

TEST REPORT

DT&C Co., Ltd. 42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel : 031-321-2664, Fax : 031-321-1664	Report No : DRTFCC1607-0091 Pages:(1) / (89) page				
1. Customer • Name : Sena Technologies, Inc. • Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea 2. Use of Report : FCC Original Grant 3. Product Name (FCC ID) : Bluetooth Stereo Motorcycle Headset (S7A-SP28) 4. Date of Test : 2016-07-04 ~ 2016-07-08 5. Test Method Used: FCC Part 15 Subpart C.247 6. Testing Environment : See appended test report 7. Test Result : ☒ Pass ☐ Fail The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full. <table border="1"><tr><td>Affirmation</td><td>Tested by Name : JungWoo Kim (Signature)</td><td>Technical Manager Name : GeunKi Son (Signature)</td></tr></table> 2016 . 07 . 12 . DT&C Co., Ltd.			Affirmation	Tested by Name : JungWoo Kim (Signature)	Technical Manager Name : GeunKi Son (Signature)
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* If this test report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description
DRTFCC1607-0091	Jul. 12, 2016	Initial issue

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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 Details of Applicant

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

1.3 Description of EUT

EUT	Bluetooth Stereo Motorcycle Headset
Model Name	DWO-5
Add Model Name	N/A
Serial Number	Identical prototype
Power Supply	DC 3.7V
Frequency Range	2402 MHz ~ 2480 MHz
Modulation Technique	GFSK, $\pi/4$ -DQPSK, 8DPSK
Number of Channels	79
Antenna Type	Internal Antenna
Antenna Gain	PK : 0.30 dBi

1.4 Declaration by the applicant / manufacturer

- NA

1.5 Information about the FHSS characteristics

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

1.6 Test conditions

Ambient Condition	
▪ Temperature	+23 °C ~ +24 °C
▪ Relative Humidity	44 % ~ 46 %

1.7 Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
MXA Signal Analyzer	Agilent	N9020A	15/9/14	16/9/14	MY50200834
DIGITAL MULTIMETER	Agilent	34401A	16/1/5	17/1/5	US36099541
Dynamic Measurement DC Source	Agilent	66332A	15/9/23	16/9/23	US37473305
Vector Signal Generator	Rohde Schwarz	SMBV100A	16/1/5	17/1/5	255571
Signal Generator	Rohde Schwarz	SMF100A	16/6/23	17/6/23	102341
Thermohygrometer	BODYCOM	BJ5478	16/4/22	17/4/22	120612-2
Loop Antenna	Schwarzbeck	FMZB1513	16/4/22	18/4/22	1513-128
TRILOG Broadband Test- Antenna(30MHz-1GHz)	SCHWARZBECK	VULB 9160	16/5/13	18/5/13	3357
Horn Antenna(1~18GHz)	ETS-LINDGREN	3115	15/2/9	17/2/9	9202-3820
Horn Antenna(18~40GHz)	A.H.Systems Inc.	SAS-574	15/9/3	17/9/3	155
PreAmplifier	Agilent	8449B	16/2/24	17/2/24	3008A00370
Low Noise Pre Amplifier(10kHz-1GHz)	tsj	MLA-010K01- B01-27	16/3/10	17/3/10	1844539
EMI TEST RECEIVER(20Hz~40GHz)	ROHDE&SCHWARZ	ESU	15/7/14	16/7/14	100469
EMI TEST RECEIVER	R&S	ESCI	16/2/25	17/2/25	100364
Highpass Filter	Wainwright Instruments	WHKX12-2580- 3000-18000- 80SS	15/9/23	16/9/23	3
Highpass Filter	Wainwright Instruments	WHNX6-6320- 8000-26500- 40CC	15/9/23	16/9/23	1
SINGLE-PHASE MASTER	NF	4420	15/9/9	16/9/9	3049354420023
ARTIFICIAL MAINS NETWORK	Narda S.T.S. / PMM	PMM L2-16B	16/6/22	17/6/22	000WX20305

1.8 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	≥ 20 dB BW or $\geq$ 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.		C
RSS Gen(6.6)	Occupied Bandwidth (99 %)	N/A		NA
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	C ^{Note 3}
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 of this device is only DC(Internal Battery) and Bluetooth function is enabled in charging status. Note 4 : The sample was tested according to the following specifications : - ANSI C63.10-2013				

1.9 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.

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, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(1), For frequency hopping systems operating in the 2400 – 2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 – 5805 MHz band : 1 Watt.

■ IC Requirements

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

2.3 Test Procedure

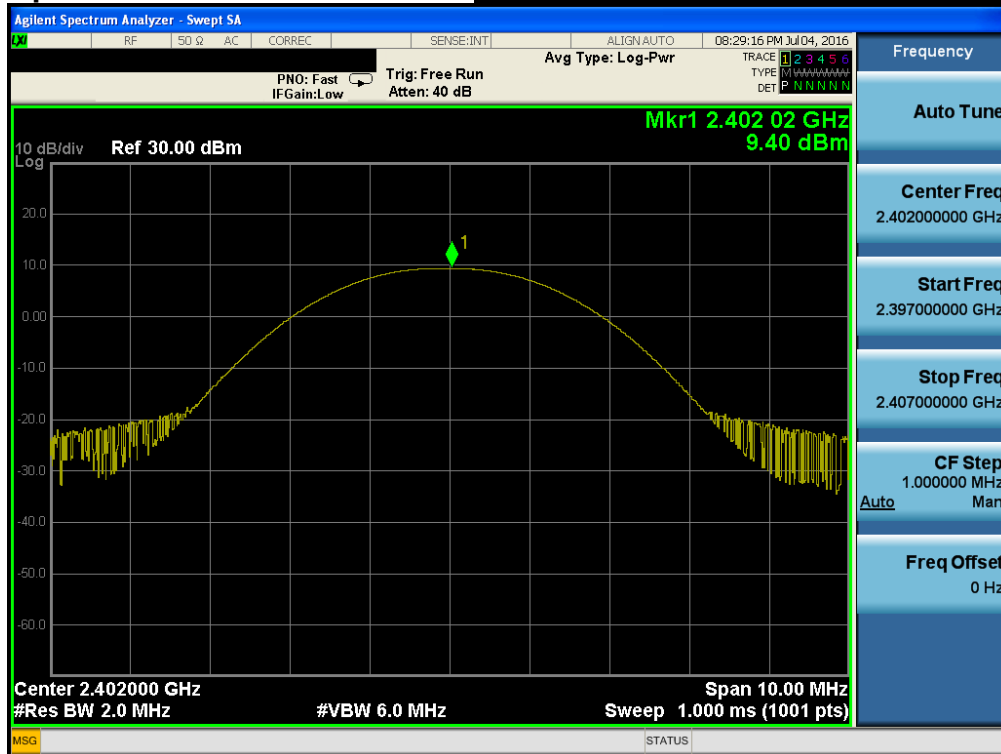
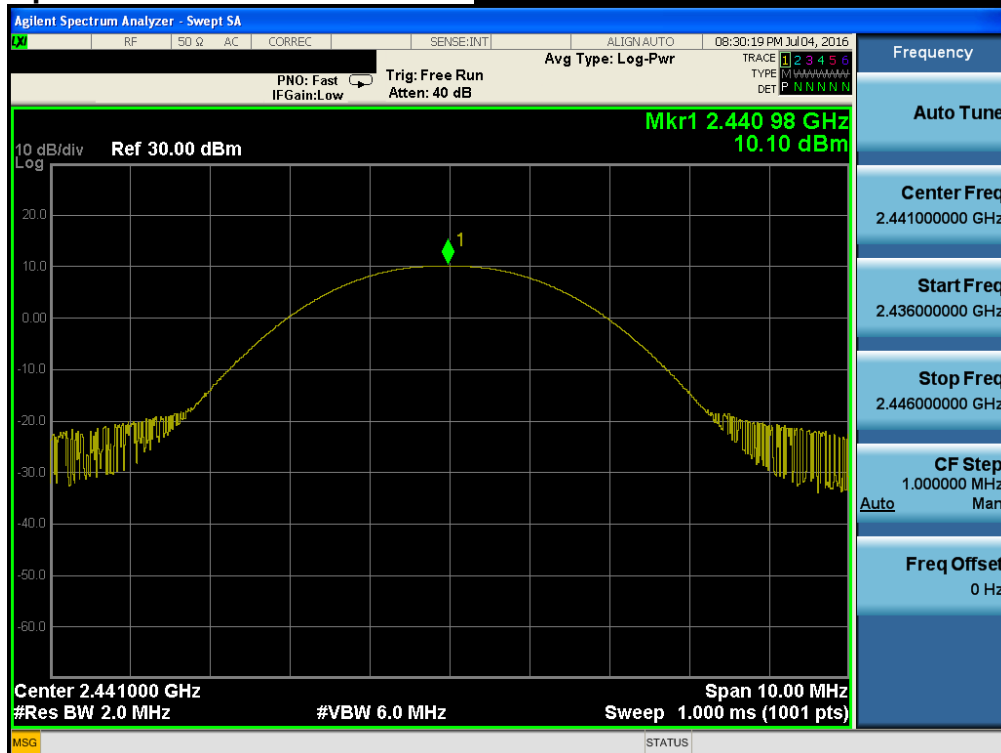
1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental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

2.4 Test Results

Modulation	Tested Channel	Frame Average Output Power		Peak Output Power	
		dBm	mW	dBm	mW
<u>GFSK</u>	Lowest	7.60	5.754	9.40	8.710
	Middle	8.14	6.516	10.10	10.233
	Highest	8.97	7.889	10.64	11.588
<u>$\pi/4$DQPSK</u>	Lowest	7.78	5.998	12.46	17.620
	Middle	8.39	6.902	13.29	21.330
	Highest	9.10	8.128	13.97	24.946
<u>8DPSK</u>	Lowest	7.80	6.026	12.77	18.923
	Middle	8.40	6.918	13.63	23.067
	Highest	9.12	8.166	14.15	26.002

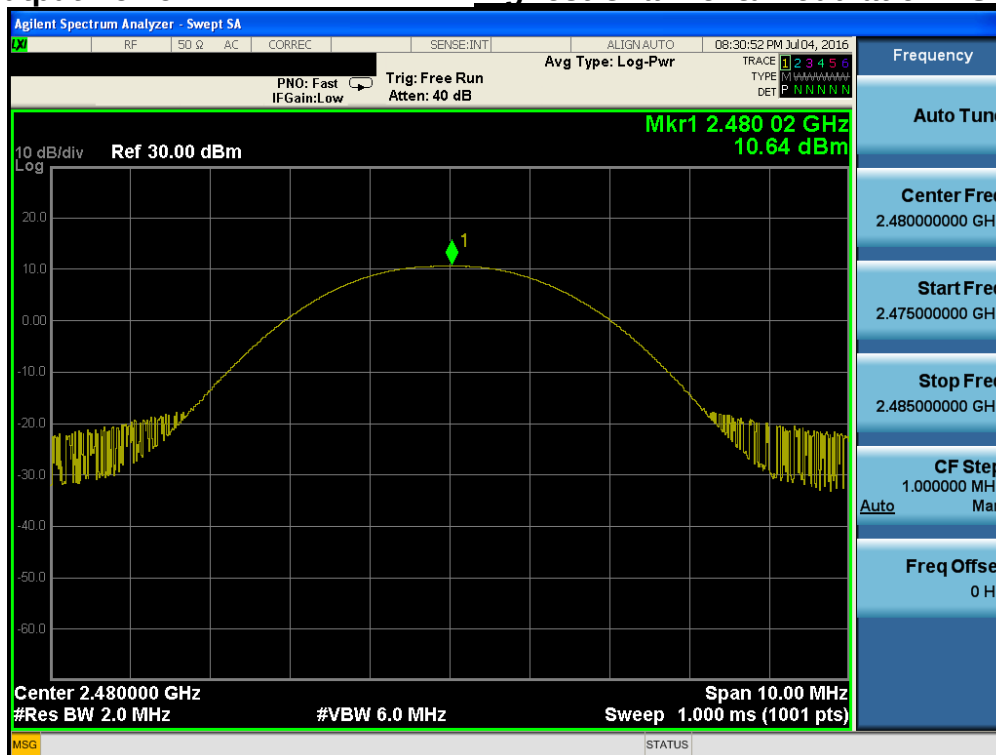
Note 1 : Average output power was using the average power meter for reference only.

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

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

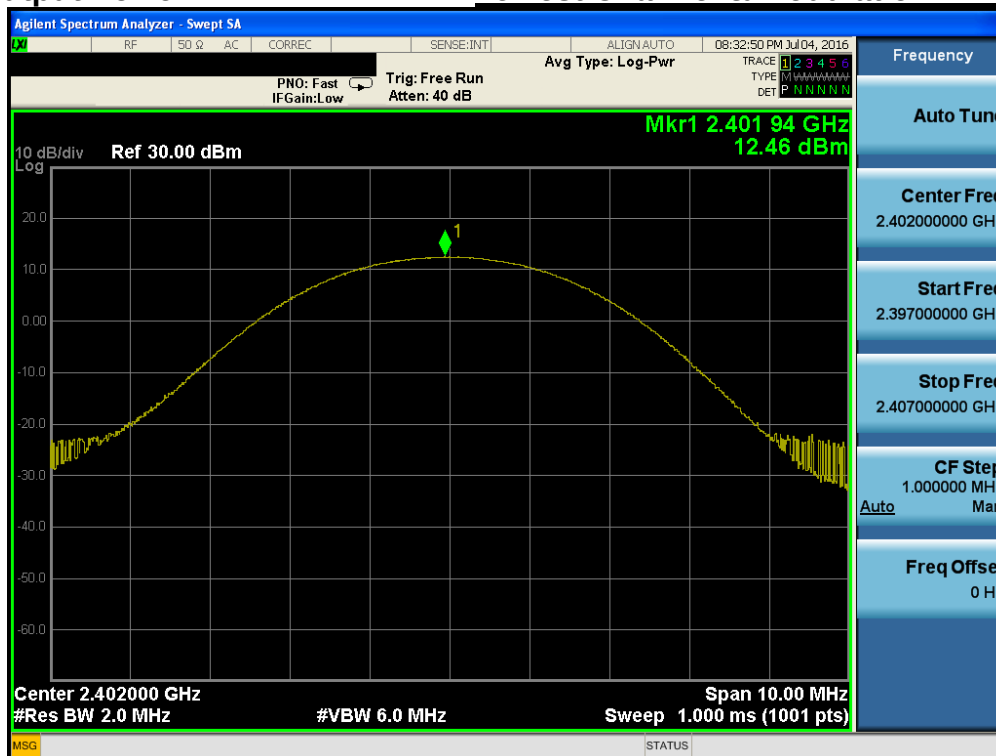
Peak Output Power

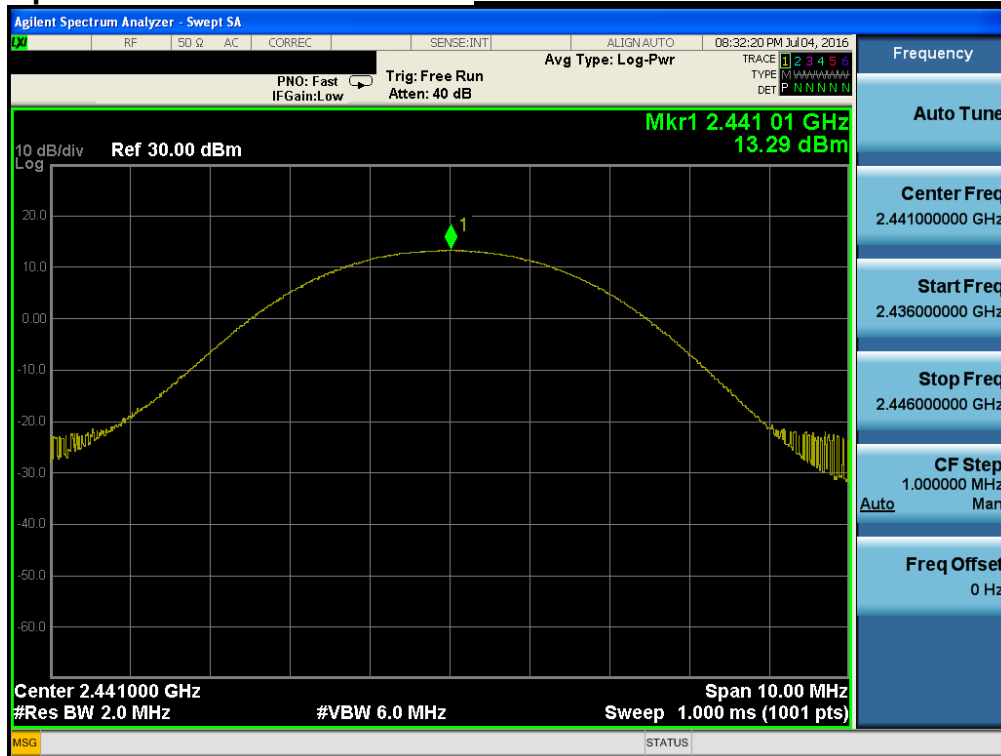
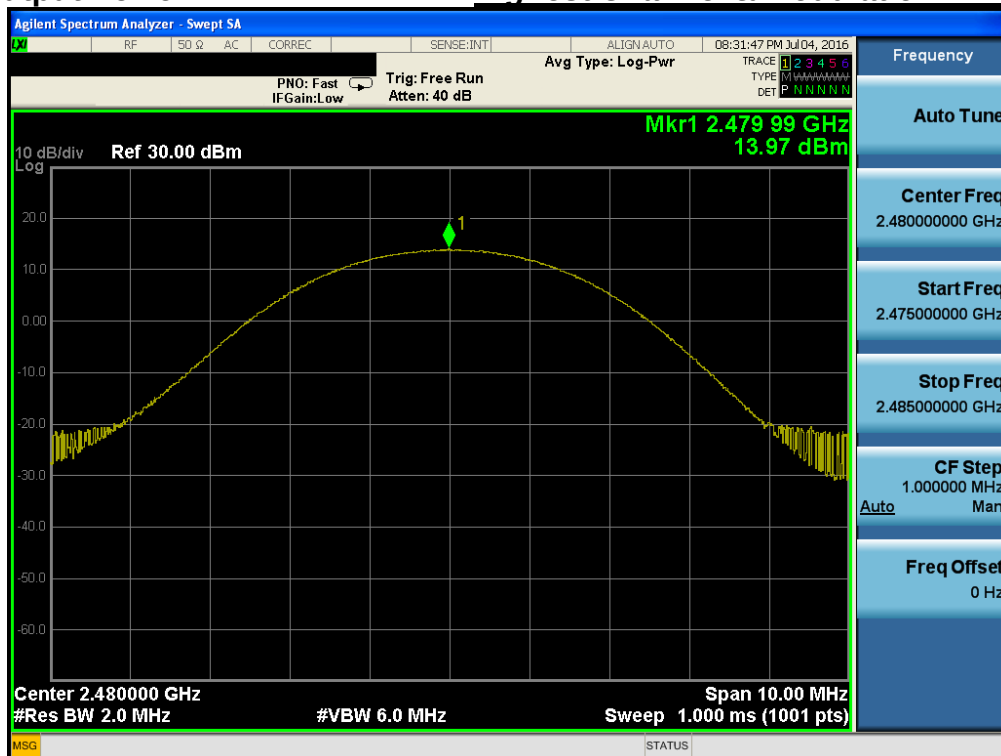
Highest Channel & Modulation : GFSK

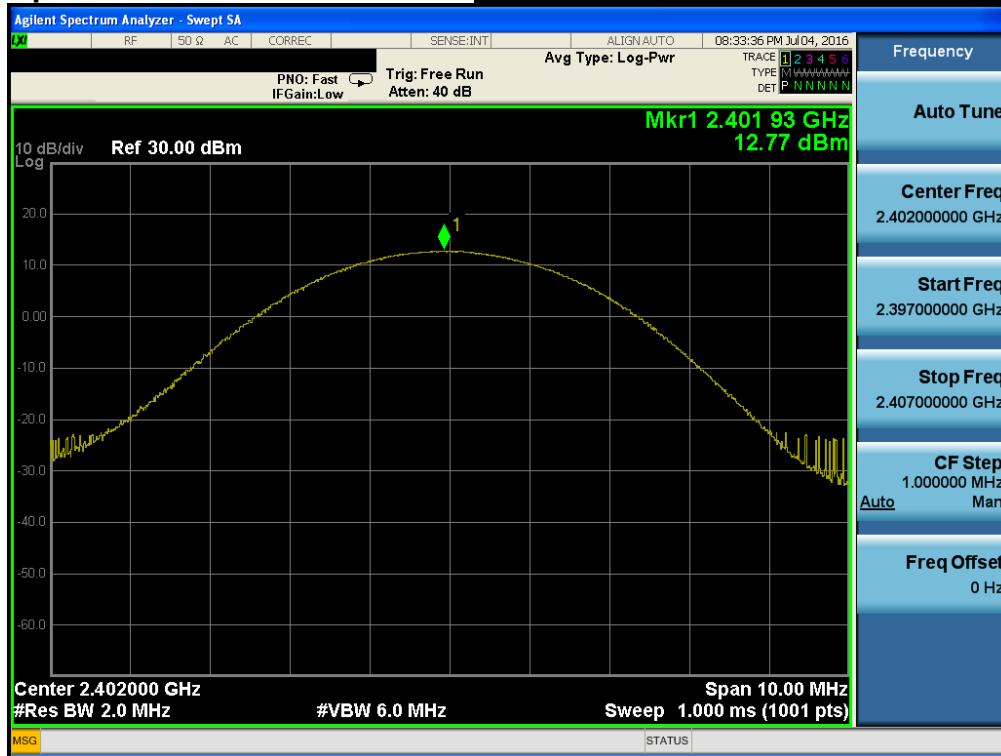
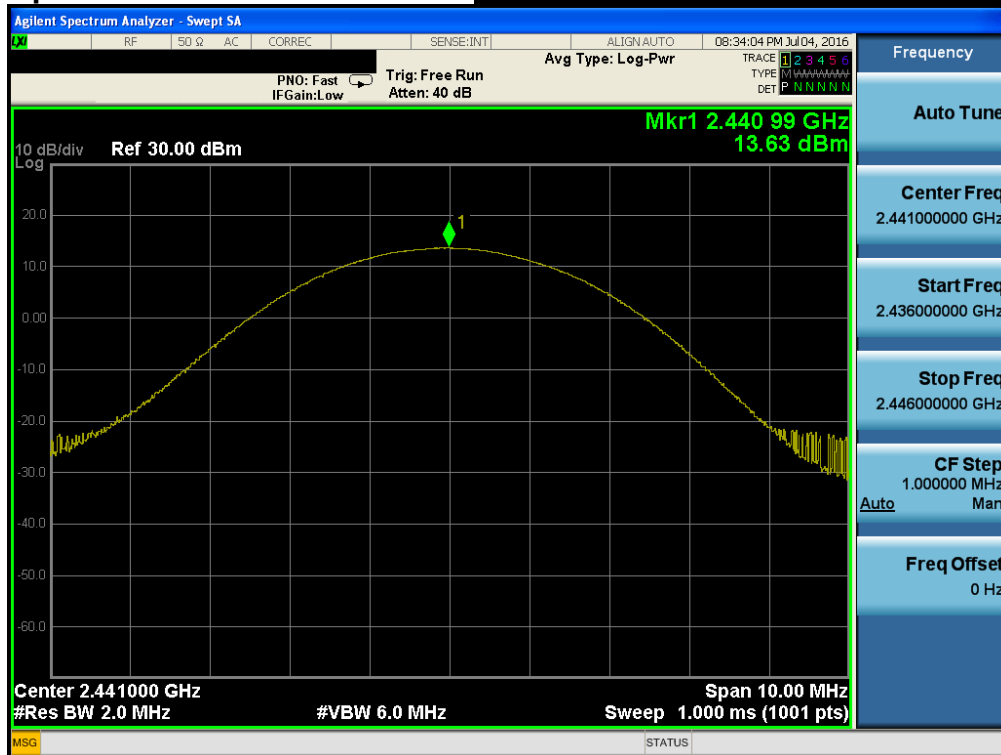


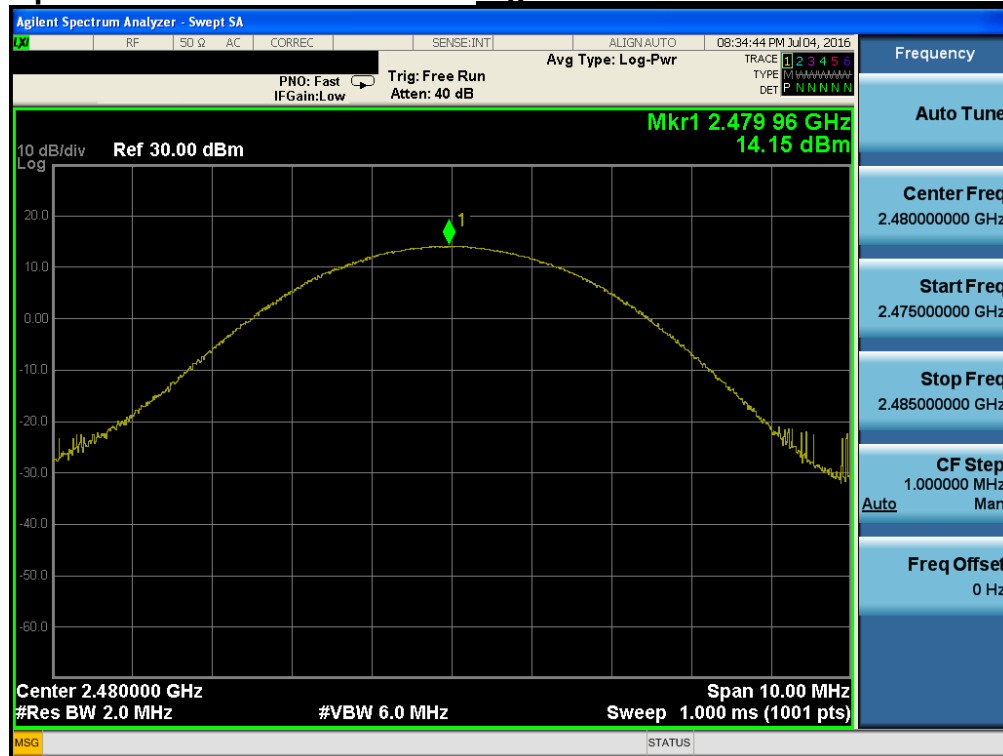
Peak Output Power

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



Peak Output Power***Middle Channel & Modulation : $\pi/4$ DQPSK*****Peak Output Power*****Highest Channel & Modulation : $\pi/4$ DQPSK***

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

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

3. 20 dB BW

3.1 Test Setup

Refer to the APPENDIX I.

3.2 Limit

Limit : Not Applicable

3.3 Test Procedure

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

3.4 Test Results

Modulation	Tested Channel	20 dB BW (MHz)
<u>GFSK</u>	Lowest	0.924
	Middle	0.978
	Highest	0.984
<u>$\pi/4$DQPSK</u>	Lowest	1.326
	Middle	1.326
	Highest	1.326
<u>8DPSK</u>	Lowest	1.335
	Middle	1.338
	Highest	1.338

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

20 dB Bandwidth

Lowest Channel & Modulation : GFSK

20 dB Bandwidth

Middle Channel & Modulation : GFSK

20 dB Bandwidth

Highest Channel & Modulation : GFSK

20 dB Bandwidth

Lowest Channel & Modulation : π /4DQPSK

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

Hopping Mode	Test Mode	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2439.992	2440.988	0.996
	$\pi/4$ -DQPSK	2439.992	2440.991	0.999
	8DPSK	2439.989	2440.991	1.002

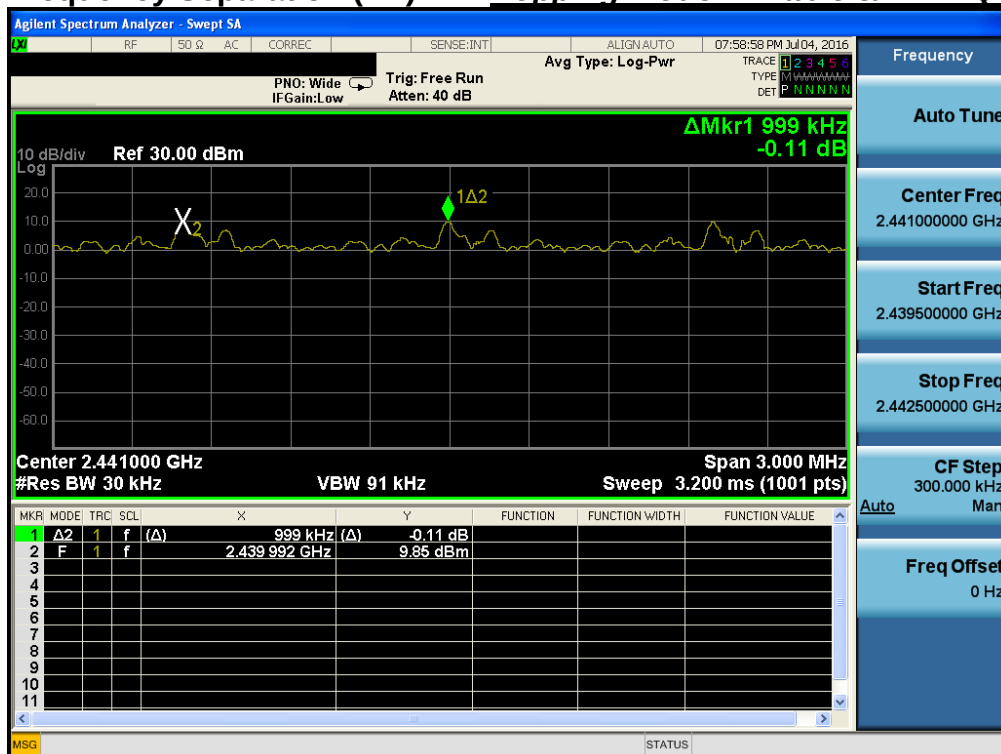
AFH mode

Hopping Mode	Test Mode	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2409.992	2410.994	1.002
	$\pi/4$ -DQPSK	2409.992	2410.991	0.999
	8DPSK	2409.995	2410.994	0.999

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

- Minimum Standard :

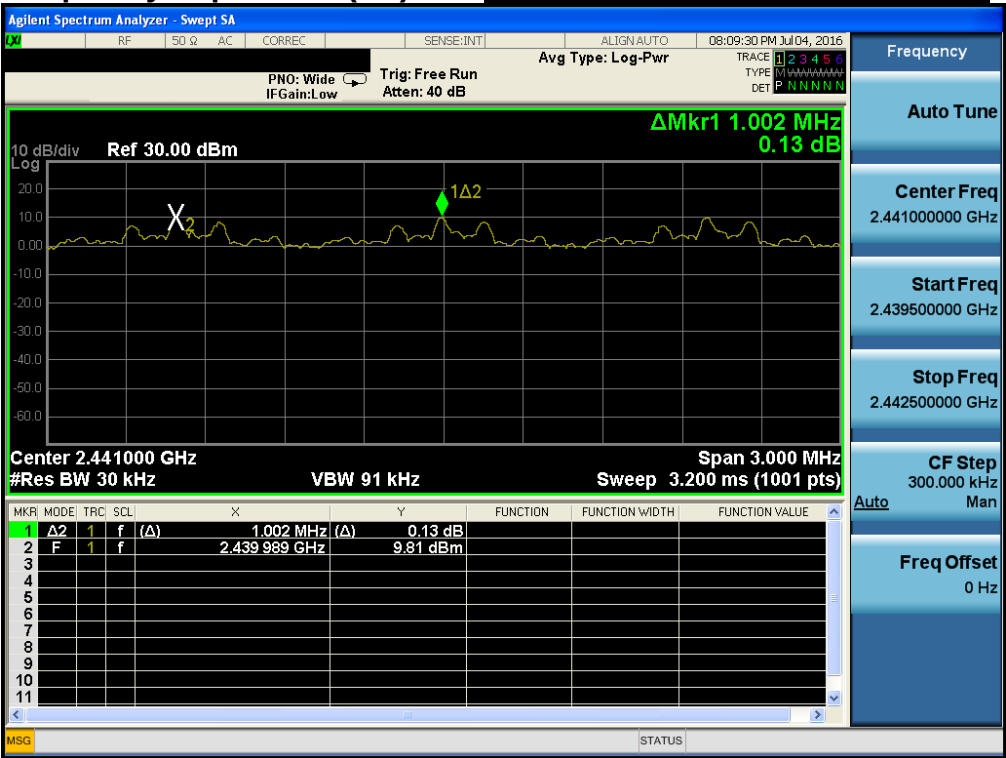
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 - 2483.5 MHz band may have hopping channel carrier frequencies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

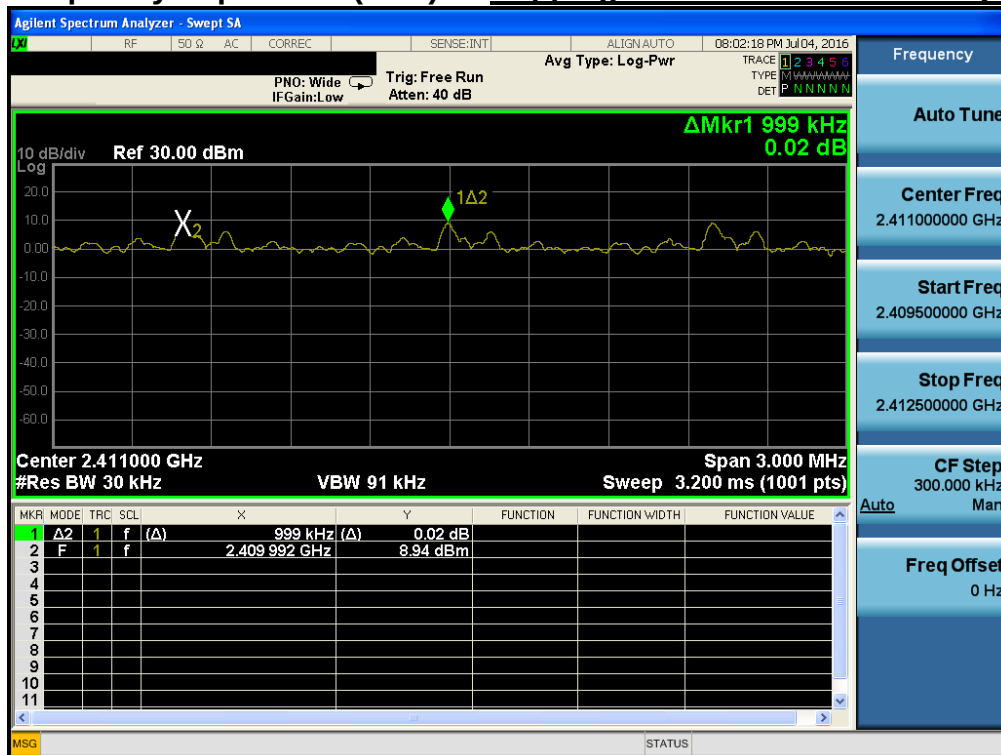
Carrier Frequency Separation (FH) Hopping mode : Enable & GFSK**Carrier Frequency Separation (FH) Hopping mode : Enable & $\pi/4$ -DQPSK**



Carrier Frequency Separation (FH)

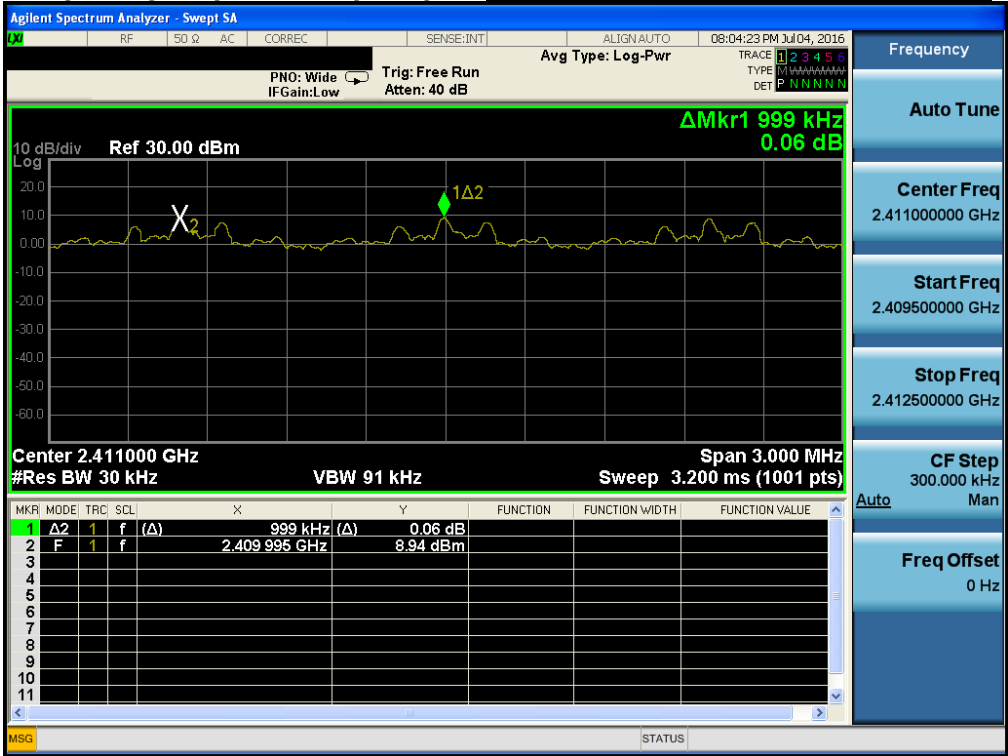
Hopping mode : Enable & 8DPSK



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



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 $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

5.4 Test Results

FH mode

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

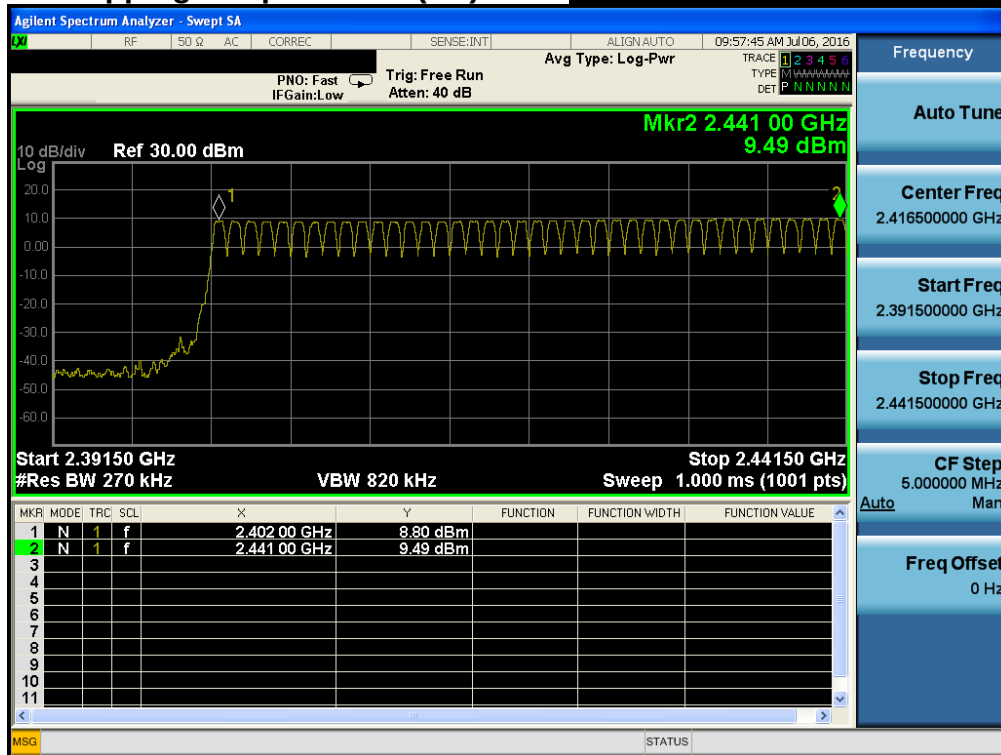
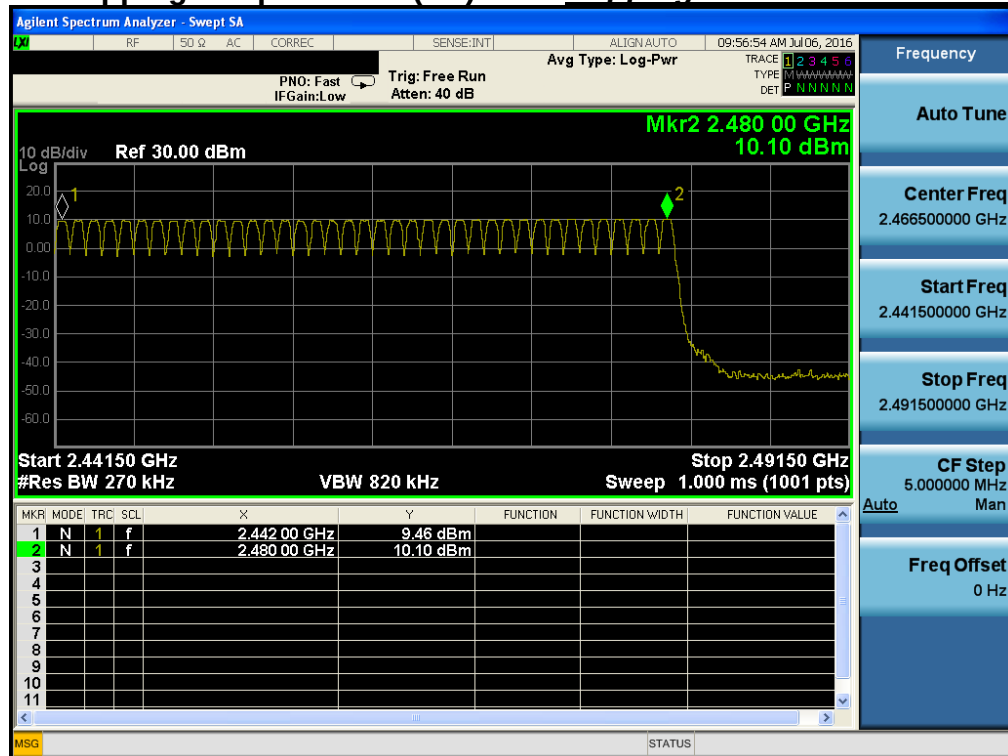
AFH mode

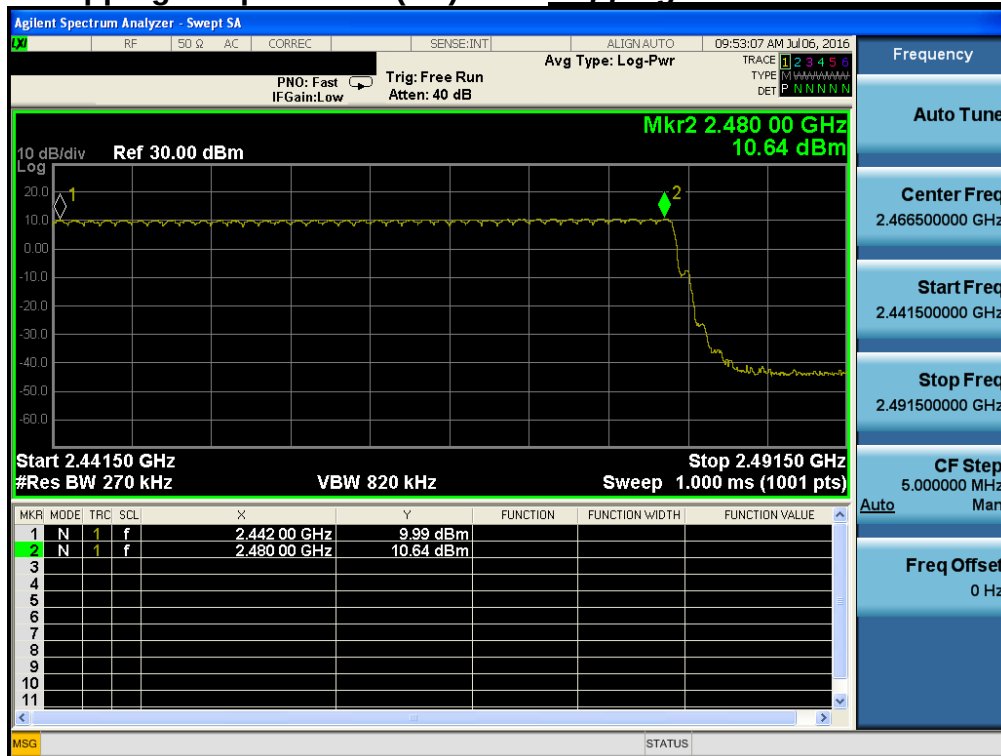
Hopping mode	Test mode	Test Result (Total Hops)
Enable	GFSK	20
	$\pi/4$ -DQPSK	20
	8DPSK	20

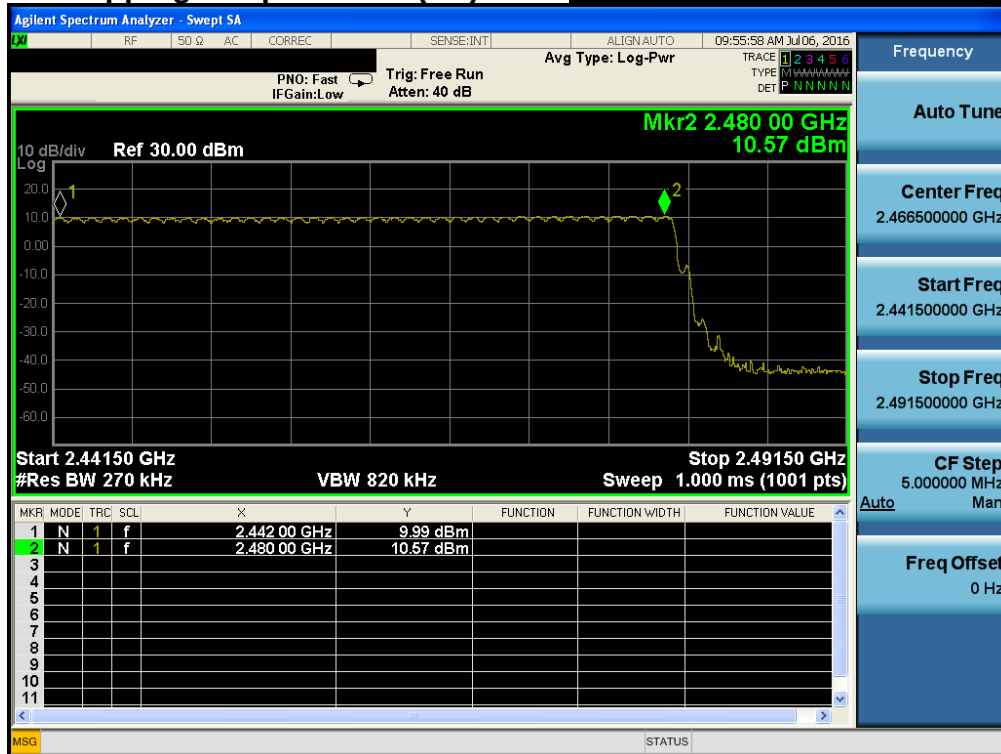
Note 1 : See next pages for actual measured spectrum plots.

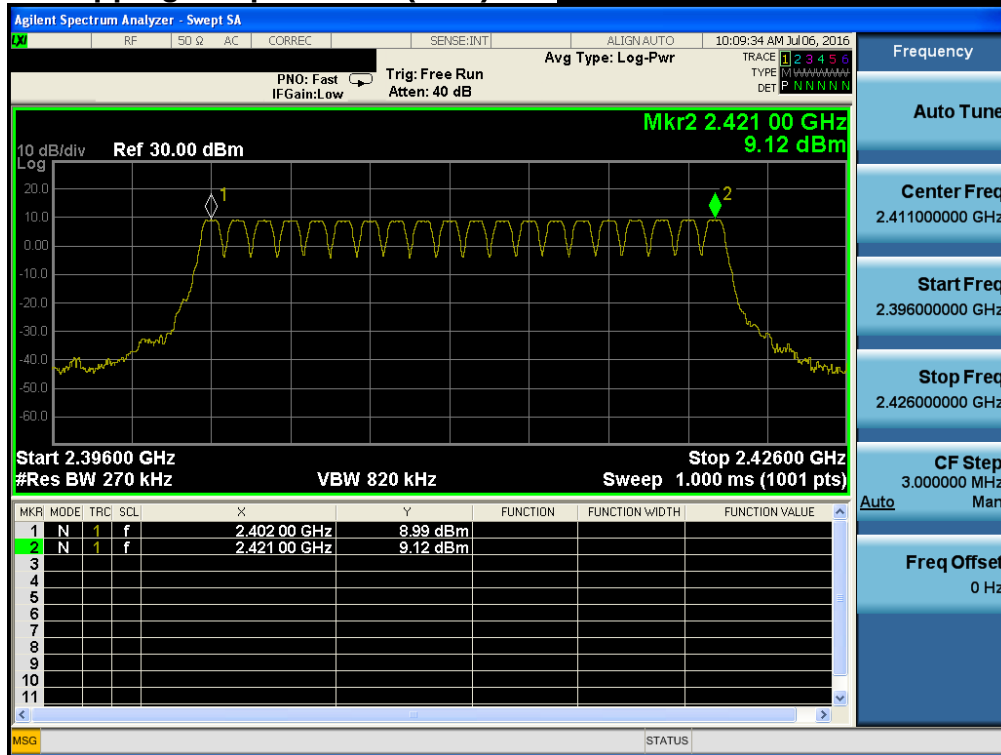
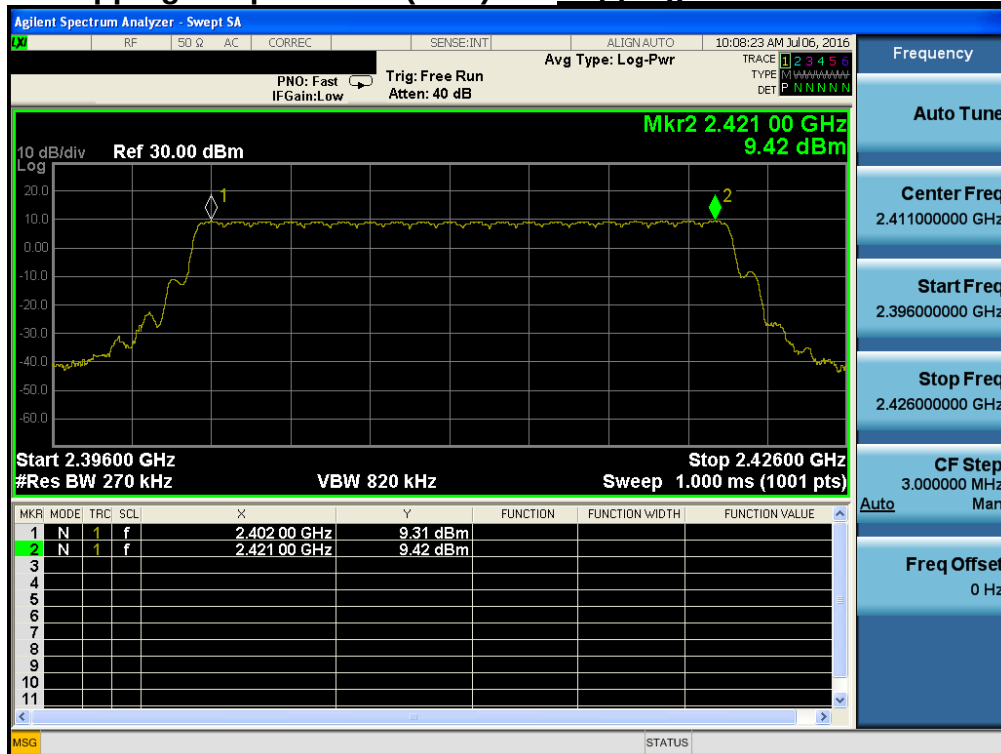
- Minimum Standard :

At least 15 hops

Number of Hopping Frequencies 1(FH)***Hopping mode : Enable & GFSK*****Number of Hopping Frequencies 2(FH)*****Hopping mode : Enable & GFSK***

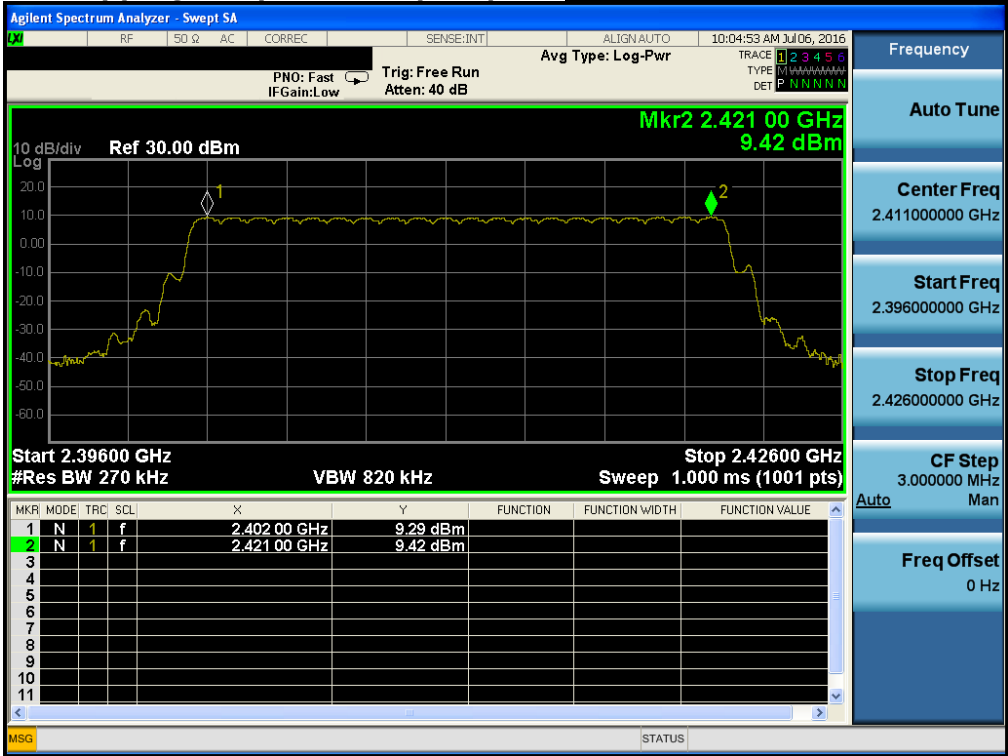
Number of Hopping Frequencies 1(FH)***Hopping mode : Enable & $\pi/4$ -DQPSK*****Number of Hopping Frequencies 2(FH)*****Hopping mode : Enable & $\pi/4$ -DQPSK***

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 = 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

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	79	2.910	3.750	0.310
	2 DH 5	79	2.910	3.750	0.310
	3 DH 5	79	2.910	3.750	0.310

AFH mode

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	20	2.910	3.750	0.155
	2 DH 5	20	2.910	3.750	0.155
	3 DH 5	20	2.910	3.750	0.155

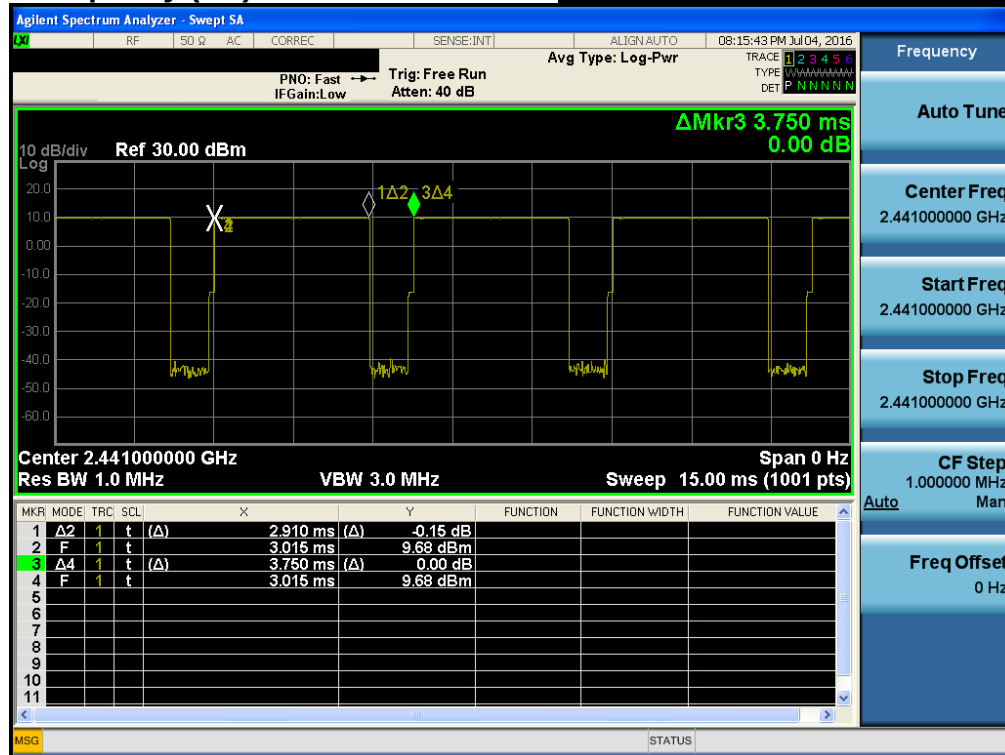
Note 1 : Dwell Time = $0.4 \times \text{Hopping channel} \times \text{Burst ON time} \times ((\text{Hopping rate} \div \text{Time slots}) \div \text{Hopping channel})$

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

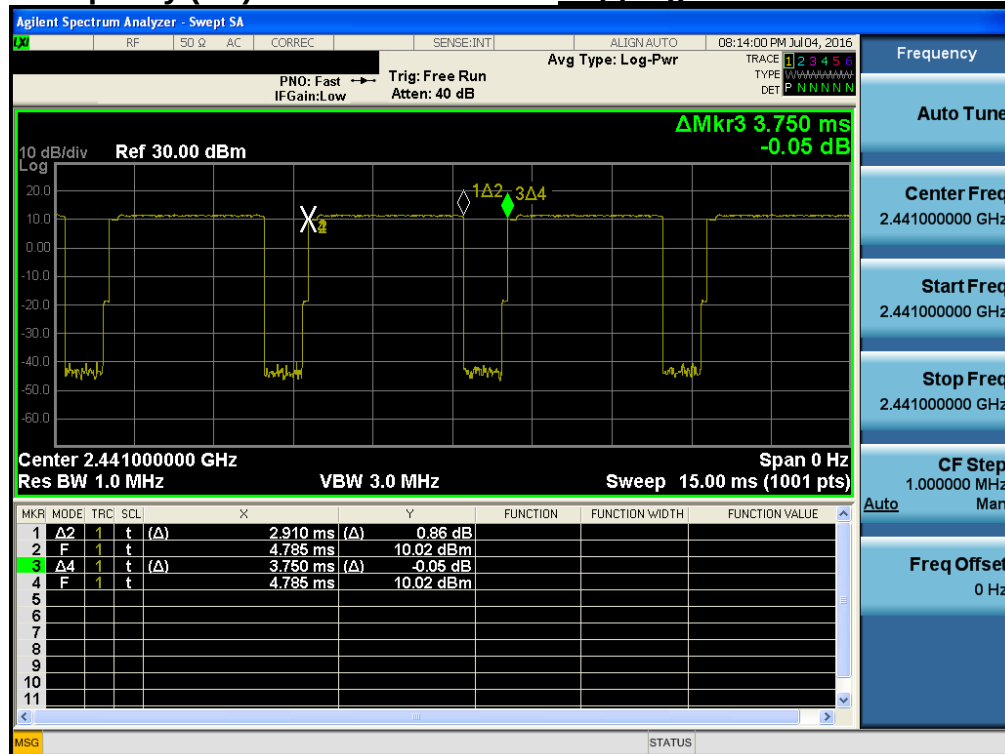
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

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

Time of Occupancy (FH)

Hopping mode : Enable & GFSK

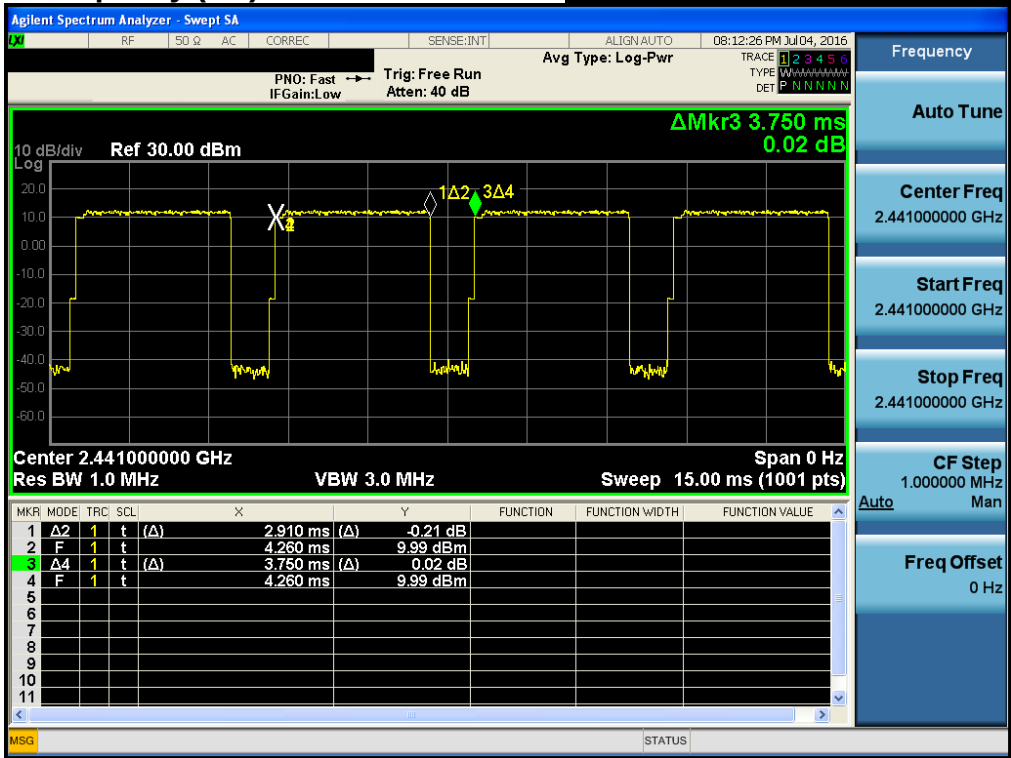
Time of Occupancy (FH)

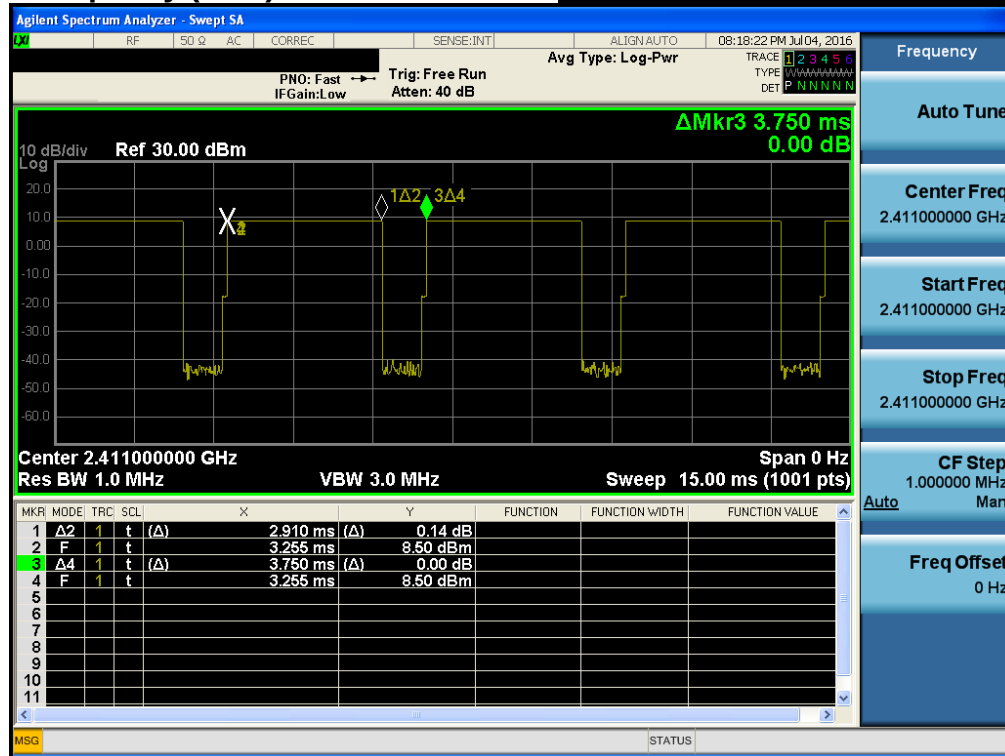
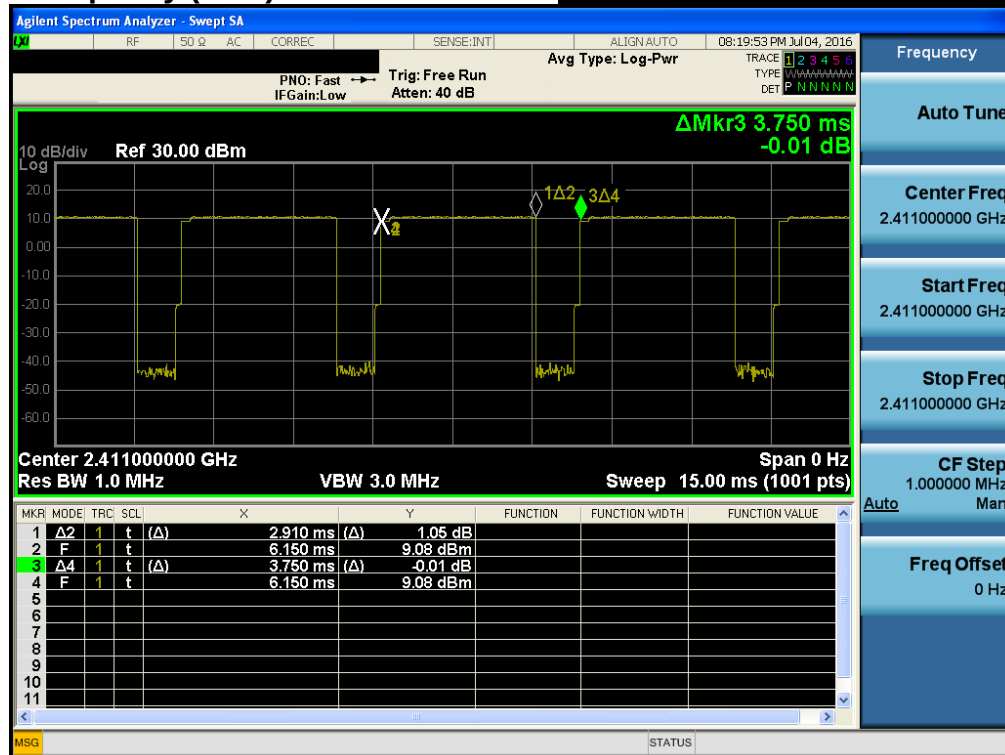
Hopping mode : Enable & $\pi/4$ -DQPSK



Time of Occupancy (FH)

Hopping mode : Enable & 8DPSK



Time of Occupancy (AFH)***Hopping mode : Enable & GFSK*****Time of Occupancy (AFH)*****Hopping mode : Enable & $\pi/4$ -DQPSK***



Time of Occupancy (AFH)

Hopping mode : Enable & 8DPSK

