TEST REPORT

Reference No.	:	WTD24D04092509W002
FCC ID	:	2BF9D-ZYS01-S6
Applicant	:	Suzhou Zhongye Sauna Equipment Co., Ltd.
Address	:	Ruikang Science and Technology Park, No. 82 Suli Road, Wuzhong District, Suzhou City, China
Manufacturer	:	Suzhou Zhongye Sauna Equipment Co., Ltd.
Address	:	Ruikang Science and Technology Park, No. 82 Suli Road, Wuzhong District, Suzhou City, China
Product	:	Far infrared sauna room, sauna room, sauna controller, intelligent sauna controller
Model(s)	:	ZY-S1, ZY-S2, ZY-S3, ZY-S4, ZY-S5, ZY-S6
Standards	:	FCC 47CFR Part 15.247
Date of Receipt sample	:	2024-04-24
Date of Test	:	2024-04-24 to 2024-05-29
Date of Issue	:	2024-06-03
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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3 Revision History

Test Report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTD24D04092509W002	2024-04-24	2024-04-24 to 2024-05-29	2024-06-03	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	Far infrared sauna room, sauna room, sauna controller, intelligent sauna controller
Model(s):	ZY-S1, ZY-S2, ZY-S3, ZY-S4, ZY-S5, ZY-S6
Model Description:	Only the model names are different. Model ZY-S2 was tested in the report.
Test Sample No.:	1-1/1
Bluetooth Version:	5.0
Hardware Version:	SX41V12
Software Version:	SX41_V10.0

4.2 Details of E.U.T.

Operation Frequency:	2402~2480MHz
Max. RF output power:	4.00dBm
Type of Modulation:	GFSK, π/4DQPSK
Antenna installation:	PCB printed antenna
Antenna Gain:	2.5dBi

Note:

#: The antenna gain is provided by the applicant, and the applicant should be responsible for its authenticity, WALTEK lab has not verified the authenticity of its information.

Ratings:	AC 220V/110V, 50Hz/60Hz, 2000W

4.3 Channel List

Normal

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	-	-

4.4 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

4.5 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.

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)	1.1307(b)(1)	PASS

6 Equipment Used during Test

6.1 Equipments List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Calibration Due Date
Conducted Emissions 1#						
1	EMI Test Receiver	R&S	ESCI	100947	2023-07-27	2024-07-26
2	LISN	R&S	ENV216	100115	2023-07-27	2024-07-26
3	Cable	Top	TYPE16(3.5M)	-	2023-07-27	2024-07-26
3m Semi-anechoic Chamber for Radiation Emissions 1#						
1	Spectrum Analyzer	R&S	FSP30	100091	2024-04-22	2025-04-21
2	Amplifier	Agilent	8447D	2944A10178	2023-07-27	2024-07-26
3	Tri-log Broadband Antenna	SCHWARZBECK	VULB9163	336	2023-08-07	2024-08-06
4	Coaxial Cable	Top	TYPE16(13M)	-	2024-04-22	2025-04-21
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120D	667	2024-01-23	2025-01-22
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2023-08-02	2024-08-01
7	Broadband Preamplifier	COMPLIANCE	PAP-1G18	2004	2023-07-27	2024-07-26
8	Coaxial Cable	Top	ZT26-NJ-NJ-8M/FA	-	2024-04-22	2025-04-21
9	Microwave Amplifier	SCHWARZBECK	BBV 9721	100472	2023-07-27	2024-07-26
10	Coaxial Cable	Top	ZT40-2.92J-2.92J-2.0M	17100919	2024-04-22	2025-04-21
3m Semi-anechoic Chamber for Radiation Emissions 2#						
1	Test Receiver	R&S	ESCI	101296	2024-04-22	2025-04-21
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2023-11-04	2024-11-03
3	Active Loop Antenna	Com-Power	AL-130R	10160007	2023-05-07	2024-05-06
4	Amplifier	ANRITSU	MH648A	M43381	2024-04-22	2025-04-21
5	Cable	HUBER+SUHNER	CBL2	525178	2024-04-22	2025-04-21
RF Conducting						
1	Spectrum Analyzer	R&S	FSP40	100501	2023-07-27	2024-07-26
2	Spectrum Analyzer	Agilent	N9020A	MY49100060	2023-07-27	2024-07-26

Test Software:

Test Item	Software name	Software version
Conduction disturbance Radiated Emission(3m)	EZ-EMC	EZ-EMC(RA-03A1-1)

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
/	/	/	/

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	

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-pea	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

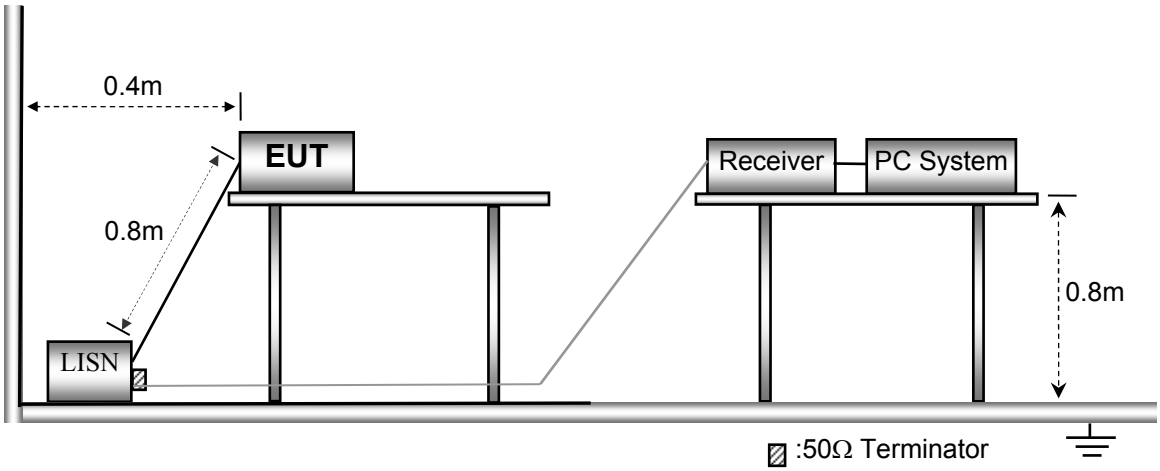
Atmospheric Pressure: 101.2kPa

EUT Operation:

The test was performed in Transmitting mode, the worst 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.



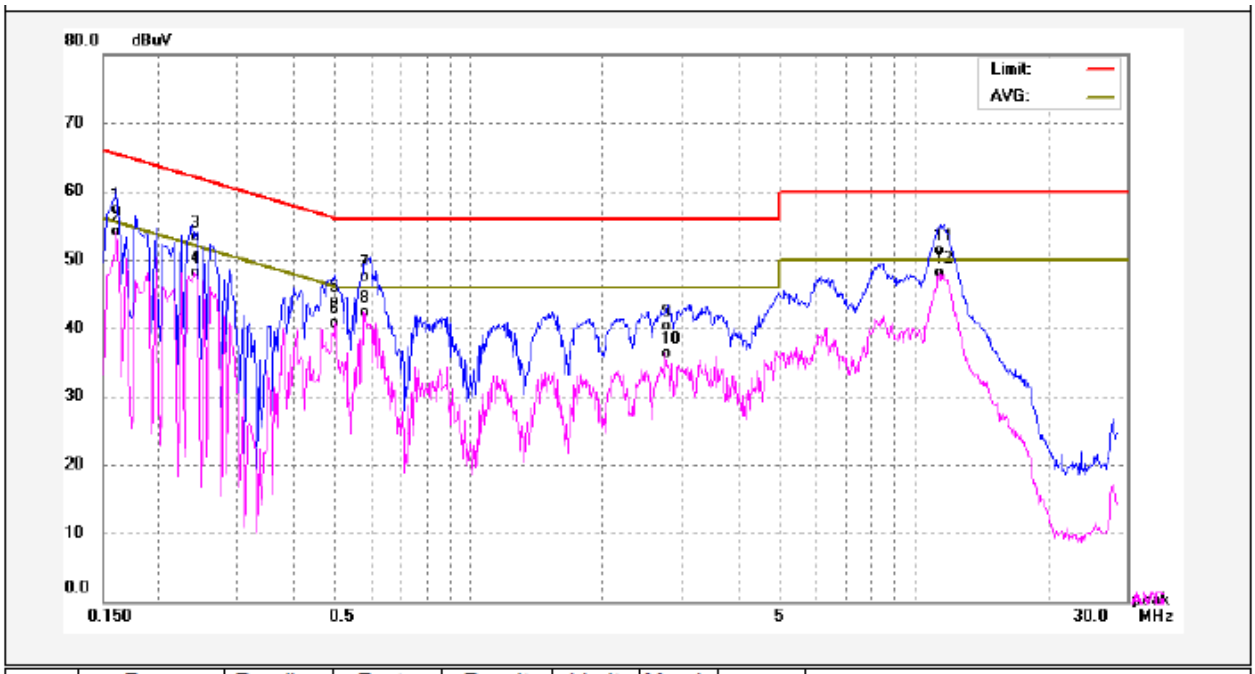
7.3 Measurement Description

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

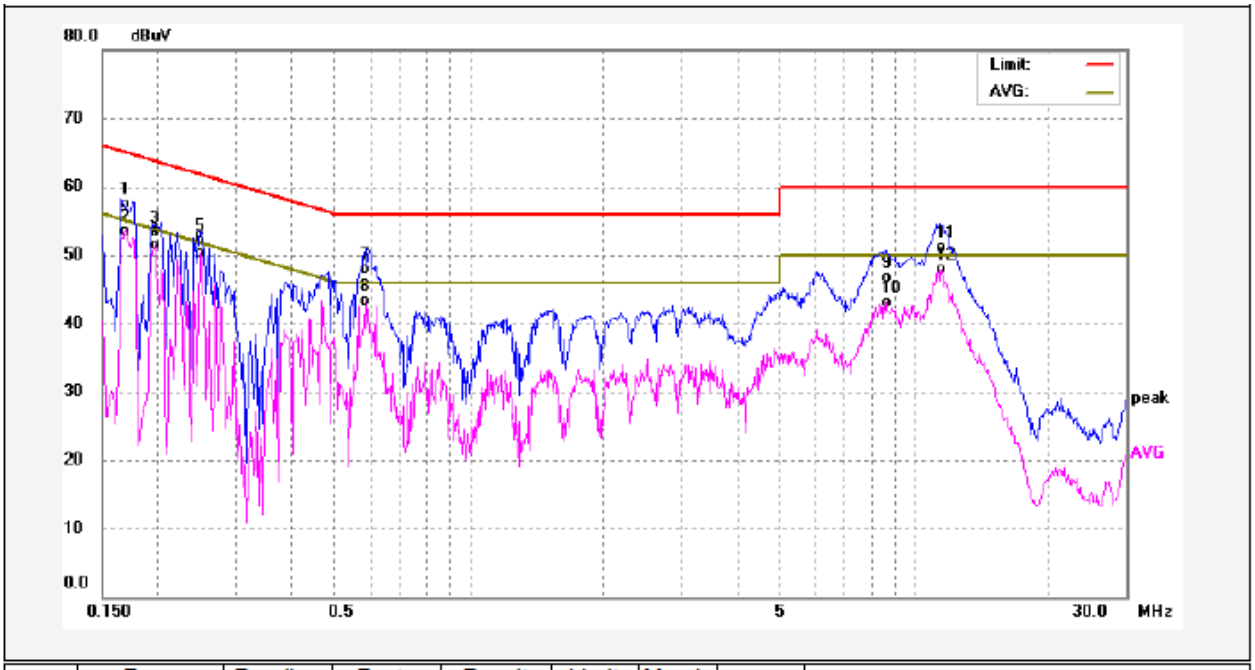
Remark: only the worst data (GFSK modulation Low channel mode) were reported

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1620	46.46	10.92	57.38	65.36	-7.98	QP	
2	0.1620	43.15	10.92	54.07	55.36	-1.29	AVG	
3	0.2419	42.27	10.94	53.21	62.03	-8.82	QP	
4	0.2419	37.23	10.94	48.17	52.03	-3.86	AVG	
5	0.5020	32.99	10.99	43.98	56.00	-12.02	QP	
6	0.5020	29.70	10.99	40.69	46.00	-5.31	AVG	
7	0.5816	36.57	10.99	47.56	56.00	-8.44	QP	
8	0.5816	31.29	10.99	42.28	46.00	-3.72	AVG	
9	2.7540	29.10	11.13	40.23	56.00	-15.77	QP	
10	2.7540	25.16	11.13	36.29	46.00	-9.71	AVG	
11	11.2979	39.73	11.51	51.24	60.00	-8.76	QP	
12	11.2979	36.59	11.51	48.10	50.00	-1.90	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1700	46.51	10.95	57.46	64.96	-7.50	QP	
2	0.1700	42.63	10.95	53.58	54.96	-1.38	AVG	
3	0.1980	42.28	10.96	53.24	63.69	-10.45	QP	
4	0.1980	40.46	10.96	51.42	53.69	-2.27	AVG	
5	0.2500	41.16	10.97	52.13	61.75	-9.62	QP	
6	0.2500	39.27	10.97	50.24	51.75	-1.51	AVG	
7	0.5856	36.89	11.00	47.89	56.00	-8.11	QP	
8	0.5856	32.23	11.00	43.23	46.00	-2.77	AVG	
9	8.6819	35.24	11.44	46.68	60.00	-13.32	QP	
10	8.6819	31.67	11.44	43.11	50.00	-6.89	AVG	
11	11.5014	39.68	11.52	51.20	60.00	-8.80	QP	
12	11.5014	36.38	11.52	47.90	50.00	-2.10	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

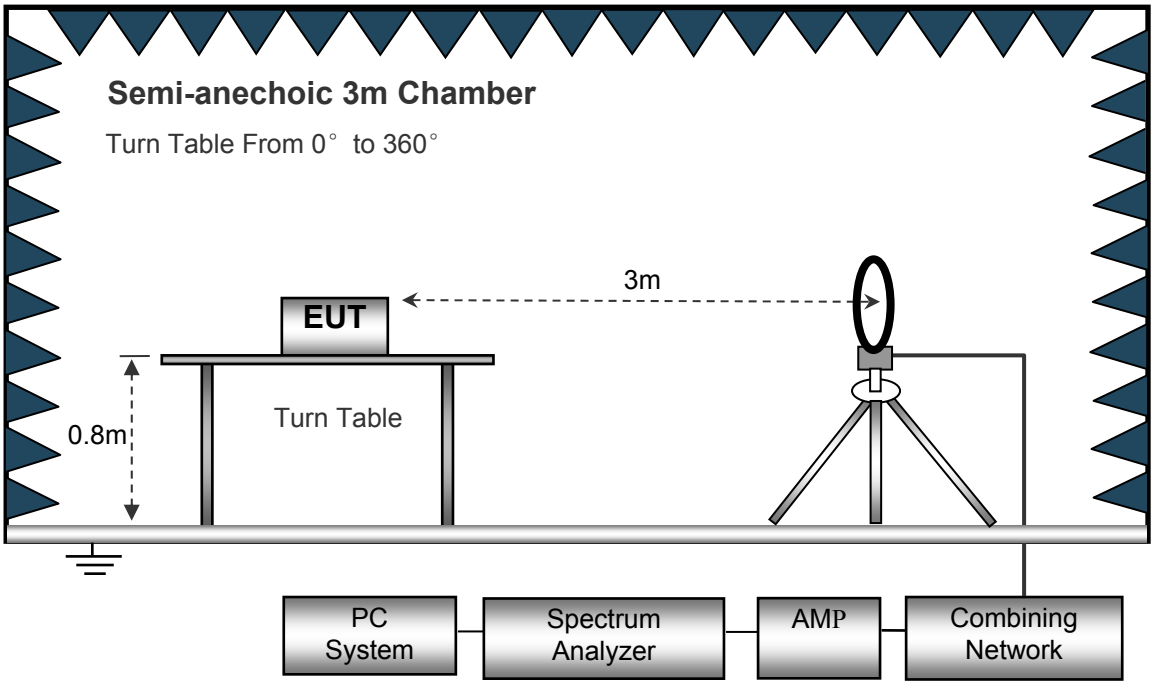
EUT Operation :

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

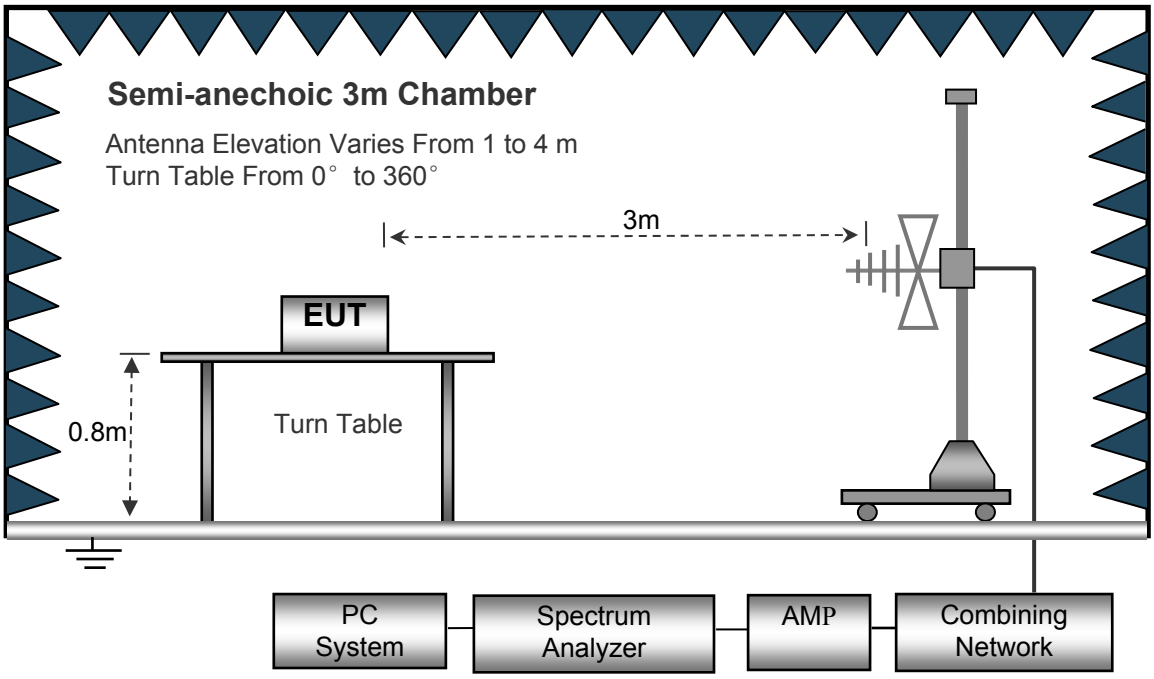
8.2 Test Setup

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

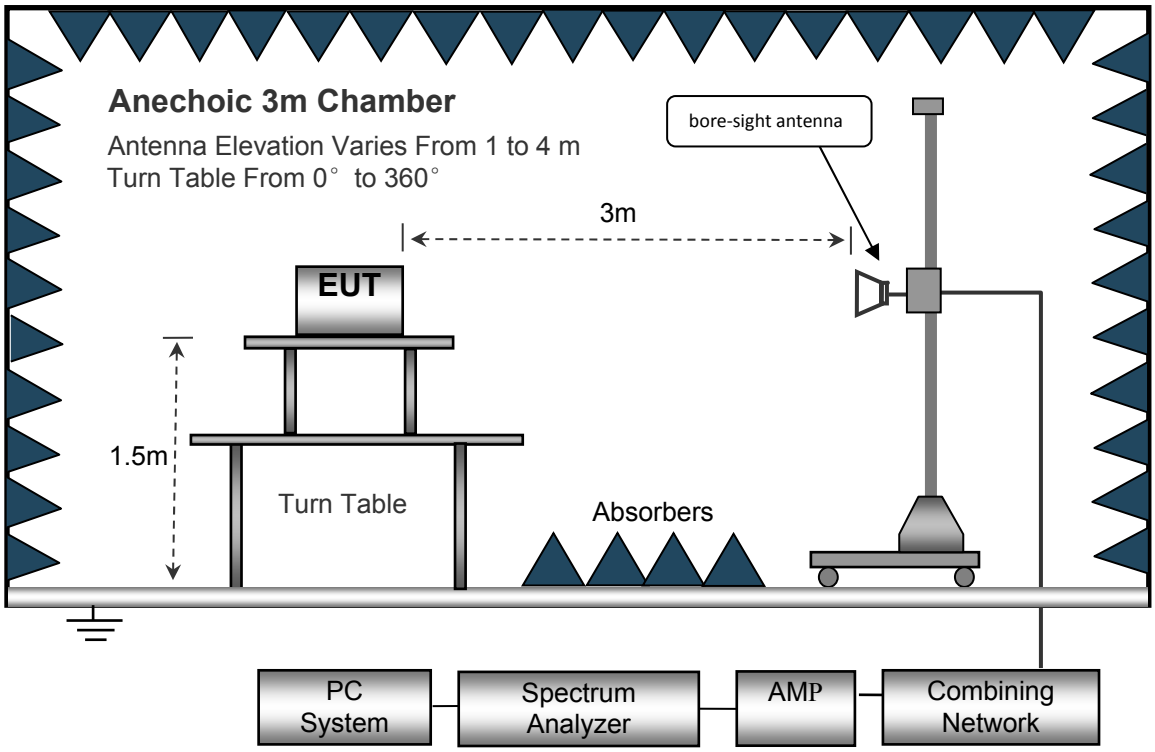
The test setup for emission measurement below 30MHz.



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

Remark: only the worst data (π/4DQPSK modulation mode) were reported.

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									
269.58	43.04	QP	263	1.6	H	-13.22	29.82	46.00	-16.18
269.58	46.60	QP	279	1.1	V	-13.22	33.38	46.00	-12.62
4804.00	51.73	PK	255	1.7	V	-1.06	50.67	74.00	-23.33
4804.00	40.16	Ave	255	1.7	V	-1.06	39.10	54.00	-14.90
7206.00	52.19	PK	218	1.3	H	1.32	53.51	74.00	-20.49
7206.00	41.56	Ave	218	1.3	H	1.32	42.88	54.00	-11.12
2348.77	46.64	PK	337	1.6	V	-13.26	33.38	74.00	-40.62
2348.77	37.27	Ave	337	1.6	V	-13.26	24.01	54.00	-29.99
2376.02	43.53	PK	141	1.7	H	-13.02	30.51	74.00	-43.49
2376.02	37.01	Ave	141	1.7	H	-13.02	23.99	54.00	-30.01
2493.87	44.47	PK	82	1.3	V	-13.20	31.27	74.00	-42.73
2493.87	38.23	Ave	82	1.3	V	-13.20	25.03	54.00	-28.97

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									
269.58	42.42	QP	267	1.4	H	-13.22	29.20	46.00	-16.80
269.58	45.30	QP	231	1.2	V	-13.22	32.08	46.00	-13.92
4882.00	51.20	PK	207	1.1	V	-0.62	50.58	74.00	-23.42
4882.00	39.15	Ave	207	1.1	V	-0.62	38.53	54.00	-15.47
7323.00	50.98	PK	286	1.6	H	2.21	53.19	74.00	-20.81
7323.00	40.19	Ave	286	1.6	H	2.21	42.40	54.00	-11.60
2341.29	46.04	PK	210	1.3	V	-13.19	32.85	74.00	-41.15
2341.29	36.61	Ave	210	1.3	V	-13.19	23.42	54.00	-30.58
2389.16	42.57	PK	266	1.5	H	-13.14	29.43	74.00	-44.57
2389.16	35.88	Ave	266	1.5	H	-13.14	22.74	54.00	-31.26
2489.54	44.15	PK	117	1.4	V	-13.08	31.07	74.00	-42.93
2489.54	38.17	Ave	117	1.4	V	-13.08	25.09	54.00	-28.91

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									
269.58	42.49	QP	191	1.6	H	-13.22	29.27	46.00	-16.73
269.58	44.22	QP	347	1.6	V	-13.22	31.00	46.00	-15.00
4960.00	50.37	PK	95	1.7	V	-0.24	50.13	74.00	-23.87
4960.00	37.81	Ave	95	1.7	V	-0.24	37.57	54.00	-16.43
7440.00	49.96	PK	290	1.2	H	2.84	52.80	74.00	-21.20
7440.00	39.15	Ave	290	1.2	H	2.84	41.99	54.00	-12.01
2324.33	45.75	PK	286	1.8	V	-13.19	32.56	74.00	-41.44
2324.33	36.74	Ave	286	1.8	V	-13.19	23.55	54.00	-30.45
2381.58	41.54	PK	323	1.4	H	-13.14	28.40	74.00	-45.60
2381.58	35.74	Ave	323	1.4	H	-13.14	22.60	54.00	-31.40
2484.41	43.75	PK	279	1.5	V	-13.08	30.67	74.00	-43.33
2484.41	36.89	Ave	279	1.5	V	-13.08	23.81	54.00	-30.19

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

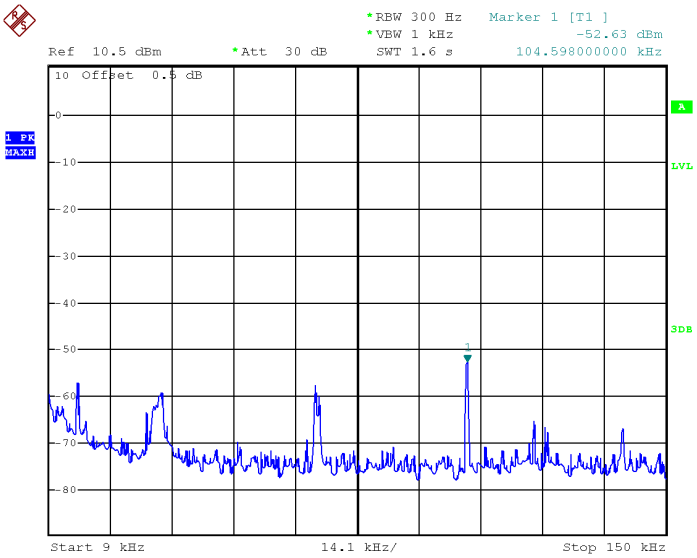
Detector function = peak, Trace = max hold

9.2 Test Result

9kHz – 150kHz

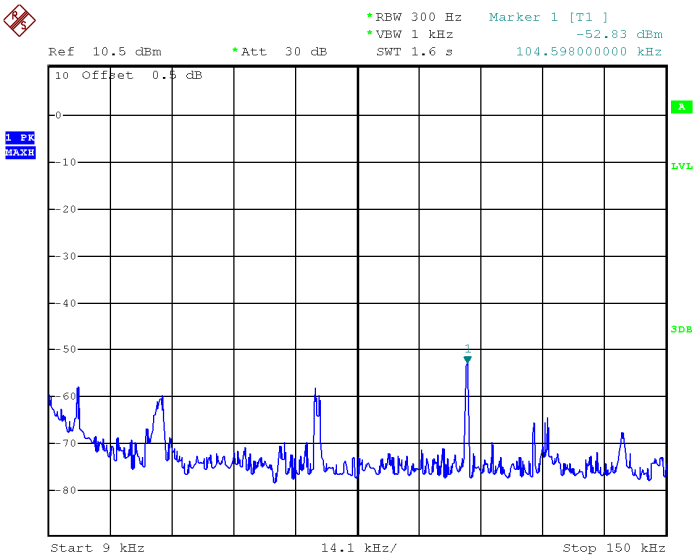
GFSK

Low Channel



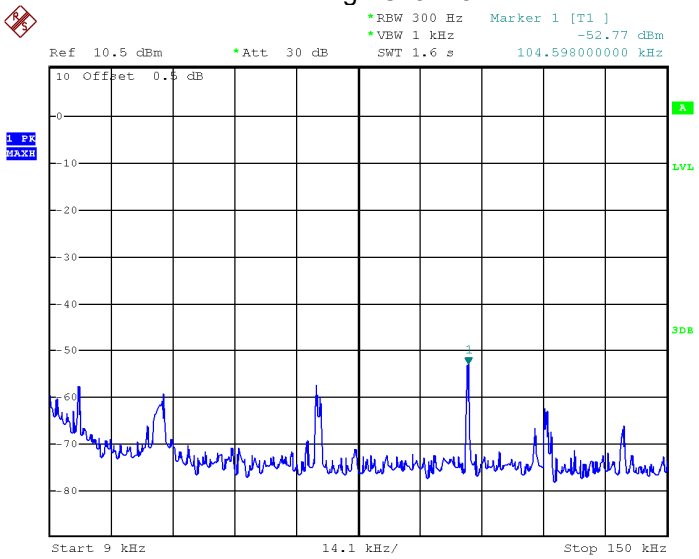
Date: 29.APR.2024 10:05:46

Middle Channel



Date: 29.APR.2024 10:06:06

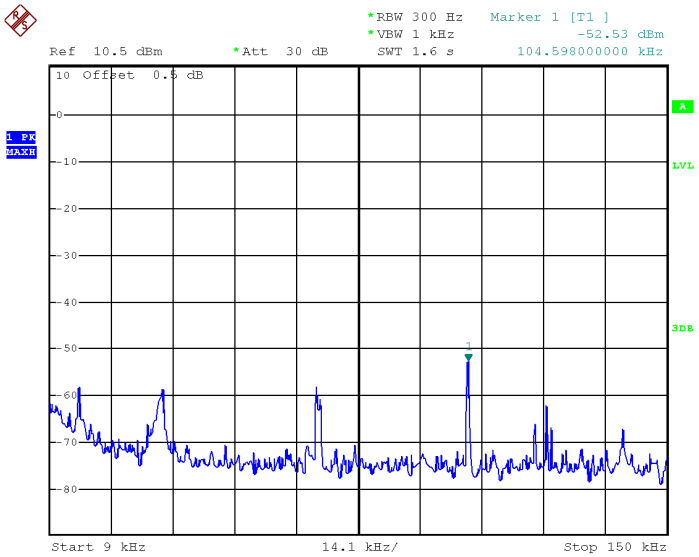
High Channel



Date: 29.APR.2024 10:06:33

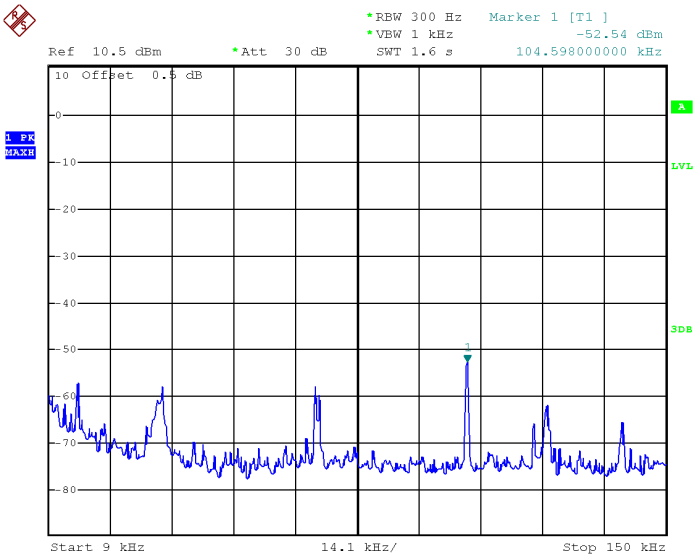
π/4DQPSK

Low Channel



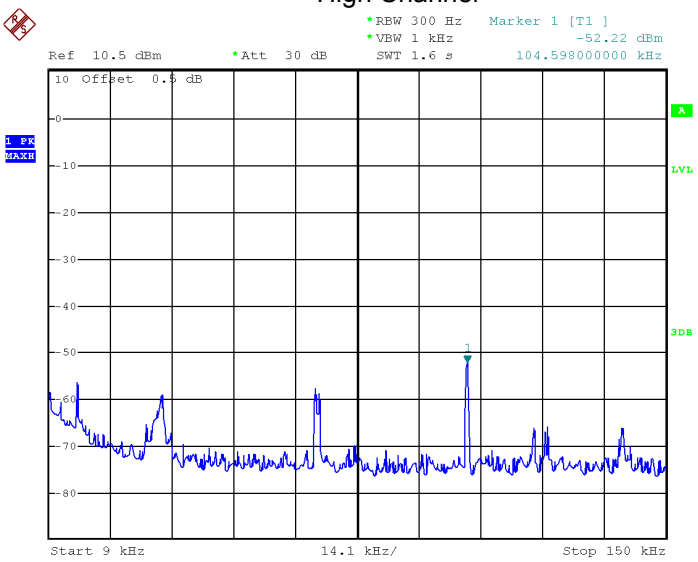
Date: 29.APR.2024 10:05:15

Middle Channel



Date: 29.APR.2024 10:04:01

High Channel

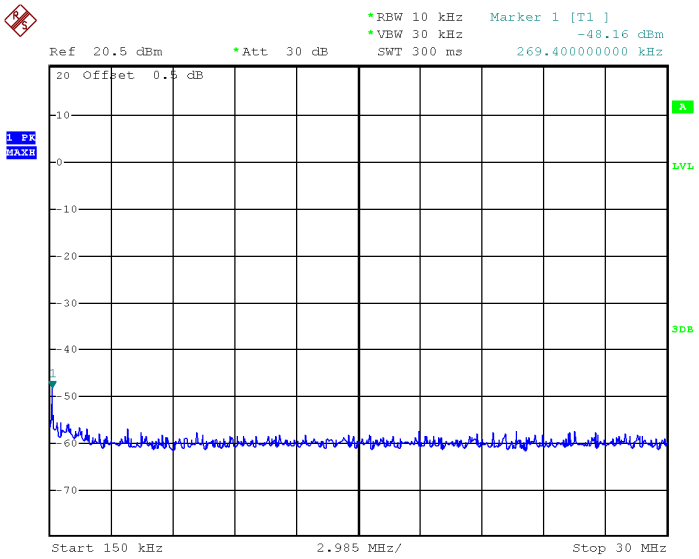


Date: 29.APR.2024 10:04:49

150kHz – 30MHz

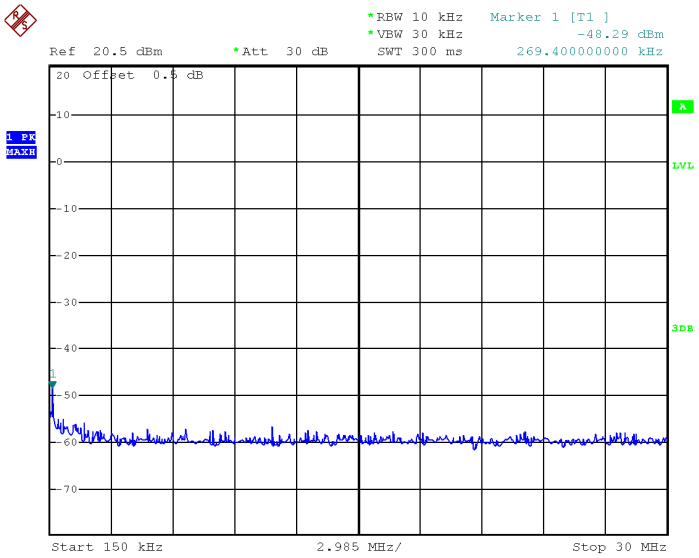
GFSK

Low Channel



Date: 29.APR.2024 10:00:29

Middle Channel



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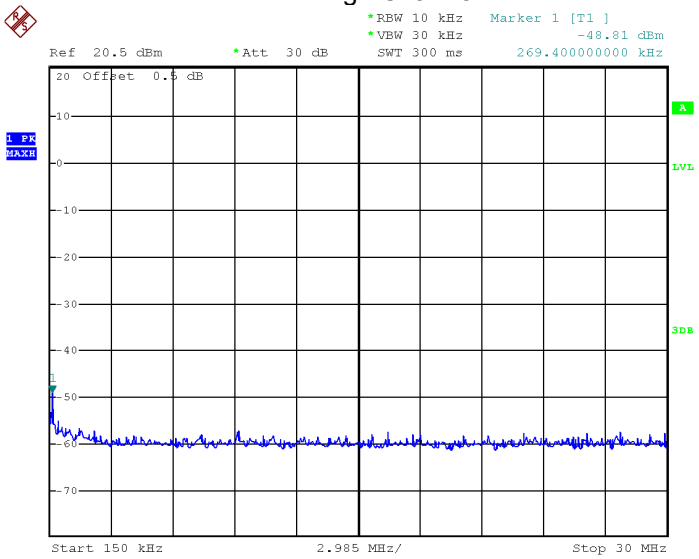
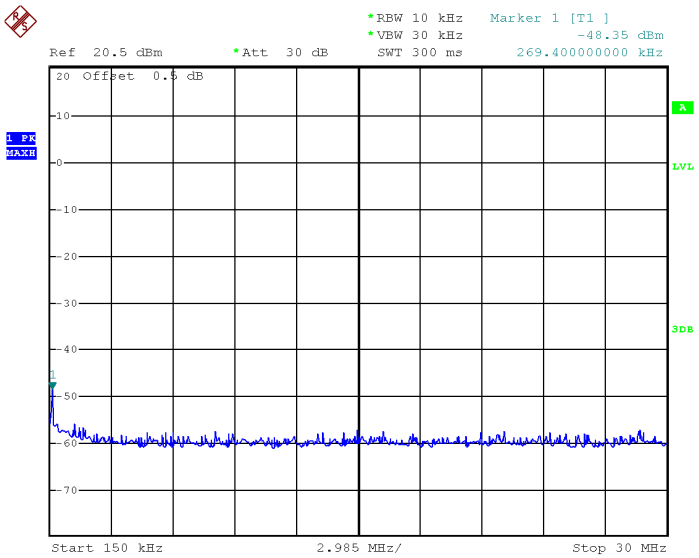
High Channel



Date: 29.APR.2024 10:00:56

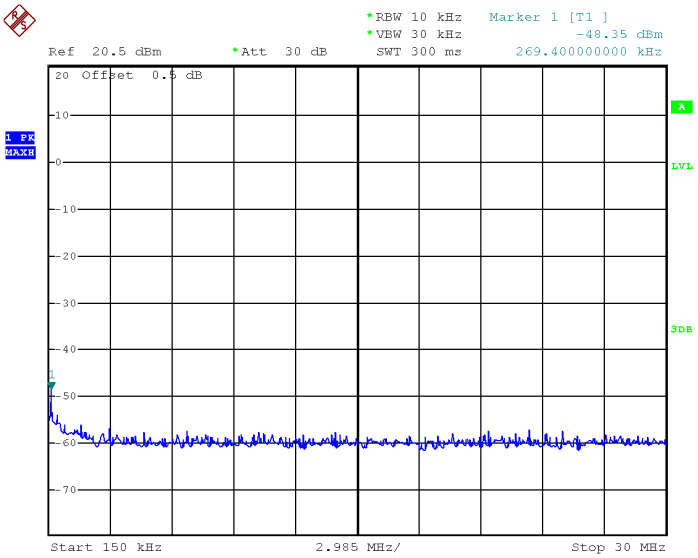
π/4DQPSK

Low Channel



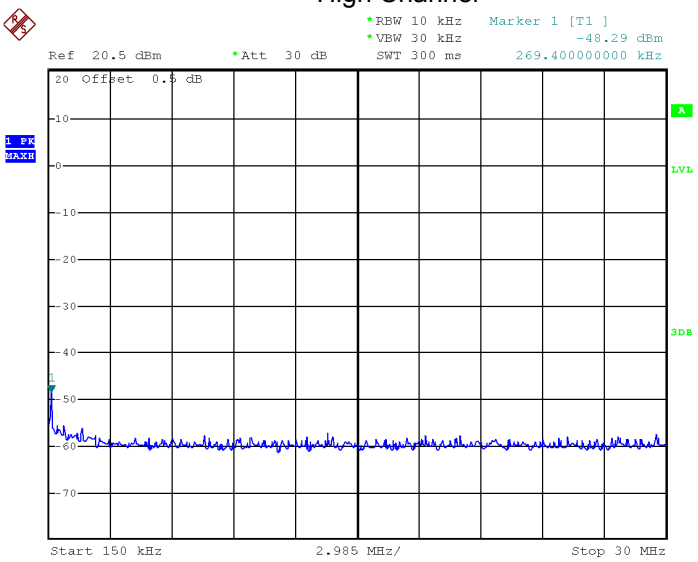
Date: 29.APR.2024 10:02:27

Middle Channel



Date: 29.APR.2024 10:01:55

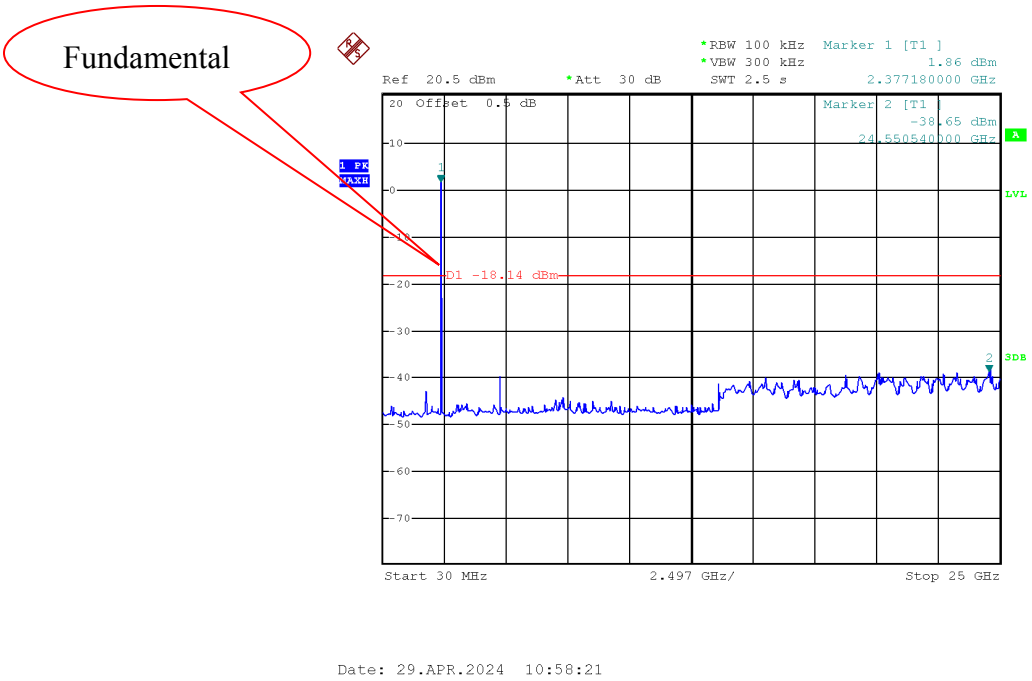
High Channel



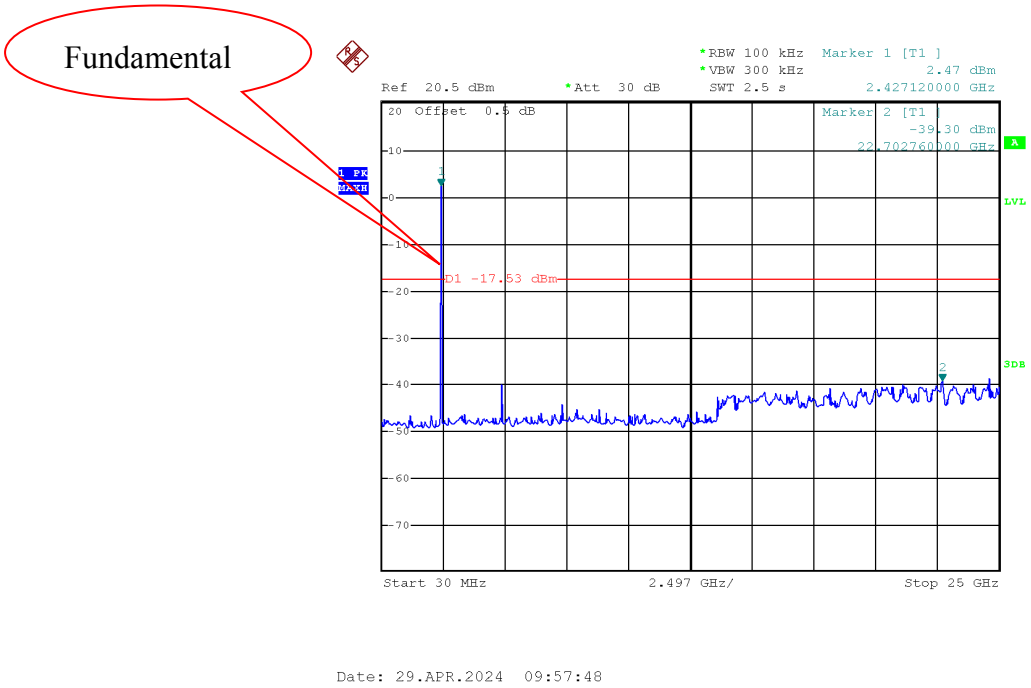
Date: 29.APR.2024 10:01:33

30MHz – 25GHz

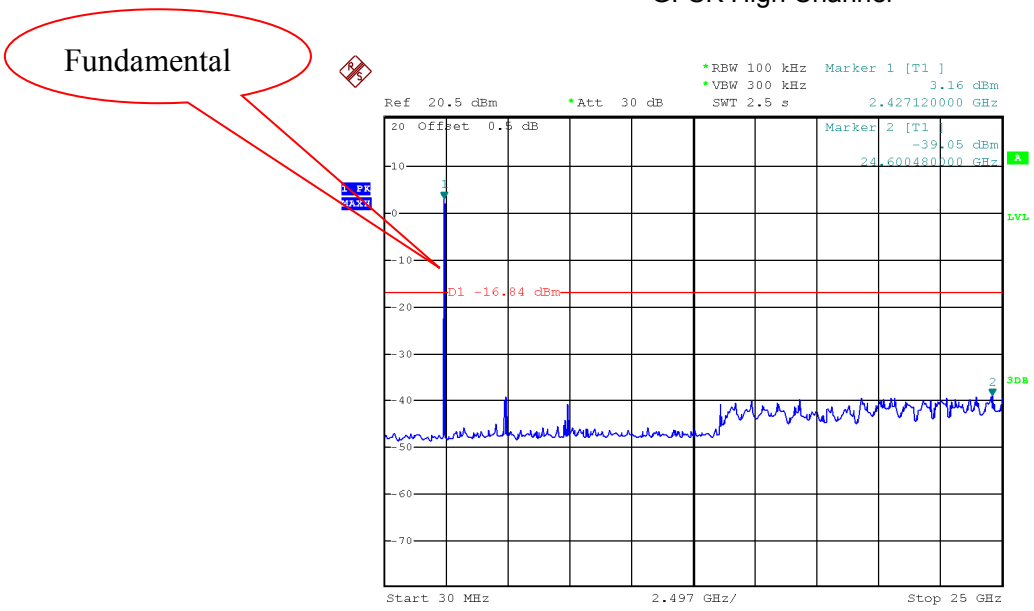
GFSK Low Channel



GFSK Middle Channel

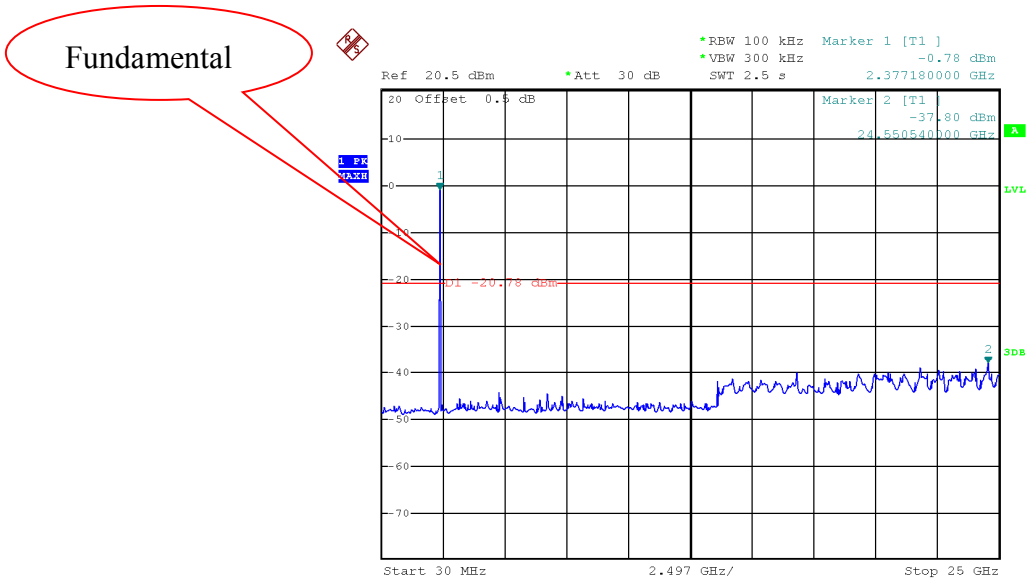


GFSK High Channel



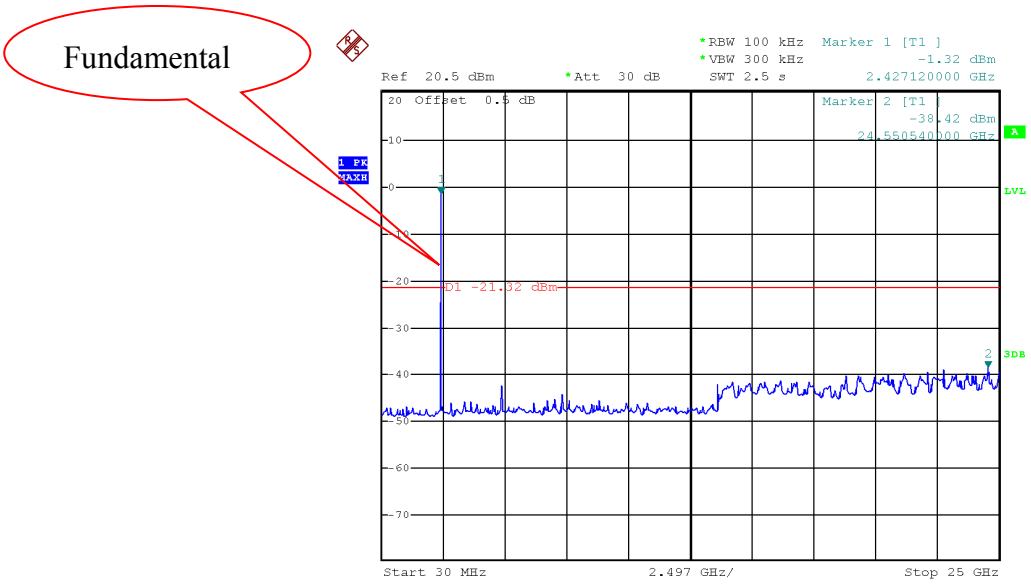
Date: 29.APR.2024 09:56:49

π/4DQPSK Low Channel



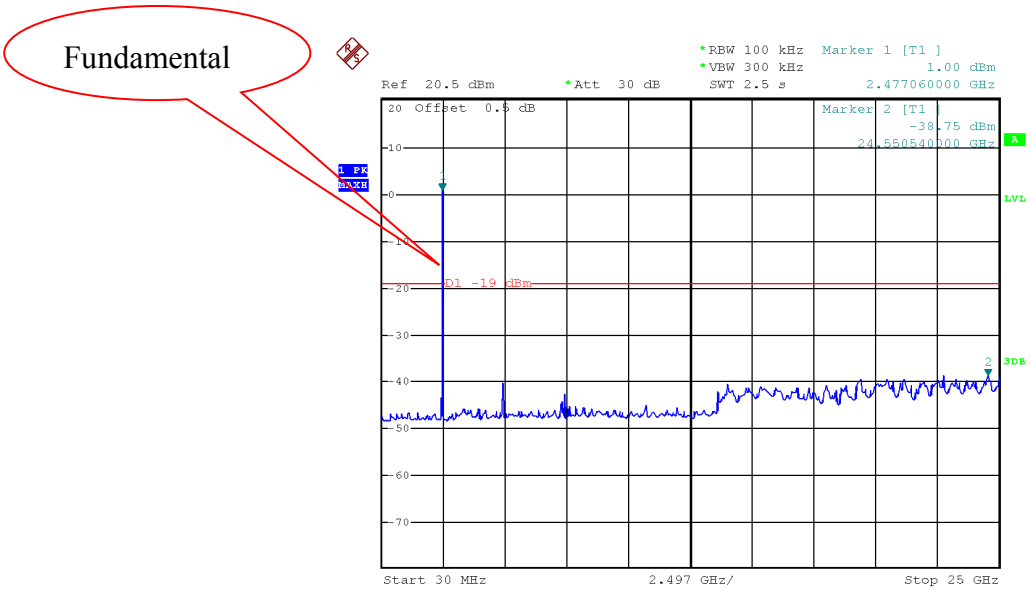
Date: 29.APR.2024 09:52:38

π/4DQPSK Middle Channel



Date: 29.APR.2024 09:50:46

π/4DQPSK High Channel



Date: 29.APR.2024 09:49:40

10 Band Edge Measurement

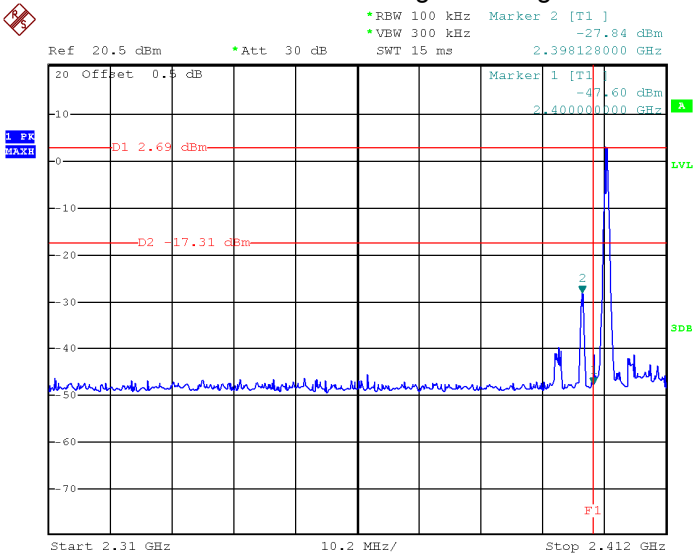
Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247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

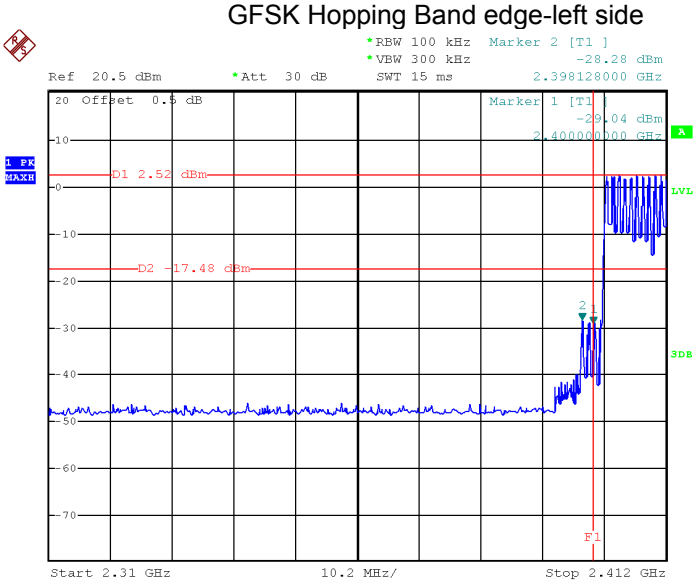
10.2 Test Result

GFSK Transmitting Band edge-left side



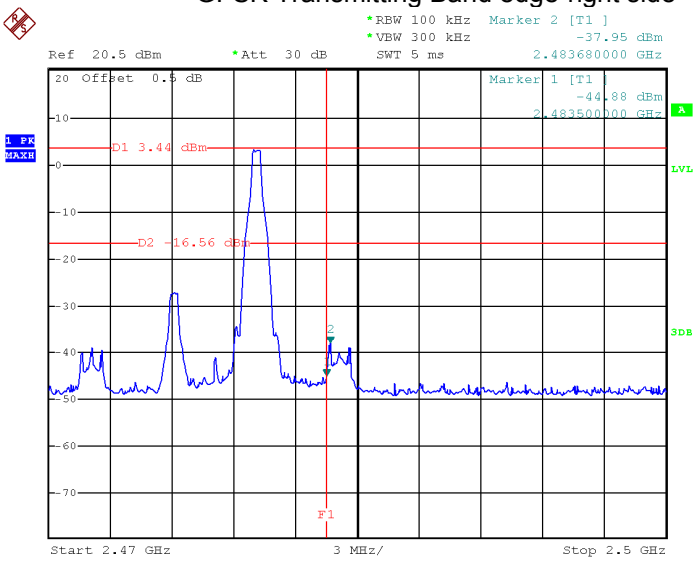
Date: 28.APR.2024 18:00:54

GFSK Hopping Band edge-left side



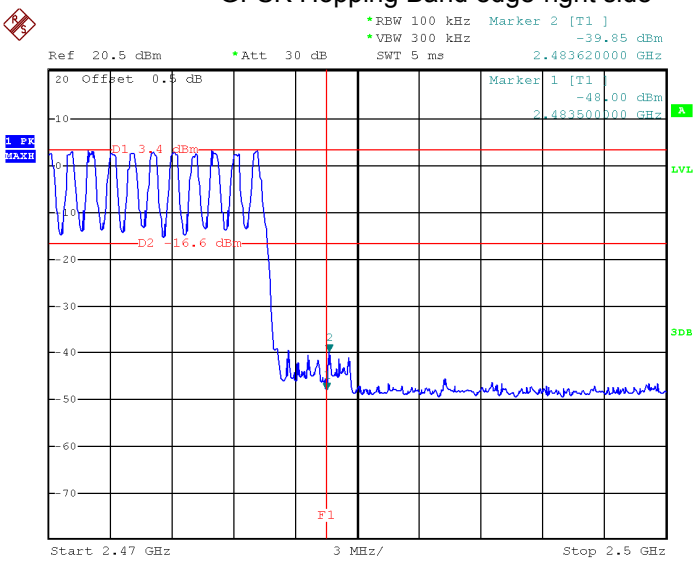
Date: 28.APR.2024 17:58:27

GFSK Transmitting Band edge-right side



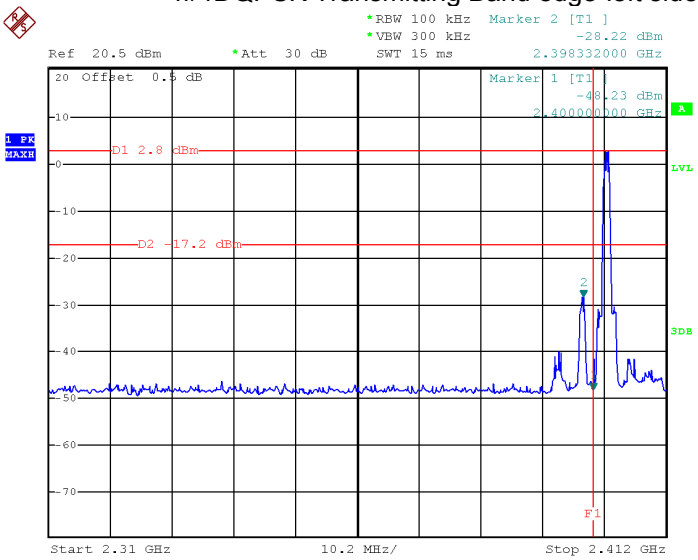
Date: 28.APR.2024 18:18:52

GFSK Hopping Band edge-right side



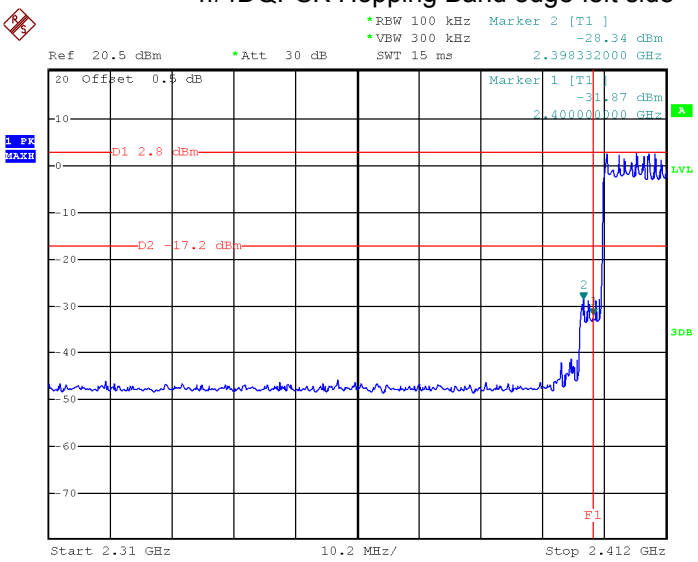
Date: 28.APR.2024 18:20:31

π/4DQPSK Transmitting Band edge-left side



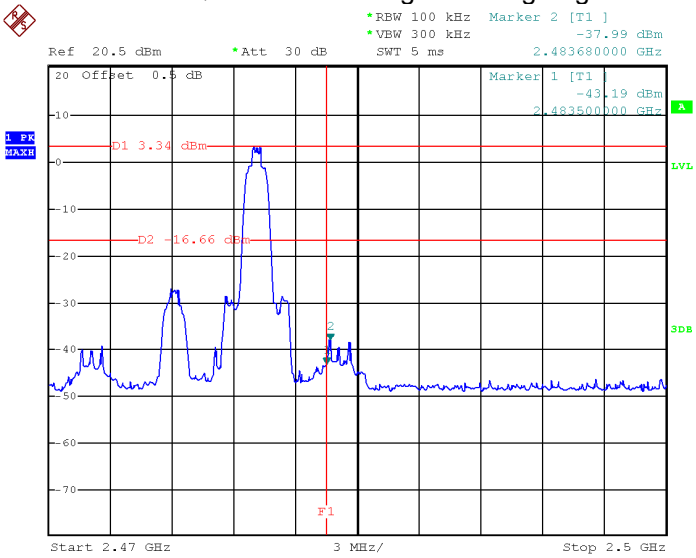
Date: 28.APR.2024 18:02:55

π/4DQPSK Hopping Band edge-left side



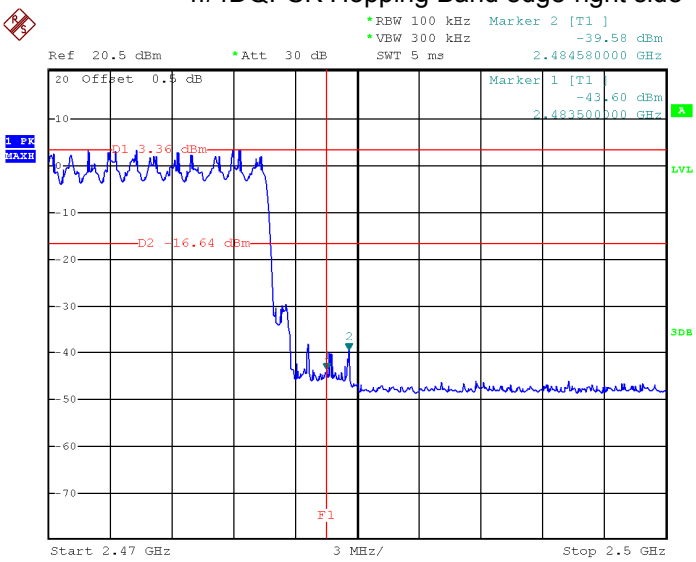
Date: 28.APR.2024 18:08:39

π/4DQPSK Transmitting Band edge-right side



Date: 28.APR.2024 18:16:50

π/4DQPSK Hopping Band edge-right side



Date: 28.APR.2024 18:13:58

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

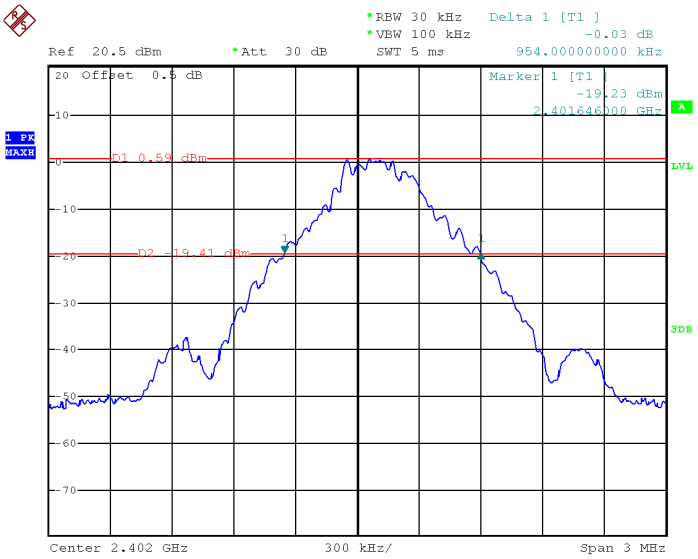
11.2 Test Result

Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
GFSK	Low	0.954	0.846
GFSK	Middle	0.948	0.846
GFSK	High	0.948	0.846
π/4DQPSK	Low	1.308	1.188
π/4DQPSK	Middle	1.314	1.188
π/4DQPSK	High	1.314	1.188

Test plots

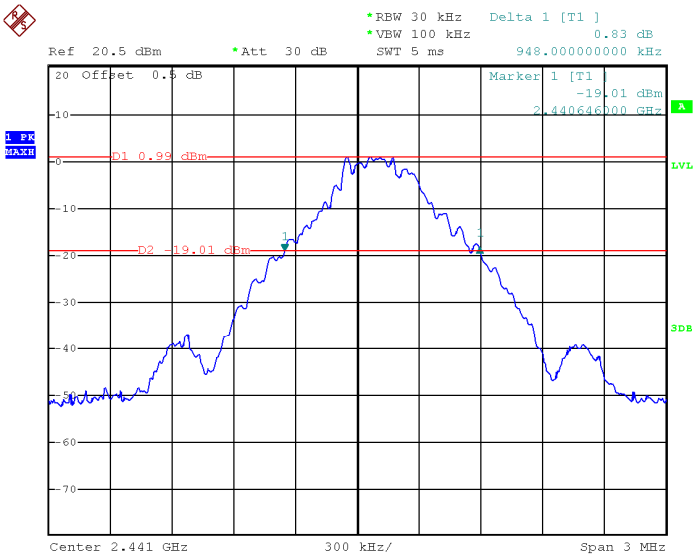
20 dB Bandwidth

GFSK Low Channel



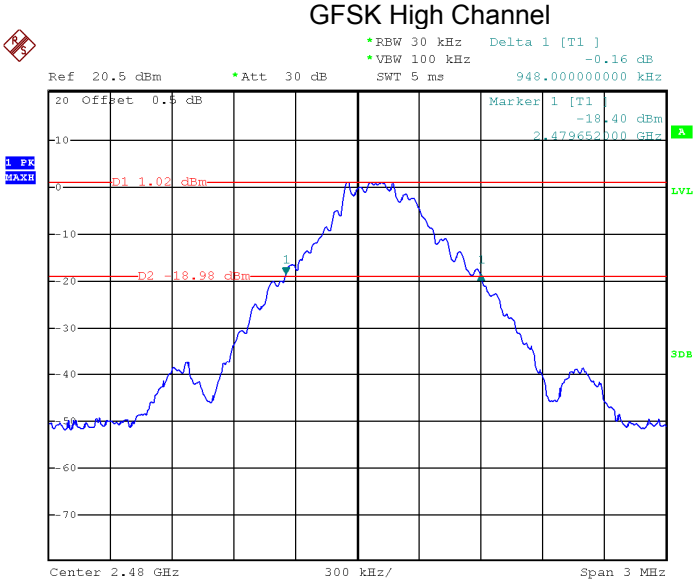
Date: 28.APR.2024 17:34:30

GFSK Middle Channel



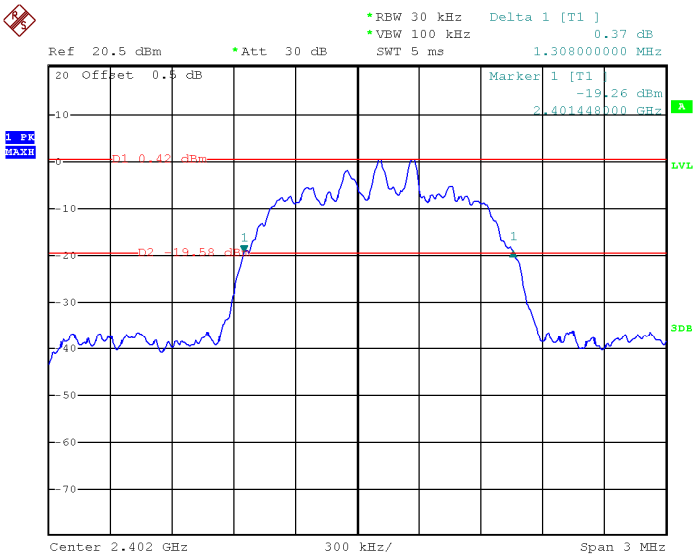
Date: 28.APR.2024 17:36:04

GFSK High Channel



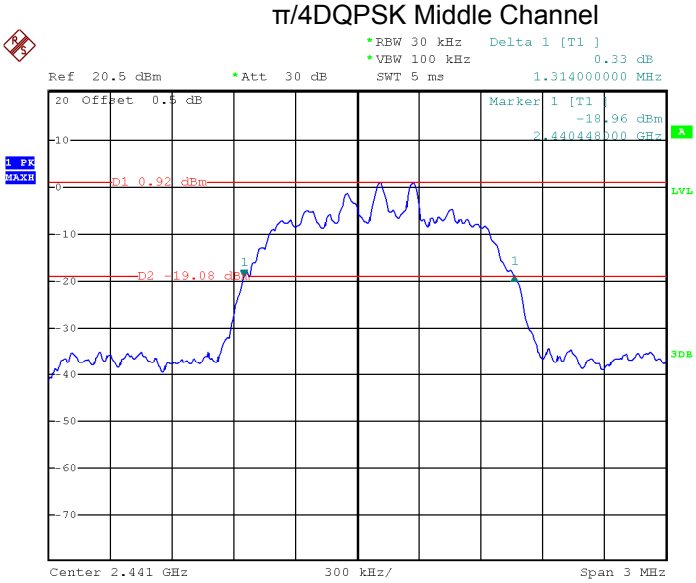
Date: 28.APR.2024 17:37:41

π/4DQPSK Low Channel



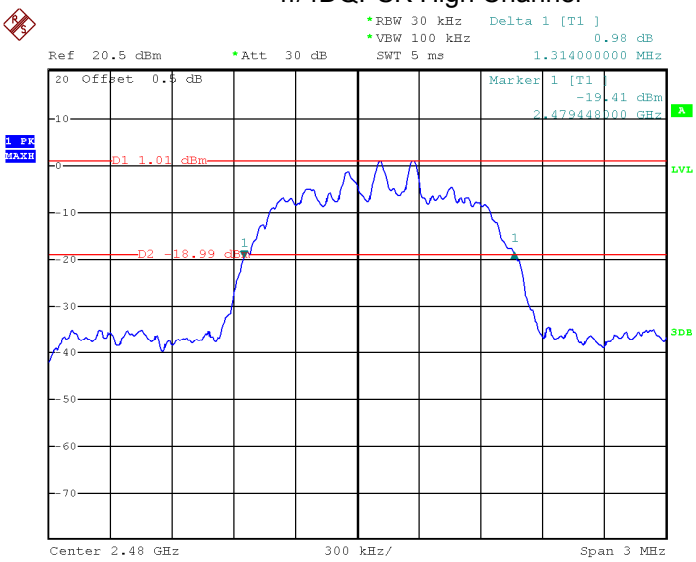
Date: 28.APR.2024 17:48:13

π/4DQPSK Middle Channel



Date: 28.APR.2024 17:44:42

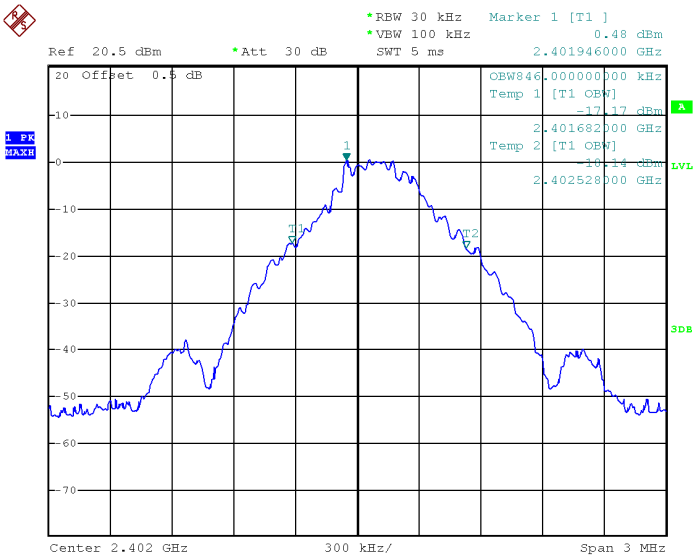
π/4DQPSK High Channel



Date: 28.APR.2024 17:39:52

99% Bandwidth

GFSK Low Channel



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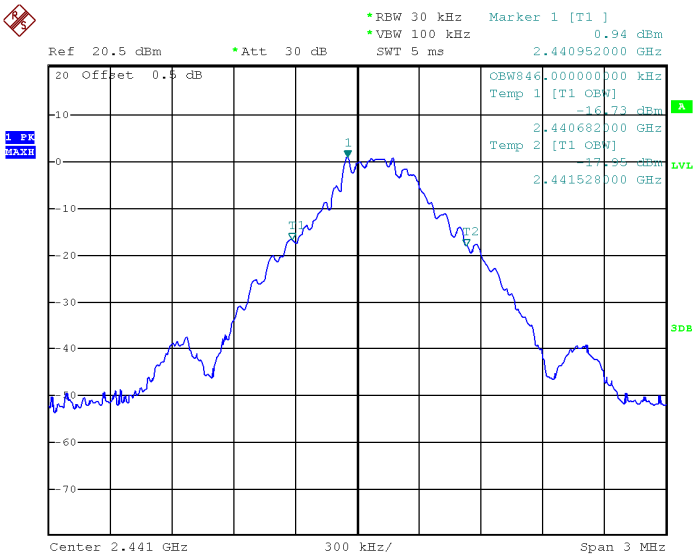
GFSK Middle Channel



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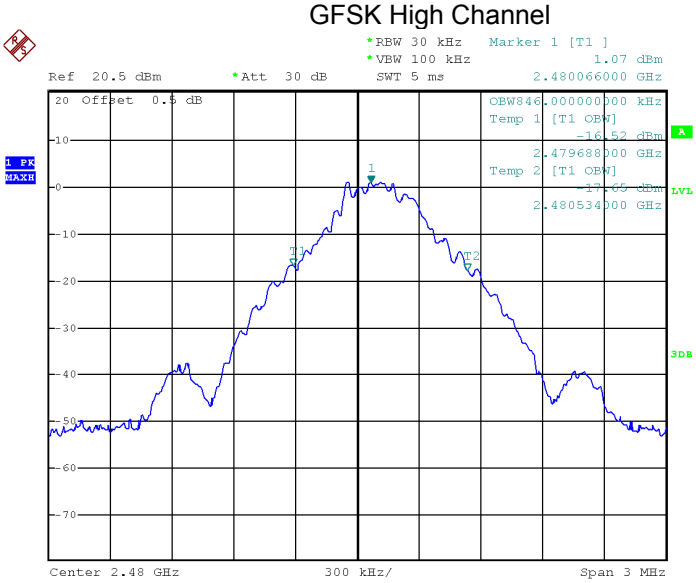
GFSK High Channel



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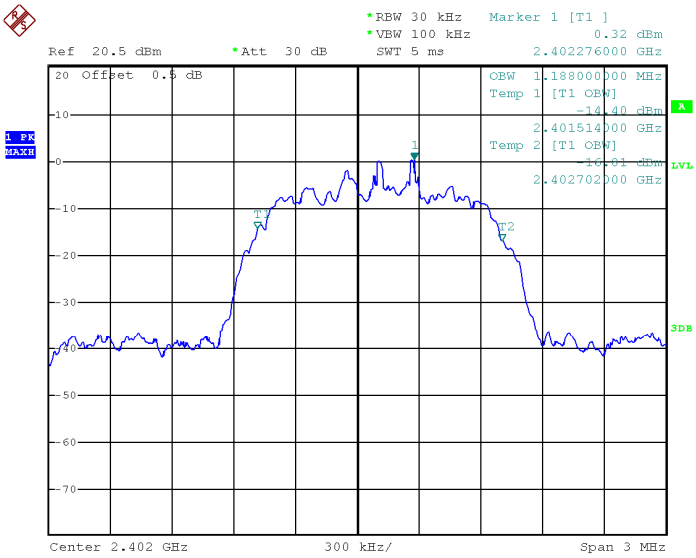
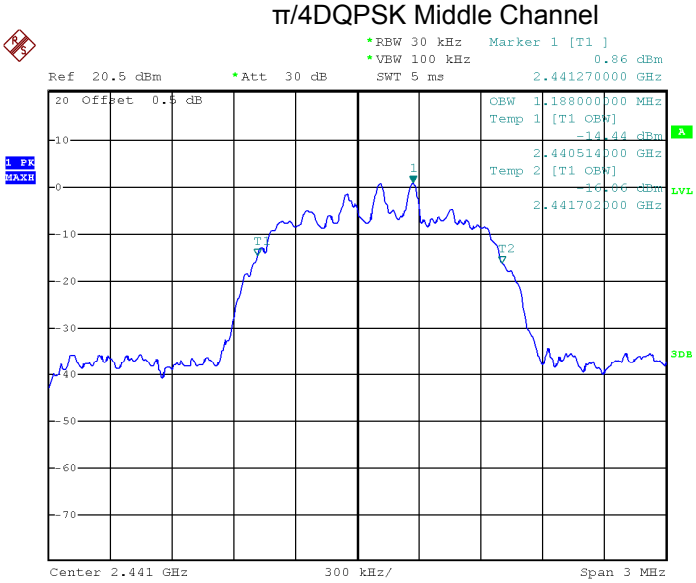
π/4DQPSK Low Channel



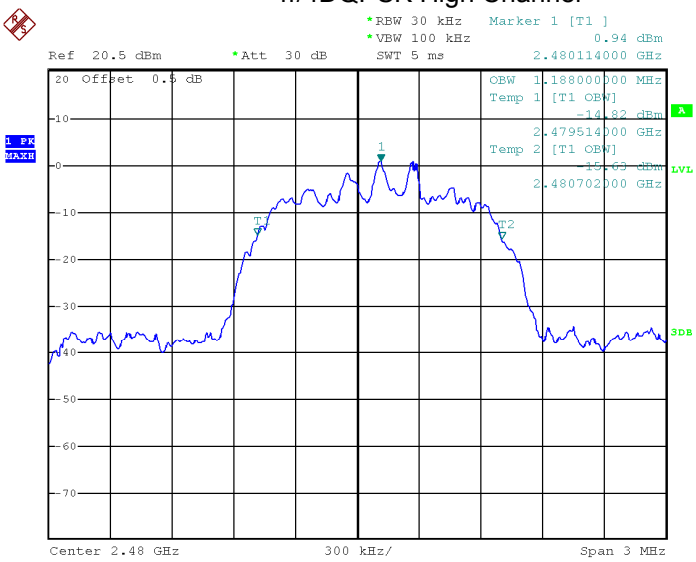
Date: 28.APR.2024 17:13:42

π/4DQPSK Middle Channel



Date: 28.APR.2024 17:13:15

π/4DQPSK High Channel



Date: 28.APR.2024 17:14:12

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

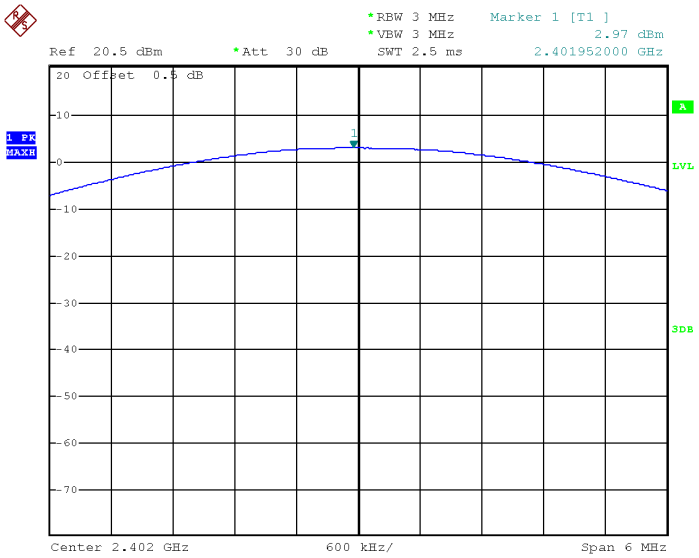
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Use the following spectrum analyzer settings:
      1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
      2) RBW ≥20 dB bandwidth 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	2.97	30
GFSK	Middle	3.31	30
GFSK	High	3.38	30
π/4DQPSK	Low	3.55	21
π/4DQPSK	Middle	3.97	21
π/4DQPSK	High	**4.00**	21

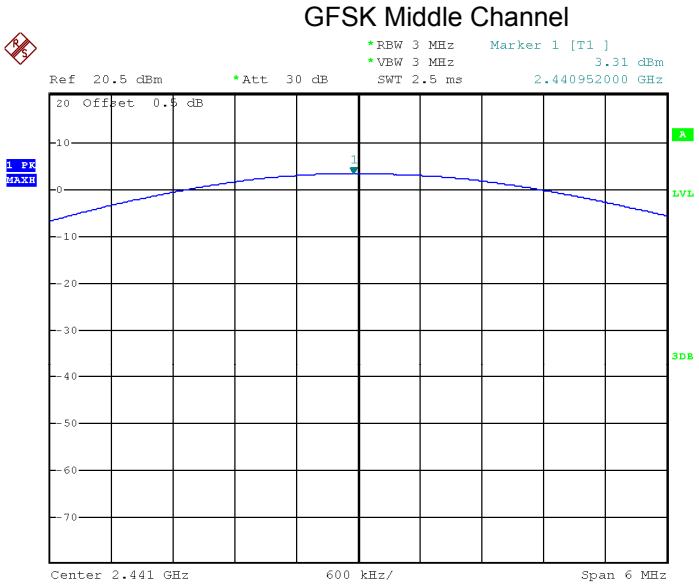
Test plots

GFSK Low Channel



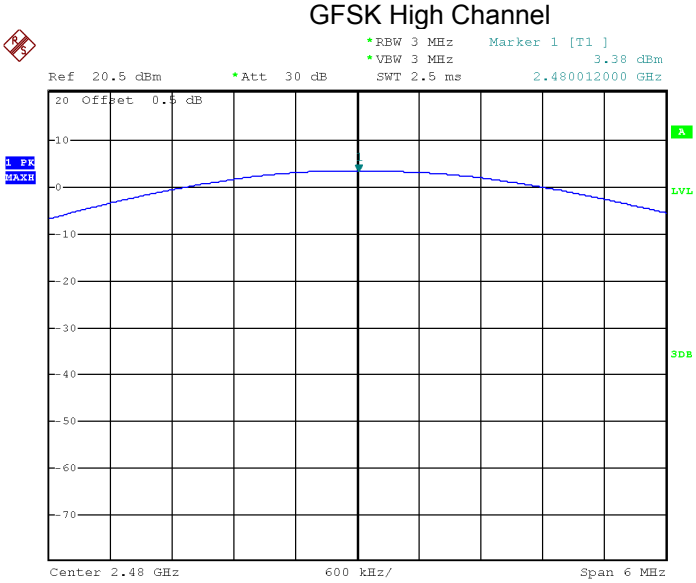
Date: 28.APR.2024 17:04:56

GFSK Middle Channel



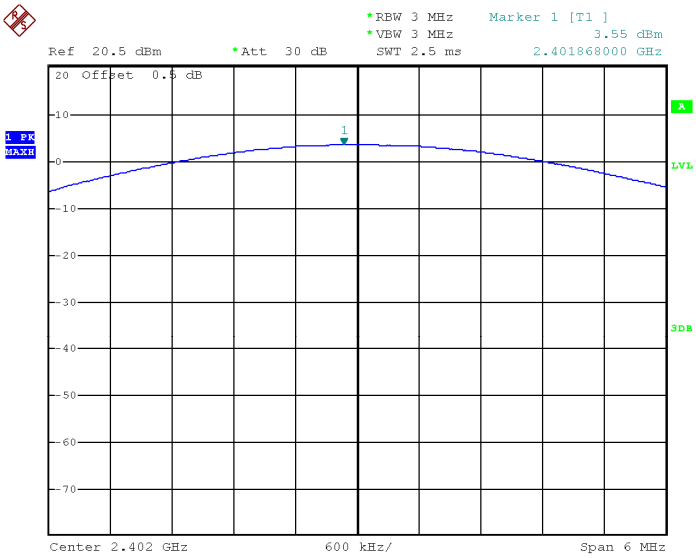
Date: 28.APR.2024 17:06:28

GFSK High Channel



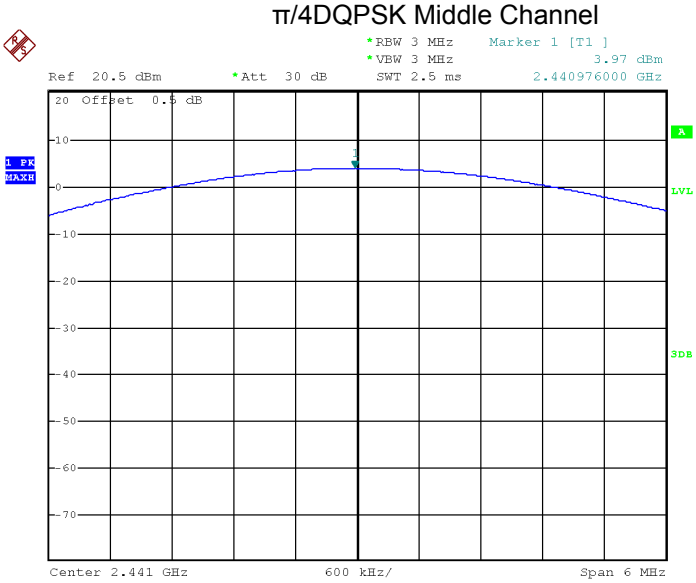
Date: 28.APR.2024 17:06:51

π/4DQPSK Low Channel



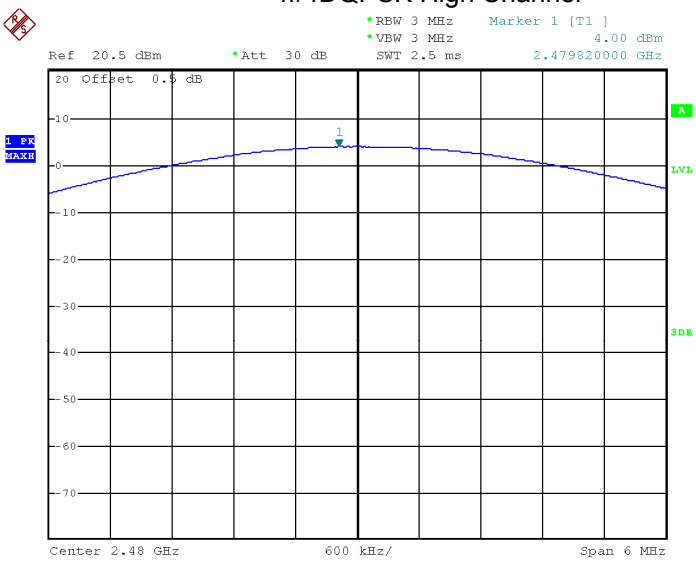
Date: 28.APR.2024 17:08:48

π/4DQPSK Middle Channel



Date: 28.APR.2024 17:07:42

π/4DQPSK High Channel



Date: 28.APR.2024 17:07:13

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

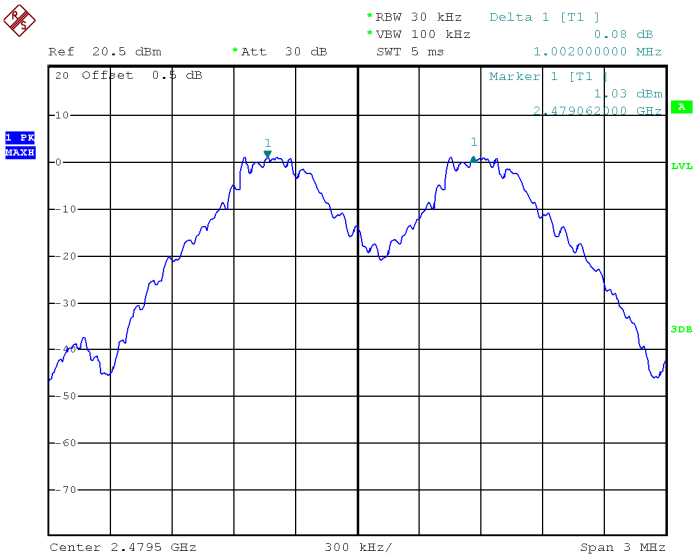
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Span: Wide enough to capture the peaks of two adjacent channels.
   b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary 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	0.636	PASS
GFSK	Middle	1.008	0.632	PASS
GFSK	High	1.008	0.632	PASS
π/4DQPSK	Low	1.002	0.872	PASS
π/4DQPSK	Middle	1.002	0.876	PASS
π/4DQPSK	High	1.002	0.876	PASS

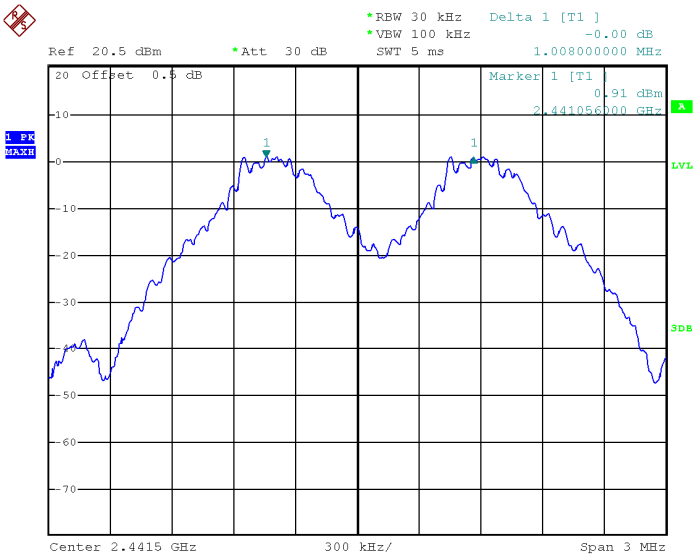
Test plots

GFSK Low Channel



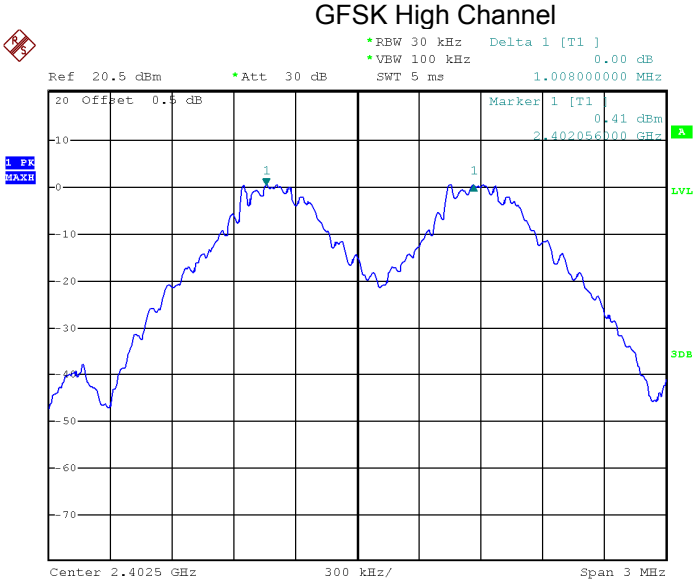
Date: 30.APR.2024 09:47:04

GFSK Middle Channel



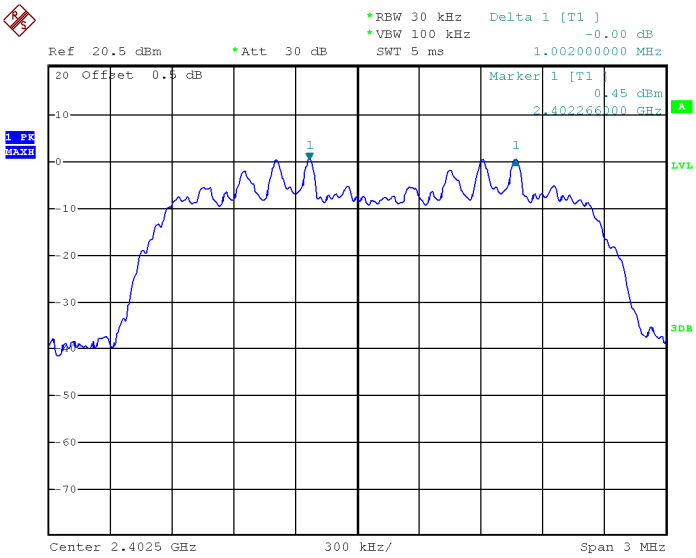
Date: 28.APR.2024 18:25:01

GFSK High Channel



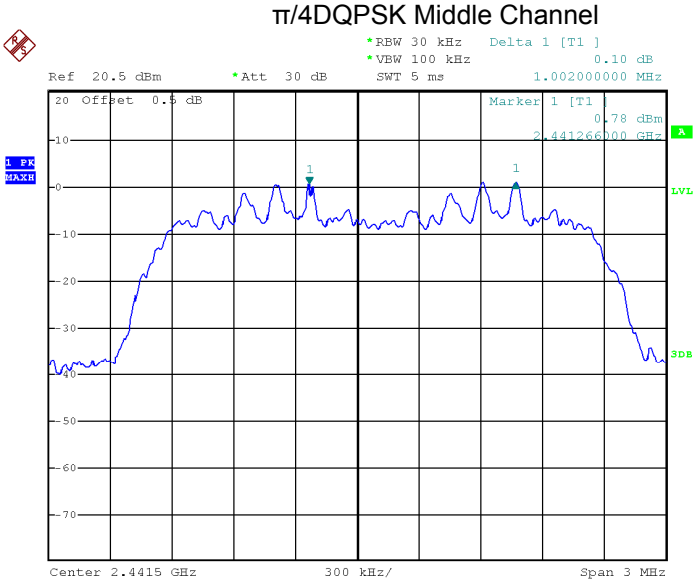
Date: 30.APR.2024 09:48:27

π/4DQPSK Low Channel



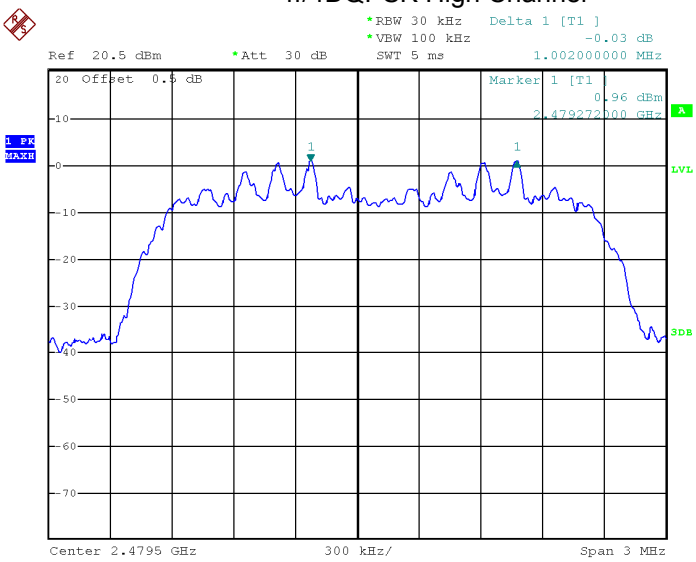
Date: 28.APR.2024 18:28:36

π/4DQPSK Middle Channel



Date: 28.APR.2024 18:30:06

π/4DQPSK High Channel



Date: 28.APR.2024 18:31:10

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

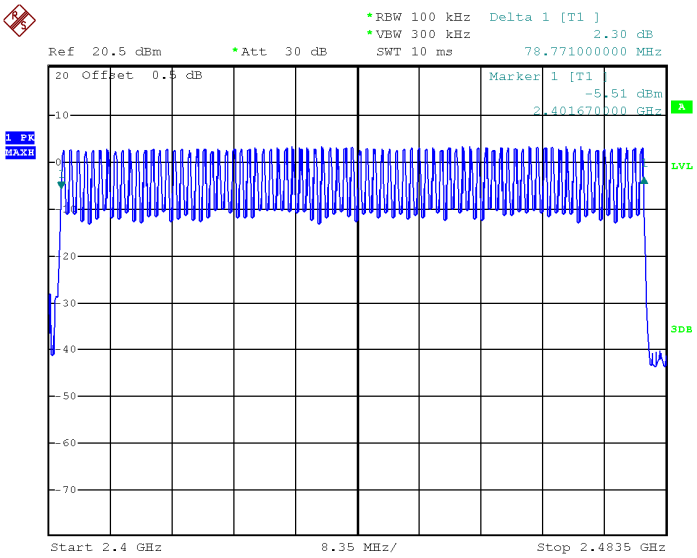
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
   a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation 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:

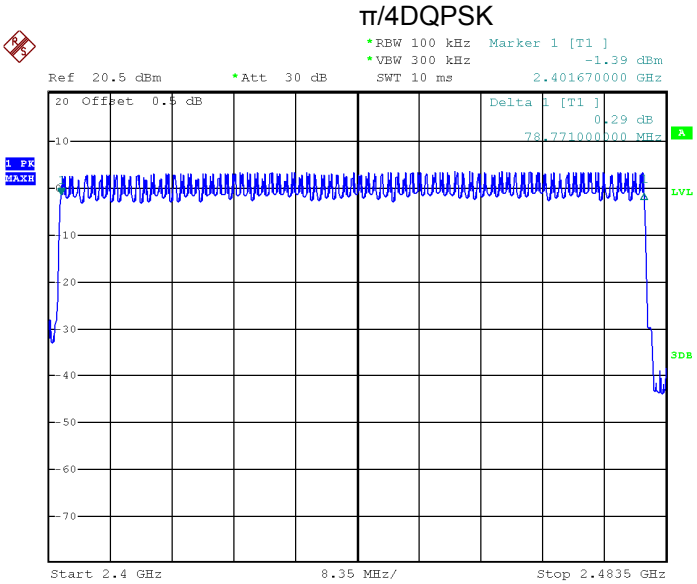
79 Channels in total

GFSK



Date: 29.APR.2024 09:36:05

π/4DQPSK



Date: 28.APR.2024 18:59:36

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).

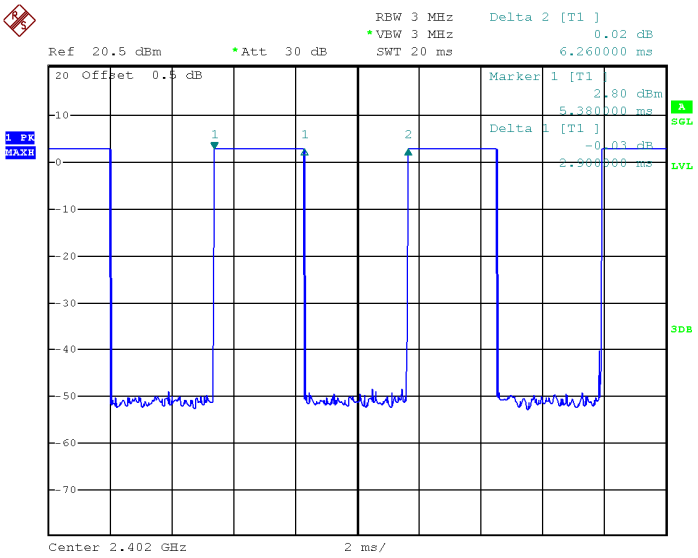
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

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	2.900	0.309	0.4
π/4DQPSK	2DH5	Low	2.860	0.305	0.4
		middle	2.860	0.305	0.4
		High	2.860	0.305	0.4

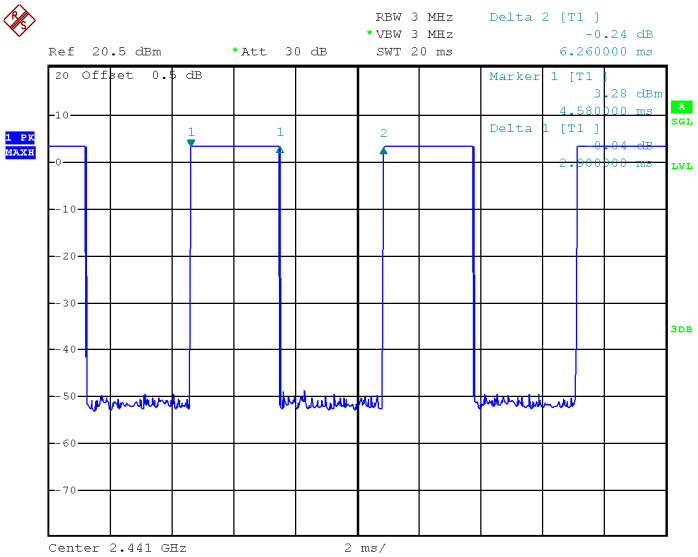
Remark: Only the worst-case mode DH5 and 2DH5 were recorded.

Test Plots
GFSK DH5 Low Channel



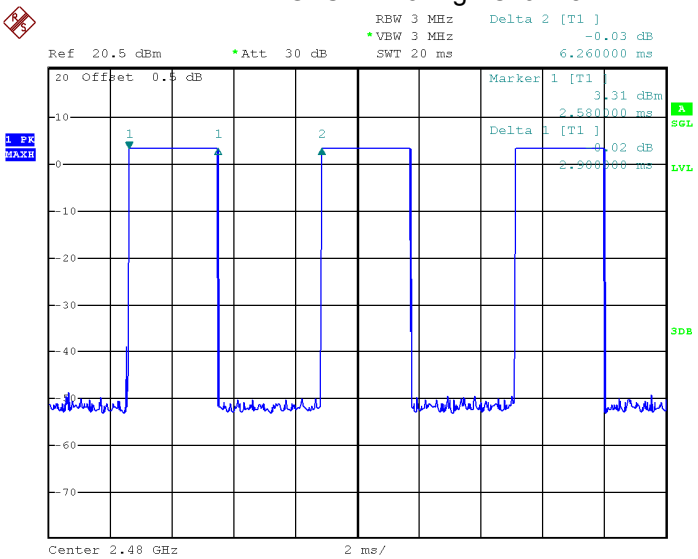
Date: 29.APR.2024 09:41:25

GFSK DH5 Middle Channel



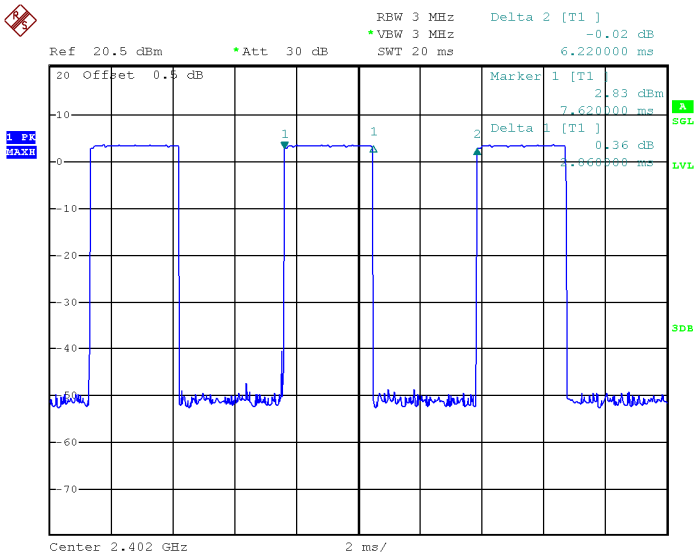
Date: 29.APR.2024 09:40:25

GFSK DH5 High Channel



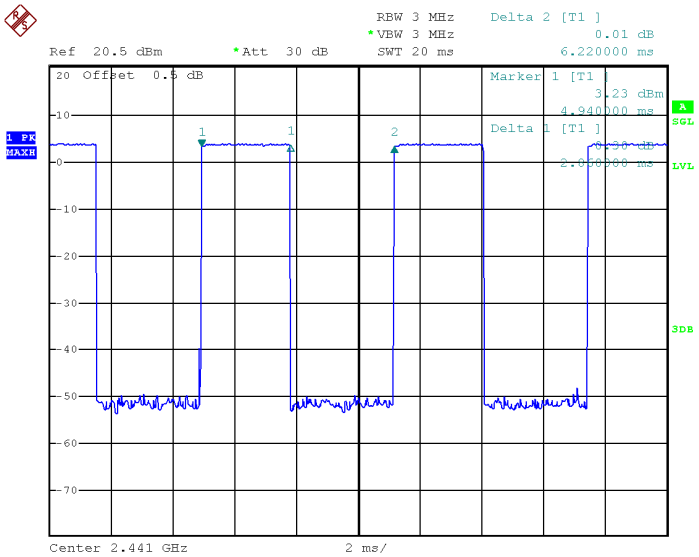
Date: 29.APR.2024 09:39:07

π/4DQPSK 2DH5 Low Channel



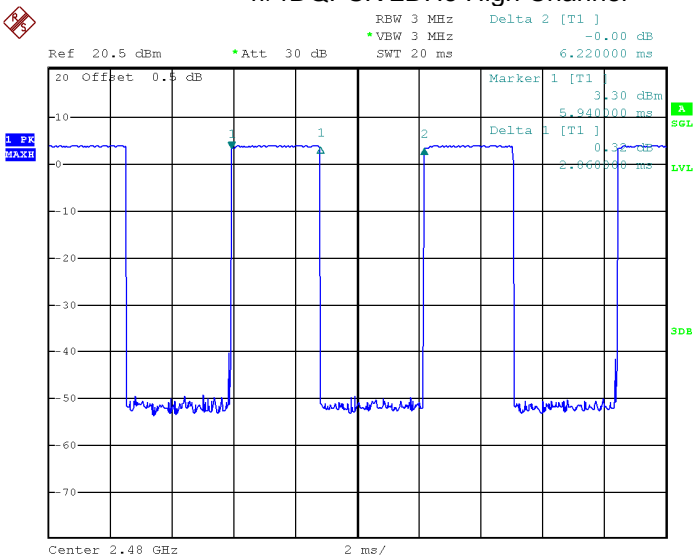
Date: 29.APR.2024 09:42:46

π/4DQPSK 2DH5 Middle Channel



Date: 29.APR.2024 09:43:44

π/4DQPSK 2DH5 High Channel



Date: 29.APR.2024 09:44:35

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.

Note: Please refer to EUT photos for more details.

17 RF Exposure

Remark: refer to MPE test report: WTD24D04092509W003.

18 Photographs of test setup and EUT.

Note: Please refer to appendix: Appendix- ZY-S2-Photos.

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