# **TEST REPORT**

# **Dt&C**

# 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: DRTFCC1709-0193
- 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 : 30K / SP46 FCC ID : S7A-SP46
- 5. Test Method Used : ANSI C63.10-2013

Test Specification : FCC Part 15 Subpart C.247

- 6. Date of Test : 2017.08.01 ~ 2017.08.10
- 7. Testing Environment : See appended test report.
- 8. Test Result : Refer to the attached test result.

Affirmation	Tested by	Technical Manager
	Name : JaeHyeok Bang	Name : HyunSu Son
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	2017.09.	15.
	DT&C Co	., Ltd.
		-
	If this report is required to confirmation of authen	ticity please contact to report@dtpc pet



# **Test Report Version**

Test Report No.	Date	Description
DRTFCC1709-0193	Sep. 15, 2017	Initial issue



# **Table of Contents**

1. General Information	4
1.1 Testing Laboratory	
1.2 Testing Environment	4
1.3 Measurement Uncertainty	4
1.4 Details of Applicant	5
1.5 Description of EUT	
1.6 Declaration by the applicant / manufacturer	
1.7 Information about the FHSS characteristics	
1.8 Test Equipment List	
1.9 Summary of Test Results	
1.10 Conclusion of worst-case and operation mode	
2. Maximum Peak Output Power Measurement	
2.1 Test Setup	
2.2 Limit	
2.3 Test Procedure	
2.4 Test Results	
3. 20 dB BW	
3.1 Test Setup	
3.2 Limit	
3.3 Test Procedure	
3.4 Test Results	
4. Carrier Frequency Separation	
4.1 Test Setup	
4.2 Limit	24
4.3 Procedure	24
4.4 Test Results	
5. Number of Hopping Frequencies	29
5.1 Test Setup	29
5.2 Limit	20
J.Z LIMIT	
5.2 Limit	
	29
5.3 Procedure	29 29
5.3 Procedure 5.4 Test Results	29 29 35
<ul><li>5.3 Procedure</li><li>5.4 Test Results</li><li>6. Time of Occupancy (Dwell Time)</li></ul>	29 29 35 35
<ul> <li>5.3 Procedure</li></ul>	29 29 35 35 35
<ul> <li>5.3 Procedure</li></ul>	29 29 35 35 35 35
5.3 Procedure	29 35 35 35 35 35 35
<ul> <li>5.3 Procedure</li></ul>	29 29 35 35 35 35 40
<ul> <li>5.3 Procedure</li></ul>	29 29 35 35 35 35 35 35 40 40
<ul> <li>5.3 Procedure</li></ul>	29 29 35 35 35 35 35 35 35 40 40 40 40
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 35 40 40 40 41
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 35 40 40 40 41
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 42 42
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 42 42 42
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 42 42 42 42 43
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 42 42 42 43 67
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 42 42 42 43 67 67
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 41 41 41 41 42 42 42 43 67 67
5.3 Procedure         5.4 Test Results         6. Time of Occupancy (Dwell Time)         6.1 Test Setup         6.2 Limit         6.3 Test Procedure         6.4 Test Results         7. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission         7.1 Test Setup         7.2 Limit         7.3. Test Procedures         7.3.1 Test Procedures for Radiated Spurious Emissions         7.3.2 Test Procedures for Conducted Spurious Emissions         7.4.1 Radiated Emissions         7.4.2 Conducted Spurious Emissions         7.4.1 Radiated Emissions         7.4.2 Conducted Spurious Emissions         8.3 Transmitter AC Power Line Conducted Emission         8.1 Test Setup         8.2 Limit         8.3 Test Procedures	29 35 35 35 35 40 40 40 40 41 41 41 42 42 42 43 67 67 67
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 40 40 40 40 41 41 41 42 42 42 42 42 43 67 67 67 67
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 35 40 40 40 41 41 41 42 42 42 43 67 67 67 67
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 35 40 40 40 41 41 41 41 42 42 42 42 67 67 67 68 69
<ul> <li>5.3 Procedure</li></ul>	29 35 35 35 35 35 40 40 40 41 41 41 42 42 42 42 67 67 67 67 68 69 69 69
5.3 Procedure	29 35 35 35 35 35 40 40 40 41 41 41 42 42 42 42 67 67 67 67 68 69 69 69 69
5.3 Procedure	
5.3 Procedure	

# **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 site is constructed in conformance with the requirements.

#### - 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			
<ul> <li>Temperature</li> </ul>	+22 °C ~ +24 °C		
Relative Humidity	44 % ~ 48 %		

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

# 1.5 Description of EUT

EUT	30K
Model Name	SP46
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, π/4-DQPSK, 8DPSK
Number of Channels	79
Antenna Type /Antenna Gain	Chip Antenna / PK : 0 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
  - 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**

Туре	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	17/07/12	18/07/12	MY50410399
Digital Multimeter	Agilent Technologies	34401A	17/01/04	18/01/04	US36099541
DC Power Supply	Agilent Technologies	66332A	16/09/08	17/09/08	MY43000440
Signal Generator	Rohde Schwarz	SMBV100A	17/01/04	18/01/04	255571
Signal Generator	Rohde Schwarz	SMF100A	17/04/21	18/04/21	102341
Thermohygrometer	BODYCOM	BJ5478	17/04/11	18/04/11	120612-2
Attenuator	SMAJK	SMJK-50-10	16/10/18	17/10/18	2-50-10
Power Meter & Wide	Apritou	ML2495A	17/04/11	18/04/11	1306007
Bandwidth Sensor	Anritsu	MA2490A	17/04/11	18/04/11	1249001

Note: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2006.

# 1.9 Summary of Test Results

FCC Part RSS Std.	Parameter	<b>Limit</b> (Using in 2400~ 2483.5 MHz)	Test Condition	Status Note 1
	Carrier Frequency Separation	>= 25 kHz or >= Two thirds of the 20 dB BW, whichever is greater.		С
15.247(a) RSS-247(5.1)	Number of Hopping Frequencies >= 15 hops			С
K33-247(5.1)	20 dB Bandwidth	N/A		С
	Dwell Time	=< 0.4 seconds		С
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	Conducted	С
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.		с
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 RSS-Gen 8.9	Radiated	NT Note2
15.207 RSS-Gen(8.8)	AC Conducted Emissions	FCC 15.207 Limits	AC Line Conducted	NA <sup>Note3</sup>
15.203	Antenna Requirements	FCC 15.203	-	С
Note 1 : C = Comply       NC = Not Comply       NT = Not Tested       NA = Not Applicable         Note 2 : According to applicant's request, this test was not perfomed this test lab.       Please refer to the "UCSFR-1709-005" test report.         Note 3 : The power supply of this device is only DC (Internal Battery) and Bluetooth function is disabled in charging status.				

**T**Dt&C

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

The EUT has three type of modulation (GFSK,  $\pi$ /4DQPSK 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.
- §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 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 ≥ 20 dB BW
  VBW ≥ RBW
  Sweep = auto
  Detector function = peak
  Trace = max hold

# 2.4 Test Results

Modulation	Tested Channel		Average Power	Peak Output Power		
Modulation	resteu Chaimei	dBm	mW	dBm	mW	
	Lowest	15.87	38.637	17.79	60.117	
<u>GFSK</u>	Middle	16.86	48.529	18.79	75.683	
	Highest	15.95	39.355	18.17	65.615	
	Lowest	7.18	5.224	12.41	17.418	
<u>π/4DQPSK</u>	Middle	9.36	8.630	15.23	33.343	
	Highest	8.17	6.561	14.14	25.942	
	Lowest	7.22	5.272	13.19	20.845	
<u>8DPSK</u>	Middle	9.41	8.730	15.89	38.815	
	Highest	8.22	6.637	14.87	30.690	

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.





#### Lowest Channel & Modulation : GFSK

#### Peak Output Power

# Middle Channel & Modulation : GFSK





#### t Spectrum Analyzer - Swept SA 50 C 37 PM Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB PNO: Fast 😱 IFGain:Low Auto Tune Mkr1 2.479 767 GHz 18.17 dBm 10 dB/div Log Ref 30.00 dBm **Center Freq** 2.48000000 GHz Start Freq 2.475000000 GHz Stop Freq 2.485000000 GHz **CF** Step 1.000000 MHz Man Auto **Freq Offset** 0 Hz Center 2.480000 GHz #Res BW 2.0 MHz Span 10.00 MHz Sweep 1.00 ms (3001 pts) #VBW 6.0 MHz

# Highest Channel & Modulation : GFSK

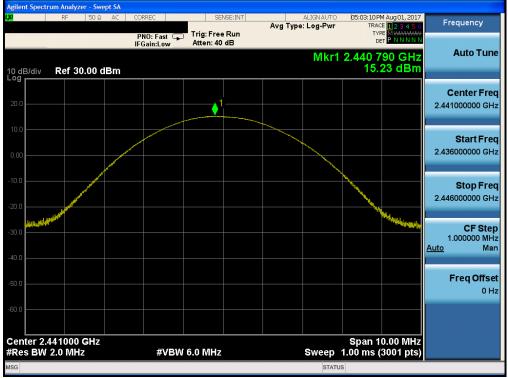
# Lowest Channel & Modulation : π/4DQPSK

#### Peak Output Power





# Middle Channel & Modulation : π/4DQPSK



#### Peak Output Power

# Highest Channel & Modulation : π/4DQPSK





#### t Spectrum Analyzer - Swept SA 13 PM A Frequency Avg Type: Log-Pwr Trig: Free Run PNO: Fast 😱 IFGain:Low Atten: 40 dB Auto Tune Mkr1 2.401 853 GHz 13.19 dBm 10 dB/div Log Ref 30.00 dBm **Center Freq** 2.402000000 GHz ۵ Start Freq 2.397000000 GHz Stop Freq 2.407000000 GHz **CF** Step 1.000000 MHz Man Auto **Freq Offset** 0 Hz Center 2.402000 GHz #Res BW 2.0 MHz Span 10.00 MHz Sweep 1.00 ms (3001 pts) #VBW 6.0 MHz

#### Lowest Channel & Modulation : 8DPSK

# Middle Channel & Modulation : 8DPSK

# Peak Output Power





#### t Spectrum Analyzer - Swept SA 50.9 05:01:24 PM Aug 01, 2017 TRACE 123456 Frequency Avg Type: Log-Pwr TYP DET PNO: Fast Trig: Free Run IFGain:Low Atten: 40 dB Auto Tune Mkr1 2.479 937 GHz 14.87 dBm 10 dB/div Log Ref 30.00 dBm **Center Freq** 2.480000000 GHz Start Freq 2.475000000 GHz Stop Freq 2.485000000 GHz WWA -**CF Step** 1.000000 MHz Man Auto **Freq Offset** 0 Hz Center 2.480000 GHz #Res BW 2.0 MHz Span 10.00 MHz Sweep 1.00 ms (3001 pts) #VBW 6.0 MHz

# 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 ≥ 3 x RBW, Span = between two times and five times the 20 dB bandwidth.

# 3.4 Test Results

Modulation	Tested Channel	20 dB BW (MHz)
	Lowest	0.932
<u>GFSK</u>	Middle	0.927
	Highest	0.925
<u>π/4DQPSK</u>	Lowest	1.246
	Middle	1.253
	Highest	1.235
	Lowest	1.254
<u>8DPSK</u>	Middle	1.255
	Highest	1.249

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







#### 20 dB Bandwidth

#### Middle Channel & Modulation : GFSK

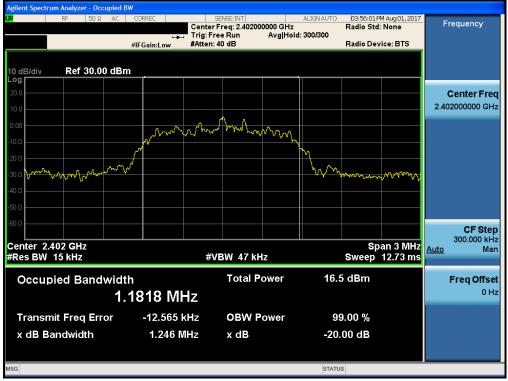




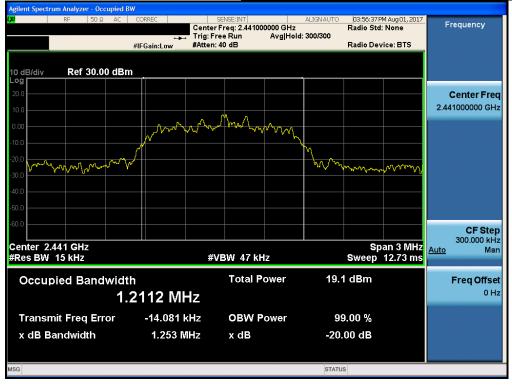


#### 20 dB Bandwidth

## Lowest Channel & Modulation : π/4DQPSK



#### Middle Channel & Modulation : π/4DQPSK



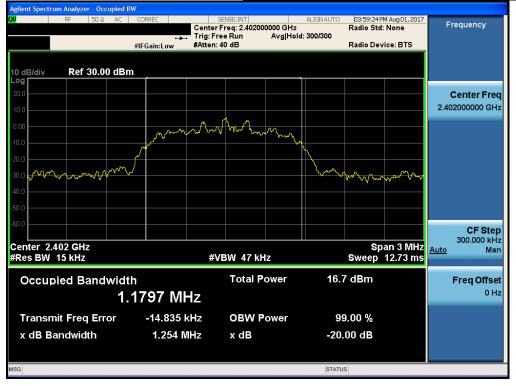
#### 20 dB Bandwidth

#### Highest Channel & Modulation : π/4DQPSK



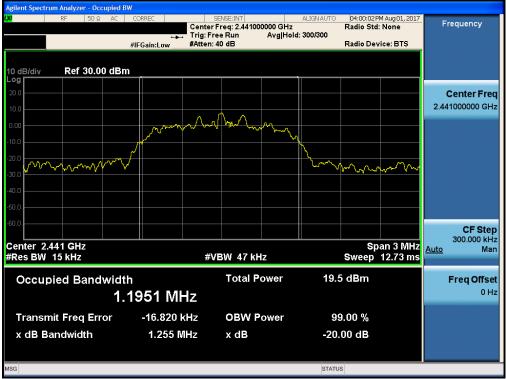


#### Lowest Channel & Modulation : 8DPSK



#### 20 dB Bandwidth

#### Middle Channel & Modulation : 8DPSK



## 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 markerdelta 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)
	GFSK	2440.997	2441.996	0.999
Enable	π/4-DQPSK	2440.997	2441.996	0.999
	8DPSK	2440.997	2441.996	0.999

#### AFH mode

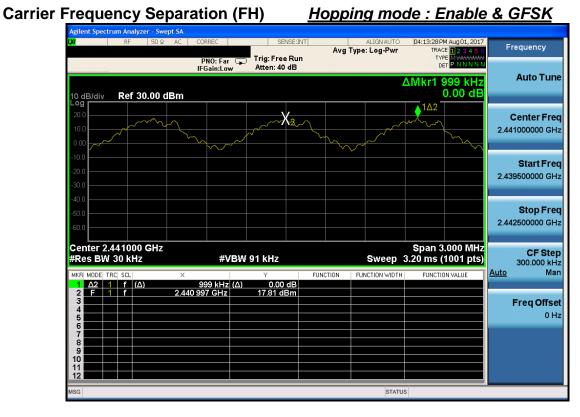
Hopping Mode	Modulation	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
GFSK Enable π/4-DQPSK		2440.994	2441.996	1.002
		2440.994	2441.996	1.002
	8DPSK	2440.997	2441.999	1.002

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

#### - Minimum Standard :

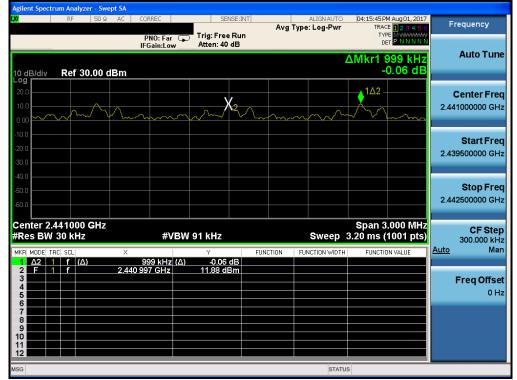
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 - 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW





Carrier Frequency Separation (FH)

Hopping mode : Enable & π/4-DQPSK





# Carrier Frequency Separation (FH) <u>Hopping mode : Enable & 8DPSK</u>

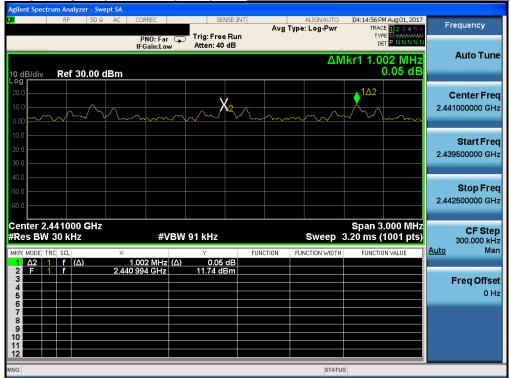
PNO: Far Trig: Free Run IFGain:Low Atten: 40 dB TYP Auto Tune ∆Mkr1 999 kHz -0.04 dB 10 dB/div Log Ref 30.00 dBm <mark></mark>1∆2 **Center Freq** X2, / 2.441000000 GHz 5 Start Freq 2.439500000 GHz Stop Freq 2.442500000 GHz Center 2.441000 GHz #Res BW 30 kHz Span 3.000 MHz Sweep 3.20 ms (1001 pts) CF Step 300.000 kHz Man #VBW 91 kHz Auto FUNCTION FUN -0.04 dB 11.91 dBm 999 kHz (∆) 2.440 997 GHz <u>Δ2 1 f (Δ)</u> F 1 f Freq Offset 0 Hz STATUS



# Carrier Frequency Separation (AFH) <u>Hopping mode : Enable & GFSK</u>

Agilent Spectrum Analyzer - Swept SA					
<b>ΙΧ</b> RF 50 Ω AC	CORREC	SENSE:INT	ALIGN AUTO Avg Type: Log-Pwr	04:10:35 PM Aug 01, 2017 TRACE 1 2 3 4 5 6 TYPE MWWWWW	Frequency
10 dB/div Ref 30.00 dBm	PNO: Far 😱 IFGain:Low	Trig: Free Run Atten: 40 dB	ΔΝ	/kr1 1.002 MHz 0.037 dB	Auto Tune
Log 20.0 10.0 0.00	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~X2~~			Center Freq 2.441000000 GHz
-10.0					Start Freq 2.439500000 GHz
-40.0					<b>Stop Freq</b> 2.442500000 GHz
Center 2.441000 GHz #Res BW 30 kHz MKR MODE TRC SCL X		Y FUN	Sweep	Span 3.000 MHz 3.20 ms (1001 pts) FUNCTION VALUE	CF Step 300.000 kHz <u>Auto</u> Man
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1.002 MHz (∆) 40 994 GHz	0.037 dB 17.772 dBm			Freq Offset 0 Hz
7 8 9 10 11 12					
MSG			STATL	JS	

# Carrier Frequency Separation (AFH) <u>Hopping mode : Enable & $\pi/4$ -DQPSK</u>





# Carrier Frequency Separation (AFH) <u>Hopping mode : Enable & 8DPSK</u>

ilent Spectrum Analyzer - Swept SA					
RF 50 Q AC	CORREC SEI	NSE:INT Ava T	ALIGNAUTO ype: Log-Pwr	04:17:32 PM Aug 01, 2017 TRACE 1 2 3 4 5 6	Frequency
	PNO: Far 😱 Trig: Free	Run	Abe: rogi m	TYPE MWWWWWW DET P N.N.N.N.N	
	IFGain:Low Atten: 40	dB			Auto Tune
			ΔM	kr1 1.002 MHz	Autorune
dB/div Ref 30.00 dBm				-0.03 dB	
				1∆2	Center Freq
					2.441000000 GHz
om the former of the	man m		~~~~~ ~		
0					
0					Start Freq
)					2.439500000 GHz
					Stop Freq
					2.442500000 GHz
nter 2.441000 GHz es BW 30 kHz	#VBW 91 kHz		0	Span 3.000 MHz	CF Step
				.20 ms (1001 pts)	300.000 kHz Auto Man
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	002 MHz (Δ) -0.03	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man
F 1 f 2.440	997 GHz 11.88 di				
					Freq Offset
					0 Hz
3			STATUS		



# 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 ind or the 20 dB bandwidth, w	less than 30% of the channel spacing	
VBW ≥ RBW	Sweep = auto	
Detector function = peak	Trace = max hold	

#### 5.4 Test Results

#### FH mode

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

#### AFH mode

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

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

#### - Minimum Standard :

At least 15 hopes



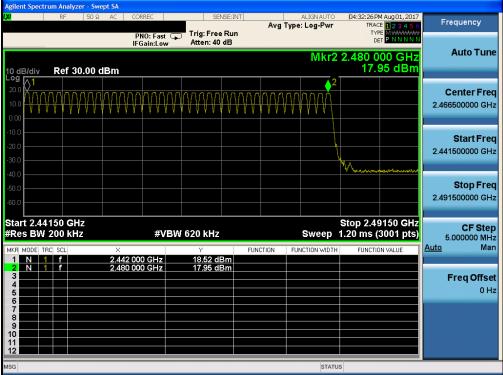
# Number of Hopping Frequencies 1(FH)

#### Hopping mode : Enable & GFSK

PN0: Fast IFGain:Low         Trig: Free Run Atten: 40 dB         Avg Type: Log-Pwr Type: Dog-Pwr Type: Dog-Pwr         TRACE 12 3 45 0 Type: Dog-Pwr           Mkr2 2.441 000 GHz 18.25 dBm         Mkr2 2.441 000 GHz 18.25 dBm	Frequency Auto Tune
10 dB/div Ref 30.00 dBm 18.25 dBm	Auto Tune
	Center Freq 2.416500000 GHz
30.0	<b>Start Freq</b> 2.391500000 GHz
-50.0 	<b>Stop Freq</b> 2.441500000 GHz
Start 2.39150 GHz         Stop 2.44150 GHz           #Res BW 200 kHz         #VBW 620 kHz         Sweep         1.20 ms (3001 pts)	CF Step 5.000000 MHz Auto Man
1 N 1 f 2.402 000 GHz 17.51 dBm	<u>tuto</u> inan
2         N         1         f         2.441 000 GHz         18.25 dBm           3         4         5         5         6         6         6         6         6         6         6         6         6         6         6         6         6         7	Freq Offset 0 Hz
11 12 STATUS	

### Hopping mode : Enable & GFSK

# Number of Hopping Frequencies 2(FH)





#### Hopping mode : Enable & π/4-DQPSK

ilent Spectrum Analyzer								
RF	50 Ω AC	CORREC	SENSE		ALIGN AUTO		M Aug 01, 2017	Frequency
		PNO: Fast 🗔	Trig: Free R		g Type: Log-Pwr	TY	CE 123456 PE MWWWW	
		IFGain:Low	Atten: 40 dE			D	et <mark>P N N N N N</mark>	
					Mkr2	2.441 0	00 GHz	Auto Tun
B/div Ref 30.0	00 dBm					12.	50 dBm	
) — — — — — — — — — — — — — — — — — — —	1							Center Fre
)	- Xara	$\sqrt{1}$	$\sim$	$\gamma$	᠋ᡞᠬᢦᠬᢦᢦᢦᢦᢦᢦ	www	mara	2.416500000 GH
)	× · ·							
	N							Start Fre
	14							2.391500000 GH
	*							
,								Stop Fre
,								2.441500000 GH
rt 2.39150 GHz						Stop 2.4	4150 GHz	05.044
es BW 200 kHz		#VBW	/ 620 kHz		Sweep		3001 pts)	CF Ste 5.000000 MH
MODE TRC SCL	×		Y	FUNCTION	FUNCTION WIDTH	EUNCTI	ON VALUE	Auto Ma
N 1 f		000 GHz	9.37 dBm		TONCHON WIDTH	Token	DIT VALUE	
N 1 f	2.441	000 GHz	12.50 dBm	1				
								Freq Offse
								0 H
					STATU	JS		
					5			

# Number of Hopping Frequencies 2(FH)

Number of Hopping Frequencies 1(FH)

# <u>Hopping mode : Enable & π/4-DQPSK</u>

ALIGN AUTO 04:34:24 PM Aug 01, 2017

# Agilent Spectrum Analyzer - Swept SA Ud RF 50 Q AC CORREC SENSE:INT A

	PNO: Fast	e Run		ACE 123456 YPE MWWWWW DET PNNNNN	Frequency
10 dB/div Ref 30.00 dBm			Mkr2 2.480 11	000 GHz .31 dBm	Auto Tune
20.0 <b>1</b> 10.0 <b>1</b> 0.00	ᡧᠬ᠇ᢑ᠊ᡳᡊᢦᠵᠧᠲ᠋ᢩᡔᠧᡊ᠋ᢩᠵᢈ		2 7	2.4	<b>Center Freq</b> 466500000 GHz
-10.0					Start Freq 141500000 GHz
-40.0					Stop Freq 191500000 GHz
Start 2.44150 GHz #Res BW 200 kHz	#VBW 620 kHz		Stop 2. Sweep 1.20 ms		CF Step 5.000000 MHz
MKR MODE TRC SCL X 1 N 1 f 2.442 2 N 1 f 2.480	2 000 GHz 12.49 d	Bm	UNCTION WIDTH FUNC	TION VALUE	Man
2 N 1 f 2.480 3 4 5 5 6	0000 GHz 11.31 d	BM			Freq Offset 0 Hz
7					
12 Msg			STATUS		



# Number of Hopping Frequencies 1(FH)



Agitent Spectrum Analyzer - Swept SA           ΙΧΙ         RF         50 Ω         AC	CORREC	SENSE:INT	ALIGN AUTO Avg Type: Log-Pwr	04:51:27 PM Aug 01, 2017 TRACE 1 2 3 4 5 6	Frequency									
		Trig: Free Run Atten: 40 dB	Avg Type: Log-Pwr	TYPE MWWWWW DET P N N N N N										
	IFGaIn:Low 4	Allen: 40 GB	Mkr2	2.441 000 GHz	Auto Tune									
10 dB/div Ref 30.00 dBm														
20.0				2	Center Freq									
10.0	$\sim \sim $	$\gamma$	$\mu_{\mu}$	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	2.416500000 GHz									
0.00														
-10.0					Start Freq									
-20.0					2.391500000 GHz									
-30.0 -40.0 -40.0														
-50.0					Stop Freq									
-60.0					2.441500000 GHz									
Start 2.39150 GHz				Stop 2.44150 GHz										
#Res BW 200 kHz	#VBW 63	20 kHz	Sweep	1.20 ms (3001 pts)	CF Step 5.000000 MHz									
MKR MODE TRC SCL X			CTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man									
2 N 1 f 2.44	2 000 GHz 1 000 GHz	8.59 dBm 12.41 dBm												
3 4					Freq Offset									
5					0 Hz									
7 8														
9														
11 12														
MSG			STATU	S										

# Number of Hopping Frequencies 2(FH)

#### Hopping mode : Enable & 8DPSK

Frequency

Auto Tune

**Center Freq** 

Start Freq

Stop Freq

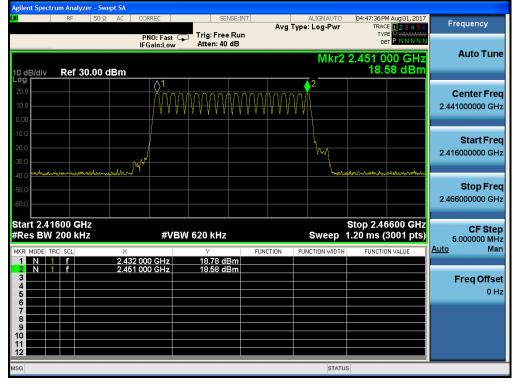
# 42 PM Aug 01, 2017 ENSE:INT Avg Type: Log-Pwr TRACE Trig: Free Run Atten: 40 dB PNO: Fast 😱 IFGain:Low Mkr2 2.480 000 GHz 11.45 dBm 10 0g Ref 30.00 dBm 12 2.466500000 GHz 2.441500000 GHz 2.491500000 GHz 40150

Start 2./ #Res Bl			#VBW 620 kHz		Stop 2.49150 GHz 1.20 ms (3001 pts)	CF Ste 5.000000 MH	
MKR MODE	TRC SCL	×	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Ma
1 N	1 f	2.442 000 (	GHz 12.10 dBm	1			
2 N	1 f	2.480 000 (	GHz 11.45 dBm	1			
3							Freq Offs
4							. 01
5							UF
6							
7							
8							
9							
10							
12							
12				1			
MSG					STATU	s	



## Number of Hopping Frequencies 1(AFH)

# Hopping mode : Enable & GFSK



#### Number of Hopping Frequencies 1(AFH) Hopping

#### <u>Hopping mode : Enable & π/4-DQPSK</u>

#### Frequency Avg Type: Log-Pwr Trig: Free Run PNO: Fast 😱 IFGain:Low YPE Atten: 40 dB Auto Tune Mkr2 2.451 000 GHz 10.19 dBm 10 dB/div Log Ref 30.00 dBm $\Diamond^1$ **Center Freq** 2.441000000 GHz Start Freq 2.416000000 GHz Stop Freq 2.466000000 GHz Start 2.41600 GHz #Res BW 200 kHz Stop 2.46600 GHz CF Step 5.000000 MHz Man #VBW 620 kHz Sweep 1.20 ms (3001 pts) Auto 2.432 000 GHz 2.451 000 GHz 12.53 dBm 10.19 dBm <u>N 1 f</u> N 1 f Freq Offset 0 Hz



# 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 >> 1 / T, where T is the expected dwell time per channel) Detector function = peak

VBW ≥ RBW

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)
	DH 5	79	2.880	3.750	0.307
Enable	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)
	DH 5	20	2.880	3.750	0.154
Enable	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.

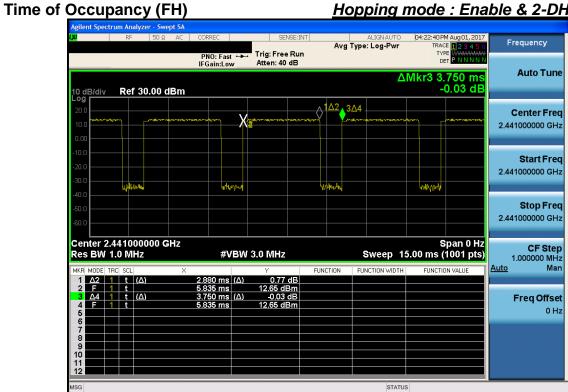


Time of Occupancy (FH)

Agilen	it Spec	trum	Anal	yzer -	Swep	t SA																	
L <mark>XI</mark>			RF	5	0Ω	AC		ORRE			<b>П</b> .,	ा ig:Fre	ENSE:I		A۱	/g Ty		Log-Pwi		TF	RACE 👖	g01,2017 23456	Frequency
		_						PNO: FGai		t <b>↔</b> ••		ten: 4							ΔMI		DET P	0 ms 0 dB	Auto Tune
10 di Log 20.0	3/div		ter	30.0	0 di	3m				/ \ <mark>4</mark>				<b>∆1∆</b> 2	2 34	4							Center Freq
10.0 0.00 -10.0																							2.441000000 GHz
-20.0 -30.0																							<b>Start Freq</b> 2.441000000 GHz
-40.0 -50.0		haint	ſ					14.,%	4ph					<b>ի</b> Գրեղի	#				wy.	Vi4V			Stop Freq
-60.0	ter 2		100	000		4-7															Sna	n 0 Hz	2.441000000 GHz
Res		1.0	MH		J Gr	12 X			#V	/BW	3.0	MHz	z	FLIN	ICTION			weep				01 pts)	CF Step 1.000000 MHz uto Man
1			t ( t (				5	.880 .295 .750	ms		1	-0.06 8.64 c		101			1011			10110			Freq Offset
4 5 6	F	1	ť					.295			1	8.64 c											0 Hz
7 8 9 10																							
11 12																							
MSG																		STA	TUS				

# Hopping mode : Enable & DH5

# Hopping mode : Enable & 2-DH5





# Hopping mode : Enable & 3-DH5

# Time of Occupancy (FH)

	RF	50 Ω	AC	CORREC		SE	NSE:INT	Δu		ALIGNAUTO e: Log-Pwr		PM Aug 01, 2017 ACE <b>1 2 3 4 5 6</b>	Frequence	су
				PNO: Fa IFGain:L		Trig: Fre Atten: 40			9 199	e. Log-i wi	Т			_
dB/div	Ref 30	.00 di	Зm							Ĺ		3.750 ms -0.02 dB	Auto	Tur
<b>g</b> ).0 ).0 00	64 <sub>1</sub>	fary) of farty	لوادر الديوية	De <sup>ret</sup> (1) be <sup>t</sup> e <sup>CA</sup> L	_X	tene star gestand B	d dan se directed	<b>∆1</b> ∆2	3∆4 ,,,,,,,,,,	า การ์ สารีการระหาร์ สาร <sub>ค</sub> าง	1170-10-1		<b>Center</b> 2.44100000	
.0 .0 .0	YIWAYAN				harr			New York			Page 1		Start 2.44100000	
1.0 1.0 1.0													<b>Stop</b> 2.44100000	
nter 2.4 s BW 1.		00 GI	lz	#	VBW	3.0 MHz			:	Sweep 1		Span 0 Hz (1001 pts)	CF 1.00000	0 M
R MODE TRO	scl t (Δ)		Х	2.880 m	s (Δ)	Y 1.69		UNCTION	FU	NCTION WIDTH	I FUNCI	TION VALUE	Auto	М
F       1         △4       1         F       1	t (∆) t (∆)			5.895 m 3.750 m 5.895 m	s s (Δ)	12.62 d -0.02 12.62 d	dB						Freq C	Offs 01
										STATI	JS			



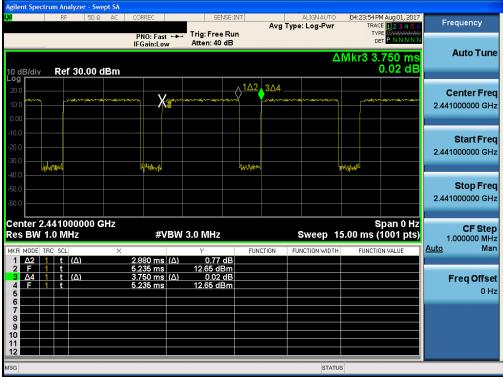
Time of Occupancy (AFH)

Agilent Spectru			pt SA											
X	RF	50 Ω	AC	CORREC		SENS	E:INT			ALIGN AUTC			Aug 01, 2017	Frequency
				PNO: Fast IFGain:Lov		Trig: Free F Atten: 40 d		A	vg Typ	e: Log-Pwr		TYPE	123456 WWWWWW PNNNNN	
10 dB/div	Ref 3	30.00 d	Bm							1	∆Mkr3	3. -0	750 ms ).01 dB	Auto Tun
20.0 10.0 0.00					X			1Δ2	3∆4					Center Fre 2.441000000 GH
20.0	Nyd,46 awybyr			1	hu			Unies				WW		<b>Start Fre</b> 2.441000000 GH
40.0 50.0 60.0														<b>Stop Fre</b> 2.441000000 GH
enter 2.44 es BW 1.0	0 MH;		Hz	#\	'BW :	3.0 MHz	51	NCTIO		Sweep		is (1	oan 0 Hz 001 pts)	CF Ste 1.000000 MH Auto Ma
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	t (/ t (/ t (/		^	2.880 ms 5.745 ms 3.750 ms 5.745 ms		-0.04 d 18.60 dBi -0.01 d 18.60 dBi	B n B					NCTION	V VALUE	Freq Offse
6 7 8 9 10 11														
SG										STAT	บร			

#### Hopping mode : Enable & DH5

# Time of Occupancy (AFH)

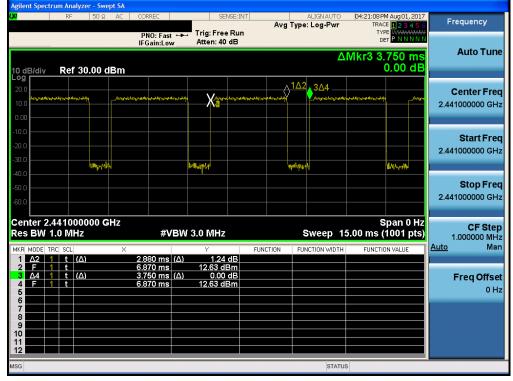
## Hopping mode : Enable & 2-DH5





## Hopping mode : Enable & 3-DH5

# Time of Occupancy (AFH)





# 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 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 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 1GHz 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.

Note: The radiated spurious emission was tested with below settings.

- Frequencies less than or equal to 1000 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 1000 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.



#### 7.3.2. Test Procedures for Conducted Spurious Emissions

- 1. The transmitter output was connected to the spectrum analyzer.
- 2. The **reference level** of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 kHz, VBW = 300 kHz.
- 3. The conducted spurious emission was tested each ranges were set as below.

Frequency range : 9 kHz ~ 30 MHz RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

Frequency range : 30 MHz ~ 10 GHz, 10 GHz ~ 25 GHz RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.

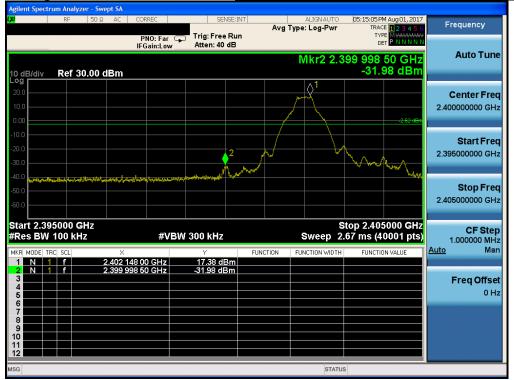
#### 7.4. Test Results

#### 7.4.1. Radiated Emissions

NT



#### Low Band-edge



#### Lowest Channel & Modulation : GFSK

#### Low Band-edge

#### Hopping mode & Modulation : GFSK





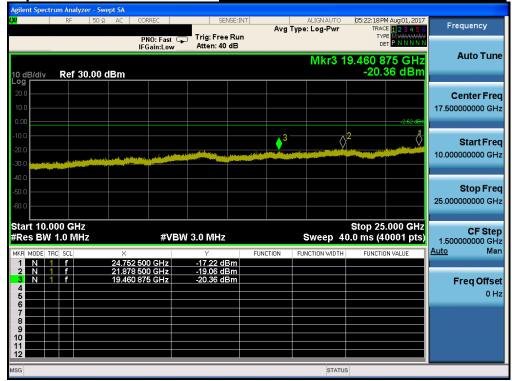
#### nt Spectrum Analyzer - Swept SA 05:19:21 PM Aug 01, 2017 TRACE 1 2 3 4 5 6 Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB TYPE DET PNO: Fast 😱 IFGain:Low Auto Tune Mkr2 18.532 2 MHz -41.89 dBm Ref 30.00 dBm 10 dB/div Log **Center Freq** 15.004500 MHz Start Freq 9.000 kHz 2 Stop Freq 30.000000 MHz Stop 30.00 MHz Sweep 5.33 ms (40001 pts) Start 9 kHz #Res BW 100 kHz CF Step 2.999100 MHz #VBW 300 kHz Auto Man FUNCTION FUNCTION WIDTH FUNCTION VALUE 281.9 kHz 18.532 2 MHz -35.54 dBm -41.89 dBm Ν 1 | f 3 **Freq Offset** 0 Hz 5 6 10 11 12 L DC Coupled ISG



## Lowest Channel & Modulation : GFSK



#### Conducted Spurious Emissions <u>Lowest Channel & Modulation : GFSK</u>



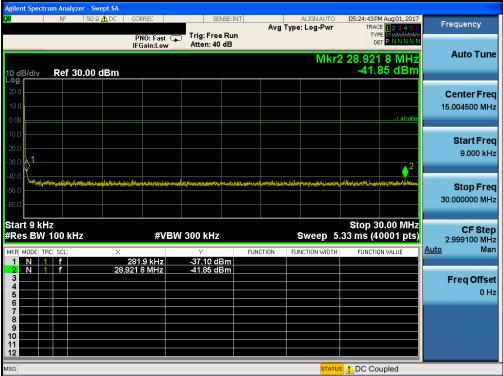


**Reference for limit** 



#### Middle Channel & Modulation : GFSK







d Spurious E		<u>Midd</u>	lle Channel	& Modulati	on : GFSK
Agilent Spectrum Analyzer - S (X) RF 50	Swept SA Ω AC CORREC PNO: Fast G IFGain:Low	SENSE:INT	ALIGNAUTC Avg Type: Log-Pwr	05:25:50 PM Aug 01, 2017 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N N	Frequency
10 dB/div Ref 30.00	) dBm		Mk	r5 5.973 37 GHz -27.27 dBm	Auto Tune
20.0	1 			-1 46 dEm	Center Fre 5.015000000 GH
-10.0			5		Start Fre 30.000000 M⊦
-40.0 -50.0					Stop Fre 10.000000000 GH
Start 30 MHz #Res BW 1.0 MHz	#VBI	V 3.0 MHz	Sweep	Stop 10.000 GHz 18.7 ms (40001 pts)	997.000000 MH
MKR         MODE         TRC         SCL           1         N         1         f           2         N         1         f           3         N         1         f           4         N         1         f           5         N         1         f	× 2.441 00 GHz 3.238 60 GHz 3.442 73 GHz 2.677 78 GHz 5.973 37 GHz	Y F 18.69 dBm -26.11 dBm -26.27 dBm -26.34 dBm -27.27 dBm	UNCTION FUNCTION WIDT	H FUNCTION VALUE	Freq Offs
6 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	5.973 57 GHZ	-27.27 ubiii			
11 12 MSG			STAT	US	

#### Middle Channel & Modulation : GFSK

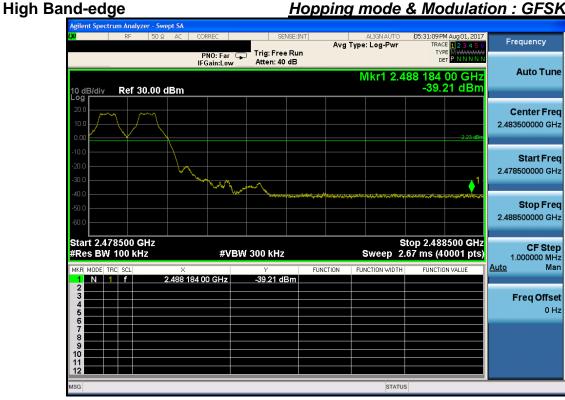




High Band-edge

#### nt Spectrum Analyzer - Swept SA Aug 01, 201 Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB TYPE DE1 PNO: Far 😱 IFGain:Low Auto Tune Mkr2 2.487 567 50 GHz -39.12 dBm 10 dB/div Ref 30.00 dBm **Center Freq** 2.483500000 GHz Start Freq 2.478500000 GHz 2 N. Stop Freq 2.488500000 GHz Start 2.478500 GHz #Res BW 100 kHz Stop 2.488500 GHz 2.67 ms (40001 pts) CF Step 1.000000 MHz #VBW 300 kHz Sweep Auto Man FUNCTION FUNCTION WIDTH FUNCTION VALUE 2.479 993 75 GHz 2.487 567 50 GHz 17.77 dBm -39.12 dBm Ν 1 | f 3 **Freq Offset** 0 Hz 11 12 STATUS ISG

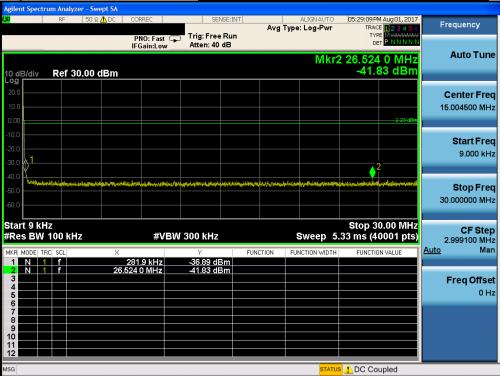
# Highest Channel & Modulation : GFSK



#### Hopping mode & Modulation : GFSK



#### Conducted Spurious Emissions <u>Highest Channel & Modulation : GFSK</u>







#### Conducted Spurious Emissions <u>Highest Channel & Modulation : GFSK</u>





Low Band-edge

## Lowest Channel & Modulation : π/4DQPSK

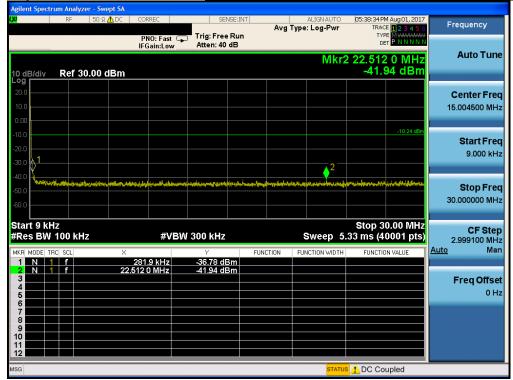


#### Hopping mode & Modulation : π/4DQPSK

#### Low Band-edge Swept SA Frequency TRACE Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB PNO: Far 😱 IFGain:Low Auto Tune Mkr1 2.400 015 00 GHz -30.95 dBm 10 dB/div Log Ref 30.00 dBm **Center Freq** 2.40000000 GHz Start Freq 2.395000000 GHz Stop Freq 2.40500000 GHz Start 2.395000 GHz #Res BW 100 kHz Stop 2.405000 GHz Sweep 2.67 ms (40001 pts) **CF Step** 1.000000 MHz Man #VBW 300 kHz Auto FUNCTION MKF 2.400 015 00 GHz -30.95 dBm N 1 f **Freq Offset** 0 Hz



#### Conducted Spurious Emissions <u>Lowest Channel & Modulation : π/4DQPSK</u>







#### Conducted Spurious Emissions <u>Lowest Channel & Modulation : π/4DQPSK</u>



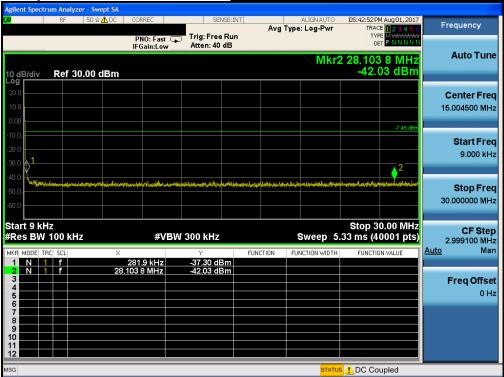


**Reference for limit** 

#### Middle Channel & Modulation : π/4DQPSK

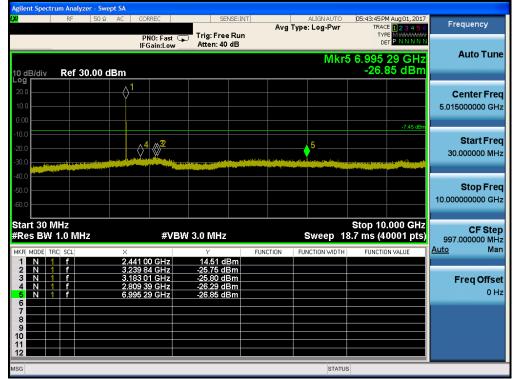


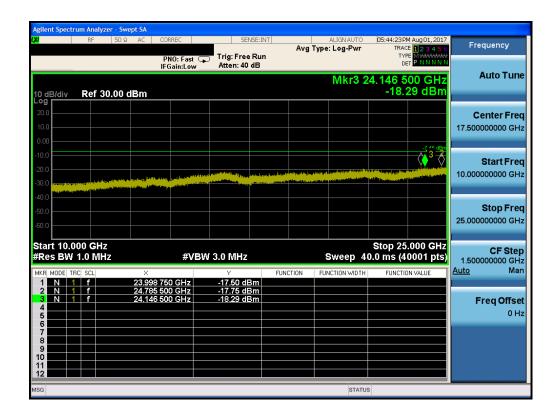






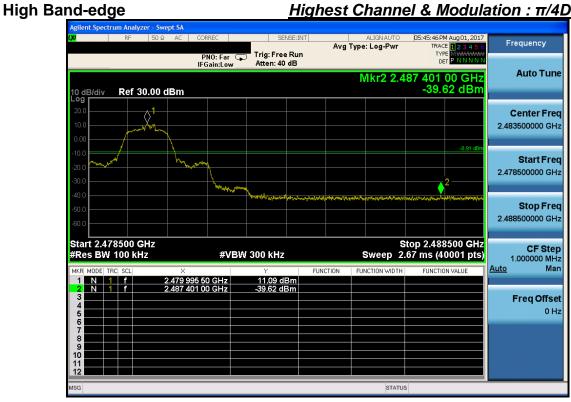
#### Middle Channel & Modulation : π/4DQPSK





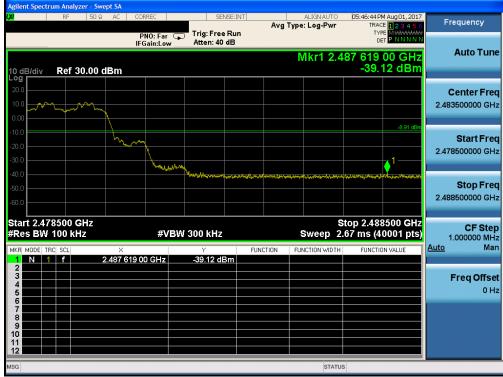


## Highest Channel & Modulation : π/4DQPSK



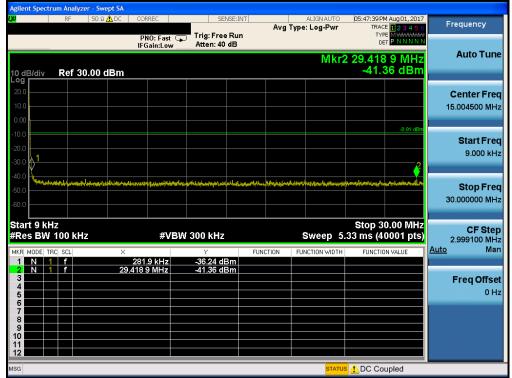
## Hopping mode & Modulation : $\pi/4DQPSK$

#### High Band-edge





#### Highest Channel & Modulation : π/4DQPSK







#### Highest Channel & Modulation : π/4DQPSK

#### nt Spectrum Analyze ept SA 05:50:00 PM Aug 01, 2017 TRACE 1 2 3 4 5 6 TYPE M WWWWW DET P N N N N N Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB PNO: Fast 🖵 IFGain:Low Auto Tune Mkr3 24.462 250 GHz -18.48 dBm Ref 30.00 dBm 10 dB/div Log **Center Freq** 17.50000000 GHz Start Freq 10.00000000 GHz Stop Freq 25.00000000 GHz Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.0 ms (40001 pts) **CF Step** 1.500000000 GHz .<u>uto</u>Man #VBW 3.0 MHz FUNCTION FUNCTION WIDTH <u>Auto</u> FUNCTION VALU 24.907 375 GHz 24.266 500 GHz 24.462 250 GHz -17.22 dBm -17.25 dBm -18.48 dBm N Freq Offset 0 Hz 11 ISG STATUS



Low Band-edge

#### Lowest Channel & Modulation : 8DPSK



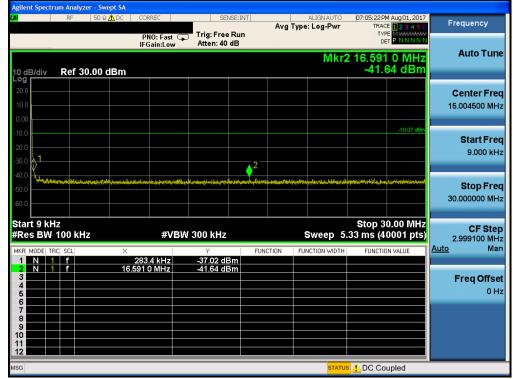
#### Low Band-edge

#### Hopping mode & Modulation : 8DPSK





#### Lowest Channel & Modulation : 8DPSK







#### Lowest Channel & Modulation : 8DPSK

#### nt Spectrum Analyzer Swept SA 07:07:07 PM Aug 01, 2017 TRACE 123456 TYPE MWWWW DET PNNNNN Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB PNO: Fast 🖵 IFGain:Low Auto Tune Mkr3 23.621 875 GHz -18.79 dBm Ref 30.00 dBm 10 dB/div Log **Center Freq** 17.50000000 GHz 3 10.07 dt $\Diamond$ Start Freq 10.00000000 GHz Stop Freq 25.00000000 GHz Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.0 ms (40001 pts) **CF Step** 1.500000000 GHz .<u>uto</u>Man #VBW 3.0 MHz FUNCTION FUNCTION WIDTH <u>Auto</u> FUNCTION VALUE -16.24 dBm -17.61 dBm -18.79 dBm 24.873 625 GHz 21.817 750 GHz 23.621 875 GHz N Freq Offset 0 Hz 11 ISG STATUS



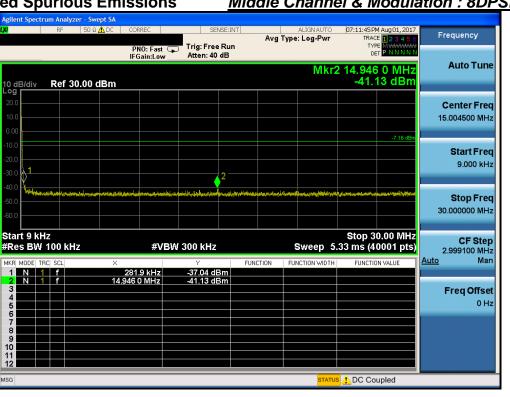
**Reference for limit** 



## Middle Channel & Modulation : 8DPSK



#### **Conducted Spurious Emissions**



Middle Channel & Modulation : 8DPSK



#### nt Spectrum Analyzer - Swept SA 07:12:35PM Aug 01, 2017 TRACE 1 2 3 4 5 ( Frequency Avg Type: Log-Pwr Trig: Free Run Atten: 40 dB PNO: Fast 🖵 IFGain:Low Auto Tune Mkr5 9.392 58 GHz -27.39 dBm 10 dB/div Log Ref 30.00 dBm **Center Freq** 5.015000000 GHz **∂**<sup>2</sup> Start Fred **⊘**<sup>3</sup> $\Diamond^4$ 30.000000 MHz Stop Freq 10.00000000 GHz Start 30 MHz #Res BW 1.0 MHz Stop 10.000 GHz Sweep 18.7 ms (40001 pts) CF Step 997.000000 MHz <u>ito</u>Man #VBW 3.0 MHz Auto FUNCTION FUNCTION WIDTH FUNCTION VALU 14.38 dBm -25.74 dBm -26.81 dBm -27.23 dBm -27.39 dBm N 1 f N 1 f N 1 f N 1 f 234 **Freq Offset** 2.239 35 GHz 9.392 58 GHz 0 Hz 5 67 10 11 ISG STATUS

#### Conducted Spurious Emissions



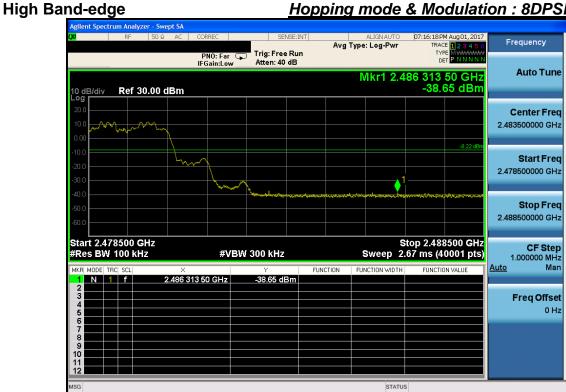


High Band-edge

## Highest Channel & Modulation : 8DPSK

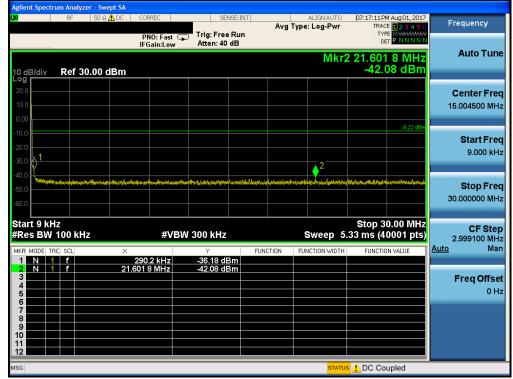
Agilent Spectrum Analyzer - Swept SA							
📈 RF 50 Ω AC CORREC	SENSE:INT	ALIGN AUTO	07:14:22 PM Aug 01, 2017	Frequency			
	Trig: Free Run	Avg Type: Log-Pwr	TRACE 1 2 3 4 5 6	ricqueriey			
PNO: Far IFGain:Lo:			TYPE MWWWWWW DET P N N N N N				
IFGalli.EU	W TREET. TO VID			Auto Tune			
		MKr2 2.4	87 874 00 GHz	Auto Fune			
10 dB/div Ref 30.00 dBm			-38.39 dBm				
Log							
20.0				Center Freq			
10.0				2.483500000 GHz			
0.00							
			-8.22 dBm				
-10.0				Start Freq			
-20.0				2.478500000 GHz			
-30.0			2	2.478500000 GH2			
<u>∿</u> .∧.	when the						
-40.0	Makerine and Manufacture and	๛ <sup>฿๛</sup> ๛๚๚๛๛๚฿๛๛๛๚฿๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛	When the work of the state of the state of the	Oton Ener			
-50.0				Stop Freq			
-60.0				2.488500000 GHz			
Start 2.478500 GHz		S	top 2.488500 GHz	CF Step			
#Res BW 100 kHz #V	/BW 300 kHz		.67 ms (40001 pts)	1.000000 MHz			
MKRI MODEI TRCI SCLI X			FUNCTION VALUE	Auto Man			
MKR MODE TRC SCL X 1 N 1 f 2.479 834 25 GHz		NCTION FUNCTION WIDTH	FUNCTION VALUE	<u>rate</u> man			
2 N 1 f 2.479 834 23 GHz							
3				Freq Offset			
4				0 Hz			
5				0112			
7							
8							
9							
11							
12							
MSG		STATUS	8				
518105							

#### Hopping mode & Modulation : 8DPSK





#### Highest Channel & Modulation : 8DPSK







#### Highest Channel & Modulation : 8DPSK

# Conducted Spurious Emissions



# 8. Transmitter AC Power Line Conducted Emission

#### 8.1 Test Setup

NA

#### 8.2 Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Conducted I	Limit (dBuV)
Frequency Range (Minz)	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

\* Decreases with the logarithm of the frequency

#### 8.3 Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10.

- The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
- The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
- 3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
- 4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

#### 8.4 Test Results

NA

# 9. Antenna Requirement

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.

#### Conclusion: Comply

DDt&C

The antenna is permanently attached. (Refer to Internal Photo file.) Therefore this E.U.T Complies with the requirement of §15.203.

#### - Minimum Standard :

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions.

# 10. Occupied Bandwidth (99 %)

## 10.1 Test Setup

NA

#### 10.2 Limit

Limit : Not Applicable

#### **10.3 Test Procedure**

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately  $3 \times RBW$ .

Spectrum analyzer plots are included on the following pages.

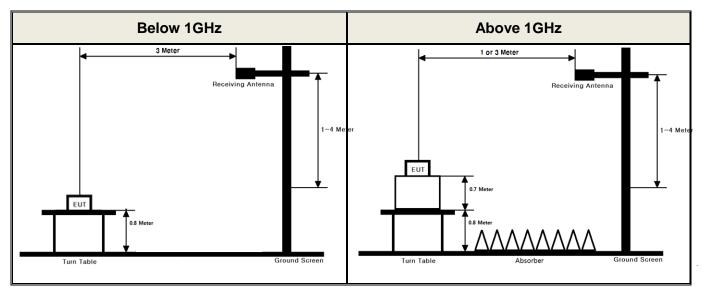
#### 10.4 Test Results

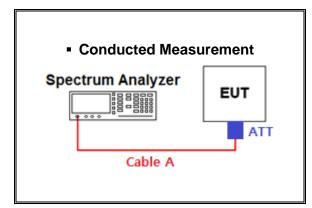
NA

# **APPENDIX I**

#### Test set up diagrams

#### Radiated Measurement





#### Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	9.18	15	11.09
1	9.45	20	10.80
2.402 & 2.441 & 2.480	9.59	25	11.28
5	10.03	-	-
10	10.43	-	-

Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test.

Path loss (S/A's Correction factor) = Cable A + Attenuator