# **TEST REPORT**

## DT&C Co., Ltd.

42, Yurim-ro,	154Beon-gil,	Cheoin-gu,	Yongin-si,	Gyeonggi-do,	Korea,	17042
	Tel : 031	1-321-2664,	Fax : 031-	-321-1664		

1. Report No: DRTFCC1912-0307

**Dt&C** 

- 2. Customer
  - Name : HYUNDAI MOBIS CO., LTD.
  - Address : 203, Teheran-ro Gangnam-gu, Seoul, South Korea, 135-977
- 3. Use of Report : FCC Original Grant
- 4. Product Name / Model Name : DIGITAL CAR AUDIO SYSTEM / ADC10SVGG FCC ID : TQ8-ADC10SVGG
- 5. Test Method Used : KDB 558074 D01v05r02, ANSI C63.10-2013 Test Specification : FCC Part 15.247
- 6. Date of Test : 2019.11.05 ~ 2019.11.22
- 7. Testing Environment : See appended test report.
- 8. Test Result : Refer to the attached test result.

Affirmation	Tested by	6.1	Reviewed by	
Ammadon	Name : InHee Bae	Ch	Name : JaeJin Lee	(Signature)

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

2019.12.04.

# DT&C Co., Ltd.

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

# **Test Report Version**

Test Report No.	Date	Description
DRTFCC1912-0307	Dec. 04, 2019	Initial issue



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## **1. General Information**

### 1.1 Testing Laboratory

#### DT&C Co., Ltd.

The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site complies with the requirements of § 2.948 according to ANSI C63.4-2014.

#### - FCC MRA Accredited Test Firm No. : KR0034

www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

#### **1.2 Testing Environment**

Ambient Condition	
<ul> <li>Temperature</li> </ul>	+21 ℃ ~ +24 ℃
Relative Humidity	35 % ~ 43 %

#### **1.3 Measurement Uncertainty**

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

Test items	Measurement uncertainty
Transmitter Output Power	0.7 dB (The confidence level is about 95 %, $k = 2$ )
Conducted spurious emission	0.9 dB (The confidence level is about 95 %, $k = 2$ )
Radiated spurious emission (1 GHz Below)	5.1 dB (The confidence level is about 95 %, $k = 2$ )
Radiated spurious emission (1 GHz ~ 18 GHz)	5.4 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, $k = 2$ )

### **1.4 Details of Applicant**

Applicant	:	HYUNDAI MOBIS CO., LTD.
Address	:	203, Teheran-ro Gangnam-gu, Seoul, South Korea, 135-977
Contact person	:	Seung Hoon Choe

### 1.5 Description of EUT

EUT	DIGITAL CAR AUDIO SYSTEM
Model Name	ADC10SVGG
Add Model Name	ADC11SVGG, ADC12SVGG, ADC13SVGG, ADC10SVGN, ADC11SVGN, ADC10SVMG, ADC10SVMG, ADC14SVGG
Hardware Version	1.0
Software Version	1.0
Serial Number	Identical prototype
Power Supply	DC 14.4 V
Frequency Range	2402 MHz ~ 2480 MHz
Modulation Technique (Data rate)	GFSK (1Mbps), π/4DQPSK (2Mbps), 8DPSK (3Mbps)
Number of Channels	79
Antenna Type	PCB Pattern Antenna
Antenna Gain	PK : -0.18 dBi

### **1.6 Declaration by the applicant / manufacturer**

- NA

#### **1.7 Information about the FHSS characteristics**

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following :
  - A) The hopping sequence is pseudorandom
    - Note 1 : Pseudorandom Frequency Hopping Sequence Table as below:
      - Channel: 08, 24, 40, 56, 42, 54, 72, 09, 01, 11, 33, 41, 34, 42, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 41, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 52, 71, 08, 24, 06, 24, 48, 56, 45, 46, 70, 01, 72, 06, 25, 33, 12, 28, 49, 60, 45, 58, 74, 13, 05, 18, 37, 49 etc

The System receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchroniztation with the transmit ted signals.

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

### **1.8 Test Equipment List**

Туре	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	18/12/19	19/12/19	MY49060056
Spectrum Analyzer	Agilent Technologies	N9020A	18/12/19	19/12/19	MY48011700
Spectrum Analyzer	Agilent Technologies	N9020A	19/06/26	20/06/26	MY46471251
DC Power Supply	Agilent Technologies	66332A	19/06/25	20/06/25	MY43001173
DC Power Supply	SM techno	SDP30-5D	19/06/25	20/06/25	305DMG304
Multimeter	FLUKE	17B	18/12/18	19/12/18	26030065WS
Signal Generator	Rohde Schwarz	SMBV100A	18/12/19	19/12/19	255571
Signal Generator	ANRITSU	MG3695C	18/12/10	19/12/10	173501
Thermohygrometer	BODYCOM	BJ5478	18/12/27	19/12/27	120612-1
Thermohygrometer	BODYCOM	BJ5478	18/12/27	19/12/27	120612-2
Thermohygrometer	BODYCOM	BJ5478	19/07/03	20/07/03	N/A
Loop Antenna	ETS	6502	19/09/18	21/09/18	00226186
BILOG ANTENNA	Schwarzbeck	VULB 9160	19/04/23	21/04/23	9160-3362
Horn Antenna	ETS-Lindgren	3115	18/01/30	20/01/30	6419
Horn Antenna	Schwarzbeck	BBHA 9120C	17/12/04	19/12/04	9120C-561
Horn Antenna	A.H.Systems Inc.	SAS-574	19/07/03	21/07/03	155
PreAmplifier	tsj	MLA-0118-J01-45	18/12/19	19/12/19	17138
PreAmplifier	tsj	MLA-1840-J02-45	19/06/27	20/06/27	16966-10728
PreAmplifier	H.P	8447D	18/12/18	19/12/18	2944A07774
Power Divider	Weinschel	WA1574	19/06/25	20/06/25	WA1574-4
Bluetooth Tester	Tescom	TC-3000C	19/06/24	20/06/24	3000C000563
High Pass Filter	Wainwright Instruments	WHKX12-935- 1000-15000-40SS	19/06/26	20/06/26	8
High Pass Filter	Wainwright Instruments	WHKX10-2838- 3300-18000-60SS	19/06/26	20/06/26	1
High Pass Filter	Wainwright Instruments	WHNX8.0/26.5- 6SS	19/06/27	20/06/27	3
Attenuator(10dB)	Hefei Shunze	SS5T2.92-10-40	19/06/27	20/06/27	16012202
Attenuator(6dB)	SRTechnology	F01-B0606-01	19/06/27	20/06/27	13092403
Attenuator(3dB)	Aeroflex/Weinschel	20515	19/06/27	20/06/27	Y2370
Attenuator(3dB)	SMAJK	SMAJK-2-3	19/06/27	20/06/27	2
Attenuator(3dB)	Cernexwave	CFADC2603U5	19/06/27	20/06/27	C11729
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2495A MA2490A	19/06/27	20/06/27	1338003 1249304
EMI Receiver	ROHDE&SCHWARZ	ESW44	19/07/30	20/07/30	101645
Cable	Junkosha	MWX241	19/01/14	20/01/14	G-04
Cable	Junkosha	MWX241	19/01/14	20/01/14	G-07
Cable	DT&C	Cable	19/01/14	20/01/14	G-13
Cable	DT&C	Cable	19/01/14	20/01/14	G-14
Cable	HUBER+SUHNER	SUCOFLEX 104	19/01/14	20/01/14	G-15
Cable	Radiall	TESTPRO3	19/01/16	20/01/16	M-01
Cable	Junkosha	MWX315	19/01/16	20/01/16	M-05
Cable	Junkosha	MWX221	19/01/16	20/01/16	M-06
Cable	DT&C	Cable	19/01/14	20/01/14	RF-10

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017. Note2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

### 1.9 Summary of Test Results

FCC Part RSS Std.	Parameter	<b>Limit</b> (Using in 2400~ 2483.5 MHz)	Test Condition	Status Note 1
	Carrier Frequency Separation	>= 25 kHz or >= Two thirds of the 20 dB BW, whichever is greater.		С
15.247(a) RSS-247(5.1)	Number of Hopping Frequencies	>= 15 hops		С
	20 dB Bandwidth	N/A		С
	Dwell Time	=< 0.4 seconds		С
15.247(b) RSS-247(5.4)	Transmitter Output Power	For FCC =< 1 Watt , if CHs >= 75 Others =< 0.125 W For IC if CHs >= 75 =< 1 Watt For Conducted Power =< 4 Watt For e.i.r.p, Others =< 0.125 W For Conducted Power. =< 0.5 Watt For e.i.r.p	Conducted	С
15.247(d) RSS-247(5.5)	Conducted Spurious Emissions	The radiated emission to any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density.		С
RSS Gen(6.7)	Occupied Bandwidth (99 %)	N/A		NA
15.247(d) 15.205 & 209 RSS-247(5.5) RSS-Gen (8.9 & 8.10)	Radiated Spurious Emissions	FCC 15.209 Limits	Radiated	С
15.207 RSS-Gen(8.8)	AC Conducted Emissions	FCC 15.207 Limits	AC Line Conducted	NA Note3
15.203	Antenna Requirements	FCC 15.203	-	с

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



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

The EUT has three types of modulation (GFSK,  $\pi$ /4DQPSK and 8DPSK). Therefore all applicable requirements were tested with all the modulations.

And packet type was tested at the worst case(DH5).

#### Tested frequency information,

- Hopping Function : Enable

	TX Frequency (MHz)	RX Frequency (MHz)
Hopping Band	2402 ~ 2480	2402 ~ 2480

- Hopping Function : Disable

	TX Frequency (MHz)	RX Frequency (MHz)
Lowest Channel	2402	2402
Middle Channel	2441	2441
Highest Channel	2480	2480



### 2. Maximum Peak Output Power Measurement

#### 2.1 Test Setup

Refer to the APPENDIX I.

### 2.2 Limit

#### FCC Requirements

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

- 1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
- 2. §15.247(b)(1), For frequency hopping systems operating in the 2400 2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725 5805 MHz band : 1 Watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

#### IC Requirements

1. 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)

### 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 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 ≥ 20 dB BW VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold

#### 2.4 Test Results

Modulation	Tested Channel		Average Power	Peak Output Power		
Woddiation	rested Chainter	dBm	mW	dBm	mW	
	Lowest	0.15	1.04	1.77	1.50	
<u>GFSK</u>	Middle	0.80	1.20	1.69	1.48	
	Highest	0.43	1.10	1.55	1.43	
	Lowest	-4.58	0.35	-1.15	0.77	
<u>π/4DQPSK</u>	Middle	-3.69	0.43	-0.85	0.82	
	Highest	-4.04	0.39	-1.09	0.78	
	Lowest	-4.55	0.35	-0.70	0.85	
<u>8DPSK</u>	Middle	-3.67	0.43	-0.59	0.87	
	Highest	-3.93	0.40	-0.69	0.85	

Note 1: The Frame average output power was tested using an average power meter for reference only. Note 2: See next pages for actual measured spectrum plots.



### Lowest Channel & Modulation : GFSK



#### **Peak Output Power**

#### Middle Channel & Modulation : GFSK





Highest Channel & Modulation : GFSK



#### **Peak Output Power**

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





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



#### **Peak Output Power**

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









#### 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 & 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 BW & Occupied BW
  - $VBW \ge 3 \times RBW$

Span = between two times and five times the 20 dB bandwidth & Occupied BW

Sweep = auto

Detector function = peak

Trace = max hold

#### 3.4 Test Results

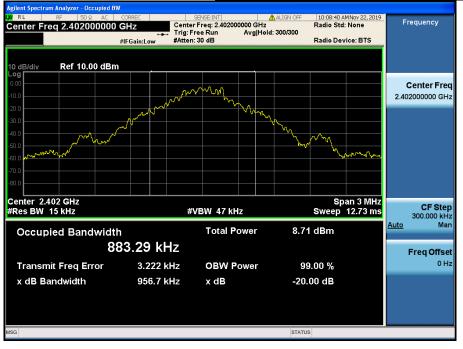
Modulation	Tested Channel	20 dB BW (MHz)
	Lowest	0.957
<u>GFSK</u>	Middle	0.957
	Highest	0.957
	Lowest	1.344
<u>π/4DQPSK</u>	Middle	1.344
	Highest	1.351
	Lowest	1.344
<u>8DPSK</u>	Middle	1.344
	Highest	1.345



# **Dt&C**

#### 20 dB BW

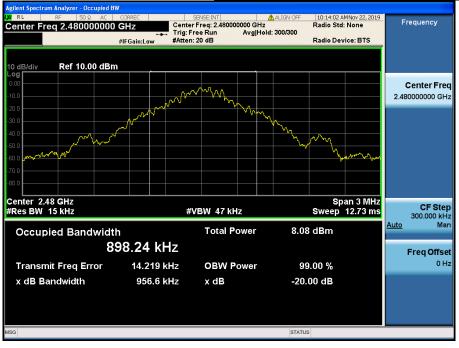
### Lowest Channel & Modulation : GFSK



#### 20 dB BW

#### Middle Channel & Modulation : GFSK Occupied BW Lenvel:INT ALIGN OF Center Freq: 2.441000000 GHz Trig: Free Run Avg|Hold: 300/300 #Atten: 20 dB 10:11:21 AM Nov 22, 2019 Radio Std: None Center Freq 2.441000000 GHz Frequency #IFGain:Low Radio Device: BTS Ref 10.00 dBm **Center Freq** $\Lambda \Lambda$ 2.441000000 GHz Center 2.441 GHz #Res BW 15 kHz Span 3 MHz Sweep 12.73 ms CF Step 300.000 kHz #VBW 47 kHz Auto Mar Occupied Bandwidth Total Power 8.20 dBm 897.28 kHz Freq Offset 0 Hz 99.00 % Transmit Freq Error 9.307 kHz **OBW Power** x dB Bandwidth 957.1 kHz x dB -20.00 dB STATUS

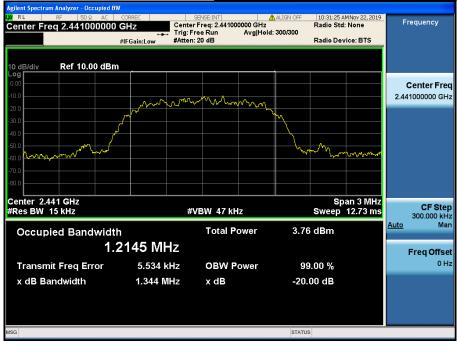
### Highest Channel & Modulation : GFSK



#### 20 dB BW

#### Lowest Channel & Modulation : π/4DQPSK Occupied BW Lenvel:INT ALIGN OF Center Freq: 2.402000000 GHz Trig: Free Run Avg|Hold: 300/300 #Atten: 20 dB 10:28:47 AM Nov 22, 2019 Radio Std: None Center Freq 2.402000000 GHz Frequency #IFGain:Low Radio Device: BTS Ref 10.00 dBm **Center Freq** 2.402000000 GHz ~~~ Mamm Center 2.402 GHz #Res BW 15 kHz Span 3 MHz Sweep 12.73 ms CF Step 300.000 kHz #VBW 47 kHz Auto Mar Occupied Bandwidth Total Power 3.67 dBm 1.2122 MHz Freq Offset **OBW Power** 0 Hz 1.936 kHz 99.00 % Transmit Freq Error x dB Bandwidth 1.344 MHz x dB -20.00 dB STATUS

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



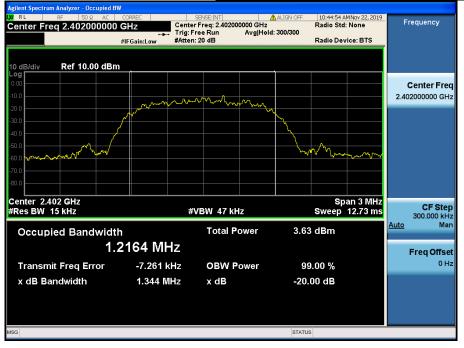
#### 20 dB BW

#### Highest Channel & Modulation : π/4DQPSK Occupied BW Lenvel:INT ALIGN OF Center Freq: 2.48000000 GHz Trig: Free Run Avg|Hold: 300/300 #Atten: 20 dB 10:34:08 AM Nov 22, 2019 Radio Std: None Center Freq 2.480000000 GHz Frequency #IFGain:Low Radio Device: BTS Ref 10.00 dBm **Center Freq** 2.48000000 GHz ኒስፈላ Mum mm Center 2.48 GHz #Res BW 15 kHz Span 3 MHz Sweep 12.73 ms CF Step 300.000 kHz #VBW 47 kHz Auto Mar Occupied Bandwidth Total Power 3.61 dBm 1.2140 MHz Freq Offset **OBW Power** 0 Hz 10.107 kHz 99.00 % Transmit Freq Error x dB Bandwidth 1.351 MHz x dB -20.00 dB STATUS



🛈 Dt&C

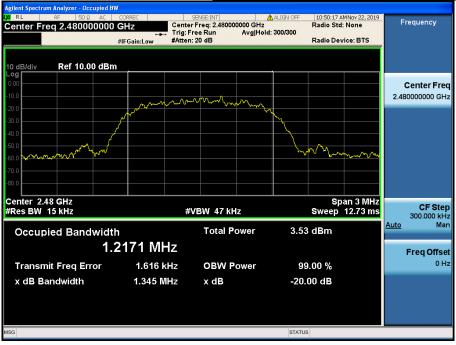
### Lowest Channel & Modulation : 8DPSK



#### 20 dB BW

#### Middle Channel & Modulation : 8DPSK Occupied BW Lenvel:INT ALIGN OF Center Freq: 2.441000000 GHz Trig: Free Run Avg|Hold: 300/300 #Atten: 20 dB 10:47:35 AM Nov 22, 2019 Radio Std: None Center Freq 2.441000000 GHz Frequency #IFGain:Low Radio Device: BTS Ref 10.00 dBm **Center Freq** 2.441000000 GHz Center 2.441 GHz #Res BW 15 kHz Span 3 MHz Sweep 12.73 ms CF Step 300.000 kHz #VBW 47 kHz Auto Mar Occupied Bandwidth Total Power 3.68 dBm 1.2180 MHz Freq Offset **OBW Power** 0 Hz -2.620 kHz 99.00 % Transmit Freq Error x dB Bandwidth 1.344 MHz x dB -20.00 dB STATUS

### Highest Channel & Modulation : 8DPSK





### 4. Carrier Frequency Separation

#### 4.1 Test Setup

Refer to the APPENDIX I.

### 4.2 Limit

Limit : ≥ 25 kHz or ≥ 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.

 $VBW \ge RBW$  Sweep = auto Detector function = peak Trace = max hold

#### 4.4 Test Results

#### FH mode

Hopping Mode	Modulation	Peak of reference channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
	GFSK	2441.006	2442.012	1.006
Enable	π/4DQPSK	2441.014	2442.012	0.998
	8DPSK	2441.010	2442.012	1.002

#### AFH mode

Hopping Mode	Modulation	Peak of reference channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (MHz)
	GFSK	2441.017	2442.015	0.998
Enable	π/4DQPSK	2441.013	2442.012	0.999
	8DPSK	2441.012	2442.007	0.995

Note 1 : See next pages for actual measured spectrum

#### - Minimum Standard :

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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



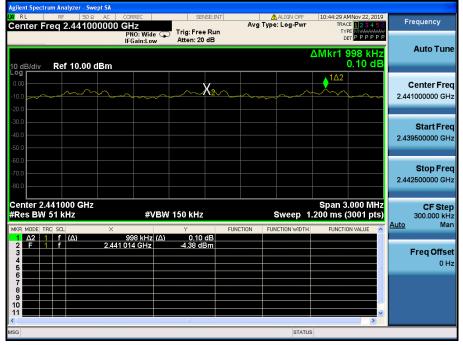
### Carrier Frequency Separation (FH)

#### Hopping mode : Enable & GFSK



#### **Carrier Frequency Separation (FH)**

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





### **Carrier Frequency Separation (FH)**

### Hopping mode : Enable & 8DPSK

Agilent Spectrum Analyzer - Swept SA W RL RF 50Ω AC	CORREC	SENSE:INT	ALIGN OFF	11:00:13 AM Nov 22, 2019	_
Center Freq 2.44100000	0 GHz		Type: Log-Pwr	TRACE 2 3 4 5 6 TYPE M 4444444	Frequency
10 dB/div Ref 10.00 dBm	IFGain:Low Atten:	20 dB	ΔN	DET P P P P P P Ikr1 1.002 MHz 0.00 dB	Auto Tune
Log 0.00 -10.0 -20.0		X2~	~~~~		Center Freq 2.441000000 GHz
-30.0					<b>Start Freq</b> 2.439500000 GHz
-60.0 -70.0 -80.0					<b>Stop Freq</b> 2.442500000 GHz
Center 2.441000 GHz #Res BW 51 kHz	#VBW 150 ki	Hz FUNCTION	Sweep 1.	Span 3.000 MHz 200 ms (3001 pts) FUNCTION VALUE	CF Step 300.000 kHz Auto Man
1         Δ2         1         f         (Δ)           2         F         1         f         2.4           3         -         -         -         2.4           4         -         -         -         -         2.4           5         - <td< td=""><td>1.002 MHz (Δ) 0.0</td><td>00 dB dBm</td><td>FORCHOR WIDTH</td><td></td><td>Freq Offset 0 Hz</td></td<>	1.002 MHz (Δ) 0.0	00 dB dBm	FORCHOR WIDTH		Freq Offset 0 Hz
6 7 7 8 9 9 10 11				~	
<			STATUS	<u>&gt;</u>	
00			STATUS		



#### Carrier Frequency Separation (AFH)

### Hopping mode : Enable & GFSK



### **Carrier Frequency Separation (AFH)**

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





### Carrier Frequency Separation (AFH)

## Hopping mode : Enable & 8DPSK

enter Fr	RF 50 G	00000 GI	RREC <b>12</b> NO: Wide 🗔	SENSE:IN	Avg	ALIGN OFF	TRACI	1Nov 22, 2019 E 1 2 3 4 5 6 E M MMMMM	Frequency
0 dB/div	Ref 10.00	, IF	Gain:Low	Atten: 20 dB			ΔMkr1 9	TPPPPP	Auto Tun
			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	X2	<u>^</u>	~~~~		~~~~	<b>Center Fre</b> 2.441000000 GH
30.0 10.0 50.0									<b>Start Fre</b> 2.439500000 G⊦
0.0 0.0 0.0									<b>Stop Fre</b> 2.442500000 GH
Res BW	RC SCL	×		150 kHz Y	FUNCTION	Sweep 1	Span 3. .200 ms (3 FUNCTIO		CF Ste 300.000 kł <u>Auto</u> Ma
1 Δ2 1 2 F 1 3		99 2.441 01	95 kHz (∆) 2 GHz	-0.08 dB -4.40 dBm					Freq Offs 0 ⊦
6 6 7 6 8 6 9 6 0 6									
1						STATUS		>	



### 5. Number of Hopping Frequencies

#### 5.1 Test Setup

Refer to the APPENDIX I.

#### 5.2 Limit

Limit : >= 15 hops

### 5.3 Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

To get higher resolution, two frequency ranges for FH mode within the 2400 ~ 2483.5 MHz were examined.

The spectrum analyzer is set to :

Span for FH mode = 50 MHz	Start Frequency = 2391.5 MHz,	Stop Frequency = 2441.5 MHz
	Start Frequency = 2441.5 MHz,	Stop Frequency = 2491.5 MHz
Span for AFH mode = 30 MHz	Start Frequency = 2426.0 MHz,	Stop Frequency = 2456.0 MHz
RBW = To identify clearly the ind	ividual channels, set the RBW to	less 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	Modulation	Test Result (Total Hops)
	GFSK	79
Enable	π/4DQPSK	79
	8DPSK	79

#### AFH mode

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

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

#### - Minimum Standard :

At least 15 hopes



### Number of Hopping Frequencies 1(FH)

### Hopping mode : Enable & GFSK

Agilent Spectru																					
LXI RL	RF	50 Ω		CORF			_	SENS	E:INT				ALIGN		10		MNov 22			Frequency	
Center Fr	eq 2.4	1650	0000			_	Tria	Free	Dun		AV	д Туре	e: Log-	PWr		TY T	.CE 12	456			
				- PN	0: Fas ain:Lo	t (→		n: 20 (								, i	DET P P F	PPP			
-				IFG	am.co	~	Thee											_		Auto Tu	ine
													M	kr2	2.4		000 0			Autorit	anc
10 dB/div	Ref 1	0.00 c	iBm													1.	44 d	Bm			_
Log			01															- 🗸			
0.00			Ann.	nn	nлr	ιnn	nnn	nn	ጉጠጠ	<del>n</del> n	nn	nne	In Ar	٦Æ	۱nn	nn	har	InA		Center F	rea
			1444	VV	γV	ΥV	1 7 7 1	{ Y Y Y	ΥΥ	γγ	[ ] ]	{	γvv	ΥV	VV	1 V V	W V V	V V I			
-10.0			[ + + + +	-í-ł	11	+ +			1.1	ŤŤ			* * *	ŤŤ	11	1 <del>1</del> 1	1 + +	t t		2.416500000 0	GHZ
-20.0																					
-30.0																					
-30.0		- 1																		Start F	reg
-40.0																				2.391500000 0	GH7
-50.0		5																		2.0010000000	
-60.0 <b>m<sup>2</sup>-005-0</b> 0	la harristan	Contraction of the local division of the loc																			
-70.0																				Stop F	req
																				2.441500000 0	GHz
-80.0																					_
Start 2.39															Sto	p 2.4	4150	GHz		CF St	tep
#Res BW 🛛	270 kH	z			#\	/BW	820	кНz				-	Swee	ep 1	.000	l ms	(3001	pts)		5.000000 N	
									_								ON VALUE		Αι		Man
MKR MODE TRI	_		× 2.402	000	011-		Ý	67 dB		FUNC	TIUN	FUP	NCTION V	WIDTH		FUNCT	IUN VALUE				_
1 N 1 2 N 1			2.402		GHZ			14 dB				_									
3			2.44	000	GHZ		1.5	++ uD												Freq Off	fset
4																					) Hz
5																		=			112
6																					
8																					
9																					
10																					
11																		~			
<																		>			
MSG													:	STATU	s						
	_	_	_	-	_	-	_	-	-	-	-	_	_	-	-	-	_	-	-		-

### Number of Hopping Frequencies 2(FH)

### Hopping mode : Enable & GFSK

ilent Spectrum Analyzer - Swept SA RL RF 50Ω AC	CORREC	SENSE:INT		ALIGN OFF	10:20:53 AM Nov 22, 2019	
enter Freq 2.466500000		Trig: Free Run		e: Log-Pwr	TRACE 2345	Frequency
) dB/div Ref 10.00 dBm	IFGain:Low	Atten: 20 dB		Mkr2	оет Р Р Р Р Р 2.480 000 GHz 1.24 dBm	Auto Tun
				2 <sup>2</sup>		Center Fre 2.466500000 G⊦
0.0 0.0 0.0						<b>Start Fre</b> 2.441500000 Gi
0.0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0					Maran ha walan di shi kashti ng Pa	<b>Stop Fre</b> 2.491500000 GH
tart 2.44150 GHz Res BW 270 kHz	#VBW	820 kHz		Sweep 1	Stop 2.49150 GHz .000 ms (3001 pts	5.000000 MI
KR MODE TRC SCL X	2 000 GHz	⊻ 1.40 dBm	FUNCTION FU	NCTION WIDTH	FUNCTION VALUE	
2 N 1 f 2.480 3 4 5 6 6	0000 GHz	1.24 dBm				Freq Offs 0 F
8 8 9 9 0						
1		Ш			~	
3				STATUS		



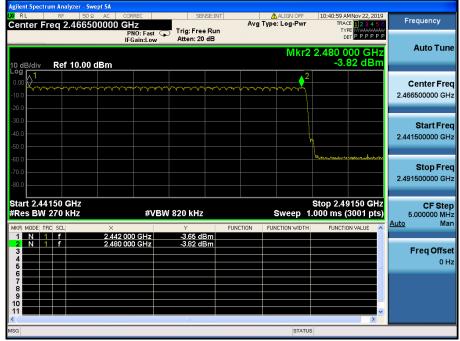
### Number of Hopping Frequencies 1(FH)

### Hopping mode : Enable & π/4DQPSK

gilent Spectrum Analyzer - Sv RL RF 50:		SENSE:INT	ALIGN OFF	10:39:47 AMNov 22, 2019	
Center Freq 2.4165	00000 GHz		Avg Type: Log-Pwr		Frequency
10 dB/div Ref 10.00	PNO: Fa IFGain:L	ast 😱 Trig: Free Run aw Atten: 20 dB	Mkr	2 2.441 000 GHz -3.72 dBm	Auto Tune
0.00 -10.0			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Center Freq 2.416500000 GHz
-30.0					<b>Start Freq</b> 2.391500000 GHz
-60.0					<b>Stop Freq</b> 2.441500000 GHz
Start 2.39150 GHz #Res BW 270 kHz	X	* <b>VBW 820 kHz</b>	Sweep	Stop 2.44150 GHz 1.000 ms (3001 pts)	CF Step 5.000000 MHz <u>Auto</u> Man
1 N 1 f 2 N 1 f 3 4 5 6 6 6 7 7 8	2.402 000 GH 2.441 000 GH				Freq Offset 0 Hz
9 10 11 *			STATI	×	

### Number of Hopping Frequencies 2(FH)

### Hopping mode : Enable & π/4DQPSK





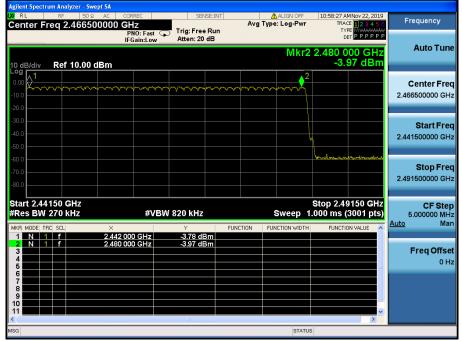
### Number of Hopping Frequencies 1(FH)

### Hopping mode : Enable & 8DPSK

Center Freq 2.416500000 GHz       Trig: Free Run       Avg Type: Log-Pwr       Trig: Frequency       Auto Tune         Mkr2 2.441 000 GHz       3.58 dBm         Odd Briter Science       Center Frequency         Mkr2 2.441 000 GHz       Center Frequency         Mkr2 2.441 000 GHz       Center Frequency         Odd Briter Science       Center Frequency         Mkr2 2.441 000 GHz       Center Frequency         Odd Briter Science       Science         Science       Science       Center Freq	Agilent Spectrum An								
Atten: 20 dB Mkr2 2.441 000 GHz 3.58 dBm Atten: 20 dB Mkr2 2.441 000 GHz 3.58 dBm Atten: 20 dB Atten: 20 dB					Avg Type		TRAC	E 123456	Frequency
Log       1       Center Freq         0.00       2.00       2.00         3.00       3.00       3.00         4.0       3.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       3.00         5.00       4.00       4.00         5.00       4.00       4.00         5.00       4.00       4.00         5.00       5.00       5.00         6.00       4.00       4.00         7.00       4.00       5.00         8.00       7.00       8.00         9.00       1       1       1         1       N       1       1       1         1       N       1       1       1         1       N       1       1       1       1         2       4.00       4.00       4.00       4.00 </th <th>10 dB/div Re</th> <th>f 10.00 dBm</th> <th>PNO: Fast G</th> <th></th> <th></th> <th>Mkr2</th> <th>DI 2.441 0</th> <th>00 GHz</th> <th>Auto Tune</th>	10 dB/div Re	f 10.00 dBm	PNO: Fast G			Mkr2	DI 2.441 0	00 GHz	Auto Tune
400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       400       4	Log				le le de la constant	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~		
700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       700       7	-50.0								
#Res BW 270 kHz         #VBW 820 kHz         Sweep 1.000 ms (3001 pts)         5.00000 MHz           MKR MODE TRC SCL         X         Y         FUNCTION         FUNCTION WIDTH         FUNCTION VALUE         Auto         Man           1         N         1         f         2.402 000 GHz         -3.55 dBm	-60.0 <b>*************</b> -70.0								
2         N         1         f         2.441000 GHz         3.59 dBm         Freq Offset           3         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4	#Res BW 270	kHz ×		Y		Sweep 1	.000 ms (	3001 pts)	5.000000 MHz
	2 N 1 f 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	2.40	1 000 GHz	-3.58 dBm					
ISG STATUS	8 9 10								
	MSG					STATUS	5		

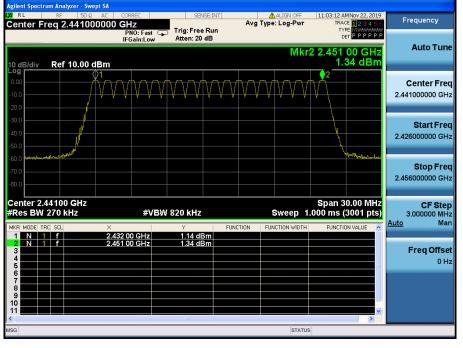
### Number of Hopping Frequencies 2(FH)

### Hopping mode : Enable & 8DPSK



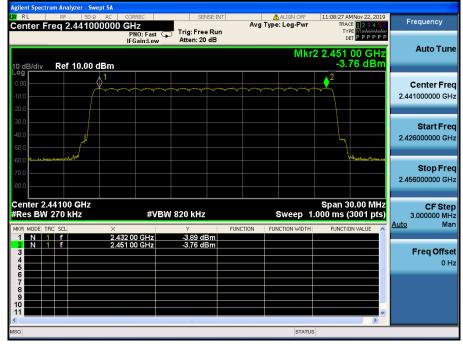
### Number of Hopping Frequencies 1(AFH)

### Hopping mode : Enable & GFSK



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

#### Hopping mode : Enable & π/4DQPSK



### Number of Hopping Frequencies 1(AFH)

## Hopping mode : Enable & 8DPSK

ilent Spectrum Analyzer - Swept						
RL RF 50 Ω A enter Freq 2.441000		SENSE:INT	Avg T	ALIGN OFF	11:11:58 AMNov TRACE	Frequency
) dB/div Ref 10.00 dB	PNO: Fast IFGain:Low	Trig: Free Run Atten: 20 dB		Mkr	2 2.451 00 -3.33	GHZ Auto Tun
	~~~~~~	~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~	2	Center Fre 2.441000000 GF
0.0						<b>Start Fre</b> 2.426000000 GH
0.0					<u> </u>	2.456000000 GH
enter 2.44100 GHz Res BW 270 kHz	X	3W 820 kHz	FUNCTION	Sweep 1.	Span 30.00 000 ms (300 FUNCTION VAL	1 pts) 3.000000 Mi
1 N 1 f 2 N 1 f 3 4 4 5 6	2.432 00 GHz 2.451 00 GHz	-3.70 dBm -3.33 dBm				Freq Offs
7 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9						×
3				STATUS	, 1	

## 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 Trace = max hold Detector function = peak

## 6.4 Test Results

#### FH mode

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	79	2.880	3.750	0.299
	2 DH 5	79	2.880	3.750	0.307
	3 DH 5	79	2.880	3.750	0.307

AFH mode

Hopping mode	Packet Type	Number of hopping Channels	Burst On Time (ms)	Period (ms)	Test Result (sec)
Enable	DH 5	20	2.880	3.750	0.154
	2 DH 5	20	2.880	3.750	0.154
	3 DH 5	20	2.880	3.750	0.154

Note 1 : Dwell Time =  $0.4 \times$  Hopping channel × Burst ON time ×

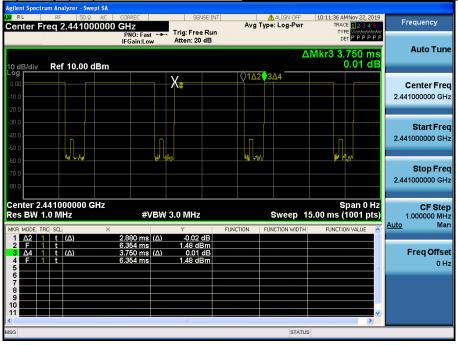
((Hopping rate ÷ Time slots) ÷ Hopping channel)

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

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

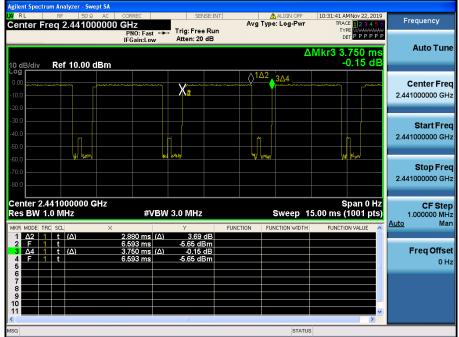


### Time of Occupancy (FH)



#### Time of Occupancy (FH)

### Hopping mode : Enable & 2-DH5

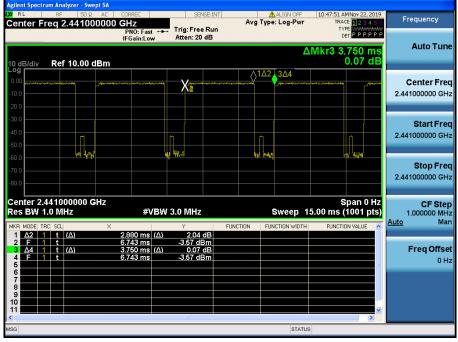


### Hopping mode : Enable & DH5



### Hopping mode : Enable & 3-DH5

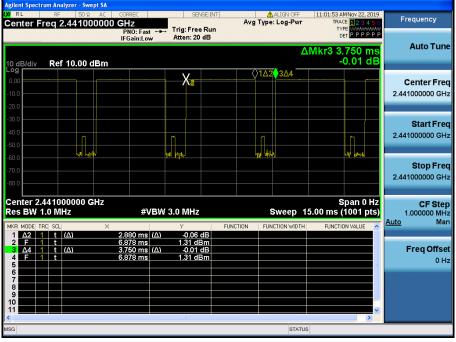
### Time of Occupancy (FH)





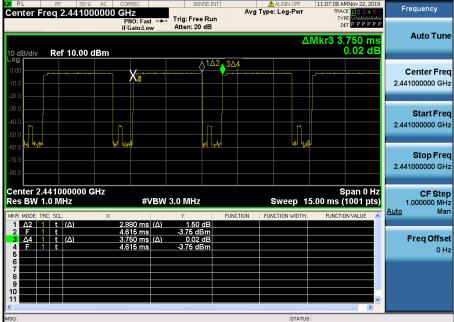
### Hopping mode : Enable & DH5

### Time of Occupancy (AFH)



#### Time of Occupancy (AFH)

# Hopping mode : Enable & 2-DH5 SENSE:INT ALIGN OFF 11107:09 AMINV 22, 2019 Frequency Avg Type: Log Pwr TRACE DEGREE Frequency





### Time of Occupancy (AFH)

### Hopping mode : Enable & 3-DH5

