

# 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 : DRTFCC2008-0227

2. Customer

• Name(FCC) : LG Electronics USA / Name(IC) : LG ELECTRONICS INC.

• Address(FCC) : 111 Sylvan Avenue North Building, Englewood Cliffs, New Jersey, United States 07632  
Address(IC) : 222, LG-ro, Jinwi-myeon Pyeongtaek-si, Gyeonggi-do 451-713 Korea (Republic Of)

3. Use of Report : FCC & IC Original Grant

4. Product Name / Model Name : DVD MINI HI-FI AUDIO / ON2D  
FCC ID : BEJON2D / IC : 2703H-ON2D

5. Test Method Used : KDB558074 D01v05r02, ANSI C63.10-2013  
Test Specification : FCC Part 15.247  
RSS-247 Issue 2 (2017-02), RSS-GEN Issue 5 (2018-04)

6. Date of Test : 2020.07.06 ~ 2020.07.10

7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing

8. Testing Environment : See appended test report.

9. Test Result : Refer to the attached test result.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

|             |                                                                                                          |                                                                                                                     |
|-------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Affirmation | Tested by                                                                                                | Reviewed by                                                                                                         |
|             | Name : JaeHyeok Bang  | Name : JaeJin Lee  (Signature) |

2020 . 08 . 04 .

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

Not abided by KS Q ISO / IEC 17025 and KOLAS accreditation.

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   | Revised by    | Reviewed by |
|-----------------|---------------|---------------|---------------|-------------|
| DRTFCC2008-0227 | Aug. 04, 2020 | Initial issue | JaeHyeok Bang | JaeJin Lee  |
|                 |               |               |               |             |
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## 1. General Information

### 1.1 Testing Laboratory

|                                                                                                                                                                                                                                                                               |   |                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------|
| <b>DT&amp;C Co., Ltd.</b>                                                                                                                                                                                                                                                     |   |                  |
| The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042.<br>The test site complies with the requirements of § 2.948 according to ANSI C63.4-2014. |   |                  |
| - FCC & IC MRA Designation No. : KR0034                                                                                                                                                                                                                                       |   |                  |
| - ISED #: 5740A                                                                                                                                                                                                                                                               |   |                  |
| <a href="http://www.dtnet.net">www.dtnet.net</a>                                                                                                                                                                                                                              |   |                  |
| Telephone                                                                                                                                                                                                                                                                     | : | + 82-31-321-2664 |
| FAX                                                                                                                                                                                                                                                                           | : | + 82-31-321-1664 |

### 1.2 Testing Environment

| Ambient Condition   |                 |
|---------------------|-----------------|
| ▪ Temperature       | +20 °C ~ +24 °C |
| ▪ Relative Humidity | 35 % ~ 45 %     |

### 1.3 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95 % level of confidence.

| Test items                                     | Measurement uncertainty                               |
|------------------------------------------------|-------------------------------------------------------|
| Transmitter Output Power                       | 0.9 dB (The confidence level is about 95 %, $k = 2$ ) |
| Conducted spurious emission                    | 1.0 dB (The confidence level is about 95 %, $k = 2$ ) |
| AC conducted emission                          | 3.6 dB (The confidence level is about 95 %, $k=2$ )   |
| Radiated spurious emission<br>(1 GHz Below)    | 4.9 dB (The confidence level is about 95 %, $k = 2$ ) |
| Radiated spurious emission<br>(1 GHz ~ 18 GHz) | 5.1 dB (The confidence level is about 95 %, $k = 2$ ) |
| Radiated spurious emission<br>(18 GHz Above)   | 5.3 dB (The confidence level is about 95 %, $k = 2$ ) |

## 1.4 Details of Applicant

Applicant (FCC) : LG Electronics USA  
 Applicant (IC) : LG ELECTRONICS INC.  
 Address (FCC) : 111 Sylvan Avenue North Building, Englewood Cliffs, New Jersey, United States 07632  
 Address (IC) : 222, LG-ro, Jinwi-myeon Pyeongtaek-si, Gyeonggi-do 451-713 Korea (Republic Of)  
 Contact person : Kyung-Su Han

## 1.5 Description of EUT

|                                         |                                                     |
|-----------------------------------------|-----------------------------------------------------|
| <b>Product Marketing Name (PMN)</b>     | DVD MINI HI-FI AUDIO                                |
| <b>Model Name</b>                       | ON2D                                                |
| <b>Add Model Name</b>                   | ON2DN, ON2K, ON44DK                                 |
| <b>Serial Number</b>                    | Conducted: 006MNAF000008<br>Radiated: 006MNVW000009 |
| <b>Hardware Version</b>                 | 1.0                                                 |
| <b>Software Version</b>                 | 1.0                                                 |
| <b>Power Supply</b>                     | AC 120 V                                            |
| <b>Frequency Range</b>                  | 2 402 MHz ~ 2 480 MHz                               |
| <b>Modulation Technique (Data rate)</b> | GFSK(1 Mbps), $\pi/4$ DQPSK(2 Mbps), 8DPSK(3 Mbps)  |
| <b>Number of Channels</b>               | 79                                                  |
| <b>Antenna Type</b>                     | PCB Pattern Antenna                                 |
| <b>Antenna Gain</b>                     | PK : -0.84 dBi                                      |

### - Auxiliary equipment for testing

| Equipment | Model Name | Serial NO. | Manufacturer | Note |
|-----------|------------|------------|--------------|------|
| -         | -          | -          | -            | -    |

## 1.6 Declaration by the applicant / manufacturer

- NA

## 1.7 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

Note 1 : Pseudorandom Frequency Hopping Sequence Table as below:

Channel: 08, 24, 40, 56, 42, 54, 72, 09, 01, 11, 33, 41, 34, 42, 65, 73, 53, 69, 06, 22, 04,  
20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 41, 58, 44, 60, 76, 13, 03, 11,  
35, 43, 37, 45, 69, 77, 52, 71, 08, 24, 06, 24, 48, 56, 45, 46, 70, 01, 72, 06, 25,  
33, 12, 28, 49, 60, 45, 58, 74, 13, 05, 18, 37, 49 etc

The System receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchroniztation with the transmitted signals.

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.

## 1.8 Test Equipment List

| Type                                | Manufacturer           | Model                         | Cal.Date<br>(yy/mm/dd) | Next.Cal.Date<br>(yy/mm/dd) | S/N                |
|-------------------------------------|------------------------|-------------------------------|------------------------|-----------------------------|--------------------|
| Spectrum Analyzer                   | Agilent Technologies   | N9020A                        | 20/06/24               | 21/06/24                    | US47360812         |
| Spectrum Analyzer                   | Agilent Technologies   | N9020A                        | 19/12/16               | 20/12/16                    | MY48011700         |
| Spectrum Analyzer                   | Agilent Technologies   | N9020A                        | 19/12/16               | 20/12/16                    | MY48010133         |
| DC Power Supply                     | Agilent Technologies   | 66332A                        | 20/06/24               | 21/06/24                    | US37473422         |
| Multimeter                          | FLUKE                  | 17B                           | 19/12/16               | 20/12/16                    | 26030065WS         |
| Signal Generator                    | Rohde Schwarz          | SMBV100A                      | 19/12/16               | 20/12/16                    | 255571             |
| Signal Generator                    | ANRITSU                | MG3695C                       | 19/12/16               | 20/12/16                    | 173501             |
| Thermohygrometer                    | BODYCOM                | BJ5478                        | 19/12/18               | 20/12/18                    | 120612-1           |
| Thermohygrometer                    | BODYCOM                | BJ5478                        | 19/12/18               | 20/12/18                    | 120612-2           |
| Thermohygrometer                    | BODYCOM                | BJ5478                        | 20/07/01               | 21/07/01                    | N/A                |
| HYGROMETER                          | TESTO                  | 608-H1                        | 20/01/21               | 21/01/21                    | 34862883           |
| Power Divider                       | Weinschel              | WA1574                        | 20/06/24               | 21/06/24                    | WA1574-4           |
| BlueTooth Tester                    | Tescom                 | TC-3000C                      | 20/06/24               | 21/06/24                    | 3000C000563        |
| Loop Antenna                        | ETS-Lindgren           | 6502                          | 20/04/24               | 22/04/24                    | 203480             |
| BILOG ANTENNA                       | Schwarzbeck            | VULB 9160                     | 19/04/23               | 21/04/23                    | 9160-3362          |
| Horn Antenna                        | ETS-Lindgren           | 3115                          | 20/01/30               | 22/01/30                    | 6419               |
| Horn Antenna                        | A.H.Systems Inc.       | SAS-574                       | 19/07/03               | 21/07/03                    | 155                |
| PreAmplifier                        | tsj                    | MLA-0118-B01-40               | 19/12/16               | 20/12/16                    | 1852267            |
| PreAmplifier                        | tsj                    | MLA-1840-J02-45               | 20/06/24               | 21/06/24                    | 16966-10728        |
| PreAmplifier                        | H.P                    | 8447D                         | 19/12/16               | 20/12/16                    | 2944A07774         |
| High Pass Filter                    | Wainwright Instruments | WHKX12-935-1000-15000-40SS    | 20/06/24               | 21/06/24                    | 8                  |
| High Pass Filter                    | Wainwright Instruments | WHKX10-2838-3300-18000-60SS   | 20/06/24               | 21/06/24                    | 1                  |
| High Pass Filter                    | Wainwright Instruments | WHNX8.0/26.5-6SS              | 20/06/24               | 21/06/24                    | 3                  |
| Attenuator                          | Hefei Shunze           | SS5T2.92-10-40                | 20/06/24               | 21/06/24                    | 16012202           |
| Attenuator                          | SRTechnology           | F01-B0606-01                  | 20/06/24               | 21/06/24                    | 13092403           |
| Attenuator                          | Aeroflex/Weinschel     | 56-3                          | 20/06/24               | 21/06/24                    | Y2370              |
| Attenuator                          | SMAJK                  | SMAJK-2-3                     | 20/06/24               | 21/06/24                    | 2                  |
| Power Meter & Wide Bandwidth Sensor | Anritsu                | ML2495A<br>MA2490A            | 20/06/24               | 21/06/24                    | 1306007<br>1249001 |
| EMI Test Receiver                   | ROHDE&SCHWARZ          | ESR                           | 19/12/17               | 20/12/17                    | 101767             |
| EMI Test Receiver                   | Rohde Schwarz          | ESU                           | 20/01/20               | 21/01/20                    | 100538             |
| PULSE LIMITER                       | Rohde Schwarz          | ESH3-Z2                       | 19/09/17               | 20/09/17                    | 101333             |
| LISN                                | SCHWARZBECK            | NSLK 8128 RC                  | 19/11/04               | 20/11/04                    | 8128 RC-387        |
| Cable                               | Junkosha               | MWX241                        | 20/01/13               | 21/01/13                    | G-04               |
| Cable                               | Junkosha               | MWX241                        | 20/01/13               | 21/01/13                    | G-07               |
| Cable                               | DT&C                   | Cable                         | 20/01/13               | 21/01/13                    | G-13               |
| Cable                               | DT&C                   | Cable                         | 20/01/13               | 21/01/13                    | G-14               |
| Cable                               | HUBER+SUHNER           | SUCOFLEX 104                  | 20/01/13               | 21/01/13                    | G-15               |
| Cable                               | Radiall                | TESTPRO3                      | 20/01/16               | 21/01/16                    | M-01               |
| Cable                               | Junkosha               | MWX315                        | 20/01/16               | 21/01/16                    | M-05               |
| Cable                               | Junkosha               | MWX221                        | 20/01/16               | 21/01/16                    | M-06               |
| Cable                               | DT&C                   | Cable                         | 20/01/13               | 21/01/13                    | RF-06              |
| Cable                               | DT&C                   | CABLE                         | 20/01/16               | 21/01/16                    | RF-82              |
| Test Software                       | tsj                    | Radiated Emission Measurement | NA                     | NA                          | Version 2.00.0177  |
| Test Software                       | tsj                    | Noise Terminal Measurement    | NA                     | NA                          | Version 2.00.0170  |

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017

Note2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

## 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(6.7)                                                         | 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                                                                                                                                                                                                                   | AC Line<br>Conducted | C                |
| 15.207<br>RSS-Gen(8.8)                                               | AC Conducted Emissions        | FCC 15.207 Limits                                                                                                                                                                                                                   | -                    | C                |
| 15.203                                                               | Antenna Requirements          | FCC 15.203                                                                                                                                                                                                                          |                      | C                |

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

Note 2 : For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated With OATS.

### 1.10 Conclusion of worst-case and operation mode

The EUT has three types 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).

#### Tested frequency information,

- Hopping Function : Enable

|              | TX Frequency (MHz) | RX Frequency (MHz) |
|--------------|--------------------|--------------------|
| Hopping Band | 2 402 ~ 2 480      | 2 402 ~ 2 480      |

- Hopping Function : Disable

|                 | TX Frequency (MHz) | RX Frequency (MHz) |
|-----------------|--------------------|--------------------|
| Lowest Channel  | 2 402              | 2 402              |
| Middle Channel  | 2 441              | 2 441              |
| Highest Channel | 2 480              | 2 480              |

## 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 2 400 - 2 483.5 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 2 400 – 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 MHz band : 1 Watt. For all other frequency hopping systems in the 2 400 – 2 483.5 MHz band: 0.125 watts.

#### ■ IC Requirements

1. RSS-247(5.4) (b), For FHSS operating in the band 2 400 – 2 483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels, the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p shall not exceed 4 W, except as provided in section 5.4(e)

### 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 peak output power 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

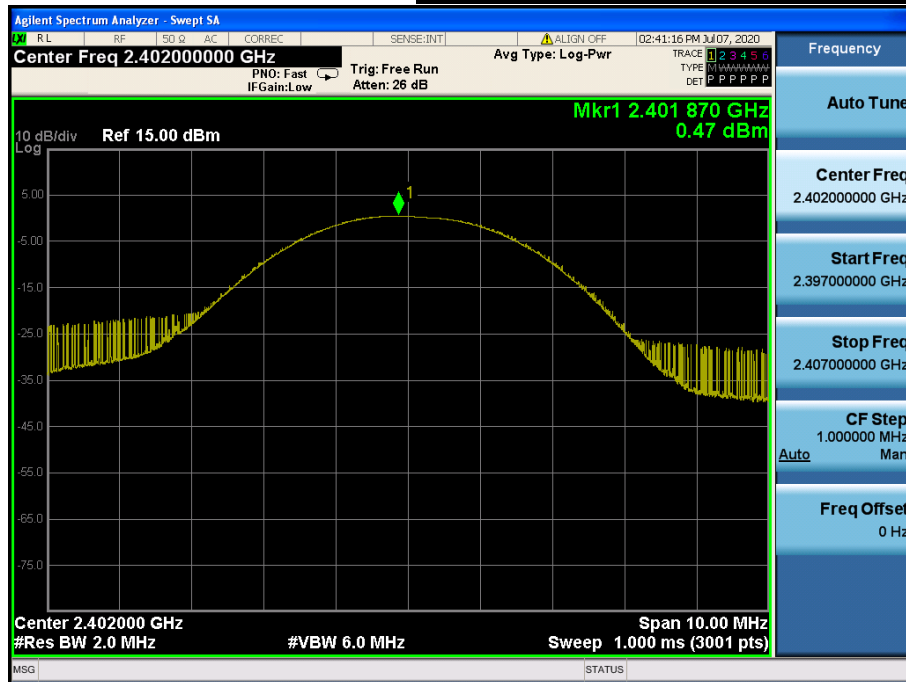
| Modulation                            | Tested Channel | Frame Average Output Power |             | Peak Output Power |             |
|---------------------------------------|----------------|----------------------------|-------------|-------------------|-------------|
|                                       |                | dBm                        | mW          | dBm               | mW          |
| <u><b>GFSK</b></u>                    | Lowest         | <b>-1.35</b>               | <b>0.73</b> | <b>0.47</b>       | <b>1.11</b> |
|                                       | Middle         | -1.64                      | 0.69        | -0.14             | 0.97        |
|                                       | Highest        | -3.70                      | 0.43        | -1.45             | 0.72        |
| <u><b><math>\pi/4</math>DQPSK</b></u> | Lowest         | <b>-2.70</b>               | <b>0.54</b> | <b>1.62</b>       | <b>1.45</b> |
|                                       | Middle         | -2.98                      | 0.50        | 1.04              | 1.27        |
|                                       | Highest        | -5.02                      | 0.31        | -0.24             | 0.95        |
| <u><b>8DPSK</b></u>                   | Lowest         | <b>-2.71</b>               | <b>0.54</b> | <b>1.98</b>       | <b>1.58</b> |
|                                       | Middle         | -3.01                      | 0.50        | 1.38              | 1.37        |
|                                       | Highest        | -5.03                      | 0.31        | 0.15              | 1.04        |

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.

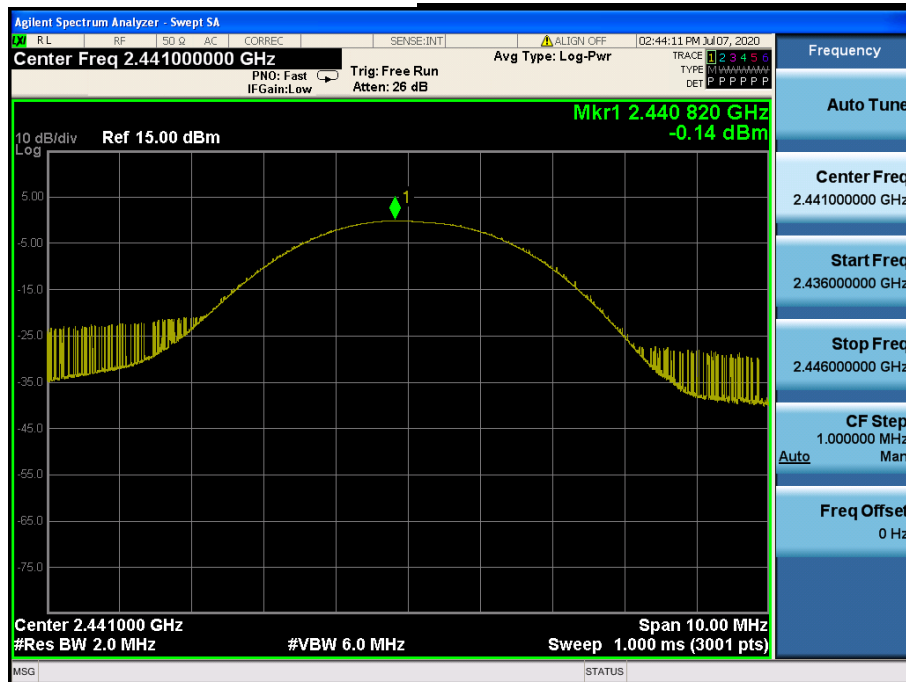
## Peak Output Power

## Lowest Channel & Modulation : GFSK

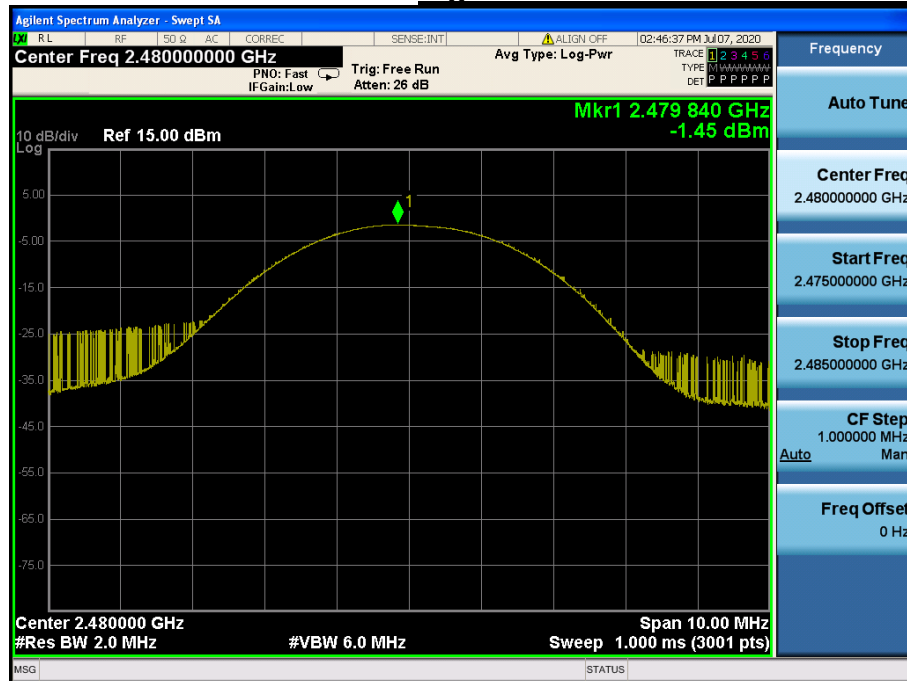


## Peak Output Power

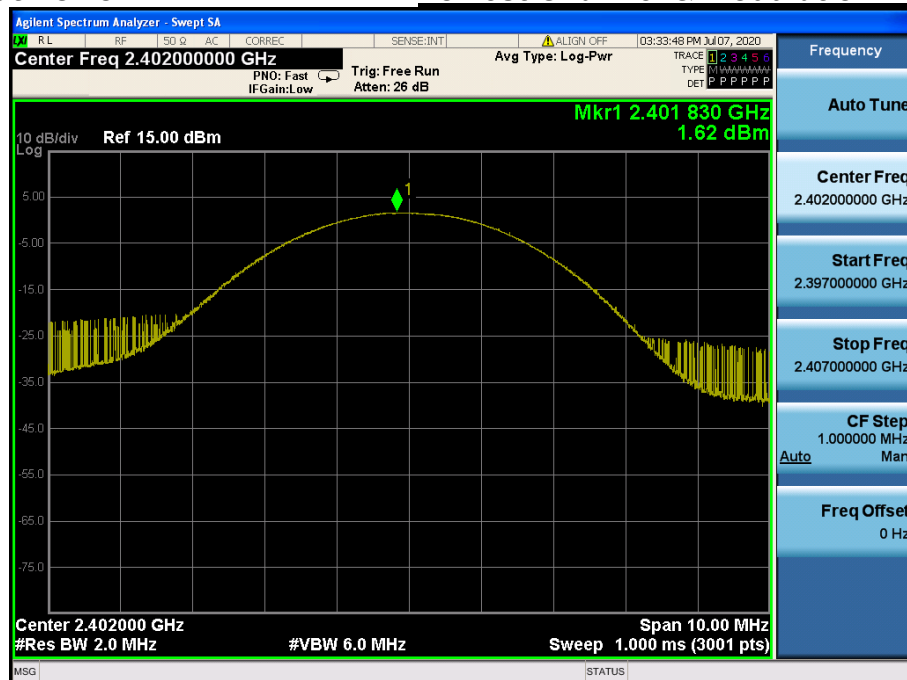
## Middle Channel & Modulation : GFSK



## Peak Output Power

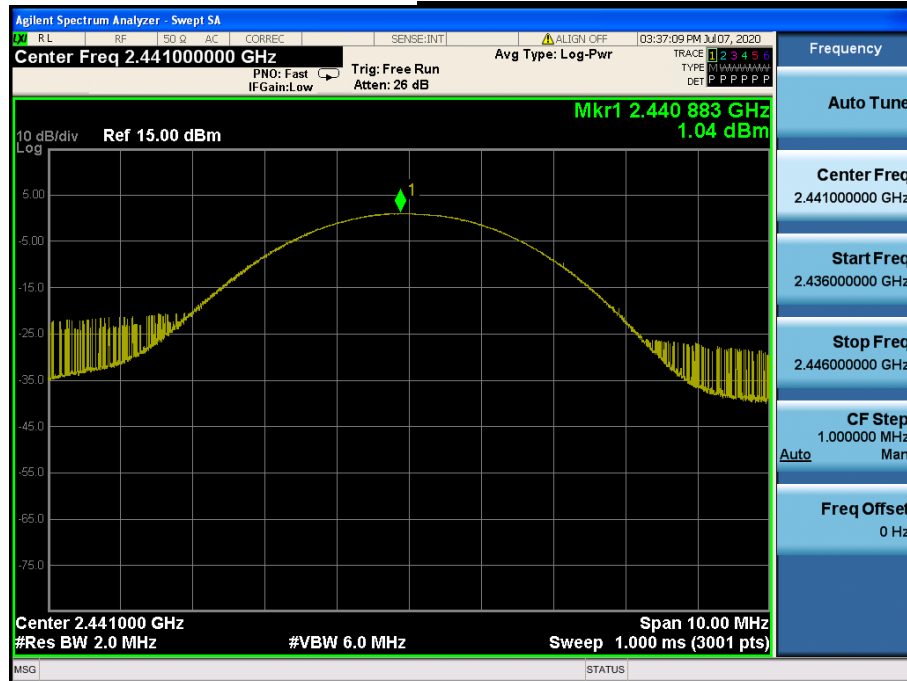
Highest Channel & Modulation : GFSK

## Peak Output Power

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

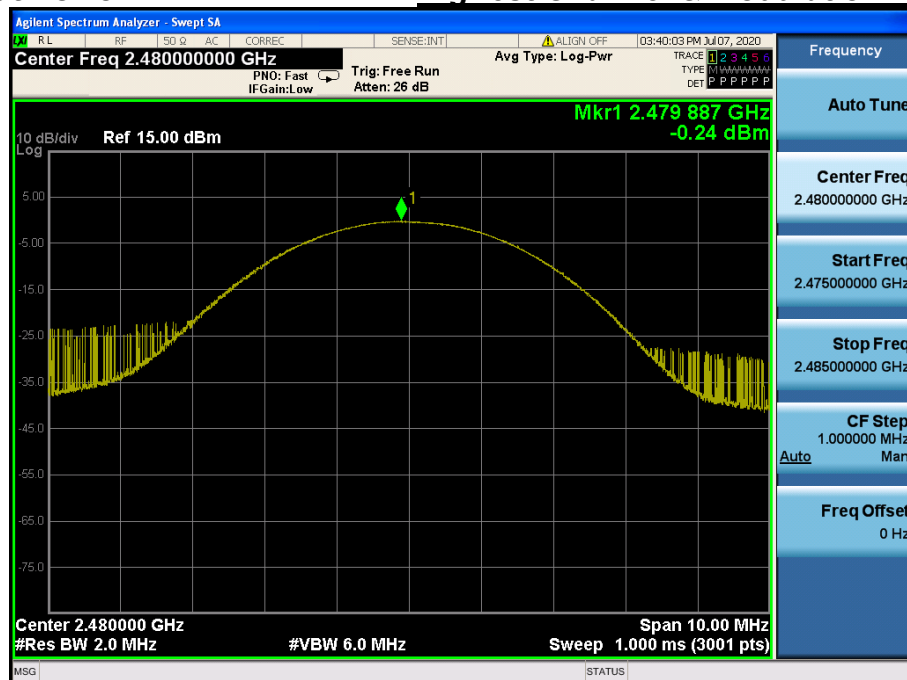
## Peak Output Power

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



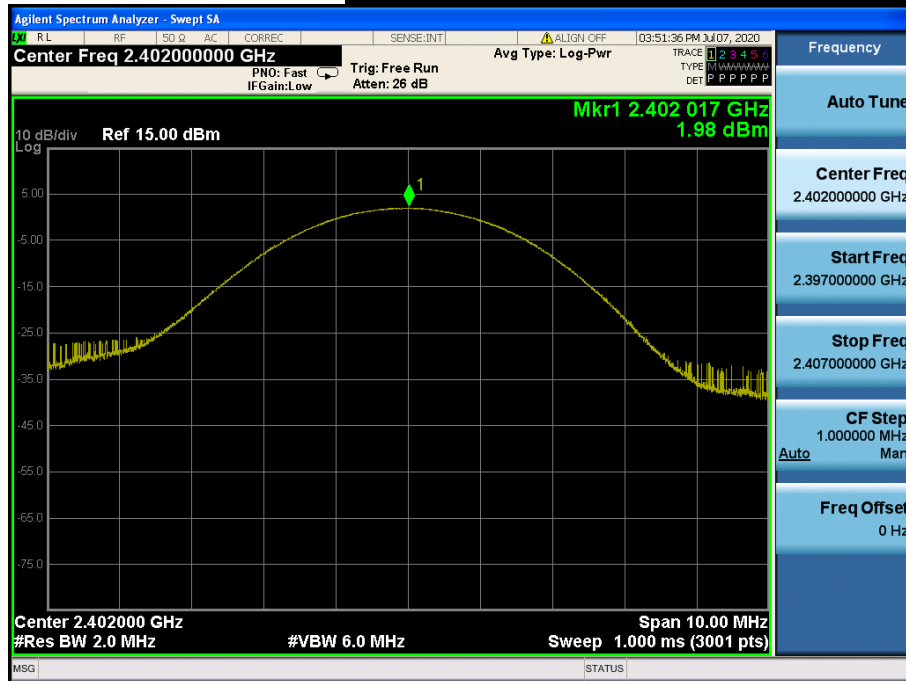
## Peak Output Power

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



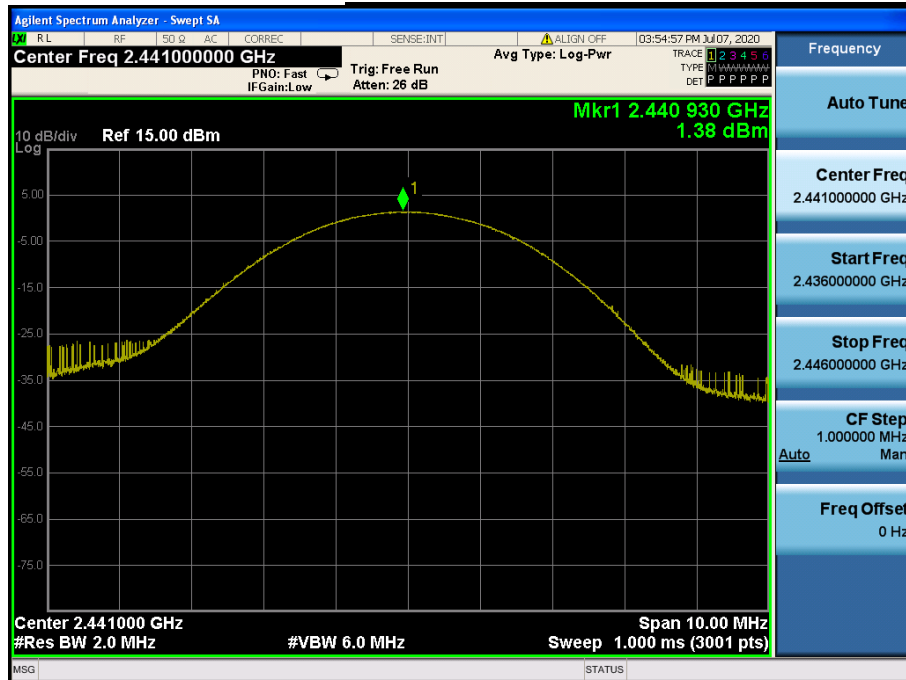
## Peak Output Power

## Lowest Channel & Modulation : 8DPSK



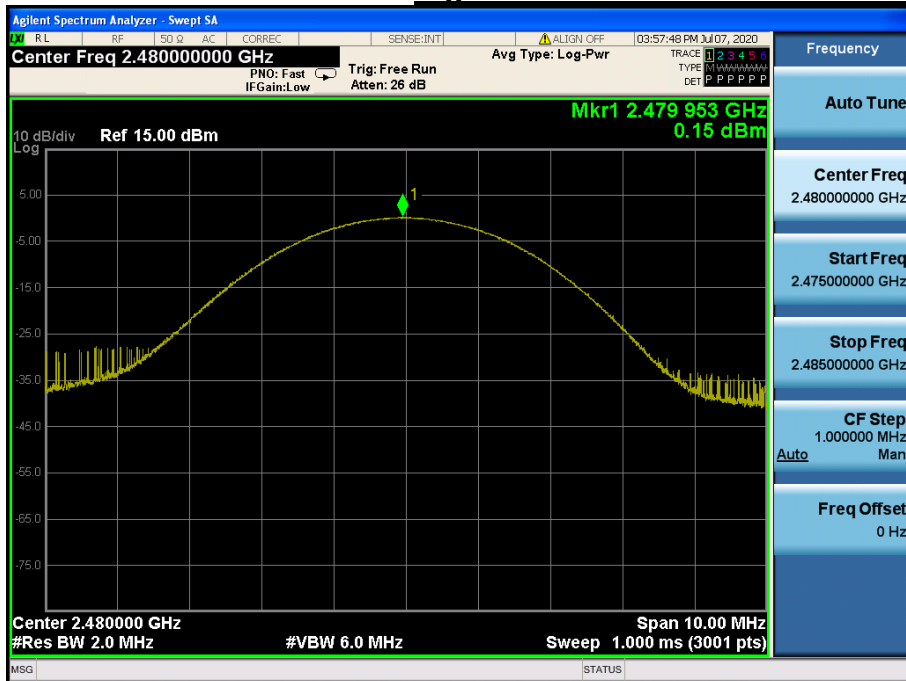
## Peak Output Power

## Middle Channel & Modulation : 8DPSK



## Peak Output Power

## Highest Channel & Modulation : 8DPSK



### 3. 20 dB BW & Occupied BW

#### 3.1 Test Setup

Refer to the APPENDIX I.

#### 3.2 Limit

Limit : Not Applicable

#### 3.3 Test Procedure

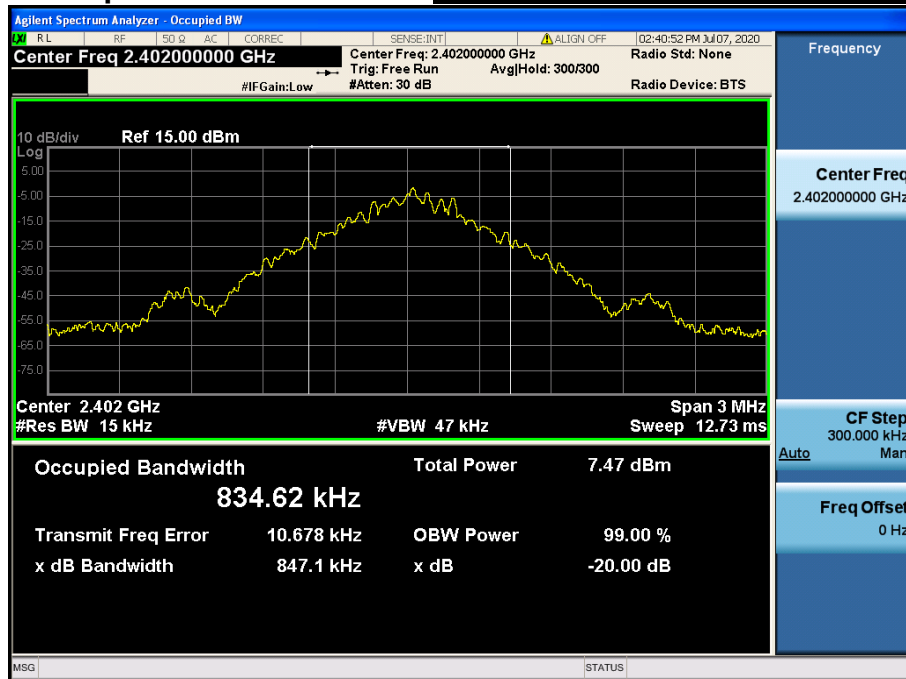
1. The 20 dB bandwidth & Occupied bandwidth were measured with a spectrum analyzer connected to RF antenna Connector(conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
2. The bandwidth of the fundamental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

#### 3.4 Test Results

| Modulation                            | Tested Channel | 20 dB BW (MHz) | Occupied BW (MHz) |
|---------------------------------------|----------------|----------------|-------------------|
| <b><u>GFSK</u></b>                    | Lowest         | 0.847          | <b>0.835</b>      |
|                                       | Middle         | 0.849          | 0.830             |
|                                       | Highest        | <b>0.849</b>   | 0.834             |
| <b><u><math>\pi/4</math>DQPSK</u></b> | Lowest         | 1.181          | <b>1.165</b>      |
|                                       | Middle         | <b>1.184</b>   | 1.165             |
|                                       | Highest        | 1.182          | 1.163             |
| <b><u>8DPSK</u></b>                   | Lowest         | 1.222          | <b>1.175</b>      |
|                                       | Middle         | <b>1.224</b>   | 1.175             |
|                                       | Highest        | <b>1.224</b>   | 1.172             |

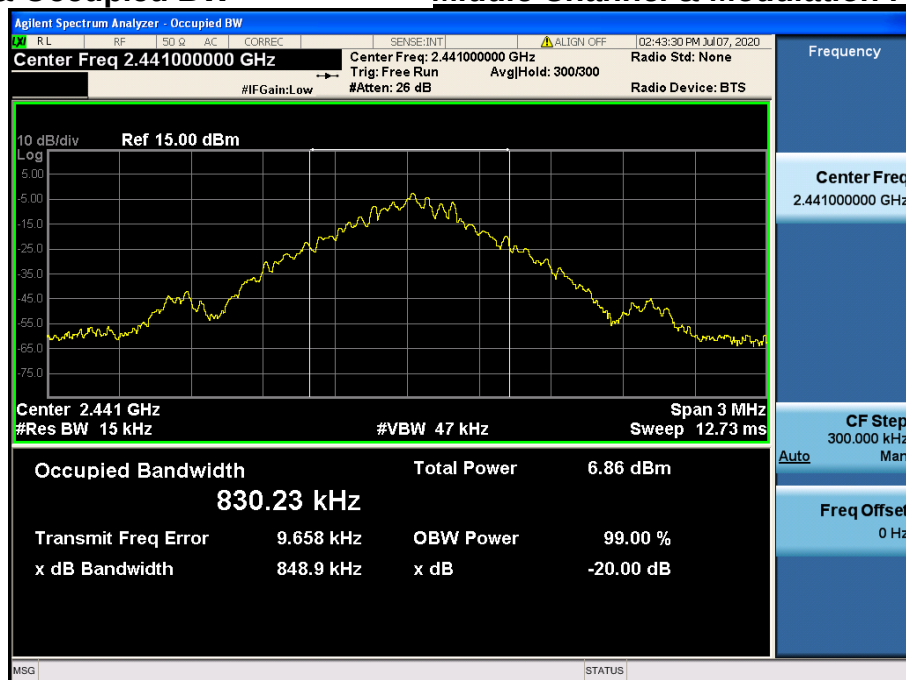
## 20 dB BW & Occupied BW

## Lowest Channel & Modulation : GFSK



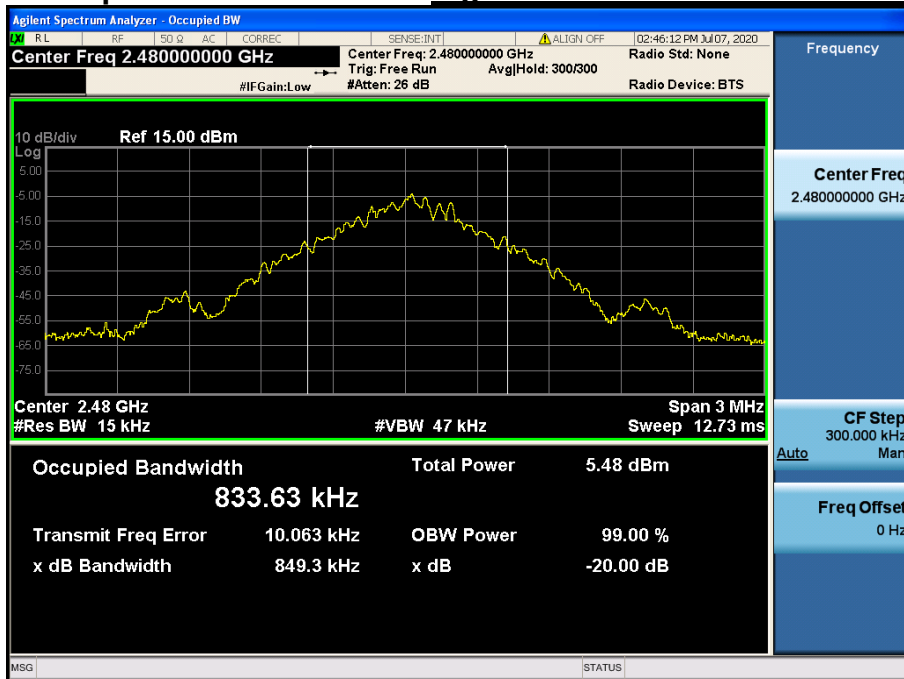
## 20 dB BW & Occupied BW

## Middle Channel & Modulation : GFSK



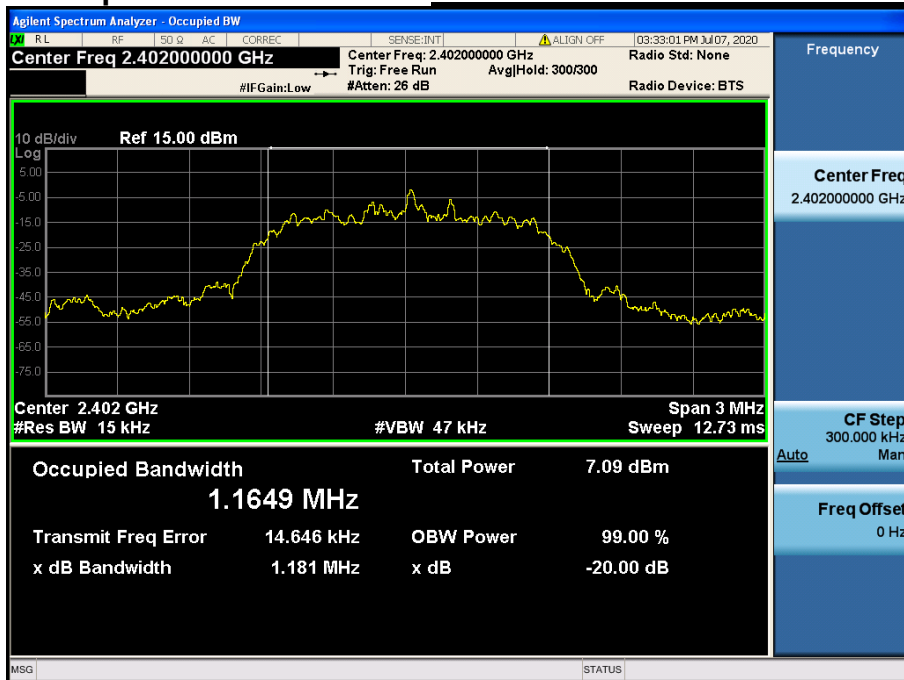
## 20 dB BW & Occupied BW

## Highest Channel & Modulation : GFSK



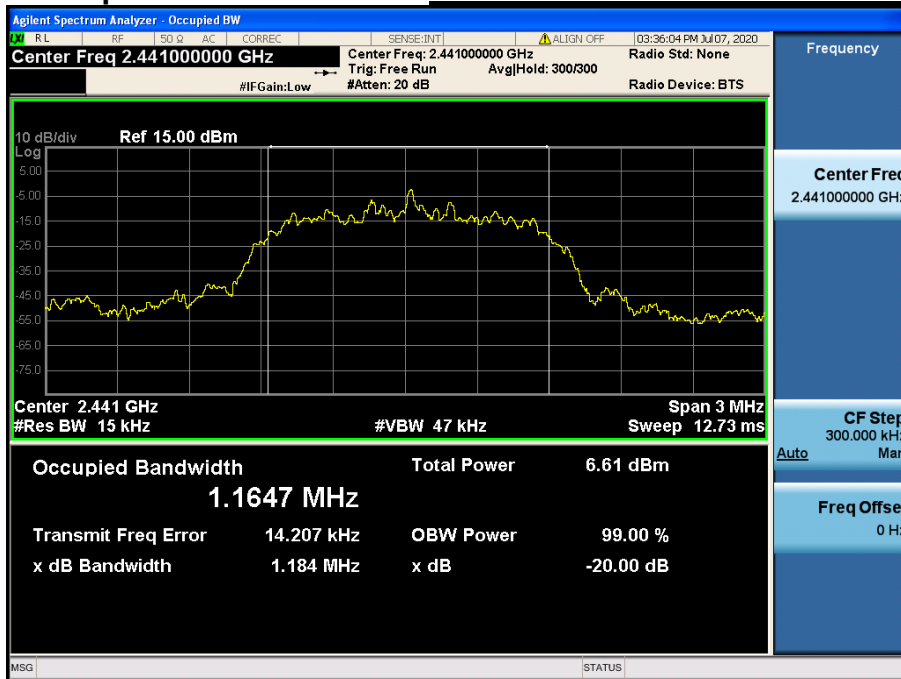
## 20 dB BW & Occupied BW

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



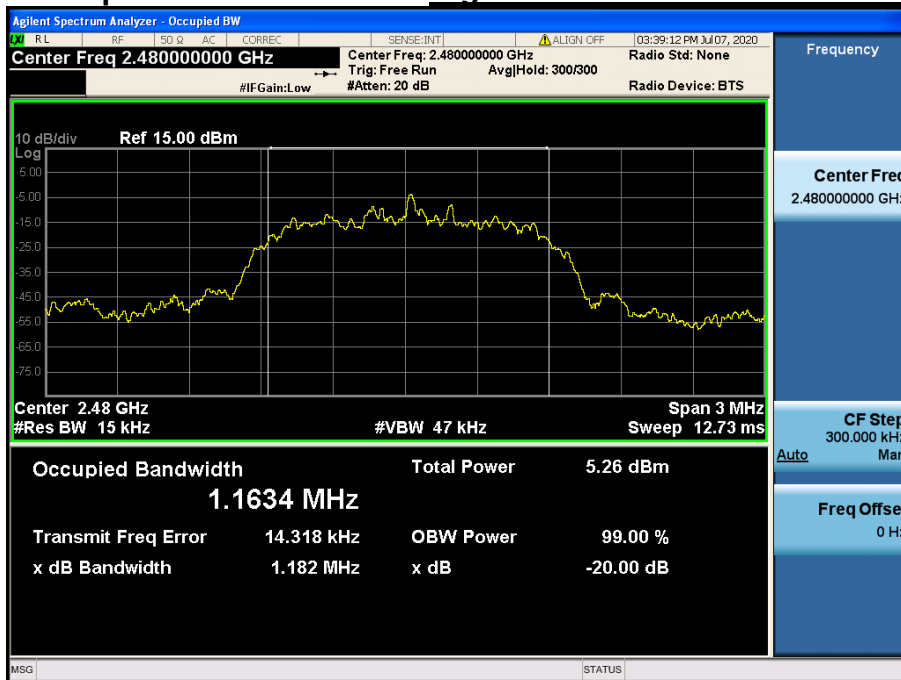
## 20 dB BW & Occupied BW

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



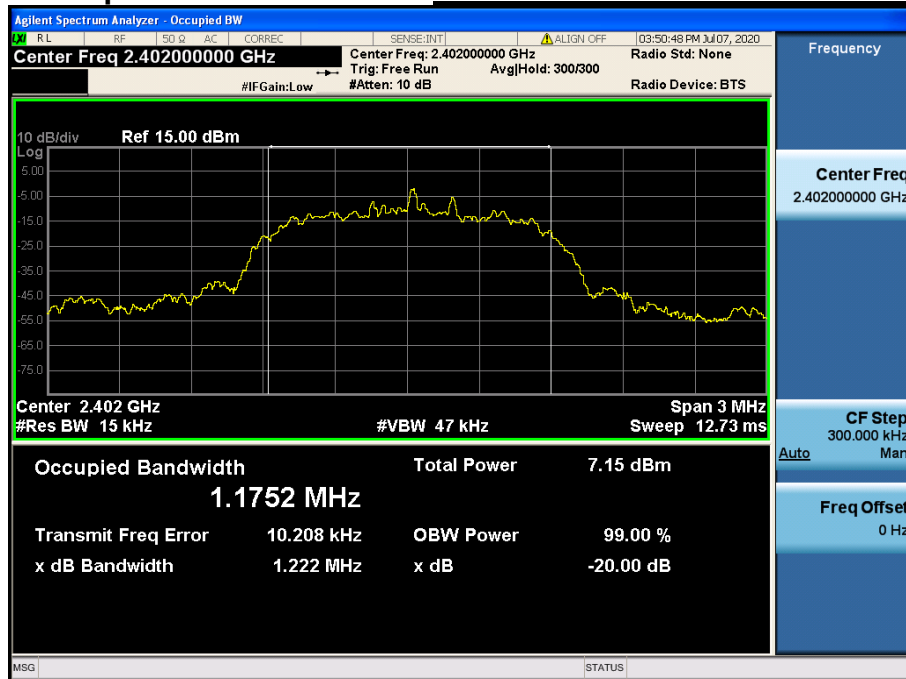
## 20 dB BW & Occupied BW

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



## 20 dB BW & Occupied BW

## Lowest Channel & Modulation : 8DPSK



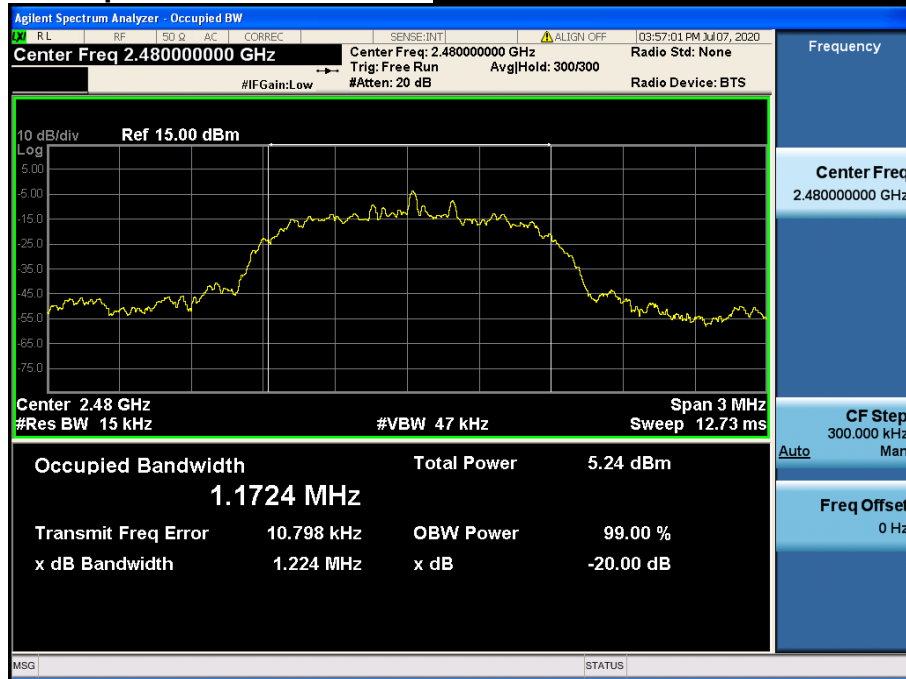
## 20 dB BW & Occupied BW

## Middle Channel & Modulation : 8DPSK



## 20 dB BW & Occupied BW

## 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 reference Channel (MHz) | Peak of adjacent Channel (MHz) | Test Result (MHz) |
|--------------|---------------|---------------------------------|--------------------------------|-------------------|
| Enable       | GFSK          | 2 441.026                       | 2 442.026                      | 1.000             |
|              | $\pi/4$ DQPSK | 2 441.026                       | 2 442.025                      | 0.999             |
|              | 8DPSK         | 2 440.026                       | 2 441.025                      | 0.999             |

#### AFH mode

| Hopping Mode | Modulation    | Peak of reference Channel (MHz) | Peak of adjacent Channel (MHz) | Test Result (MHz) |
|--------------|---------------|---------------------------------|--------------------------------|-------------------|
| Enable       | GFSK          | 2 441.026                       | 2 442.025                      | 0.999             |
|              | $\pi/4$ DQPSK | 2 440.026                       | 2 441.026                      | 1.000             |
|              | 8DPSK         | 2 440.026                       | 2 441.026                      | 1.000             |

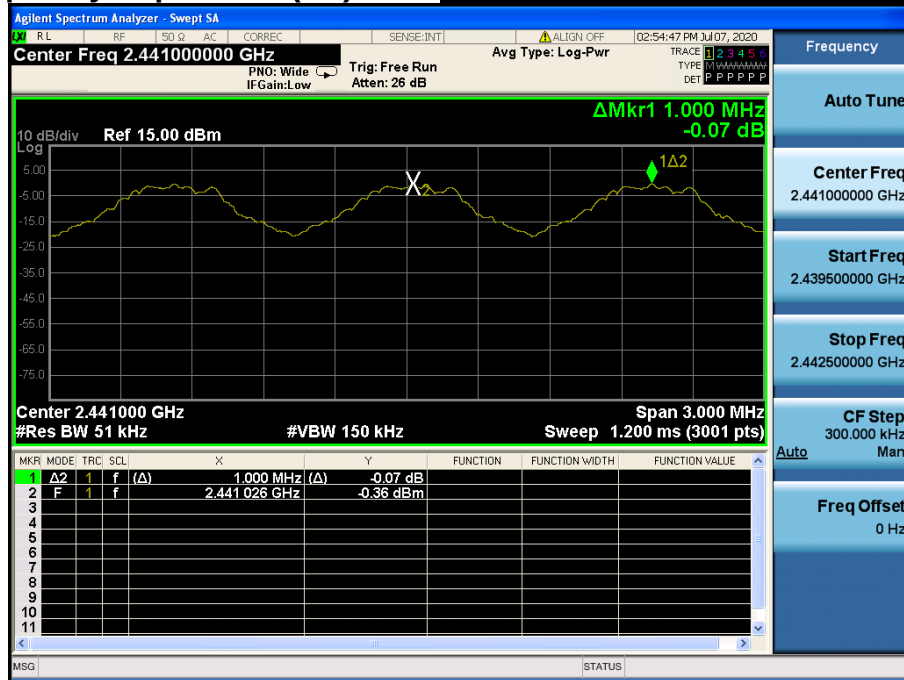
Note 1 : See next pages for actual measured spectrum

#### - 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 2 400 – 2 483.5 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

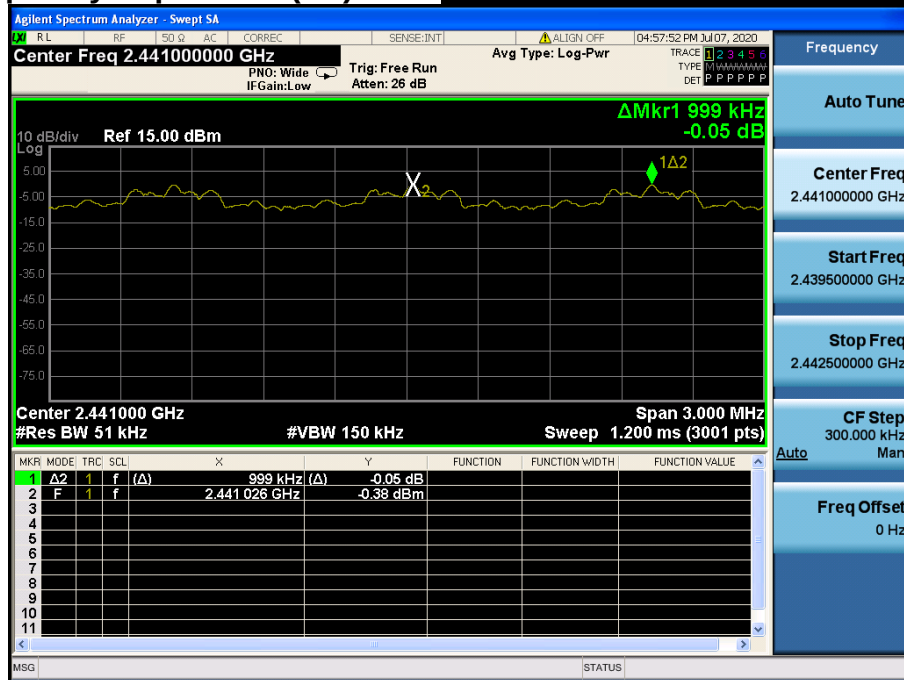
## Carrier Frequency Separation (FH)

*Hopping mode : Enable & GFSK*



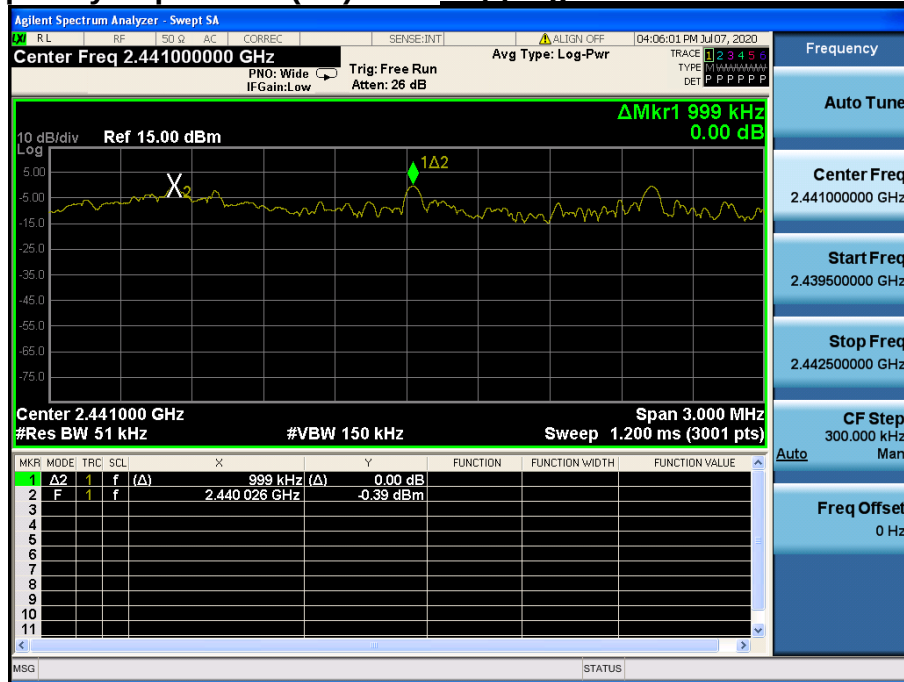
## Carrier Frequency Separation (FH)

*Hopping mode : Enable &  $\pi/4$ DQPSK*

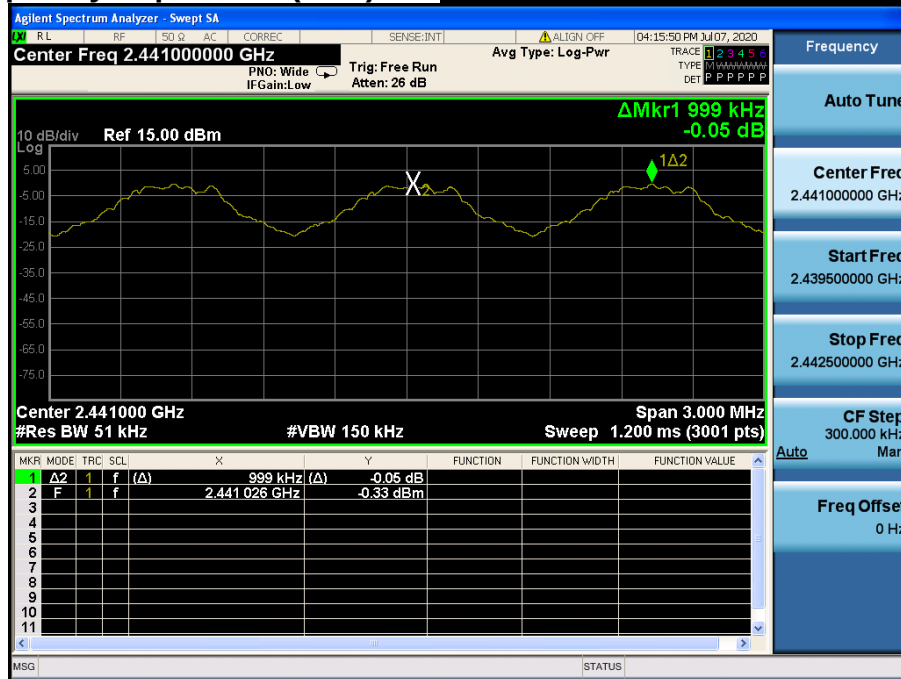


# Carrier Frequency Separation (FH)

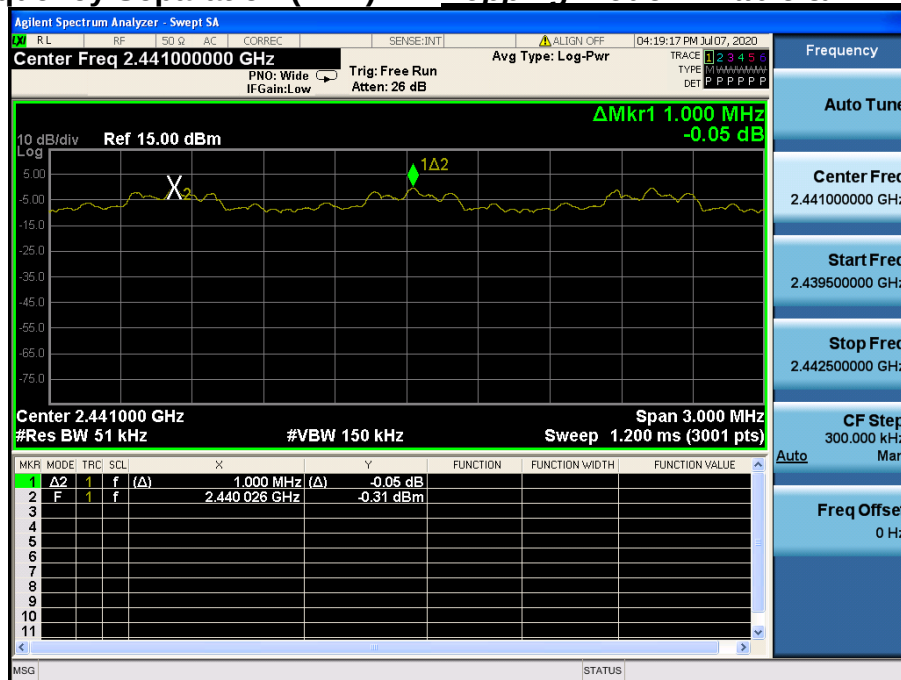
# Hopping mode : Enable & 8DPSK



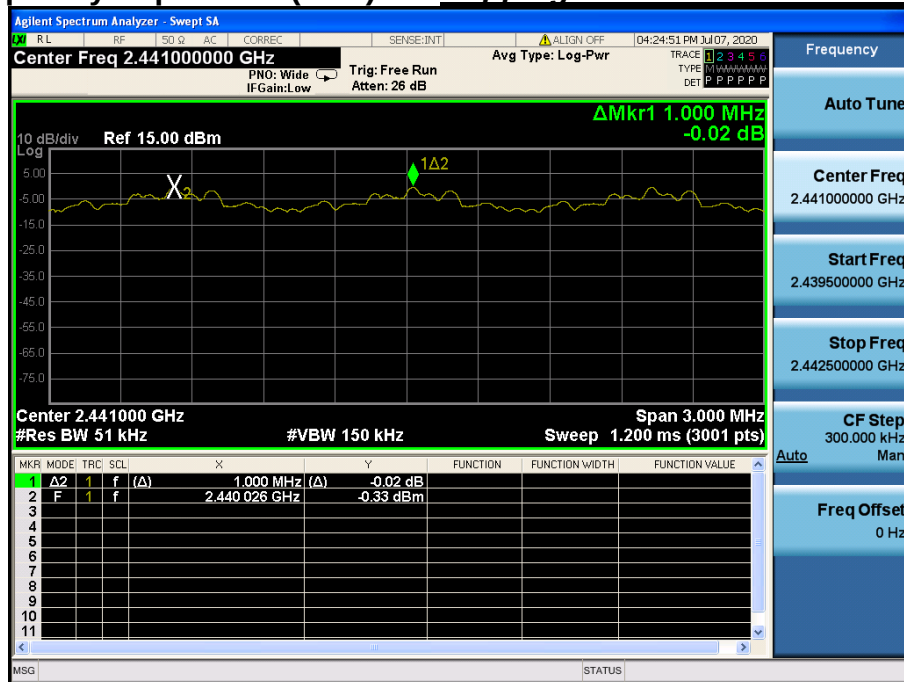
# Carrier Frequency Separation (AFH) *Hopping mode : Enable & GFSK*



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



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



## 5. Number of Hopping Frequencies

### 5.1 Test Setup

Refer to the APPENDIX I.

### 5.2 Limit

Limit :  $\geq 15$  hops

### 5.3 Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

To get higher resolution, two frequency ranges for FH mode within the 2 400 ~ 2 483.5 MHz were examined.

The spectrum analyzer is set to :

Span for FH mode = 50 MHz      Start Frequency = 2 391.5 MHz,   Stop Frequency = 2 441.5 MHz

Start Frequency = 2 441.5 MHz,   Stop Frequency = 2 491.5 MHz

Span for AFH mode = 30 MHz      Start Frequency = 2 426.0 MHz,   Stop Frequency = 2 456.0 MHz

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

### 5.4 Test Results

#### FH mode

| Hopping mode | Modulation    | Test Result (Total Hops) |
|--------------|---------------|--------------------------|
| Enable       | GFSK          | 79                       |
|              | $\pi/4$ DQPSK | 79                       |
|              | 8DPSK         | 79                       |

#### AFH mode

| Hopping mode | Modulation    | Test Result (Total Hops) |
|--------------|---------------|--------------------------|
| Enable       | GFSK          | 20                       |
|              | $\pi/4$ DQPSK | 20                       |
|              | 8DPSK         | 20                       |

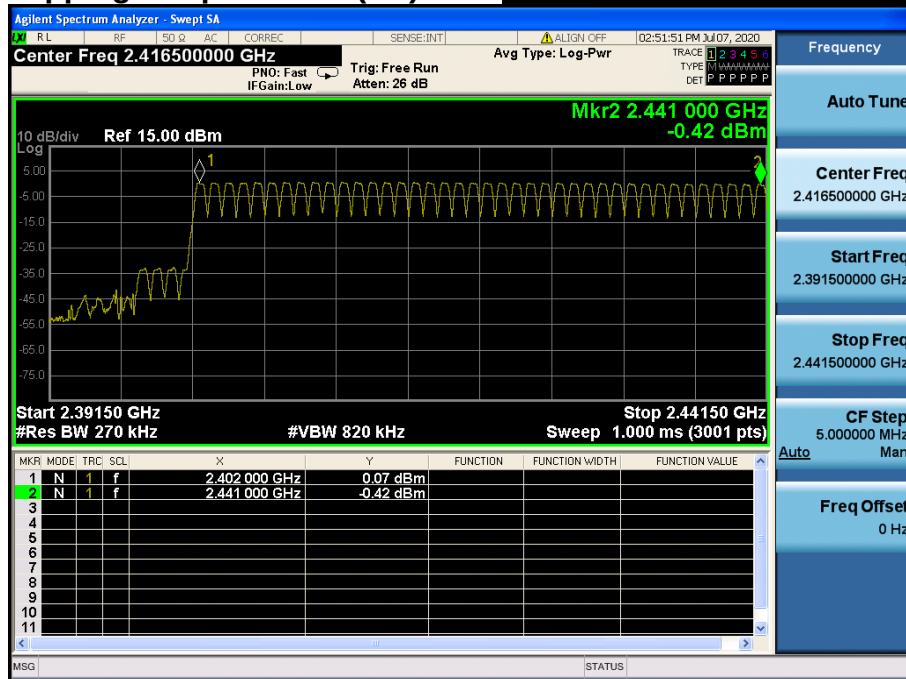
Note 1 : See next pages for actual measured spectrum plots.

#### - Minimum Standard :

At least 15 hops

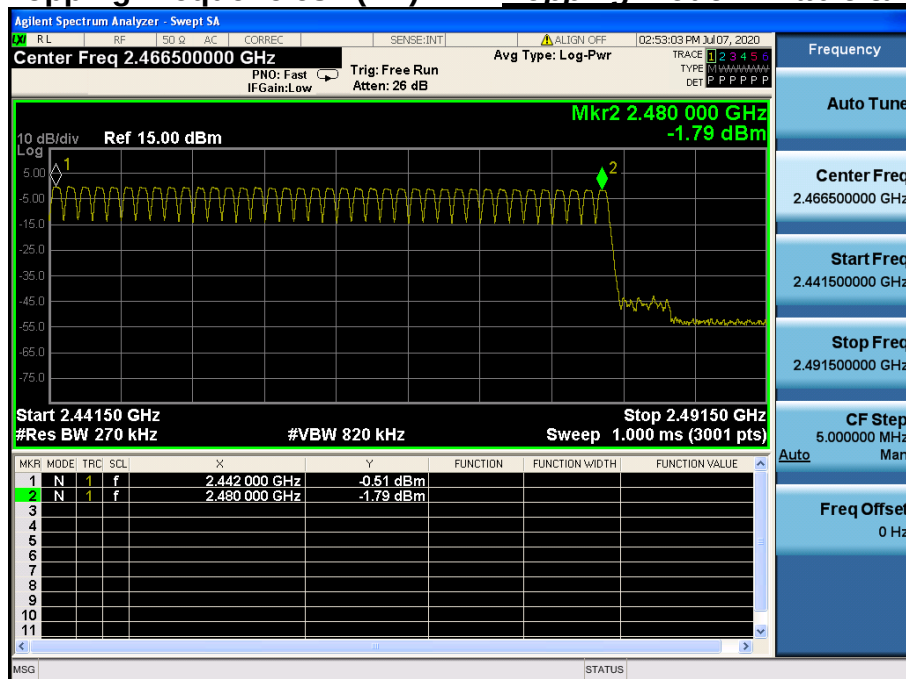
## Number of Hopping Frequencies 1(FH)

**Hopping mode : Enable & GFSK**



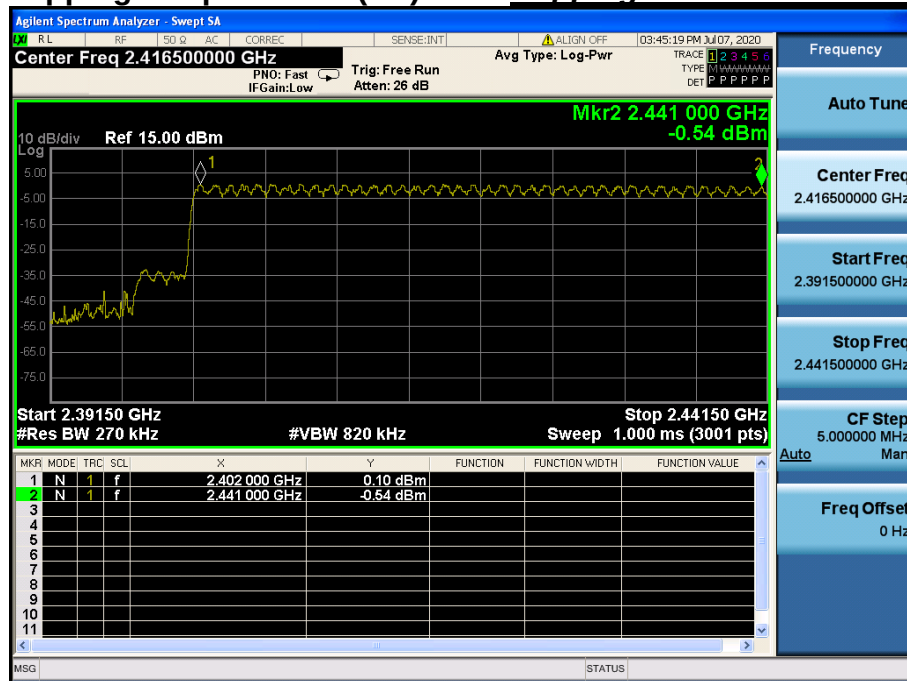
## Number of Hopping Frequencies 2(FH)

**Hopping mode : Enable & GFSK**



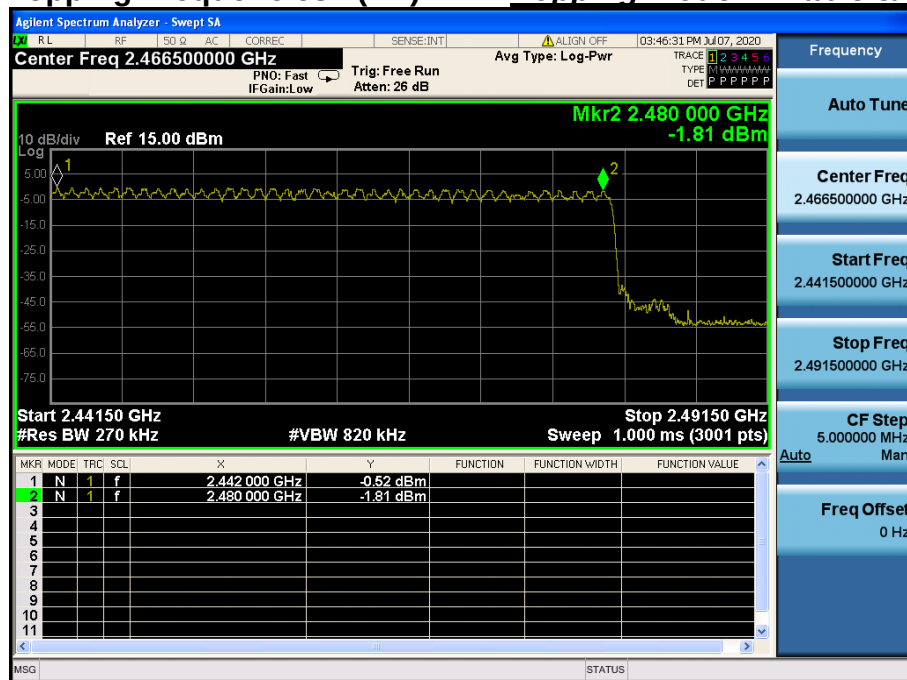
## Number of Hopping Frequencies 1(FH)

**Hopping mode : Enable &  $\pi/4$ DQPSK**



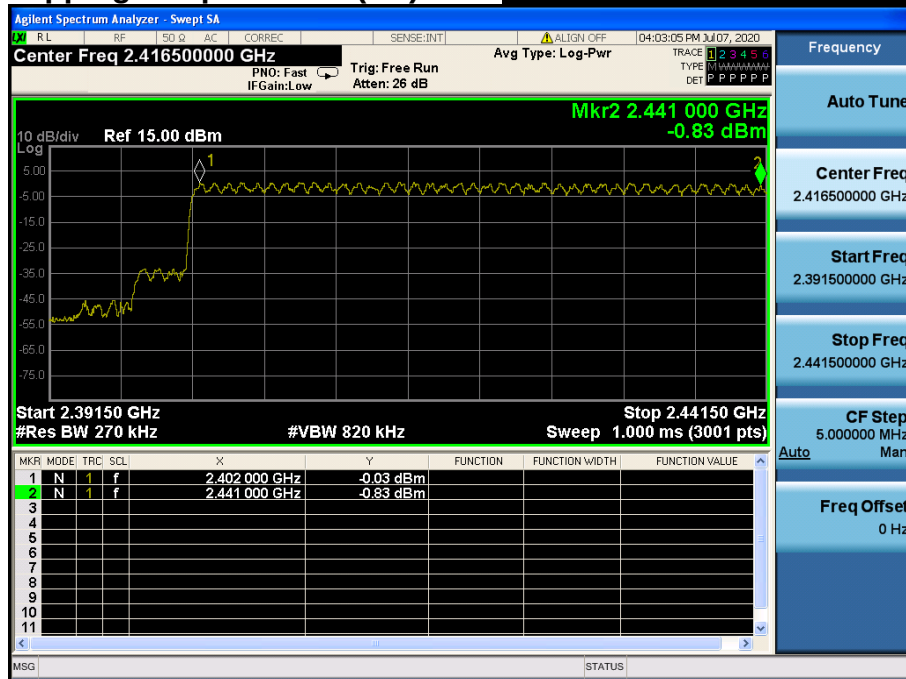
## Number of Hopping Frequencies 2(FH)

**Hopping mode : Enable &  $\pi/4$ DQPSK**



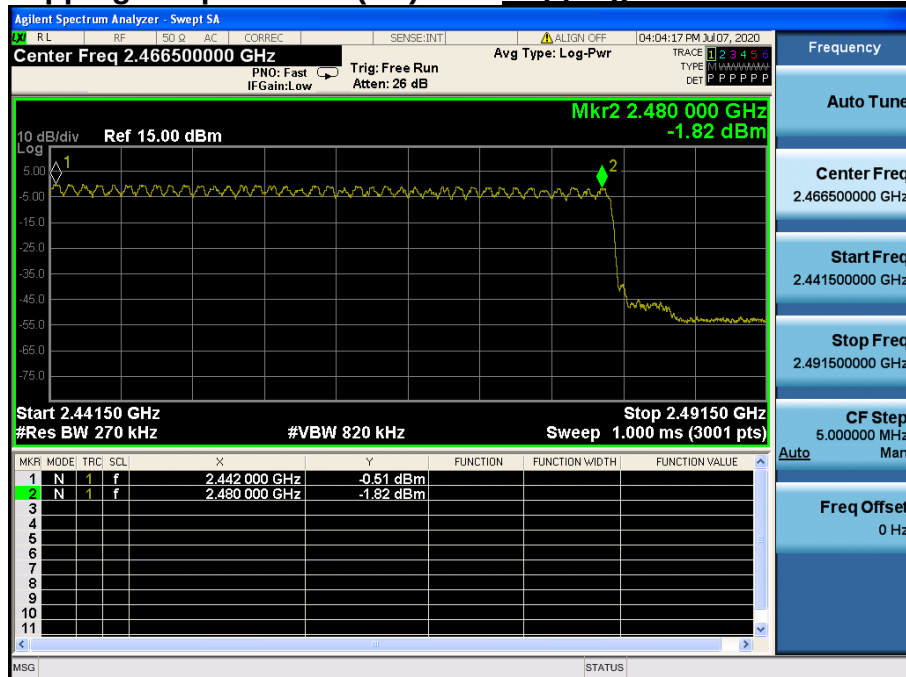
## Number of Hopping Frequencies 1(FH)

**Hopping mode : Enable & 8DPSK**

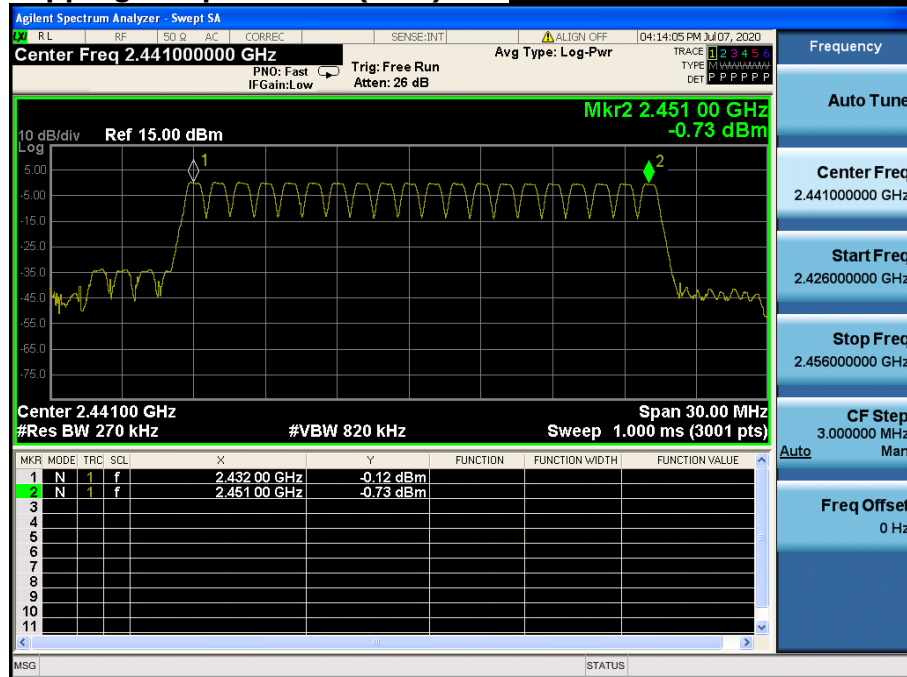


## Number of Hopping Frequencies 2(FH)

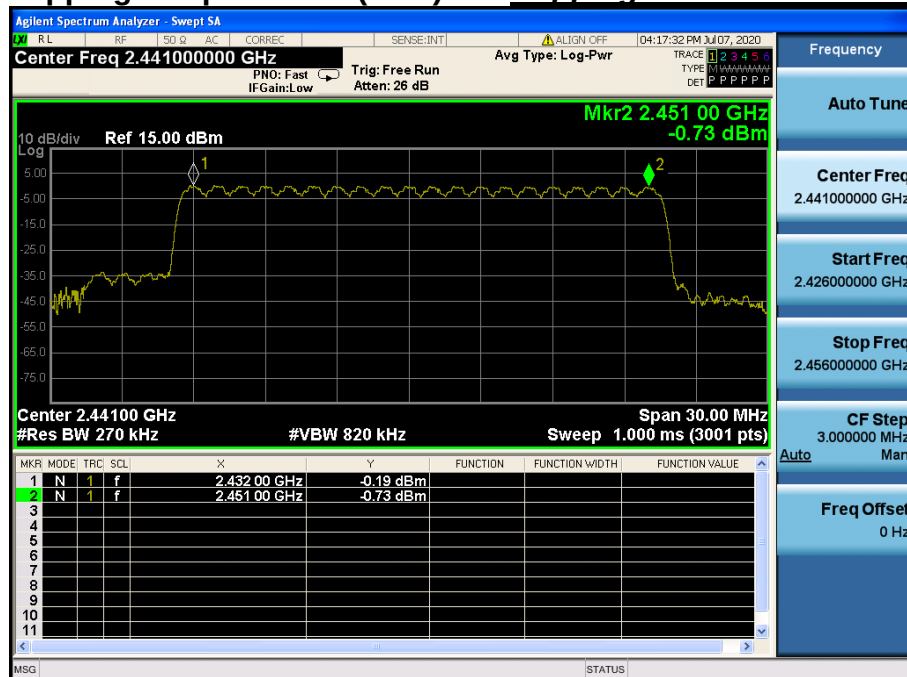
**Hopping mode : Enable & 8DPSK**



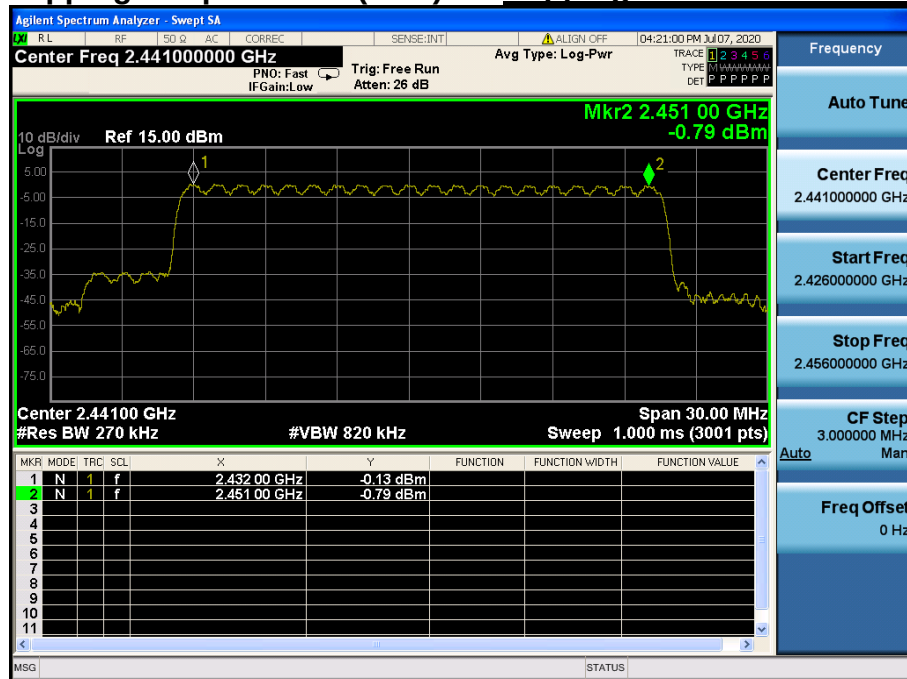
Number of Hopping Frequencies 1(AFH) Hopping mode : Enable & GFSK



Number of Hopping Frequencies 1(AFH) Hopping mode : Enable &  $\pi/4$ DQPSK



Number of Hopping Frequencies 1(AFH) *Hopping mode : Enable & 8DPSK*



## 6. Time of Occupancy (Dwell Time)

### 6.1 Test Setup

Refer to the APPENDIX I.

### 6.2 Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

### 6.3 Test Procedure

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

The spectrum analyzer is set to :

Center frequency = 2 441 MHz

Span = zero

RBW = 1 MHz (RBW shall be  $\leq$  channel spacing and where possible RBW should be set  $\gg 1 / T$ , where T is the expected dwell time per channel)

VBW  $\geq$  RBW

Detector function = peak

Trace = max hold

### 6.4 Test Results

#### FH mode

| Hopping mode | Packet Type | Number of hopping Channels | Burst On Time (ms) | Period (ms) | Test Result (sec) |
|--------------|-------------|----------------------------|--------------------|-------------|-------------------|
| Enable       | DH 5        | 79                         | 2.880              | 3.750       | 0.307             |
|              | 2 DH 5      | 79                         | 2.880              | 3.750       | 0.307             |
|              | 3 DH 5      | 79                         | 2.880              | 3.750       | 0.307             |

#### AFH mode

| Hopping mode | Packet Type | Number of hopping Channels | Burst On Time (ms) | Period (ms) | Test Result (sec) |
|--------------|-------------|----------------------------|--------------------|-------------|-------------------|
| Enable       | DH 5        | 20                         | 2.880              | 3.750       | 0.154             |
|              | 2 DH 5      | 20                         | 2.880              | 3.750       | 0.154             |
|              | 3 DH 5      | 20                         | 2.880              | 3.750       | 0.154             |

Note 1 : Dwell Time =  $0.4 \times \text{Hopping channel} \times \text{Burst ON time} \times$

$((\text{Hopping rate} \div \text{Time slots}) \div \text{Hopping channel})$

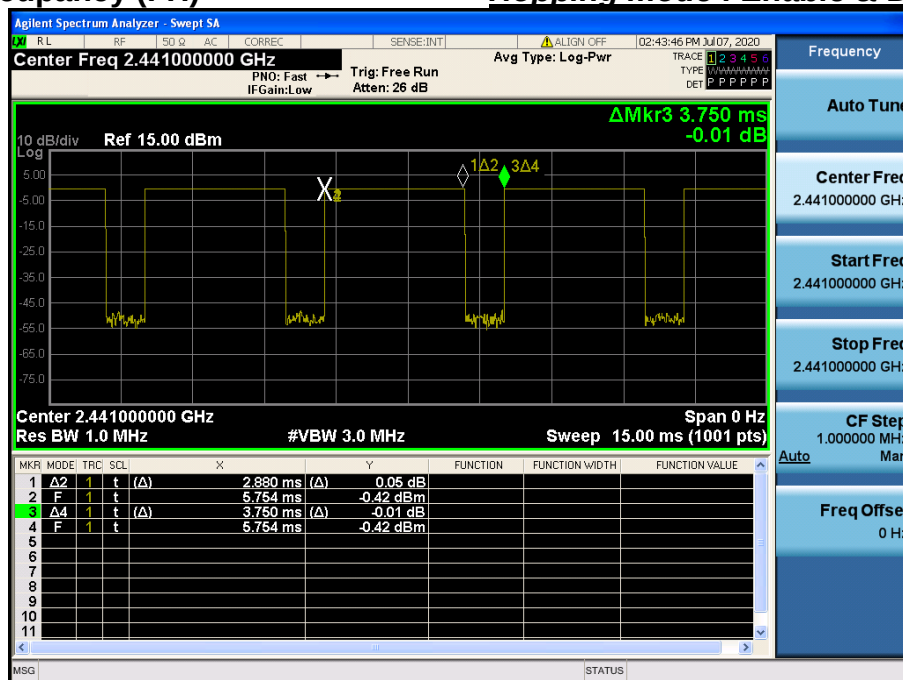
- Time slots for DH5 = 6 slots (TX = 5 slots / RX = 1 slot)

- Hopping Rate = 1 600 for FH mode & 800 for AFH mode

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

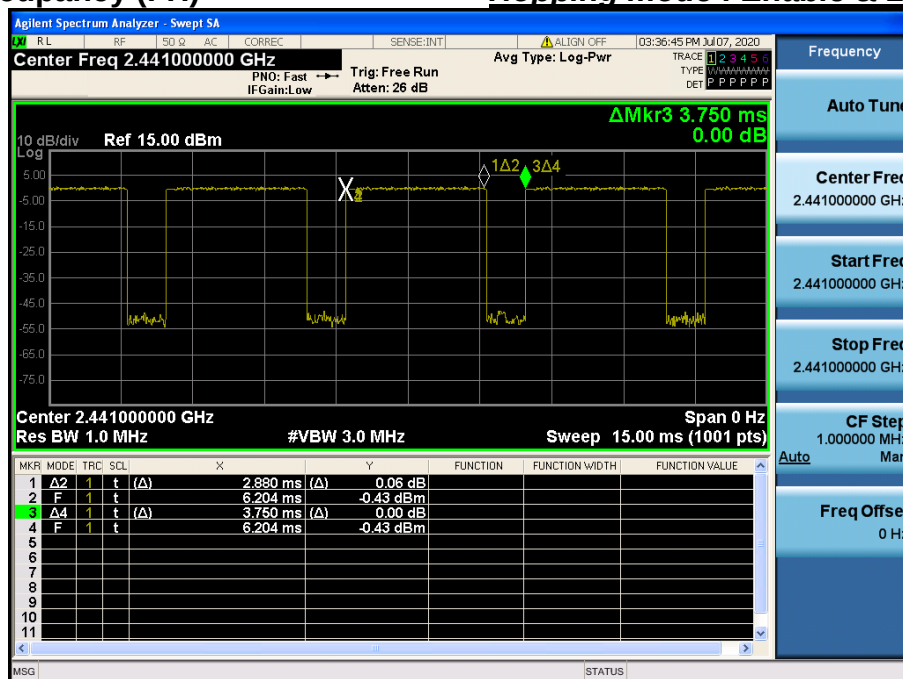
## Time of Occupancy (FH)

## Hopping mode : Enable &amp; DH5



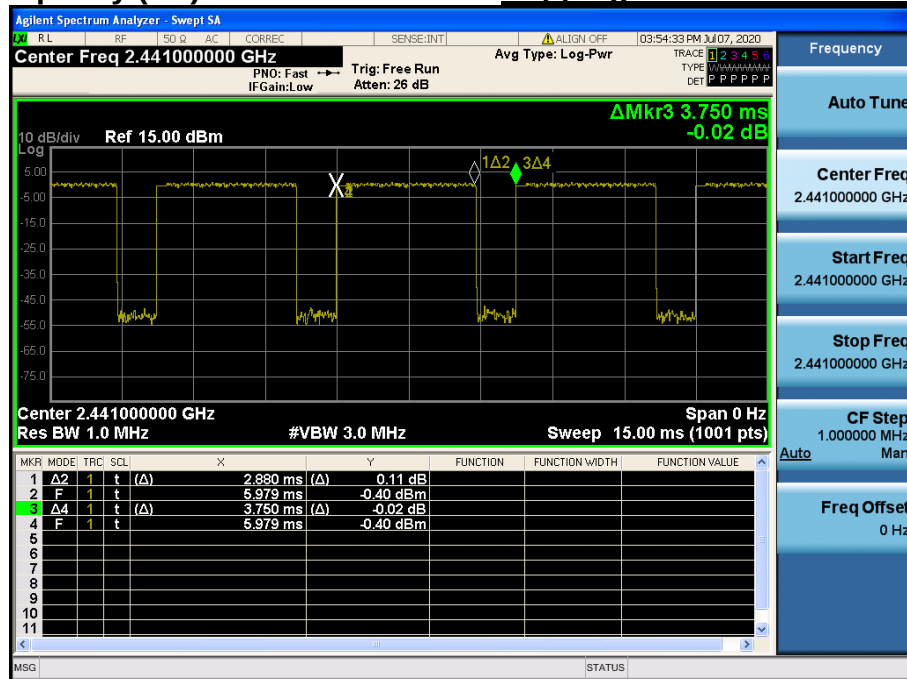
## Time of Occupancy (FH)

## Hopping mode : Enable &amp; 2-DH5

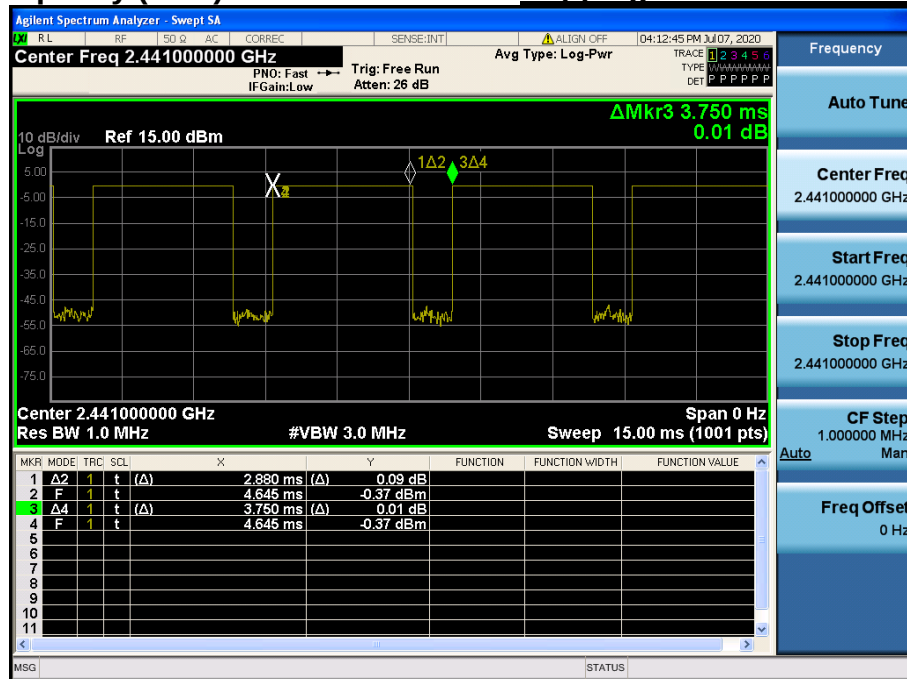


# Time of Occupancy (FH)

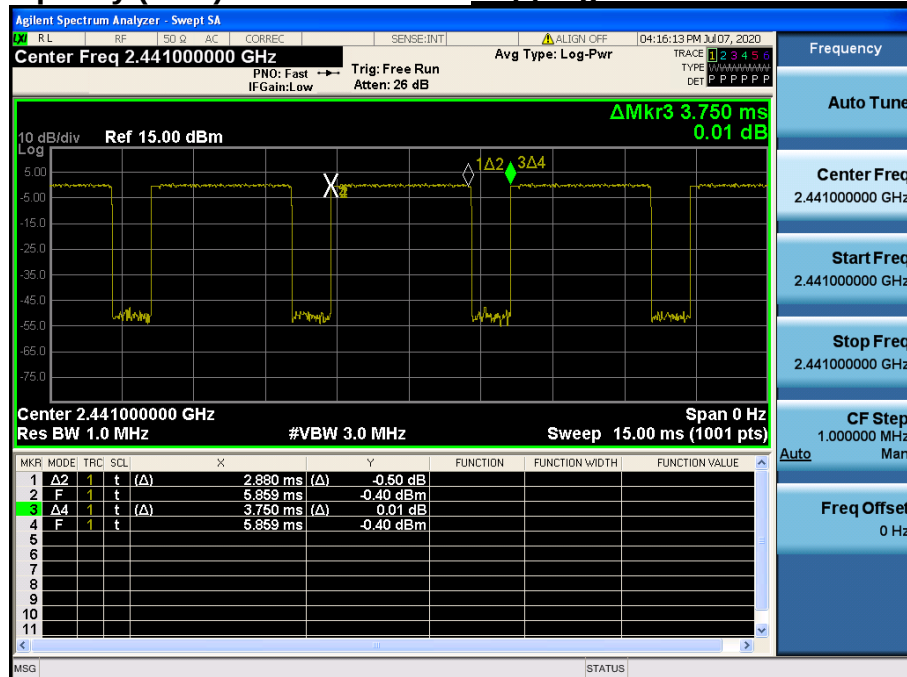
## Hopping mode : Enable & 3-DH5



## Time of Occupancy (AFH)

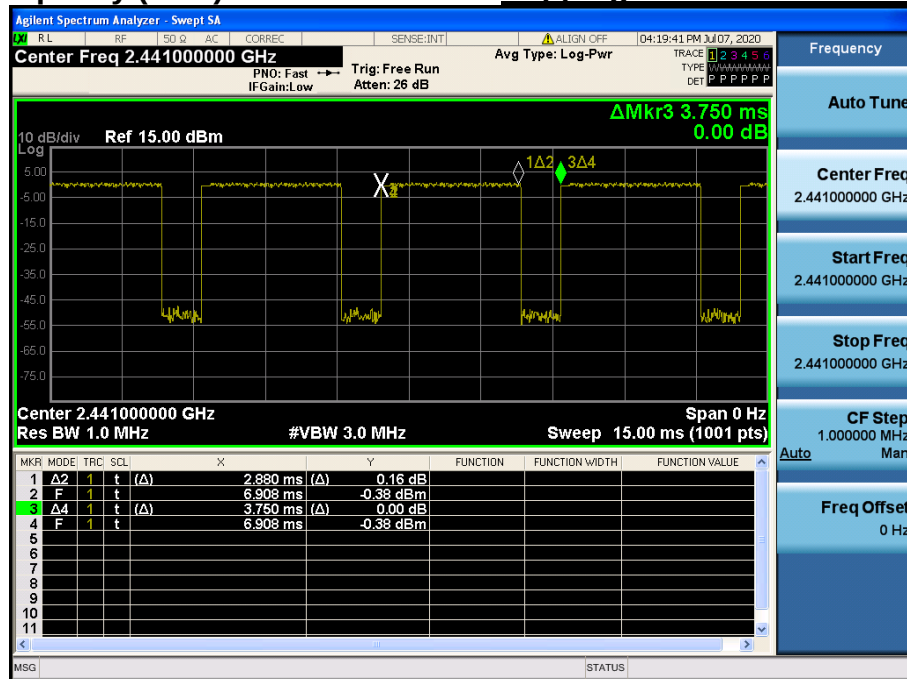
Hopping mode : Enable & DH5

## Time of Occupancy (AFH)

Hopping mode : Enable & 2-DH5

# Time of Occupancy (AFH)

## Hopping mode : Enable & 3-DH5



## 7. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

### 7.1 Test Setup

Refer to the APPENDIX I.

### 7.2 Limit

According to §15.247(d), 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

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 (MHz) | Limit (uV/m)  | Measurement Distance (meter) |
|-----------------|---------------|------------------------------|
| 0.009 ~ 0.490   | 2400/F (kHz)  | 300                          |
| 0.490 ~ 1705    | 24000/F (kHz) | 30                           |
| 1705 ~ 30.0     | 30            | 30                           |
| 30 ~ 88         | 100 **        | 3                            |
| 88 ~ 216        | 150 **        | 3                            |
| 216 ~ 960       | 200 **        | 3                            |
| Above 960       | 500           | 3                            |

\*\* Except as provided in 15.209(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. 15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below :

| MHz               | MHz                 | MHz                   | MHz             | GHz          | GHz           |
|-------------------|---------------------|-----------------------|-----------------|--------------|---------------|
| 0.009 ~ 0.110     | 8.41425 ~ 8.41475   | 108 ~ 121.94          | 1300 ~ 1427     | 4.5 ~ 5.15   | 14.47 ~ 14.5  |
| 0.495 ~ 0.505     | 12.29 ~ 12.293      | 123 ~ 138             | 1435 ~ 1626.5   | 5.35 ~ 5.46  | 15.35 ~ 16.2  |
| 2.1735 ~ 2.1905   | 12.51975 ~ 12.52025 | 149.9 ~ 150.05        | 1645.5 ~ 1646.5 | 7.25 ~ 7.75  | 17.7 ~ 21.4   |
| 4.125 ~ 4.128     | 12.57675 ~ 12.57725 | 156.52475 ~ 156.52525 | 1660 ~ 1710     | 8.025 ~ 8.5  | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 13.36 ~ 13.41       | 156.7 ~ 156.9         | 1718.8 ~ 1722.2 | 9.0 ~ 9.2    | 23.6 ~ 24.0   |
| 4.20725 ~ 4.20775 | 16.42 ~ 16.423      | 162.0125 ~ 167.17     | 2200 ~ 2300     | 9.3 ~ 9.5    | 31.2 ~ 31.8   |
| 6.215 ~ 6.218     | 16.69475 ~ 16.69525 | 167.72 ~ 173.2        | 2310 ~ 2390     | 10.6 ~ 12.7  | 36.43 ~ 36.5  |
| 6.26775 ~ 6.26825 | 16.80425 ~ 16.80475 | 240 ~ 285             | 2483.5 ~ 2500   | 13.25 ~ 13.4 | Above 38.6    |
| 6.31175 ~ 6.31225 | 25.5 ~ 25.67        | 322 ~ 335.4           | 2655 ~ 2900     |              |               |
| 8.291 ~ 8.294     | 37.5 ~ 38.25        | 399.90 ~ 410          | 3260 ~ 3267     |              |               |
| 8.362 ~ 8.366     | 73 ~ 74.6           | 608 ~ 614             | 3332 ~ 3339     |              |               |
| 8.37625 ~ 8.38675 | 74.8 ~ 75.2         | 960 ~ 1240            | 3345.8 ~ 3358   |              |               |
|                   |                     |                       | 3600 ~ 4400     |              |               |

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

## 7.3. Test Procedures

### 7.3.1. Test Procedures for Radiated Spurious Emissions

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.  
The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 1 or 3 meter away from the interference-receiving antenna.
3. For measurements above 1 GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.
4. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
7. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

### Measurement Instrument Setting

- Frequencies less than or equal to 1 000 MHz  
The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
- Frequencies above 1 000 MHz  
The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.  
The result of Average measurement is calculated using PK result and duty correction factor.