

# TEST REPORT



**DT&C Co., Ltd.**

42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042  
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1612-0160

2. Customer

• Name : Sena Technologies, Inc.

• Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea

3. Use of Report : FCC & IC Original Grant

4. Product Name / Model Name : Bluetooth Serial Adapter / IW07

FCC ID / IC : S7A-IW07 / 8154A-IW07

5. Test Method Used : FCC Part 15 Subpart C.247

RSS-247 Issue 1 (2015-05), RSS-GEN Issue 4 (2014-11)

6. Date of Test : 2016-10-21 ~ 2016-11-01

7. Testing Environment : See appended Test Report.

8. Test Result : Refer to the attached Test Result.

|             |                                  |                                   |
|-------------|----------------------------------|-----------------------------------|
| Affirmation | Tested by                        | Technical Manager                 |
|             | Name : Jaejin Lee<br>(Signature) | Name : Wonjung Lee<br>(Signature) |

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

2016 . 12 . 09 .

**DT&C Co., Ltd.**

If this report is required to confirmation of authenticity, please contact to [report@dtnc.net](mailto:report@dtnc.net)

## Test Report Version

| Test Report No. | Date          | Description   |
|-----------------|---------------|---------------|
| DRTFCC1612-0160 | Dec. 09, 2016 | Initial issue |
|                 |               |               |
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## 1. General Information

### 1.1 Testing Laboratory

| DT&C Co., Ltd.                                 |                                             |                                                                                     |
|------------------------------------------------|---------------------------------------------|-------------------------------------------------------------------------------------|
| Standard                                       | Site number                                 | Address                                                                             |
| FCC                                            | <input checked="" type="checkbox"/> 165783  | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 804488             | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 596748             | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 678747             | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| IC                                             | <input checked="" type="checkbox"/> 5740A-3 | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 5740A-2            | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| <a href="http://www.dtnc.net">www.dtnc.net</a> |                                             |                                                                                     |
| Telephone                                      | :                                           | + 82-31-321-2664                                                                    |
| FAX                                            | :                                           | + 82-31-321-1664                                                                    |

### 1.2 Details of Applicant

Applicant : Sena Technologies, Inc.  
 Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea  
 Contact person : Seunghyun Kim

### 1.3 Description of EUT

|                             |                            |               |
|-----------------------------|----------------------------|---------------|
| <b>EUT</b>                  | Bluetooth Serial Adapter   |               |
| <b>Model Name</b>           | IW07                       |               |
| <b>Add Model Name</b>       | NA                         |               |
| <b>Serial Number</b>        | Identical prototype        |               |
| <b>Hardware version</b>     | 2.1                        |               |
| <b>Software version</b>     | 2.0.X                      |               |
| <b>Power Supply</b>         | DC 3.7 V                   |               |
| <b>Frequency Range</b>      | 2402 MHz ~ 2480 MHz        |               |
| <b>Modulation Technique</b> | GFSK, $\pi/4$ DQPSK, 8DPSK |               |
| <b>Number of Channels</b>   | 79                         |               |
| <b>Antenna Type</b>         | Dipole Antenna             |               |
| <b>Antenna Gain</b>         | M/N: R-AN2400-1901RS       | PK : 5.70 dBi |
|                             | M/N: R-AN2400-5801RS       | PK : 3.17 dBi |
|                             | M/N: AN2400-3306RS         | PK : 1.70 dBi |

### 1.4 Declaration by the applicant / manufacturer

- NA

## 1.5 Information about the FHSS characteristics

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following :
  - A) The hopping sequence is pseudorandom
  - B) All channels are used equally on average
  - C) The receiver input bandwidth equals the transmit bandwidth
  - D) The receiver hops in sequence with the transmit signal
- 15.247(g) : In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
- 15.247(h) : In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection / hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
- 15.247(h) : The EUT employs Adaptive Frequency Hopping (AFH) which identifies sources of interference namely devices operating in 802.11 WLAN and excludes them from the list of available channels. The process of re-mapping reduces the number of test channels from 79 channels to a minimum number of 20 channels.

## 1.6 Test conditions

| Ambient Condition   |                 |
|---------------------|-----------------|
| ▪ Temperature       | +20 °C ~ +23 °C |
| ▪ Relative Humidity | 43 % ~ 50 %     |

## 1.7 Measurement Uncertainty

| Test items                                  | Measurement uncertainty                             |
|---------------------------------------------|-----------------------------------------------------|
| Transmitter Output Power                    | 0.94 dB (The confidence level is about 95 %, k = 2) |
| Conducted spurious emission                 | 0.99 dB (The confidence level is about 95 %, k = 2) |
| AC conducted emission                       | 2.4 dB (The confidence level is about 95 %, k = 2)  |
| Radiated spurious emission (1 GHz Below)    | 5.1 dB (The confidence level is about 95 %, k = 2)  |
| Radiated spurious emission (1 GHz ~ 18 GHz) | 5.4 dB (The confidence level is about 95 %, k = 2)  |
| Radiated spurious emission (18 GHz Above)   | 5.3 dB (The confidence level is about 95 %, k = 2)  |

## 1.8 Test Equipment List

| Type                                | Manufacturer         | Model                       | Cal.Date<br>(yy/mm/dd) | Next.Cal.Date<br>(yy/mm/dd) | S/N                 |
|-------------------------------------|----------------------|-----------------------------|------------------------|-----------------------------|---------------------|
| MXA Signal Analyzer                 | Agilent Technologies | N9020A                      | 16/01/06               | 17/01/06                    | MY46471172          |
| MXA Signal Analyzer                 | Agilent Technologies | N9020A                      | 16/10/11               | 17/10/11                    | MY46471251          |
| DC Power Supply                     | Agilent Technologies | 66332A                      | 16/09/08               | 17/09/08                    | US37473422          |
| DC Power Supply                     | SM techno            | SDP30-5D                    | 16/01/05               | 17/01/05                    | 305DLJ204           |
| Multimeter                          | FLUKE                | 17B                         | 16/04/21               | 17/04/21                    | 26030065WS          |
| Vector Signal Generator             | R&S                  | SMBV100A                    | 16/01/05               | 17/01/05                    | 255571              |
| Signal Generator                    | R&S                  | SMF100A                     | 16/06/23               | 17/06/23                    | 102341              |
| Power Meter & Wide Bandwidth Sensor | Anritsu              | ML2496A/<br>MA2411B         | 16/06/23               | 17/06/23                    | 1338004/<br>1306053 |
| Thermohygrometer                    | BODYCOM              | BJ5478                      | 16/02/25               | 17/02/25                    | 1209                |
| Loop Antenna                        | Schwarzbeck          | FMZB1513                    | 16/04/22               | 18/04/22                    | 1513-128            |
| Biglog Antenna                      | SCHAFFNER            | CBL6112B                    | 14/12/10               | 16/12/10                    | 2737                |
| Horn Antenna                        | ETS                  | 3117                        | 16/05/03               | 18/05/03                    | 140394              |
| Horn Antenna                        | A.H.Systems.         | SAS-574                     | 15/04/30               | 17/04/30                    | 154                 |
| Low Noise Pre Amplifier             | tsj                  | MLA-010K01-B01-27           | 16/03/10               | 17/03/10                    | 1844539             |
| Amplifier                           | Agilent              | 8449B                       | 16/02/24               | 17/02/24                    | 3008A00370          |
| High-pass filter                    | Wainwright           | WHKX12-2580-3000-18000-80SS | 16/09/09               | 17/09/09                    | 3                   |
| High-pass filter                    | Wainwright           | WHNX6-6320-8000-26500-40CC  | 16/09/13               | 17/09/13                    | 1                   |
| EMI TEST RECEIVER                   | R&S                  | ESR7                        | 16/02/25               | 17/02/25                    | 101061              |
| EMI TEST RECEIVER                   | R&S                  | ESCI                        | 16/02/25               | 17/02/25                    | 100364              |
| SINGLE-PHASE MASTER                 | NF                   | 4420                        | 16/09/08               | 17/09/08                    | 3049354420023       |
| Artificial Mains Network            | Narda S.T.S. / PMM   | PMM L2-16B                  | 16/06/22               | 17/06/22                    | 000WX20305          |

## 1.9 Summary of Test Results

| FCC Part<br>RSS Std.                                                 | Parameter                     | Limit<br>(Using in 2400~ 2483.5 MHz)                                                                                                                                                                                                | Test<br>Condition    | Status<br>Note 1   |
|----------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------|
| 15.247(a)<br>RSS-247(5.1)                                            | Carrier Frequency Separation  | >= 25 kHz or<br>>= Two thirds of the 20 dB BW,<br>whichever is greater.                                                                                                                                                             | Conducted            | C                  |
|                                                                      | Number of Hopping Frequencies | >= 15 hops                                                                                                                                                                                                                          |                      | C                  |
|                                                                      | 20 dB Bandwidth               | N/A                                                                                                                                                                                                                                 |                      | C                  |
|                                                                      | Dwell Time                    | =< 0.4 seconds                                                                                                                                                                                                                      |                      | C                  |
| 15.247(b)<br>RSS-247(5.4)                                            | Transmitter Output Power      | <b>For FCC</b><br>=< 1 Watt , if CHs >= 75<br>Others =< 0.125 W<br><b>For IC</b><br>if CHs >= 75<br>=< 1 Watt For Conducted Power<br>=< 4 Watt For e.i.r.p,<br>Others<br>=< 0.125 W For Conducted Power.<br>=< 0.5 Watt For e.i.r.p |                      | C                  |
| 15.247(d)<br>RSS-247(5.5)                                            | Conducted Spurious Emissions  | The radiated emission to any<br>100 kHz of out-band shall be at<br>least 20 dB below the highest<br>in-band spectral density.                                                                                                       | Radiated             | C                  |
| RSS Gen(6.6)                                                         | Occupied Bandwidth (99 %)     | N/A                                                                                                                                                                                                                                 |                      | C                  |
| 15.247(d)<br>15.205 & 209<br>RSS-247(5.5)<br>RSS-Gen<br>(8.9 & 8.10) | Radiated Spurious Emissions   | FCC 15.209 Limits<br>RSS-Gen 8.9                                                                                                                                                                                                    | Radiated             | C <sup>Note2</sup> |
| 15.207<br>RSS-Gen(8.8)                                               | AC Conducted Emissions        | FCC 15.207 Limits                                                                                                                                                                                                                   | AC Line<br>Conducted | C                  |
| 15.203<br>RSS-Gen(8.3)                                               | Antenna Requirements          | FCC 15.203                                                                                                                                                                                                                          | -                    | C                  |

Note 1 : C = Comply NC = Not Comply NT = Not Tested NA = Not Applicable

Note 2 : Each antennas of this device were tested and the worst data was reported.

Note 3 : The sample was tested according to the following specifications :

- ANSI C63.10-2013

## 1.10 Conclusion of worst-case and operation mode

The EUT has three type of modulation (GFSK,  $\pi/4$ DQPSK and 8DPSK).

Therefore all applicable requirements were tested with all the modulations.

And packet type was tested at the worst case(DH5).

The field strength of spurious emission was measured in three orthogonal EUT positions (X-axis, Y-axis and Z-axis).

Tested frequency information,

- Hopping Function : Enable

|                     | TX Frequency (MHz) | RX Frequency (MHz) |
|---------------------|--------------------|--------------------|
| <b>Hopping Band</b> | 2402 ~ 2480        | 2402 ~ 2480        |

- Hopping Function : Disable

|                        | TX Frequency (MHz) | RX Frequency (MHz) |
|------------------------|--------------------|--------------------|
| <b>Lowest Channel</b>  | 2402               | 2402               |
| <b>Middle Channel</b>  | 2441               | 2441               |
| <b>Highest Channel</b> | 2480               | 2480               |

## 2. Maximum Peak Output Power Measurement

### 2.1 Test Setup

Refer to the APPENDIX I.

### 2.2 Limit

#### ■ FCC Requirements

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(1), For frequency hopping systems operating in the 2400 – 2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 – 5805 MHz band : 1 Watt.

#### ■ IC Requirements

1. RSS-247(5.4), For FHSs operating in the band 2400 - 2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels.

### 2.3 Test Procedure

1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;  
Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel  
RBW  $\geq$  20 dB BW  
VBW  $\geq$  RBW  
Sweep = auto  
Detector function = peak  
Trace = max hold

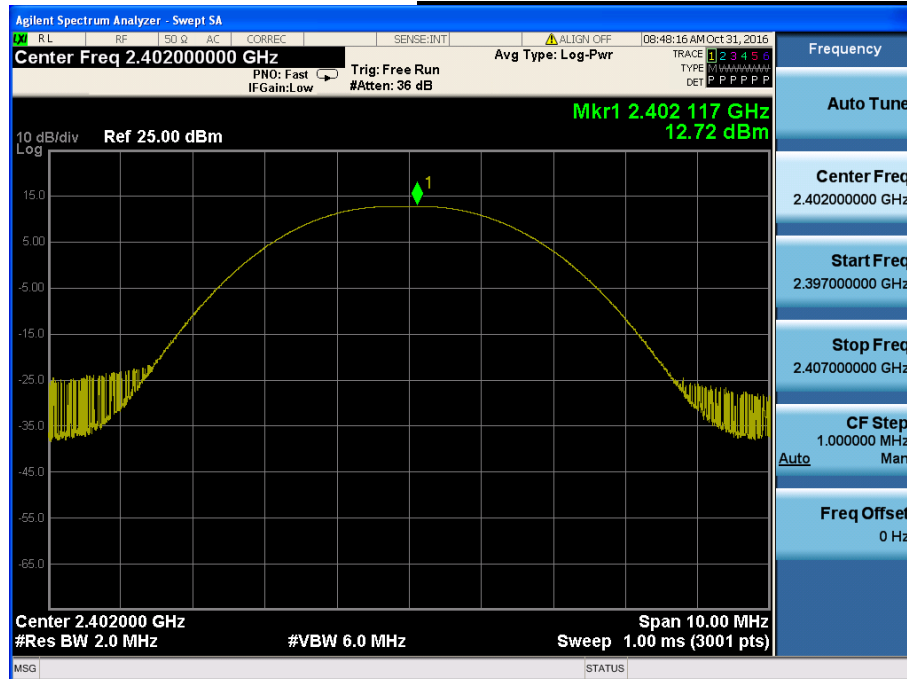
## 2.4 Test Results

| Modulation                            | Tested Channel | Frame Average Output Power |               | Peak Output Power |               |
|---------------------------------------|----------------|----------------------------|---------------|-------------------|---------------|
|                                       |                | dBm                        | mW            | dBm               | mW            |
| <b><u>GFSK</u></b>                    | <b>Lowest</b>  | 11.44                      | 13.932        | 12.72             | 18.707        |
|                                       | <b>Middle</b>  | 12.16                      | 16.444        | 13.52             | 22.491        |
|                                       | <b>Highest</b> | <b>12.22</b>               | <b>16.672</b> | <b>13.61</b>      | <b>22.961</b> |
| <b><u><math>\pi/4</math>DQPSK</u></b> | <b>Lowest</b>  | <b>1.36</b>                | <b>1.368</b>  | <b>5.36</b>       | <b>3.436</b>  |
|                                       | <b>Middle</b>  | 0.95                       | 1.245         | 5.00              | 3.162         |
|                                       | <b>Highest</b> | -0.29                      | 0.935         | 3.84              | 2.421         |
| <b><u>8DPSK</u></b>                   | <b>Lowest</b>  | <b>1.37</b>                | <b>1.371</b>  | <b>5.63</b>       | <b>3.656</b>  |
|                                       | <b>Middle</b>  | 0.95                       | 1.245         | 5.13              | 3.258         |
|                                       | <b>Highest</b> | -0.28                      | 0.938         | 3.98              | 2.500         |

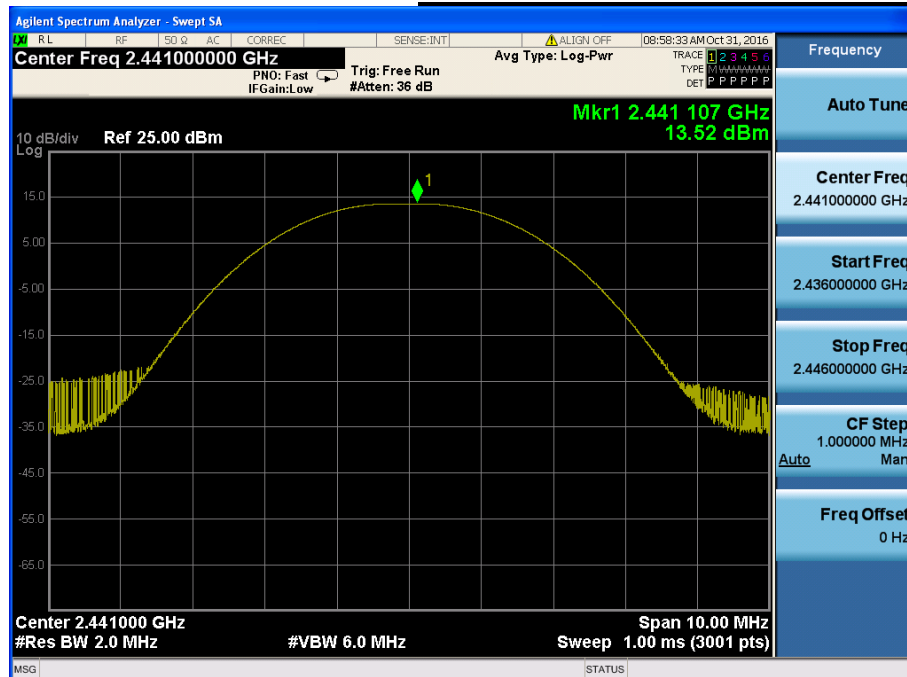
Note 1 : The frame average output power was tested using an average power meter for reference only.

Note 2 : See next pages for actual measured spectrum plots.

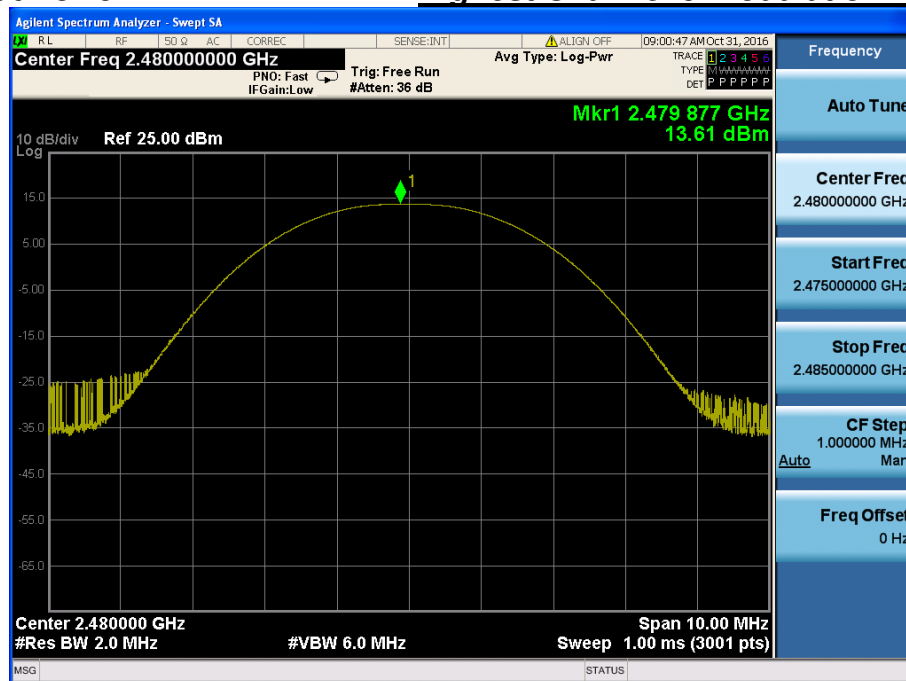
## Peak Output Power

Lowest Channel & Modulation : GFSK

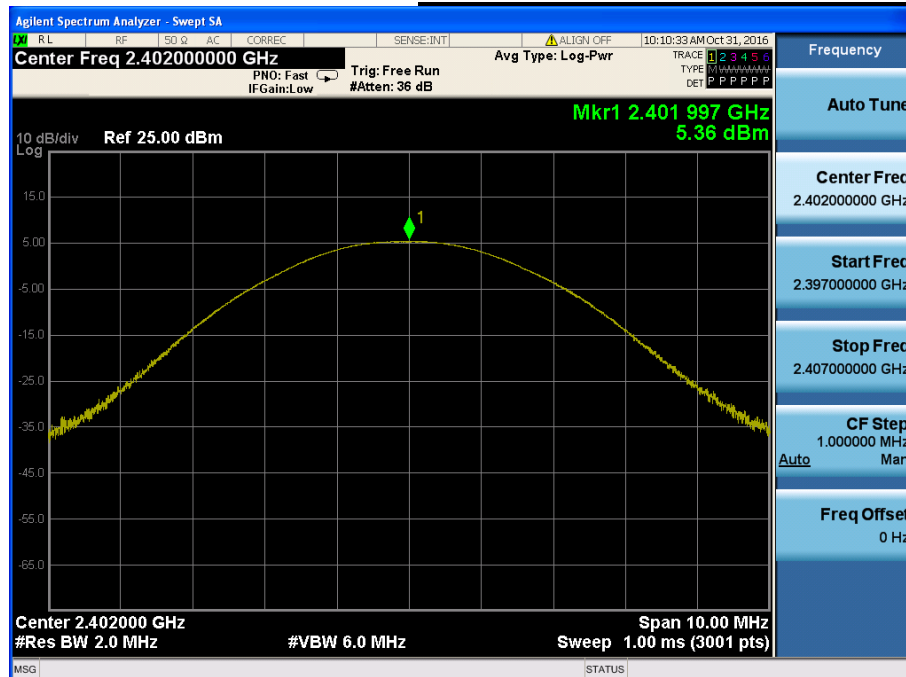
## Peak Output Power

Middle Channel & Modulation : GFSK

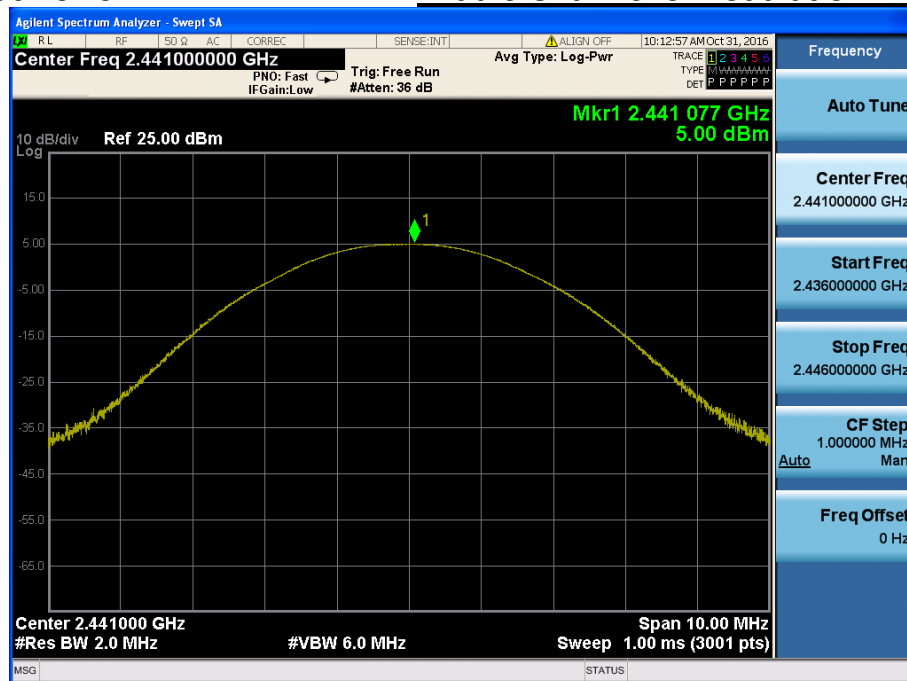
## Peak Output Power

Highest Channel & Modulation : GFSK

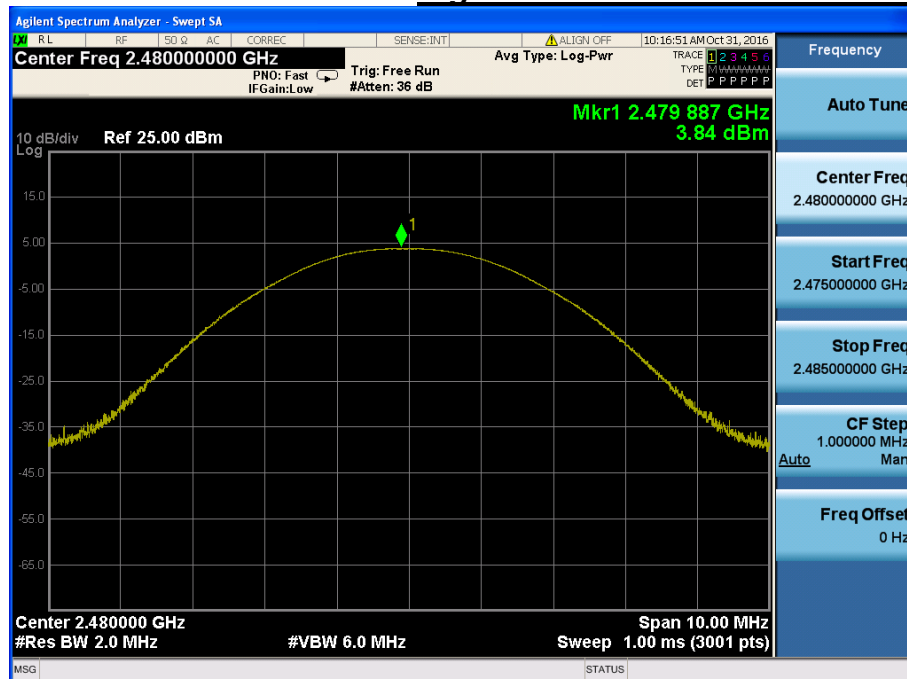
## Peak Output Power

Lowest Channel & Modulation :  $\pi/4$ DQPSK

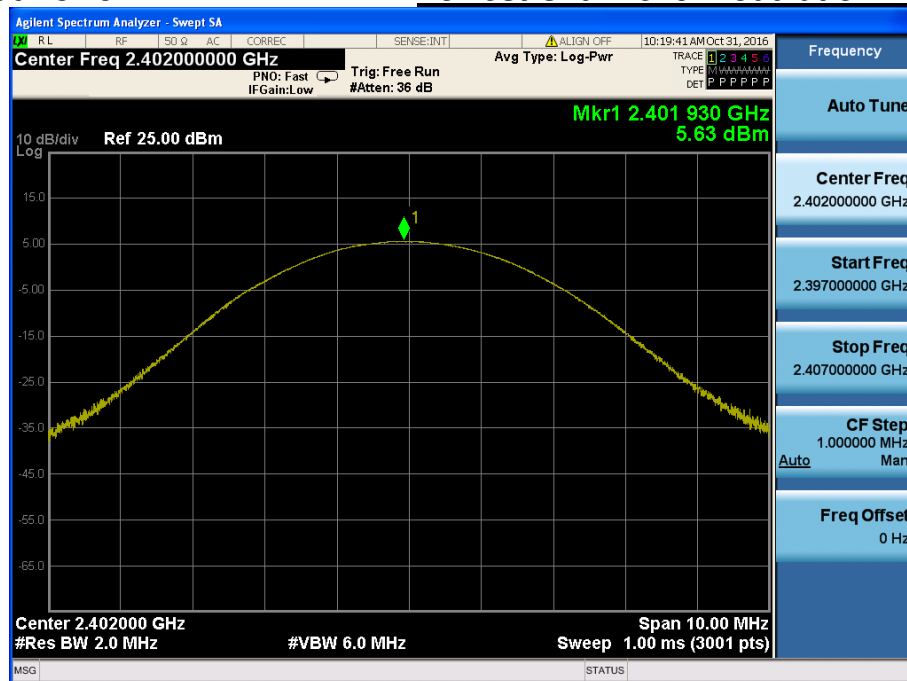
## Peak Output Power

Middle Channel & Modulation :  $\pi/4$ DQPSK

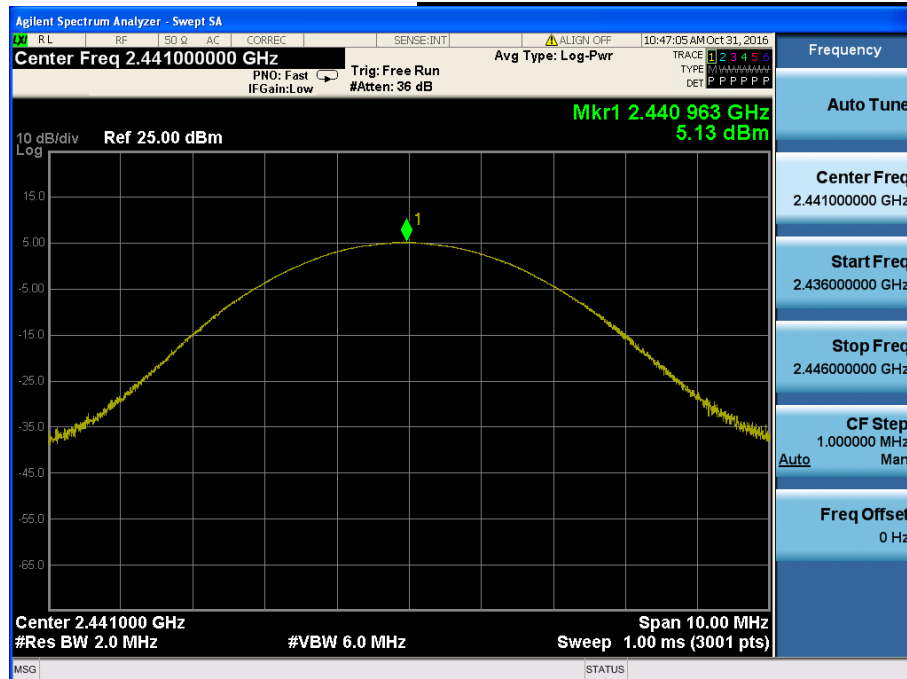
## Peak Output Power

Highest Channel & Modulation :  $\pi/4$ DQPSK

## Peak Output Power

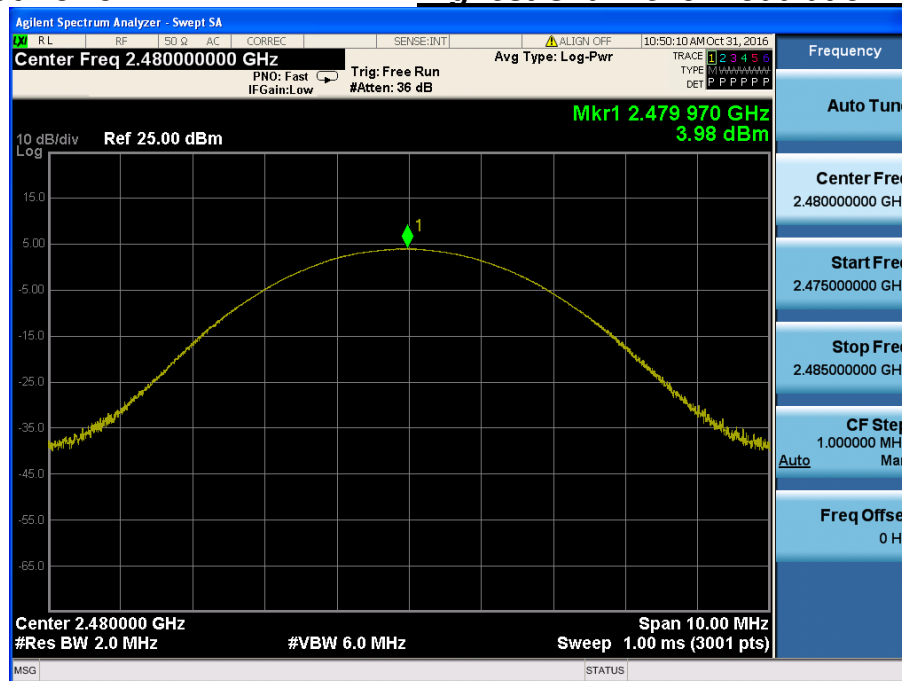
Lowest Channel & Modulation : 8DPSK

## Peak Output Power

Middle Channel & Modulation : 8DPSK

## Peak Output Power

## Highest Channel & Modulation : 8DPSK



### 3. 20 dB BW

#### 3.1 Test Setup

Refer to the APPENDIX I.

#### 3.2 Limit

Limit : Not Applicable

#### 3.3 Test Procedure

1. The 20 dB bandwidth were measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting: RBW shall be in the range of 1% to 5% of the 20 dB bandwidth and VBW  $\geq 3 \times$  RBW, Span = between two times and five times the 20 dB bandwidth.

#### 3.4 Test Results

| Modulation                            | Tested Channel | 20 dB BW (MHz) |
|---------------------------------------|----------------|----------------|
| <b><u>GFSK</u></b>                    | Lowest         | 0.936          |
|                                       | Middle         | 0.933          |
|                                       | Highest        | <b>0.939</b>   |
| <b><u><math>\pi/4</math>DQPSK</u></b> | Lowest         | 1.221          |
|                                       | Middle         | <b>1.224</b>   |
|                                       | Highest        | 1.209          |
| <b><u>8DPSK</u></b>                   | Lowest         | <b>1.248</b>   |
|                                       | Middle         | 1.248          |
|                                       | Highest        | 1.248          |

Note 1 : See next pages for actual measured spectrum plots.

## 20 dB Bandwidth

## Lowest Channel & Modulation : GFSK



## 20 dB Bandwidth

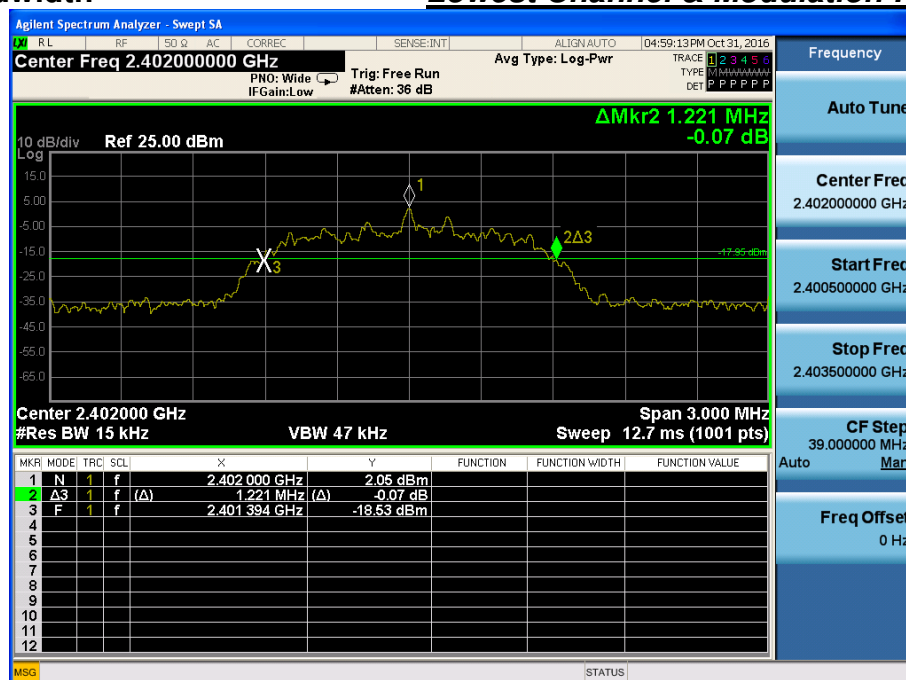
## Middle Channel & Modulation : GFSK



## 20 dB Bandwidth

Highest Channel & Modulation : GFSK

## 20 dB Bandwidth

Lowest Channel & Modulation :  $\pi/4$ DQPSK

## 20 dB Bandwidth

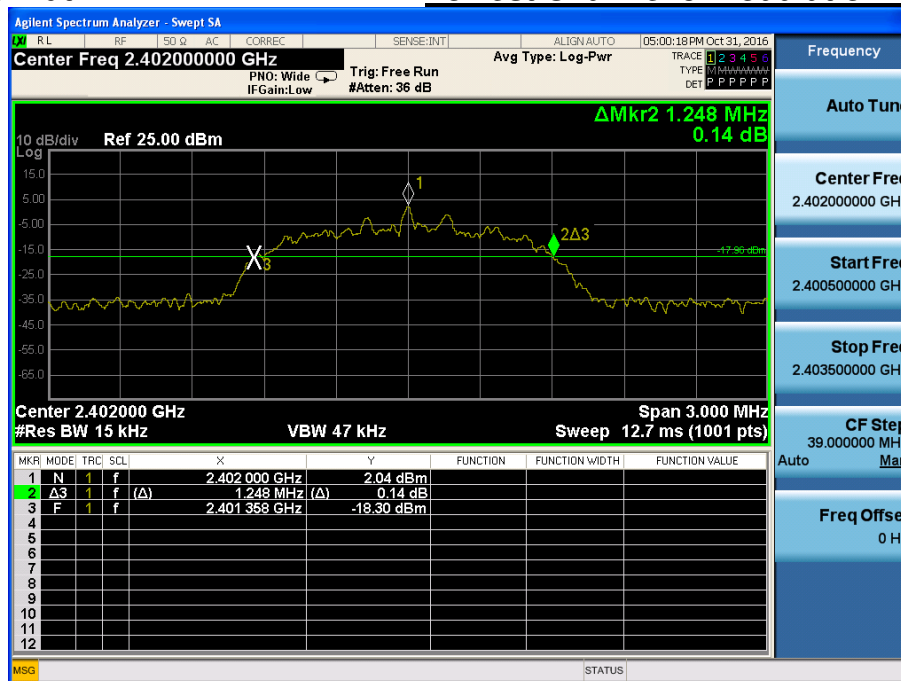
Middle Channel & Modulation :  $\pi/4$ DQPSK

## 20 dB Bandwidth

Highest Channel & Modulation :  $\pi/4$ DQPSK

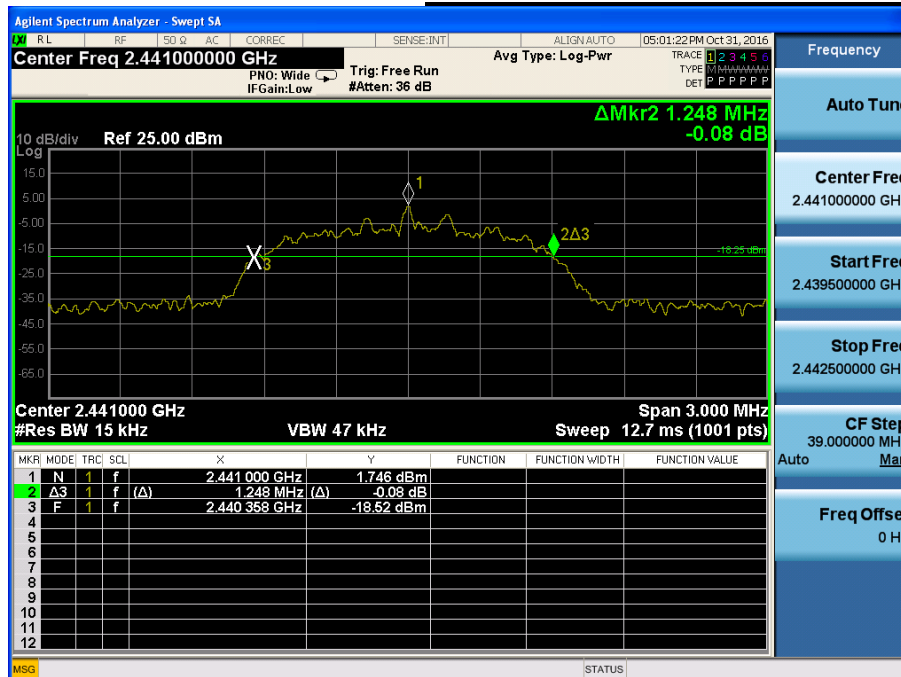
## 20 dB Bandwidth

## Lowest Channel & Modulation : 8DPSK



## 20 dB Bandwidth

## Middle Channel & Modulation : 8DPSK



20 dB Bandwidth

Highest Channel & Modulation : 8DPSK



## 4. Carrier Frequency Separation

### 4.1 Test Setup

Refer to the APPENDIX I.

### 4.2 Limit

Limit :  $\geq 25$  kHz or  $\geq$  Two-Thirds of the 20 dB BW whichever is greater.

### 4.3 Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to :

Span = wide enough to capture the peaks of two adjacent channels

RBW = Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

### 4.4 Test Results

#### FH mode

| Hopping Mode | Modulation    | Peak of center channel (MHz) | Peak of adjacent Channel (MHz) | Test Result (MHz) |
|--------------|---------------|------------------------------|--------------------------------|-------------------|
| Enable       | GFSK          | 2441.150                     | 2442.152                       | 1.002             |
|              | $\pi/4$ DQPSK | 2441.000                     | 2442.002                       | 1.002             |
|              | 8DPSK         | 2440.997                     | 2441.999                       | 1.002             |

#### AFH mode

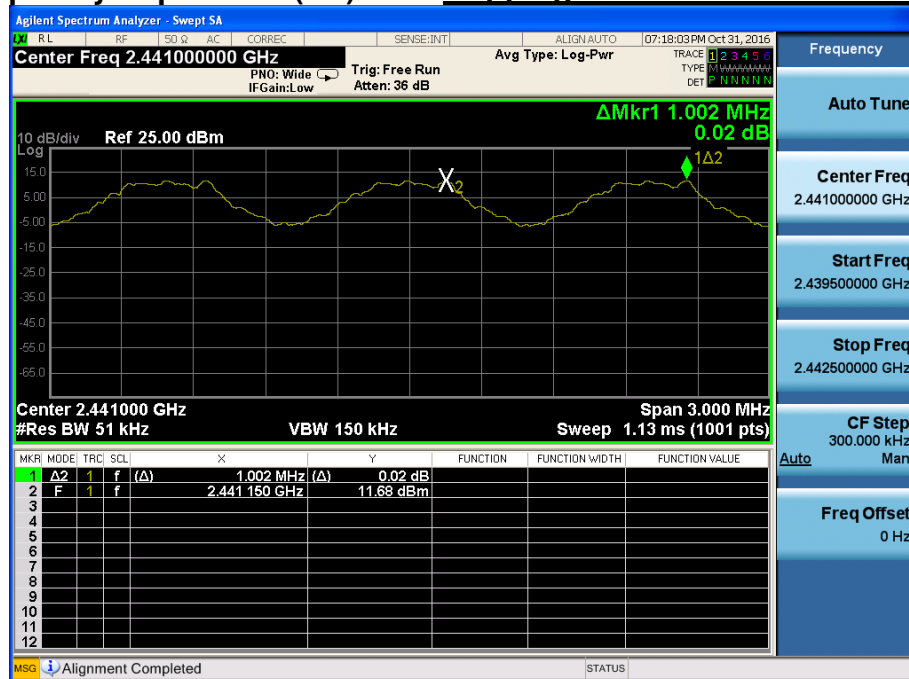
| Hopping Mode | Modulation    | Peak of center channel (MHz) | Peak of adjacent Channel (MHz) | Test Result (MHz) |
|--------------|---------------|------------------------------|--------------------------------|-------------------|
| Enable       | GFSK          | 2410.991                     | 2411.993                       | 1.002             |
|              | $\pi/4$ DQPSK | 2411.000                     | 2412.002                       | 1.002             |
|              | 8DPSK         | 2411.000                     | 2412.002                       | 1.002             |

Note 1 : See next pages for actual measured spectrum plots.

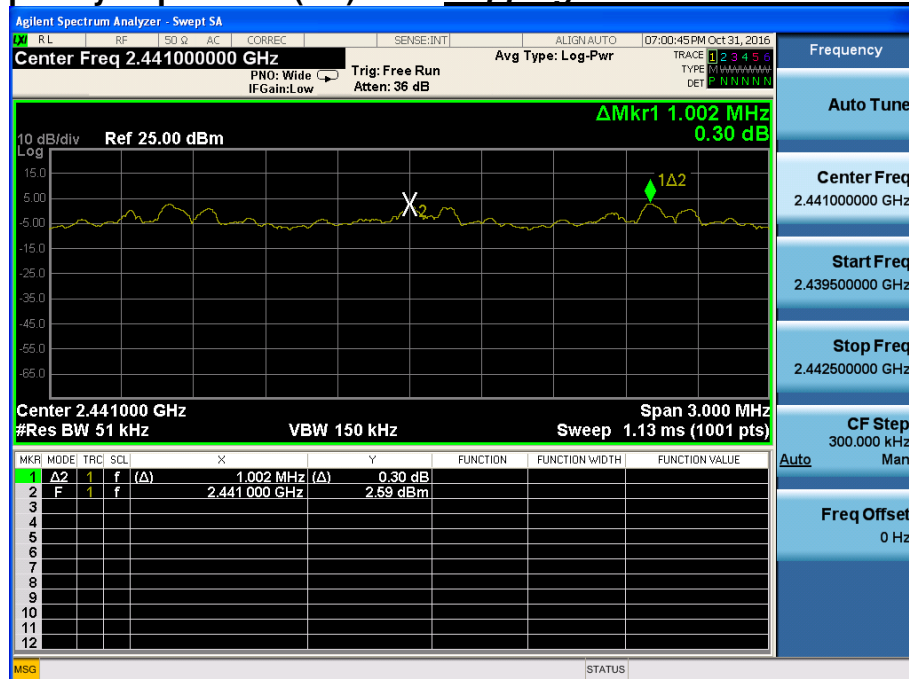
#### - Minimum Standard :

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

## Carrier Frequency Separation (FH)

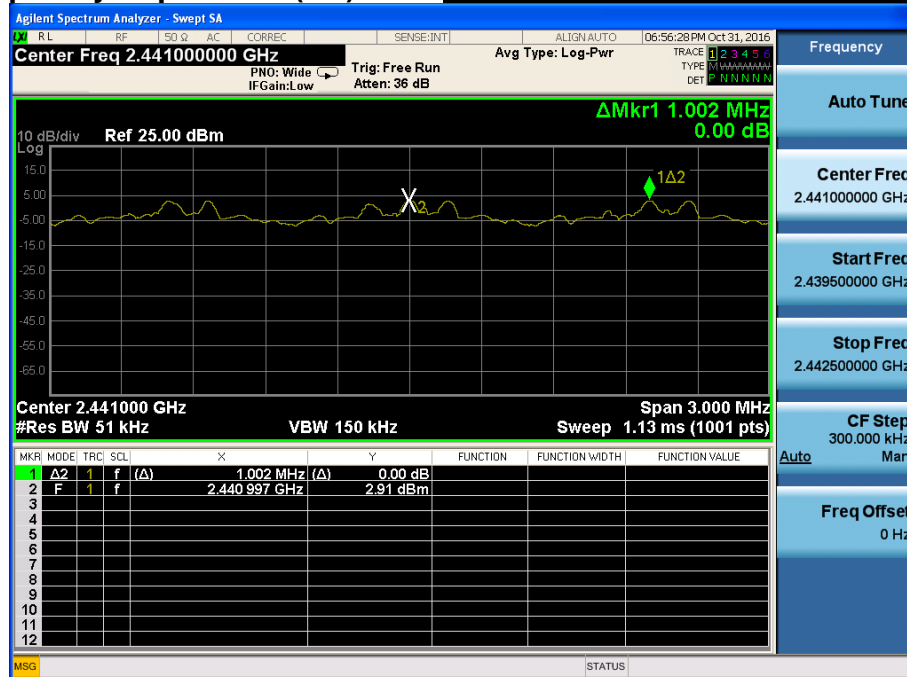
Hopping mode : Enable & GFSK

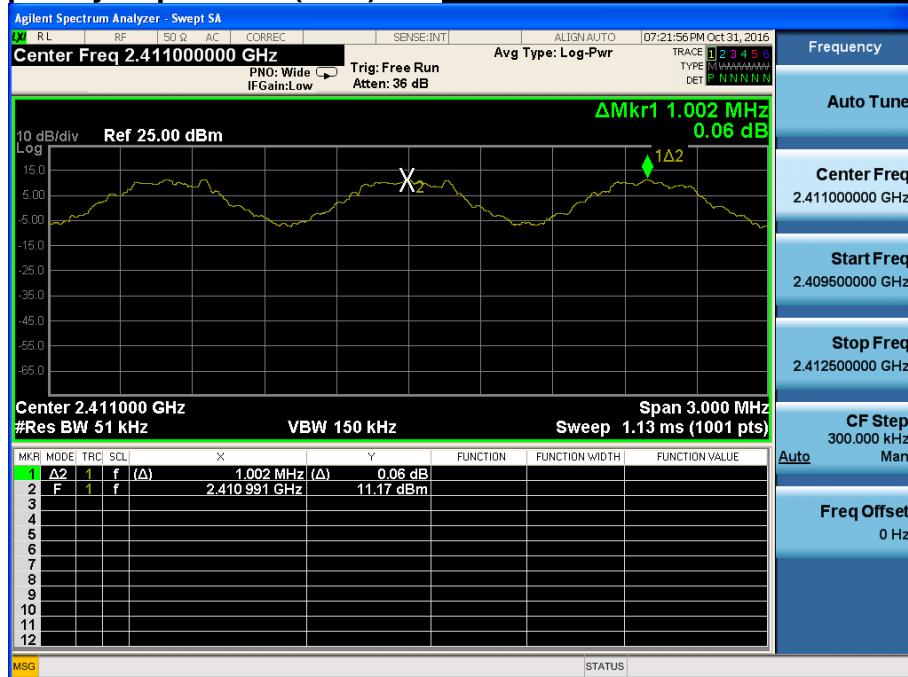
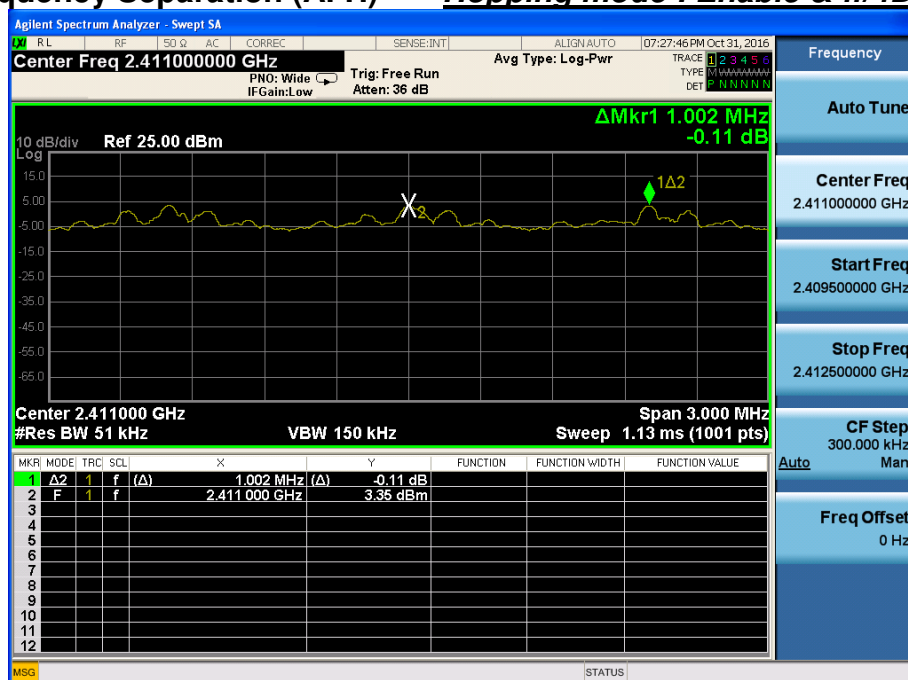
## Carrier Frequency Separation (FH)

Hopping mode : Enable & π/4DQPSK

## Carrier Frequency Separation (FH)

## Hopping mode : Enable & 8DPSK



**Carrier Frequency Separation (AFH)      *Hopping mode : Enable & GFSK*****Carrier Frequency Separation (AFH)      *Hopping mode : Enable &  $\pi/4$ DQPSK***

# Carrier Frequency Separation (AFH) *Hopping mode : Enable & 8DPSK*

