TEST REPORT

Reference No.	:	WTF23D05104063W002
FCC ID	:	2AYBO-SPSG2BT
Applicant	:	JVCKENWOOD USA Corporation
Address	:	4001 Worsham Ave, Long Beach, CA 90808, USA
Manufacturer	:	Hong Kong Etech Groups Ltd.
Address	:	RM 747, 7/F STAR HSE 3, SALISBURY RD TST, Hong Kong
Product	:	Bluetooth Speaker
Model(s)	:	SP-SG2BT
Standards	:	FCC 47CFR Part 15.247
Date of Receipt sample	:	2023-06-01
Date of Test	:	2023-06-01 to 2023-06-08
Date of Issue	:	2023-07-11
Test Result	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

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2 Contents

3 Revision History

Test Report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF23D05104063W002	2023-06-01	2023-06-01 to 2023-06-08	2023-07-11	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	Bluetooth Speaker
Model(s):	SP-SG2BT
Bluetooth Version:	V5.3(BLE is not supported)
Hardware Version:	BS454-V3.0
Software Version:	BP18454(JVC-SPSG2BT)_6969D_Jq202305

4.2 Details of E.U.T.

Operation Frequency:	2402~2480MHz
Max. RF output power:	-1.77dBm
Type of Modulation:	GFSK, π/4DQPSK
Antenna installation:	Inverted F Antenna
Antenna Gain:	-0.68dBi
Ratings:	DC 5V from type-C USB port or DC 3.7V from battery
Battery:	DC 3.7V 600mAh 2.22Wh
Accessory:	USB cable USB type A plug to USB type C plug, length 30cm

Note: for more details, please refer to user manual and EUT photos.

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	1	2403	2	2404	3	2405
4	2406	5	2407	6	2408	7	2409
8	2410	9	2411	10	2412	11	2413
12	2414	13	2415	14	2416	15	2417
16	2418	17	2419	18	2420	19	2421
20	2422	21	2423	22	2424	23	2425
24	2426	25	2427	26	2428	27	2429
28	2430	29	2431	30	2432	31	2433
32	2434	33	2435	34	2436	35	2437
36	2438	37	2439	38	2440	39	2441
40	2442	41	2443	42	2444	43	2445
44	2446	45	2447	46	2448	47	2449
48	2450	49	2451	50	2452	51	2453
52	2454	53	2455	54	2456	55	2457
56	2458	57	2459	58	2460	59	2461
60	2462	61	2463	62	2464	63	2465
64	2466	65	2467	66	2468	67	2469
68	2470	69	2471	70	2472	71	2473
72	2474	73	2475	74	2476	75	2477
76	2478	77	2479	78	2480	-	-

Frequency hopping systems (FHS):

This transmitter device is frequency hopping device, and complies with RSS-247 Requirements.

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. The average time of occupancy on any channel is less than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels（79 channels）employed.

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 an Bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for RSS-247.

Pseudorandom Frequency Hopping Sequence Table as below:

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

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

4.4 Test Facility

The test facility has a test site registered with the following organizations:

ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

Waltek Testing Group Co., Ltd. Has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration number 7760A, October 15, 2016.

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.

Waltek Testing Group Co., Ltd. EMC Laboratory `has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration number 523476, September 10, 2019.

4.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test Lab: N/A

Lab address: N/A

Test items: N/A

4.6 Abnormalities from Standard Conditions

None.

4.7 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting	2402MHz	2441MHz	2480MHz

Note: The EUT has been tested under its typical operating condition. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst-case data were reported.

5 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	PASS
Conducted Spurious emissions	15.247(d)	PASS
Band edge	15.247(d) 15.205(a)	PASS
Conducted Emission	15.207	PASS
20 dB Bandwidth and 99% Bandwidth	15.247(a)(1)	PASS
Maximum Peak Output Power	15.247(b)(1)	PASS
Frequency Separation	15.247(a)(1)	PASS
Number of Hopping Frequency	15.247(a)(1)(iii)	PASS
Dwell time	15.247(a)(1)(iii)	PASS
Antenna Requirement	15.203	Complies
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	2.1093	PASS

6 Equipment Used during Test

6.1 Equipments List

Conducted Emissions Test Site 2#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1	EMI Test Receiver	R&S	ESPI	101155	2022-08-01	2023-07-31
2	LISN	SCHWARZBECK	NSLK 8128	8128-259	2022-11-30	2023-11-29
3	Limiter	CYBERTEK	EM5010	261115-001-0024	2022-08-01	2023-07-31
4	Cable	Laplace	RF300	-	2022-08-01	2023-07-31
3m Semi-anechoic Chamber for Radiation Emissions Test site 1#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1	Spectrum Analyzer	R&S	FSP30	100091	2023-04-24	2024-04-23
2	Amplifier	Agilent	8447D	2944A10178	2022-08-01	2023-07-31
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2022-08-07	2023-08-06
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2023-04-24	2024-04-23
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2023-02-02	2024-02-01
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2022-07-29	2023-07-28
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2022-08-08	2023-08-07
8	Coaxial Cable (above 1GHz)	ZT26-NJ-NJ-8M/FA	1GHz-18GHz	NA	2023-02-02	2024-02-01
3m Semi-anechoic Chamber for Radiation Emissions Test site 2#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No**	**Last Calibration Date**	**Calibration Due Date**
1	Test Receiver	R&S	ESCI	101296	2023-04-24	2024-04-23
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2022-10-31	2023-10-30
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2023-05-07	2024-05-06
4	Amplifier	ANRITSU	MH648A	M43381	2023-04-24	2024-04-23
5	Cable	HUBER+SUHNER	CBL2	525178	2023-04-24	2024-04-23
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	Spectrum Analyzer	R&S	FSP40	100501	2022-08-01	2023-07-31
2.	EXA Signal Analyzer	Malaysia Keysight	N9010A	MY50520207	2022-08-01	2023-07-31

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
AC ADAPTER	Xiaomi	MDY-11-ER	GD61912T100719J

6.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	± 3.64 dB(AC mains 150KHz~30MHz)
Radiated Spurious Emissions	± 5.08 dB (Bilog antenna 30M~1000MHz)
	± 4.99 dB (Horn antenna 1000M~25000MHz)
Radio Frequency	± 1 x 10^{-7}Hz
RF Power	± 0.42 dB
Dwell time	1.0%
Conducted Spurious Emissions	± 2.76 dB (9kHz~26500MHz)
Confidence interval：95%. Confidence factor:k=2	

6.4 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P. R. China.

7 Conducted Emission

Test Requirement: FCC 47CFR Part 15 Section 15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Limit:

Frequency (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46
0.5 to 5	56	46
5to 30	60	50

7.1 E.U.T. Operation

Operating Environment**:**

Temperature: 22.8 °C

Humidity: 52.6 % RH

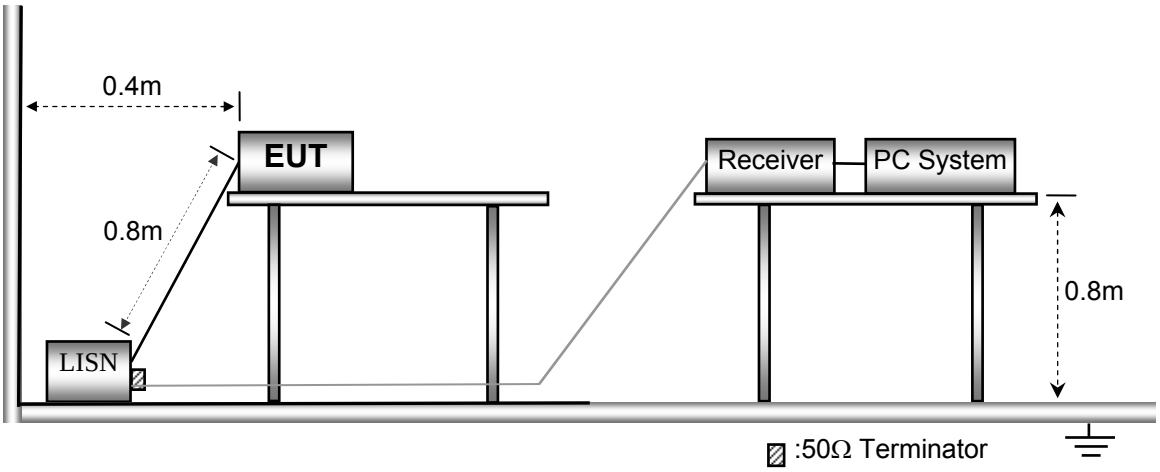
Atmospheric Pressure: 101.2kPa

EUT Operation:

The test was performed in TX Transmitting mode, the test data were shown in the report.

7.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10: 2013.



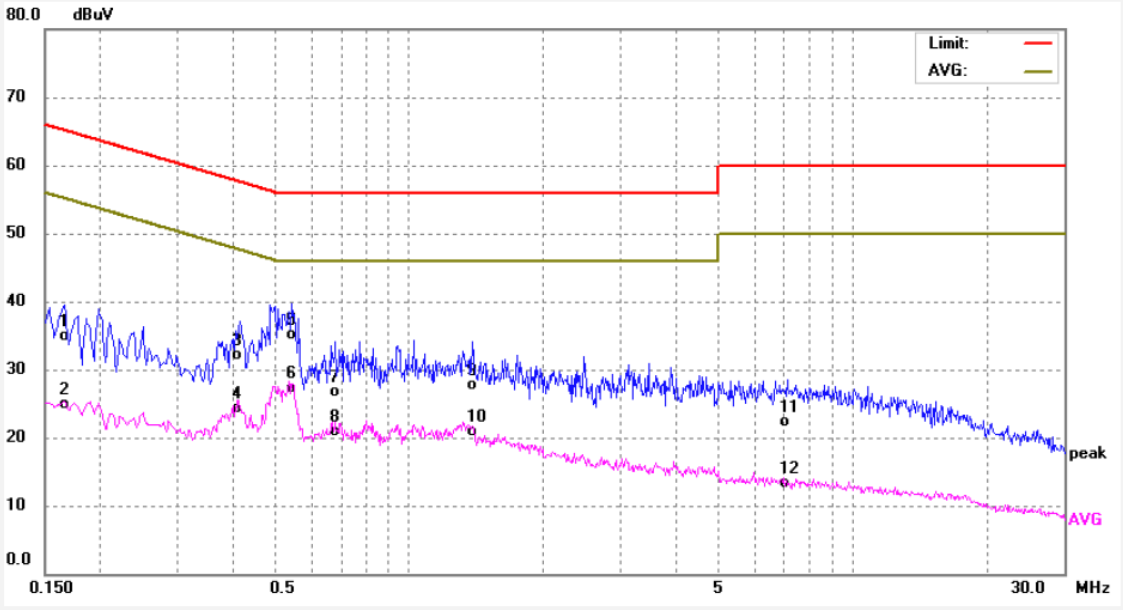
7.3 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

7.4 Conducted Emission Test Result

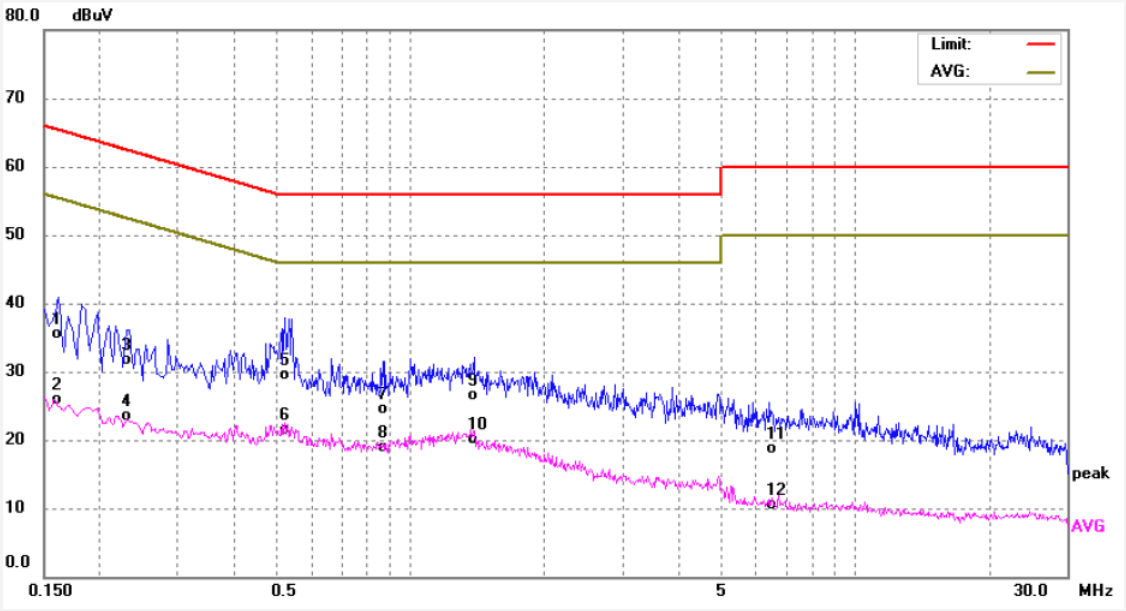
Remark: only the worst data (GFSK modulation Low channel mode) were reported

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1660	23.87	10.98	34.85	65.15	-30.30	QP	
2	0.1660	13.93	10.98	24.91	55.15	-30.24	AVG	
3	0.4140	21.30	10.78	32.08	57.57	-25.49	QP	
4	0.4140	13.49	10.78	24.27	47.57	-23.30	AVG	
5	0.5420	24.36	10.72	35.08	56.00	-20.92	QP	
6	0.5420	16.67	10.72	27.39	46.00	-18.61	AVG	
7	0.6820	16.06	10.67	26.73	56.00	-29.27	QP	
8	0.6820	10.16	10.67	20.83	46.00	-25.17	AVG	
9	1.3820	17.14	10.55	27.69	56.00	-28.31	QP	
10	1.3820	10.44	10.55	20.99	46.00	-25.01	AVG	
11	7.1060	11.60	10.79	22.39	60.00	-37.61	QP	
12	7.1060	2.58	10.79	13.37	50.00	-36.63	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1620	24.61	10.94	35.55	65.36	-29.81	QP	
2	0.1620	15.06	10.94	26.00	55.36	-29.36	AVG	
3	0.2300	20.77	10.93	31.70	62.45	-30.75	QP	
4	0.2300	12.54	10.93	23.47	52.45	-28.98	AVG	
5	0.5220	18.77	10.70	29.47	56.00	-26.53	QP	
6	0.5220	10.73	10.70	21.43	46.00	-24.57	AVG	
7	0.8700	13.90	10.54	24.44	56.00	-31.56	QP	
8	0.8700	8.29	10.54	18.83	46.00	-27.17	AVG	
9	1.3900	15.98	10.48	26.46	56.00	-29.54	QP	
10	1.3900	9.61	10.48	20.09	46.00	-25.91	AVG	
11	6.4340	8.02	10.72	18.74	60.00	-41.26	QP	
12	6.4340	-0.20	10.72	10.52	50.00	-39.48	AVG	

8 Radiated Spurious Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.205 &15.209 & 15.247

Test Method: ANSI C63.10: 2013

Test Result: PASS

Measurement Distance: 3m

Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

8.1 EUT Operation

Operating Environment **:**

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

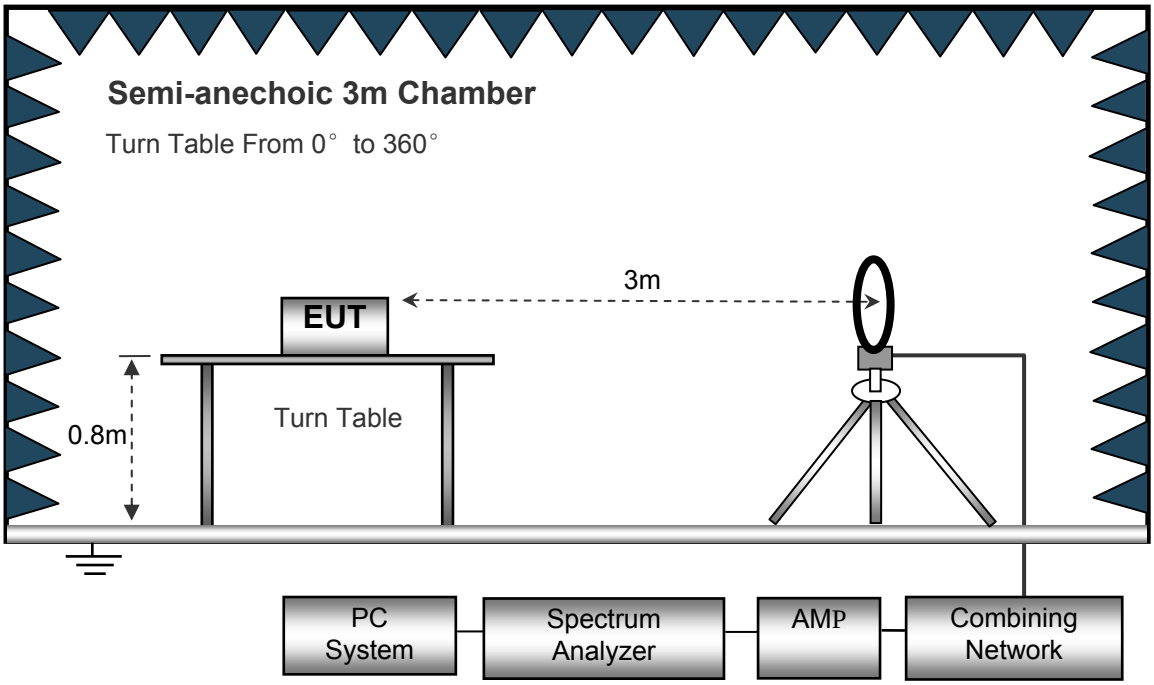
EUT Operation :

The test was performed in TX Transmitting mode, the test data were shown in the report.

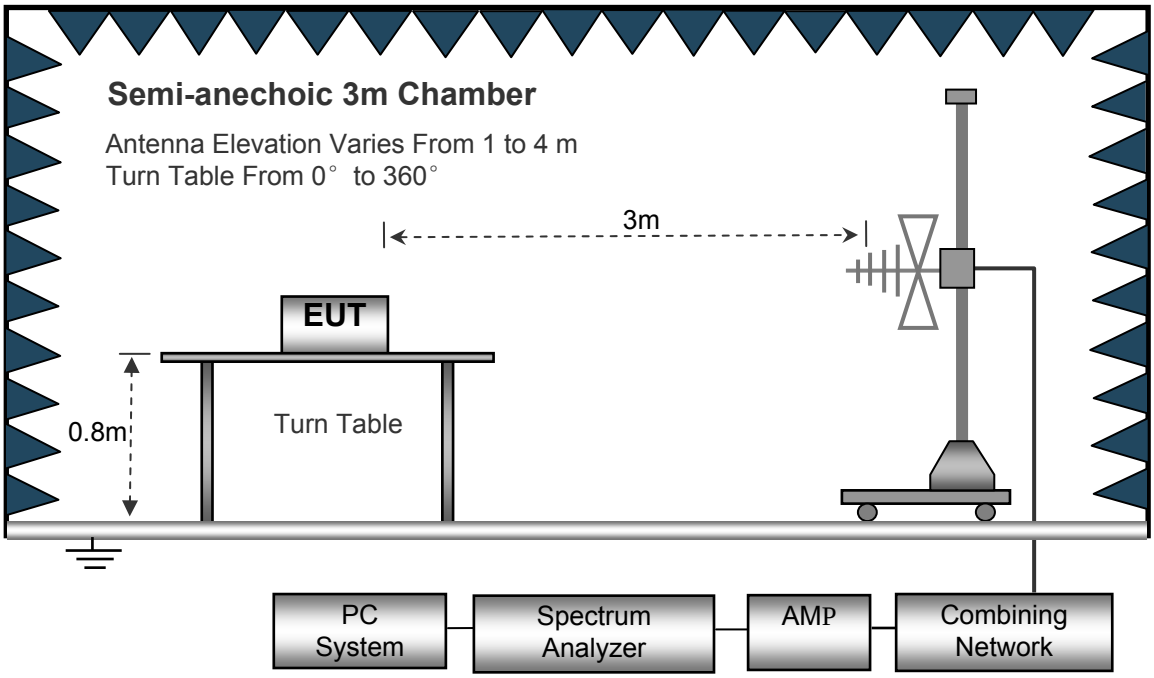
8.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10: 2013.

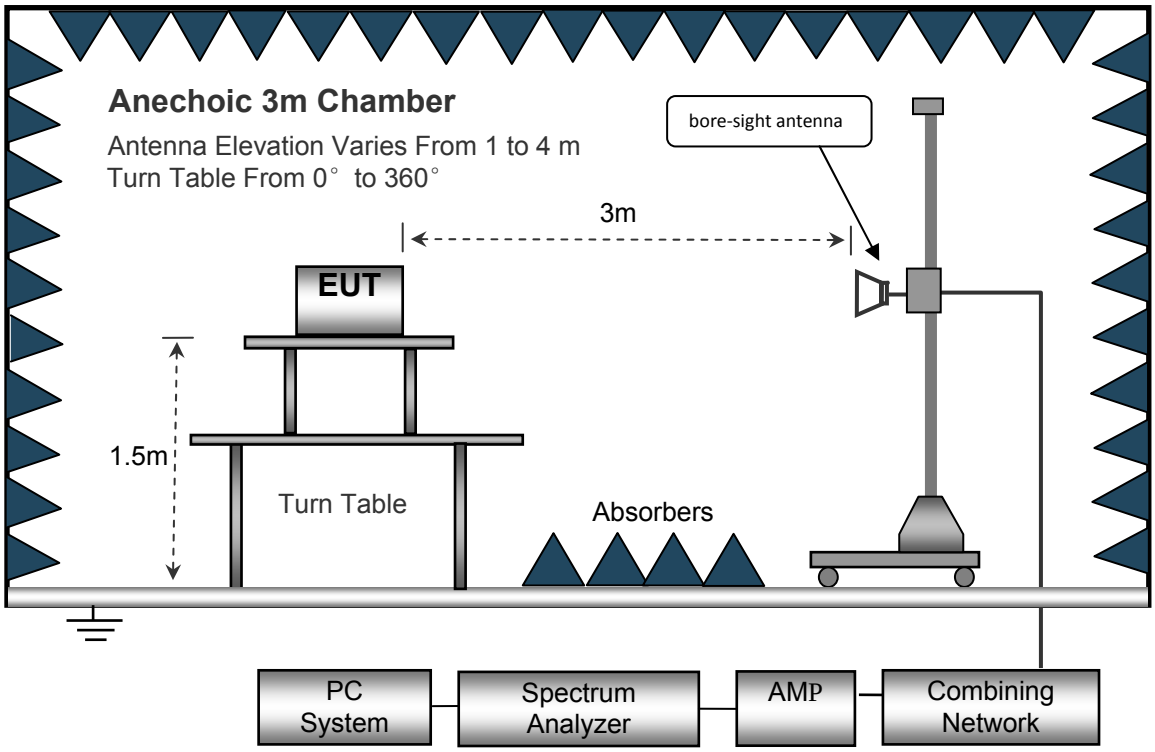
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.



8.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz

Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 100kHz
Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 3MHz
Detector ..... Ave.
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 10Hz

8.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the Z position. So the data shown was the Z position only.

8.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

8.6 Summary of Test Results

Test Frequency: 9KHz~30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 8GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel									
234.36	42.66	QP	198	1.9	H	-16.25	26.41	46.00	-19.59
234.36	48.83	QP	233	1.4	V	-16.25	32.58	46.00	-13.42
4804.00	54.57	PK	196	1.5	V	-1.06	53.51	74.00	-20.49
4804.00	43.25	Ave	196	1.5	V	-1.06	42.19	54.00	-11.81
7206.00	46.39	PK	300	1.9	H	1.33	47.72	74.00	-26.28
7206.00	36.21	Ave	300	1.9	H	1.33	37.54	54.00	-16.46
2323.32	46.28	PK	259	1.2	V	-13.19	33.09	74.00	-40.91
2323.32	37.30	Ave	259	1.2	V	-13.19	24.11	54.00	-29.89
2352.33	42.25	PK	166	1.1	H	-13.14	29.11	74.00	-44.89
2352.33	37.03	Ave	166	1.1	H	-13.14	23.89	54.00	-30.11
2484.70	43.20	PK	310	1.4	V	-13.08	30.12	74.00	-43.88
2484.70	38.97	Ave	310	1.4	V	-13.08	25.89	54.00	-28.11

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Middle Channel									
234.36	42.53	QP	345	1.5	H	-16.25	26.28	46.00	-19.72
234.36	47.41	QP	30	1.9	V	-16.25	31.16	46.00	-14.84
4882.00	54.33	PK	156	1.6	V	-0.62	53.71	74.00	-20.29
4882.00	42.82	Ave	156	1.6	V	-0.62	42.20	54.00	-11.80
7323.00	45.03	PK	314	1.7	H	2.21	47.24	74.00	-26.76
7323.00	35.34	Ave	314	1.7	H	2.21	37.55	54.00	-16.45
2337.04	46.18	PK	309	1.3	V	-13.19	32.99	74.00	-41.01
2337.04	36.32	Ave	309	1.3	V	-13.19	23.13	54.00	-30.87
2386.44	41.16	PK	353	1.8	H	-13.14	28.02	74.00	-45.98
2386.44	36.53	Ave	353	1.8	H	-13.14	23.39	54.00	-30.61
2494.34	42.39	PK	79	1.7	V	-13.08	29.31	74.00	-44.69
2494.34	37.53	Ave	79	1.7	V	-13.08	24.45	54.00	-29.55

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK High Channel									
234.36	42.10	QP	239	1.4	H	-16.25	25.85	46.00	-20.15
234.36	47.70	QP	322	1.7	V	-16.25	31.45	46.00	-14.55
4960.00	53.94	PK	203	1.9	V	-0.24	53.70	74.00	-20.30
4960.00	42.99	Ave	203	1.9	V	-0.24	42.75	54.00	-11.25
7440.00	45.21	PK	160	1.5	H	2.84	48.05	74.00	-25.95
7440.00	33.93	Ave	160	1.5	H	2.84	36.77	54.00	-17.23
2318.64	45.92	PK	46	1.9	V	-13.19	32.73	74.00	-41.27
2318.64	35.75	Ave	46	1.9	V	-13.19	22.56	54.00	-31.44
2376.35	40.48	PK	78	1.0	H	-13.14	27.34	74.00	-46.66
2376.35	35.72	Ave	78	1.0	H	-13.14	22.58	54.00	-31.42
2498.40	42.19	PK	9	1.6	V	-13.08	29.11	74.00	-44.89
2498.40	36.89	Ave	9	1.6	V	-13.08	23.81	54.00	-30.19

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
π/4DQPSK Low Channel									
234.36	40.83	QP	232	1.6	H	-16.25	24.58	46.00	-21.42
234.36	46.51	QP	149	1.7	V	-16.25	30.26	46.00	-15.74
4804.00	51.60	PK	178	1.4	V	-1.06	50.54	74.00	-23.46
4804.00	40.02	Ave	178	1.4	V	-1.06	38.96	54.00	-15.04
7206.00	43.31	PK	342	1.7	H	1.33	44.64	74.00	-29.36
7206.00	33.81	Ave	342	1.7	H	1.33	35.14	54.00	-18.86
2337.60	44.52	PK	235	1.4	V	-13.19	31.33	74.00	-42.67
2337.60	35.53	Ave	235	1.4	V	-13.19	22.34	54.00	-31.66
2366.63	40.65	PK	98	1.1	H	-13.14	27.51	74.00	-46.49
2366.63	38.10	Ave	98	1.1	H	-13.14	24.96	54.00	-29.04
2497.53	42.70	PK	333	1.1	V	-13.08	29.62	74.00	-44.38
2497.53	35.15	Ave	333	1.1	V	-13.08	22.07	54.00	-31.93

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
π/4DQPSK Middle Channel									
234.36	40.59	QP	300	1.5	H	-16.25	24.34	46.00	-21.66
234.36	47.02	QP	196	1.9	V	-16.25	30.77	46.00	-15.23
4882.00	51.56	PK	98	1.3	V	-0.62	50.94	74.00	-23.06
4882.00	40.48	Ave	98	1.3	V	-0.62	39.86	54.00	-14.14
7323.00	42.64	PK	32	1.7	H	2.21	44.85	74.00	-29.15
7323.00	34.44	Ave	32	1.7	H	2.21	36.65	54.00	-17.35
2313.21	43.21	PK	123	1.2	V	-13.19	30.02	74.00	-43.98
2313.21	36.37	Ave	123	1.2	V	-13.19	23.18	54.00	-30.82
2378.92	40.16	PK	270	1.3	H	-13.14	27.02	74.00	-46.98
2378.92	36.73	Ave	270	1.3	H	-13.14	23.59	54.00	-30.41
2491.36	42.76	PK	232	1.9	V	-13.08	29.68	74.00	-44.32
2491.36	35.23	Ave	232	1.9	V	-13.08	22.15	54.00	-31.85

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
π/4DQPSK High Channel									
234.36	41.38	QP	74	1.0	H	-16.25	25.13	46.00	-20.87
234.36	46.92	QP	352	1.8	V	-16.25	30.67	46.00	-15.33
4960.00	51.41	PK	59	1.5	V	-0.24	51.17	74.00	-22.83
4960.00	39.19	Ave	59	1.5	V	-0.24	38.95	54.00	-15.05
7440.00	43.63	PK	222	1.0	H	2.84	46.47	74.00	-27.53
7440.00	33.63	Ave	222	1.0	H	2.84	36.47	54.00	-17.53
2319.86	44.03	PK	232	1.5	V	-13.19	30.84	74.00	-43.16
2319.86	35.40	Ave	232	1.5	V	-13.19	22.21	54.00	-31.79
2354.39	38.80	PK	94	1.3	H	-13.14	25.66	74.00	-48.34
2354.39	36.16	Ave	94	1.3	H	-13.14	23.02	54.00	-30.98
2483.83	42.32	PK	11	1.6	V	-13.08	29.24	74.00	-44.76
2483.83	35.92	Ave	11	1.6	V	-13.08	22.84	54.00	-31.16

Test Frequency: 8GHz~25GHz

The measurements were more than 20 dB below the limit and not recorded

9 Conducted Spurious Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Result: PASS

Limit:

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 this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

9.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

2. Set the spectrum analyzer:

Blow 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

Above 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

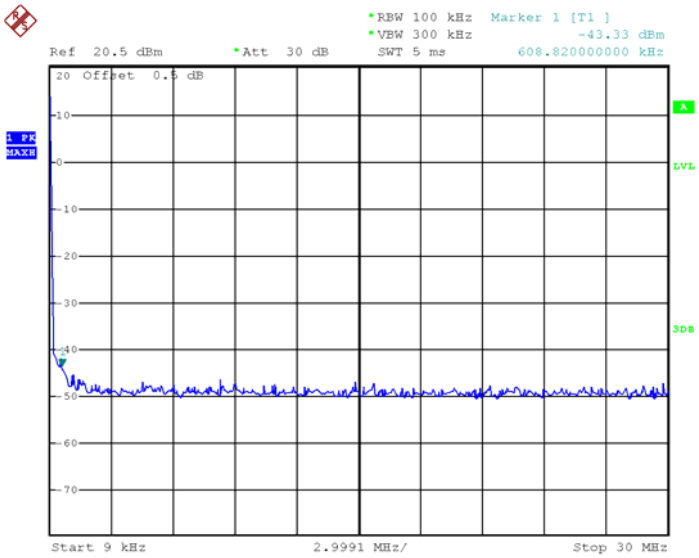
Detector function = peak, Trace = max hold

9.2 Test Result

9KHz - 30MHz

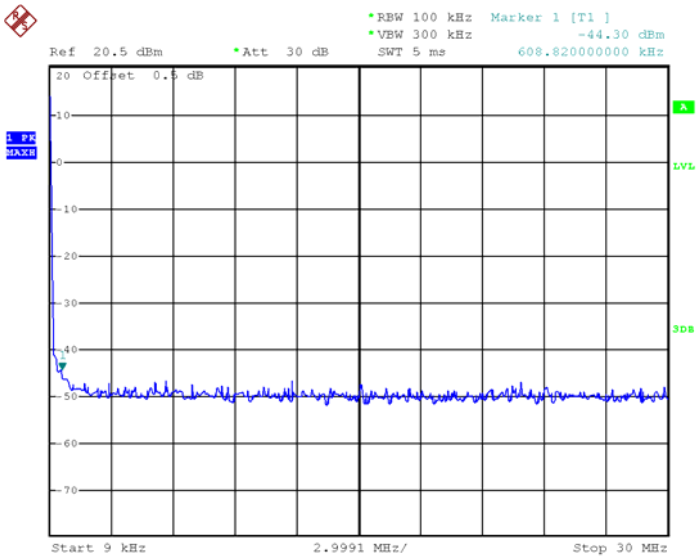
GFSK

Low Channel



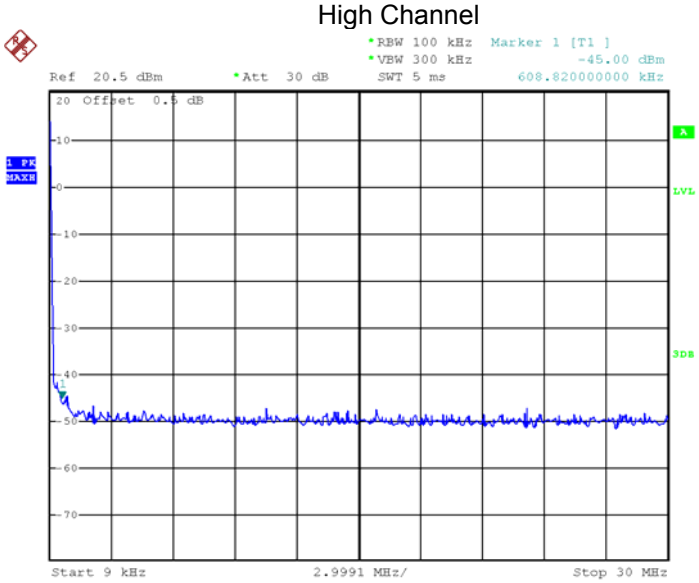
Date: 7.JUN.2023 19:17:14

Middle Channel



Date: 7.JUN.2023 19:18:19

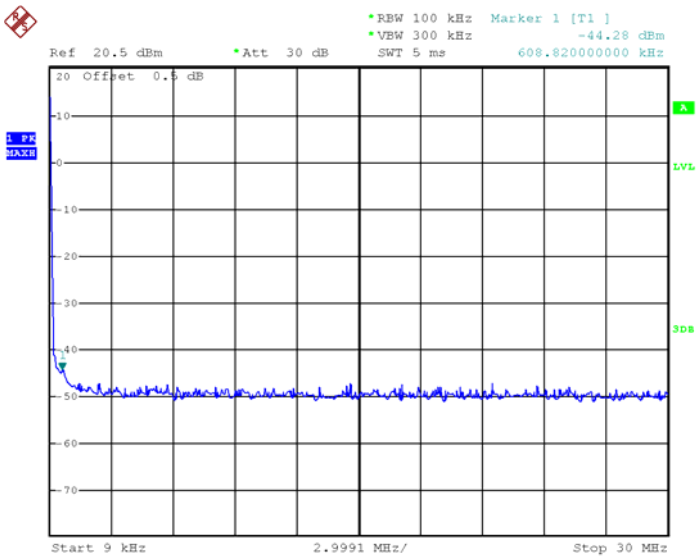
High Channel



Date: 7.JUN.2023 19:19:31

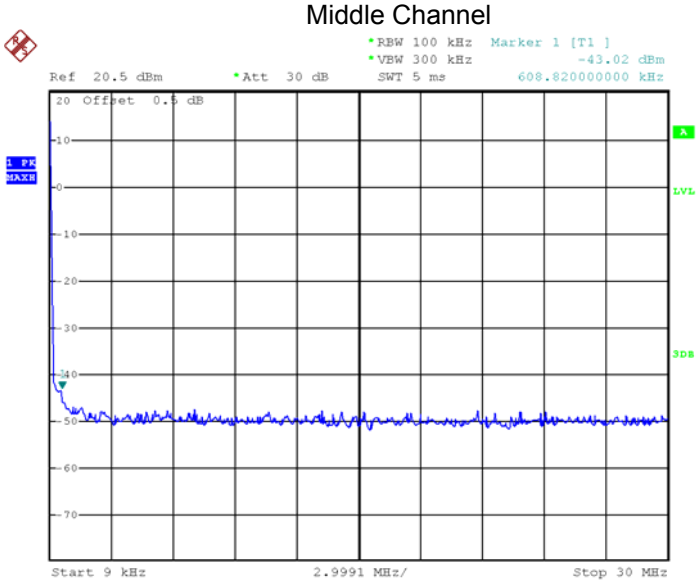
π/4DQPSK

Low Channel



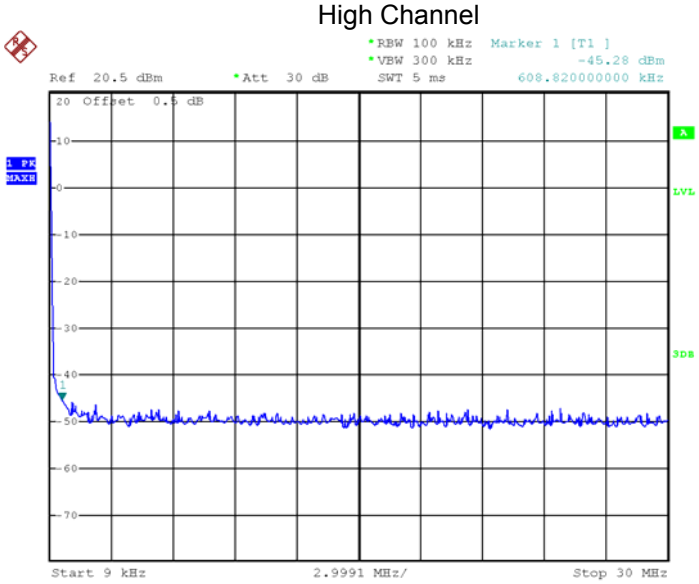
Date: 7.JUN.2023 19:21:15

Middle Channel



Date: 7.JUN.2023 19:22:59

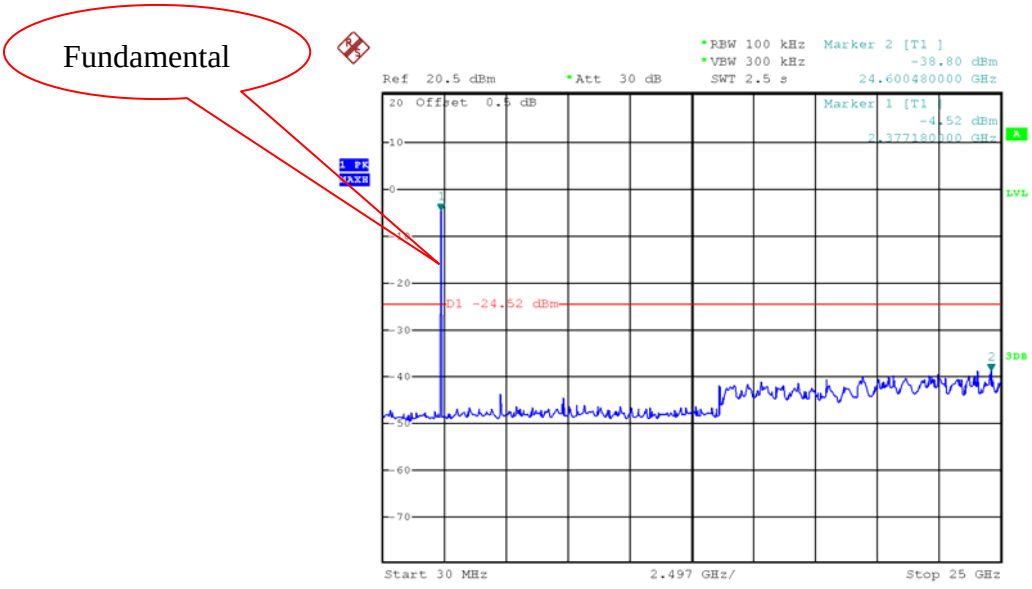
High Channel



Date: 7.JUN.2023 19:24:31

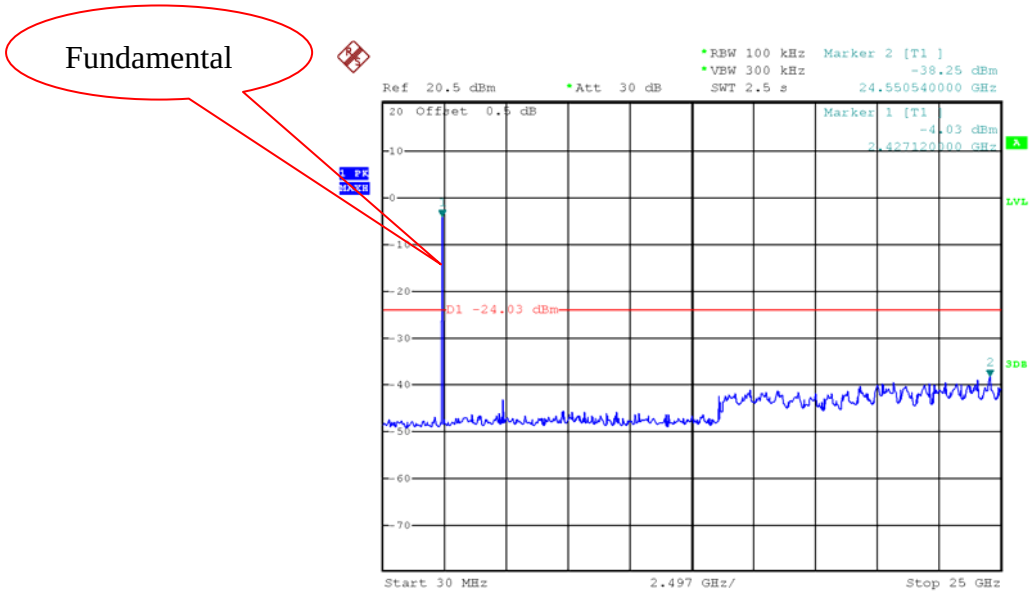
30MHz – 25GHz

GFSK Low Channel



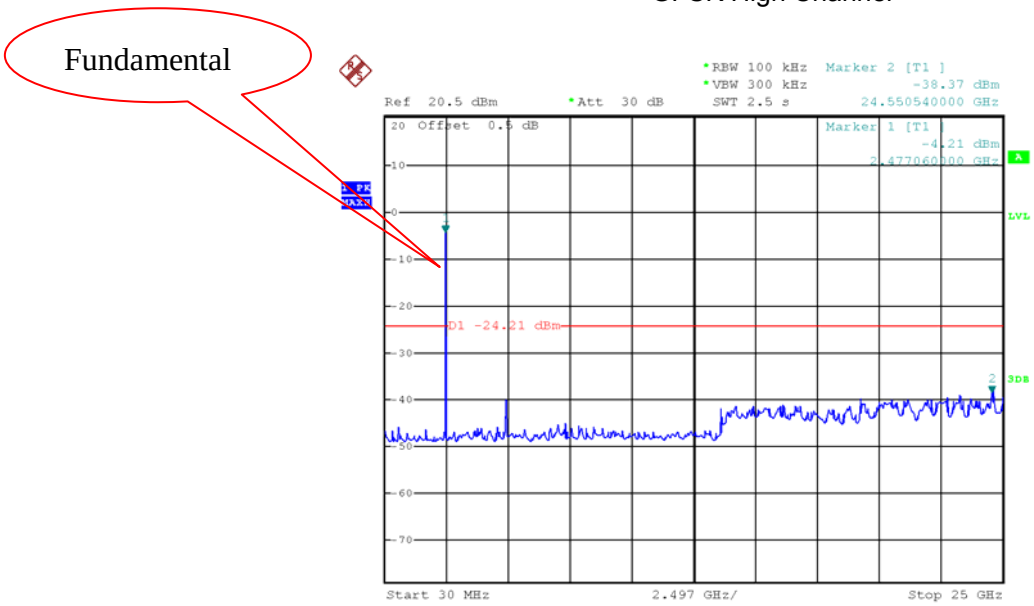
Date: 7.JUN.2023 19:17:50

GFSK Middle Channel

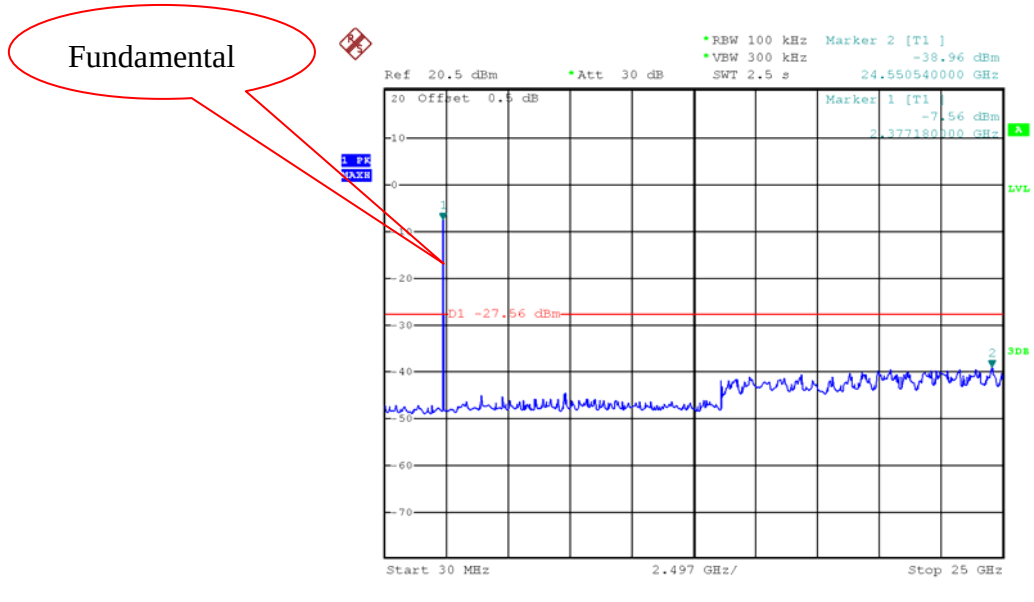


Date: 7.JUN.2023 19:19:04

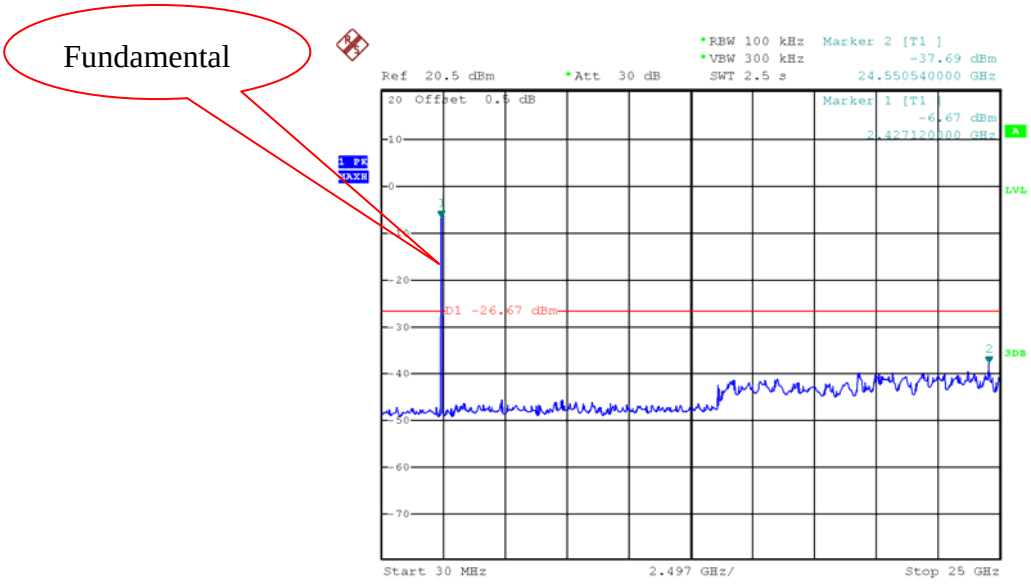
GFSK High Channel



π/4DQPSK Low Channel

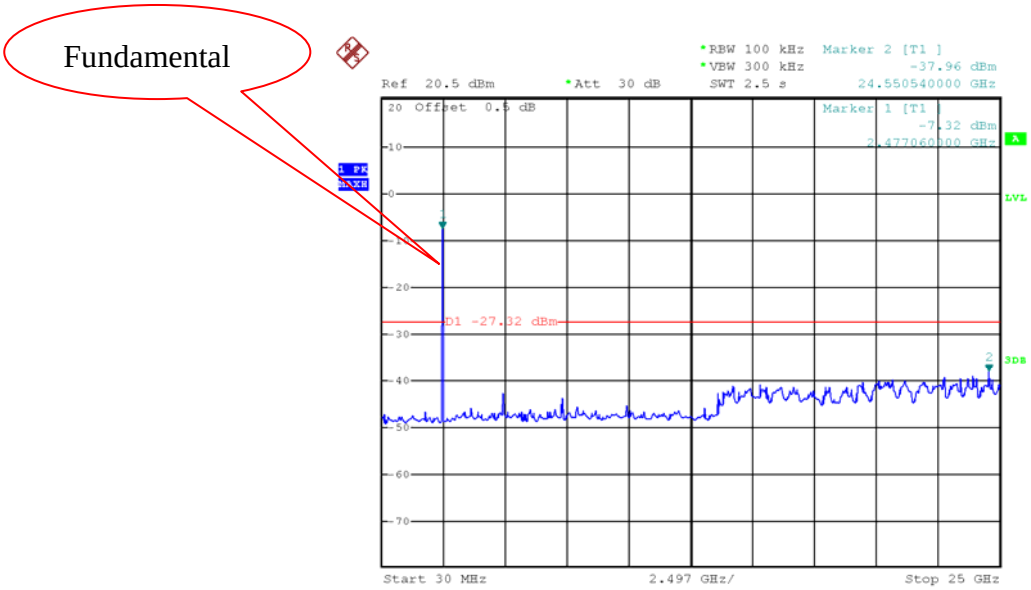


π/4DQPSK Middle Channel



Date: 7.JUN.2023 19:27:40

π/4DQPSK High Channel



Date: 7.JUN.2023 19:26:17

10 Band Edge Measurement

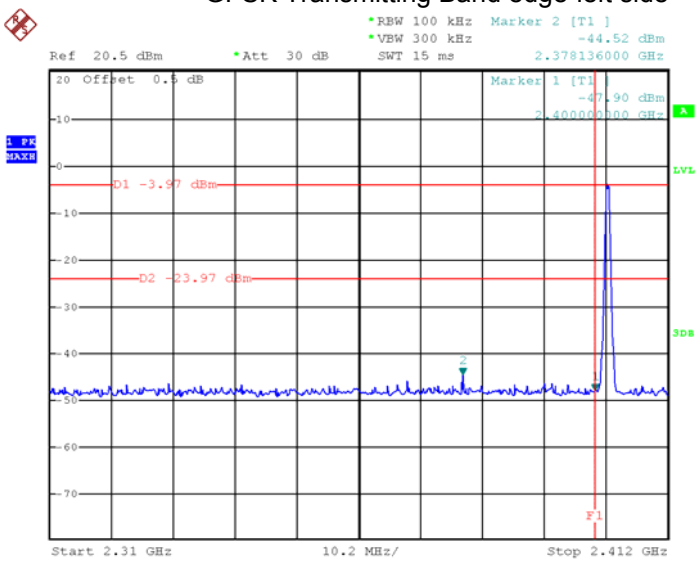
Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247 (d),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 this section, 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)).
Test Mode:	Transmitting

10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
   Detector function = peak, Trace = max hold

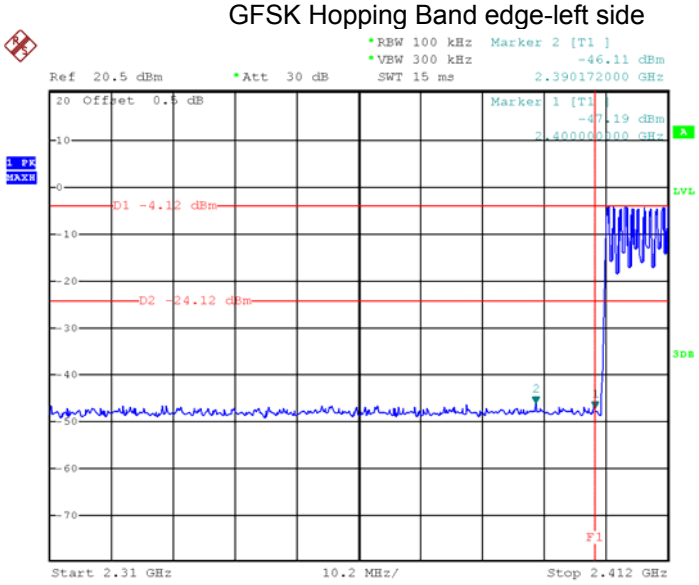
10.2 Test Result

GFSK Transmitting Band edge-left side



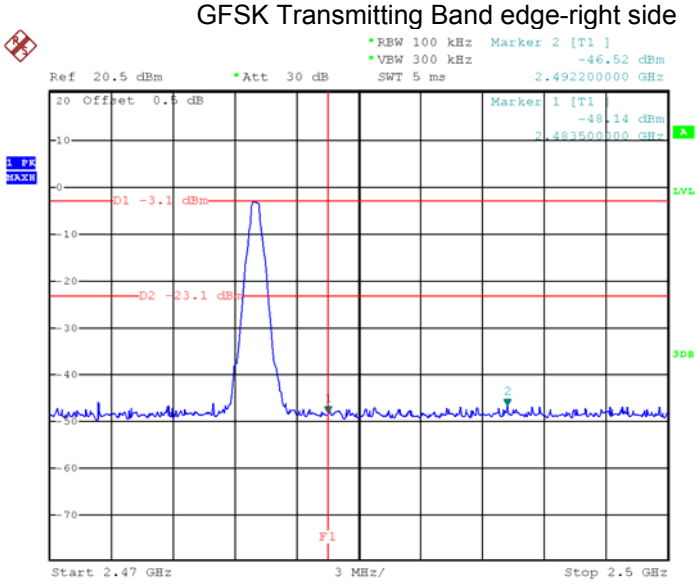
Date: 7.JUN.2023 18:13:30

GFSK Hopping Band edge-left side



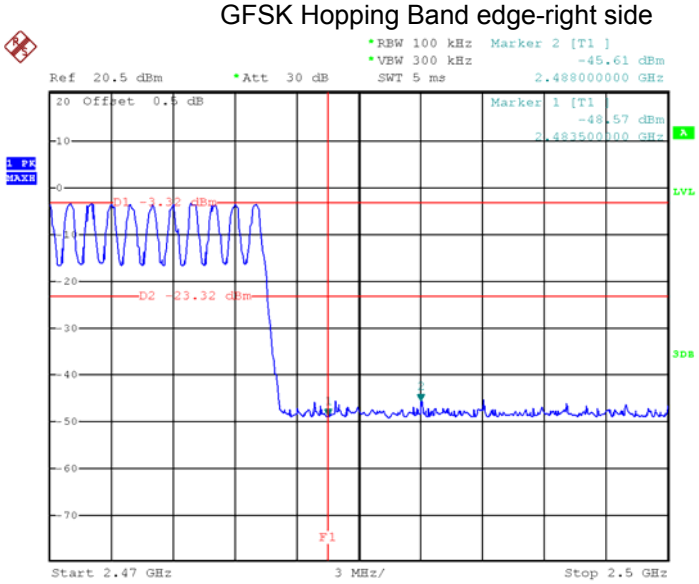
Date: 7.JUN.2023 18:15:51

GFSK Transmitting Band edge-right side



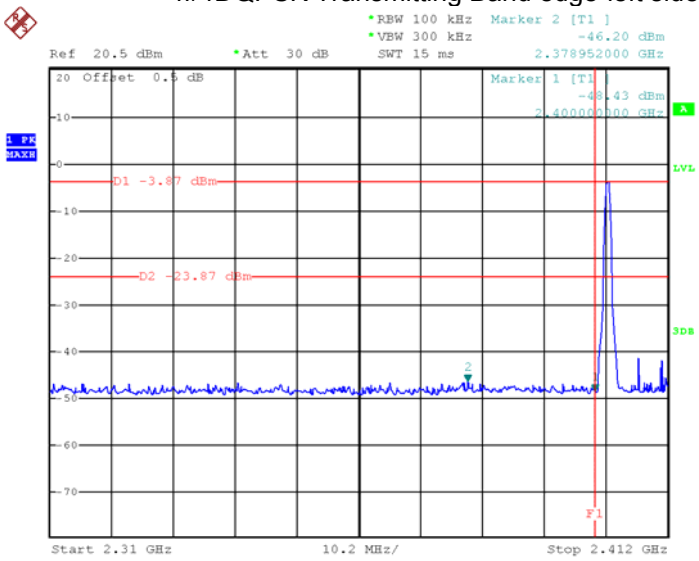
Date: 7.JUN.2023 18:19:03

GFSK Hopping Band edge-right side



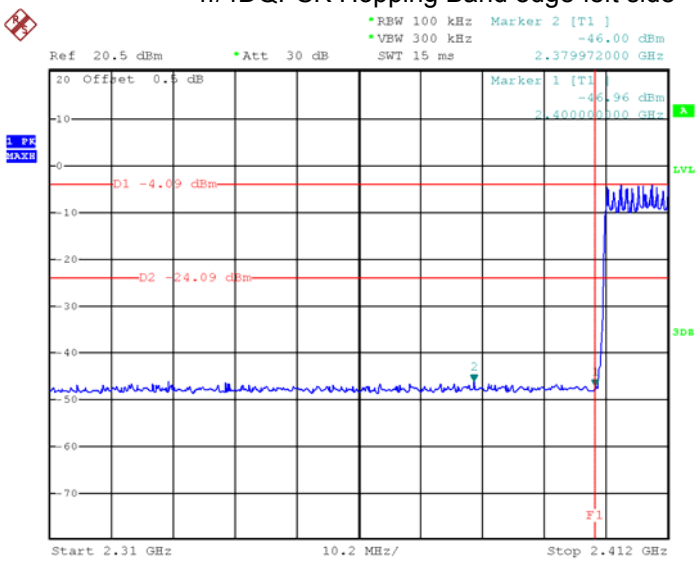
Date: 7.JUN.2023 18:17:38

π/4DQPSK Transmitting Band edge-left side



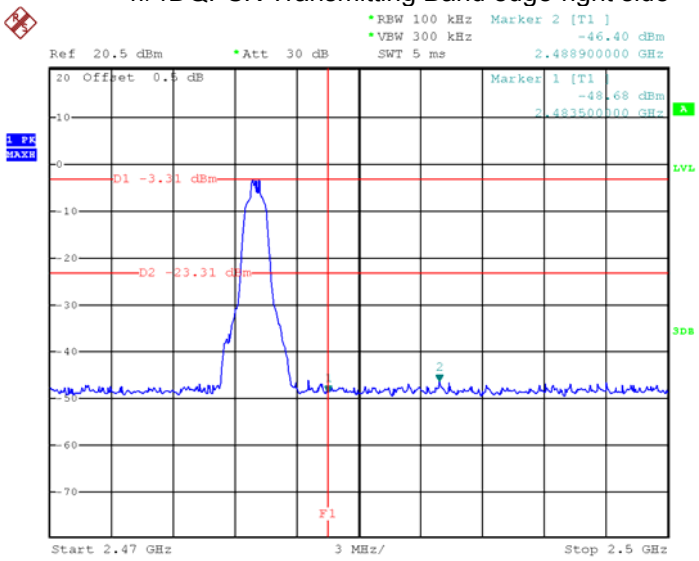
Date: 7.JUN.2023 18:20:55

π/4DQPSK Hopping Band edge-left side



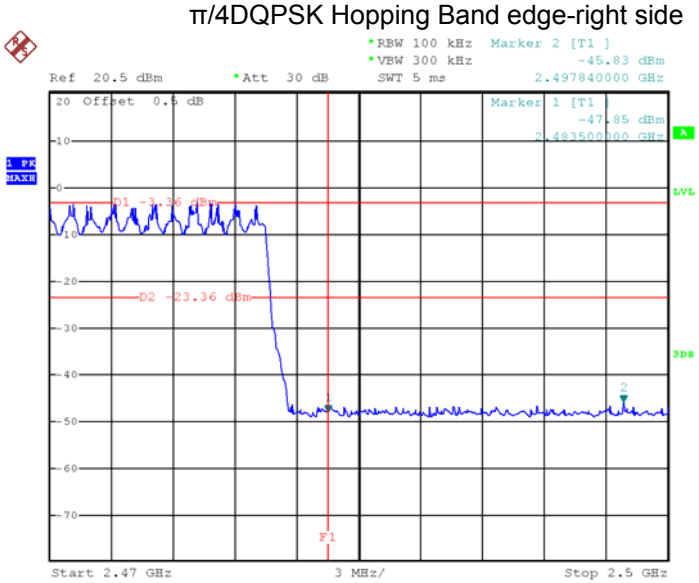
Date: 7.JUN.2023 18:25:00

π/4DQPSK Transmitting Band edge-right side



Date: 7.JUN.2023 18:30:08

π/4DQPSK Hopping Band edge-right side



Date: 7.JUN.2023 18:28:18

11 20 dB Bandwidth and 99% Bandwidth Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Mode: Test in fixing operating frequency at low, Middle, high channel.

11.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

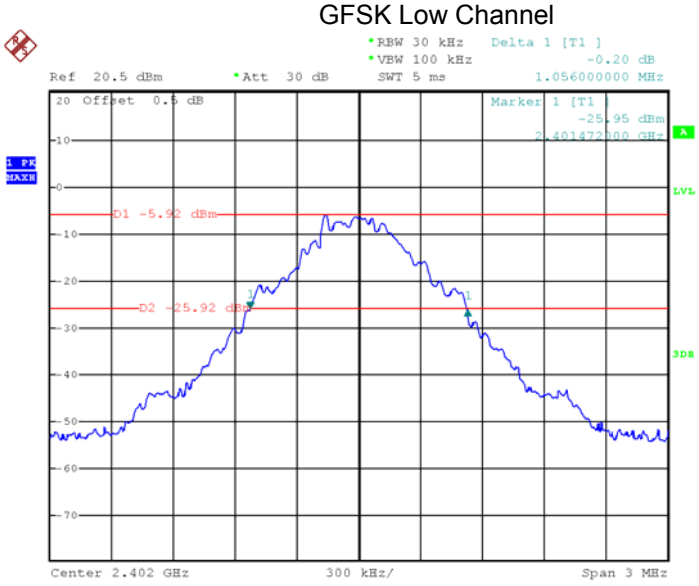
11.2 Test Result

Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
GFSK	Low	1.056	0.966
GFSK	Middle	1.074	0.984
GFSK	High	1.080	0.996
π/4DQPSK	Low	1.344	1.236
π/4DQPSK	Middle	1.350	1.254
π/4DQPSK	High	1.362	1.272

Test plots

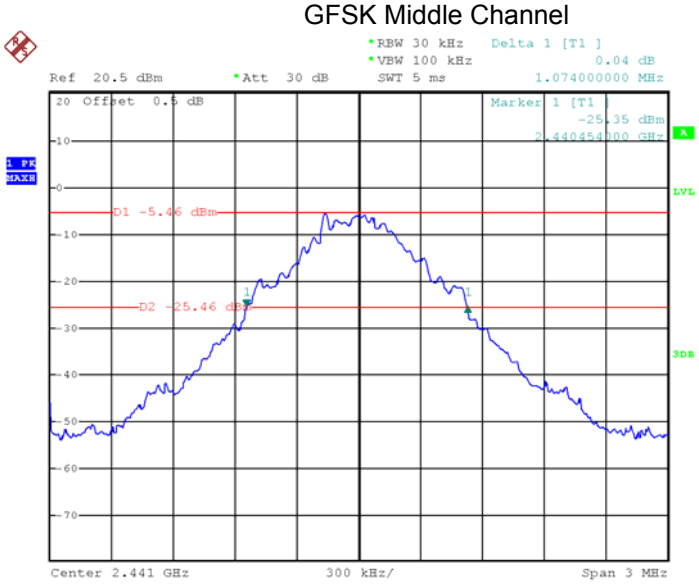
20 dB Bandwidth

GFSK Low Channel



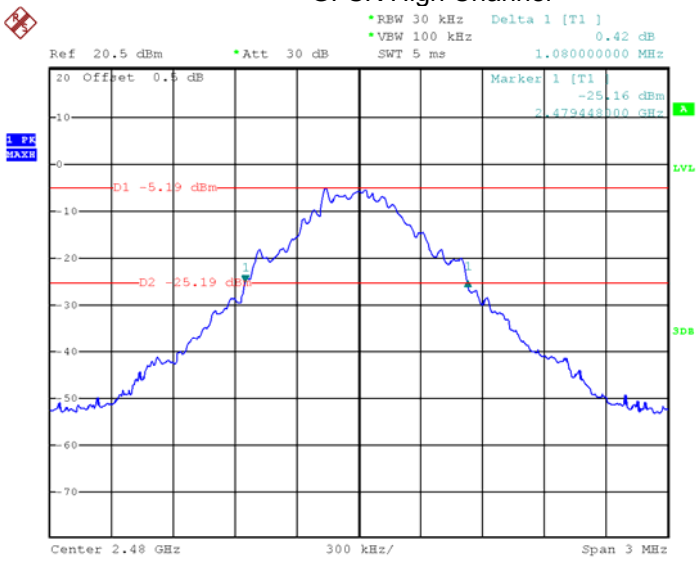
Date: 7.JUN.2023 17:57:04

GFSK Middle Channel



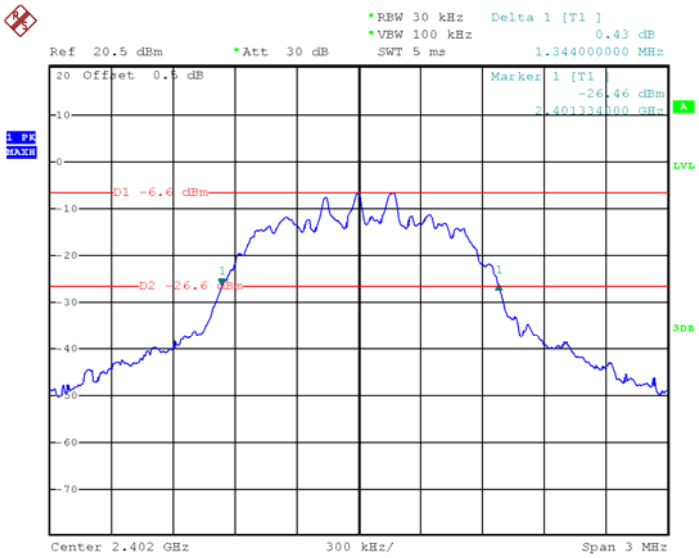
Date: 7.JUN.2023 17:55:58

GFSK High Channel



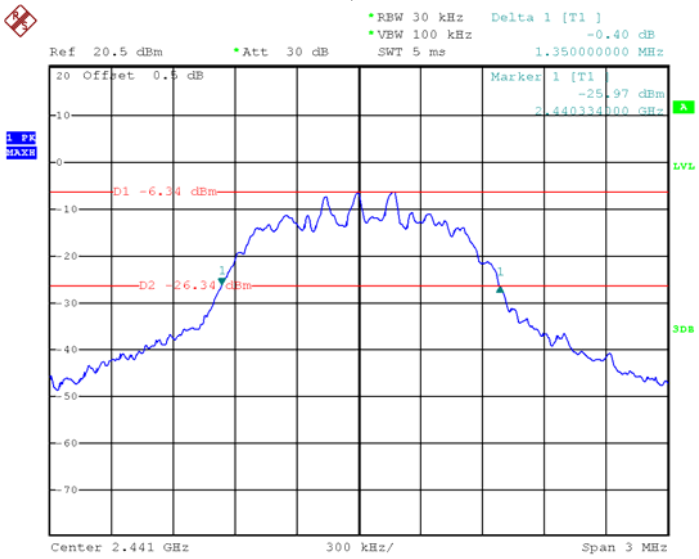
Date: 7.JUN.2023 17:55:03

π/4DQPSK Low Channel



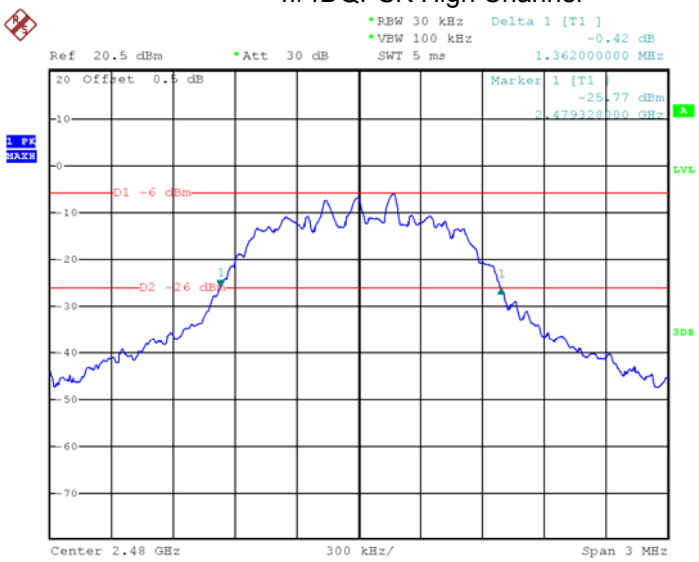
Date: 7.JUN.2023 17:53:04

π/4DQPSK Middle Channel



Date: 7.JUN.2023 17:51:43

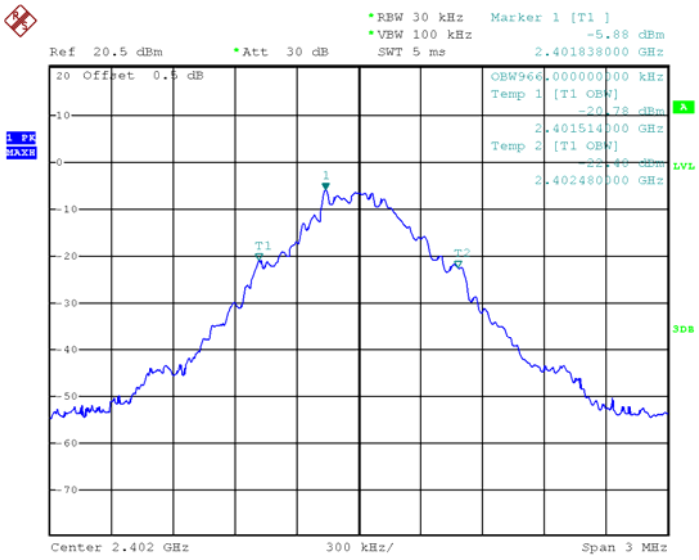
π/4DQPSK High Channel



Date: 7.JUN.2023 17:49:36

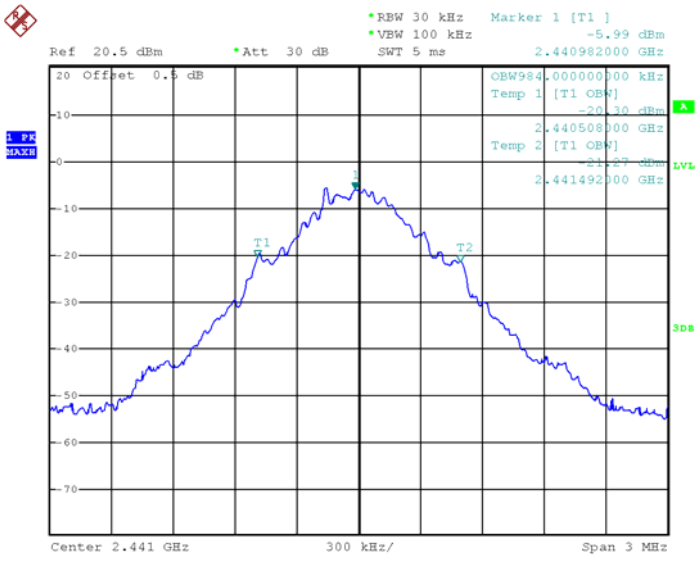
99% Bandwidth

GFSK Low Channel



Date: 7.JUN.2023 17:37:18

GFSK Middle Channel



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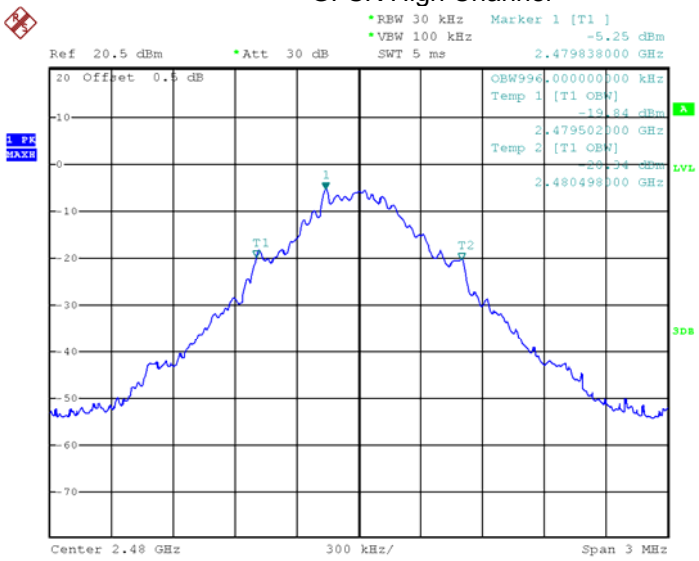
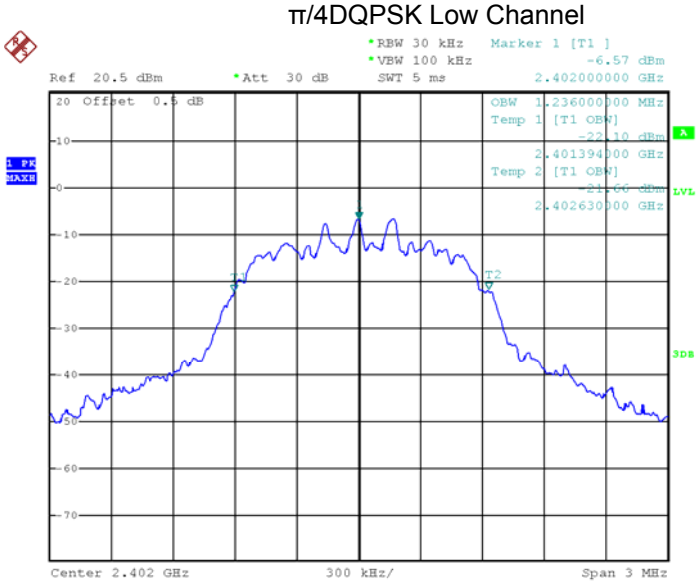
GFSK High Channel



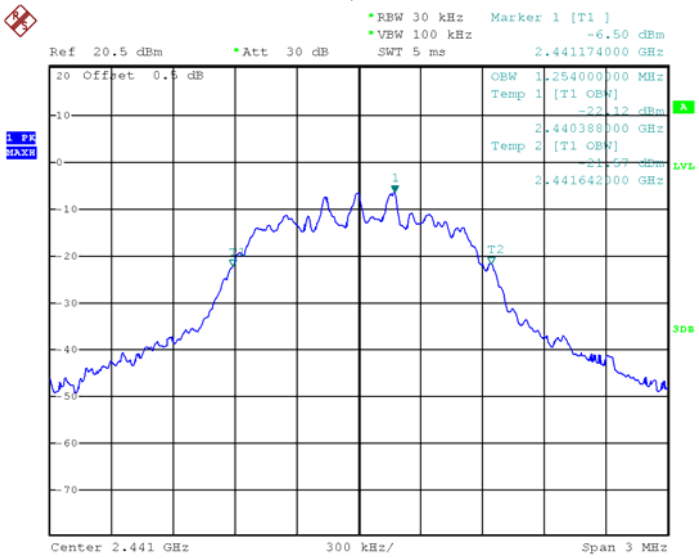
Date: 7.JUN.2023 17:38:39

π/4DQPSK Low Channel



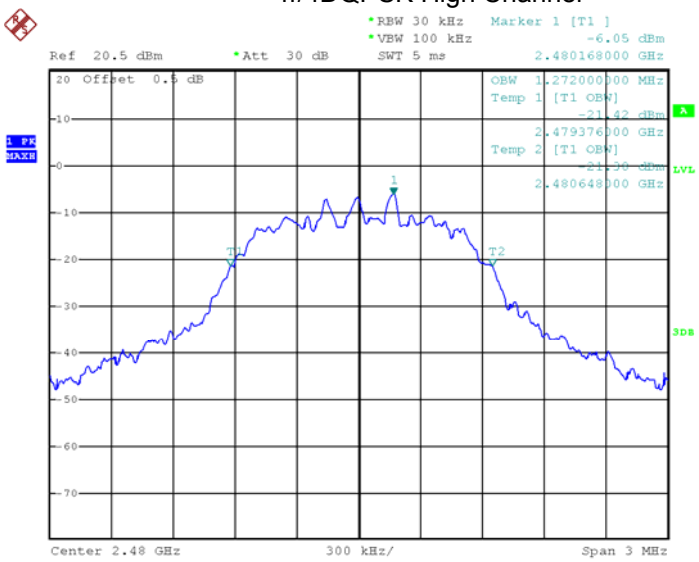
Date: 7.JUN.2023 17:39:44

π/4DQPSK Middle Channel



Date: 7.JUN.2023 17:40:22

π/4DQPSK High Channel



Date: 7.JUN.2023 17:41:20

12 Maximum Peak Output Power

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247 (a)(1), For frequency hopping systems operating in the 2400 2483.5 MHz band by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater 0.125 watts..

Test mode: Test in fixing frequency transmitting mode.

12.1 Test Procedure

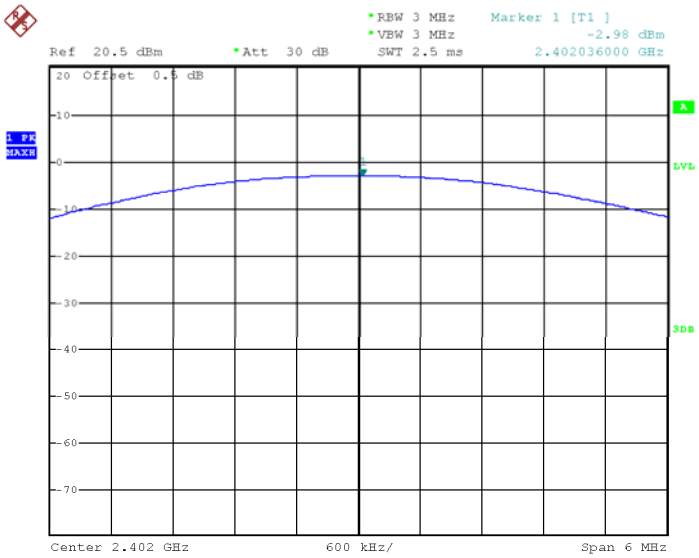
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Use the following spectrum analyzer settings:
      1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
      2) RBW ≥20 dB bandwidth of the emission being measured.
      3) VBW ≥ RBW.
      4) Sweep: Auto.
      5) Detector function: Peak.
      6) Trace: Max hold.
   b) Allow trace to stabilize.
   c) Use the marker-to-peak function to set the marker to the peak of the emission.
   d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
   e) A plot of the test results and setup description shall be included in the test report.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

12.2 Test Result

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	-2.98	30
GFSK	Middle	-2.64	30
GFSK	High	-2.36	30
π/4DQPSK	Low	-2.23	21
π/4DQPSK	Middle	-2.16	21
π/4DQPSK	High	**-1.77**	21

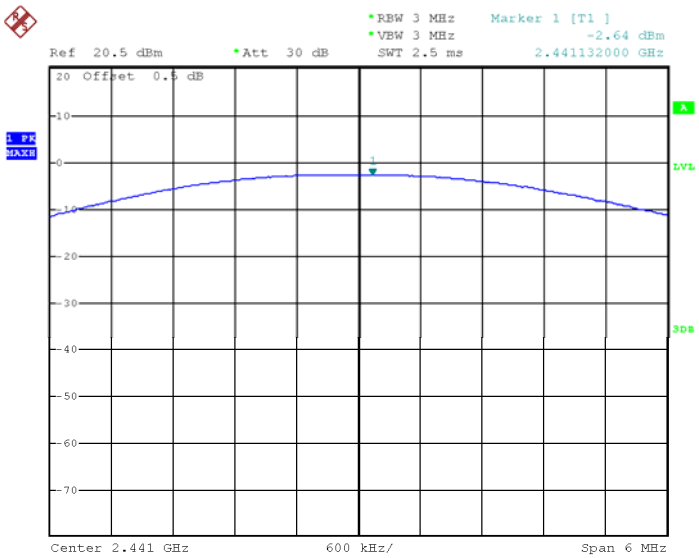
Test plots

GFSK Low Channel



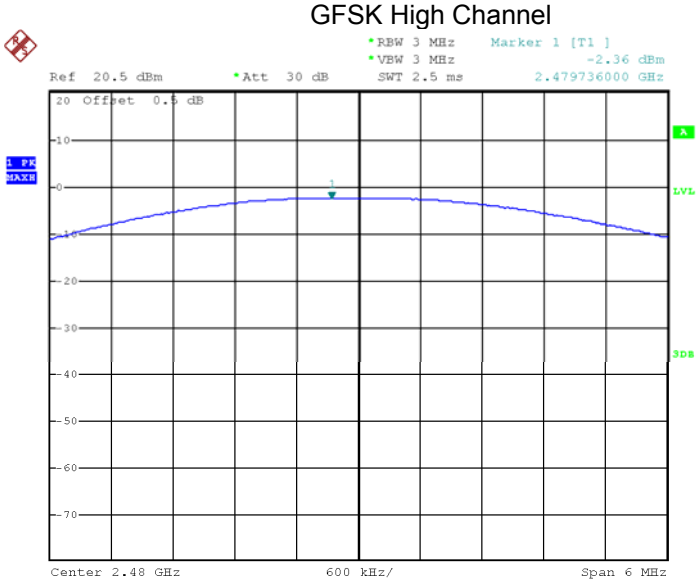
Date: 7.JUN.2023 17:23:16

GFSK Middle Channel



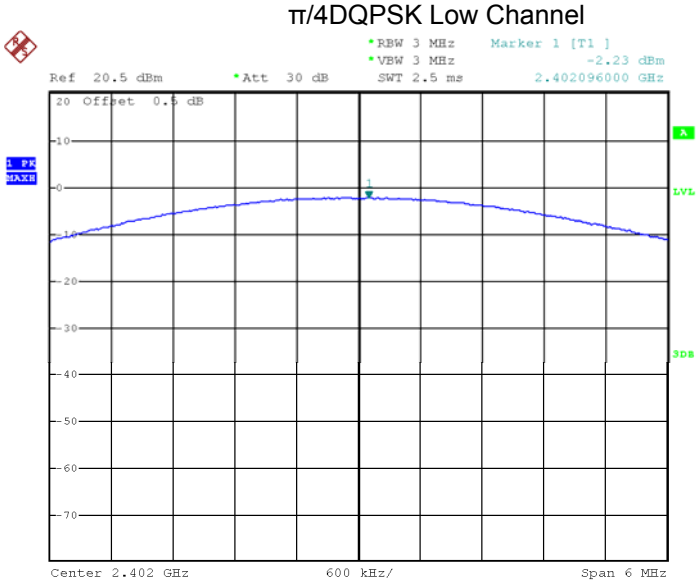
Date: 7.JUN.2023 17:23:54

GFSK High Channel



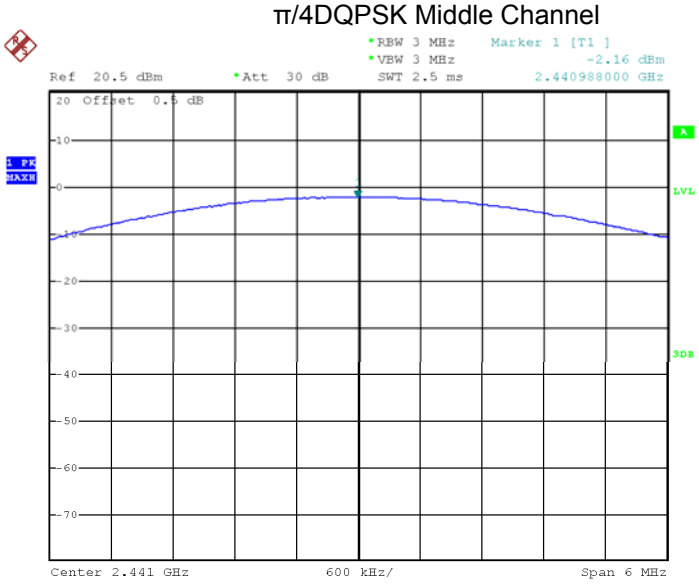
Date: 7.JUN.2023 17:24:19

π/4DQPSK Low Channel



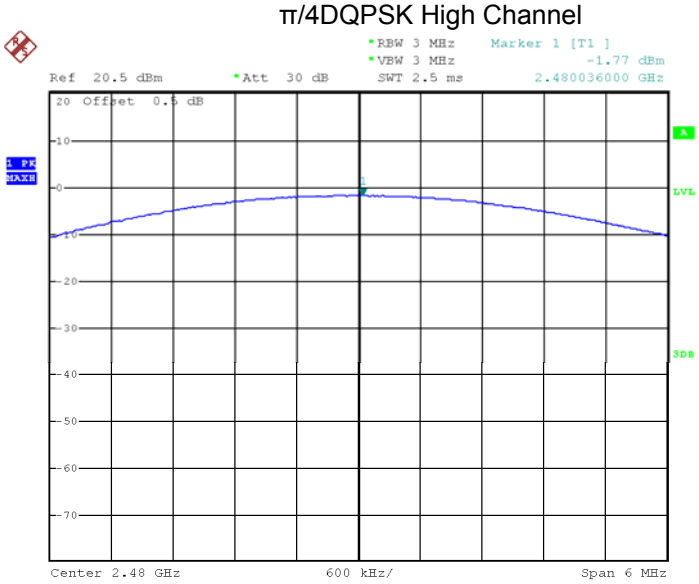
Date: 7.JUN.2023 17:26:08

π/4DQPSK Middle Channel



Date: 7.JUN.2023 17:25:23

π/4DQPSK High Channel



Date: 7.JUN.2023 17:24:51

13 Hopping Channel Separation

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with power no greater than 0.125W.

Test Mode: Test in hopping transmitting operating mode.

13.1 Test Procedure

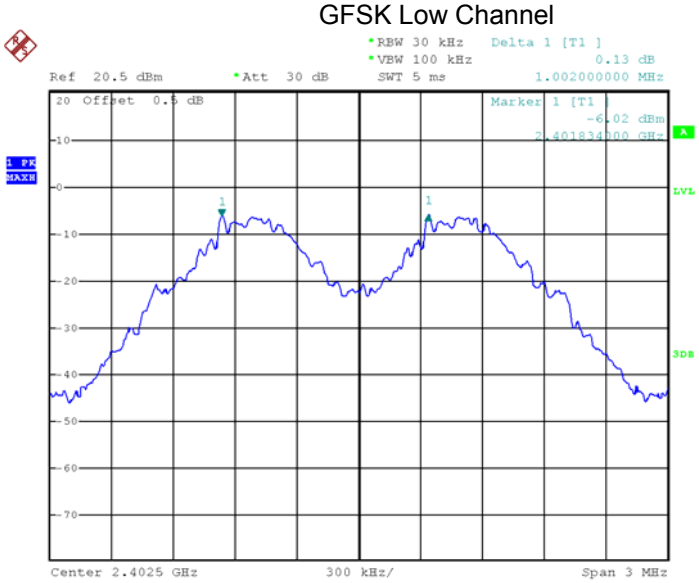
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Span: Wide enough to capture the peaks of two adjacent channels.
   b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
   c) Video (or average) bandwidth (VBW) ≥ RBW.
   d) Sweep: Auto.
   e) Detector function: Peak.
   f) Trace: Max hold.
   g) Allow the trace to stabilize.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

13.2 Test Result

Modulation	Test Channel	Separation (MHz)	Limit(MHz)	Result
GFSK	Low	1.002	0.704	PASS
GFSK	Middle	1.002	0.716	PASS
GFSK	High	1.002	0.720	PASS
π/4DQPSK	Low	1.002	0.896	PASS
π/4DQPSK	Middle	1.002	0.900	PASS
π/4DQPSK	High	1.002	0.908	PASS

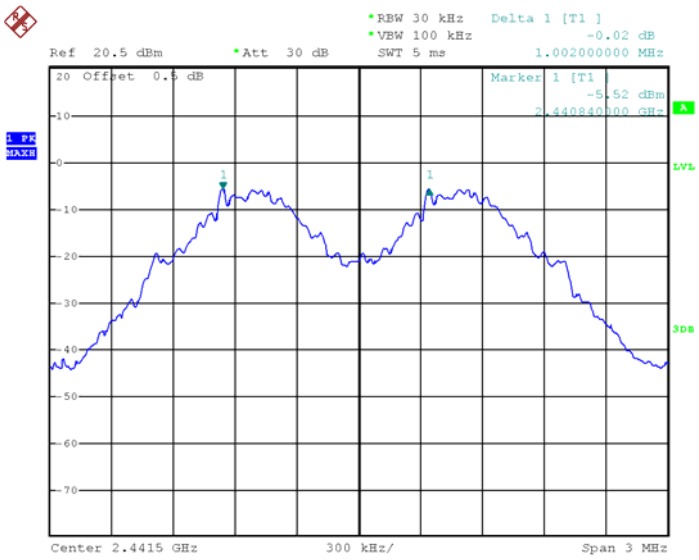
Test plots

GFSK Low Channel



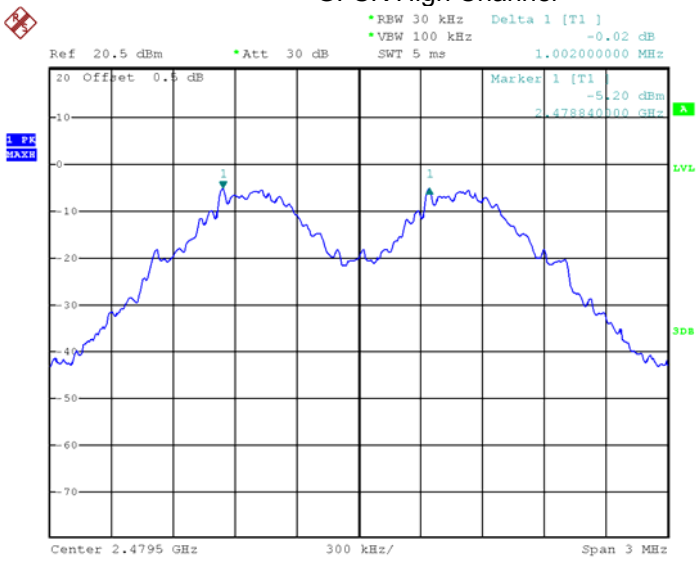
Date: 7.JUN.2023 17:58:01

GFSK Middle Channel



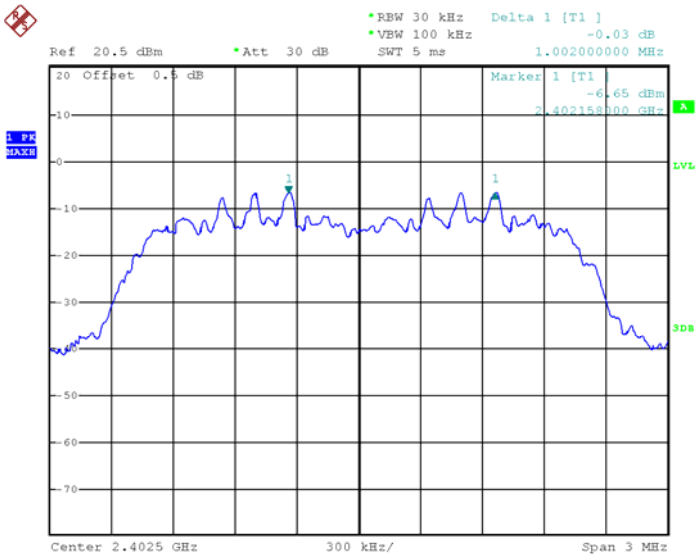
Date: 7.JUN.2023 18:00:06

GFSK High Channel



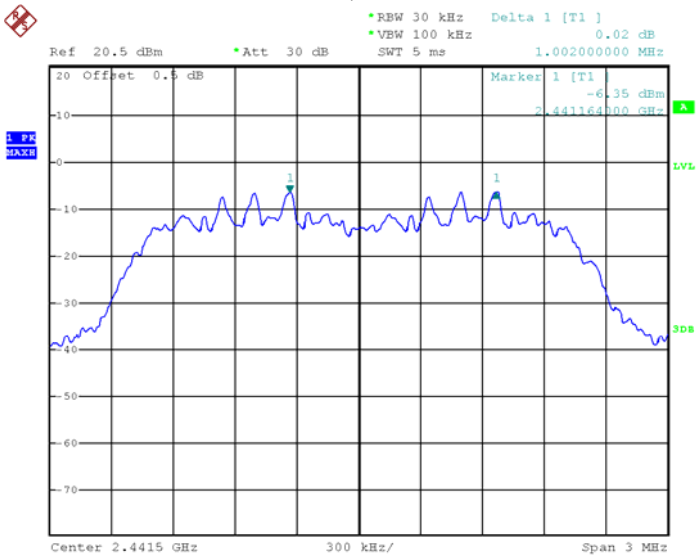
Date: 7.JUN.2023 18:01:45

π/4DQPSK Low Channel



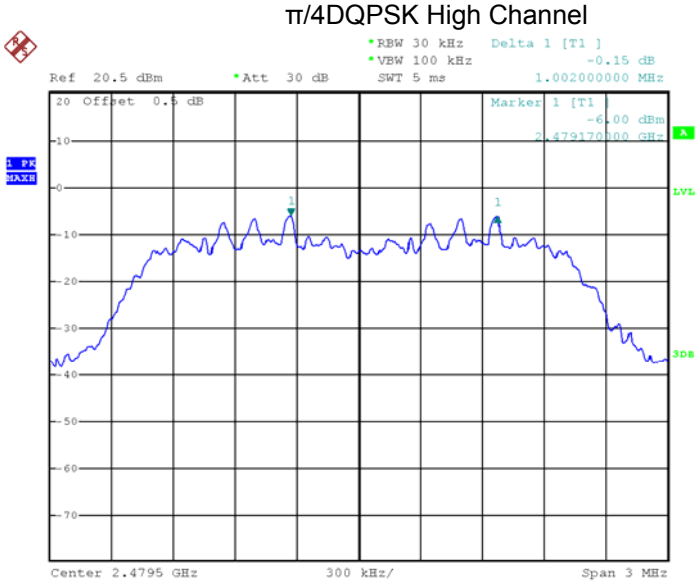
Date: 7.JUN.2023 18:06:59

π/4DQPSK Middle Channel



Date: 7.JUN.2023 18:05:26

π/4DQPSK High Channel



Date: 7.JUN.2023 18:03:26

14 Number of Hopping Frequency

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Mode: Test in hopping transmitting operating mode.

14.1 Test Procedure

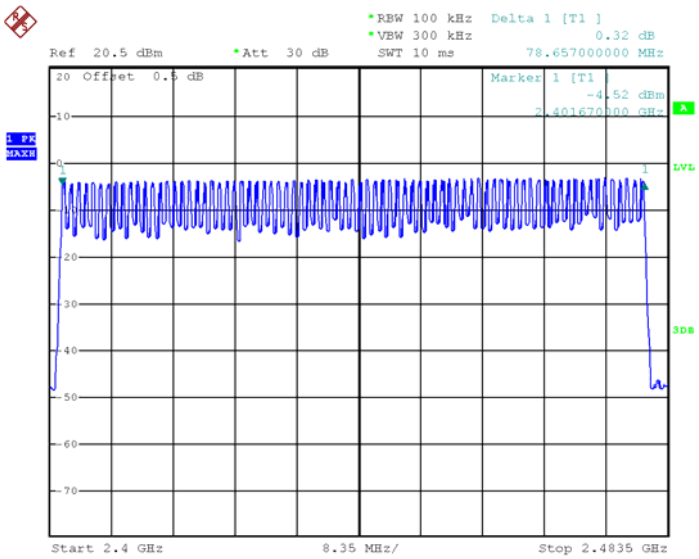
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
   b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
   c) VBW ≥ RBW.
   d) Sweep: Auto.
   e) Detector function: Peak.
   f) Trace: Max hold.
   g) Allow the trace to stabilize..
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

14.2 Test Result

Test Plots:

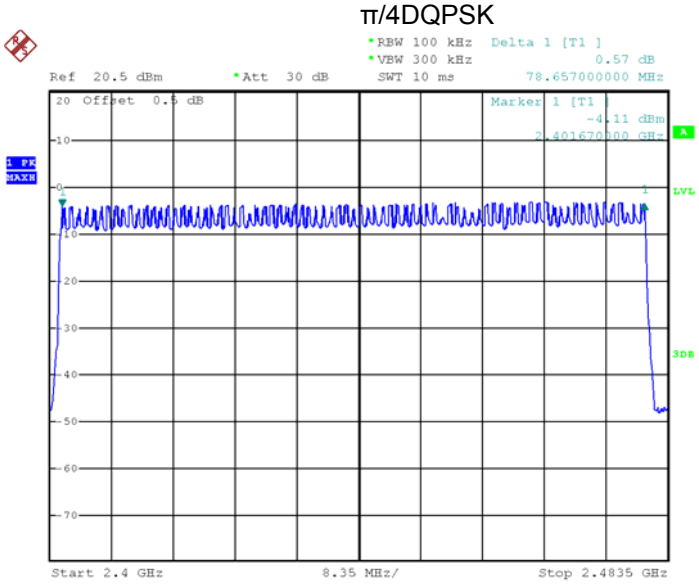
79 Channels in total

GFSK



Date: 7.JUN.2023 19:16:12

π/4DQPSK



Date: 7.JUN.2023 19:12:07

15 Dwell Time

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247(a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Mode: Test in hopping transmitting operating mode.

15.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

15.2 Test Result

DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

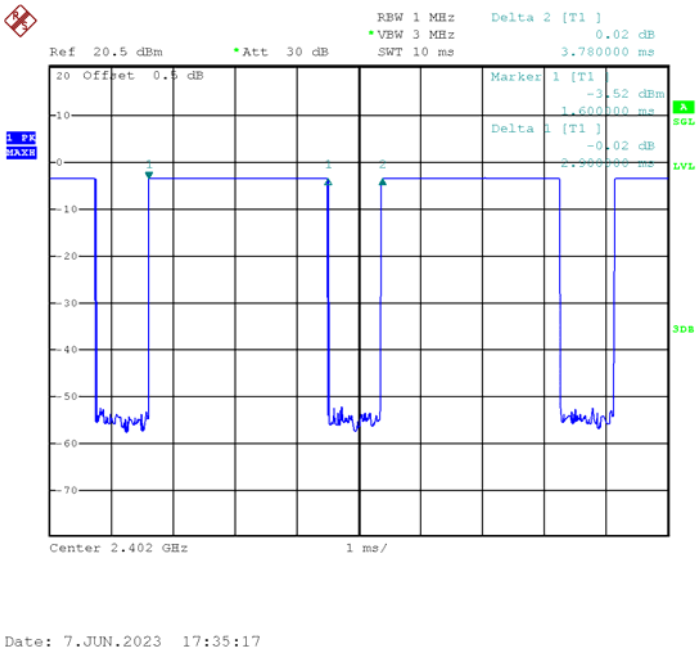
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

Data Packet	Dwell Time(s)
DH5	1600/79/6*0.4*79*(MkrDelta)/1000
DH3	1600/79/4*0.4*79*(MkrDelta)/1000
DH1	1600/79/2*0.4*79*(MkrDelta)/1000
Remark: Mkr Delta is once pulse time.	

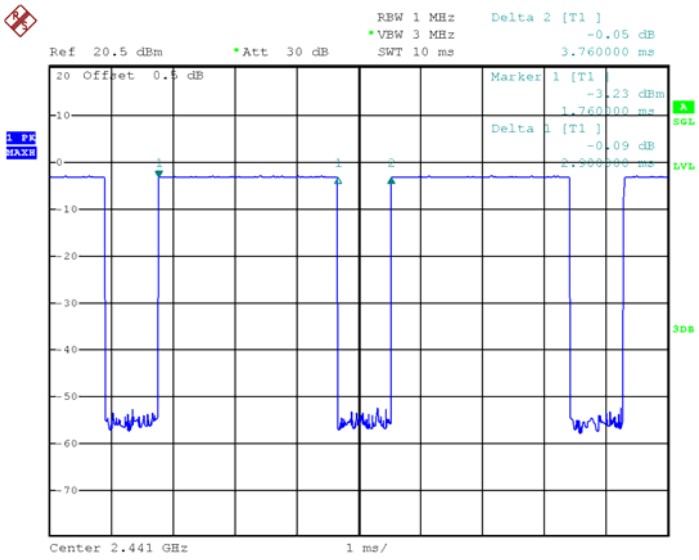
Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	DH5	Low	2.900	0.309	0.4
		middle	2.900	0.309	0.4
		High	2.860	0.305	0.4
π/4DQPSK	2DH5	Low	2.880	0.307	0.4
		middle	2.880	0.307	0.4
		High	2.880	0.307	0.4

Remark: Only the worst-case mode DH5 is recorded.

Test Plots
GFSK DH5 Low Channel

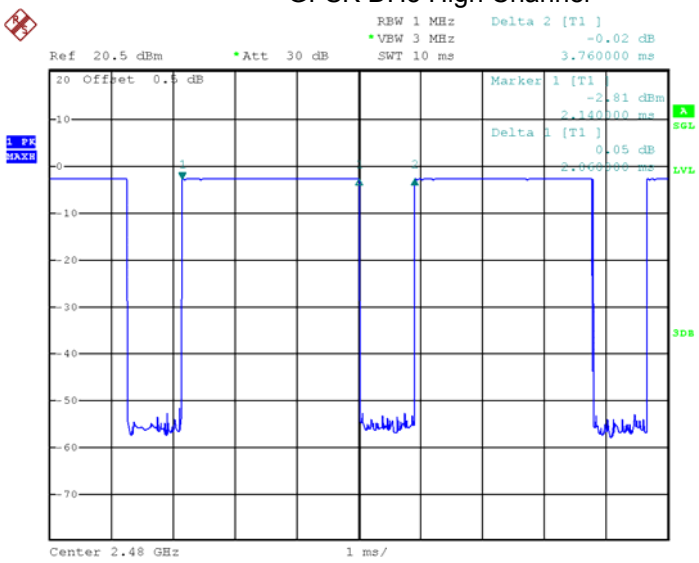


GFSK DH5 Middle Channel



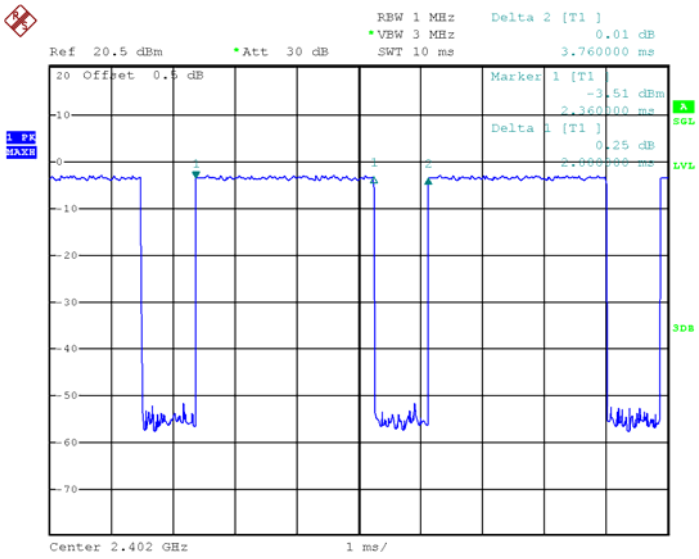
Date: 7.JUN.2023 17:34:23

GFSK DH5 High Channel



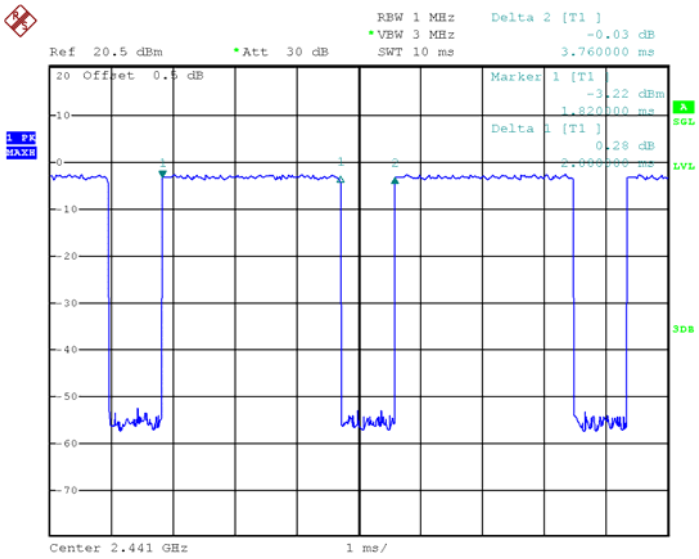
Date: 7.JUN.2023 17:36:13

π/4DQPSK 2DH5 Low Channel



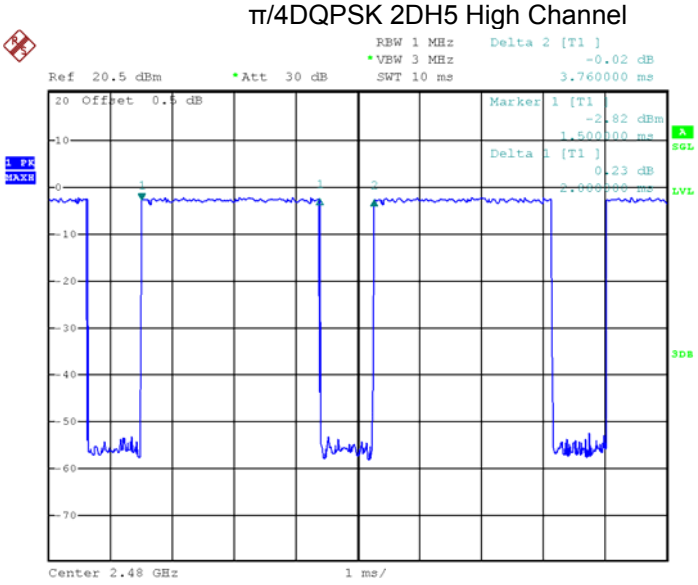
Date: 7.JUN.2023 17:31:16

π/4DQPSK 2DH5 Middle Channel



Date: 7.JUN.2023 17:32:02

π/4DQPSK 2DH5 High Channel



Date: 7.JUN.2023 17:32:49

16 Antenna Requirement

According to the FCC Part 15 Paragraph 15.203, 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. This product has an integrated antenna, fulfil the requirement of this section.

17 RF Exposure

Remark: refer to MPE test report: WTF23D05104063W003.

18 Photographs of test setup and EUT.

Note: Please refer to appendix: Appendix-SP-SG2BT -Photos.

======End of Report======