TEST REPORT

	DT&C Co., Ltd.
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1. Report No : DRTFCC2207-07	128
2. Customer	
Name (FCC) : SENA TECHNOLO	GIES.Inc / Name (IC) : SENA TECHNOLOGIES.Inc
	569-gil, Gangnam-gu Seoul South Korea 9-gil, Gangnam-gu Seoul 137-130 Korea (Republic Of)
3. Use of Report : FCC & IC Certi	fication
4. Product Name / Model Name : FCC ID : S7A-SP109 IC : 8154A-SP109	M1 / SP109
5. FCC Regulation(s): Part 15.24 IC Standard(s): RSS-247 Issue Test Method used: KDB558074	
6. Date of Test : 2022.04.22 ~ 202	22.07.12
7. Location of Test : 🛛 Permane	nt Testing Lab 🔲 On Site Testing
8. Testing Environment : See app	ended test report.
9. Test Result : Refer to the attack	ned test result.
The results shown in this test report r This test report is not related to KOL/	efer only to the sample(s) tested unless otherwise stated.
Tested by	Technical Manager
Affirmation Name : JaeHyeok Bang	(Signature) Name : JaeJin Lee (Signature)
	2022.07.21.
	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	Revised by	Reviewed by
DRTFCC2207-0128	Jul. 21, 2022	Initial issue	JaeHyeok Bang	JaeJin Lee



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1. General Information

1.1. Description of EUT

Equipment Class	DSS-Part 15 Spread Spectrum Transmitter
Product Name	M1
Model Name	SP109
Add Model Name	-
Firmware Version Identification Number	1.0
EUT Serial Number	No Specified
Power Supply	DC 3.8 V
Frequency Range	2 402 MHz ~ 2 480 MHz
Max. RF Output Power	17.54 dBm (0.057 W)
Modulation Technique (Data rate)	GFSK(1 Mbps), π/4DQPSK(2 Mbps), 8DPSK(3 Mbps)
Number of Channels	79
Antenna Specification	Antenna Type: Chip Antenna Gain: 0.30 dBi (PK)

1.2. Declaration by the applicant / manufacturer

- NA

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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	+20 °C ~ +27 °C
 Relative Humidity 	34 % ~ 42 %

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	0.9 dB (The confidence level is about 95 %, $k = 2$)
AC power-line conducted emission	3.4 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, π /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

- Test Software: BlueTest3_3.3.5.817
- Power setting: 16

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	22/06/24 23/06/24	US47360812
Spectrum Analyzer	Agilent Technologies	N9020A	21/12/16	22/12/16	MY48010133
Spectrum Analyzer	Agilent Technologies	N9020A	21/12/16	22/12/16	MY48011700
DC Power Supply	Agilent Technologies	66332A	21/06/24 22/06/24	22/06/24 23/06/24	US37473422
Multimeter	FLUKE	17B+	21/12/16	22/12/16	36390701WS
Signal Generator	Rohde Schwarz	SMBV100A	21/12/16	22/12/16	255571
Signal Generator	ANRITSU	MG3695C	21/12/16	22/12/16	173501
Thermohygrometer	BODYCOM	BJ5478	21/12/16	22/12/16	120612-2
Thermohygrometer	BODYCOM	BJ5478	21/12/16	22/12/16	120612-1
Thermohygrometer	BODYCOM	BJ5478	21/06/24 22/06/24	22/06/24 23/06/24	N/A
Loop Antenna	ETS-Lindgren	6502	21/01/28	23/01/28	00226186
Hybrid Antenna	Schwarzbeck	VULB 9160	21/12/16	22/12/16	3362
Horn Antenna	ETS-Lindgren	3117	21/06/24 22/06/24	22/06/24 23/06/24	00143278
Horn Antenna	A.H.Systems Inc.	SAS-574	21/06/24 22/06/24	22/06/24 23/06/24	155
PreAmplifier	tsj	MLA-0118-B01-40	21/12/16	22/12/16	1852267
PreAmplifier	tsj	MLA-1840-J02-45	21/06/24 22/06/24	22/06/24 23/06/24	16966-10728
PreAmplifier	H.P	8447D	21/12/16	22/12/16	2944A07774
High Pass Filter	Wainwright Instruments	WHKX12-935-1000- 15000-40SS	21/06/24 22/06/24	22/06/24 23/06/24	8
High Pass Filter	Wainwright Instruments	WHKX10-2838-3300- 18000-60SS	21/06/24 22/06/24	22/06/24 23/06/24	1
High Pass Filter	Wainwright Instruments	WHNX8.0/26.5-6SS	21/06/24 22/06/24	22/06/24 23/06/24	3
Attenuator	Hefei Shunze	SS5T2.92-10-40	21/06/24 22/06/24	22/06/24 23/06/24	16012202
Attenuator	SMAJK	SMAJK-2-3	21/06/24 22/06/24	22/06/24 23/06/24	3
Attenuator	SMAJK	SMAJK-2-3	21/06/24 22/06/24	22/06/24 23/06/24	2
Attenuator	Aeroflex/Weinschel	86-10-11	22/06/24	23/06/24	408
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A MA2490A	21/12/16	22/12/16	1338004 1249303
EMI Test Receiver	ROHDE&SCHWARZ	ESU	21/11/12	22/11/12	100469
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	21/08/23	22/08/23	101333
LISN	SCHWARZBECK	NSLK 8128 RC	21/10/22	22/10/22	8128 RC-387
HYGROMETER	TESTO	608-H1	22/01/14	23/01/14	34862883
Cable	DT&C	Cable	22/01/04	23/01/04	G-1
Cable	DT&C	Cable	22/01/04	23/01/04	G-2
Cable	HUBER+SUHNER	SUCOFLEX 100	22/01/04	23/01/04	G-3
Cable	DT&C	Cable	22/01/04	23/01/04	G-4
Cable	DT&C	Cable	22/06/08	23/06/08	G-5
Cable	Junkosha	MWX241	22/01/04	23/01/04	mmW-1
Cable	Junkosha	MWX241	22/01/04	23/01/04	mmW-4
Cable	HUBER+SUHNER	SUCOFLEX100	22/01/04	23/01/04	M-01
Cable	HUBER+SUHNER JUNFLON	SUCOFLEX100 MWX241	22/01/04	23/01/04 23/01/04	M-02
Cable			22/01/04		M-03
Cable		J12J101757-00	22/01/04	23/01/04	M-07
Cable	HUBER+SUHNER	SUCOFLEX106	22/01/04	23/01/04	M-09
Cable Test Software	DT&C tsj	Cable Noise Terminal	22/01/04 NA	23/01/04 NA	RFC-45 Version
Test Software	tsj	Measurement Radiated Emission	NA	NA	2.00.0170 Version
Noted. The measurement of		Measurement			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 attached. (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 DescriptionLimit (Using in 2 400~ 2 483.5 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	For FCC =< 0.125 W(conducted) For IC =< 0.125 W(conducted) =< 4 Watt(e.i.r.p)		с
		20 dB Bandwidth	NA		С
15 247(0)		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 Channels	>= 15 hops	Conducted	
		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	C Note3
15.207	RSS-Gen[8.8]	AC Power-Line Part 15.207 Limits Conducted Emissions (Refer to section 10)		AC Line Conducted	C Note4
15.203	-	Antenna Requirement	Part 15.203 (Refer to section 2)	-	С

Not Comply Comply Not lested NA : Not Applicable

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

Note 3: This test item was performed in three orthogonal EUT positions and the worst case data was reported.

Note 4: AC Line Conducted Test was tested in charging mode. Bluetooth / LE mode does not work while charging.



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 2 400-2 483.5 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	Burst Average Output Power		Peak Output Power		Antenna Gain	e.i.r.p ^{Note3}
	Testeu Chaimer	dBm	mW	dBm	mW	(dBi)	(dBm)
	Lowest	16.85	48.42	17.34	54.20	0.30	17.64
<u>GFSK</u>	Middle	16.83	48.19	17.54	56.75	0.30	17.84
	Highest	17.19	52.36	17.39	54.83	0.30	17.69
	Lowest	7.81	6.04	10.36	10.86	0.30	10.66
<u>π/4DQPSK</u>	Middle	7.66	5.83	11.00	12.59	0.30	11.30
	Highest	8.44	6.98	11.11	12.91	0.30	11.41
<u>8DPSK</u>	Lowest	7.92	6.19	11.25	13.34	0.30	11.55
	Middle	7.69	5.87	11.87	15.38	0.30	12.17
	Highest	8.48	7.05	11.90	15.49	0.30	12.20

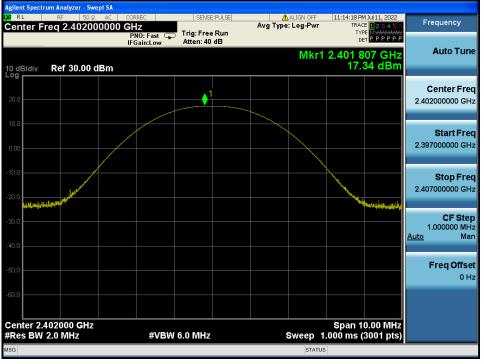
Note 1: The average output power was tested using an average power meter for reference only. Note 2: See next pages for actual measured spectrum plots.

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_{EUT} = gain of the EUT radiating element (antenna), in dBi



Lowest Channel & Modulation : GFSK



Peak Output Power

Middle Channel & Modulation : GFSK









Peak Output Power

Lowest Channel & Modulation : π/4DQPSK





Middle Channel & Modulation : π/4DQPSK



Peak Output Power

Highest Channel & Modulation : π/4DQPSK









Peak Output Power <u>Middle Channel & Modulation : 8DPSK</u>



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 ≥ 3 × 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	0.934	0.867	
<u>GFSK</u>	Middle	0.934	0.863	
	Highest	0.931	0.861	
	Lowest	1.321	1.209	
<u>π/4DQPSK</u>	Middle	1.322	1.212	
	Highest	1.322	1.209	
	Lowest	1.313	1.208	
<u>8DPSK</u>	Middle	1.324	1.209	
	Highest	1.333	1.208	



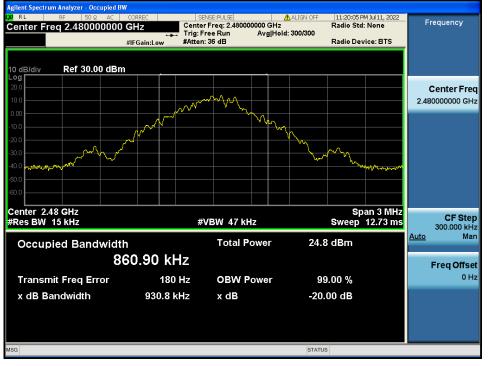


20 dB BW & Occupied BW





Highest Channel & Modulation : GFSK



20 dB BW & Occupied BW

Lowest Channel & Modulation : π/4DQPSK



Middle Channel & Modulation : π/4DQPSK

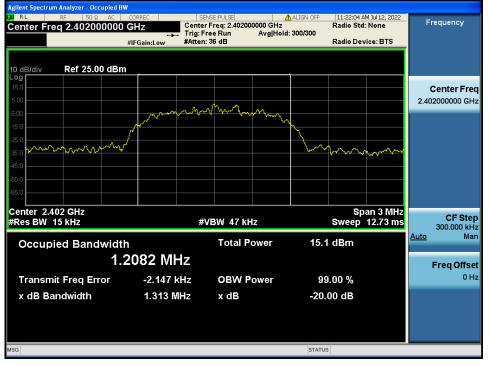


20 dB BW & Occupied BW

Highest Channel & Modulation : π/4DQPSK

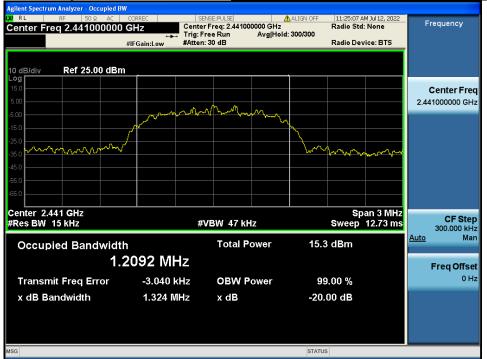


Lowest Channel & Modulation : 8DPSK



20 dB BW & Occupied BW

Middle Channel & Modulation : 8DPSK



Highest Channel & Modulation : 8DPSK





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	2 441.013	2 442.015	1.002
Enable	π/4DQPSK	2 440.020	2 441.025	1.005
	8DPSK	2 441.166	2 442.170	1.004

AFH mode

Hopping Mode	Modulation	Peak of reference channel(MHz)	Peak of adjacent Channel(MHz)	Test Result (MHz)
	GFSK	2 441.166	2 442.168	1.002
Enable	π/4DQPSK	2 441.014	2 442.009	0.995
	8DPSK	2 441.167	2 442.173	1.006

Note 1 : See next pages for actual measured spectrum

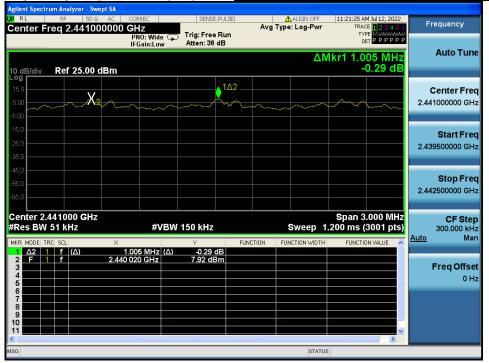
Carrier Frequency Separation (FH)

Hopping mode : Enable&GFSK

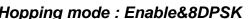
Agilent Spectrum Analyzer - Swept SA				
Center Freq 2.441000000 GHz	SENSE:PULSE	ALIGN OFF Avg Type: Log-Pwr	11:29:43 PM Jul 11, 2022 TRACE 1 2 3 4 5 6	Frequency
PNO: N	ide 🕞 Trig: Free Run ow Atten: 40 dB			
IFGain	_owΑπτen: 40 dB			Auto Tune
		ΔΙν	1kr1 1.002 MHz 0.13 dB	
10 dB/div Ref 30.00 dBm				
20.0	X			Center Freq
10.0				2.441000000 GHz
0.00				
-10.0				Start Freq
-20.0				2.439500000 GHz
-30.0				
-40.0				
-50.0				Stop Freq
-60.0				2.442500000 GHz
Center 2.441000 GHz #Res BW 51 kHz	#VBW 150 kHz	Swoon 1	Span 3.000 MHz 200 ms (3001 pts).	CF Step
				300.000 kHz Auto Man
MKR MODE TRC SCL X 1 Δ2 1 f (Δ) 1.002 M		CTION FUNCTION WIDTH	FUNCTION VALUE	
2 F 1 f 2.441 013 G	z 17.25 dBm			Erog Offoot
3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4				Freq Offset 0 Hz
5				0112
7				
8				
10				
<	Ш		>	
MSG		STATUS		

Carrier Frequency Separation (FH)

Hopping mode : Enable&π/4DQPSK



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



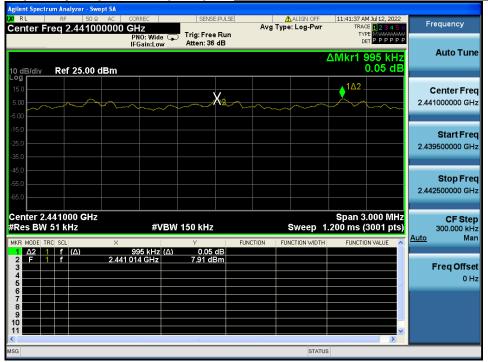
Agilent Spec											
LXI RL Center	RF Frea			ORREC		E:PULSE	Avg	ALIGN OFF	TRAC	4 Jul 12, 2022 E <mark>1 2 3 4 5 6</mark>	Frequency
				PNO: Wide IFGain:Lov							
10 dB/div	Re	f 25.00 (dBm					ΔN	/lkr1 1.0	04 MHz 0.13 dB	Auto Tune
Log 15.0 5.00	~	~~~		~~~~	~~~~~	X2	~~~	~~~^	~~^	1Δ2 <u> </u>	Center Freq 2.441000000 GHz
-15.0 -25.0 -35.0											Start Freq 2.439500000 GHz
-45.0 -55.0 -65.0											Stop Freq 2.442500000 GHz
Center 2 #Res BV				#V	'BW 150 kHz			Sweep 1	Span 3 .200 ms (.000 MHz 3001 pts)	CF Step 300.000 kHz Auto Man
MKR MODE		(A)	×	004 MHz	γ (Δ) 0.13		NCTION	FUNCTION WIDTH	FUNCTIO	IN VALUE	<u>Auto</u> Man
2 F 3 4 5			2.441 1	66 GHz	(Δ) 0.13 8.14 d	ав Bm					Freq Offset 0 Hz
6 7 8 9 10 11											
<					Ш					<u>></u>	
MSG								STATU	S		

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

TDt&C

			-				- 1			
	8:42 PM Jul 11, 2022	11:38:42	ALIGN OFF			SENSE	RREC		nalyzer - Swa F 50 Ω	
Frequency	TRACE 1 2 3 4 5 6	TF	e: Log-Pwr	Avg Ty				00000 GI		
	DET PPPPP					Trig: Free Atten: 40	NO: Wide 🕞 Gain:Low	P		
Auto Tune	1.002 MHz	Alend d	A B				Gam.cow			
	-0.01 dB	IKIT I.	ΔIV					dBm	ef 30.00 d	div R
	▲1∆2									
Center Fred	\sim		~		~~X2			\sim	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
2.441000000 GHz			~	~	~		· · · · ·	- hour		
Start Fred										
2.439500000 GHz										
Stop Fred										
2.442500000 GHz										
	an 3.000 MHz ms (3001 pts)	Span	Curson 4			150 kHz	#\/B\		000 GHz	er 2.441 BW 51
300.000 kHz Auto Man							#VDV			
<u>Mato</u> Inter	UNCTION VALUE	FUNC	NCTION WIDTH	TION		۲ -0.01 c	2 MHz (Δ)	× 1.00	1 (Δ)	
						17.33 dB	6 GHz	2.441 16	(Δ)	F 1 f
Freq Offse										
0 Ha	=									
										\rightarrow
	~									
						111				
		5	STATUS							

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



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

Center Freq 2.441000000 GHz Trig: Free Run Avg Type: Log-Pwr Trid: Pred England Comparison of the part of the	Agilent Spectrum Analyzer - Swept SA				
Center Pred 2.44100000 GH2 Trig: Free Run Atten: 36 dB Trig: Free Run Atten: 36 dB Auto Tune 10 dB/div Ref 25.00 dBm -0.27 dB -0.24 dB				11:45:05 AM Jul 12, 2022	Frequency
IFGain:Low Atten: 36 dB Cell Law Auto Tune	Center Freq 2.44100000	PNO: Wide 👝 Trig: Free Rui		TYPE M MAAAAAAAA	
Line AMRKP1 1.006 WHz -0.27 dB Center Freq 2.44100000 GHz 150 10		IFGain:Low Atten: 36 dB		DETPPPPP	
Cog Center Freq 150 Center Freq 250 Start Freq 251 Start Freq 250 Start Freq 251 Start Freq 252 Start Freq 253 Start Freq 254 Start Freq 255 Start Freq 260 Start Freq 210 Start Freq 24 T 1 Center 2.441000 GHz #Res BW 51 kHz Y PUNCTION FUNCTION VALUE 1 Atta Start Freq 3 T 1 Atta Start Freq 3 T 2 T 1 Atta Start Freq 3 Start Freq 3 T 2 T 1 T			Δ	/kr1 1.006 MHz	Auto Tune
150 1Δ2 Center Freq 150 250 250 250 250	10 dB/div Ref 25.00 dBm			-0.27 dB	
500 X2 <				102	
500 300			X.		
150 Start Freq 250 Start Freq 30 Start Freq 310000 GHz Freq 31000 GHz Start Freq 3100 GHz Start Freq 3100 GHz Start Freq 3100 GHz Start Freq 3100 GHz Star 3100 GHz </td <td></td> <td></td> <td></td> <td></td> <td>2.441000000 GHz</td>					2.441000000 GHz
25 0 Start Freq 24 0 Start Freq 25 0 Start Freq 24 0 Start Freq 2 F 1 f 1 A2 2 F 1 A2	-5.00				
250 360 2.43950000 GHz 360 360 360 450 360 550 360 550 360 550 360 550 360 550 360 550 360 550 360 550 360 560 360 560 360 560 360 560 360 560 360 560 360 560 3600 MHz F 1 1 2 5 3 3 3 4 3 5 3 6 3 7 3 8 3 9 3 10 1 10 1 10 1 10 1 10 1 10 1 10 1 10 1	-15.0				Start Fred
350 450 <	-25.0				•
Stop Freq 2.442500000 GHz Stop Freq 2.442500000 GHz Center 2.441000 GHz #Res BW 51 kHz #VBW 150 kHz Sweep 1.200 ms (3001 Mtz) MKR MODE TRC SCL × Y FUNCTION WIDTH FUNCTION VALUE 1 Δ2 F 1 f (Δ) -0.27 dB 3 - - - - - - 4 - - - - - - 5 - - - - - - - 2 F 1 f 2.441167 GHz 8.18 dBm - - - - 8 -	-35.0				
2 - 441000 GHz	-45.0				
250	-55.0				Stop Freq
Center 2.441000 GHz #VBW 150 kHz Span 3.000 MHz CF Step #Res BW 51 kHz #VBW 150 kHz Sweep 1.200 ms (3001 pts) Auto Man 1 Δ2 F 1 f f (Δ) 1.006 MHz (Δ) -0.27 dB Function width Function value Freq Offset 2 F 1 f f 2.441167 GHz 8.18 dBm -					2.442500000 GHz
#Res BW 51 kHz #VBW 150 kHz Sweep 1.200 ms (3001 pts) MKR MODE TRC SCL X Y FUNCTION FUNCTION VAIDTH FUNCTION VAIDTH 1 Δ2 1 f (Δ) 1.006 MHz (Δ) 0.27 dB 2 F 1 f 2.441 167 GHz 8.18 dBm Freq Offset 3 - - - - - - 4 - - - - - - 5 - - - - - - 6 - - - - - - 9 - - - - - - 9 - - - - - - 10 - - - - - -	-80.0				
#Res BW 51 kHz #VBW 150 kHz Sweep 1.200 ms (3001 pts) Auto Auto Man 1 Δ2 1 f (Δ) 1.006 MHz (Δ) 0.27 dB Function vultities Function vultities Function value Man 2 F 1 f 2.441 167 GHz 8.18 dBm Fine data Fine data Man 3 - - - - - - Fine data Man 5 - - - - - - - - - Man 9 -	Center 2.441000 GHz			Span 3.000 MHz	CE Step
MRR MODE TRC SCI X Y Y FUNCTION FUNCTION WIDTH FUNCTION VALUE 1 Δ2 F 1 f (Δ) 1.006 MHz (Δ) 0.27 dB 2 F 1 f 2.441 167 GHz 8.18 dBm Freq Offset 3 - - - - - - 6 - - - - - 7 - - - - - 8 - - - - - 9 - - - - - 10 - - - - - 11 - - - - -	#Res BW 51 kHz	#VBW 150 kHz	Sweep 1	.200 ms (3001 pts)	300.000 kHz
2 F 1 f 2.441167 GHz 8.18 dBm 3 - - - - - 0 Hz 0 Hz 4 - - - - - 0 Hz 0 Hz 6 - - - - - - 0 Hz 7 - - - - - - - 0 Hz 9 - - - - - - - - 0 Hz 10 - - - - - - - - - - - 0 Hz - - 0 Hz - - - 0 Hz - - - - 0 Hz - 0 Hz 0 Hz - - - 0 Hz - 0 Hz - 0 Hz - - 0 Hz - </th <th>MKR MODE TRC SCL X</th> <th>Y</th> <th>FUNCTION FUNCTION WIDTH</th> <th>FUNCTION VALUE</th> <th><u>Auto</u> Man</th>	MKR MODE TRC SCL X	Y	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man
3 - - - Freq Offset 4 - - - 0 Hz 6 - - - 0 Hz 7 - - - - 8 - - - - 9 - - - - 10 - - - -		1.006 MHz (Δ) -0.27 dB			
5 0 Hz 6 0 0 Hz 7 0 0 Hz 9 0 0 0 Hz 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		11 167 GHZ 8.18 dBm			Freq Offset
					0 Hz
8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9					
	<			×	
MSG STATUS	MSG		STATU	s	

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, whichever 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.

Dt&C

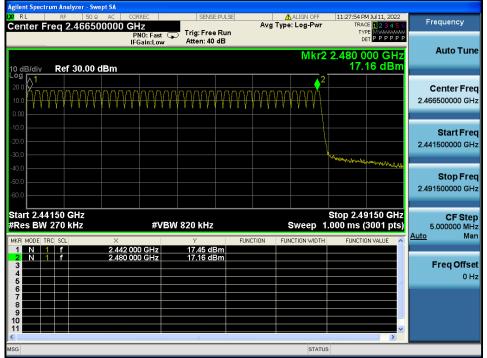
Number of Hopping Channels 1(FH)

Hopping mode : Enable & GFSK

Agilent Spectrum Analyz					
LXIRL RF	50 Ω AC CORREC	SENSE:PULSE	ALIGN OFF	11:26:42 PM Jul 11, 2022	Frequency
Center Freq 2.4		rig: Free Run	Avg Type: Log-Pwr	TRACE 1 2 3 4 5 6 TYPE MWWWWW	
	PNO: F IEGain:l			DETPPPPP	
	IFGain:I	.ow Atten: 40 dB			Auto Tune
			Mkr2	2.441 000 GHz	Auto Tune
10 dB/div Ref 3	0.00 dBm			17.44 dBm	
20.0	0 ¹				
20.0	ληρηγου	ορησοροσορο	nannnanan	nnnnnnnnn	Center Freq
10.0		<u>╒┰┰╫┰┰╓┰╫╓┰╓╓</u>	<u>₩₩₩₩₩₩₩₩₩₩</u>		2.416500000 GHz
0.00					
0.00					
-10.0	A				Otherst English
20.0					Start Freq
-20.0					2.391500000 GHz
-30.0	Lon 19				
-30.0	e versee				
-40.0					Stop From
-50.0					Stop Freq
					2.441500000 GHz
-60.0					
Start 2.39150 GI				Stop 2.44150 GHz	CF Step
#Res BW 270 k⊦	lz i	≇VBW 820 kHz	Sweep 1.	000 ms (3001 pts)	5.000000 MHz
		1			Auto Man
MKR MODE TRC SCL	×		CTION FUNCTION WIDTH	FUNCTION VALUE	
1 N 1 f	2.402 000 GH 2.441 000 GH	z 17.00 dBm z 17.44 dBm			
3	2.441 000 GF	2 17.44 dBm			Freq Offset
4					•
5				E	0 Hz
6					
7					
8					
9					
11				~	
<				>	
2 T.A.				,	
MSG			STATUS		

Number of Hopping Channels 2(FH)

Hopping mode : Enable & GFSK





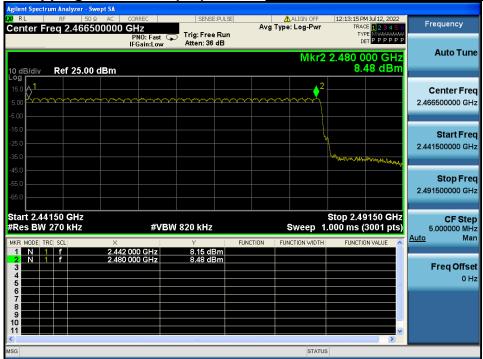
Number of Hopping Channels 1(FH)

Hopping mode : Enable&π/4DQPSK

Agilent Spectrum Analyzer - Swept SA				
(X) RL RF 50 ହ AC Center Freq 2.416500000	CORREC SENSE:PULS	Avg Type: Log-Pwr	12:12:03 PM Jul 12, 2022 TRACE 1 2 3 4 5 6	Frequency
10 dB/diy Ref 25.00 dBm	PNO: Fast 🖵 Trig: Free Run IFGain:Low Atten: 36 dB		2.441 000 GHz 7.46 dBm	Auto Tune
15.00				Center Freq 2.416500000 GHz
-5.00 -15.0 -25.0 -35.0				Start Freq 2.391500000 GHz
-45.0				Stop Freq 2.441500000 GHz
Start 2.39150 GHz #Res BW 270 kHz MKR MODE TRC SCL X	#VBW 820 kHz		Stop 2.44150 GHz .000 ms (3001 pts) FUNCTION VALUE	CF Step 5.000000 MHz <u>Auto</u> Man
1 N 1 f 2.40 2 N 1 f 2.44 3 - - - - 4 - - - - - 6 - </td <td>02 000 GHz 7.54 dBm 41 000 GHz 7.46 dBm</td> <td></td> <td></td> <td>Freq Offset 0 Hz</td>	02 000 GHz 7.54 dBm 41 000 GHz 7.46 dBm			Freq Offset 0 Hz
MSG	10	STATUS		

Number of Hopping Channels 2(FH)

Hopping mode : Enable &π/4DQPSK





Number of Hopping Channels 1(FH)



Agilent Spectrum Analy								
Center Freq 2.4			SENSE:PULSE		ALIGN OFF	11:34:18 AM TRACE	Jul 12, 2022	Frequency
Center Freq 2.4		PNO: Fast 😱 T	rig: Free Run	U.A. Me	. Log-i wi	TYPE	PPPPPP	
		IFGain:Low 6	tten: 36 dB					Auto Tune
					Mkr2	2.441 00		Autorune
10 dB/div Ref 2	25.00 dBm					8.1	7 dBm	
Log 15.0	A 1						2	0
							and the main	Center Freq
5.00	/ ¥ ¥ ¥ ¥		***				1 7 4 7	2.416500000 GHz
-5.00								
-15.0								Start Freq
-25.0	- N							2.391500000 GHz
-35.0	www.							
-45.0								
-55.0								Stop Freq
-65.0								2.441500000 GHz
-80.0								
Start 2.39150 G	Hz					Stop 2.44	150 GHz	CF Step
#Res BW 270 kl	Ηz	#VBW 82	0 kHz	ę	Sweep 1	.000 ms (3	001 pts)	5.000000 MHz
MKR MODE TRC SCL	×		Y F	UNCTION FUN	ICTION WIDTH	FUNCTION	VALUE	<u>Auto</u> Man
1 N 1 f		000 GHz	7.53 dBm					
2 N 1 f	2.441 (000 GHz	8.17 dBm					Freq Offset
4								0 Hz
5							=	
7								
8								
10								
			100				~	
MSG					STATUS			

Number of Hopping Channels 2(FH)





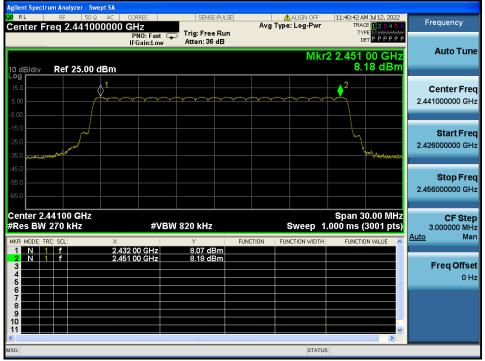
Number of Hopping Channels 1(AFH)

Hopping mode : Enable & GFSK

Agilent Spectri LXI R L		Swept SA iO Ω AC	CORF	250	CENI	E:PULSE		4	ALIGN OFF		22-21 D	4 Jul 11, 2022	
Center Fr					JUN		Avg		Log-Pw		TRAC	E 1 2 3 4 5 6	Frequency
			PN	0: Fast G	Trig: Fre						TY	PE MWWWWW TPPPPP	
			IFG	ain:Low	Atten: 4	7 a B							Auto Tune
									M	kr2 2		00 GHz	Auto Tulk
10 dB/div	Ref 30.0	0 dBm									17.	39 dBm	
Log 20.0		h ¹								- A	2		
		МM	M	1 mm	mmm	nnn	mm	$\neg r$	nnr	1 mm			Center Fred
10.0		11	V V	VVV	VVV	VV	' V V	V	VV	VV			2.441000000 GHz
0.00											$\left\{ - \right\}$		
-10.0													Start Fred
-20.0											\rightarrow		2.426000000 GHz
-30.0	and and										hay		2.42000000 8112
-40.0	windlaged and											- construction of the second	
													Stop Fred
-50.0													2.456000000 GH
-60.0													
Center 2.4	44400 CH	-								6.		0.00 MHz	
#Res BW		2		#VB)	V 820 kHz			9	ween			3001 pts)	CF Step 3.000000 MHz
				W VIDY									Auto Mar
MKR MODE TF	RC SCL	×	432 00	CHa	۲ 17.31 d		ICTION	FUNG	CTION WID	TH	FUNCTIO	IN VALUE	
2 N 1	f	2.	452 00	GHZ	17.39 d								
3													Freq Offset
5												=	0 Hz
6													
7 8													
9													
10												~	
<					111								
MSG									STA	TUS			
											_		

Number of Hopping Channels 1(AFH)

Hopping mode : Enable &π/4DQPSK



Number of Hopping Channels 1(AFH)



Agilent Spectr												
Center F	RF	50 \$	2 AC	CORREC	SENSE:P			ALIGN OFF		M Jul 12, 2022	Frequency	
Center F	req2	2.4410	00000	GHz	Trig: Free F		Vg Type	e: Log-Pwr	TRA TY	CE <mark>1 2 3 4 5 6</mark> PE M Intellete		
				PNO: Fast G	Atten: 36 d				C	PE MWWWWW ET P P P P P P		
								Miles	0.0.454	00 GHz	Auto Tun	ie
	_							IVINI		18 dBm		
10 dB/div Log	Rei	f 25.00	dBm						<u>.</u>	To ubili		
15.0			<u>1</u>						2		Center Fre	
			L.	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					- 1 I
5.00											2.441000000 GH	12
-5.00												
-15.0											Start Fre	
-25.0		-									2.426000000 GH	
-35.0 mm/44.43	mother	f. 14								WALLAND	2.42000000 GH	12
-00.0 No.48										and an effective		
-45.0											Stop Fre	
-55.0											2.456000000 GH	
-65.0											2.456000000 GH	12
Center 2.									Span 3	0.00 MHz	CF Ste	р
#Res BW	270	kHz		#VB	N 820 kHz			Sweep 1	.000 ms ((3001 pts)		
MKR MODE T	RC SCL		×		Y	FUNCTIO	N FUI	NCTION WIDTH	FUNCTI	ON VALUE 🛛 🔼	Auto Ma	'n
1 N 1	f		2.43	2 00 GHz	7.98 dBn	า						
2 N 1 3	f		2.45	1 00 GHz	8.18 dBn	1					Freq Offse	et
4											0 H	
5										=		12
6												
8												
9												
11										~		
<					ш					>		
MSG								STATUS	5			
	_											

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.



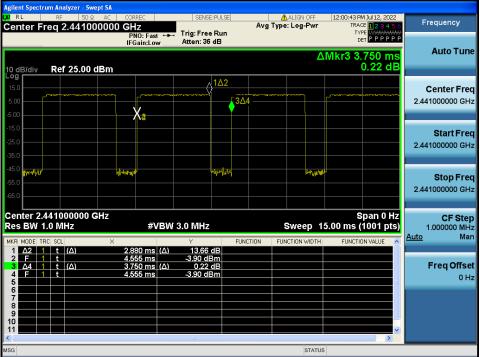
Time of Occupancy (FH)

🗱 RL RF 50 Ω AC CORREC SENSE:PULSE 🛕 ALIGN OFF 11:17:21 PM Jul 11, 2022	Frequency
Center Freq 2.441000000 GHz Avg Type: Log-Pwr TRACE 123456 PND: Fast Trig: Free Run Trig: Control of the PPPP P	riequency
IFGain:Low Atten: 40 dB	
ΔMkr3 3.750 ms	Auto Tune
	Center Freq
	2.441000000 GHz
	2.441000000 GH2
	Start Freq
-20.0	2.441000000 GHz
-30.0	2.441000000 GH2
-40.0 WINGH MANAGE WITHIN WITHIN WITHIN A	Stop Freq
-50.0	2.441000000 GHz
-60.0	2.44 1000000 GHZ
Center 2.441000000 GHz Span 0 Hz	CF Step
Res BW 1.0 MHz #VBW 3.0 MHz Sweep 15.00 ms (1001 pts)	1.000000 MHz
MKR MODE TRC SCL X Y FUNCTION VIDTH FUNCTION VALUE 🔺 🗛	<u>uto</u> Man
1 Δ2 1 t (Δ) 2.880 ms (Δ) 9.03 dB	
2 F 1 t 6.878 ms 8.30 dBm 3 Δ4 1 t (Δ) 3.750 ms (Δ) -0.19 dB	Freq Offset
4 F 1 t 6.878 ms 8.30 dBm	0 Hz
	0112
9 10 10 10 10 10 10 10 10 10 10 10 10 10	
MSG STATUS	

Time of Occupancy (FH)



Hopping mode : Enable&DH5





Time of Occupancy (FH)

Hopping mode : Enable&3-DH5

gilent Spectrum Analyzer - Swept SA C RL RF 50Ω AC	CORREC	SENSE:PULSE		ALIGN OFF		1 Jul 12, 2022	Frequency
Center Freq 2.44100000	PNO: Fast +++ T	rig: Free Run Atten: 36 dB	Avg Type	: Log-Pwr	TYP	123456 WWWWWW PPPPPP	riequency
IO dB/div Ref 25.00 dBm	IFGain:Low 4	Atten: 36 dB		Δ	Vikr3 3.	750 ms).09 dB	Auto Tune
5.00		0.5.40.50.50.40.40.40.40.40.40.40.40.40.40.40.40.40		NJTATION CONTRACTOR		ngladd (nafa Istrafan	Center Free 2.441000000 GH
15.0 -25.0 -35.0							Start Fre 2.441000000 GH
-45.0	lowyaho		n an				Stop Fre 2.441000000 GH
Center 2.441000000 GHz Res BW 1.0 MHz	#VBW 3.			Sweep 15	.00 ms (′		CF Stej 1.000000 MH Auto Ma
MKR MODE TRC SCL X 1 Δ2 1 t (Δ) 2 F 1 t (Δ) 3 Δ4 1 t (Δ) 4 F 1 t (Δ) 5	2.880 ms (Δ) 5.769 ms 3.750 ms (Δ) 5.769 ms	Y FUI 1.66 dB -0.09 dB -0.09 dB -0.09 dB 8.57 dBm -0.09 dB	NCTION FUN	ICTION WIDTH	FUNCTIO		Freq Offse 0 H
6 7 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9							
ISG		113		STATUS			

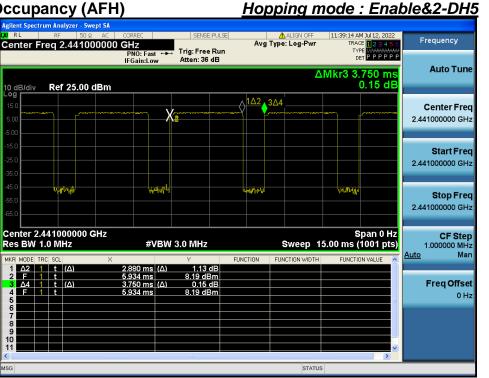


Time of Occupancy (AFH)

Hopping mode : Enable&DH5

	um Analyzer - S							
RL	RF 50		CORREC	SENSE:		ALIGN OFF	11:31:06 PM Jul 11, 2022 TRACE 1 2 3 4 5 6	Frequency
Center F	req 2.4410	00000	PNO: Fast IFGain:Low	Atten: 40 o	Run	/g Type: Log-Pwr	TYPE WWWWWWW DET P P P P P P	
10 dB/div	Ref 30.00	dBm				l	∆Mkr3 3.750 ms 0.05 dB	Auto Tune
Log 20.0			,		3∆4			Conton From
10.0		X	2					Center Freq 2.441000000 GHz
0.00								
-10.0								Start Freq 2.441000000 GHz
-30.0								2.441000000 GH2
-40.0		No. Product		LAN YON		moundin	ht altimute	Stop Freq
-60.0								2.441000000 GHz
	441000000	GHz	-40.4			0	Span 0 Hz	CF Step
Res BW 1		×	#VE	3W 3.0 MHz Y	FUNCTION	FUNCTION WIDTH	15.00 ms (1001 pts)	1.000000 MHz <u>Auto</u> Man
1 <u>Δ2</u> 1 2 F 1	t (∆)		2.880 ms (/	∆) -0.04 d 17.41 dB				
3 <u>Δ4</u> 1 4 F 1	t (∆) t		3.750 ms (/ 3.806 ms		В			Freq Offset 0 Hz
5								0112
8								
9 10 11							~	
(Ш				
SG						STATU	JS	

Time of Occupancy (AFH)



Time of Occupancy (AFH)

Hopping mode : Enable&3-DH5

XIRL	rm Analyzer - Sw RF 50 Ω	2 AC CO	DRREC	SENSE:	PULSE		ALIGN OFF		M Jul 12, 2022	Frequency
Center Fr	eq 2.4410		Hz PNO: Fast ←	📕 Trig: Freel		Avg Typ	e: Log-Pwr	TY	CE 1 2 3 4 5 6 PE WWWWW	Frequency
			FGain:Low	Atten: 36 d	IB				ET PPPPP	Auto Tune
	B-60500	-15					Δ	Mkr3 3	.750 ms 0.09 dB	Auto Tune
10 dB/div Log	Ref 25.00	dBm			<u>∧1∆2</u>				0.00 ab	
15.0	Annotation	and	X	n an		3∆4	mathematic	Annewhere	and the second second	Center Freq
5.00			X <u>a</u>					l [2.441000000 GHz
-5.00										
-15.0										Start Freq
-25.0										2.441000000 GHz
15.0										
-45.0 4/101	64	Y	internet.		ynanywi		Ալիս	hr f g fal		Stop Freq
-65.0										2.441000000 GHz
Center 2.4 Res BW 1	41000000 (.0 MHz	GHZ	#VB	W 3.0 MHz			Sweep 1		ipan 0 Hz 1001 pts)	CF Step 1.000000 MHz
MKR MODE TR		×		Y	FUN		NCTION WIDTH		DN VALUE	Auto Man
1 <u>Δ2</u> 1 2 F 1	t (Δ)	2.	880 ms (∆ 960 ms) 2.21 d 8.29 dB	в					
3 🛆 4 1	t (Δ)	3.	750 ms (A) -0.09 d	в					Freq Offset
4 F 1 5	t	4.	960 ms	8.29 dB	m				=	0 Hz
6										
8										
10										
<				Ш					>	
MSG							STATUS	5		



9. Unwanted Emissions

9.1. Test Setup

Refer to the APPENDIX I.

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)).

FCC Limit (uV/m) IC Limit (µA/m) Measurement Distance (m) Frequency (MHz) 0.009 - 0.4902 400 / F (kHz) 6.37/F (F in kHz) 300 0.490 - 1.705 24 000 / F (kHz) 63.7/F (F in kHz) 30 1.705 - 30.0 30 0.08 30

- Part 15.209 & RSS-Gen[8.9]: General requirement

	Frequency (MHz)	FCC Limit (uV/m)	IC Limit (uV/m)	Measurement Distance (m)
	30 ~ 88	100 **	100	3
Γ	88 ~ 216	150 **	150	3
	216 ~ 960	200 **	200	3
	Above 960	500	500	3

**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.



- 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 = Δt = 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)** = <u>-24.79 dB</u> 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

Data of Test : 2022-07-07 ~ 2022-07-12

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)
2 389.97	Н	Z	PK	58.20	2.27	N/A	N/A	60.47	74.00	13.53
2 389.97	Н	Z	AV	58.20	2.27	-24.79	N/A	35.68	54.00	18.32
4 804.42	V	Х	PK	59.68	2.66	N/A	N/A	62.34	74.00	11.66
4 804.42	V	Х	AV	59.68	2.66	-24.79	N/A	37.55	54.00	16.45
7 206.45	V	Х	PK	58.36	7.29	N/A	N/A	65.65	74.00	8.35
7 206.45	V	Х	AV	58.36	7.29	-24.79	N/A	40.86	54.00	13.14
9 608.58	V	Х	PK	54.19	8.62	N/A	N/A	62.81	74.00	11.19
9 608.58	V	Х	AV	54.19	8.62	-24.79	N/A	38.02	54.00	15.98
12 009.12	V	Х	PK	57.19	9.09	N/A	N/A	66.28	74.00	7.72
12 009.12	V	Х	AV	57.19	9.09	-24.79	N/A	41.49	54.00	12.51

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)
4 881.59	V	Х	PK	57.77	2.88	N/A	N/A	60.65	74.00	13.35
4 881.59	V	Х	AV	57.77	2.88	-24.79	N/A	35.86	54.00	18.14
7 323.47	V	Х	PK	57.98	7.07	N/A	N/A	65.05	74.00	8.95
7 323.47	V	Х	AV	57.98	7.07	-24.79	N/A	40.26	54.00	13.74
12 204.26	V	Х	PK	54.57	9.15	N/A	N/A	63.72	74.00	10.28
12 204.26	V	Х	AV	54.57	9.15	-24.79	N/A	38.93	54.00	15.07

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)
2 483.83	Н	Z	PK	62.72	3.46	N/A	N/A	66.18	74.00	7.82
2 483.83	Н	Z	AV	62.72	3.46	-24.79	N/A	41.39	54.00	12.61
4 959.94	V	Х	PK	56.43	3.08	N/A	N/A	59.51	74.00	14.49
4 959.94	V	Х	AV	56.43	3.08	-24.79	N/A	34.72	54.00	19.28
7 440.40	V	Х	PK	57.01	8.10	N/A	N/A	65.11	74.00	8.89
7 440.40	V	Х	AV	57.01	8.10	-24.79	N/A	40.32	54.00	13.68
9 919.23	V	Х	PK	51.58	9.52	N/A	N/A	61.10	74.00	12.90
9 919.23	V	Х	AV	51.58	9.52	-24.79	N/A	36.31	54.00	17.69
12 400.79	V	Х	PK	53.94	9.22	N/A	N/A	63.16	74.00	10.84
12 400.79	V	Х	AV	53.94	9.22	-24.79	N/A	38.37	54.00	15.63

Data of Test : 2022-06-23 ~ 2022-06-24

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

Lowest Channel

Dt&C

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)
2 389.27	Н	Z	PK	53.19	4.46	N/A	N/A	57.65	74.00	16.35
2 389.27	Н	Z	AV	53.19	4.46	-24.79	N/A	32.86	54.00	21.14
4 804.29	V	Х	PK	55.08	2.40	N/A	N/A	57.48	74.00	16.52
4 804.29	V	Х	AV	55.08	2.40	-24.79	N/A	32.69	54.00	21.31
7 206.39	V	Х	PK	52.53	7.29	N/A	N/A	59.82	74.00	14.18
7 206.39	V	Х	AV	52.53	7.29	-24.79	N/A	35.03	54.00	18.97

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)
4 882.31	V	Х	PK	57.43	2.38	N/A	N/A	59.81	74.00	14.19
4 882.31	V	Х	AV	57.43	2.38	-24.79	N/A	35.02	54.00	18.98
7 322.52	V	Х	PK	54.09	7.11	N/A	N/A	61.20	74.00	12.80
7 322.52	V	Х	AV	54.09	7.11	-24.79	N/A	36.41	54.00	17.59
9 763.47	V	Х	PK	45.90	10.12	N/A	N/A	56.02	74.00	17.98
9 763.47	V	Х	AV	45.90	10.12	-24.79	N/A	31.23	54.00	22.77

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)
2 483.51	Н	Z	PK	59.27	5.40	N/A	N/A	64.67	74.00	9.33
2 483.51	Н	Z	AV	59.27	5.40	-24.79	N/A	39.88	54.00	14.12
4 959.74	V	Х	PK	57.06	2.45	N/A	N/A	59.51	74.00	14.49
4 959.74	V	Х	AV	57.06	2.45	-24.79	N/A	34.72	54.00	19.28
7 440.58	V	Х	PK	53.38	8.13	N/A	N/A	61.51	74.00	12.49
7 440.58	V	Х	AV	53.38	8.13	-24.79	N/A	36.72	54.00	17.28
9 919.36	V	Х	PK	51.29	10.40	N/A	N/A	61.69	74.00	12.31
9 919.36	V	Х	AV	51.29	10.40	-24.79	N/A	36.90	54.00	17.10
12 399.32	V	Х	PK	49.50	9.96	N/A	N/A	59.46	74.00	14.54
12 399.32	V	Х	AV	49.50	9.96	-24.79	N/A	34.67	54.00	19.33

Data of Test : 2022-06-23 ~ 2022-06-24

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

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)
2 389.92	Н	Z	PK	53.24	4.46	N/A	N/A	57.70	74.00	16.30
2 389.92	Н	Z	AV	53.24	4.46	-24.79	N/A	32.91	54.00	21.09
4 804.30	V	Х	PK	55.33	2.40	N/A	N/A	57.73	74.00	16.27
4 804.30	V	Х	AV	55.33	2.40	-24.79	N/A	32.94	54.00	21.06
7 206.13	V	Х	PK	52.86	7.29	N/A	N/A	60.15	74.00	13.85
7 206.13	V	Х	AV	52.86	7.29	-24.79	N/A	35.36	54.00	18.64

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)
4 881.94	V	Х	PK	57.79	2.38	N/A	N/A	60.17	74.00	13.83
4 881.94	V	Х	AV	57.79	2.38	-24.79	N/A	35.38	54.00	18.62
7 323.36	V	Х	PK	53.97	7.11	N/A	N/A	61.08	74.00	12.92
7 323.36	V	Х	AV	53.97	7.11	-24.79	N/A	36.29	54.00	17.71
9 764.19	V	Х	PK	45.59	10.13	N/A	N/A	55.72	74.00	18.28
9 764.19	V	Х	AV	45.59	10.13	-24.79	N/A	30.93	54.00	23.07

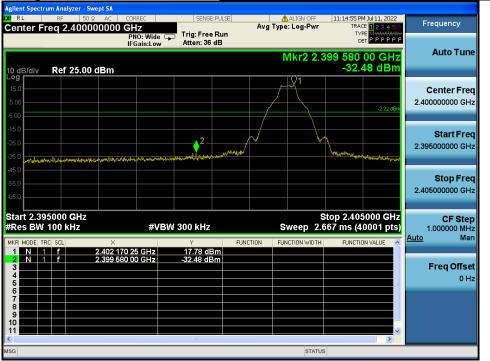
Highest Channel

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)
2 483.53	Н	Z	PK	61.13	5.40	N/A	N/A	66.53	74.00	7.47
2 483.53	Н	Z	AV	61.13	5.40	-24.79	N/A	41.74	54.00	12.26
4 959.93	V	Х	PK	58.16	2.45	N/A	N/A	60.61	74.00	13.39
4 959.93	V	Х	AV	58.16	2.45	-24.79	N/A	35.82	54.00	18.18
7 439.71	V	Х	PK	54.56	8.13	N/A	N/A	62.69	74.00	11.31
7 439.71	V	Х	AV	54.56	8.13	-24.79	N/A	37.90	54.00	16.10
9 920.32	V	Х	PK	51.21	10.40	N/A	N/A	61.61	74.00	12.39
9 920.32	V	Х	AV	51.21	10.40	-24.79	N/A	36.82	54.00	17.18
12 400.47	V	Х	PK	49.98	9.96	N/A	N/A	59.94	74.00	14.06
12 400.47	V	Х	AV	49.98	9.96	-24.79	N/A	35.15	54.00	18.85



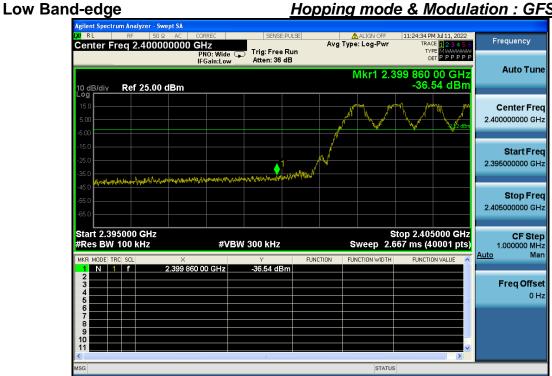
9.4.2. Unwanted Emissions(Conducted)

Low Band-edge



Lowest Channel & Modulation : GFSK

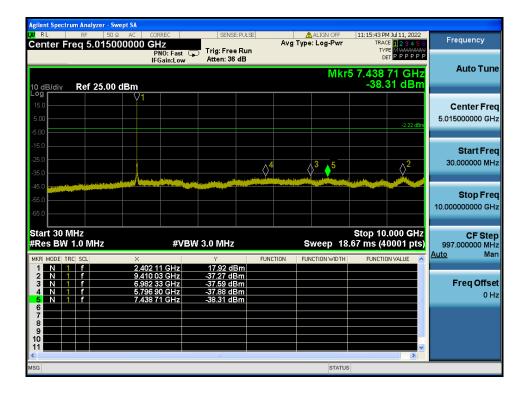






Lowest Channel & Modulation : GFSK

Agilent Spect													
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			IFGain:Lo	w	Atten: 36	ав							Auto Tuno
										Mkr1 29	0.2 kHz		Auto Tune
10 dB/div	Dof 2	5.00 dBm									01 dBm		
Log	Rei Z.	5.00 UBIII											
15.0													
													Center Freq
5.00											-2.22 dBr		15.004500 MHz
-5.00											-2.22 OBI		
-15.0													Start Freq
-25.0													9.000 kHz
													9.000 KHZ
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Lowest Channel & Modulation : GFSK



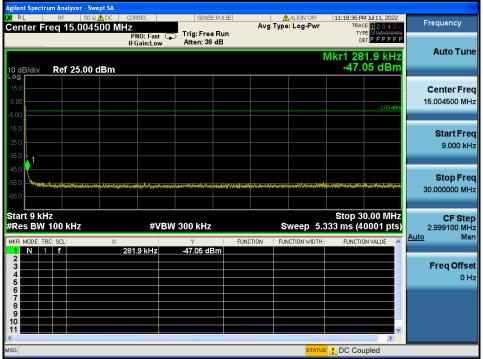


Reference for limit



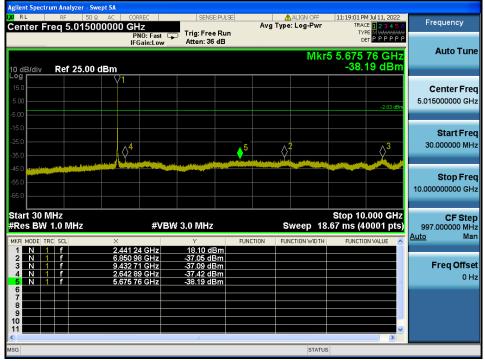


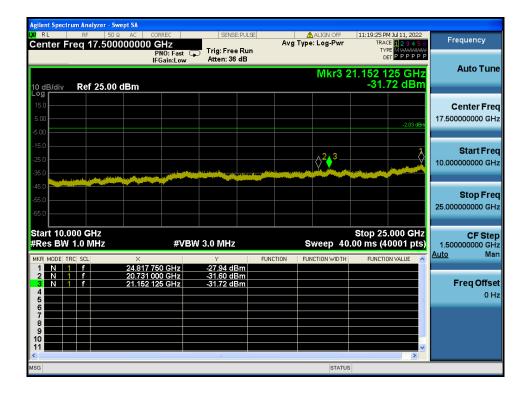




Conducted Spurious Emissions <u>A</u>









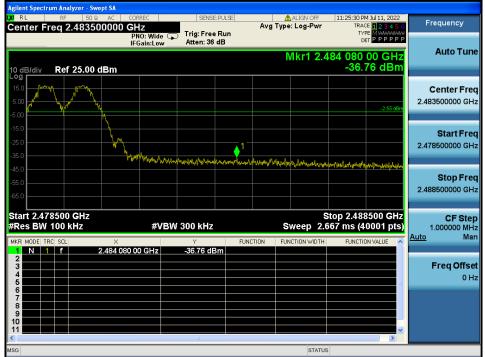
High Band-edge

Highest Channel & Modulation : GFSK



High Band-edge

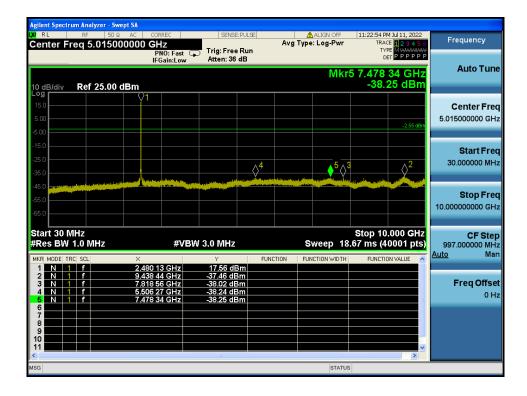
Hopping mode & Modulation : GFSK



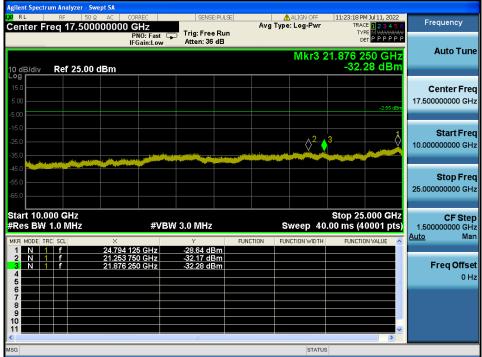


Conducted Spurious Emissions <u>Highest Channel & Modulation : GFSK</u>

			alyzer - S													
LXI RL Cent		RF	50 15.00	12 🔔 DO		RREC		SENS	E:PULSE	A		ALIGN OFF		PM Jul 11, 2022	6	Frequency
CCIII		eq	10.00	+500	Р	NO: Fas Gain:Lov		Trig: Fre Atten: 36			- 3 - 77		т		4	
10 dE	3/div	Rei	f 25.0) dBr	n									81.9 kHz .51 dBm		Auto Tune
Log 15.0 5.00														-2.55 dBr		Center Freq 15.004500 MHz
-15.0 -25.0 -35.0	1															Start Freq 9.000 kHz
-45.0 -55.0 -65.0	Land Land	M til fin	<u>م او الم الم الم الم الم الم الم الم الم الم</u>	Dechlistoffte	ljap Handilia	alines (nert)	ميداخير	halista an ann an an ann an an an an an an an	ng waa ya adaga	ka, njevani	shaadoo aa a	umentariti)eerendijare	alfa din fili na fili n	ng förd a ståla beja henda		Stop Freq 30.000000 MHz
#Re	t 9 kH s BW	100	kHz		×	#\	/BW	300 kHz Y		FUNCTION		weep 5.	333 ms (30.00 MHz 40001 pts		CF Step 2.999100 MHz <u>Auto</u> Man
2 3 4 5 6 7 8 9	N 1	f			281	.9 kHz		-46.51 d	Bm							Freq Offset 0 Hz
10 11 <								all.				STATU	s /! DC Co	oupled		



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





Low Band-edge

Lowest Channel & Modulation : π/4DQPSK



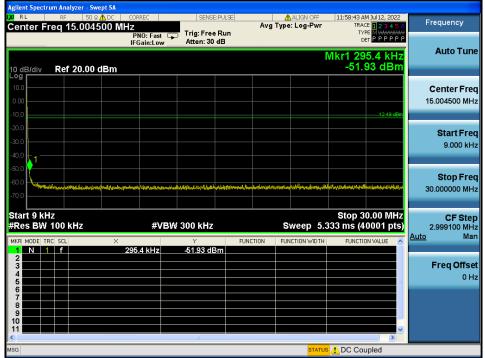
Low Band-edge

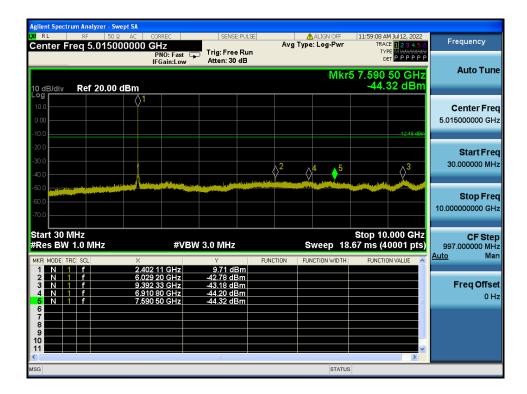
Hopping mode & Modulation : π/4DQPSK



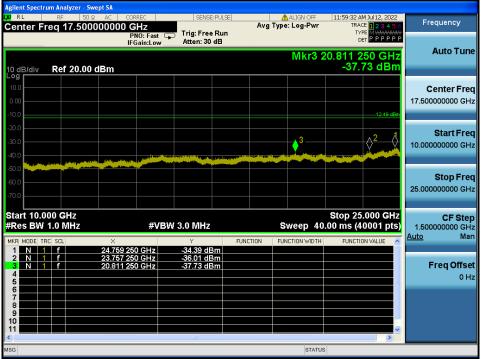


Conducted Spurious Emissions <u>Lowest Channel & Modulation : $\pi/4DQPSK</u>$ </u>





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



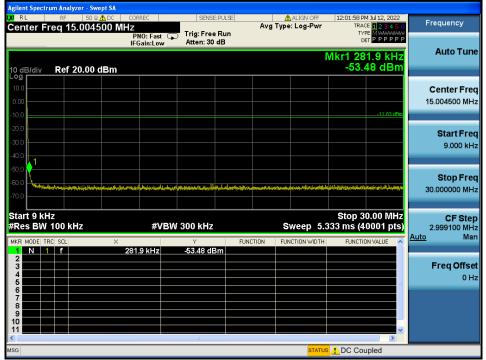


Reference for limit

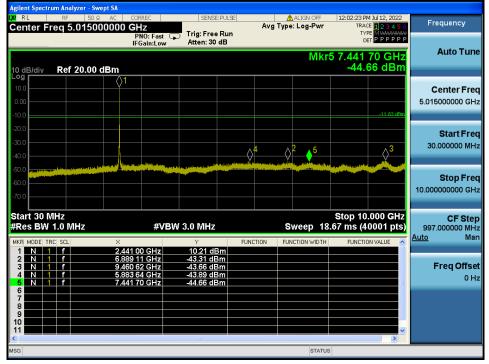
Middle Channel & Modulation : π/4DQPSK

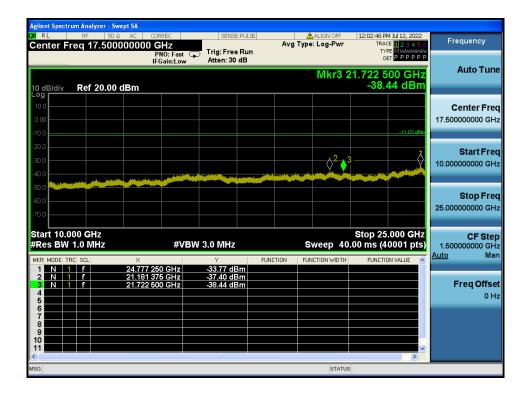


Conducted Spurious Emissions <u>Middle Channel & Modulation : π/4DQPSK</u>



Middle Channel & Modulation : π/4DQPSK







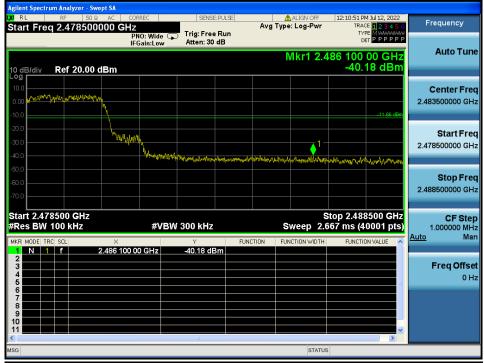
High Band-edge

Highest Channel & Modulation : π/4DQPSK

Agilent Spectrum Analyzer - Swept SA					
Center Freq 2.483500000	GHz	ENSE:PULSE Avg Free Run	ALIGN OFF	12:04:35 PM Jul 12, 2022 TRACE 1 2 3 4 5 6 TYPE MWWWW	Frequency
		: 30 dB	Mkr2 2.4	_{рет} рррррр 84 700 00 GHz	Auto Tune
10 dB/div Ref 20.00 dBm				-38.16 dBm	
10.0 0.00					Center Freq 2.483500000 GHz
-20.0	with the second second	2 ·			Start Freq 2.478500000 GHz
-40.0		utreanend anandranan an	al fall and a first of the fall of the fal	Nadirik (politik katika ang ang ang ang ang ang ang ang ang an	Stop Freq 2.488500000 GHz
-70.0 Start 2.478500 GHz #Res BW 100 kHz	#VBW 300 k	Hz		top 2.488500 GHz 67 ms (40001 pts)	CF Step 1.000000 MHz
MKRI MODE TRC SCL X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Man
1 N 1 f 2.480 1 2 N 1 f 2.484 7 3 4 5 6 6	75 75 GHz 8.1	4 dBm 5 dBm			Freq Offset 0 Hz
7 8 9 10 11				~	
MSG			STATUS		

High Band-edge

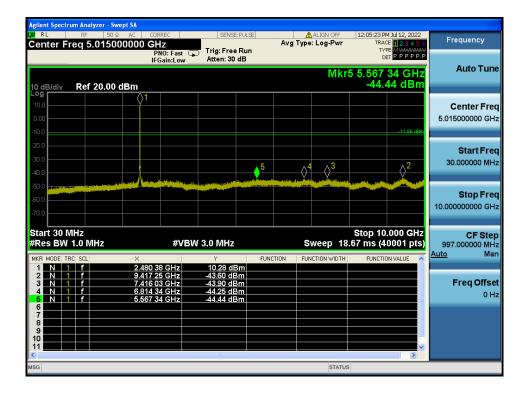
Hopping mode & Modulation : π/4DQPSK



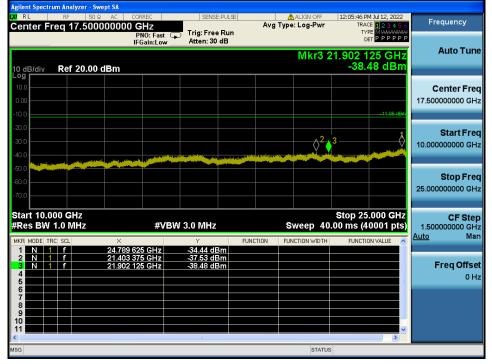


Highest Channel & Modulation : π/4DQPSK

		zer - Swept SA							
L <mark>XI</mark> RL	RF	50 Q 🚹 DC	CORREC	SENSE:PU		ALIGN OFF		4 Jul 12, 2022	Frequency
Center	Freg 15	5.004500 N	Hz			g Type: Log-Pwr		^E 123456	rrequency
			PNO: Fast	🏹 Trig: Free Ri			TY	E MWWWWW T P P P P P P	
			IFGain:Low	Atten: 30 dE	1				
							Mkr1 30	37647	Auto Tune
10 dB/div	Ref 2	20.00 dBm					-01.	72 dBm	
Log									
10.0									Center Freq
0.00									15.004500 MHz
0.00									15.004500 10112
-10.0								-11.86 dBm	
-20.0									
-20.0									Start Freq
-30.0									9.000 kHz
10.0									5.000 KH2
-40.0 1 -									
-50.0 🔽									
-60.0									Stop Freq
-60.0	والمتأ والتعاور للاله	A threw takes Handrices	المحمدية المصريف والمحادث وحاكات	والمرجع المحمود بالمالي وخاط المحمو المراج	and rinker aly sail in	بيجامر ويهير بالدمط وجنيلان وأجن	فيقتيه يتججه سيتقير العؤامي الد	in such a set of the s	30.000000 MHz
-70.0									00.000000 Mil 12
Start 9 k	H7						Stop 3	0.00 MHz	05.064
#Res BV		47	#\/D	W 300 kHz		Cwoon 5	.333 ms (4		CF Step
#Res DV	VIUUN	12	#VD	W JUU KHZ		aweep a	.555 ms (4	ooor pis,	2.999100 MHz
MKR MODE	TRC SCL	×		Y	FUNCTION	FUNCTION WIDTH	FUNCTIO	IN VALUE	<u>Auto</u> Man
1 N	1 f		303.7 kHz	-51.72 dBm					
2									
3									Freq Offset
4									0 Hz
5									
7									
8									
9									
10									
11								~	
<				Ш.				>	
MSG						STATU	JS 🚺 DC Cou	pled	



Highest Channel & Modulation : π/4DQPSK





Low Band-edge

Lowest Channel & Modulation : 8DPSK



Low Band-edge

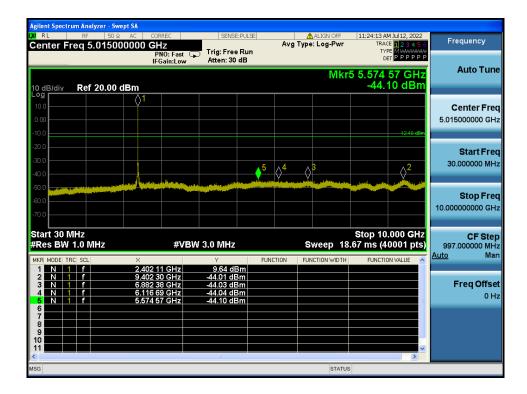
Hopping mode & Modulation : 8DPSK





Lowest Channel & Modulation : 8DPSK

Agrient Spect	RF		000054	0.011 10.0	min com					
Center F		50 2 <u>A</u> DC	CORREC	SENSE	:PULSE		ALIGN OFF		M Jul 12, 2022 CE 123456	Frequency
Contor I	109 10.0	70-7500 m	PNO: Fast	Trig: Free		0 //		TY	PE MWWWWW ET P P P P P P	
			IFGain:Lov	Atten: 30	dB					Auto Tune
									7.2 kHz	Autorune
10 dB/div	Ref 20	.00 dBm						-52.	57 dBm	
Log 10.0										
										Center Freq
0.00										15.004500 MHz
-10.0									12.40 dBm	
-20.0										Start Freq
-30.0										9.000 kHz
-40.0										5.000 KH12
-50.0										
-60.0										Stop Freq
	little land tit They	ngendenijsk menoperatorsk	والمسمود المسمولية	مردية المعالية والمعطول والمعام	nandelski historika	wydastaapoest (Joge	terne, statistica stat	ahijanatayahi	manningian	30.000000 MHz
-70.0										
Start 9 ki	17							Ston 3	0.00 MHz	CF Step
#Res BW			#∖	/BW 300 kHz		S	weep 5.3		0001 pts)	2.999100 MHz
MKR MODE T	BC SCI	×		Y	FUNCTIO		CTION WIDTH		ON VALUE	<u>Auto</u> Man
	1 f	~	287.2 kHz	-52.57 dB				Toneth		
2										Freq Offset
4										0 Hz
5									=	0112
7										
8 9										
10										
11									×	
NICO								• 00.0	2	
MSG							STATUS	上 DC Coi	upiea	









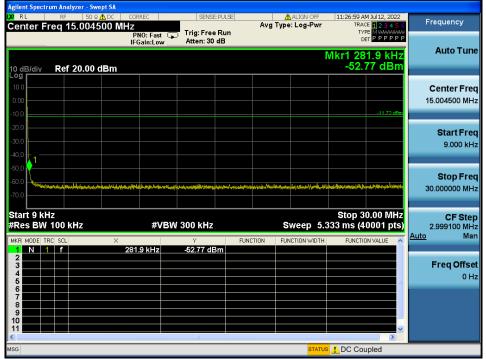


Reference for limit

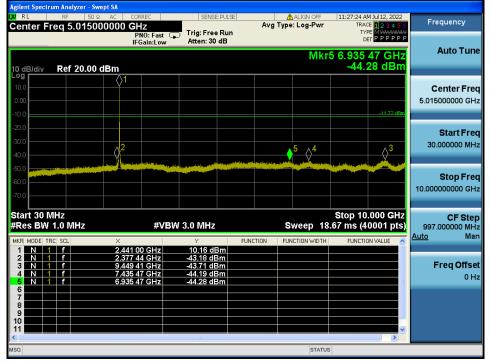


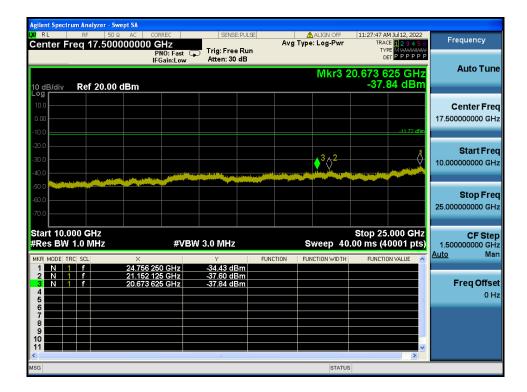


Conducted Spurious Emissions <u>Middle Channel & Modulation : 8DPSK</u>



Middle Channel & Modulation : 8DPSK







High Band-edge

Highest Channel & Modulation : 8DPSK

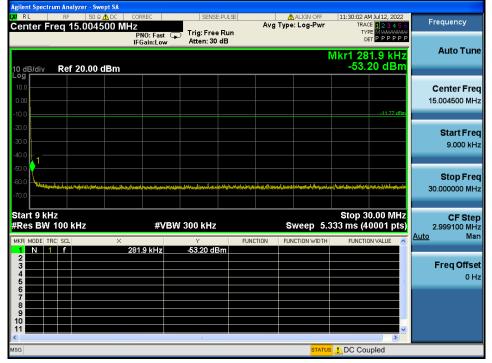
Agilent Spectrum Analyzer - Swept SA				
	CORREC SENSE:PU	Avg Type: Log-Pwr	11:29:40 AM Jul 12, 2022 TRACE 123456	Frequency
	PNO: Wide Trig: Free R IFGain:Low Atten: 30 dE			Auto Tune
10 dB/div Ref 20.00 dBm		IVIKT2 2.4	84 760 00 GHz -38.91 dBm	
100 0.00 -10.0				Center Freq 2.483500000 GHz
-30.0	m	2-	ervezetingstefteletikoveten	Start Freq 2.478500000 GHz
-50.0 -60.0 -70.0				Stop Freq 2.488500000 GHz
Start 2.478500 GHz #Res BW 100 kHz	#VBW 300 kHz	S Sweep 2.6	itop 2.488500 GHz i67 ms (40001 pts)	CF Step 1.000000 MHz
MKR MODE TRC SCL X 1 N 1 f 2.479 8	39 75 GHz 8.23 dBm		FUNCTION VALUE	<u>Auto</u> Man
3 4	60 00 GHz _38.91 dBm			Freq Offset 0 Hz
6 7 8 9 10 11			~	
MSG		STATUS		

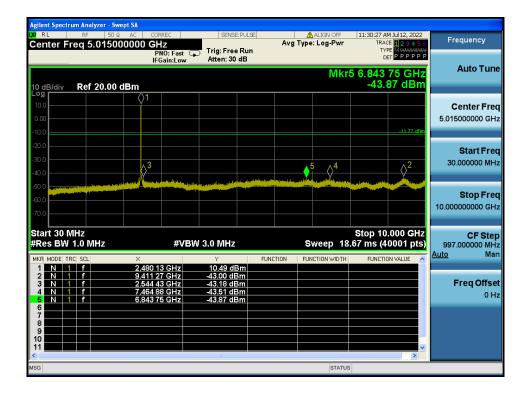
High Band-edge

Hopping mode & Modulation : 8DPSK



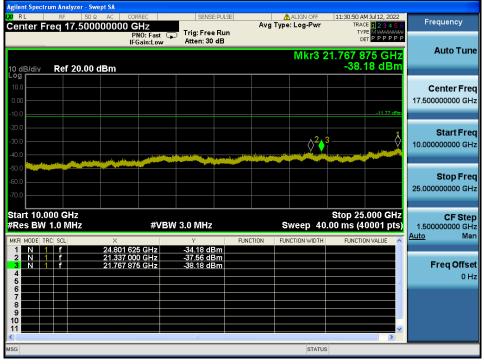
Highest Channel & Modulation : 8DPSK











10. AC Power-Line Conducted Emissions

10.1. Test Setup

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

10.2. Limit

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

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

Frequency Range (MHz)	Conducted Limit (dBuV)						
	Quasi-Peak	Average					
0.15 ~ 0.50	66 to 56 *	56 to 46 *					
0.5 ~ 5.0	56	46					
5 ~ 30	60	50					

* Decreases with the logarithm of the frequency

10.3. Test Procedure

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

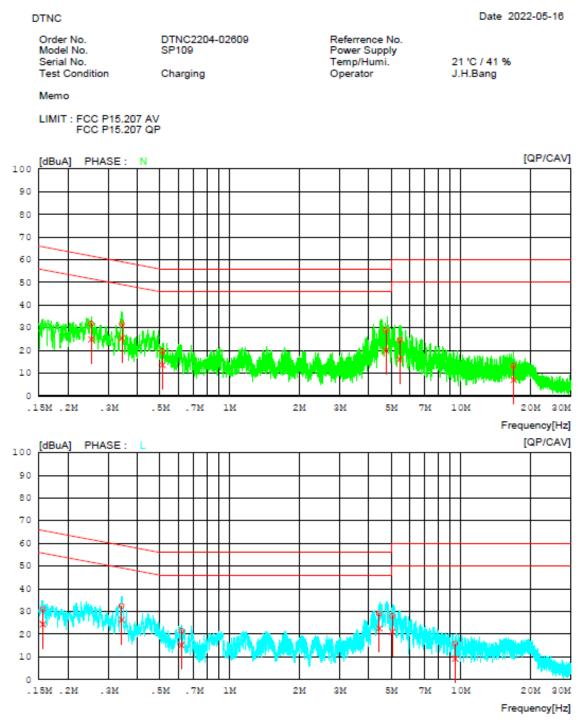
- The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
- 2. The EUT was connected 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.



10.4. Test Results

AC Power-Line Conducted Emissions (Graph) – Charging Mode

Results of Conducted Emission



AC Power-Line Conducted Emissions (List) – Charging Mode

Results of Conducted Emission

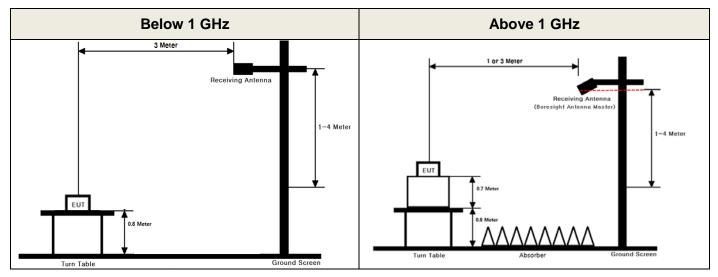
DTNC				Date	2022-05-16			
Order No. DTNC2204-02609 Model No. SP109 Serial No. Test Condition Charging			Referrence No. Power Supply Temp/Humi. Operator	21 'C / 41 % J.H.Bang	6			
Memo	Memo							
LIMIT : FCC P15.207 AV FCC P15.207 Qf								
•	DING C.FACTOR		LIMIT	MARGIN	PHASE			
QP [MHz] [dBuA	CAV [dBuA] [dB]	QP CAV [dBuA][dBui	-	7 QP CAV aA] [dBuA][dBuA	1			
1 0.25234 21.85	514.89 10.00	31.85 24.89	61.68 51.6	8 29.8326.79	N			
2 0.34211 21.72	215.42 10.00	31.72 25.42	59.15 49.1	5 27.4323.73	N			
3 0.51292 9.73	3 3.55 10.01	19.7413.56	56.00 46.0	0 36.2632.44	N			
4 4.75042 18.69	9 9.76 10.21	28.90 19.97	56.00 46.0	0 27.1026.03	N			
5 5.44630 14.36	5 5.89 10.22	24.5816.11	60.00 50.0	0 35.4233.89	N			
6 16.95141 2.65	5-3.37 10.49	13.14 7.12	60.00 50.0	0 46.8642.88	N			
7 0.15592 20.99	914.38 9.99	30.9824.37	65.68 55.6	8 34.7031.31	L			
8 0.34168 22.36	516.25 10.00	32.3626.25	59.16 49.1	6 26.80 22.91	L			
9 0.62012 11.37		21.38 15.13			L			
10 4.44577 18.85		29.05 22.55			L			
11 5.06306 17.73		27.94 20.91			L			
12 9.47522 5.43	3-1.06 10.33	15.76 9.27	60.00 50.0	0 44.2440.73	L			



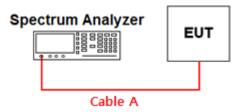
APPENDIX I

Test set up diagrams

Radiated Measurement



Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	0.49	15	2.24
1	0.55	20	2.49
2.402 & 2.441 & 2.480	1.43	25	3.09
5	1.69	-	-
10	2.02	-	-

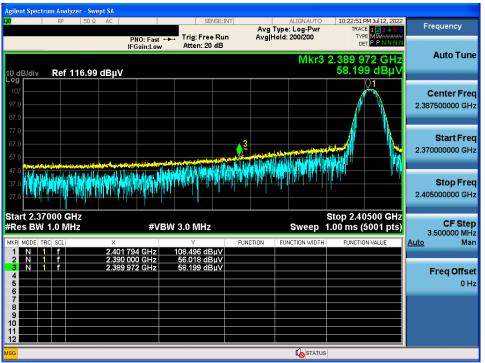
Note 1: The path loss from EUT to Spectrum analyzer was measured and used for test. Path loss (S/A's correction factor) = Cable A + Power Splitter



APPENDIX II

Unwanted Emissions (Radiated) Test Plot

GFSK & Lowest & Z & Hor



GFSK & Highest & Z & Hor

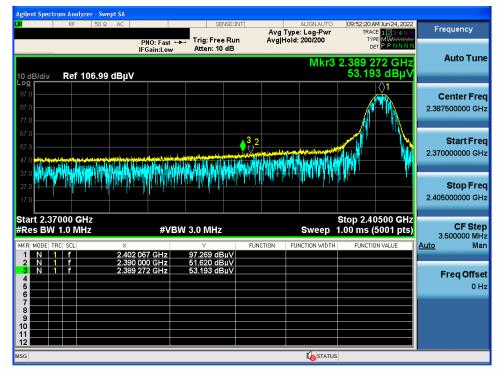
Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 Trig: Free Run Atten: 20 dB PNO: Fast ↔↔ IFGain:Low Auto Tune Mkr3 2.483 834 4 GHz 62.715 dBµ\ Ref 116.99 dBµV Center Freq 2.489000000 GHz **3** Start Freq 2.478000000 GHz ALAN ARTIN MENDERIK MANDELAN MENDELAN KERTING DER KANNEL DER KANNEL DER KANNEL DER KANNEL DER KANNEL DER KANNE Stop Freq 2.50000000 GHz Start 2.47800 GHz #Res BW 1.0 MHz Stop 2.50000 GHz 1.00 ms (5001 pts) CF Step 2.40200000 GHz #VBW 3.0 MHz Sweep Auto Man FUNCTION FUNCTION 60.404 dBµ 62.715 dBµ Freq Offset 0 Hz 5 6 7 8 9 10 11 12 **I**STATUS

Detector Mode : PK



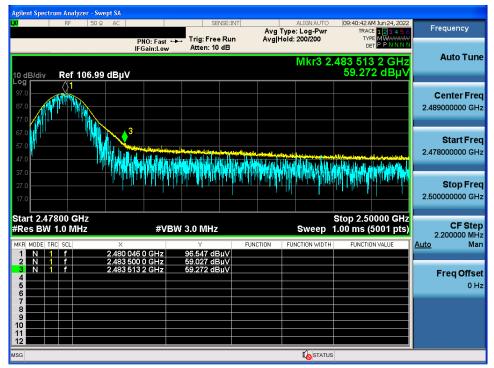
Detector Mode : PK

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



Detector Mode : PK

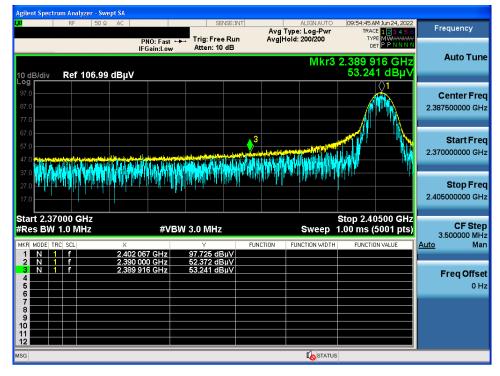
π /4DQPSK & Highest & Z & Hor





Detector Mode : PK

8DPSK & Lowest & Z & Hor

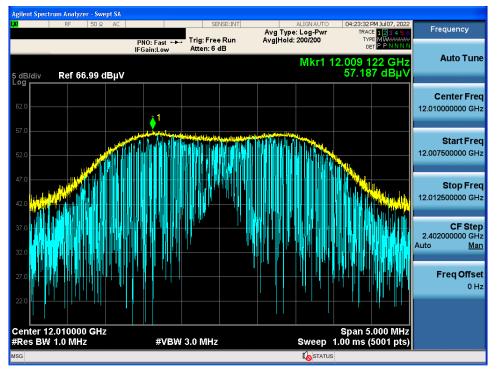


8DPSK & Highest & Z & Hor

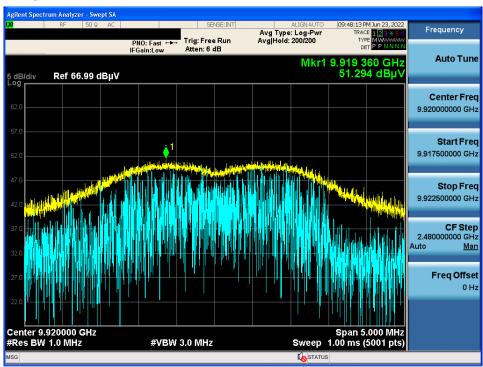
nt Spectrum Analyzer - Swept SA SENSE:INT Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 Trig: Free Run PNO: Fast + IFGain:Low Atten: 10 dB Auto Tune Mkr3 2.483 526 4 GHz 61.132 dBµ\ Ref 106.99 dBµV **Center Freq** 2.489000000 GHz 3 Start Freq 2.478000000 GHz n<mark>en par l'induir</mark>i in stand sold 2 dis it. e linn in Stop Freq 2.50000000 GHz Start 2.47800 GHz #Res BW 1.0 MHz Stop 2.50000 GHz 1.00 ms (5001 pts) CF Step 2.200000 MHz #VBW 3.0 MHz Sweep Man Auto FUN N N 2.483 500 0 GH; 2.483 526 4 GH; 59.008 dBμ\ 61.132 dBμ\ **Freq Offset** 456789 0 Hz 9 10 11 12 MSG **I**STATUS

Detector Mode : PK

GFSK & Lowest & X & Ver



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





8DPSK & Highest& X & Ver

