FCC RADIO TEST REPORT

The device described below is tested by Dongguan Nore Testing Center Co., Ltd. to determine the maximum emission levels emanating from the device, the severe levels which the device can endure and E.U.T.'s performance criterion. The test results, data evaluation, test procedures, and equipment of configurations shown in this report were made in accordance with the procedures in ANSI C63.10(2013).

Applicant	:	Chongqing Jingranyouxu Technology Co., Ltd.
Address	:	No. 1th, 6/F, post Office building, Mercury Science and Technology Building, No. 5th Huangshan Avenue, High-tech park, Chongqing City, China
Manufacturer	:	Chongqing Jingranyouxu Technology Co., Ltd.
Address	:	No. 1th, 6/F, post Office building, Mercury Science and Technology Building, No. 5th Huangshan Avenue, High-tech park, Chongqing City, China
Factory	:	Chongqing Datiejiang Science and Technology Co.,Ltd.
Address	:	NO.368, BOE Avenue, Beibei District, Chongqing
E.U.T.	:	Household Label Printer
Model No.	:	T7, T1, T2, T3, T4, T5, T6, T8, T9, T10, C18-1A, C18-1B, C18-1C, C18-1D, C18-1E, C18-1F, C18-1G, C18-1H, C18-1I, C18-1J (For model difference refer to section 1.1)
Brand Name	:	MAKEiD
FCC ID	:	2AUMQ-T7
Measurement Standard	:	FCC PART 15.247
Date of Receiver	:	September 05, 2019
Date of Test	:	September 06, 2019 to September 30, 2019
Date of Report	:	October 10, 2019

This Test Report is Issued Under the Authority of :

Prepared by	Approved & Authorized Signer
Evan Yang / Engineer	Iori Fan / Authorized Signatory

This test report is for the customer shown above and their specific product only. This report applies to above tested sample only and shall not be reproduced in part without written approval of Dongguan Nore Testing Center Co., Ltd.

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Revision History of This Test Report

Report Number	Description	Issued Date
NTC1909105FV00	Initial Issue	2019-10-10

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test

Product Name	:	Household Label Printer
Model difference	:	T7, T1, T2, T3, T4, T5, T6, T8, T9, T10, C18-1A, C18-1B, C18-1C, C18-1D, C18-1E, C18-1F, C18-1G, C18-1H, C18-1I, C18-1J
Model difference	:	We hereby state that these models are identical in interior structure, electrical circuits and components, just model name is different. Therefore only model T7 is for tests.
E.U.T. Type	:	Class B
Rating	:	DC 5V from USB Port DC 7.4V from built-in battery

Technical Specification:

BT Function		
Version	:	V4.2 (BR/EDR + BLE)
Frequency Range	:	2400-2483.5MHz
Modulation Type	:	GFSK for BLE GFSK, π/4-DQPSK, 8DPSK for BR/EDR
Number of Channel	:	40 for BLE 79 for BR/EDR
Channel Space	:	2MHz for BLE 1MHz for BR/EDR
Antenna Type	:	PCB on-board antenna
Antenna Gain	:	2 dBi

Note: This report is applicable to Bluetooth(BR/EDR) function

Bluetooth Channel List

Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz
1	2402	21	2422	41	2442	61	2462
2	2403	22	2423	42	2443	62	2463
3	2404	23	2424	43	2444	63	2464
4	2405	24	2425	44	2445	64	2465
5	2406	25	2426	45	2446	65	2466
6	2407	26	2427	46	2447	66	2467
7	2408	27	2428	47	2448	67	2468
8	2409	28	2429	48	2449	68	2469
9	2410	29	2430	49	2450	69	2470
10	2411	30	2431	50	2451	70	2471
11	2412	31	2432	51	2452	71	2472
12	2413	32	2433	52	2453	72	2473
13	2414	33	2434	53	2454	73	2474
14	2415	34	2435	54	2455	74	2475
15	2416	35	2436	55	2456	75	2476
16	2417	36	2437	56	2457	76	2477
17	2418	37	2438	57	2458	77	2478
18	2419	38	2439	58	2459	78	2479
19	2420	39	2440	59	2460	79	2480
20	2421	40	2441	60	2461		

Note: According to section 15.31(m), regards to the operating frequency range over 10MHz, the Lowest, middle, and the Highest frequency of channel were selected to perform the test. The selected frequency and test software see below:

Channel	Frequency (MHz)
1	2402
40	2441
79	2480

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: 2AUMQ-T7 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rule.

1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters.

1.4 Equipment Modifications

Not available for this EUT intended for grant.

1.5 Support Device

Description	Manufacturer	Model	S/N
AC/DC Adapter	SAMSUNG	ETA-U90CBC	RT4F629wS/B-E

Note: The adapter is used for conducted emission tests

1.6 Test Facility and Location

Site Description

EMC Lab : Listed by CNAS, August 13, 2018
The certificate is valid until August 13, 2024
The Laboratory has been assessed and proved to be in compliance with CNAS/CL01
The Certificate Registration Number is L5795.

Listed by A2LA, November 01, 2017
The certificate is valid until December 31, 2019
The Laboratory has been assessed and proved to be in compliance with ISO17025
The Certificate Registration Number is 4429.01

Listed by FCC, November 06, 2017
The Designation Number is CN1214
Test Firm Registration Number: 907417

Listed by Industry Canada, June 08, 2017
The Certificate Registration Number. Is 46405-9743

Name of Firm : Dongguan Nore Testing Center Co., Ltd.
(Dongguan NTC Co., Ltd.)

Site Location : Building D, Gaosheng Science and Technology Park, Hongtu Road, Nancheng District, Dongguan City, Guangdong Province, China

1.7 Summary of Test Results

FCC Rules	Description Of Test	Uncertainty	Result
§15.207 (a)	AC Power Line Conducted Emission	±1.06dB	Compliant
§15.247(d),§15.209, §15.205	Radiated Emission	±3.70dB	Compliant
§15.247(a)(1)	Channel Separation	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)	20dB Bandwidth	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)(iii)	Hopping Channel Number	±1.42 x10^{-4}%	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	±5%	Compliant
§15.247(b)	Max Peak Output Power	±1.06dB	Compliant
§15.247(d)	Band Edge	±1.70dB	Compliant
§15.203	Antenna Requirement	N/A	Compliant
§15.247(d)	Conducted Spurious Emission	±1.70dB	Compliant

2. SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 Special Accessories

Not available for this EUT intended for grant.

2.3 Description of test modes

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5 mode in all modulation type GFSK, π/4-DQPSK and 8DPSK were tested.

Test Item	Software	Description
Conducted RF Testing and Radiated testing	ESP_RF_test_tool_v1.1.0	Set the EUT to different modulation and channel

Output power setting table:

Test Mode	Set Tx Output Power	Data rate
GFSK	1dBm	DH1
π/4-DQPSK	3dBm	2-DH1
8DPSK	3dBm	3-DH1

2.4 EUT Exercise

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.

3. FREQUENCY HOPPING SYSTEM REQUIREMENTS

3.1 Standard and Limit

According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

3.2 EUT Pseudorandom Frequency Hopping Sequence

Pseudorandom Frequency Hopping Sequence Table as below:
Channel: 08, 24, 40, 56, 34, 51, 72, 09, 01, 64, 22, 33, 41, 32, 47, 65, 73, 53, 69, 06, 17, 04, 20, 36, 52, 38, 66, 70, 78, 68, 76, 21, 29, 10, 26, 49, 00, 58, 44, 59, 75, 13, 03, 14, 11, 35, 43, 37, 50, 61, 77, 55, 71, 02, 23, 07, 27, 39, 54, 46, 48, 15, 63, 62, 67, 25, 31, 12, 28, 19, 60, 42, 57, 74, 16, 05, 18, 30, 45, etc.

The system receiving have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

3.3 Frequency Hopping System

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

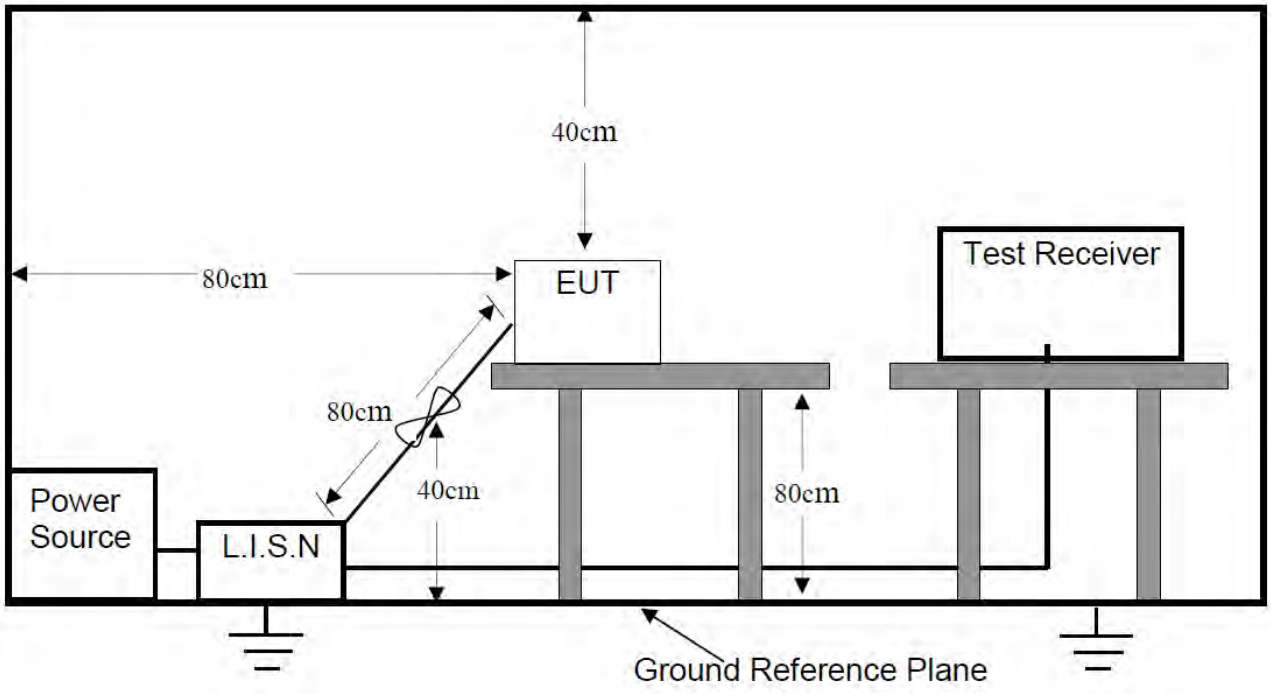
This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with a bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements FCC Part 15.247 rule.

4. AC POWER LINE CONDUCTED EMISSIONS

4.1 Test SET-UP (Block Diagram of Configuration)



4.2 Test Condition

Test Requirement: FCC Part 15.207

Frequency Range: 150KHz ~ 30MHz

Detector: RBW 9KHz, VBW 30KHz

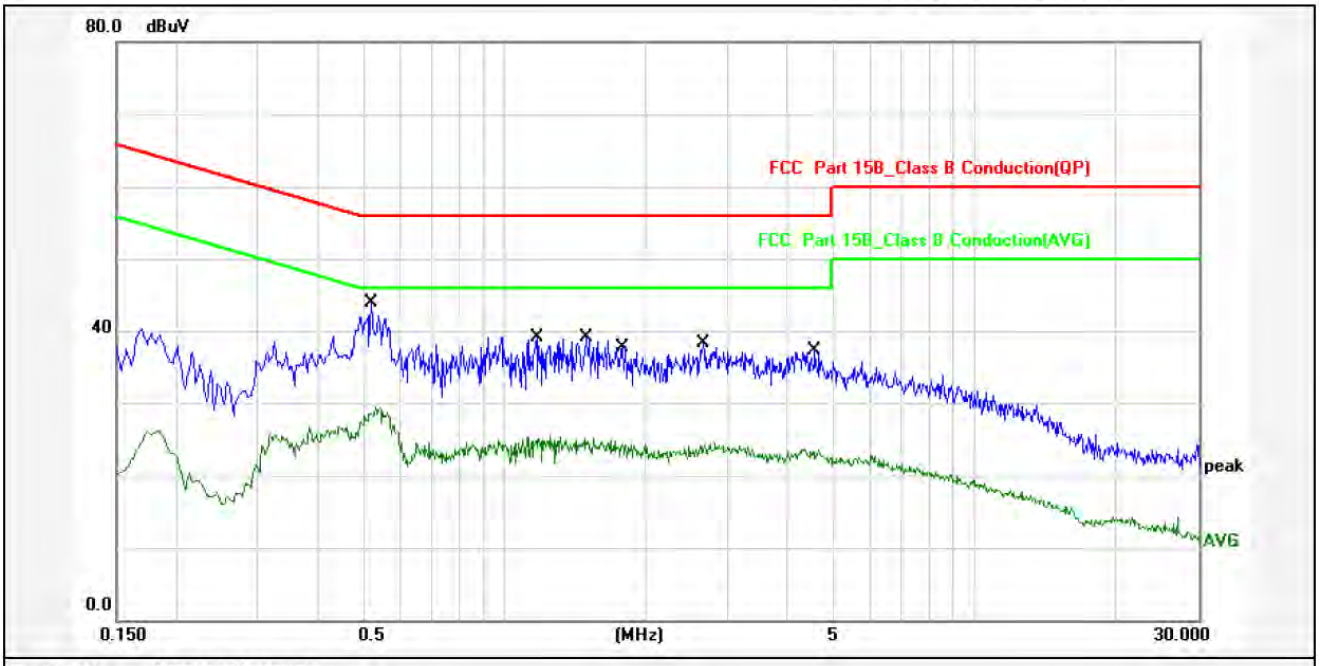
Operation Mode: BT Communication

4.3 Measurement Results

PASS

Please refer to the following pages of the worst case

Test Time: 2019-09-11 21:52:15

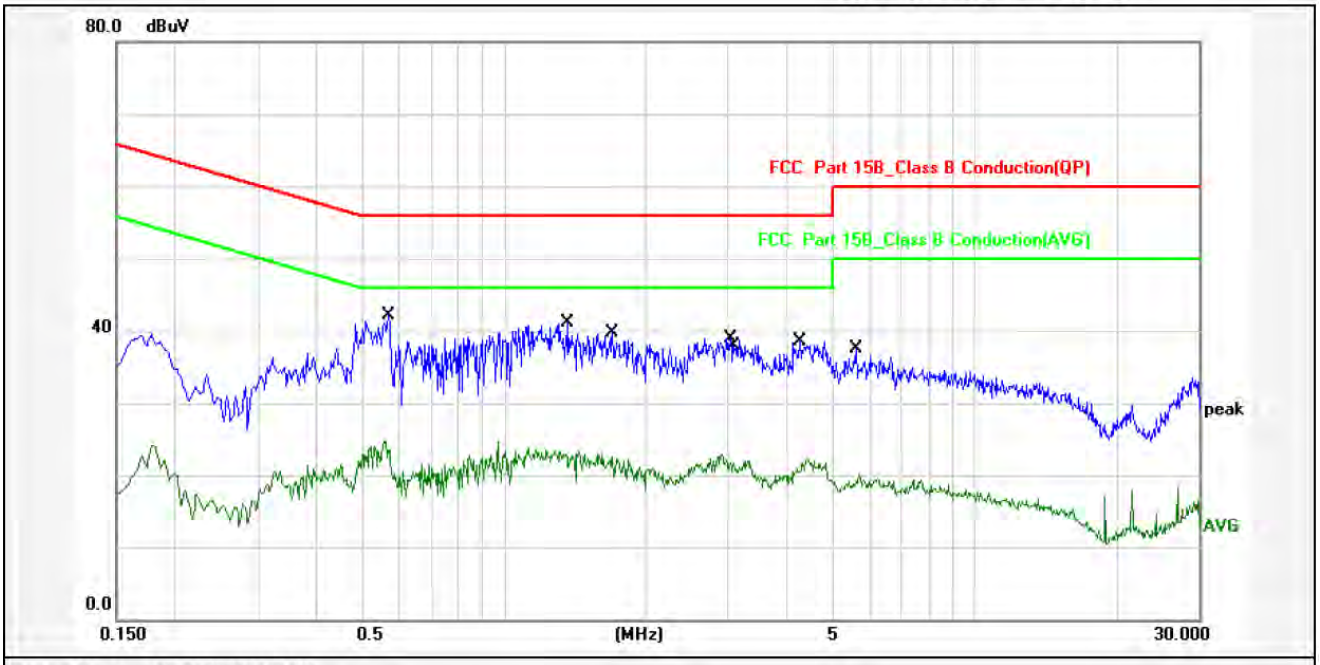


Report No.: NTC1909105FV00
Test Standard: FCC Part 15B_Class B Conduction(QP)
Test item: Conducted Emission
Phase: N
Applicant: Chongqing Jingranyouxu Technology Co., Ltd.
Temp.(C)/Hum.(%): 24(℃) / 52.8 %
Product: Household Label Printer
Power Rating: AC 120V/60Hz
Model No.: T7
Test Engineer: QM

Test Mode: BT Communication
Remark:

No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.5220	10.60	33.30	43.90	56.00	-12.10	QP	P	
2	0.5220	10.60	17.99	28.59	46.00	-17.41	AVG	P	
3	1.1740	10.60	28.51	39.11	56.00	-16.89	QP	P	
4	1.1740	10.60	14.49	25.09	46.00	-20.91	AVG	P	
5	1.4980	10.61	28.56	39.17	56.00	-16.83	QP	P	
6	1.4980	10.61	14.48	25.09	46.00	-20.91	AVG	P	
7	1.7860	10.62	27.30	37.92	56.00	-18.08	QP	P	
8	1.7860	10.62	13.73	24.35	46.00	-21.65	AVG	P	
9	2.6540	10.66	27.65	38.31	56.00	-17.69	QP	P	
10	2.6540	10.66	13.74	24.40	46.00	-21.60	AVG	P	
11	4.5858	10.76	26.57	37.33	56.00	-18.67	QP	P	
12	4.5858	10.76	12.59	23.35	46.00	-22.65	AVG	P	

Test Time: 2019-09-11 21:54:00



Report No.: NTC1909105FV00
Test Standard: FCC Part 15B_Class B Conduction(QP)
Test item: Conducted Emission
Applicant: Chongqing Jingranyouxu Technology Co., Ltd.
Product: Household Label Printer
Model No.: T7
Phase: L1
Temp.(C)/Hum.(%): 24(℃) / 52.8 %
Power Rating: AC 120V/60Hz
Test Engineer: QM

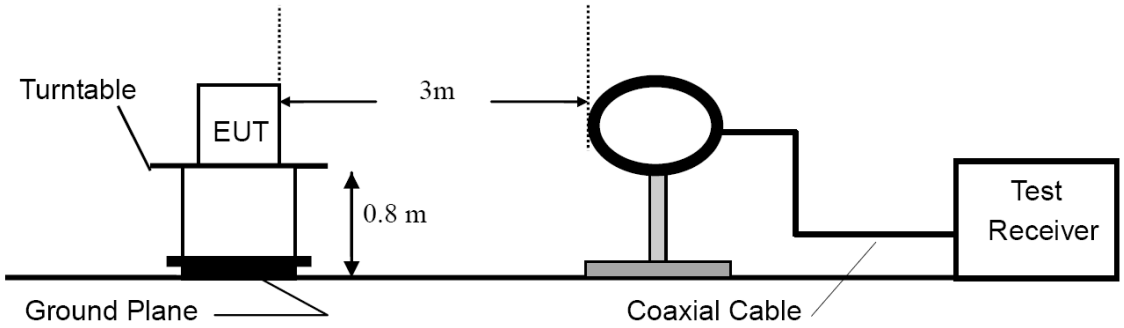
Test Mode: BT Communication
Remark:

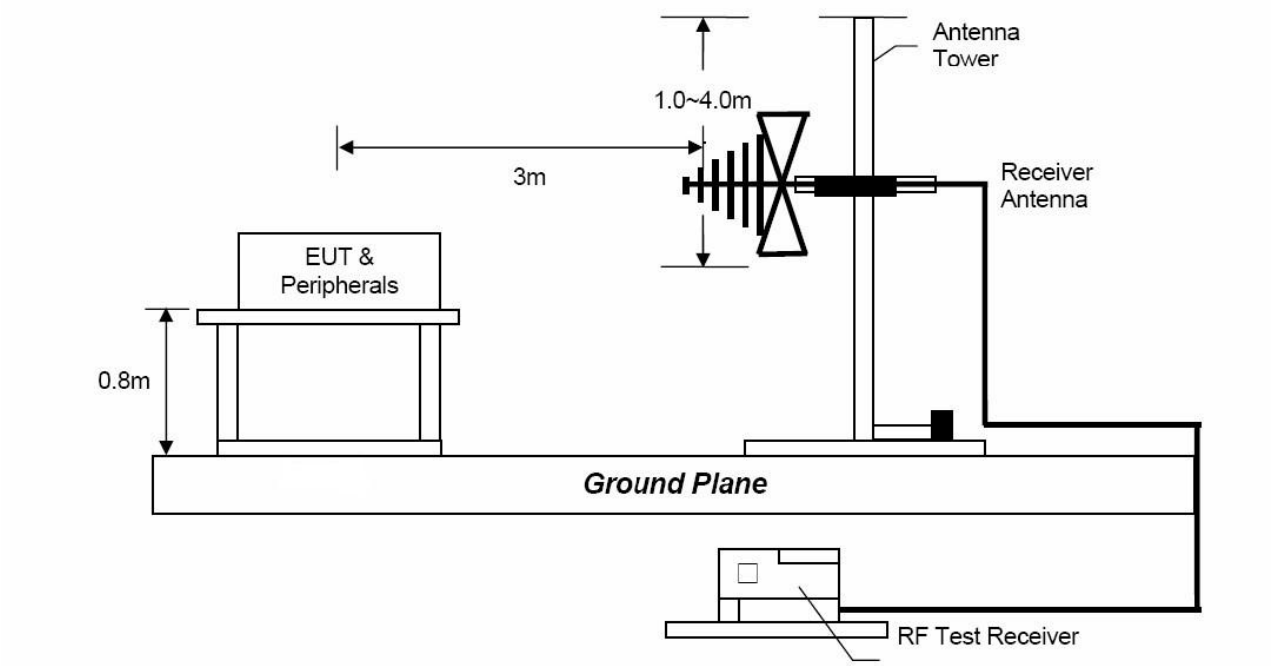
No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.5700	10.60	31.42	42.02	56.00	-13.98	QP	P	
2	0.5700	10.60	14.16	24.76	46.00	-21.24	AVG	P	
3	1.3700	10.61	30.40	41.01	56.00	-14.99	QP	P	
4	1.3700	10.61	12.71	23.32	46.00	-22.68	AVG	P	
5	1.7020	10.61	29.08	39.69	56.00	-16.31	QP	P	
6	1.7020	10.61	11.86	22.47	46.00	-23.53	AVG	P	
7	3.0260	10.68	28.24	38.92	56.00	-17.08	QP	P	
8	3.0860	10.68	11.06	21.74	46.00	-24.26	AVG	P	
9	4.2499	10.75	27.81	38.56	56.00	-17.44	QP	P	
10	4.2499	10.75	10.95	21.70	46.00	-24.30	AVG	P	
11	5.6099	10.80	26.64	37.44	60.00	-22.56	QP	P	
12	5.6099	10.80	9.34	20.14	50.00	-29.86	AVG	P	

5. RADIATED EMISSION

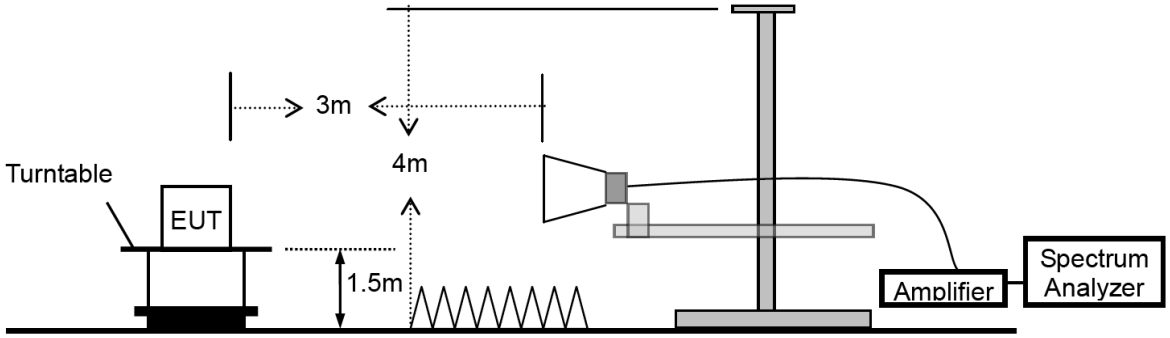
5.1 Test SET-UP (Block Diagram of Configuration)

5.1.1 Radiated Emission Test Set-Up, Frequency below 30MHz





5.1.2 Radiated Emission Test Set-Up, Frequency above 1GHz



5.2 Measurement Procedure

a. Blow 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.
b. For the radiated emission test above 1GHz:
The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. The height of antenna 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.
e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
f. A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Level	Resolution Bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
	Average	1 MHz	10 Hz

5.3 Limit

Frequency range MHz	Distance Meters	Field Strengths Limit (15.209)
		μV/m
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960	3	500

Remark : (1) Emission level (dB)μV = 20 log Emission level μV/m

(2) The smaller limit shall apply at the cross point between two frequency bands.

(3) As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

(4) The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

5.4 Measurement Results

Please refer to following plots of the worst case: 8DPSK Low channel.

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit. Therefore, 9kHz-30MHz data were not recorded.

Test Time: 2019/9/18 20:24:27

Report No.:	NTC1909105FV00		
Test Standard:	FCC Part 15B_Class B 3M Radiation	Test Distance:	
Test item:	Radiation Emission	Ant. Polarization:	Vertical
Applicant:	Chongqing Jingranyouxu Technology Co., Ltd.	Temp.(C)/Hum.(%):	27.3(℃) / 60 %
Product:	Household Label Printer	Power Rating:	DC 7.4V
Model No.:	T7	Test Engineer:	SLY

Test Mode: TX 2402MHz

Remark:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	73.1025	-15.48	49.58	34.10	40.00	-5.90	QP	100	199	P	
2	86.5027	-11.85	48.80	36.95	40.00	-3.05	QP	100	224	P	
3	113.7142	-8.27	34.91	26.64	43.50	-16.86	QP	100	141	P	
4	148.9624	-8.79	44.15	35.36	43.50	-8.14	QP	100	157	P	
5	167.8243	-9.86	44.35	34.49	43.50	-9.01	QP	100	254	P	
6	199.9856	-11.50	45.69	34.19	43.50	-9.31	QP	100	300	P	

Test Time: 2019/9/18 20:28:34

Report No.:	NTC1909105FV00		
Test Standard:	FCC Part 15B_Class B 3M Radiation	Test Distance:	
Test item:	Radiation Emission	Ant. Polarization:	Horizontal
Applicant:	Chongqing Jingranyouxu Technology Co., Ltd.	Temp.(C)/Hum.(%):	27.3(℃) / 60 %
Product:	Household Label Printer	Power Rating:	DC 7.4V
Model No.:	T7	Test Engineer:	SLY

Test Mode: TX 2402MHz

Remark:

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	92.1388	-10.43	45.93	35.50	43.50	-8.00	QP	200	175	P	
2	110.9569	-8.36	34.95	26.59	43.50	-16.91	QP	200	88	P	
3	131.2965	-7.83	34.72	26.89	43.50	-16.61	QP	200	105	P	
4	146.3734	-8.66	41.71	33.05	43.50	-10.45	QP	200	248	P	
5	159.7844	-9.40	44.85	35.45	43.50	-8.05	QP	200	293	P	
6	197.8928	-11.40	48.30	36.90	43.50	-6.60	QP	200	335	P	

Modulation:	8DPSK (the worst case)		
Frequency Range:	1-25GHz	Test Date:	September 26, 2019
Test Result:	PASS	Temperature:	25 ℃
Measured Distance:	3m	Humidity:	64 %
Test By:	Sance	Test Results:	PASS

Freq. (MHz)	Ant.Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV)		Limit @3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
Operation Mode: TX Mode (Low)										
4804	H	50.74	39.68	4.07	54.81	43.75	74.00	54.00	-19.19	-10.25
7206	H	45.56	30.66	10.27	55.83	40.93	74.00	54.00	-18.17	-13.07

4804	V	52.36	40.90	4.07	56.43	44.97	74.00	54.00	-17.57	-9.03
7206	V	46.11	30.64	10.27	56.38	40.91	74.00	54.00	-17.62	-13.09

Operation Mode: TX Mode (Mid)										
4882	H	51.90	38.69	4.57	56.47	43.26	74.00	54.00	-17.53	-10.74
7323	H	46.39	31.31	10.05	56.44	41.36	74.00	54.00	-17.56	-12.64

4882	V	53.49	42.04	4.57	58.06	46.61	74.00	54.00	-15.94	-7.39
7323	V	46.45	31.17	10.05	56.50	41.22	74.00	54.00	-17.50	-12.78

Operation Mode: TX Mode (High)										
4960	H	52.70	40.65	5.05	57.75	45.70	74.00	54.00	-16.25	-8.30
7440	H	46.50	31.83	9.76	56.26	41.59	74.00	54.00	-17.74	-12.41

4960	V	53.24	41.42	5.05	58.29	46.47	74.00	54.00	-15.71	-7.53
7440	V	46.70	31.42	9.76	56.46	41.18	74.00	54.00	-17.54	-12.82

Other harmonics emissions are lower than 10dB below the allowable limit.

Note: (1) All Readings are Peak Value and AV.
(2) Emission Level= Reading Level + Factor
(3) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(4) Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 10dB below the permissible limits.
(5) Measurement uncertainty: ±3.7dB.
(6) Horn antenna used for the emission over 1000MHz.

6. CHANNEL SEPARATION

6.1 Measurement Procedure

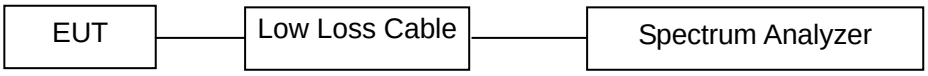
Minimum Hopping Channel Carrier Frequency Separation, FCC Rule 15.247(a)(1):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable, and using the Marker and Max-Hold function to record the separation of two adjacent channels.

6.2 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

6.3 Test SET-UP (Block Diagram of Configuration)



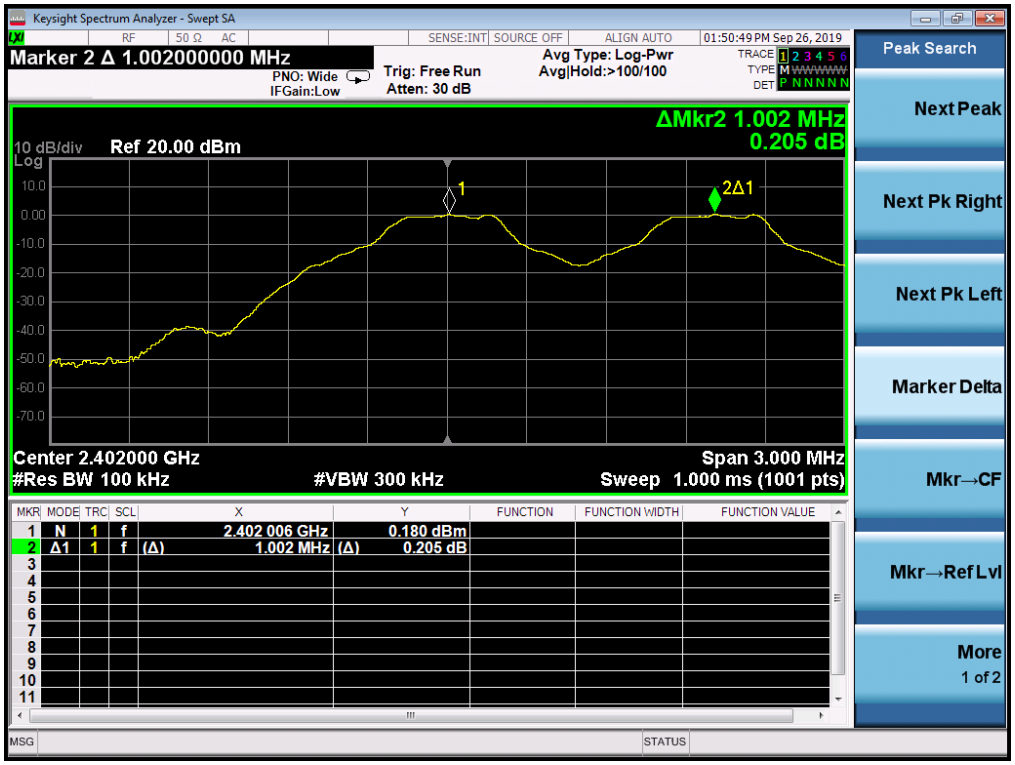
6.4 Measurement Results

Refer to attached data chart.

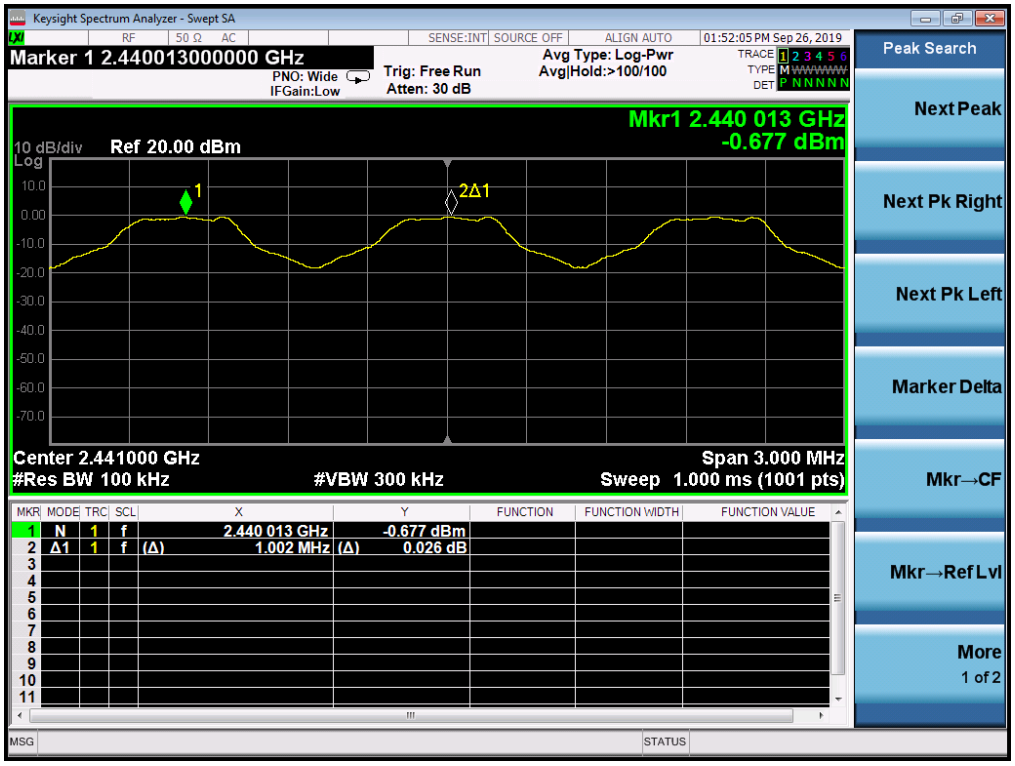
Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	100kHz	VBW:	300kHz
Packet:	DH1, 2DH1, 3DH1(Worst case)	Spectrum Detector:	PK
Test By:	Sance	Test Date:	Sep. 25, 2019
Temperature:	24 ℃	Humidity:	50 %
Test Result:	PASS		

Channel	Test Frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Bandwidth (kHz)
GFSK			
Lowest	2402	1002	>631.9
Middle	2441	1002	>631.7
Highest	2480	1002	>632.2
π/4-DQPSK			
Lowest	2402	1002	>878.7
Middle	2441	1002	>877.3
Highest	2480	1002	>878.7
8DPSK			
Lowest	2402	1002	>872.7
Middle	2441	1005	>872.7
Highest	2480	1002	>872.7

GFSK Lowest Channel

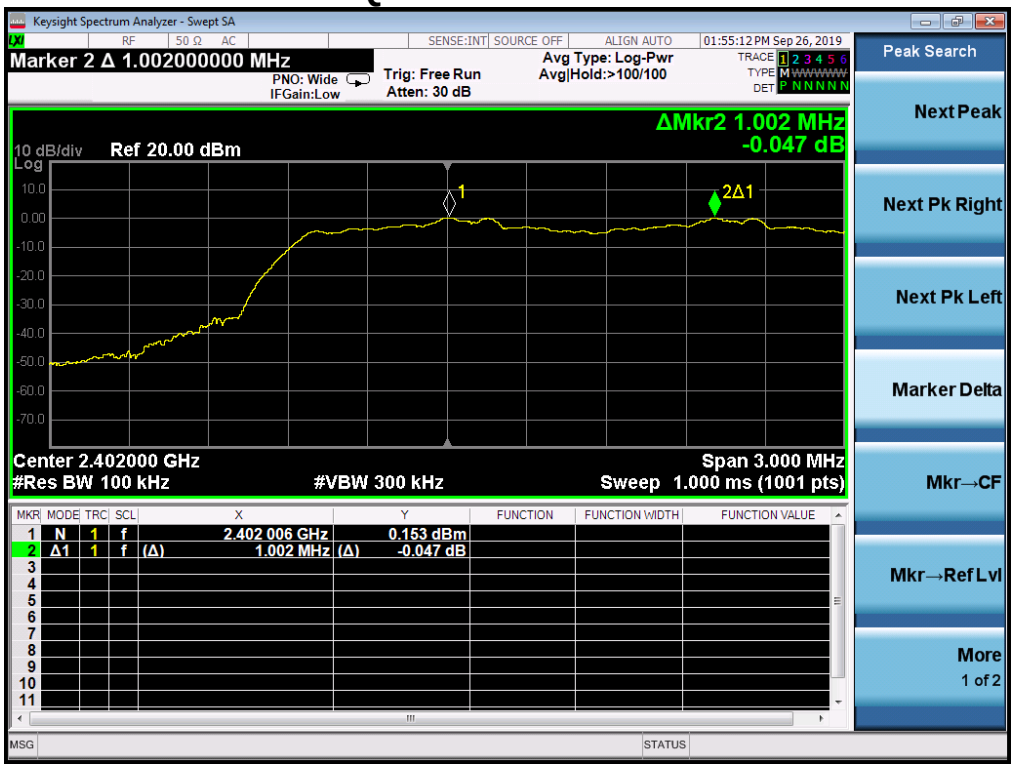


GFSK Middle Channel

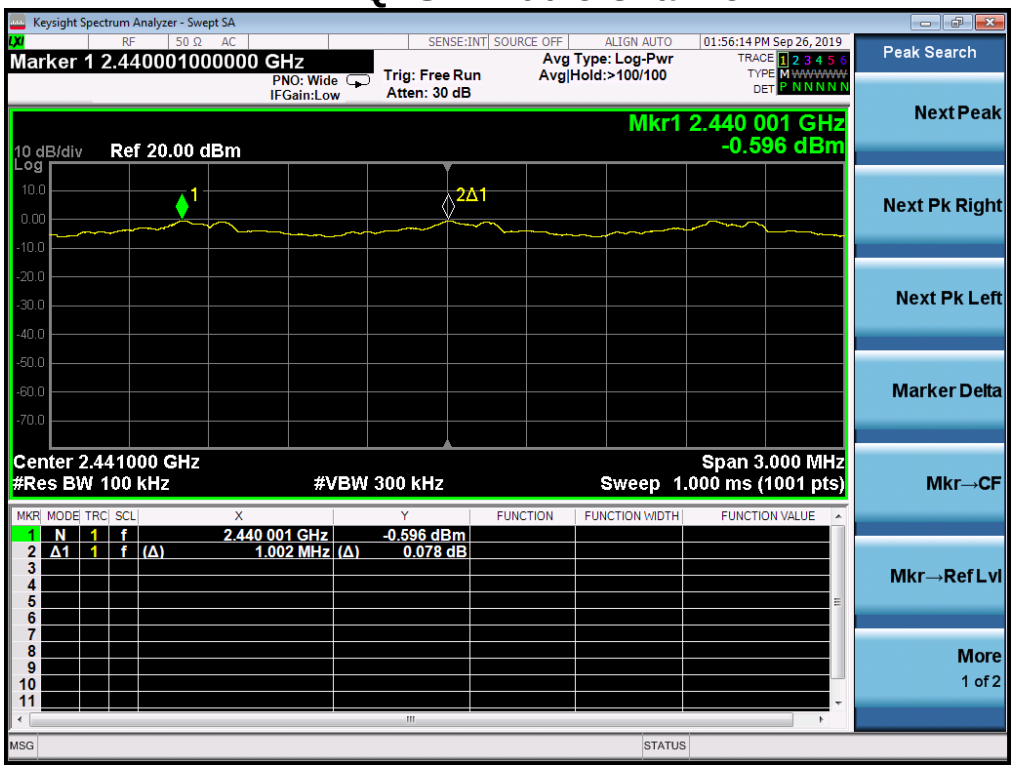


GFSK Highest Channel

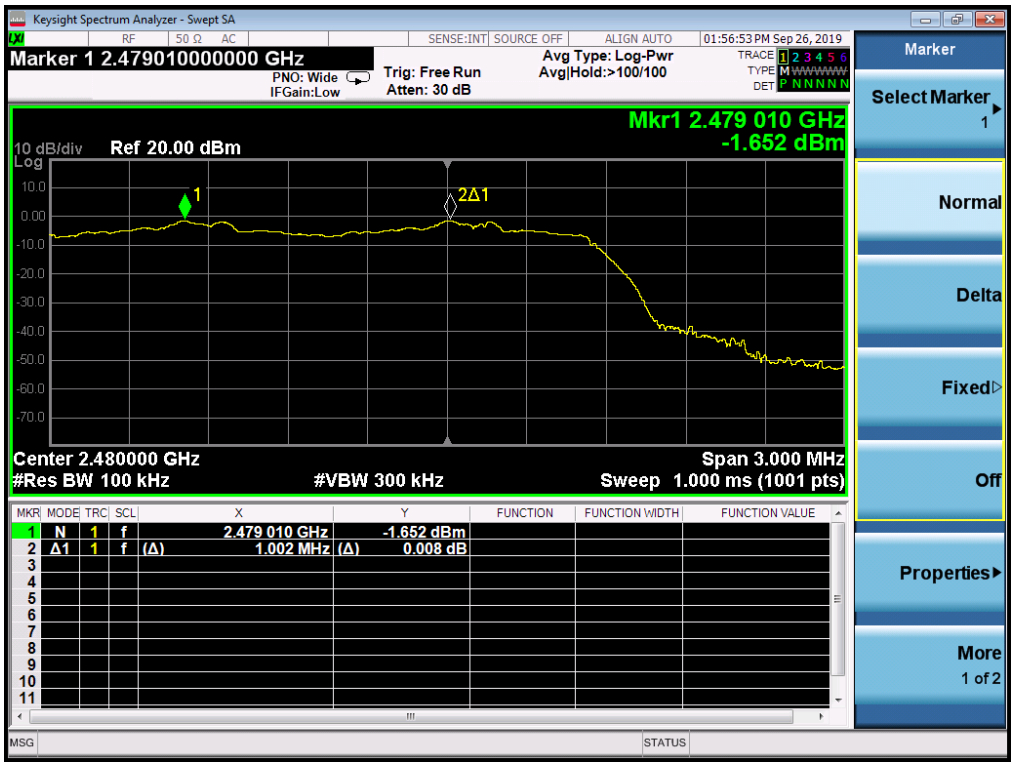
π/4-DQPSK Lowest Channel



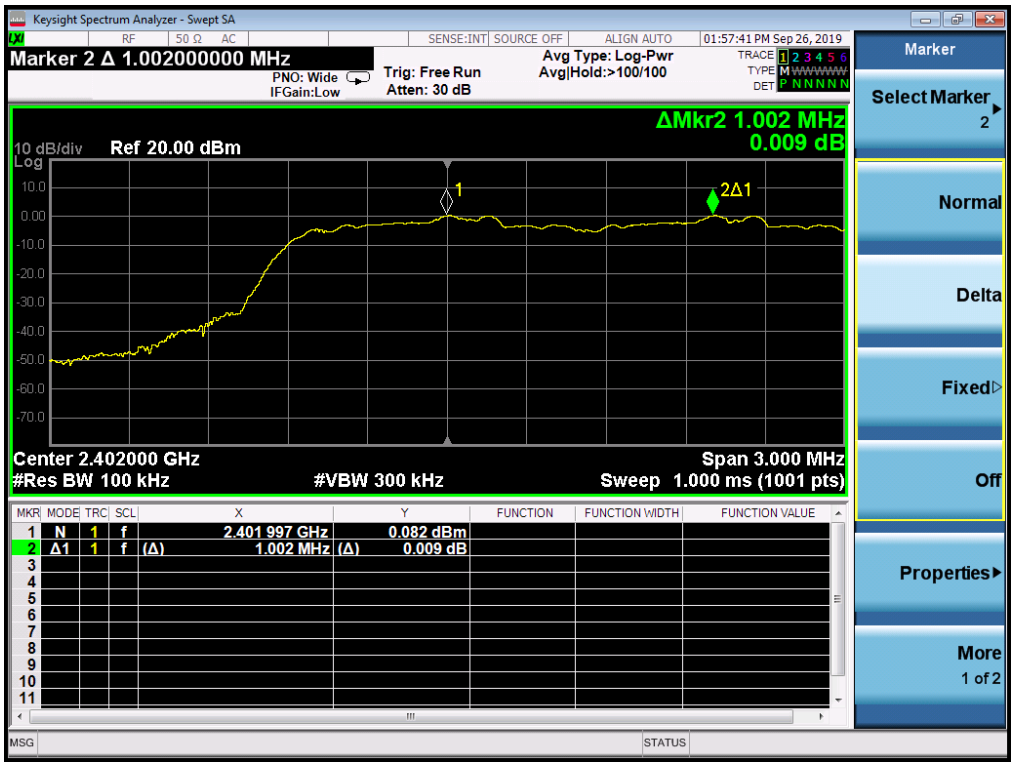
π/4-DQPSK Middle Channel



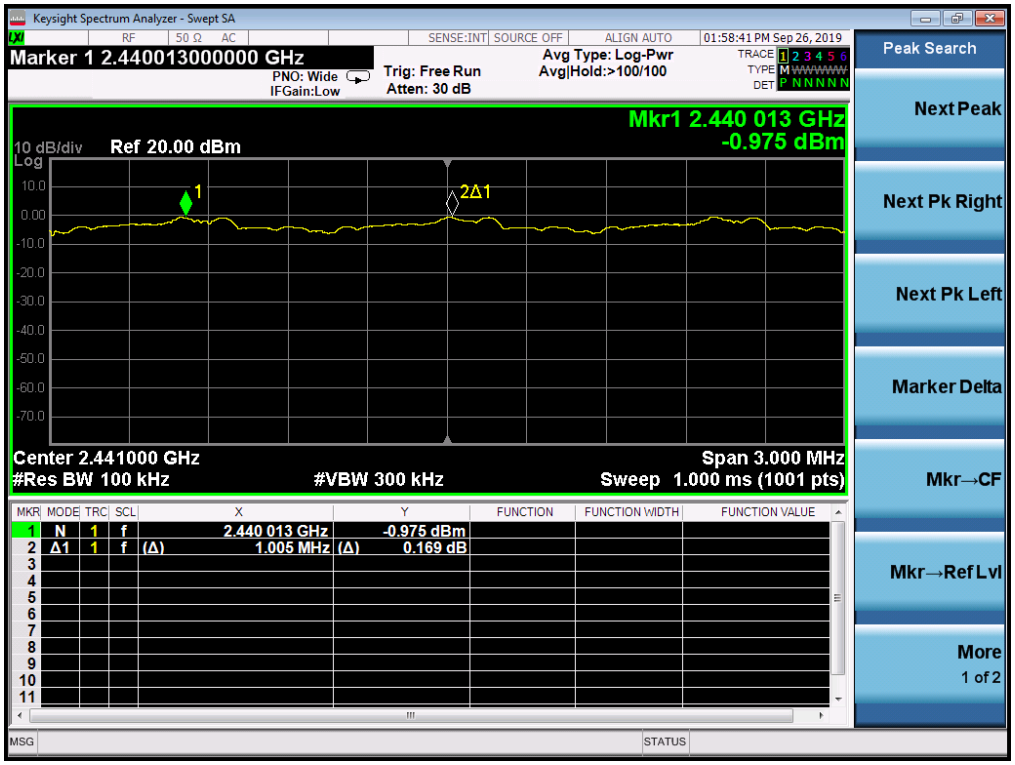
π/4-DQPSK Highest Channel



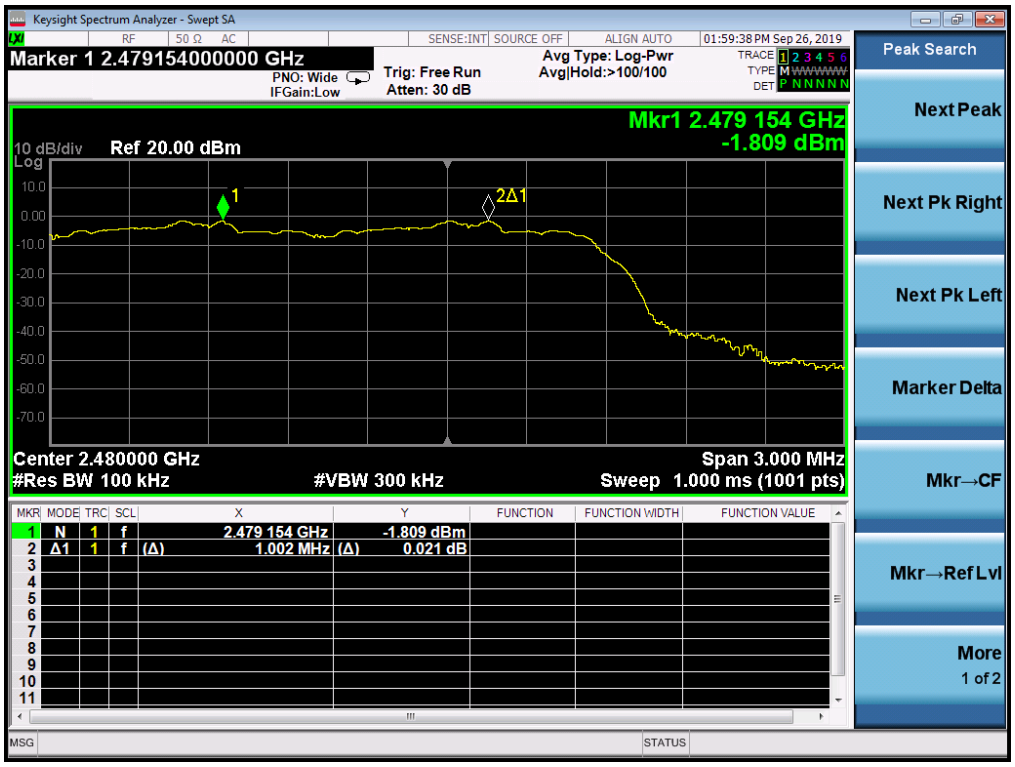
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



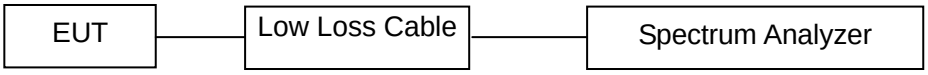
7. 20DB BANDWIDTH

7.1 Measurement Procedure

Maximum 20dB RF Bandwidth, FCC Rule 15.247(a)(1):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

7.2 Test SET-UP (Block Diagram of Configuration)



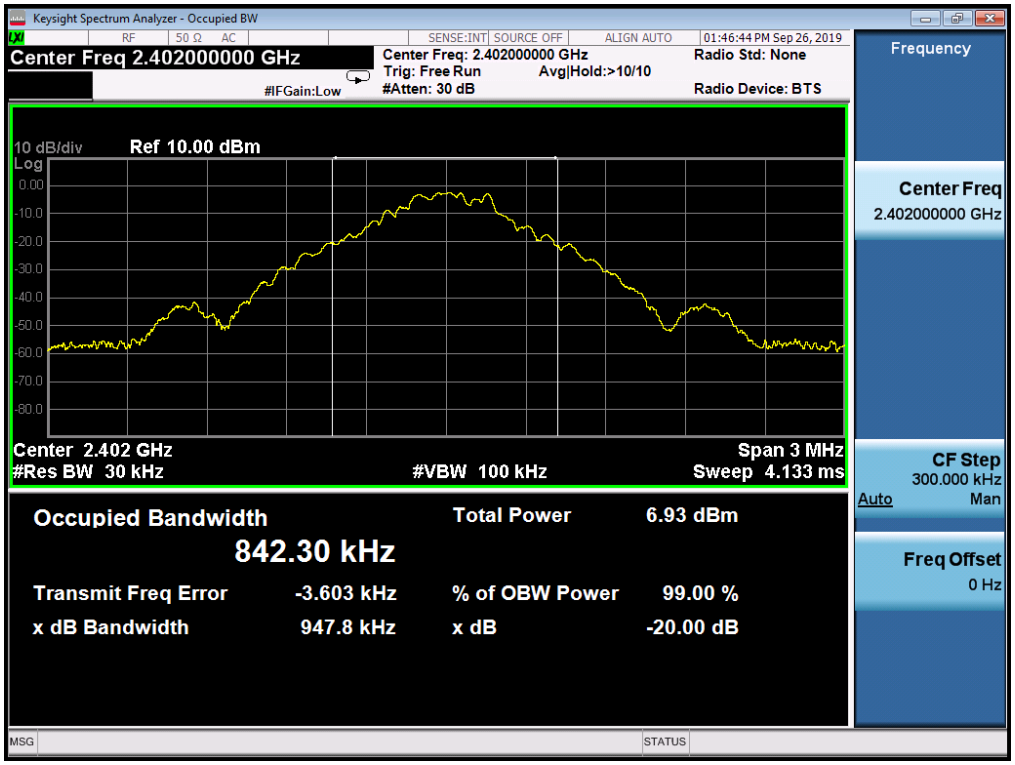
7.3 Measurement Results

Refer to attached data chart.

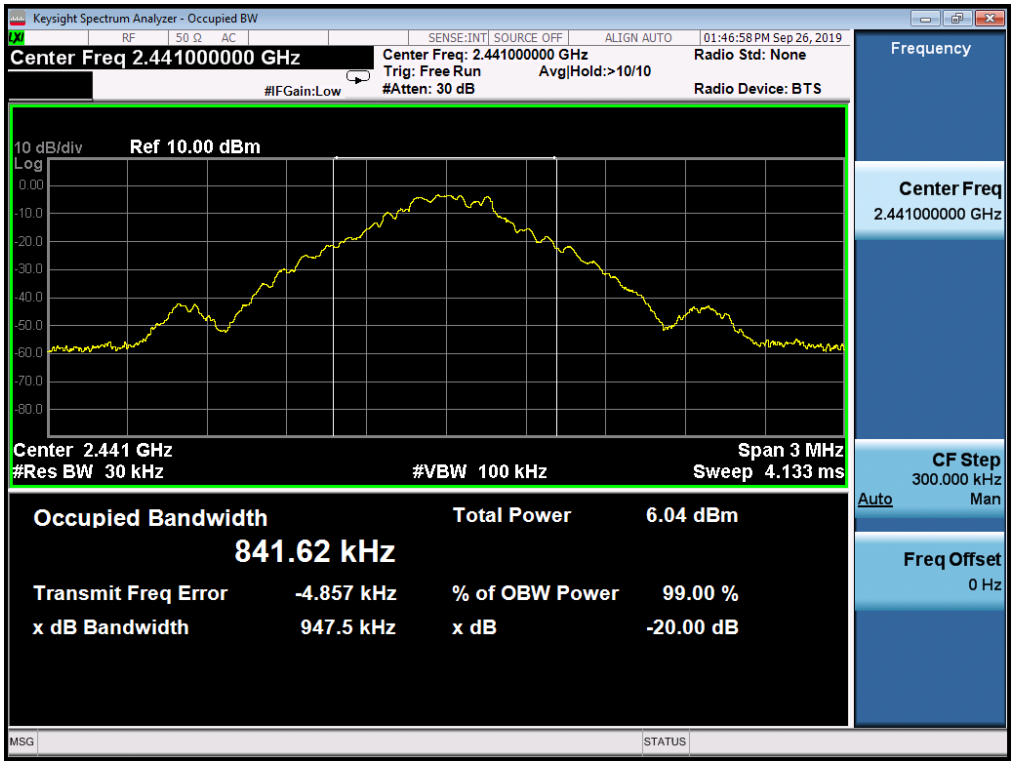
Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	30kHz	VBW:	100kHz
Packet:	DH1, 2DH1, 3DH1(Worst case)	Spectrum Detector:	PK
Test By:	Sance	Test Date:	Sep. 25, 2019
Temperature:	24 ℃	Humidity:	50 %
Test Result:	PASS		

Channel	Test Frequency (MHz)	20dB Down BW(kHz)
GFSK		
Lowest	2402	947.8
Middle	2441	947.5
Highest	2480	948.3
π/4-DQPSK		
Lowest	2402	1.318
Middle	2441	1.316
Highest	2480	1.318
8DPSK		
Lowest	2402	1.309
Middle	2441	1.309
Highest	2480	1.309

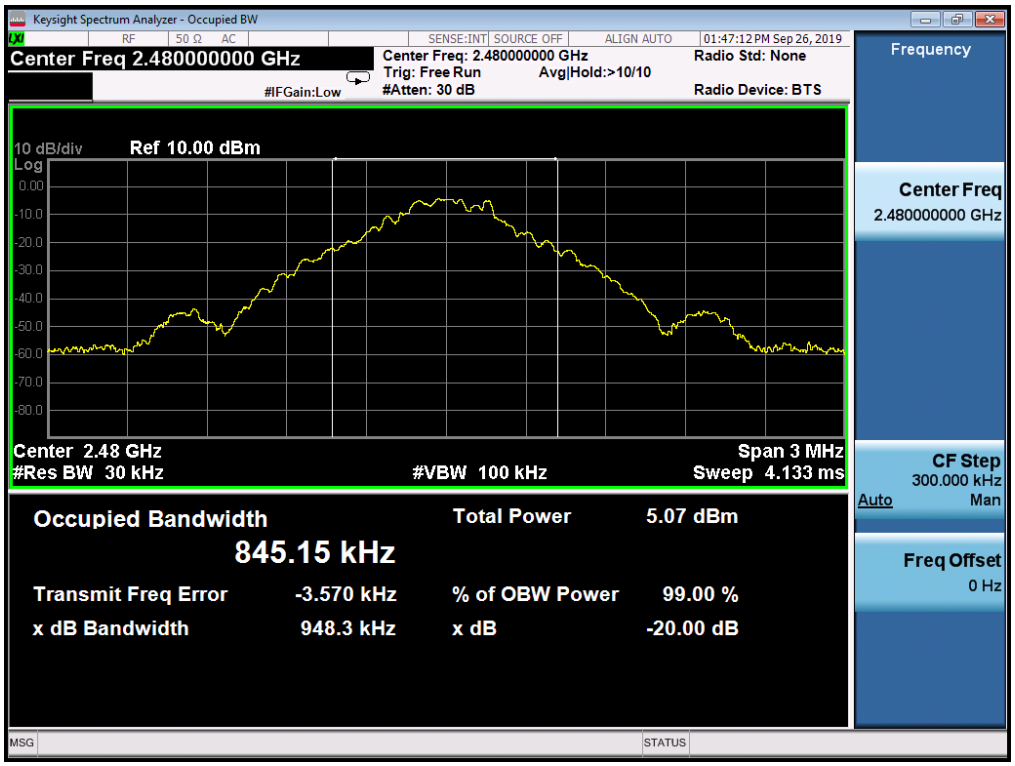
GFSK Lowest Channel



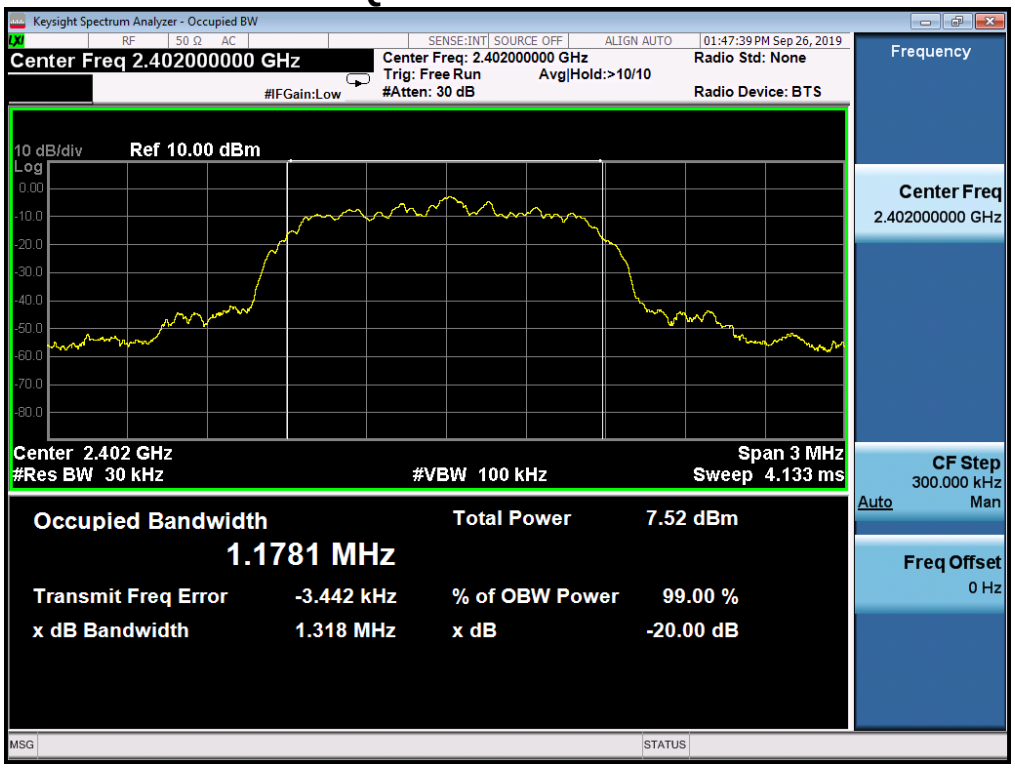
GFSK Middle Channel



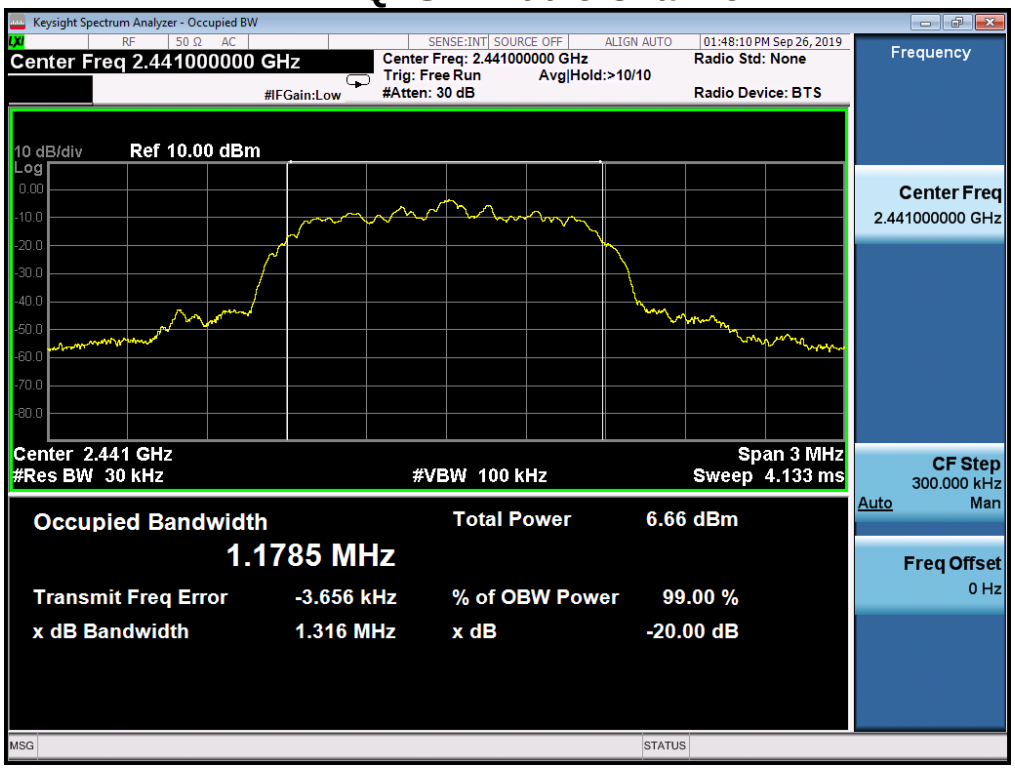
GFSK Highest Channel



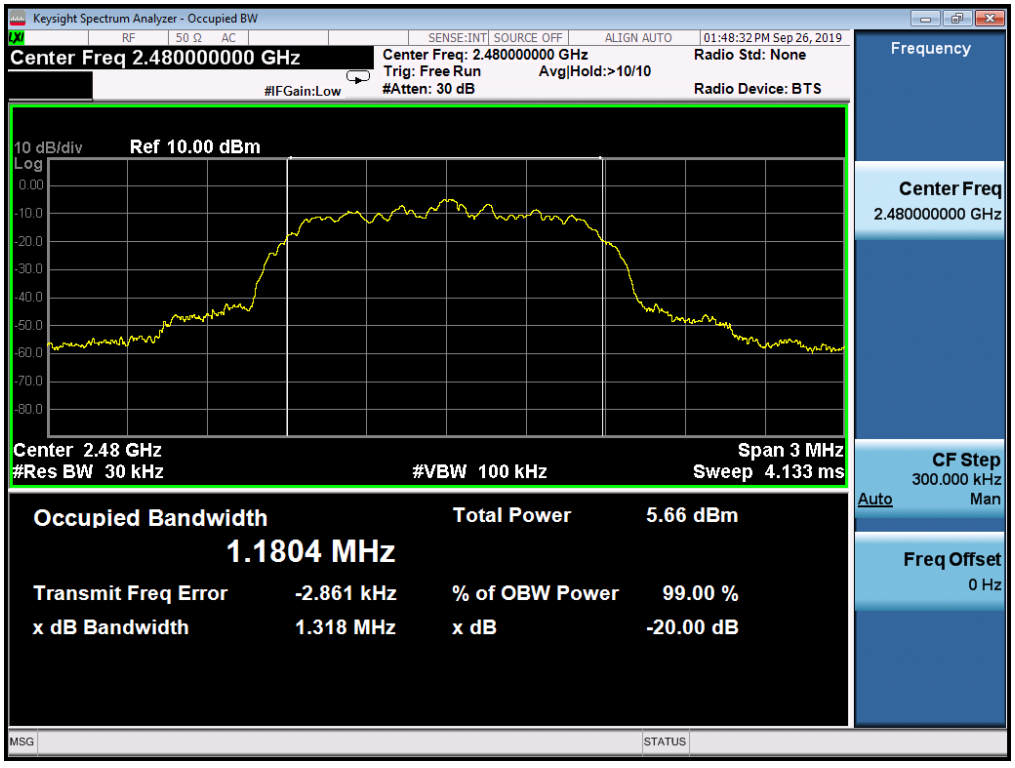
π/4-DQPSK Lowest Channel



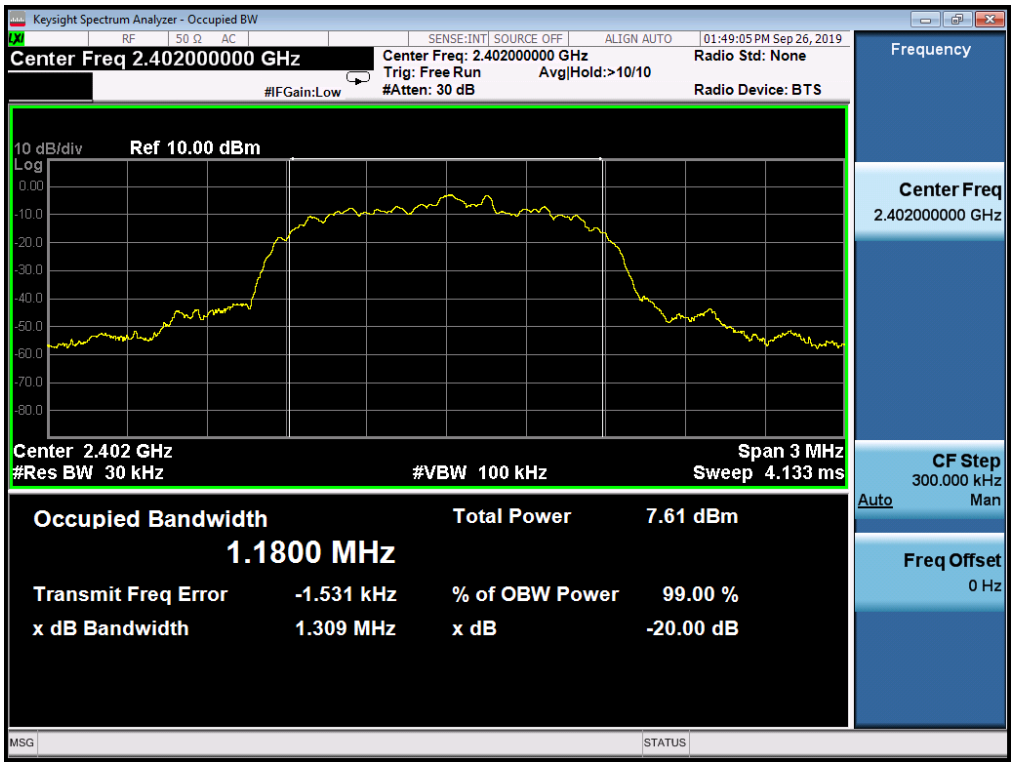
π/4-DQPSK Middle Channel



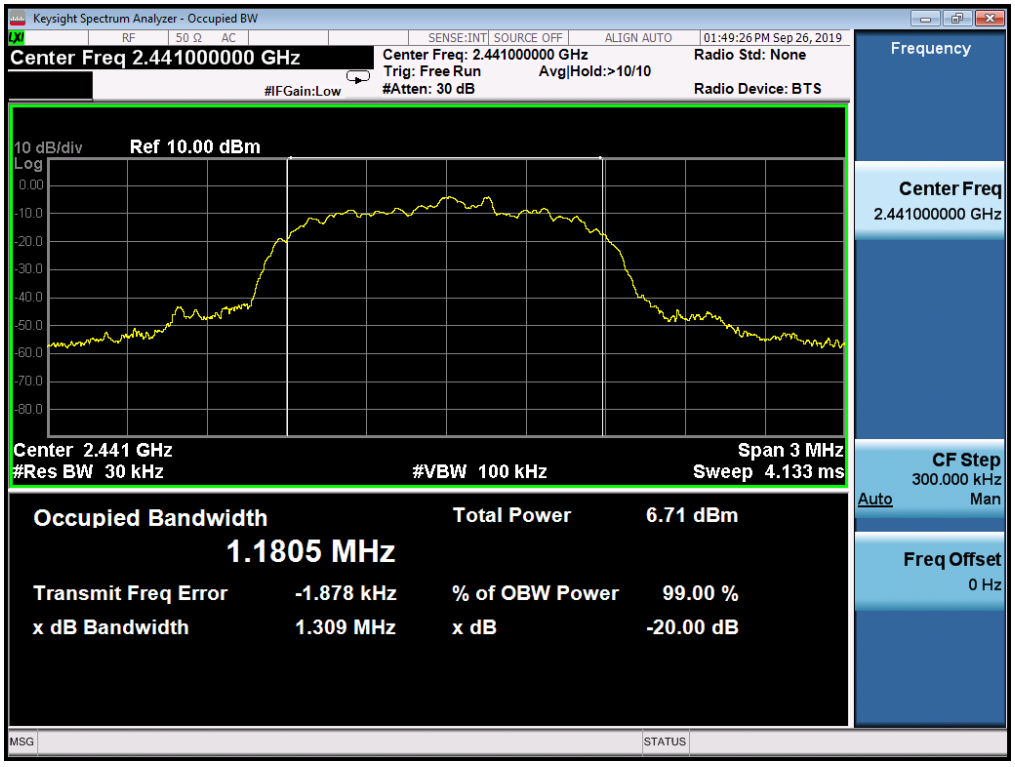
π/4-DQPSK Highest Channel



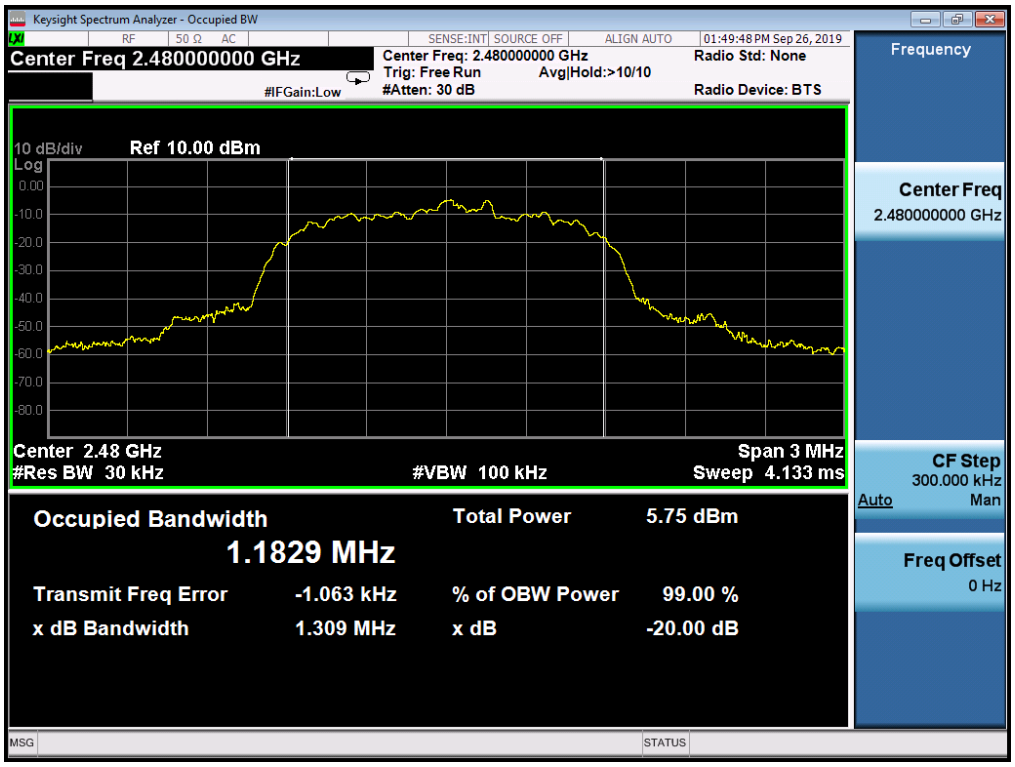
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



8. HOPPING CHANNEL NUMBER

8.1 Measurement Procedure

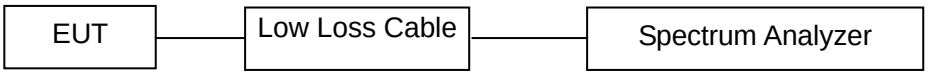
Minimum Number of Hopping Frequencies, FCC Rule 15.247(a)(1)(iii):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, and the spectrum analyzer set to MAX HOLD readings were taken for 3-5 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

8.2 Limit

Frequency hopping systems in the 2400-2483.5MHz band shall use at least 15 channels.

8.3 Test SET-UP (Block Diagram of Configuration)

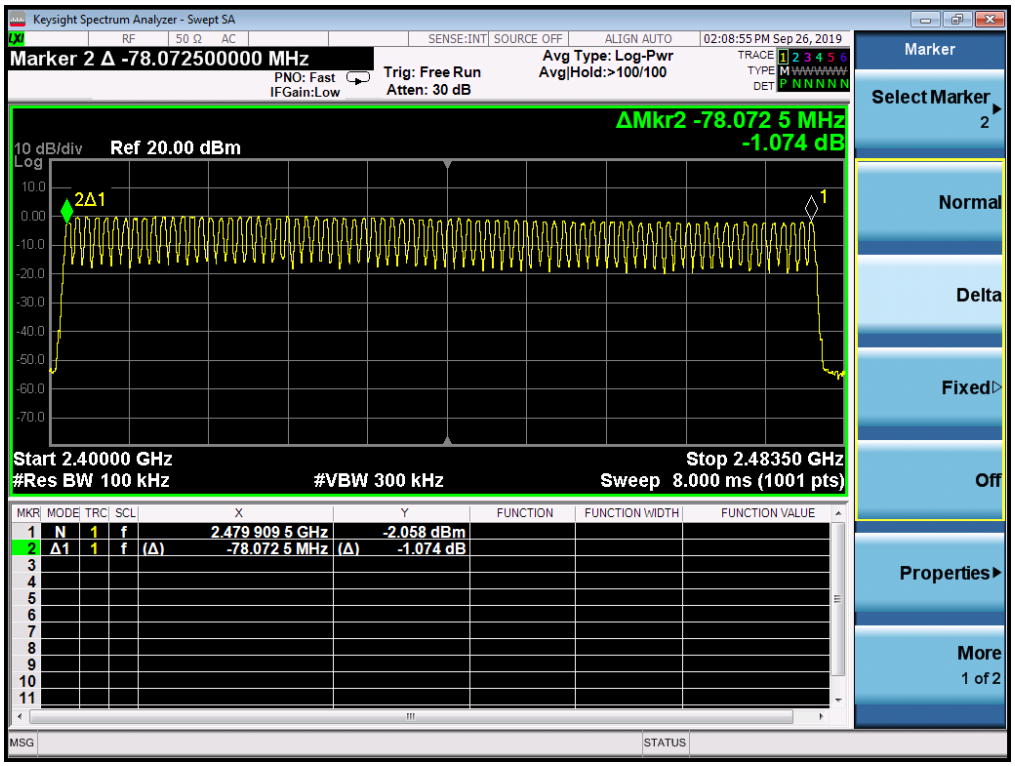


8.4 Measurement Results

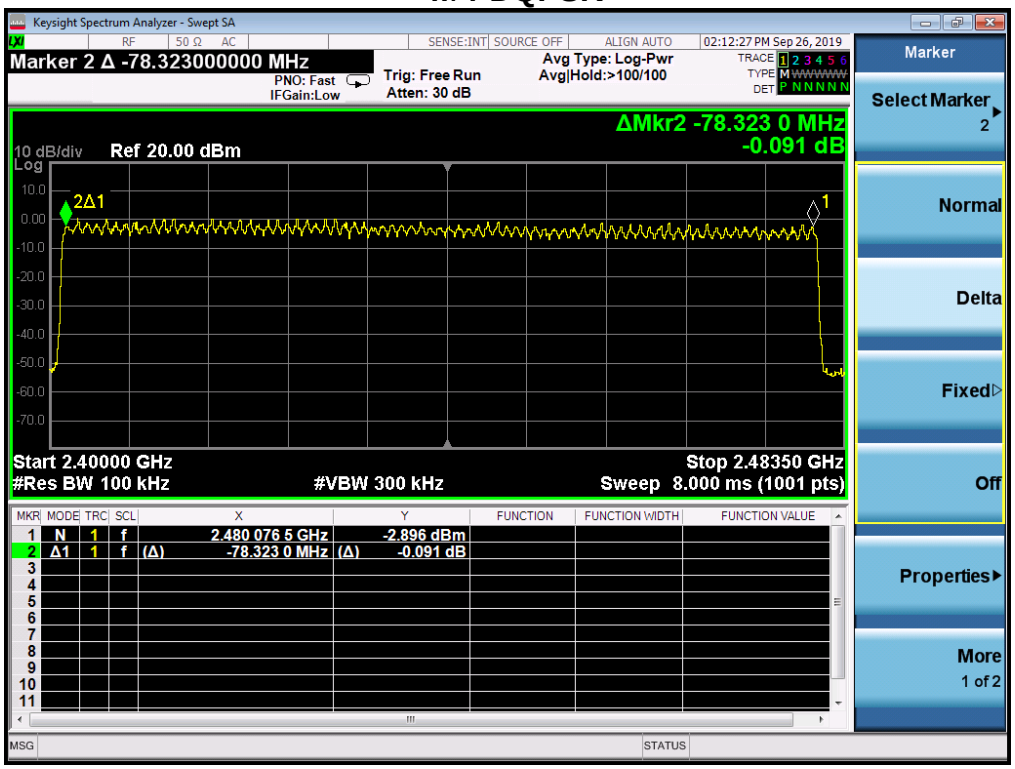
Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	100kHz	VBW:	300kHz
Packet:	DH1, 2DH1, 3DH1(Worst case)	Spectrum Detector:	PK
Test By:	Sance	Test Date:	Sep. 25, 2019
Temperature:	24 ℃	Humidity:	50 %
Test Result:	PASS		

Hopping Channel Frequency Range	Number of Hopping Channels	Limit
2400-2483.5	79	≥15

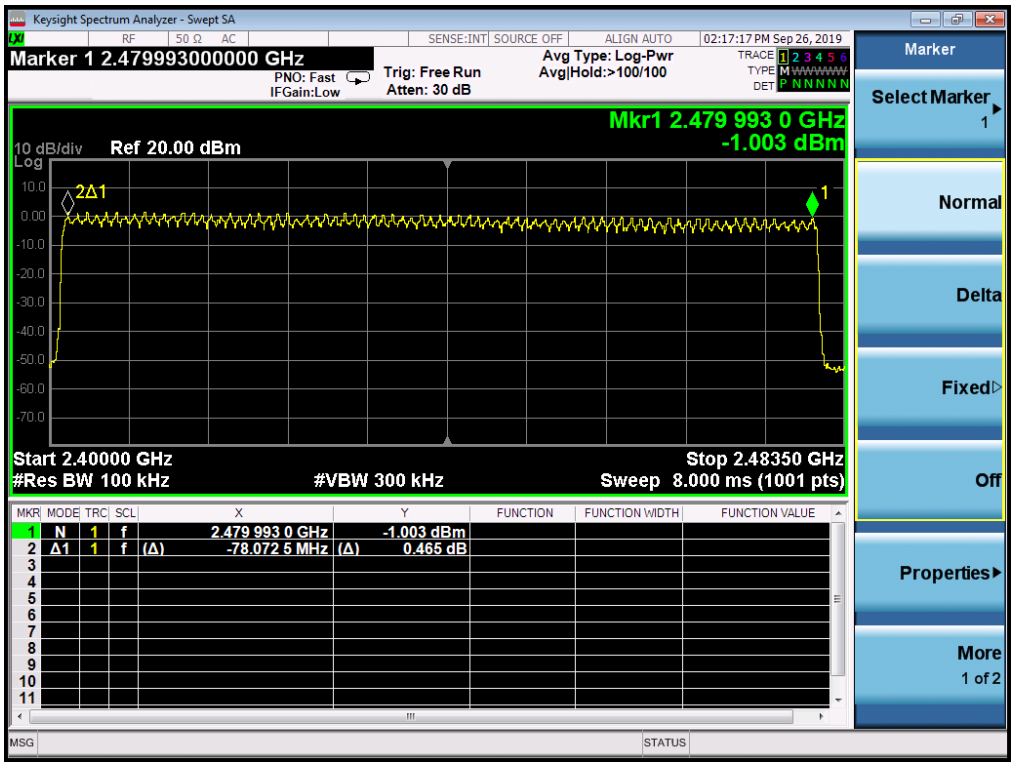
GFSK



π/4-DQPSK



8DPSK


Keysight Spectrum Analyzer - Swept SA
RF
50 Ω AC
SENSE:INT
SOURCE OFF
ALIGN AUTO
02:17:17 PM Sep 26, 2019
Marker 1 2.479993000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P N N N N N
Mkr1 2.479 993 0 GHz
-1.003 dBm
10 dB/div
Log
Ref 20.00 dBm
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
2Δ1
1
Start 2.40000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.48350 GHz
Sweep 8.000 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.479 993 0 GHz -1.003 dBm
2 Δ1 1 f (Δ) -78.072 5 MHz (Δ) 0.465 dB
3
4
5
6
7
8
9
10
11
MSG
STATUS
Marker
Select Marker 1
Normal
Delta
Fixed
Off
Properties
More 1 of 2

9. TIME OF OCCUPANCY (DWELL TIME)

9.1 Measurement Procedure

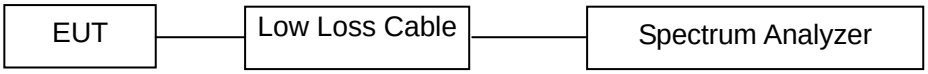
Average Channel Occupancy Time, FCC Ref:15.247(a)(1)(iii):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable.
The spectrum analyzer center frequency was set to one of the known hopping channels. The Sweep was set to 10 ms, the SPAN was set to Zero SPAN. The time duration of the transmissions so captured was measured with the Marker Delta function

9.2 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

9.3 Test SET-UP (Block Diagram of Configuration)



9.4 Measurement Results

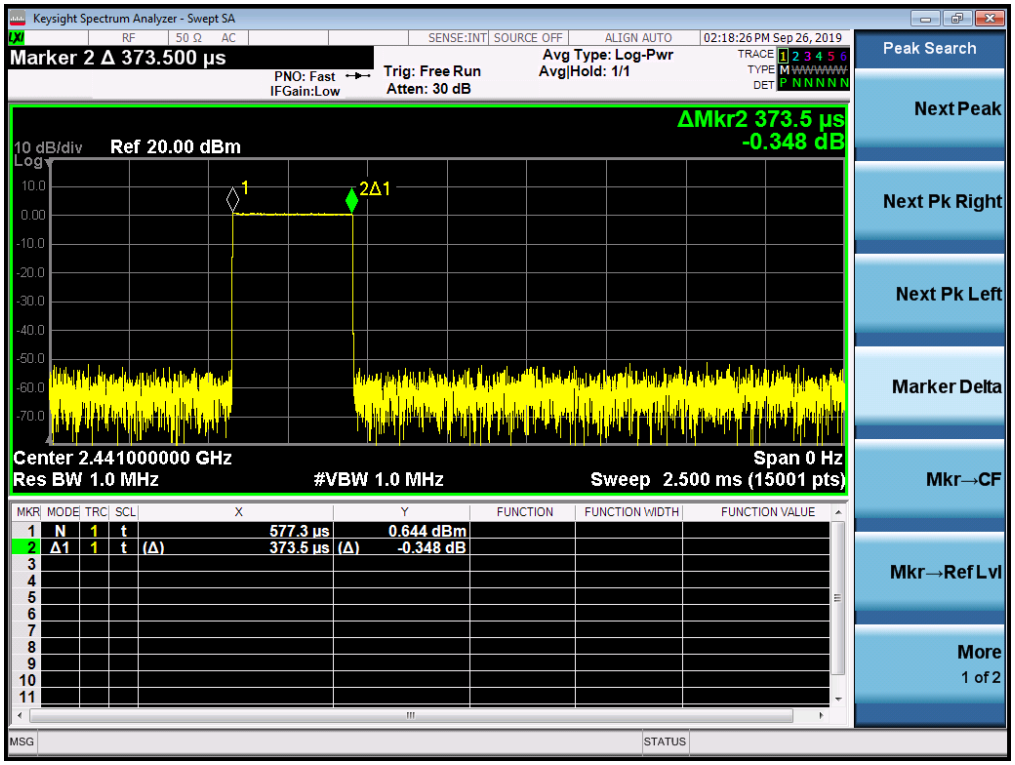
Refer to attached data chart.

The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

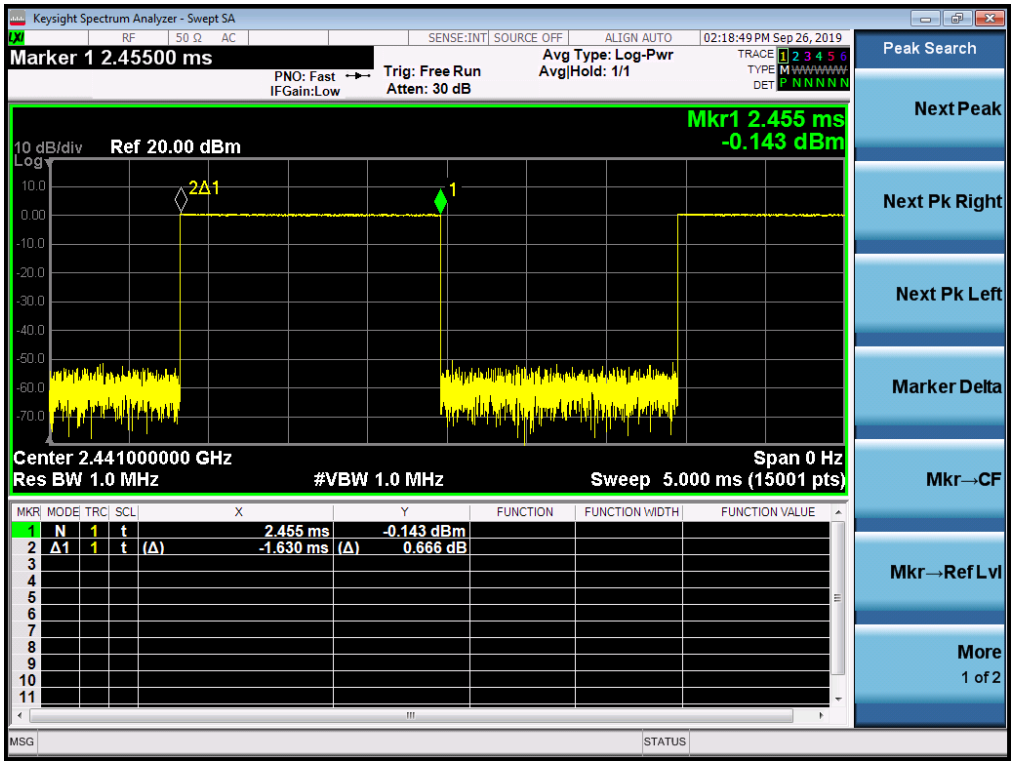
Modulation:	GFSK, π/4-DQPSK, 8DPSK		
RBW:	1MHz	VBW:	1MHz
Spectrum Detector:	PK	Test By:	Sance
Temperature:	24 ℃	Humidity:	50 %
Test Result:	PASS	Test Date:	Sep. 25, 2019

Packet	Frequency (MHz)	Result (msec)			Limit (msec)
GFSK					
DH1	2441	0.374	(ms)*(1600/(2*79))*31.6=	119.68	400
DH3	2441	1.630	(ms)*(1600/(4*79))*31.6=	260.80	400
DH5	2441	2.876	(ms)*(1600/(6*79))*31.6=	306.77	400
π/4-DQPSK					
2-DH1	2441	0.388	(ms)*(1600/(2*79))*31.6=	124.16	400
2-DH3	2441	1.634	(ms)*(1600/(4*79))*31.6=	261.44	400
2-DH5	2441	2.890	(ms)*(1600/(6*79))*31.6=	308.27	400
8DPSK					
3-DH1	2441	0.390	(ms)*(1600/(2*79))*31.6=	124.80	400
3-DH3	2441	1.640	(ms)*(1600/(4*79))*31.6=	262.40	400
3-DH5	2441	2.890	(ms)*(1600/(6*79))*31.6=	308.27	400

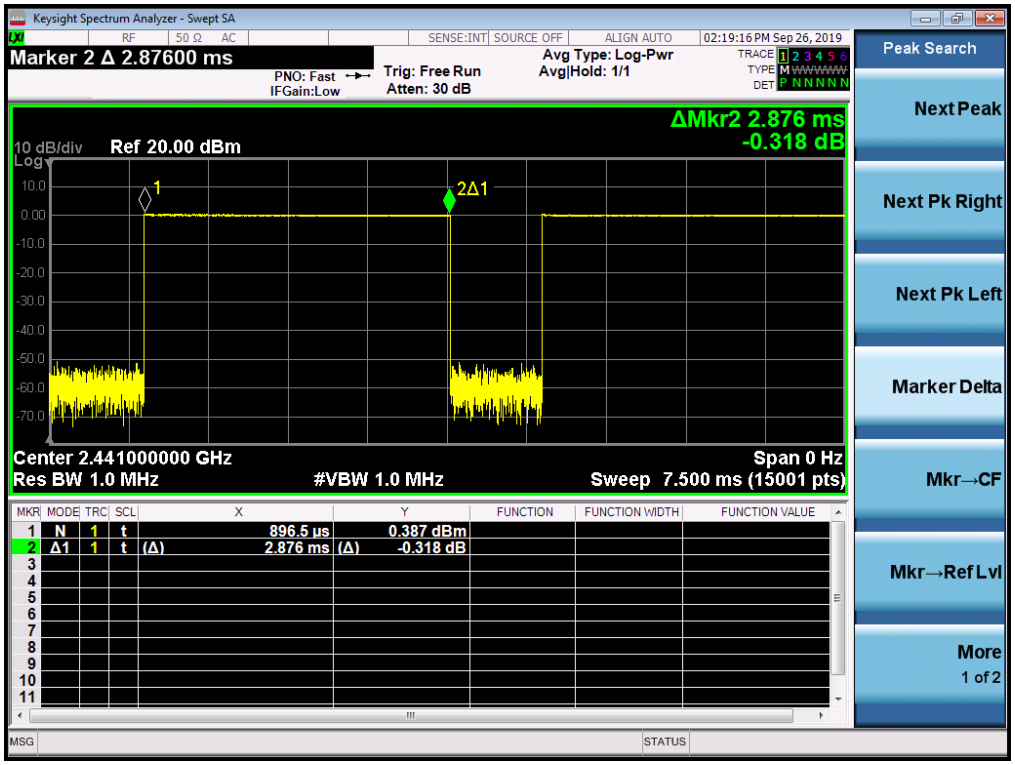
GFSK DH1



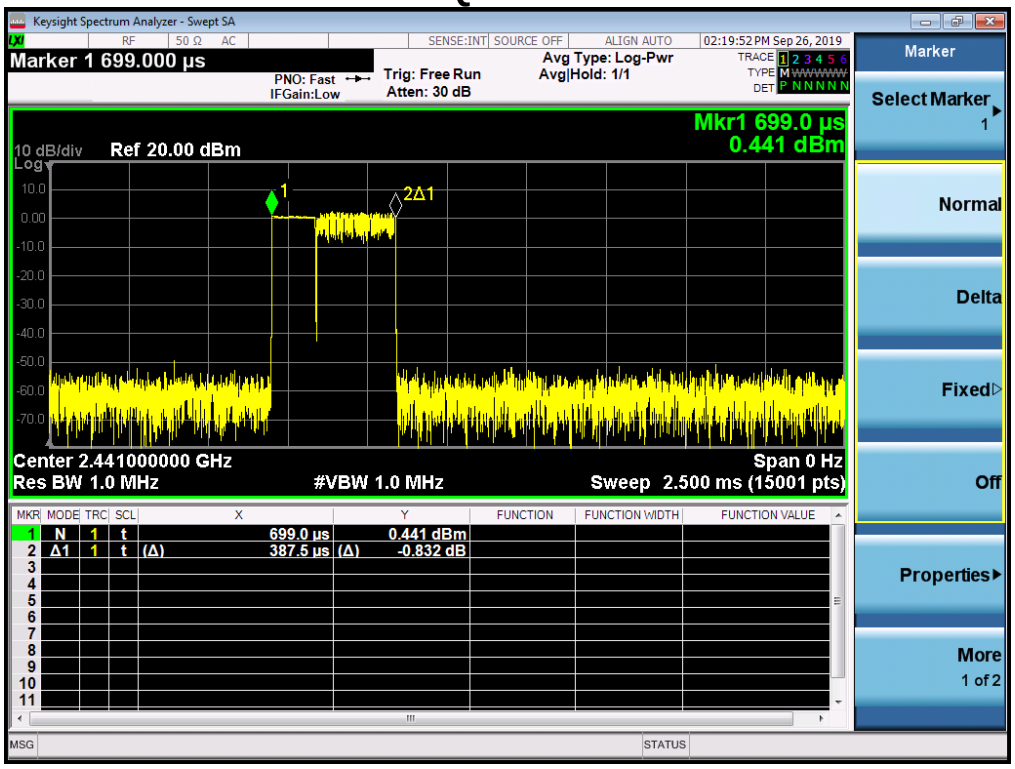
GFSK DH3



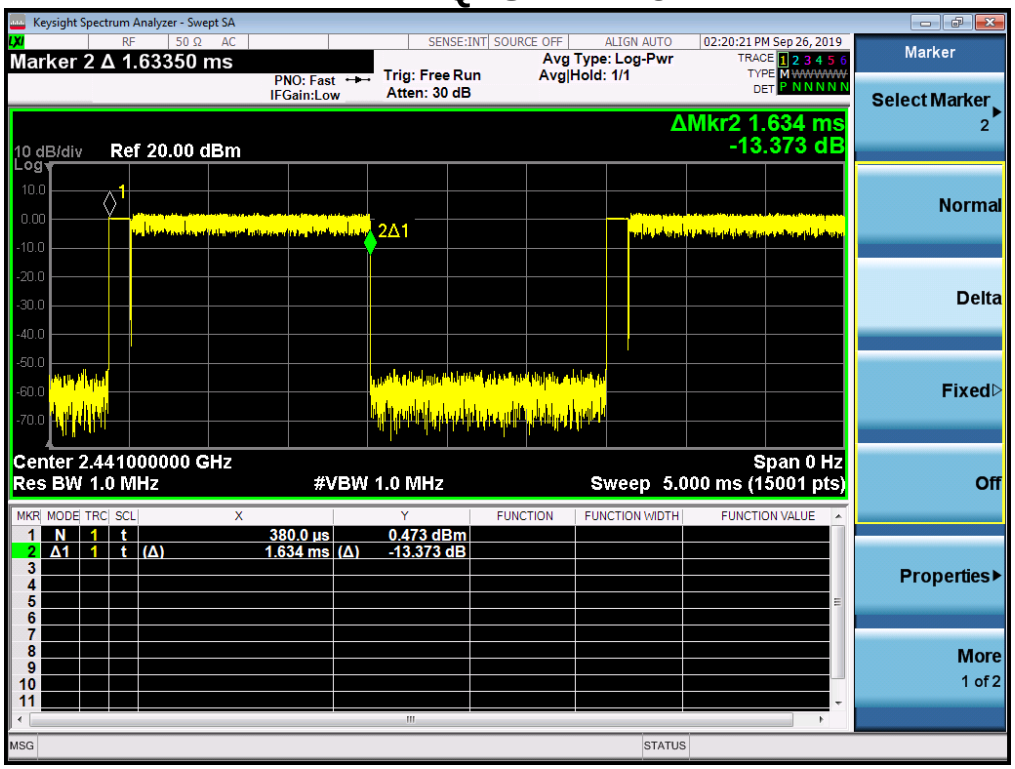
GFSK DH5



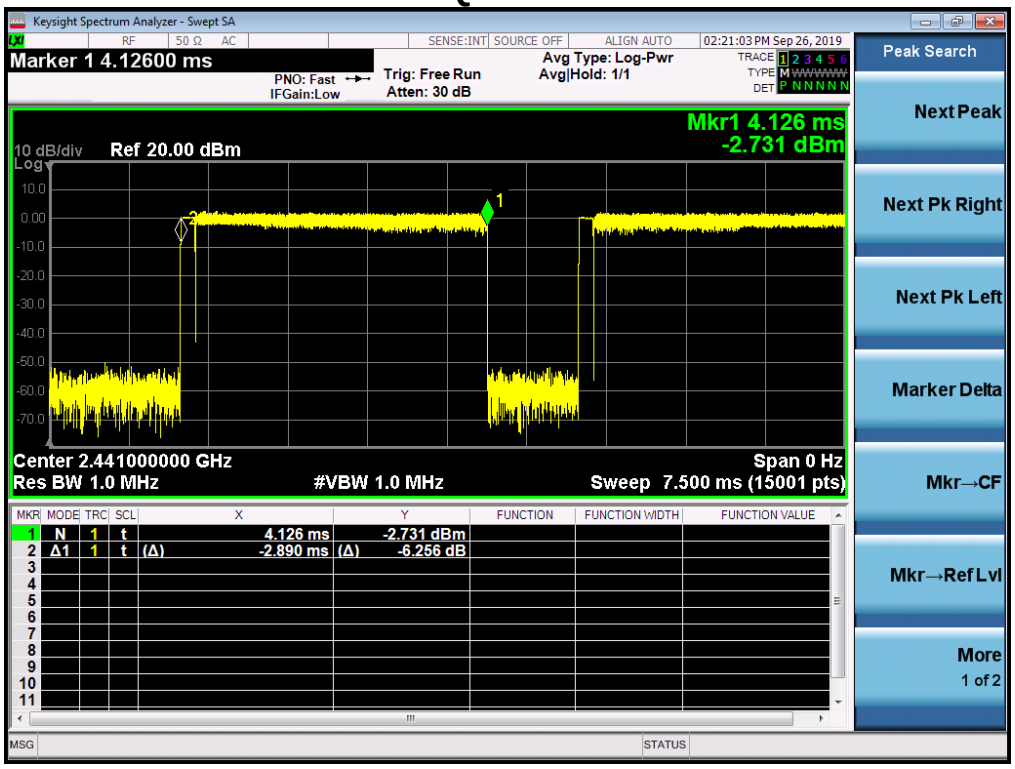
π/4-DQPSK 2-DH1



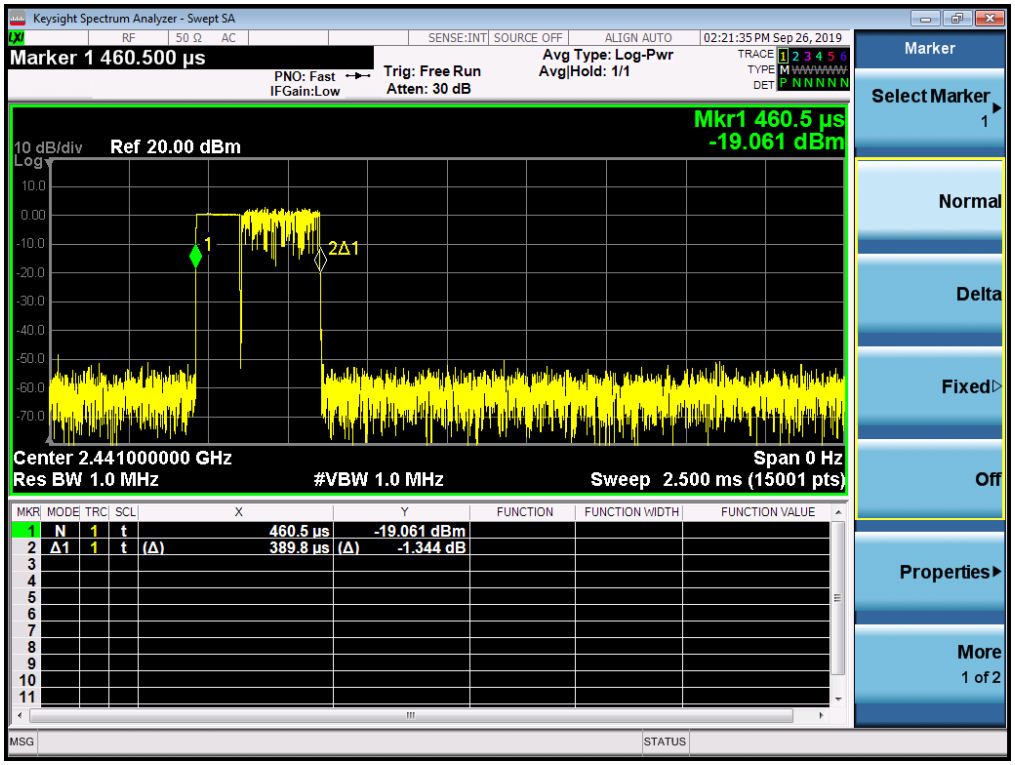
π/4-DQPSK 2-DH3



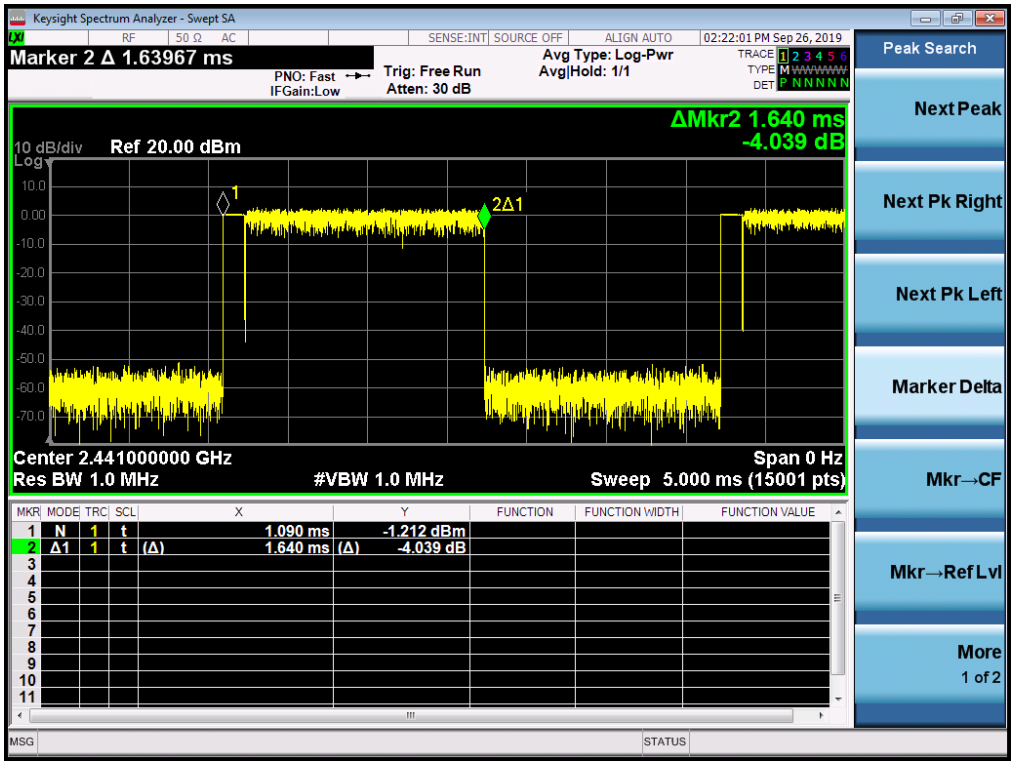
π/4-DQPSK 2-DH5



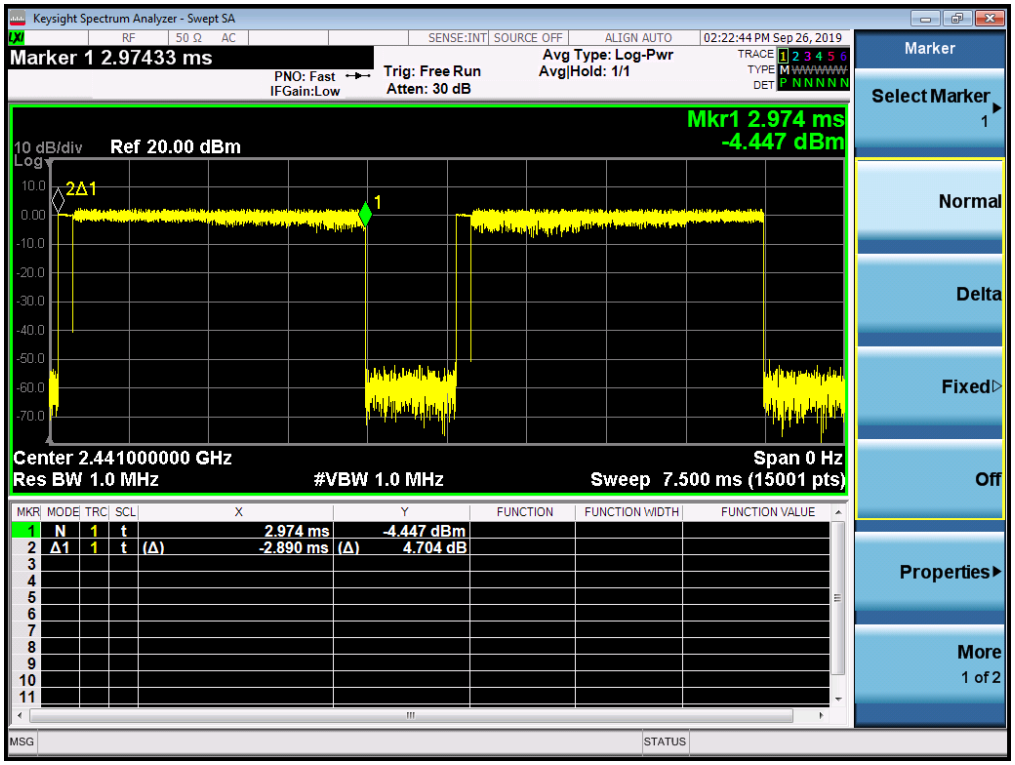
8DPSK 3-DH1



8DPSK 3-DH3



8DPSK 3-DH5


Keysight Spectrum Analyzer - Swept SA
RF 50 Ω AC
SENSE:INT SOURCE OFF ALIGN AUTO 02:22:44 PM Sep 26, 2019
Marker 1 2.97433 ms
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 1/1
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P N N N N N
Mkr1 2.974 ms
-4.447 dBm
10 dB/div
Log
Ref 20.00 dBm
2Δ1
1
Center 2.441000000 GHz
Res BW 1.0 MHz
#VBW 1.0 MHz
Span 0 Hz
Sweep 7.500 ms (15001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 t 2.974 ms -4.447 dBm
2 Δ1 1 t (Δ) -2.890 ms (Δ) 4.704 dB
Marker
Select Marker 1
Normal
Delta
Fixed
Off
Properties
More 1 of 2
MSG
STATUS

10. MAXIMUM PEAK OUTPUT POWER

10.1 Measurement Procedure

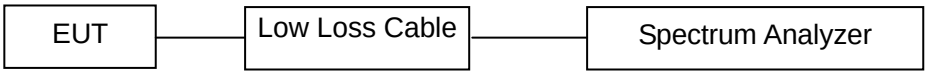
Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm. Cable loss was considered during this measurement.

10.2 Limit

For all other frequency hopping systems in the 2400-2483.5MHz band: 0.125 watts.

10.3 Test SET-UP (Block Diagram of Configuration)

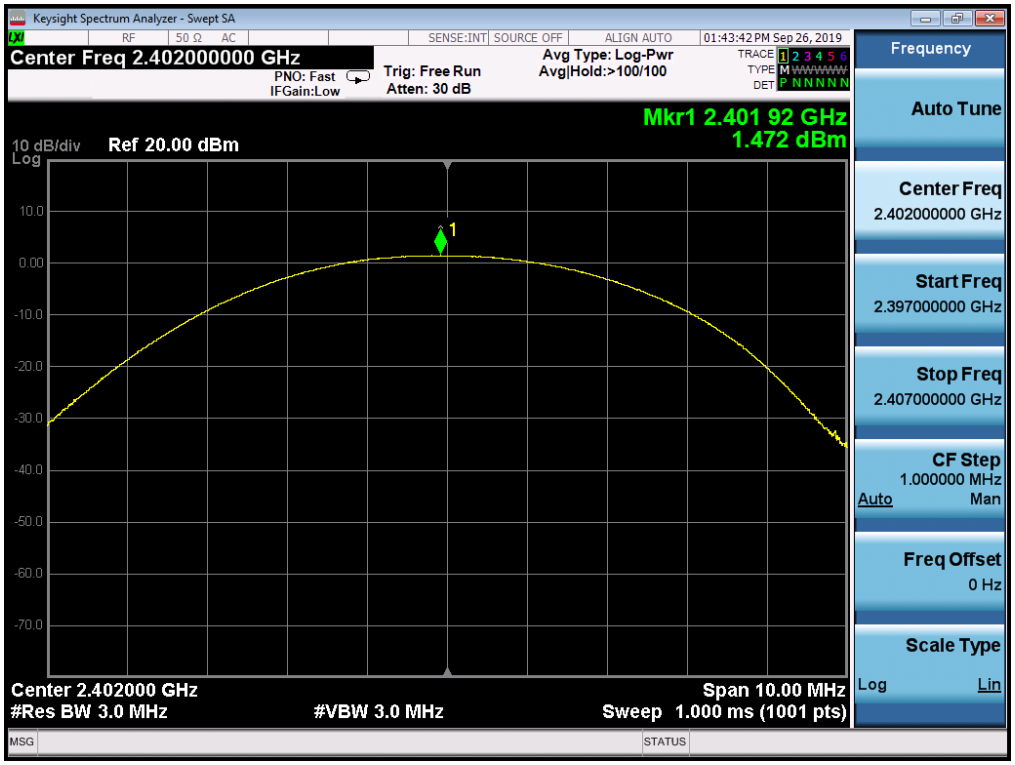


10.4 Measurement Results

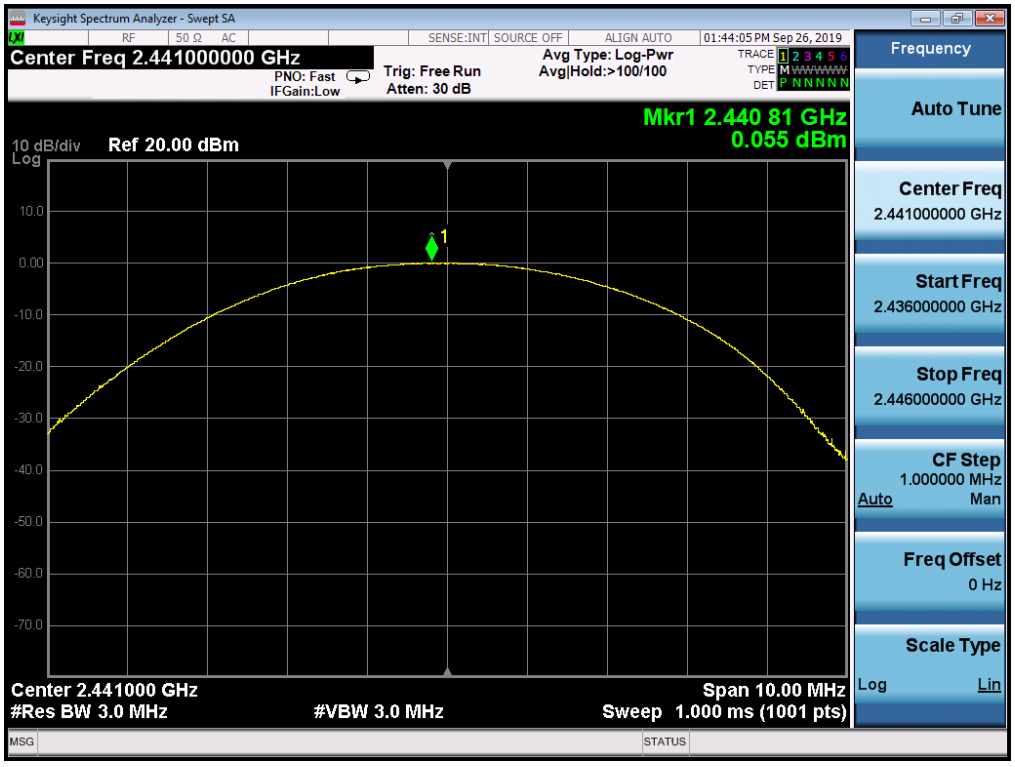
RBW:	3MHz	VBW:	3MHz
Packet:	DH1, 2DH1, 3DH1(Worst case)	Spectrum Detector:	PK
Test By:	Sance	Test Date:	Sep. 25, 2019
Temperature:	24 ℃	Humidity:	50 %

Channel Frequency (MHz)	Peak Power output (dBm)	Peak Power output (mW)	Peak Power Limit (dBm/W)	Results
GFSK				
2402.00	1.472	1.403	21 / 0.125	PASS
2441.00	0.055	1.013	21 / 0.125	PASS
2480.00	-0.922	0.809	21 / 0.125	PASS
π/4-DQPSK				
2402.00	3.247	2.112	21 / 0.125	PASS
2441.00	2.373	1.727	21 / 0.125	PASS
2480.00	1.389	1.377	21 / 0.125	PASS
8DPSK				
2402.00	3.585	2.283	21 / 0.125	PASS
2441.00	2.764	1.890	21 / 0.125	PASS
2480.00	1.834	1.525	21 / 0.125	PASS

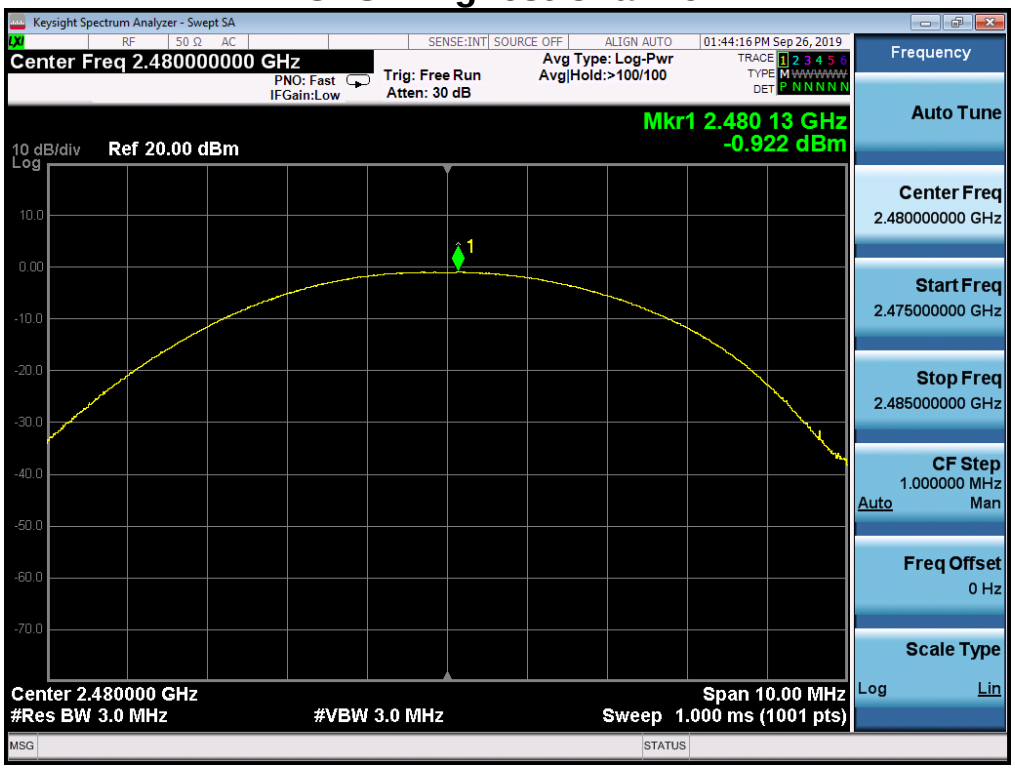
GFSK Lowest Channel



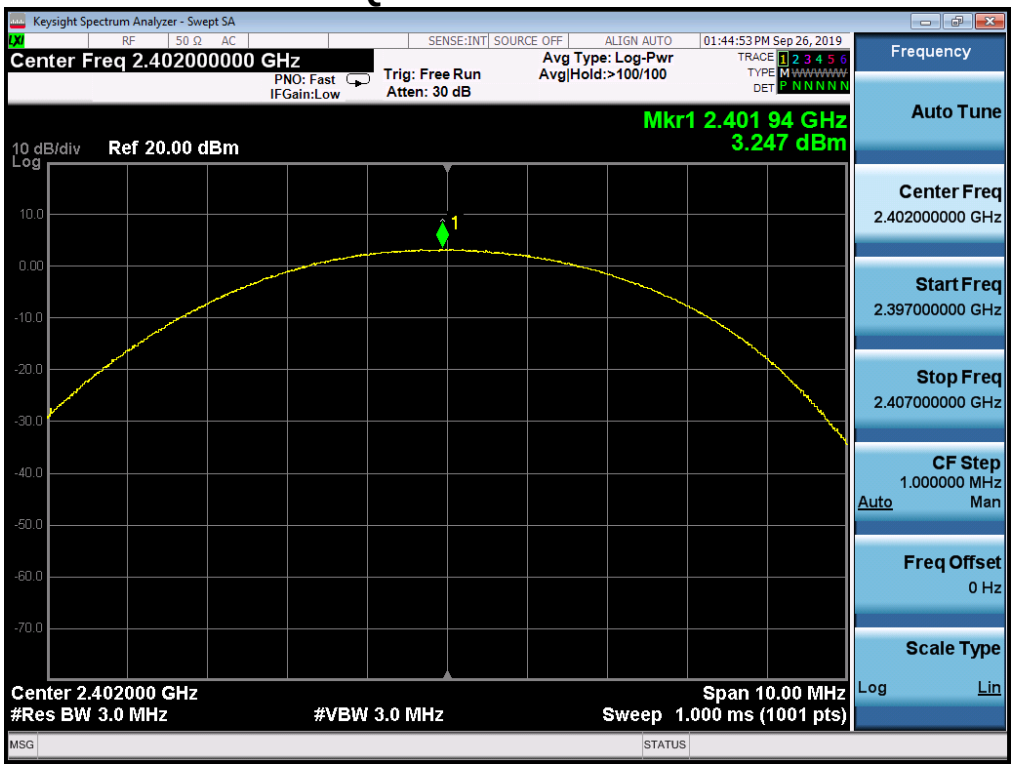
GFSK Middle Channel



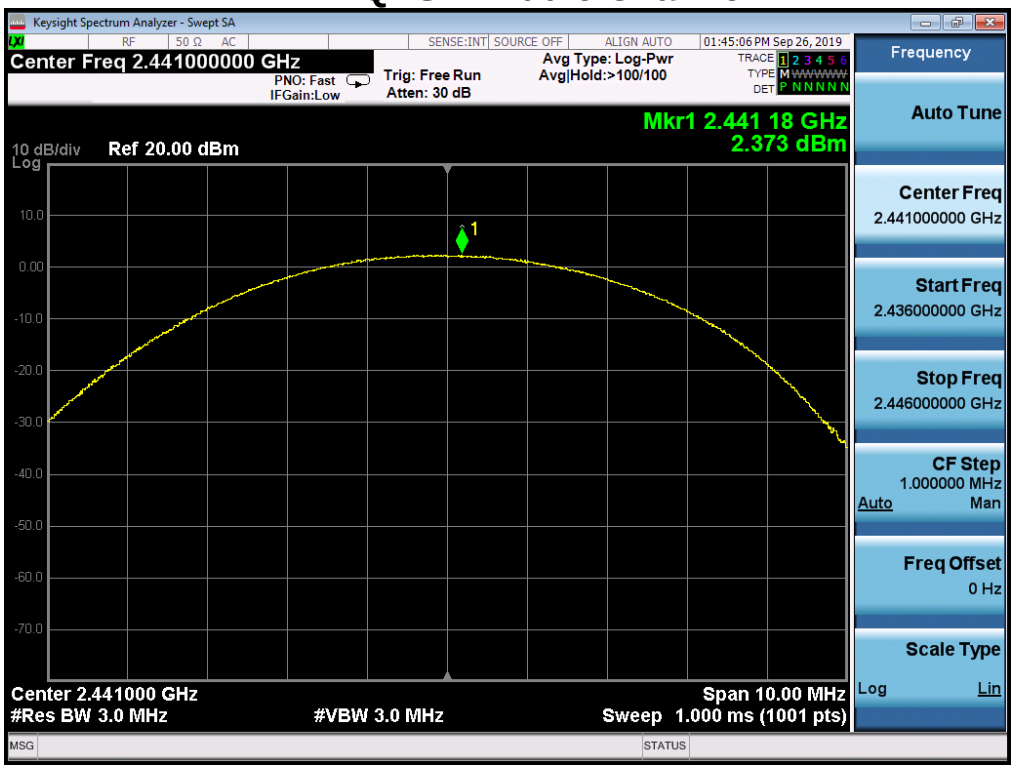
GFSK Highest Channel



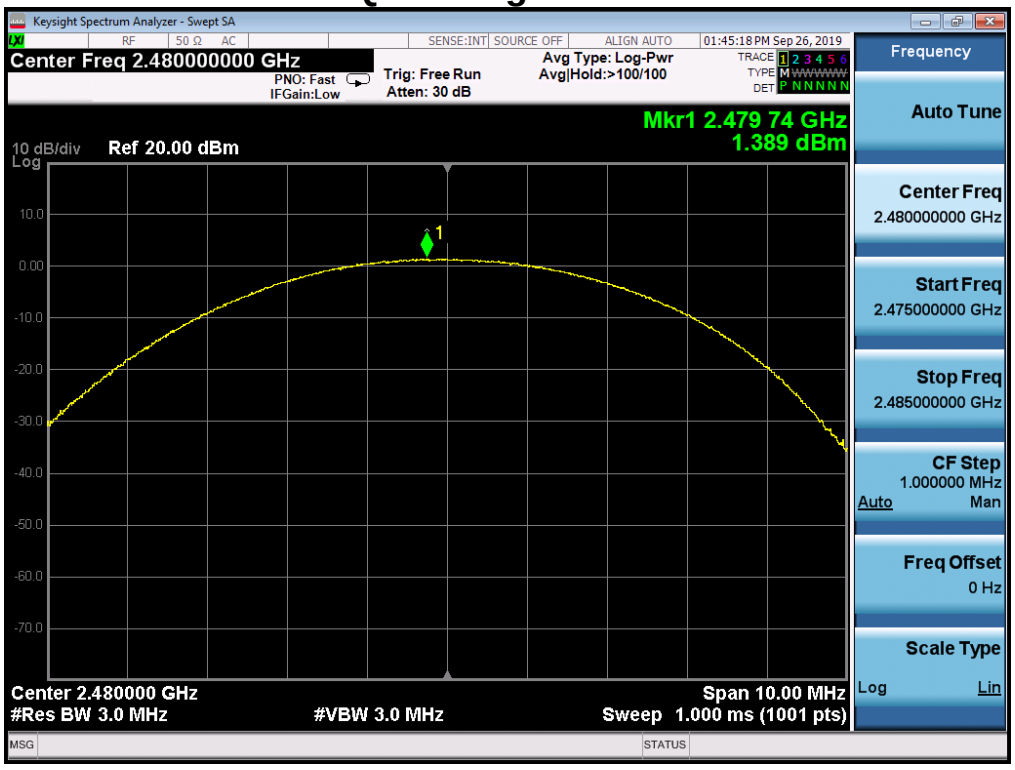
π/4-DQPSK Lowest Channel



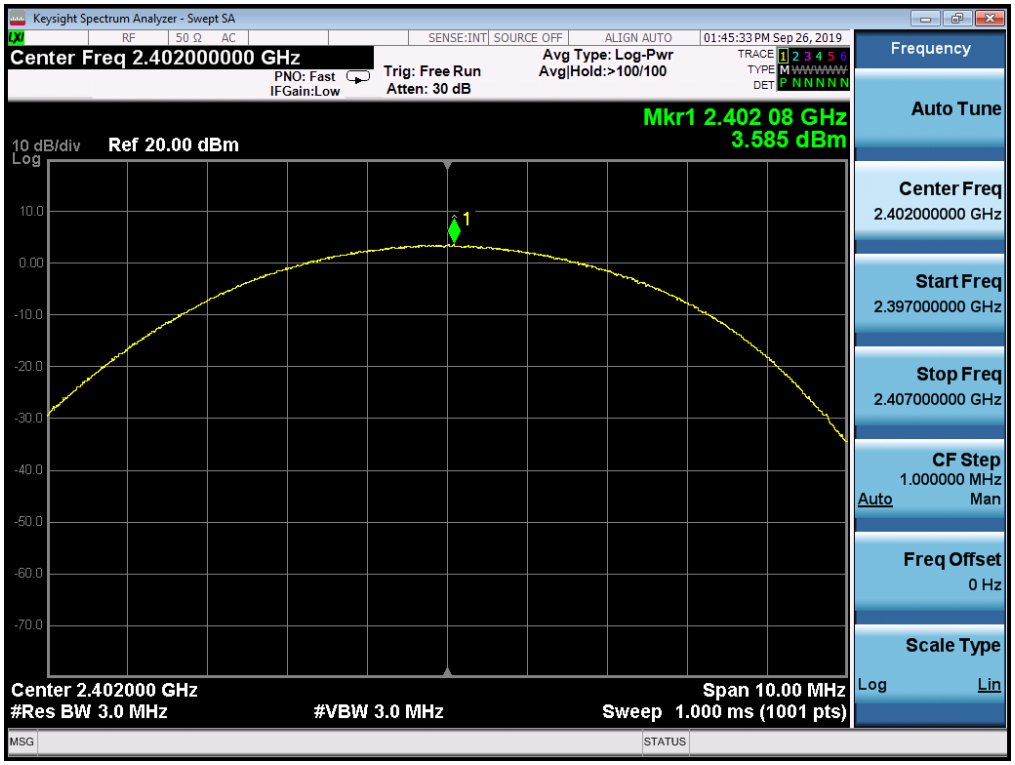
π/4-DQPSK Middle Channel



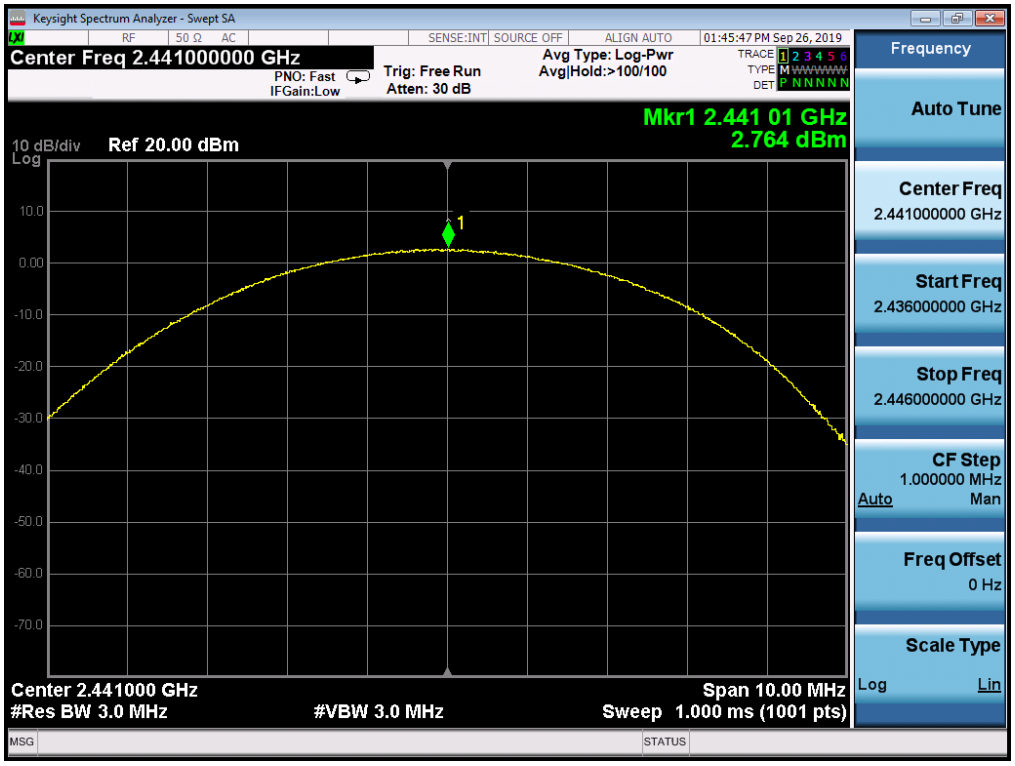
π/4-DQPSK Highest Channel



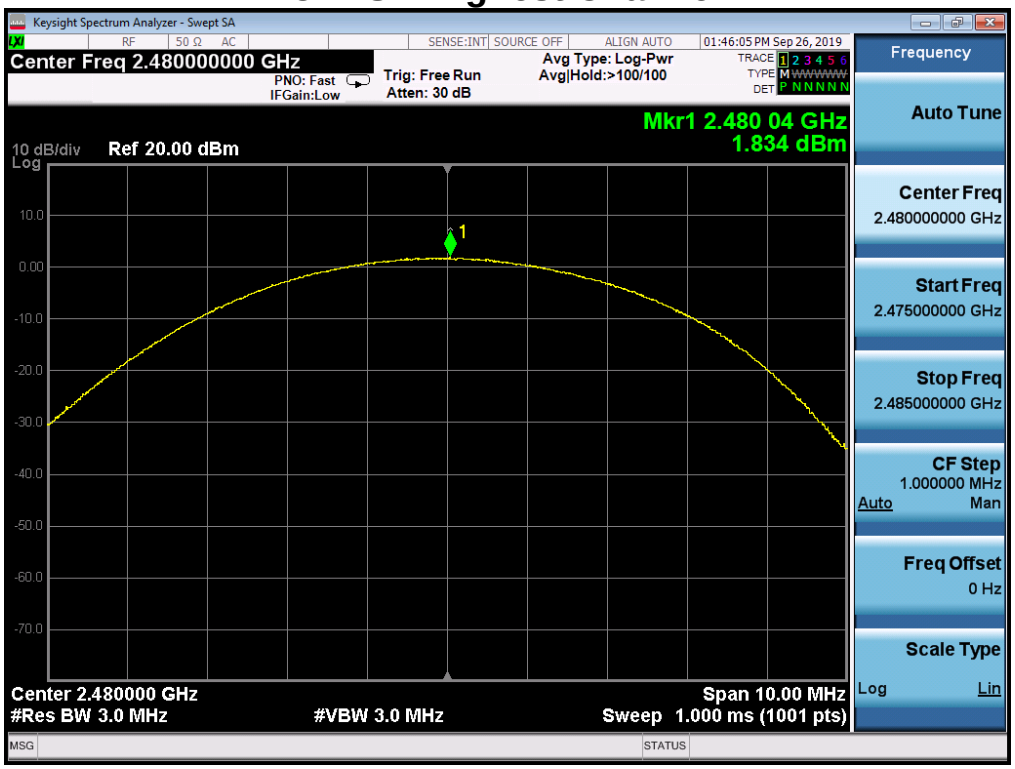
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



11. BAND EDGE

11.1 Measurement Procedure

Out of Band Conducted Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. The resolution bandwidth is set to100KHz, and the video bandwidth set to 300kHz.

11.2 Limit

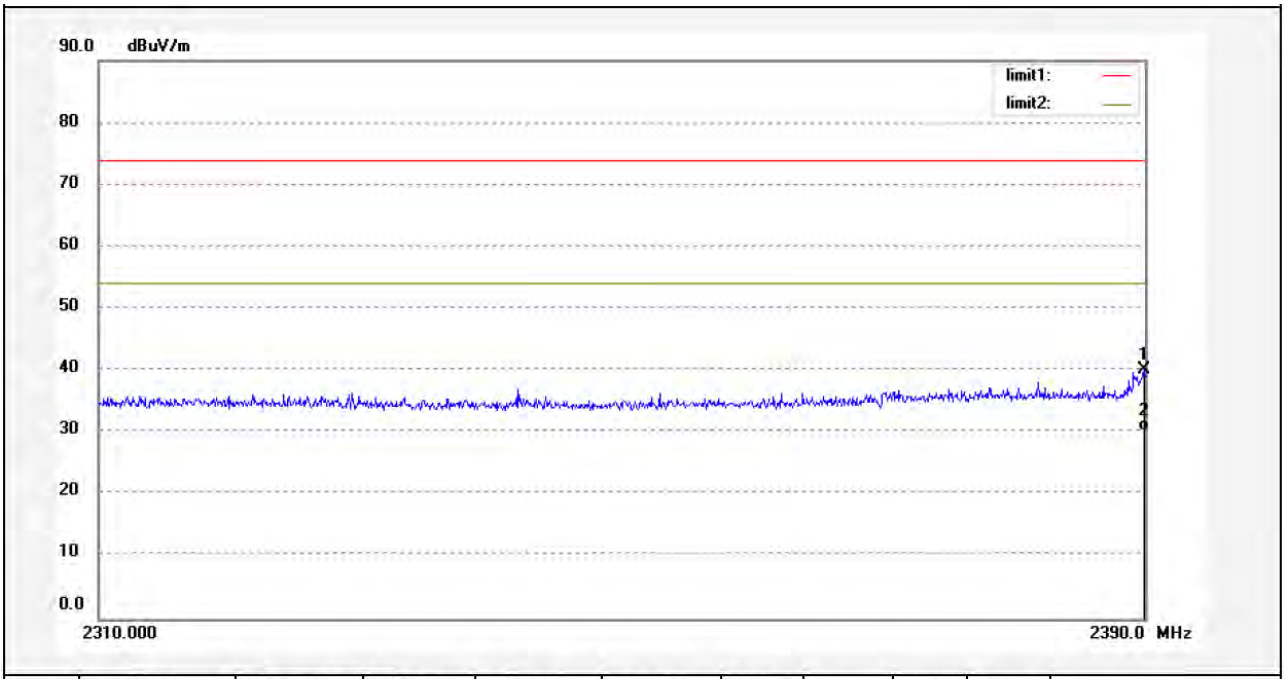
15.247(d)In any 100KHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

11.3 Measurement Results

Please see below test table and plots.

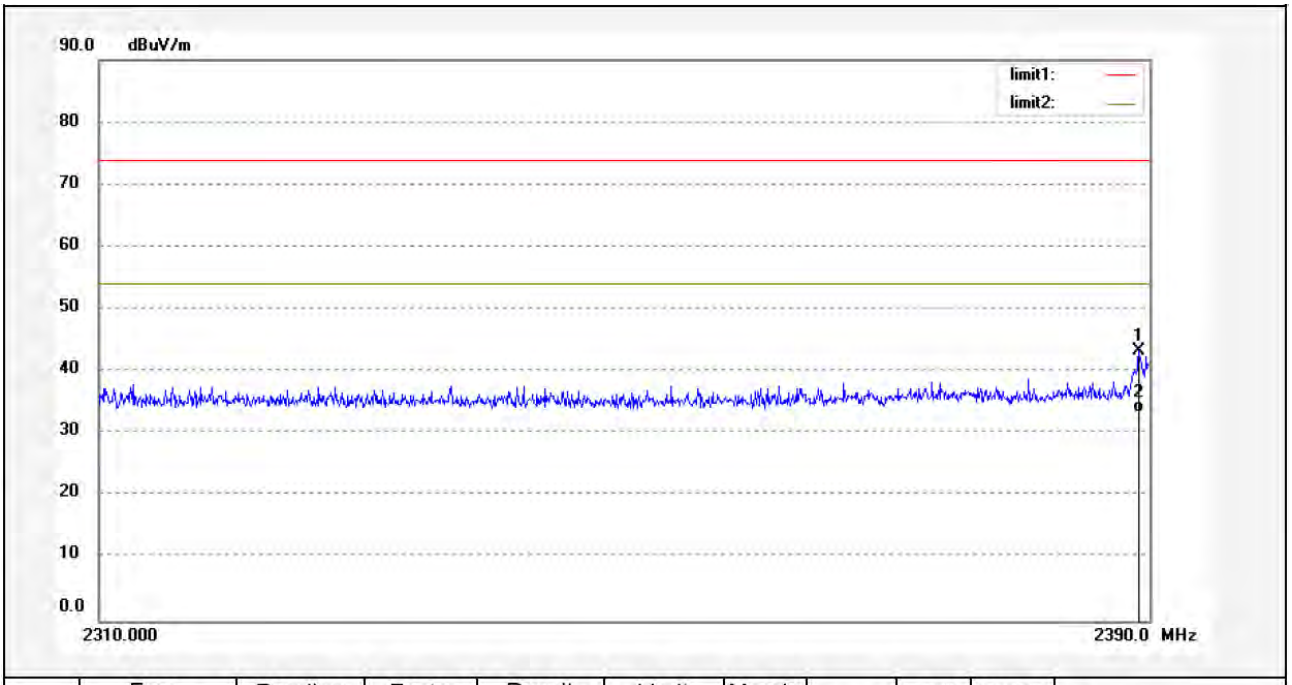
For Radiated restricted band: (The worst case: 8DPSK)

Temperature:	25 ℃	Humidity:	64 %
Test By:	Sance	Test Date:	September 25, 2019
Measured Distance:	3m	Test Result:	PASS
Test Mode:	TX 2402MHz (8DPSK)	Ant. Polarization:	Horizontal



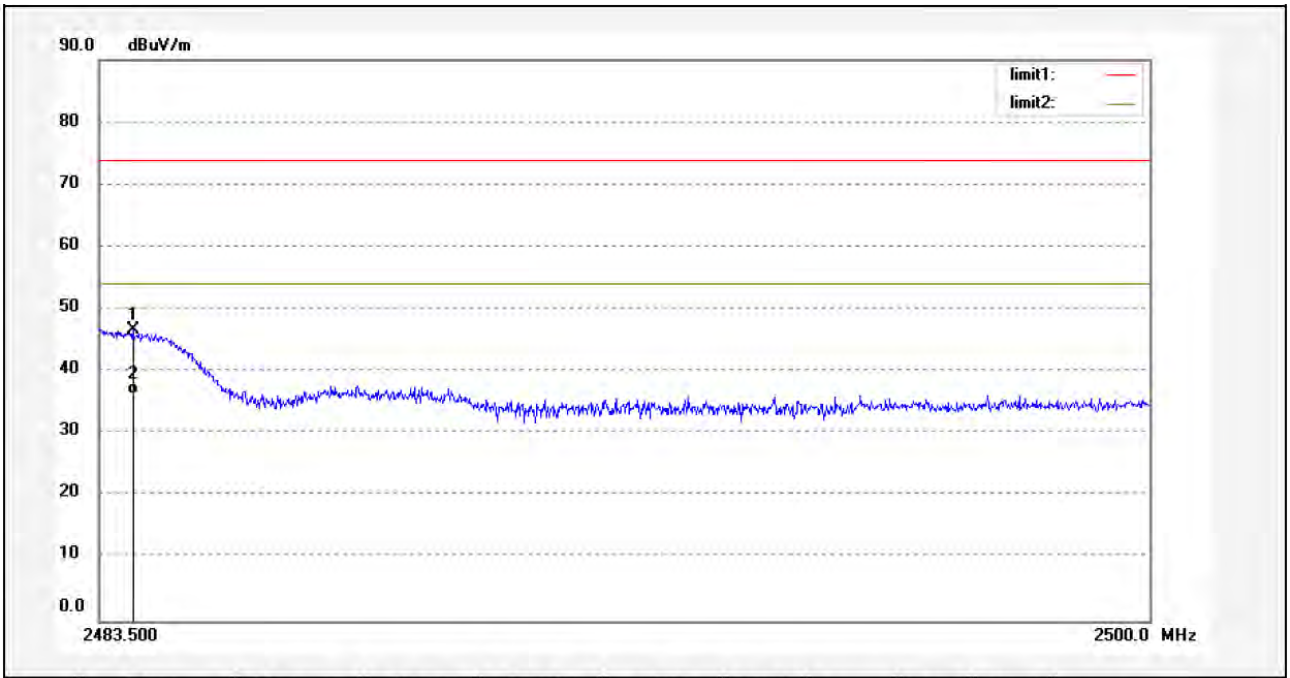
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2389.920	39.27	0.79	40.06	74.00	-33.94	peak	200	88	
2	2389.920	29.47	0.79	30.26	54.00	-23.74	AVG	200	124	

Temperature:	25 ℃	Humidity:	64 %
Test By:	Sance	Test Date:	September 25, 2019
Measured Distance:	3m	Test Result:	PASS
Test Mode:	TX 2402MHz (8DPSK)	Ant. Polarization:	Vertical



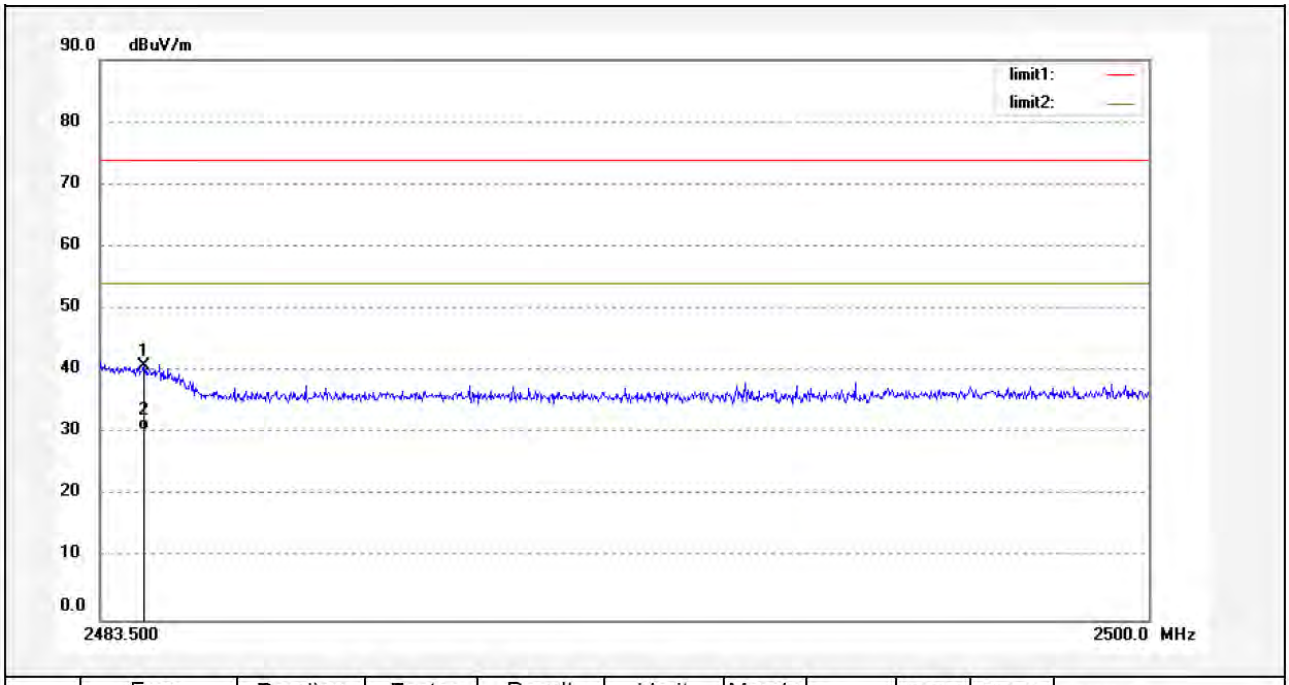
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2389.200	42.46	0.79	43.25	74.00	-30.75	peak	100	274	
2	2389.200	32.62	0.79	33.41	54.00	-20.59	AVG	100	307	

Temperature:	25 ℃	Humidity:	64 %
Test By:	Sance	Test Date:	September 25, 2019
Measured Distance:	3m	Test Result:	PASS
Test Mode:	TX 2480MHz (8DPSK)	Ant. Polarization:	Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2484.028	45.57	1.09	46.66	74.00	-27.34	peak	200	168	
2	2484.028	35.16	1.09	36.25	54.00	-17.75	AVG	200	171	

Temperature:	25 ℃	Humidity:	64 %
Test By:	Sance	Test Date:	September 25, 2019
Measured Distance:	3m	Test Result:	PASS
Test Mode:	TX 2480MHz (8DPSK)	Ant. Polarization:	Vertical

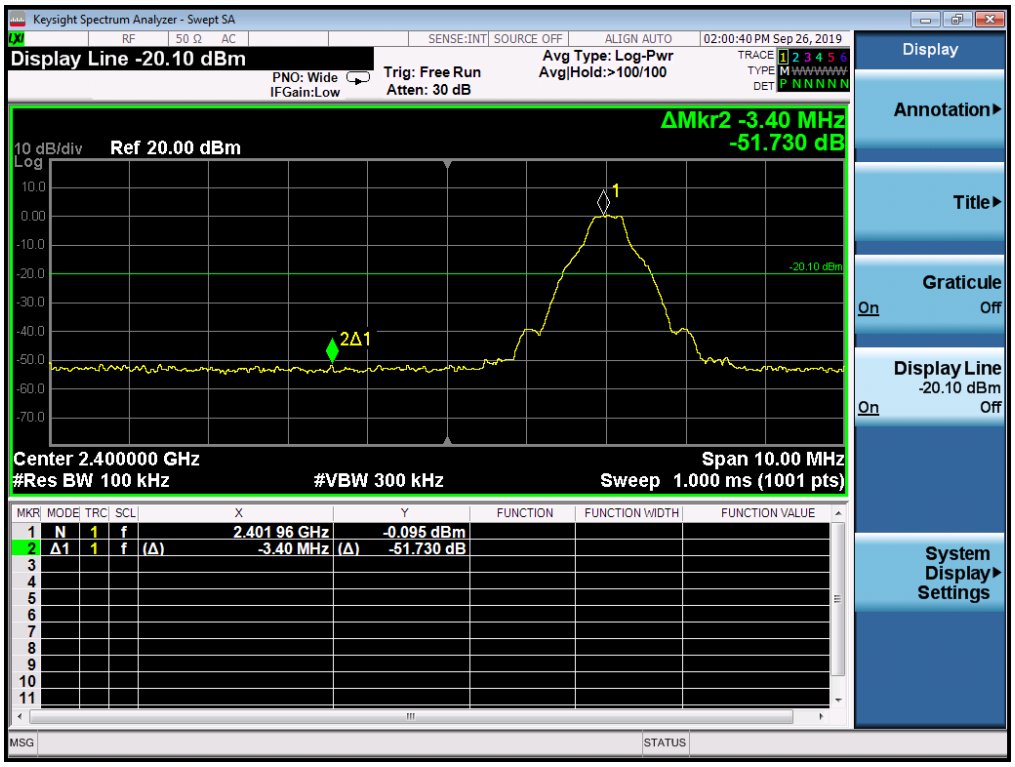


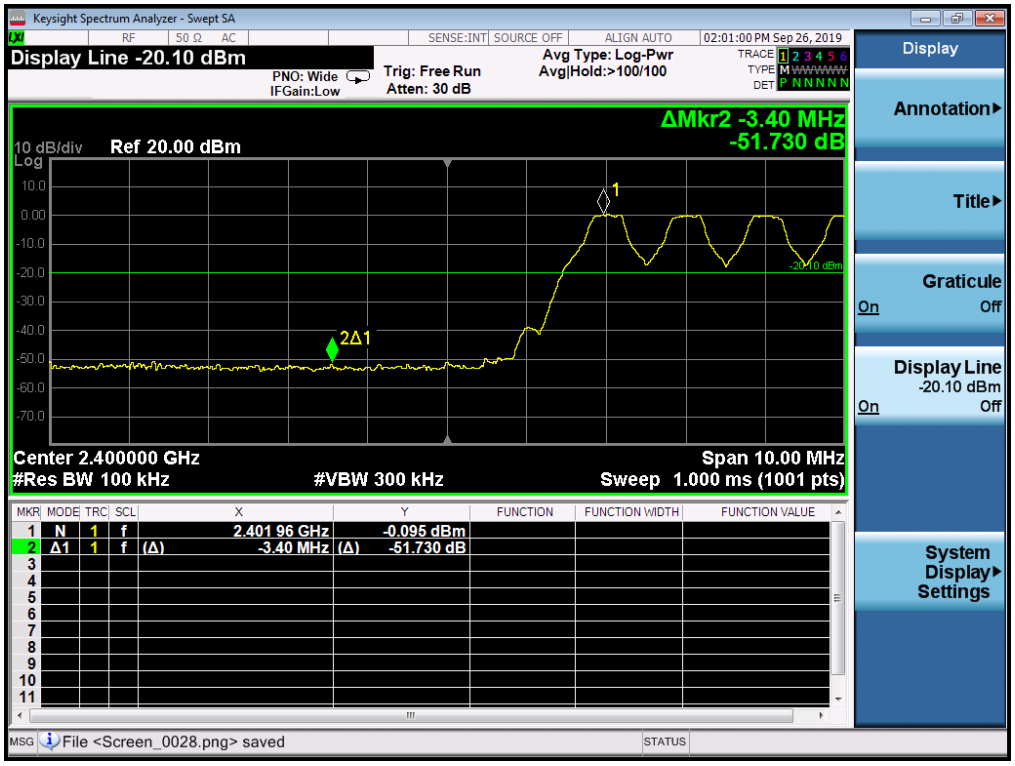
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2484.193	39.64	1.09	40.73	74.00	-33.27	peak	100	109	
2	2484.193	29.32	1.09	30.41	54.00	-23.59	AVG	100	77	

Note: (1) Result= Reading + Factor
(2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
(3) Horn antenna used for the emission over 1000MHz.

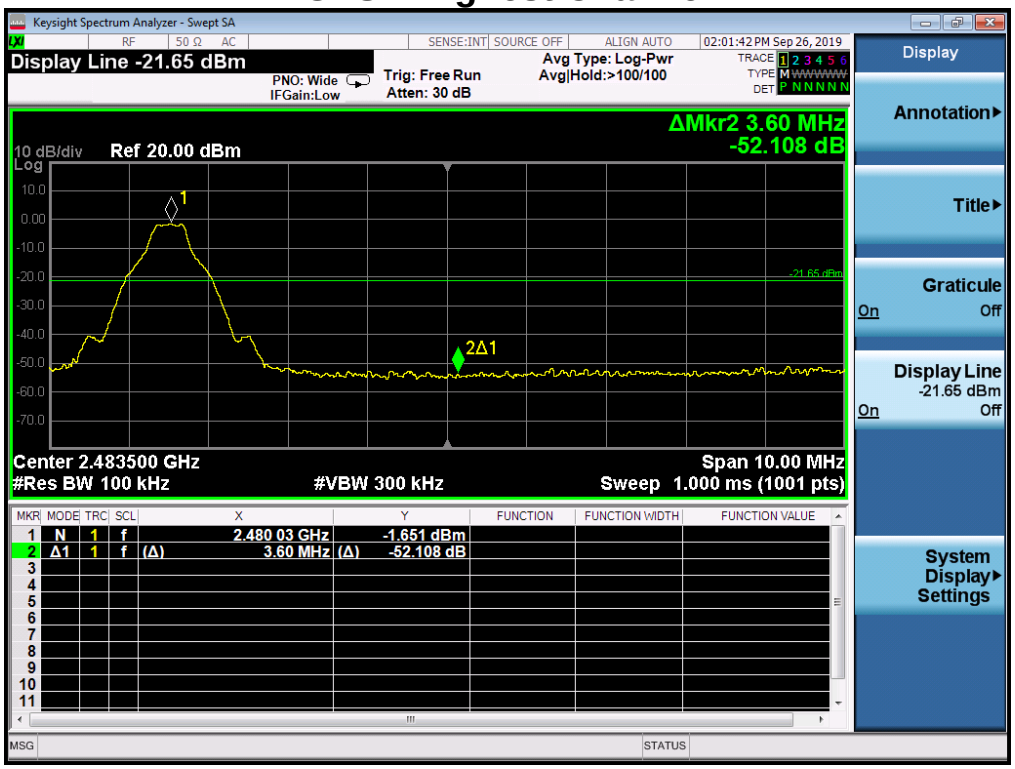
For RF Conducted restricted band:

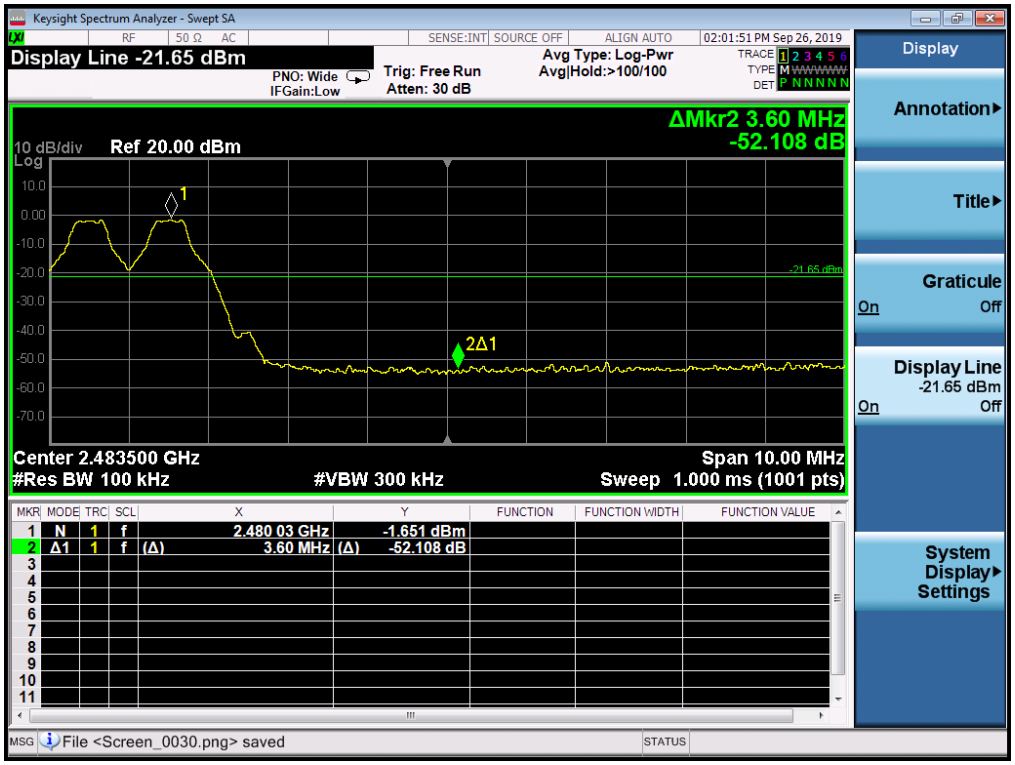
GFSK Lowest Channel



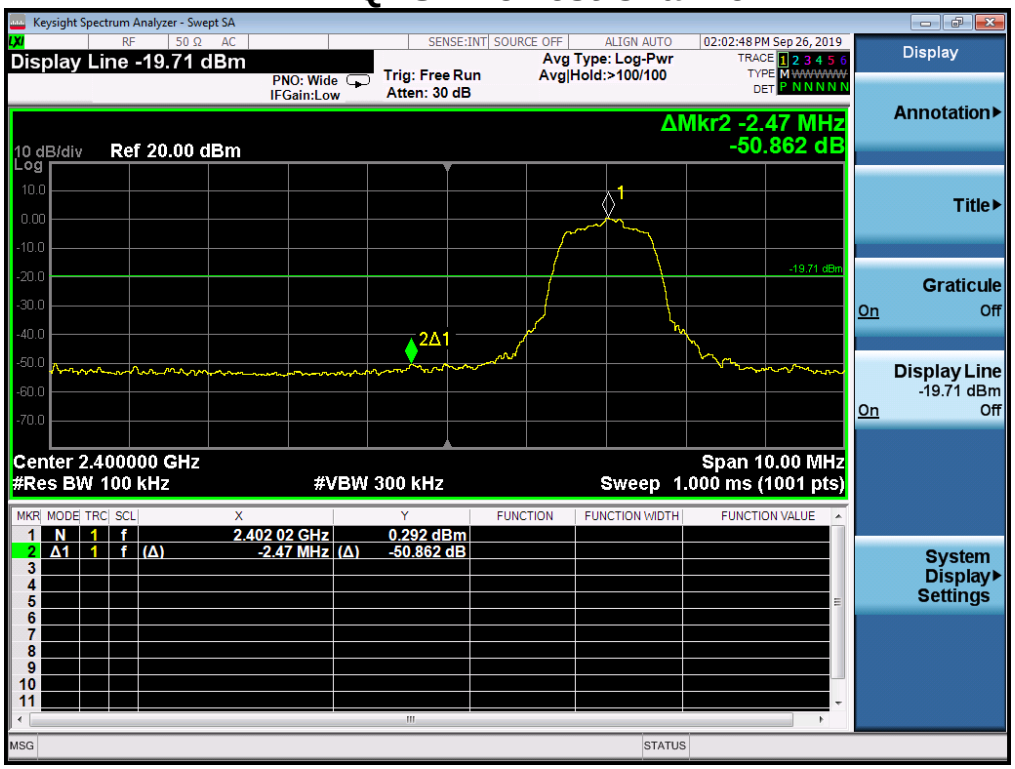


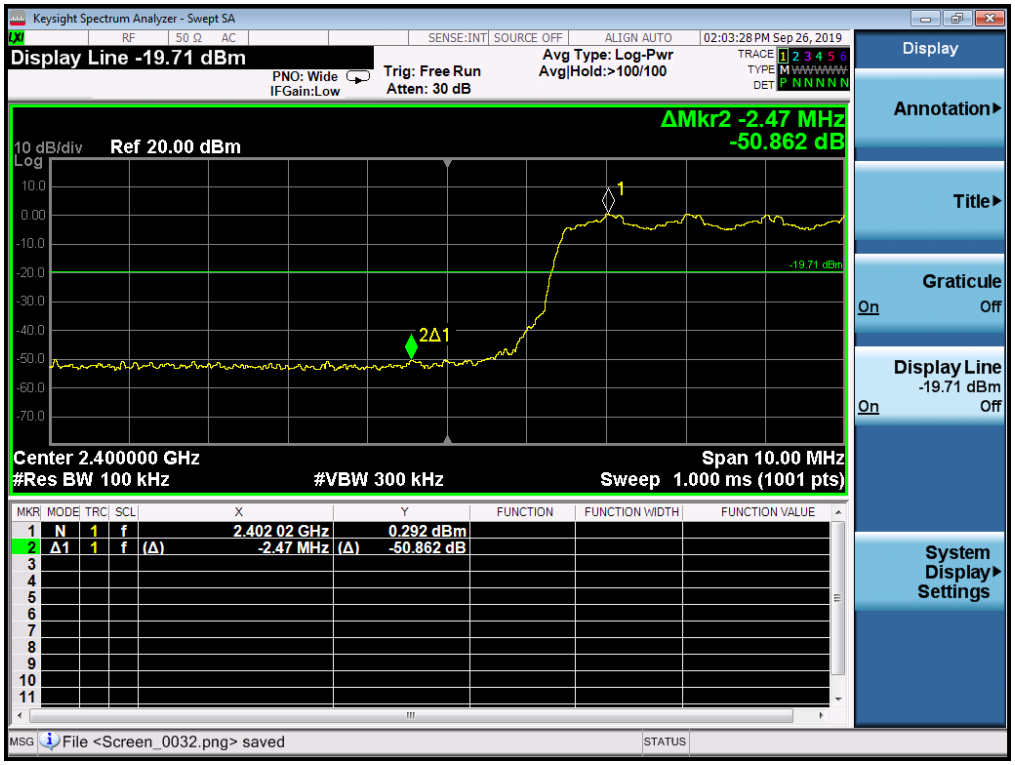
GFSK Highest Channel



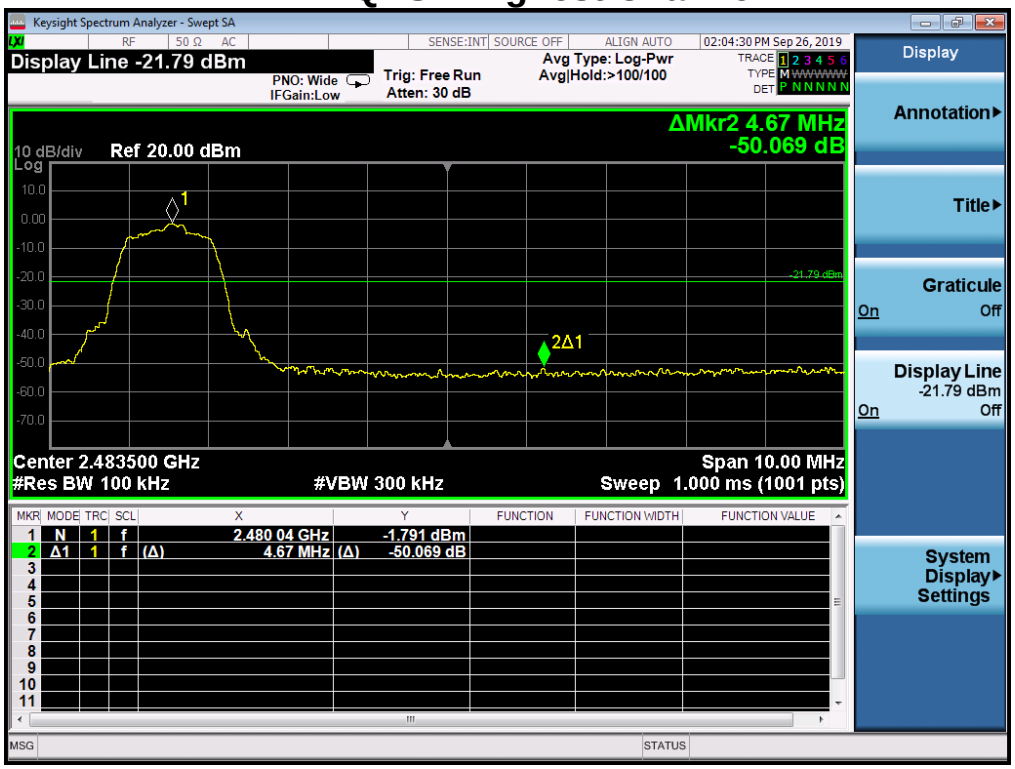


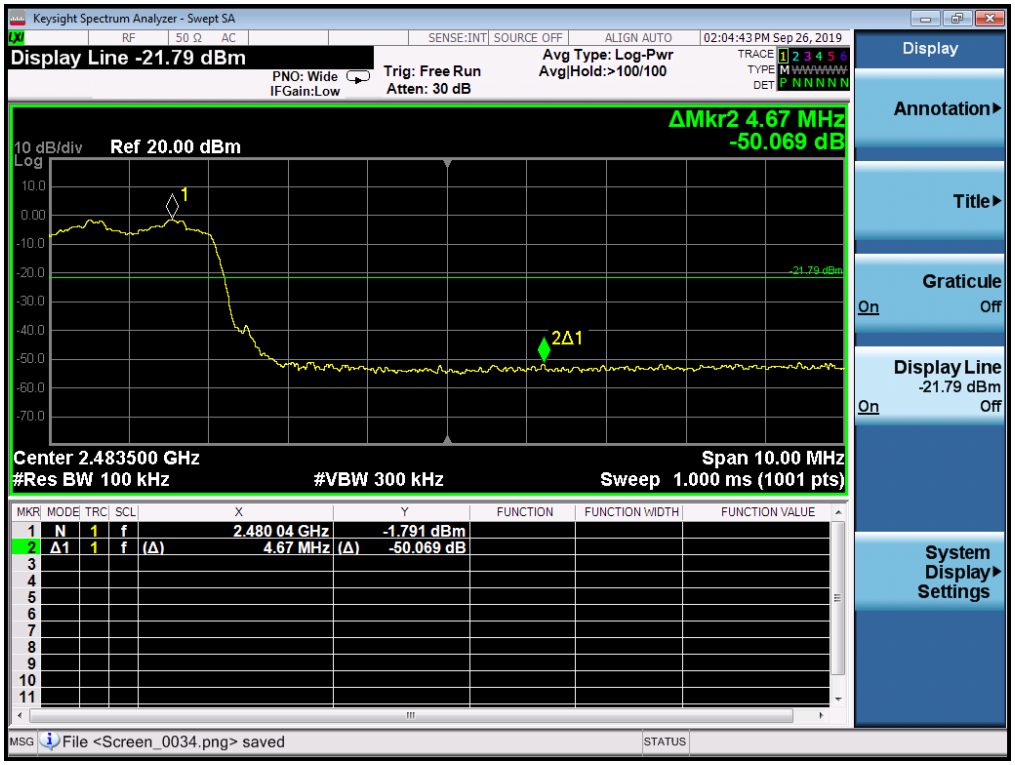
π/4-DQPSK Lowest Channel



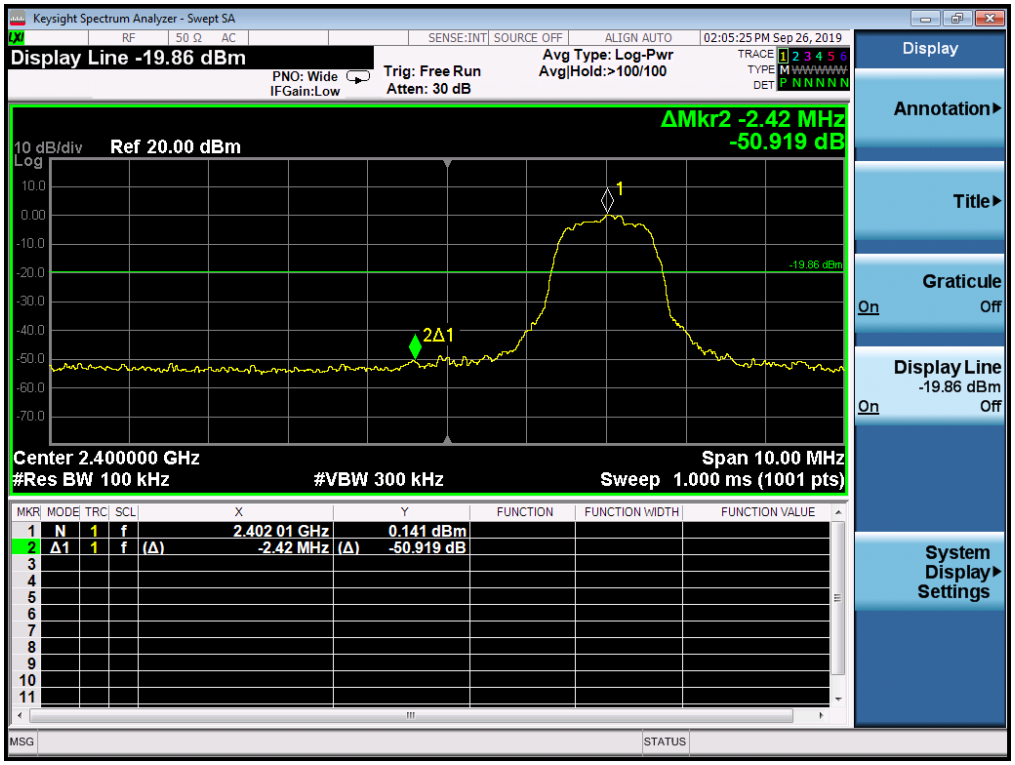


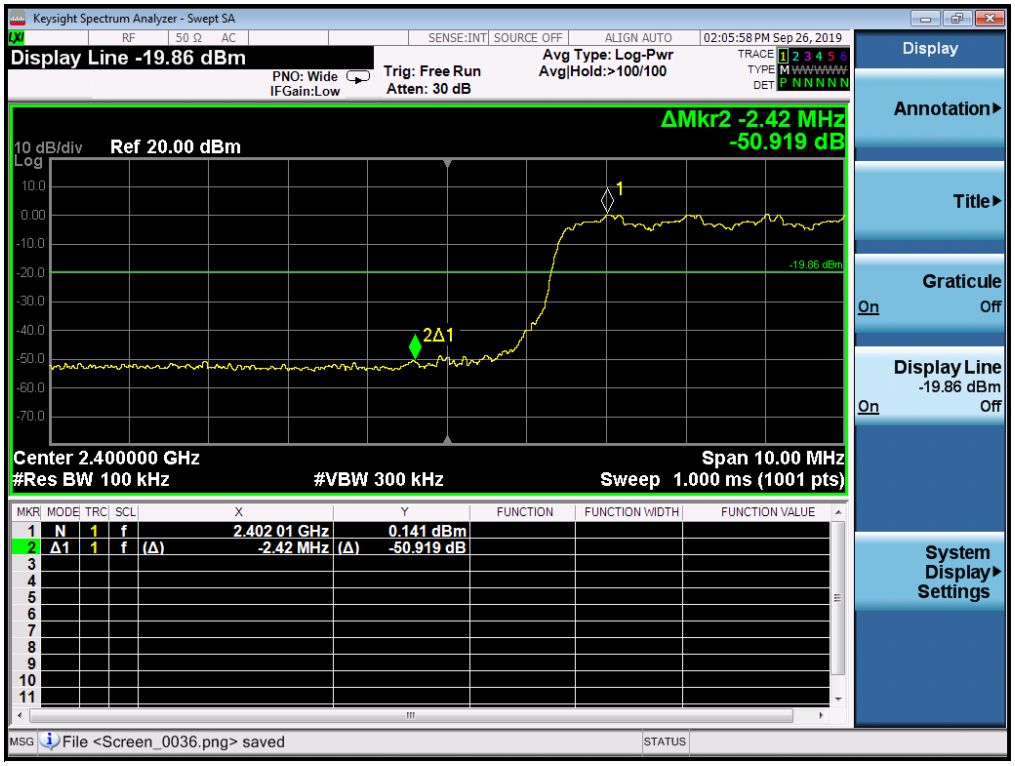
π/4-DQPSK Highest Channel



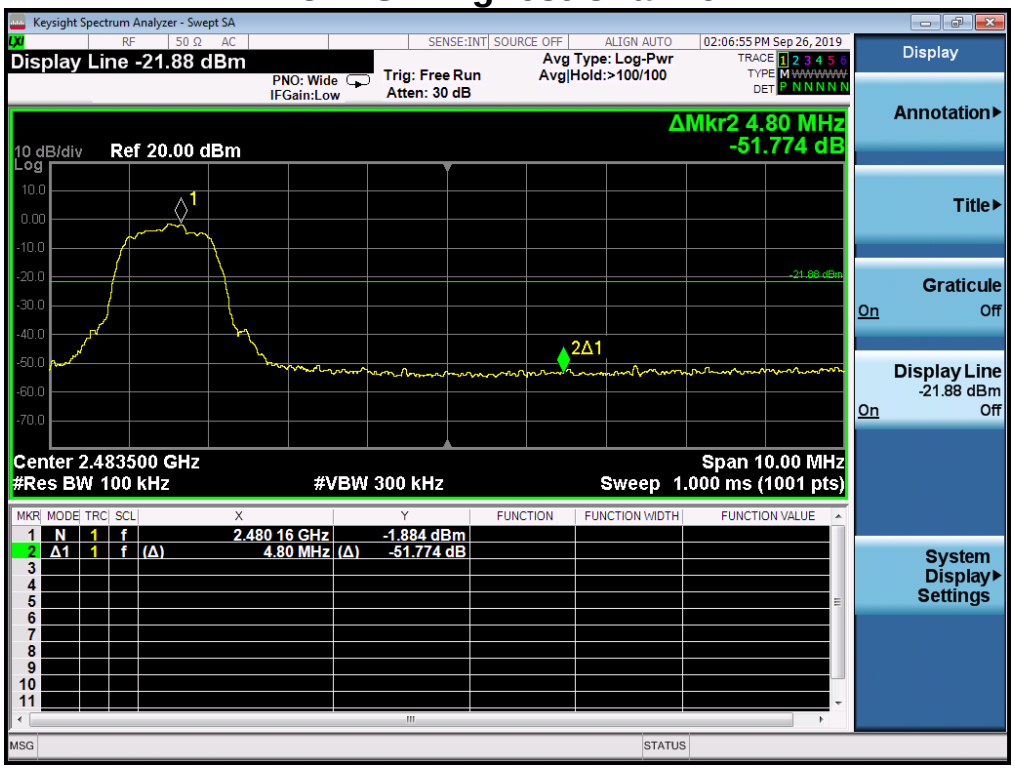


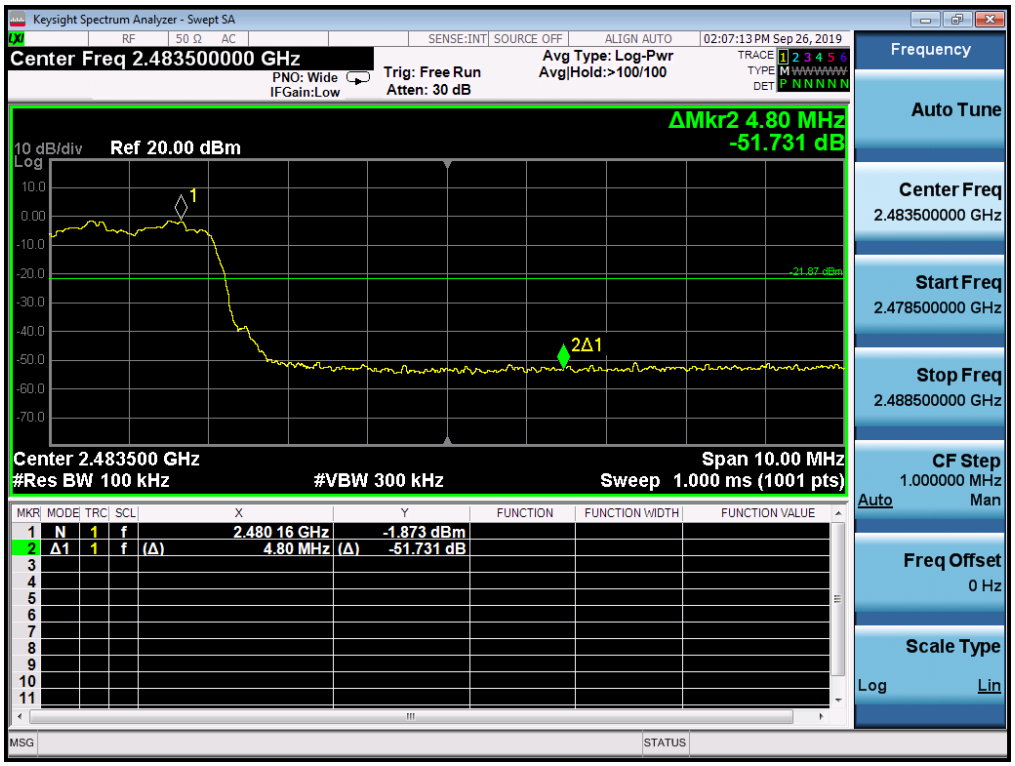
8DPSK Lowest Channel





8DPSK Highest Channel





12. ANTENNA APPLICATION

12.1 Antenna requirement

According to of FCC part 15C section 15.203 and 15.240:

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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

12.2 Measurement Results

The antenna is PCB on-board antenna and no consideration of replacement, and the best case gain of the antenna is 2dBi. Therefore, the antenna is consider meet the requirement.

13. CONDUCTED SPURIOUS EMISSIONS

13.1 Measurement Procedure

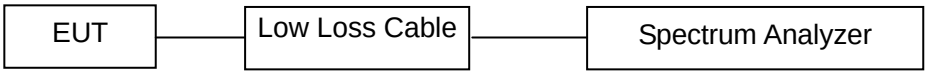
Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. All spurious emission and up tp the tenth harmonic was measured and they were found to be at least 20dB below the highest level of the desired power in the passband.

13.2 Limit

In any 100KHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

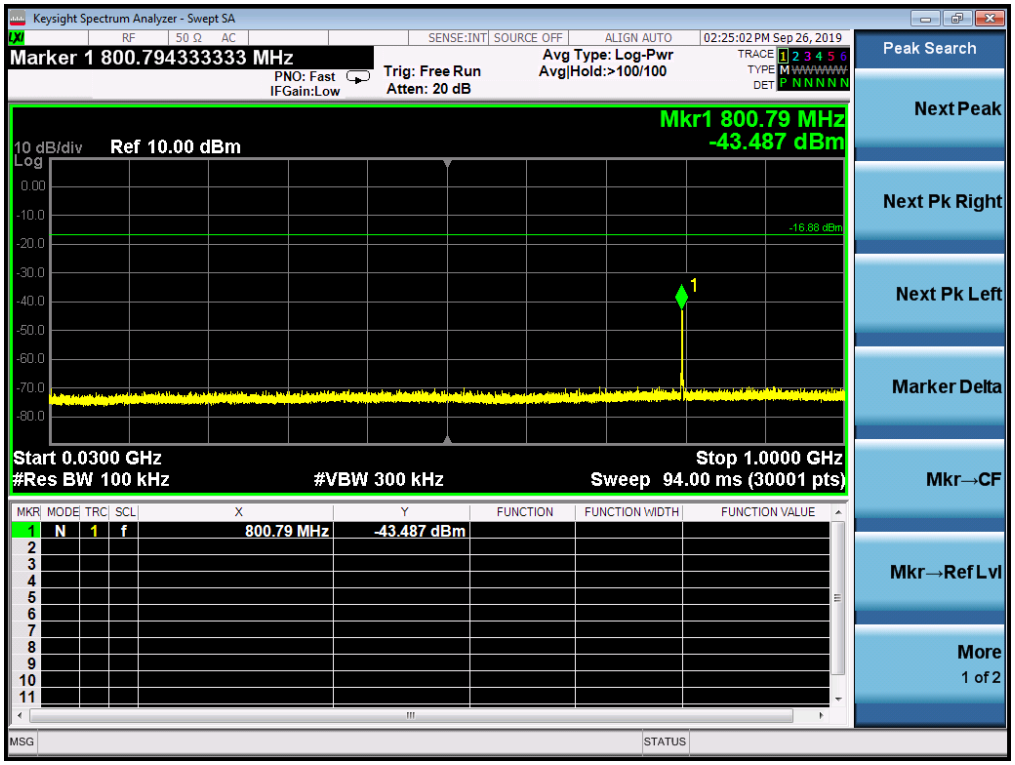
13.3 Test SET-UP (Block Diagram of Configuration)

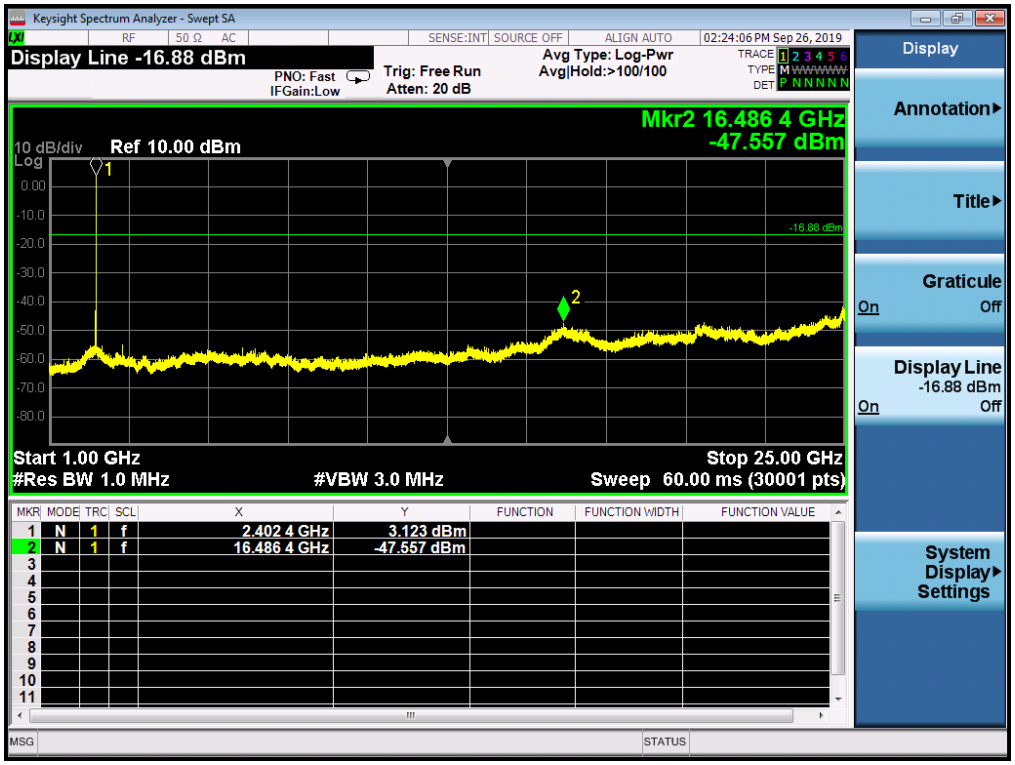


13.4 Measurement Results

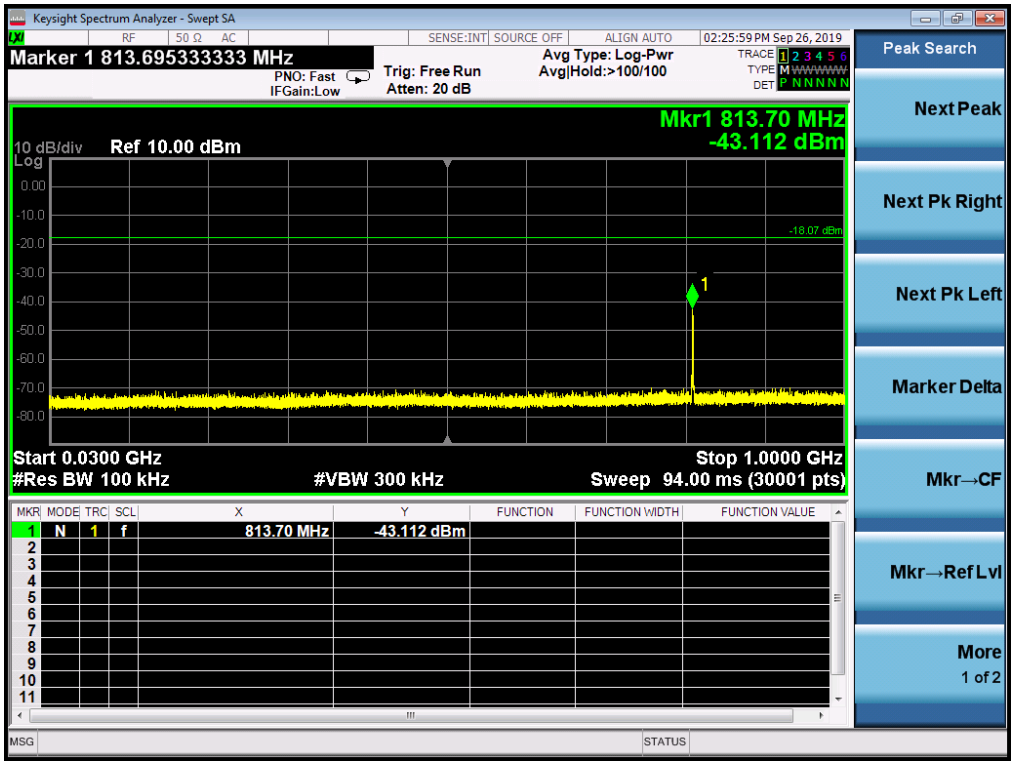
Please refer to following plots, the worst case (8DPSK) was shown.

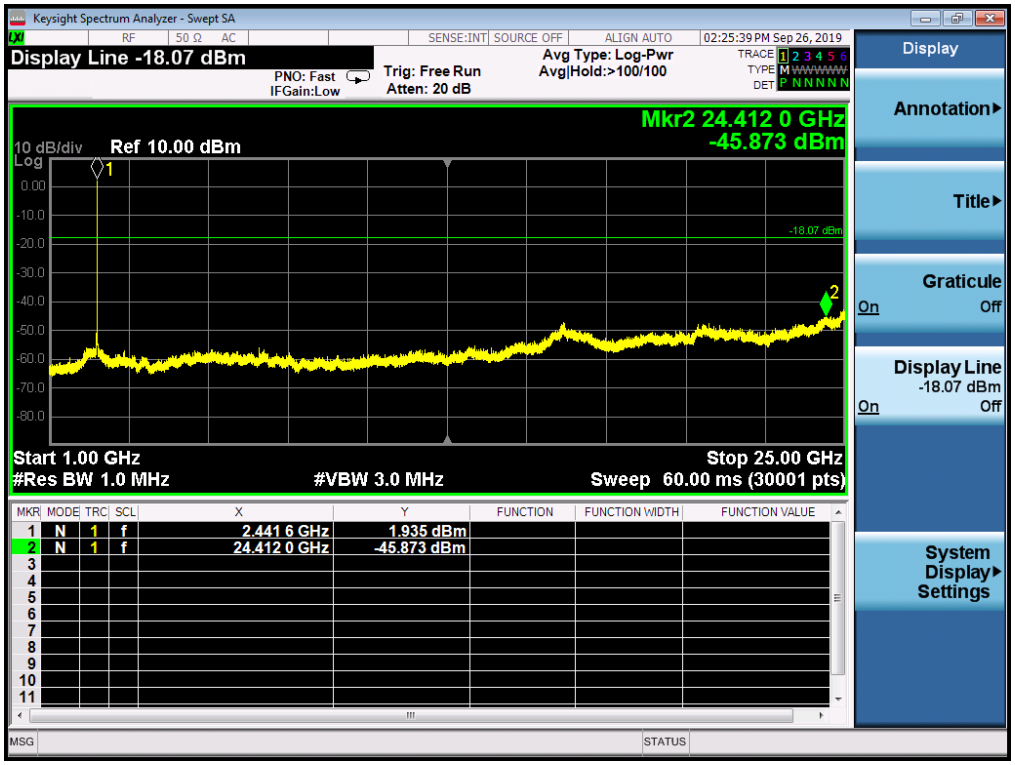
Lowest Channel



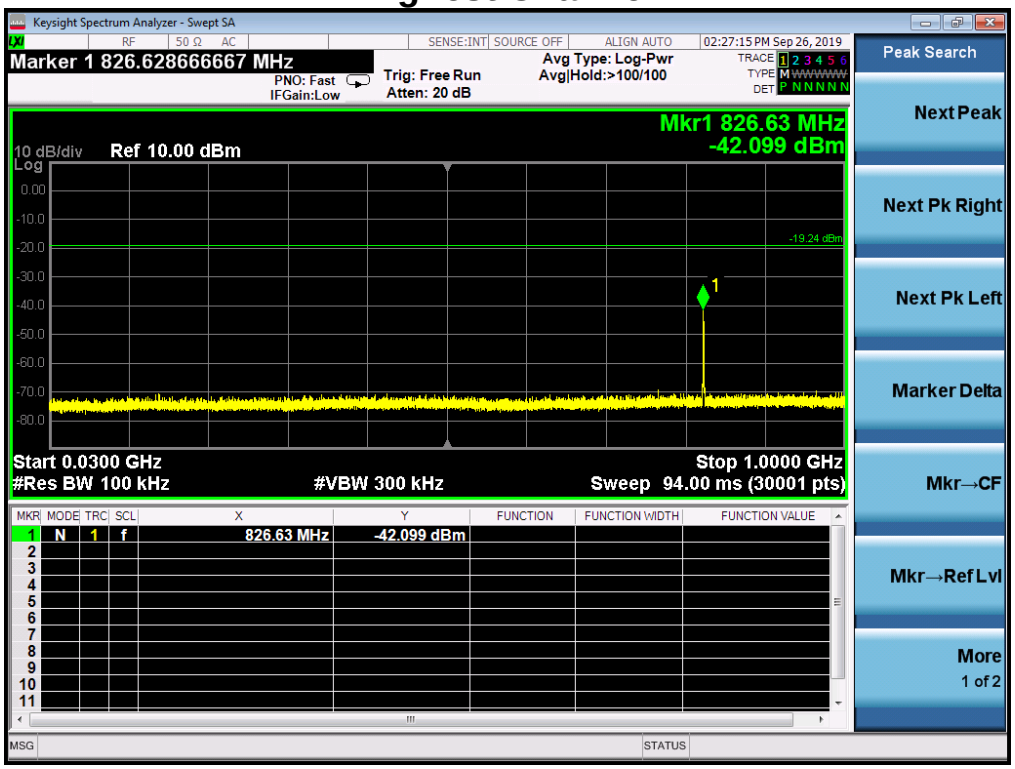


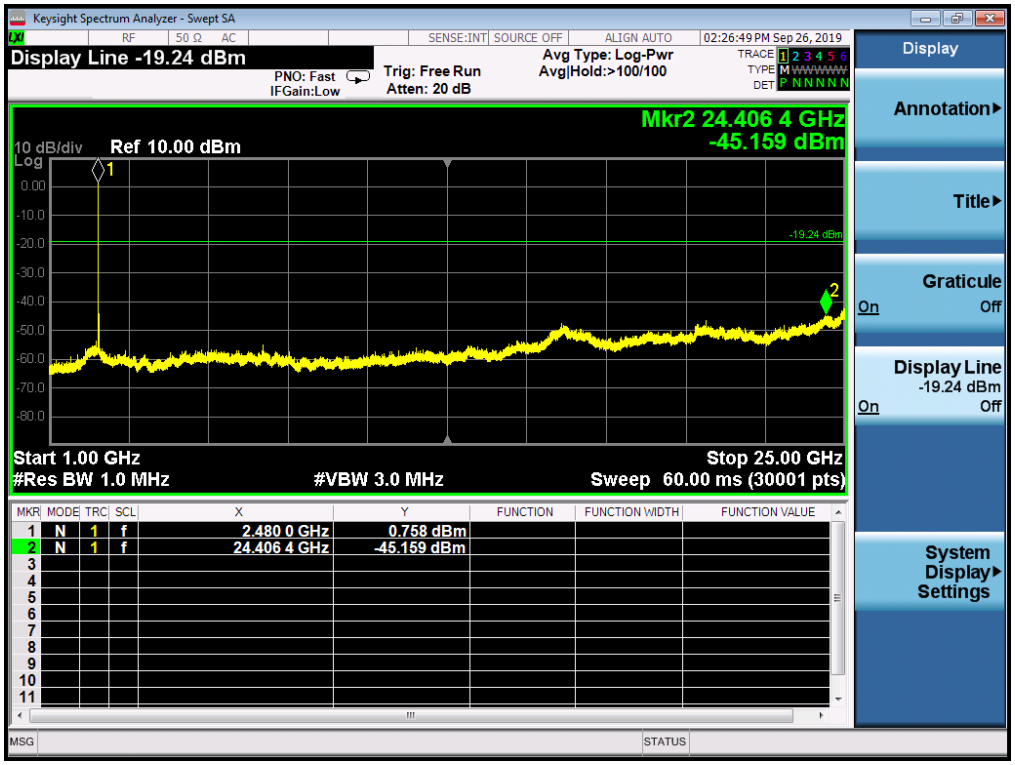
Middle Channel





Highest Channel





Note: Sweep points=30001pts

14. TEST EQUIPMENT LIST

Description	Manufacturer	Model Number	Serial Number	Characteristics	Calibration Date	Calibration Due Date
Test Receiver	Rohde & Schwarz	ESCI7	100837	9KHz~7GHz	Mar. 14, 2019	1 year
Antenna	Schwarzbeck	VULB9162	9162-010	30MHz~7GHz	Mar. 23, 2019	1 year
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	20Hz~26.5GHz	Mar. 14, 2019	1 year
Spectrum Analyzer	Keysight	N9020A	MY54200831	20Hz~26.5GHz	Apr. 24, 2019	1 year
Spectrum Analyzer	Rohde & Schwarz	FSV40	101003	10Hz~40GHz	Apr. 24, 2019	1 year
Horn Antenna	Schwarzbeck	BBHA9170	9170-372	15GHz~40GHz	Mar. 23, 2019	1 year
Pre-Amplifier	EMCI	EMC 184045	980102	18GHz~40GHz	Apr. 24, 2019	1 year
Power Sensor	DARE	RPR3006W	15I00041SNO64	100MHz~6GHz	Mar. 14, 2019	1 year
Communication Tester	Rohde & Schwarz	CMW500	149004	70MHz~6GHz	Mar. 14, 2019	1 year
Horn Antenna	COM-Power	AH-118	071078	500MHz~18GHz	Mar. 23, 2019	1 year
Pre-Amplifier	HP	HP 8449B	3008A00964	1GHz~26.5GHz	Mar. 14, 2019	1 year
Pre-Amplifier	HP	HP 8447D	1145A00203	100KHz~1.3GHz	Mar. 14, 2019	1 year
Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	9KHz~30MHz	Apr. 24, 2019	1 year
Temperature & Humidity Chamber	REMAFEE	SYHR225L	N/A	-40~150℃	Apr. 24, 2019	1 year
DC Source	MY	MY8811	N/A	0~30V	N/A	N/A
Temporary antenna connector	TESCOM	SS402	N/A	9KHz~25GHz	N/A	N/A
Power Meter	Anritsu	ML2495A	1139001	100k-65GHz	Apr. 24, 2019	1 year
Power Sensor	Anritsu	MA2411B	100345	300M-40GHz	Apr. 24, 2019	1 year
Test Software	EZ	EZ_EMC	N/A	N/A	N/A	N/A

Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

---END---