

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 : DRTFCC1704-0064

2. Customer

• Name : Sena Technologies, Inc.

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

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : Momentum / SP42

FCC : S7A-SP42

5. Test Method Used : ANSI C63.10-2013

Test Specification : FCC Part 15 Subpart C.247,

RSS-247 Issue 2 (2017-02), RSS-GEN Issue 4 (2014-11)

6. Date of Test : 2017.03.13 ~ 2017.04.24

7. Testing Environment : See appended test report.

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

Affirmation	Tested by	Technical Manager
	Name : JungWoo Kim (Signature)	Name : HyunSu Son (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.

2017 . 04 . 27 .

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
DRTFCC1704-0064	Apr. 27, 2017	Initial issue

Table of Contents

1. General Information	4
1.1 Testing Laboratory	4
1.2 Testing Environment	4
1.3 Measurement Uncertainty	4
1.4 Details of Applicant	5
1.5 Description of EUT	5
1.6 Declaration by the applicant / manufacturer	5
1.7 Information about the FHSS characteristics	6
1.8 Test Equipment List.....	7
1.9 Summary of Test Results.....	8
1.10 Conclusion of worst-case and operation mode.....	9
2. Maximum Peak Output Power Measurement	10
2.1 Test Setup	10
2.2 Limit.....	10
2.3 Test Procedure.....	10
2.4 Test Results	11
3. 20 dB BW	22
3.1 Test Setup	22
3.2 Limit.....	22
3.3 Test Procedure.....	22
3.4 Test Results	23
4. Carrier Frequency Separation	34
4.1 Test Setup	34
4.2 Limit.....	34
4.3 Procedure.....	34
4.4 Test Results	34
5. Number of Hopping Frequencies	44
5.1 Test Setup	44
5.2 Limit.....	44
5.3 Procedure.....	44
5.4 Test Results	44
6. Time of Occupancy (Dwell Time).....	56
6.1 Test Setup	56
6.2 Limit.....	56
6.3 Test Procedure.....	56
6.4 Test Results	56
7. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	66
7.1 Test Setup	66
7.2 Limit.....	66
7.3. Test Procedures.....	67
7.3.1. Test Procedures for Radiated Spurious Emissions	67
7.3.2. Test Procedures for Conducted Spurious Emissions.....	68
7.4. Test Results	69
7.4.1. Radiated Emissions.....	69
7.4.3.1. Conducted Spurious Emissions_Module 0	81
7.4.3.2. Conducted Spurious Emissions_Module 1.....	105
8. Transmitter AC Power Line Conducted Emission	129
8.1 Test Setup	129
8.2 Limit.....	129
8.3 Test Procedures.....	129
8.4 Test Results	129
9. Antenna Requirement.....	130
10. Occupied Bandwidth (99 %)	131
10.1 Test Setup	131
10.2 Limit.....	131
10.3 Test Procedure.....	131
10.4 Test Results	131
APPENDIX I.....	145
APPENDIX II.....	146

1. General Information

1.1 Testing Laboratory

DT&C Co., Ltd.		
Standard	Site number	Address
FCC	☒ 165783	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935
	☐ 804488	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935
	☐ 596748	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935
	☐ 678747	683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080
IC	☒ 5740A-3	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935
	☐ 5740A-2	683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.2 Testing Environment

Ambient Condition	
▪ Temperature	+21 °C ~ +25 °C
▪ Relative Humidity	34 % ~ 42 %

1.3 Measurement Uncertainty

Test items	Measurement uncertainty
Transmitter Output Power	0.92 dB (The confidence level is about 95 %, k = 2)
Conducted spurious emission	0.94 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 : Sena Technologies, Inc.
Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea
Contact person : Seunghyun Kim

1.5 Description of EUT

EUT	Momentum
Model Name	SP42
Add Model Name	NA
Serial Number	Identical prototype
Hardware version	1.0
Software version	1.0
Power Supply	DC 3.7 V
Frequency Range	2402 MHz ~ 2480 MHz
Modulation Technique	GFSK, $\pi/4$ -DQPSK, 8DPSK
Number of Channels	79
Antenna Type /Antenna Gain (Module 0)	Chip antenna / PK : 0.535 dBi (Model : SENA_003)
Antenna Type /Antenna Gain (Module 1)_ANT1	External Antenna / PK : 1.200 dBi (Model : SENA-DP01-19.7)
Antenna Type /Antenna Gain (Module 1)_ANT 2	External Antenna / PK : 1.000 dBi (Model : SENA-DP02-19)

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
 - 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	16/09/09	17/09/09	MY50200834
Digital Multimeter	Agilent Technologies	34401A	17/01/04	18/01/04	US36099541
DC Power Supply	SM techno	SDP30-5D	17/01/05	18/01/05	305DLJ204
Signal Generator	Rohde Schwarz	SMBV100A	17/01/04	18/01/04	255571
Signal Generator	Rohde Schwarz	SMF100A	16/06/23	17/06/23	102341
Thermohygrometer	BODYCOM	BJ5478	16/04/22	17/04/22	120612-2
			17/04/11	18/04/11	
Loop Antenna	Schwarzbeck	FMZB1513	16/04/22	18/04/22	1513-128
Bilog Antenna	SCHAFFNER	CBL6112B	16/05/23	18/05/23	2737
Horn Antenna	ETS-LINDGREN	3117	16/05/03	18/05/03	00140394
Horn Antenna	A.H.Systems Inc.	SAS-574	15/09/03	17/09/03	155
PreAmplifier	Agilent	8449B	17/01/11	18/01/11	3008A00370
PreAmplifier	tsj	MLA-010K01-B01-27	17/03/06	18/03/06	1844539
EMI TEST RECEIVER	Rohde Schwarz	ESU	16/07/18	17/07/18	100469
Highpass Filter	Wainwright Instruments	WHKX12-2580-3000-18000-80SS	16/09/09	17/09/09	3
Highpass Filter	Wainwright Instruments	WHNX6-6320-8000-26500-40CC	16/09/13	17/09/13	1
Attenuator	SMAJK	SMAJK-50-10	16/09/08	17/09/08	15081902
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2495A	16/05/02	17/05/02	1306007
		MA2490A	16/05/02	17/05/02	1249001

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. =< 0.5 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.	Radiated	C
RSS Gen(6.6)	Occupied Bandwidth (99 %)	N/A		C
15.247(d) 15.205 & 209 RSS-247(5.5) RSS-Gen (8.9 & 8.10)	Radiated Spurious Emissions	FCC 15.209 Limits RSS-Gen 8.9	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 : This test item was performed in each axis and the worst case data was reported.

Note 3 : The power supply of this device is only DC (Internal Battery) and Bluetooth function is disabled in charging status.

Note 4 : 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)
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 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

<Module 0>

Modulation	Tested Channel	Frame Average Output Power		Peak Output Power	
		dBm	mW	dBm	mW
<u>GFSK</u>	Lowest	4.27	2.673	7.16	5.200
	Middle	6.62	4.592	9.47	8.851
	Highest	6.30	4.266	9.07	8.072
<u>$\pi/4$DQPSK</u>	Lowest	3.65	2.317	8.29	6.745
	Middle	5.54	3.581	10.16	10.375
	Highest	5.36	3.436	9.78	9.506
<u>8DPSK</u>	Lowest	3.71	2.350	8.27	6.714
	Middle	5.61	3.639	10.20	10.471
	Highest	5.38	3.451	9.74	9.419

<Module 1>

Modulation	Tested Channel	Frame Average Output Power		Peak Output Power	
		dBm	mW	dBm	mW
<u>GFSK</u>	Lowest	15.01	31.696	16.80	47.863
	Middle	16.06	40.365	18.20	66.069
	Highest	15.79	37.931	17.98	62.806
<u>$\pi/4$DQPSK</u>	Lowest	3.42	2.198	7.84	6.081
	Middle	5.31	3.396	10.84	12.134
	Highest	5.23	3.334	10.67	11.668
<u>8DPSK</u>	Lowest	3.65	2.317	8.27	6.714
	Middle	5.59	3.622	11.10	12.882
	Highest	5.38	3.451	10.74	11.858

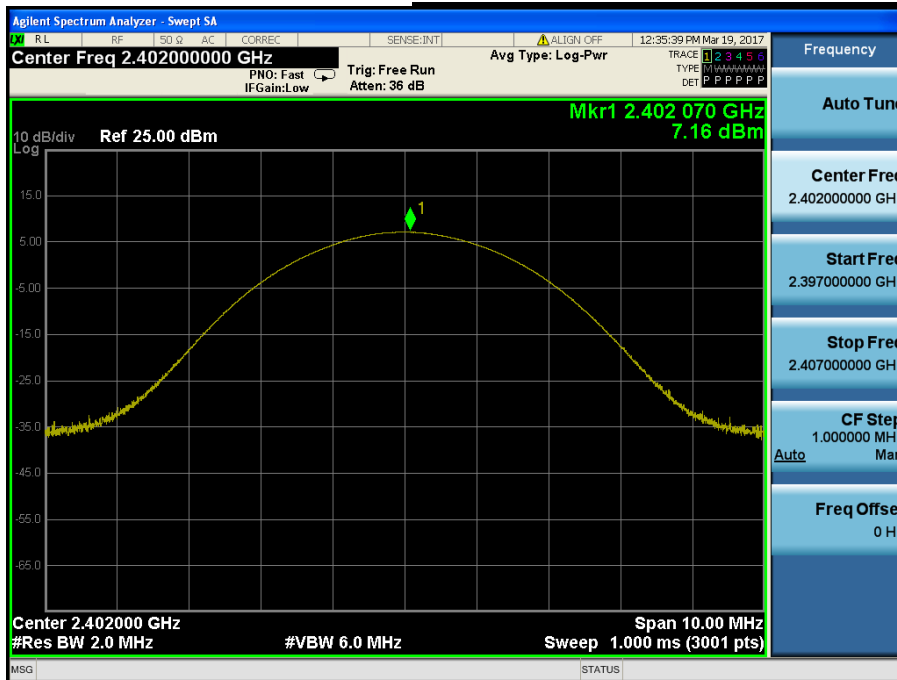
Note 1 : The frame average output power was tested using an average power meter for reference only.

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

<Module 0>

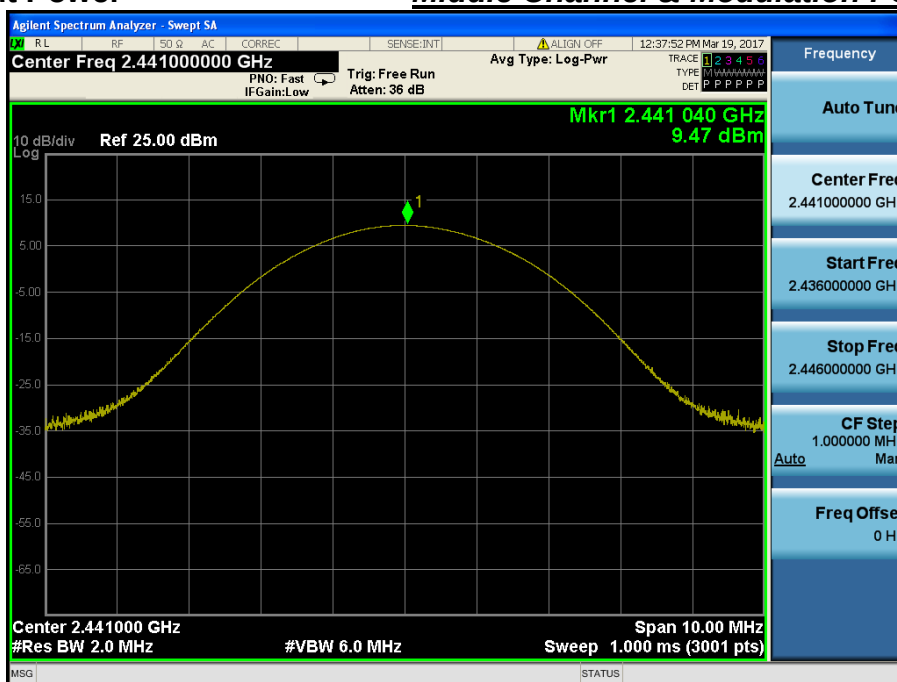
Peak Output Power

Lowest Channel & Modulation : GFSK

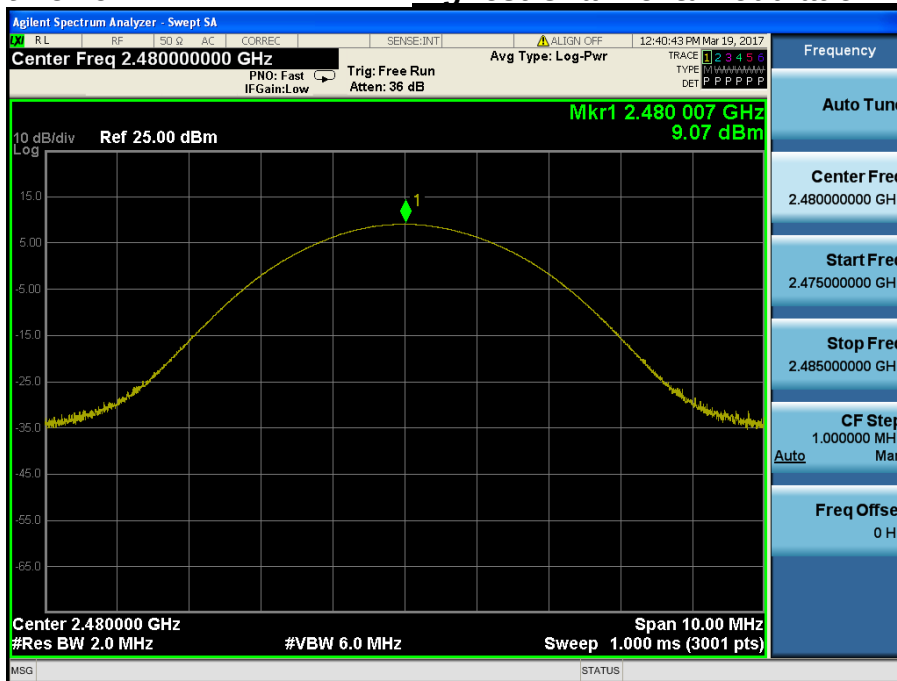


Peak Output Power

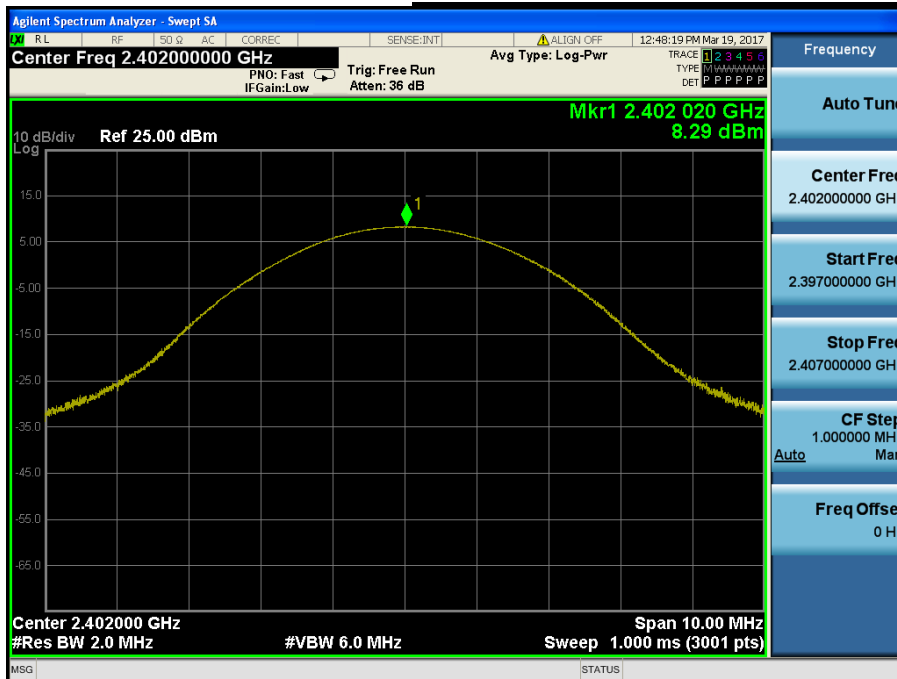
Middle Channel & Modulation : GFSK



Peak Output Power

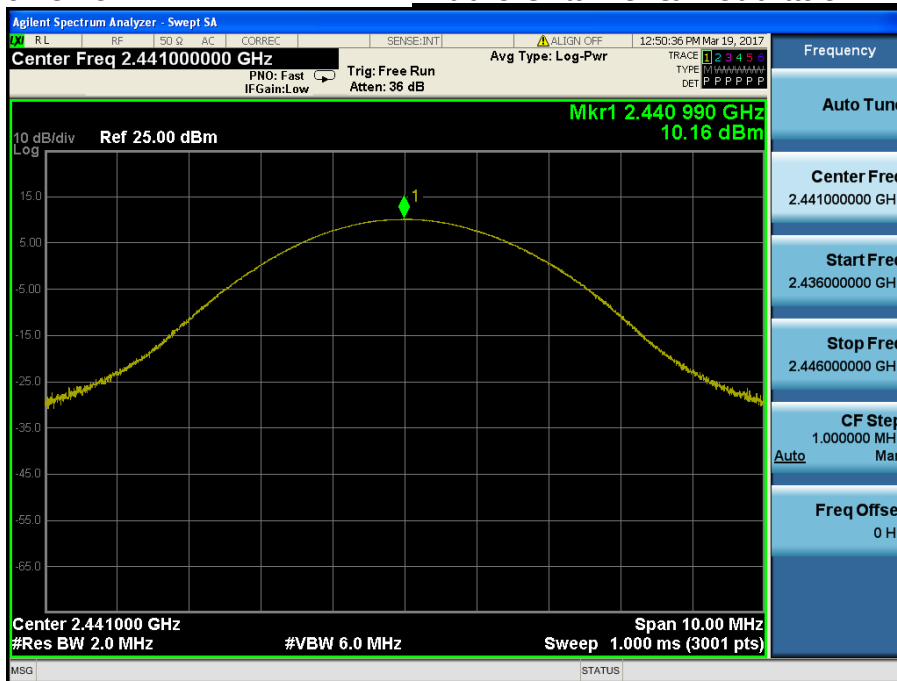
Highest Channel & Modulation : GFSK

Peak Output Power

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

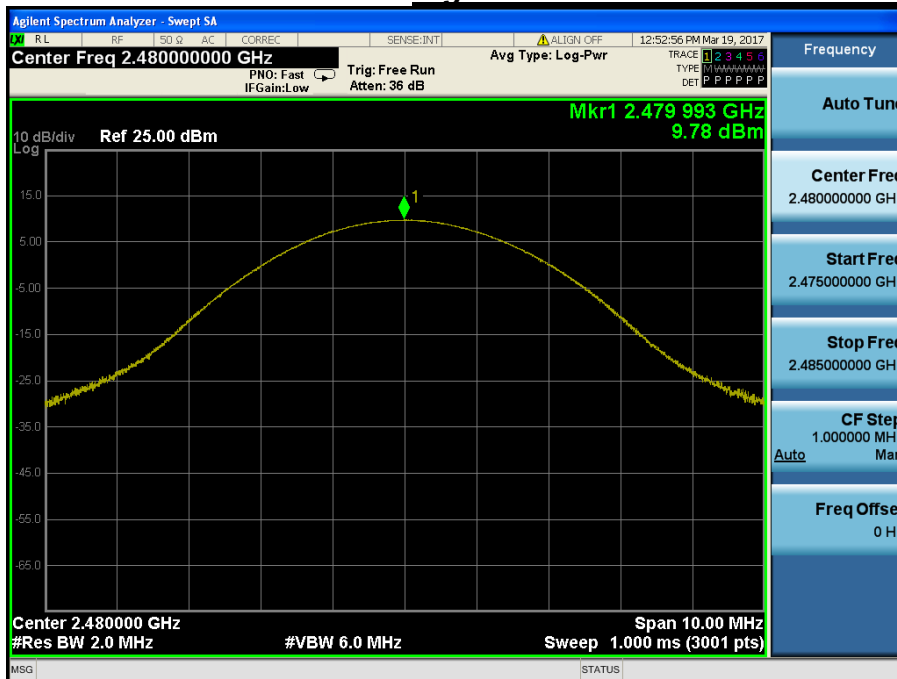
Peak Output Power

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



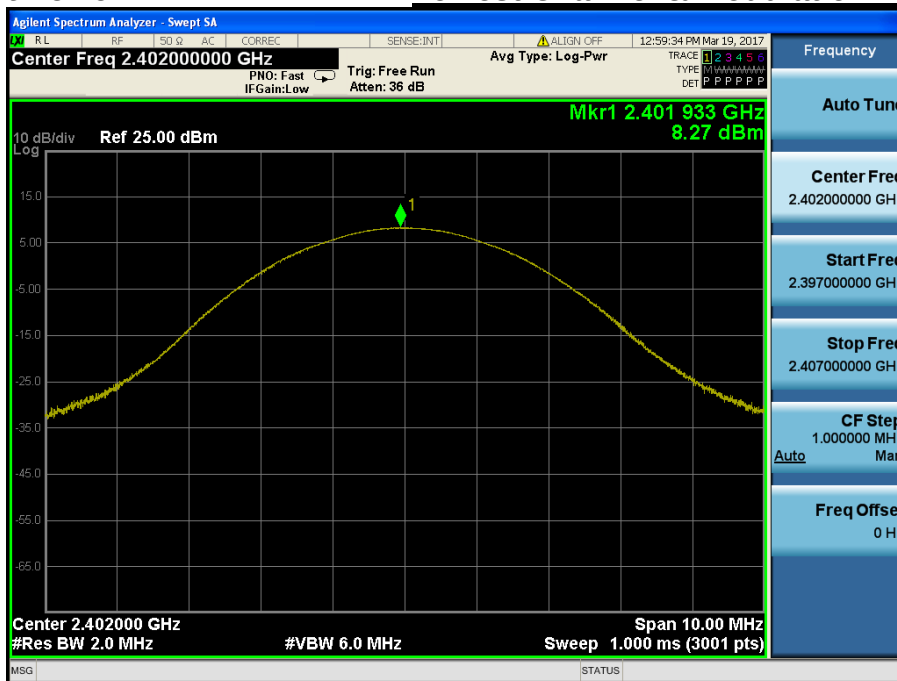
Peak Output Power

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



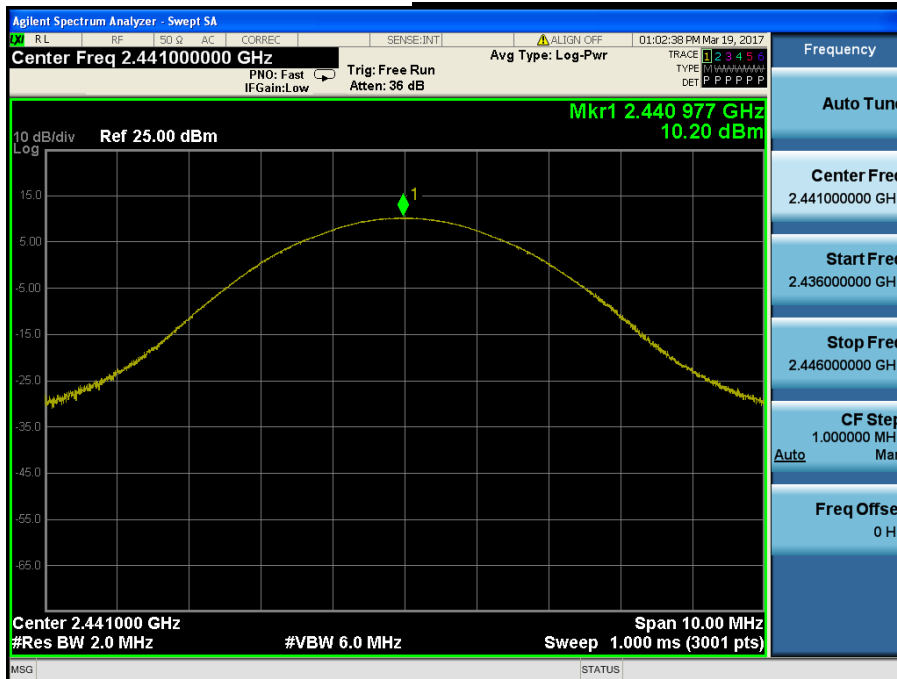
Peak Output Power

Lowest Channel & Modulation : 8DPSK



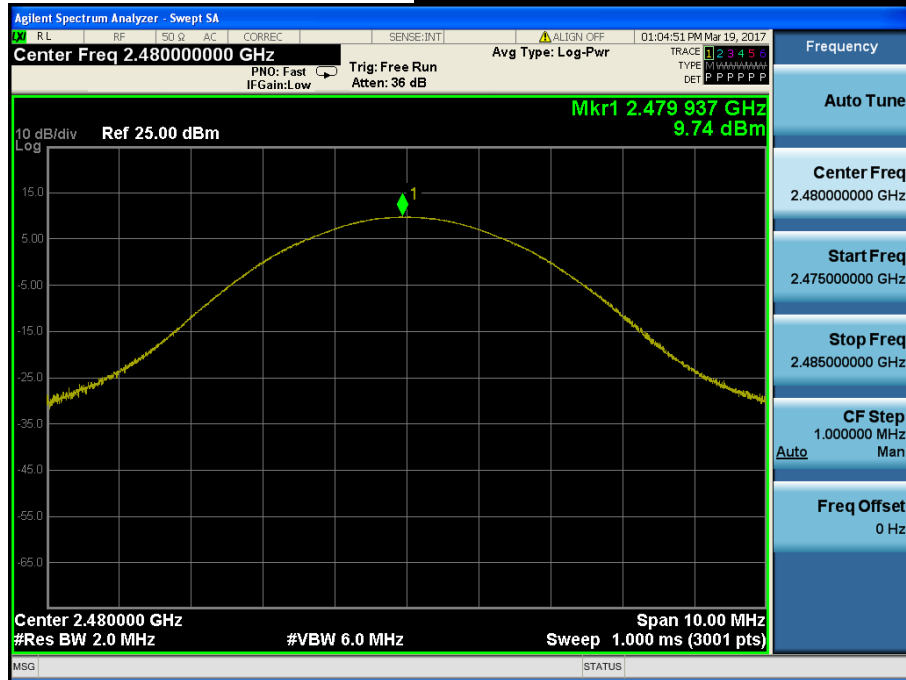
Peak Output Power

Middle Channel & Modulation : 8DPSK



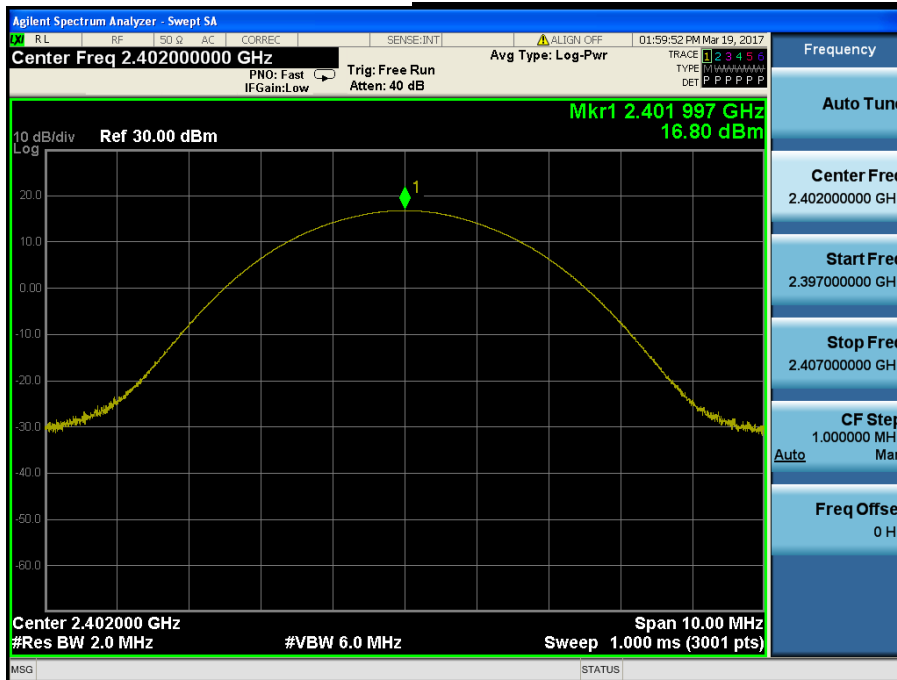
Peak Output Power

Highest Channel & Modulation : 8DPSK

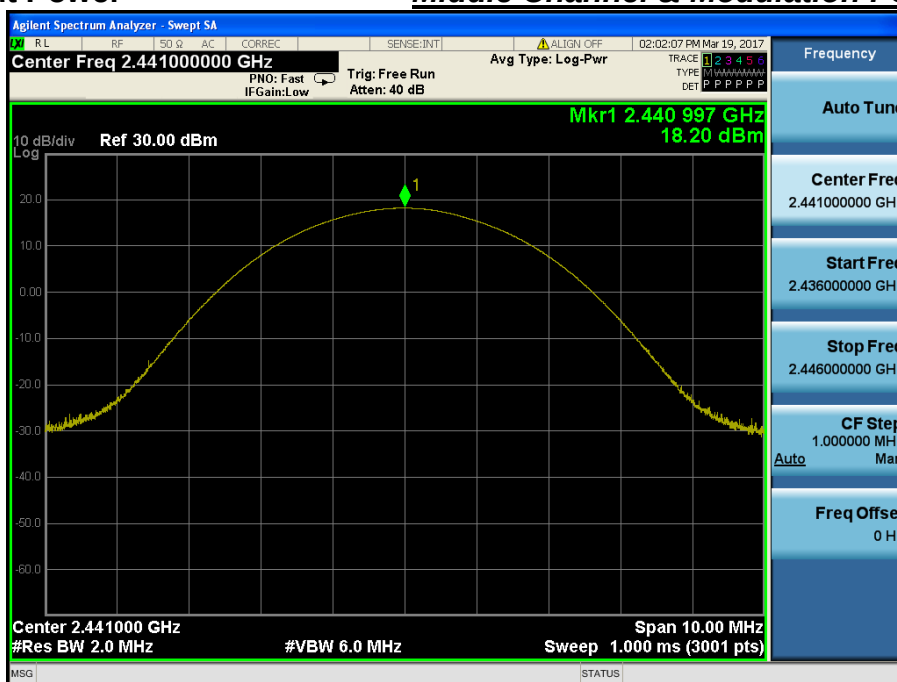


<Module 1>

Peak Output Power

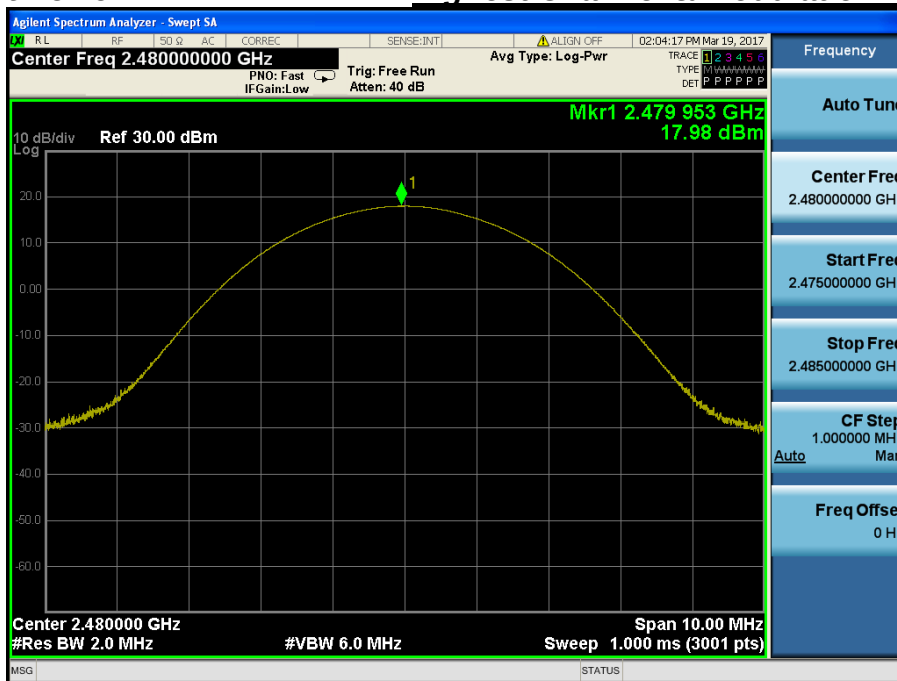
Lowest Channel & Modulation : GFSK

Peak Output Power

Middle Channel & Modulation : GFSK

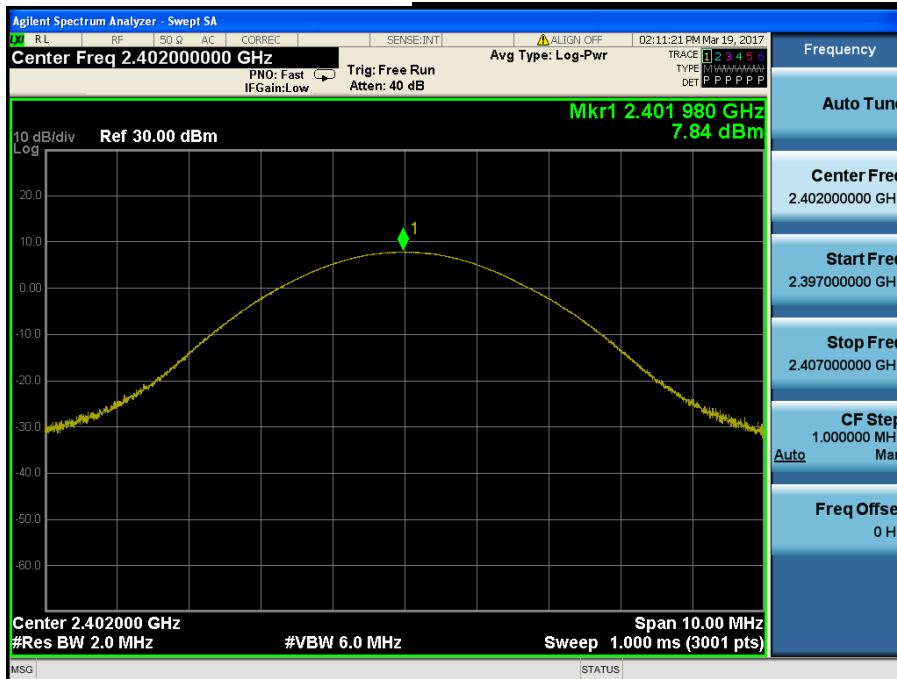
Peak Output Power

Highest Channel & Modulation : GFSK



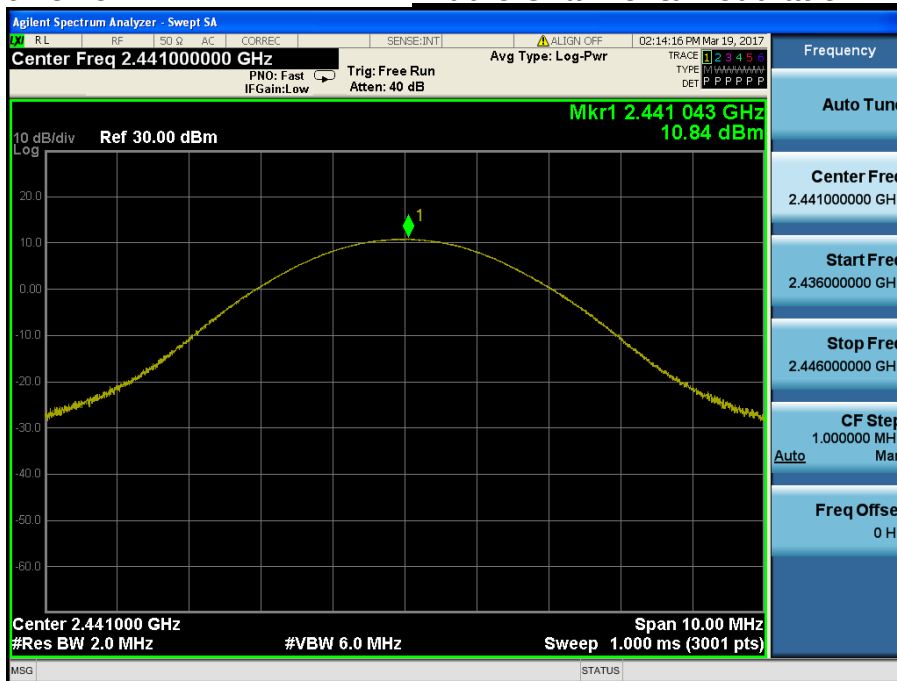
Peak Output Power

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



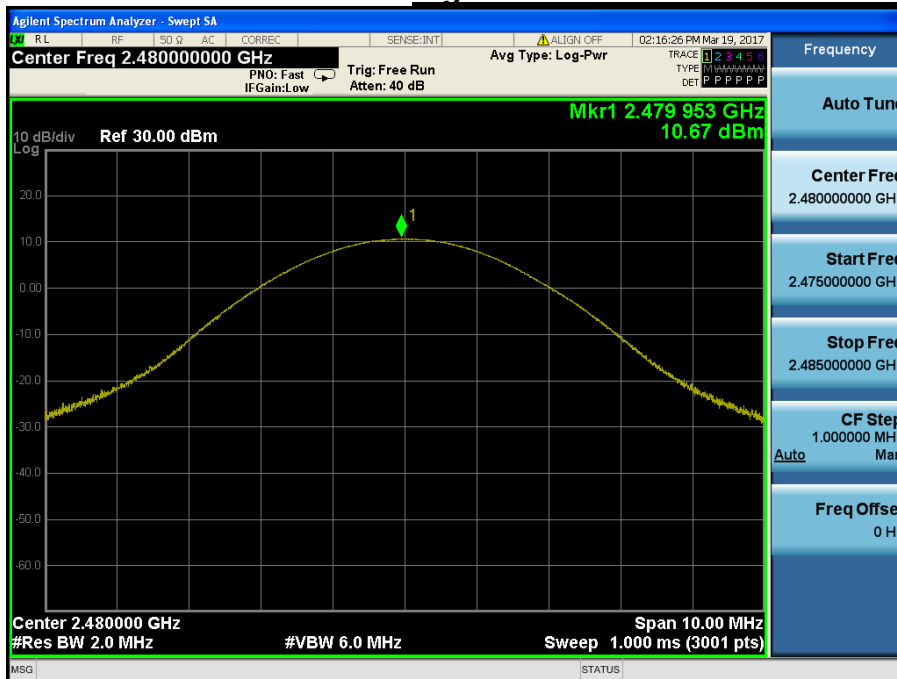
Peak Output Power

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



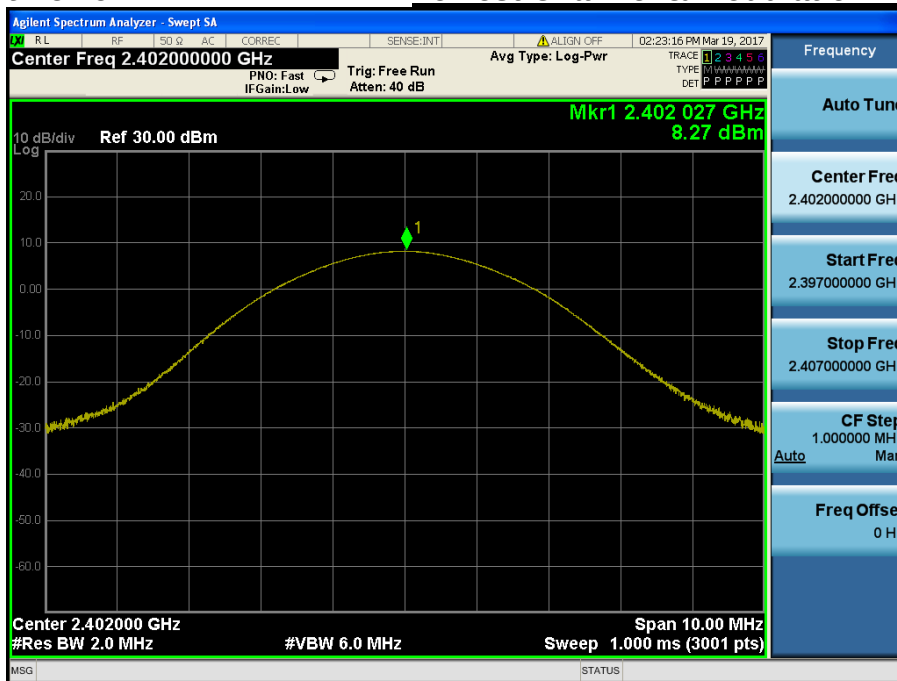
Peak Output Power

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



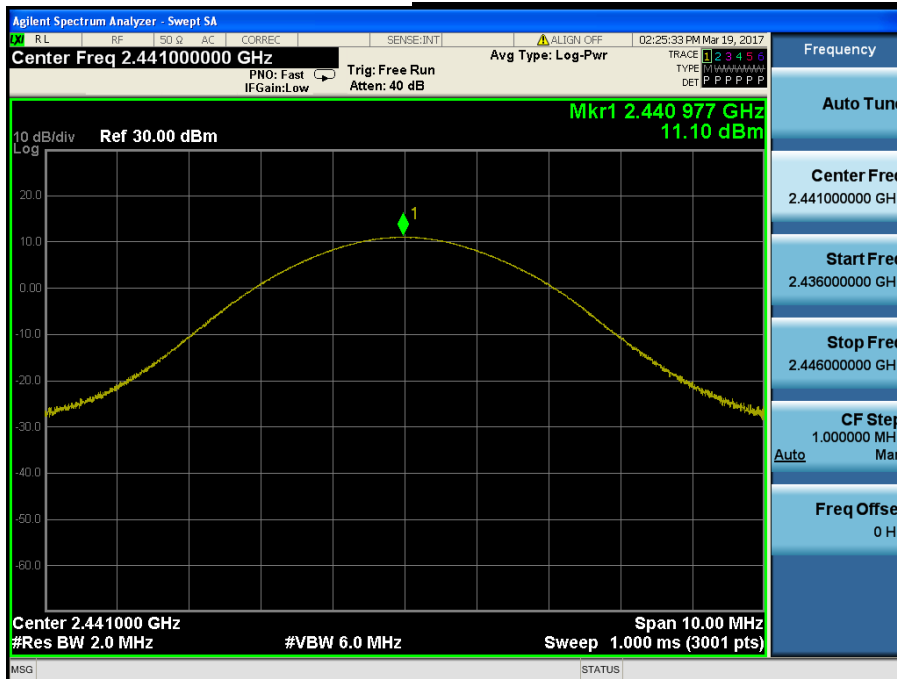
Peak Output Power

Lowest Channel & Modulation : 8DPSK



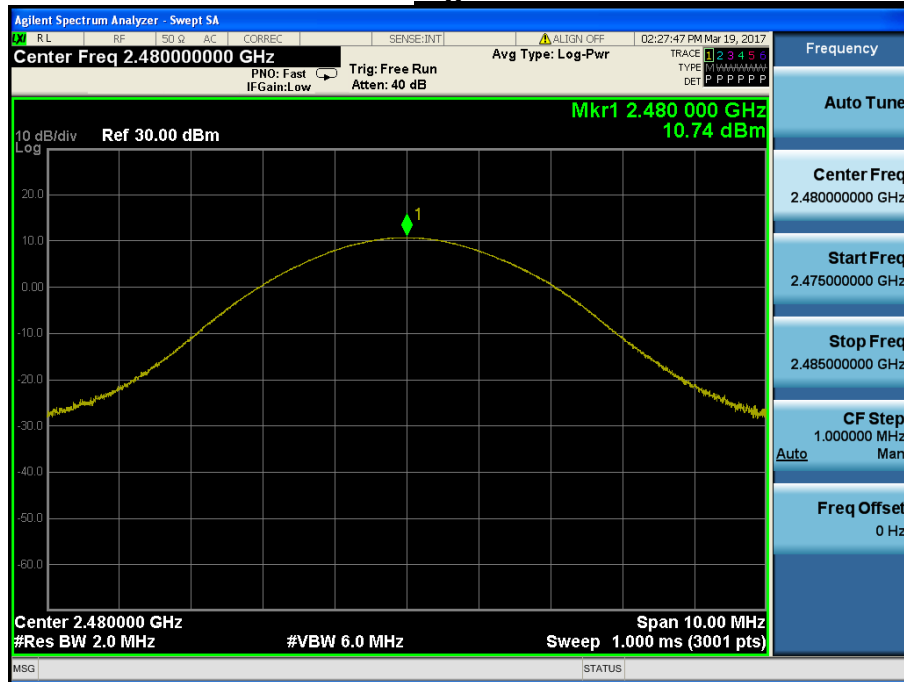
Peak Output Power

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

<Module 0>

Modulation	Tested Channel	20 dB BW (MHz)
<u>GFSK</u>	Lowest	1.041
	Middle	1.047
	Highest	1.048
<u>$\pi/4$DQPSK</u>	Lowest	1.330
	Middle	1.330
	Highest	1.332
<u>8DPSK</u>	Lowest	1.298
	Middle	1.296
	Highest	1.297

<Module 1>

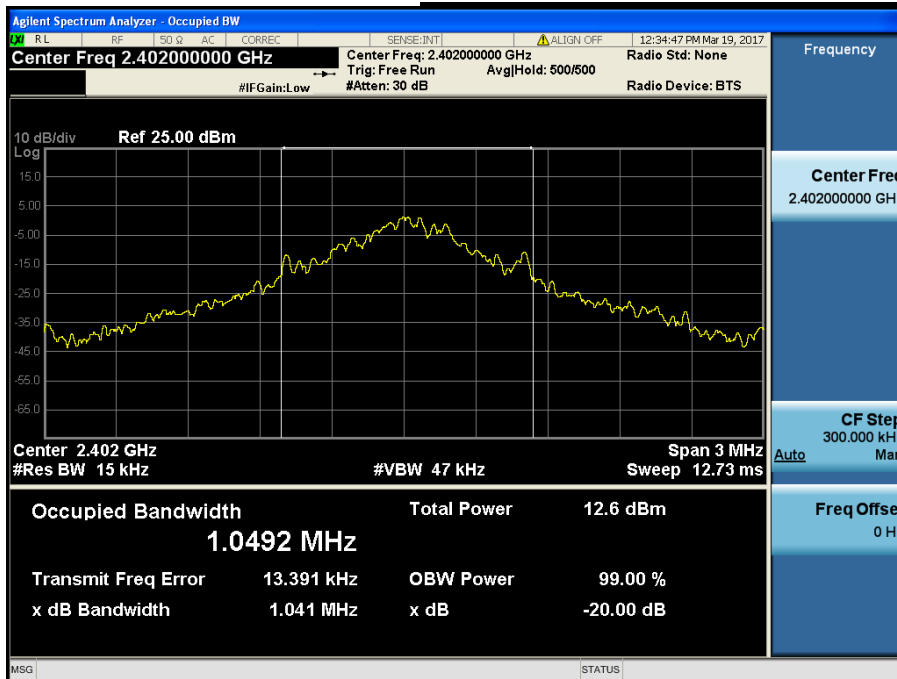
Modulation	Tested Channel	20 dB BW (MHz)
<u>GFSK</u>	Lowest	1.039
	Middle	1.056
	Highest	1.052
<u>$\pi/4$DQPSK</u>	Lowest	1.342
	Middle	1.341
	Highest	1.342
<u>8DPSK</u>	Lowest	1.327
	Middle	1.324
	Highest	1.326

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

<Module 0>

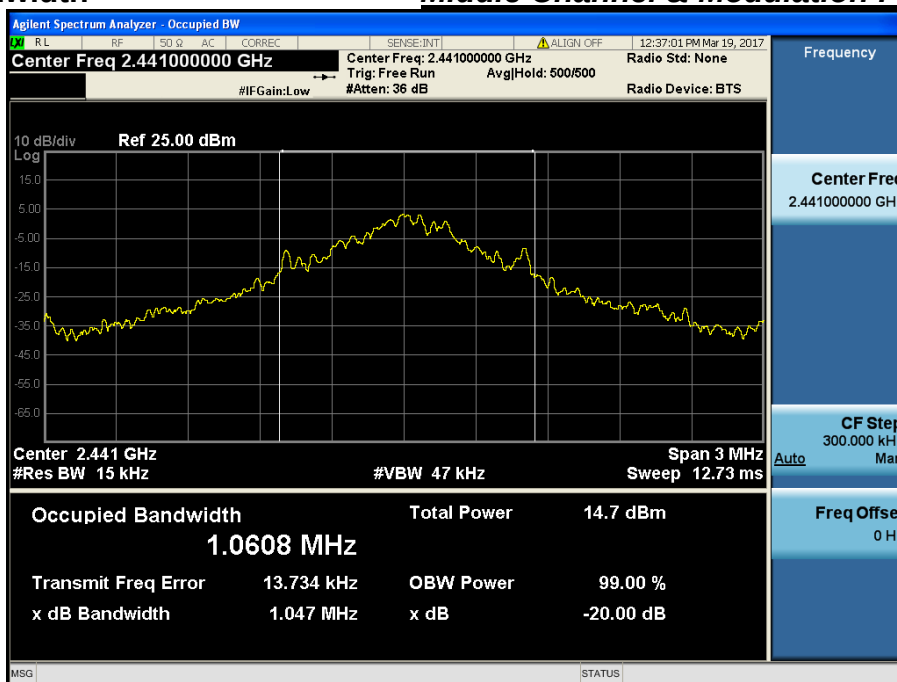
20 dB Bandwidth

Lowest Channel & Modulation : GFSK



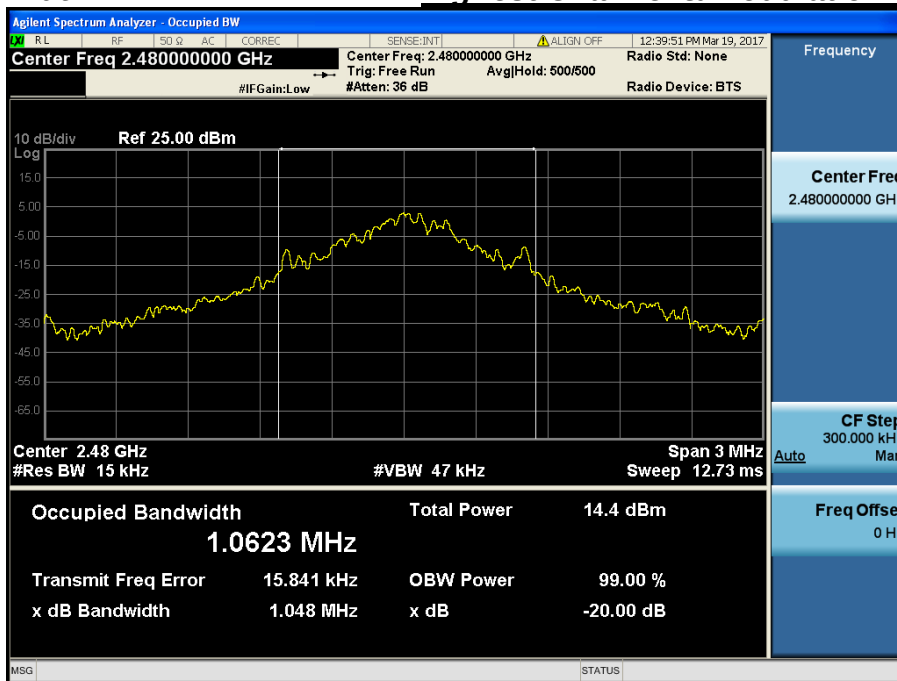
20 dB Bandwidth

Middle Channel & Modulation : GFSK



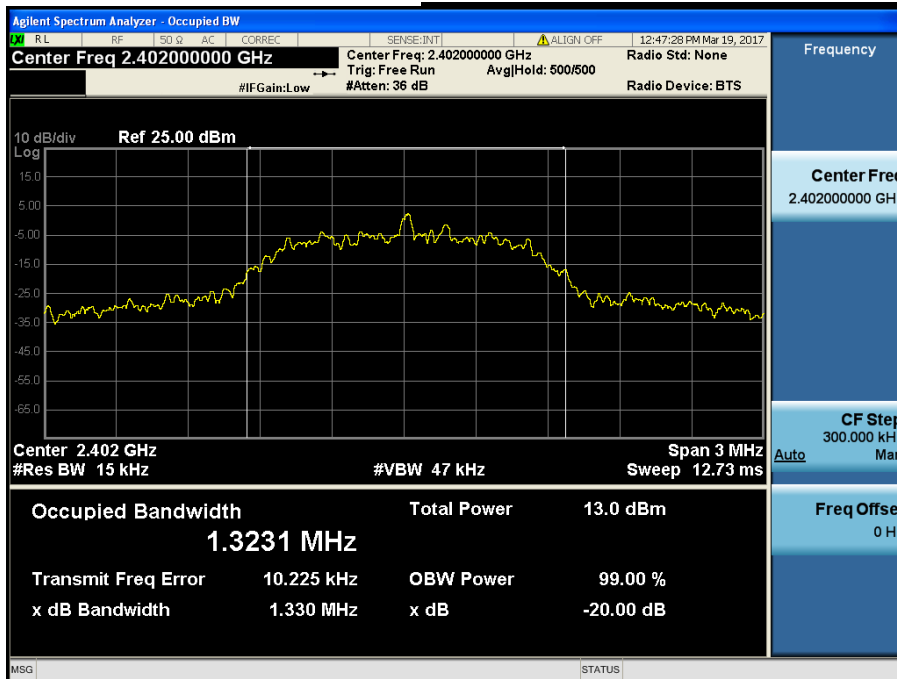
20 dB Bandwidth

Highest Channel & Modulation : GFSK



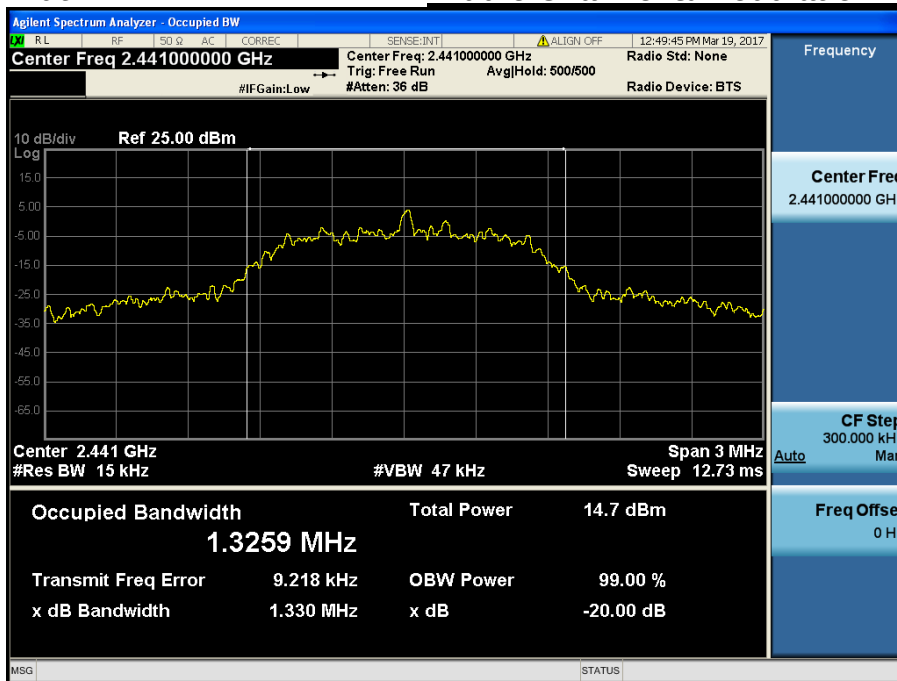
20 dB Bandwidth

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



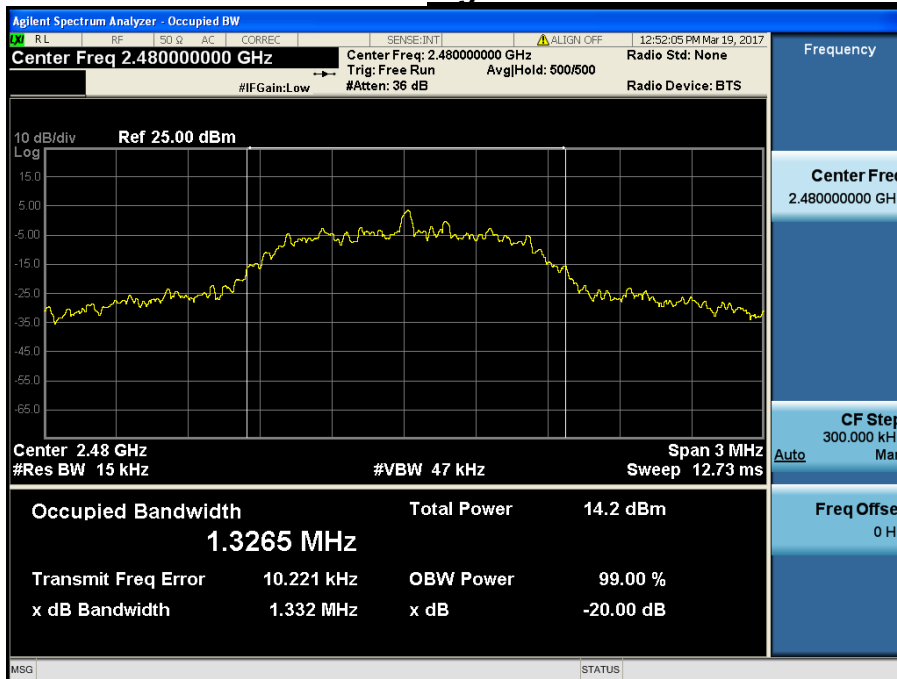
20 dB Bandwidth

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



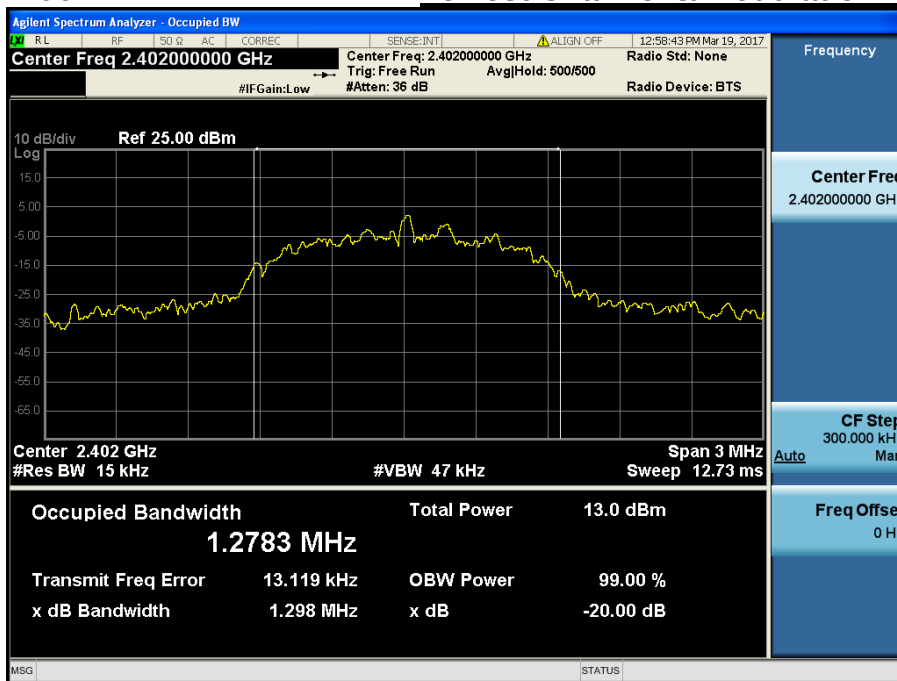
20 dB Bandwidth

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



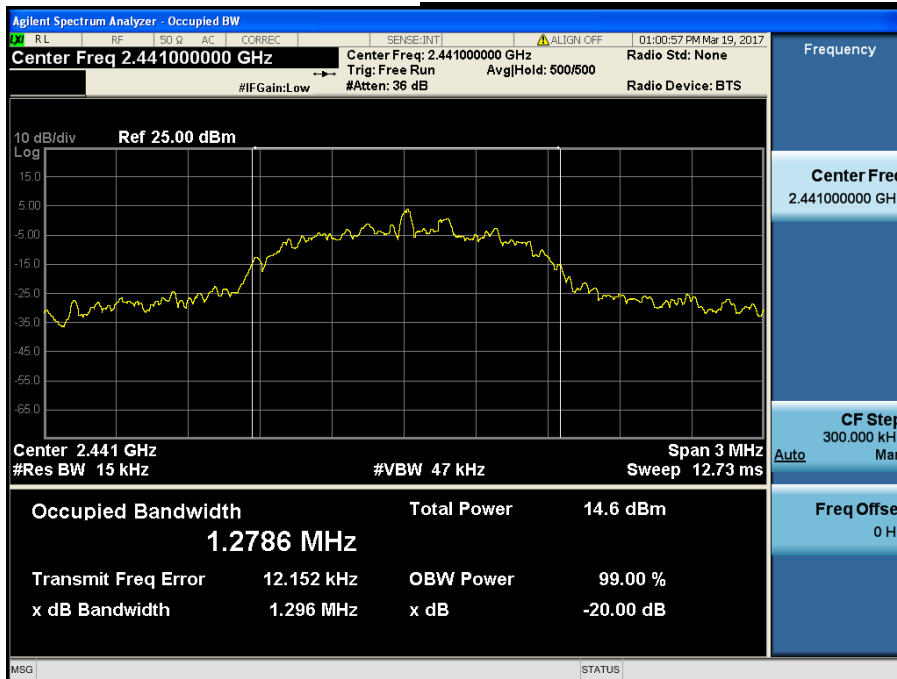
20 dB Bandwidth

Lowest Channel & Modulation : 8DPSK



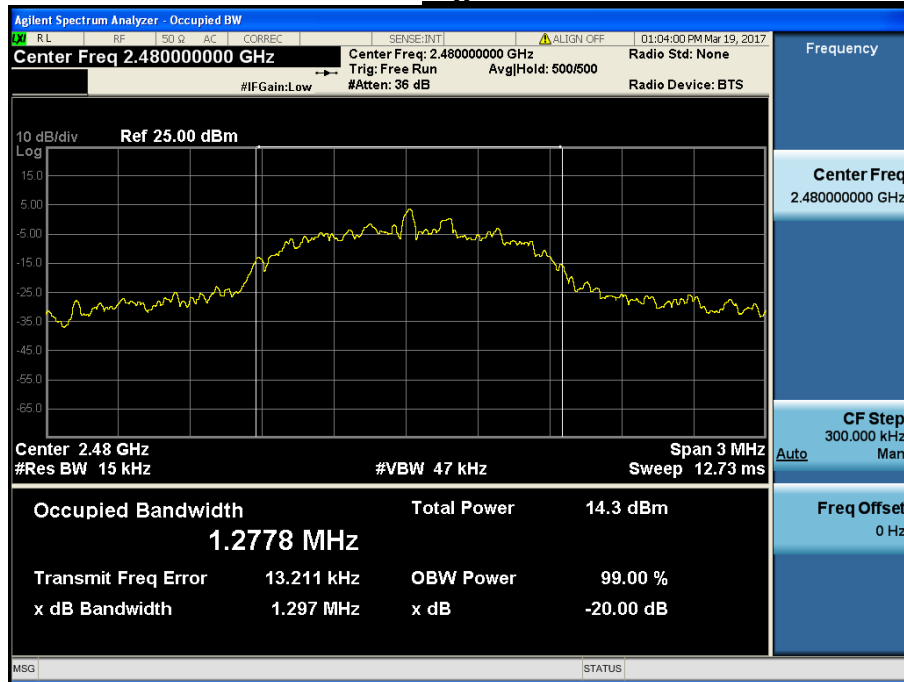
20 dB Bandwidth

Middle Channel & Modulation : 8DPSK



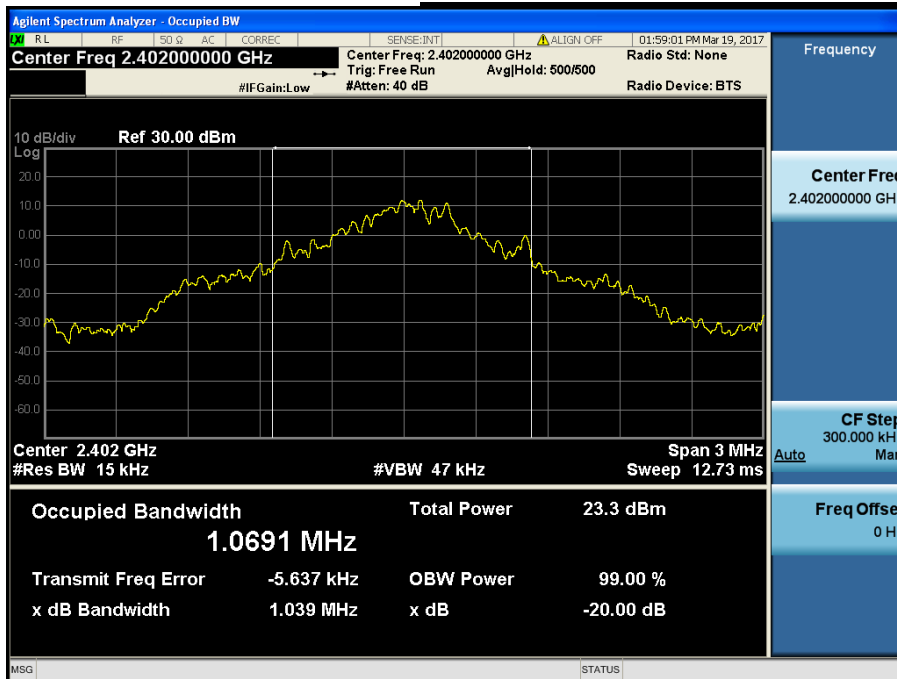
20 dB Bandwidth

Highest Channel & Modulation : 8DPSK

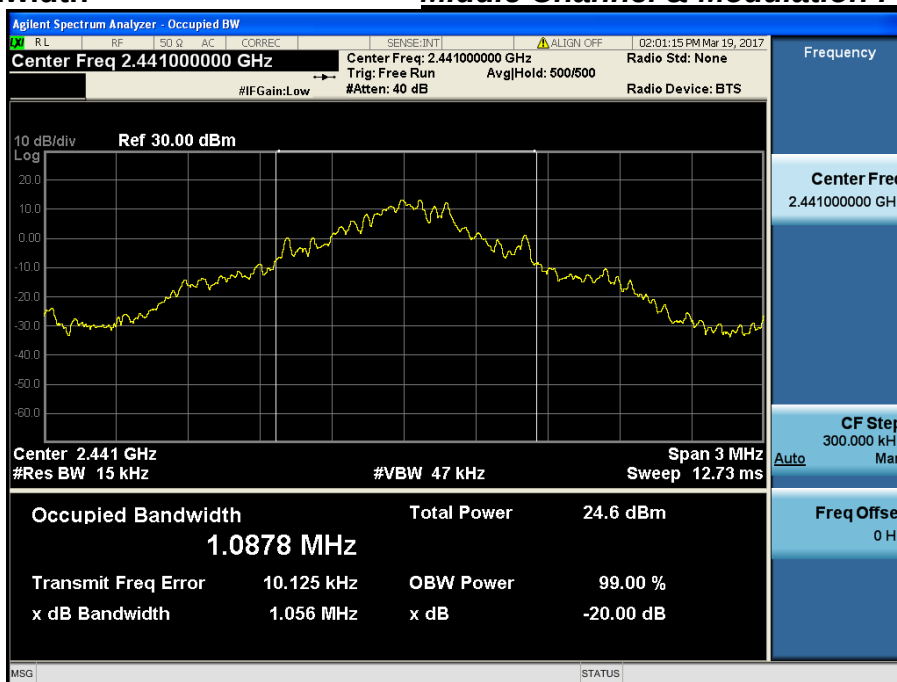


<Module 1>

20 dB Bandwidth

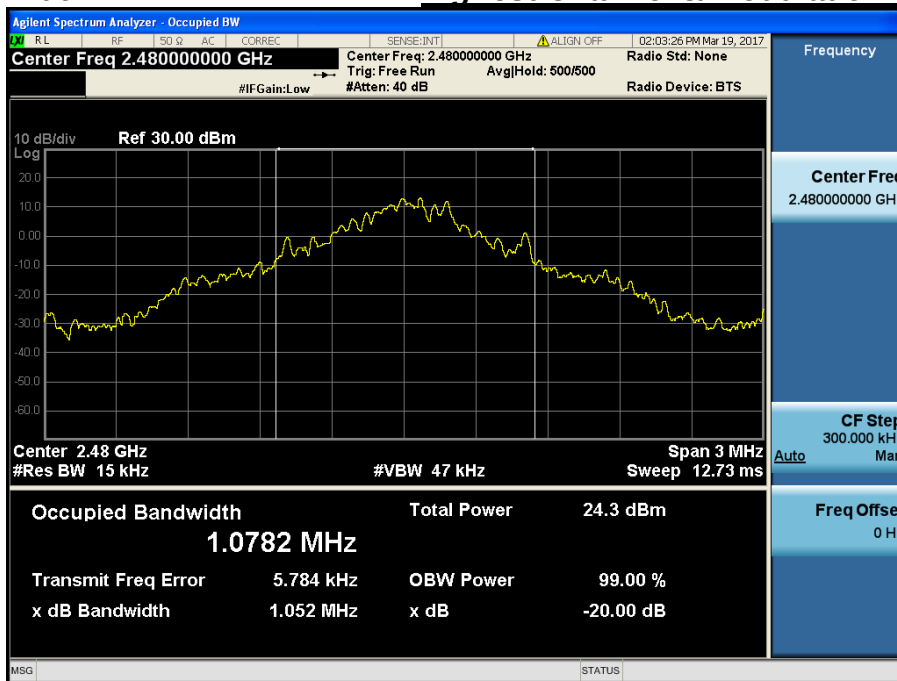
Lowest Channel & Modulation : GFSK

20 dB Bandwidth

Middle Channel & Modulation : GFSK

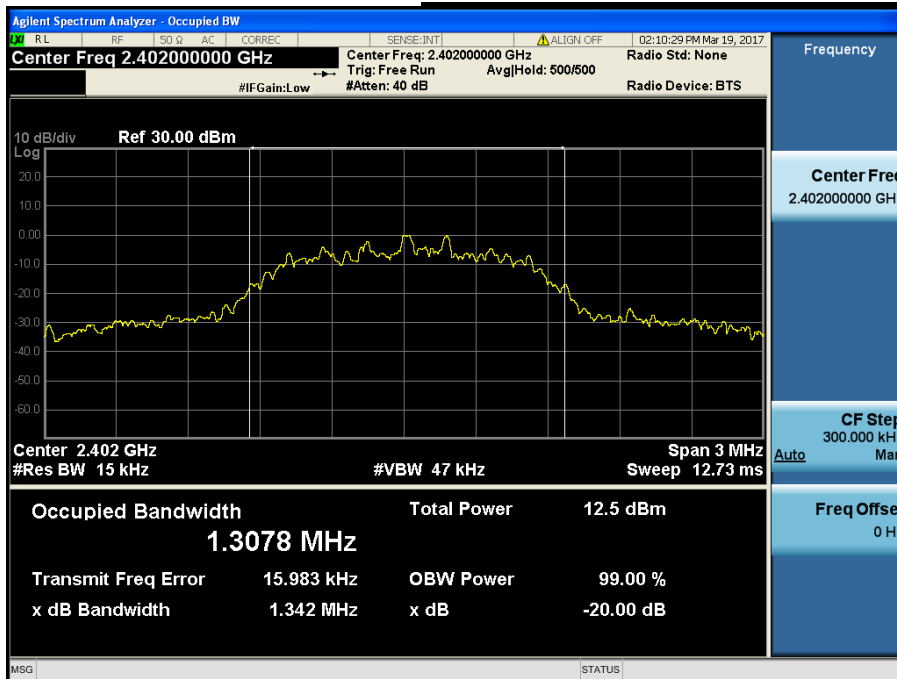
20 dB Bandwidth

Highest Channel & Modulation : GFSK



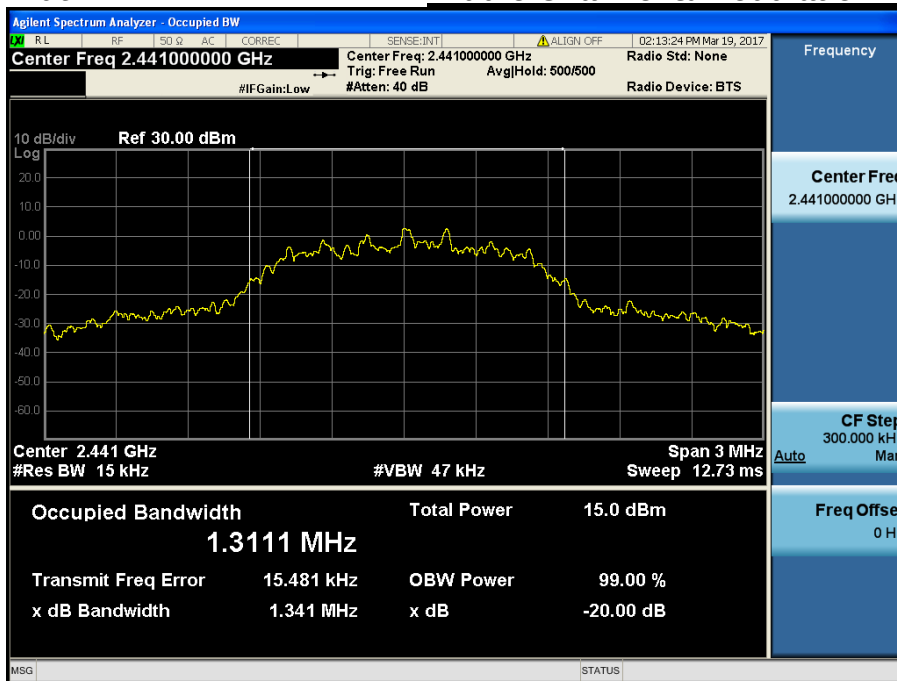
20 dB Bandwidth

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



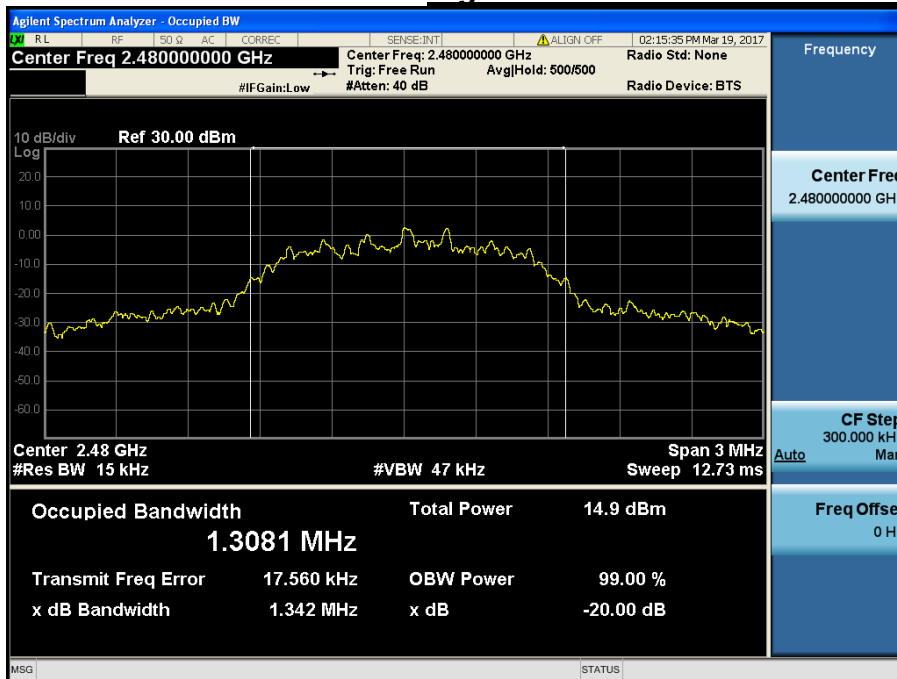
20 dB Bandwidth

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



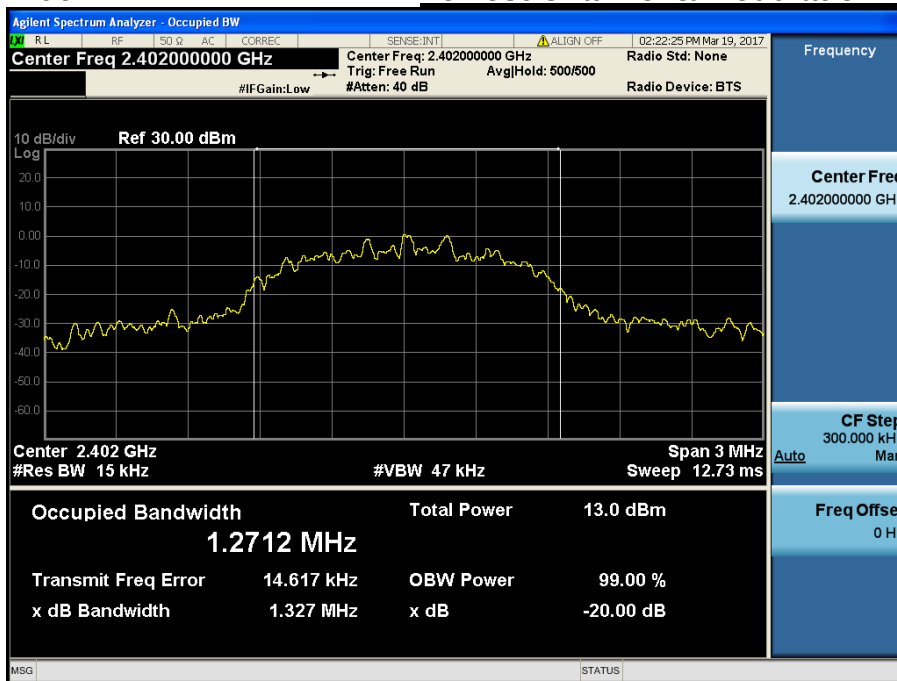
20 dB Bandwidth

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



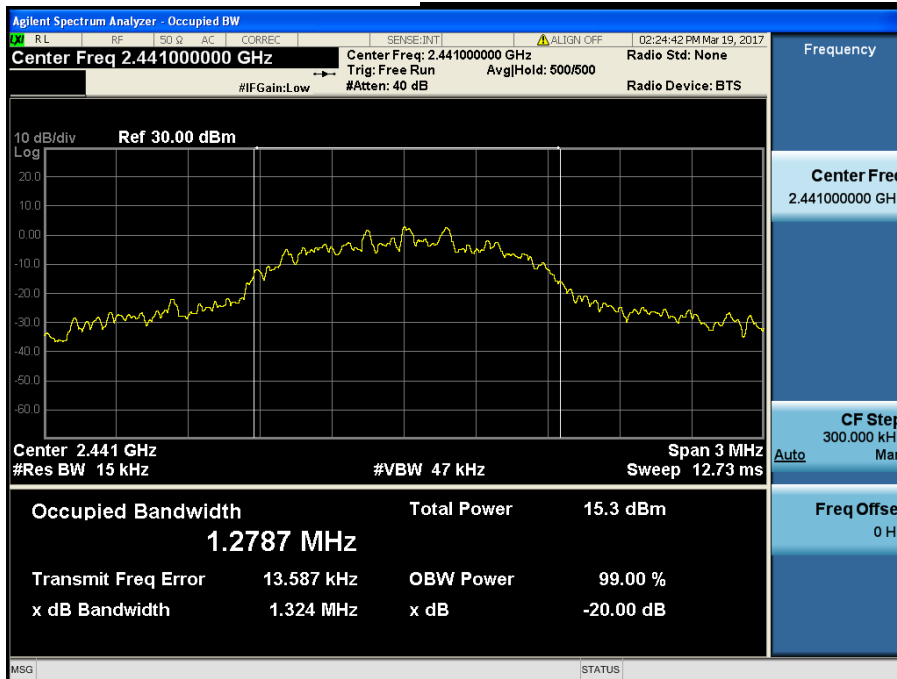
20 dB Bandwidth

Lowest Channel & Modulation : 8DPSK



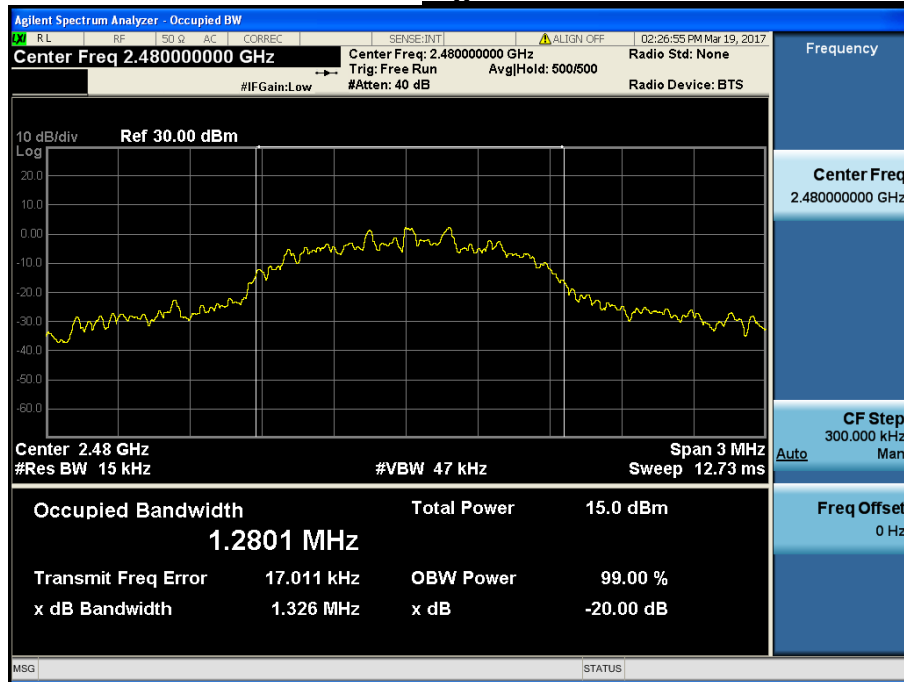
20 dB Bandwidth

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 : ≥ 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_Module 0

Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2441.012	2442.011	0.999
	$\pi/4$ -DQPSK	2441.012	2442.011	0.999
	8DPSK	2441.012	2442.011	0.999

AFH mode_Module 0

Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2441.009	2442.011	1.002
	$\pi/4$ -DQPSK	2441.012	2442.011	0.999
	8DPSK	2441.012	2442.011	0.999

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

FH mode_Module 1

Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2441.015	2442.014	0.999
	$\pi/4$ -DQPSK	2441.018	2442.017	0.999
	8DPSK	2441.177	2442.176	0.999

AFH mode_Module 1

Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2441.015	2442.017	1.002
	$\pi/4$ -DQPSK	2441.021	2442.017	0.996
	8DPSK	2441.177	2442.176	0.999

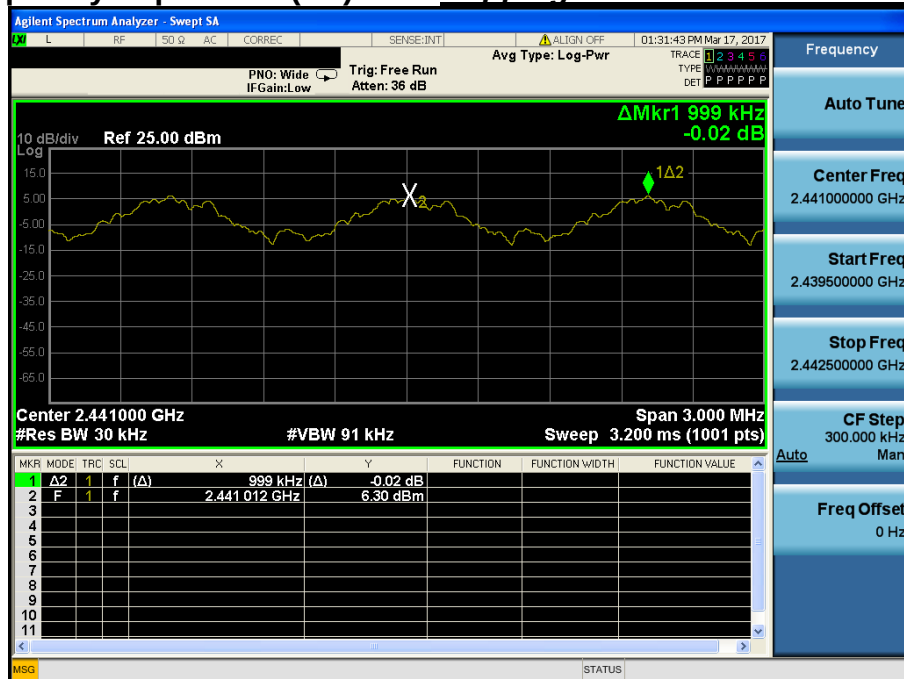
Note 1 : See next pages for actual measured spectrum plots.

- Minimum Standard :

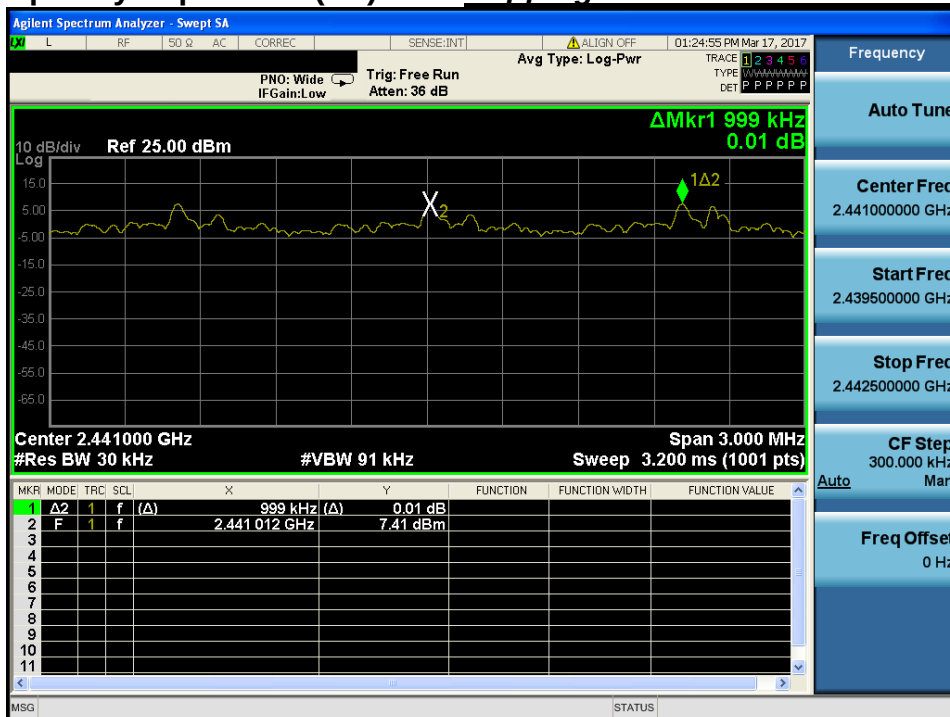
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
Alternatively, frequency hopping systems operating in the 2400 - 2483.5 MHz band may have hopping channel carrier frequencies 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

<Module 0>

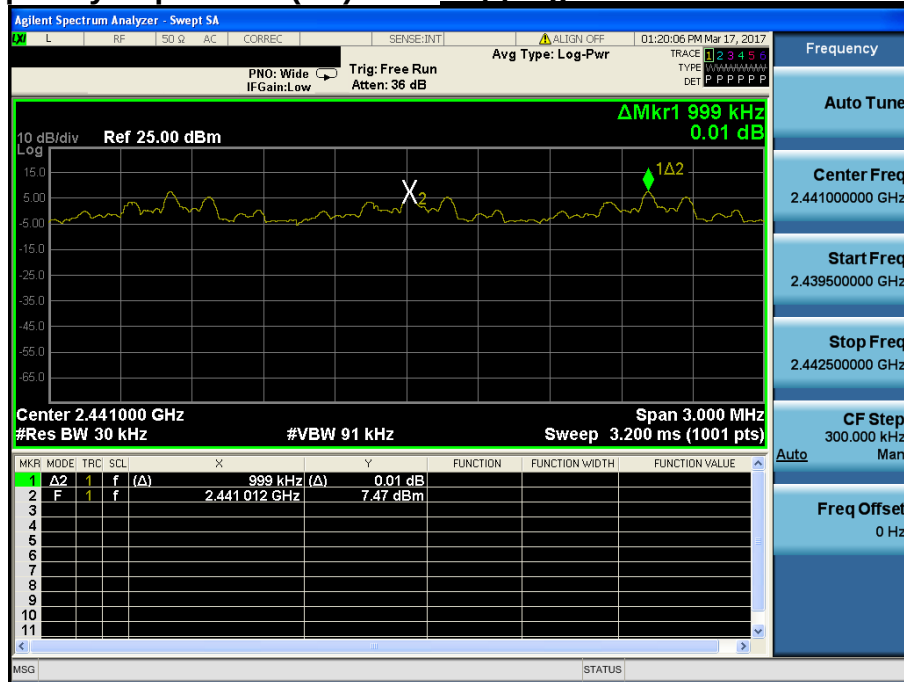
Carrier Frequency Separation (FH) *Hopping mode : Enable & GFSK*



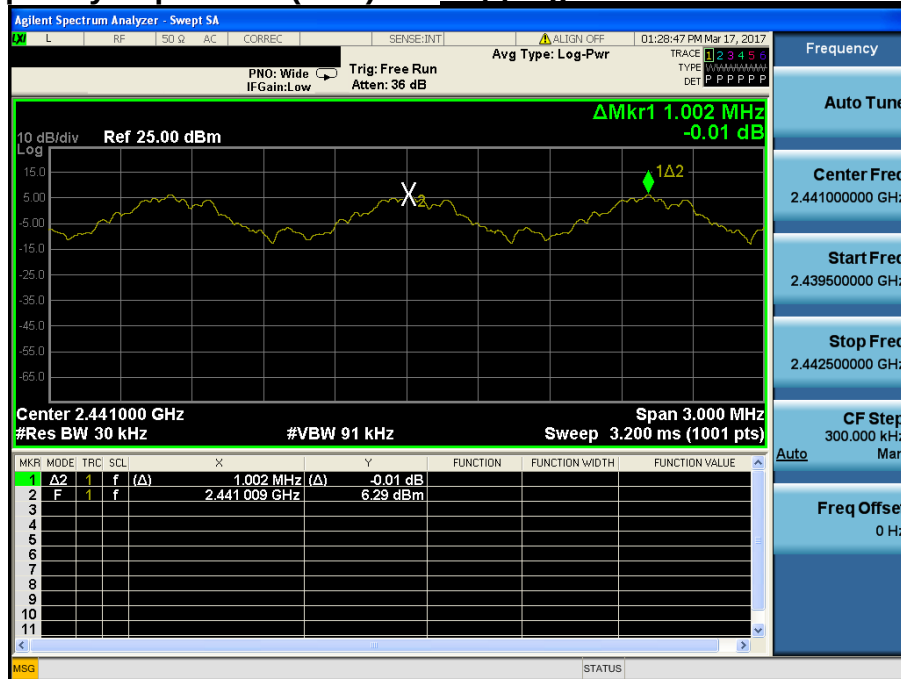
Carrier Frequency Separation (FH) *Hopping mode : Enable & $\pi/4$ -DQPSK*



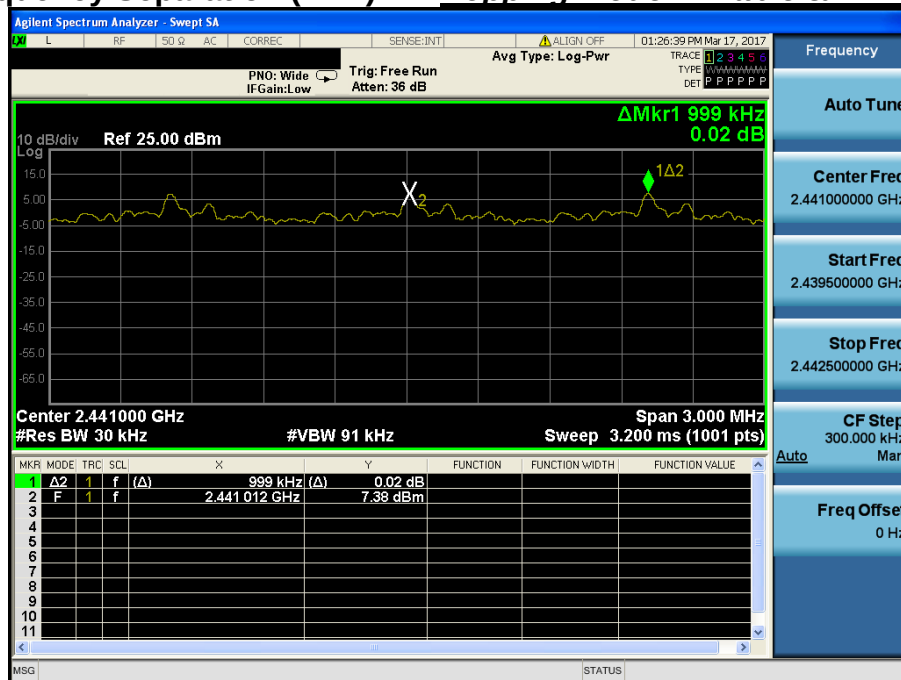
Carrier Frequency Separation (FH) Hopping mode : Enable & 8DPSK



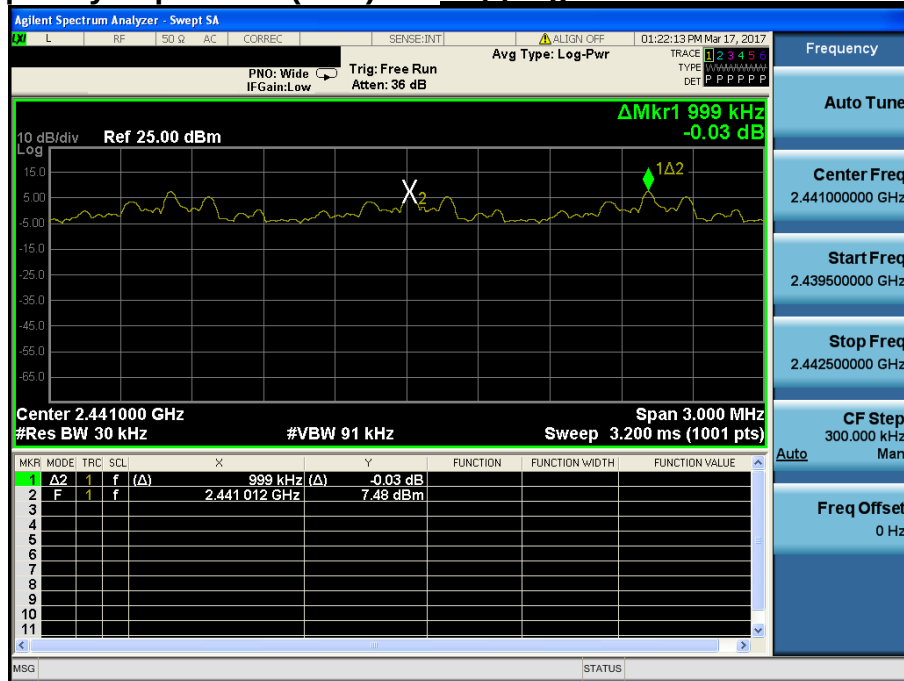
Carrier Frequency Separation (AFH) *Hopping mode : Enable & GFSK*



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

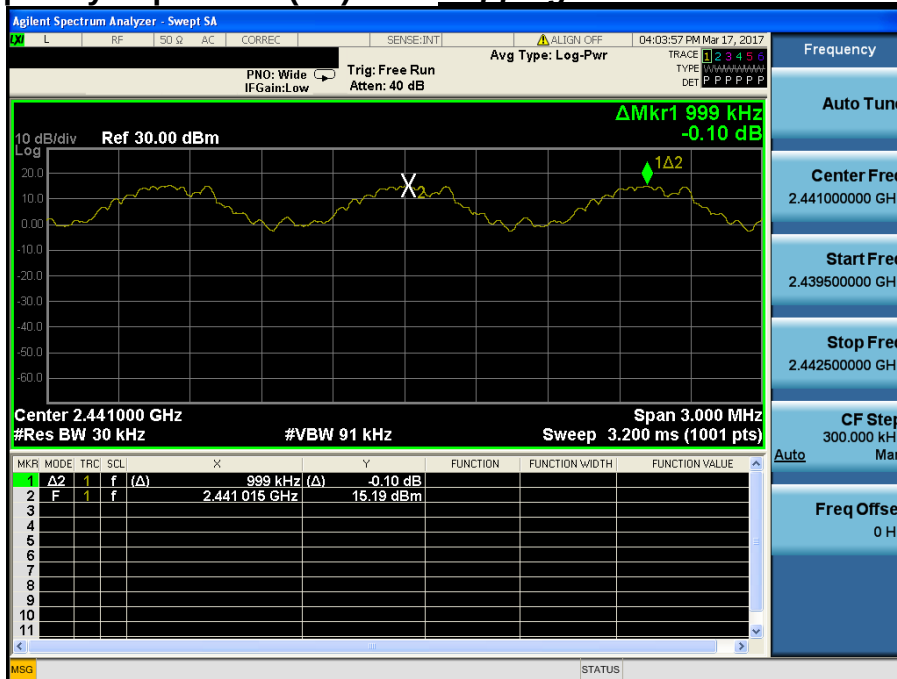


Carrier Frequency Separation (AFH) *Hopping mode : Enable & 8DPSK*

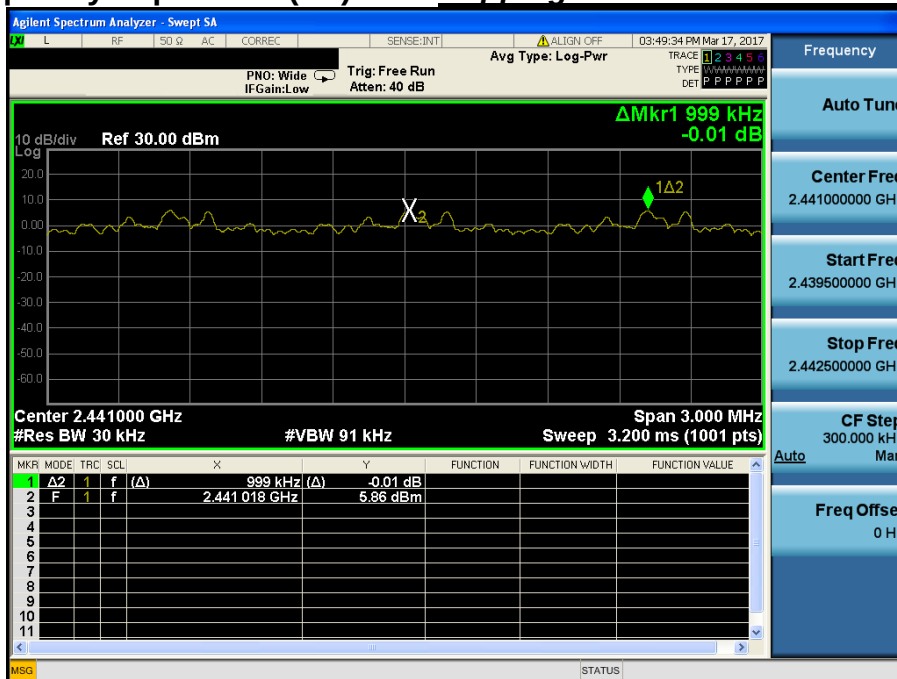


<Module 1>

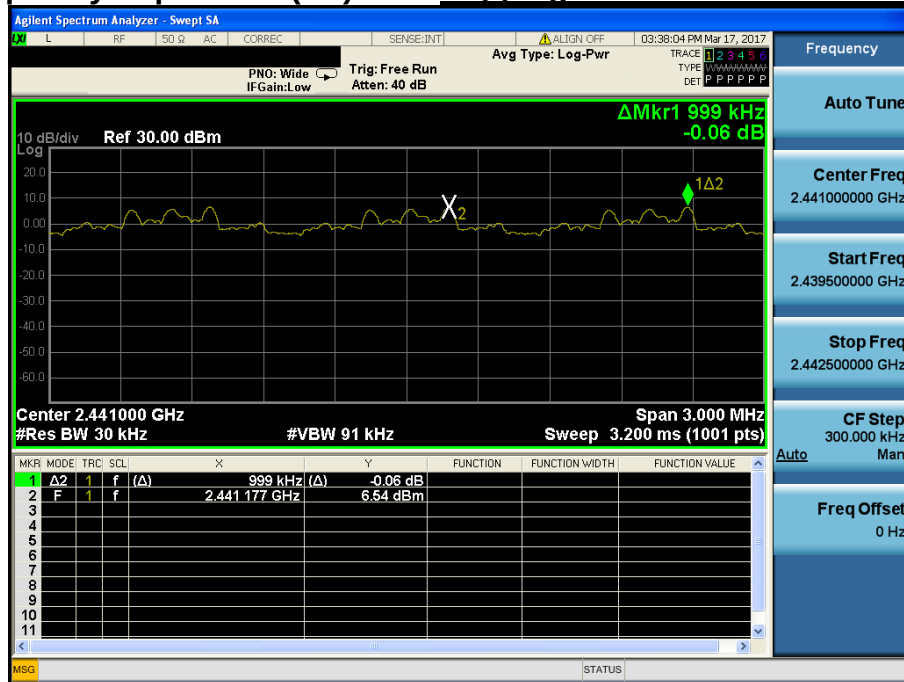
Carrier Frequency Separation (FH) *Hopping mode : Enable & GFSK*



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



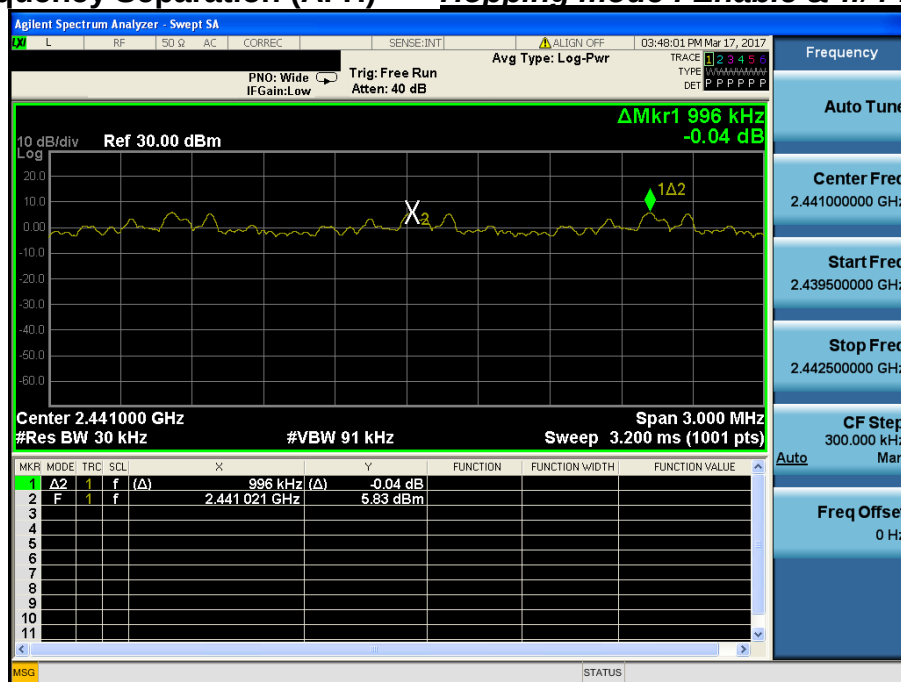
Carrier Frequency Separation (FH) Hopping mode : Enable & 8DPSK



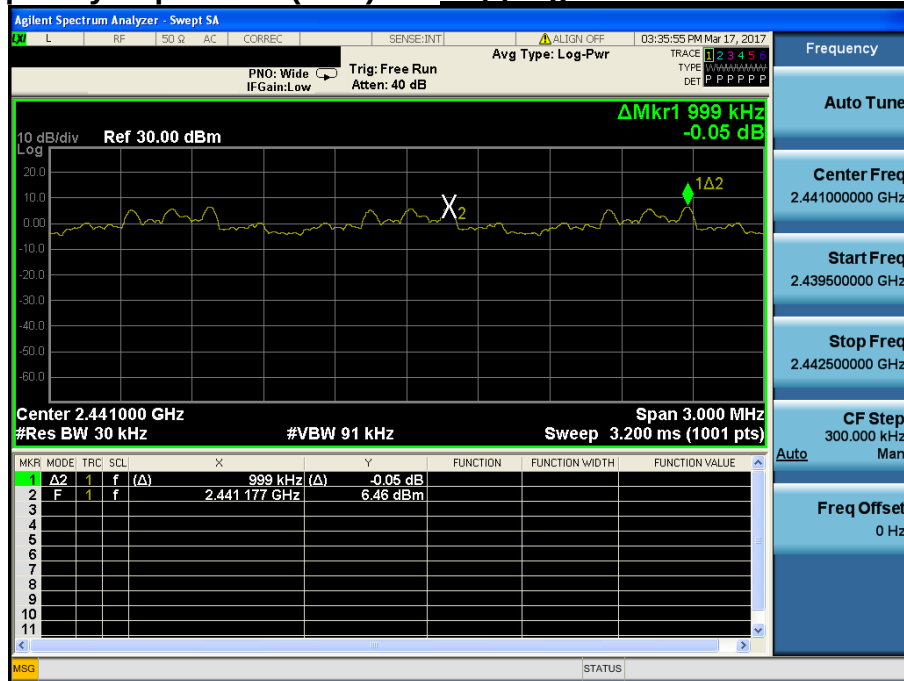
Carrier Frequency Separation (AFH) *Hopping mode : Enable & GFSK*



Carrier Frequency Separation (AFH) *Hopping mode : Enable & π/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 : ≥ 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 = 50 MHz Start Frequency = 2416.0 MHz, Stop Frequency = 2466.0 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_Module 0

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

AFH mode_Module 0

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.

FH mode_Module 1

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

AFH mode_Module 1

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.

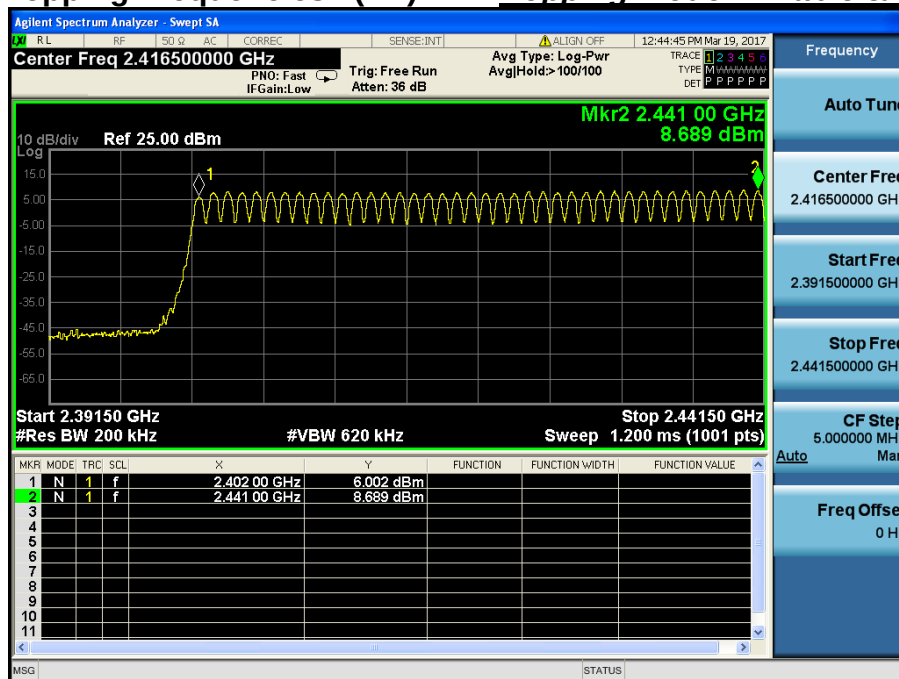
- Minimum Standard :

At least 15 hops

<Module 0>

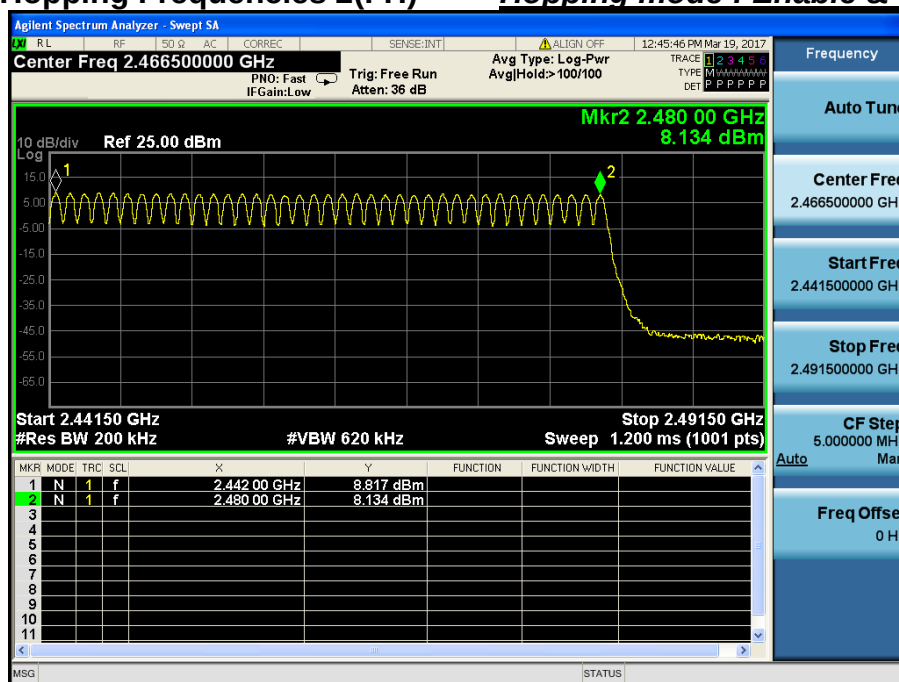
Number of Hopping Frequencies 1(FH)

Hopping mode : Enable & GFSK



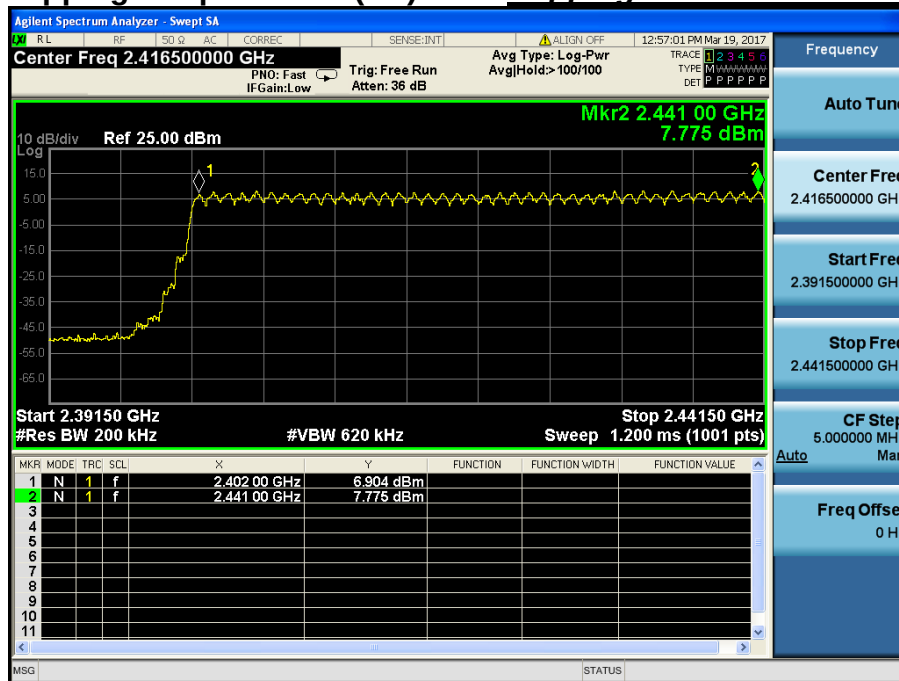
Number of Hopping Frequencies 2(FH)

Hopping mode : Enable & GFSK



Number of Hopping Frequencies 1(FH)

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



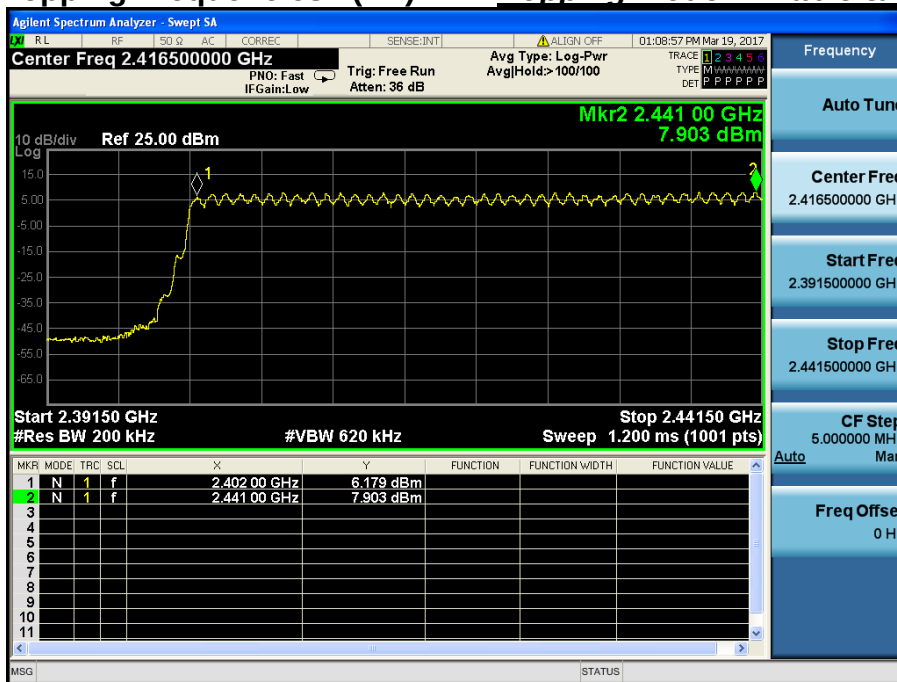
Number of Hopping Frequencies 2(FH)

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



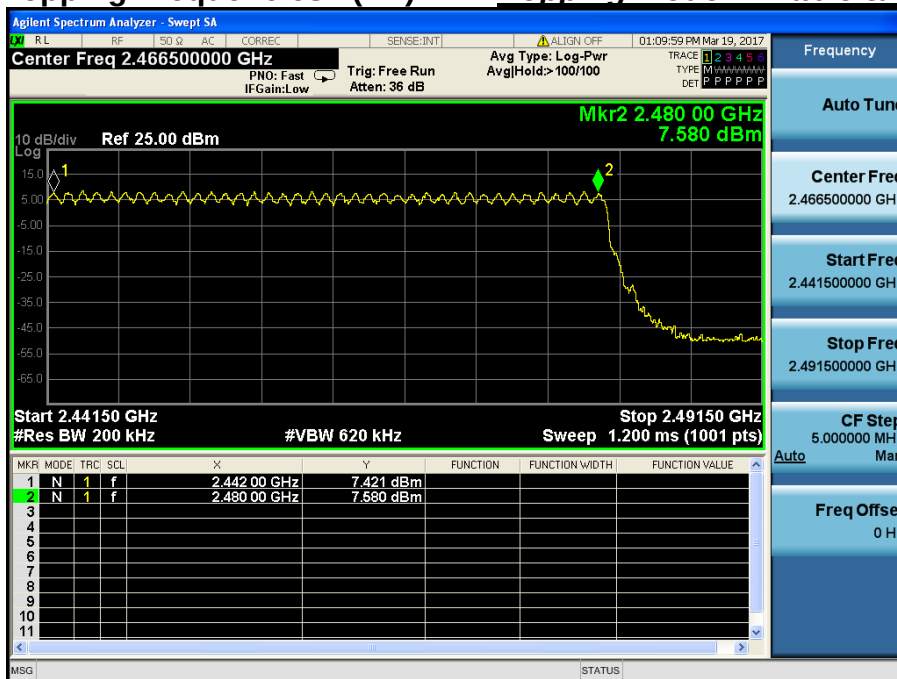
Number of Hopping Frequencies 1(FH)

Hopping mode : Enable & 8DPSK

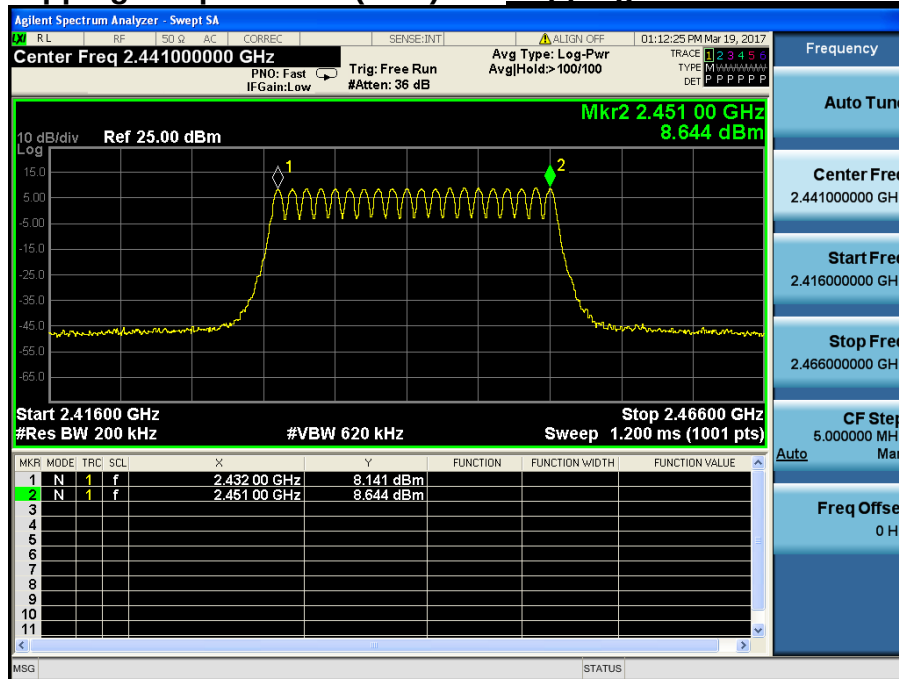


Number of Hopping Frequencies 2(FH)

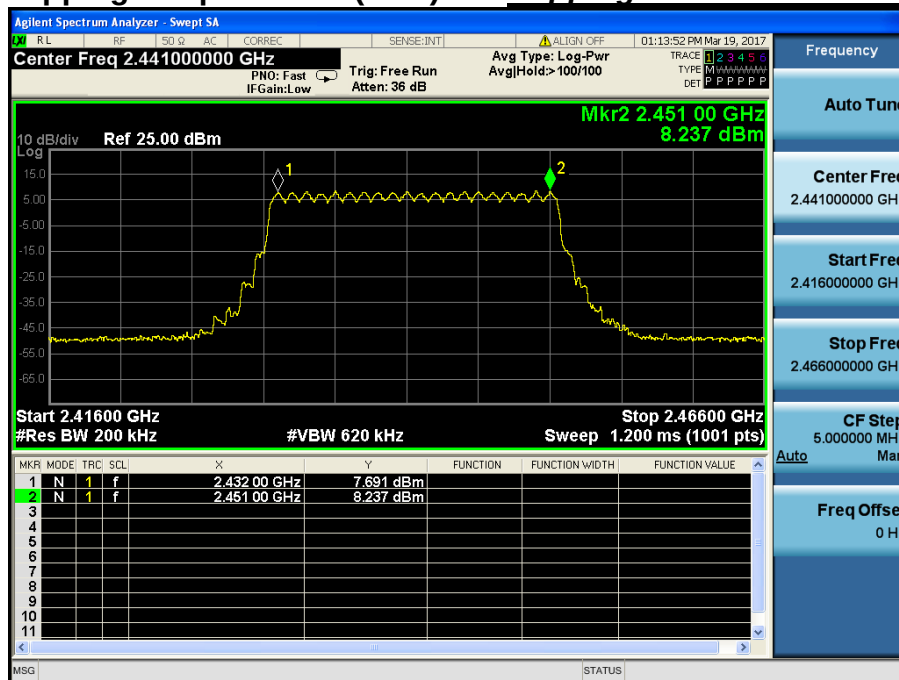
Hopping mode : Enable & 8DPSK



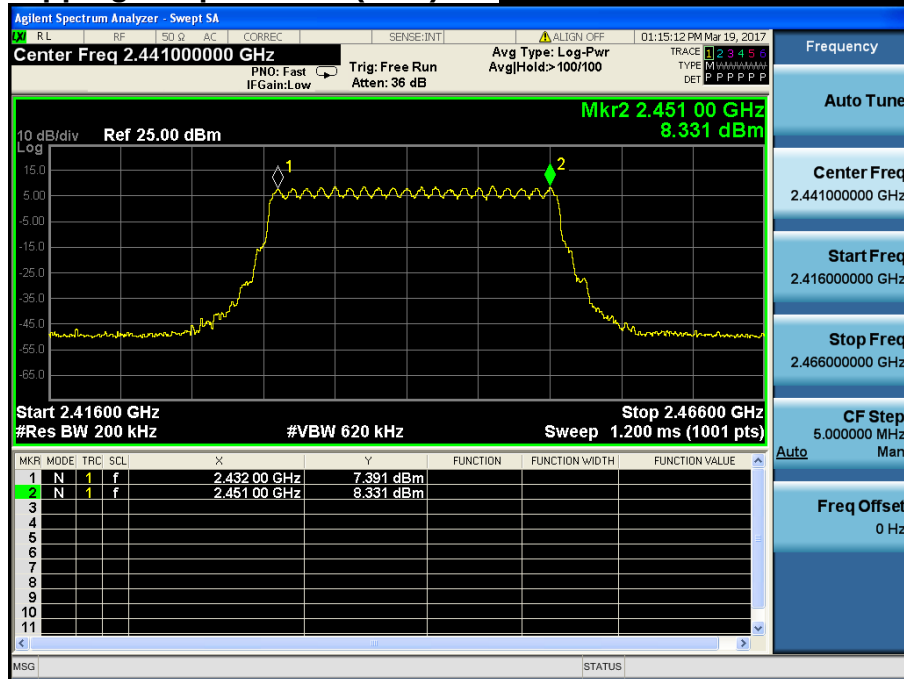
Number of Hopping Frequencies 1(AFH) *Hopping mode : Enable & GFSK*



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



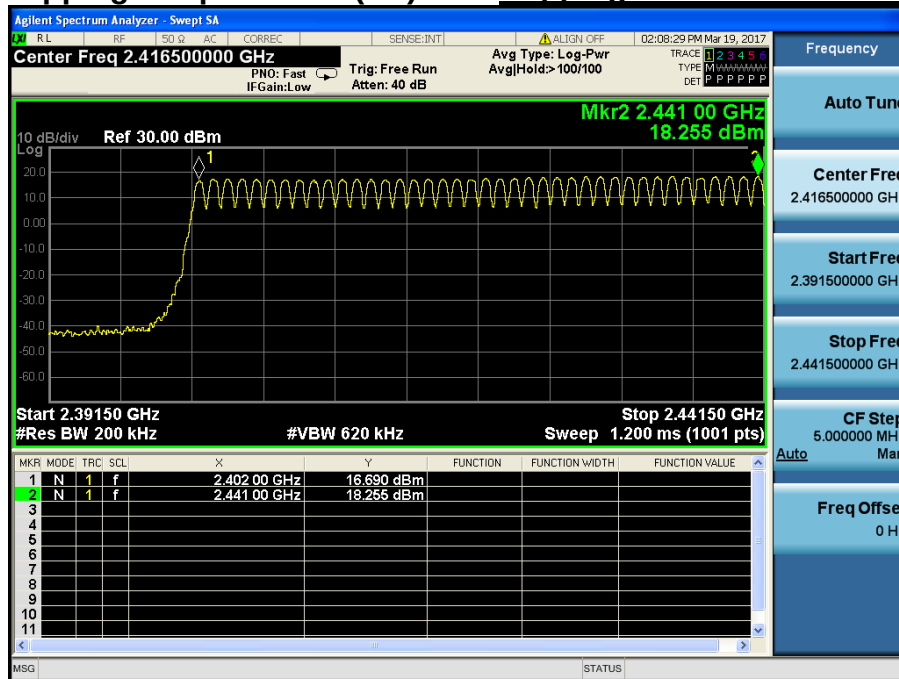
Number of Hopping Frequencies 1(AFH) *Hopping mode : Enable & 8DPSK*



<Module 1>

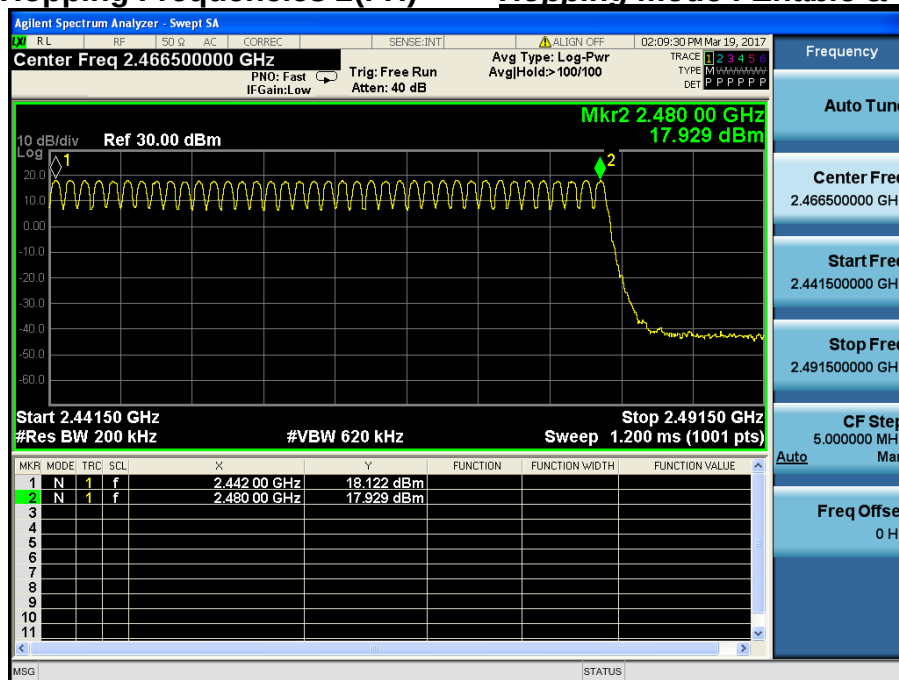
Number of Hopping Frequencies 1(FH)

Hopping mode : Enable & GFSK



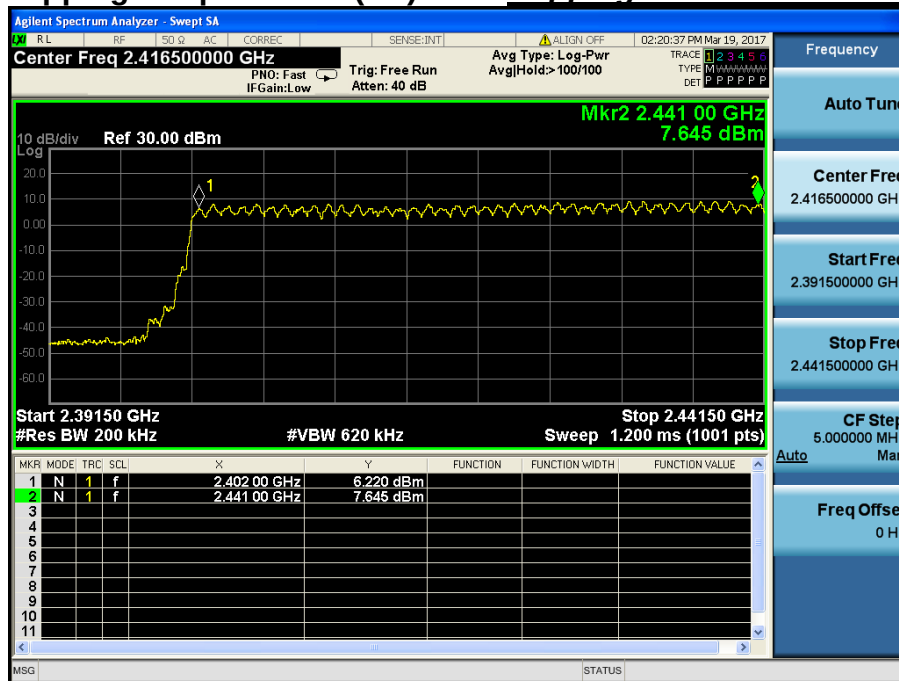
Number of Hopping Frequencies 2(FH)

Hopping mode : Enable & GFSK



Number of Hopping Frequencies 1(FH)

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



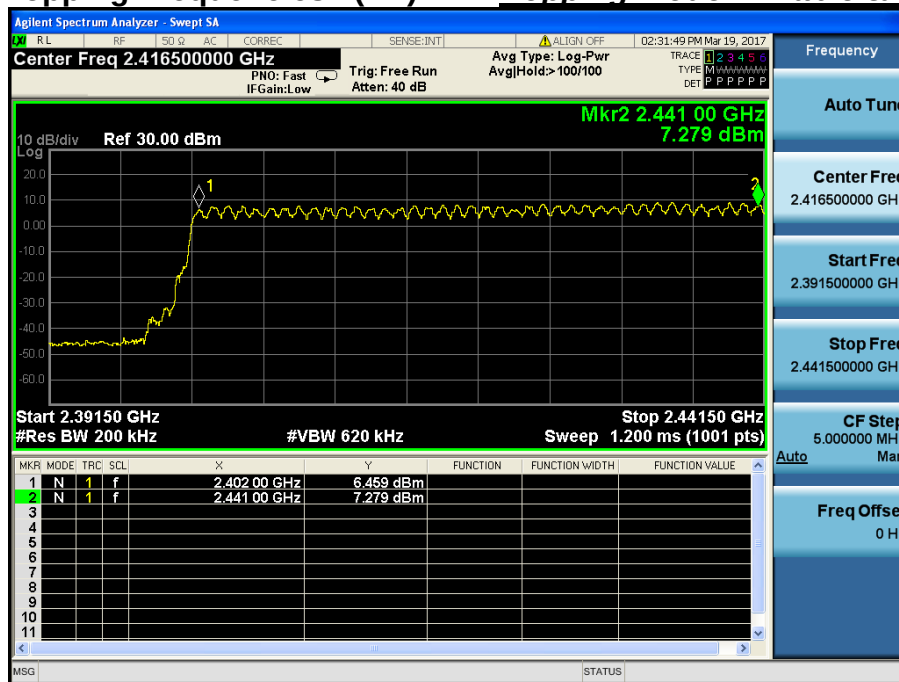
Number of Hopping Frequencies 2(FH)

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



Number of Hopping Frequencies 1(FH)

Hopping mode : Enable & 8DPSK

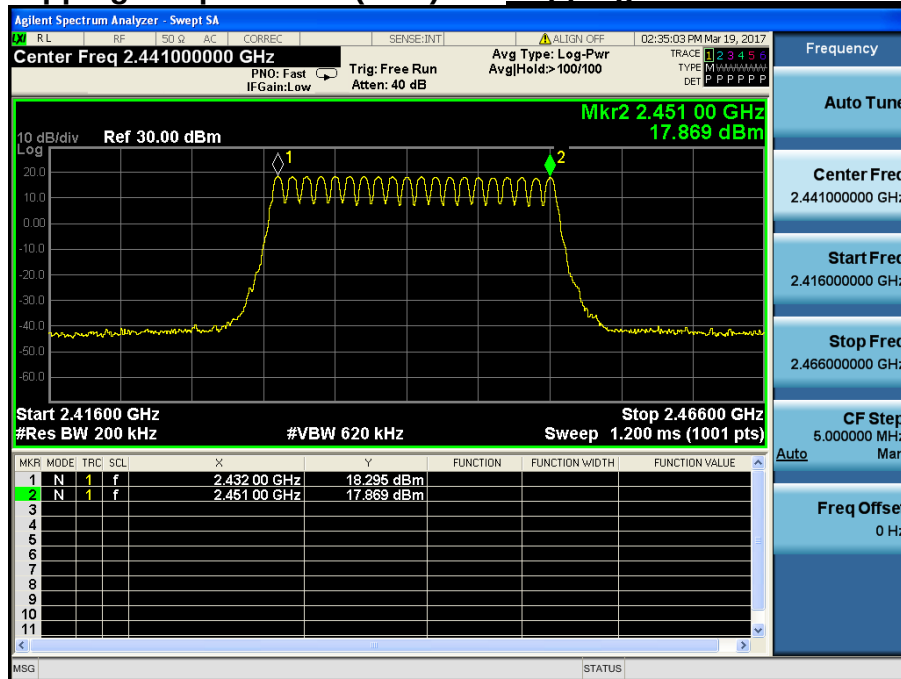


Number of Hopping Frequencies 2(FH)

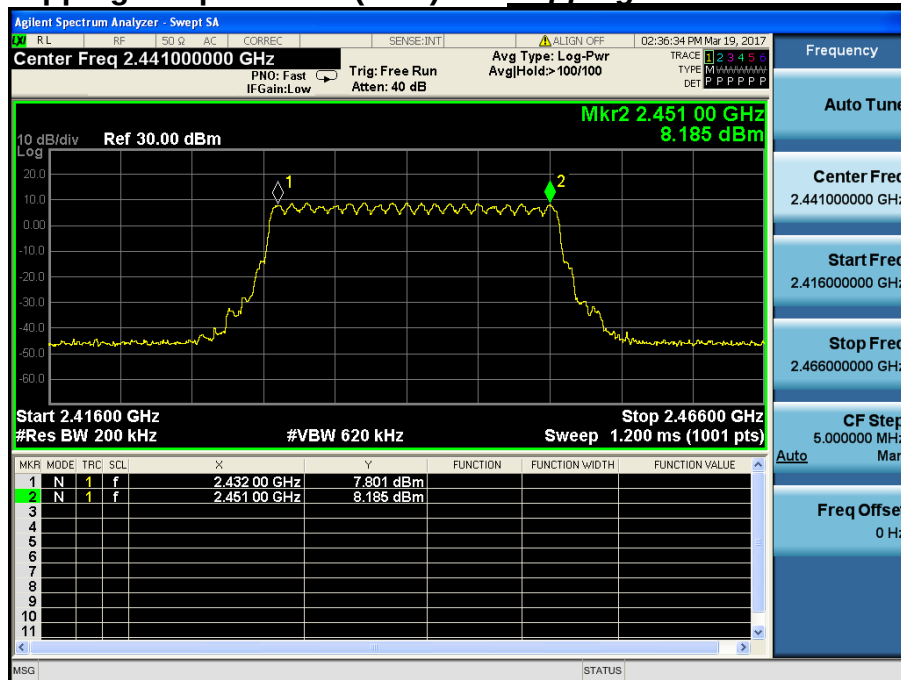
Hopping mode : Enable & 8DPSK



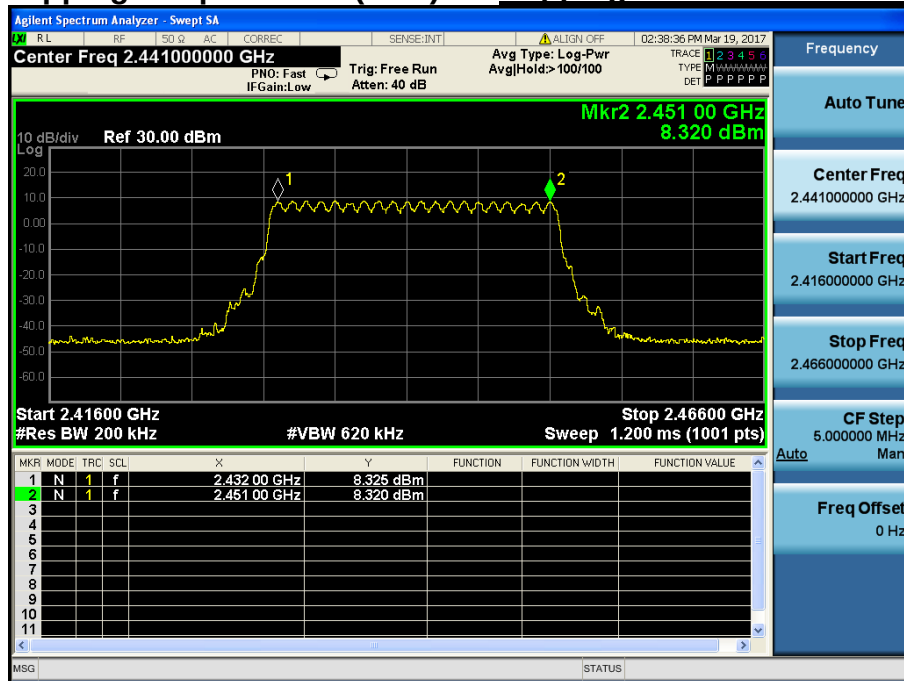
Number of Hopping Frequencies 1(AFH) *Hopping mode : Enable & GFSK*



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 = 2441 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_Module 0

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_Module 0

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 slot / RX = 1 slot)

- Hopping Rate = 1600 for FH mode & 800 for AFH mode

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

FH mode_Module 1

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_Module 1

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 = $0.4 \times \text{Hopping channel} \times \text{Burst ON time} \times ((\text{Hopping rate} \div \text{Time slots}) \div \text{Hopping channel})$

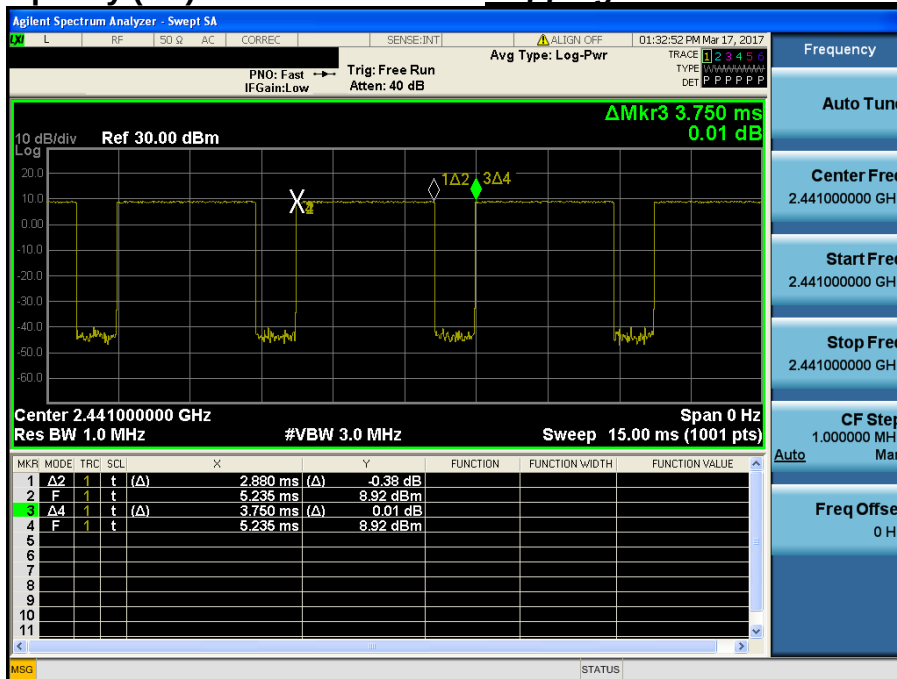
- Time slots for DH5 = 6 slots (TX = 5 slot / RX = 1 slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

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

<Module 0>

Time of Occupancy (FH)

Hopping mode : Enable & DH5



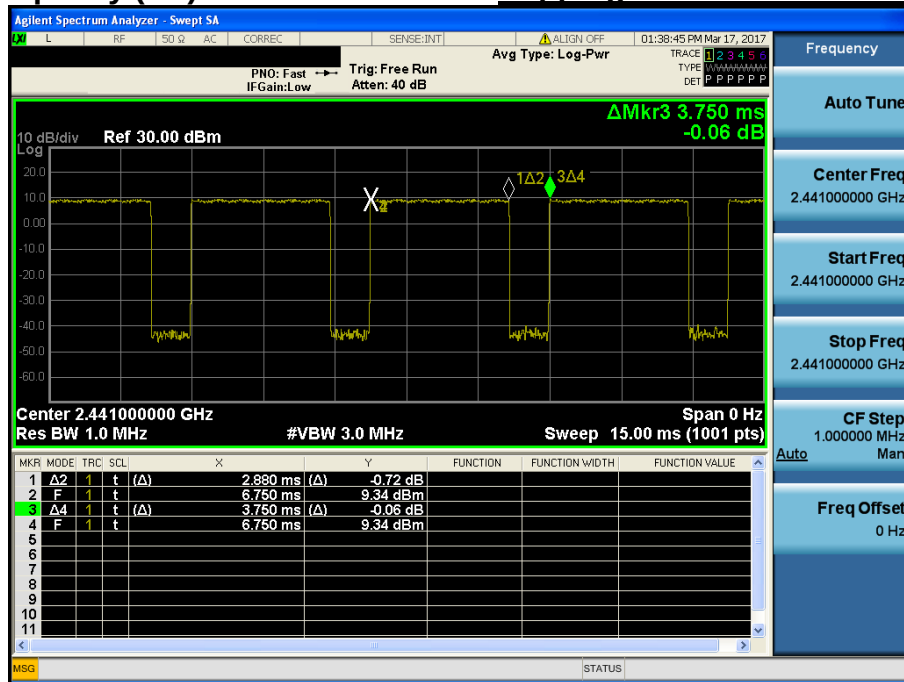
Time of Occupancy (FH)

Hopping mode : Enable & 2-DH5



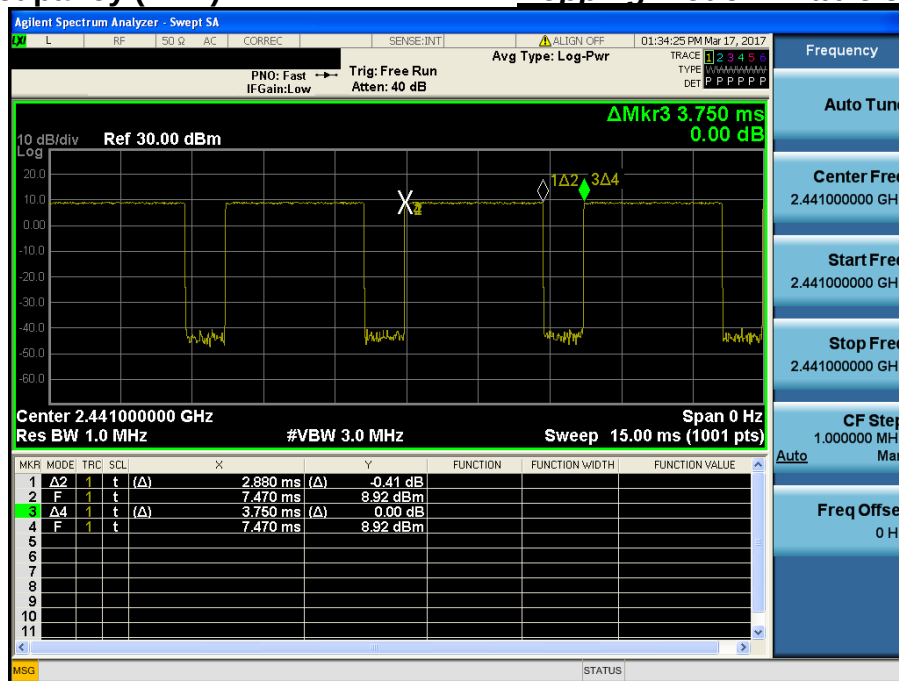
Time of Occupancy (FH)

Hopping mode : Enable & 3-DH5



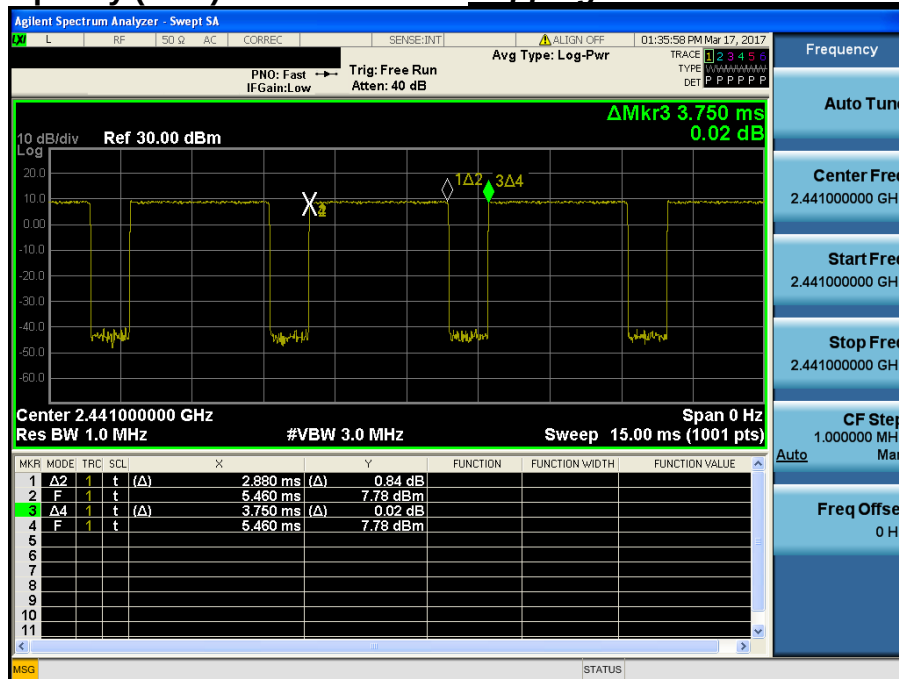
Time of Occupancy (AFH)

Hopping mode : Enable & DH5

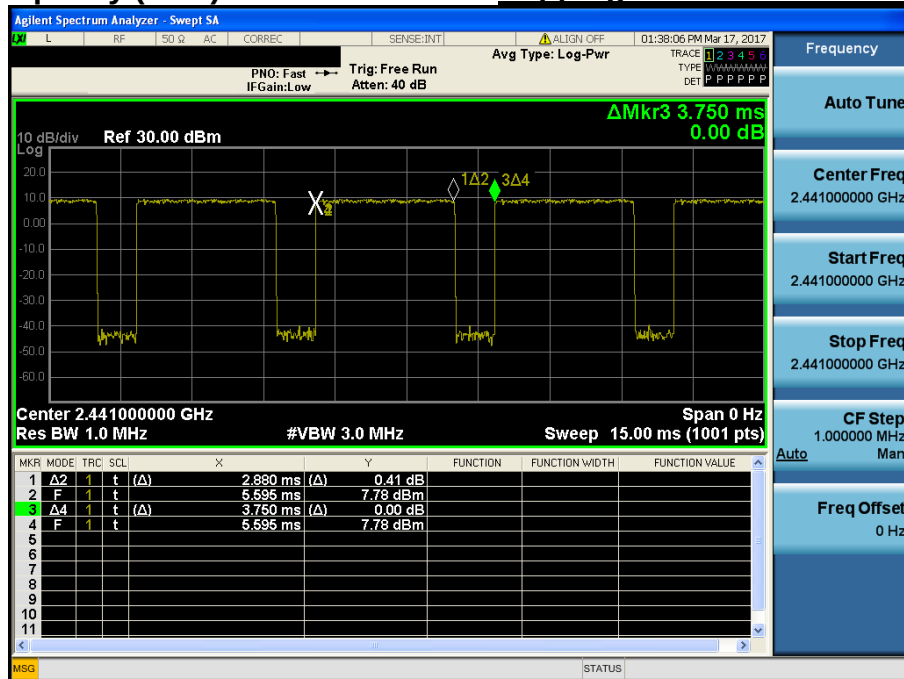


Time of Occupancy (AFH)

Hopping mode : Enable & 2-DH5



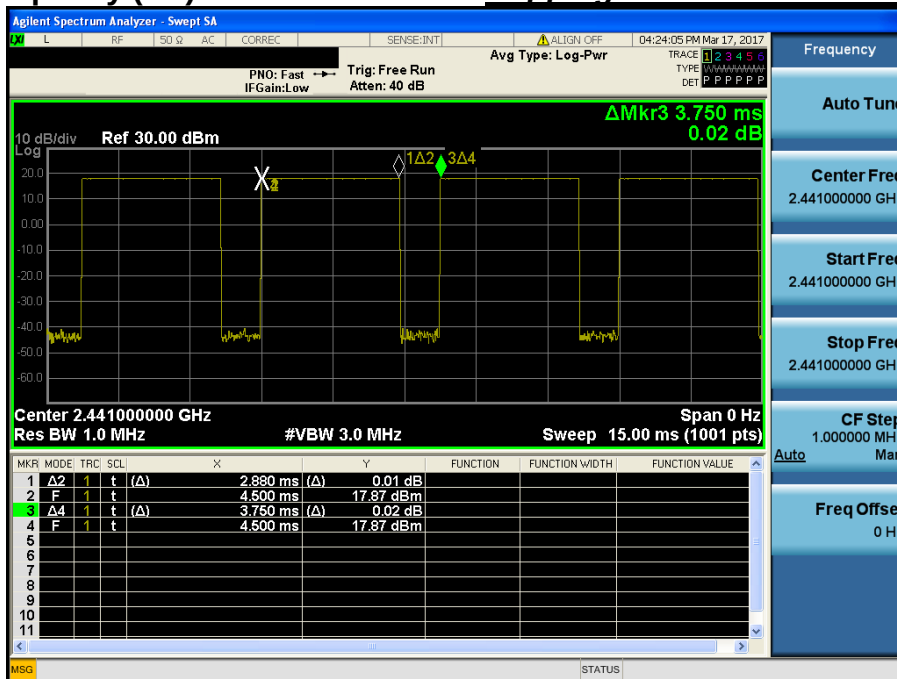
Time of Occupancy (AFH)

Hopping mode : Enable & 3-DH5

<Module 1>

Time of Occupancy (FH)

Hopping mode : Enable & DH5



Time of Occupancy (FH)

Hopping mode : Enable & 2-DH5

