RF Test Report

For

Project No.:	ZKT-240801L9141E-2
Model:	EF6-2
Client:	Autel Robotics Co., Ltd.
Manufacturer:	Autel Robotics Co., Ltd.
Product Description:	Autel Smart Controller SE V2
Test Engineer:	Jim Liu
Test Date:	2024-05-28

Test Summary

Item	**Result**
Bandwidth	Pass
Maximum Conducted Output Power	Pass
Carrier Frequency Separation	Pass
Number of Hopping Frequencies	Pass
Time of Occupancy (Dwell Time)	Pass
Unwanted Emissions In Non-restricted Frequency Bands	Pass
Frequency Error	Pass
Form731	Pass

1. Bandwidth

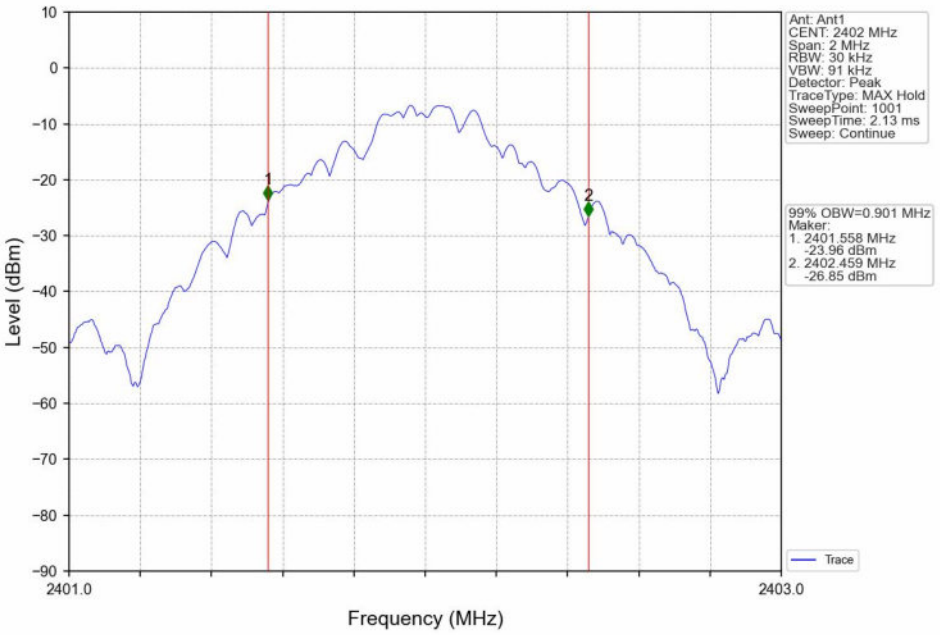
1.1 OBW

1.1.1 Test Result

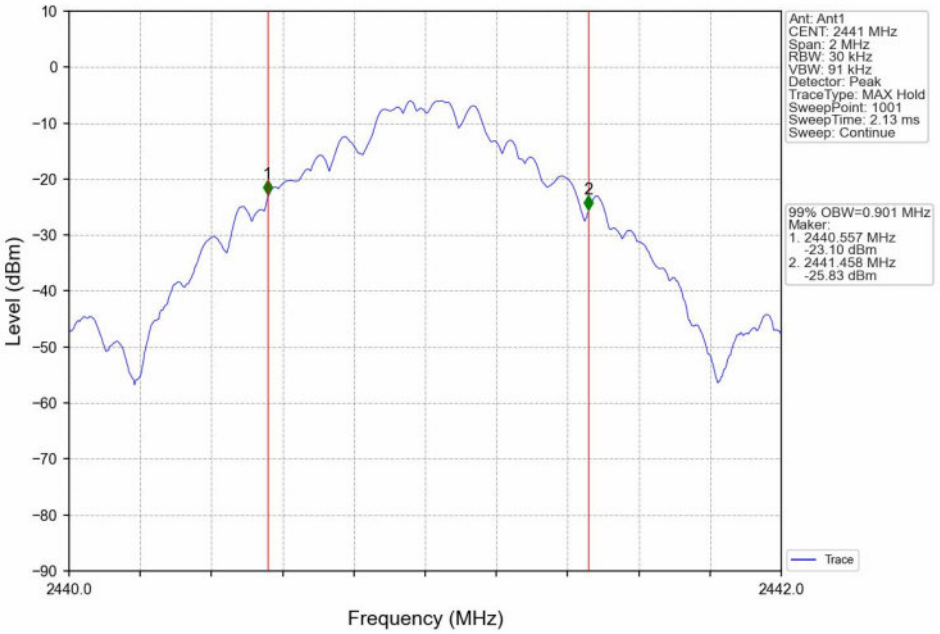
Mode	TX Type	Frequency (MHz)	Packet Type	ANT	99% Occupied Bandwidth (MHz)		Verdict
					Result	Limit	
GFSK	SISO	2402	DH5	1	0.901	/	Pass
		2441	DH5	1	0.901	/	Pass
		2480	DH5	1	0.895	/	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	1.194	/	Pass
		2441	2DH5	1	1.207	/	Pass
		2480	2DH5	1	1.201	/	Pass
8DPSK	SISO	2402	3DH5	1	1.201	/	Pass
		2441	3DH5	1	1.198	/	Pass
		2480	3DH5	1	1.201	/	Pass

1.1.2 Test Graph

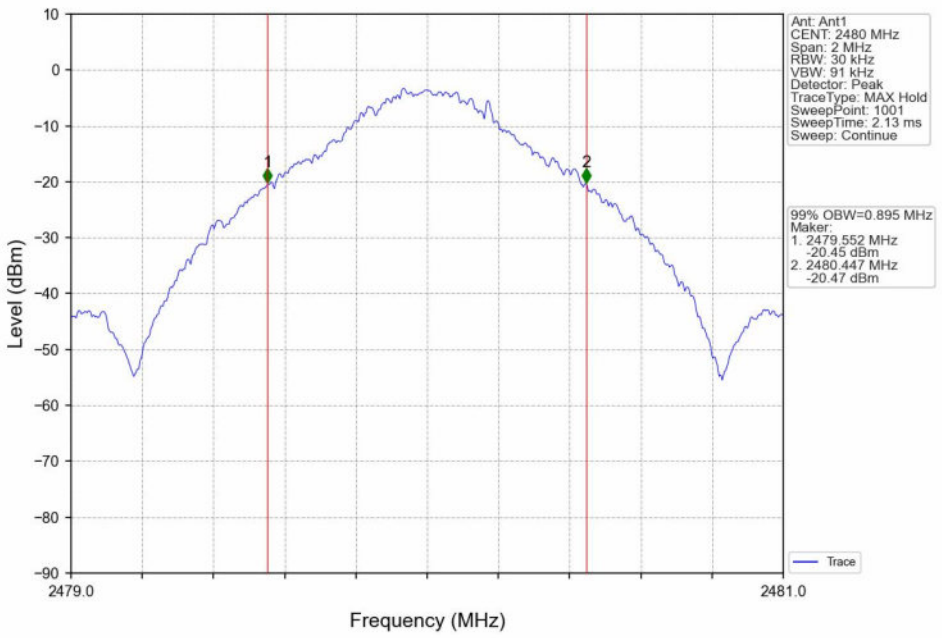
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



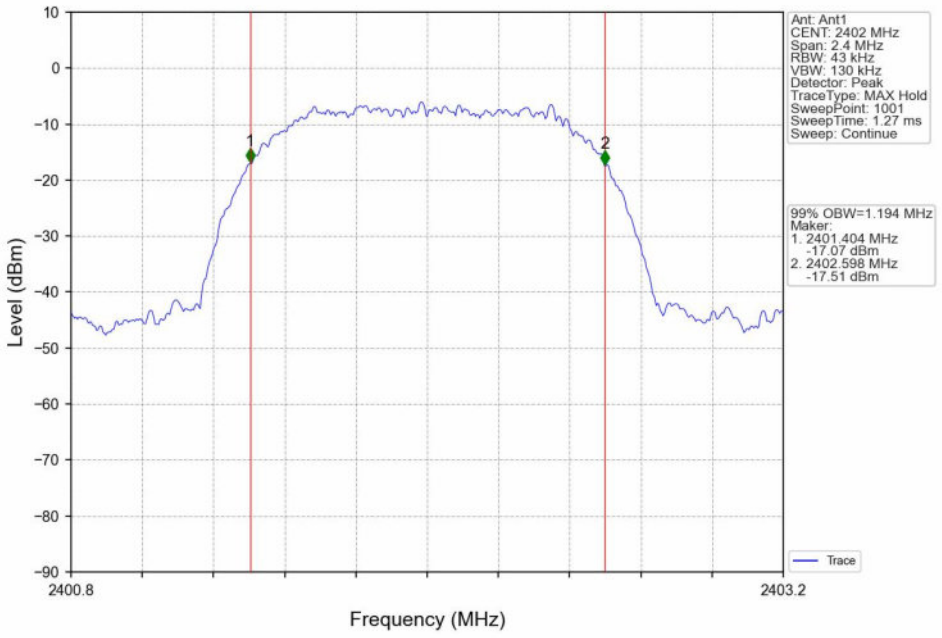
GFSK_DH5_MCH_2441MHz_Ant1_NTNV



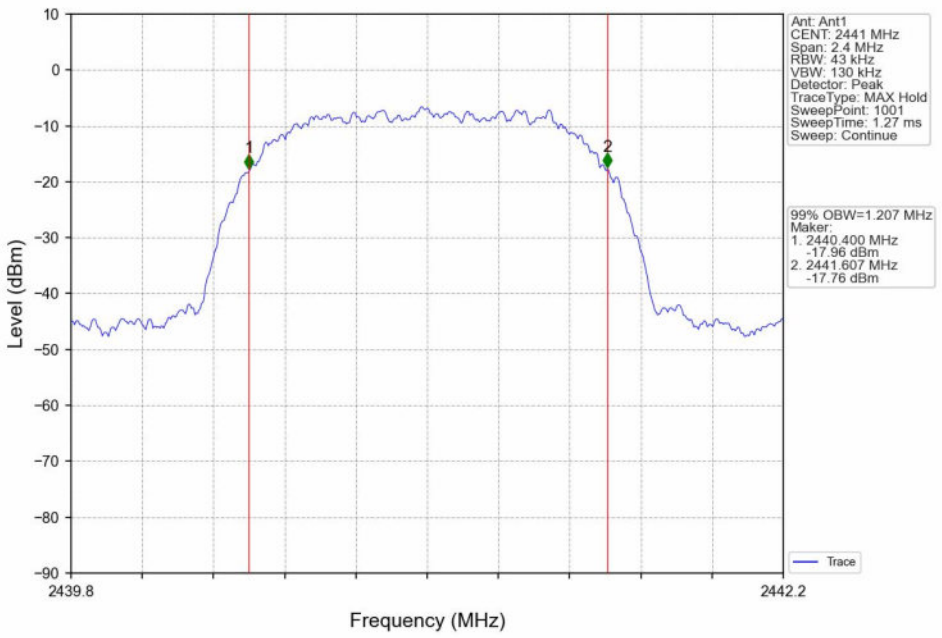
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



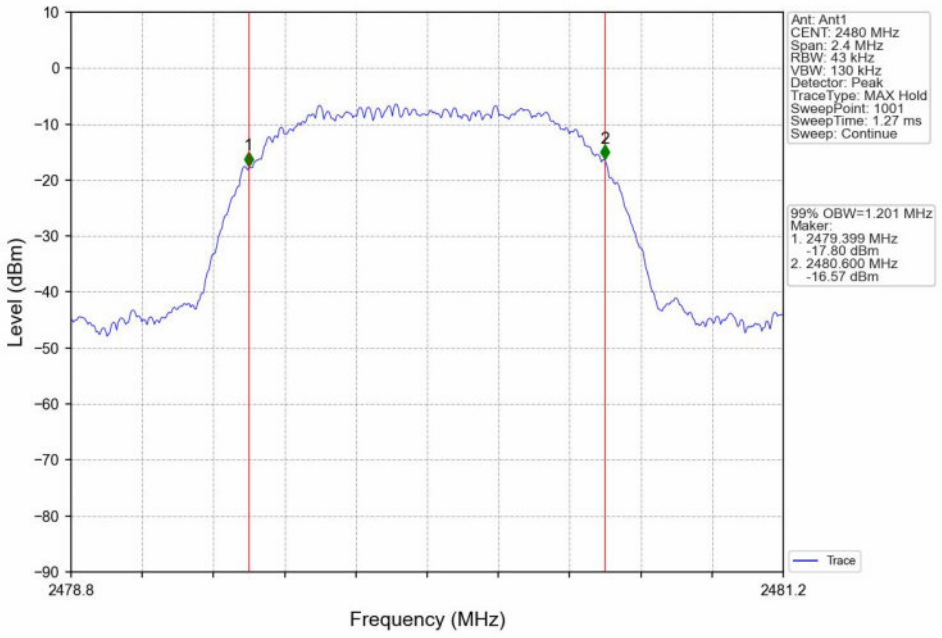
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



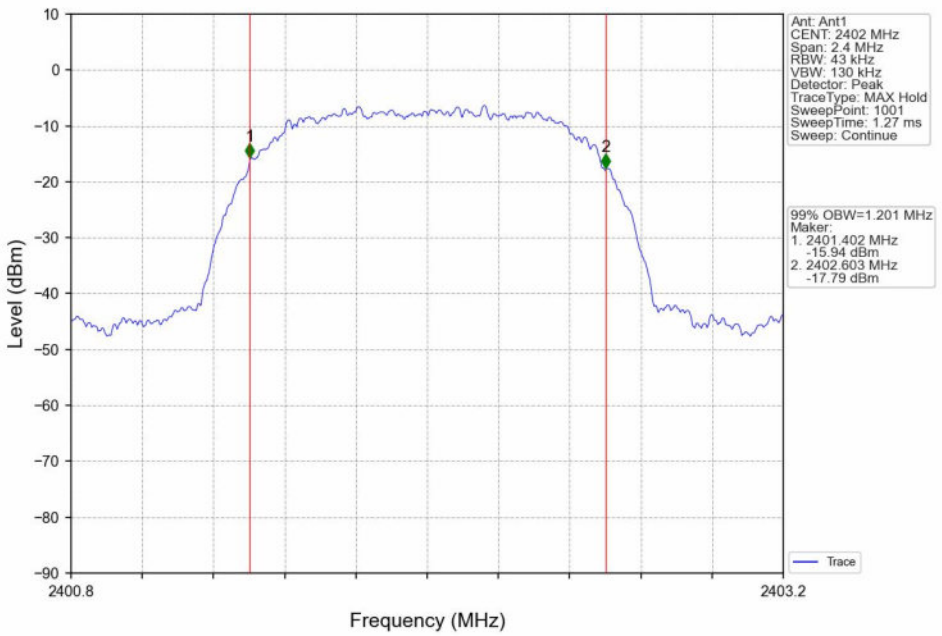
Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV



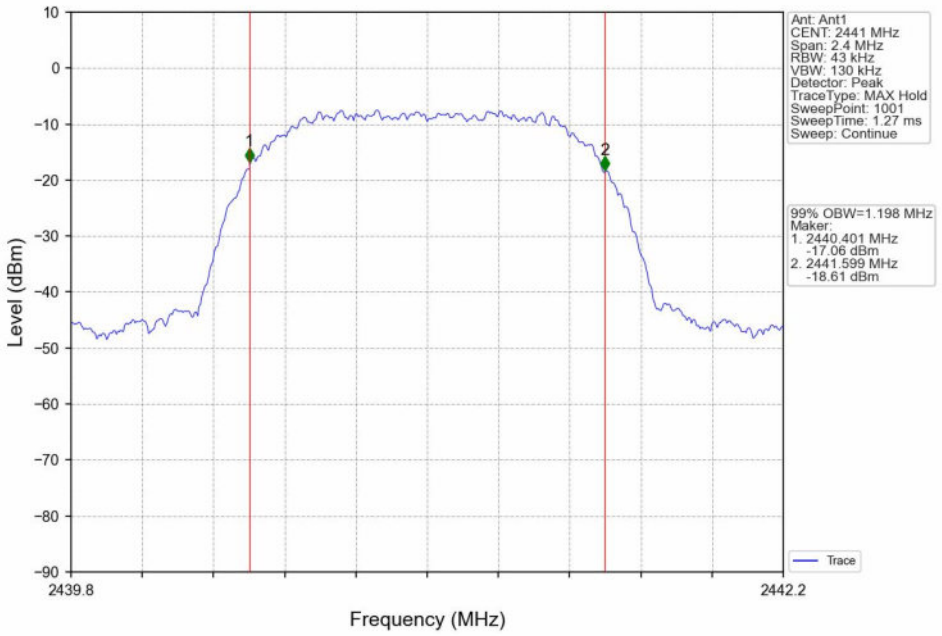
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV



8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV



8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV



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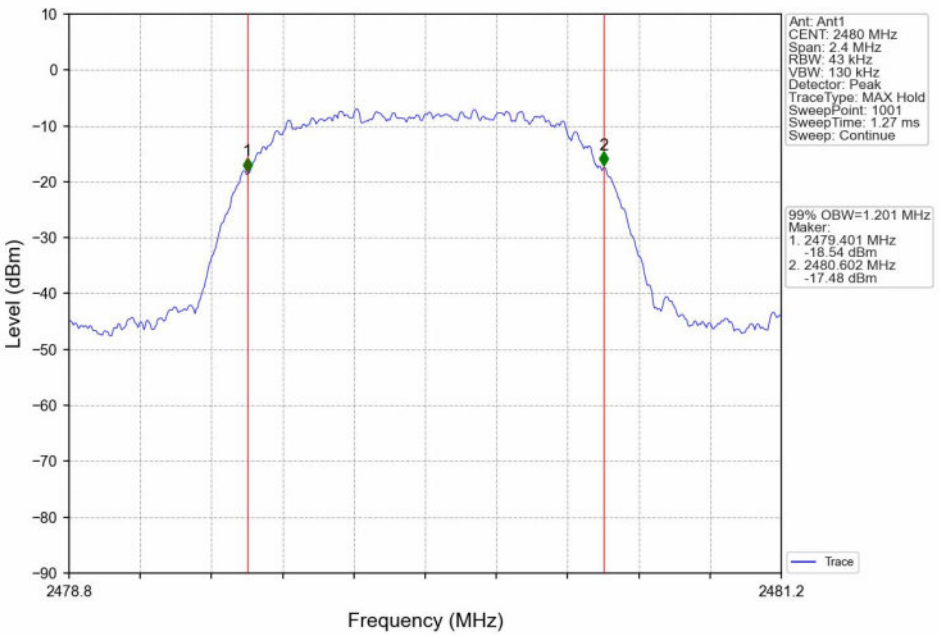


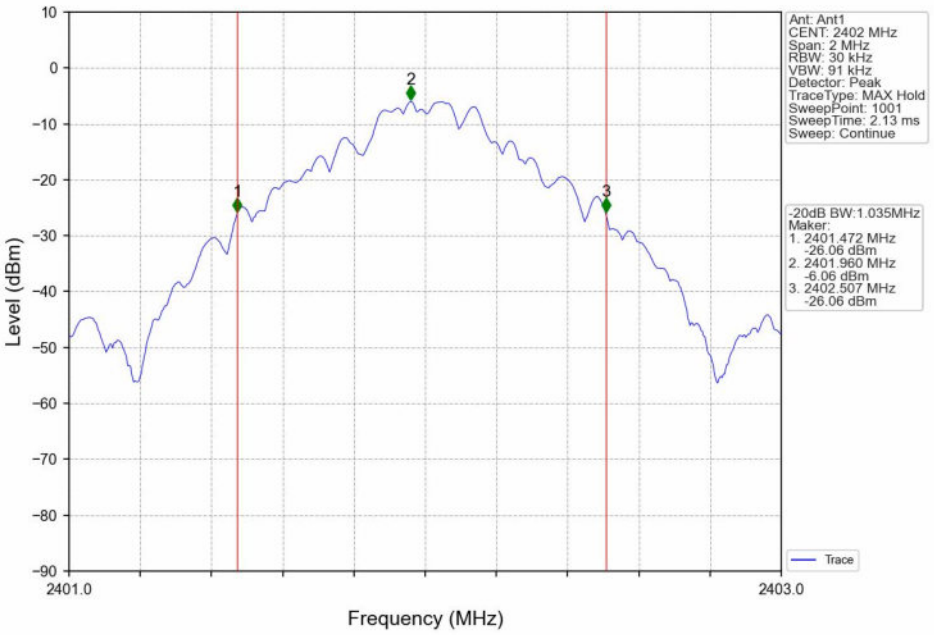
1.2 20dB BW

1.2.1 Test Result

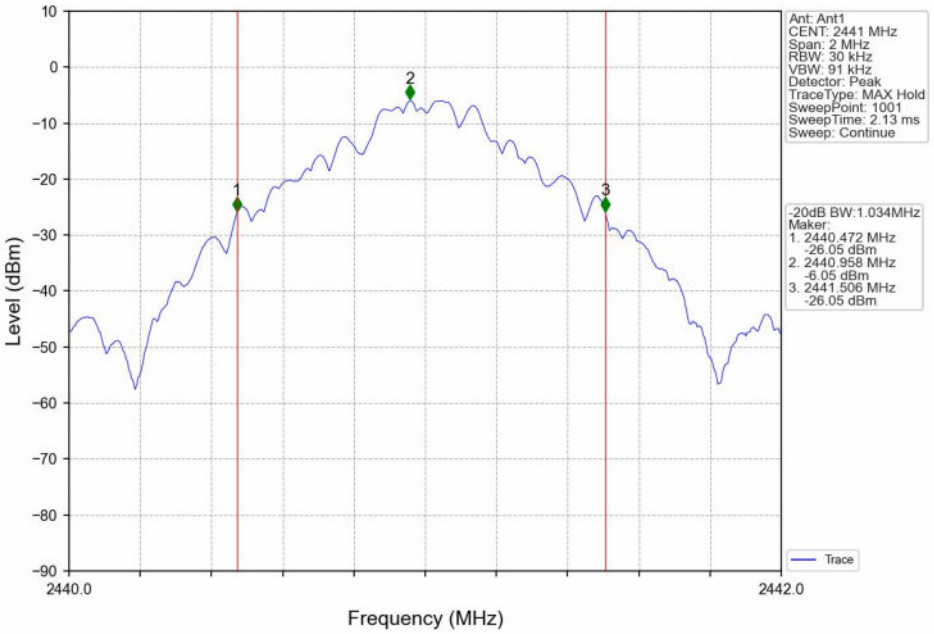
Mode	TX Type	Frequency (MHz)	Packet Type	ANT	20dB Bandwidth (MHz)		Verdict
					Result	Limit	
GFSK	SISO	2402	DH5	1	1.035	/	Pass
		2441	DH5	1	1.034	/	Pass
		2480	DH5	1	1.046	/	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	1.364	/	Pass
		2441	2DH5	1	1.368	/	Pass
		2480	2DH5	1	1.360	/	Pass
8DPSK	SISO	2402	3DH5	1	1.357	/	Pass
		2441	3DH5	1	1.370	/	Pass
		2480	3DH5	1	1.376	/	Pass

1.2.2 Test Graph

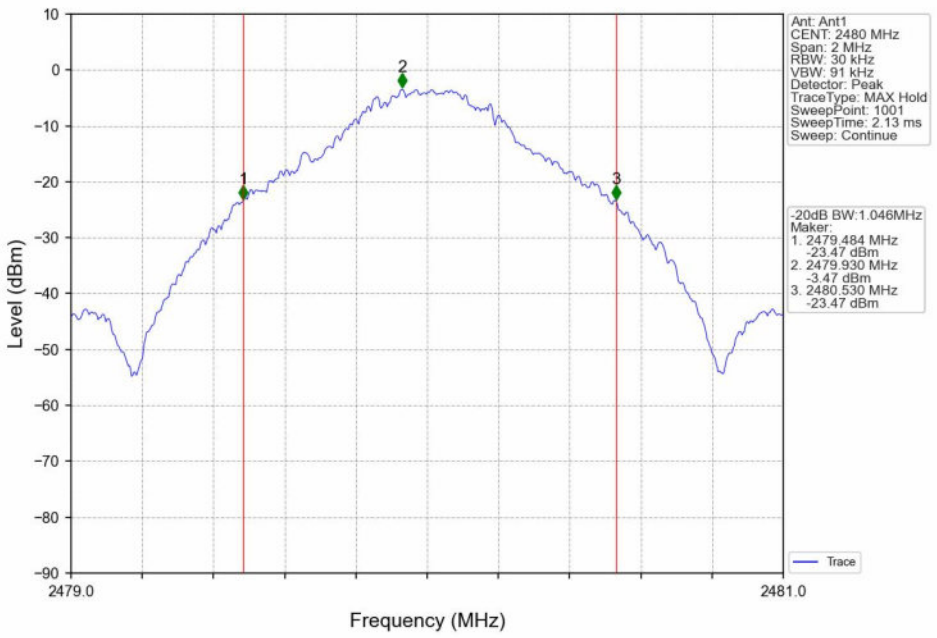
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



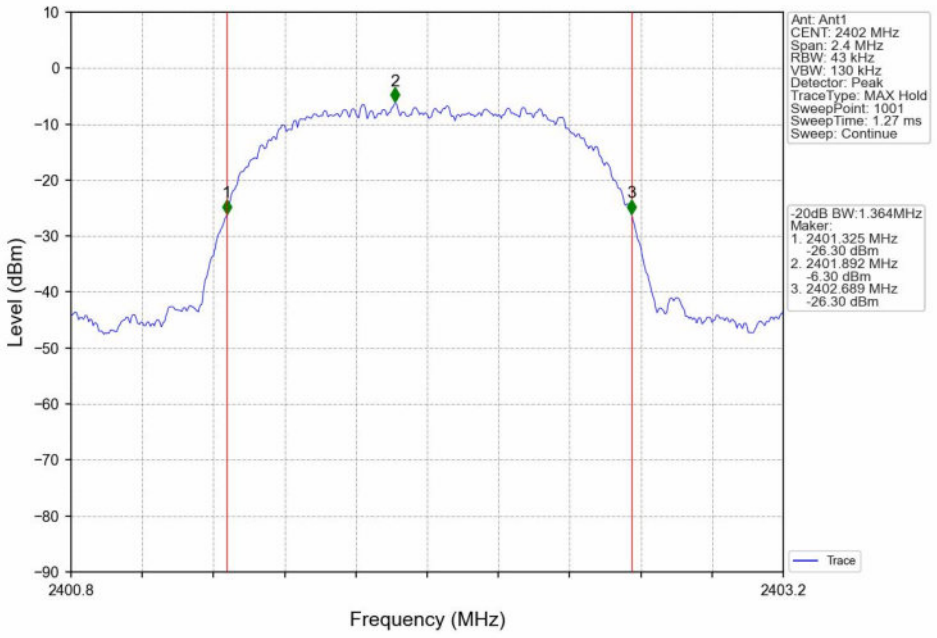
GFSK_DH5_MCH_2441MHz_Ant1_NTNV

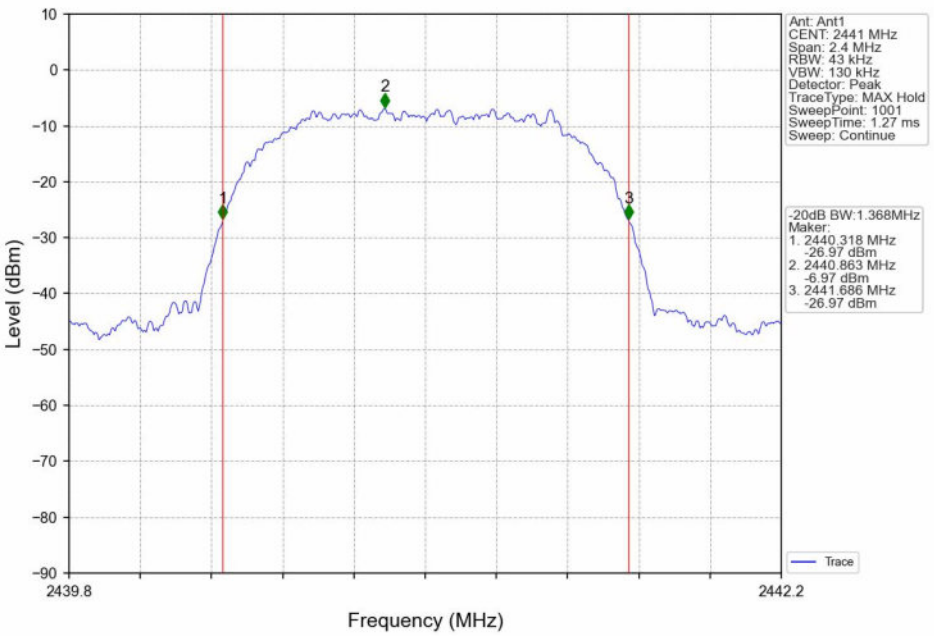


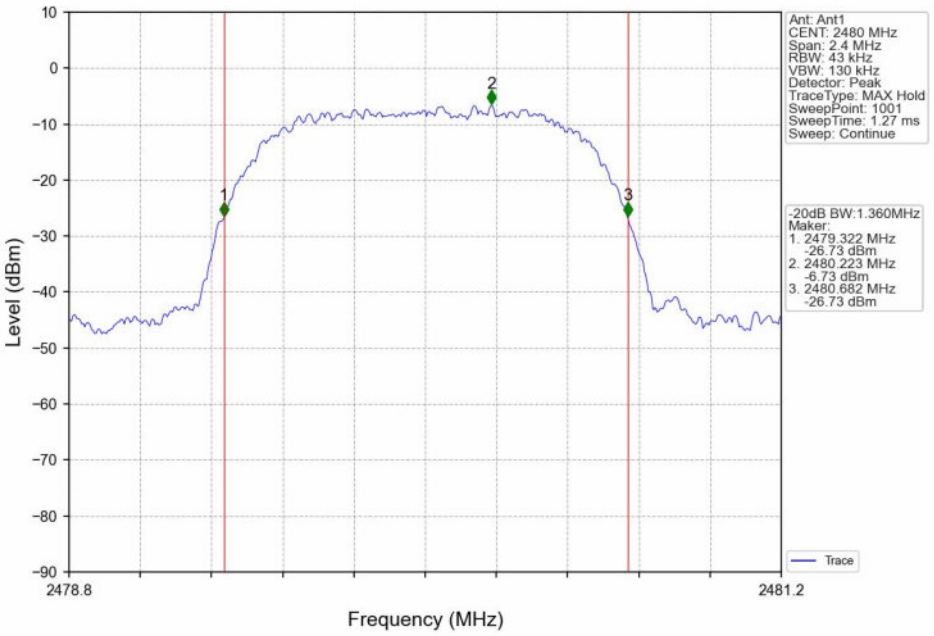
GFSK_DH5_HCH_2480MHz_Ant1_NTNV

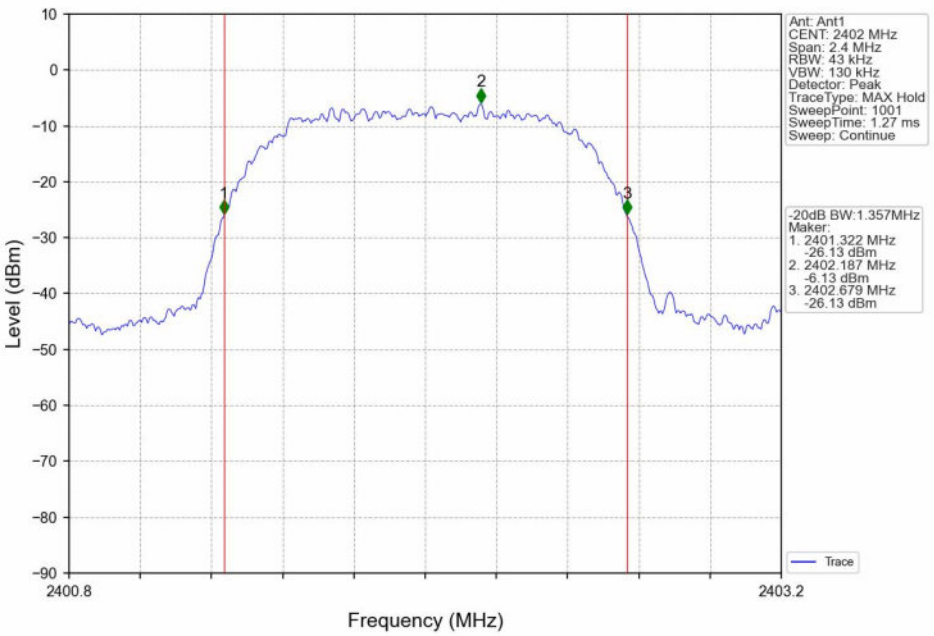


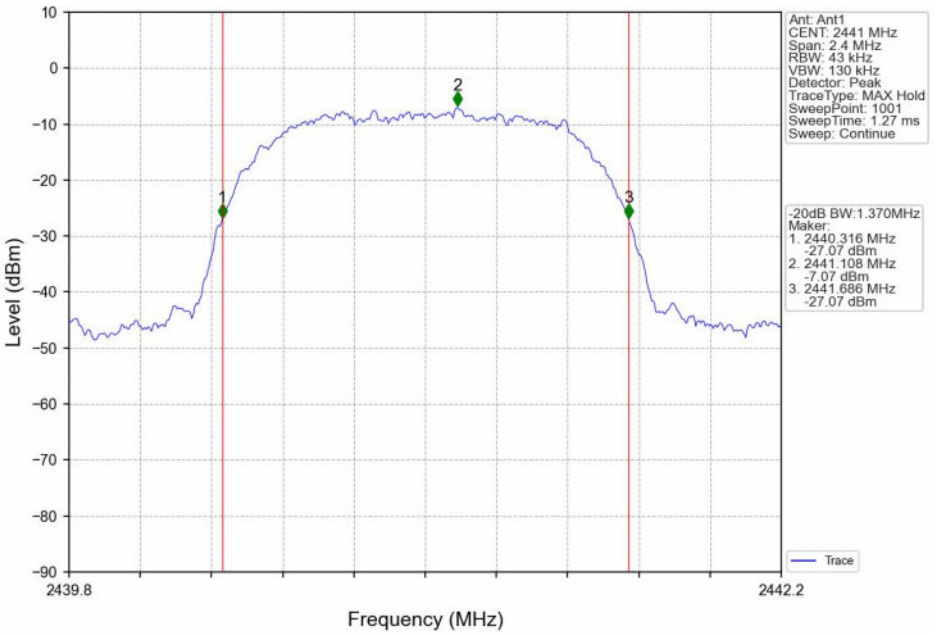
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV


Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV


8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV


8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV


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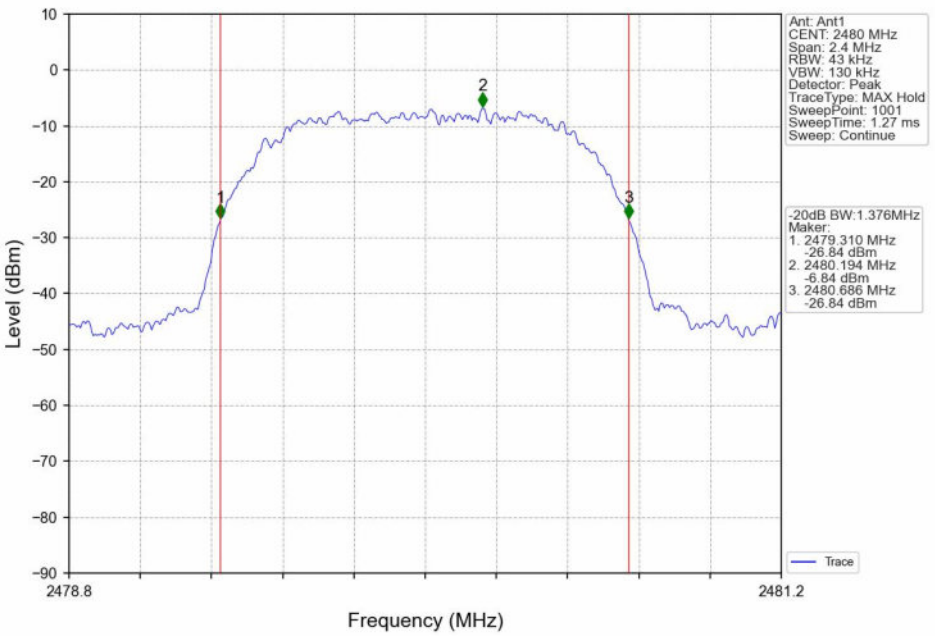


2. Maximum Conducted Output Power

2.1 Power

2.1.1 Test Result

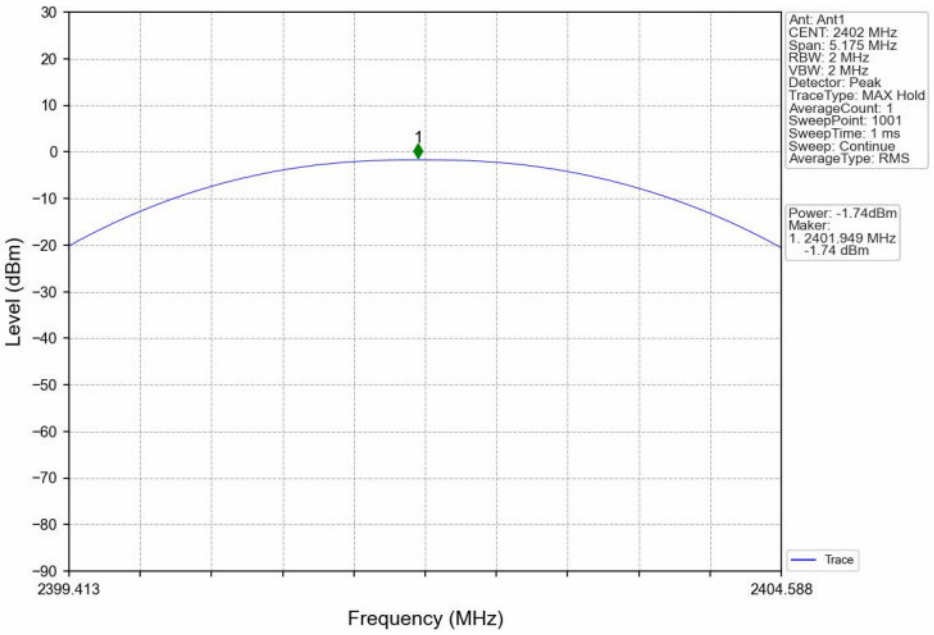
Mode	TX Type	Frequency (MHz)	Packet Type	Maximum Peak Conducted Output Power (dBm)		Verdict
				ANT1	Limit	
GFSK	SISO	2402	DH5	-1.74	<=20.97	Pass
		2441	DH5	-1.88	<=20.97	Pass
		2480	DH5	-2.07	<=20.97	Pass
Pi/4DQPSK	SISO	2402	2DH5	-1.36	<=20.97	Pass
		2441	2DH5	-1.76	<=20.97	Pass
		2480	2DH5	-1.51	<=20.97	Pass
8DPSK	SISO	2402	3DH5	-0.81	<=20.97	Pass
		2441	3DH5	-1.38	<=20.97	Pass
		2480	3DH5	-1.12	<=20.97	Pass
Note1: Antenna Gain: Ant1: 1.10dBi;						

EIRP

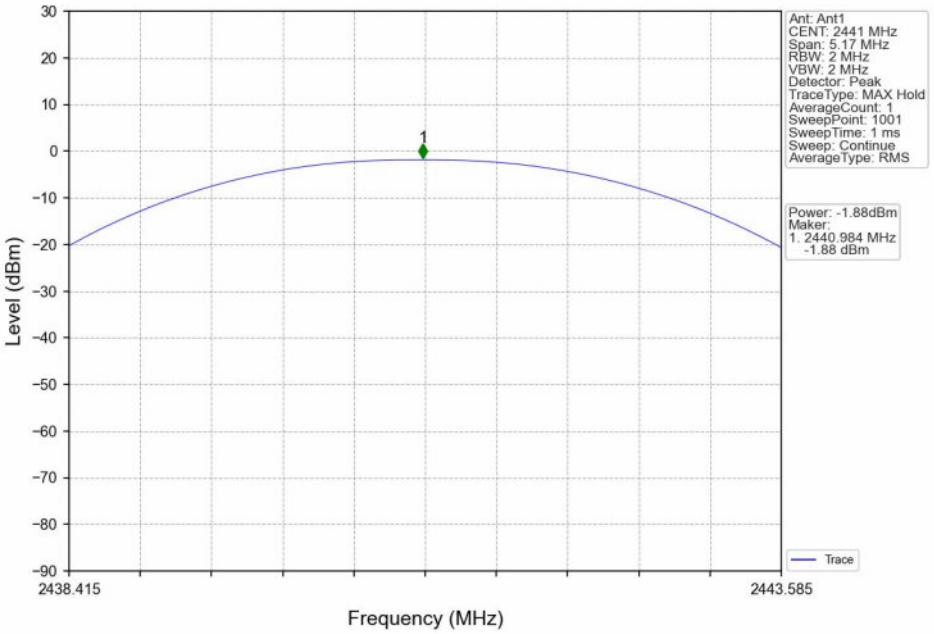
Mode	TX Type	Frequency (MHz)	Packet Type	E.I.R.P (dBm)		Verdict
				ANT1	Limit	
GFSK	SISO	2402	DH5	-0.64	<=36.02	Pass
		2441	DH5	-0.78	<=36.02	Pass
		2480	DH5	-0.97	<=36.02	Pass
Pi/4DQPSK	SISO	2402	2DH5	-0.26	<=36.02	Pass
		2441	2DH5	-0.66	<=36.02	Pass
		2480	2DH5	-0.41	<=36.02	Pass
8DPSK	SISO	2402	3DH5	0.29	<=36.02	Pass
		2441	3DH5	-0.28	<=36.02	Pass
		2480	3DH5	-0.02	<=36.02	Pass
Note1: Antenna Gain: Ant1: 1.10dBi; Note2: E.I.R.P = Measured Power + Antenna Gain						

2.1.2 Test Graph

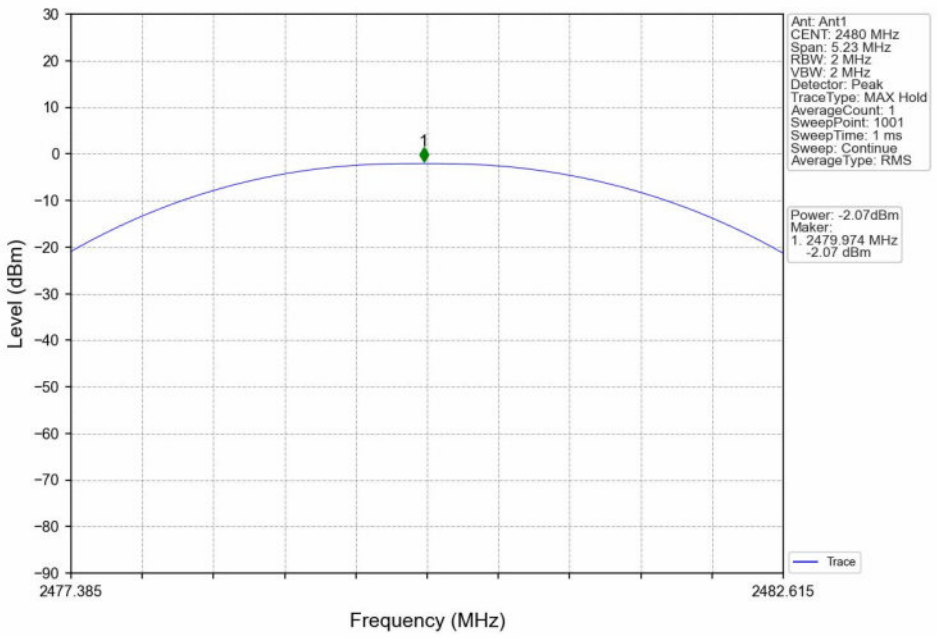
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



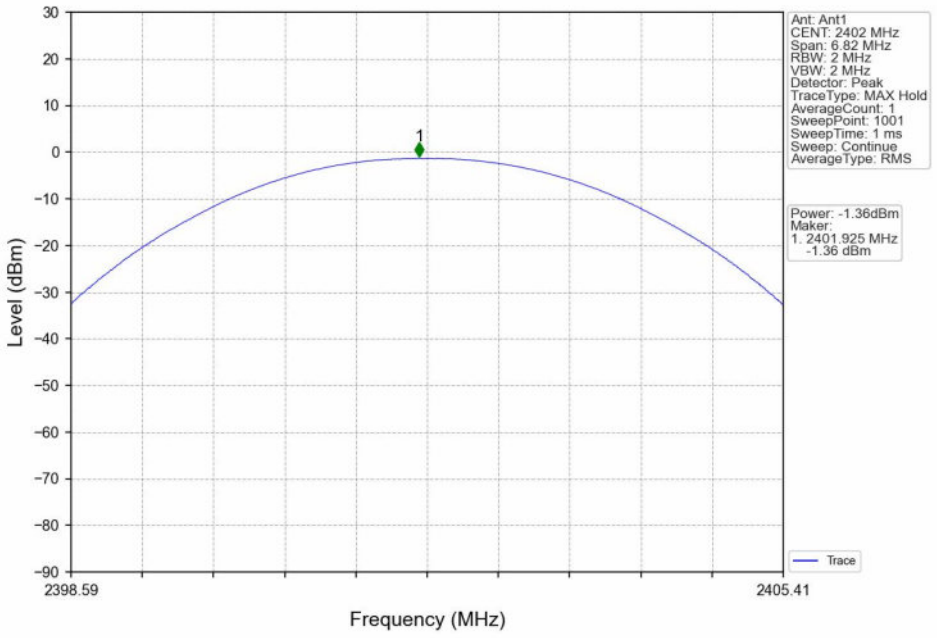
GFSK_DH5_MCH_2441MHz_Ant1_NTNV

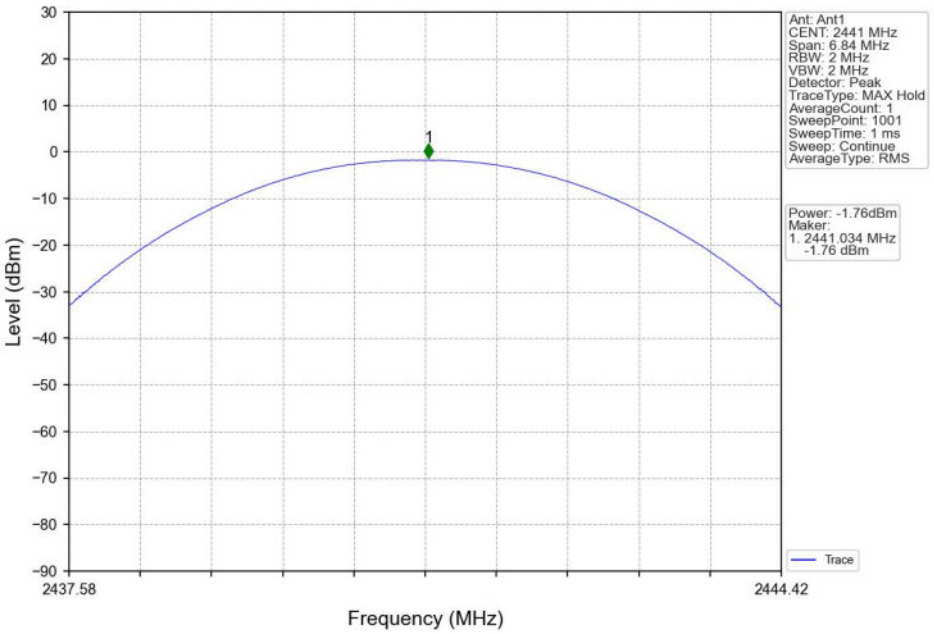


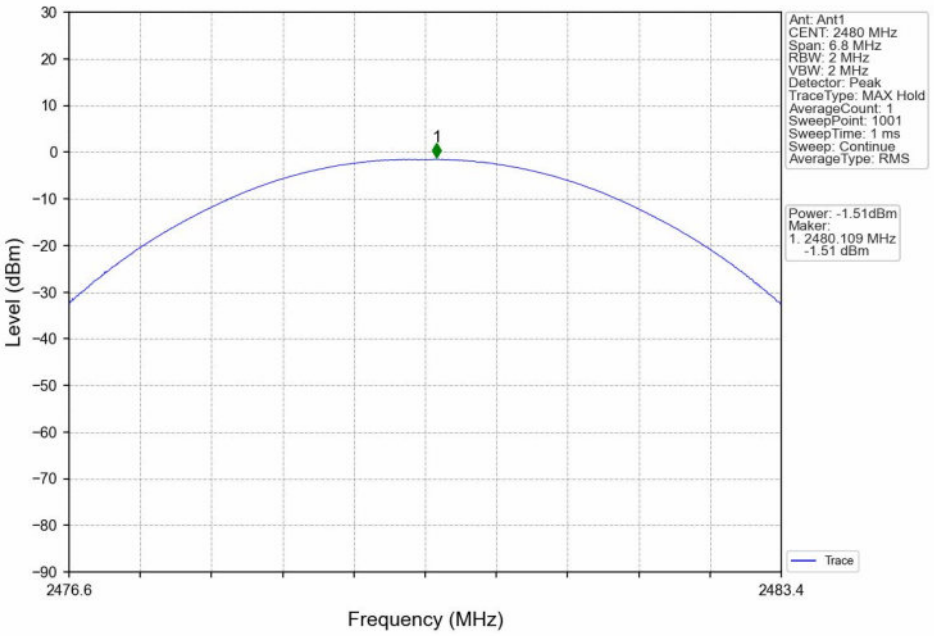
GFSK_DH5_HCH_2480MHz_Ant1_NTNV

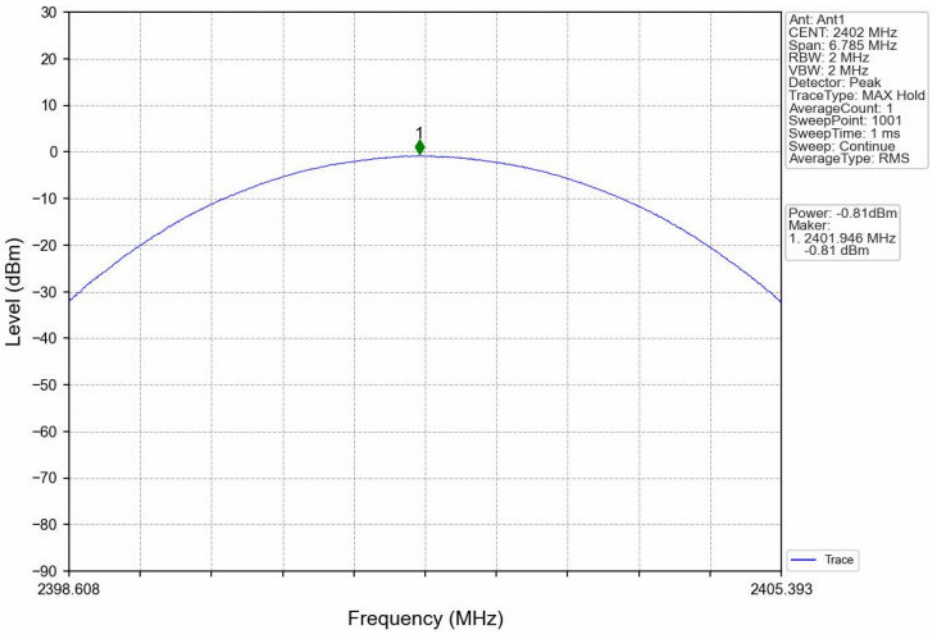
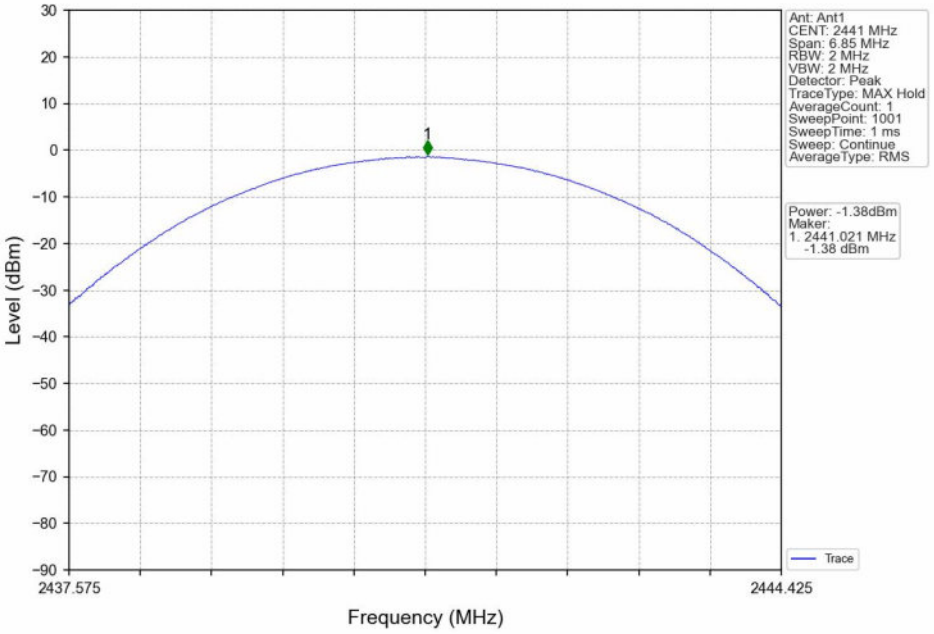


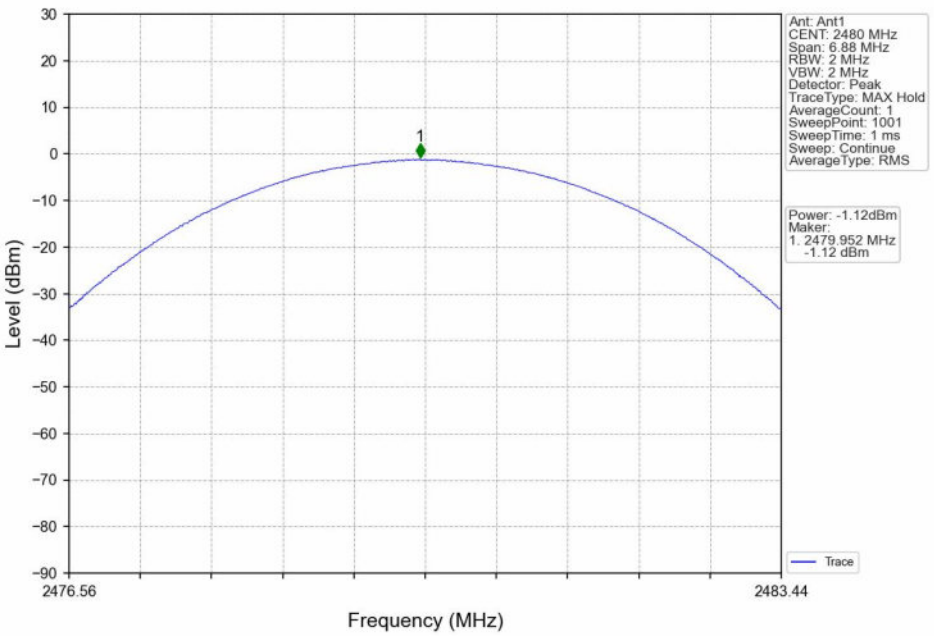
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV


Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV


8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV

8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV


8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV


3. Carrier Frequency Separation

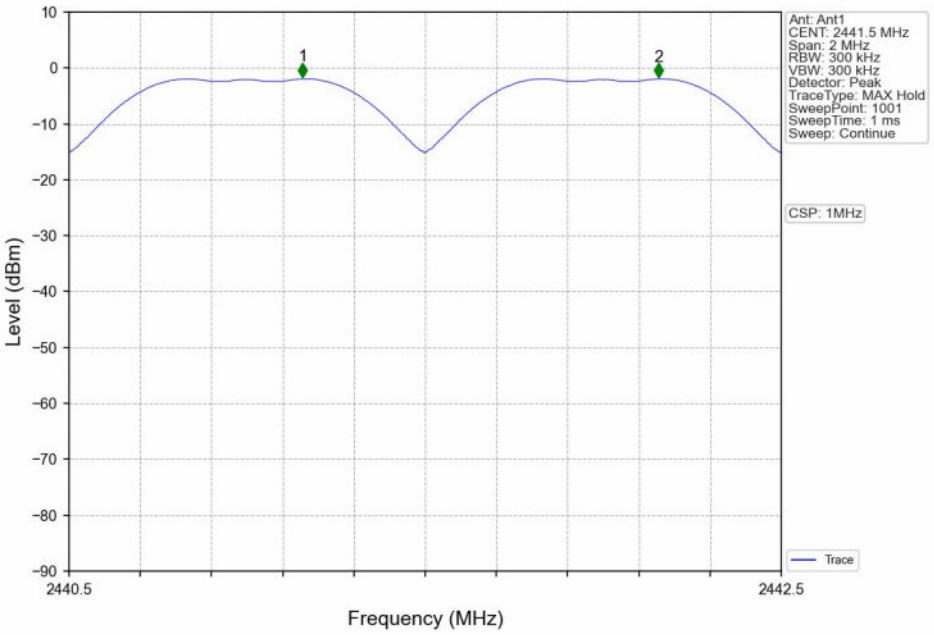
3.1 Ant1

3.1.1 Test Result

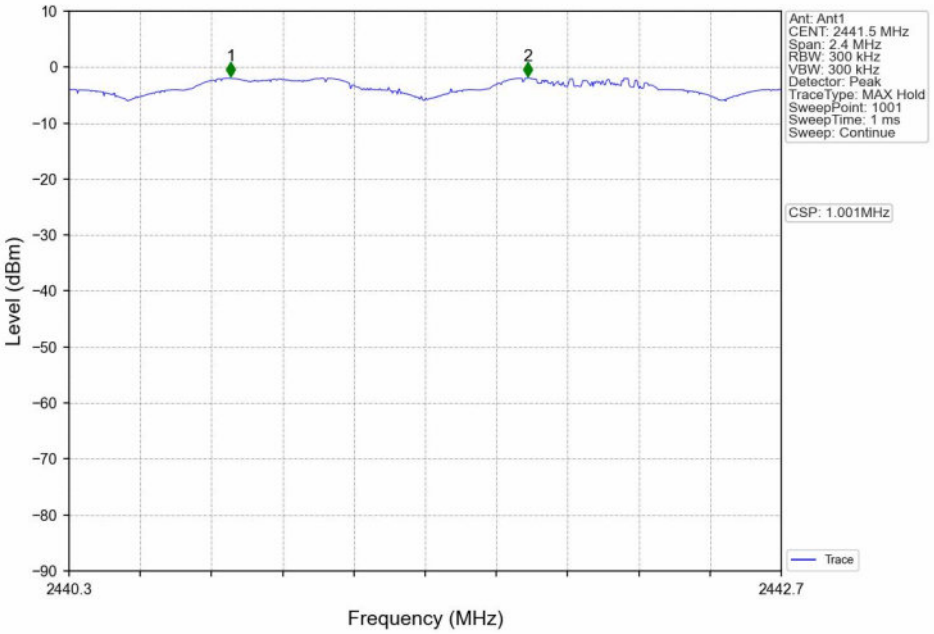
Ant1							
Mode	TX Type	Frequency (MHz)	Packet Type	Channel Separation (MHz)	20dB Bandwidth (MHz)	Limit (MHz)	Verdict
GFSK	SISO	HOPP	DH5	1.000	1.046	>=0.697	Pass
Pi/4DQPSK	SISO	HOPP	2DH5	1.001	1.368	>=0.912	Pass
8DPSK	SISO	HOPP	3DH5	0.991	1.376	>=0.917	Pass

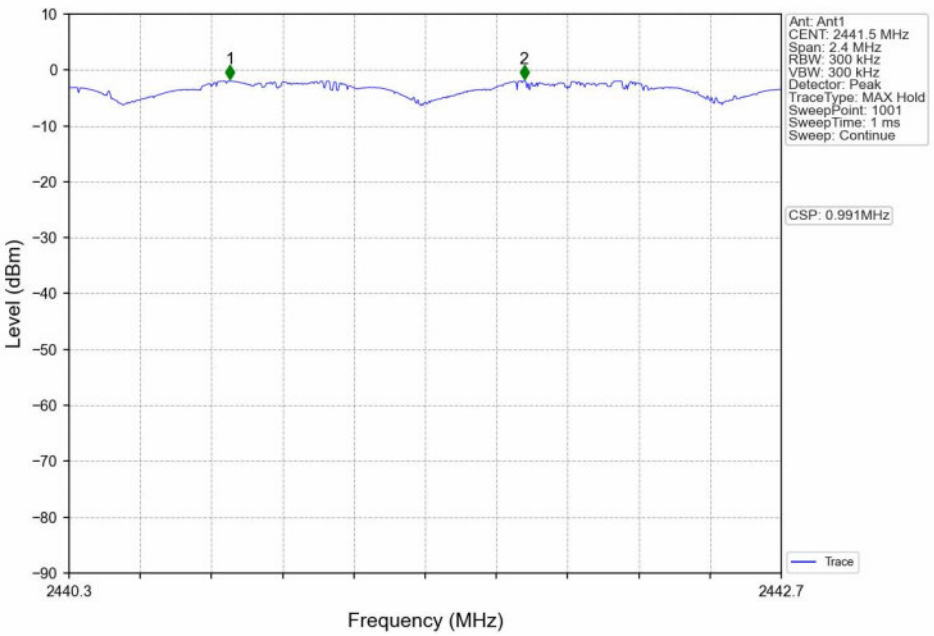
3.1.2 Test Graph

GFSK_DH5_HOPP_Ant1_NTNV



Pi/4DQPSK_2DH5_HOPP_Ant1_NTNV



8DPSK_3DH5_HOPP_Ant1_NTNV


4. Number of Hopping Frequencies

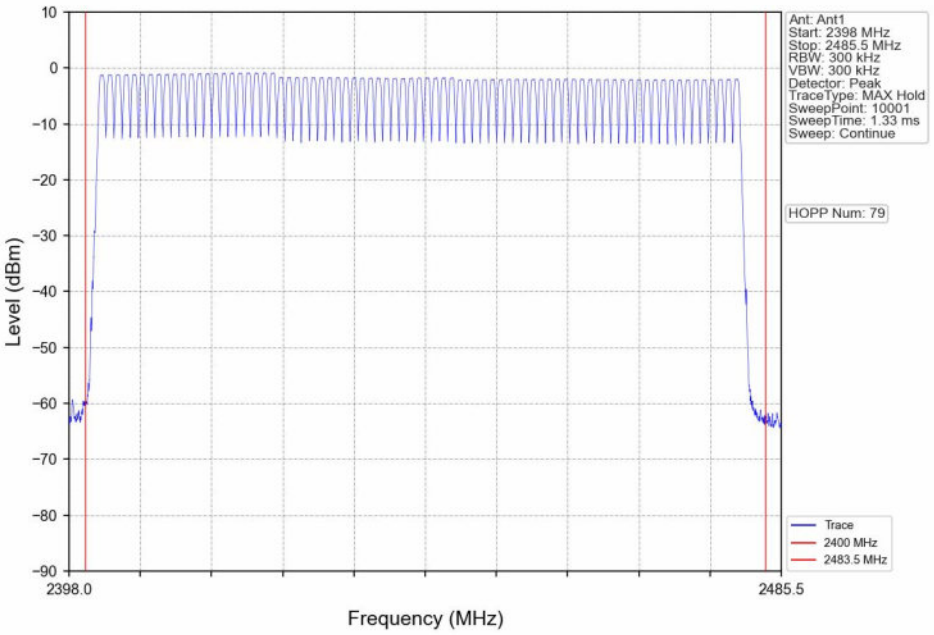
4.1 HoppNum

4.1.1 Test Result

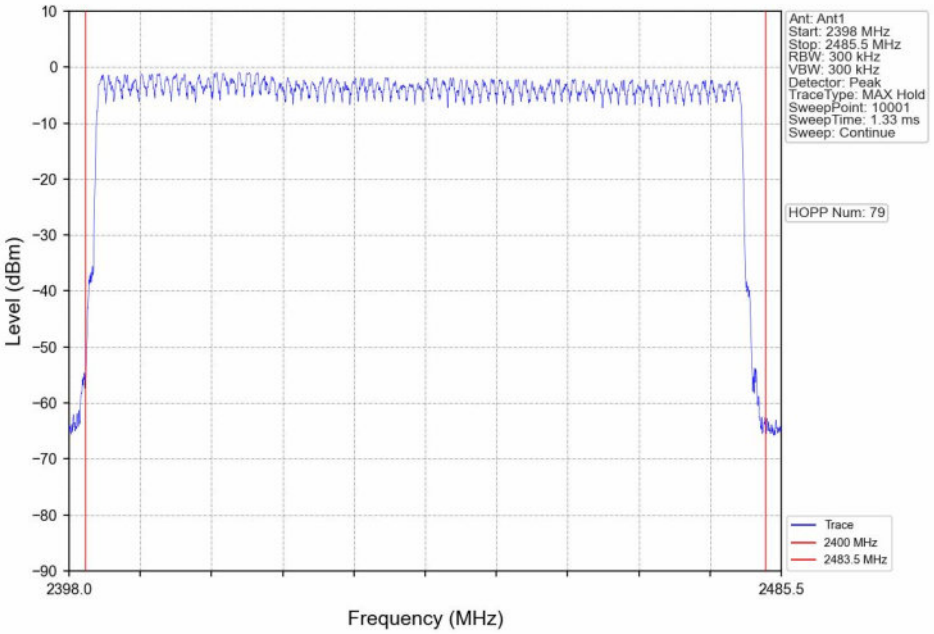
Mode	TX Type	Frequency (MHz)	Packet Type	Num of Hopping Frequencies		Verdict
				ANT1	Limit	
GFSK	SISO	HOPP	DH5	79	>=15	Pass
Pi/4DQPSK	SISO	HOPP	2DH5	79	>=15	Pass
8DPSK	SISO	HOPP	3DH5	79	>=15	Pass

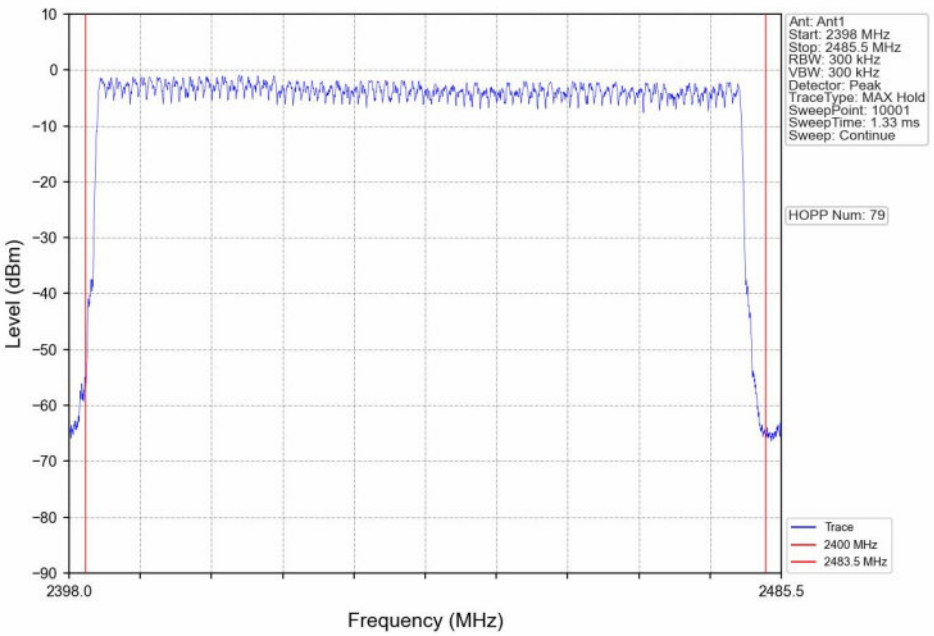
4.1.2 Test Graph

GFSK_DH5_HOPP_Ant1_NTNV



Pi/4DQPSK_2DH5_HOPP_Ant1_NTNV



8DPSK_3DH5_HOPP_Ant1_NTNV


5. Time of Occupancy (Dwell Time)

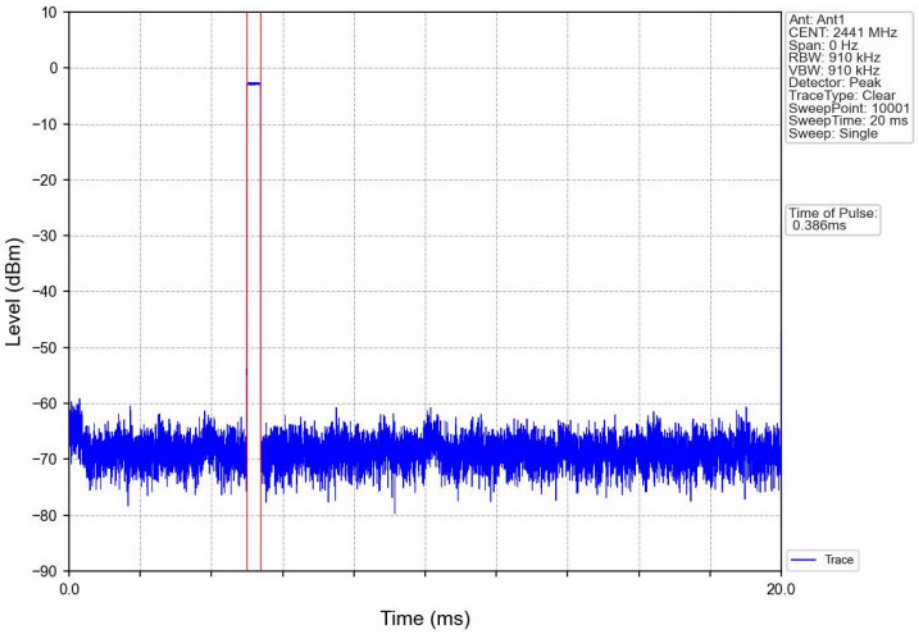
5.1 Ant1

5.1.1 Test Result

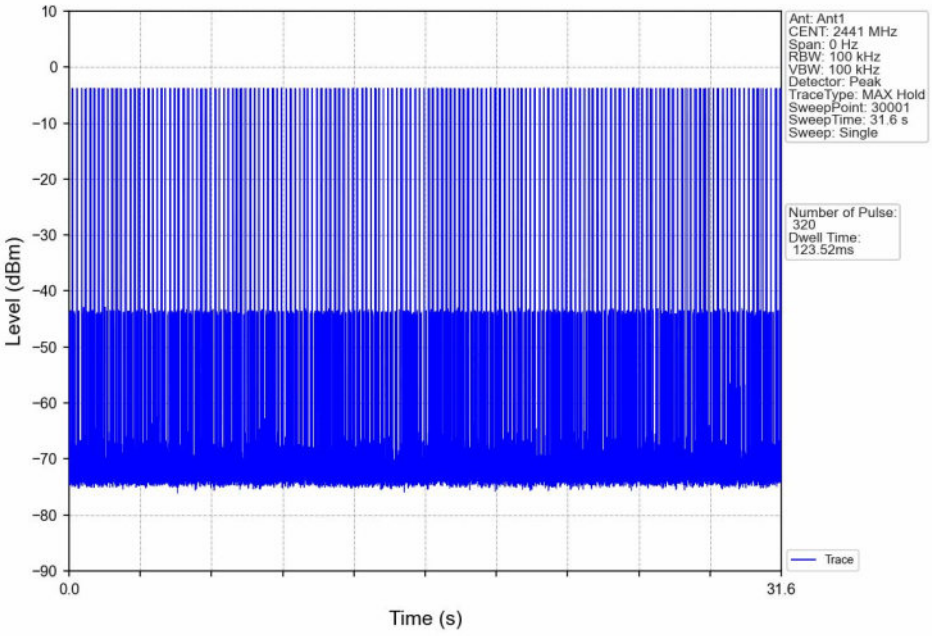
Ant1									
Mode	TX Type	Frequency (MHz)	Packet Type	Duration of Single Pulse (ms)	Observation Period (s)	Num of Pulse in Observation Period	Dwell Time (ms)	Limit (ms)	Verdict
GFSK	SISO	HOPP	DH1	0.386	31.600	320	123.520	<=400	Pass
			DH3	1.642	31.600	169	277.498	<=400	Pass
			DH5	2.892	31.600	104	300.768	<=400	Pass
Pi/4DQPSK	SISO	HOPP	2DH1	0.404	31.600	320	129.280	<=400	Pass
			2DH3	1.656	31.600	174	288.144	<=400	Pass
			2DH5	2.898	31.600	110	318.780	<=400	Pass
8DPSK	SISO	HOPP	3DH1	0.396	31.600	320	126.720	<=400	Pass
			3DH3	1.654	31.600	162	267.948	<=400	Pass
			3DH5	2.900	31.600	110	319.000	<=400	Pass

5.1.2 Test Graph

GFSK_DH1_HOPP_Ant1_NTNV



GFSK_DH1_HOPP_Ant1_NTNV



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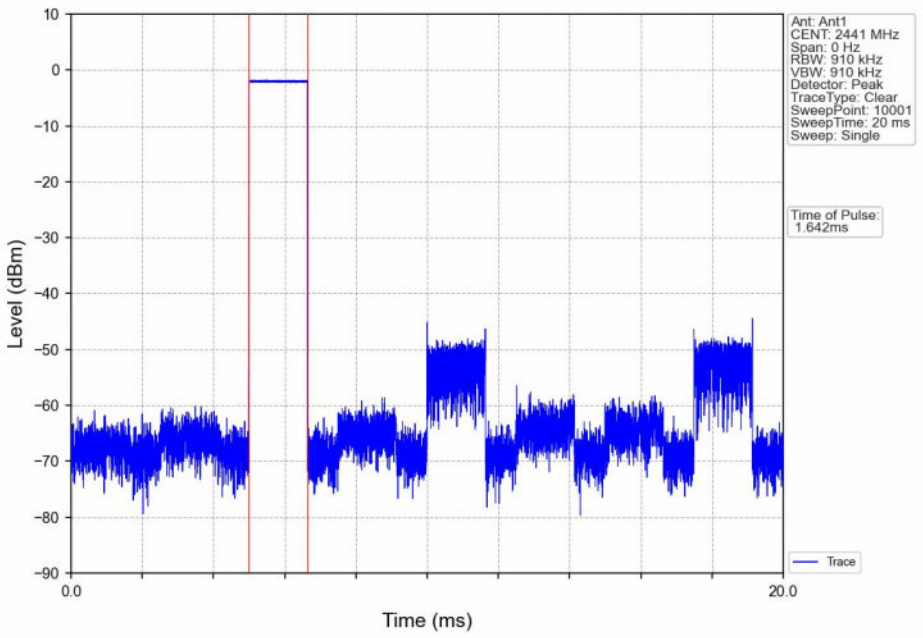
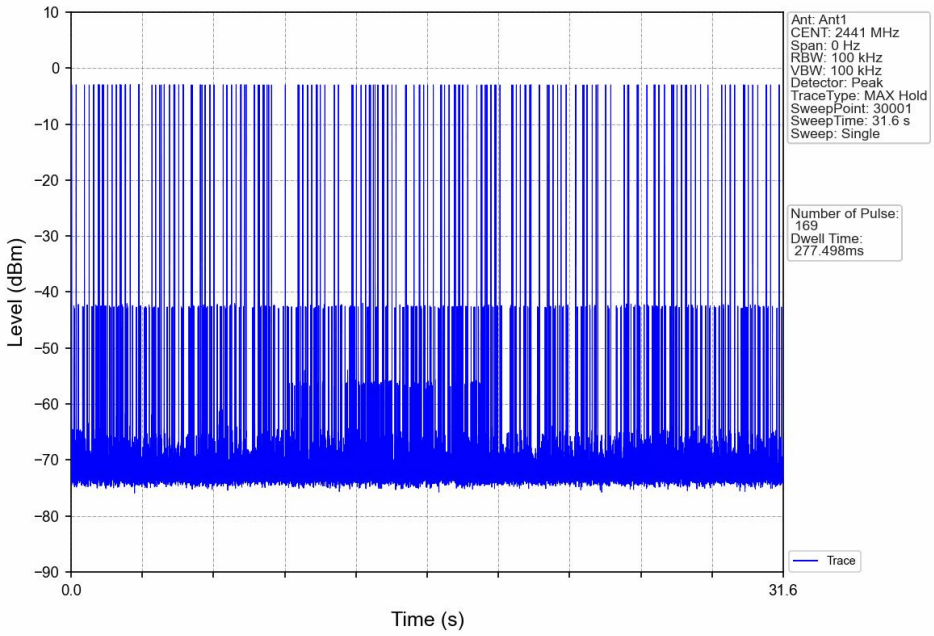
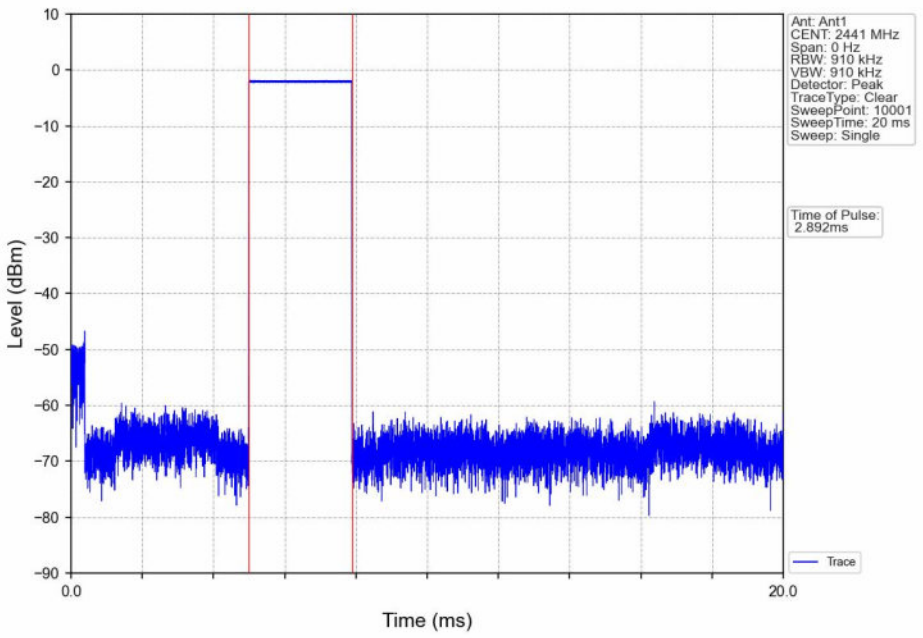


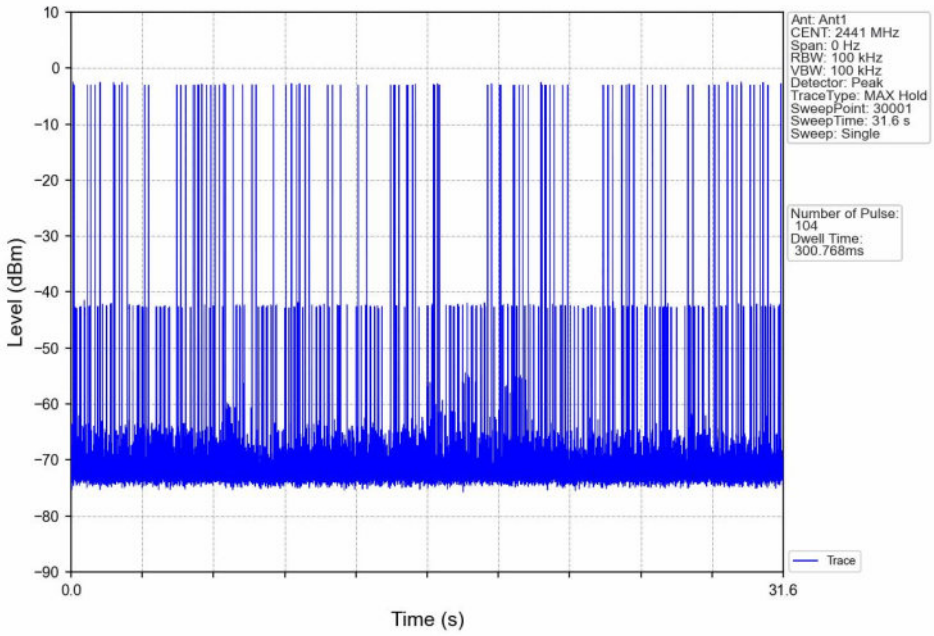
GFSK_DH3_HOPP_Ant1_NTNV

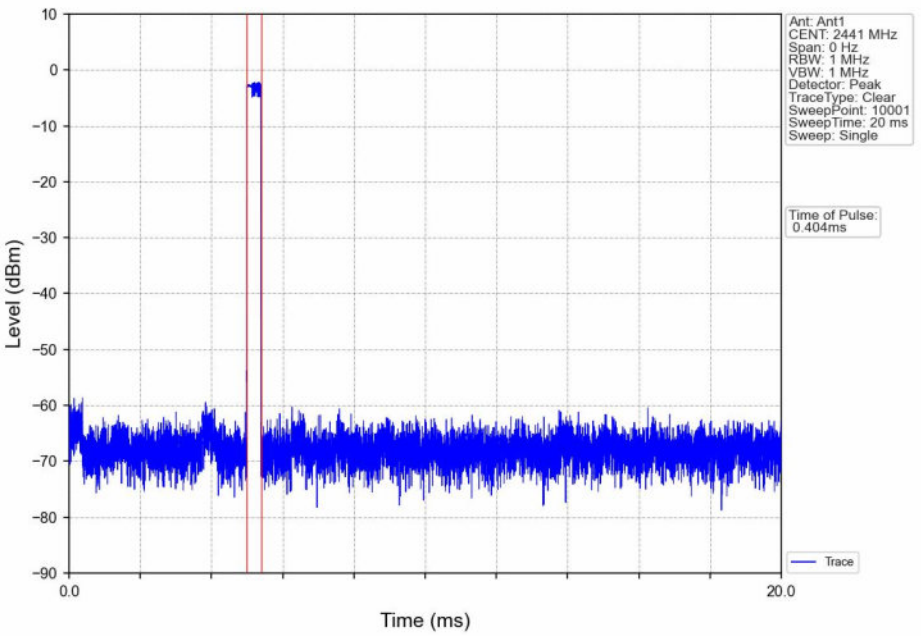


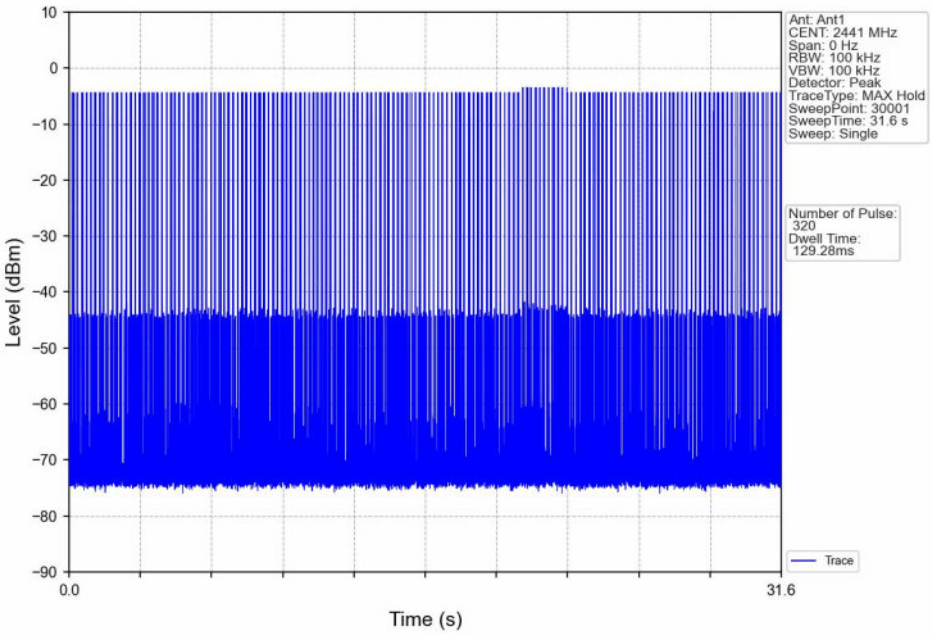
GFSK_DH5_HOPP_Ant1_NTNV

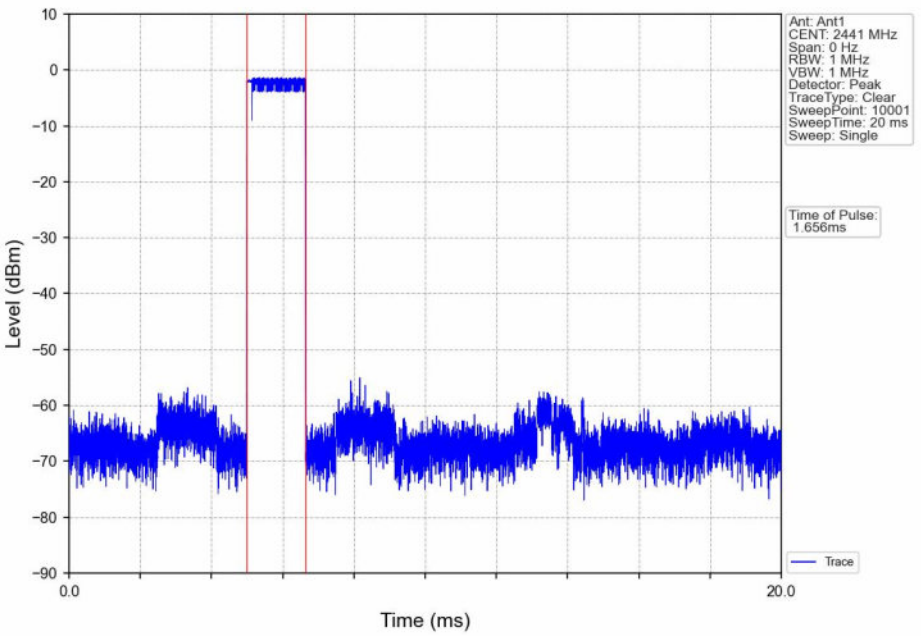


GFSK_DH5_HOPP_Ant1_NTNV



Pi/4DQPSK_2DH1_HOPP_Ant1_NTNV


Pi/4DQPSK_2DH1_HOPP_Ant1_NTNV


Pi/4DQPSK_2DH3_HOPP_Ant1_NTNV


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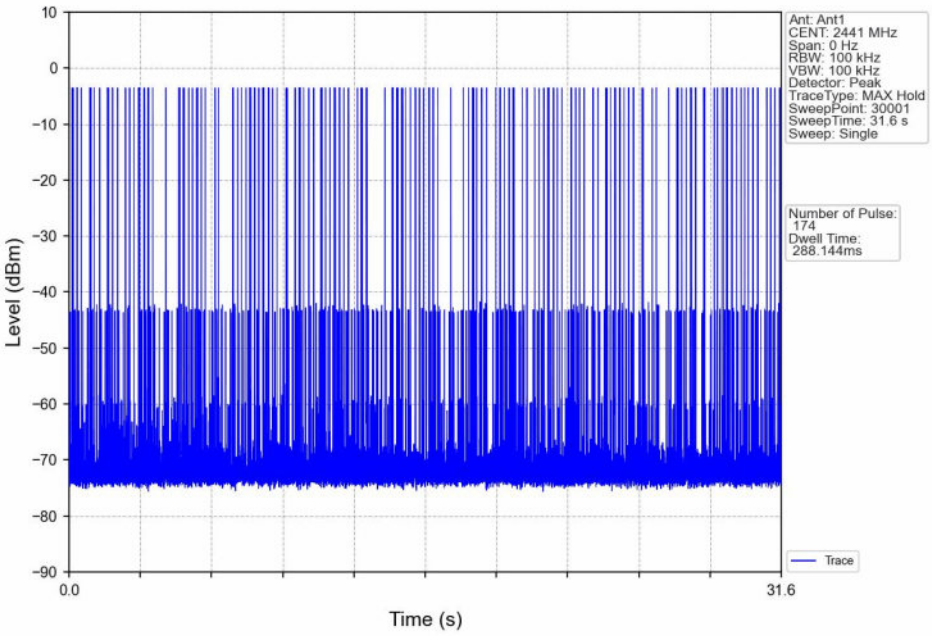

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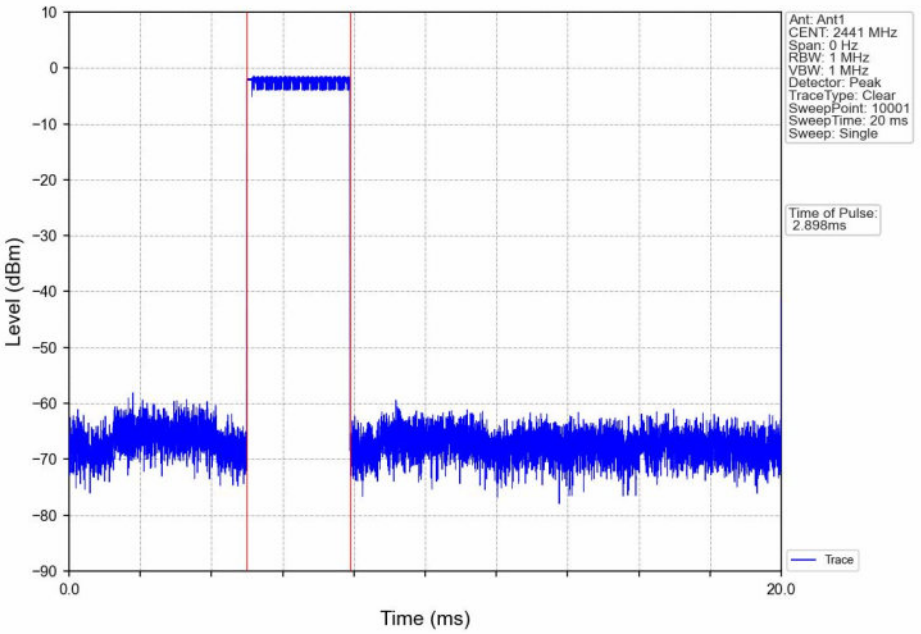

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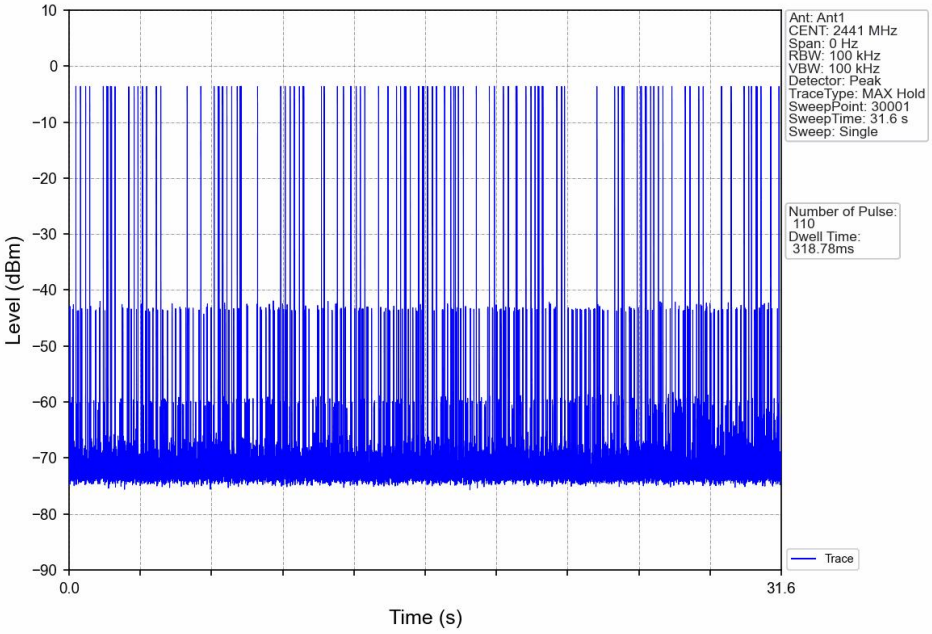
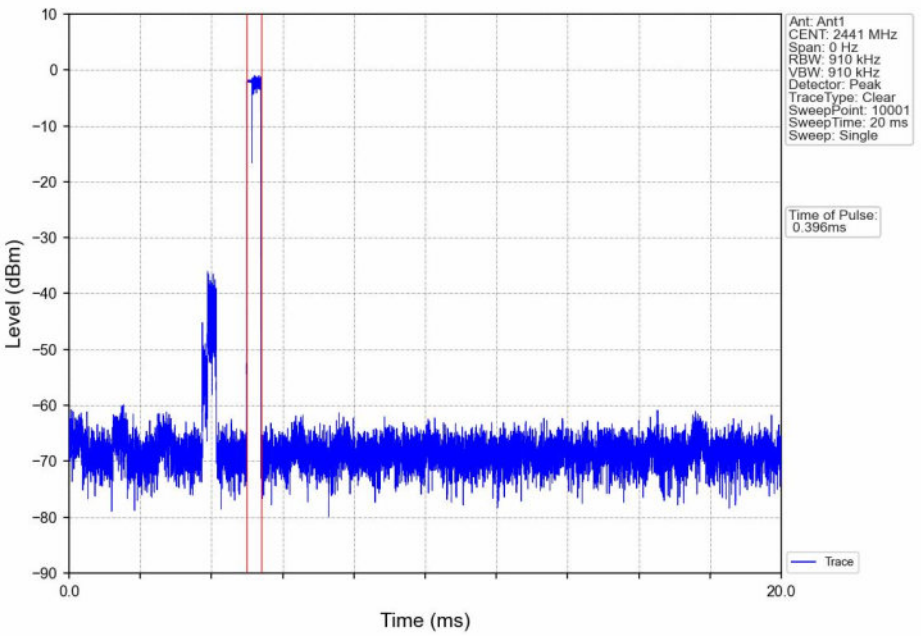


8DPSK_3DH1_HOPP_Ant1_NTNV


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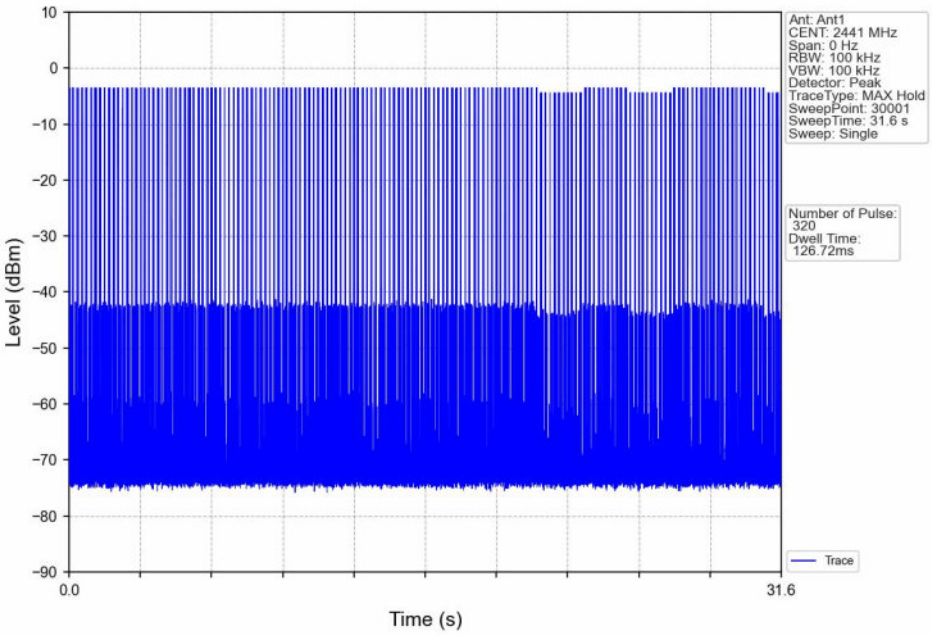

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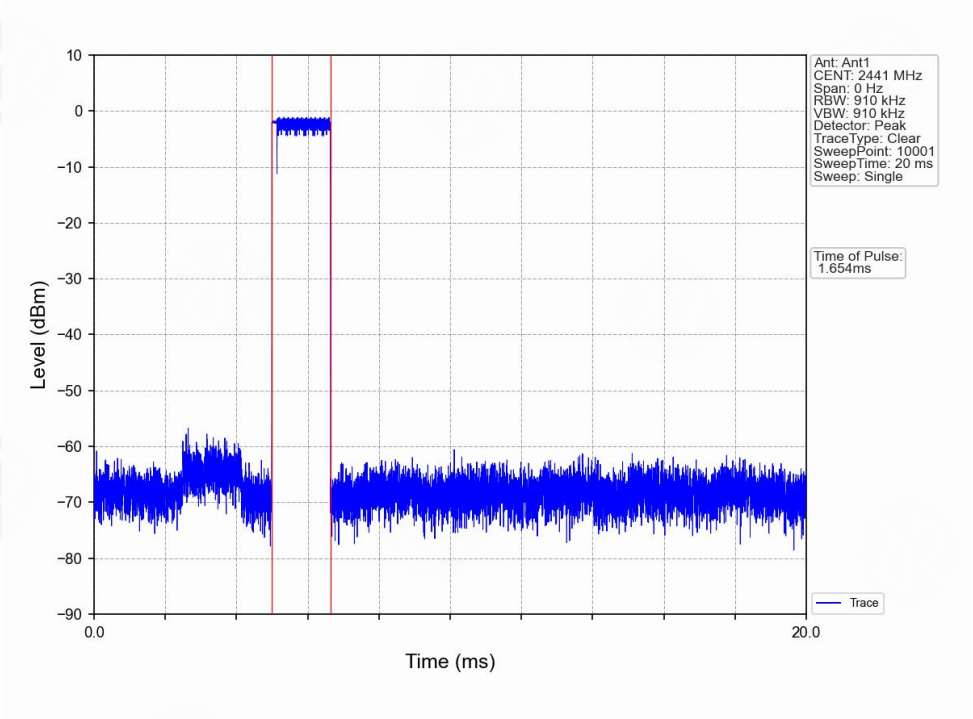

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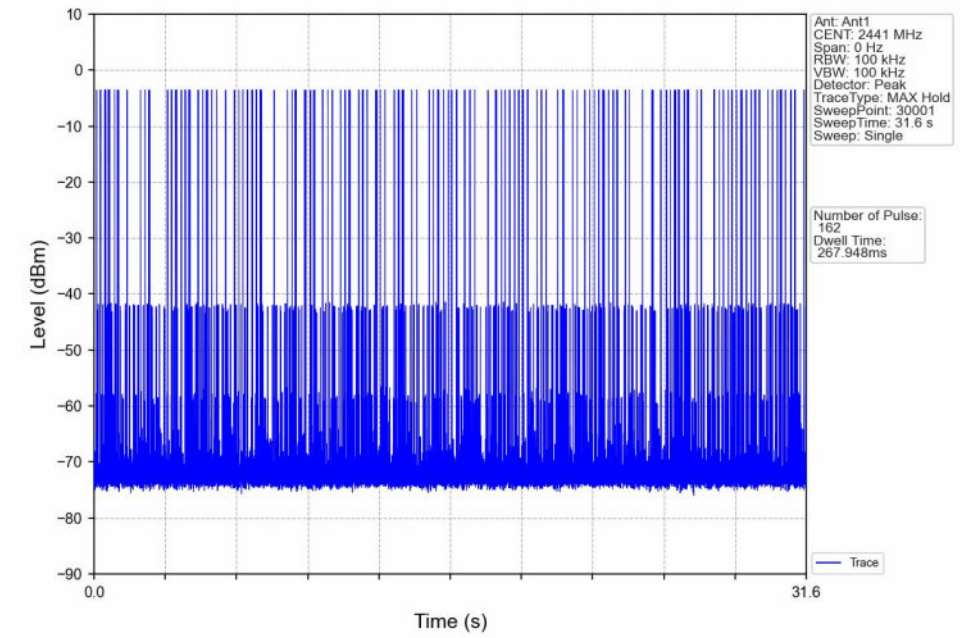
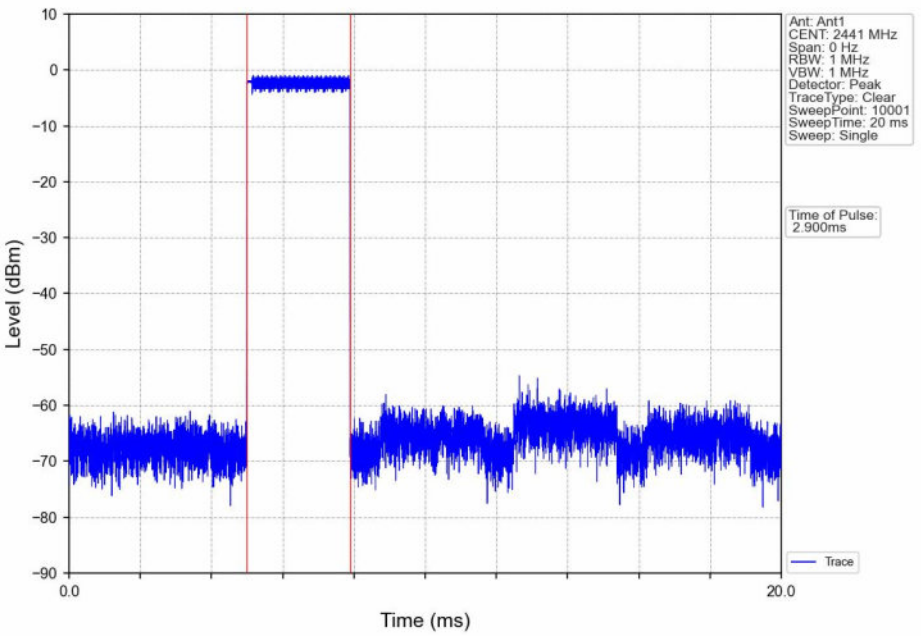


8DPSK_3DH5_HOPP_Ant1_NTNV


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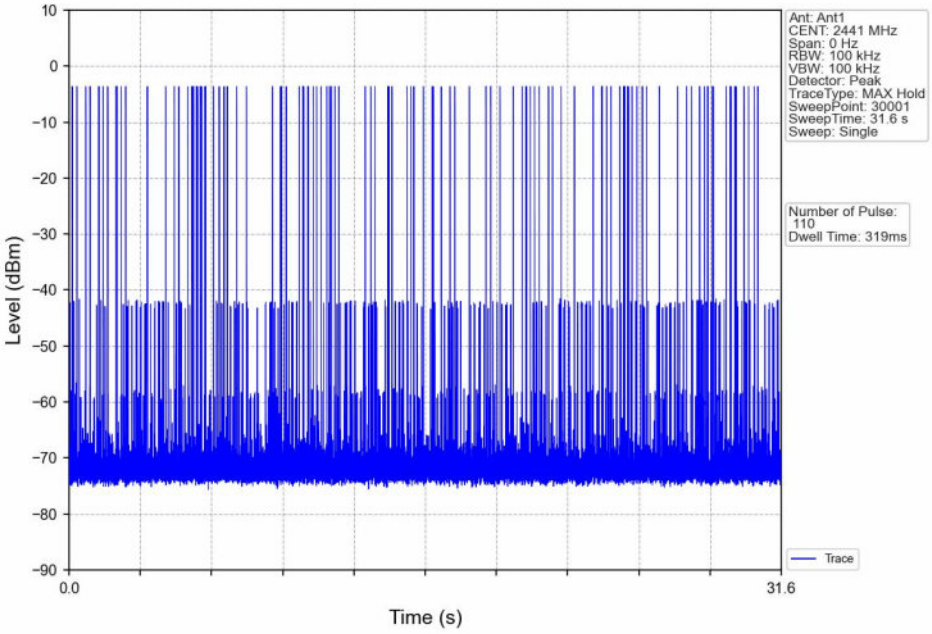


6. Unwanted Emissions In Non-restricted Frequency Bands

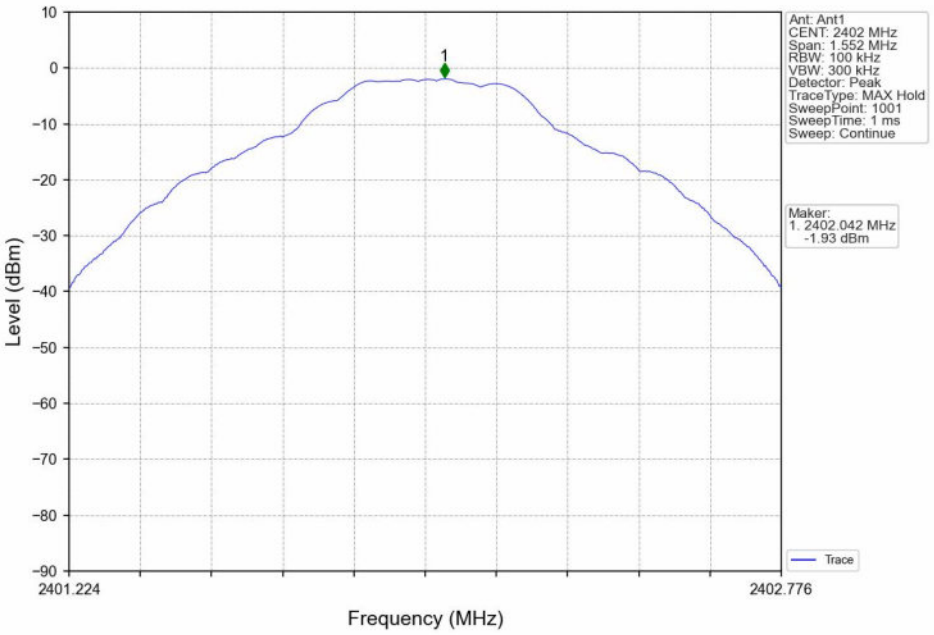
6.1 Ref

6.1.1 Test Result

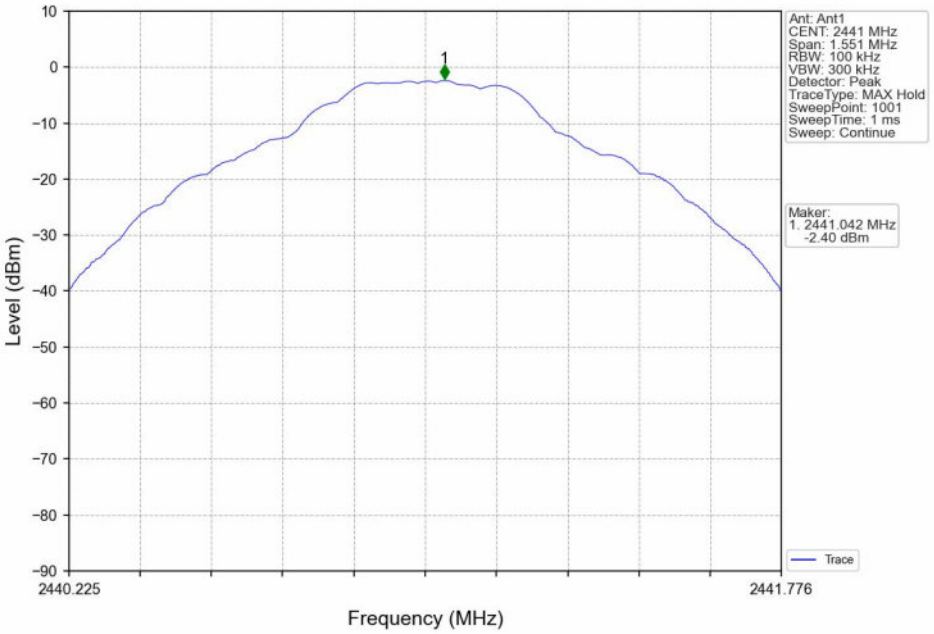
Mode	TX Type	Frequency (MHz)	Packet Type	ANT	Level of Reference (dBm)
GFSK	SISO	2402	DH5	1	**-1.93**
		2441	DH5	1	-2.40
		2480	DH5	1	-1.97
Pi/4DQPSK	SISO	2402	2DH5	1	**-4.09**
		2441	2DH5	1	-4.64
		2480	2DH5	1	-4.36
8DPSK	SISO	2402	3DH5	1	**-4.38**
		2441	3DH5	1	-4.62
		2480	3DH5	1	-5.00
Note1: Refer to FCC Part 15.247 (d) and ANSI C63.10-2013, the channel contains the maximum PSD level was used to establish the reference level.					

6.1.2 Test Graph

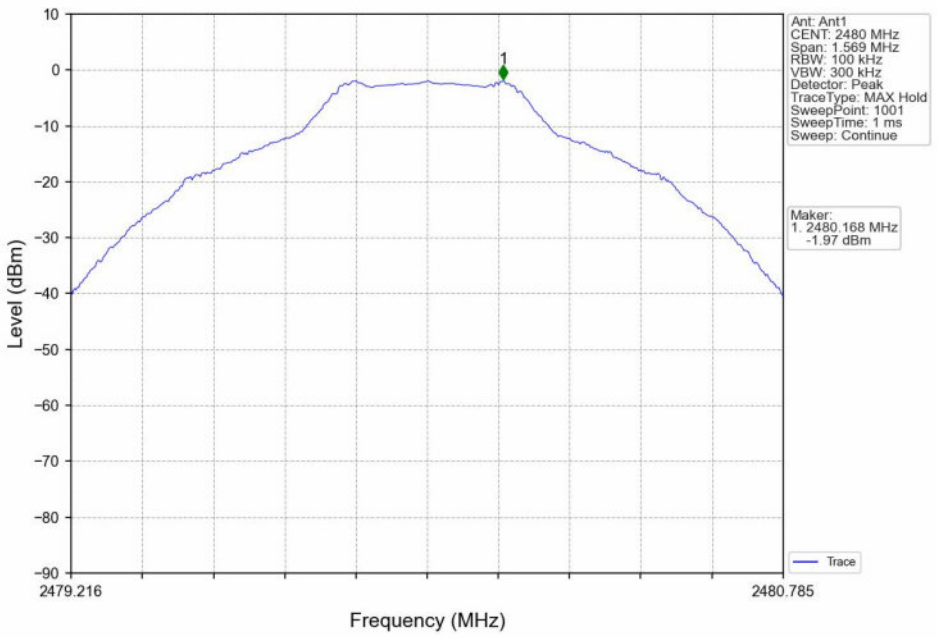
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



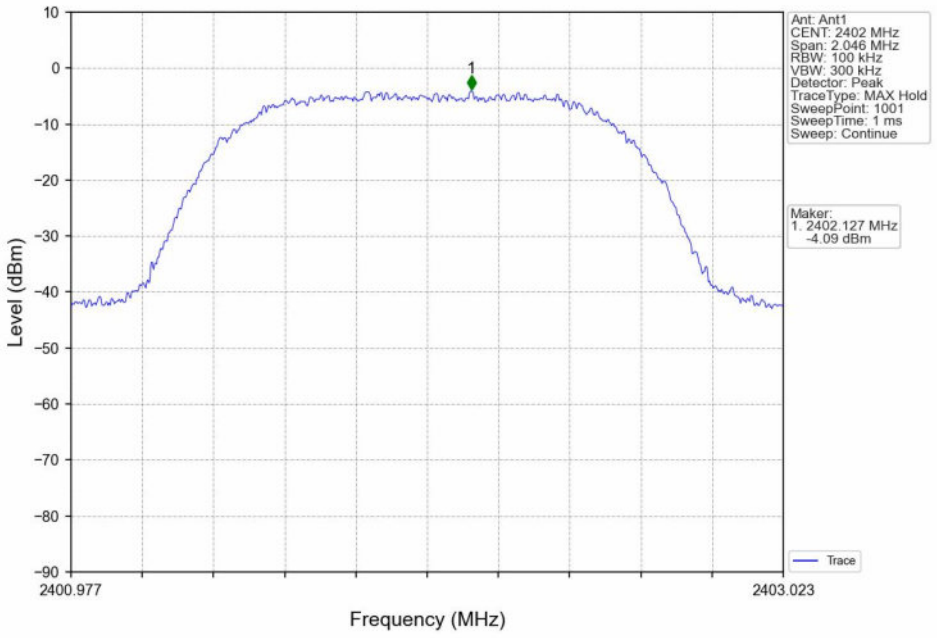
GFSK_DH5_MCH_2441MHz_Ant1_NTNV



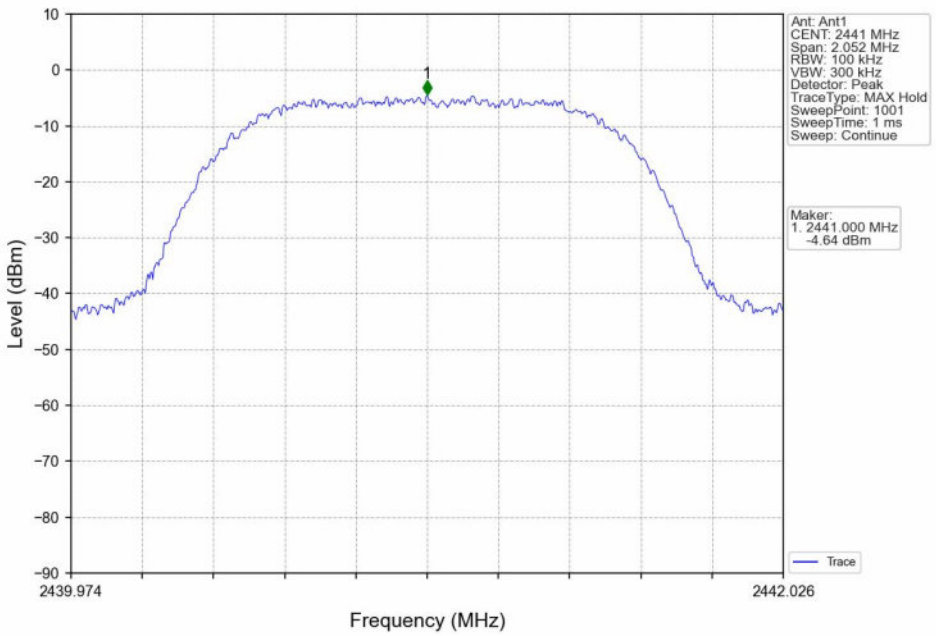
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



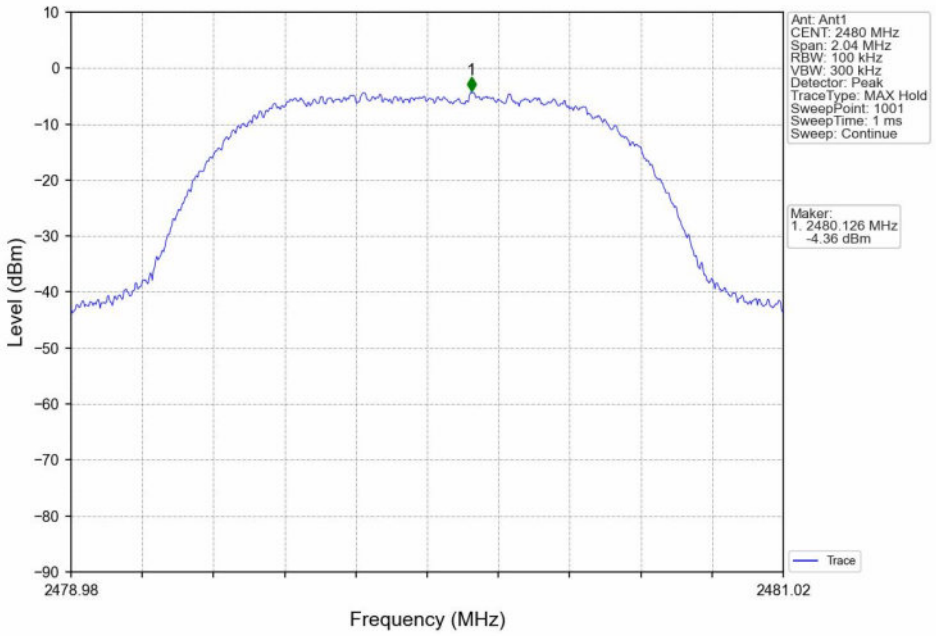
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



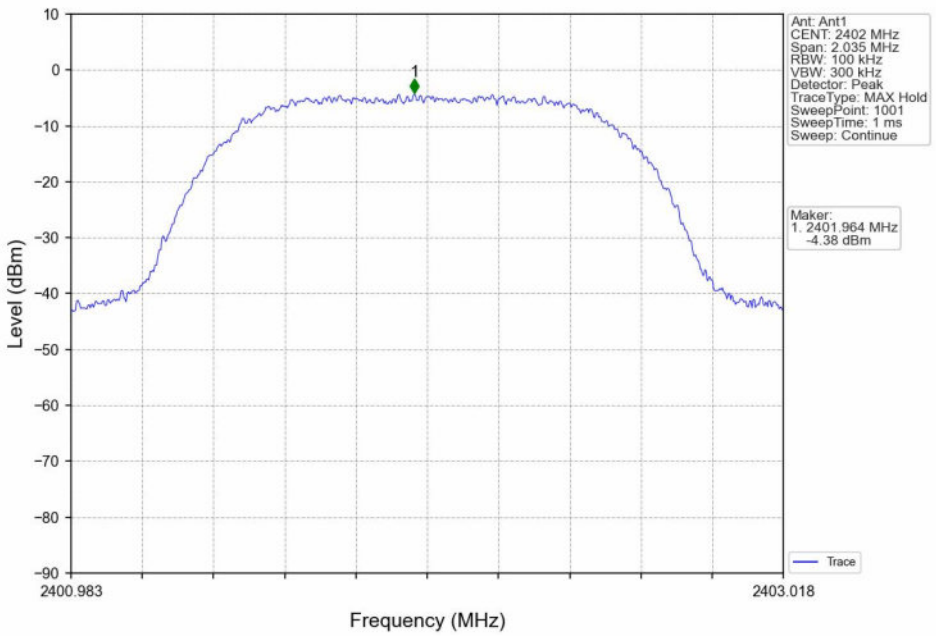
Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV



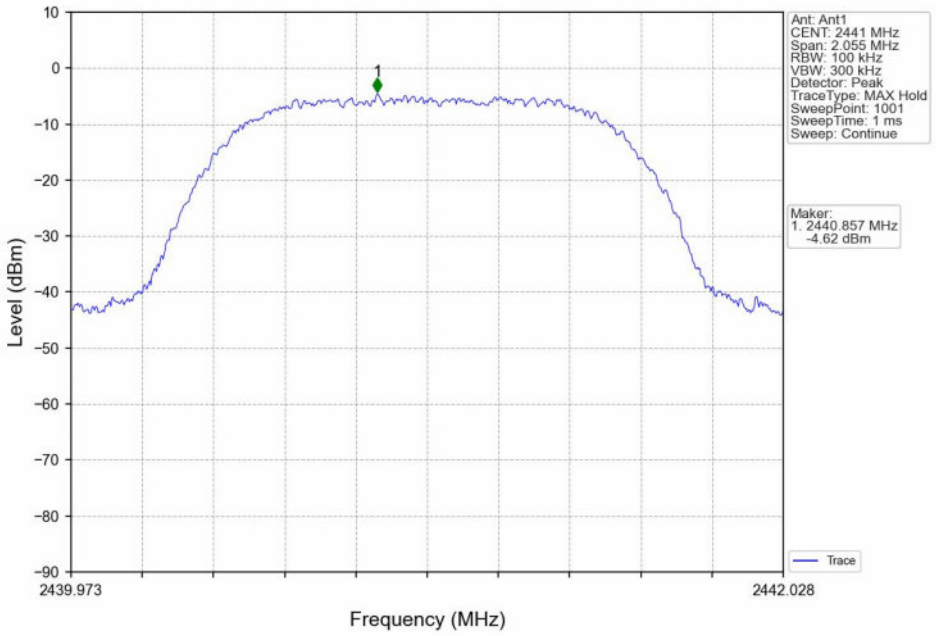
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV

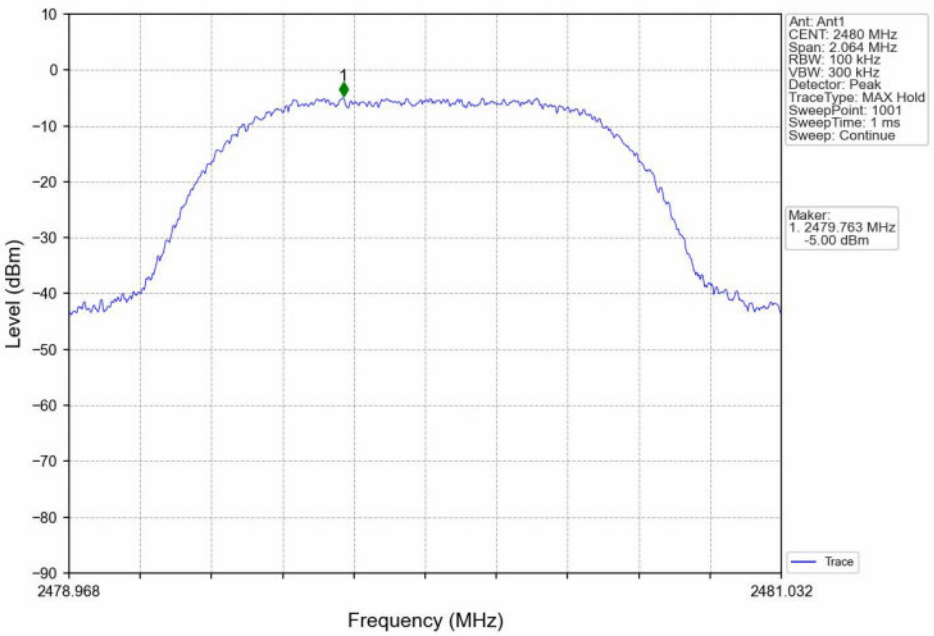


8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV



8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV



8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV


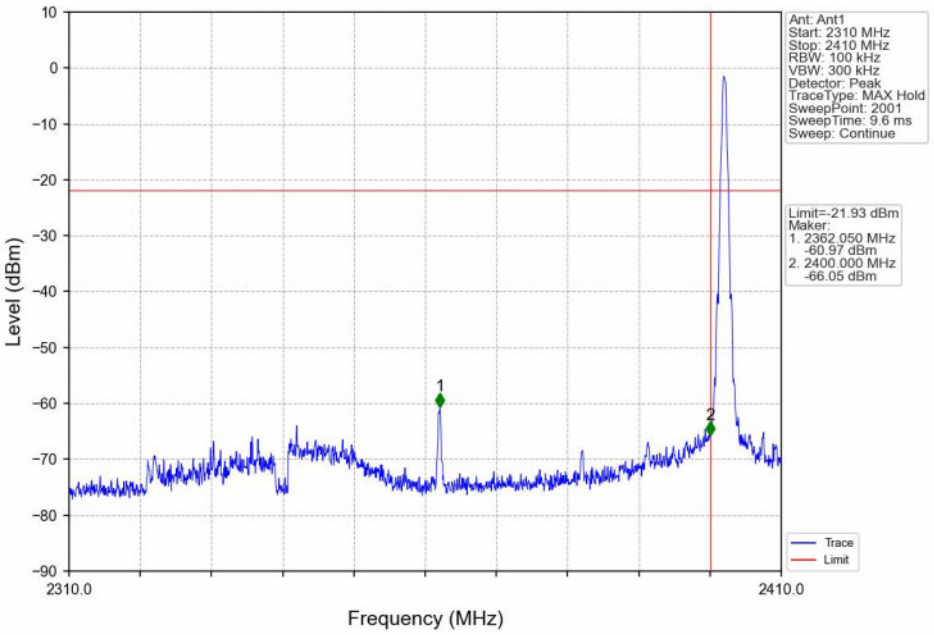
6.2 CSE

6.2.1 Test Result

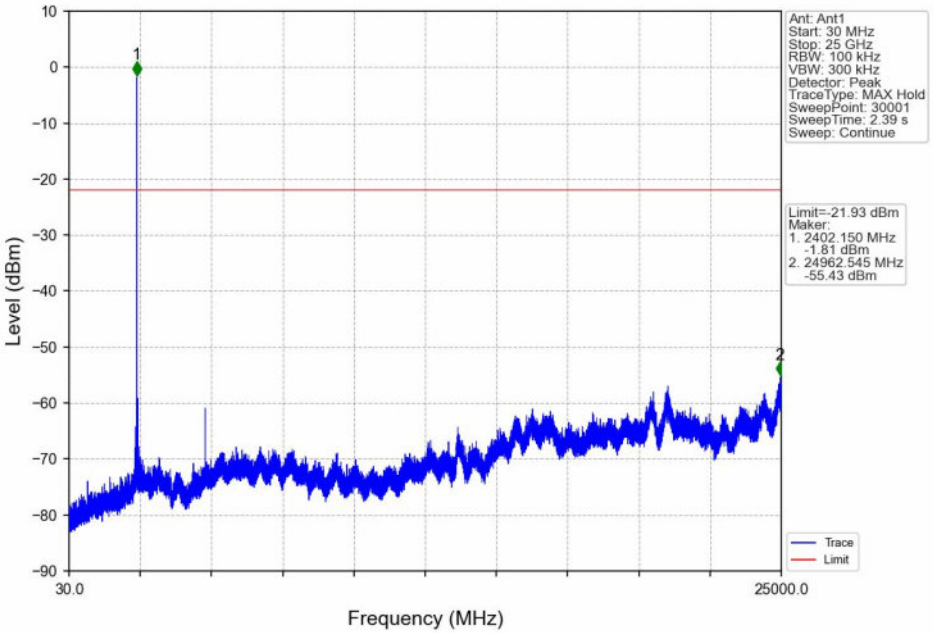
Mode	TX Type	Frequency (MHz)	Packet Type	ANT	Level of Reference (dBm)	Limit (dBm)	Verdict
GFSK	SISO	2402	DH5	1	-1.93	-21.93	Pass
		2441	DH5	1	-1.93	-21.93	Pass
		2480	DH5	1	-1.93	-21.93	Pass
		HOPP	DH5	1	-1.93	-21.93	Pass
					-1.93	-21.93	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	-4.09	-24.09	Pass
		2441	2DH5	1	-4.09	-24.09	Pass
		2480	2DH5	1	-4.09	-24.09	Pass
		HOPP	2DH5	1	-4.09	-24.09	Pass
					-4.09	-24.09	Pass
8DPSK	SISO	2402	3DH5	1	-4.38	-24.38	Pass
		2441	3DH5	1	-4.38	-24.38	Pass
		2480	3DH5	1	-4.38	-24.38	Pass
		HOPP	3DH5	1	-4.38	-24.38	Pass
					-4.38	-24.38	Pass
Note1: Refer to FCC Part 15.247 (d) and ANSI C63.10-2013, the channel contains the maximum PSD level was used to establish the reference level.							

6.2.2 Test Graph

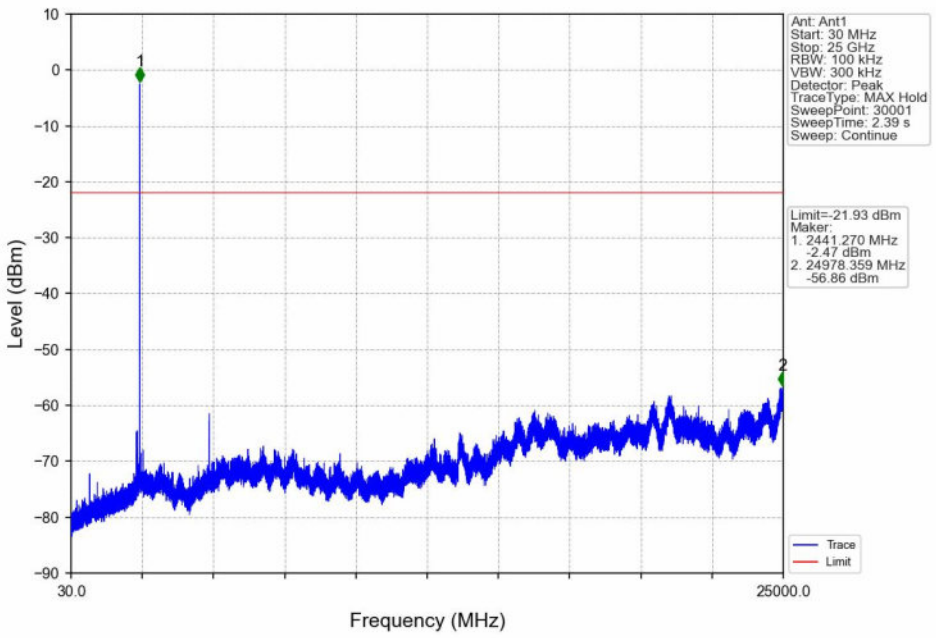
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



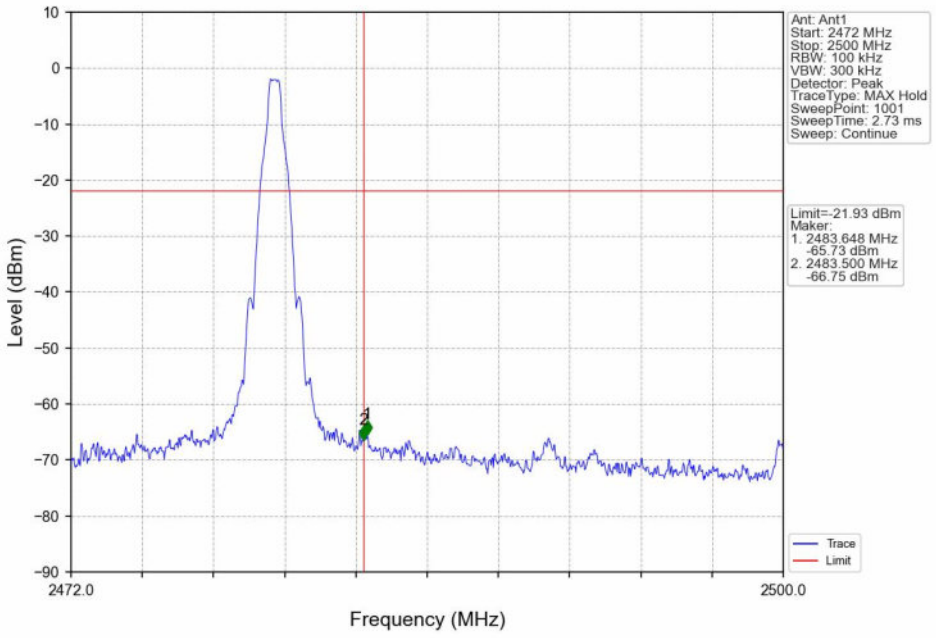
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



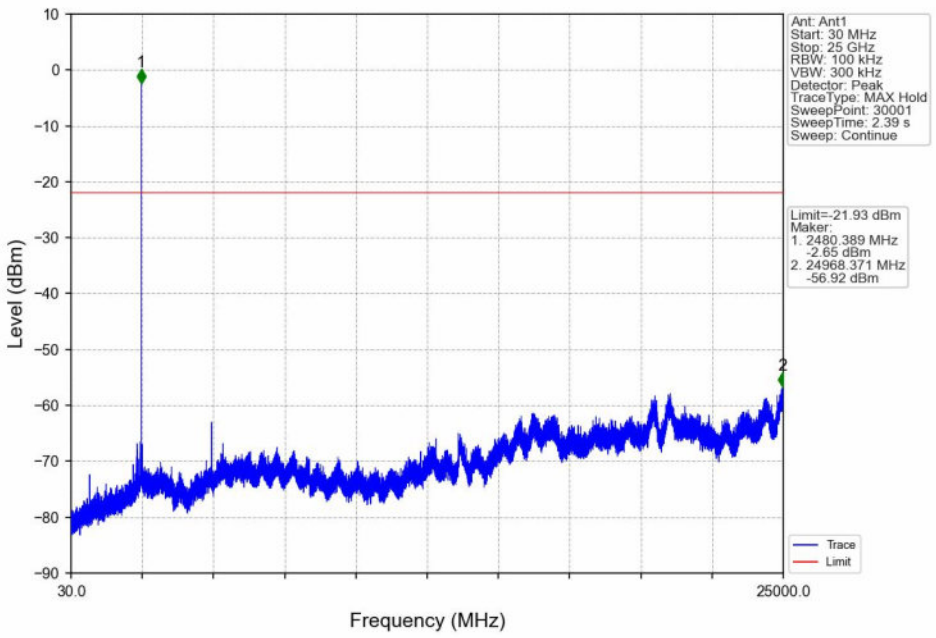
GFSK_DH5_MCH_2441MHz_Ant1_NTNV



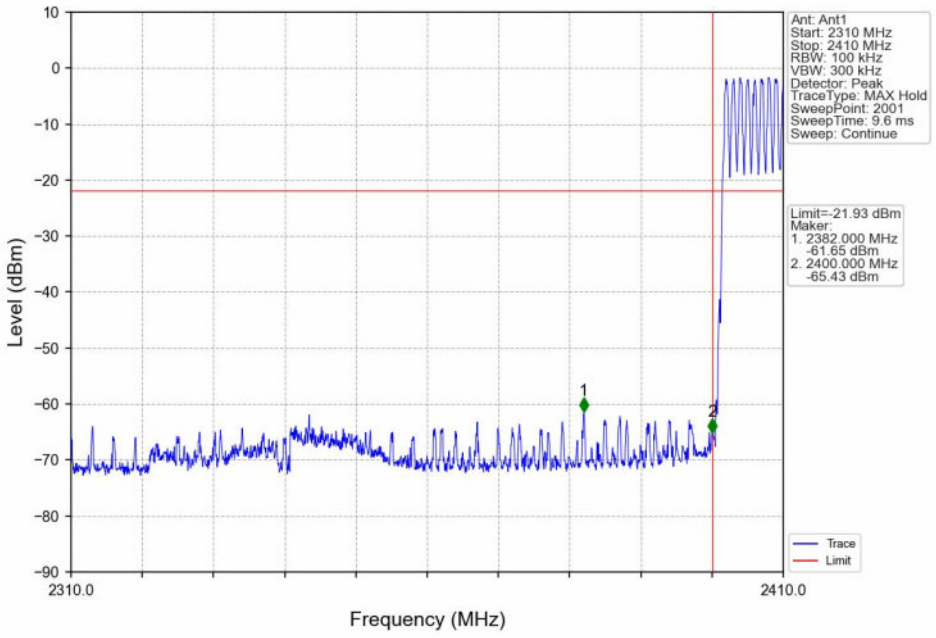
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



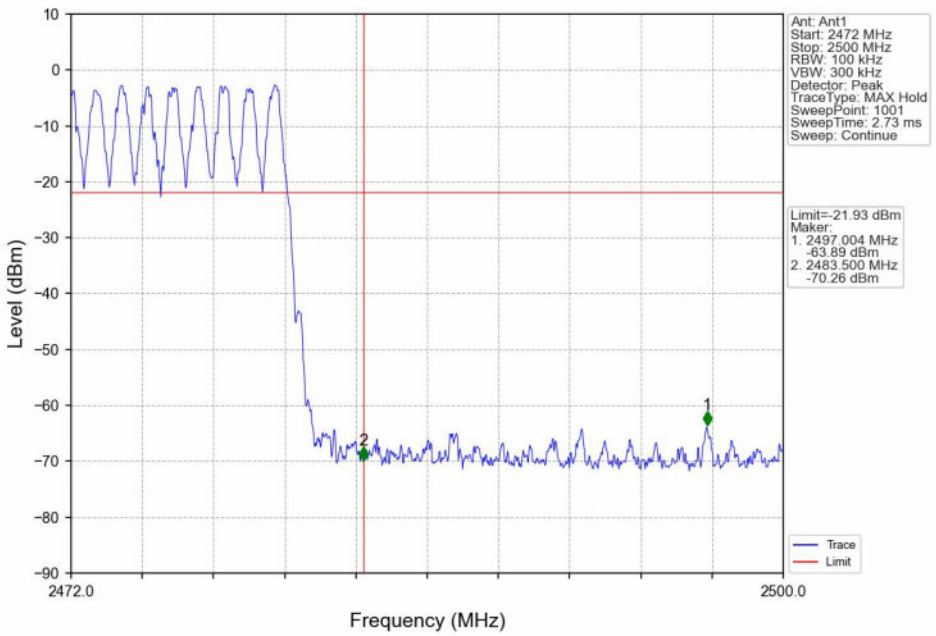
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



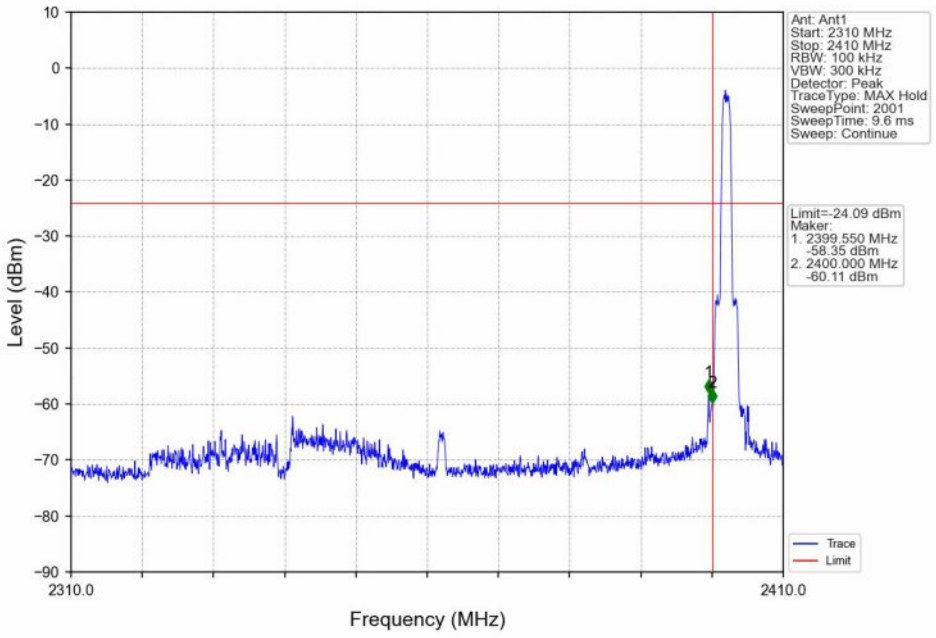
GFSK_DH5_HOPP_Ant1_NTNV



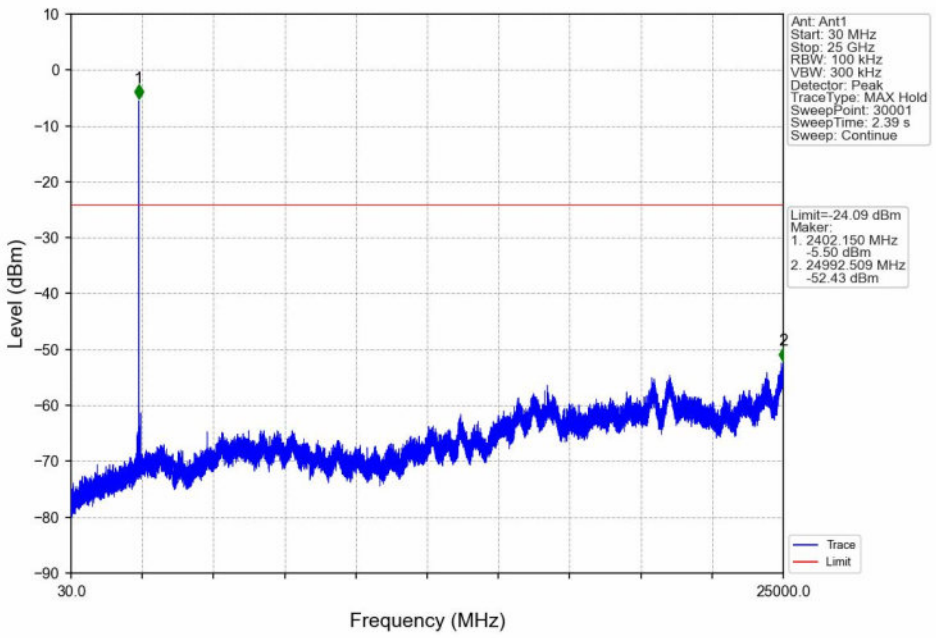
GFSK_DH5_HOPP_Ant1_NTNV



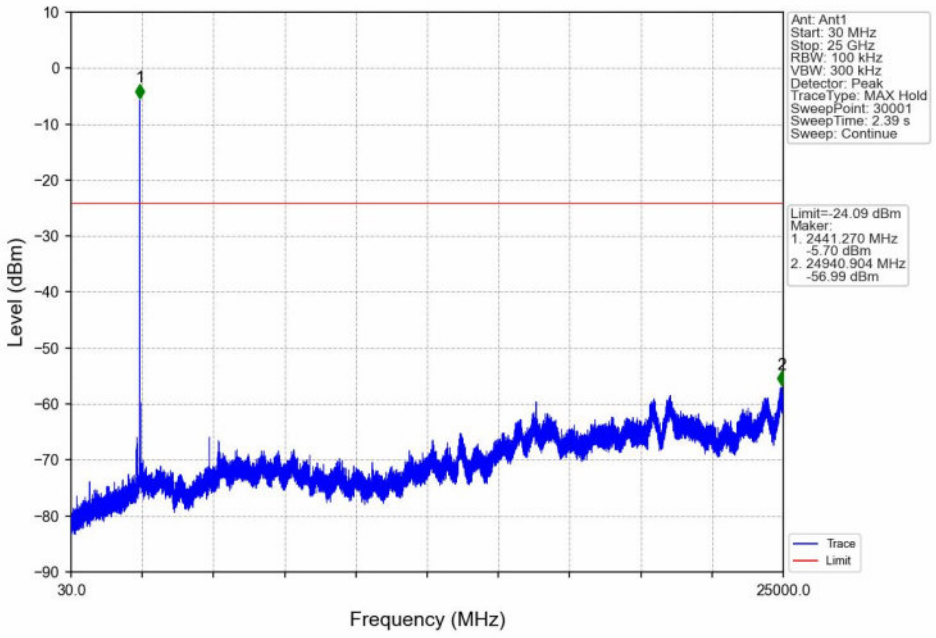
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV

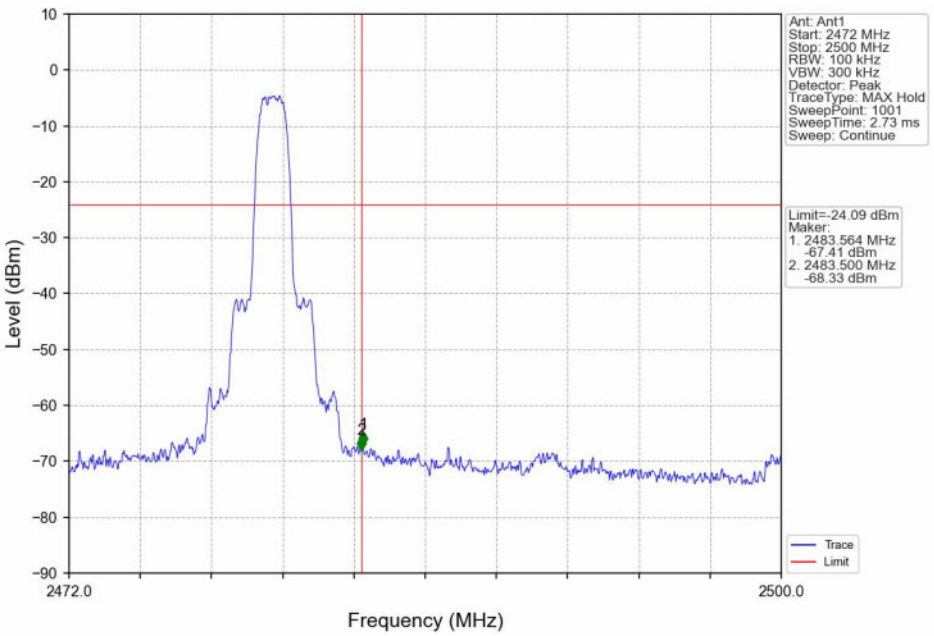


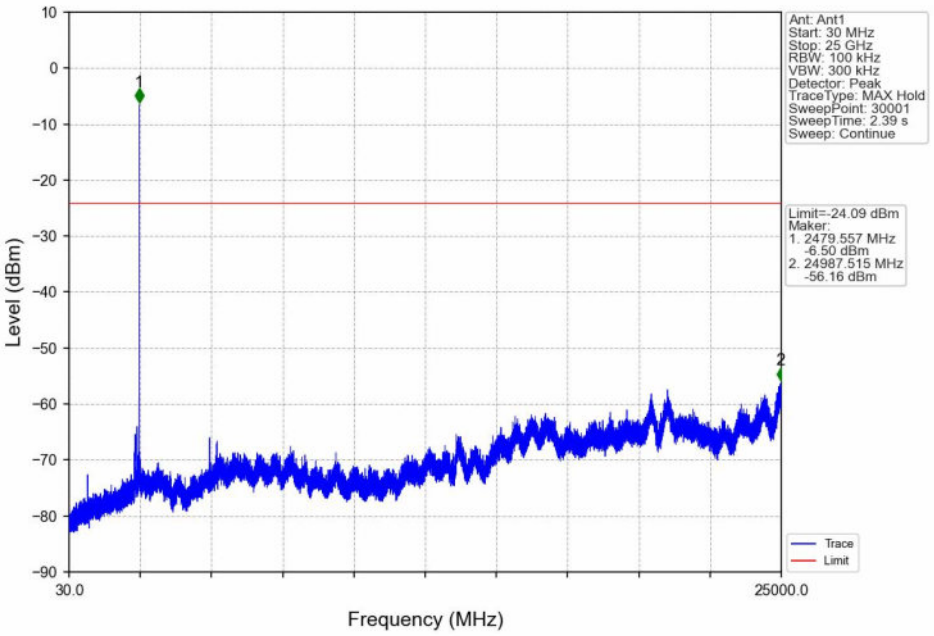
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV

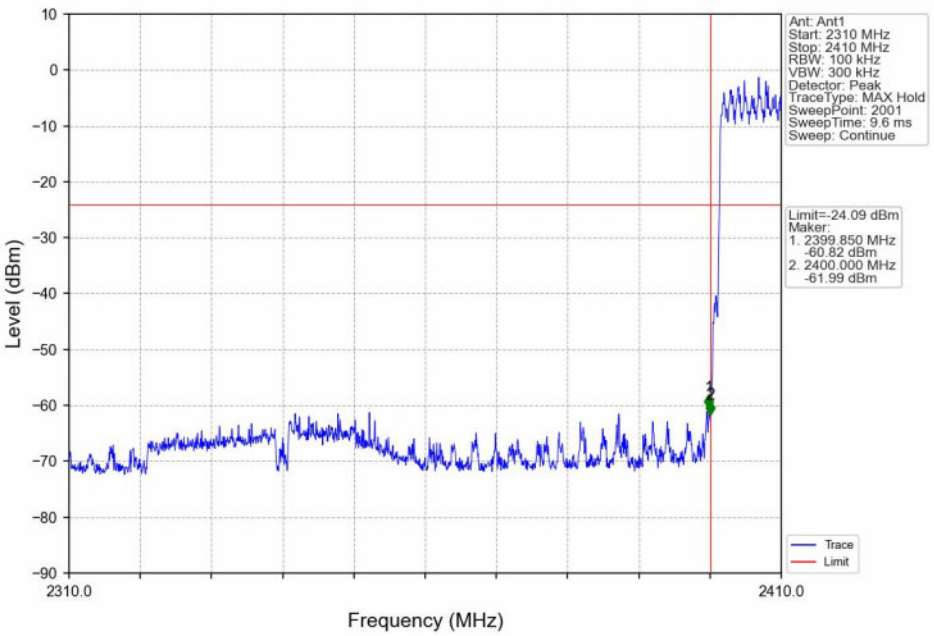


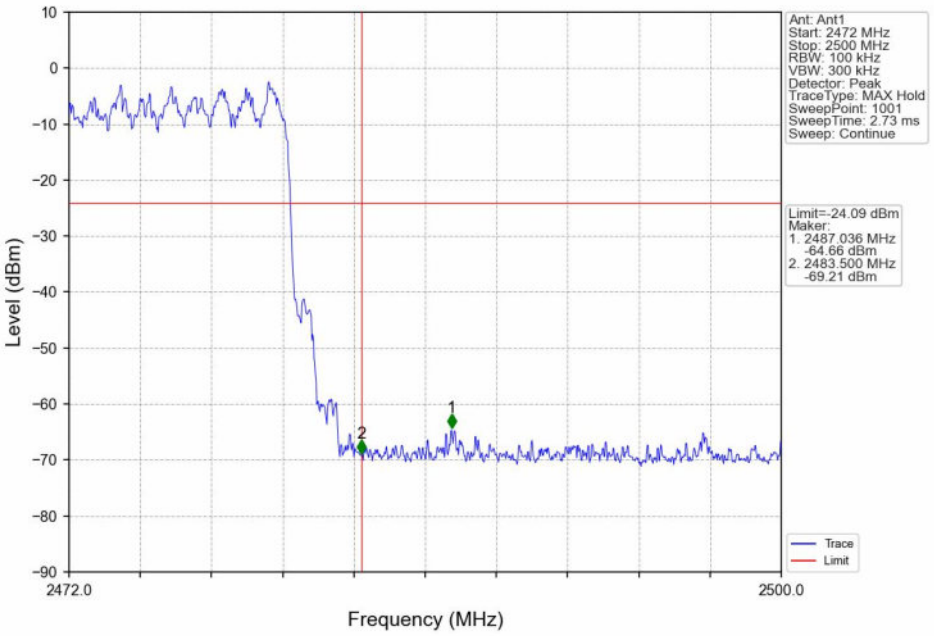
Pi/4DQPSK_2DH5_MCH_2441MHz_Ant1_NTNV

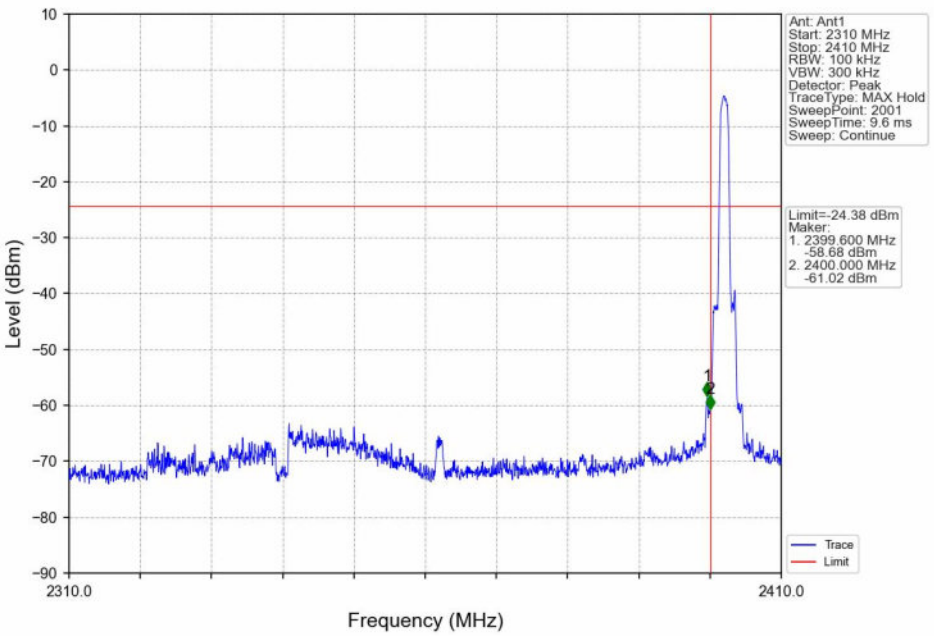


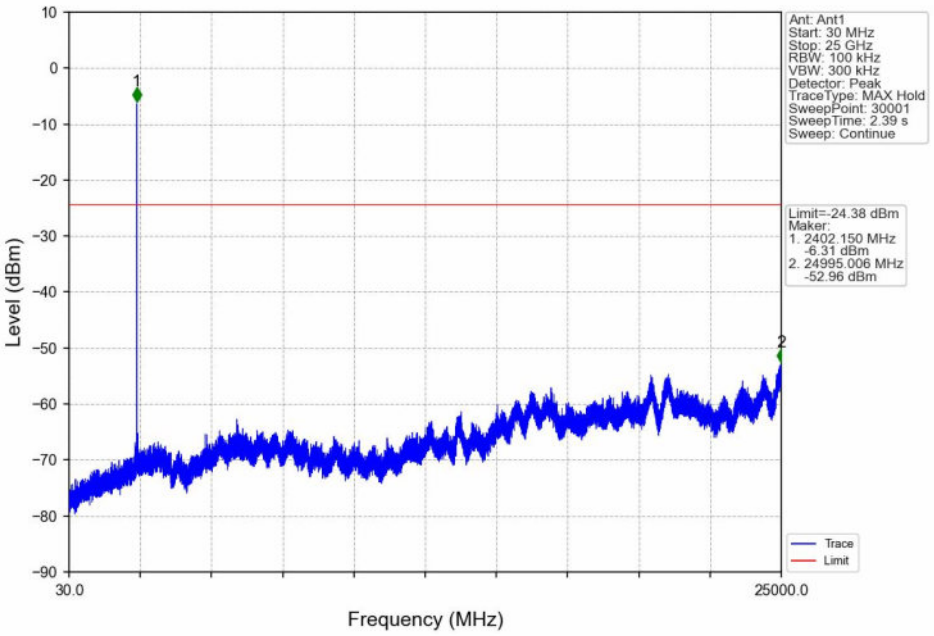
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV


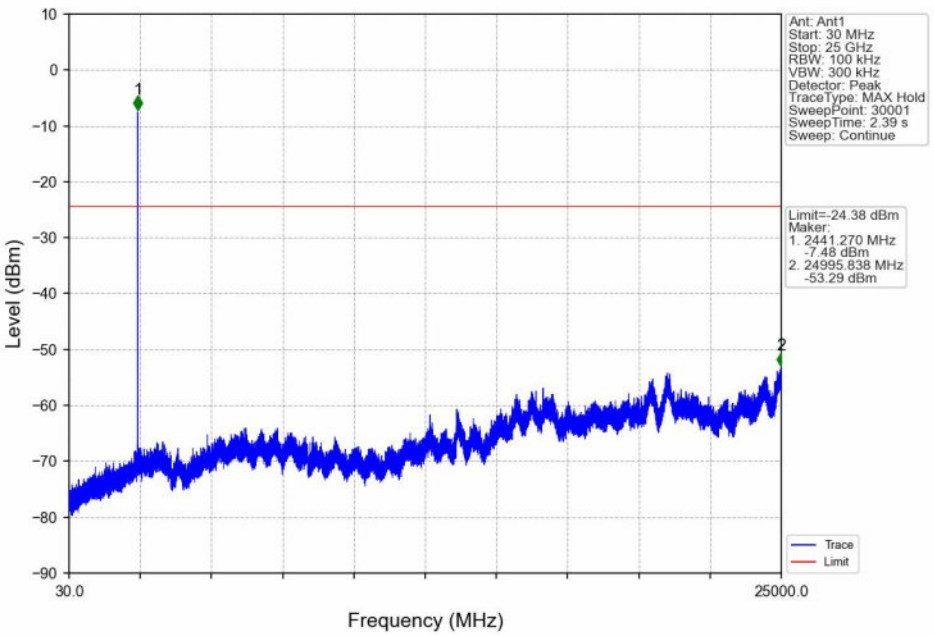
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV


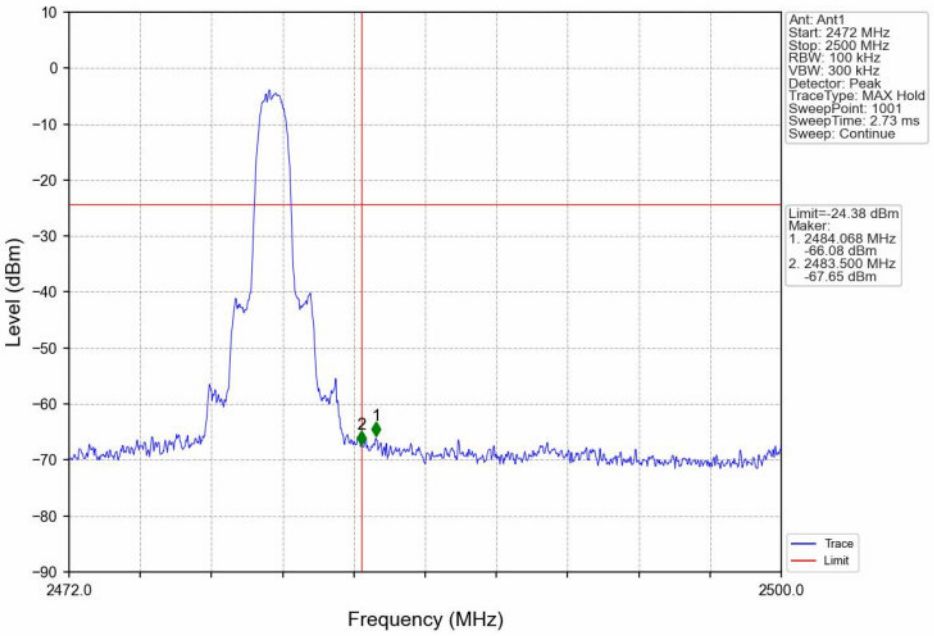
Pi/4DQPSK_2DH5_HOPP_Ant1_NTNV


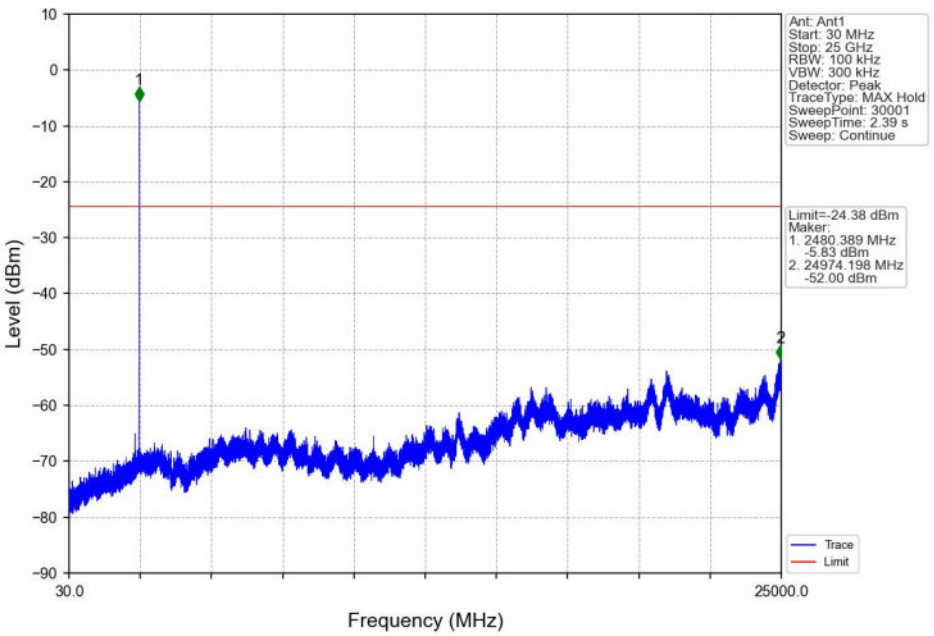
Pi/4DQPSK_2DH5_HOPP_Ant1_NTNV


8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV


8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV


8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV


8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV


8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV

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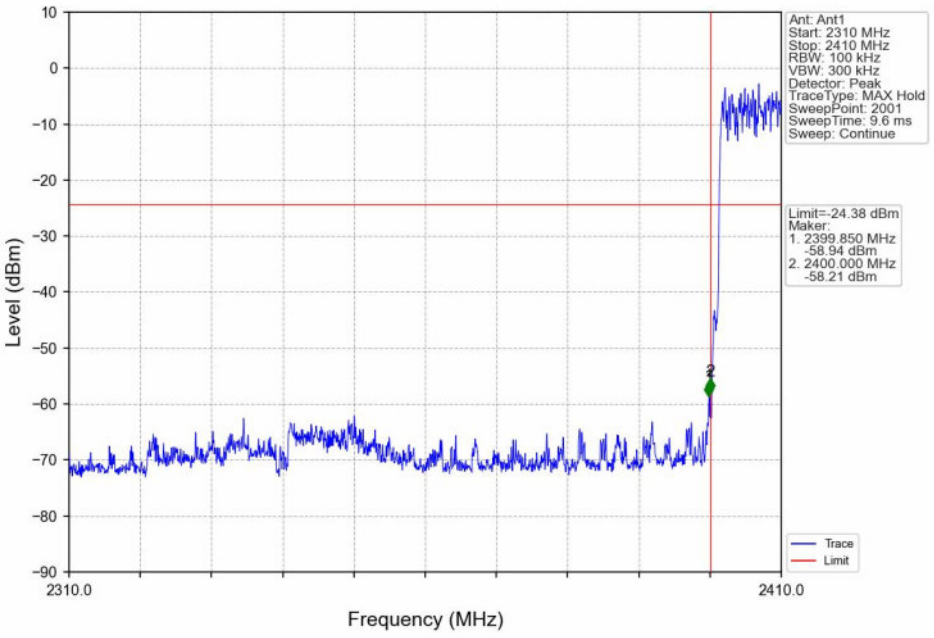
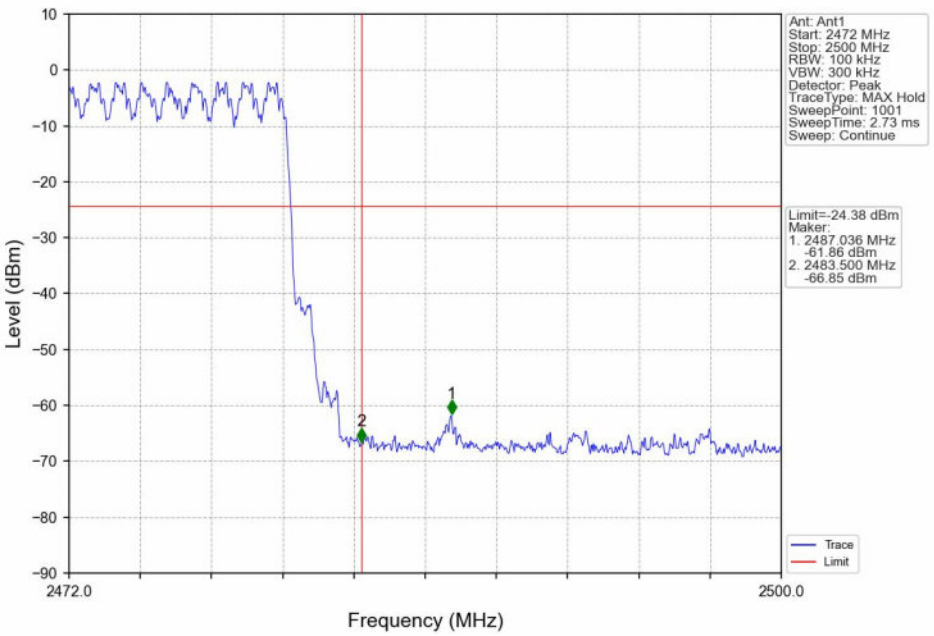


8DPSK_3DH5_HOPP_Ant1_NTNV


7. Form731

7.1 Form731

7.1.1 Test Result

Lower Freq (MHz)	High Freq (MHz)	MAX Power (W)	MAX Power (dBm)
2402	2480	0.0009	-0.41