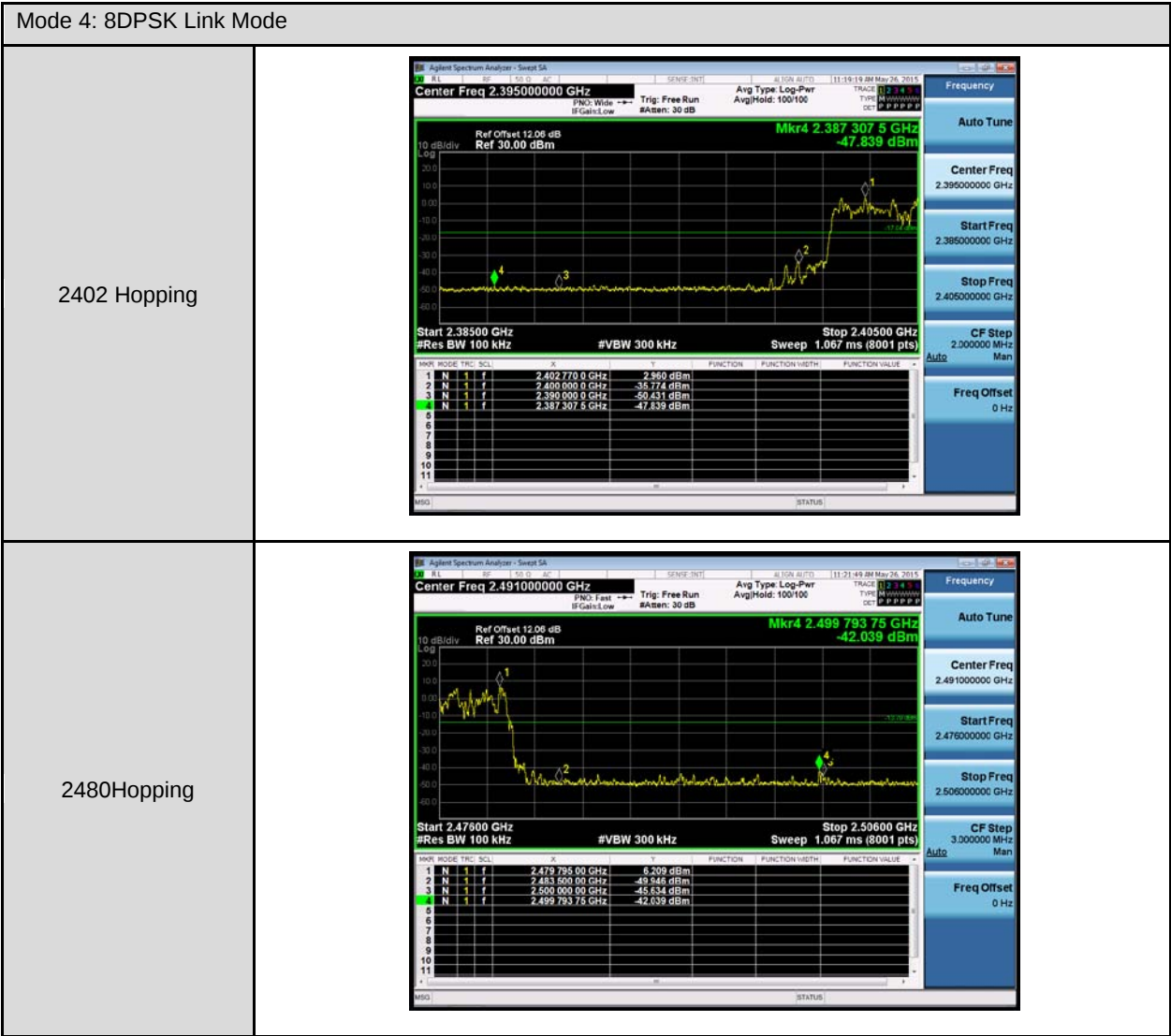


2480No-Hopping

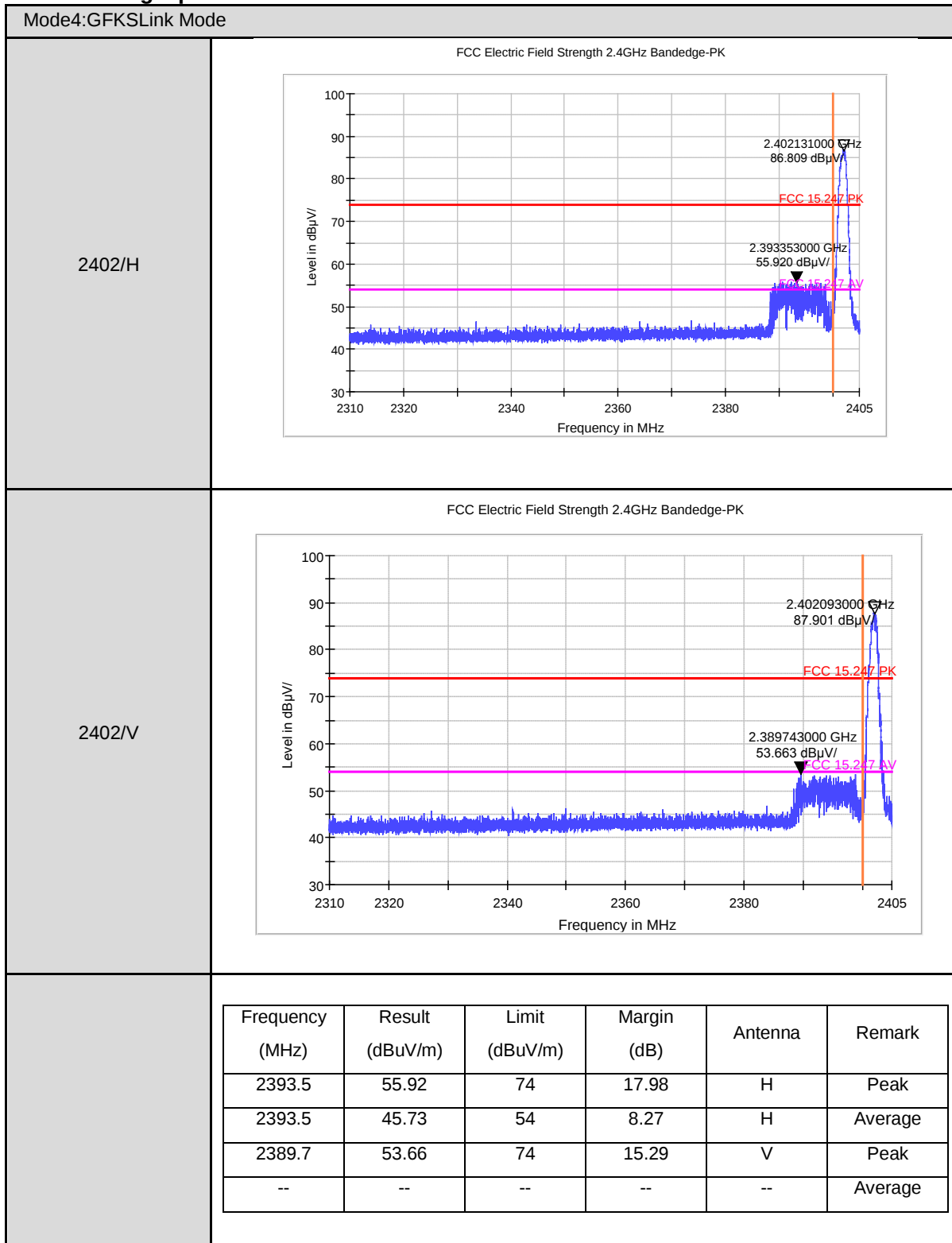






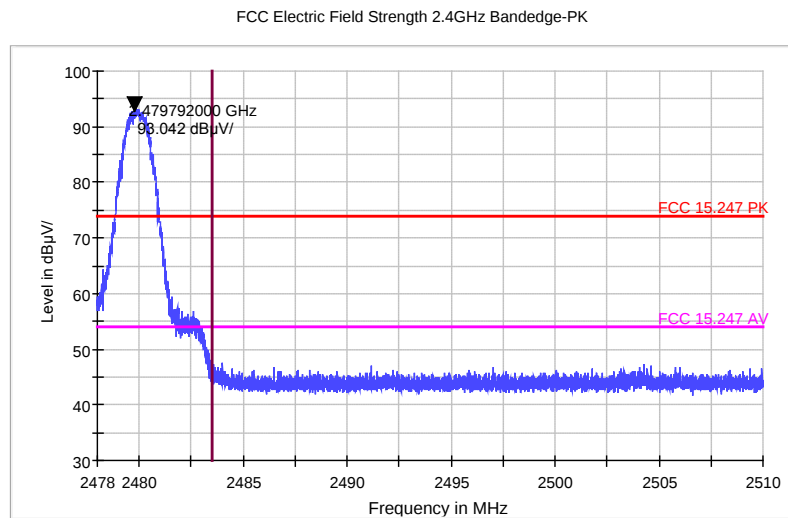


## Radiated Band EdgespuriousEmission

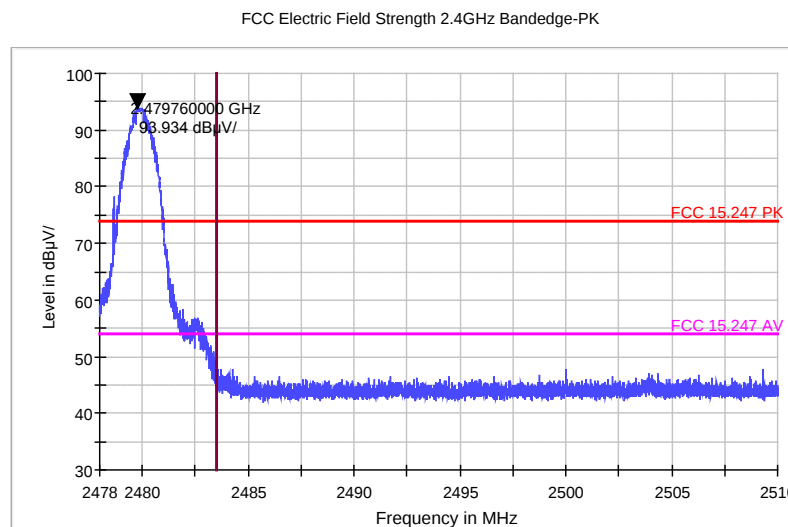


Mode4:GFKSLink Mode

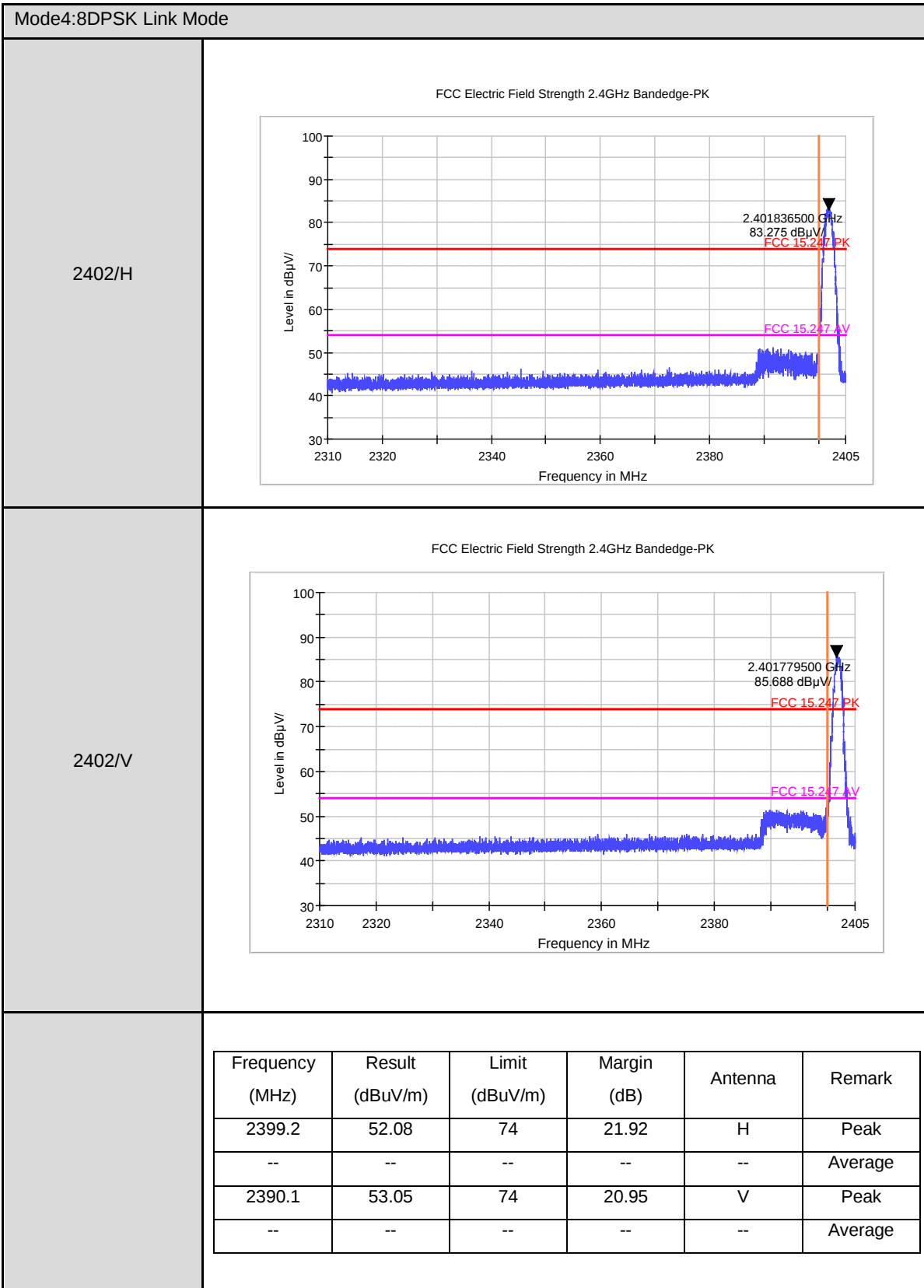
2480/H

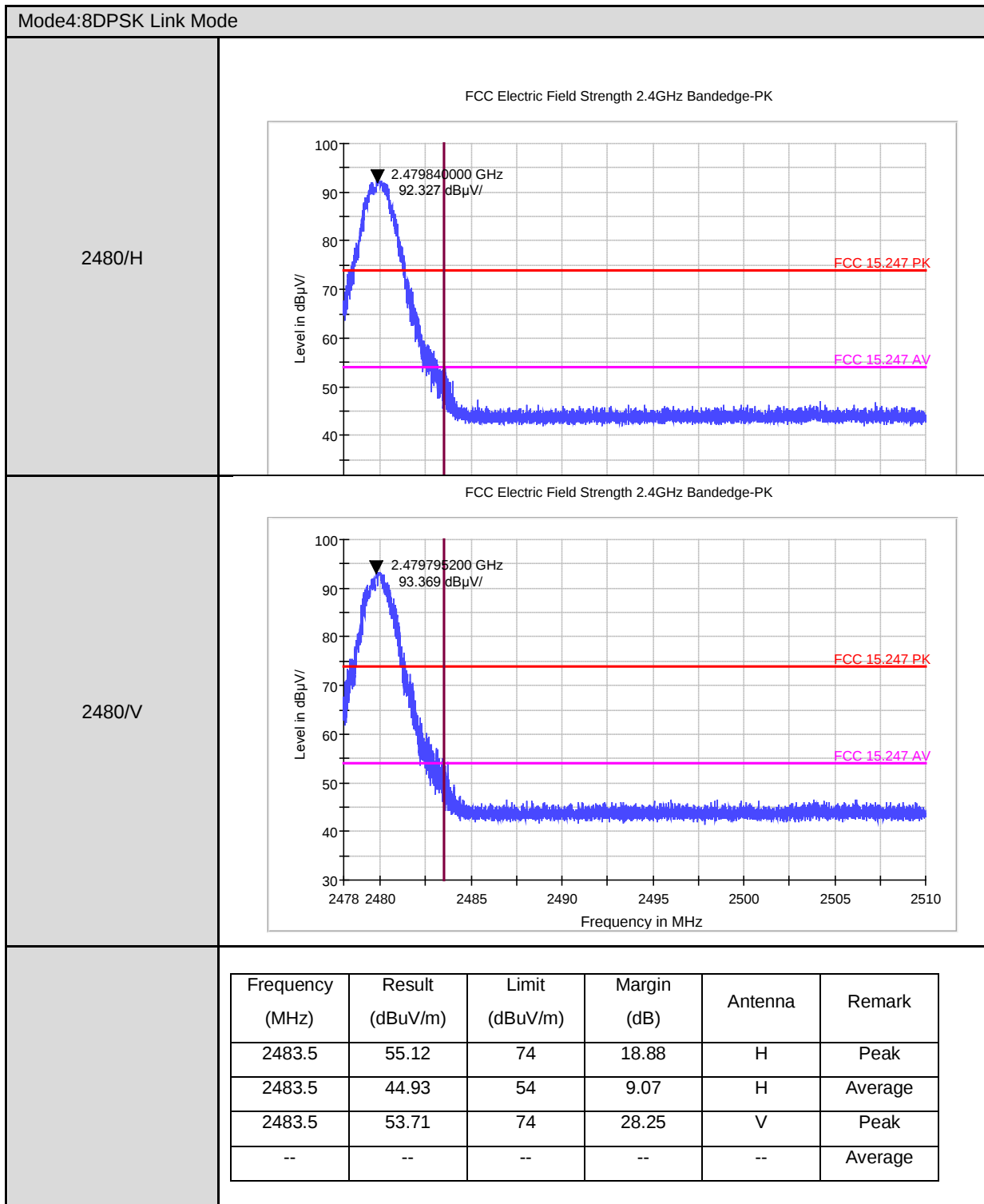


2480/V



| Frequency (MHz) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna | Remark  |
|-----------------|-----------------|----------------|-------------|---------|---------|
| 2483.5          | 51.22           | 74             | 22.78       | H       | Peak    |
| --              | --              | --             | --          | --      | Average |
| 2483.5          | 49.92           | 74             | 24.08       | V       | Peak    |
| --              | --              | --             | --          | --      | Average |





## **13 Antenna Measurement**

### **13.1 Limit**

For intentional device, according to 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 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

### **13.2 AntennaConnector Construction**

The antenna used in this product is internal PCB antenna. And the maximum Gain of this antenna is 0.5dBi.

-----The End-----