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 : DRTFCC1805-0131(1)
2. Customer
   - Name : HYUNDAI MOBIS CO., LTD.
   - Address : 203 Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : DIGITAL CAR AVN SYSTEM / ATC44F2AN
   FCC ID : TQ8-ATC44F2AN
5. Test Method Used : ANSI C63.10-2013
   Test Specification : FCC Part 15 Subpart C.247
6. Date of Test : 2018.03.27 ~ 2018.04.06
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by Name : InHee Bae (Signature)	Reviewed by Name : GeunKi Son (Signature)

2018 . 05 . 23 .

DT&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description
DRTFCC1805-0131	May. 21, 2018	Initial issue
DRTFCC1805-0131(1)	May. 23, 2018	Updated Equipment List

Table of Contents

1. General Information

1.1 Testing Laboratory

DT&C Co., Ltd.		
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. The test site comply with the requirements of § 2.948 according to ANSI 63.4-2014. **- FCC MRA Accredited Test Firm No. : KR0034**		
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.2 Testing Environment

Ambient Condition	
▪ Temperature	+21 ℃ ~ +25 ℃
▪ Relative Humidity	38 % ~ 42 %

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	1.0 dB (The confidence level is about 95 %, k = 2)
Conducted spurious emission	1.1 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)

1.4 Details of Applicant

Applicant : HYUNDAI MOBIS CO., LTD.
Address : 203 Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977
Contact person : Seung Hoon Choe

1.5 Description of EUT

EUT	DIGITAL CAR AVN SYSTEM
Model Name	ATC44F2AN
Add Model Name	NA
Serial Number	Identical prototype
Hardware version	1.0
Software version	1.0
Power Supply	DC 14.4 V
Frequency Range	2402 MHz ~ 2480 MHz
Modulation Technique	GFSK, π/4-DQPSK, 8DPSK
Number of Channels	79
Antenna Type /Antenna Gain	Pattern Antenna / PK : -0.05 dBi

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 badwidths of Their corresponding transmitters and shift frequencies in synchroniztation with the transmit Ted 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 (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	17/07/17	18/07/17	US47360812
Spectrum Analyzer	Agilent Technologies	N9020A	17/09/05	18/09/05	MY46471251
BlueTooth Tester	TESCOM	TC-3000C	17/12/26	18/12/26	3000C000396
DC Power Supply	Agilent Technologies	66332A	17/09/05	18/09/05	MY43000211
DC Power Supply	SM techno	SDP30-5D	17/12/26	18/12/26	305DKA013
Multimeter	FLUKE	17B	17/12/26	18/12/26	26030065WS
Power Splitter	Anritsu	K241B	17/12/27	18/12/27	1301184
Signal Generator	Rohde Schwarz	SMBV100A	17/12/27	18/12/27	255571
Signal Generator	Rohde Schwarz	SMF100A	17/12/27	18/12/27	102341
Thermohygrometer	BODYCOM	BJ5478	18/01/03	19/01/03	120612-2
Loop Antenna	Schwarzbeck	FMZB1513	18/01/30	20/01/30	1513-128
BILOG ANTENNA	Schwarzbeck	VULB 9160	16/08/05	18/08/05	9160-3362
HORN ANT	ETS	3117	16/05/13	18/05/13	140394
HORN ANT	A.H.Systems	SAS-574	17/07/31	19/07/31	155
PreAmplifier	Agilent Technologies	8449B	17/09/05	18/09/05	3008A02108
PreAmplifier	TSJ	MLA-010K01-B01-27	18/03/05	19/03/05	1844539
EMI Test Receiver	Rohde Schwarz	ESR7	18/02/13	19/02/13	101061
High-pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	17/09/05	18/09/05	3
High-pass filter	Wainwright	WHNX6-6320-8000-26500-40CC	17/09/05	18/09/05	1
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A MA2411B	17/12/27	18/12/27	1338004 1306053
CABLE	DTNC	CABLE	17/06/22	18/06/22	C-016-4
CABLE	DTNC	CABLE	17/06/22	18/06/22	RF-81
CABLE	Radiall	TESETPRO3	17/06/22	18/06/22	RF-74
CABLE	HUBER+SUHNER	SUCOFLEX103	17/06/22	18/06/22	RF-75
CABLE	Radiall	TESTPRO3	17/06/22	18/06/22	RF-66
CABLE	DTNC	CABLE	18/02/21	19/02/21	RF-61

Note 1 : The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.
Note 2 : 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 RSS Std.	Parameter	Limit (Using in 2400~ 2483.5 MHz)	Test Condition	Status Note 1
15.247(a) RSS-247(5.1)	Carrier Frequency Separation	>= 25 kHz or >= Two thirds of the 20 dB BW, 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) RSS-247(5.4)	Transmitter Output Power	**For FCC** =< 1 Watt , if CHs >= 75 Others =< 0.125 W **For IC** if CHs >= 75 =< 1 Watt For Conducted Power =< 4 Watt For e.i.r.p, Others =< 0.125 W For Conducted Power. =< 4 Watt For e.i.r.p		C
15.247(d) RSS-247(5.5)	Conducted Spurious Emissions	The radiated emission to any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density.		C
RSS Gen(6.6)	Occupied Bandwidth (99 %)	N/A		NA
15.247(d) 15.205 & 209 RSS-247(5.5) RSS-Gen (8.9 & 8.10)	Radiated Spurious Emissions	FCC 15.209 Limits	Radiated	C Note2
15.207 RSS-Gen(8.8)	AC Conducted Emissions	FCC 15.207 Limits	AC Line Conducted	NA Note3
15.203 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 : For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.

Note 3 : This device is installed in a car. Therefore the power source is a battery of car.

1.10 Conclusion of worst-case and operation mode

The EUT has three type of modulation (GFSK, π/4DQPSK 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	2402 ~ 2480	2402 ~ 2480

- Hopping Function : Disable

	TX Frequency (MHz)	RX Frequency (MHz)
Lowest Channel	2402	2402
Middle Channel	2441	2441
Highest Channel	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 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.

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 ≥ 20 dB BW
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

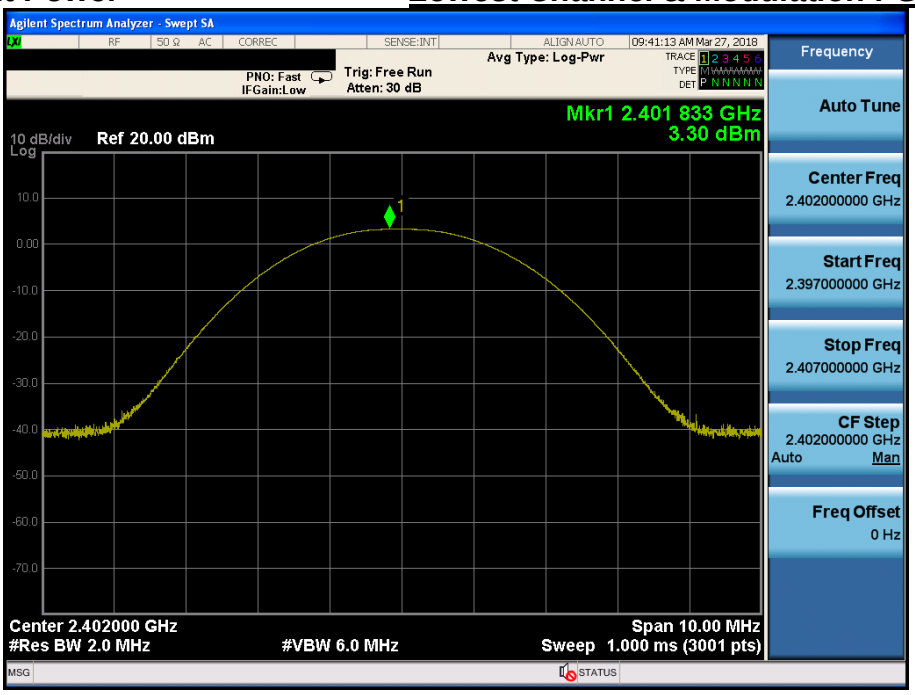
2.4 Test Results

Modulation	Tested Channel	Frame Average Output Power		Peak Output Power	
		dBm	mW	dBm	mW
GFSK	**Lowest**	2.81	1.91	3.30	2.14
	Middle	**3.00**	**2.00**	**3.43**	**2.20**
	Highest	1.81	1.52	3.06	2.02
π/4DQPSK	**Lowest**	1.15	1.30	4.06	2.55
	Middle	**1.32**	**1.36**	**4.21**	**2.64**
	Highest	0.12	1.03	3.83	2.42
8DPSK	**Lowest**	1.13	1.30	4.38	2.74
	Middle	**1.30**	**1.35**	**4.53**	**2.84**
	Highest	0.09	1.02	4.15	2.60

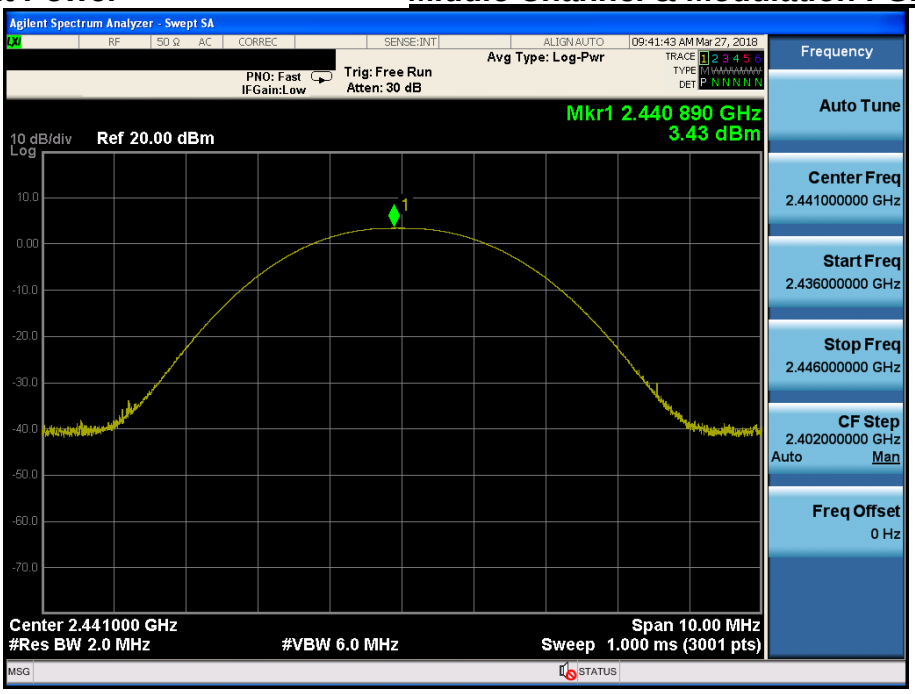
Note 1 : The frame average output power was tested using an average power meter for reference only.

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

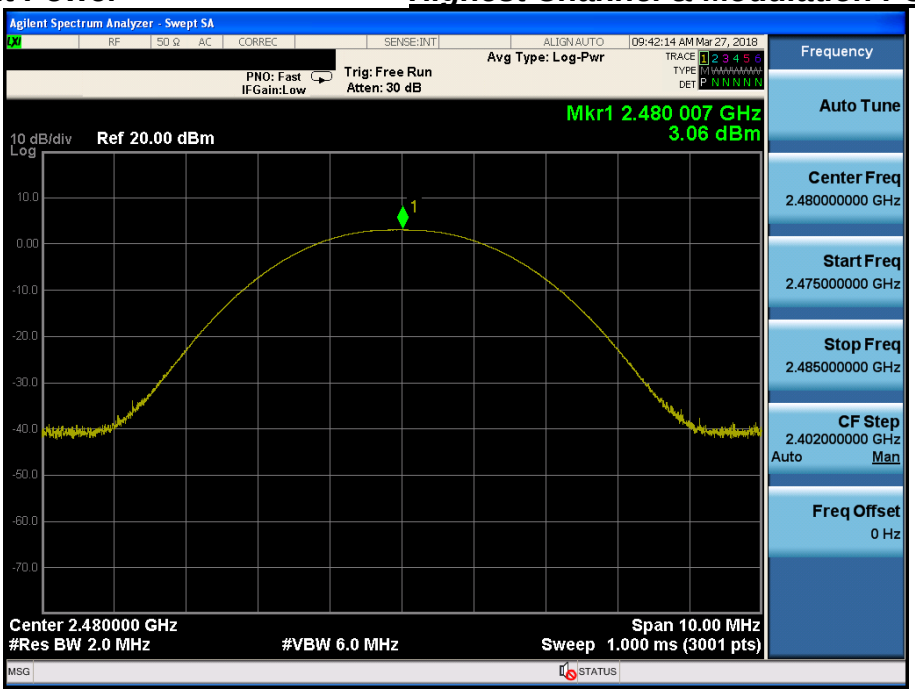
Peak Output Power ***Lowest Channel & Modulation : GFSK***



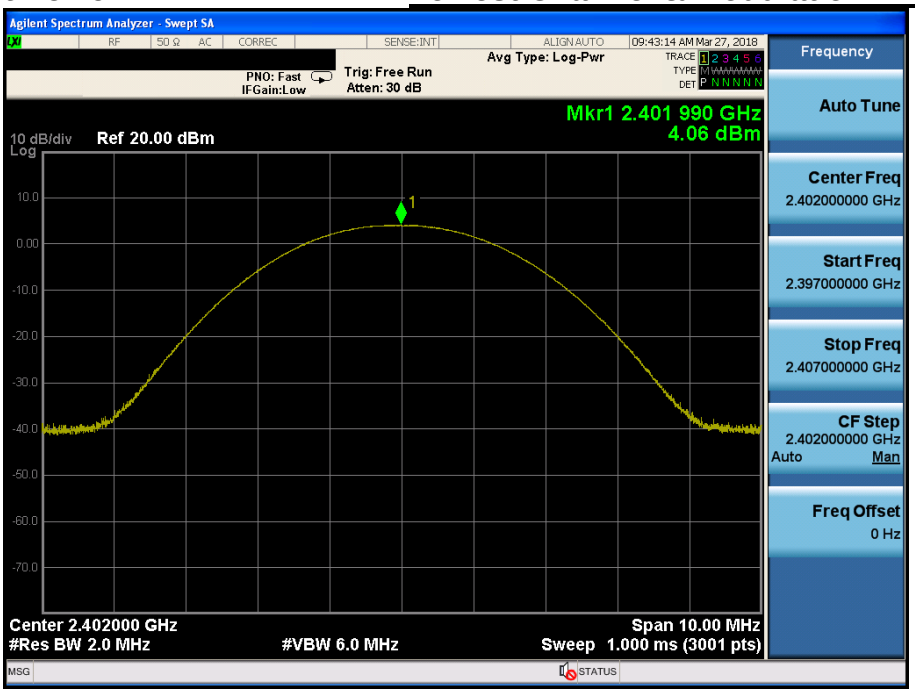
Peak Output Power ***Middle Channel & Modulation : GFSK***



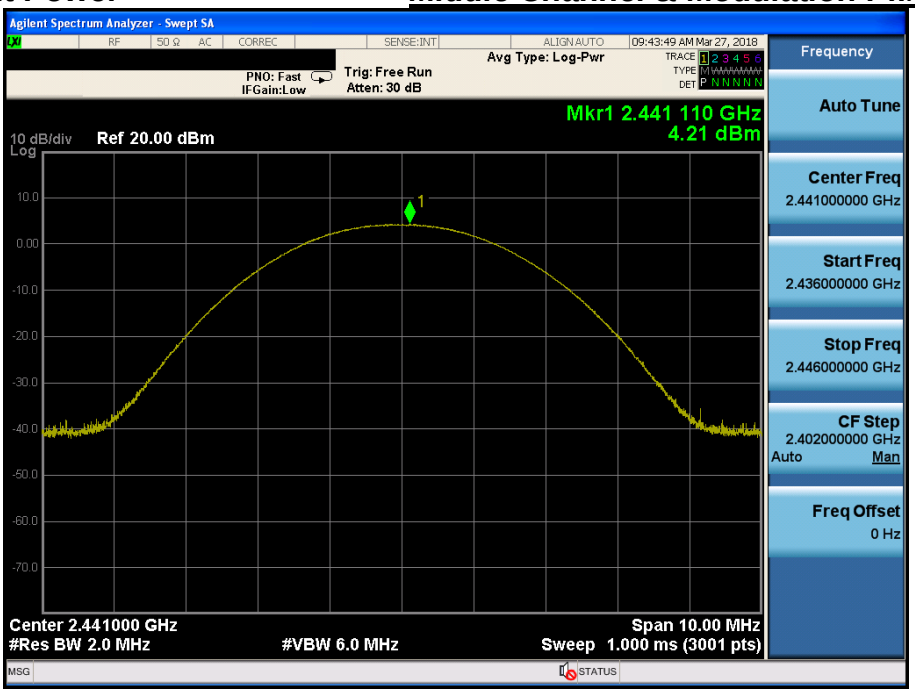
Peak Output Power ***Highest Channel & Modulation : GFSK***



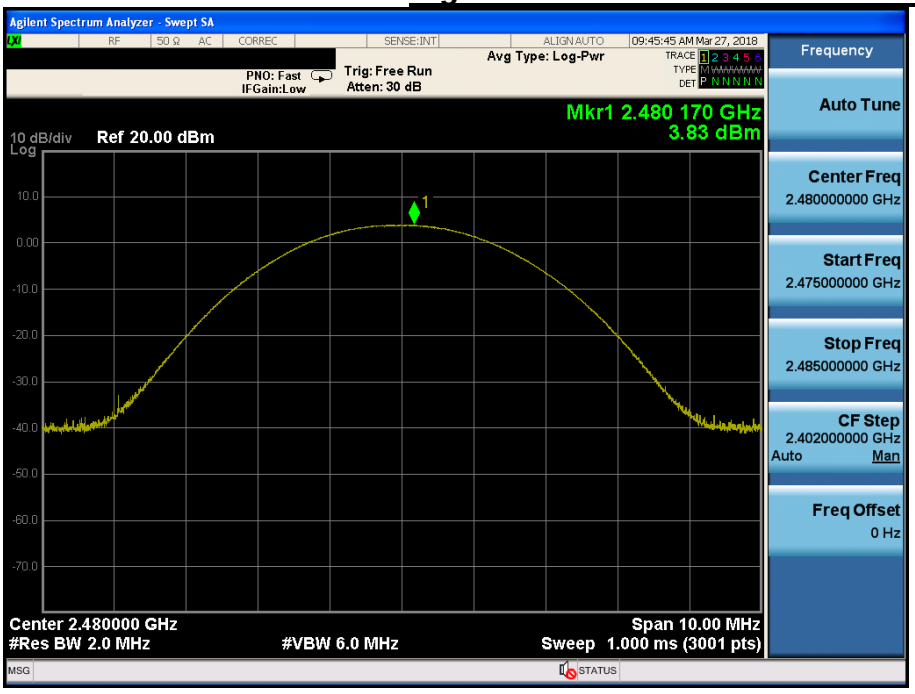
Peak Output Power ***Lowest Channel & Modulation : π/4DQPSK***



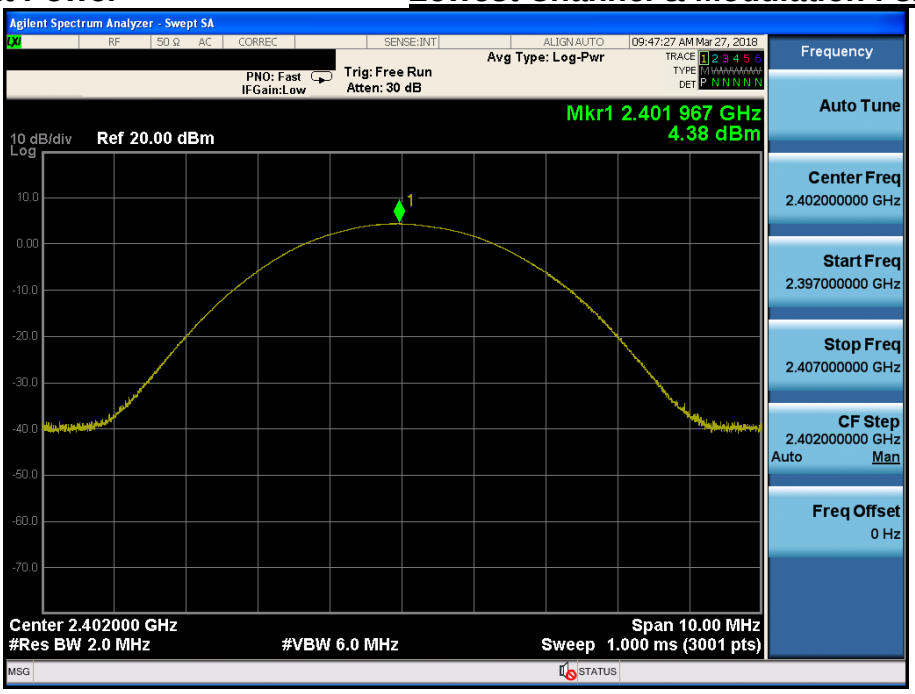
Peak Output Power ***Middle Channel & Modulation : π/4DQPSK***



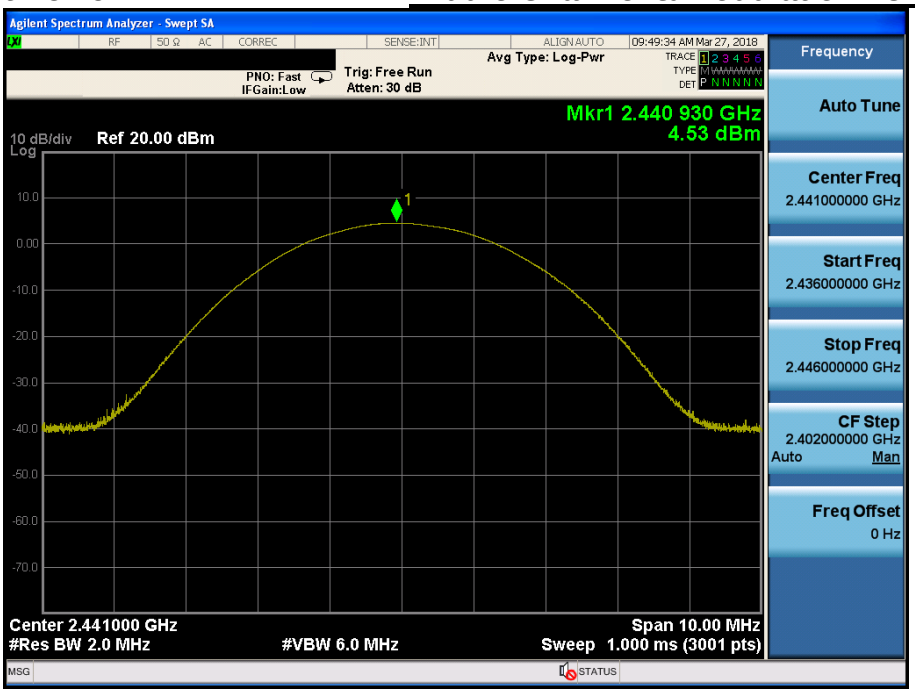
Peak Output Power ***Highest Channel & Modulation : π/4DQPSK***



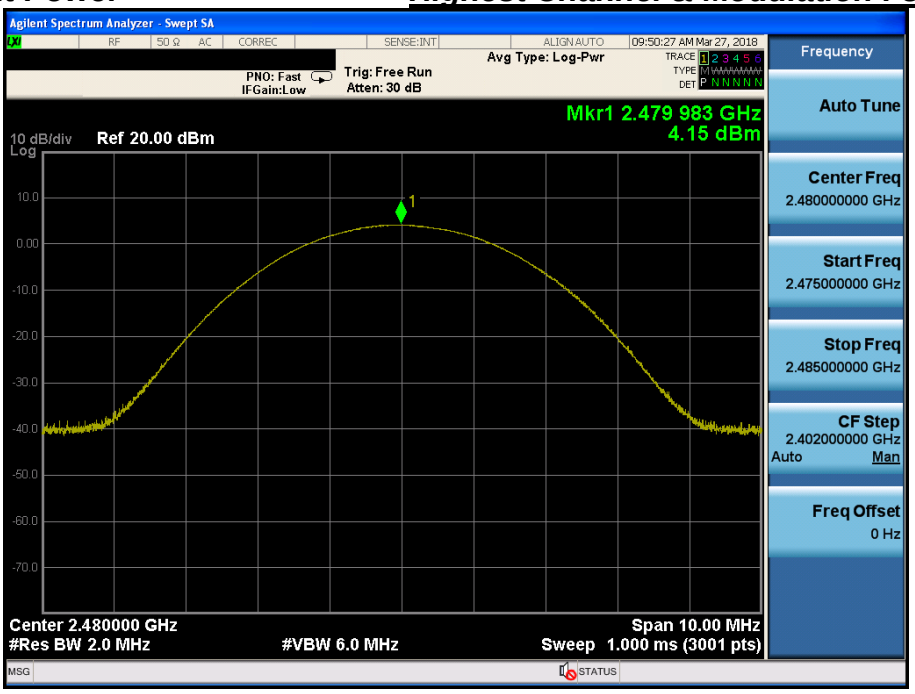
Peak Output Power ***Lowest Channel & Modulation : 8DPSK***



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

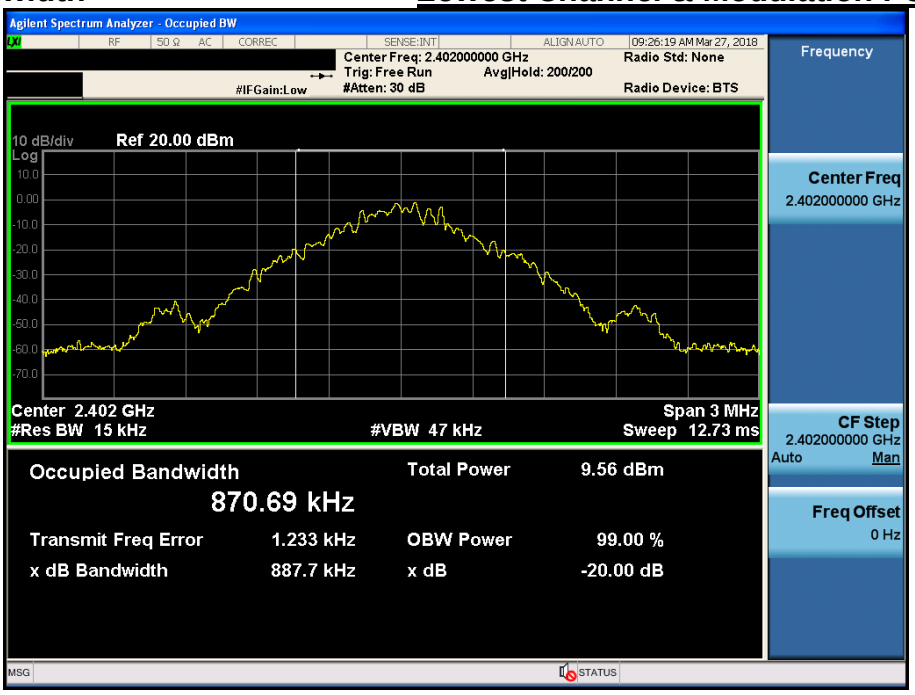
3.3 Test Procedure

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 ≥ 3 × 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)
GFSK	**Lowest**	0.888	-
	Middle	**0.888**	-
	Highest	0.888	-
π/4DQPSK	**Lowest**	1.306	-
	Middle	**1.310**	-
	Highest	1.303	-
8DPSK	**Lowest**	**1.269**	-
	Middle	1.254	-
	Highest	1.263	-

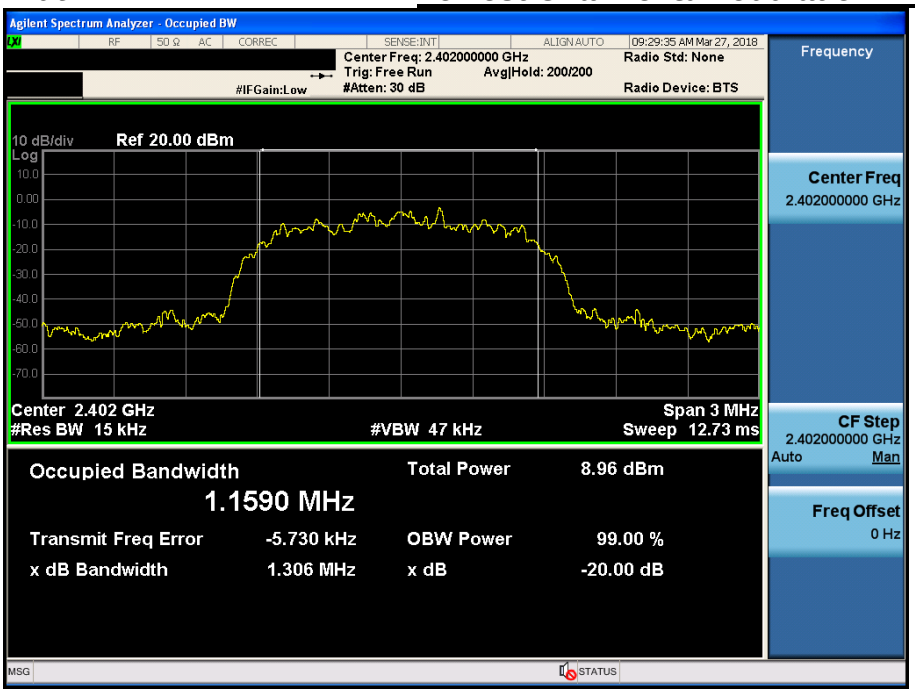
20 dB Bandwidth ***Lowest Channel & Modulation : GFSK***



20 dB Bandwidth ***Middle Channel & Modulation : GFSK***

20 dB Bandwidth ***Highest Channel & Modulation : GFSK***

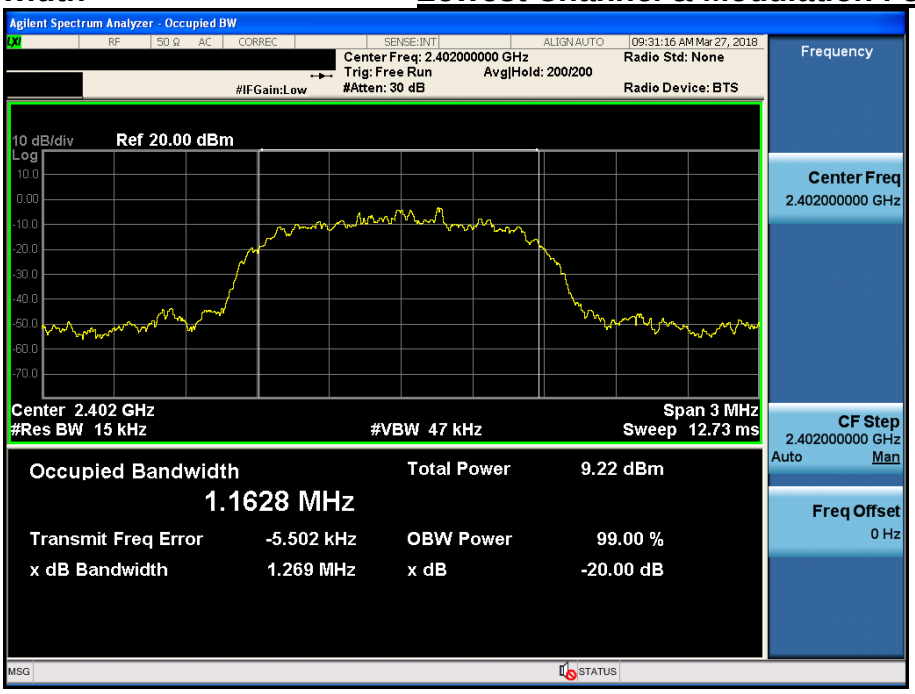
20 dB Bandwidth ***Lowest Channel & Modulation : π/4DQPSK***



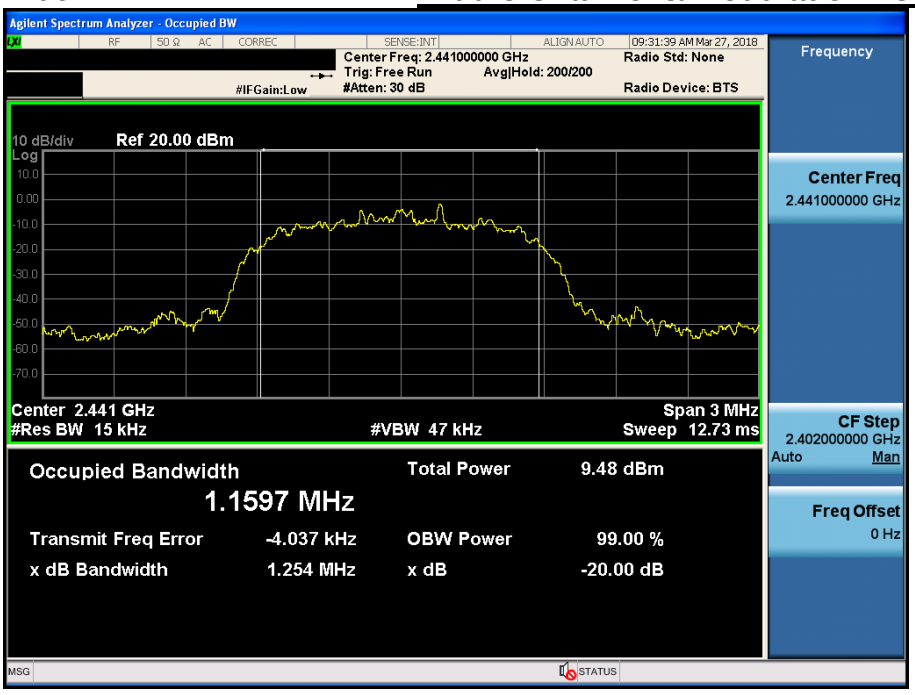
20 dB Bandwidth ***Middle Channel & Modulation : π/4DQPSK***

20 dB Bandwidth ***Highest Channel & Modulation : π/4DQPSK***

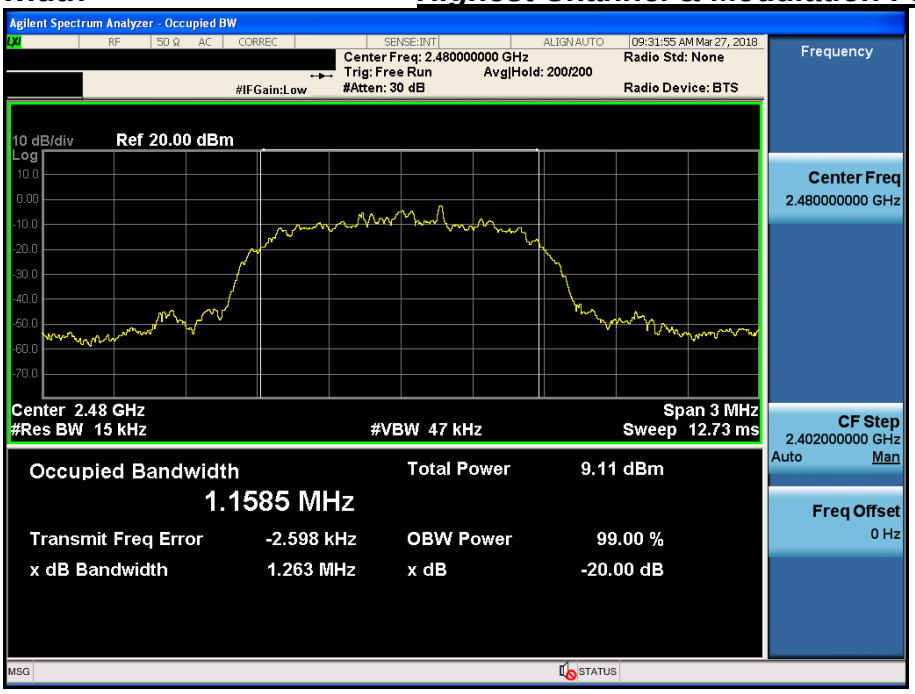
20 dB Bandwidth ***Lowest Channel & Modulation : 8DPSK***



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 : ≥ 25 kHz or ≥ 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 ≥ 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	2440.966	2441.966	1.000
	π/4-DQPSK	2441.000	2442.000	1.000
	8DPSK	2440.998	2441.998	1.000

AFH mode

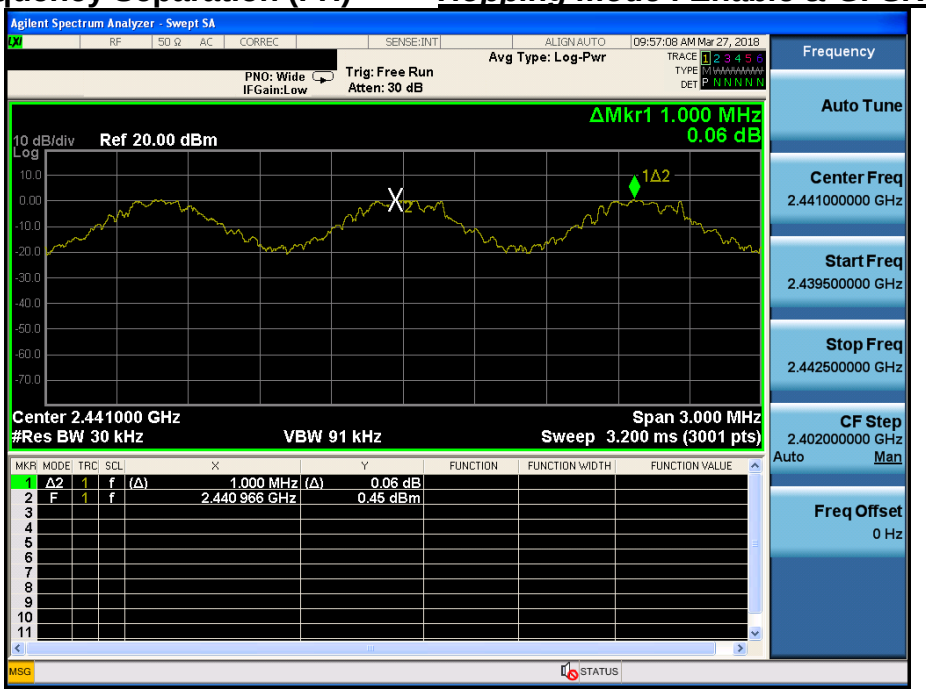
Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2411.004	2412.004	1.000
	π/4-DQPSK	2410.989	2411.989	1.000
	8DPSK	2411.154	2412.154	1.000

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

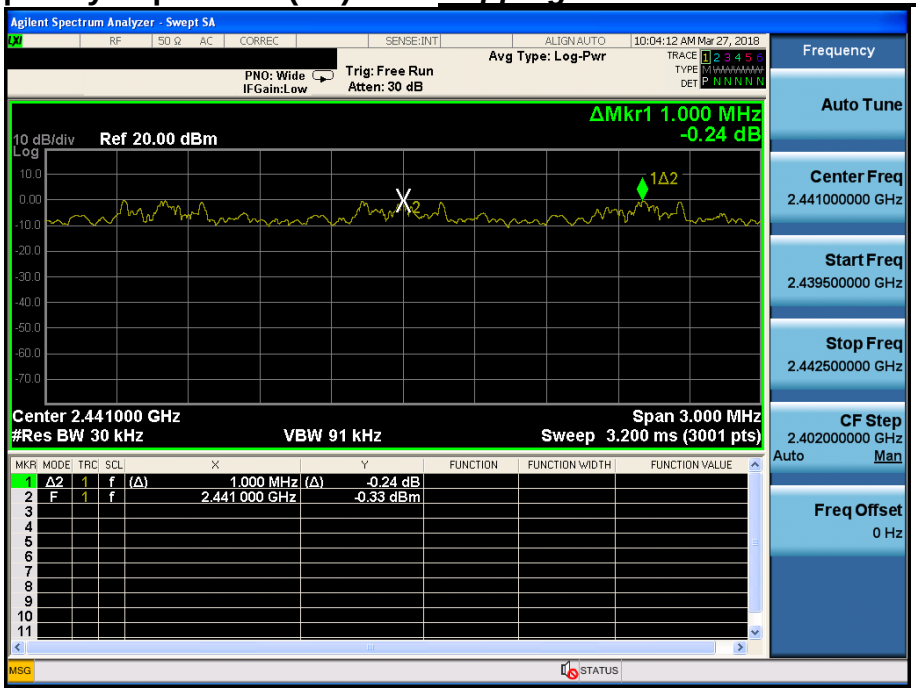
- **Minimum Standard :**

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

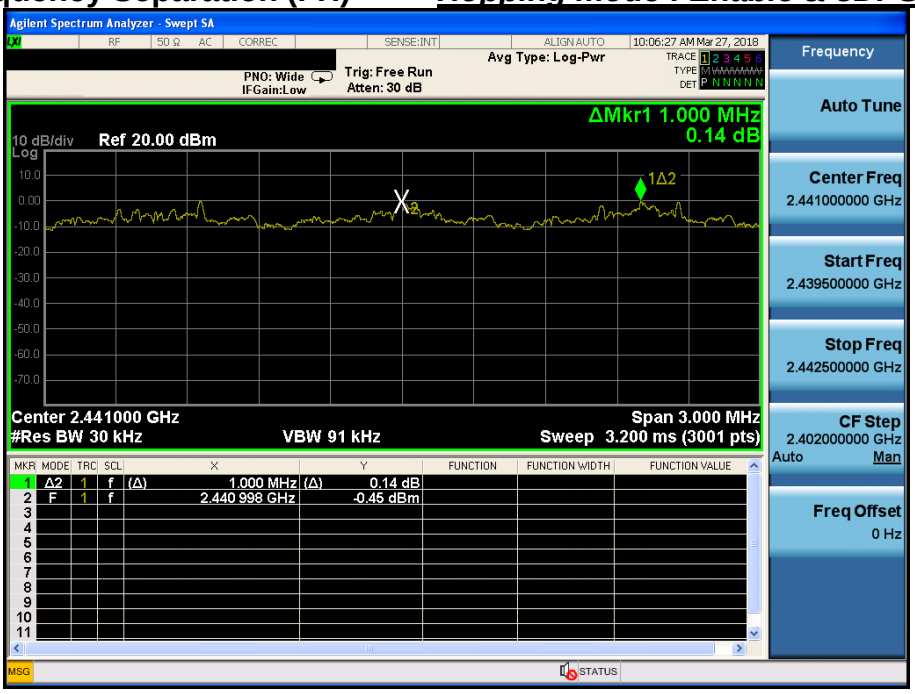
Carrier Frequency Separation (FH) ***Hopping mode : Enable & GFSK***



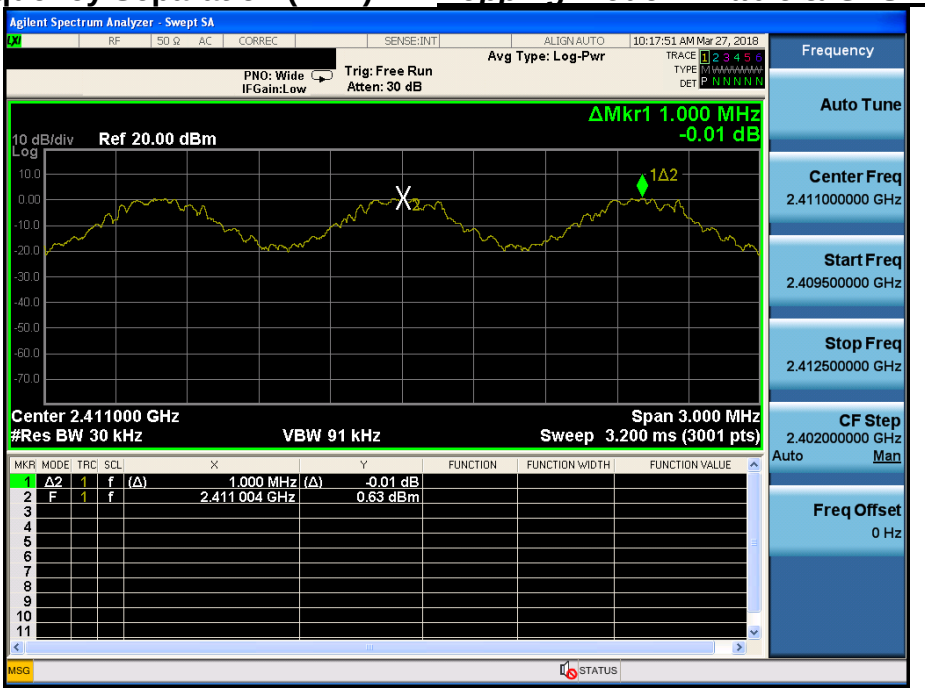
Carrier Frequency Separation (FH) ***Hopping mode : Enable & π/4DQPSK***



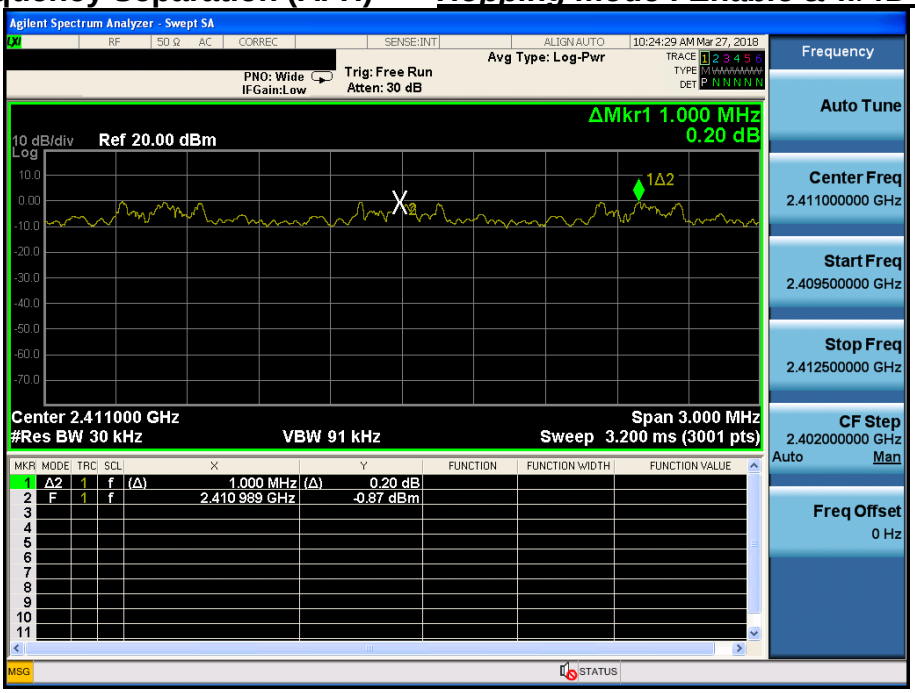
Carrier Frequency Separation (FH) ***Hopping mode : Enable & 8DPSK***



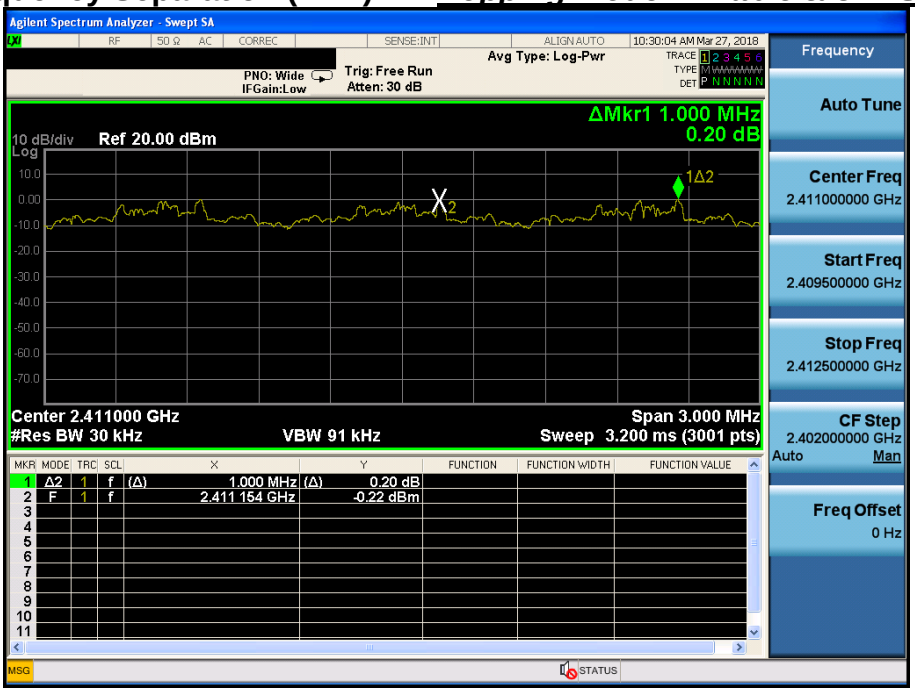
Carrier Frequency Separation (AFH) ***Hopping mode : Enable & GFSK***



Carrier Frequency Separation (AFH) ***Hopping mode : Enable & π/4DQPSK***



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 : >= 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 2400 ~ 2483.5 MHz were examined.

The spectrum analyzer is set to :

Span for FH mode = 50 MHz Start Frequency = 2391.5 MHz, Stop Frequency = 2441.5 MHz
Start Frequency = 2441.5 MHz, Stop Frequency = 2491.5 MHz
Span for AFH mode = 30 MHz Start Frequency = 2396.0 MHz, Stop Frequency = 2426.0 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 ≥ 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
	π/4-DQPSK	79
	8DPSK	79

AFH mode

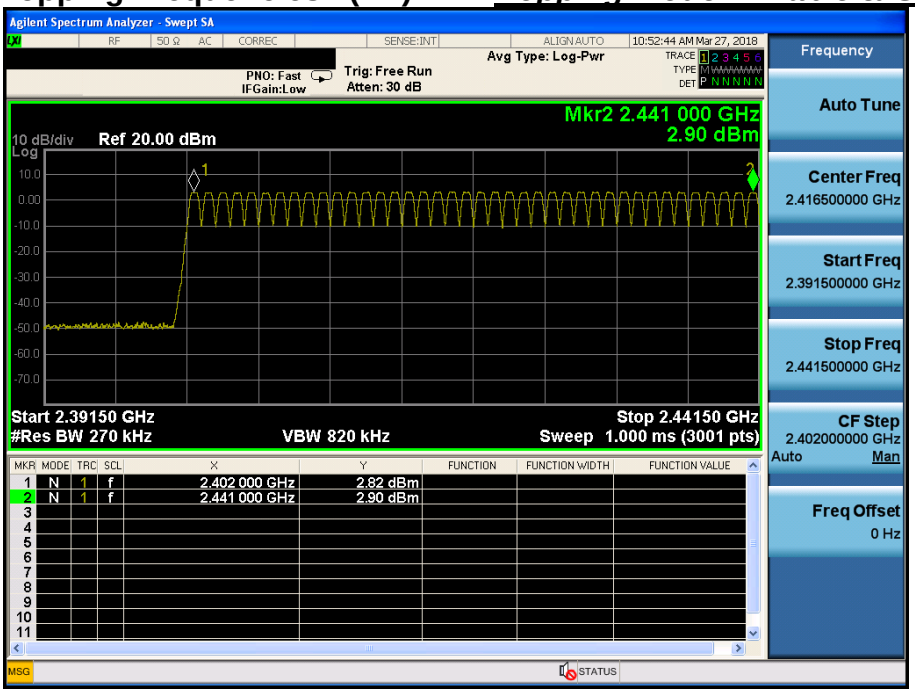
Hopping mode	Modulation	Test Result (Total Hops)
Enable	GFSK	20
	π/4-DQPSK	20
	8DPSK	20

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

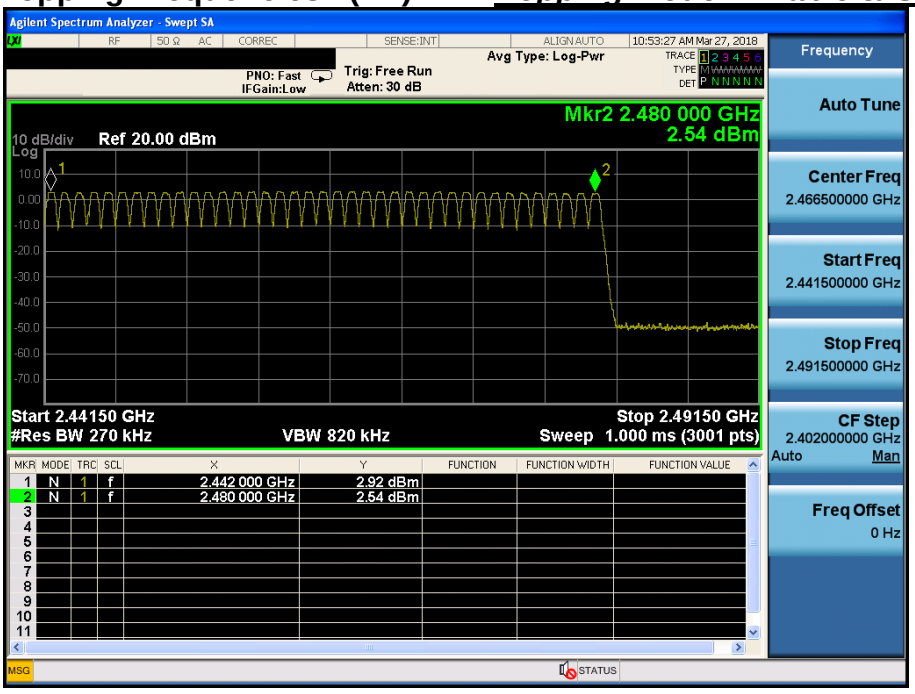
- Minimum Standard :

At least 15 hopes

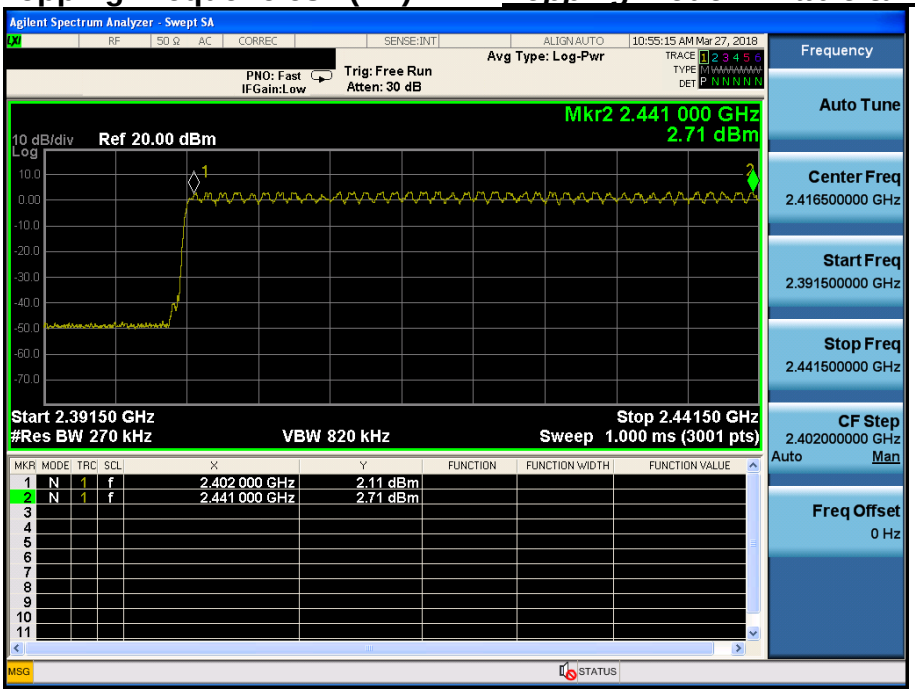
Number of Hopping Frequencies 1(FH) ***Hopping mode : Enable & GFSK***



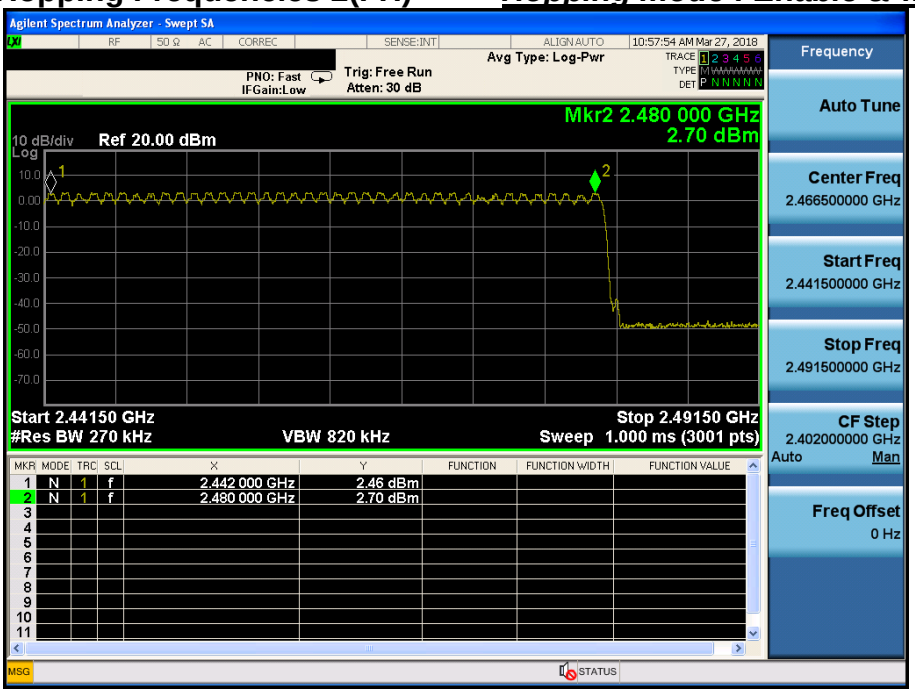
Number of Hopping Frequencies 2(FH) ***Hopping mode : Enable & GFSK***



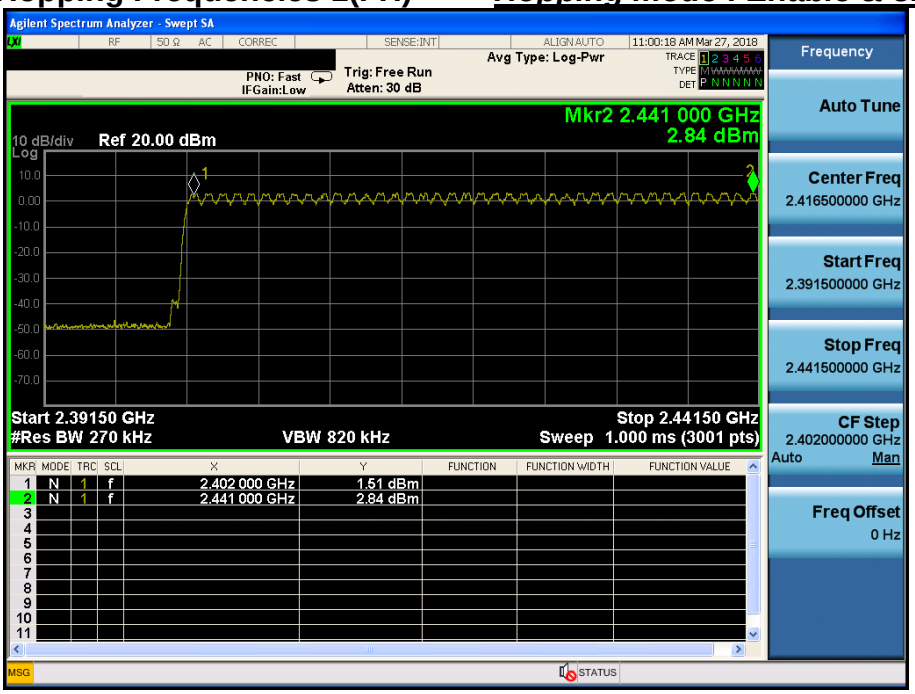
Number of Hopping Frequencies 1(FH) ***Hopping mode : Enable & π/4DQPSK***



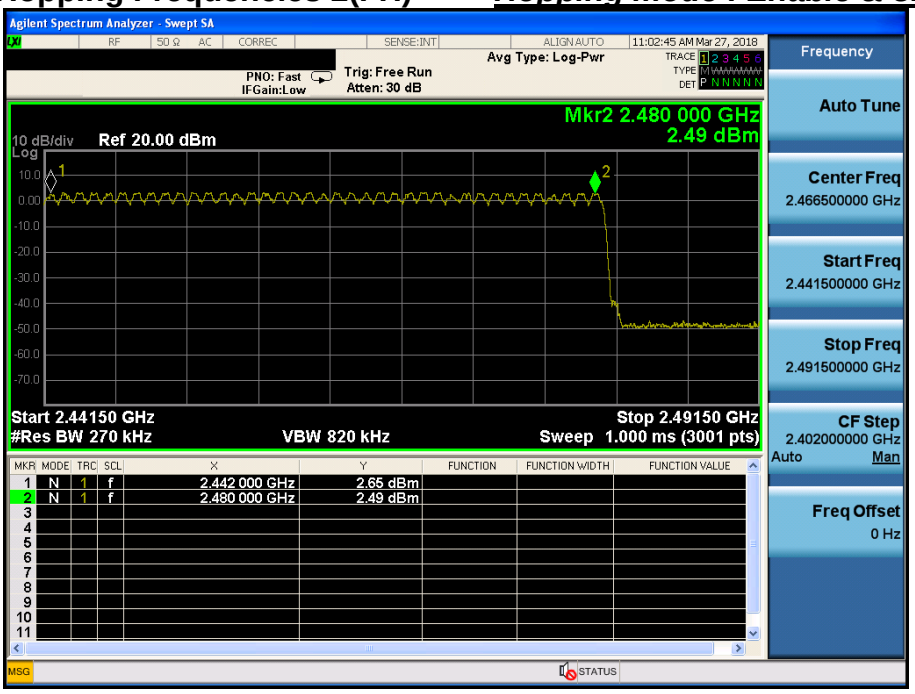
Number of Hopping Frequencies 2(FH) ***Hopping mode : Enable & π/4DQPSK***



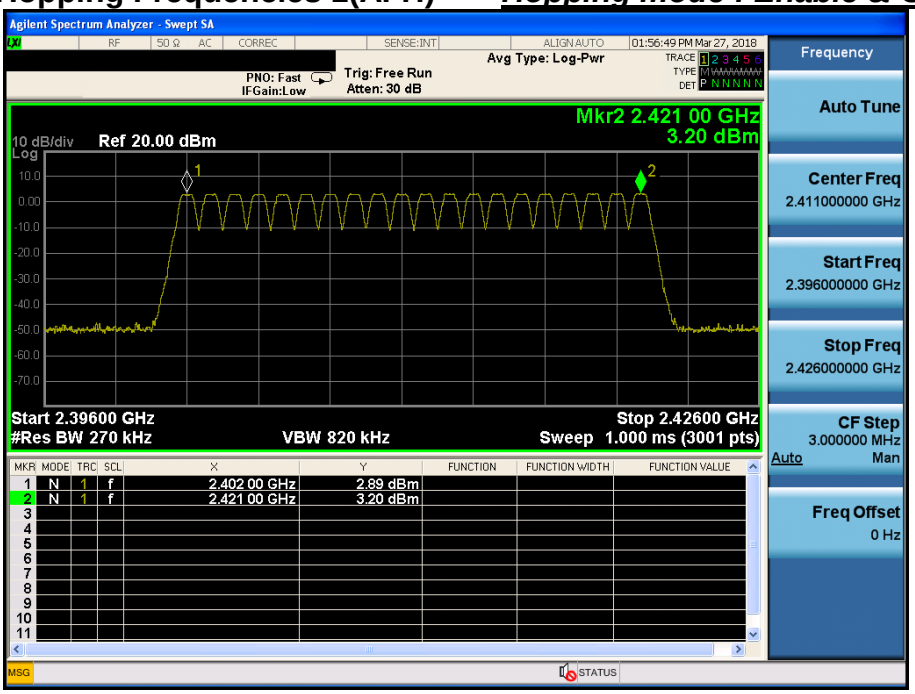
Number of Hopping Frequencies 1(FH) ***Hopping mode : Enable & 8DPSK***



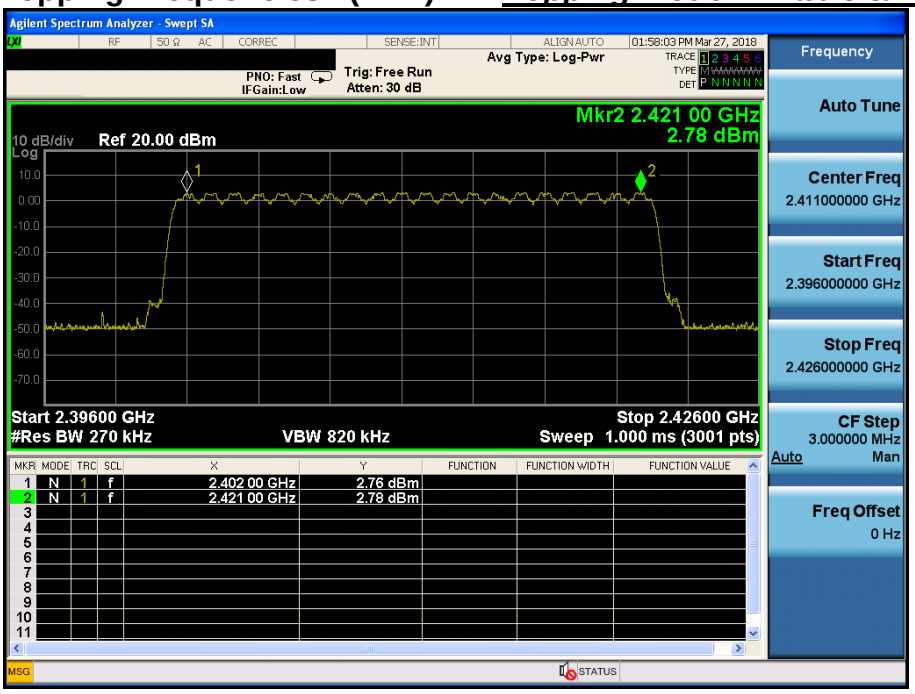
Number of Hopping Frequencies 2(FH) ***Hopping mode : Enable & 8DPSK***



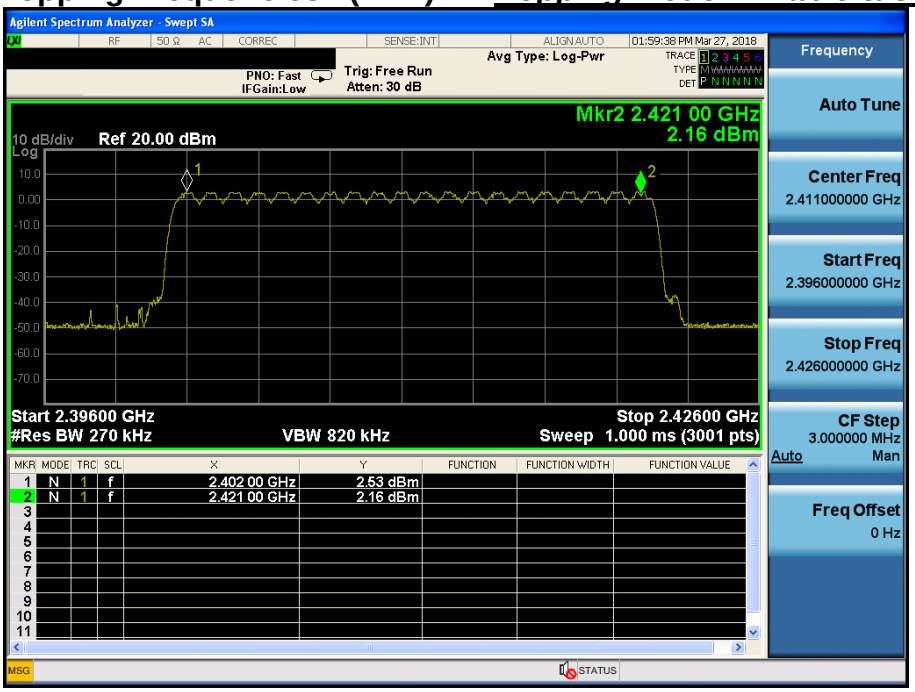
Number of Hopping Frequencies 1(AFH) ***Hopping mode : Enable & GFSK***



Number of Hopping Frequencies 1(AFH) ***Hopping mode : Enable & π/4DQPSK***



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 = 2441 MHz (AFH: 2411MHz) Span = zero

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

VBW ≥ 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

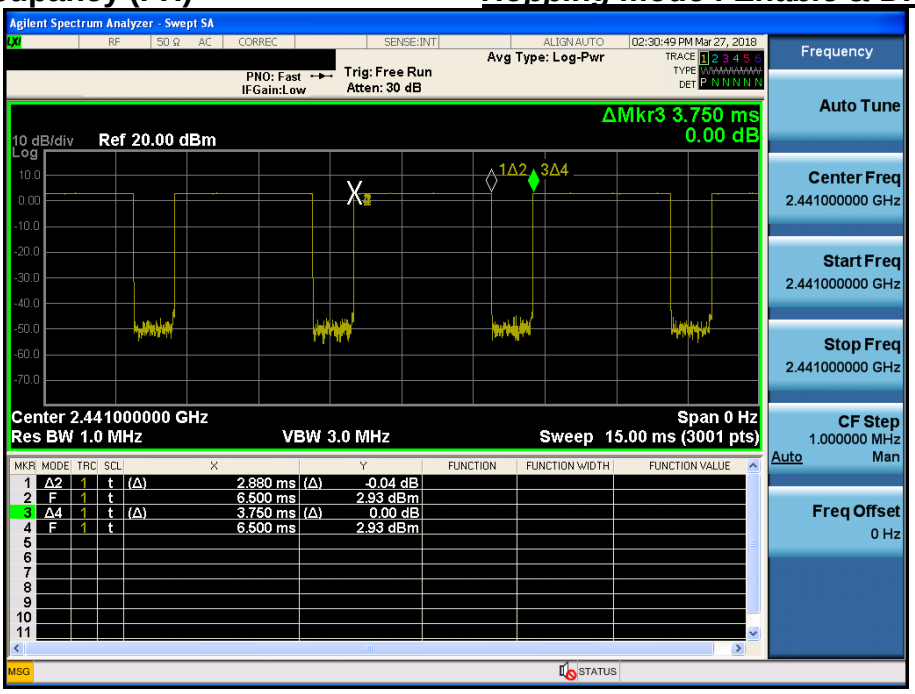
Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	20	2.880	3.750	0.154
	2 DH 5	20	2.880	3.750	0.154
	3 DH 5	20	2.880	3.750	0.154

Note 1 : Dwell Time = 0.4 × Hopping channel × Burst ON time × ((Hopping rate ÷ Time slots) ÷ Hopping channel)

- Time slots for DH5 = 6 slots (TX = 5 slot / RX = 1 slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

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

Time of Occupancy (FH) ***Hopping mode : Enable & DH5***



Time of Occupancy (FH) ***Hopping mode : Enable & 2-DH5***