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 : DRTFCC1604-0051 Pages:(1) / (81) page



1. Customer

- Name : Humax Automotive Co., Ltd.
- Address : (Yubang-dong, 3F), 2, Yeongmulro, Cheoin-gu Yong-in-si, Gyeonggi-do South Korea
- 2. Use of Report : FCC Original Grant
- 3. Product Name (FCC ID): Car Audio (YRN-HAMT2005)
- 4. Date of Test : 2016-04-01 ~ 2016-04-06
- 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.

Affirmation	Tested by		Technical Manager	
Ammation	Name : JungWoo Kim	(Spature)	Name : GeunKi Son	(Signature)

2016.04.08.

DT&C Co., Ltd.

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



Test Report Version

Test Report No.	Date	Description
DRTFCC1604-0051	April 08, 2016	Initial issue



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1. General Information

1.1 Testing Laboratory

DT&C	Co ., l	Ltd.			
Standard Site number			Address		
	\square	165783	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935		
FCC		804488	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935		
FUU		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		
		5740A-3	42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935		
IC		5740A-2	683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080		
<u>www.d</u>	tnc.ne	<u>et</u>			
Teleph	one	: + 8	32-31-321-2664		
FAX		: + 8	-31-321-1664		

1.2 Details of Applicant

Applicant	:	Humax Automotive Co., Ltd.			
Address	:	(Yubang-dong, 3F), 2, Yeongmulro, Cheoin-gu Yong-in-si, Gyeonggi-do South Korea			
Contact person	:	Ilkwon Lee			



1.3 Description of EUT

EUT	Car Audio
Model Name	HAMT2005
Add Model Name	N/A
Serial Number	Identical prototype
Power Supply	DC 12 V
Frequency Range	2402 MHz ~ 2480 MHz
Modulation Technique	GFSK, π/4-DQPSK, 8DPSK
Number of Channels	79
Antenna Type	Internal Antenna
Antenna Gain	PK : 3.34 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	+22 °C ~ +24 °C	
 Relative Humidity 	34 % ~ 39 %	



1.7 Test Equipment List

Туре	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Signal Analyzer	Agilent Technologies	N9020A	15/09/14	16/09/14	MY50200834
DIGITAL MULTIMETER	Agilent Technologies	34401A	16/01/05	17/01/05	US36099541
DC Power Supply	SM techno	SDP30-5D	16/01/05	17/01/05	305DLJ204
Bluetooth Tester	TESCOM	TC-3000B	15/06/26	16/06/26	3000B640046
Power Meter & Wide	Agilent	N1911A	15/10/20	16/10/20	MY53360016
Bandwidth Sensor	Technologies	N1921A	15/10/20	16/10/20	MY53360018
Vector Signal Generator	Rohde Schwarz	SMBV100A	16/01/05	17/01/05	255571
Signal Generator	Rohde Schwarz	SMF100A	15/06/29	16/06/29	102341
Power Splitter	Anritsu	K241B	15/06/25	16/06/25	017060
Thermohygrometer	BODYCOM	BJ5478	15/05/08	16/05/08	120612-2
PreAmplifier	Agilent	8449B	16/02/24	17/02/24	3008A00370
LOOP Antenna	Schwarzbeck	FMZB1513	14/04/29	16/04/29	1513-128
Horn Antenna	A.H.Systems	SAS-574	15/04/30	17/04/30	154
TRILOG Broadband Test-Antenna	Schwarzbeck	VULB 9160	14/04/30	16/04/30	3358
EMI TEST RECEIVER	R&S	ESR7	15/10/19	16/10/19	101109
High-pass filter	Wainwright Instruments	WHKX3.0	16/01/06	17/01/06	12
Low Noise Pre Amplifier	tsj	MLA-010K01-B01- 27	16/03/10	17/03/10	1844539
Horn Antenna	ETS-LINDGREN	3115	15/02/09	17/02/09	9202-3820



1.8 Summary of Test Results

FCC Part RSS Std.	Parameter	Limit (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
100 247 (0.1)	20 dB Bandwidth	N/A		С
	Dwell Time	=< 0.4 seconds		С
15.247(b) RSS-247(5.4)For FCC = < 1 Watt , i Others = <Transmitter Output PowerFor IC if CHs >= 75 = < 1 Watt F = < 4 Watt F Others = < 0.125 W		<pre>=< 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,</pre>	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		С
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 Note 3
15.203 RSS-Gen(8.3)	Antenna Requirements	FCC 15.203	-	С

Note 2 : This test item was performed in each axis and the worst case data was reported.

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

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, π /4DQPSK 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. 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 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 ≥ 20 dB BW VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold



2.4 Test Results

Modulation	Tested Channel		Average t Power	Peak Output Power	
wouldton	rested Ghanner	dBm	mW	dBm	mW
	Lowest	-1.18	0.762	-0.47	0.897
<u>GFSK</u>	Middle	-0.38	0.916	0.60	1.148
	Highest	-0.41	0.910	0.59	1.146
	Lowest	-4.16	0.384	-1.74	0.670
<u>π/4DQPSK</u>	Middle	-2.67	0.541	-0.36	0.920
	Highest	-2.76	0.530	-0.40	0.912
8DPSK	Lowest	-4.13	0.386	-1.47	0.713
	Middle	-2.62	0.547	-0.16	0.964
	Highest	-2.71	0.536	-0.24	0.946

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

Middle Channel & Modulation : GFSK









Peak Output Power

Lowest Channel & Modulation : π/4DQPSK



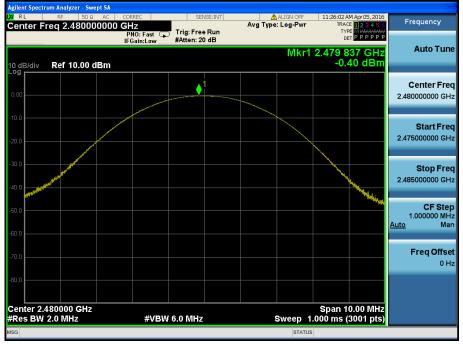


Middle Channel & Modulation : π/4DQPSK



Peak Output Power

Highest Channel & Modulation : π/4DQPSK





Lowest Channel & Modulation : 8DPSK



Peak Output Power

Middle Channel & Modulation : 8DPSK





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 × RBW, Span = between two times and five times the 20 dB bandwidth.

Modulation	Tested Channel	20 dB BW (MHz)
	Lowest	0.890
<u>GFSK</u>	Middle	0.890
	Highest	0.870
	Lowest	1.200
<u>π/4DQPSK</u>	Middle	1.230
	Highest	1.250
	Lowest	1.240
<u>8DPSK</u>	Middle 0.890 Highest 0.870 Lowest 1.200 Middle 1.230 Highest 1.250	1.260
	Highest	1.260

3.4 Test Results

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





Lowest Channel & Modulation : GFSK

20 dB Bandwidth

Middle Channel & Modulation : GFSK





Highest Channel & Modulation : GFSK



20 dB Bandwidth

Lowest Channel & Modulation : π/4DQPSK



Middle Channel & Modulation : π/4DQPSK



20 dB Bandwidth

<u>Highest Channel & Modulation : π/4DQPSK</u>





Lowest Channel & Modulation : 8DPSK

20 dB Bandwidth



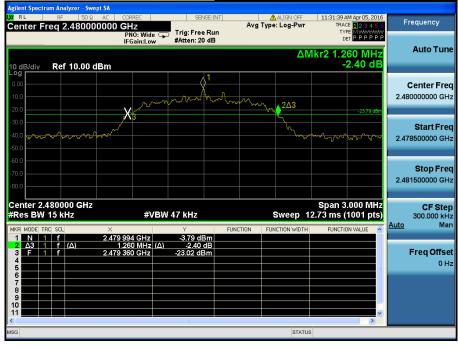
20 dB Bandwidth

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	Test Mode	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
	GFSK	2440.997	2441.996	0.999
Enable	π/4-DQPSK	2440.994	2441.996	1.002
	8DPSK	2440.997	2441.999	1.002

AFH mode

Hopping Mode	Test Mode	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
Enable	GFSK	2410.997	2411.996	0.999
	π/4-DQPSK	2410.997	2411.999	1.002
	8DPSK	2410.997	2411.996	0.999

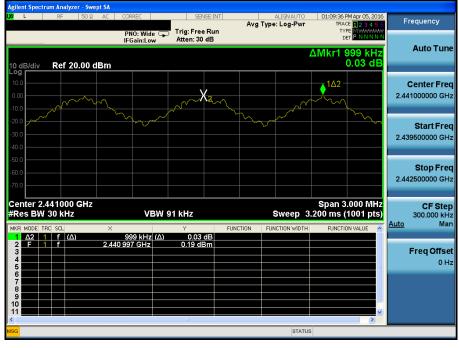
Note 1 : See next pages for actual measured spectrum plots.

- 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

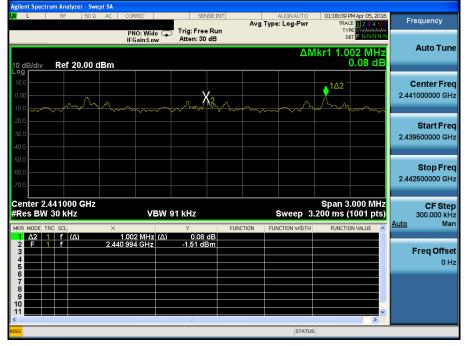


Carrier Frequency Separation (FH) <u>Hopping mode : Enable & GFSK</u>



Carrier Frequency Separation (FH)

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





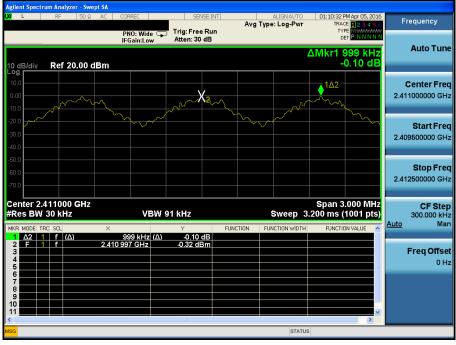
Carrier Frequency Separation (FH)



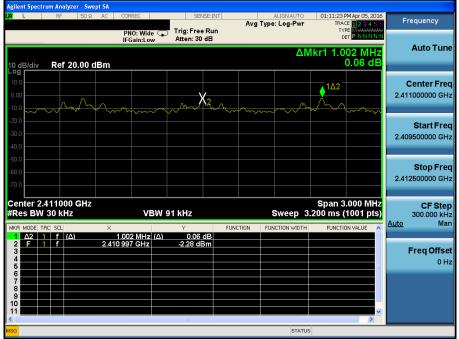
Frequency Avg Type: Log-Pwr PNO: Wide 🖵 Trig: Free Run IFGain:Low Atten: 30 dB DET ΔMkr1 1.002 MHz -0.02 dB Auto Tune Ref 20.00 dBm /div •1∆2 **Center Freq** Xz 2.441000000 GHz Start Freq 2.439500000 GHz **Stop Freq** 2.442500000 GHz Center 2.441000 GHz #Res BW 30 kHz Span 3.000 MHz Sweep 3.200 ms (1001 pts) CF Step 300.000 kHz Man VBW 91 kHz <u>Auto</u> 1.002 MHz (Δ) 2.440 997 GHz -0.02 dB -1.26 dBm Δ2 1 f (Δ) F 1 f Freq Offset 0 Hz STATUS



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

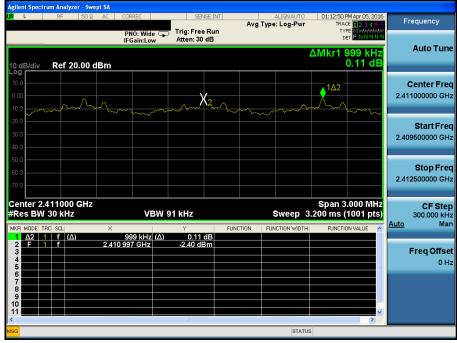


Carrier Frequency Separation (AFH) <u>Hopping mode : Enable & $\pi/4$ -DQPSK</u>





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,	
Span for AFH mode = 30 MHz	Start Frequency = 2396.0 MHz,	Stop Frequency = 2426.0 MHz
RBW = To identify clearly the indi	vidual channels, set the RBW to le	ess than 30% of the channel spacing
or the 20 dB bandwidth, w	vhichever is smaller.	
VBW ≥ RBW	Sweep = auto	
Detector function = peak	Trace = max hold	

5.4 Test Results

FH mode

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

AFH mode

Hopping mode	Test mode	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

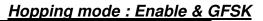


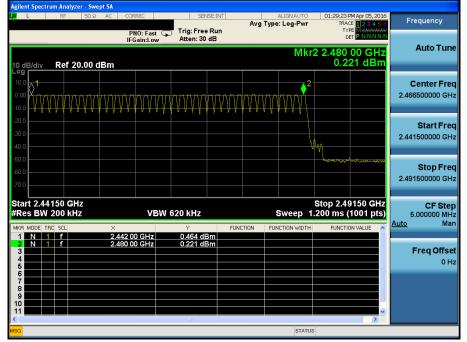
Number of <u>Hopping Frequencies 1(FH)</u>



L RF		REC	SENSE:IN	Avg Type	ALIGNAUTO :: Log-Pwr	01:28:37 PM Apr 05, 20 TRACE 12345 TYPE MIANNA	Frequency
0 dB/div Re	۹۱ ۱۴۵ f 20.00 dBm		Atten: 30 dB		Mkr	2 2.441 00 GH 0.502 dBr	Auto Tune
0 dB/div Re 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Â ¹				MM		Center Freq 2.416500000 GHz
20.0 30.0 40.0	Nut						Start Freq 2.391500000 GHz
-50.0							Stop Freq 2.441500000 GHz
Start 2.39150 #Res BW 200	kHz ×	VBW 62	Y		Sweep 1.	Stop 2.44150 GH 200 ms (1001 pts FUNCTION VALUE	Z 5.000000 MHz <u>Auto</u> Man
1 N 1 f 2 N 1 f 3 4 5 5 5 5 6	2.402 0 2.441 0	0 GHz	0.550 dBm 0.502 dBm				Freq Offset 0 Hz
7 8 9 10 11						>	<u>∽</u>
ISG					STATUS		

Number of Hopping Frequencies 2(FH)







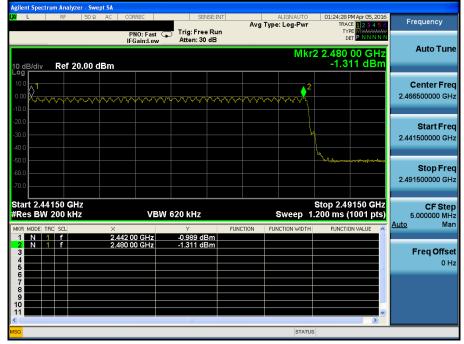
Number of <u>Hopping Frequencies 1(FH)</u>



L	RF	50Ω AC	CORREC	SENSE:	Avg	ALIGNAUTO Type: Log-Pwr	01:27:08 PM Apr 05, 2016 TRACE 1 2 3 4 5 6 TYPE M MANAGE	Frequency
0 dB/div	Ref 20	.00 dBm	PNO: Fast IFGain:Low	Atten: 30 dB		Mkr	2 2.441 00 GHz -0.877 dBm	
			γ	vvvvvv	~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Center Fre 2.416500000 GF
20.0 30.0 40.0								Start Fre 2.391500000 GH
50.0 60.0 70.0								Stop Fre 2.441500000 GH
KRES BW		×		N 620 kHz Y	FUNCTION	Sweep 1	Stop 2.44150 GHz .200 ms (1001 pts) FUNCTION VALUE	
1 N 2 N 3 4 5 6	1 f		402 00 GHz 441 00 GHz	-2.643 dBm -0.877 dBm				Freq Offs 0 F
7 8 9 10 11							~	
sG						STATUS	,	

Number of Hopping Frequencies 2(FH)

Hopping mode : Enable & π/4-DQPSK



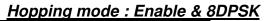


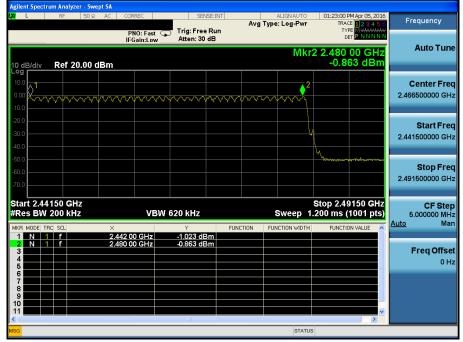
Number of <u>Hopping Frequencies 1(FH)</u>



L	RF	50Ω AC	CORREC	SENSE	A	ALIGNAUTO	r TRA	PM Apr 05, 2016	Frequency
	D -5 20 (PNO: Fast IFGain:Low	Trig: Free R Atten: 30 dl		Mk	r <mark>2 2.441</mark>	00 GHz	Auto Tune
0 dB/div -og 10.0 0.00	Ref 20.0		᠂ᠰᡗ᠊ᠺ᠕᠕ᡘ	vvvvvv	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Center Fred 2.416500000 GH;
20.0 30.0 40.0		<i>,</i>							Start Free 2.391500000 GH:
-50.0 -60.0 -70.0	randa and the second of the								Stop Fred 2.441500000 GH2
Res BW		×		W 620 kHz	FUNCTION	Sweep	1.200 ms (4150 GHz 1001 pts) DN VALUE	CF Step 5.000000 MH <u>Auto</u> Mar
1 N 1 2 N 1 3 4 5 6			02 00 GHz 41 00 GHz	-2.64 dBn -1.03 dBn					Freq Offset 0 Hz
7 8 9 10 11								v	
ISG						STAT	US		

Number of Hopping Frequencies 2(FH)

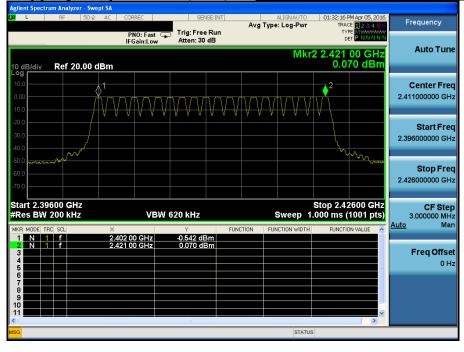






Number of Hopping Frequencies 1(AFH)

Hopping mode : Enable & GFSK



Number of Hopping Frequencies 1(AFH)







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

 VBW ≥ RBW
 Detector function = peak

 Trace = max hold

6.4 Test Results

FH mode

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
	DH 5	79	2.910	3.750	0.310
Enable	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)
	DH 5	20.000	2.910	3.750	0.155
Enable	2 DH 5	20.000	2.910	3.750	0.155
	3 DH 5	20.000	2.910	3.750	0.155

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)

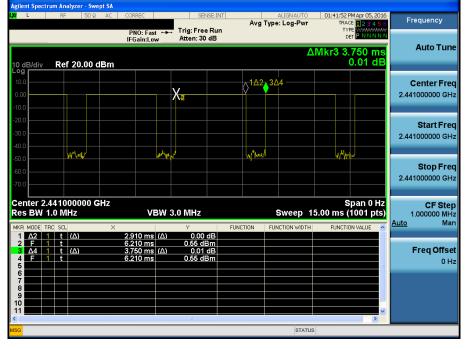
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

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



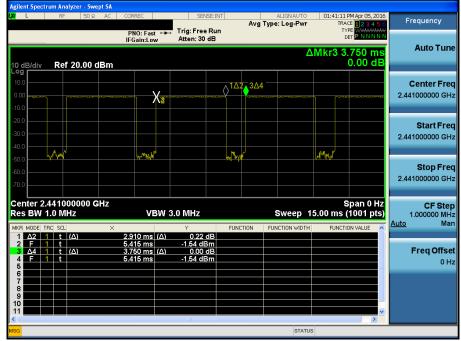
Hopping mode : Enable & GFSK

Time of Occupancy (FH)



Time of Occupancy (FH)

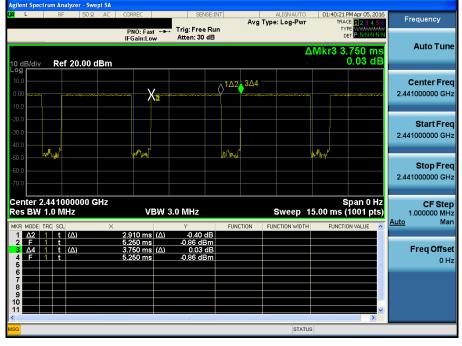
Hopping mode : Enable & π/4-DQPSK





Hopping mode : Enable & 8DPSK

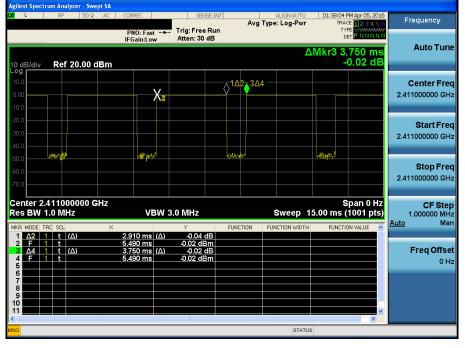
Time of Occupancy (FH)





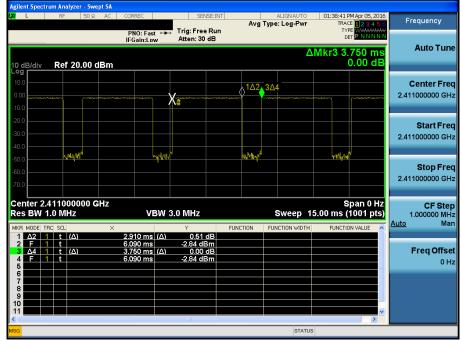
Hopping mode : Enable & GFSK

Time of Occupancy (AFH)



Time of Occupancy (AFH)

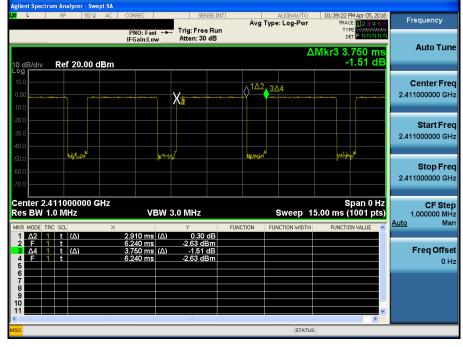
Hopping mode : Enable & π/4-DQPSK





Hopping mode : Enable & 8DPSK

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 §15.205(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 :

1						
	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 1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
- NOTE 2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
- NOTE 3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz for Average detection (AV) at frequency above 1 GHz.



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.

7.3.3. Test Plot

Refer to the APPENDIX II



7.4. Test Results

7.4.1. Radiated Emissions

9 kHz ~ 25 GHz Data (Modulation : GFSK)

Lowest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2375.35	Н	Х	PK	51.14	-3.03	N/A	N/A	48.11	74.00	25.89
2376.05	Н	Х	AV	42.01	-3.03	-24.70	N/A	14.28	54.00	39.72
4804.23	Н	Х	PK	46.90	6.21	N/A	N/A	53.11	74.00	20.89
4804.12	Н	Х	AV	37.23	6.21	-24.70	N/A	18.74	54.00	35.26

Middle Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.98	Н	Х	PK	45.95	6.29	N/A	N/A	52.24	74.00	21.76
4882.02	Н	Х	AV	36.16	6.29	-24.70	N/A	17.75	54.00	36.25

Highest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.58	Н	Х	PK	52.81	-2.77	N/A	N/A	50.04	74.00	23.96
2483.53	Н	Х	AV	43.78	-2.77	-24.70	N/A	16.31	54.00	37.69
4960.25	Н	Х	PK	46.80	6.37	N/A	N/A	53.17	74.00	20.83
4960.01	н	Х	AV	38.20	6.37	-24.70	N/A	19.87	54.00	34.13

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m.

In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log(applied distance / required distance) = 20 log(1 m / 3 m) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.91 ms

- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.91 X 20) = 1.718 \approx 2

- The Worst Case Dwell Time = T [ms] x H' = 2.91 ms X 2 = 5.82 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log(5.82 / 100) = -24.70 dB

4. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.



9 kHz ~ 25 GHz Data (Modulation : π /4DQPSK)

Lowest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2376.25	Н	Х	PK	52.18	-3.03	N/A	N/A	49.15	74.00	24.85
2376.20	н	Х	AV	39.58	-3.03	-24.70	N/A	11.85	54.00	42.15
4804.21	Н	Х	PK	45.18	6.21	N/A	N/A	51.39	74.00	22.61
4804.25	н	Х	AV	32.88	6.21	-24.70	N/A	14.39	54.00	39.61

Middle Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.94	Н	Х	PK	44.18	6.29	N/A	N/A	50.47	74.00	23.53
4882.00	Н	Х	AV	32.08	6.29	-24.70	N/A	13.67	54.00	40.33

Highest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.73	Н	Х	PK	52.31	-2.77	N/A	N/A	49.54	74.00	24.46
2483.53	Н	Х	AV	40.79	-2.77	-24.70	N/A	13.32	54.00	40.68
4960.03	Н	Х	PK	44.69	6.37	N/A	N/A	51.06	74.00	22.94
4960.09	Н	Х	AV	32.23	6.37	-24.70	N/A	13.90	54.00	40.10

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m.

In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log(applied distance / required distance) = 20 log(1 m / 3 m) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.91 ms

- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.91 X 20) = 1.718 = 2

- The Worst Case Dwell Time = T [ms] x H' = 2.91 ms X 2 = 5.82 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log(5.82 / 100) = -24.70 dB

4. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.



9 kHz ~ 25 GHz Data (Modulation : <u>8DPSK</u>)

Lowest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2375.90	Н	Х	PK	50.86	-3.03	N/A	N/A	47.83	74.00	26.17
2376.10	н	Х	AV	39.61	-3.03	-24.70	N/A	11.88	54.00	42.12
4804.32	Н	Х	PK	45.91	6.21	N/A	N/A	52.12	74.00	21.88
4803.89	н	Х	AV	32.97	6.21	-24.70	N/A	14.48	54.00	39.52

Middle Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.96	Н	Х	PK	44.47	6.29	N/A	N/A	50.76	74.00	23.24
4882.19	Н	Х	AV	32.24	6.29	-24.70	N/A	13.83	54.00	40.17

Highest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.62	Н	Х	PK	52.67	-2.77	N/A	N/A	49.90	74.00	24.10
2483.53	Н	Х	AV	40.88	-2.77	-24.70	N/A	13.41	54.00	40.59
4959.82	Н	Х	PK	45.14	6.37	N/A	N/A	51.51	74.00	22.49
4959.97	Н	Х	AV	32.19	6.37	-24.70	N/A	13.86	54.00	40.14

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = 20 log(applied distance / required distance) = 20 log(1 m / 3 m) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels = Δt = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.91 ms

- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.91 X 20) = 1.718 \approx 2

- The Worst Case Dwell Time = T [ms] x H' = 2.91 ms X 2 = 5.82 ms

- D.C.F = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log(5.82 / 100) = -24.70 dB

4. Sample Calculation.

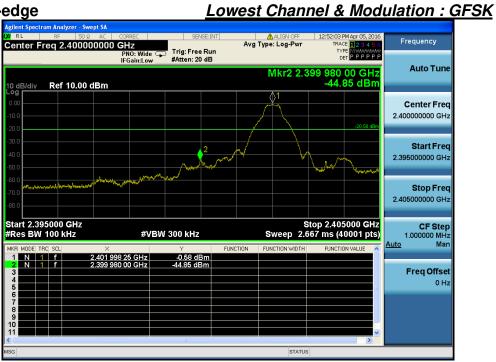
Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

 $\label{eq:Where, T.F = Total Factor, \quad AF = Antenna \ Factor, \quad CL = Cable \ Loss, \quad AG = Amplifier \ Gain.$



7.4.2. Conducted Spurious Emissions

Low Band-edge



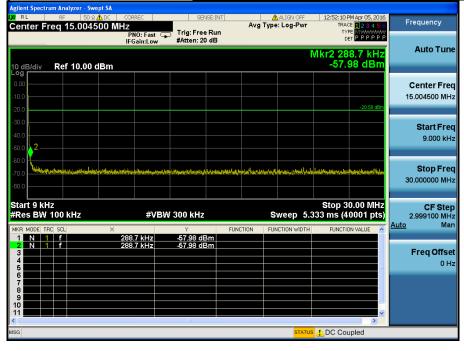
Low Band-edge ctrum Analyzer - Swept SA Frequency ALIGN OFF Avg Type: Log-Pwr Trig: Free Run #Atten: 20 dB PNO: Wide 🖵 IFGain:Low Auto Tune Mkr1 2.399 993 00 GHz -42.51 dBm Ref 10.00 dBm dB/div Center Freq 2.40000000 GHz Start Freq 2.395000000 GHz Stop Freq 2.40500000 GHz **CF Step** 1.000000 MHz Man Start 2.395000 GHz #Res BW 100 kHz Stop 2.405000 GHz Sweep 2.667 ms (40001 pts) #VBW 300 kHz Auto FUNCTION 2.399 993 00 GHz -42.51 dBm Freq Offset 0 Hz STATUS

Hopping mode & Modulation : GFSK



Conducted Spurious Emissions <u>Lowe</u>

Lowest Channel & Modulation : GFSK



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

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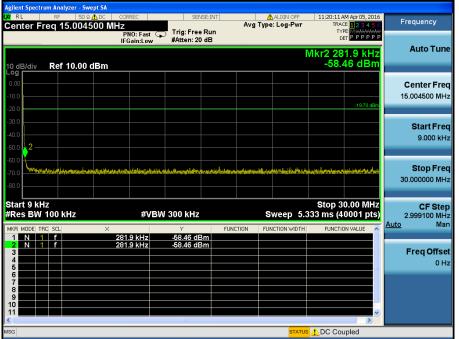


Reference for limit





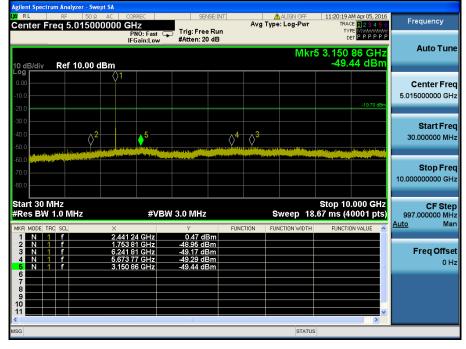
Conducted Spurious Emissions <u>Middle Channel & Modulation : GFSK</u>





Conducted Spurious Emissions <u>Midd</u>

Middle Channel & Modulation : GFSK



Agilent Spectrum Analyzer - Swept SA				
Center Freq 17.50 Ω AC CORREC	SENSE:INT	ALIGN OFF Avg Type: Log-Pwr	11:20:27 AM Apr 05, 2016 TRACE 1 2 3 4 5 6	Frequency
PNO: Fast IFGain:Lov	Trig: Free Run #Atten: 20 dB		TYPE MWWWWW DET PPPPP	
IFGain:Luv	Atten: 20 db	Milero (24.044 500 GHz	Auto Tune
10 dB/div Ref 10.00 dBm		IVINIO 2	-41.66 dBm	
				O antan Enan
-10.0				Center Freq 17.50000000 GHz
-20.0			-19.70 dBm	17.50000000 GHZ
-30.0				
-40.0				Start Freq
	a distant second distant second s		A Defendence of the second sec	10.00000000 GHz
-70.0				Stop Freq
-80.0				25.00000000 GHz
Start 10.000 GHz #Res BW 1.0 MHz #V	BW 3.0 MHz	Sweep 40	Stop 25.000 GHz .00 ms (40001 pts)	CF Step 1.50000000 GHz
MKR MODE TRC SCL X		NCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man
1 N 1 f 23.762 500 GHz 2 N 1 f 24.793 000 GHz	-41.28 dBm -41.35 dBm			
3 N 1 f 24.044 500 GHz	-41.66 dBm			Freq Offset
5			=	0 Hz
8				
10				
11 <			>	
MSG		STATUS	3	



High Band-edge

Highest Channel & Modulation : GFSK



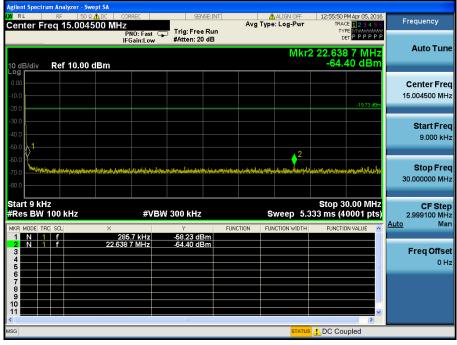
High Band-edge

Hopping mode & Modulation : GFSK





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



Agilent Spect															
Center F	RF rea		AC	COR		S	ENSE:IN	T	Avg T		IGN OFF og-Pwr	TR4	PM Apr 05, 20:	6	Frequency
Contor	- oq	0101000		PN	IO: Fast ain:Low	Trig: Fre #Atten: 3			-		-	יד	PEMWWWW	94F	
				IFG	ain:LUW	#Accent.	20 08				Mkr	5 2 4 5 9	34 GH		Auto Tune
10 dB/div Log	Re	f 10.00 c									WIKI		51 dBn		
				1											Center Freq
-10.0															5.015000000 GHz
-20.0													-19.73 dB		
-30.0															04-44 E-44
-40.0					x 5			2	<u>3_4</u>						Start Freq 30.000000 MHz
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-70.0															Stop Freq
-80.0															10.00000000 GHz
Start 30 I												Oten di			
#Res BW		MHz			#VE	3W 3.0 MH	z			Swe	eep 18	.67 ms (4	0.000 GH: 10001 pts	9	CF Step 997.000000 MHz
MKR MODE T	RC SCL		×			Y		FUNC	TION	FUNCTI	ON WIDTH	FUNCT	ION VALUE	ā l	<u>Auto</u> Man
1 N	1 f 1 f				3 GHz 3 GHz	0.34 o -49.00 o									
3 N	1 f		6.2	55 02	2 GHz 1 GHz	-49.33 c -49.35 c	:Bm								Freq Offset
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10															
<						Ш								×	
MSG											STATUS	•			



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

gilent Spectrum Analyzer - Swe	ept SA				
RL RF 50 Ω Center Freq 17.5000		SENSE:INT	ALIGN OFF Avg Type: Log-Pwr	12:56:07 PM Apr 05, 2016 TRACE 1 2 3 4 5 6	Frequency
	PNO: Fast ⊂ IFGain:Low	Trig: Free Run #Atten: 20 dB		DET P P P P P	
			Mkr3 2	4.492 250 GHz	Auto Tun
0 dB/div Ref 10.00 d	dBm			-41.47 dBm	
0.00					Center Fre
10.0					17.50000000 GH
20.0				-19.73 dBm	
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60.0					Stop Fr
70.0					25.00000000 G
Start 10.000 GHz Res BW 1.0 MHz		W 3.0 MHz	0	Stop 25.000 GHz .00 ms (40001 pts)	CF Ste
KES BW TO WHZ			-	FUNCTION VALUE	1.500000000 G Auto M
1 N 1 f	× 24.053 125 GHz	-41.04 dBm	UNCTION FUNCTION WIDTH	FUNCTION VALUE	
2 N 1 f 3 N 1 f	23.800 750 GHz 24.492 250 GHz	-41.39 dBm -41.47 dBm			Freq Offs
4					0
5					
8					
9					
10 11				<u>~</u>	



Low Band-edge

Lowest Channel & Modulation : π/4DQPSK



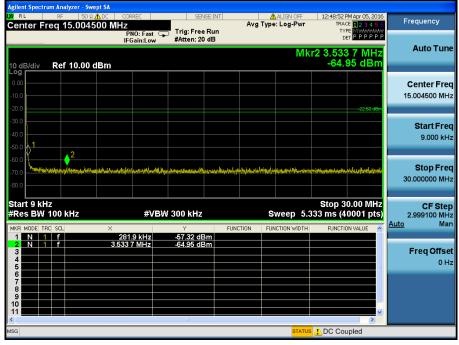
Low Band-edge

Hopping mode & Modulation : π/4DQPSK





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



enter	RE	50 Ω A	ic co	ORREC	SE	NSE:INT		ALIGN OFF	12:49:00	PM Apr 05, 2016	
cinter		.0150000	000 G			e Run	Avg	Type: Log-Pwr	TRA T)		Frequency
10 dB/di	v Ref	10.00 dBi		Gam.Low	in Reen. 2			Mk		95 GHz 72 dBm	Auto Tune
-og 0.00 10.0 20.0			∆ 1							-22.60 dBm	Center Fred 5.015000000 GH
30.0 40.0 50.0				5			2 2		an an ai japon a	y Milwater (Ministry	Start Free 30.000000 MH
-60.0			مريد المريد ا المريد المريد ا								Stop Fre 10.000000000 GH
	0 MHz W 1.0 N	/IHz	×	#VE	BW 3.0 MHz		ICTION	Sweep 1	3.67 ms (4	0.000 GHz 10001 pts)	CF Ste 997.000000 MH <u>Auto</u> Ma
1 N 2 N	1 f 1 f 1 f		2.402	11 GHz 44 GHz 39 GHz	-2.53 d -49.09 d -49.24 d	Bm Bm Bm					Freq Offs
3 N 4 N	1 f		6.412	30 GHz	-49.61 d						0.4
3 N 4 N 5 N 6 7 8 9 10 11			6.412	30 GHz 95 GHz	-49.61 d -49.72 d						0 H



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

		Ω AC CORREC	SEN:	SE:INT	ALIGN OFF	12:49:08 PM		Frequency
enter Fr	eq 17.50	0000000 GHz	ast 😱 Trig: Free		ype: Log-Pwr	TYPE	123456 M WWWWW	Frequency
		IFGain:L				DET	PPPPPP	
					Mkr3 2	24.030 62	5 GHz	Auto Tur
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								Otopii
30.0								25.000000000 G
30.0	00 GHz					Stop 25.0	00 GHz	25.00000000 G
80.0 tart 10.00			¥VBW 3.0 MHz		Sweep 40	Stop 25.0 .00 ms (400		25.000000000 G
tart 10.00 Res BW	1.0 MHz	×	#VBW 3.0 MHz	FUNCTION	Sweep 40		001 pts)	25.00000000 G CF St 1.50000000 G
10.0 Res BW 10.00 Res BW 1000 RR MODE TR	1.0 MHz	× 23.975 125 GH	Y Iz -40.77 dB	m		.00 ms (400	001 pts)	25.00000000 G CF St 1.50000000 G
tart 10.00 Res BW ⁻ ^{KR MODE TRI 1 N 1 2 N 1}	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF St 1.50000000 G <u>Auto</u> M
30.0 Res BW 7 IKR MODE TRI 1 N 1 2 N 1 3 N 1 4	1.0 MHz	× 23.975 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF St 1.500000000 G <u>Auto</u> M Freq Offs
Ctart 10.00 Res BW KR MODE TRI 1 N 1 2 N 1 3 N 1	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF St 1.500000000 G <u>Auto</u> M Freq Offs
50.0 Res BW KR MODE TRI 1 N 1 2 N 1 3 N 1 4 5 6 7	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF St 1.500000000 G <u>Auto</u> M Freq Offs
30.0 Res BW KR MODE TRI 1 N 2 N 3 N 4 5 6 6	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF Str 1.500000000 G <u>Auto</u> M Freq Offs
60.0 Res BW IKR MODE TRI 1 N 2 N 3 N 4 5 6 7 8 9 10	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts) Value	25.00000000 G CF St 1.500000000 G <u>Auto</u> M Freq Offs
60.0	1.0 MHz	× 23.975 125 GH 24.164 125 GH	z -40.77 dB z -40.79 dB	m		.00 ms (400	001 pts)	25.00000000 G CF Sto 1.50000000 G



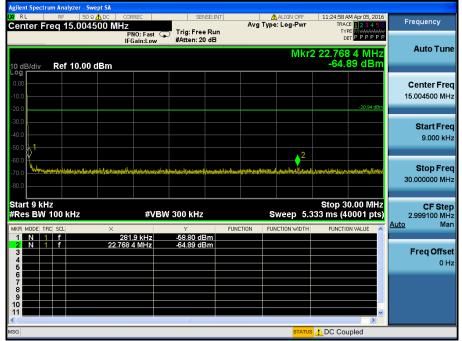
Reference for limit

Middle Channel & Modulation : π/4DQPSK



Conducted Spurious Emissions

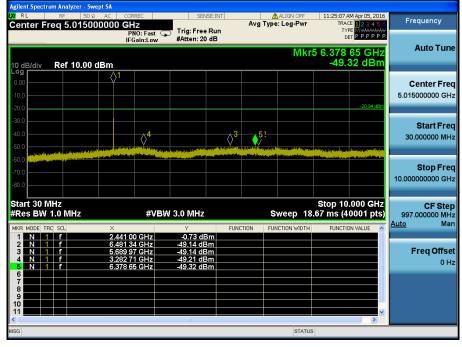
Middle Channel & Modulation : π/4DQPSK





Conducted Spurious Emissions <u>Midd</u>

Middle Channel & Modulation : π/4DQPSK



	um Analyzer - S							
Center F		0 Ω AC CORREC 0000000 GHz	SENSE:I	Avg	ALIGN OFF	TRAC	M Apr 05, 2016 E <mark>1 2 3 4 5 6</mark>	Frequency
		PNO: Fast IFGain:Low				TYF	е Миллалаа ТРРРРРР	
10 dB/div	Ref 10.0	0 dBm			Mkr3 2	22.324 0 -42.0	00 GHz 06 dBm	Auto Tune
0.00 -10.0 -20.0							-20.94 dBm	Center Freq 17.50000000 GHz
-30.0 -40.0 -50.0					A start of a		² ¹ ¹ ¹ ² ¹	Start Freq 10.000000000 GHz
-60.0 -70.0 -80.0								Stop Freq 25.000000000 GHz
Start 10.0 #Res BW		#V	BW 3.0 MHz		Sweep 40		.000 GHz 0001 pts)	CF Step 1.50000000 GHz Auto Man
MKR MODE TH	RC SCL	× 24.359 500 GHz	۲ -41.84 dBm	FUNCTION	FUNCTION WIDTH	FUNCTIO	IN VALUE	Auto Man
2 N 1 3 N 1 4 5	f	23.783 500 GHz 22.324 000 GHz	-41.88 dBm -42.06 dBm					Freq Offset 0 Hz
6 7 8 9 10								
11 							>	
MSG					STATUS	5		



High Band-edge

Highest Channel & Modulation : π/4DQPSK



High Band-edge

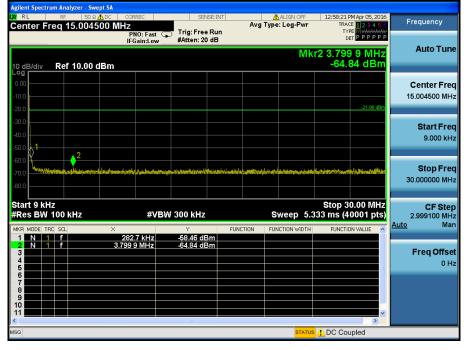
Hopping mode & Modulation : π/4DQPSK





Conducted Spurious Emissions

Highest Channel & Modulation : π/4DQPSK



Agilent Spectrur XI RL	RF 50 Ω	AC COR		SEN	BE:INT	Ανα Τι	ALIGN OFF		M Apr 05, 2016 E 1 2 3 4 5 6	Frequency
Center Fre	Ref 10.00	PN IFG	⊿ IO: Fast Ģ iain:Low	Trig: Free #Atten: 20		(1 810		דיי ס 5 5.748	54 GHz	Auto Tune
0.00		1 							-21.06 dBm	Center Freq 5.015000000 GHz
-30.0 -40.0 -50.0	and the second s	Miteraliza jestu si Area				4	∂ ³ ∂ ²	The state of the s	acusystant Marstall	Start Freq 30.000000 MHz
-60.0 -70.0 -80.0	انتقار یا خاریند معدی می در برای م انتقار یا خاریند معدی ا							i Malificacio contribucen co		Stop Freq 10.000000000 GHz
Start 30 MI #Res BW 1	.0 MHz	× 2.479 88		V 3.0 MHz Y -0.76 dB			Sweep 18	.67 ms (4	.000 GHz 0001 pts) ^{IN VALUE}	CF Step 997.000000 MHz <u>Auto</u> Man
2 N 1 3 N 1 4 N 1 5 N 1 6 7	f f f	7.594 99 7.194 94 6.282 93 5.748 54) GHz 1 GHz 3 GHz	-49.49 dB -49.58 dB -49.63 dB -49.64 dB	m m m				=	Freq Offset 0 Hz
8 9 10 11				Ĩ						
MSG							STATUS			



Conducted Spurious Emissions

Highest Channel & Modulation : π/4DQPSK





Low Band-edge

Lowest Channel & Modulation : 8DPSK



Low Band-edge

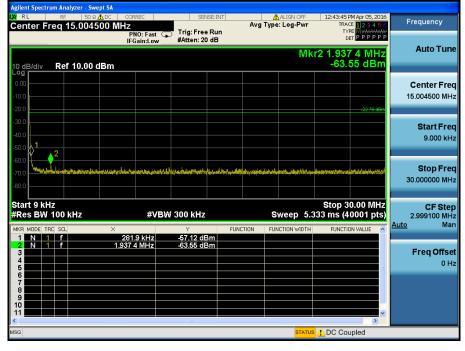
Hopping mode & Modulation : 8DPSK





Conducted Spurious Emissions

Lowest Channel & Modulation : 8DPSK



Agilent Spectrum Analyzer - Sv X/ RL RF 50.0		SENSE:INT	ALIGN OFF	12:43:54 PM Apr 05, 2016	
Center Freq 5.0150	00000 GHz		Avg Type: Log-Pwr	TRACE 1 2 3 4 5 6	Frequency
	PNO: Fast ⊂ IFGain:Low	#Atten: 20 dB			
10 dB/div Ref 10.00	dBm		Mkr	5.817 83 GHz -49.84 dBm	Auto Tune
0.00	{1				Center Free
-10.0					5.015000000 GH
-20.0				-22.76 dBm	
40.0					Start Free 30.000000 MH
-50.0				Halfanda, y Salama, Salay di Alfand Sanadahili kutara.	30.00000 MH
60.0	and the second se	and also as particular and the state of the	and the same with the second state of the seco	and a first state of the second	Stop Fre
-70.0					10.000000000 GH
Start 30 MHz #Res BW 1.0 MHz	#VB	N 3.0 MHz	Sweep 18.	Stop 10.000 GHz 67 ms (40001 pts)	CF Stej 997.000000 MH
MKR MODE TRC SCL	× 2.402 36 GHz	-2.11 dBm	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Ma
2 N 1 f	5.897 10 GHz 3.165 81 GHz	-49.56 dBm -49.63 dBm			Freq Offse
4 N 1 f	6.319 82 GHz 5.817 83 GHz	-49.84 dBm -49.84 dBm			0 H
6	0.017 00 0112				
8					
10				×	
< Isg			STATUS		
			314103		



Conducted Spurious Emissions

Lowest Channel & Modulation : 8DPSK

Agilent Spectrum Analy	50 Ω AC CORREC	SENSE:IN		ALIGN OFF	12:44:02 PM Apr 05, 2010	
Center Freq 1/	7.500000000 GHz PNO: Fas IEGain:Lo			e: Log-Pwr	TRACE 12345 TYPE MWWWW DET PPPPP	
	10.00 dBm			Mkr3 2	4.147 625 GHz -41.18 dBm	Auto Tune
-10.0					-22.76 dBn	Center Freq 17.500000000 GHz
-30.0			l (sou) te l an a set a lla state d'a sui far sou d'alla set a set a lla state d'a sou d'alla set a set a set	e pineta per la per la per la resta	3	Start Freq 10.000000000 GHz
-60.0 -70.0 -80.0						Stop Fred 25.000000000 GHz
Start 10.000 GH #Res BW 1.0 MI	Hz #\	/BW 3.0 MHz			Stop 25.000 GHz .00 ms (40001 pts	
MKR MODE TRC SCL 1 N 1 f 2 N 1 f 3 N 1 f 4 - - - 5 - - -	× 24.627 250 GHz 24.698 125 GHz 24.147 625 GHz	-40.57 dBm -40.58 dBm -41.18 dBm	FUNCTION FUN	NCTION WIDTH	FUNCTION VALUE	Freq Offset
6 7 8 9 10						
<		Ш		STATUS	> >	

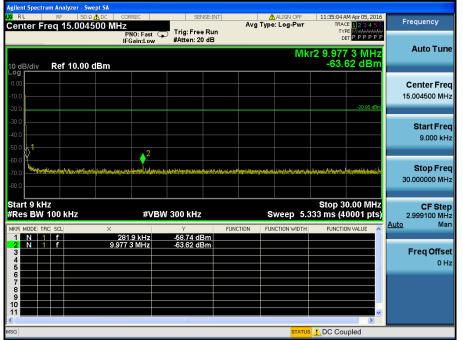


Reference for limit





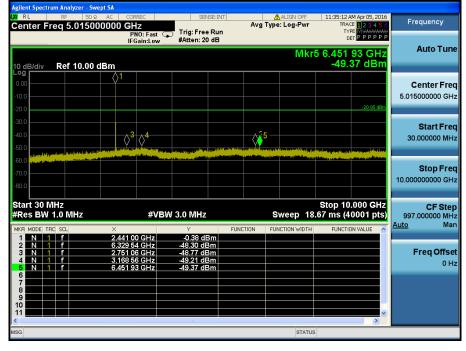
Conducted Spurious Emissions <u>Middle Channel & Modulation : 8DPSK</u>





Conducted Spurious Emissions

Middle Channel & Modulation : 8DPSK



	um Analyzer - Sv						
Center Fi		Ω AC CORREC	SENSE:	Avg	ALIGN OFF	11:35:20 AM Apr 05, 2016 TRACE 12 3 4 5 6	Frequency
	-	PNO: Fast IFGain:Lov	, 🂬 Trig: Free Ru #Atten: 20 dE			DET PPPP	
10 dB/div	Ref 10.00	dBm			Mkr3 2	Auto Tune	
Log 0.00 -10.0 -20.0						-20.95 dBm	Center Freq 17.500000000 GHz
-30.0 -40.0 -50.0					de presidente de la constance de		Start Freq 10.000000000 GHz
-60.0 -70.0 -80.0							Stop Freq 25.000000000 GHz
Start 10.0 #Res BW		#V	BW 3.0 MHz		Sweep 40	Stop 25.000 GHz .00 ms (40001 pts)	CF Step 1.50000000 GHz
MKR MODE TF	RC SCL	× 24.839 875 GHz	۲ -40.39 dBm	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Man
2 N 1 3 N 1 4 5	f	23.976 250 GHz 24.672 250 GHz	-40.80 dBm -41.25 dBm				Freq Offset 0 Hz
6 7 8 9 10							
<			Ш			×	
MSG					STATUS		



High Band-edge

Highest Channel & Modulation : 8DPSK



High Band-edge

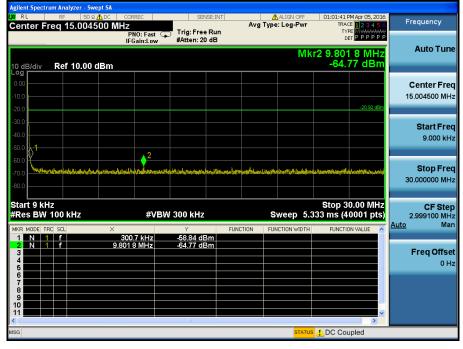
Hopping mode & Modulation : 8DPSK





Conducted Spurious Emissions

Highest Channel & Modulation : 8DPSK



Agilent Spectrum Analyzer - Sv X/ RL RF 509	wept SA Ω AC CORREC	SENSE:INT	ALIGN OFF	01:01:49 PM Apr 05, 2016	
Center Freq 5.0150		Trig: Free Run	Avg Type: Log-Pwr	TRACE 1 2 3 4 5 6	Frequency
	PNO: Fast G IFGain:Low	#Atten: 20 dB			Austa Tum
10 dB/div Ref 10.00	dBm		Mkr	5 6.361 70 GHz -49.48 dBm	Auto Tune
0.00	<u>\</u> 1				Center Free
10.0					5.015000000 GH
-20.0				-20.92 dBm	
-30.0					Start Fre
-40.0	/X <mark>12</mark>				30.000000 MH
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-70.0					10.000000000 GH
-80.0					
Start 30 MHz #Res BW 1.0 MHz	#VBV	V 3.0 MHz	Sweep 18	Stop 10.000 GHz 67 ms (40001 pts)	CF Stej 997.000000 MH
MKR MODE TRC SCL	×	Y	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Ma
1 N 1 f 2 N 1 f	2.479 88 GHz 3.260 03 GHz	-0.71 dBm -48.57 dBm			
3 N 1 f	6.262 75 GHz	-48.71 dBm			Freq Offse
4 N 1 f 5 N 1 f	3.173 79 GHz 6.361 70 GHz	-49.24 dBm -49.48 dBm		=	он
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8					
10					
<				×	
SG			STATUS		



Conducted Spurious Emissions

Highest Channel & Modulation : 8DPSK

Agilent Spectru IXI RL Cepter Fr	RF 50	wept SA Ω AC CORF 0000000 GI		SEN:	SE:INT	ALIGN OFF	TRAC	M Apr 05, 2016	Frequency
10 dB/div	Ref 10.00	PN IFG	0: Fast G ain:Low	Trig: Free #Atten: 20		 Mkr3 2	DI 24.879 2	50 GHz 99 dBm	Auto Tune
Log 0.00 -10.0 -20.0								-20.92 dBm	Center Freq 17.50000000 GHz
-30.0								2^{2}	Start Freq 10.000000000 GHz
-60.0									Stop Freq 25.00000000 GHz
Start 10.0 #Res BW	1.0 MHz	×		V 3.0 MHz Y		Weep 40	.00 ms (4	.000 GHz 0001 pts) IN VALUE	CF Step 1.500000000 GH: <u>Auto</u> Mar
1 N 1 2 N 1 3 N 1 4 5	f f f	24.614 875 24.002 500 24.879 250	GHz	-40.74 dB -40.99 dB -40.99 dB	m				Freq Offset 0 Hz
6 7 8 9 10									
K MSG				110		STATUS			



8. Transmitter AC Power Line Conducted Emission

8.1 Test Setup

Not Applicable

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 Limit (dBuV)				
Frequency hange (MHZ)	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

Not Applicable



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

The antenna is printed to the internal PCB (Refer to Internal Photo file.)

- 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

Refer to the APPENDIX I.

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

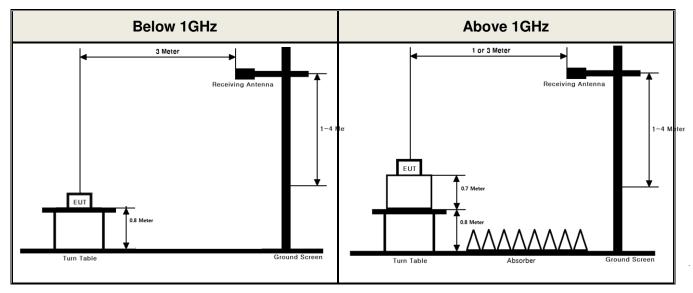
Not Applicable



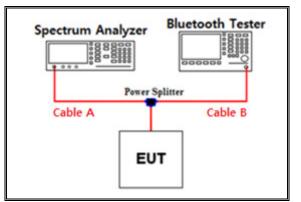
APPENDIX I

Test set up diagrams

Radiated Measurement



Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)	
0.03	6.36	15	9.16	
1	6.59	20	9.47	
2402 & 2440 & 2480	7.23	25	11.24	
5	8.13	-	-	
10	8.64	-	-	

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

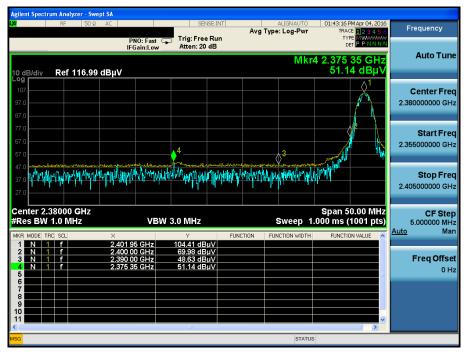
Path loss (S/A's Correction factor) = Cable A + Power splitter



APPENDIX II

Unwanted Emissions (Radiated) Test Plot

GFSK & Lowest & X & Hor



Detector Mode : AV

GFSK & Lowest & X & Hor





GFSK & Highest & X & Hor

Agilent Spectrum Analyzer - Swept SA					
LXI RF 50Ω AC	SENSE:INT	ALIGNAUTO C Avg Type: Log-Pwr	2:12:19 PM Apr 04, 2016 TRACE 1 2 3 4 5 6	Frequency	
PNO: Fast IFGain:Low 10 dB/div Ref 116.99 dBµV	Trig: Free Run Atten: 20 dB	Mkr3 2.4	түре Мулики рет Р Р N N N N 183 575 GHz 52.81 dBµV	Auto Tune	
Log 107 97.0 87.0				Center Freq 2.487500000 GHz	
77.0 67.0 57.0				Start Freq 2.475000000 GHz	
47.0 37.0 Hudener () Johnson J. Had Strand Andre () 27.0	nadiy taga liyinada taga kulaya	delikelindendendendendendende heler.	kinanteripi pelanski finatako	Stop Freq 2.500000000 GHz	
	Center 2.48750 GHz Span 25.00 MHz #Res BW 1.0 MHz VBW 3.0 MHz Sweep 1.000 ms (1001 pts)				
MKR MODE TRC SCL X	Y FUNCTI	ON FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man	
N 1 f 2.479 975 GHz 2 N 1 f 2.483 500 GHz 3 N 1 f 2.483 575 GHz 4 5 6 6	99.62 dBµV 53.03 dBµV 52.81 dBµV		H	Freq Offset 0 Hz	
6 7 8 9 10 11					
K MSG		STATUS			

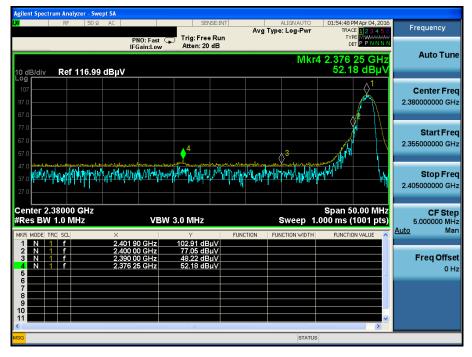
Detector Mode : AV

GFSK & Highest & X & Hor





$\pi/4DQPSK$ & Lowest & X & Hor



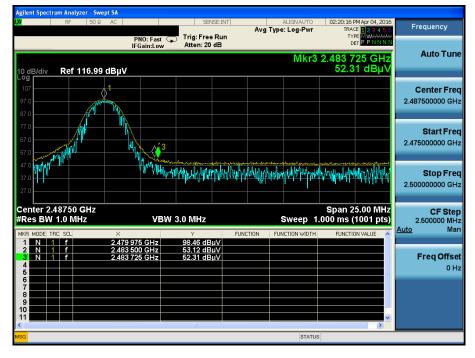
Detector Mode : AV

π/4DQPSK & Lowest & X & Hor





$\pi/4DQPSK$ & Highest & X & Hor



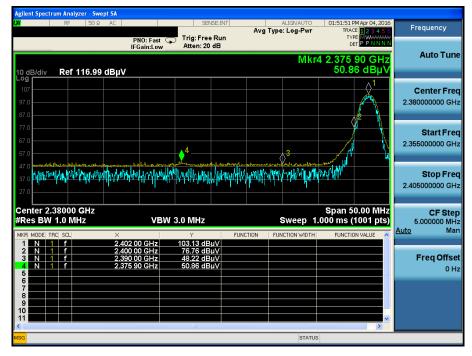
Detector Mode : AV

$\pi/4DQPSK$ & Highest & X & Hor





8DPSK & Lowest & X & Hor



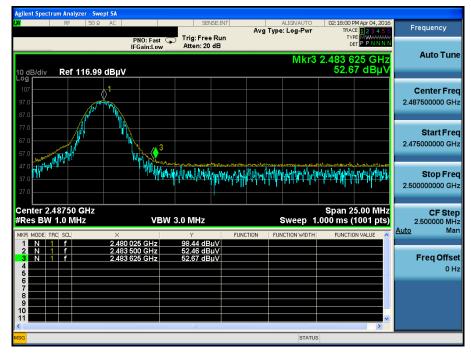
Detector Mode : AV

8DPSK & Lowest & X & Hor



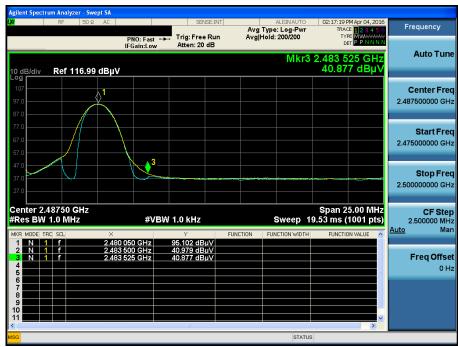


8DPSK & Highest & X & Hor



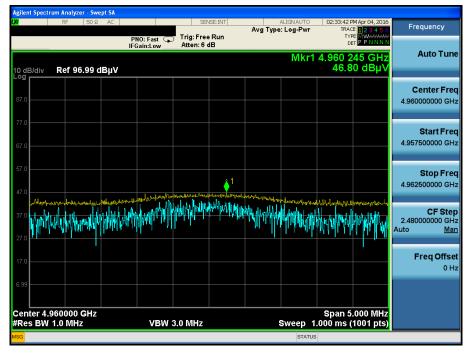
Detector Mode : AV

8DPSK & Highest & X & Hor





GFSK & Highest & X & Hor



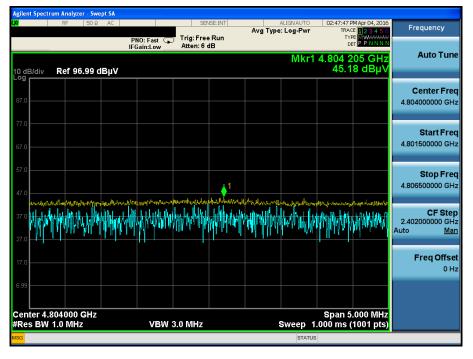
GFSK & Highest & X & Hor

nt Spectrum Analyzer - Swept SA Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 TYPE MW00000 DET P P N N N Trig: Free Run Atten: 6 dB PNO: Fast +++ Auto Tune Mkr1 4.960 010 GHz 38.195 dBµV Ref 96.99 dBµV I0 dB/div **Center Freq** 4.96000000 GHz Start Freq 4.957500000 GHz Stop Freq 4.962500000 GHz <mark>|</mark>1 CF Step 2.48000000 GHz Auto Man Freq Offset 0 Hz Center 4.960000 GHz #Res BW 1.0 MHz Span 5.000 MHz Sweep 3.933 ms (1001 pts) #VBW 1.0 kHz

Detector Mode : AV



$\pi/4DQPSK$ & Lowest & X & Hor



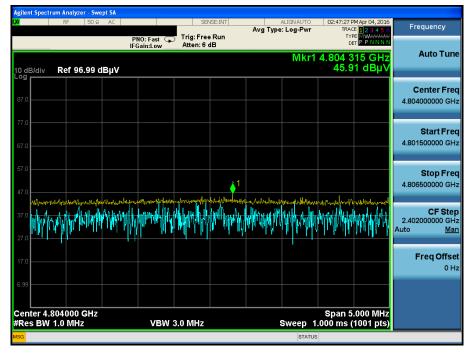
Detector Mode : AV

π/4DQPSK & Lowest & X & Hor





8DPSK & Lowest & X & Hor



Detector Mode : AV

8DPSK & Lowest & X & Hor

