

TEST REPORT

Reference No...... : WTD21D09098668W002
FCC ID : 2ADCSIFC67X1
Applicant..... : SMART Wireless Computing Inc.
Address..... : 39870 Eureka Dr, Newark, CA 94560, United States of America
Manufacturer : SMART Wireless Computing Inc.
Address..... : 39870 Eureka Dr, Newark, CA 94560, United States of America
Product..... : System on Module-IFC67X1
Model(s). : IFC67X1
Standards..... : FCC CFR47 Part 15.247:2018
Date of Receipt sample .. : 2021-09-16
Date of Test : 2021-09-16 to 2021-11-12
Date of Issue..... : 2021-11-12
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.

Prepared By:

Waltek Testing Group Co., Ltd.

Address: No. 77, Houjie Section, Guantai Road, Houjie Town, Dongguan City, Guangdong, China

Tel: +86-769-2267 6998

Fax: +86-769-2267 6828

Compiled by:

Approved by:

Levi Xiao

Levi Xiao / Project Engineer



Daniel Liu

Daniel Liu / Designated Reviewer

2 Contents

	Page
1 COVER PAGE.....	1
2 CONTENTS	2
3 REVISION HISTORY	4
4 GENERAL INFORMATION.....	5
4.1 GENERAL DESCRIPTION OF E.U.T.	5
4.2 DETAILS OF E.U.T.	5
4.3 CHANNEL LIST	6
4.4 TEST MODE	6
5 TEST SUMMARY	7
6 EQUIPMENT USED DURING TEST	8
6.1 EQUIPMENTS LIST	8
6.2 DESCRIPTION OF SUPPORT UNITS	9
6.3 MEASUREMENT UNCERTAINTY	9
6.4 TEST FACILITY	9
6.5 TEST EQUIPMENT CALIBRATION	9
7 RADIATED SPURIOUS EMISSIONS.....	10
7.1 EUT OPERATION.....	10
7.2 TEST SETUP	11
7.3 SPECTRUM ANALYZER SETUP	12
7.4 TEST PROCEDURE	13
7.5 CORRECTED AMPLITUDE & MARGIN CALCULATION	13
7.6 SUMMARY OF TEST RESULTS	14
8 CONDUCTED SPURIOUS EMISSIONS.....	22
8.1 TEST PROCEDURE	22
8.2 TEST RESULT	23
9 BAND EDGE MEASUREMENT	31
9.1 TEST PROCEDURE	31
9.2 TEST RESULT	32
10 BANDWIDTH MEASUREMENT.....	38
10.1 TEST PROCEDURE.....	38
10.2 TEST RESULT	38
11 MAXIMUM PEAK OUTPUT POWER	45
11.1 TEST PROCEDURE.....	45
11.2 TEST RESULT	45
12 HOPPING CHANNEL SEPARATION	51
12.1 TEST PROCEDURE.....	51
12.2 TEST RESULT	51
13 NUMBER OF HOPPING FREQUENCY.....	55
13.1 TEST PROCEDURE.....	55
13.2 TEST RESULT	55
14 DWELL TIME	57
14.1 TEST PROCEDURE.....	57
14.2 TEST RESULT	57

15 ANTENNA REQUIREMENT 62

16 RF EXPOSURE..... 63

17 PHOTOGRAPHS OF TEST SETUP AND EUT..... 63

3 Revision History

Test report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTD21D09098668 W002	2021-09-16	2021-09-16 to 2021-11-12	2021-11-12	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	System on Module-IFC67X1
Model(s):	IFC67X1
Wi-Fi Specification:	2.4G-802.11b/g/n HT20/n HT40 5G-802.11a/n/ac HT20 /n/ac HT40 /ac HT80/ ac HT80+ HT80
Bluetooth Version:	Bluetooth v5.0 with BLE
GNSS:	Support
Hardware Version:	IFC67X1-XX-PX
Software Version:	Android 9.0

4.2 Details of E.U.T.

Operation Frequency:	Bluetooth: 2402~2480MHz
Max. RF output power:	Bluetooth: 1.97dBm
Type of Modulation:	Bluetooth: GFSK, Pi/4 DQPSK, 8DPSK
Antenna installation:	Bluetooth: Stamped Metal Antenna,PCB printed antenna
Antenna Gain:	PCB printed antenna (2.1dBi), Stamped Metal Antenna (0.6dBi)
Ratings:	DC 3.3V

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

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
Conduct Emission	15.207	N/A
20dB 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
Adaptive frequency hopping transmission	15.247(g)	Complies ^{note1}
Adaptive frequency hopping	15.247(h)	Complies ^{note1}
Antenna Requirement	15.203	Complies
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS
note1: by the manufacturer declare		

6 Equipment Used during Test

6.1 Equipments List

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	2021-04-26	2022-04-25
2	Amplifier	Agilent	8447D	2944A10178	2021-04-26	2022-04-25
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2021-08-23	2022-08-22
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2021-04-26	2022-04-25
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2021-04-26	2022-04-25
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2021-07-30	2022-07-29
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2021-07-26	2022-07-25
8	Coaxial Cable (above 1GHz)	ZT26-NJ-NJ-8M/FA	1GHz-18GHz	NA	2021-04-26	2022-04-25
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	2021-04-26	2022-04-25
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2020-10-31 2021-10-28	2021-10-29 2022-10-27
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2021-04-26	2022-04-25
4	Amplifier	ANRITSU	MH648A	M43381	2021-04-26	2022-04-25
5	Cable	HUBER+SUHNER	CBL2	525178	2021-04-26	2022-04-25
RF Conducted Testing						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMC Analyzer (9k~26.5GHz)	Agilent	E7405A	MY45114943	2021-04-26	2022-04-25
2.	Spectrum Analyzer	R&S	FSP30	100091	2021-04-26	2022-04-25
3.	EXA Signal Analyzer	Malaysia Keysight	N9010A	MY50520207	2021-04-26	2022-04-25

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
Computer	Dell	K053	/
Mouse	Lenovo	AP01	/
Transfer/carrier board	SMART Wireless Computing Inc.	/	/

6.3 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-6}$
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Radiated Spurious Emissions test	± 5.03 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)
Conducted Emissions test	± 3.64 dB (AC mains 150KHz~30MHz)
Conducted Spurious Emissions test	± 3.12 dB (9kHz~30MHz)
	± 4.21 dB (30M~1000MHz)
	± 5.14 dB (1000M~26500MHz)

6.4 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. Certificate Number: 4243.01

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.

6.5 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 Radiated Spurious Emissions

Test Requirement: FCC CFR47 Part 15 Section 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	$2400/F(\text{kHz})$	300	$10000 * 2400/F(\text{kHz})$	$20\log^{(2400/F(\text{kHz}))} + 80$
0.490 ~ 1.705	$24000/F(\text{kHz})$	30	$100 * 24000/F(\text{kHz})$	$20\log^{(24000/F(\text{kHz}))} + 40$
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	$20\log^{(500)}$

7.1 EUT Operation

Operating Environment :

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

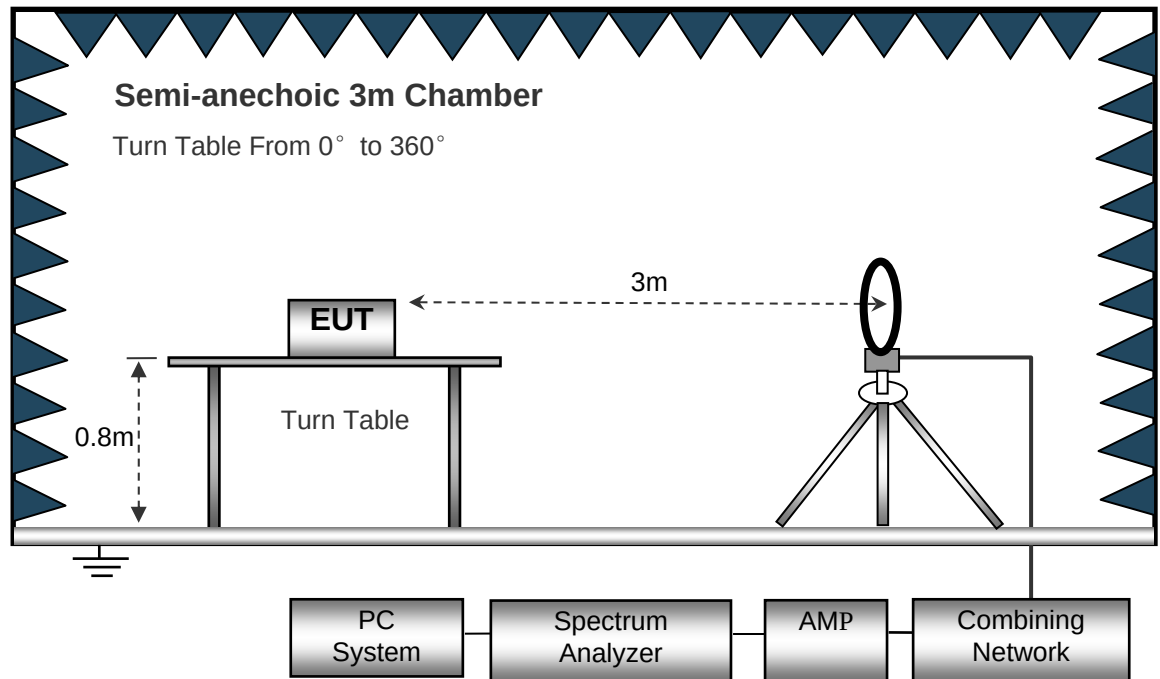
EUT Operation :

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

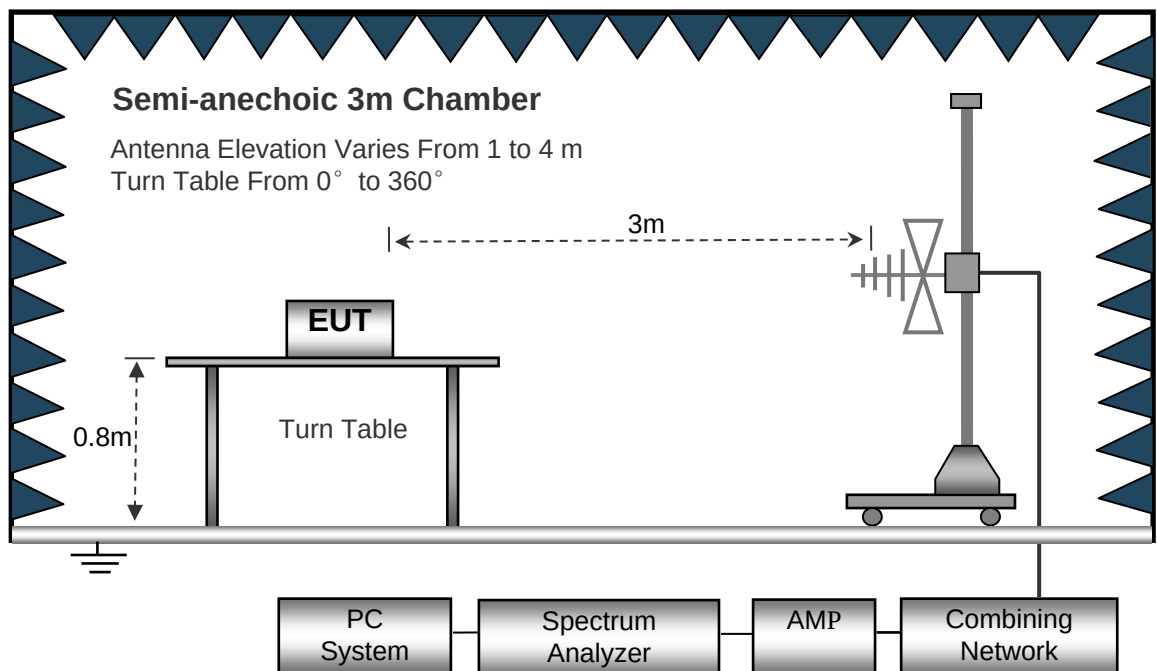
7.2 Test Setup

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

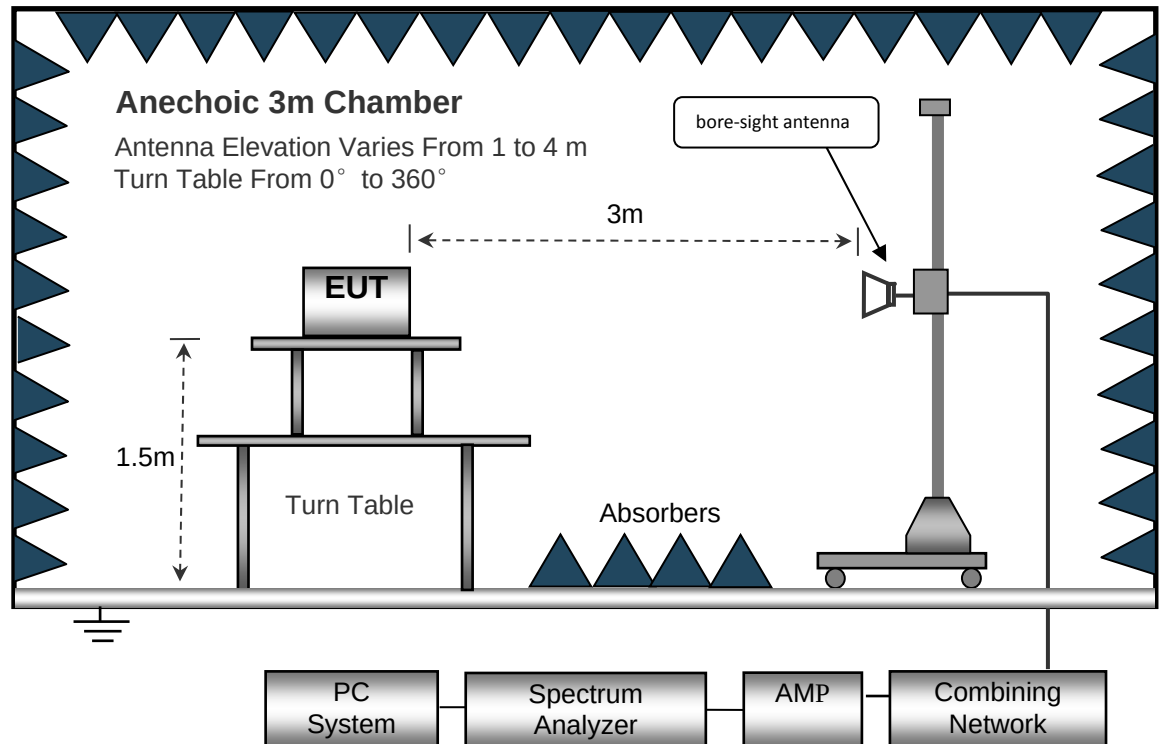
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



7.3 Spectrum Analyzer Setup

Below 30MHz

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

30MHz ~ 1GHz

Sweep Speed Auto
DetectorPK
Resolution Bandwidth.....100kHz
Video Bandwidth.....300kHz

Above 1GHz

Sweep Speed Auto
DetectorPK
Resolution Bandwidth.....1MHz
Video Bandwidth.....3MHz
DetectorAve.
Resolution Bandwidth.....1MHz
Video Bandwidth.....10Hz

7.4 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.

7.5 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:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Corr. Ampl.} - \text{Limit}$$

7.6 Summary of Test Results

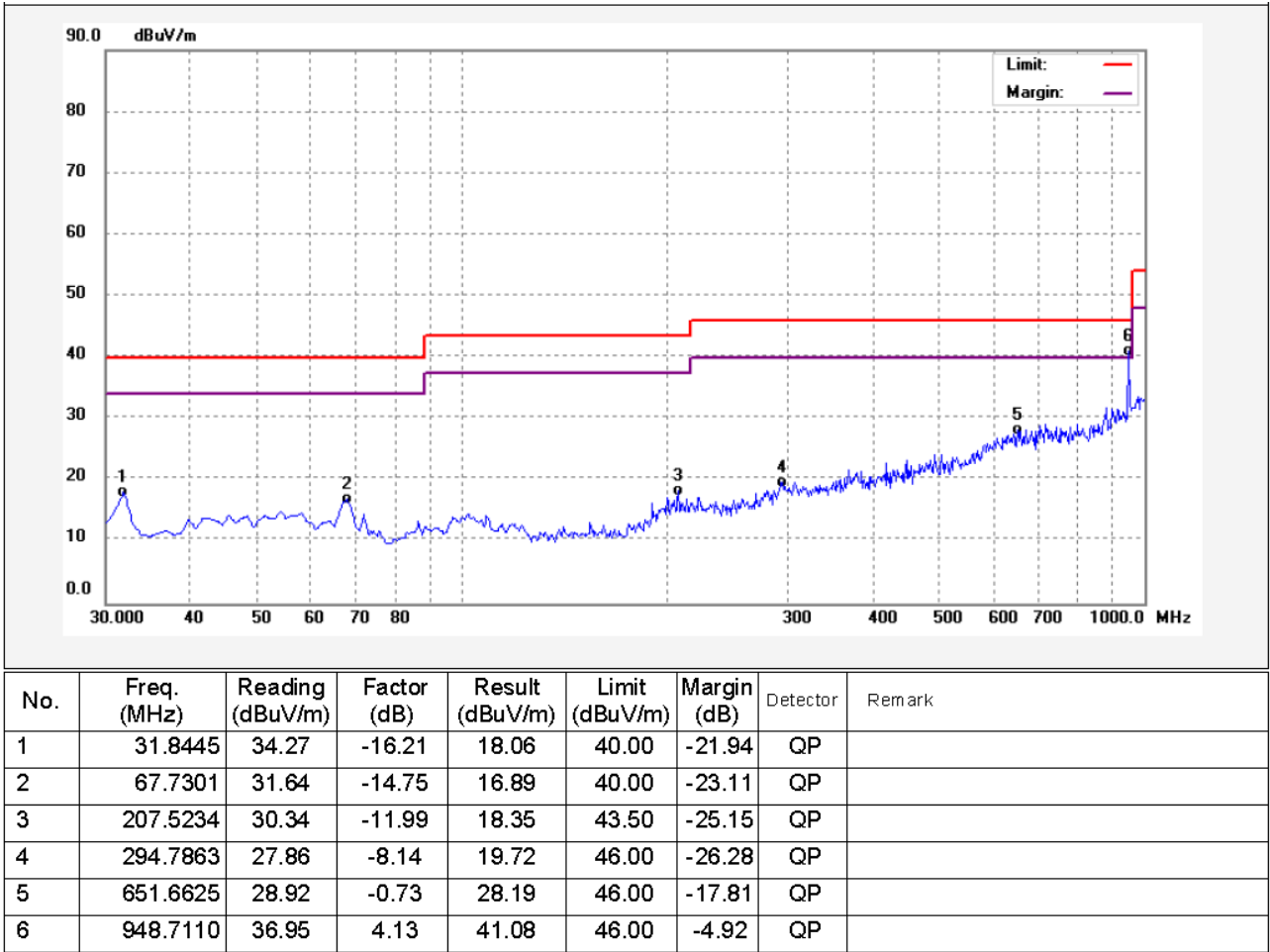
Test Frequency: 9KHz~30MHz

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

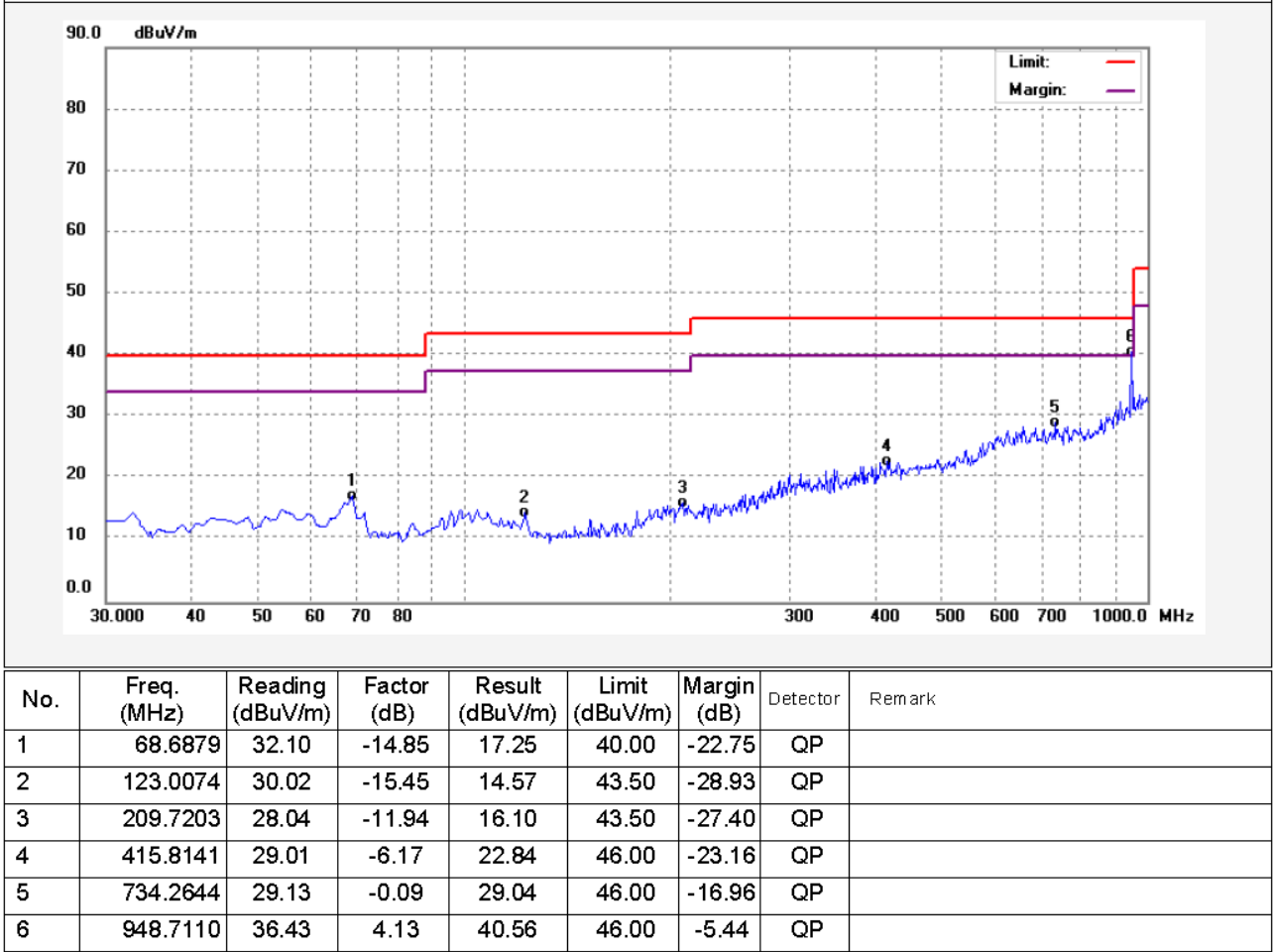
Test Frequency: 30MHz ~ 1GHz(Only the worst case GFSK mode Low Channel were record in the report.)

BT: Stamped Metal Antenna

Low Channel 2402MHz (Vertical)

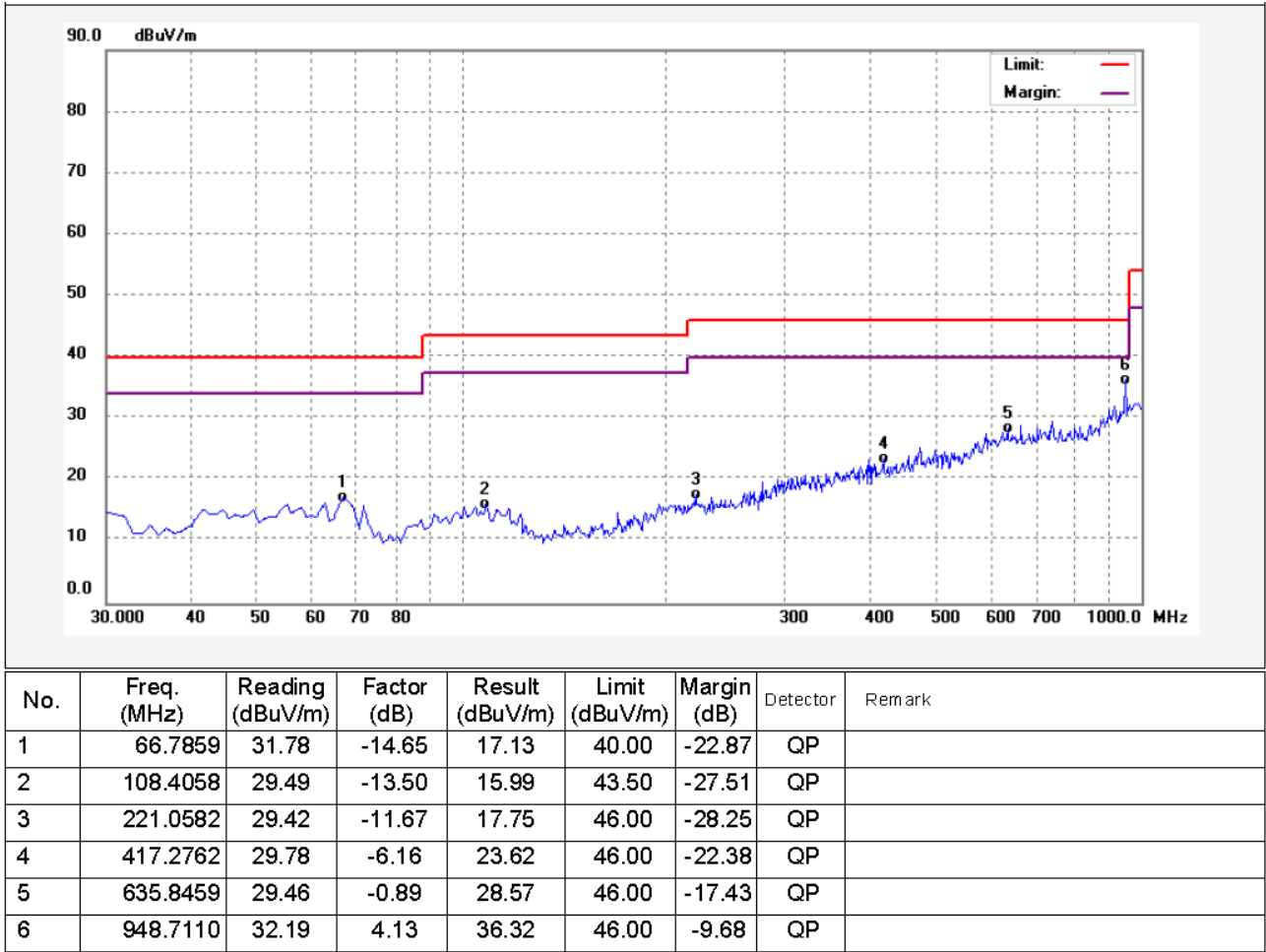


Low Channel 2402MHz (Horizontal)

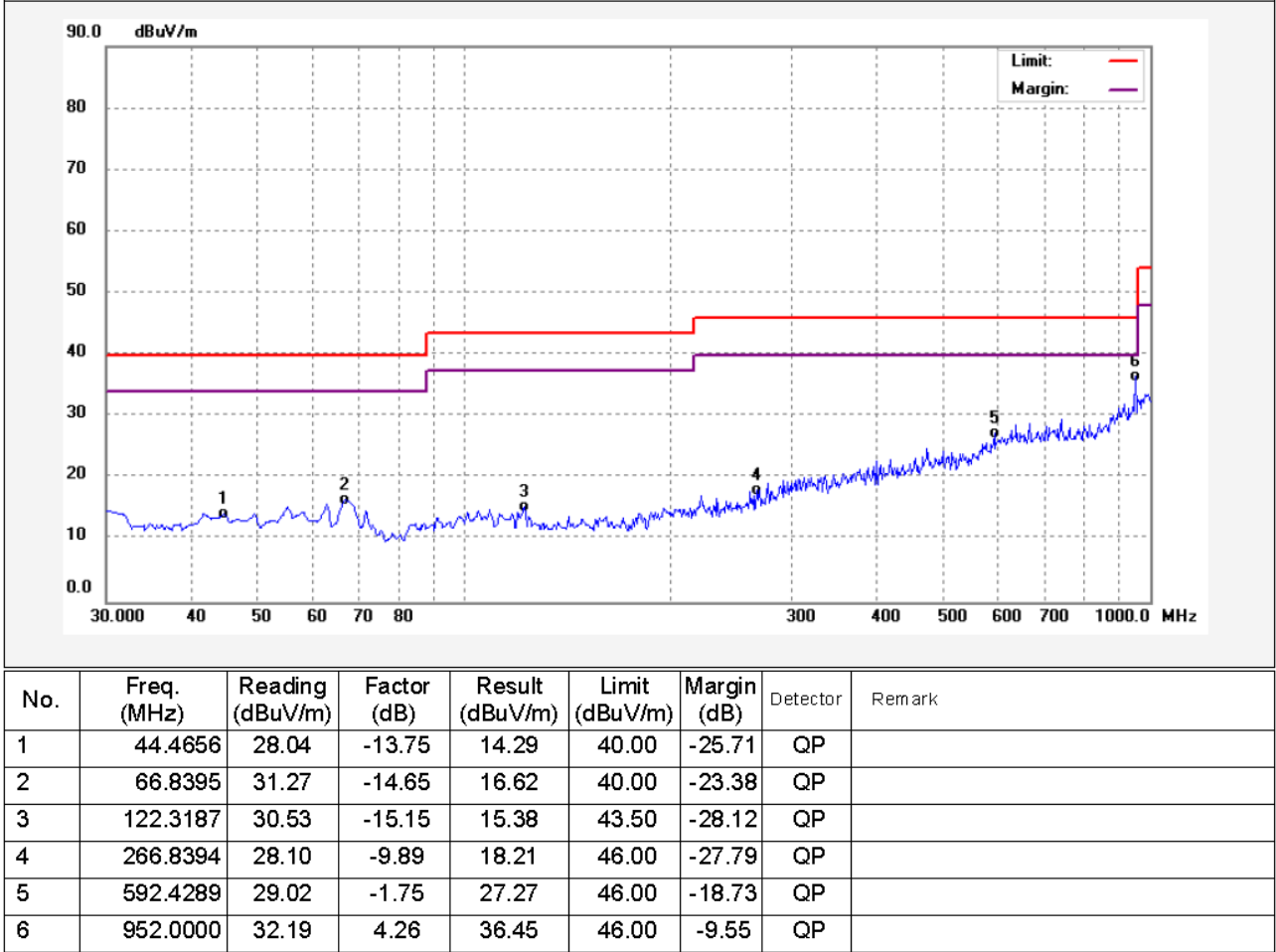


BT: PCB printed antenna

Low Channel 2402MHz (Vertical)



Low Channel 2402MHz (Horizontal)

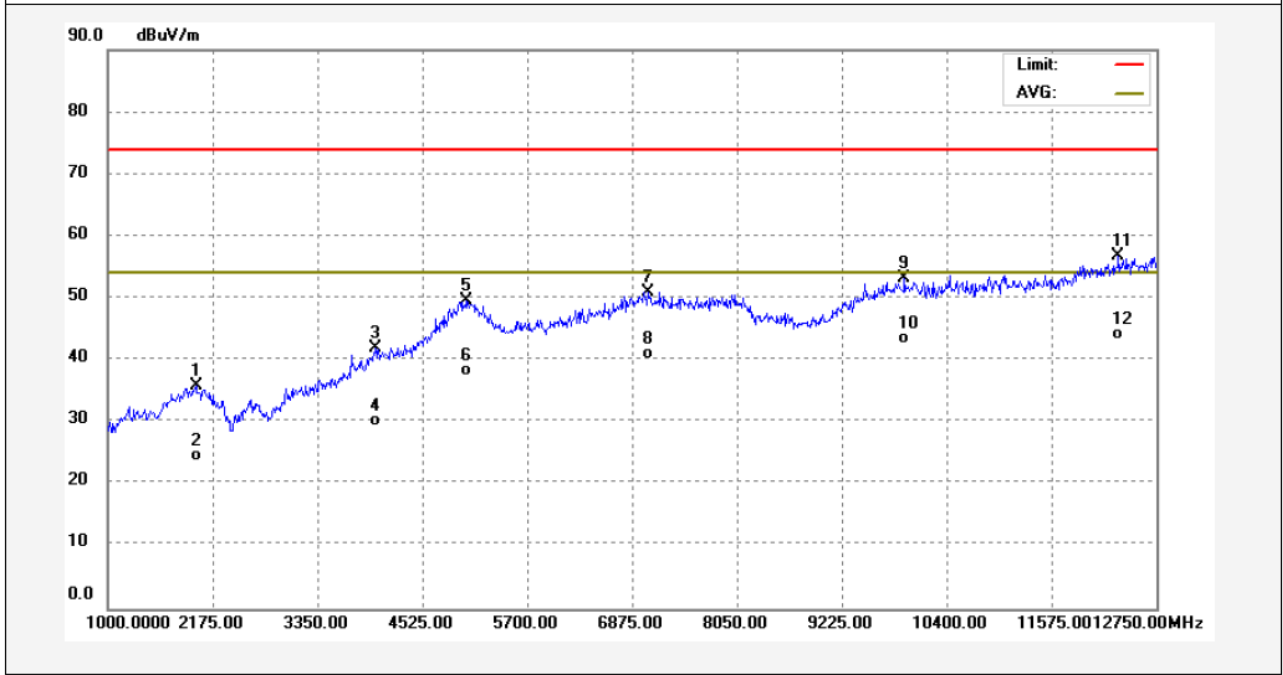


Test Frequency: 1GHz ~ 12.75GHz

Remark: The current test plots doesn't have the fundamental signal, It's blocked by the filter

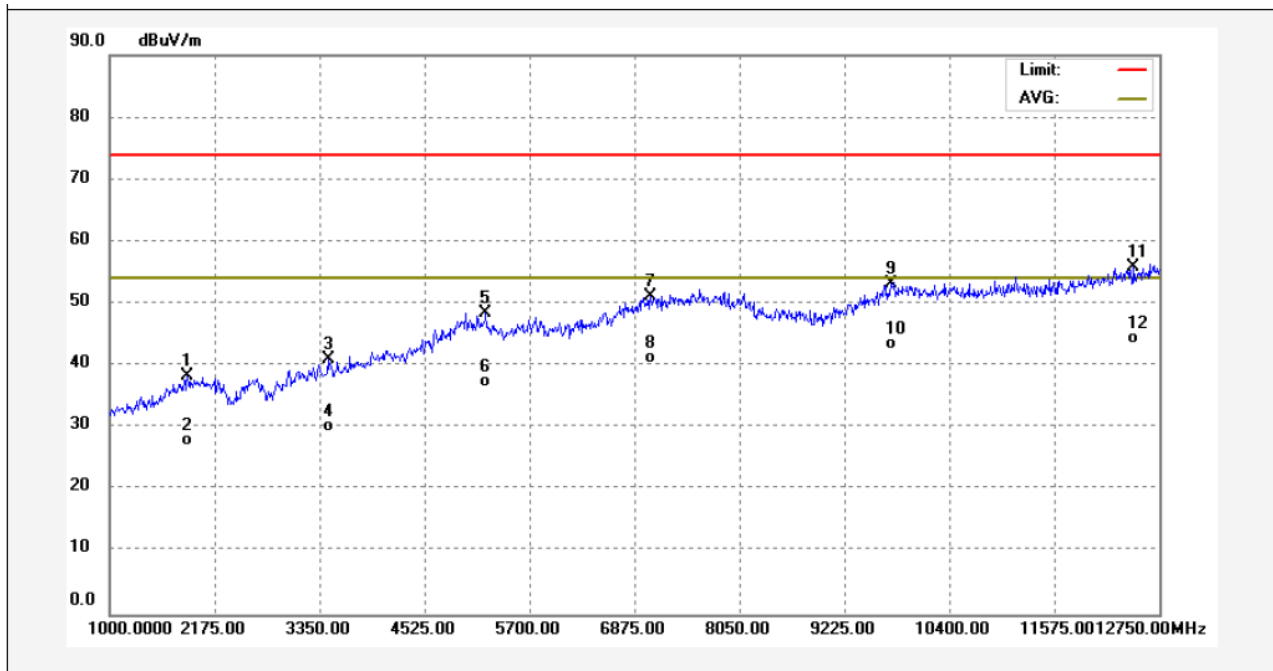
Test Low Channel 2402MHz (Vertical)

BT: Stamped Metal Antenna



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	1987.988	46.31	-10.45	35.86	74.00	-38.14	peak	
2	1987.988	35.00	-10.45	24.55	54.00	-29.45	AVG	
3	3999.249	48.68	-6.81	41.87	74.00	-32.13	peak	
4	3999.249	37.09	-6.81	30.28	54.00	-23.72	AVG	
5	5022.523	51.05	-1.43	49.62	74.00	-24.38	peak	
6	5022.523	39.69	-1.43	38.26	54.00	-15.74	AVG	
7	7057.307	48.50	2.53	51.03	74.00	-22.97	peak	
8	7057.307	38.46	2.53	40.99	54.00	-13.01	AVG	
9	9927.177	49.30	3.83	53.13	74.00	-20.87	peak	
10	9927.177	39.68	3.83	43.51	54.00	-10.49	AVG	
11	12326.576	50.01	6.80	56.81	74.00	-17.19	peak	
12	12326.576	37.39	6.80	44.19	54.00	-9.81	AVG	

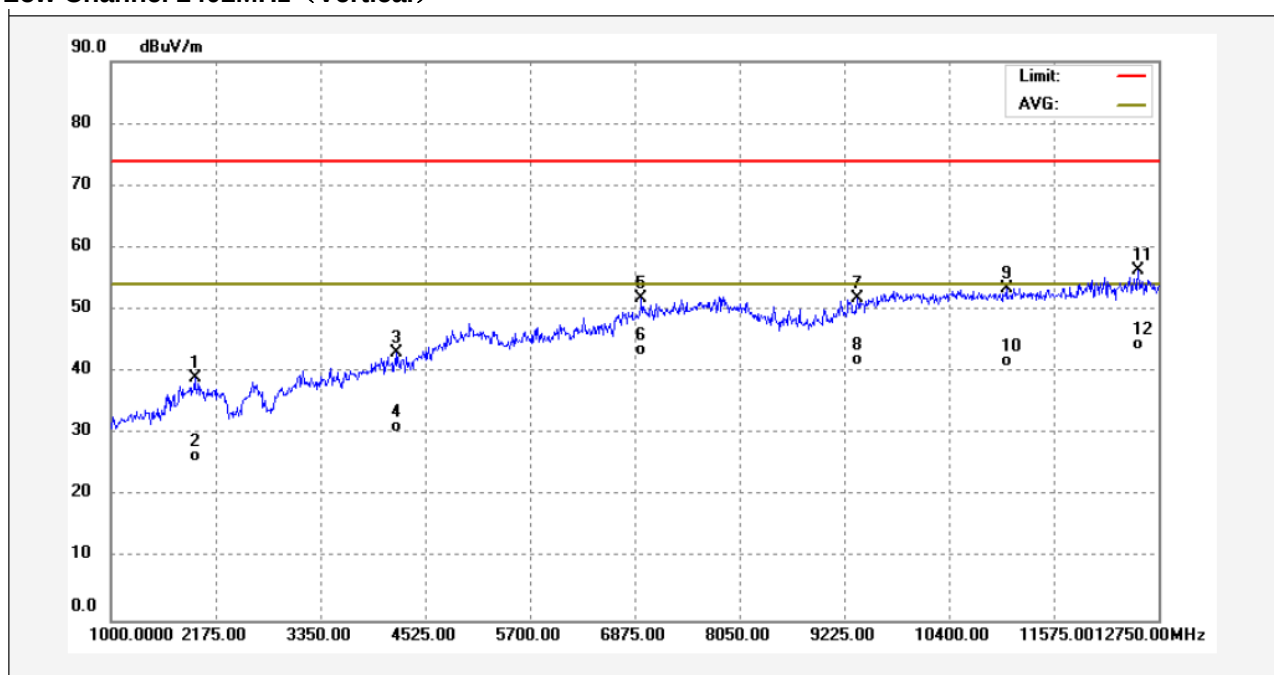
Low Channel 2402MHz (Horizontal)



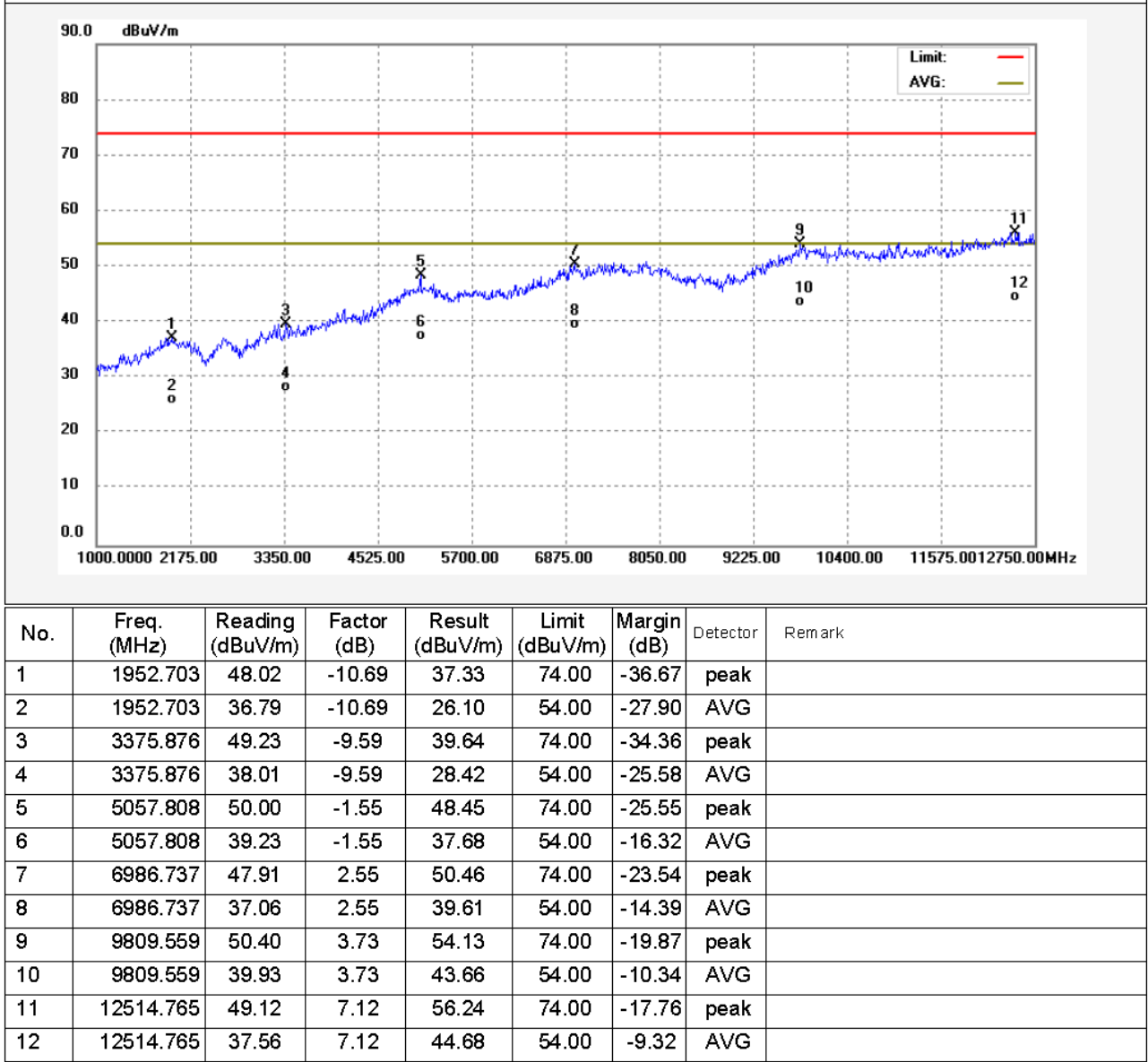
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	1870.370	49.52	-11.24	38.28	74.00	-35.72	peak	
2	1870.370	39.35	-11.24	28.11	54.00	-25.89	AVG	
3	3446.446	50.52	-9.38	41.14	74.00	-32.86	peak	
4	3446.446	39.63	-9.38	30.25	54.00	-23.75	AVG	
5	5210.711	50.58	-2.11	48.47	74.00	-25.53	peak	
6	5210.711	39.57	-2.11	37.46	54.00	-16.54	AVG	
7	7057.307	48.63	2.53	51.16	74.00	-22.84	peak	
8	7057.307	38.68	2.53	41.21	54.00	-12.79	AVG	
9	9750.751	49.44	3.68	53.12	74.00	-20.88	peak	
10	9750.751	39.93	3.68	43.61	54.00	-10.39	AVG	
11	12467.718	48.85	7.03	55.88	74.00	-18.12	peak	
12	12467.718	37.39	7.03	44.42	54.00	-9.58	AVG	

BT: PCB printed antenna

Low Channel 2402MHz (Vertical)



Low Channel 2402MHz (Horizontal)



Test Frequency: 12.75GHz ~ 25GHz

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

8 Conducted Spurious Emissions

Test Requirement: FCC CFR47 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)).

8.1 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:

Below 1GHz:

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

Detector function = peak, Trace = max hold

Above 1GHz:

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

Detector function = peak, Trace = max hold

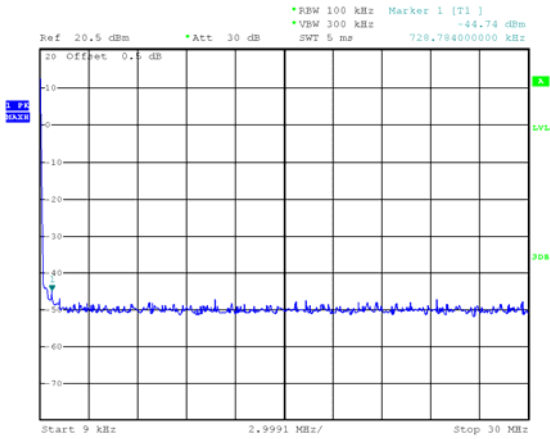
8.2 Test Result

9KHz - 30MHz

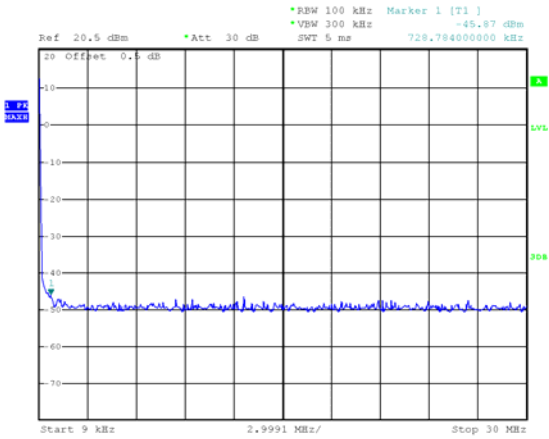
Modulation: GFSK

Low Channel

Middle Channel

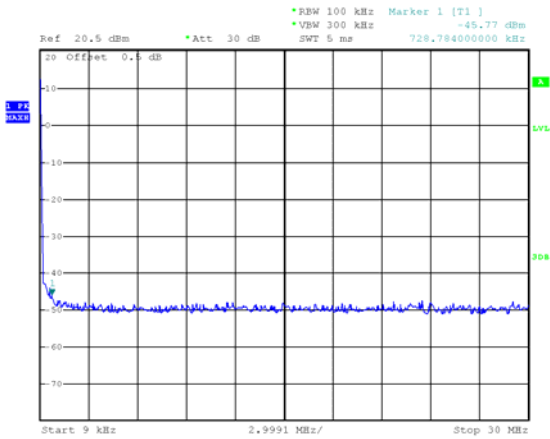


Date: 28.OCT.2021 10:56:41



Date: 28.OCT.2021 10:57:10

High Channel

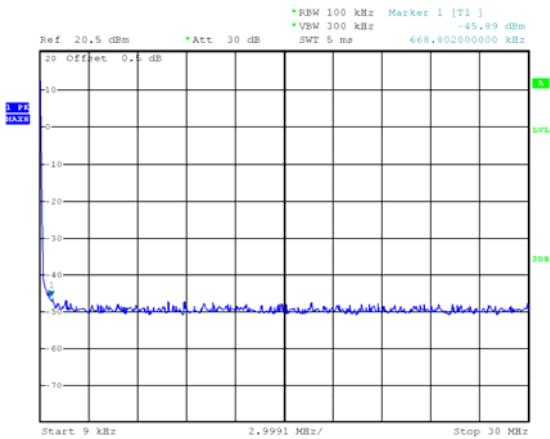


Date: 28.OCT.2021 10:57:30

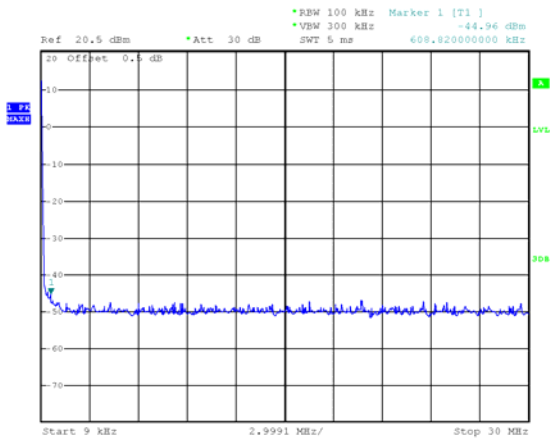
Modulation: Pi/4 DQPSK

Low Channel

Middle Channel

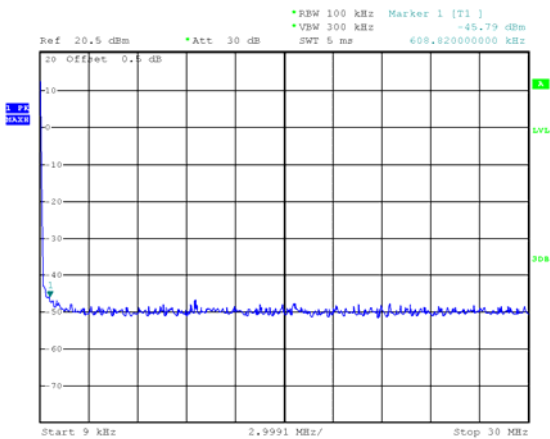


Date: 28.OCT.2021 10:58:24



Date: 28.OCT.2021 10:58:01

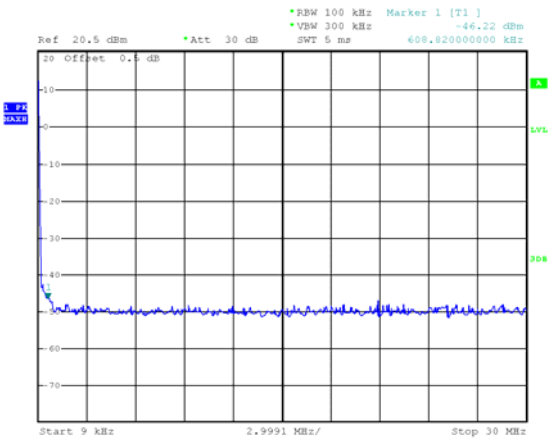
High Channel



Date: 28.OCT.2021 10:57:46

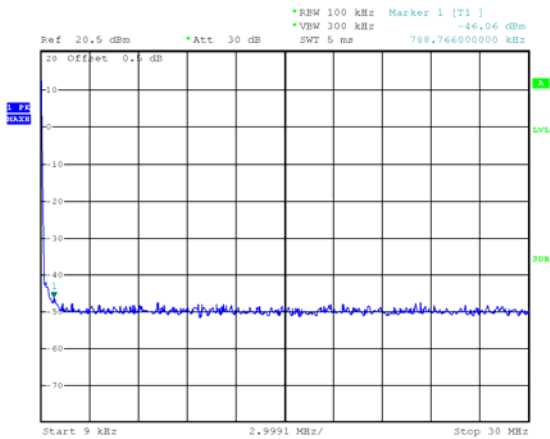
Modulation: 8DPSK

Low Channel



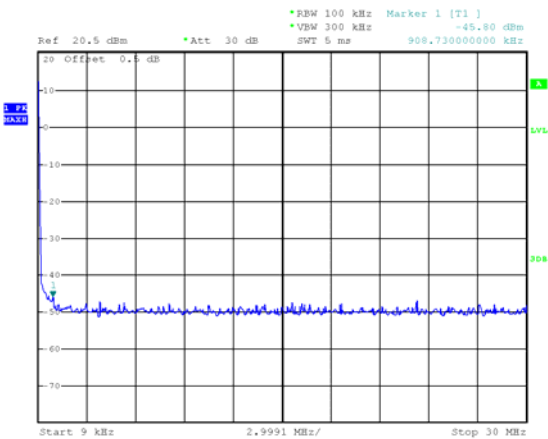
Date: 28.OCT.2021 10:58:38

Middle Channel



Date: 28.OCT.2021 10:58:54

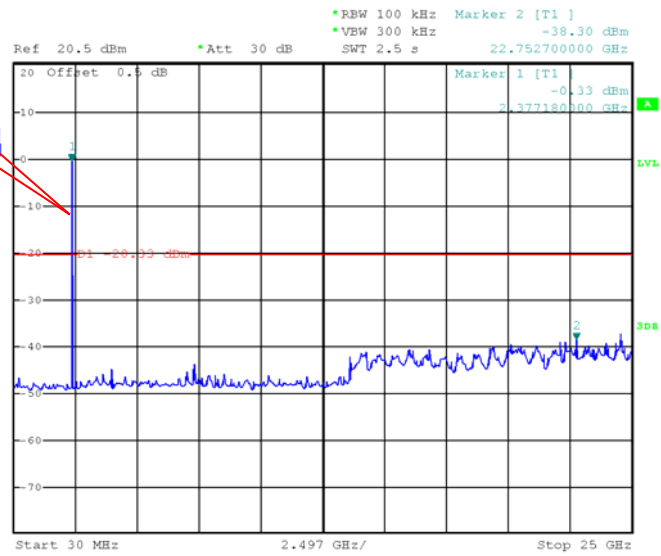
High Channel



Date: 28.OCT.2021 10:59:11

30MHz – 25GHz
GFSK Low Channel

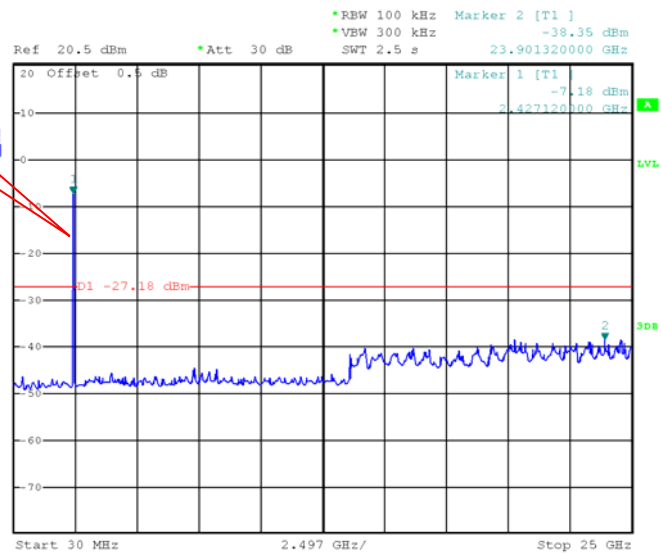
Fundamental



Date: 28.OCT.2021 11:01:28

GFSK Middle Channel

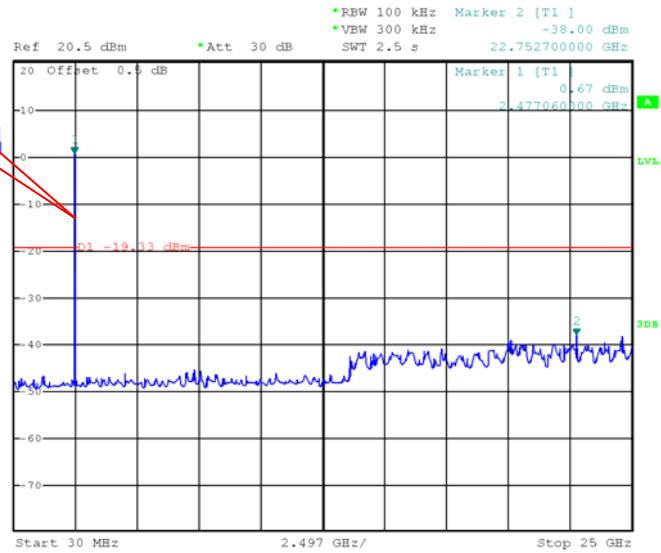
Fundamental



Date: 28.OCT.2021 11:00:44

GFSK High Channel

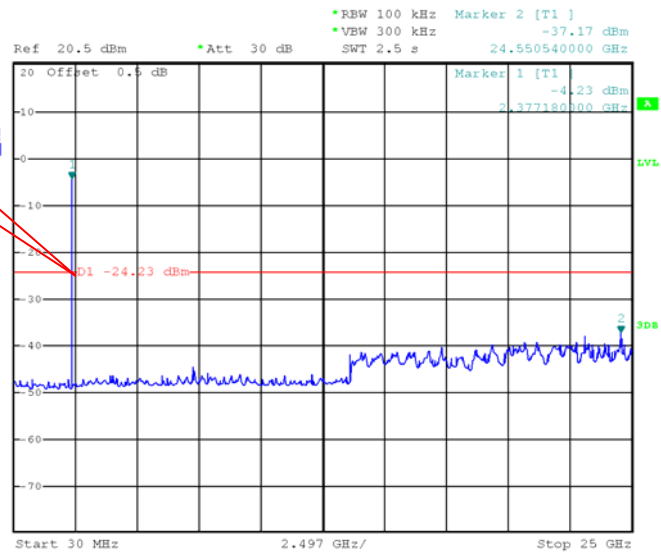
Fundamental



Date: 28.OCT.2021 11:05:38

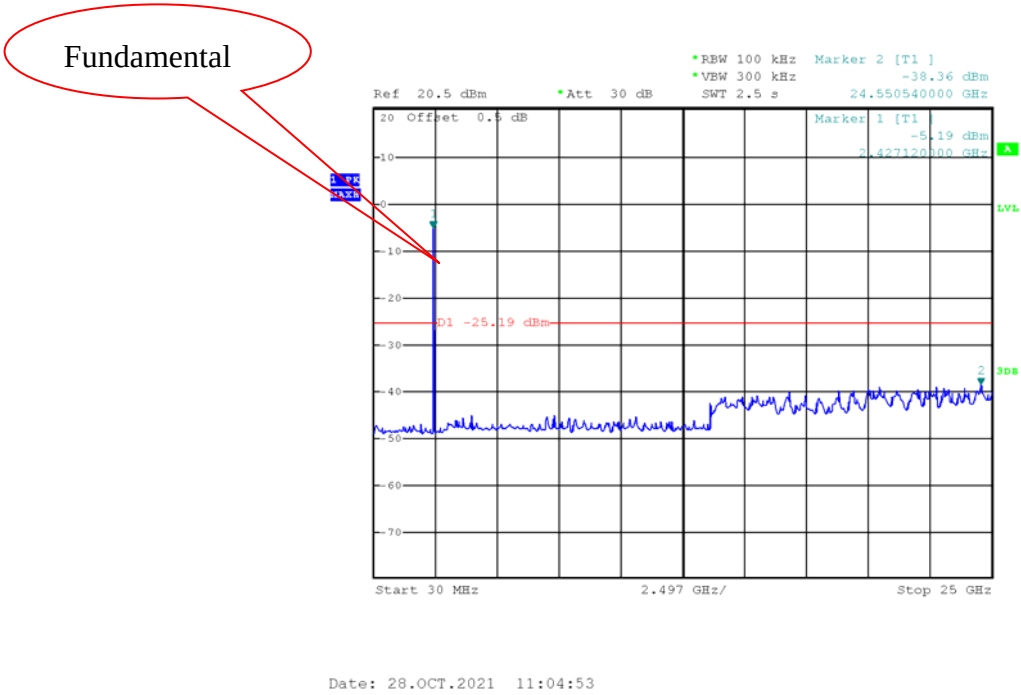
Pi/4 DQPSK Low Channel

Fundamental

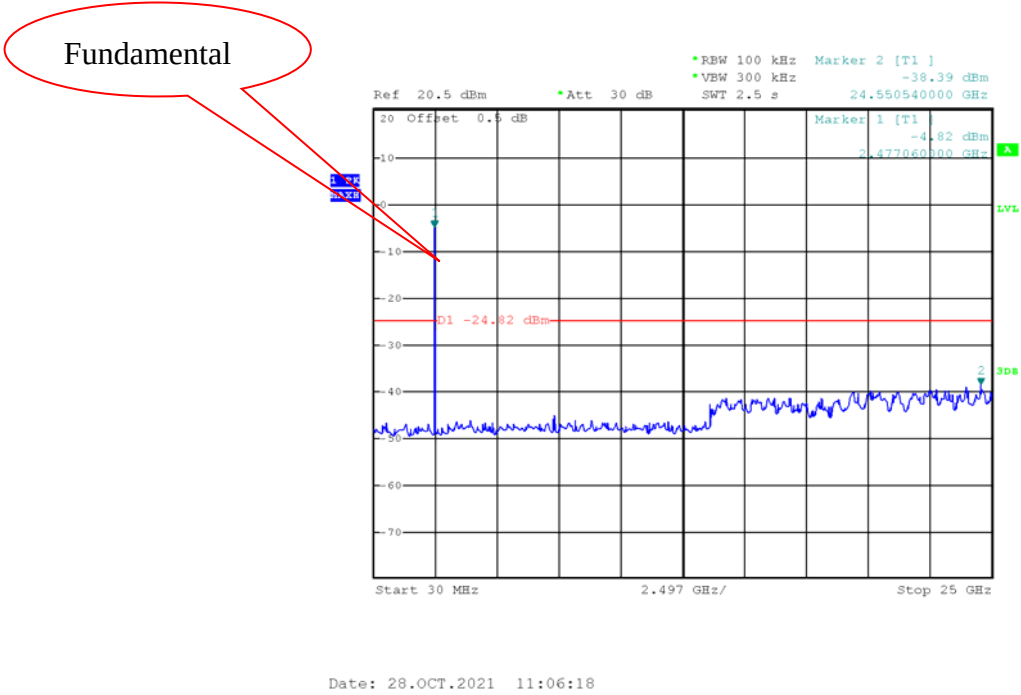


Date: 28.OCT.2021 11:02:15

Pi/4 DQPSK Middle Channel

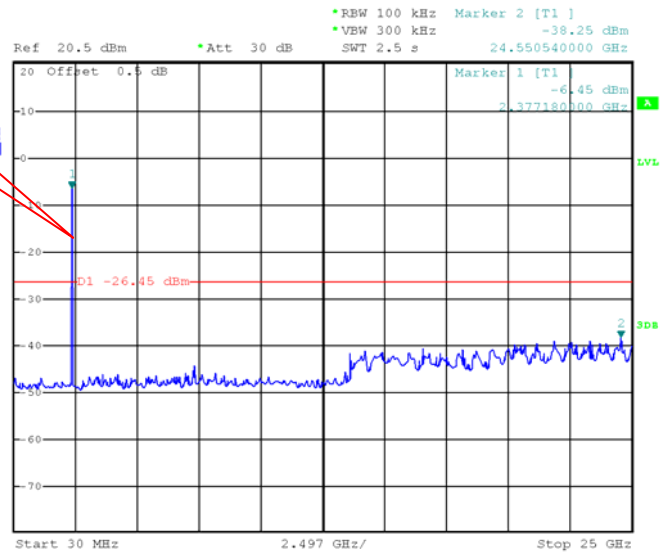


Pi/4 DQPSK High Channel



8DPSK Low Channel

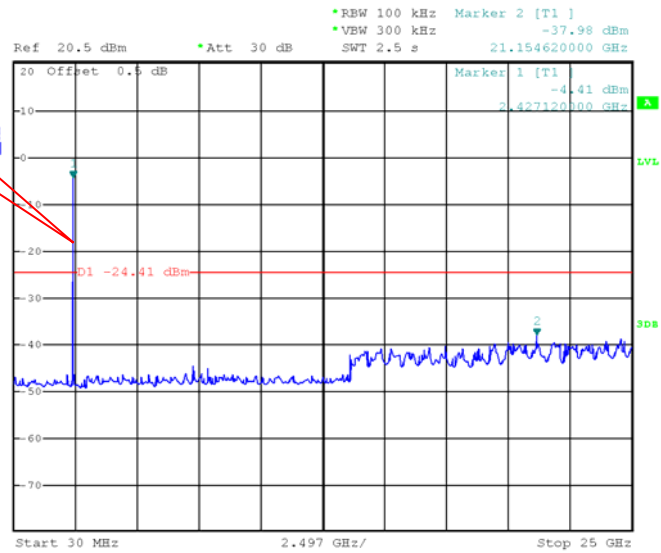
Fundamental



Date: 28.OCT.2021 11:02:56

8DPSK Middle Channel

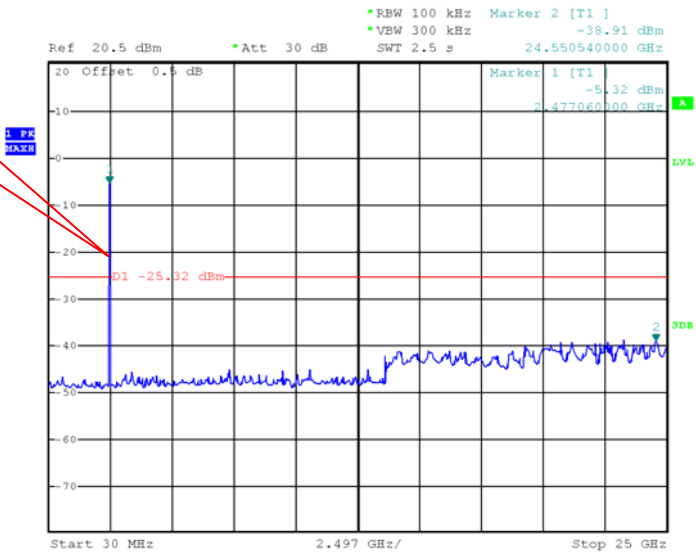
Fundamental



Date: 28.OCT.2021 11:03:50

8DPSK High Channel

Fundamental



Date: 28.OCT.2021 11:07:20

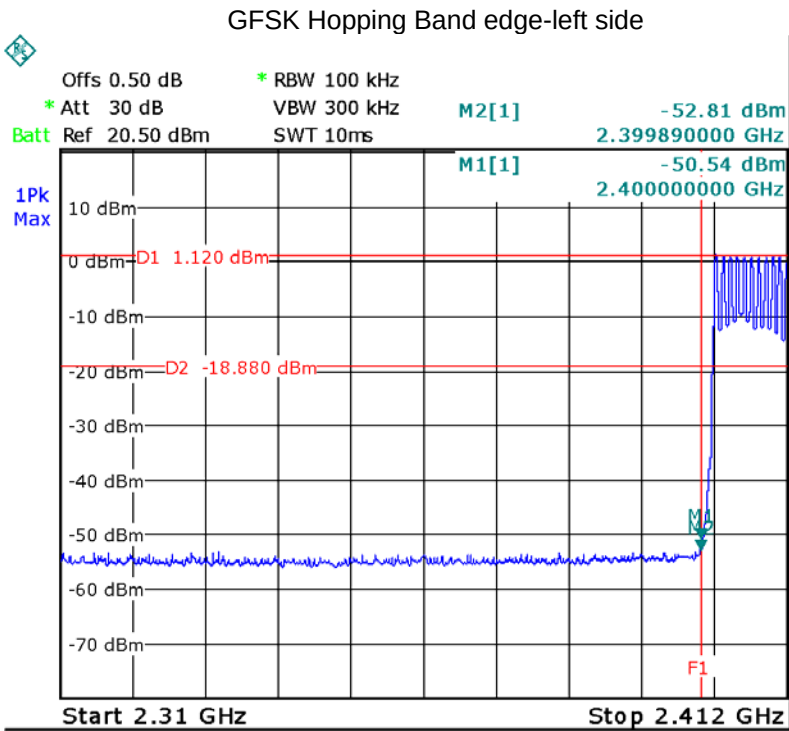
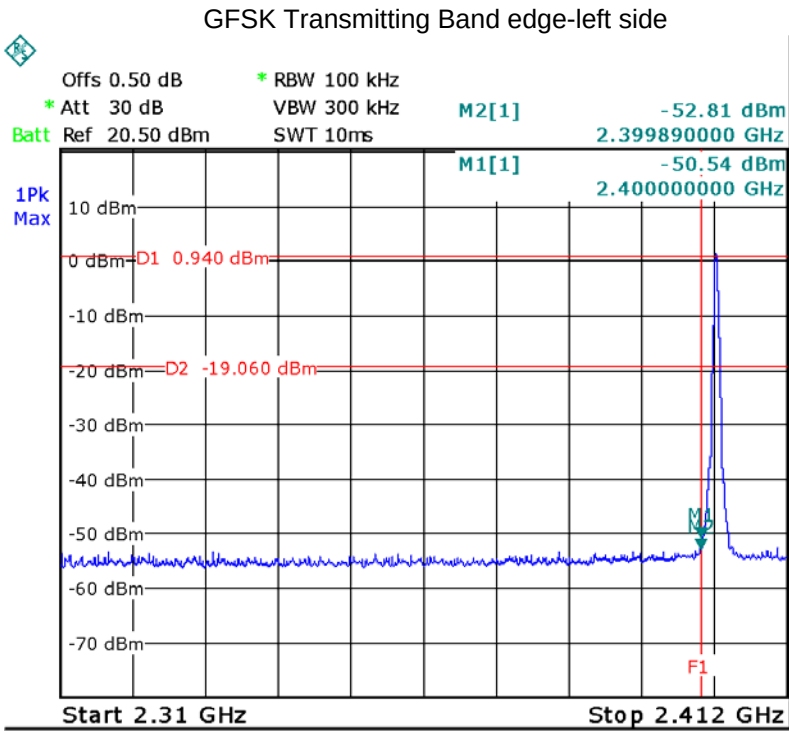
9 Band Edge Measurement

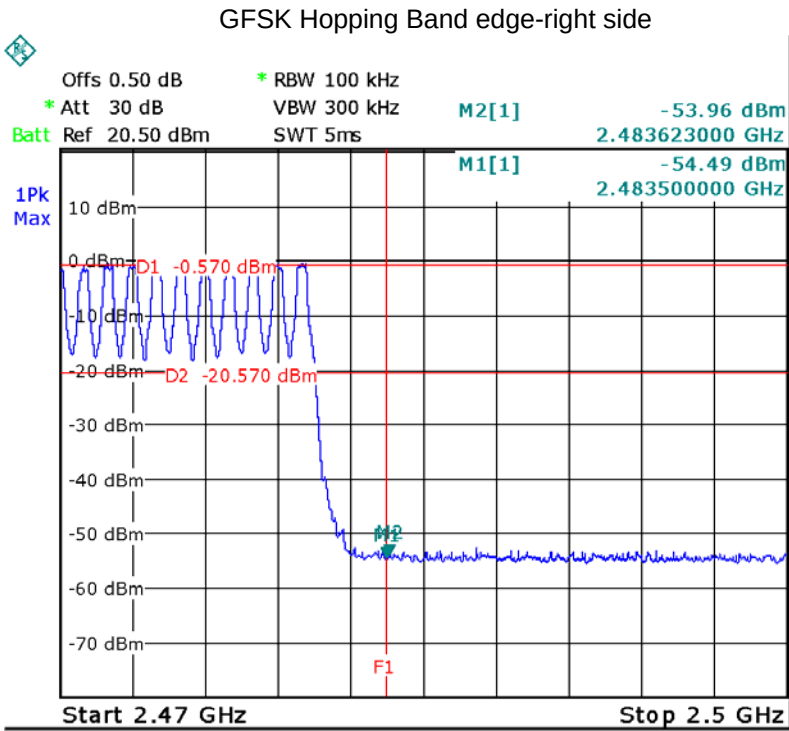
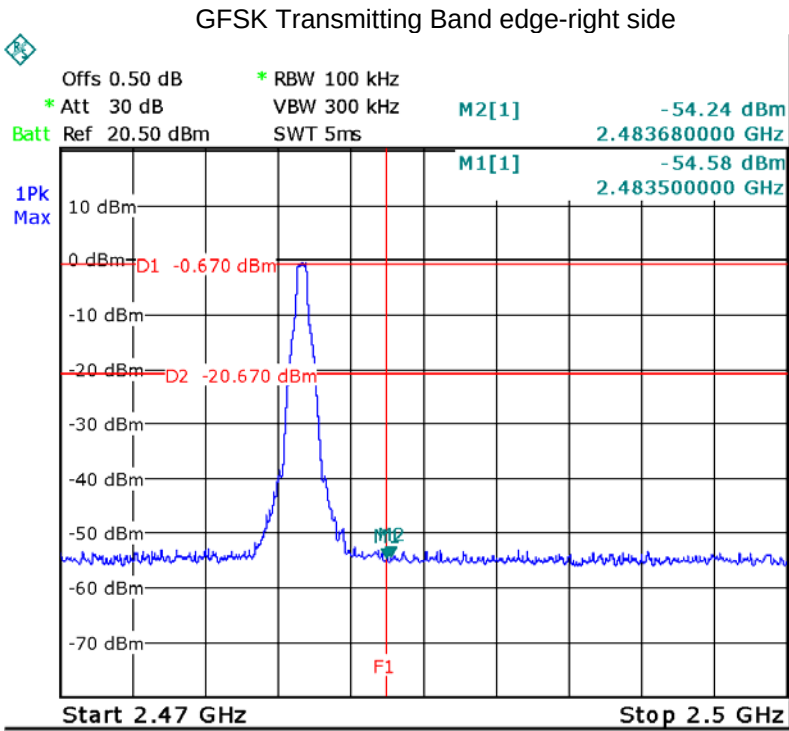
Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247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

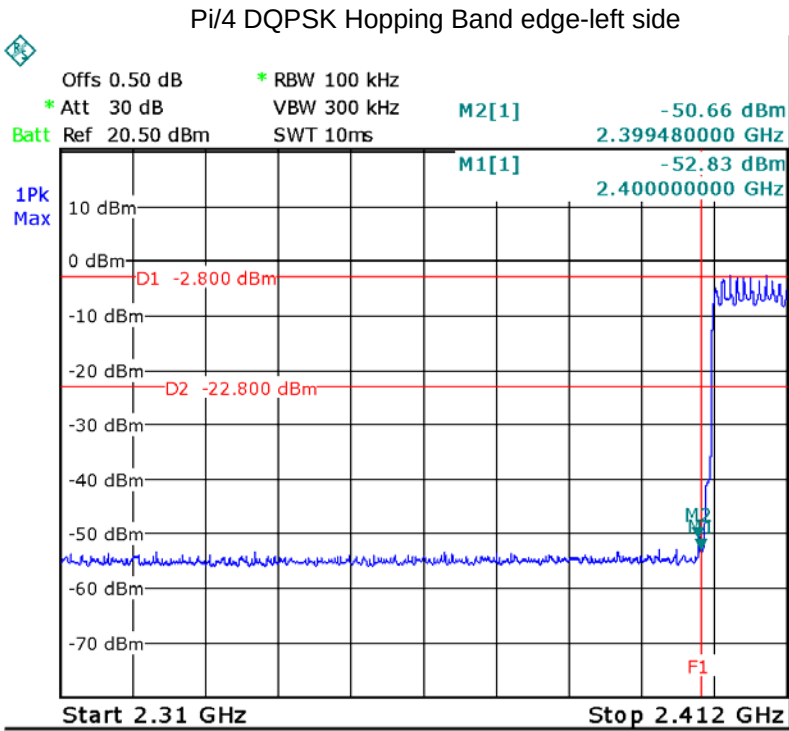
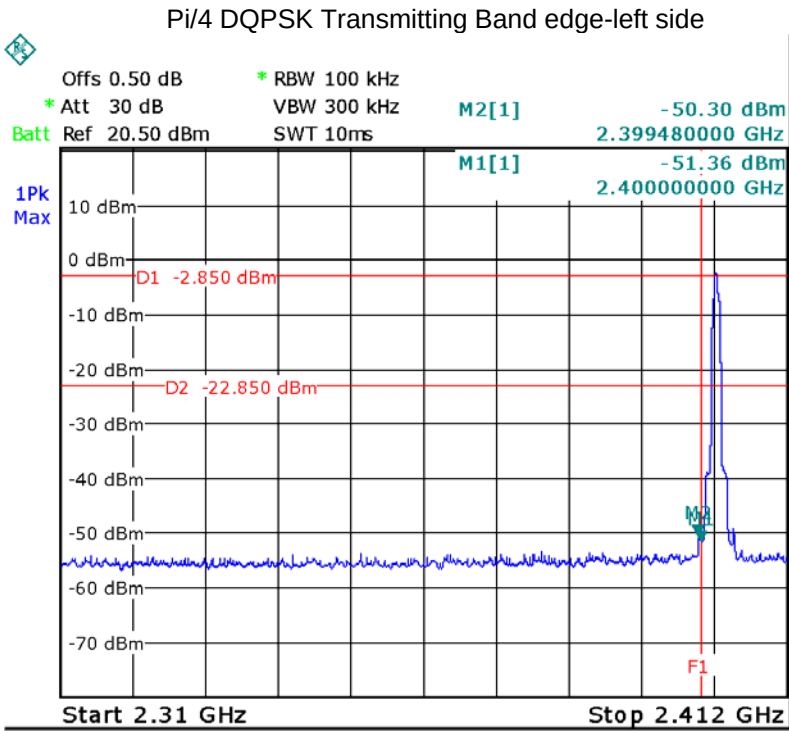
9.1 Test Procedure

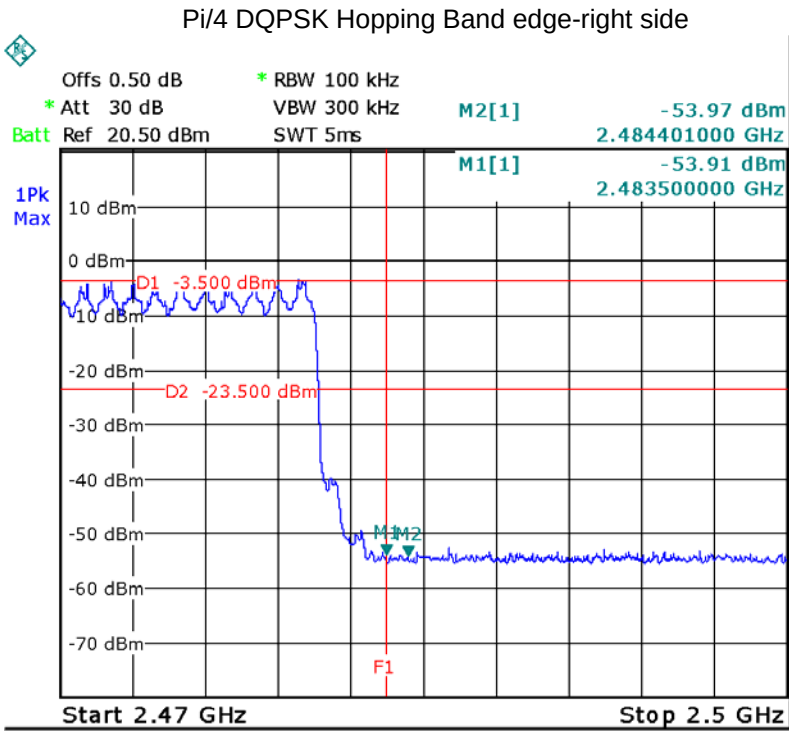
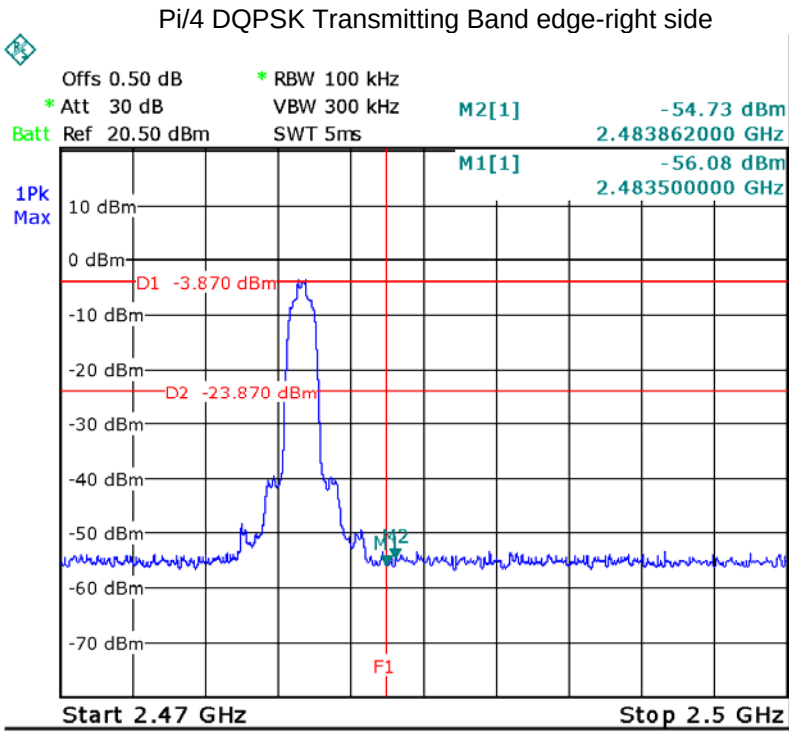
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold

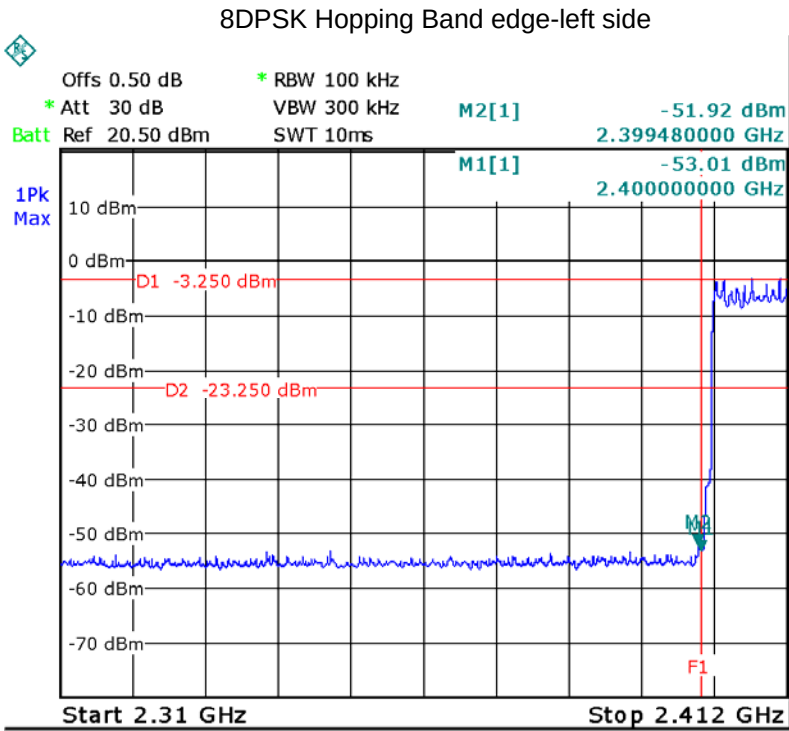
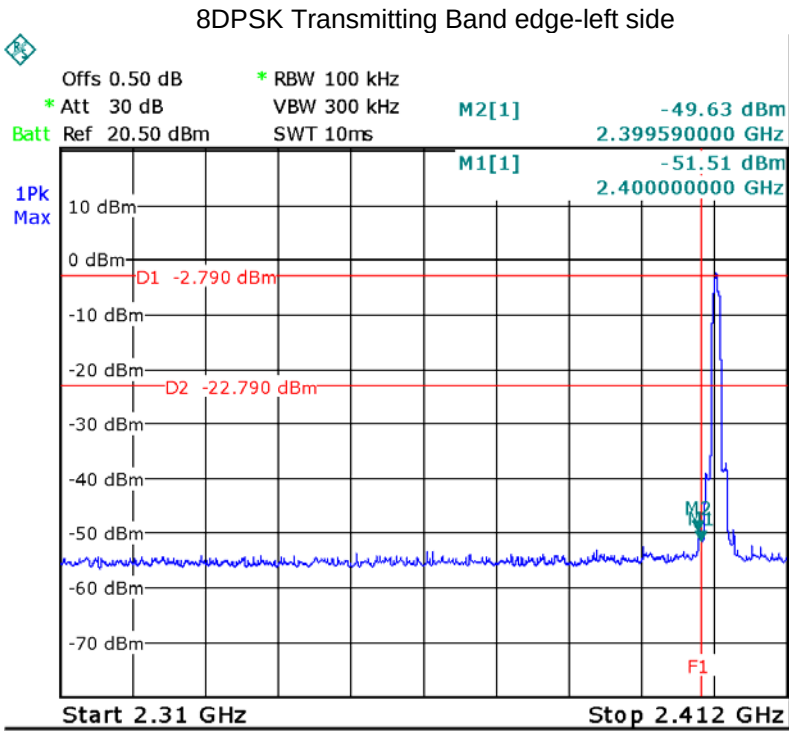
9.2 Test Result

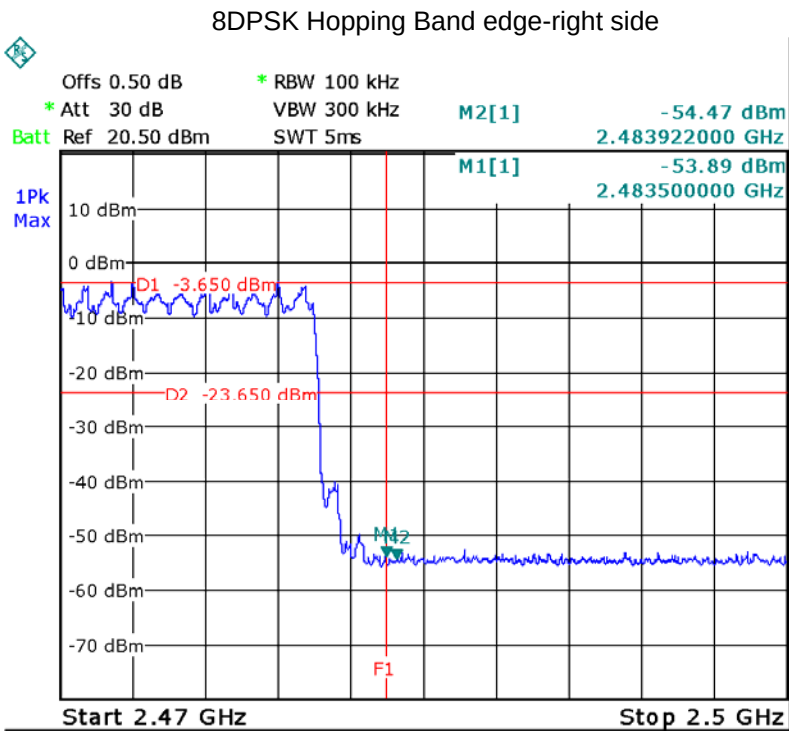
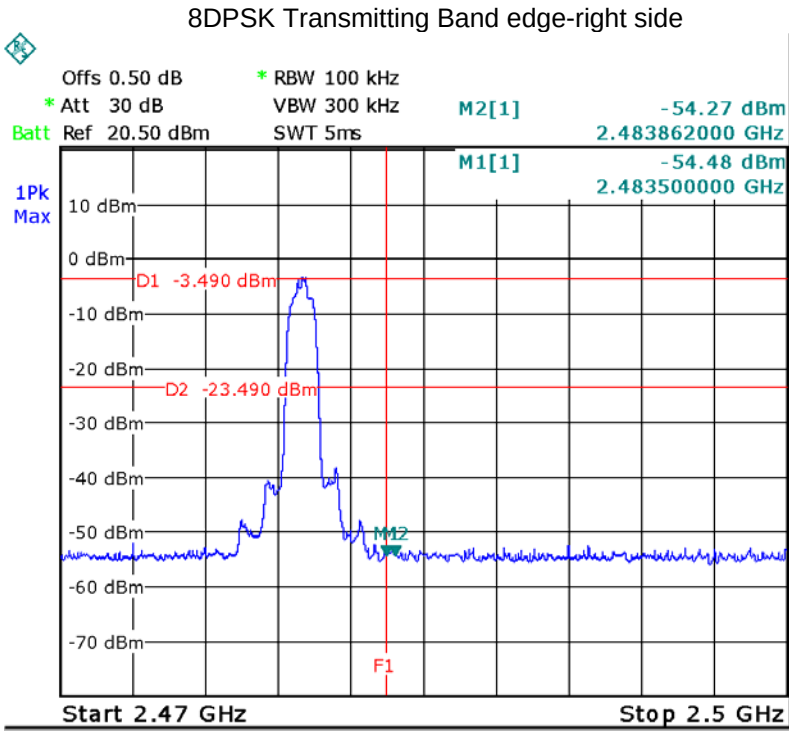












10 Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

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

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 = 30kHz, VBW = 100kHz

10.2 Test Result

Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
GFSK	Low	0.940	0.832
GFSK	Middle	0.874	0.844
GFSK	High	0.946	0.844
$\pi/4$ DQPSK	Low	1.270	1.180
$\pi/4$ DQPSK	Middle	1.287	1.174
$\pi/4$ DQPSK	High	1.287	1.174
8DPSK	Low	1.293	1.174
8DPSK	Middle	1.293	1.180
8DPSK	High	1.287	1.174

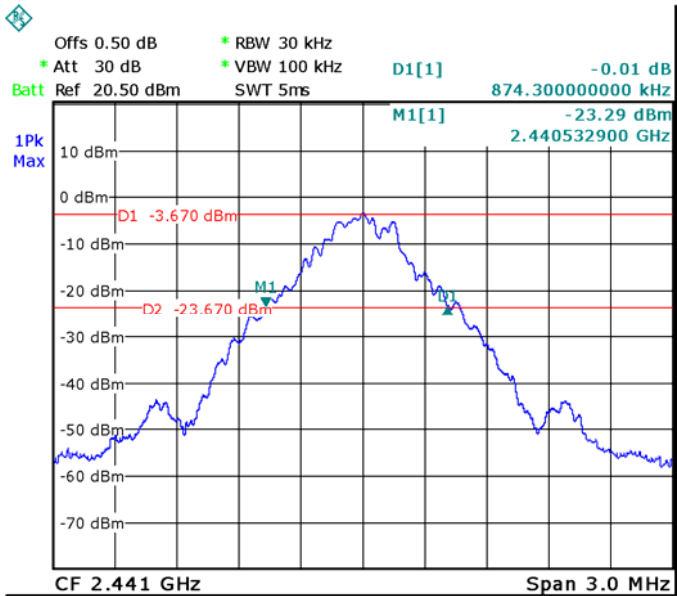
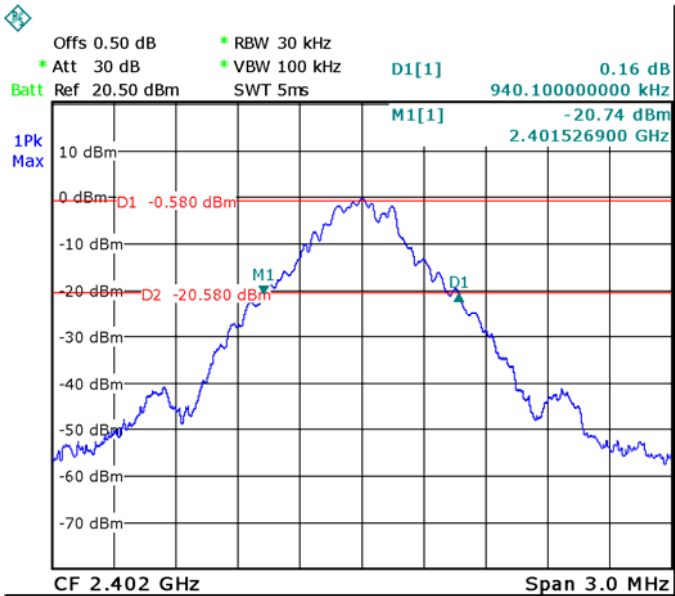
Test plots

20 dB Bandwidth

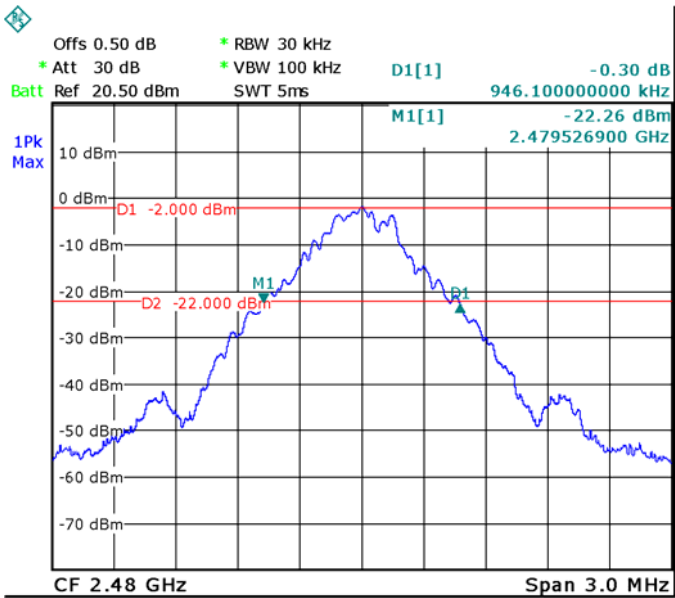
Modulation: GFSK

Low Channel

Middle Channel

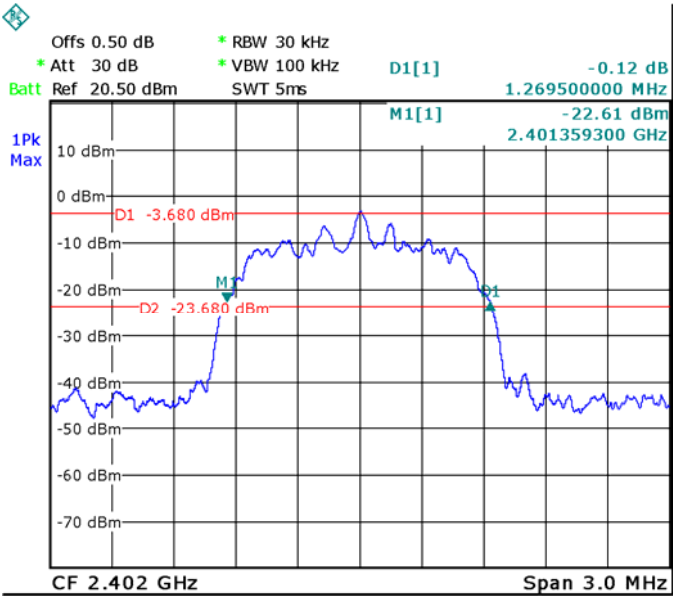


High Channel

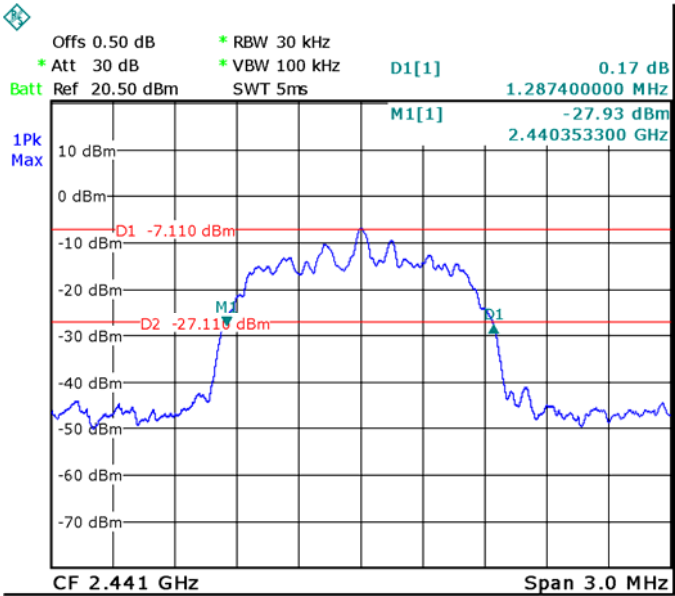


Modulation: $\pi/4$ DQPSK

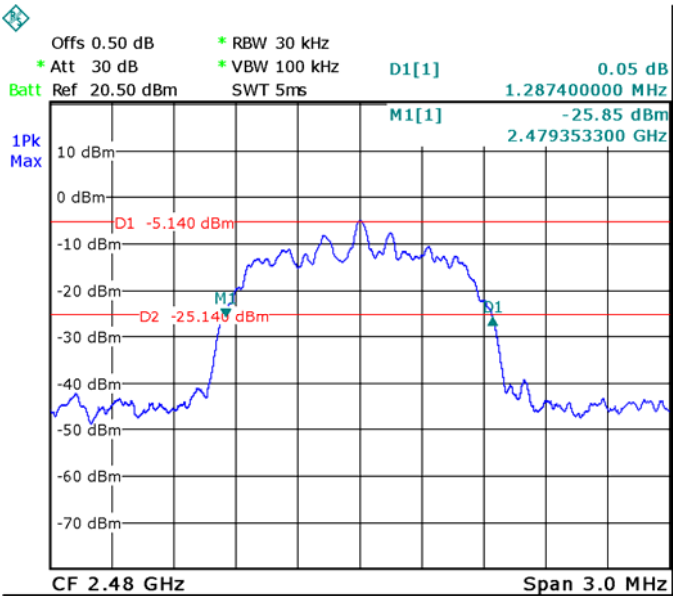
Low Channel



Middle Channel

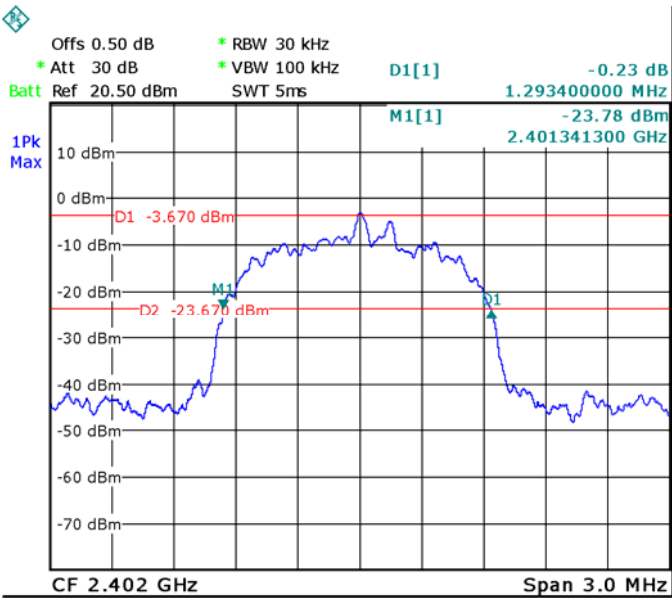


High Channel

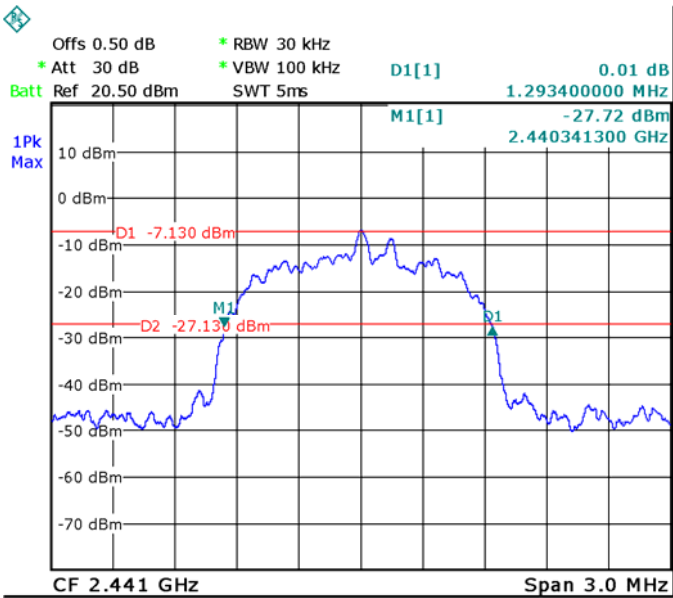


Modulation: 8DPSK

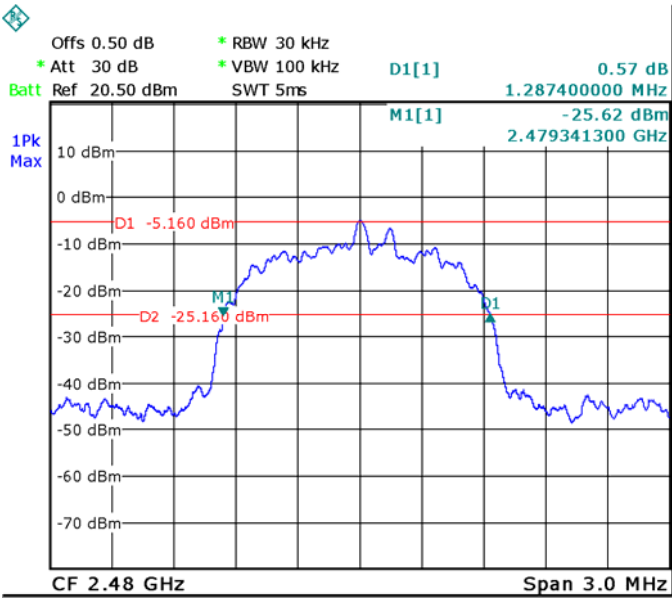
Low Channel



Middle Channel



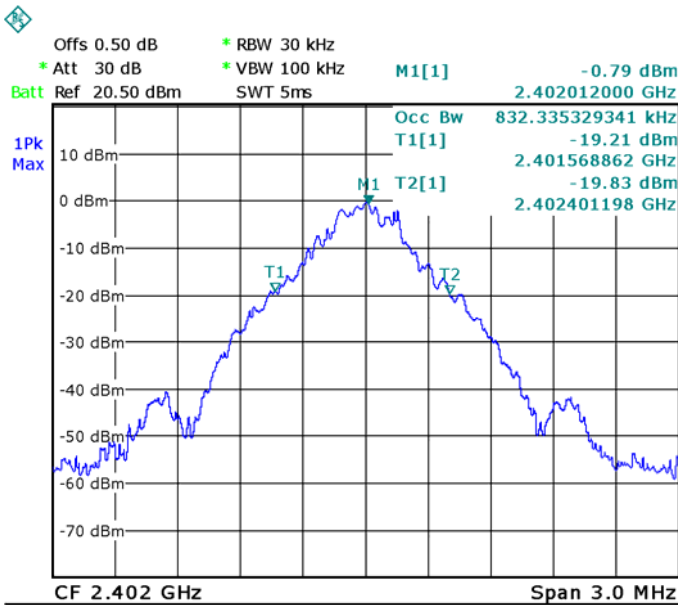
High Channel



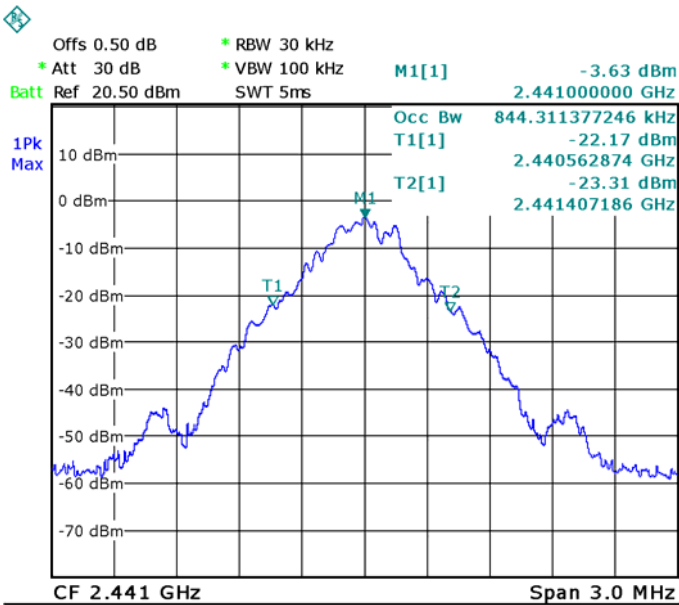
99% Bandwidth

Modulation: GFSK

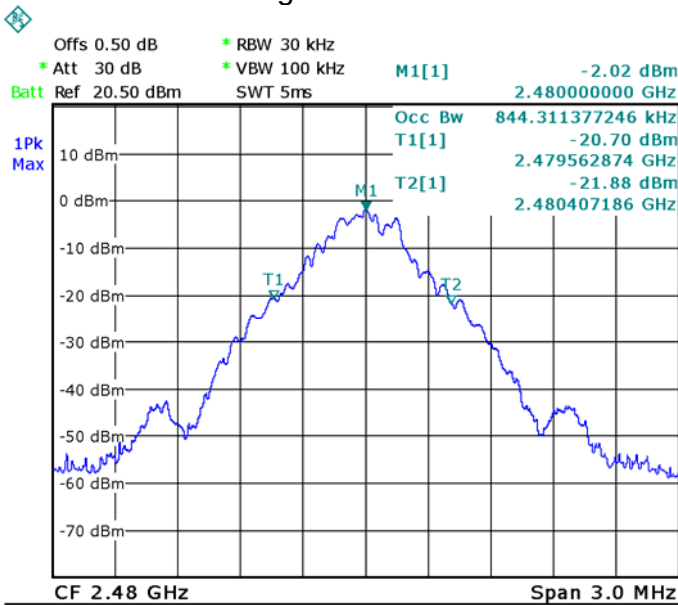
Low Channel



Middle Channel

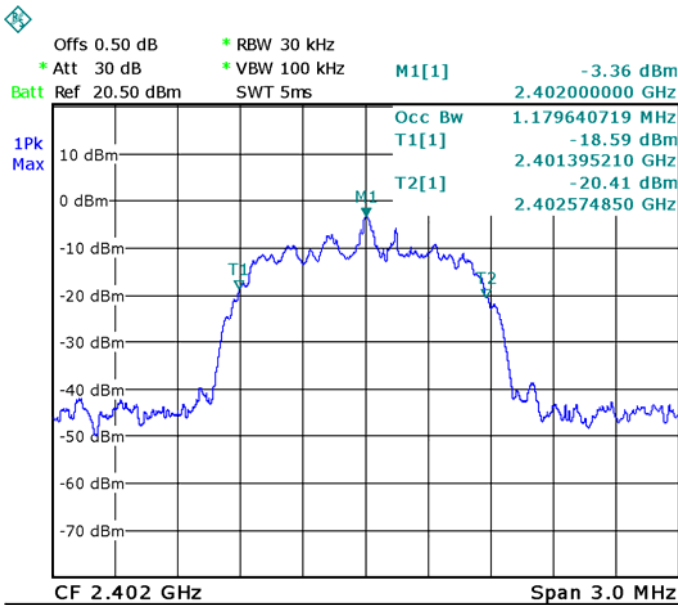


High Channel

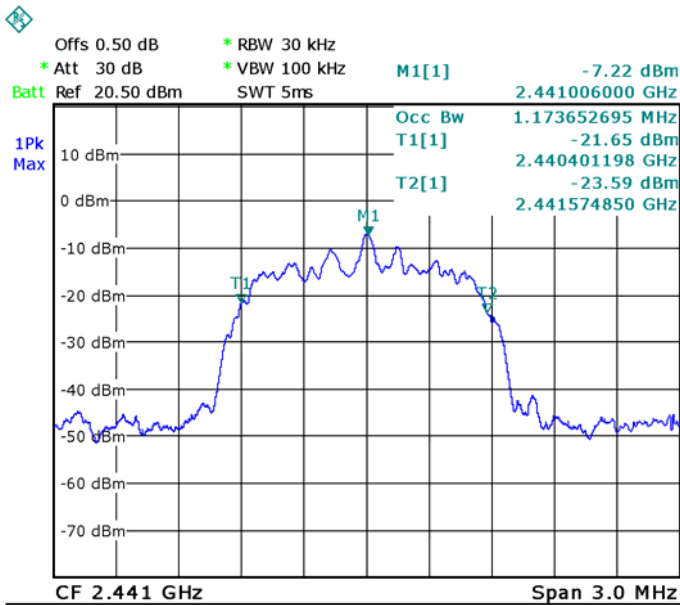


Modulation: $\pi/4$ DQPSK

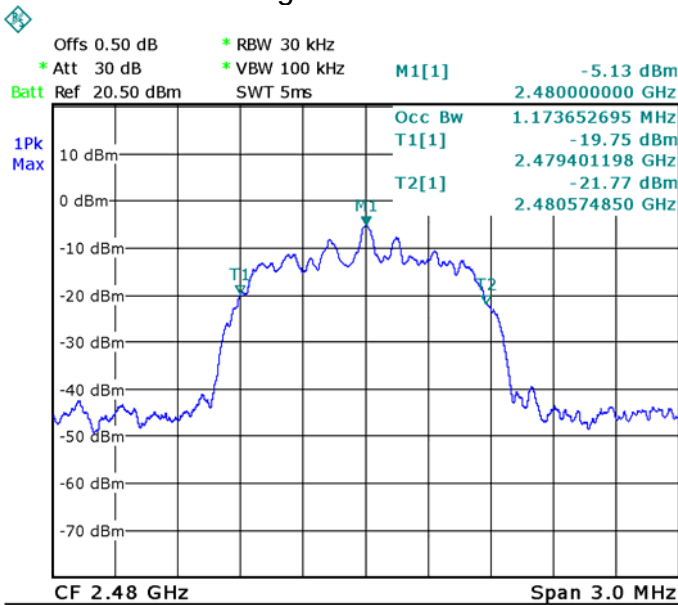
Low Channel



Middle Channel

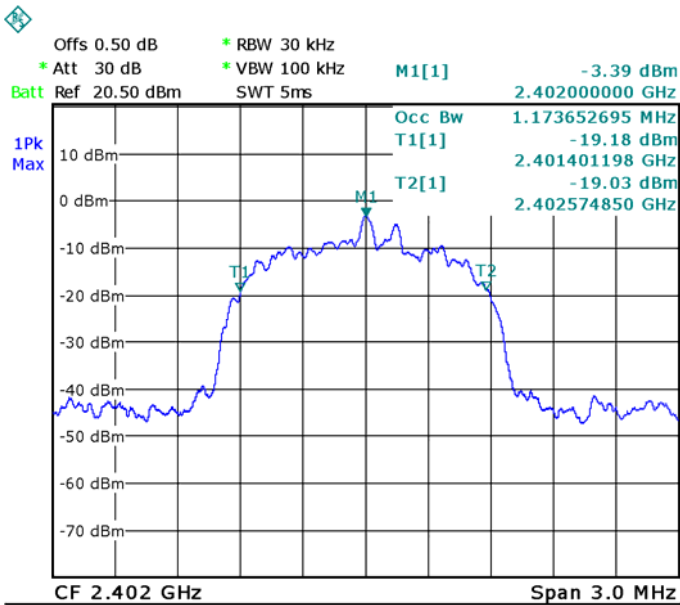


High Channel

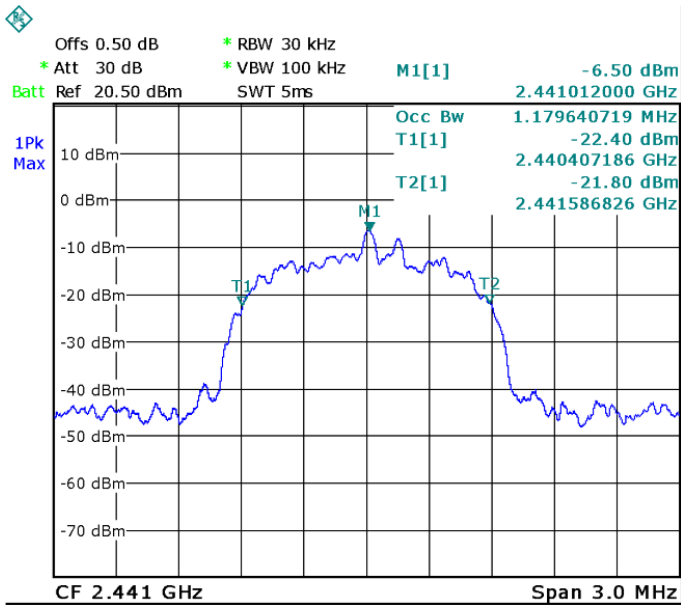


Modulation: 8DPSK

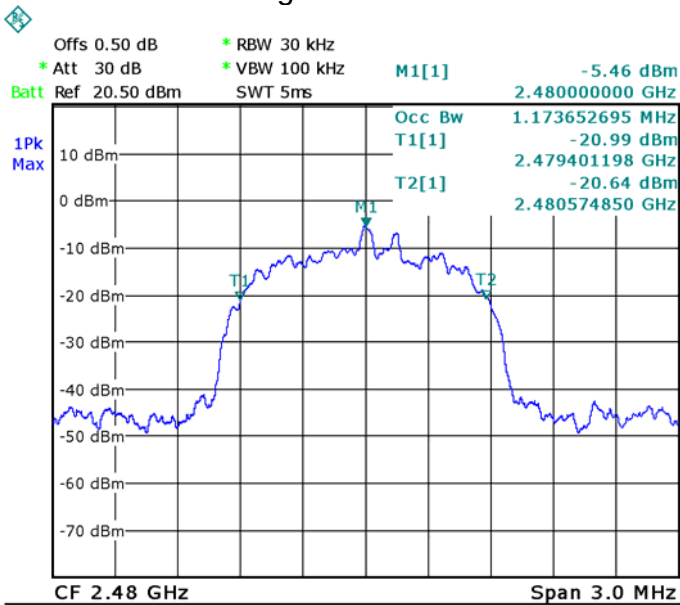
Low Channel



Middle Channel



High Channel



11 Maximum Peak Output Power

Test Requirement:	FCC CFR47 Part 15 Section 15.247
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
Test mode:	Test in fixing frequency transmitting mode.

11.1 Test Procedure

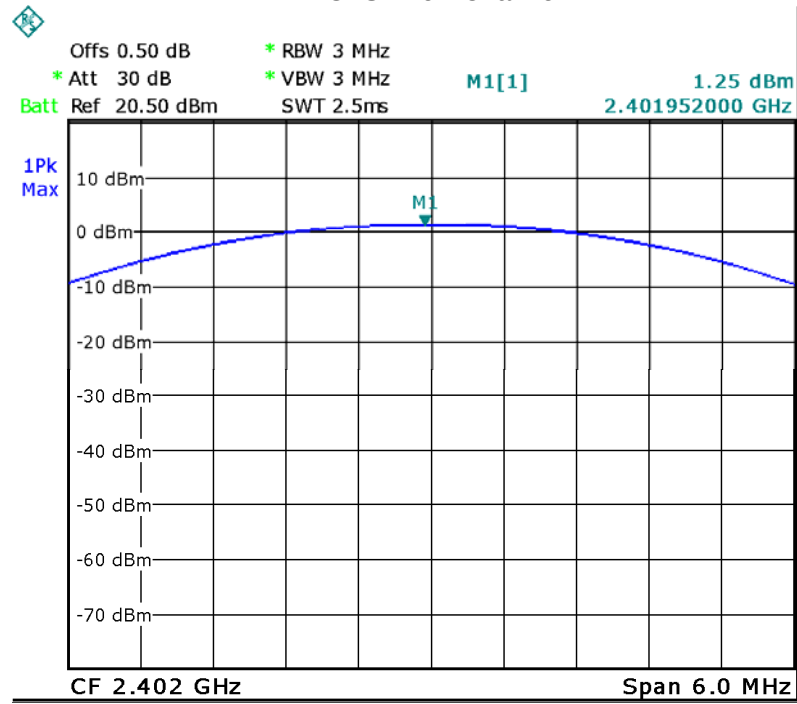
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.///

11.2 Test Result

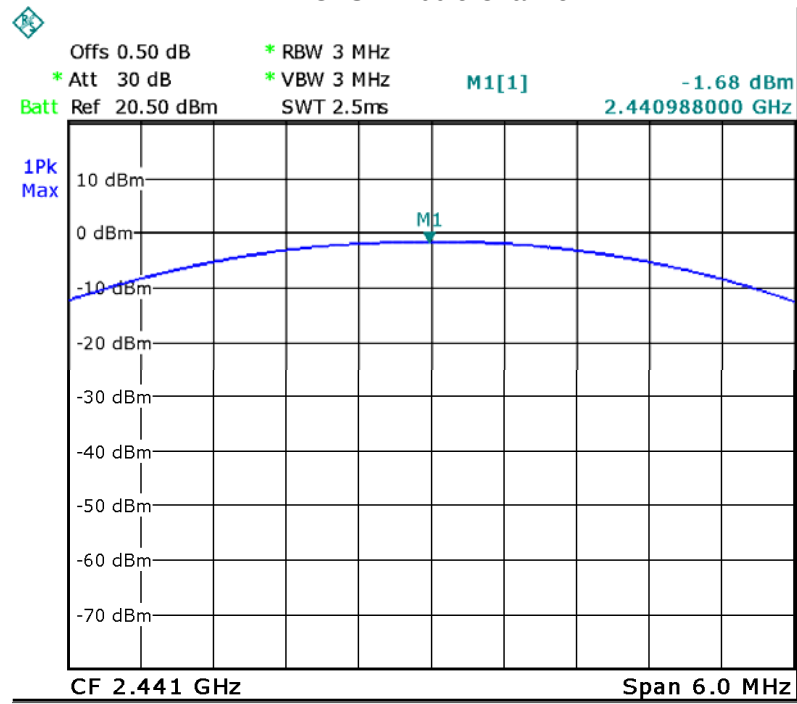
Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	1.25	21
GFSK	Middle	-1.68	21
GFSK	High	-0.13	21
Pi/4 DQPSK	Low	0.39	21
Pi/4 DQPSK	Middle	1.57	21
Pi/4 DQPSK	High	-0.98	21
8DPSK	Low	0.79	21
8DPSK	Middle	1.97	21
8DPSK	High	-0.61	21

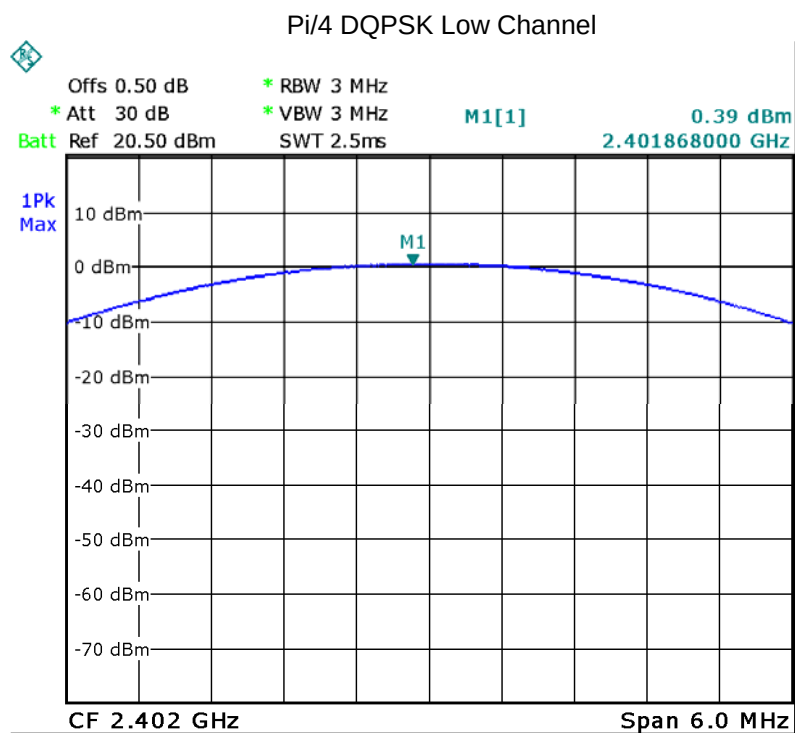
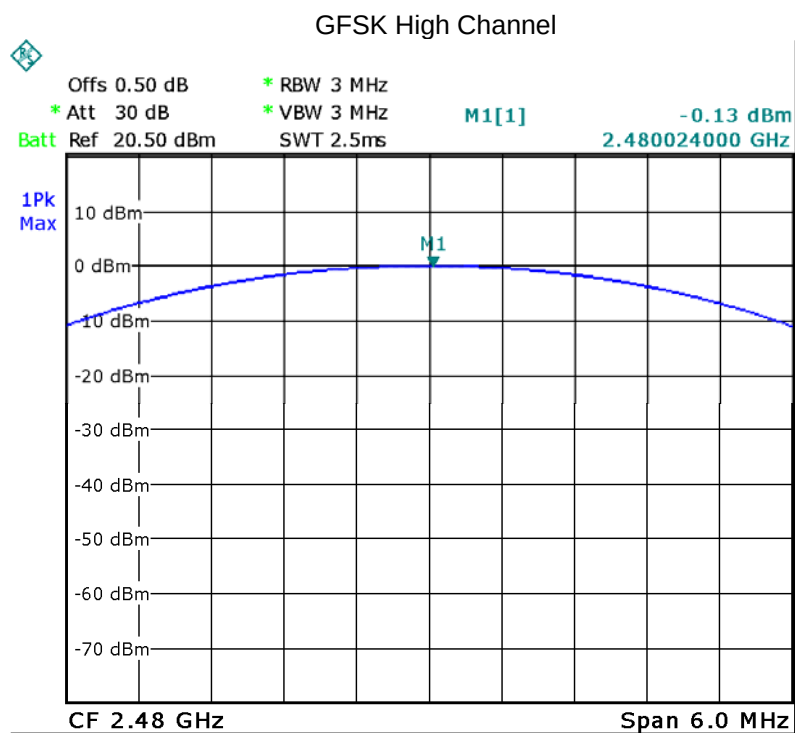
Test plots

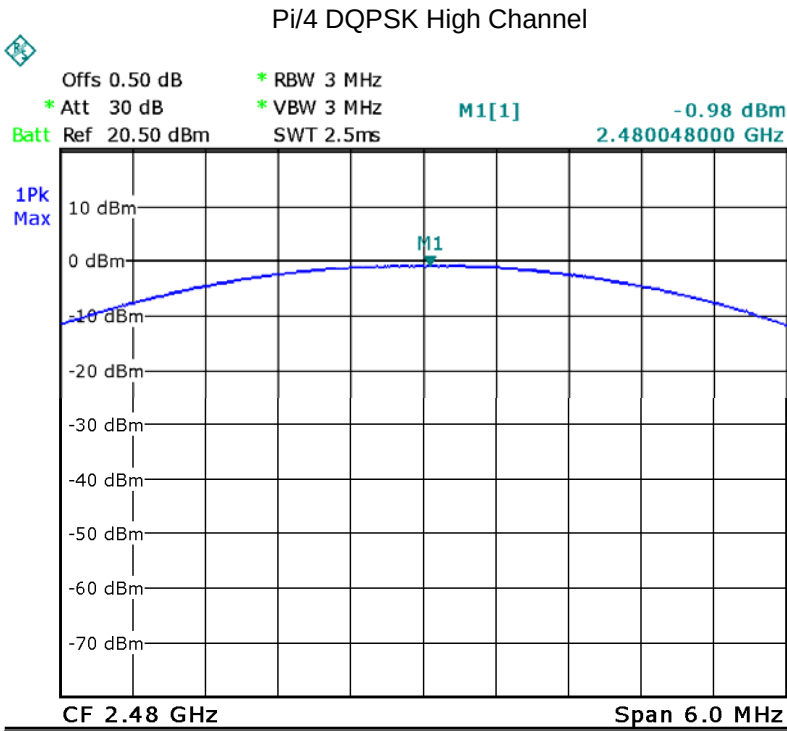
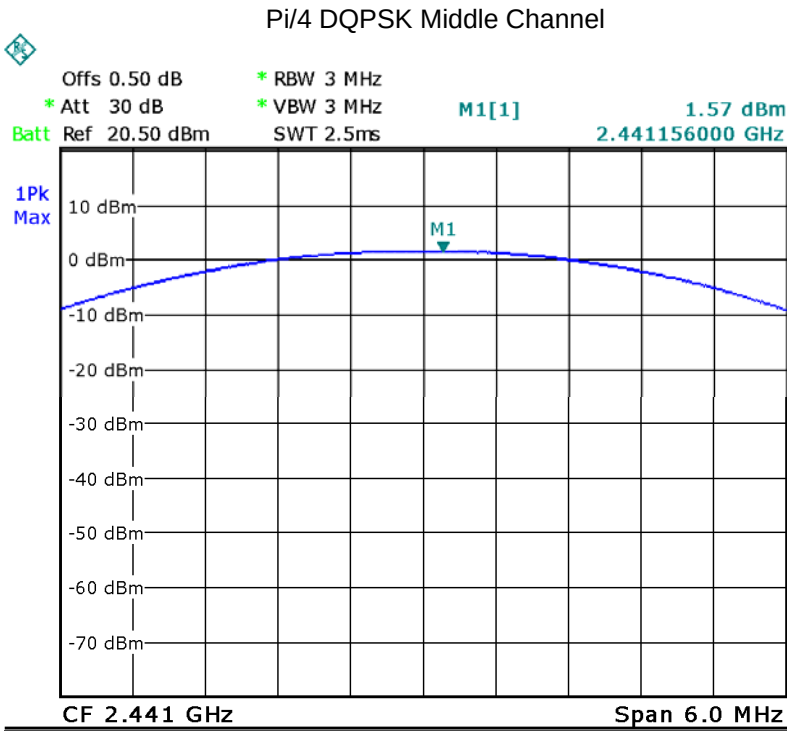
GFSK Low Channel

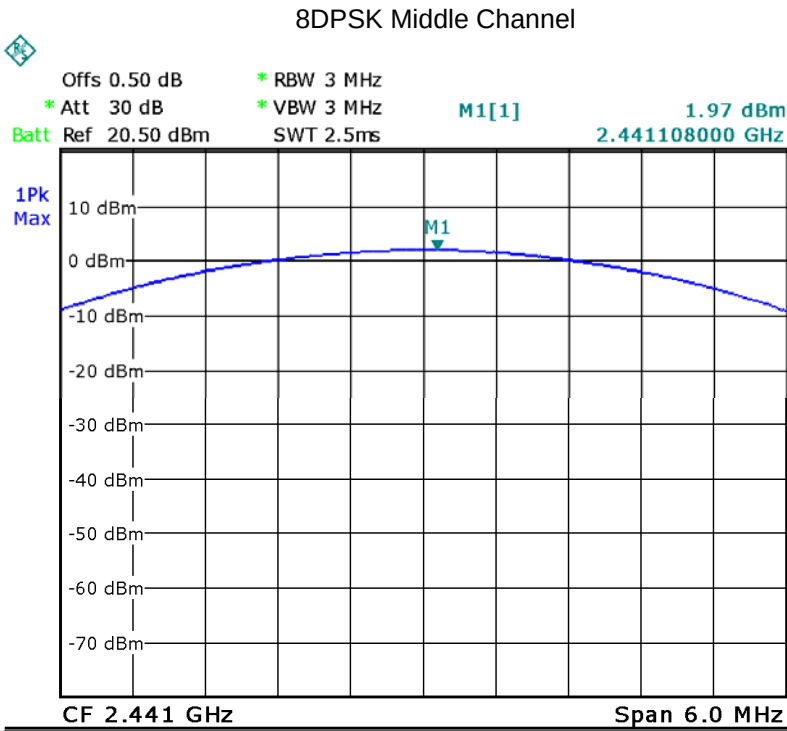
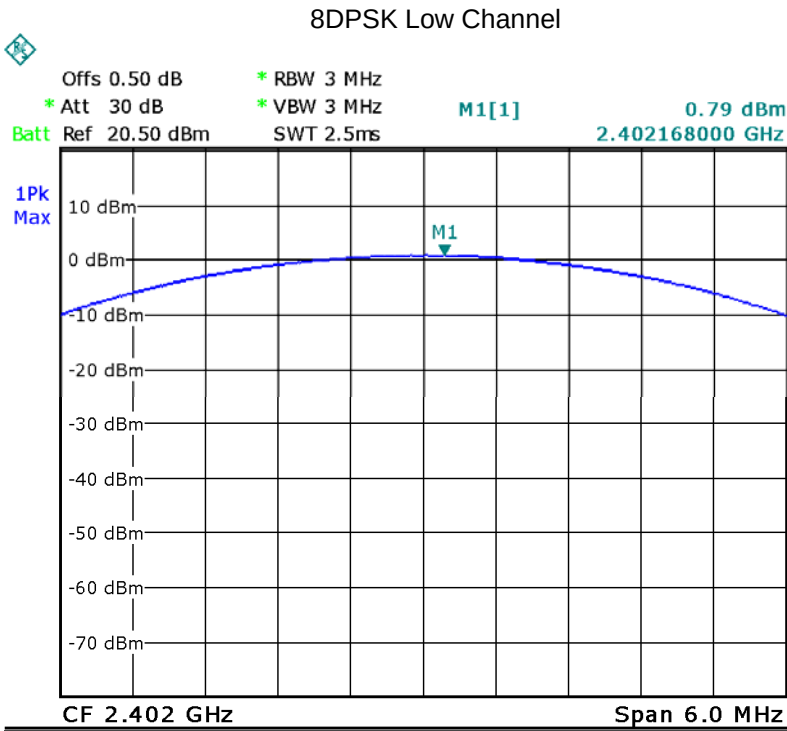


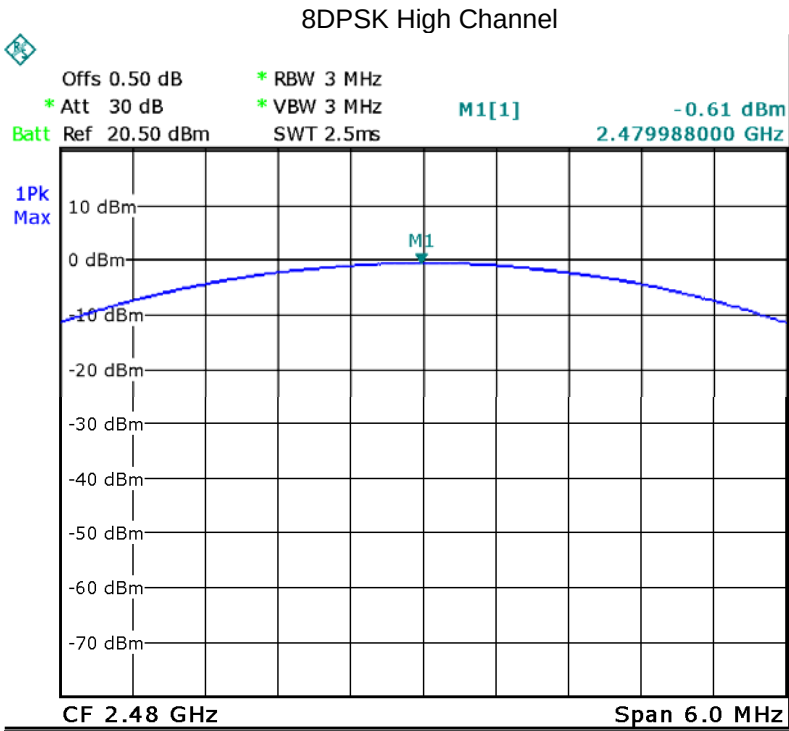
GFSK Middle Channel











12 Hopping Channel Separation

Test Requirement:	FCC CFR47 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 an output power no greater than 0.125W.
Test Mode:	Test in hopping transmitting operating 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: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
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.

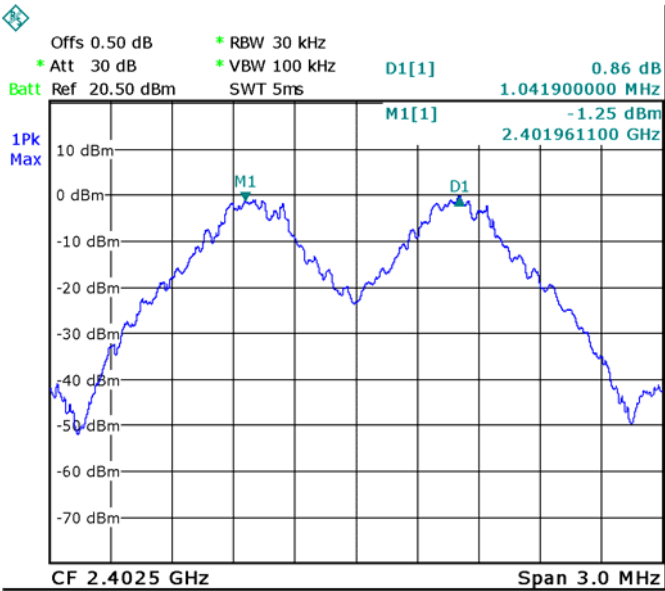
12.2 Test Result

Modulation	Test Channel	Separation (MHz)	Limit(2/3 of the 20 dB bandwidth MHz)	Result
GFSK	Low	1.042	0.627	PASS
GFSK	Middle	1.000	0.583	PASS
GFSK	High	1.000	0.631	PASS
Pi/4 DQPSK	Low	1.000	0.847	PASS
Pi/4 DQPSK	Middle	1.000	0.858	PASS
Pi/4 DQPSK	High	1.006	0.858	PASS
8DPSK	Low	1.000	0.862	PASS
8DPSK	Middle	1.006	0.862	PASS
8DPSK	High	1.000	0.858	PASS

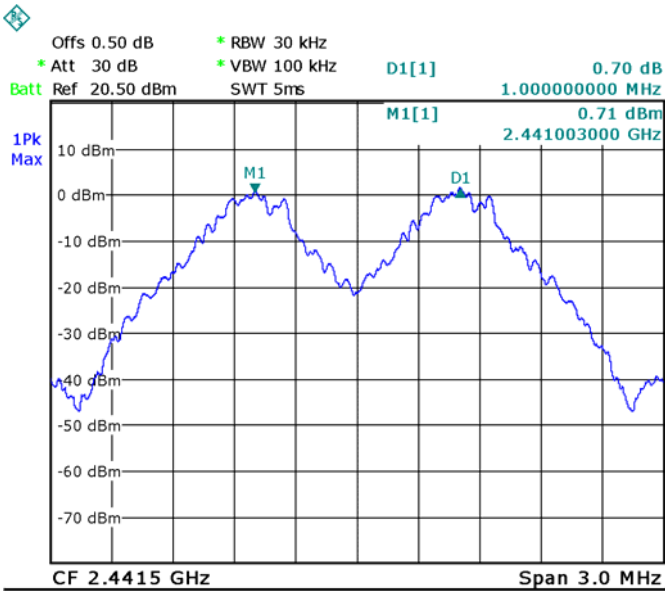
Test plots

Modulation: GFSK

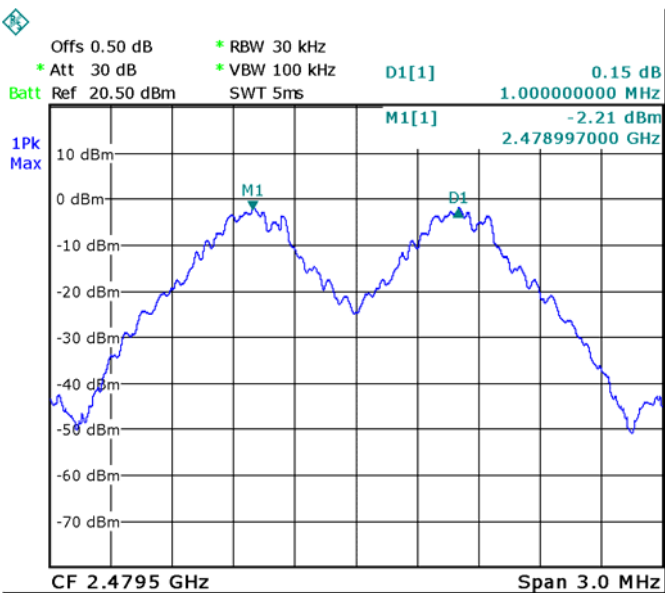
Low Channel



Middle Channel

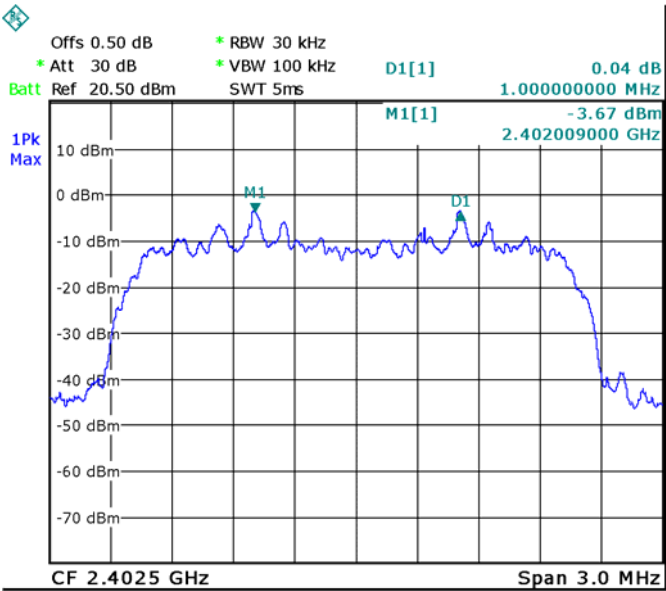


High Channel

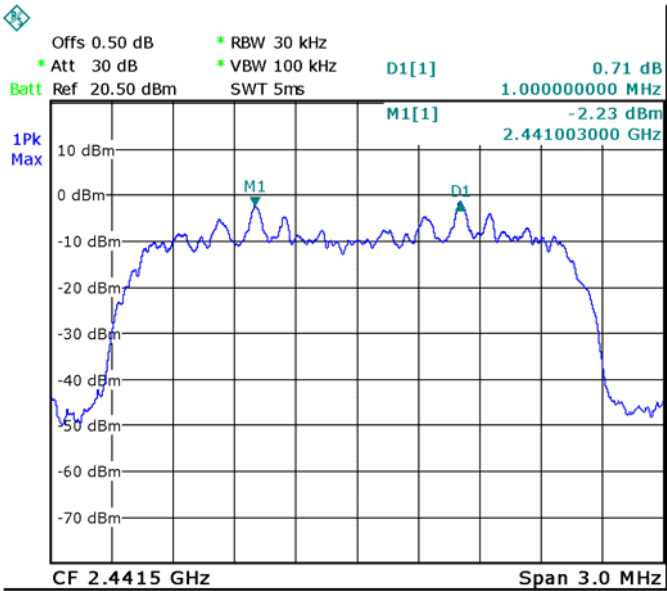


Modulation: $\pi/4$ DQPSK

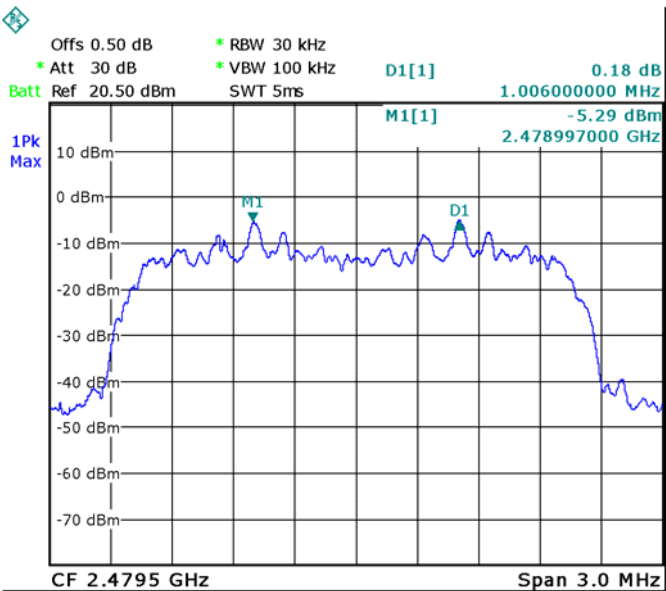
Low Channel



Middle Channel

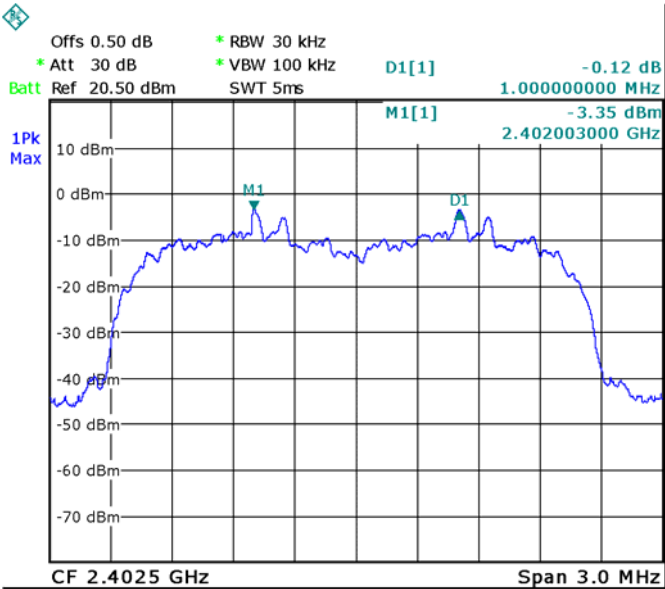


High Channel

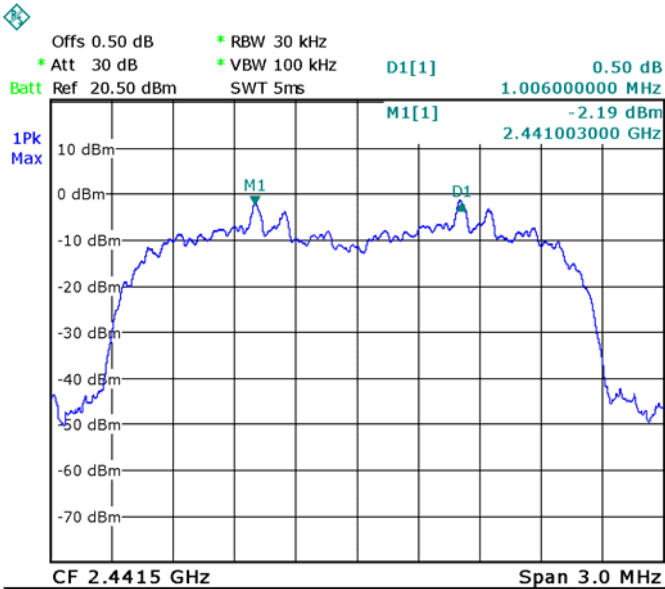


Modulation: 8DPSK

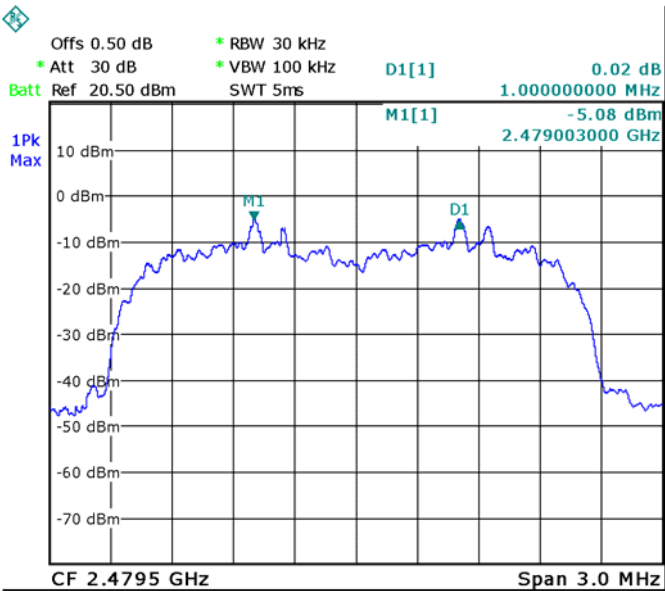
Low Channel



Middle Channel



High Channel



13 Number of Hopping Frequency

Test Requirement:	FCC CFR47 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.

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: RBW = 0.1MHz. VBW = 0.3MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
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;

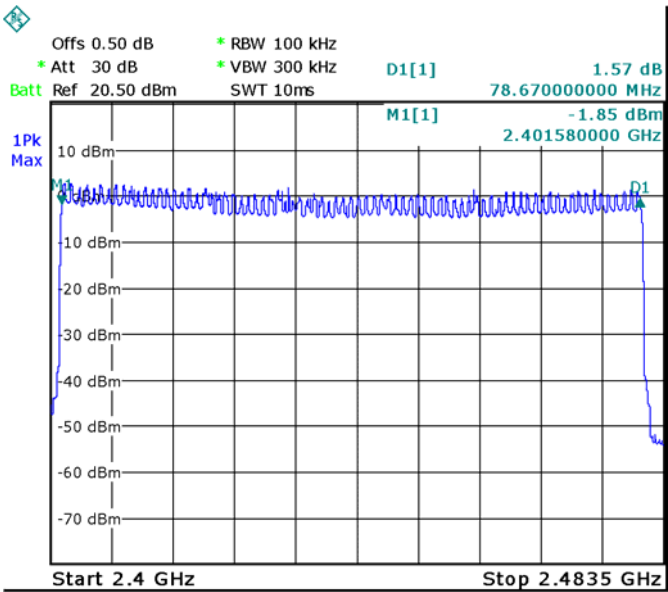
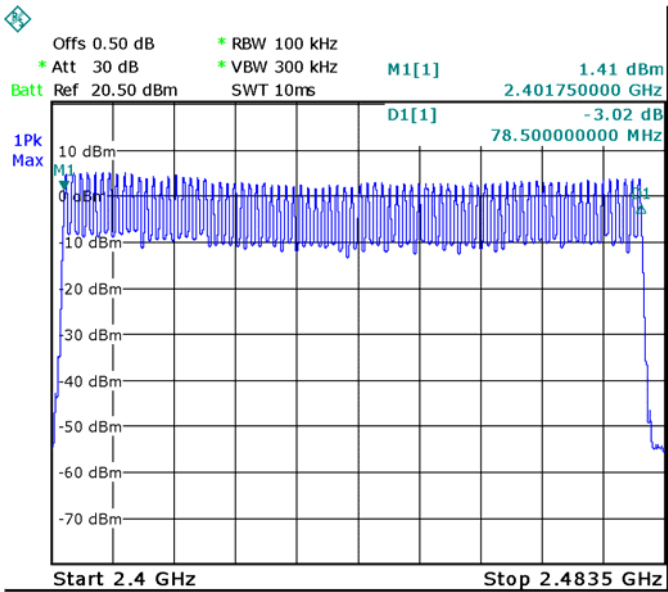
13.2 Test Result

Mode	Hopping Sequence		
	Hopping Number	Limit	Result
GFSK	79	≥15	PASS
$\pi/4$ DQPSK	79		
8DPSK	79		

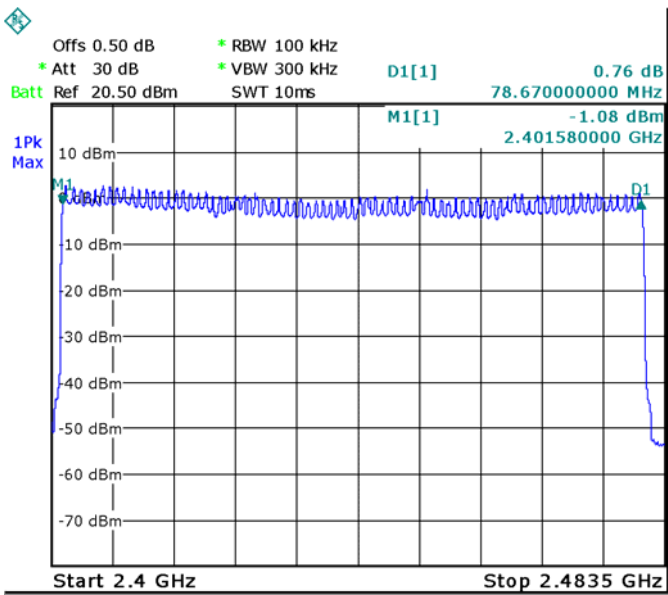
Test Plots:

Modulation: GFSK

Modulation: $\pi/4$ DQPSK



Modulation: 8DPSK



14 Dwell Time

Test Requirement:	FCC CFR47 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.

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 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).

14.2 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	2.880	0.307	0.4
		middle	2.880	0.307	0.4
		High	2.860	0.305	0.4
Pi/4DQPSK	DH5	Low	2.880	0.307	0.4
		middle	2.880	0.307	0.4
		High	2.880	0.307	0.4
8DPSK	DH5	Low	2.860	0.305	0.4
		middle	2.880	0.307	0.4
		High	2.860	0.305	0.4

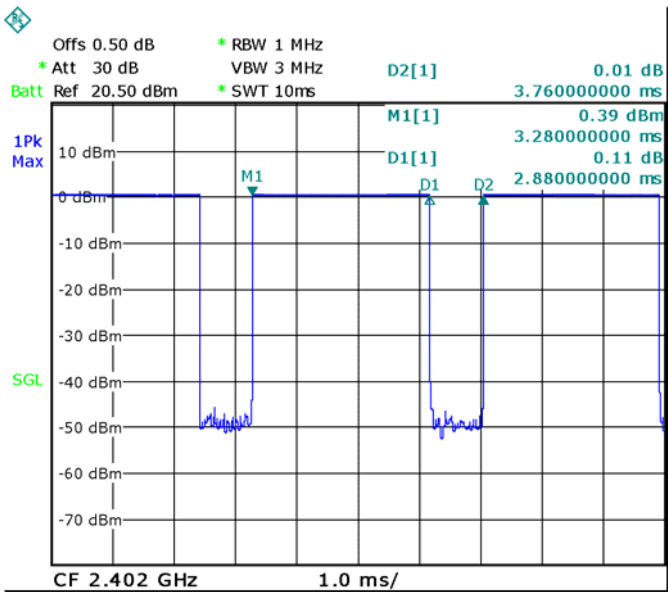
Remark: Only the worst-case mode DH5 is recorded.

Test Plots

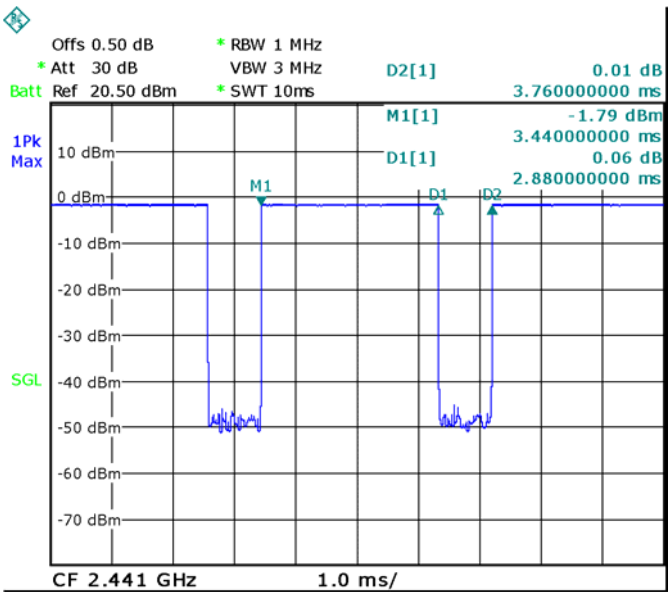
Modulation: GFSK

Data Packet: DH5

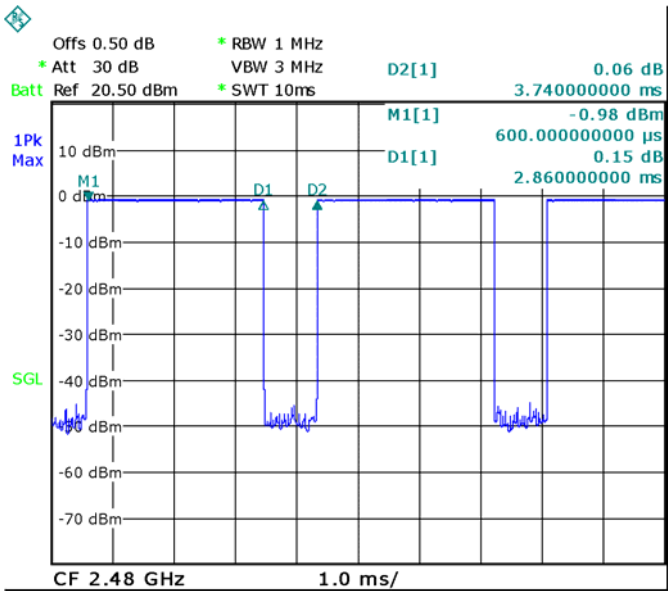
Low Channel



Middle Channel



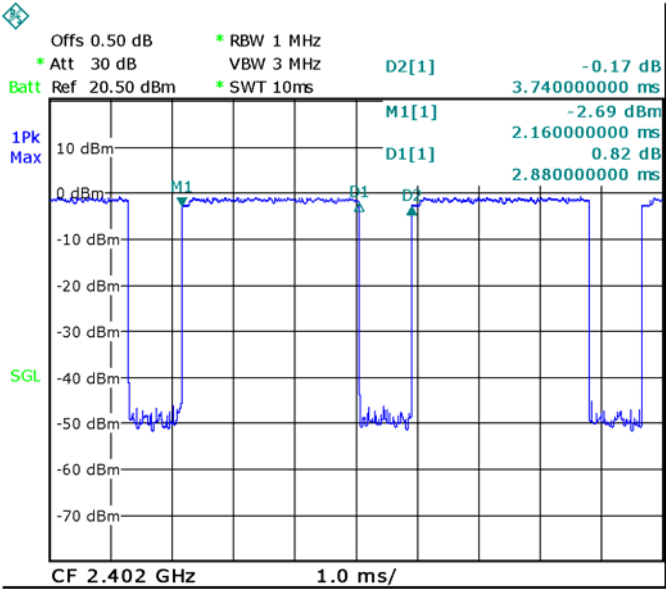
High Channel



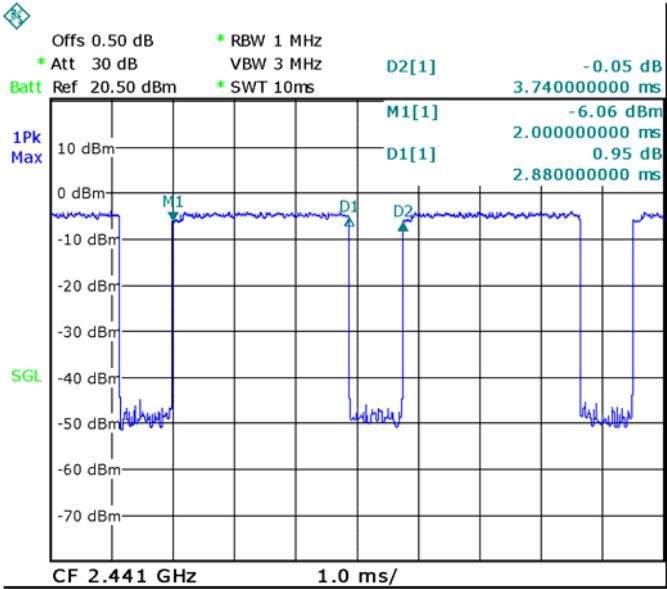
Modulation: $\pi/4$ DQPSK

Data Packet: 2DH5

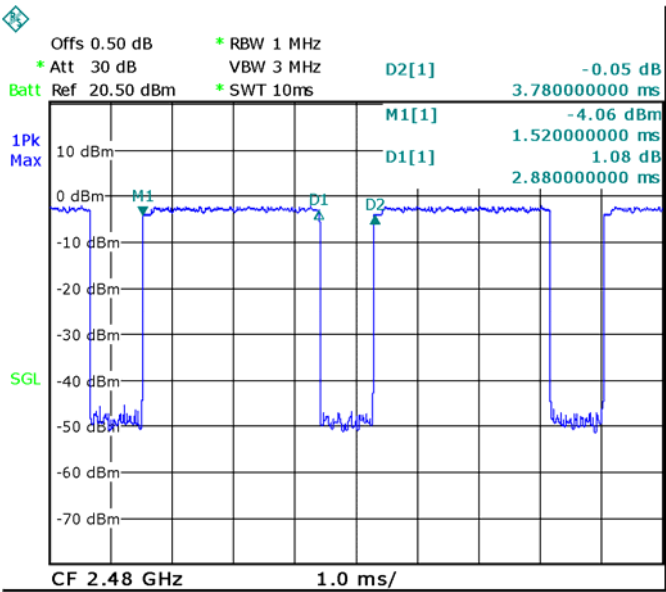
Low Channel



Middle Channel

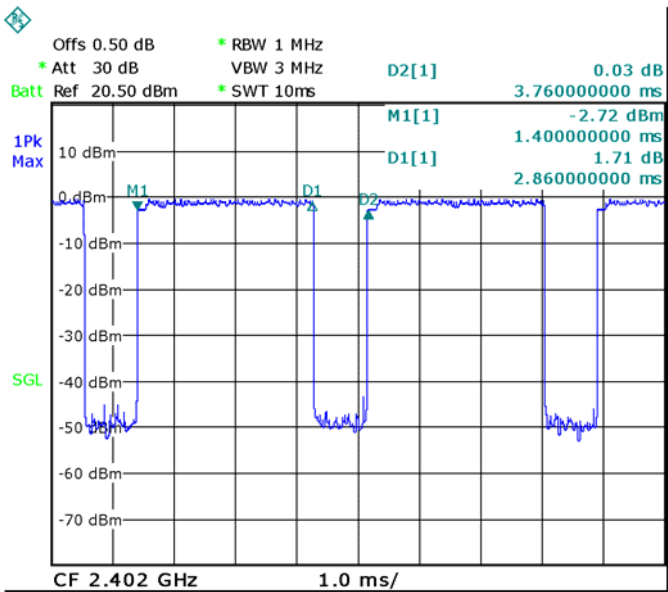


High Channel

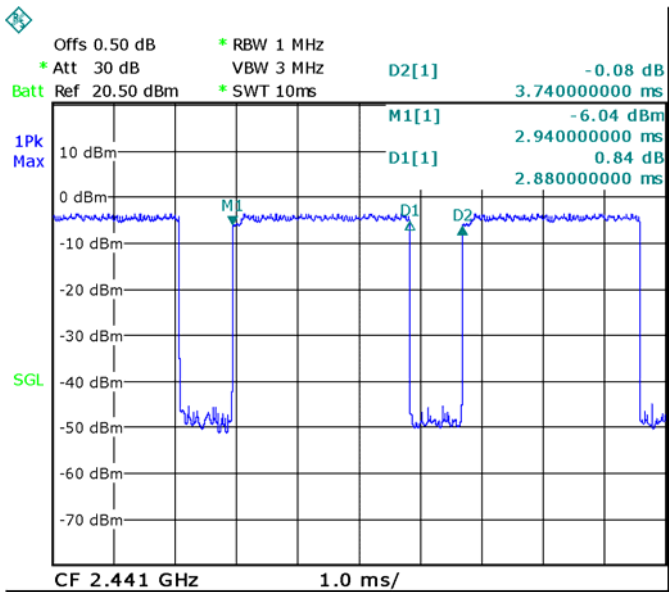


Modulation: 8DPSK
Data Packet: 3DH5

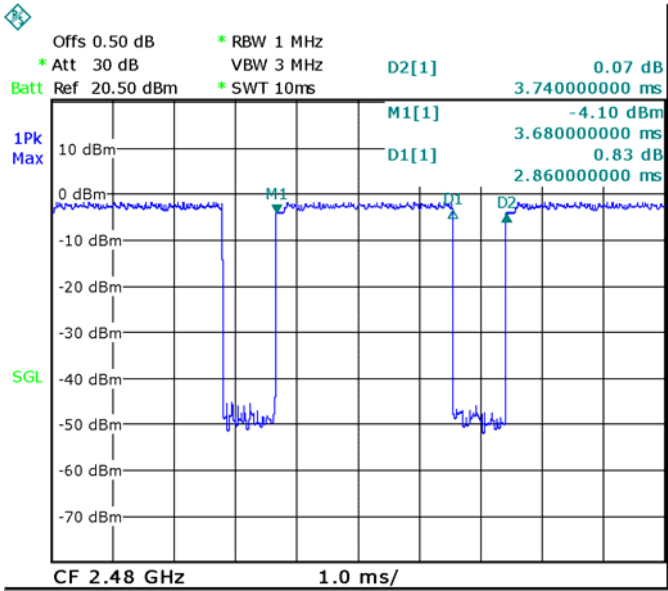
Low Channel



Middle Channel



High Channel



15 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.

16 RF Exposure

Remark: refer to MPE test report: WTD21D09098668W005.

17 Photographs of test setup and EUT.

Note: Please refer to appendix: IFC67X1-Photo.

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