

## TEST REPORT

100, Jangjateo-ro, Hobeop-myeon, Icheon-si, Gyeonggi-do, 17396, Korea Tel: 031-637-8898 / Fax: 0505-116-8895

1. Client					
• Name	:	Sena Technologies Co	o., Ltd.		
Address.	:	19, Heolleung-ro 569	-gil, Gangna	am-gu, Seoul, Korea	
2. Use of Report FCC Approval					
3. Sample Des	scription				
Product I	Name :	Wireless Communicat	ion Systems		
<ul> <li>Model Na</li> </ul>	ame:	SHARK MW			
4. Date of Rec	eipt:	2024-07-05			
5. Date of Tes	t:	2024-07-21 ~ 2024-	07-31		
6. Test Method	:	FCC Part 15 Subpart (	C 15.247		
7. Test Results	3 :	Refer to the test res	ults		
		port are the results of tes ording to the requirement			
Affirmation	Tested by	20	Technical I	Manager	
	Jong-Myoung	, Shin (Sign)	Kyung-Ta	aek, L <del>de (S</del> ign)	
				Aug 12, 2024	
EMC Labs Co., Ltd.					

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APPENDIX II UNCERTAINTY ······



# <u>Version</u>

TEST REPORT NO.	DATE	DESCRIPTION
KR0140-RF2408-003	Aug 12, 2024	Initial Issue

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## 1. Applicant & Manufacturer & Test Laboratory Information

#### 1.1 Applicant Information

Applicant	Sena Technologies Co., Ltd.
Applicant Address 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Korea	
Contact Person	Seunghyun Kim
Telephone No.	+82-2-573-7772
Fax No.	+82-2-573-7710
E-mail	shkim77@sena.com

### 1.2. Manufacturer Information

Manufacturer	Sena Technologies Co., Ltd.	
Manufacturer Address	19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Korea	

## 1.3 Test Laboratory Information

Laboratory	EMC Labs Co., Ltd.
Laboratory Address         100, Jangjateo-ro, Hobeop-myeon, Icheon-si, Gyeonggi-do, Rep Korea	
Contact Person	Jong-Myoung, Shin
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Fax No.	+82-505-116-8895
FCC Designation No.	KR0140
FCC Registration No.	580000
IC Site Registration No.	28751



## 2. Equipment under Test(EUT) Information

#### 2.1 General Information

Product Name	Wireless Communication Systems	
Model Name SHARK MW		
Variant Model Name	N-Com Mesh	
FCC ID	S7A-SP168	
Rated Voltage	DC 3.7 V	

#### 2.2 Additional Information

Operating Frequency	2 402 MHz ~ 2 480 MHz
Number of channel	79
Modulation Type	BDR Mode(GFSK), EDR Mode(Pi/4 DQPSK, 8DPSK)
Antenna Type	PCB Pattern Antenna
Antenna Gain	0.38 dBi
Firmware Version	1.0
Hardware Version	1.0
Test software	Lab Test Tool V2.9.1

#### 2.3 Test Frequency

Test mode	Test Frequency (MHz)				
	Low Frequency	Middle Frequency	High Frequency		
GFSK	2 402	2 480			
Pi/4 DQPSK	2 402 2 441 2 480				
8DPSK	2 402 2 441 2 480				

#### 2.4 Worst-Case

BDR	GFSK (DH5)
EDR	8DPSK (3-DH5)

Note: The power measurement has been conducted to determine the worst-case mode from all possible Combinations between available modulations, data rates.

#### 2.5 Mode of operation during the test

- The EUT continuous transmission mode during the test with set at Low Channel, Middle Channel, and High Channel. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, YZ, XZ planes.

#### 2.6 Modifications of EUT

- None

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## 3. Test Summary

Applied	FCC Rule	IC Rule	Test Items	Test Condition	Result
$\square$	15.203	-	Antenna Requirement		С
$\square$	15.247(a)	-	20 dB Bandwidth		С
$\square$	_	RSS GEN (6.7)	Occupied Bandwidth (99%)		С
$\square$	15.247(a)	RSS-247 (5.1)	Number of Hopping Frequencies		С
$\square$	15.247(a)	RSS-247 (5.1)	Time of Occupancy (Dwell Time)		С
$\square$	15.247(a)	RSS-247 (5.1)	Carrier Frequencies Separation		С
$\square$	15.247(b)	RSS-247 (5.4)	Peak Output Power		С
$\square$	15.247(d)	RSS-247 (5.5)	Conducted Spurious Emission		С
	15.247(d) 15.205 & 15.209	RSS-247 (5.5) RSS-GEN (8.9 & 8.10)	Radiated Spurious Emission	Radiated	С
	15.207	RSS-GEN (8.8)	Conducted Emissions	AC Line Conducted	С

<u>Note 1</u>: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

The sample was tested according to the following specification: ANSI C63.10:2013.

Compliance was determined by specification limits of the applicable standard according to customer requirements.



### 4. Used equipment on test

Description	Manufacturer	Model Name	Serial Name	Next Cal.
TEMP & HUMID CHAMBER	JFM	JFMA-001	20200929-01	2024.12.07
CONTROLLER	AMWON TECHNOLOGY	TEMI2500	S7800VK191 0707	2024.12.07
PSA SERIES SPECTRUM ANALYZER	AGILENT	E4440A	MY45304057	2024.12.08
MXG ANALOG SIGNAL GENERATOR	AGILENT	N5183A	MY50141890	2024.12.08
SYSTEM DC POWER SUPPLY	AGILENT	6674A	MY53000118	2024.12.11
VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	257524	2024.12.08
DIRECTIONAL COUPLER	AGILENT	773D	2839A01855	2024.12.08
ATTENUATOR	AGILENT	8493C	73193	2024.12.08
TERMINATIOM	HEWLETT PACKARD	909D	07492	2024.12.08
POWER DIVIDER	HEWLETT PACKARD	11636A	06916	2024.12.08
SLIDE-AC	DAEKWANG TECH	SV-1023	NONE	2024.11.10
DIGITAL MULTIMETER	HUMANTECHSTORE	15B+	50561541WS	2024.12.08
ATTENUATOR	ACE RF COMM	ATT SMA 20W 20dB 8GHz	A-0820.SM20.2	2025.04.04
DC POWER SUPPLY	AGILENT	E3634A	MY40012120	2025.02.22
USB Peak Power Sensor	Anritsu	MA24408A	12321	2024.11.09
High Pass Filter	WT Microwave INC.	WT-A3314-HS	WT22111804-1	2024.12.08
High Pass Filter	WT Microwave INC.	WT-A1935-HS	WT22111804-2	2024.12.08
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSU26	200444	2025.02.22
ATTENUATOR	Mini-Circuits	BW-K3-2W44+	2318-1	2025.06.28
ATTENUATOR	Mini-Circuits	BW-K3-2W44+	2318-2	2025.06.28
Balanced Temperature and Humidity Control System	ESPEC CORP.	SH-241	92004650	2025.06.13
ACTIVE LOOP ANTENNA	TESEQ	HLA 6121	55685	2024.12.22
Biconilog ANT	Schwarzbeck	VULB 9160	3260	2026.04.01
Biconilog ANT	Schwarzbeck	VULB9168	902	2024.11.30
Horn ANT	Schwarzbeck	BBHA9120D	974	2024.11.30
Horn ANT	Schwarzbeck	BBHA9120D	1497	2025.01.04
Amplifier	TESTEK	TK-PA18H	200104-L	2025.03.14
Horn ANT	Schwarzbeck	BBHA9170	01188	2025.03.19
Horn ANT	Schwarzbeck	BBHA9170	01189	2025.03.19
AMPLIFIER	TESTEK	TK-PA1840H	220105-L	2025.03.14
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	101952	2025.03.14
Test Receiver	ROHDE & SCHWARZ	ESR7	101616	2025.06.27
LISN	ROHDE & SCHWARZ	ENV216	100409	2025.01.04
PULSE LIMITER	lignex1	EPL-30	NONE	2025.01.04

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### 5. Antenna Requirement

According to §15.203 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 of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

According to §15.247(b)(4) e conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### 5.1 Result

#### Complies

(The transmitter has a PCB Pattern Antenna. The directional peak gain of the antenna is 0.38 dBi.)



## 6. 20 dB Bandwidth & Occupied Bandwidth (99%)

#### 6.1 Test Setup

Refer to the APPENDIX I.

### 6.2 Limit

Limit : Not Applicable

### 6.3 Test Procedure

- 1. The 20 dB bandwidth & Occupied bandwidth were measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
- 2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting:

RBW = 1% to 5% of the 20 dB Bandwidth & Occupied Bandwidth  $VBW \ge 3 \times RBW$ Span = between two times and five times the 20 dB Bandwidth & Occupied Bandwidth Sweep = Auto Detector function = Peak Trace = Max Hold

#### 6.4 Test Result

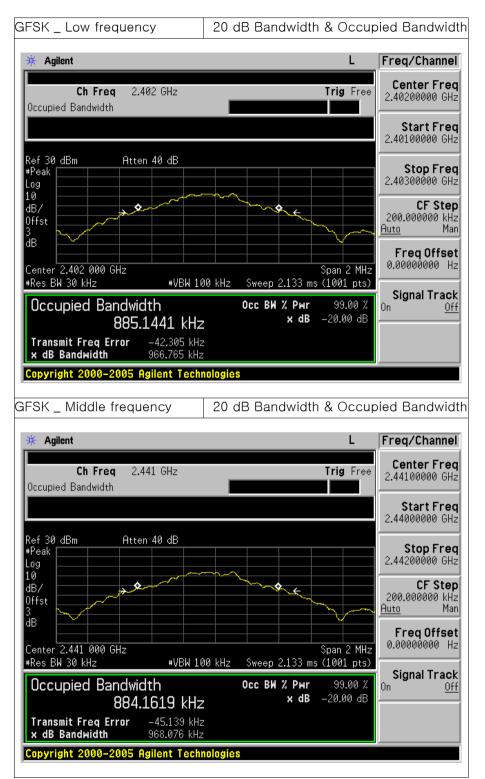
Test Mode	Test Frequency	20 dB Bandwidth (MHz)	Occupied Bandwidth (MHz)
	Low	0.967	0.885
GFSK	Middle	0.968	0.884
	High	0.968	0.884
	Low	1.277	1.155
8DPSK	Middle	1.277	1.156
	High	1.279	1.157

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#### 6.5 Test Plot



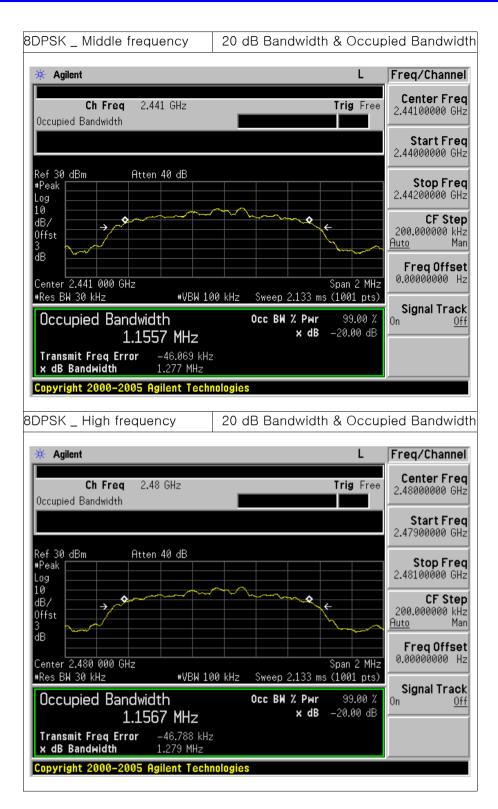
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## 7. Number of Hopping Frequencies

### 7.1 Test Setup

Refer to the APPENDIX I.

## 7.2 Limit

Limit : >= 15 hops

### 7.3 Test 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  $\sim$  2483.5 MHz were examined.

The spectrum analyzer is set to:

 Span = 50 MHz

 RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

 VBW ≥ RBW
 Sweep = Auto

 Detector = Peak
 Trace = Max hold

#### 7.4 Test Result

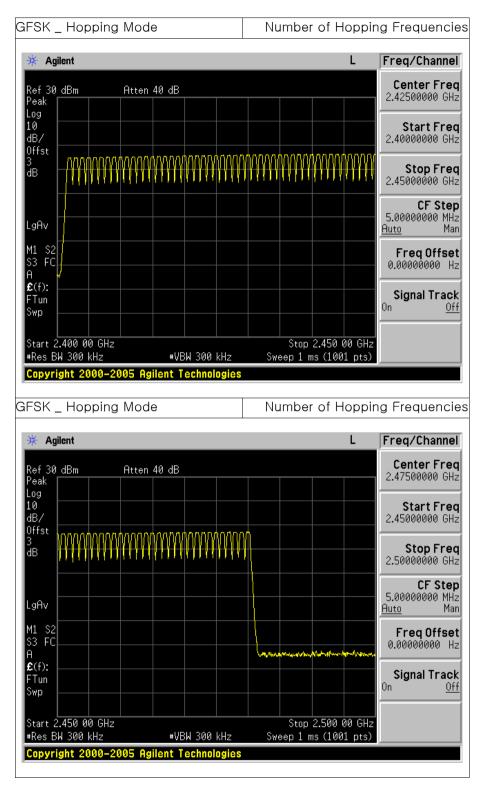
Test Mode	Number of Hopping Channels
GFSK	79
8DPSK	79

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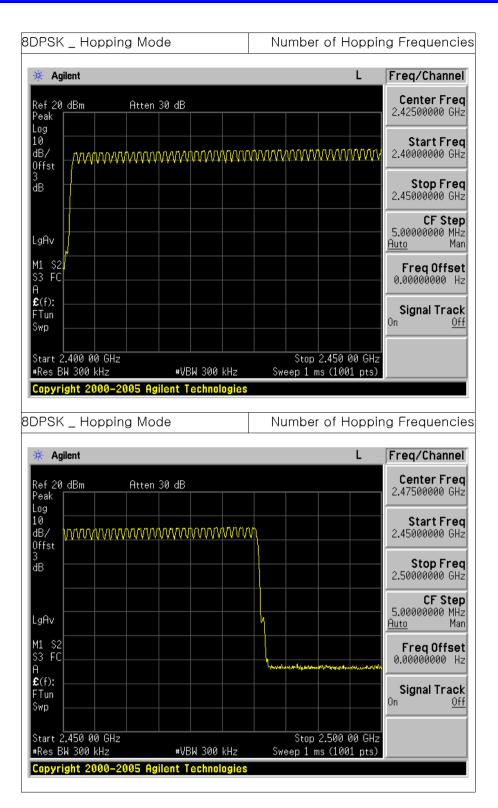


#### 7.5 Test Plot



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## 8. Time of Occupancy (Dwell Time)

#### 8.1 Test Setup

Refer to the APPENDIX I.

### 8.2 Limit

The maximum permissible time of occupancy is 400 ms within a period of 400 ms multiplied by the number of hopping channels employed.

#### 8.3 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 = Peak

Trace = Max hold
```

### 8.4 Test Result

Test Mode	Number of Hopping Channels	Burst On Time (ms)	Result (sec)	Limit (sec)
GFSK (non-AFH)	79	2.884	0.31	0.40
GFSK (AFH)	20	2.884	0.15	0.40
8DPSK (non-AFH)	79	2.876	0.31	0.40
8DPSK (AFH)	20	2.876	0.15	0.40

Note: Dwell Time = 0.4 x Hopping channel x Burst On Time x ((Hopping rate / Time slots) / Hopping channel)

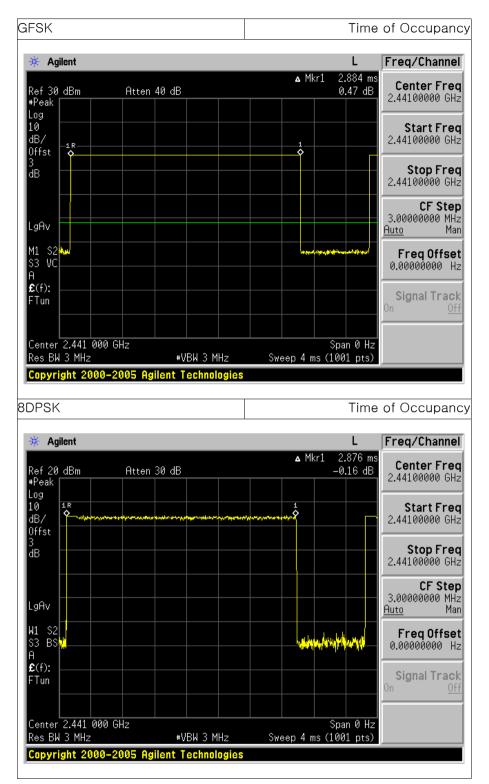
- Time slots for DH5 = 6 slots (TX = 5 slot / RX = 1 slot)

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





#### 8.5 Test Plot



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#### 9. Carrier Frequencies Separation

#### 9.1 Test Setup

Refer to the APPENDIX I.

#### 9.2 Limit

Limit :  $\geq$  25 kHz or  $\geq$  Two-Thirds of the 20 dB Bandwidth whichever is greater.

#### 9.3 Test Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

After the trace being stable, the reading value between the peaks of the adjacent channels using the marker delta function was recorded as the measurement results.

The spectrum analyzer is set to:

Span = wide enough to capture the peaks of two adjacent channelsRBW = Start with the RBW set to approximately 30% of the channel spacing; adjust asnecessary to best identify the center of each individual channel. $VBW \ge RBW$ Sweep = AutoDetector = PeakTrace = Max hold

Test Mode	Test Frequency	Carrier Frequencies Separation (MHz)	Min. Limit (MHz)
	Low	1.023	0.645
GFSK	Middle	0.981	0.645
	High	-1.002	0.645
	Low	0.999	0.851
8DPSK	Middle	1.002	0.851
	High	-0.999	0.853

#### 9.4 Test Result

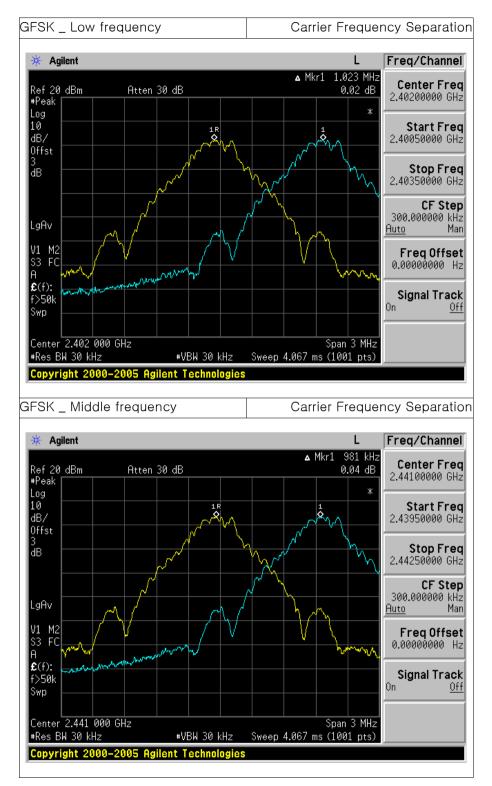
Note: Limit(kHz) = Test Result of 20 dB BW \* 2/3

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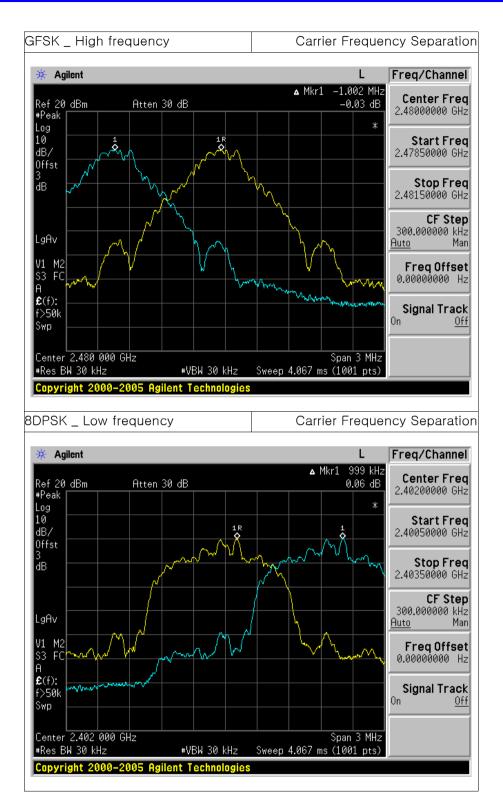


#### 9.5 Test Plot



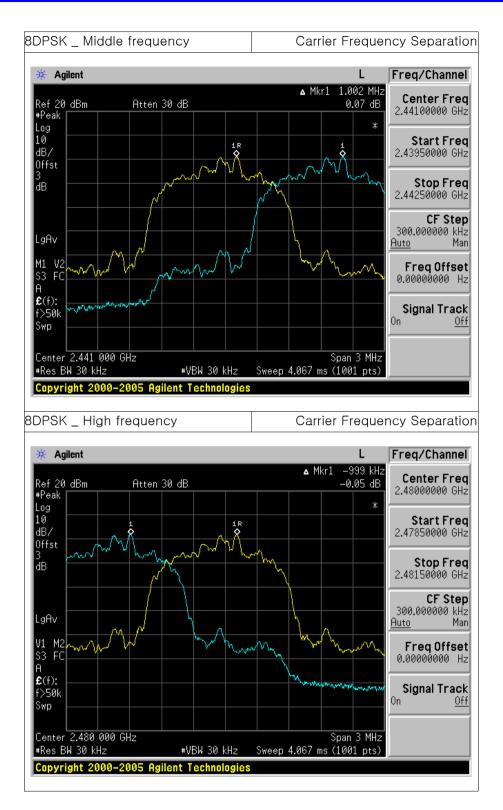
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#### 10. Peak Output Power

#### 10.1 Test Setup

Refer to the APPENDIX I.

#### 10.2 Limit

■ FCC Requirements

The maximum peak output power of the intentional radiator shall not exceed the following:

- §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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
- IC Requirements
- RSS-247(5.4) (b), 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, except as provided in section 5.4(e)

#### 10.3 Test Procedure

- 1. The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, a spectrum analyzer was used to record the shape of the transmit signal.
- 2. The peak output power of the fundamental frequency was measured with the spectrum analyzer using;

Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel

 $RBW \ge 20 dB Bandwidth$   $VBW \ge RBW$  Sweep = Auto Detector function = PeakTrace = Max Hold

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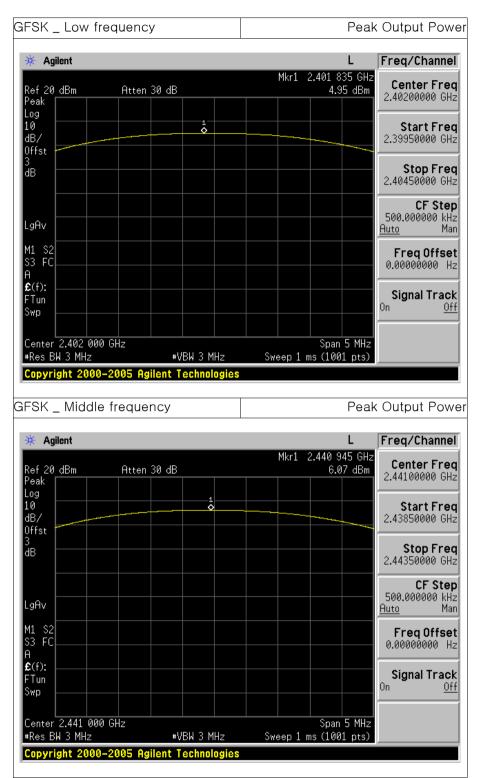
#### 10.4 Test Result

Test Mode	Test Frequency Peak Output Power		
Test Mode	rest Frequency	dBm	mW
	Low	4.95	3.13
GFSK	Middle	6.07	4.05
	High	6.72	4.70
	Low	2.96	1.98
Pi/4 DQPSK	Middle	4.11	2.58
	High	4.80	3.02
	Low	3.12	2.05
8DPSK	Middle	4.26	2.67
	High	4.91	3.10





#### 10.5 Test Plot



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	requency				Coutput Pov
Agilent				L	Freq/Channe
əf 20 dBm əak	Atten 30 d	B	Mkr1	2.480 015 GHz 6.72 dBm	Center Fre 2.48000000 GH
pg 3/ ifst		\$	·		<b>Start Fre</b> 2.47750000 GH
3					<b>Stop Fre</b> 2.48250000 GH
JAV					<b>CF Ste</b> 500.000000 kH <u>Auto</u> Ma
L S2 3 FC					<b>Freq Offse</b> 0.00000000 +
(f): Tun 1/p					<b>Signal Trac</b> On <u>O</u>
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Res BW 3 MHz		#VBW 3 MHz	Sweep 1 r	ns (1001 pts)	
Agilent			Mler 1	L 2.401 805 GHz	Freq/Channe
əf 20 dBm əak og	Atten 30 d	B		2.401 805 GHz 2.96 dBm	Center Fre 2.40200000 GH
)		1			
3/ Fst		1 <b>♦</b>			
3/ ifst		•         •			Start Fre 2.39950000 GH Stop Fre 2.40450000 GH
3/ ifst 3					2.39950000 GH
3/ ifst 3 gAv 1 \$2 3 FC					2.39950000 GH Stop Fre 2.40450000 GH CF Ste 500.000000 kH
3/ ifst 3 IAV					2.39950000 GH Stop Fre 2.40450000 GH CF Ste 500.000000 KH <u>Auto</u> Ma Freq Offse

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4 DQPSK _	Middle frequ	ency		Peal	< Output Pow
Agilent				L	Freq/Channe
ef 20 dBm eak	Atten 30 dB		Mkr1	2.440 795 GHz 4.11 dBm	Center Fred 2.44100000 GH:
og 0 B/		1 <b>♦</b>			Start Fred 2.43850000 GH:
ffst B					Stop Free 2,44350000 GH
gAv					CF Step 500.000000 kH: Auto Ma
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onvright 2000	-2005 Agilent T	echnologies			_
opyright 2000	Loop Hynent I	Connerogree			
	High frequer			Peal	< Output Pow
4 DQPSK _					
4 DQPSK _			Mkr1	L	Freq/Channe
4 DQPSK _ ♦ <b>Agilent</b> ef 20 dBm eak			Mkr1		Freq/Channe Center Free
4 DQPSK _ Agilent ef 20 dBm eak og 0 B/	High frequer		Mkr1	<b>L</b> 2.479 940 GHz	Freq/Channe Center Free 2.48000000 GH Start Free
4 DQPSK _ <b>Agilent</b> ef 20 dBm eak og 8 B/ ffst	High frequer		Mkr1	<b>L</b> 2.479 940 GHz	Freq/Channe Center Fred 2.48000000 GH Start Fred 2.47750000 GH Stop Fred
4 DQPSK _ <b>Agilent</b> ef 20 dBm eak og B/ ffst B	High frequer		Mkr1	<b>L</b> 2.479 940 GHz	Freq/Channe Center Free 2.48000000 GH: Start Free 2.47750000 GH: Stop Free 2.48250000 GH: CF Step 500.000000 kH:
4 DQPSK _ ★ Agilent ef 20 dBm eak bg 0 B/ ffst B gAv 1 S2 3 FC	High frequer		Mkr1	<b>L</b> 2.479 940 GHz	Freq/Channe Center Fred 2.48000000 GH: Start Fred 2.47750000 GH: Stop Fred 2.48250000 GH: CF Step 500.000000 kH: <u>Auto</u> Ma Freq Offse
4 DQPSK _ Agilent ef 20 dBm eak bg ffst B ffst a gAv 1 S2 3 FC (f): Tun	High frequer		Mkr1	<b>L</b> 2.479 940 GHz	Freq/Channel           Center Freq           2.48000000 GH           Start Freq           2.47750000 GH           Stop Freq           2.48250000 GH           CF Stej           500.000000 kH           Auto           Freq Offse           0.0000000 H           Signal Track
4 DQPSK _	High frequen			<b>L</b> 2.479 940 GHz	Center Free           2.48000000 GH:           Start Free           2.47750000 GH:           Stop Free           2.48250000 GH:           CF Step           500.0000000 kH:           Auto           Freq Offse:           0.00000000 H:           Signal Track           On           On

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PSK _ Low					-
Agilent				L	Freq/Channe
əf 20 dBm əak	Atten 30 dB		Mkr1	2.401 830 GHz 3.12 dBm	Center Fre 2.40200000 GH
1g ) 3/					<b>Start Fre</b> 2.39950000 GH
ifst					<b>Stop Fre</b> 2.40450000 GH
ıΑv					<b>CF Ste</b> 500.000000 kH Auto Ma
L S2 3 FC					Freq Offse 0.00000000 +
(f):					<b>Signal Trac</b> On <u>O</u>
enter 2.402 000	ð GHz			Span 5 MHz	
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opyright 2000	*\ -2005 Agilent 1	Technologies		Peal L	Freq/Channe
p <b>yright 2000</b> PSK <u>Midd</u> <b>Agilent</b>	*\ -2005 Agilent 1	<b>Technologies</b>		Peal	Freq/Channe Center Fre
ppyright 2000 PSK _ Midd Agilent 20 dBm 20 dBm 3/	# -2005 Agilent T le frequency	<b>Technologies</b>		Peal L 2.440 845 GHz	Freq/Channe Center Fre 2.44100000 GH Start Fre
PSK _ Midd Agilent 20 dBm 20 dBm 20 dBm 20 dBm 20 dBm 21 dBm 23 dBm 24 dBm 25 dBm 26 dBm 27 dBm 28 dBm 29 dBm 29 dBm 20 dBm 2	# -2005 Agilent T le frequency	<b>Fechnologies</b>		Peal L 2.440 845 GHz	Freq/Channe
PSK _ Midd PSK _ Midd Agilent 9 9 9 1 9 1 9 1 1 9 1 1 9 1 1 9 1	# -2005 Agilent T le frequency	<b>Fechnologies</b>		Peal L 2.440 845 GHz	Freq/Channe Center Fre 2.44100000 GH Start Fre 2.43850000 GH Stop Fre
p <b>yright 2000</b> PSK <u>Midd</u> <b>Agilent</b>	# -2005 Agilent T le frequency	<b>Fechnologies</b>		Peal L 2.440 845 GHz	Freq/Channe Center Fre 2.44100000 GH Start Fre 2.43850000 GH Stop Fre 2.44350000 GH CF Ste 500.000000 kH
Agilent           PSK _ Midd           Agilent	# -2005 Agilent T le frequency	<b>Fechnologies</b>		Peal L 2.440 845 GHz	Freq/Channel           Center Fre           2.44100000 GH           Start Fre           2.43850000 GH           Stop Fre           2.44350000 GH           CF Ste           500.000000 KH           Auto           Freq Offse           0.0000000 H           Signal Trace
Spyright         2000           PSK Midd         Agilent           Agilent	+ -2005 Agilent 1 le frequency Atten 30 dB 	<b>Fechnologies</b>		Peal L 2.440 845 GHz 4.26 dBm	Freq/Channel           Center Fre           2.44100000 GH           Start Fre           2.43850000 GH           Stop Fre           2.44350000 GH           CF Ste           500.000000 kH           Auto           Freq Offse           0.00000000 H           Signal Trac           On         0
PSK _ Midd PSK _ Midd Agilent f 20 dBm bak ifst jfst jfst jfv L S2	+ -2005 Agilent 1 le frequency Atten 30 dB 	<b>Fechnologies</b>	Mkr1	Peal L 2.440 845 GHz	Freq/Channel           Center Fre           2.44100000 GH           Start Fre           2.43850000 GH           Stop Fre           2.44350000 GH           CF Ste           500.000000 kH           Auto           Freq Offse           0.00000000 H           Signal Trac           On         0

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BDPSK _ High freque	ncy	Peak	Cutput Powe
* Agilent		L	Freq/Channel
	n 30 dB	Mkr1 2.479 930 GHz 4.91 dBm	Center Freq 2.4800000 GHz
Peak Log 10			Start Freq
dB/ Offst	<b>◇</b>		2.47750000 GHz
3 dB			<b>Stop Freq</b> 2.48250000 GHz
LgAv			<b>CF Step</b> 500.000000 kHz <u>Auto</u> Man
M1 S2 S3 FC A			FreqOffset 0.00000000 Hz
£(f): FTun Swp			<b>Signal Track</b> On <u>Off</u>
Center 2.480 000 GHz #Res BW 3 MHz	#VBW 3 MHz	Span 5 MHz Sweep 1 ms (1001 pts)	
Copyright 2000-2005 A	gilent Technologies		

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## 11. TX Radiated Spurious Emission and Conducted Spurious Emission

### 11.1 Test Setup

Refer to the APPENDIX I.

### 11.2 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

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				

radiator shall not exceed the field strength levels specified in the following table

\*\* 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.

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According to § 15.205(a) and (b), only spurious emissions are permitted in any of The frequency bands listed below:

MHz	MHz	GHz
16.42 ~ 16.423	399.90 ~ 410	4.5 ~ 5.15
16.69475 ~ 16.69525	608 ~ 614	5.35 ~ 5.46
16.80425 ~ 16.80475	960 ~ 1240	7.25 ~ 7.75
25.5 ~ 25.67	1300 ~ 1427	8.025 ~ 8.5
37.5 ~ 38.	1435 ~ 1626.5	9.0 ~ 9.2
25 73 ~ 74.6	1645.5 ~ 1646.5	9.3 ~ 9.5
74.8 ~ 75.2	1660 ~ 1710	10.6 ~ 12.7
108 ~ 121.94	1718.8 ~ 1722.2	13.25 ~ 13.4
149.9 ~ 150.05	2200 ~ 2300	14.47 ~ 14.5
156.52475 ~ 156.52525	2310 ~ 2390	15.35 ~ 16.2
156.7 ~ 156.9	2483.5 ~ 2500	17.7 ~ 21.4
162.0125 ~ 167.17	2690 ~ 2900	22.01 ~ 23.12
3345.8 ~ 3358	3260 ~ 3267	23.6 ~ 24.0
3600 ~ 4400	3332 ~ 3339	31.2 ~ 31.8
3345.8 ~ 3358	240 ~ 285	36.43 ~ 36.5
3600 ~ 4400	322 ~ 335.4	Above 38.6
	$\begin{array}{r} \mbox{MHz} \\ 16.42 ~ 16.423 \\ 16.69475 ~ 16.69525 \\ 16.80425 ~ 16.80475 \\ 25.5 ~ 25.67 \\ 37.5 ~ 38. \\ 25 73 ~ 74.6 \\ 74.8 ~ 75.2 \\ 108 ~ 121.94 \\ 149.9 ~ 150.05 \\ 156.52475 ~ 156.52525 \\ 156.7 ~ 156.9 \\ 162.0125 ~ 167.17 \\ 3345.8 ~ 3358 \\ 3600 ~ 4400 \\ 3345.8 ~ 3358 \end{array}$	MHzMHz16.42 ~ 16.423399.90 ~ 41016.69475 ~ 16.69525608 ~ 61416.80425 ~ 16.80475960 ~ 124025.5 ~ 25.671300 ~ 142737.5 ~ 38.1435 ~ 1626.525 73 ~ 74.61645.5 ~ 1646.574.8 ~ 75.21660 ~ 1710108 ~ 121.941718.8 ~ 1722.2149.9 ~ 150.052200 ~ 2300156.52475 ~ 156.525252310 ~ 2390156.7 ~ 156.92483.5 ~ 2500162.0125 ~ 167.172690 ~ 29003345.8 ~ 33583260 ~ 32673600 ~ 44003332 ~ 33393345.8 ~ 3358240 ~ 285

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.



#### 11.3 Test Procedure for Radiated Spurious Emission

- 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 3.75 meter away from the interference-receiving antenna.
- 3. For measurements above 1 GHz 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.
- 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.
   (The EUT was pre-tested with three axes (X, Y, Z) and the final test was performed at the worst case.)
- 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.

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#### Measurement Instrument Setting

- Frequency Range: Below 1 GHz RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak
- Frequency Range: Above 1 GHz
   Peak Measurement
   RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Average Measurement RBW = 1MHz, VBW ≥ 1/T, Detector = Peak, Sweep Time = Auto, Trace Mode = Max Hold until the trace stabilizes

#### 11.4 Test Procedure for Conducted Spurious Emission

- 1. The transmitter output was connected to the spectrum analyzer.
- The reference level of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 kHz, VBW = 300 kHz.
- The conducted spurious emission was tested each ranges were set as below. Frequency range: 30 MHz ~ 26.5 GHz RBW = 100 kHz, VBW = 300 kHz, Sweep Time = Auto, Detector = Peak, Trace = Max Hold

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



#### 11.5 Test Result

### 9 kHz ~ 25 GHz Data (Modulation: GFSK)

#### • Low frequency

Fraguanav	Rea	ding		<b></b>	0.005	Lin	nits	Re	sult	Mai	rgin
Frequency	(dBu	V/m)	Pol.	T.F (dB)	DCCF (dB)	(dBu	iV/m)	(dBu	iV/m)	(d	В)
(MHz)	AV / Peak				(dB) (dB)	AV /	Peak	AV /	Peak	AV /	Peak
2 389.80	N/A	30.93	Н	9.00	-24.78	54.0	74.0	15.2	39.9	38.8	34.1
4 803.78	N/A	44.50	V	-0.92	-24.78	54.0	74.0	18.8	43.6	35.2	30.4

#### Middle frequency

Fraguanay	Rea	ding		<b></b>	0.005	Limits		Result		Margin					
Frequency	(dBu	V/m)	Pol.	T.F (dB)	DCCF (dB)	(dBu	iV/m)	(dBu	V/m)	(d	В)				
(MHz)	AV ,	/ Peak		(00)	(00)	AV / Peak		AV / Peak		AV / Peak		AV /	Peak	AV /	Peak
4 882.04	N/A	44.64	V	-0.95	-24.78	54.0	74.0	18.9	43.7	35.1	30.3				

#### • High frequency

Fraguanay	Rea	ding		<b></b>	0.005	Lin	nits	Re	sult	Mai	rgin		
Frequency	(dBu	V/m)	Pol. T.F (dB)	DCCF (dB)	(dBuV/m)		(dBuV/m)		(dB)				
(MHz)	AV ,	/ Peak		(00)			AV / Peak				Peak	AV /	Peak
2 483.66	N/A	38.26	Н	9.84	-24.78	54.0	74.0	23.3	48.1	30.7	25.9		
4 959.69	N/A	44.57	V	-0.82	-24.78	54.0	74.0	19.0	43.8	35.0	30.3		

Note 1: The radiated emissions were inverstigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: DCCF(Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.884 ms - 100 ms /  $\Delta t$  [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.884 X 20) = 1.73

≒ 2

- The Worst Case Dwell Time = T [ms] x H' = 2.884 ms X 2 = 5.77 ms

- DCCF = 20 x log(The Worst Case Dwell Time / 100 ms) dB = 20 x log( 5.77 / 100 ) = -24.78 dB

Note 3: Sample Calculation.

Margin = Limit - Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF TF = Ant factor + Cable Loss + Filter Loss - Amp Gain + Distance Factor

Distance Factor = 20log(applied distance/required distance) = 20log(3.75m/3m) = 1.94



#### 9 kHz ~ 25 GHz Data (Modulation: 8DPSK)

#### • Low frequency

Fraguanay	Rea	ding			0.005	Lin	nits	Re	sult	Mai	rgin
Frequency	(dBu	V/m)	Pol. T.F (dB)	DCCF (dB)	(dBuV/m)		(dBuV/m)		(dB)		
(MHz)	AV ,	/ Peak		(00)	(00)	AV / Peak		AV /	Peak	AV /	Peak
2 389.96	N/A	31.18	Н	9.00	-24.80	54.0	74.0	15.4	40.2	38.6	33.8
4 803.92	N/A	43.79	V	-0.92	-24.80	54.0	74.0	18.1	42.9	35.9	31.1

#### Middle frequency

	Rea	ding				Limits		Result		Margin	
Frequency	(dBu	(dBuV/m)		T.F (dB)	DCCF (dB)	(dBu	IV/m)	(dBu	IV/m)	(d	B)
(MHz)	AV ,	/ Peak		(00)	AV / Peak		AV / Peak		AV / Peak		
4 882.05	N/A	45.03	V	-0.95	-24.80	54.0	74.0	19.3	44.1	34.7	29.9

#### • High frequency

Frequency	Rea	ding		<b></b>	2225	Lin	nits	Re	sult	Mai	rgin
Frequency	(dBu	V/m)	Pol. T.F (dB)		(dBuV/m)		(dBuV/m)		(dB)		
(MHz)	AV /	/ Peak					AV /	Peak			
2 483.92	N/A	38.70	Н	9.84	-24.80	54.0	74.0	23.7	48.5	30.3	25.5
4 959.98	N/A	44.36	V	-0.82	-24.80	54.0	74.0	18.7	43.5	35.3	30.5

Note 1: The radiated emissions were inverstigated 9 kHz to 25 GHz.

Note 2: DCCF(Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels, where T = pulse width = 2.876 ms - 100 ms /  $\Delta t$  [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.876 X 20) = 1.74  $\approx 2$ 

- The Worst Case Dwell Time = T [ms] x H' = 2.876 ms X 2 = 5.75 ms

- DCCF =  $20 \times \log(\text{The Worst Case Dwell Time / 100 ms}) dB = <math>20 \times \log(5.75 / 100) = -24.80 dB$ Note 3: Sample Calculation.

Margin = Limit - Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF

TF = Ant factor + Cable Loss + Filter Loss - Amp Gain + Distance Factor

Distance Factor = 20log(applied distance/required distance) = 20log(3.75m/3m) = 1.94

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### 11.6 Test Plot for Radiated Spurious Emission

#### • GFSK \_ Low frequency

						F	lestricte	ed Banc	d - Peak
MultiView 🗄	Spactrum	Spectrur	n 2 🕱	Spectrum 3	X Spectru	um 4 🕱	1		
Ref Level 97	7.00 dBµV	• RBV	V 1 MHz		Specif	4 La	[	2.21	
<ul> <li>Att Input</li> <li>1 Frequency S</li> </ul>	1 AC PS	1.01 ms ⊕ VBV On Not	ch Off	e Auto Sweep			Fre	equency 2.35	• 1Pk Max
								M1[1]	
90 dBµV									.3898000 GHZ
80 dBµV									
70 dBµV									
60 dBµV									
50 dBµV									
40 dBµV									
									MI
30 dBµV	aborer thank	a when when the	here the realized by	no ano have	walkharden	Laboration	a have a hallow have	manpalamenal	Marrie With Marrielle
20 dBµV									
10 dBµV									
0 dBµV									
2.31 GHz			1001 pt:	s	8	.0 MHz/			2.39 GHz
							C	Spuriou	s – Peak
	Spectrum		ectrum 2	X Spectr	um 3 🛛 🛛				
Ref Level 97 Att	0 dB SWT	1.01 ms 🖷 VBV	V 1 MHz V 3 MHz Mode	e Auto Sweep			Fre	equency 4.80	40000 GHz
Input 1 Frequency S	1 AC PS Sweep	On Not					1	M1[1]	• 1Pk Max
90 dBµV								M1[1] 4.	44.50 dBμV 80378000 GHz
80 dBµV									
70 dBµV									
60 dBµV									
50 dBµV									
				MI	all and allowed				
40 dBUV	Marth Warder	and all and a second	Who Armen	and the second s	- whallweldy	monter	and the second	mutaheath	www.www.
30 dBµV									
20 dBµV									
10 dBµV									
о dbµV			1001 pt:			.0 MHz/			pan 10.0 MHz

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#### • GFSK \_ Middle frequency

			9	Spurious - Pea
MultiView 🗄 Spectrum 🛛 🕱	pectrum 2 🕱 Spec	trum 3 🕅		$\nabla$
Ref Level         97.00 dBµV         RE           Att         0 dB         SWT 1.01 ms         VE           Input         1 AC         PS         On         No	W 3 MHz Mode Auto Sweep		Fre	equency 4.8820000 GHz
1 Frequency Sweep				<ul> <li>1Pk Max</li> <li>M1[1] 44.64 dBµV</li> <li>4.88204000 GHz</li> </ul>
30 dBµV				
70 dBµV				
50 dBµv				
50 dBµV		11		
to den water and the second of the second	Aprilia house in a furning	- how when when	an manager	www.willianter.
10 dBµV				
10 dBµV				
.0 dBµV				
CF 4.882 GHz	1001 pts	1.0	MHz/	Span 10.0 MHz

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#### • GFSK \_ High frequency

						H	lestricte	ed Banc	
MultiView 🗄	Spectrum	Spectrur	m 2 🕱	Spectrum 3	X Spectru	um 4 🕅 🕱			_ ▽
Ref Level 97 Att			V 1 MHz	e Auto Sweep			Fre	equency 2.49	17500 GHz
Input 1 Frequency S	1 AC PS	On Not	ch Off						• 1Pk Max
90 dBµV							~	1[1] 2	38.26 dBµV .4836570 GHz
80 dBµV									
70 dBµV									
60 dBµV									
50 dBµV									
M1 an ar									
40 dBµV	- Maryan where	and the property	Problem March 19	warmupper					
30 dBµV				a sa sa sa sa chikina.	"lat-whyle.why	what you are	n day to a first of the second of the second se	when had some of the	hendlyhnandra
20 dBµV									
10 dBµV									
0 dBµV									
2.4835 GHz	1	1	1001 pt	S.	1.	.65 MHz/			2.5 GHz
							ç	Spurious	s – Peak
MultiView	Spectrum	x Sp	ectrum 2	X Spectr		<u>,</u>			
Ref Level 97	- spectrum			A Specu					~
	.00 dBµV	• RBV	¥ 1 MHz ¥ 3 MHz Mod		um 3 🛛 🏾	<u>,</u>	Fee		▼ 00000 CH-
Input 1 Frequency S	0 dB SWT 1 AC PS	• RBV	V 3 MHz Mod		um 3 2	<u>,</u>	Fre	equency 4.96	
1 Frequency S	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod		um 3 (x		Fre	M1[1]	600000 GHz
	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod		um 3 2		Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod		um 3 2		Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod		um 3 2		Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod		um 3 (2		Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod				Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S 90 d8μν 80 d8μν 70 d8μν	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod				Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S           90 d8μν           80 d8μν           70 d8μν           60 d8μν           50 d8μν	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod				Fre	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S           90 d8μν           80 d8μν           70 d8μν           60 d8μν           50 d8μν	0 dB SWT 1 AC PS	• RBV 1.01 ms • VBV	V 3 MHz Mod Off			the forestore store	Fr.	M1[1]	000000 GHz • 1Pk Max 44.57 dBμV
1 Frequency S           90 d8μν           80 d8μν           70 d8μν           60 d8μν           50 d8μν	0 dB SWT 1AC PS weep	RBV 1.01 ms • VBV On Not	V 3 MHz Mod Off					M1[1] 4.	000000 GHz 1Pk Max 44.57 dBµV 95969000 GHz
1 Frequency S 90 dвµV — 80 dвµV — 70 dвµV — 60 dвµV — 50 dвµV — 40 dвµV — 30 dвµV —	0 dB SWT 1AC PS weep	RBV 1.01 ms • VBV On Not	V 3 MHz Mod Off		um 3 (2			M1[1] 4.	000000 GHz 1Pk Max 44.57 dBµV 95969000 GHz
1 Frequency S           90 d8μν           80 d8μν           70 d8μν           60 d8μν           50 d8μν           40 d8μν	0 dB SWT 1AC PS weep	RBV 1.01 ms • VBV On Not	V 3 MHz Mod Off					M1[1] 4.	000000 GHz 1Pk Max 44.57 dBµV 95969000 GHz
1 Frequency S           90 dвµv           80 dвµv           70 dвµv           60 dвµv           50 dвµv           40 dвµv           30 dвµv	0 dB SWT 1AC PS weep	RBV 1.01 ms • VBV On Not	V 3 MHz Mod Off					M1[1] 4.	000000 GHz 1Pk Max 44.57 dBµV 95969000 GHz
1 Frequency S           90 dвµv           80 dвµv           70 dвµv           60 dвµv           50 dвµv           40 dвµv           30 dвµv           20 dвµv	0 dB SWT 1AC PS weep	RBV 1.01 ms • VBV On Not	V 3 MHz Mod Off					M1[1] 4.	000000 GHz 1Pk Max 44.57 dBµV 95969000 GHz

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# • 8DPSK \_ Low frequency

						R	estricte	ed Banc	і – Реак
MultiView 🕀	Spectrum	Spectrur	n 2 🕱	Spectrum 3	X Spectru	um 4 🕅 🕱			_ ▽
Ref Level 97 Att	7.00 dBµV	● RBV 1.01 ms ● VBV	/ 1 MHz	e Auto Sweep			Fre	equency 2.35	00000 GHz
Input 1 Frequency S	1 AC PS	On Note	sh Off						• 1Pk Max
90 dBµV								M1[1]	31.18 dBµV .3899600 GHz
80 dBµV									
70 dBµV									
60 dBµV									
50 dBµV									
40 dBµV									MI
30 dBµV	mmmhh	the second second	فالمعسر ف					معصاد وروار الم	marmelyer
20 dBµV	a war and a faith	enerater) Ann chaile an fha	Construct a construint	Mallan and Charley	an a	an share and a factor	when a first set of a set of a		
20 0004									
10 dBµV									
0 dBµV									
2.31 GHz			1001 pt	s	8	.0 MHz/			2.39 GHz
							S	Spuriou	s – Peak
	~					-			
Ref Level 97	Spectrum		ectrum 2	X Spectr	um 3 🛛 🛛	Z			~
Att Input			/ 1 MHz			-A			
	0 dB SWT 1 AC PS	● RBW 1.01 ms ● VBW On Note	/ 1 MHz / 3 MHz Mode ch Off	e Auto Sweep			Fre	equency 4.80	40000 GHz
1 Frequency S	0 dB SWT 1 AC PS	● RB¥ 1.01 ms ● VBW On Note	V 1 MHz V 3 MHz Modu sh Off	e Auto Sweep			Fre	M1[1]	• 1Pk Max • 1Pk Max 43.79 dBµV
	0 dB SWT 1 AC PS	I.01 ms = VBW On Note	V 1 MHz V 3 MHz Mode ch Off	e Auto Sweep			Fre	M1[1]	40000 GHz
1 Frequency S	0 dB SWT 1 AC PS	1.01 ms = VBW On Note	/ 1 MHz / 3 MHz Mod/ ch Off	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	1.01 ms = VBW On Note	/ 1 MHz Mode / 3 MHz Mode ch Off	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	1.01 ms = VBW On Not	/ 1 MHz Mode / 3 MHz Mode ch Off	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 dBµV	0 dB SWT 1 AC PS	1.01 ms = VBW On Note	/ 1 MHz Mod 3 MHz Mod	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 d8μν 80 d8μν 70 d8μν	0 dB SWT 1 AC PS	1.01 ms = VBW On Not	/ 1 MHz Mod 3 MHz Mod	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 dBµV 80 dBµV 70 dBµV 60 dBµV	0 dB SWT 1 AC PS	1.01 ms = VBW On Note	/ 1 MHz Mod 3 MHz Mod ch Off	e Auto Sweep			Fre	M1[1]	40000 GHz ● 1Pk Max 43.79 dBµV
1 Frequency S 90 dBµV 80 dBµV 70 dBµV 60 dBµV	0 dB SWT 1AC PS Sweep	1.01 ms = VBW On Not	1 MHz Mod 3 MHz Mod ch Off	e Auto Sweep	and the second second			M1[1]	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz
1         Frequency S           90         dBµV           80         dBµV           70         dBµV           60         dBµV           50         dBµV	0 dB SWT 1AC PS Sweep	1.01 ms + VBW On Note	y 1MHz Mod 3 MHz Mod ch Off	e Auto Sweep		Construction of the Constr		M1[1] 4.	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz
1 Frequency S 90 dBµV	0 dB SWT 1AC PS Sweep	1.01 ms + VBW On Note	, 1 MHz Mod 3 MHz Mod th Off	e Auto Sweep	en de la deserve de la des			M1[1] 4.	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz
1 Frequency S 90 dBµV	0 dB SWT 1AC PS Sweep	1.01 ms + VBW On Note	1 MHZ Mod 3 MHZ Mod ch Off	e Auto Sweep				M1[1] 4.	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz
<ol> <li>Frequency S</li> <li>90 dвµv</li> <li>80 dвµv</li> <li>70 dвµv</li> <li>60 dвµv</li> <li>50 dвµv</li> <li>40 dвµv</li> <li>30 dвµv</li> </ol>	0 dB SWT 1AC PS Sweep	1.01 ms + VBW On Note	1 MHz Mod 3 MHz Mod	e Auto Sweep		Van Calendary		M1[1] 4.	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz
<ol> <li>Frequency S</li> <li>90 dвµv</li> <li>80 dвµv</li> <li>60 dвµv</li> <li>60 dвµv</li> <li>50 dвµv</li> <li>40 dвµv</li> <li>30 dвµv</li> <li>20 dвµv</li> </ol>	0 dB SWT 1AC PS Sweep	1.01 ms + VBW On Note	1 MHZ Mod 3 MHZ Mod ch Off	e Auto Sweep				M1[1] 4.	40000 GHz 1Pk Max 43.79 dBµV 30392000 GHz

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### • 8DPSK \_ Middle frequency

				Spurious - Pea
	ectrum 2 X Spect	rum 3 🛛 🕱	l	$\nabla$
Ref Level         97.00 dBµV         RB <sup>1</sup> Att         0 dB         SWT 1.01 ms         VBV           Input         1 AC         PS         On         Not			F	requency 4.8820000 GHz
1 Frequency Sweep				● 1Pk Max M1[1] 45.03 dBµV 4.88205000 GH2
80 dBµv				
70 dBµV				
i0 dBµV				
0 dBµV	lund	41 Y		
ajdenserverserverserverserverserverserverserverserverserverserverserverserverserverserverserverserverserverserv	toghty and all and a second		ulgerrander for and and	And the second the matter with the second
10 dBµV				
10 dBµv				
0 dBµV				
) dBµv	1001 pts	1.0	) MHz/	Span 10.0 MHz

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# • 8DPSK \_ High frequency

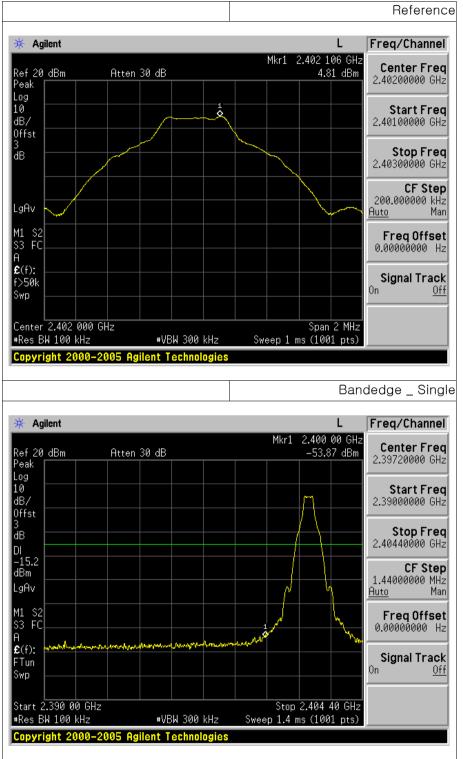
						R	estricte	ed Band	d - Peak
MultiView ==	Spectrum	Spectrur	n 2 🕱	Spectrum 3	X Spectru	ım 4 🕱			▽
Ref Level 97 Att	.00 dBµV		/ 1 MHz	e Auto Sweep	La opecar		Fra		917500 GHz
Input I Frequency S	1 AC PS	On Note	sh Off	e Auto Sweep			10	equency 2.4:	• 1Pk Max
							M	1[1]	38.70 dBµV 2.4839200 GHz
90 dBµV									
80 dBµV									
70 dBµV									
60 dBµV−									
50 dBµV									
M1									
40 dBµV-	Mystylesontward	normanaturatura	-						
30 dBµV	· · · ·		manyonapp	mandragan	hterriter and the	hopenante	Wmphathypular	hardsperger	e-Milespelification
60 In 11									
20 dBµV									
10 dBµV									
0 dBµV									
2.4835 GHz			1001 pt	5	1	65 MHz/			2.5 GHz
				-	1	00111127			
				-	1.	00111127	S	Spuriou	
	γ					2	ç	Spuriou	s – Peak
MultiView 8	Spectrum	BBW	ectrum 2	X Spectr		2			s – Peak
Ref Level 97 Att Input	.00 dBµV 0 dB SWT 1 AC PS		/ 1 MHz / 3 MHz Mod	X Spectr		2			s – Peak
Ref Level 97 Att	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97 Att Input	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97 Att Input 1 Frequency S	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97           Att           Input           I Frequency S           90 d8µv           80 d8µv	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97 Att Input Frequency S 90 dBpV	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97           Att           Input           I Frequency S           90 d8µv           80 d8µv	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
RefLevel         97           Att         Input           Input         80 d8µV           80 d8µV         80 d8µV           70 d8µV         60 d8µV	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr		2		equency <b>4.96</b>	s – Peak
Ref Level 97                • Att Input                 1 Frequency S                 90 dBµV                 80 dBµV                 70 dBµV	.00 dBµV 0 dB SWT 1 AC PS	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod	X Spectr	um 3 🛛 🛛	2		equency <b>4.96</b>	s – Peak
RefLevel         97           Att         Input           Input         80 d8µV           80 d8µV         80 d8µV           70 d8µV         60 d8µV	.00 dBµV 0 dB SWT 1 AC PS weep	● RB₩ 1.01 ms ● VB₩	/ 1 MHz / 3 MHz Mod h Off	X Spectr				M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz
RefLevel 97                • Att Input            1 Frequency S           90 d8µV           80 d8µV           70 d8µV           50 d8µV	.00 dBµV 0 dB SWT 1 AC PS weep	RBM 1.01 ms • VBW On Note	/ 1 MHz / 3 MHz Mod h Off	X Spectr	um 3 🛛 🛛		Fre	M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz
Ref Level 97           * Att Input           1 frequency S           90 dBµV           80 dBµV           70 dBµV           50 dBµV           40 dBµV           30 dBµV	.00 dBµV 0 dB SWT 1 AC PS weep	RBM 1.01 ms • VBW On Note	/ 1 MHz / 3 MHz Mod h Off	X Spectr	um 3 🛛 🛛		Fre	M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz
Ref Level 97           • Att Input           • Input           • Input	.00 dBµV 0 dB SWT 1 AC PS weep	RBM 1.01 ms • VBW On Note	/ 1 MHz / 3 MHz Mod h Off	X Spectr	um 3 🛛 🛛		Fre	M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz
Ref Level 97           * Att Input           1 frequency S           90 dBµV           80 dBµV           70 dBµV           50 dBµV           40 dBµV           30 dBµV	.00 dBµV 0 dB SWT 1 AC PS weep	RBM 1.01 ms • VBW On Note	/ 1 MHz / 3 MHz Mod h Off	X Spectr	um 3 🛛 🛛		Fre	M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz
Ref Level 97           * Att           Input           1           90 dBµV           80 dBµV           70 dBµV           50 dBµV           40 dBµV           30 dBµV           20 dBµV	00 dBµV 0 dB SWT 1 AC PS weep	RBM 1.01 ms • VBW On Note	/ 1 MHz / 3 MHz Mod h Off	X Spectr	um 3 🛛 🛛		Fre	M1[1] 4.96	S − Peak           ▼           500000 GHz           ■1Pk Max           44.36 dByV           25998000 GHz

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### 11.7 Test Plot for Conducted Spurious Emission

• GFSK \_ Low frequency



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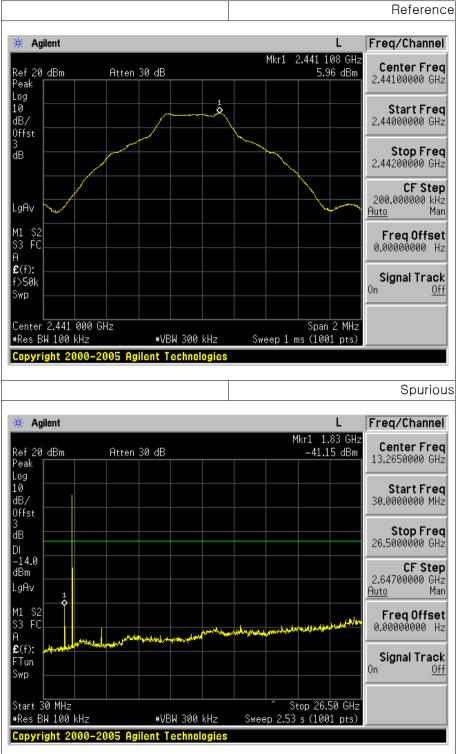


		Bande	dge _ Hoppin
🔆 Agilent		L	Freq/Channel
Ref 20 dBm Peak	Atten 30 dB	Mkr1 2.400 00 GHz -54.78 dBm	Center Freq 2.39720000 GHz
Log 10 dB/			Start Freq 2.39000000 GHz
0ffst 3 dB			Stop Freq 2.40440000 GHz
DI -15.2 dBm			2.40440000 GH2 CF Step 1.44000000 MHz
LgAv M1 S2		N	Auto Man Freq Offset
S3 FC A £(f):		1 ml	0.00000000 Hz
FTun Swp			<b>Signal Track</b> On <u>Off</u>
Start 2.390 00 GHz #Res BW 100 kHz	#VBW 300 kHz	Stop 2.404 40 GHz Sweep 1.4 ms (1001 pts)	
Copyright 2000-2	005 Agilent Technologie	8	
			Spuriou
* Agilent		L	Freq/Channel
Ref 20 dBm Peak	Atten 30 dB	Mkr1 1.83 GHz _47.10 dBm	Center Freq 13.2650000 GHz
Log 10 dB/ Offst			Start Freq 30.0000000 MHz
dB			<b>Stop Freq</b> 26.5000000 GHz
-15.2 dBm LgAv			<b>CF Step</b> 2.64700000 GHz Auto Man
M1 S2 🕹		المنافر ومعادر ومعادر والمروم و	Freq Offset 0.0000000 Hz
A £(f): Manual Manual Manual FTun Sun	here we have a second		Signal Track
Swp			
Start 30 MHz #Res BW 100 kHz	₩VBW 300 kHz	Stop 26.50^GHz Sweep 2.53 s (1001 pts)	
Copyright 2000-2	005 Agilent Technologie	8	

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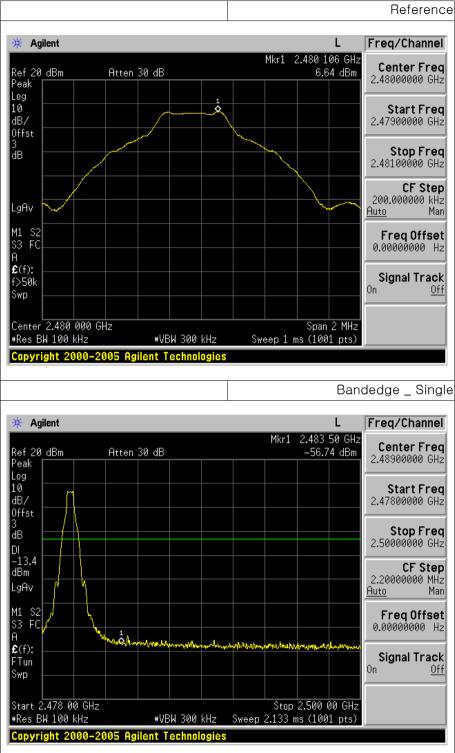
• GFSK \_ Middle frequency



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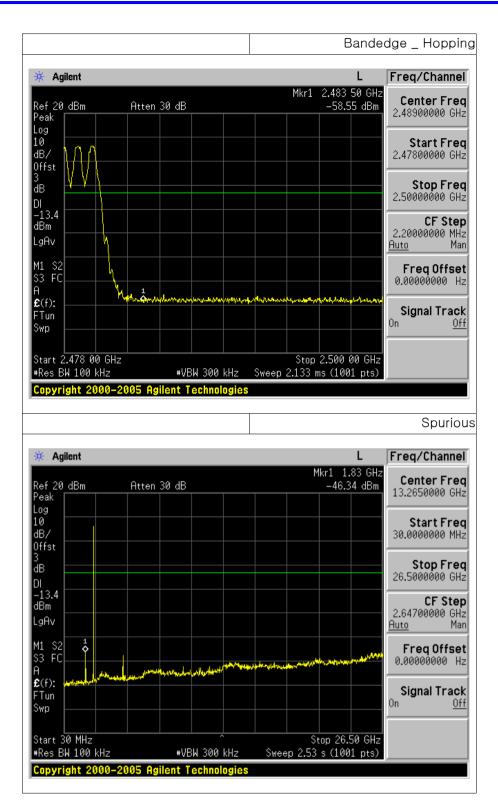


• GFSK \_ High frequency



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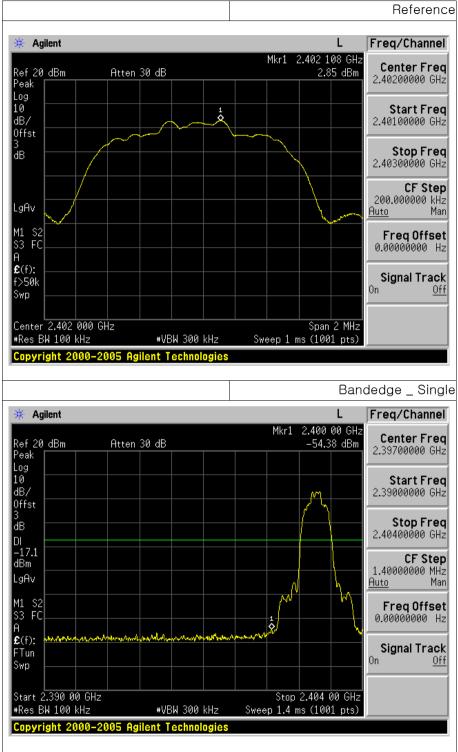




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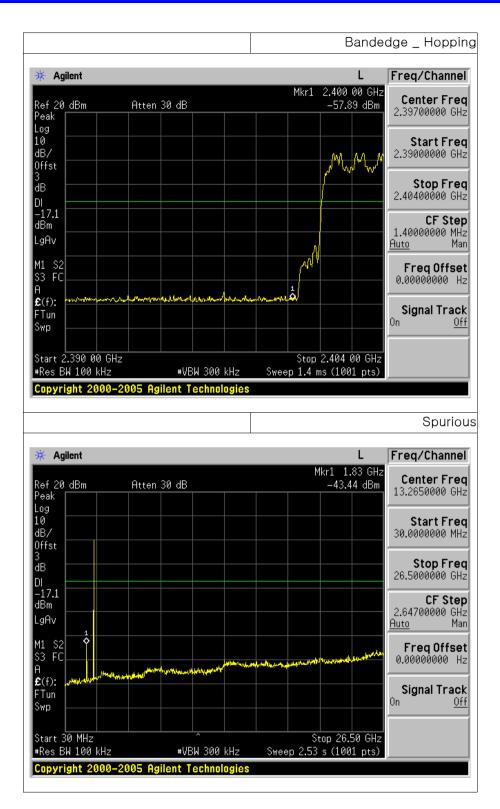


• 8DPSK \_ Low frequency



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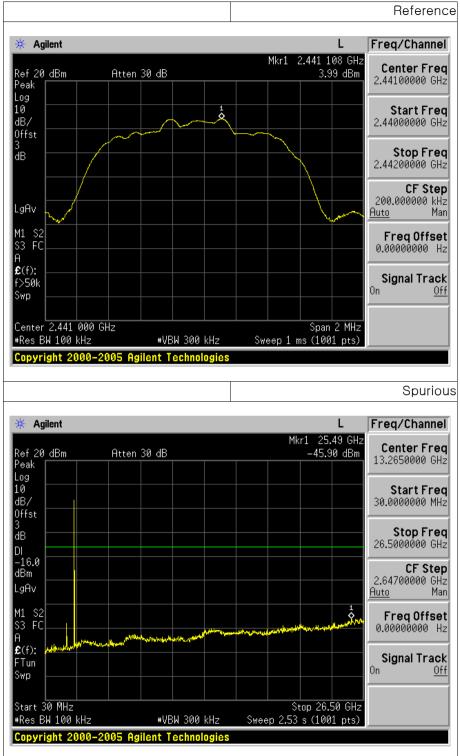




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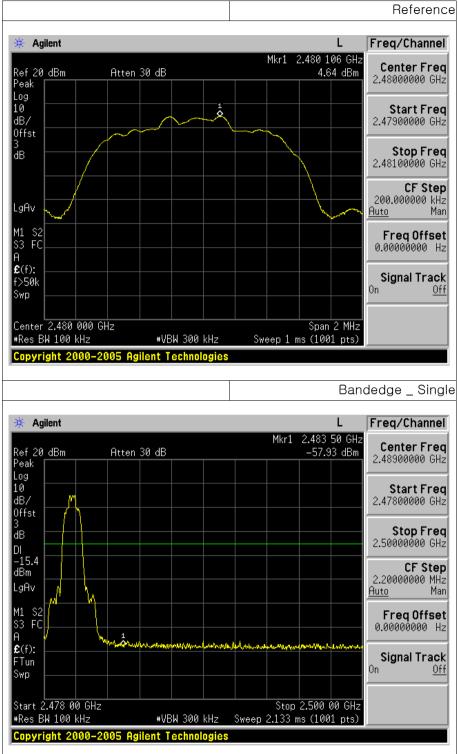
• 8DPSK \_ Middle frequency



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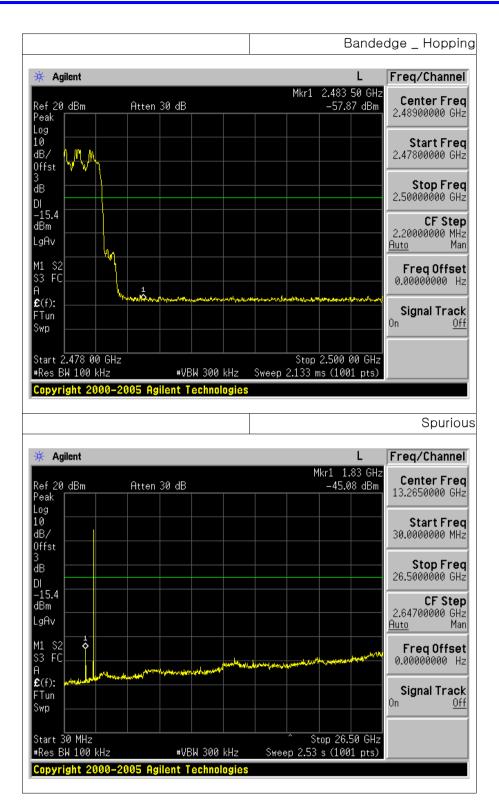


• 8DPSK \_ High frequency



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# 12. Conducted Emission

## 12.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

# 12.2 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.

Fraguanay Banga (MHz)	Conducted Limit (dBuV)				
Frequency Range (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

## 12.3 Test Procedure

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.

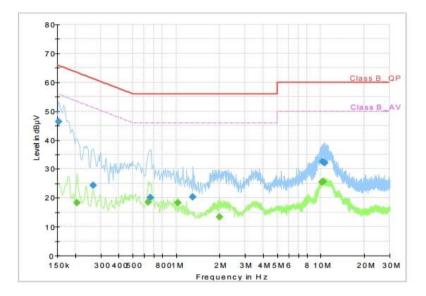
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### 12.4 Test Result

• AC Line Conducted Emission (Graph)

SHARK MW\_Charging Mode\_L1



# **Conducted Emission**

Final\_Result

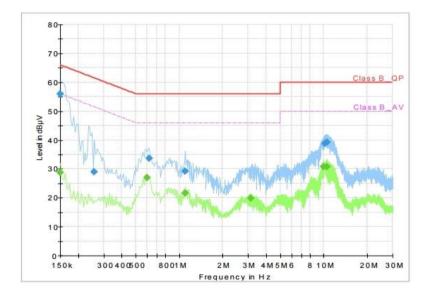
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.154	46.34		65.78	19.44	9	L1	20.7
0.206		18.25	53.37	35.12	9	L1	20.7
0.266	24.39		61.24	36.86	9	L1	20.5
0.640		18.49	46.00	27.51	9	L1	20.4
0.660	20.08		56.00	35.92	9	L1	20.3
1.030		18.17	46.00	27.83	9	L1	20.0
1.300	20.36		56.00	35.64	9	L1	20.0
2.000		13.26	46.00	32.74	9	L1	19.9
10.240		25.48	50.00	24.52	9	L1	20.0
10.260	32.53		60.00	27.47	9	L1	20.0
10.440		25.52	50.00	24.48	9	L1	20.0
10.680	32.13		60.00	27.87	9	L1	20.0

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SHARK MW\_Charging Mode\_N



# **Conducted Emission**

#### Final\_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.150		28.76	56.00	27.24	9	N	20.6
0.150	55.92		66.00	10.08	9	N	20.6
0.258	28.89		61.50	32.61	9	N	20.5
0.600		26.86	46.00	19.14	9	N	20.7
0.620	33.75		56.00	22.25	9	N	20.6
1.100	29.16		56.00	26.84	9	N	20.0
1.100		21.69	46.00	24.31	9	N	20.0
3.130		19.76	46.00	26.24	9	N	19.9
9.990		30.70	50.00	19.30	9	N	20.0
10.180	38.75		60.00	21.25	9	N	20.0
10.500	39.26		60.00	20.74	9	N	20.0
10.530		30.83	50.00	19.17	9	N	20.0

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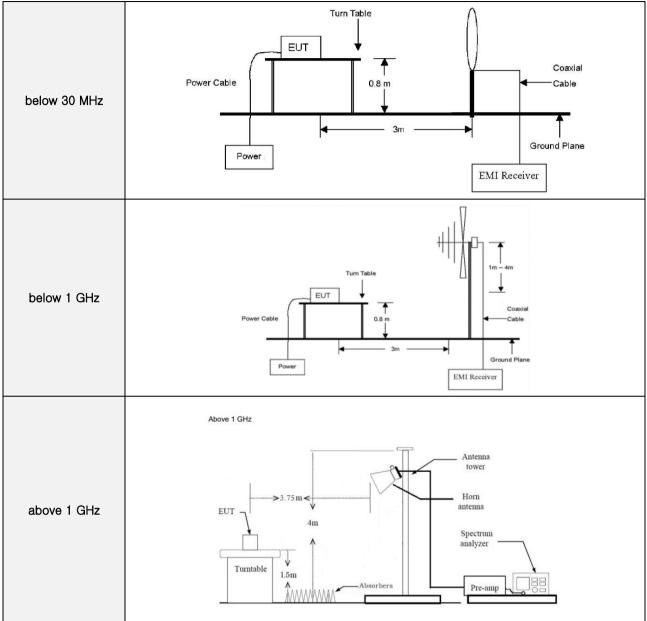
APPENDIX I

TEST SETUP

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#### Radiated Measurement



#### • Conducted Measurement

		_			
Conducted	EUT		Attenuator	Spectrum Analyzer	

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APPENDIX II

UNCERTAINTY

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Measurement Item	Expanded Uncertainty U = <i>k</i> Uc ( <i>k</i> =2)			
Conducted RF power	0.34 dB			
Conducted Spurious Emissions	0.34 dB			
Radiated Spurious Emissions	6.34 dB			
Conducted Emissions	1.74 dB			