TE	ST	RE	PO	RT

	DT&C Co., Ltd.					
<b>Dt&amp;C</b>	42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042 Tel : 031-321-2664, Fax : 031-321-1664					
1. Report No : DRTFCC2201-0030						
2. Customer						
• Name (FCC) : HYUNDAI MOBIS CO	., LTD. / Name (IC) : Hyundai MOBIS Co., Ltd					
	angnam-gu Seoul South Korea 135-977 gnam-gu Seoul 135-977 Korea (Republic Of)					
3. Use of Report : FCC & IC Certific	ation					
4. Product Name / Model Name : DI FCC ID : TQ8-DA330SNAN IC : 5074A-DA330SNKN	SPLAY CAR SYSTEM / DA330SNAN(FCC), DA330SNKN(IC)					
5. FCC Regulation(s): Part 15.247 IC Standard(s): RSS-247 Issue 2, Test Method used: KDB558074 D						
6. Date of Test : 2021.12.21 ~ 2022.	01.18					
7. Location of Test : 🛛 Permanent	Testing Lab 🔲 On Site Testing					
8. Testing Environment : See appen	ded test report.					
9. Test Result : Refer to the attache	d test result.					
The results shown in this test report refe This test report is not related to KOLAS	er only to the sample(s) tested unless otherwise stated. accreditation.					
Affirmation Tested by	Reviewed by					
Name : ChangWon Lee	(Signature) Name : JaeJin Lee					
	2022.01.27.					
	DT&C Co., Ltd.					
If this report is required to co	onfirmation of authenticity, please contact to report@dtnc.net					



# **Test Report Version**

Test Report No.	Date	Description	Revised by	Reviewed by
DRTFCC2201-0030	Jan. 27, 2022	Initial issue	ChangWon Lee	JaeJin Lee



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APPENDIX I	

## **1. General Information**

## 1.1. Description of EUT

Equipment Class	DSS-Part 15 Spread Spectrum Transmitter
Product Name	DISPLAY CAR SYSTEM
Model Name(FCC)	DA330SNAN
Model Name(IC)	DA330SNKN
Add Model Name(FCC)	DA331SNEG, DA334SPIG, DA335SPIG, DA332SPGG, DA333SPGG, DA334SPGG, DA335SPGG, DA336SPGG, DA337SPGG, DA330SPGN
Add Model Name(IC)	DA335SNGG, DA336SNGG, DA332SNGN, DA331SNFN, DA331SNGL, DA337SNGG, DA338SNGG, DA335SNGN, DA335SNEP, DA336SNEP, DA337SNEP
Firmware Version Identification Number	1.0
EUT Serial Number	Conducted : T026329, Radiated : T026331
Power Supply	DC 14.4 V
Frequency Range	2 402 MHz ~ 2 480 MHz
Max. RF Output Power	2.09 dBm (0.002 W)
Modulation Technique (Data rate)	GFSK(1 Mbps), π/4DQPSK(2 Mbps), 8DPSK(3 Mbps)
Number of Channels	79
Antenna Specification	Antenna Type: PCB Pattern Antenna Gain: -0.18 dBi (PK)

## 1.2. Declaration by the applicant / manufacturer

- NA

## **1.3. 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 Part 2.948 according to ANSI C63.4-2014.

#### - FCC & IC MRA Designation No. : KR0034

#### - ISED#: 5740A

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

## **1.4. Testing Environment**

Ambient Condition		
Temperature	+21 ℃ ~ +25 ℃	
<ul> <li>Relative Humidity</li> </ul>	37 % ~ 41 %	

## **1.5. 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.

Parameter	Measurement uncertainty
Antenna-port conducted emission	1.0 dB (The confidence level is about 95 %, $k = 2$ )
Radiated emission (1 GHz Below)	4.9 dB (The confidence level is about 95 %, $k = 2$ )
Radiated emission (1 GHz ~ 18 GHz)	5.0 dB (The confidence level is about 95 %, $k = 2$ )
Radiated emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, k = 2)

## 1.6. 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.

## 1.7. 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).

## **EUT Operation test setup**

Bluetooth tester was used to control the transmit parameters during test.

## **Tested frequency information**

- Hopping Function : Enable

	Tested Frequency (MHz)
Hopping Band	2 402 ~ 2 480

- Hopping Function : Disable

	Tested Frequency (MHz)		
Lowest Channel	2 402		
Middle Channel	2 441		
Highest Channel	2 480		

## 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	21/06/24	22/06/24	US47360812
Spectrum Analyzer	Agilent Technologies	N9020A	20/12/16	21/12/16	MY48011700
Spectrum Analyzer	Aglient rechnologies	N9020A	21/12/16	22/12/16	101740011700
Spectrum Analyzer	Agilent Technologies	N9020A	21/06/24	22/06/24	MY50200867
Multimeter	FLUKE	17B+	20/12/16	21/12/16	36390701WS
Wullimeter	FLORE	ПОТ	21/12/16	22/12/16	30390701113
Signal Generator	Rohde Schwarz	SMBV100A	20/12/16	21/12/16	255571
Signal Generator	Ronde Schwarz	SIVID V TOUR	21/12/16	22/12/16	200071
Signal Generator	ANRITSU	MG3695C	20/12/16	21/12/16	173501
Signal Generator	ANKII 30	WG3093C	21/12/16	22/12/16	175501
BlueTooth Tester	TESCOM	TC-3000C	20/12/16	21/12/16	3000C000396
Dide tooth tester	TESCOM	10-30000	21/12/16	22/12/16	30000000390
Power Splitter	Anritsu	K241B	20/12/16	21/12/16	1301182
Fower Spiller	Annisu	K241D	21/12/16	22/12/16	1301162
Thormobygromotor	VIAOMI		20/12/16	21/12/16	00080675
Thermohygrometer	XIAOMI	MHO-C201	21/12/16	22/12/16	00089675
Thermohygrometer	BODYCOM	BJ5478	20/12/16	21/12/16	120612-2
Thermohygrometer	BODYCOW	DJ0470	21/12/16	22/12/16	120012-2
DC Power Supply	SM techno	SDP30-5D	21/06/24	22/06/24	305DMG305
DC Power Supply	SM techno	SDP30-5D	21/06/24	22/06/24	305DNF079
DC Power Supply	Agilent Technologies	66332A	21/06/24	22/06/24	MY43000211
Loop Antenna	ETS-Lindgren	6502	21/01/28	23/01/28	00226186
BILOG Antenna	Schwarzbeck	VULB9160	21/12/16	22/12/16	3362
Horn Antenna	ETS-Lindgren	3117	21/06/24	22/06/24	00143278
Horn Antenna	A.H.Systems Inc.	SAS-574	21/06/24	22/06/24	155
Des Area l'élar	1.2	MI A 0440 D04 40	20/12/16	21/12/16	4050007
PreAmplifier	tsj	MLA-0118-B01-40	21/12/16	22/12/16	1852267
Dro Area lifier	H.P	8447D	20/12/16	21/12/16	0044407774
PreAmplifier	п.Р		21/12/16	22/12/16	2944A07774
PreAmplifier	tsj	MLA-1840-J02-45	21/06/24	22/06/24	16966-10728
High Pass Filter	Wainwright Instruments	WHKX10-2838- 3300-18000-60SS	21/06/24	22/06/24	1
High Pass Filter	Wainwright Instruments	WHNX8.0/26.5-6SS	21/06/24	22/06/24	3
Attenuator	Hefei Shunze	SS5T2.92-10-40	21/06/24	22/06/24	16012202
Attenuator	SRTechnology	F01-B0606-01	21/06/24	22/06/24	13092403
Attenuator	Aeroflex/Weinschel	56-3	21/06/24	22/06/24	Y2370
Attenuator	SMAJK	SMAJK-2-3	21/06/24	22/06/24	2
Power Meter Wide Bandwidth Sensor	Anritsu	ML2495A MA2490A	21/06/24	22/06/24	1306007 1249001
Cable	DT&C	Cable	21/01/08 22/01/04	22/01/08 23/01/04	- G-1
Cable	DT&C	Cable	21/01/08 22/01/04	22/01/08 23/01/04	G-2
		SUCOFLEX 100	21/01/08	22/01/08	
Cable	HUBER+SUHNER		22/01/04	23/01/04	G-3
			21/01/08	22/01/08	
Cable	DT&C	Cable	22/01/04	23/01/04	G-4



Туре	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Cable	Radiall	TESTPRO3	21/01/08	22/01/08	M-01
Cable	Raulali	TESTERUS	22/01/04	23/01/04	101-01
Cable	DT&C	Cable	21/01/08	22/01/08	M-02
Cable	DIAC	Cable	22/01/04	23/01/04	101-02
Cable	HUBER+SUHNER	SUCOFLEX 104	21/01/08	22/01/08	M-03
Cable	HUBER+SUHNER		22/01/04	23/01/04	
	lunkeshe	MWX221	21/01/08	22/01/08	- M-07
Cable	Junkosha		22/01/04	23/01/04	
Cabla	HUBER+SUHNER	SUCOFLEX106	21/01/08	22/01/08	M 00
Cable	HUBER+SURNER	SUCOFLEXIUS	22/01/04	23/01/04	M-09
Cable	570.0	0-1-1-	21/01/05	22/01/05	DEC 44
Cable	DT&C	Cable	22/01/04	23/01/04	RFC-44
Test Software	tsj	Radiated Emission Measurement	NA	NA	Version 2.00.0177

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.

## 2. Antenna Requirement

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.

#### **Conclusion:** Comply

The antenna is permanently printed on the PCB. (Refer to Internal Photo file.) Therefore this E.U.T complies with the requirement of Part 15.203

## 3. Summary of Test Results

FCC part section(s)	RSS section(s)	Test Description	Limit (Using in 2400~ 2483.5 MHz)	Test Condition	Status Note 1
15.247(a) 15.247(b)	RSS-247[5.1] RSS-247[5.4]	Maximum Peak Conducted Output Power	Conducted Output For IC		с
		20 dB Bandwidth	NA		С
15.247(a)	RSS-247[5.1]	Carrier Frequency Separation	>= 25 kHz or >= Two thirds of the 20 dB BW, whichever is greater.		с
13.247 (a)	100-247[0.1]	Number of Hopping Channels	>= 15 hops	Conducted	с
		Time of Occupancy	=< 0.4 seconds		С
-	RSS-Gen[6.7]	Occupied Bandwidth (99 %)	NA		с
15.247(d)	RSS-247[5.5]	Unwanted Emissions (Conducted)	The radiated emission to any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density.	-	с
15.247(d) 15.205 15.209	RSS-247[5.5] RSS-Gen[8.9] RSS-Gen[8.10]	Unwanted Emissions (Radiated)	Part 15.209 Limits (Refer to section 9)	Radiated	С
15.207	RSS-Gen[8.8]	AC Power-Line Conducted Emissions	Part 15.207 Limits (Refer to section 10)	AC Line Conducted	NA Note3
15.203	-	Antenna Requirement	Part 15.203 (Refer to section 2)	-	С

Note 2: For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.

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



## 4. Maximum Peak Conducted Output Power

## 4.1. Test Setup

Refer to the APPENDIX I.

## 4.2. 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 2 400 MHz 2 483.5 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 2 400 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 MHz 5 805 MHz band : 1 Watt. For all other frequency hopping systems in the 2 400 MHz 2 483.5 MHz band: 0.125 watts.

### IC Requirements

- RSS-247[5.1] (b), For FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.
- 2. RSS-247[5.4] (b), For FHSS operating in the band 2 400 MHz 2 483.5 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)

## 4.3. 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

## 4.4. Test Results

Modulation	Tested Channel		Average t Power		Output wer	Antenna Gain	e.i.r.p <sup>Note3</sup>
wouldton	Testeu Channer	dBm	mW	dBm	mW	(dBi)	(dBm)
	Lowest	0.39	1.09	1.13	1.30	-0.18	0.95
<u>GFSK</u>	Middle	1.27	1.34	1.99	1.58	-0.18	1.81
	Highest	0.72	1.18	2.09	1.62	-0.18	1.91
	Lowest	-4.81	0.33	-1.77	0.67	-0.18	-1.95
<u>π/4DQPSK</u>	Middle	-3.55	0.44	-0.21	0.95	-0.18	-0.39
	Highest	-3.90	0.41	-0.26	0.94	-0.18	-0.44
	Lowest	-4.80	0.33	-1.15	0.77	-0.18	-1.33
<u>8DPSK</u>	Middle	-3.53	0.44	0.07	1.02	-0.18	-0.11
	Highest	-3.88	0.41	0.05	1.01	-0.18	-0.13

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

Note 3: e.i.r.p =  $P_{cond} + G_{EUT}$ 

 $P_{cond}$  = measured power at feedpoint of the EUT antenna, in dBm (Peak Conducted Output Power) G<sub>EUT</sub> = gain of the EUT radiating element (antenna), in dBi

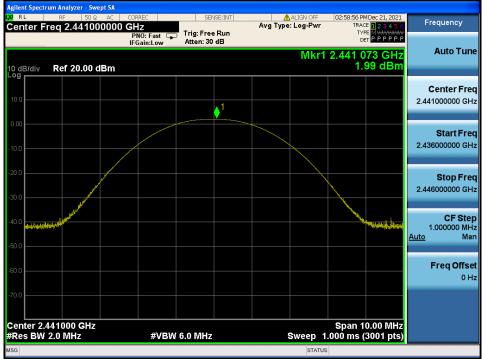


## Lowest Channel & Modulation : GFSK



### **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





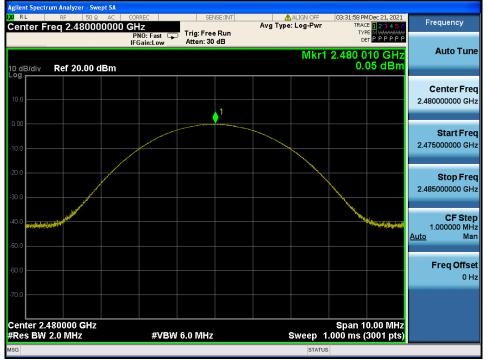








## Highest Channel & Modulation : 8DPSK



## 5. 20 dB BW & Occupied BW

## 5.1. Test Setup

Refer to the APPENDIX I.

## 5.2. Limit

Limit : Not Applicable

## 5.3. Test Procedure

- 1. The 20 dB bandwidth was 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

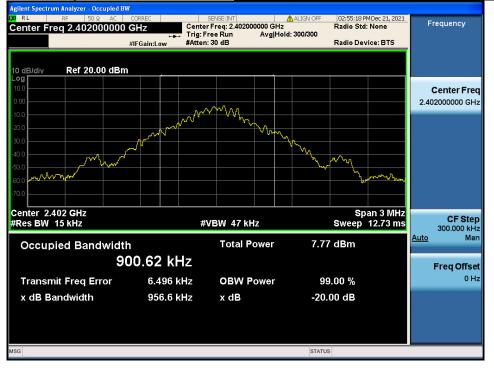
Detector function = peak

Trace = max hold

## 5.4. Test Results

Modulation	Tested Channel	20 dB BW (MHz)	Occupied BW (MHz)
	Lowest	0.957	0.901
<u>GFSK</u>	Middle	0.957	0.893
	Highest	0.950	0.897
	Lowest	1.344	1.212
<u>π/4DQPSK</u>	Middle	1.346	1.214
	Highest	1.347	1.212
	Lowest	1.344	1.216
<u>8DPSK</u>	Middle	1.345	1.216
	Highest	1.346	1.216

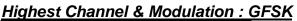


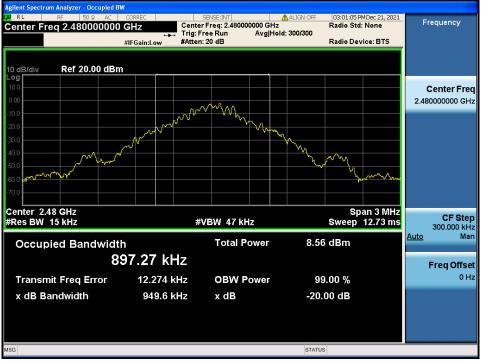


## 20 dB BW & Occupied BW

## Middle Channel & Modulation : GFSK







## 20 dB BW & Occupied BW

## Lowest Channel & Modulation : π/4DQPSK







## 20 dB BW & Occupied BW

## Highest Channel & Modulation : π/4DQPSK







## 20 dB BW & Occupied BW











## 6. Carrier Frequency Separation

## 6.1. Test Setup

Refer to the APPENDIX I.

## 6.2. Limit

Limit : ≥ 25 kHz or ≥ Two-Thirds of the 20 dB BW whichever is greater.

## 6.3. 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 markerdelta function was recorded as the measurement results.

The spectrum analyzer is set to :

Span = wide enough to capture the peaks of two adjacent channels

RBW = Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.

VBW ≥ RBW Sweep = auto

Detector function = peak Trace = max hold

## 6.4. Test Results

### FH mode

Hopping Mode	Modulation	Peak of reference channel(MHz)	Peak of adjacent Channel(MHz)	Test Result (MHz)
	GFSK	2 440.013	2 441.011	0.998
Enable	π/4DQPSK	2 440.012	2 441.014	1.002
	8DPSK	2 441.010	2 442.013	1.003

#### AFH mode

Hopping Mode	Modulation	Peak of reference channel(MHz)	Peak of adjacent Channel(MHz)	Test Result (MHz)
	GFSK	2 441.012	2 442.011	0.999
Enable	π/4DQPSK	2 441.015	2 442.013	0.998
	8DPSK	2 441.013	2 442.010	0.997

Note 1 : See next pages for actual measured spectrum



## Carrier Frequency Separation (FH)

<u>Hopping mode : Enable&GFSK</u>

Agilent Spectrum Analyzer - Swept SA	
M RL         RF         50 Ω         AC         CORREC         SENSE:INT         ▲ALIGN OFF         03:09:53 PM Dec 21, 202           Center Freq 2.441000000 GHz         Avg Type: Log-Pwr         TRACE         23:45         12:345	
PNO: Wide Trig: Free Run 1996 IFGain:Low Atten: 30 dB DET PPPP	
∆Mkr1 998 kH 10 dB/div Ref 20.00 dBm -0.07 dI	2
$\begin{array}{c} \mathbf{L} \mathbf{U} \mathbf{U} \mathbf{U} \mathbf{U} \mathbf{U} \mathbf{U} \mathbf{U} U$	Center Freq 2.441000000 GHz
-20.0	<b>Start Freq</b> 2.439500000 GHz
50.0	Stop Freq
-60.0	2.442500000 GHz
Center 2.441000 GHz Span 3.000 MH #Res BW 51 kHz #VBW 150 kHz Sweep 1.200 ms (3001 pts	300.000 kHz
MKR         MODE         TRC   SCL         X         Y         FUNCTION         FUNCTION VALUE           1         Δ2         1         f         (Δ)         998 kHz         (Δ)         -0.07 dB	Auto Man
2         F         1         f         2.440 013 GHz         1.03 dBm           3         4         5	<b>Freq Offset</b> 0 Hz
6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	
MSG STATUS	

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

## Hopping mode : Enable&π/4DQPSK





## Carrier Frequency Separation (FH)

Hopping mode : Enable&8DPSK

Agilent Spectrum Analyzer - Swept S							
<b>Center Freq 2.4410000</b>		SENSE:INT	Aua	ALIGN OFF		1Dec 21, 2021 E 1 2 3 4 5 6	Frequency
Center Freq 2.4410000	PNO: Wide 🗔	Trig: Free Run		Type. Log-i wi	TYF		
	IFGain:Low	Atten: 30 dB			DE	TFFFFFF	Auto Tune
				ΔN	1kr1 1.0		Auto Tune
10 dB/div Ref 20.00 dBr	n				-(	0.02 dB	
Log 10.0							Conton From
0.00					_1∆2		Center Freq 2.441000000 GHz
		X2-				-	2.441000000 GHz
-10.0			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
-20.0							Start Freq
-30.0							2.439500000 GHz
-40.0							
-50.0							
-60.0							Stop Freq
-70.0							2.442500000 GHz
Center 2.441000 GHz						000 MHz	CF Step
#Res BW 51 kHz	#VBW	150 kHz		Sweep 1	.200 ms (3	3001 pts)	300.000 kHz Auto Man
	×	Y	FUNCTION	FUNCTION WIDTH	FUNCTIO	N VALUE	<u>Auto</u> Man
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1.003 MHz (Δ) .441 010 GHz	-0.02 dB -3.78 dBm					
3							Freq Offset
4 5							0 Hz
6							
8							
9							
11						~	
<						>	
MSG				STATUS			



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

	ım Analyzer - Swep						
Center Fr	RF 50 Ω eq 2.44100		SENSE:II	Avg Typ	ALIGN OFF e: Log-Pwr	03:53:20 PM Dec 21, 2021 TRACE 1 2 3 4 5 6	Frequency
		PNO: Wide IFGain:Low		n		DET PPPPF	
10 dB/div Log	Ref 20.00 d	Bm				∆Mkr1 999 kHz 0.11 dB	
10.0 0.00		~	×2	~			Center Freq 2.441000000 GHz
-20.0 -30.0 -40.0							<b>Start Freq</b> 2.439500000 GHz
-50.0 -60.0 -70.0							<b>Stop Freq</b> 2.442500000 GHz
Center 2.4 #Res BW	41000 GHz 51 kHz	#V	BW 150 kHz		Sweep 1.	Span 3.000 MHz 200 ms (3001 pts)	300.000 kHz
MKR MODE TR	C SCL	× 999 kHz i	γ (Δ) 0.11 dB	FUNCTION FU	NCTION WIDTH	FUNCTION VALUE	Auto Man
2 F 1 3 4 5	f	2.441 012 GHz	1.18 dBm				<b>Freq Offset</b> 0 Hz
6 7 8 9 10 11							
MSG			111		STATUS		

## Carrier Frequency Separation (AFH) <u>Hopping mode : Enable&π/4DQPSK</u>

Agilent Spectr	rum Analy	yzer - Swe	pt SA								
Center F	req 2.	50 Ω 44100	0000 G	ORREC HZ PNO: Wide		e Run	Avg	ALIGN OFF	TRAC	1Dec 21, 2021 E 1 2 3 4 5 6 E MMAAAAA	Frequency
10 dB/div	Ref	20.00 d		FGain:Low	Atten: 3				∆Mkr1 s	98 kHz 0.00 dB	Auto Tu
-og 10.0 0.00		~~~	~~~		~~~~	X2~~					<b>Center Fr</b> 2.441000000 G
20.0 30.0 40.0											<b>Start Fr</b> 2.439500000 G
50.0 50.0 70.0											<b>Stop Fr</b> 2.442500000 G
enter 2. Res BW				#VE	3W 150 kH:	2		Sweep 1	Span 3. .200 ms (	.000 MHz 3001 pts)	CF St 300.000 k
IKR MODE TR	f (	Δ)		998 kHz (		dB	NCTION	FUNCTION WIDTH	FUNCTIO	N VALUE	<u>Auto</u> N
2 F 1 3 4 5	f		2.441 (	15 GHz	-3.75 c	IBm					Freq Offs 0
6 7 8 9 10											
11										×	
SG								STATUS	5		



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

Agilent Spectr	um Analyze	er - Swept SA								
IXI RL	RF	50 Q AC	CORREC	SEN	SE:INT		ALIGN OFF		4Dec 21, 2021 E 1 2 3 4 5 6	Frequency
Center F	req 2.4	4100000	PNO: Wide	Trig: Free		Avg type	. Log-Fwi	TY		
			IFGain:Low		dB			DI	ПРРРРРР	A
								∆Mkr1 §		Auto Tune
10 dB/div	Ref 20	).00 dBm						l	0.03 dB	
Log										
10.0								▲1∆2		Center Freq
0.00	-	$\sim \sim$			(2~) -		~			2.441000000 GHz
-10.0		~ - \	~~~~	~~~~~	12	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	$\sim \sim \sim$		~~~~~	
-20.0										Start Freq
-30.0										2.439500000 GHz
-40.0										2.40000000000
-50.0										
-60.0										Stop Freq
										2.442500000 GHz
-70.0										
Center 2.	441000	GHz						Span 3	.000 MHz	CF Step
#Res BW	51 kHz		#V	BW 150 kHz		Ş	Sweep 1	.200 ms (		300.000 kHz
MKR MODE T	RC SCL	×		Y	FUNCT	ION FUN	ICTION WIDTH	FUNCTIO	IN VALUE	<u>Auto</u> Man
<u>1</u> Δ2 1			997 kHz							
2 F 1	f	2.44	11 013 GHz	-3.72 dE	3m					Freq Offset
4										0 Hz
5									=	
7										
8										
10										
11				ш					~	
MSG							STATU	5		

## 7. Number of Hopping Channels

## 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 2 400 MHz ~ 2 483.5 MHz were examined.

The spectrum analyzer is set to :

Span for FH mode = 50 MHz	Start Frequency = 2 391.5 MHz,	Stop Frequency = 2 441.5 MHz
	Start Frequency = 2 441.5 MHz,	Stop Frequency = 2 491.5 MHz
Span for AFH mode = 30 MHz	Start Frequency = 2 426.0 MHz,	Stop Frequency = 2 456.0 MHz
		ss than 30 % of the channel spacing
or the 20 dB bandwidth, v	vhichever is smaller.	
VBW ≥ RBW	Sweep = auto	
Detector function = peak	Trace = max hold	

## 7.4. 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.



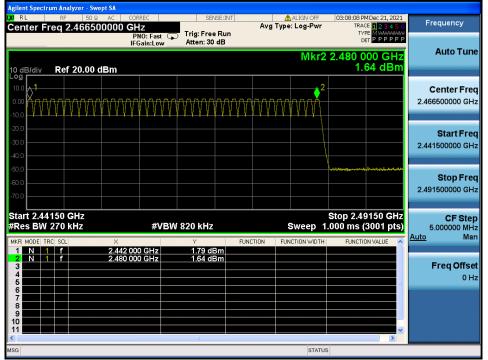
## Number of Hopping Channels 1(FH)

Hopping mode : Enable & GFSK

Agilent Spectrum Analyzer - Swept SA					
				3:06:56 PM Dec 21, 2021	
Center Freq 2.416500000 G	Hz		e: Log-Pwr	TRACE 123456	Frequency
	PNO: Fast 😱 Trig: Fre			TYPE MWWWWW DET P P P P P P	
	FGain:Low Atten: 30	) dB		DET	
			Mkr2.2	441 000 GHz	Auto Tune
			WIN12 2.	1.90 dBm	
10 dB/div Ref 20.00 dBm				1.90 dBm	
Log					
10.0				<u>\</u>	Center Freq
					2.416500000 GHz
	(#VVVVVVVVVV)	*****	*****	****	2.41000000000112
-10.0	<u> </u>	<u>, , , , , , , , , , , , , , , , , , , </u>	*****	<u> </u>	
-20.0					
					Start Freq
-30.0					2.391500000 GHz
-40.0					
-50.0					
-60.0					Stop Freq
					2.441500000 GHz
-70.0					
Start 2.39150 GHz			Sto	op 2.44150 GHz	CF Step
#Res BW 270 kHz	#VBW 820 kHz			0 ms (3001 pts)	5.000000 MHz
			encop nee		Auto Man
MKR MODE TRC SCL X	Y		NCTION WIDTH	FUNCTION VALUE	<u>Auto</u> man
	00 GHz 1.05 d				
	00 GHz 1.90 di	Bm			E
3					Freq Offset
4					0 Hz
6					
7					
8					
9					
10					
11				~	
<				>	
MSG			STATUS		

## Number of Hopping Channels 2(FH)

Hopping mode : Enable & GFSK





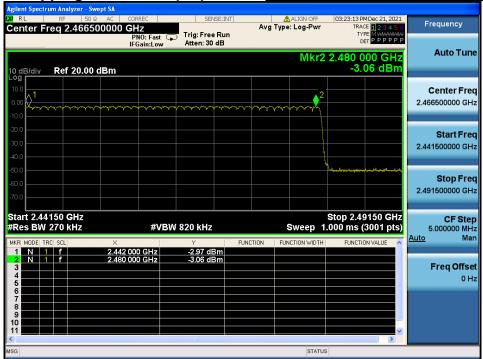
## Number of Hopping Channels 1(FH)

## Hopping mode : Enable&π/4DQPSK

Agilent Spectrum Analyzer - Swe					
		SENSE:INT	ALIGN OFF	03:22:00 PM Dec 21, 2021 TRACE 1 2 3 4 5 6 TYPE MWWWW	Frequency
10 dB/div Ref 20.00 d	PNO: Fast G	☐ Trig: Free Run Atten: 30 dB	Mkr2	2.441 000 GHz -2.91 dBm	Auto Tune
10.0 0.00 -10.0				·····	Center Freq 2.416500000 GHz
-20.0 -30.0 -40.0					Start Freq 2.391500000 GHz
-50.0 -60.0 -70.0					<b>Stop Freq</b> 2.441500000 GHz
Start 2.39150 GHz #Res BW 270 kHz	#VBV	<b>820 kHz</b>		Stop 2.44150 GHz .000 ms (3001 pts) FUNCTION VALUE	CF Step 5.000000 MHz <u>Auto</u> Man
1 N 1 f 2 N 1 f 3 4 5 6	2.402 000 GHz 2.441 000 GHz	-4.13 dBm -2.91 dBm			<b>Freq Offset</b> 0 Hz
7 8 9 10 11				~	
MSG			STATUS		

## Number of Hopping Channels 2(FH)

## Hopping mode : Enable &π/4DQPSK





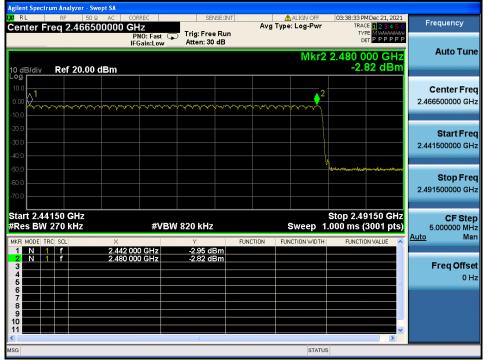
## Number of Hopping Channels 1(FH)

## Hopping mode : Enable&8DPSK

	Spectrur		ılyzer - Swo									
LXI RL		RF	50 Ω		CORREC	SEN	SE:INT		ALIGN OFF		4Dec 21, 2021	Frequency
Cent	er Fre	eq 2	2.41650	00000		<b>T</b>	-	Avg Typ	e: Log-Pwr	TRA	E 123456	Frequency
					PNO: Fast G	Trig: Free Atten: 30				D		
					IFGain:Low	Atten: 30	a0					Auto Tune
									Mkr2	2.441 0	00 GHz	Auto Tune
10 dB	(diu	Dof	20.00	dBm							75 dBm	
Log	July	Rei	20.00									
10.0												Center Freq
				⊿1							2	-
0.00				X		mm	www.		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	1 mm	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	2.416500000 GHz
-10.0				have	~~~~~							
-20.0												
-20.0												Start Freq
-30.0												2.391500000 GHz
-40.0												2.031000000 0112
-50.0			الجيل محمودهم									
-60.0												Stop Freq
												2.441500000 GHz
-70.0												
L L												
	2.391										150 GHz	CF Step
#Res	BW 2	270	kHz		#VB\	N 820 kHz			Sweep 1	l.000 ms (	3001 pts)	5.000000 MHz
MKD M	ODE TRC	l en		×		Y	ELIN	CTION   FU	NCTION WIDTH	EUNCTI	IN VALUE	<u>Auto</u> Man
	N 1	f			000 GHz	-3.92 di			NCTION WIDTH	Token	IN VALUE	
	N 1	f		2.441	000 GHz	-2.75 di	3m					
3												Freq Offset
4												0 Hz
5											=	
6												
8												
9												
10												
11											~	
		_									>	
MSG									STATU	S		
									A succession of the second sec			

## Number of Hopping Channels 2(FH)

## Hopping mode : Enable & 8DPSK





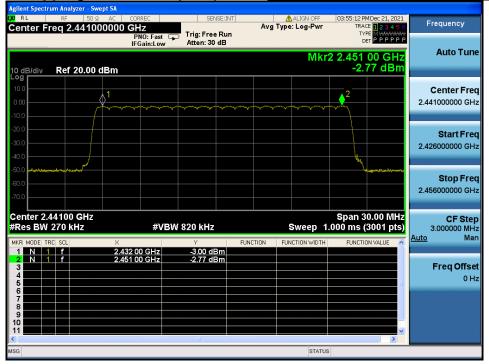
## Number of Hopping Channels 1(AFH)

Hopping mode : Enable & GFSK

Agilent Spectrum Analyzer - Swept SA					
LX/RL RF 50Ω AC	CORREC	SENSE:INT	🛕 ALIGN OFF	03:49:51 PM Dec 21, 2021	Frequency
Center Freq 2.441000000	GHz		Avg Type: Log-Pwr	TRACE 1 2 3 4 5 6	Frequency
		Trig: Free Run Atten: 30 dB			
	IFGain:Low	Atten: 30 dB			A
			Mkr	2 2.451 00 GHz	Auto Tune
				2.06 dBm	
10 dB/div Ref 20.00 dBm				2.00 GDII	
				.2	
10.0					Center Freq
	$\gamma m m m$	$\neg \neg \neg \neg \neg \neg$	n - n - n - n - n - n - n - n - n - n -		2.441000000 GHz
	V V V V V	$\vee$ $\vee$ $\vee$ $\vee$ $\vee$	V $V$ $V$ $V$ $V$ $V$ $V$ $V$ $V$ $V$	$\mathcal{M}$	
-10.0	<u> </u>	<u> </u>	<u> </u>	* \	
-20.0					
					Start Freq
-30.0				4	2.426000000 GHz
-40.0				Y	
				٩, ١	
-50.0				Te development to specify the pro-	
-60.0					Stop Freq
					2.456000000 GHz
-70.0					
Center 2.44100 GHz				Span 30.00 MHz	CF Step
#Res BW 270 kHz	#VBW 8	20 kHz	Sweep 1.	000 ms (3001 pts)	3.000000 MHz
					Auto Man
MKR MODE TRC SCL X		Y FUNC	TION FUNCTION WIDTH	FUNCTION VALUE	Mari
1 N 1 f 2.43	2 00 GHz	1.84 dBm			
	1 00 GHz	2.06 dBm			En a Offerst
3					Freq Offset
4 5					0 Hz
6				=======================================	
7					
8					
9					
10					
11				×	
<		ш		>	
MSG			STATUS		

## Number of Hopping Channels 1(AFH)

## Hopping mode : Enable &π/4DQPSK





## Number of Hopping Channels 1(AFH) Hopping mode : Enable & 8DPSK

Agilent Spect									
LXI RL	RF	50 Ω AC	CORREC	SENS	SE:INT	ALIGN OFF		MDec 21, 2021	Frequency
Center F	req 2.4	4100000	0 GHz			vg Type: Log-Pwr	TRA	<sup>CE</sup> 123456	Frequency
			PNO: Fast IFGain:Low	Trig: Free Atten: 30 (			D	PE MWWWWWW ET P P P P P P	
			IFGain:Low	Atten. 30 G	20				Auto Tune
						Mki	r2 2.451		Autorune
10 dB/div	Ref 20	.00 dBm					-2.	65 dBm	
Log									
10.0							<u> </u>		Center Freq
		1					▲2		
0.00		Å	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	v-v-v-v-		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	mar and a		2.441000000 GHz
-10.0									
-20.0									
									Start Freq
-30.0									2.426000000 GHz
-40.0									
		N					μų.		
-50.0		<u> </u>					٦,	and and the property of the second	
-60.0									Stop Freq
-70.0									2.456000000 GHz
-70.0									
Center 2.						_		0.00 MHz	CF Step
#Res BW	270 kH	Z	#VE	W 820 kHz		Sweep 7	1.000 ms (	3001 pts)	3.000000 MHz
MKR MODE T	BCI SCI I	×		Y	FUNCTION	FUNCTION WIDTH	EUNCTI	ON VALUE	<u>Auto</u> Man
	1 f		.432 00 GHz	-2.75 dB		Tonenon wom	l longin		
2 N *	1 f		.451 00 GHz	-2.65 dB					
3									Freq Offset
4									0 Hz
5								=	
7									
8									
9									
10									
11								~	
<									
MSG						STATU	JS		

## 8. Time of Occupancy

## 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 = 2 441 MHz

Span = zero

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

VBW ≥ RBW

Detector function = peak

Trace = max hold

## 8.4. Test Results

#### FH mode

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

AFH mode

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

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

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

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

- Hopping Rate = 1 600 for FH mode & 800 for AFH mode

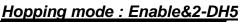
Note 2 : See next pages for actual measured spectrum plots.

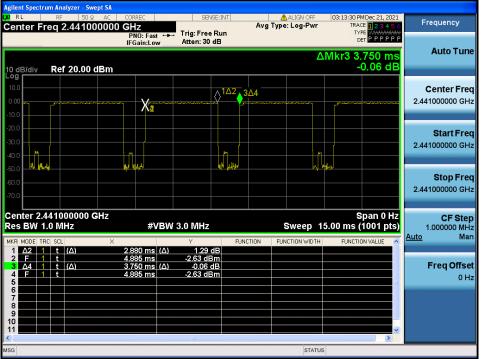


## Time of Occupancy (FH)

		ctrun		alyzer -																	
LXI RI Cen		Ere	RF	5 2.441	ם ב החחו		CORREC	2		SE	NSE:IN	Т	Avg.		ALIGN OFF	02:5		4Dec 21, E 1 2 3			Frequency
CCI	LGI	пс	ч <i>2</i>		000	000	PNO:	Fast ←		Frig: Fre Atten: 30							TYE	E WWW	<b>WWW</b>		
		_					IFGair	n:Low	_	Atten: 30									_		Auto Tune
															2	INK		750 0.03			
10 dE Log	3/div		Ref	20.0	V aB	m												0.00	uв		
10.0	<u> </u>												<mark>1</mark> 4	2	3∆4						Center Freq
0.00			+							X	-		¥	-			_		=		2.441000000 GHz
-10.0	<u> </u>																				
-20.0																					Start Freq
-30.0																					2.441000000 GHz
-40.0									-11				- I n					1			2.441000000 8112
-50.0				կ հղ	1				w had	h			- pł k	nyya			- 4	Maya			
-60.0																					Stop Freq
-70.0																					2.441000000 GHz
				0000	) GH	z				0 B4U							S	pan 0	Hz		CF Step
Res				HZ				#VB	W 3.	0 MHz				,	Sweep 1		```		ots)		1.000000 MHz Auto Man
MKR I	MODE	TRC		(A)		Х	2 000	ms (∆	,	Y -0.21	dD	FUNC	TION	FUN	ICTION WIDTH	F	UNCTIO	IN VALUE	^	-	
2	F	1	ť				6.548	ms		1.97 d	Bm										
3 4	<u>∆4</u> F	1	t	( <u></u> )			3.750 6.548	ms (∆ ms	)	-0.03 1.97 d											Freq Offset 0 Hz
5																			=		0 Hz
7																					
8			_																		
10																					
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MSG															STATU	s			_		
	_	_	_	_	_	_	_	_	_		_	_	_	_		-	_	_	_		

## Time of Occupancy (FH)





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## Hopping mode : Enable&DH5



## Time of Occupancy (FH)

## Hopping mode : Enable&3-DH5

Agilent Spectrum Analyzer - Swept SA	000050		ALIGN OFF		
Center Freq 2.441000000		SENSE:INT	Avg Type: Log-Pwr	03:28:43 PM Dec 21, 2021 TRACE 1 2 3 4 5 6	Frequency
Center Freq 2.44 1000000	PNO: Fast +++	Trig: Free Run		TYPE WAAAAAAAAA	
	IFGain:Low	Atten: 30 dB		DETPPPP	
			Δ	Mkr3 3.750 ms	Auto Tune
10 dB/div Ref 20.00 dBm			_	-0.07 dB	
Log					
10.0		142			Center Freq
0.00			3∆4		2.441000000 GHz
	Xa	and the second of the second o			2.441000000 GHZ
-10.0					
-20.0					Otart Errar
-30.0					Start Freq
					2.441000000 GHz
-40.0		fi			
-50.0 ///	ya parv	by by the	ц Ļ <sub>А</sub>	al <sup>th</sup> i	
-60.0					Stop Freq
-70.0					2.441000000 GHz
-70.0					
Center 2.441000000 GHz				Span 0 Hz	0.5.01
Res BW 1.0 MHz	#VBM	3.0 MHz	Sween 1	5.00 ms (1001 pts)	CF Step 1.000000 MHz
			-		Auto Man
MKR MODE TRC SCL X	0.000		NCTION FUNCTION WIDTH	FUNCTION VALUE	<u>riato</u> man
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	2.880 ms (∆) 5.020 ms	2.00 dB -2.77 dBm			
$3 \Delta 4 1 t (\Delta)$	3.750 ms (Δ)	-0.07 dB			Freq Offset
4 F 1 t	5.020 ms	-2.77 dBm			0 Hz
5				3	
7					
8					
9					
11				~	
<				>	
MSG			STATU	5	
				1	

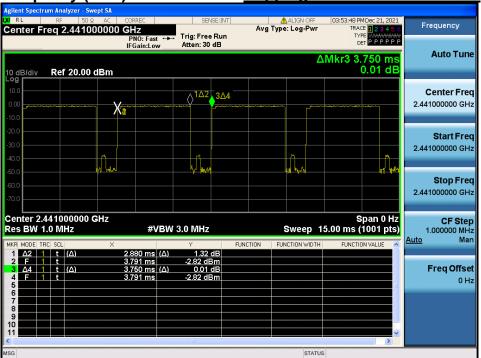


## Time of Occupancy (AFH)

Hopping mode : Enable&DH5

Agilent Spectr											
LXI RL	RF	50 Ω A			SENSE:I	T		ALIGN OFF		IDec 21, 2021	Frequency
Center F	req 2.4	410000			Trig: Free Ru		Avg Typ	e: Log-Pwr		E 123456	rrequerrey
			PNO: Fast IFGain:Low		Atten: 30 dB				DE	ΤΡΡΡΡΡ	
				_				•	Mkr3 3.	750	Auto Tune
								Δ		0.04 dB	
10 dB/div Log	Ref 2	0.00 dBr	n							J.04 UB	
10.0					1/	2,3∆4					0
					()						Center Freq
0.00			X <u>a</u>								2.441000000 GHz
-10.0											
-20.0											
-30.0											Start Freq
								M	(		2.441000000 GHz
-40.0					—						
-50.0 M Josef			VU Kang		<u> </u>	แห		ling lans	•		
-60.0											Stop Freq
-70.0											2.441000000 GHz
-70.0											
Center 2.	441000	000 CH7	i							pan 0 Hz	OF Otom
Res BW 1				BW 3	.0 MHz			Sweep 1	5 00 ms (	1001 nts)	CF Step 1.000000 MHz
											Auto Man
MKR MODE T			×	( • )	Y O OO JID	FUNC	TION FU	NCTION WIDTH	FUNCTIO	N VALUE	<u>- 1010</u>
1 <u>Δ2</u> 1 2 F 1	t (∆	)	2.880 ms 4.600 ms	( <u>  </u> )	0.00 dB 2.17 dBm						
<b>3</b> ∆4 1	t (∆	)	3.750 ms	(Δ)	0.04 dB						Freq Offset
4 F 1			4.600 ms		2.17 dBm					_	0 Hz
6											
7											
8											
10											
11										~	
<										>	
MSG								STATUS			

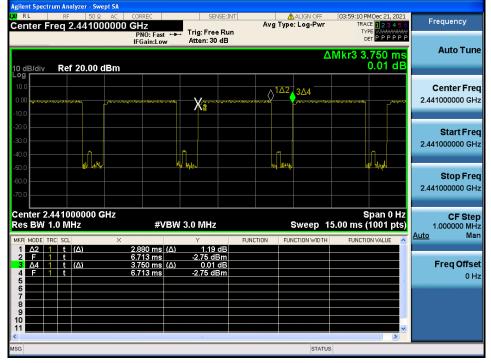






## Time of Occupancy (AFH)

Hopping mode : Enable&3-DH5





З

## 9. Unwanted Emissions

## 9.1. Test Setup

Refer to the APPENDIX I.

Above 960

## 9.2. Limit

Part 15.247(d), Part 15.205, Part 15.209 & RSS-247 [5.5], RSS-Gen [8.9], RSS-Gen [8.10] 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 Part 15.247 the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

#### - Part 15.209 & RSS-Gen[8.9]: General requirement IC Limit (µA/m) Measurement Distance (m) Frequency (MHz) FCC Limit (uV/m) 2 400 / F (kHz) 0.009 - 0.4906.37/F (F in kHz) 300 0.490 - 1.7052 4000 / F (kHz) 63.7/F (F in kHz) 30 1.705 - 30.0 30 0.08 30

Frequency (MHz)	FCC Limit (uV/m)	IC Limit (uV/m)	Measurement Distance (m)
30 ~ 88	100 **	100	3
88 ~ 216	150 **	150	3
216 ~ 960	200 **	200	3

500

\*\*Except as provided in paragraph (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.

500

#### - Part 15.205(a): Restricted band of operation

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.414 25 ~ 8.414 75	108 ~ 121.94	1 300 ~ 1 427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1 435 ~ 1 626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.173 5 ~ 2.190 5	12.519 75 ~ 12.520 25	149.9 ~ 150.05	1 645.5 ~ 1 646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.576 75 ~ 12.577 25	156.524 75 ~ 156.525 25	1 660 ~ 1 710	8.025 ~ 8.5	22.01 ~ 23.12
4.177 25 ~ 4.177 75	13.36 ~ 13.41	156.7 ~ 156.9	1 718.8 ~ 1 722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.207 25 ~ 4.207 75	16.42 ~ 16.423	162.012 5 ~ 167.17	2 200 ~ 2 300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.694 75 ~ 16.695 25	167.72 ~ 173.2	2 310 ~ 2 390	10.6 ~ 12.7	36.43 ~ 36.5
6.267 75 ~ 6.268 25	16.804 25 ~ 16.804 75	240 ~ 285	2 483.5 ~ 2 500	13.25 ~ 13.4	Above 38.6
6.311 75 ~ 6.312 25	25.5 ~ 25.67	322 ~ 335.4	2 655 ~ 2 900		
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3 260 ~ 3 267		
8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3 332 ~ 3 339		
8.376 25 ~ 8.386 75	74.8 ~ 75.2	960 ~ 1 240	3 345.8 ~ 3 358		
			3 600 ~ 4 400		

#### - RSS-GEN[8.10]: Restricted frequency bands

MHz	MHz	MHz	MHz	MHz	GHz
0.090 ~ 0.110	8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3 345.8 ~ 3 358	9.0 ~ 9.2
0.495 ~ 0.505	8.376 25 ~ 8.386 75	74.8 ~ 75.2	960 ~ 1 427	3 500 ~ 4 400	9.3 ~ 9.5
2.173 5 ~ 2.190 5	8.414 25 ~ 8.414 75	108 ~ 138	1 435 ~ 1 626.5	4 500 ~ 5 150	10.6 ~ 12.7
3.020 ~ 3.026	12.29 ~ 12.293	149.9 ~ 150.05	1 645.5 ~ 1 646.5	5 350 ~ 5 460	13.25 ~ 13.4
4.125 ~ 4.128	12.519 75 ~ 12.520 25	156.524 75 ~	1 660 ~ 1 710	7 250 ~ 7 750	14.47 ~ 14.5
4.177 25 ~ 4.177 75	12.576 75 ~ 12.577 25	156.525 25	1 718.8 ~ 1 722.2	8 025 ~ 8 500	15.35 ~ 16.2
4.207 25 ~ 4.207 75	13.36 ~ 13.41	156.7 ~ 156.9	2 200 ~ 2 300		17.7 ~ 21.4
5.677 ~ 5.683	16.42 ~ 16.423	162.01 25 ~ 167.17	2 310 ~ 2 390		22.01 ~ 23.12
6.215 ~ 6.218	16.694 75 ~ 16.695 25	167.72 ~ 173.2	2 483.5 ~ 2 500		23.6 ~ 24.0
6.267 75 ~ 6.268 25	16.804 25 ~ 16.804 75	240 ~ 285	2 655 ~ 2 900		31.2 ~ 31.8
6.311 75 ~ 6.312 25	25.5 ~ 25.67	322 ~ 335.4	3 260 ~ 3 267		36.43 ~ 36.5
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3 332 ~ 3 339		Above 38.6

## 9.3. Test Procedures

### 9.3.1. Test Procedures for Unwanted Emissions(Radiated)

- The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 1 or 3 meter away from the interference-receiving antenna.
- 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.
- 5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 7. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

#### **Measurement Instrument Setting**

- Frequencies less than or equal to 1 000 MHz The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasipeak detection (QP) at frequency below 1 GHz.
- Frequencies above 1 000 MHz
   The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
   The result of Average measurement is calculated using PK result and duty correction factor.



### 9.3.2. Test Procedures for Unwanted Emissions(Conducted)

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

Frequency range : 9 kHz ~ 30 MHz RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40 001

Frequency range : 30 MHz ~ 10 GHz, 10 GHz ~ 25 GHz RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40 001

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

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2 001 to get accurate emission level within 100 kHz BW.

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

## 9.4. Test Results

## 9.4.1. Unwanted Emissions(Radiated)

#### Test Notes.

1. The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found below listed frequencies.

2. Information of Distance Correction Factor

For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.

In this case, the distance correction factor is applied to the result.

- Calculation of distance factor

At frequencies below 30 MHz = 40 log(tested distance / specified distance)

At frequencies at or above 30 MHz = 20 log(tested distance / specified distance)

When distance factor is "N/A", the measurements were performed at the specified distance and distance factor is not applied. 3. DCCF Calculation. (DCCF = Duty Cycle Correction Factor)

- Time to cycle through all channels =  $\Delta t$  = T [ms] X 20 minimum hopping channels , where T = pulse width = 2.88 ms

- 100 ms / Δt [ms] = H -> Round up to next highest integer, to account for worst case, H' = 100 / (2.88 X 20) = 1.74 = 2

- The Worst Case Dwell Time = T [ms] x H' = 2.88 ms X 2 = 5.76 ms

- DCCF = 20 Log(The Worst Case Dwell Time / 100 ms) dB = 20 log( 5.76 / 100 ) = -24.79 dB

4. Sample Calculation.

Margin = Limit - Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL - AG

Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss,

AL = Attenuator Loss, DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

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

#### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 388.84	V	Х	PK	49.46	4.46	N/A	N/A	53.92	74.00	20.08
2 388.84	V	Х	AV	49.46	4.46	-24.79	N/A	29.13	54.00	24.87
4 803.27	V	Х	PK	50.12	2.40	N/A	N/A	52.52	74.00	21.48
4 803.27	V	Х	AV	50.12	2.40	-24.79	N/A	27.73	54.00	26.27

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4 882.04	V	Х	PK	49.66	2.38	N/A	N/A	52.04	74.00	21.96
4 882.04	V	Х	AV	49.66	2.38	-24.79	N/A	27.25	54.00	26.75

Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 484.05	V	Х	PK	49.95	5.40	N/A	N/A	55.35	74.00	18.65
2 484.05	V	Х	AV	49.95	5.40	-24.79	N/A	30.56	54.00	23.44
4 961.03	V	Х	PK	50.05	2.45	N/A	N/A	52.50	74.00	21.50
4 961.03	V	Х	AV	50.05	2.45	-24.79	N/A	27.71	54.00	26.29



#### 9 kHz ~ 25 GHz Data (Modulation : $\pi$ /4DQPSK)

Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 389.01	V	Х	PK	49.31	4.46	N/A	N/A	53.77	74.00	20.23
2 389.01	V	Х	AV	49.31	4.46	-24.79	N/A	28.98	54.00	25.02
4 802.52	V	Х	PK	50.00	2.40	N/A	N/A	52.40	74.00	21.60
4 802.52	V	Х	AV	50.00	2.40	-24.79	N/A	27.61	54.00	26.39

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4 882.04	V	Х	PK	49.15	2.38	N/A	N/A	51.53	74.00	22.47
4 882.04	V	Х	AV	49.15	2.38	-24.79	N/A	26.74	54.00	27.26

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 484.26	V	Х	PK	50.01	5.41	N/A	N/A	55.42	74.00	18.58
2 484.26	V	Х	AV	50.01	5.41	-24.79	N/A	30.63	54.00	23.37
4 960.67	V	Х	PK	49.73	2.45	N/A	N/A	52.18	74.00	21.82
4 960.67	V	Х	AV	49.73	2.45	-24.79	N/A	27.39	54.00	26.61



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

#### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 389.35	V	Х	PK	49.52	4.46	N/A	N/A	53.98	74.00	20.02
2 389.35	V	Х	AV	49.52	4.46	-24.79	N/A	29.19	54.00	24.81
4 804.71	V	Х	PK	50.05	2.40	N/A	N/A	52.45	74.00	21.55
4 804.71	V	Х	AV	50.05	2.40	-24.79	N/A	27.66	54.00	26.34

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4 881.03	V	Х	PK	49.65	2.35	N/A	N/A	52.00	74.00	22.00
4 881.03	V	Х	AV	49.65	2.35	-24.79	N/A	27.21	54.00	26.79

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2 483.60	V	Х	PK	49.72	5.40	N/A	N/A	55.12	74.00	18.88
2 483.60	V	Х	AV	49.72	5.40	-24.79	N/A	30.33	54.00	23.67
4 959.86	V	Х	PK	49.42	2.45	N/A	N/A	51.87	74.00	22.13
4 959.86	V	Х	AV	49.42	2.45	-24.79	N/A	27.08	54.00	26.92