TEST REPORT

Reference No.	:	WTS18S04108768-1W
FCC ID	:	OR8-TM100M
Applicant	:	Microlab Electronics Co.,Ltd.
Address	:	South Baozi Rd., Shenzhen Microlab Industrial Park, ShenZhen, China
Manufacturer	:	Microlab Electronics Co.,Ltd.
Address	:	South Baozi Rd., Shenzhen Microlab Industrial Park, ShenZhen, China
Product	:	Woofer
Model(s)	:	TM-100, NERO SB42, TM-60, TM-61, TM-120, TM-61SB, TM-60SB, TM-150
Standards	:	FCC CFR47 Part 15.247:2018
Date of Receipt sample	:	2018-04-19
Date of Test	:	2018-04-30 to 2018-05-17
Date of Issue	:	2018-05-25
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 Laboratories Introduction

Waltek Services (Shenzhen) Co., Ltd is a professional third-party testing and certification laboratory with multi-year product testing and certification experience, established strictly in accordance with ISO/IEC 17025 requirements, and accredited by ILAC (International Laboratory Accreditation Cooperation) member. A2LA (American Association for Laboratory Accreditation, the certification number is 4243.01) of USA, CNAS (China National Accreditation Service for Conformity Assessment, the registration number is L3110) of China.Meanwhile, Waltek has got recognition as registration and accreditation laboratory from EMSD (Electrical and Mechanical Services Department), and American Energy star, FCC(The Federal Communications Commission), CEC(California energy efficiency), ISED Canada (Innovation, Science and Economic Development Canada). It's the strategic partner and data recognition laboratory of international authoritative organizations, such as Intertek(ETL-SEMKO), TÜV Rheinland, TÜV SÜD, etc.

Waltek Services (Shenzhen) Co., Ltd is one of the largest and the most comprehensive third party testing laboratory in China. Our test capability covered four large fields: safety test. ElectroMagneticCompatibility(EMC), and energy performance, wireless radio. As a professional, comprehensive, justice international test organization, we still keep the scientific and rigorous work attitude to help each client satisfy the international standards and assist their product enter into globe market smoothly.

2.1 Test Facility

A. Accreditations for Conformity Assessment (International)

Country/Region	Scope Covered By	Scope	Note
USA	ISO/IEC 17025	FCC ID \ SDoC(VOC/DOC)	1
Canada		IC ID \ VOC	2
Japan		MIC-T \ MIC-R	-
Europe		EMCD \ RED	-
Taiwan		NCC	-
Hong Kong		OFCA	-
Australia		RCM	-
India		WPC	-
Thailand		NTC	-
Singapore		IDA	-
Note: 1. FCC Designation No.: CN1201. Test Firm Registration No.: 523476. 2. ISED Canada Registration No.: 7760A			

B.TCBs and Notify Bodies Recognized Testing Laboratory.

Recognized Testing Laboratory of …	Notify body number
TUV Rheinland	Optional.
Intertek	
TUV SUD	
SGS	
Phoenix Testlab GmbH	0700
Element Materials Technology Warwick Ltd.	0891
Timco Engineering, Inc.	1177
Eurofins Product Service GmbH	0681

3 Contents

Page

4 Revision History

Test report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTS18S04108768-1W	2018-04-19	2018-04-30 to 2018-05-17	2018-05-25	original	-	Valid

5 General Information

5.1 General Description of E.U.T.

Product:	Woofer
Model(s):	TM-100, NERO SB42, TM-60, TM-61, TM-120, TM-61SB, TM-60SB, TM-150
Model difference:	The Model TM-100 work with power board 1 or power board 2. The difference test was performed between the model working with power board 1 and power board 2. All the models are same in all aspect. Only model name is different. TM-100 is test sample.
Bluetooth Version:	Bluetooth v3.0+EDR

Frequency hopping systems (FHS):

This transmitter device is frequency hopping device, and complies with FCC Part15.247 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 FCC Part15.247.

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

5.2 Details of E.U.T.

Operation Frequency: 2402~2480MHz

Max. RF output power: 8.14dBm

Type of Modulation: GFSK, Pi/4 DQPSK, 8DPSK

Antenna installation: PCB printed antenna

Antenna Gain: 0dBi

Ratings: Input: AC 100-240V~, 50/60Hz 900mA

5.3 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	-	-

5.4 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

6 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	PASS
Band edge	15.247(d) 15.205(a)	PASS
Conducted Emission	15.207	PASS
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
Antenna Requirement	15.203	Complies
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS

7 Equipment Used during Test

7.1 Equipments List

Conducted Emissions Test Site						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	R&S	ESCI	101155	2017-09-15	2018-09-14
2.	LISN	SCHWARZBECK	NSLK 8128	8128-289	2017-09-15	2018-09-14
3.	Limiter	York	MTS-IMP-136	261115-001-0024	2017-09-15	2018-09-14
4.	Cable	LARGE	RF300	-	2017-07-18	2018-07-17
3m Semi-anechoic Chamber for Radiation Emissions Test site						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1	Spectrum Analyzer	R&S	FSP30	100091	2018-04-20	2019-04-19
2	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2017-05-18	2018-05-17
3	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2018-04-07	2019-04-06
4	Coaxial Cable (above 1GHz)	Top	1GHz-18GHz	EW02014-7	2018-04-07	2019-04-06
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2017-09-14	2018-09-13
6	Microwave Broadband Preamplifier	SCHWARZBECK	BBV 9721	100472	2017-10-25	2018-10-24
7	Cable	Top	18GHz-40GHz	-	2017-10-25	2018-10-24
3m Semi-anechoic Chamber for Radiation Emissions Test site						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No**	**Last Calibration Date**	**Calibration Due Date**
1	Test Receiver	R&S	ESCI	101296	2018-04-20	2019-04-19
2	Ative Loop Antenna	Beijing Dazhi	ZN30900A	-	2018-04-17	2019-04-16
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2018-04-19	2019-04-18
4	Amplifier	ANRITSU	MH648A	M43381	2018-04-20	2019-04-19
5	Cable	HUBER+SUHNER	CBL2	525178	2018-04-20	2019-04-19
6	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2017-10-14	2018-10-15
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	2017-09-14	2018-09-13

2.	Spectrum Analyzer (9k-6GHz)	R&S	FSL6	100959	2017-10-21	2018-10-20
3.	Signal Analyzer (9k~26.5GHz)	Agilent	N9010A	MY50520207	2018-04-20	2019-04-19
4.	Coaxial Cable (10Hz-30GHz)	/	/	/	2017-09-12	2018-09-11
5.	Antenna Connector*	/	/	/	2017-09-12	2018-09-11
6	DC Block	Gwave	GDCB-3G-N-SMA	140307001	2017-09-12	2018-09-11
"*": The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.						

7.2 Description of Support Units

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

7.3 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	

7.4 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.

8 Conducted Emission

Test Requirement: FCC CFR 47 Part 15 Section 15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Class/Severity: Class B

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
5 to 30	60	50

8.1 E.U.T. Operation

Operating Environment **:**

Temperature: 22.8 °C

Humidity: 52.6 % RH

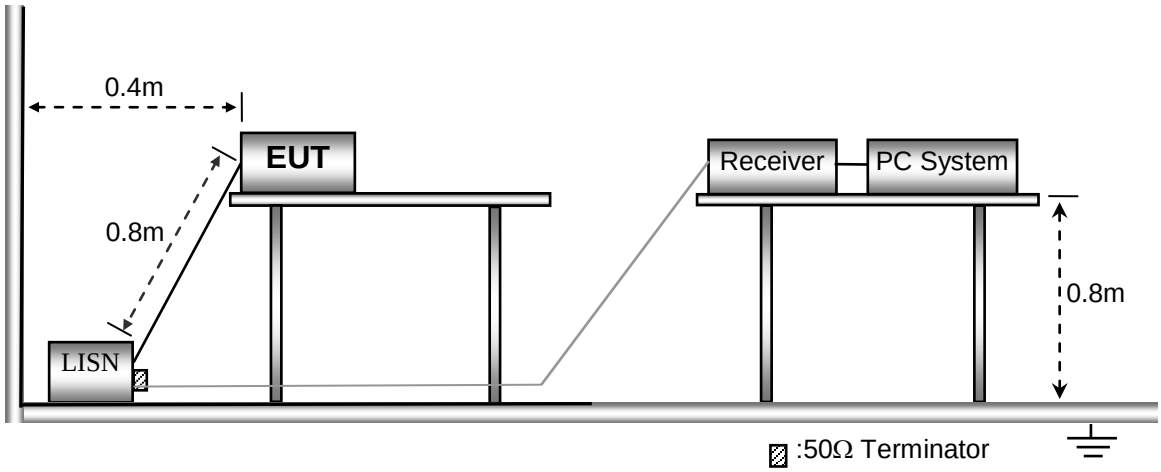
Atmospheric Pressure: 101.2kPa

EUT Operation **:** Transmitting mode(GFSK)

The test was performed in Transmitting mode and with difference power board.

8.2 EUT Setup

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



8.3 Measurement Description

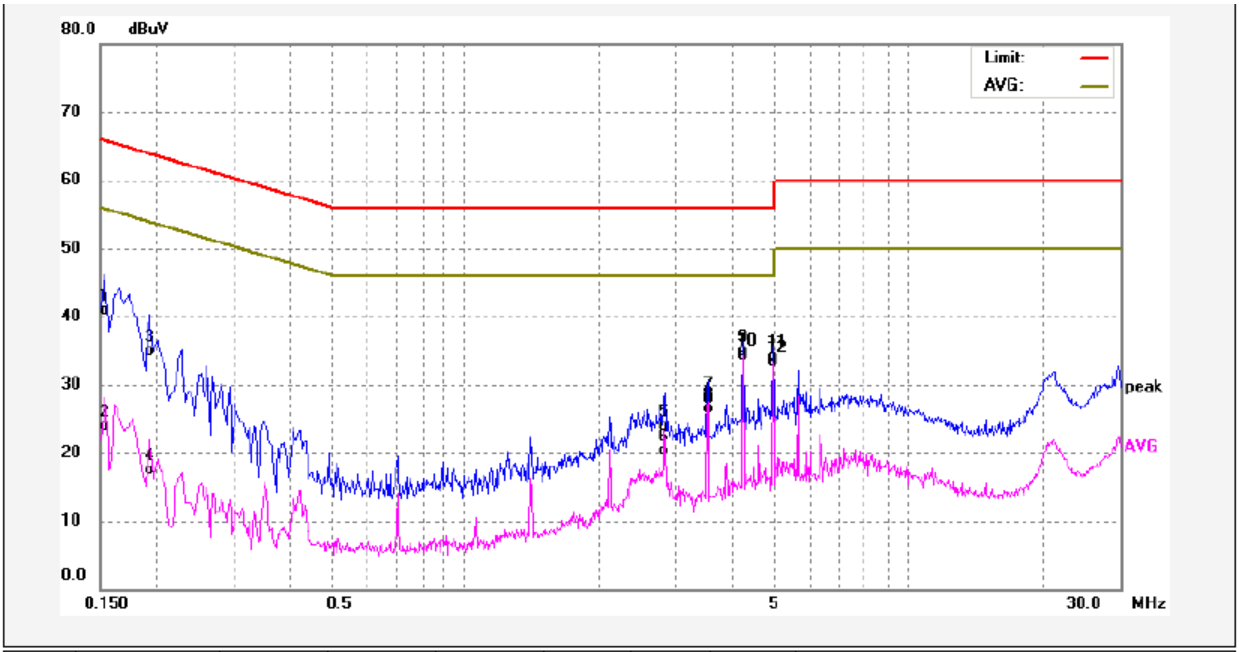
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

8.4 Conducted Emission Test Result

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

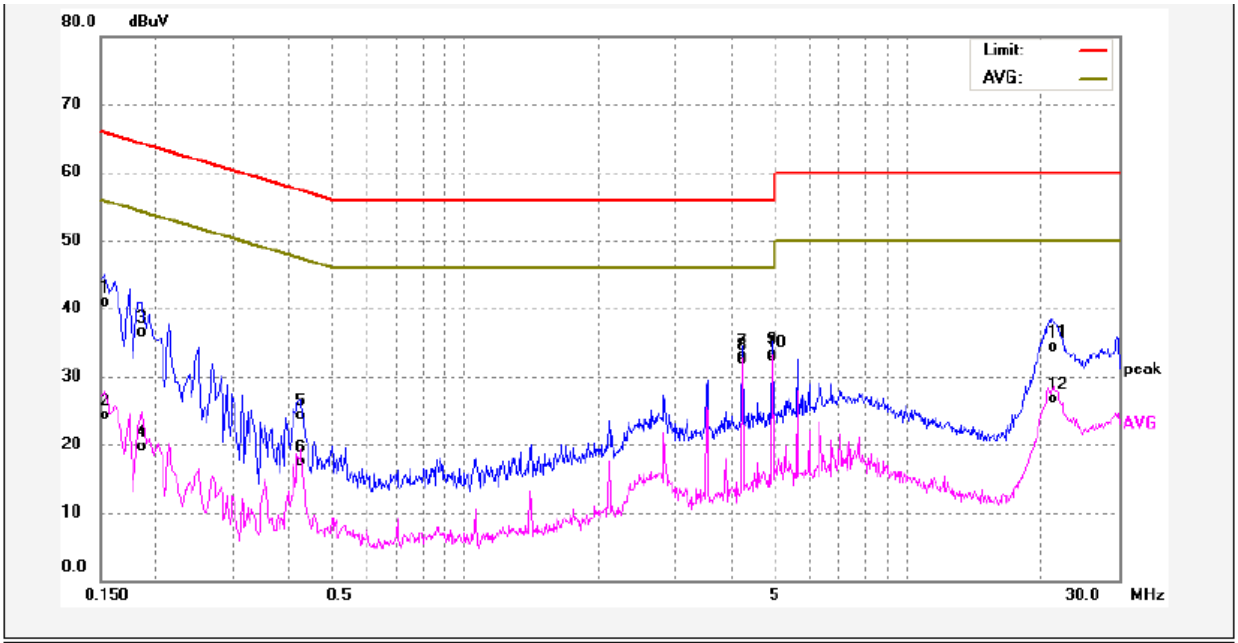
EUT with Power Board 1

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1539	31.29	9.64	40.93	65.78	-24.85	QP	
2	0.1539	14.28	9.64	23.92	55.78	-31.86	AVG	
3	0.1940	25.32	9.62	34.94	63.86	-28.92	QP	
4	0.1940	7.89	9.62	17.51	53.86	-36.35	AVG	
5	2.8260	13.98	9.93	23.91	56.00	-32.09	QP	
6	2.8260	10.29	9.93	20.22	46.00	-25.78	AVG	
7	3.5300	18.03	9.94	27.97	56.00	-28.03	QP	
8	3.5300	16.65	9.94	26.59	46.00	-19.41	AVG	
9	4.2340	24.87	9.97	34.84	56.00	-21.16	QP	
10	4.2340	24.30	9.97	34.27	46.00	-11.73	AVG	
11	4.9380	24.05	10.04	34.09	56.00	-21.91	QP	
12	4.9380	23.24	10.04	33.28	46.00	-12.72	AVG	

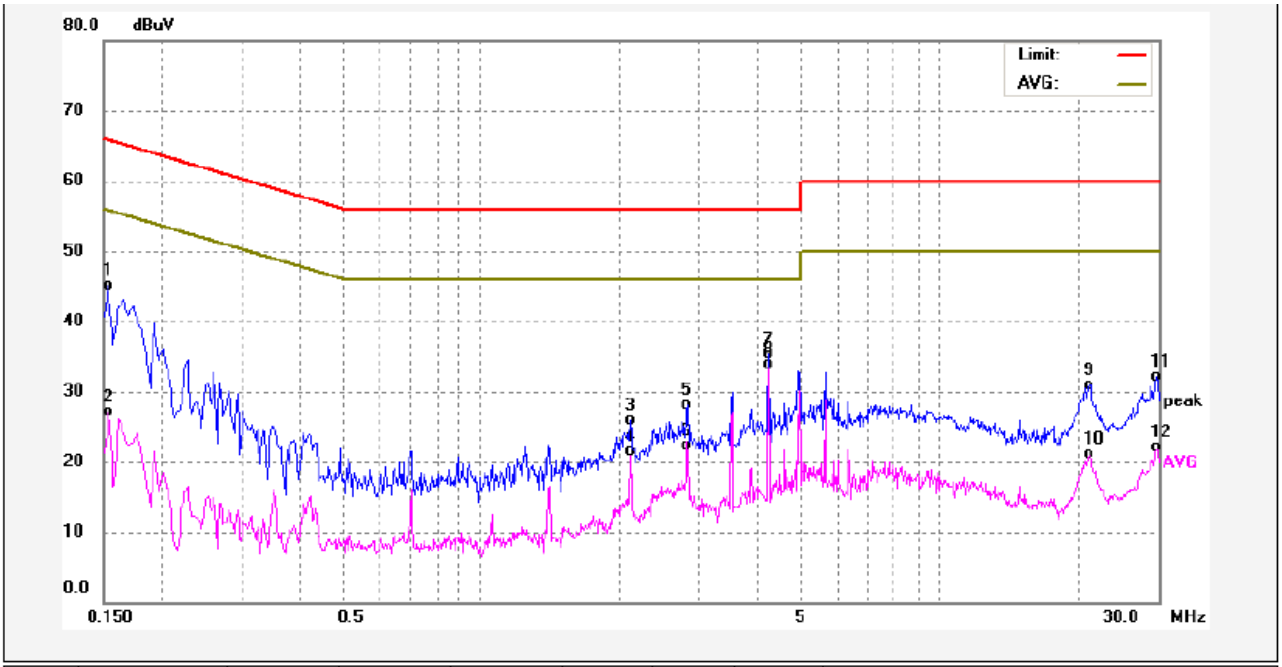
Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1539	31.30	9.64	40.94	65.78	-24.84	QP	
2	0.1539	14.66	9.64	24.30	55.78	-31.48	AVG	
3	0.1860	26.86	9.63	36.49	64.21	-27.72	QP	
4	0.1860	10.16	9.63	19.79	54.21	-34.42	AVG	
5	0.4220	14.57	9.64	24.21	57.41	-33.20	QP	
6	0.4220	7.78	9.64	17.42	47.41	-29.99	AVG	
7	4.2340	23.05	9.97	33.02	56.00	-22.98	QP	
8	4.2340	22.57	9.97	32.54	46.00	-13.46	AVG	
9	4.9380	23.32	10.04	33.36	56.00	-22.64	QP	
10	4.9380	22.89	10.04	32.93	46.00	-13.07	AVG	
11	21.2540	24.01	10.35	34.36	60.00	-25.64	QP	
12	21.2540	16.40	10.35	26.75	50.00	-23.25	AVG	

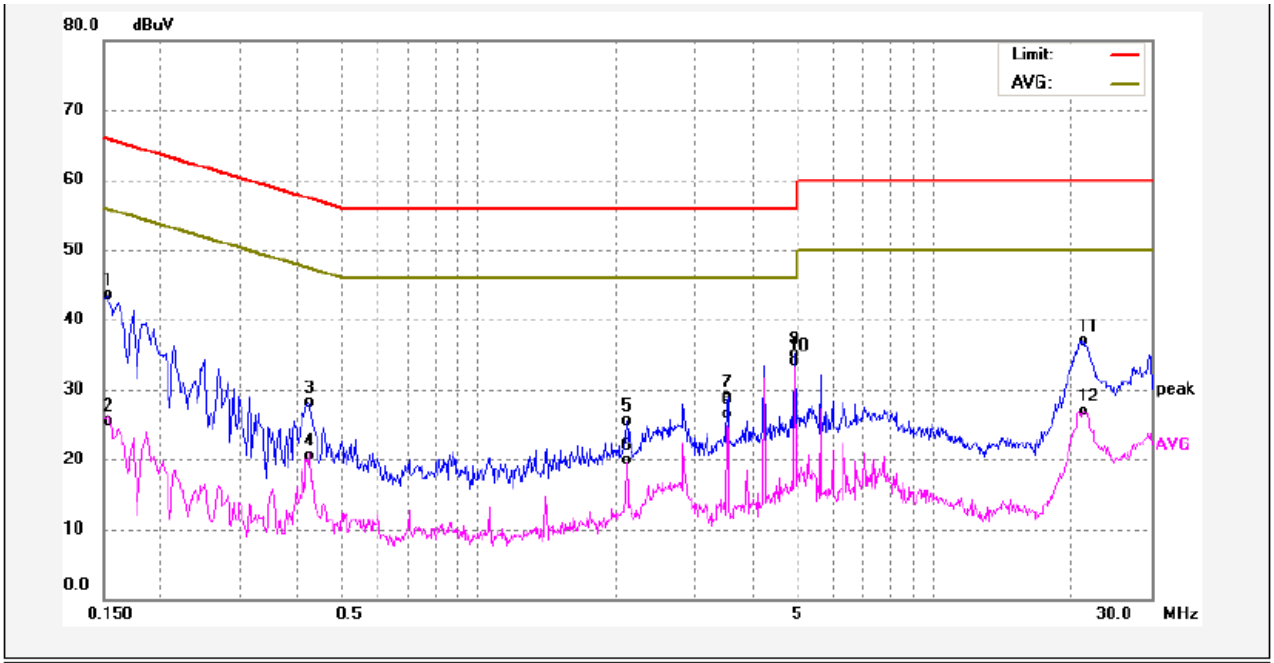
EUT with Power Board 2

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1539	35.44	9.64	45.08	65.78	-20.70	QP	
2	0.1539	17.42	9.64	27.06	55.78	-28.72	AVG	
3	2.1179	15.92	9.95	25.87	56.00	-30.13	QP	
4	2.1179	11.60	9.95	21.55	46.00	-24.45	AVG	
5	2.8260	18.22	9.93	28.15	56.00	-27.85	QP	
6	2.8260	12.41	9.93	22.34	46.00	-23.66	AVG	
7	4.2339	25.35	9.97	35.32	56.00	-20.68	QP	
8	4.2339	23.85	9.97	33.82	46.00	-12.18	AVG	
9	21.3779	20.63	10.35	30.98	60.00	-29.02	QP	
10	21.3779	10.73	10.35	21.08	50.00	-28.92	AVG	
11	29.7820	21.75	10.44	32.19	60.00	-27.81	QP	
12	29.7820	11.71	10.44	22.15	50.00	-27.85	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1539	33.90	9.64	43.54	65.78	-22.24	QP	
2	0.1539	15.82	9.64	25.46	55.78	-30.32	AVG	
3	0.4219	18.43	9.64	28.07	57.41	-29.34	QP	
4	0.4219	10.85	9.64	20.49	47.41	-26.92	AVG	
5	2.1179	15.46	9.95	25.41	56.00	-30.59	QP	
6	2.1179	9.92	9.95	19.87	46.00	-26.13	AVG	
7	3.5299	19.04	9.94	28.98	56.00	-27.02	QP	
8	3.5299	16.60	9.94	26.54	46.00	-19.46	AVG	
9	4.9378	25.12	10.04	35.16	56.00	-20.84	QP	
10	4.9378	24.00	10.04	34.04	46.00	-11.96	AVG	
11	21.2540	26.59	10.35	36.94	60.00	-23.06	QP	
12	21.2540	16.61	10.35	26.96	50.00	-23.04	AVG	

9 Radiated Spurious Emissions

Test Requirement: FCC CFR47 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	$20\log^{(500)}$

9.1 EUT Operation

Operating Environment **:**

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

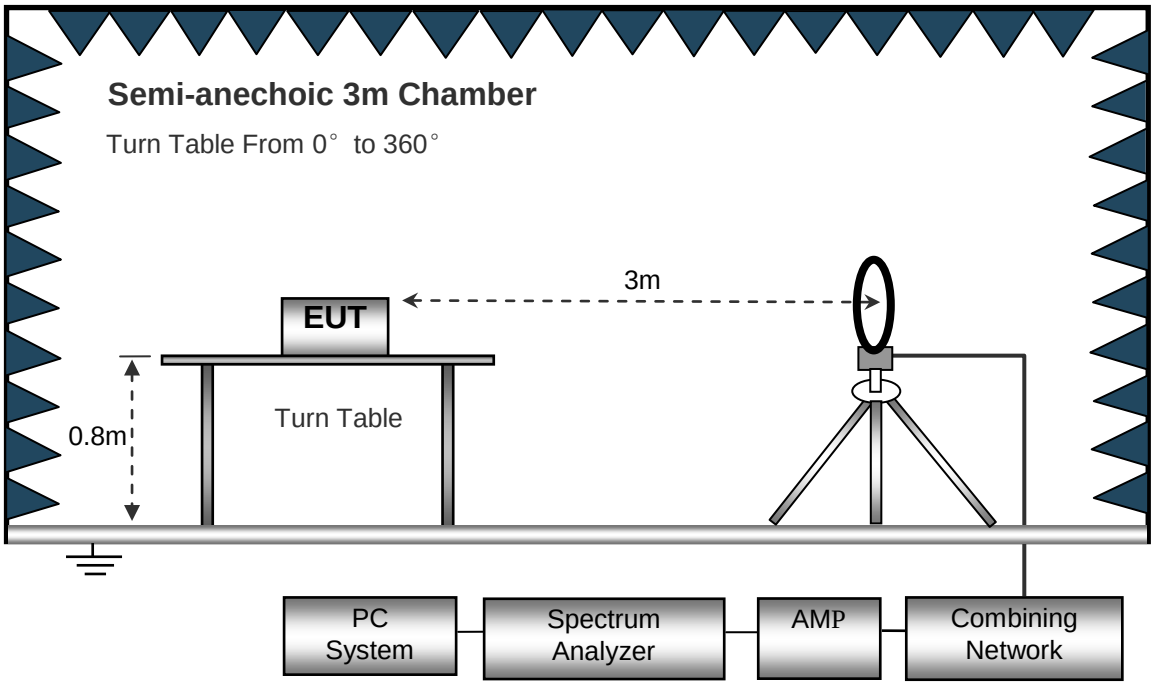
EUT Operation **:** Transmitting mode(GFSK)

The test was performed in Transmitting mode and with difference power board.

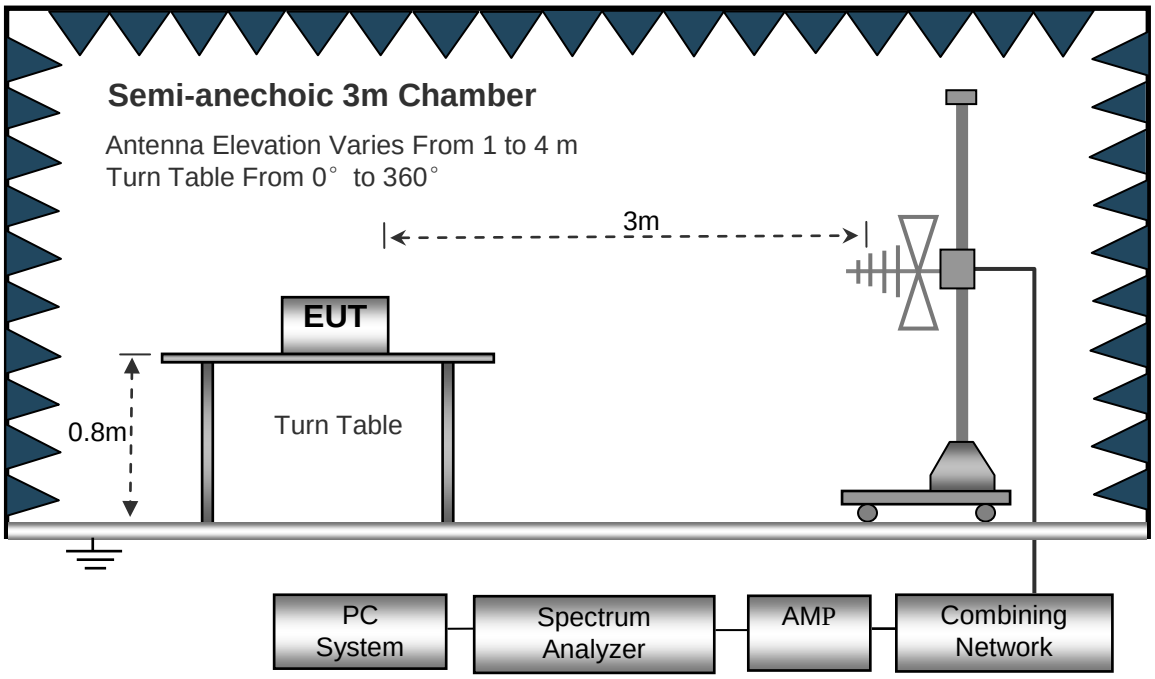
9.2 Test Setup

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

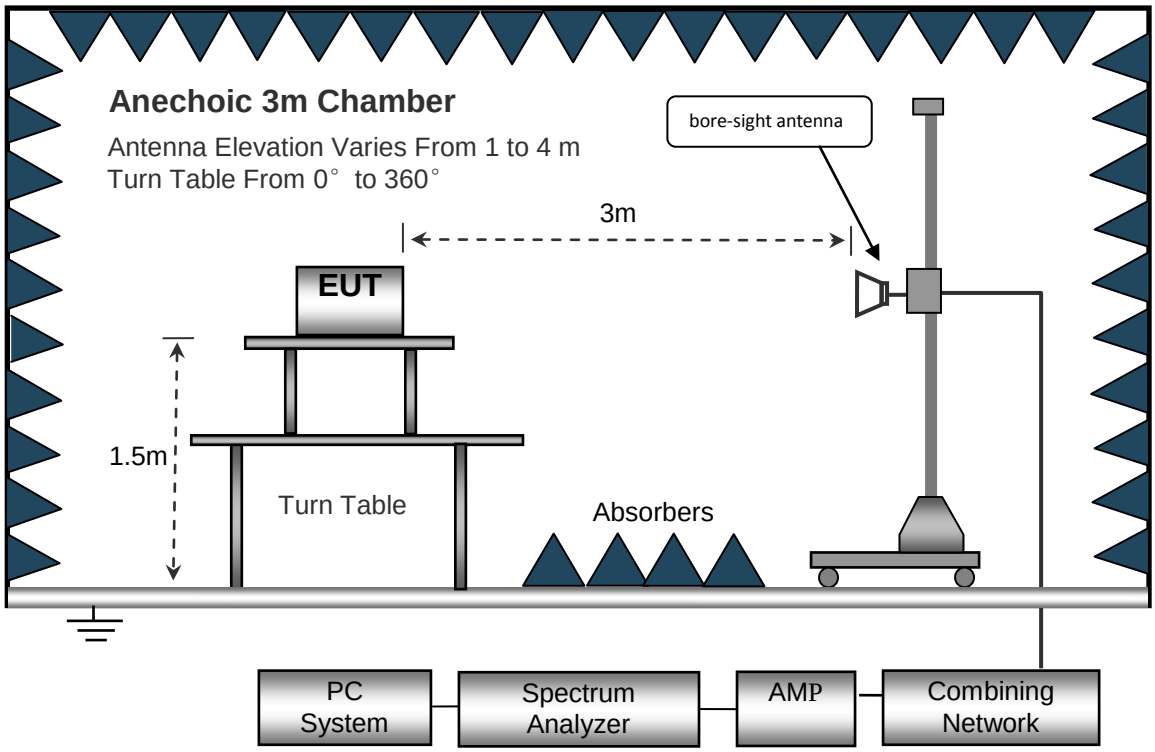
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



9.3 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

9.4 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.

9.5 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

9.6 Summary of Test Results

9.6.2 Test result of EUT with Power Board 1

Test Frequency: 9kHz to 30MHz

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

Test Frequency: 30MHz ~ 18GHz

Remark: only the worst data (GFSK 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)
GFSK Low Channel									
265.28	37.08	QP	72	1.2	H	-13.35	23.73	46.00	-22.27
265.28	40.69	QP	64	1.6	V	-13.35	27.34	46.00	-18.66
4804.00	46.78	PK	219	1.6	V	-1.06	45.72	74.00	-28.28
4804.00	42.01	Ave	219	1.6	V	-1.06	40.95	54.00	-13.05
7206.00	42.35	PK	144	2.0	H	1.33	43.68	74.00	-30.32
7206.00	37.33	Ave	144	2.0	H	1.33	38.66	54.00	-15.34
2319.31	45.64	PK	71	1.2	V	-13.19	32.45	74.00	-41.55
2319.31	38.71	Ave	71	1.2	V	-13.19	25.52	54.00	-28.48
2382.94	42.59	PK	311	1.9	H	-13.14	29.45	74.00	-44.55
2382.94	38.49	Ave	311	1.9	H	-13.14	25.35	54.00	-28.65
2499.62	44.07	PK	237	1.7	V	-13.08	30.99	74.00	-43.01
2499.62	36.04	Ave	237	1.7	V	-13.08	22.96	54.00	-31.04

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									
265.28	35.33	QP	301	1.6	H	-13.35	21.98	46.00	-24.02
265.28	41.04	QP	220	1.6	V	-13.35	27.69	46.00	-18.31
4882.00	48.44	PK	102	1.6	V	-0.62	47.82	74.00	-26.18
4882.00	45.64	Ave	102	1.6	V	-0.62	45.02	54.00	-8.98
7323.00	43.01	PK	215	1.2	H	2.21	45.22	74.00	-28.78
7323.00	37.06	Ave	215	1.2	H	2.21	39.27	54.00	-14.73
2342.47	46.88	PK	156	1.1	V	-13.19	33.69	74.00	-40.31
2342.47	38.99	Ave	156	1.1	V	-13.19	25.80	54.00	-28.20
2385.11	44.11	PK	207	1.9	H	-13.14	30.97	74.00	-43.03
2385.11	38.14	Ave	207	1.9	H	-13.14	25.00	54.00	-29.00
2492.54	42.89	PK	126	1.9	V	-13.08	29.81	74.00	-44.19
2492.54	36.76	Ave	126	1.9	V	-13.08	23.68	54.00	-30.32

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									
265.28	38.92	QP	44	1.5	H	-13.35	25.57	46.00	-20.43
265.28	39.65	QP	31	1.2	V	-13.35	26.30	46.00	-19.70
4960.00	47.76	PK	326	1.7	V	-0.24	47.52	74.00	-26.48
4960.00	44.79	Ave	326	1.7	V	-0.24	44.55	54.00	-9.45
7440.00	42.60	PK	189	1.3	H	2.84	45.44	74.00	-28.56
7440.00	37.72	Ave	189	1.3	H	2.84	40.56	54.00	-13.44
2327.36	45.58	PK	202	1.0	V	-13.19	32.39	74.00	-41.61
2327.36	37.47	Ave	202	1.0	V	-13.19	24.28	54.00	-29.72
2386.81	43.11	PK	184	1.5	H	-13.14	29.97	74.00	-44.03
2386.81	38.91	Ave	184	1.5	H	-13.14	25.77	54.00	-28.23
2494.82	43.13	PK	216	1.6	V	-13.08	30.05	74.00	-43.95
2494.82	36.92	Ave	216	1.6	V	-13.08	23.84	54.00	-30.16

Test Frequency : 18GHz to 25GHz

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

9.6.3 Test result of EUT with Power Board 2

Test Frequency: 9kHz to 30MHz

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

Test Frequency: 30MHz ~ 18GHz

Remark: only the worst data (GFSK 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)
GFSK Low Channel									
265.28	37.03	QP	127	1.8	H	-13.35	23.68	46.00	-22.32
265.28	40.39	QP	259	2.0	V	-13.35	27.04	46.00	-18.96
4804.00	47.58	PK	76	2.0	V	-1.06	46.52	74.00	-27.48
4804.00	41.89	Ave	76	2.0	V	-1.06	40.83	54.00	-13.17
7206.00	41.87	PK	251	1.2	H	1.33	43.20	74.00	-30.80
7206.00	38.12	Ave	251	1.2	H	1.33	39.45	54.00	-14.55
2319.31	46.99	PK	340	1.7	V	-13.19	33.80	74.00	-40.20
2319.31	37.27	Ave	340	1.7	V	-13.19	24.08	54.00	-29.92
2382.94	44.49	PK	201	1.3	H	-13.14	31.35	74.00	-42.65
2382.94	38.27	Ave	201	1.3	H	-13.14	25.13	54.00	-28.87
2499.62	42.62	PK	113	1.5	V	-13.08	29.54	74.00	-44.46
2499.62	38.76	Ave	113	1.5	V	-13.08	25.68	54.00	-28.32

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									
265.28	33.88	QP	268	1.7	H	-13.35	20.53	46.00	-25.47
265.28	40.81	QP	89	1.6	V	-13.35	27.46	46.00	-18.54
4882.00	48.39	PK	293	1.9	V	-0.62	47.77	74.00	-26.23
4882.00	42.71	Ave	293	1.9	V	-0.62	42.09	54.00	-11.91
7323.00	42.22	PK	347	1.3	H	2.21	44.43	74.00	-29.57
7323.00	36.10	Ave	347	1.3	H	2.21	38.31	54.00	-15.69
2342.47	46.44	PK	54	1.0	V	-13.19	33.25	74.00	-40.75
2342.47	39.38	Ave	54	1.0	V	-13.19	26.19	54.00	-27.81
2385.11	43.34	PK	7	1.8	H	-13.14	30.20	74.00	-43.80
2385.11	36.93	Ave	7	1.8	H	-13.14	23.79	54.00	-30.21
2492.54	43.30	PK	270	1.2	V	-13.08	30.22	74.00	-43.78
2492.54	37.68	Ave	270	1.2	V	-13.08	24.60	54.00	-29.40

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									
265.28	39.70	QP	264	1.3	H	-13.35	26.35	46.00	-19.65
265.28	39.97	QP	144	2.0	V	-13.35	26.62	46.00	-19.38
4960.00	48.60	PK	173	1.0	V	-0.24	48.36	74.00	-25.64
4960.00	40.54	Ave	173	1.0	V	-0.24	40.30	54.00	-13.70
7440.00	43.46	PK	12	1.9	H	2.84	46.30	74.00	-27.70
7440.00	38.61	Ave	12	1.9	H	2.84	41.45	54.00	-12.55
2327.36	46.95	PK	154	1.3	V	-13.19	33.76	74.00	-40.24
2327.36	38.14	Ave	154	1.3	V	-13.19	24.95	54.00	-29.05
2386.81	43.07	PK	119	1.7	H	-13.14	29.93	74.00	-44.07
2386.81	37.14	Ave	119	1.7	H	-13.14	24.00	54.00	-30.00
2494.82	44.38	PK	133	1.4	V	-13.08	31.30	74.00	-42.70
2494.82	38.36	Ave	133	1.4	V	-13.08	25.28	54.00	-28.72

Test Frequency : 18GHz to 25GHz

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

10 Band Edge Measurement

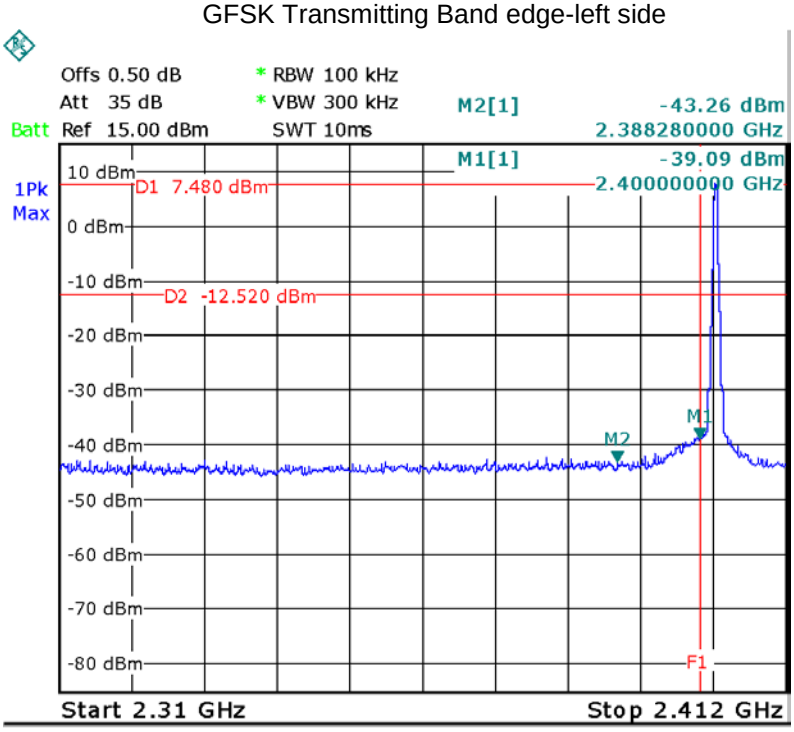
Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247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

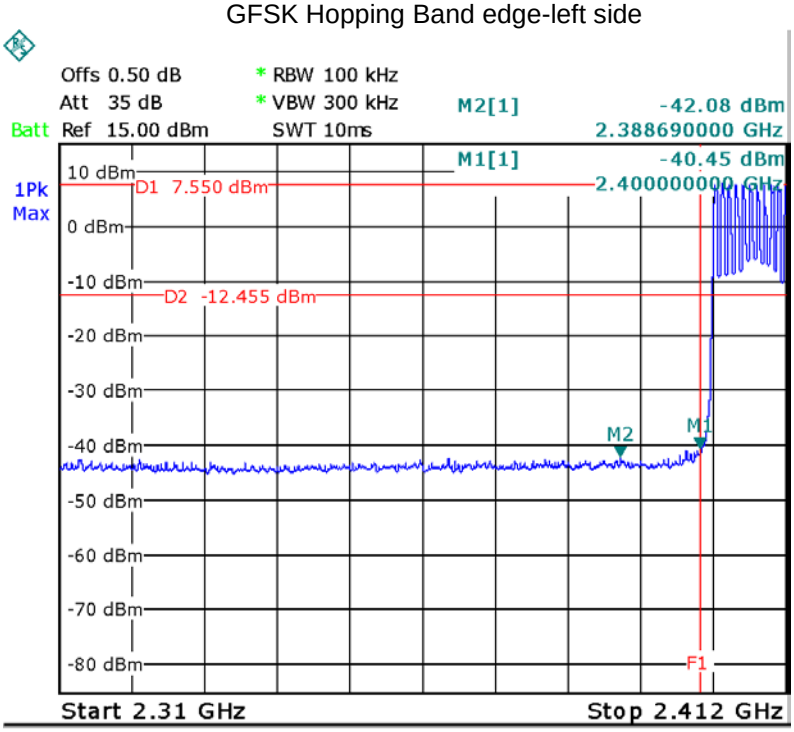
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
   Detector function = peak, Trace = max hold

10.2 Test Result

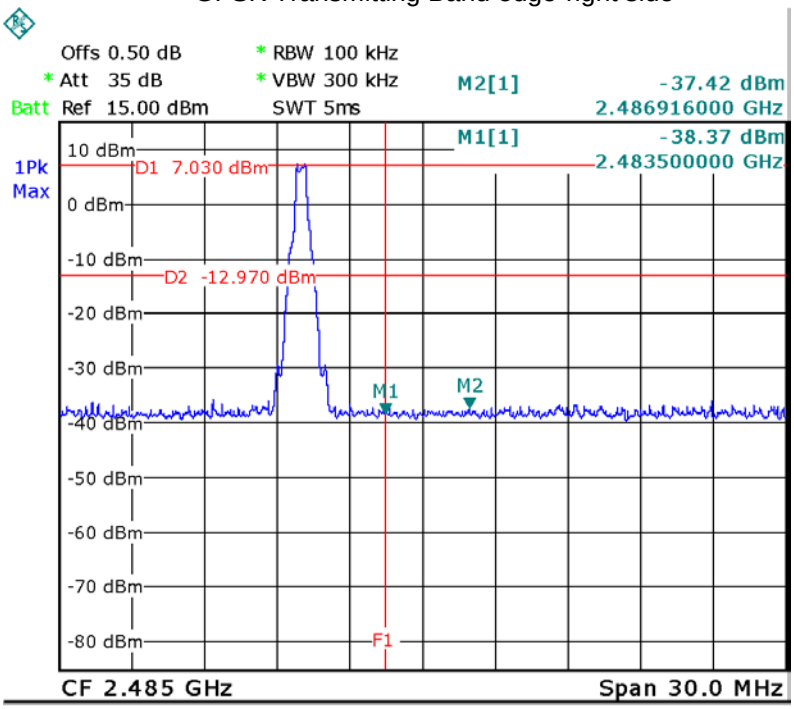
GFSK Transmitting Band edge-left side



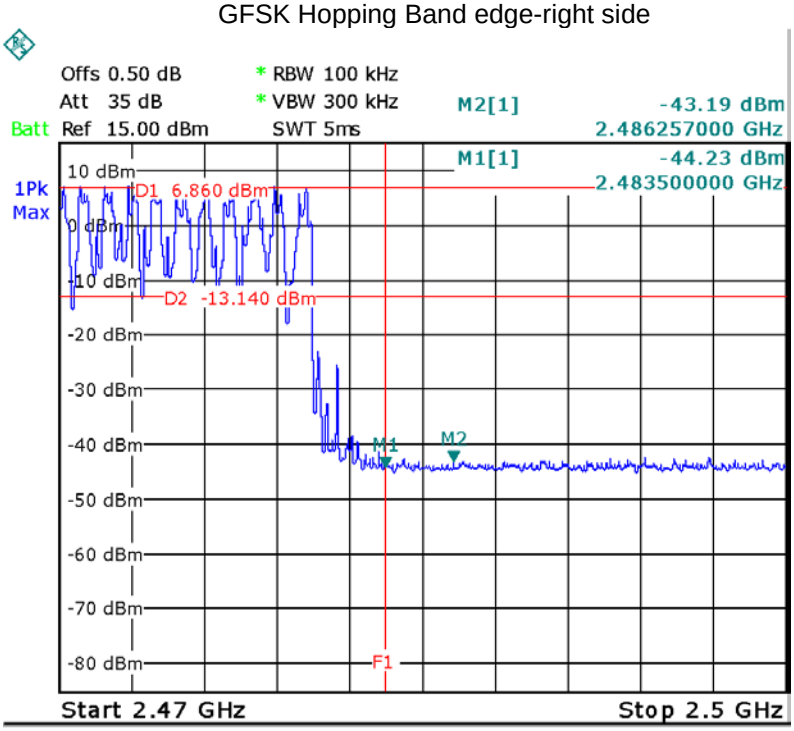
GFSK Hopping Band edge-left side



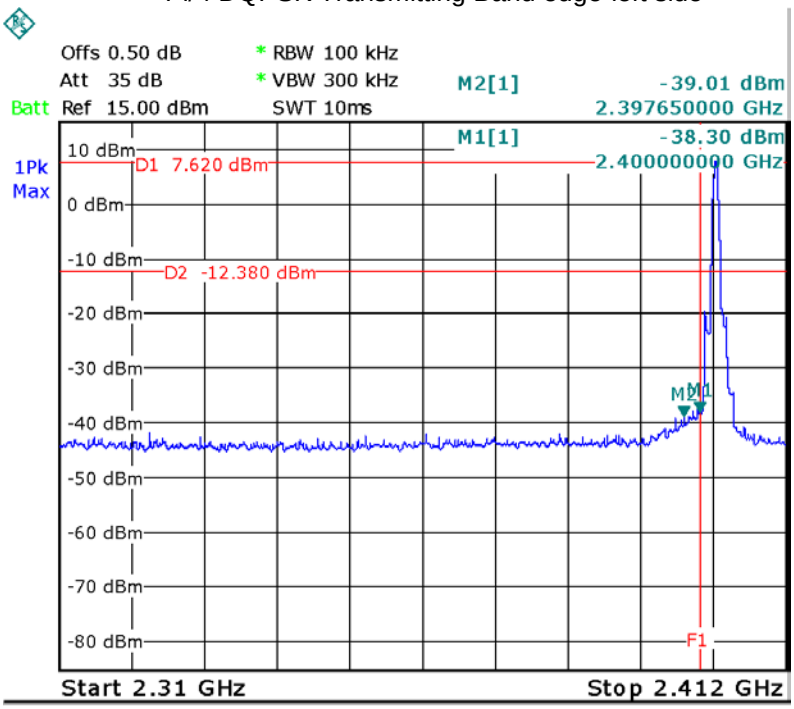
GFSK Transmitting Band edge-right side



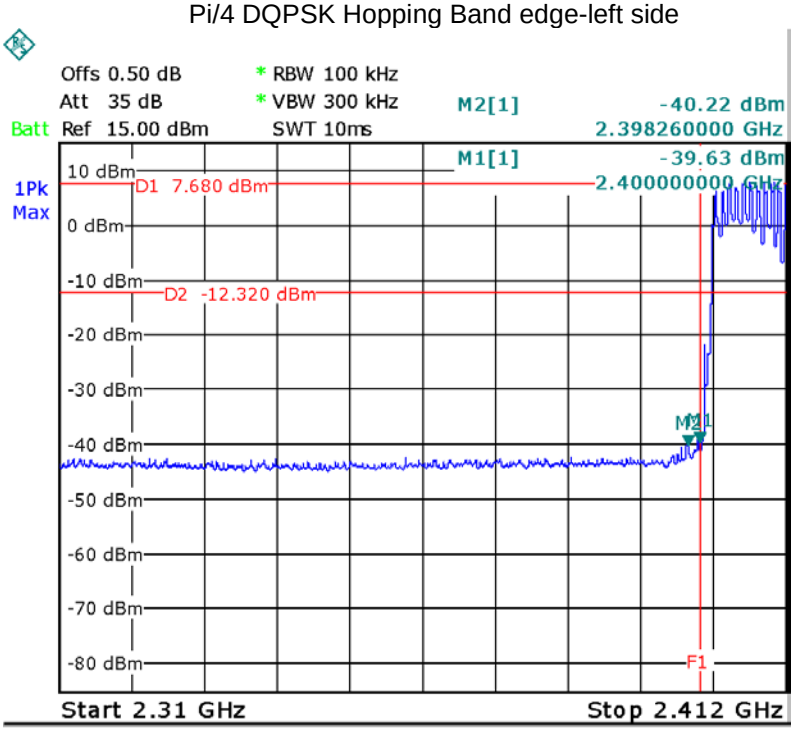
GFSK Hopping Band edge-right side



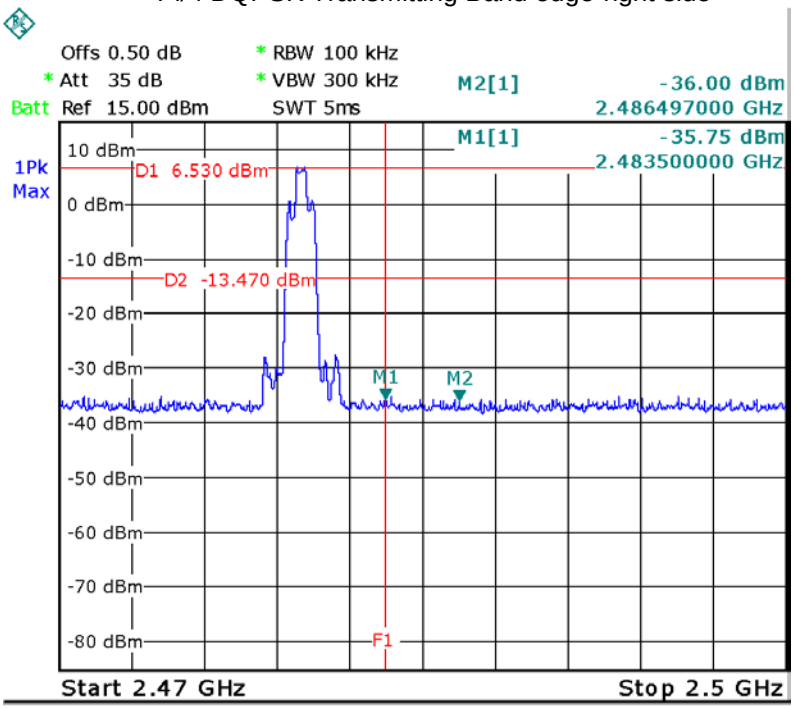
Pi/4 DQPSK Transmitting Band edge-left side



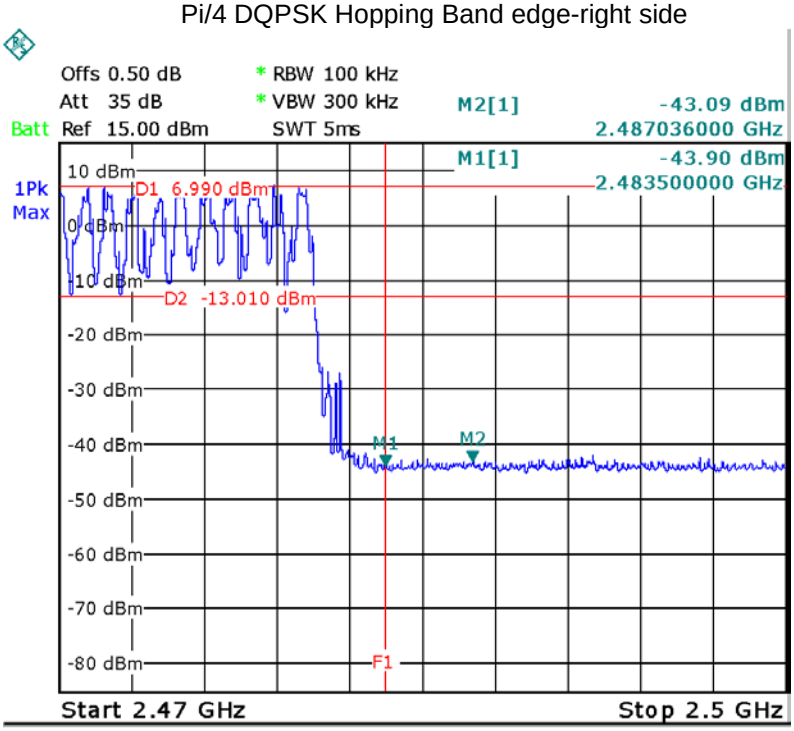
Pi/4 DQPSK Hopping Band edge-left side



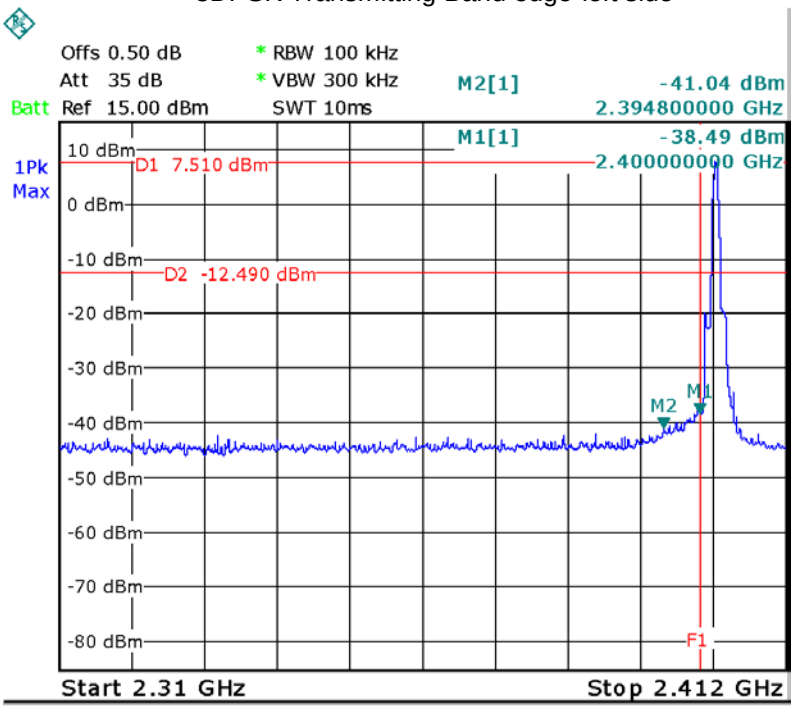
Pi/4 DQPSK Transmitting Band edge-right side



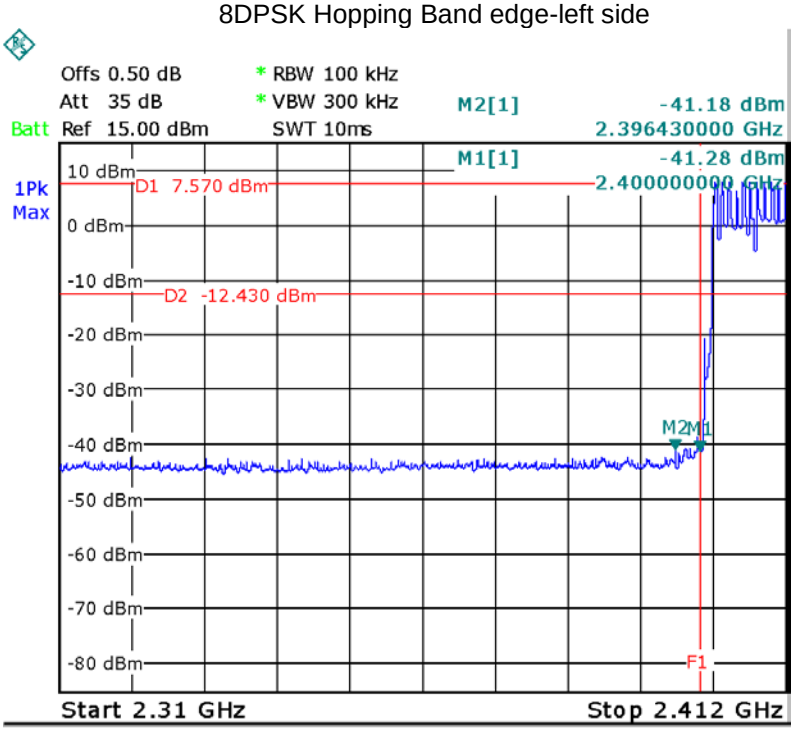
Pi/4 DQPSK Hopping Band edge-right side



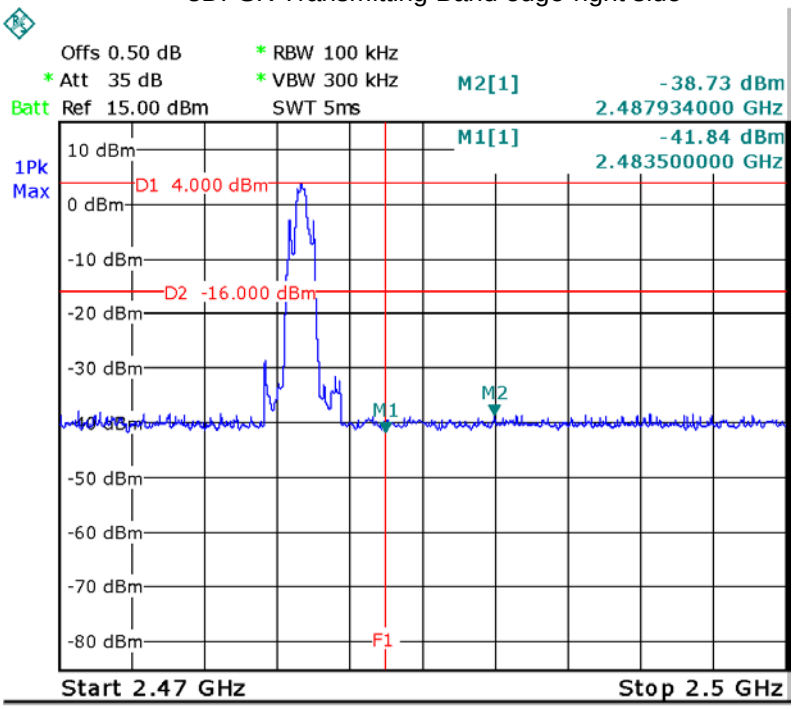
8DPSK Transmitting Band edge-left side



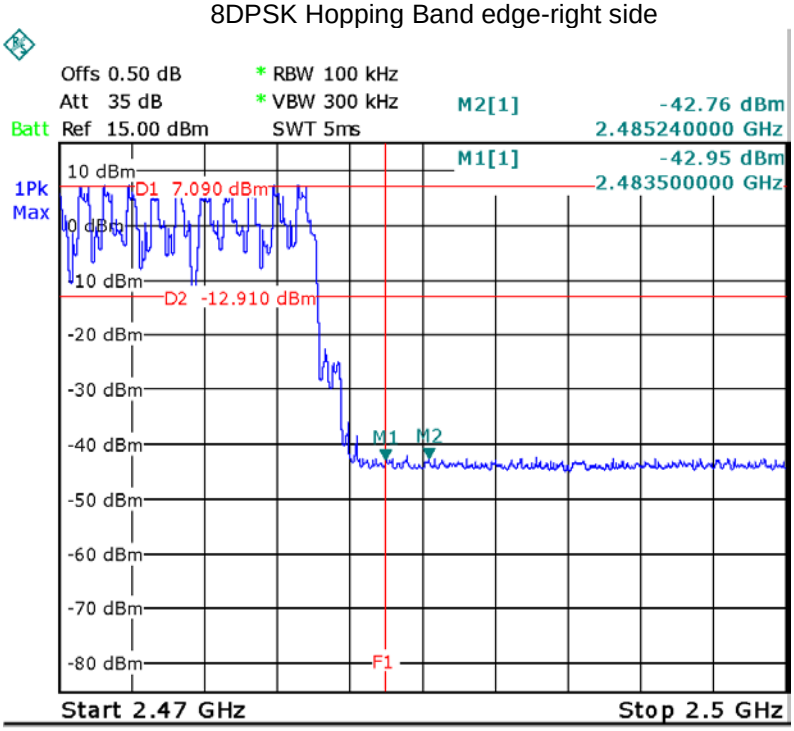
8DPSK Hopping Band edge-left side



8DPSK Transmitting Band edge-right side



8DPSK Hopping Band edge-right side



11 20 dB 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.

11.1 Test Procedure

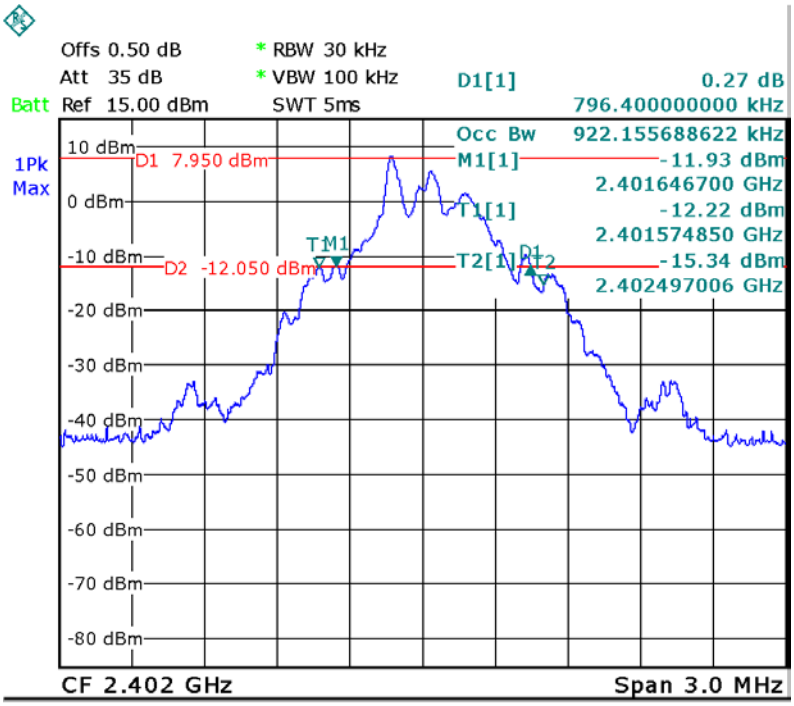
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

11.2 Test Result

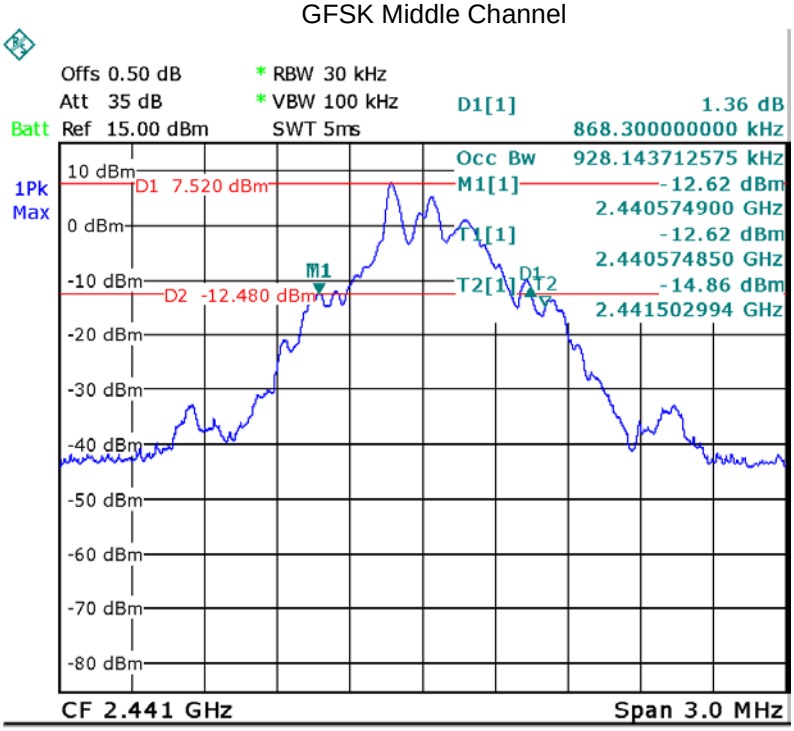
Modulation	Test Channel	Bandwidth(MHz)
GFSK	Low	0.796
GFSK	Middle	0.868
GFSK	High	0.874
Pi/4 DQPSK	Low	1.120
Pi/4 DQPSK	Middle	1.126
Pi/4 DQPSK	High	1.138
8DPSK	Low	1.138
8DPSK	Middle	1.138
8DPSK	High	1.138

Test plots

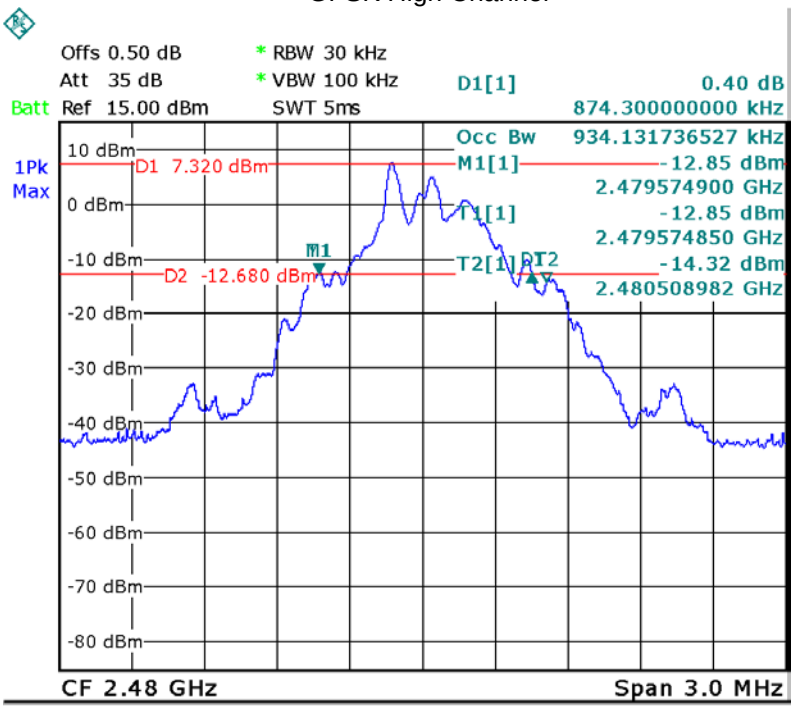
GFSK Low Channel



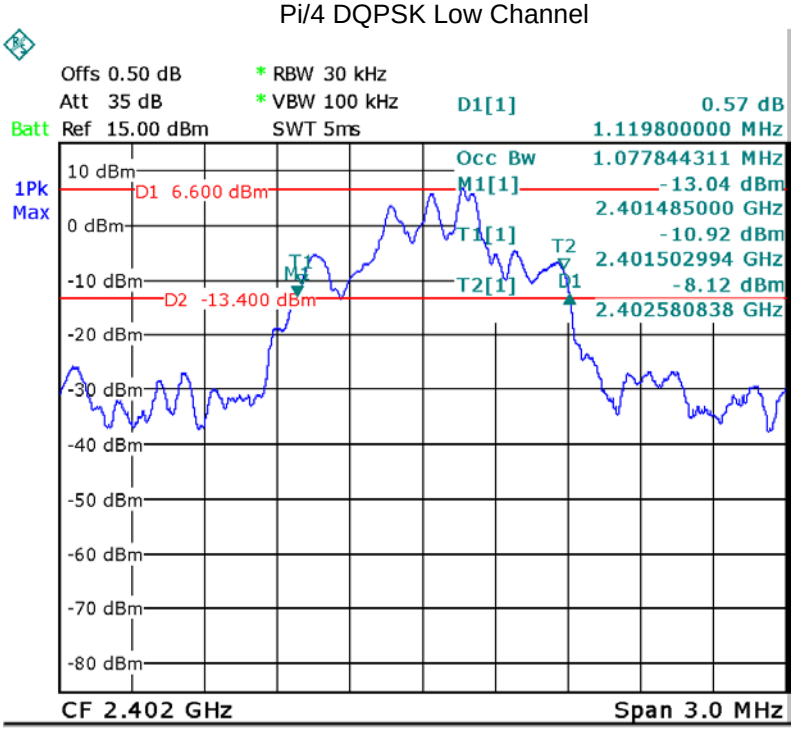
GFSK Middle Channel



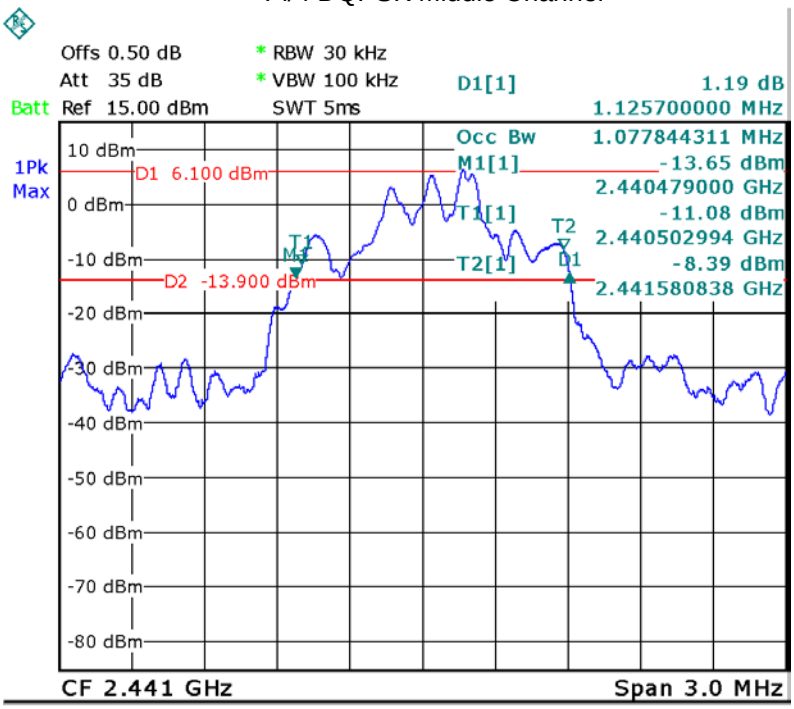
GFSK High Channel



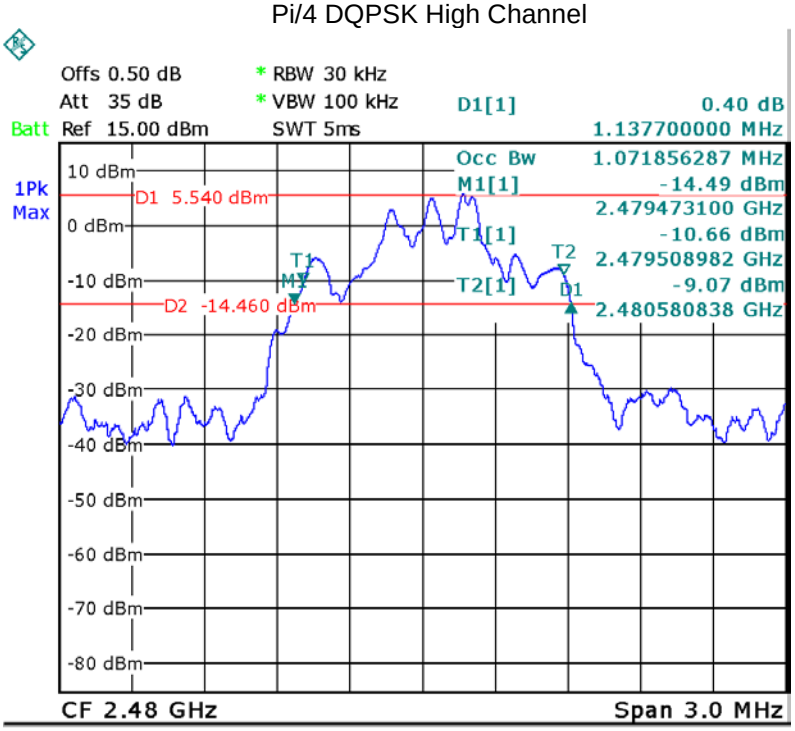
Pi/4 DQPSK Low Channel



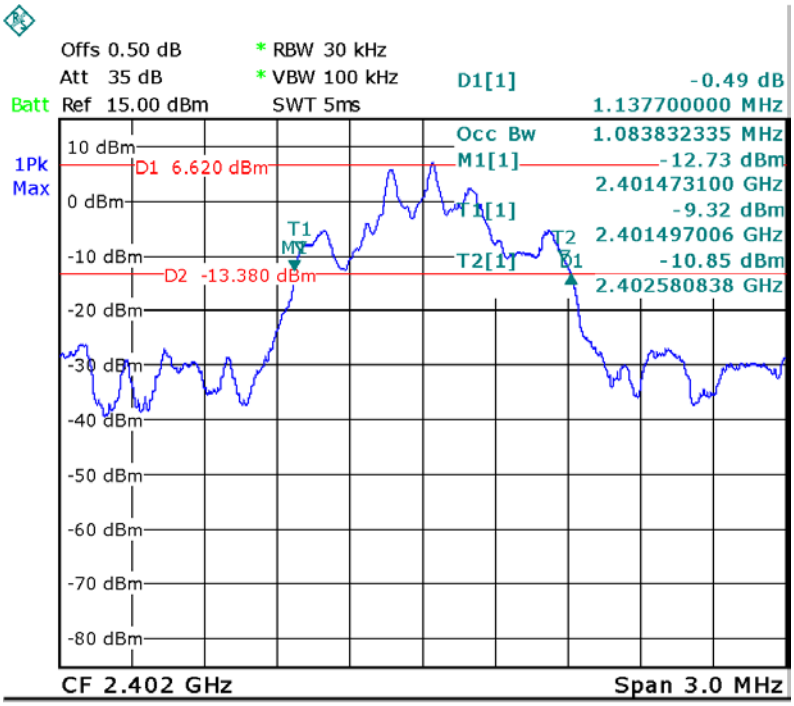
Pi/4 DQPSK Middle Channel



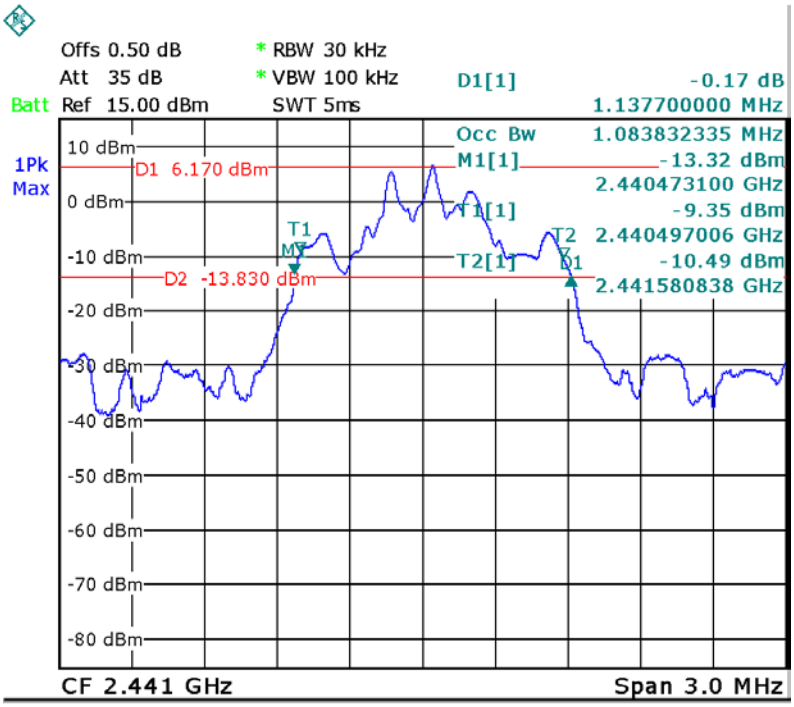
Pi/4 DQPSK High Channel



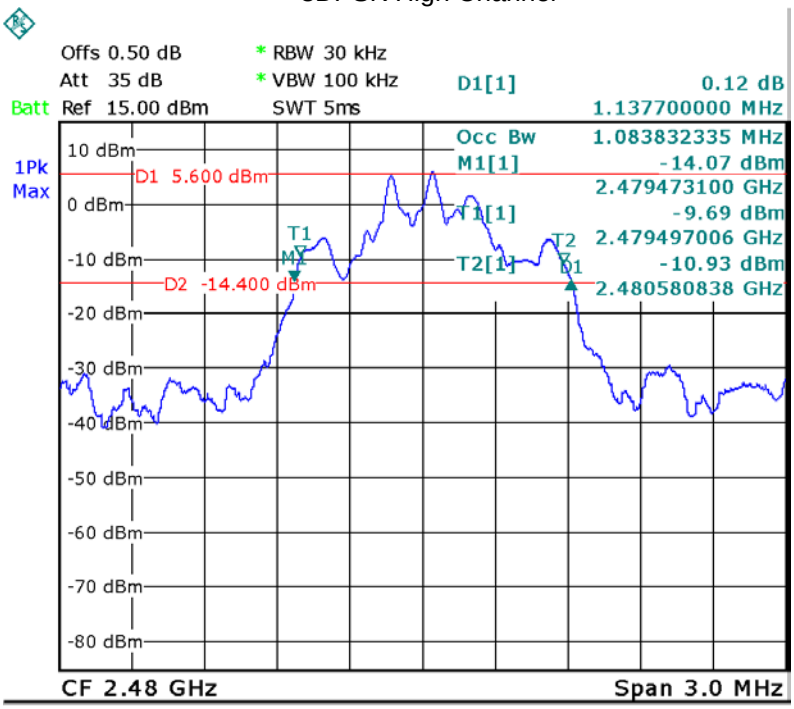
8DPSK Low Channel



8DPSK Middle Channel



8DPSK High Channel



12 Maximum Peak Output Power

Test Requirement: FCC CFR47 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

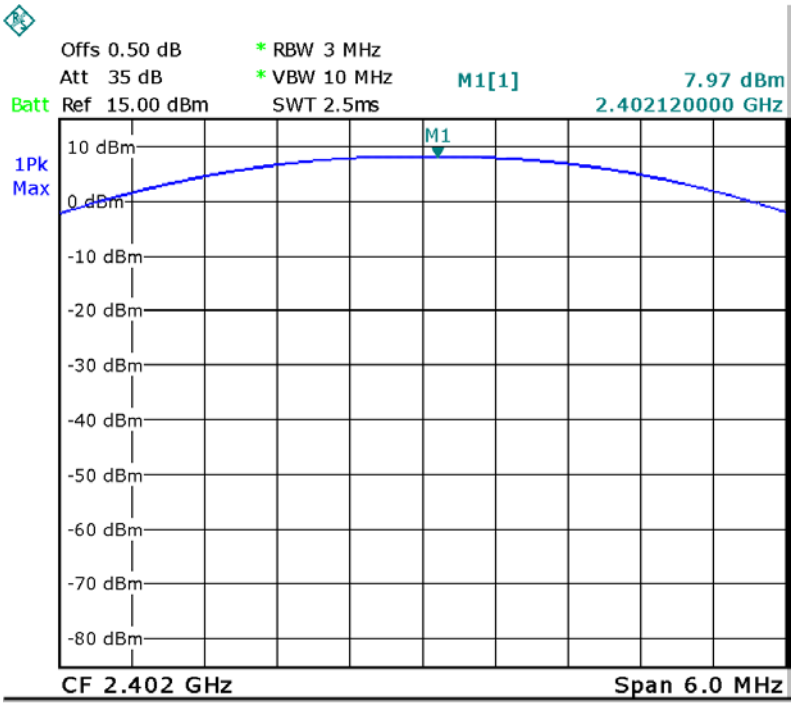
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3MHz. VBW = 10MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

12.2 Test Result

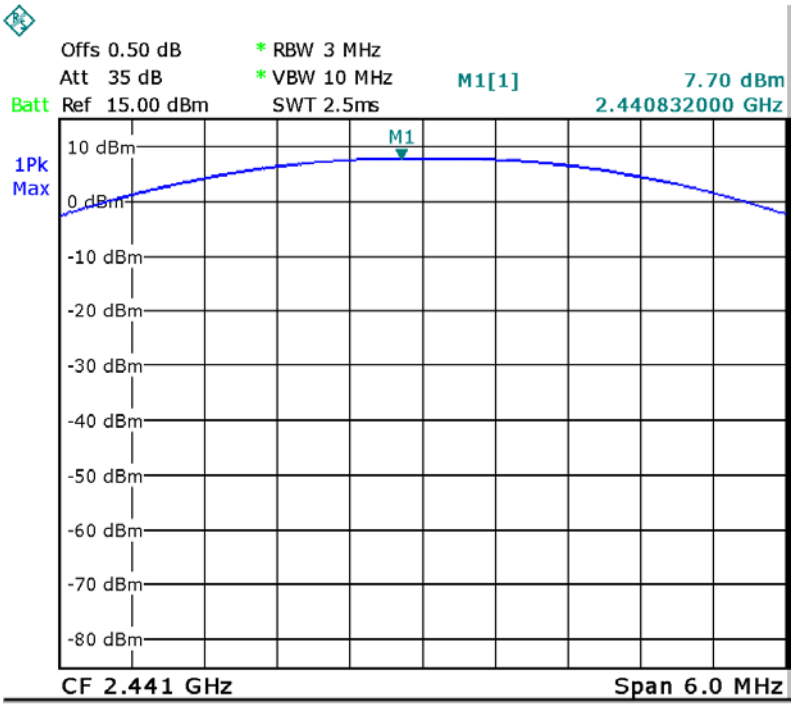
Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	7.97	30
GFSK	Middle	7.70	30
GFSK	High	7.45	30
Pi/4 DQPSK	Low	8.12	21
Pi/4 DQPSK	Middle	7.90	21
Pi/4 DQPSK	High	7.66	21
8DPSK	Low	8.14	21
8DPSK	Middle	7.89	21
8DPSK	High	7.41	21

Test plots

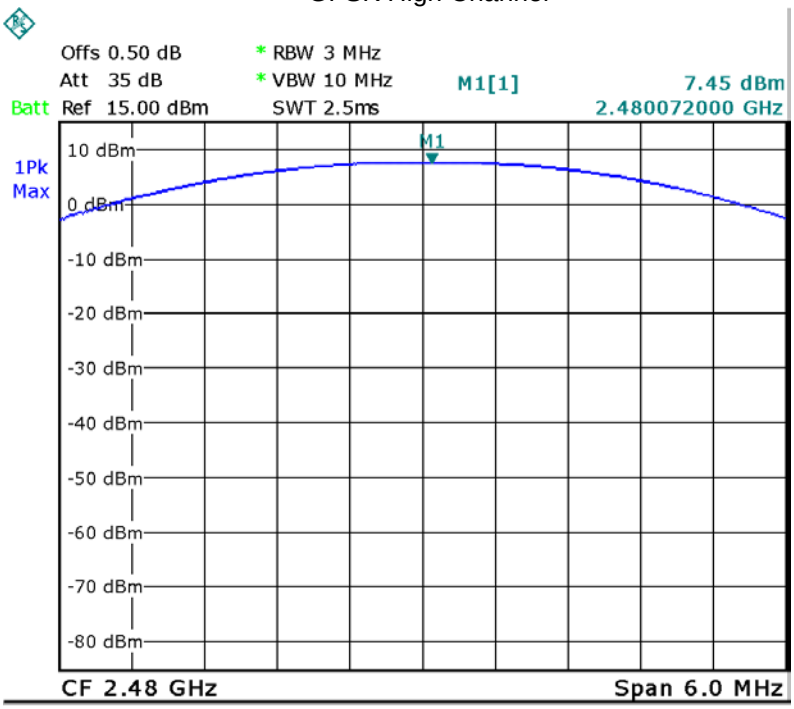
GFSK Low Channel



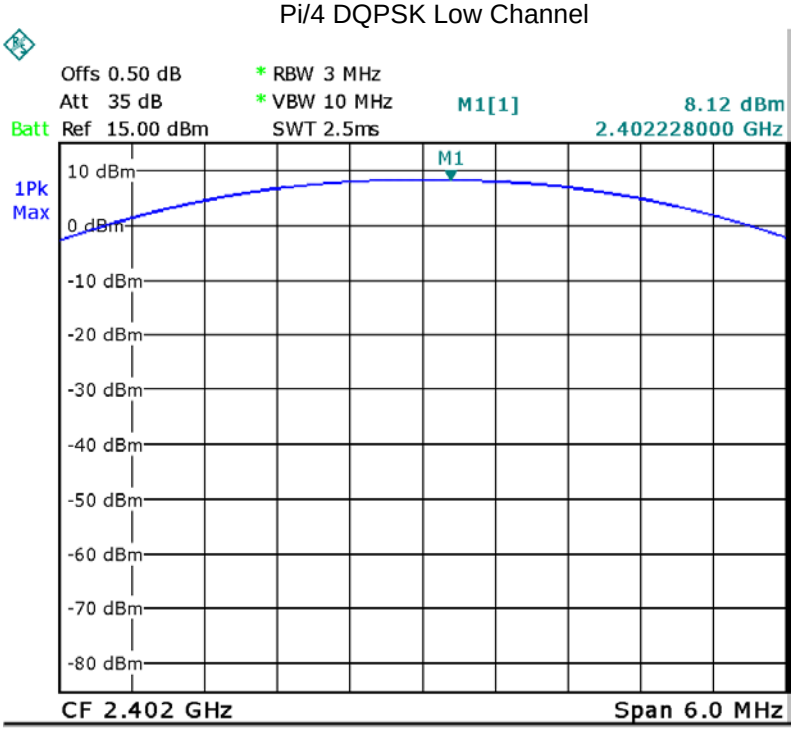
GFSK Middle Channel



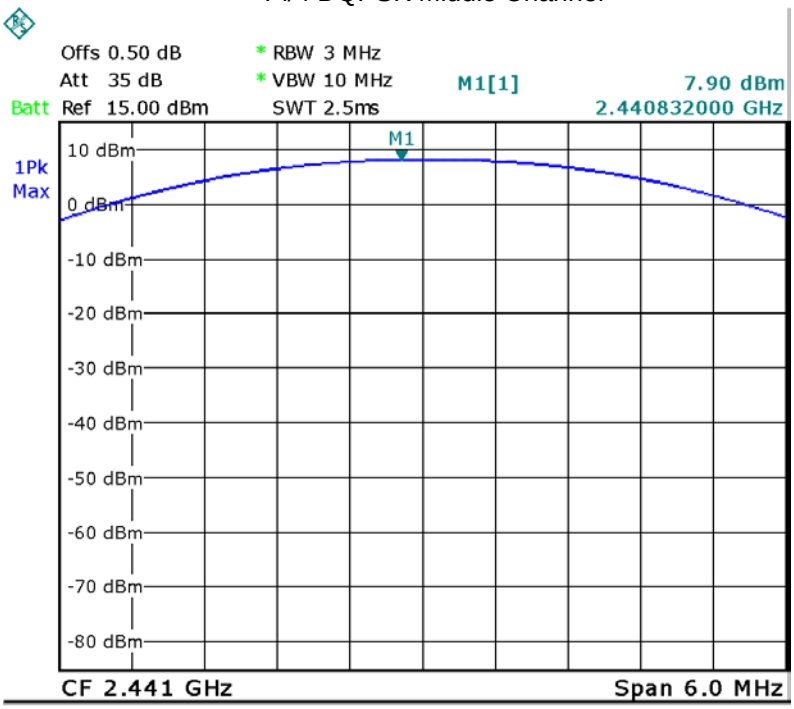
GFSK High Channel



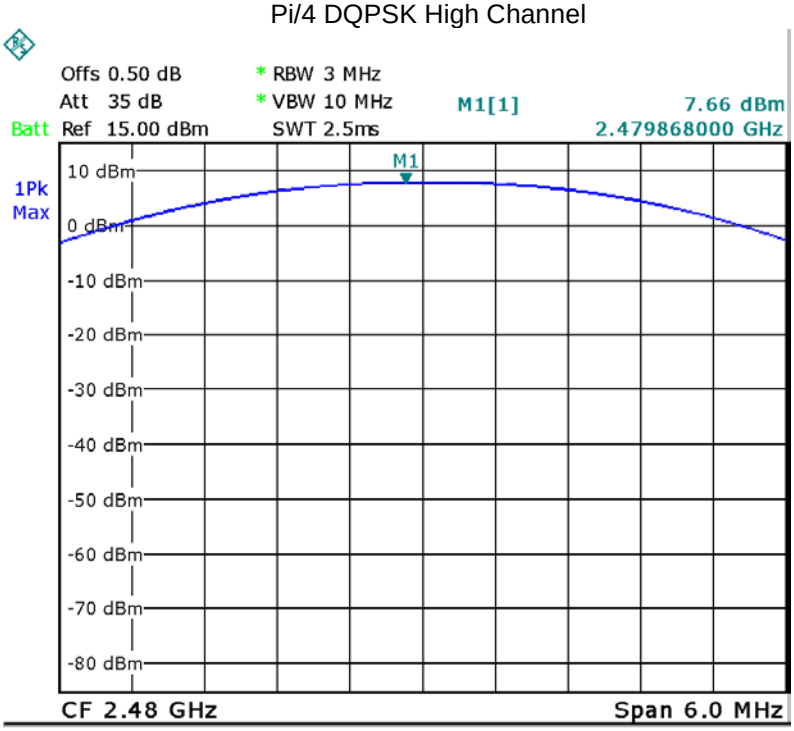
Pi/4 DQPSK Low Channel



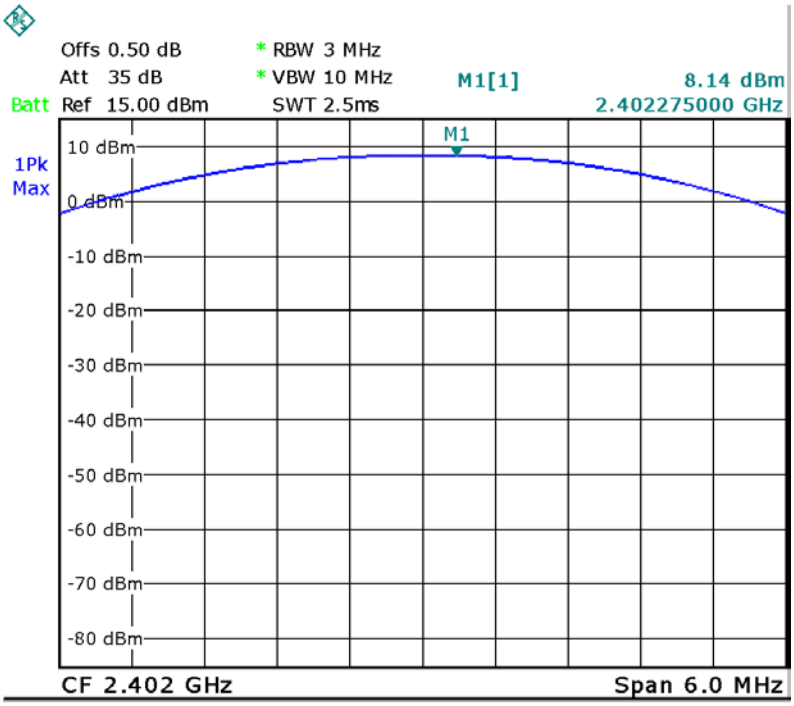
Pi/4 DQPSK Middle Channel



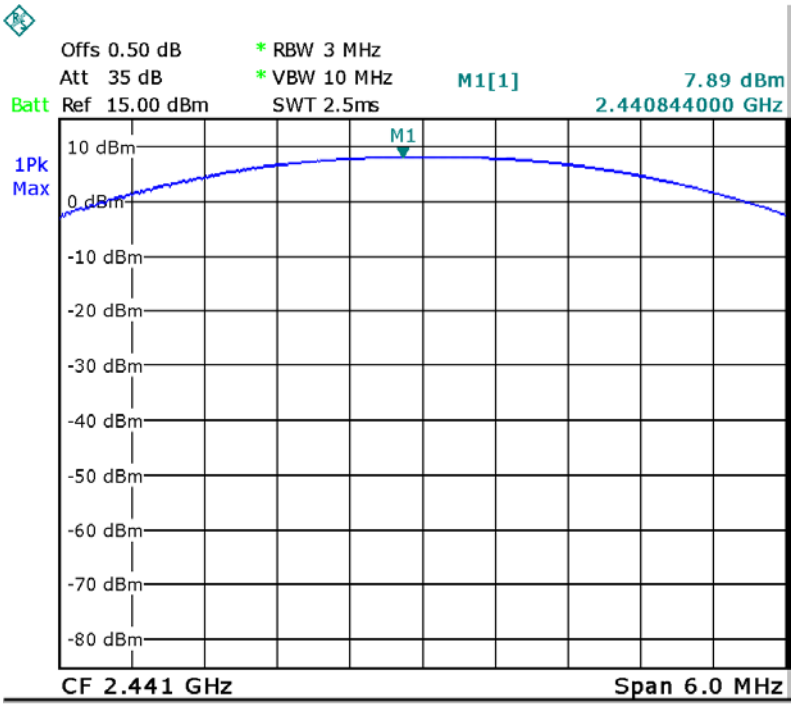
Pi/4 DQPSK High Channel



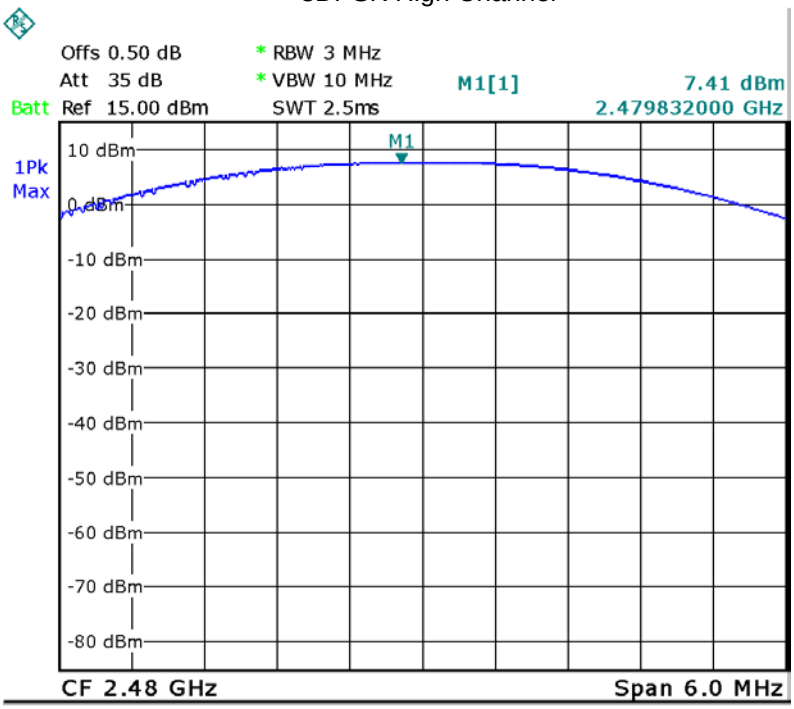
8DPSK Low Channel



8DPSK Middle Channel



8DPSK High Channel



13 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.

13.1 Test Procedure

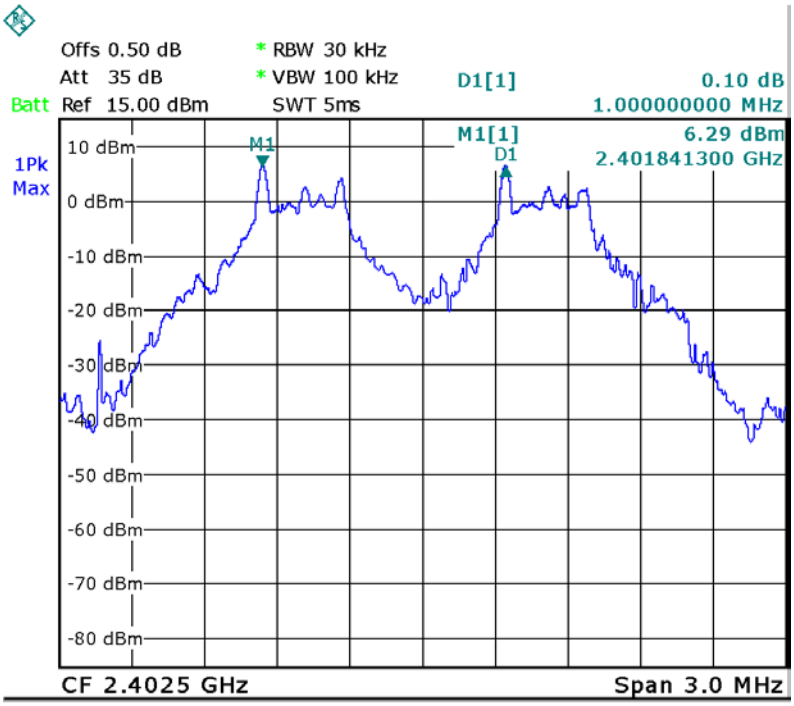
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to 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.

13.2 Test Result

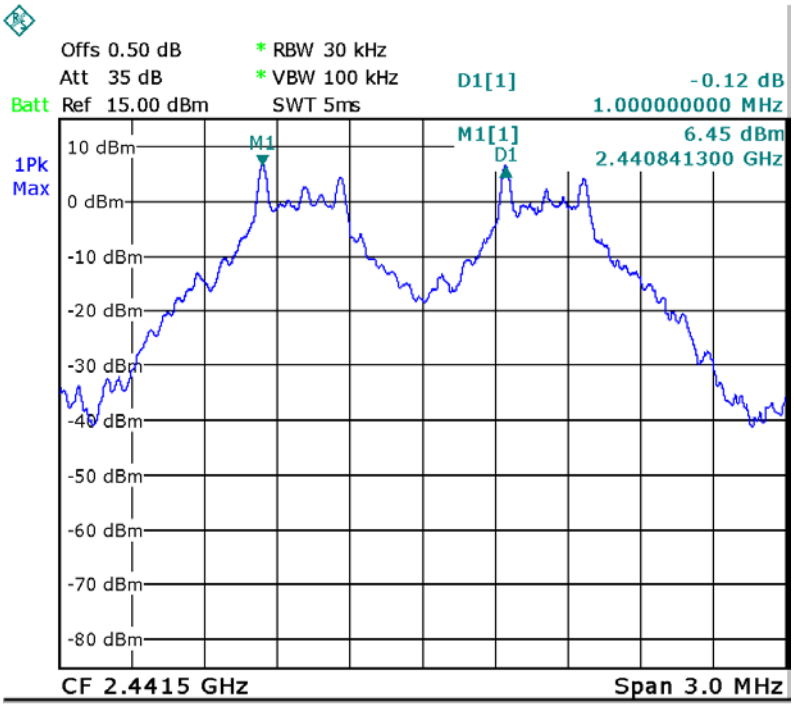
Modulation	Test Channel	Separation (MHz)	Limit(MHz)	Result
GFSK	Low	1.000	0.531	PASS
GFSK	Middle	1.000	0.579	PASS
GFSK	High	1.000	0.583	PASS
Pi/4 DQPSK	Low	1.000	0.747	PASS
Pi/4 DQPSK	Middle	1.000	0.751	PASS
Pi/4 DQPSK	High	1.000	0.759	PASS
8DPSK	Low	1.000	0.759	PASS
8DPSK	Middle	1.000	0.759	PASS
8DPSK	High	1.000	0.759	PASS

Test plots

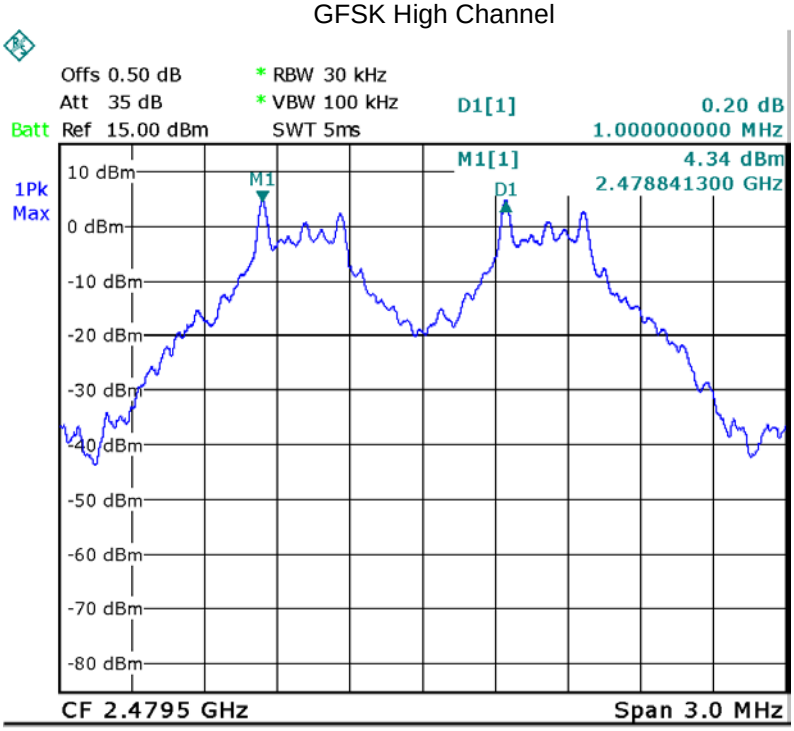
GFSK Low Channel



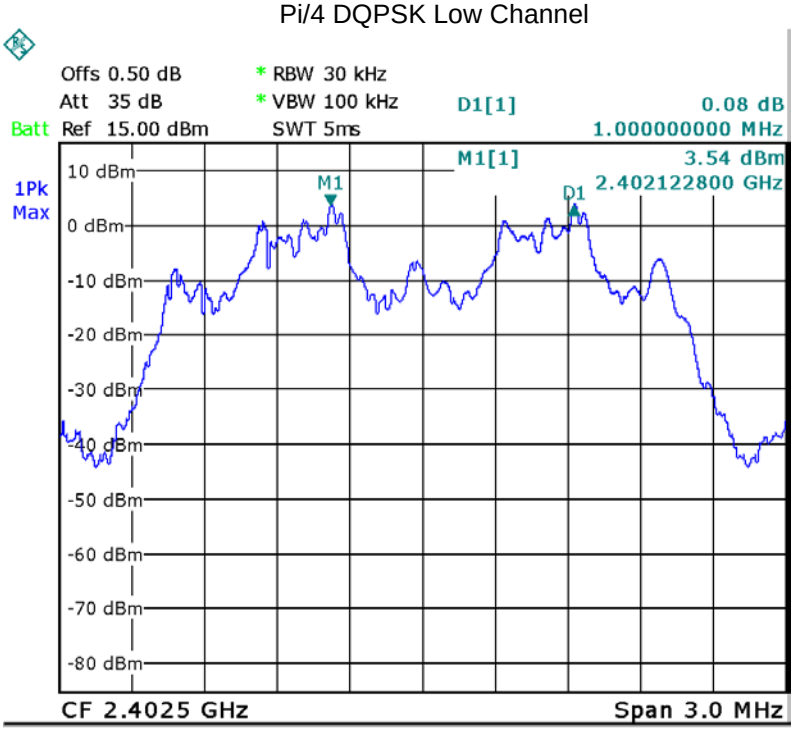
GFSK Middle Channel



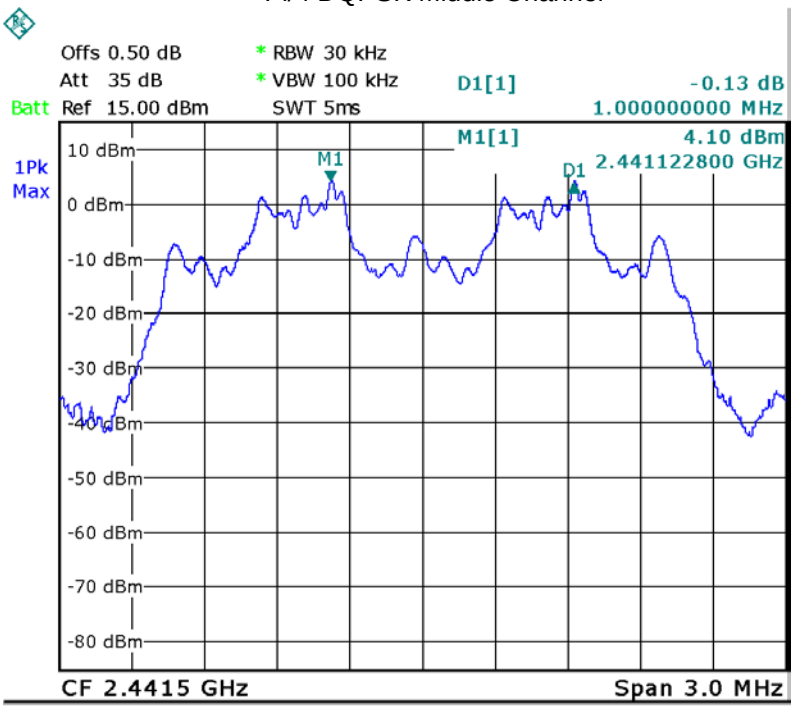
GFSK High Channel



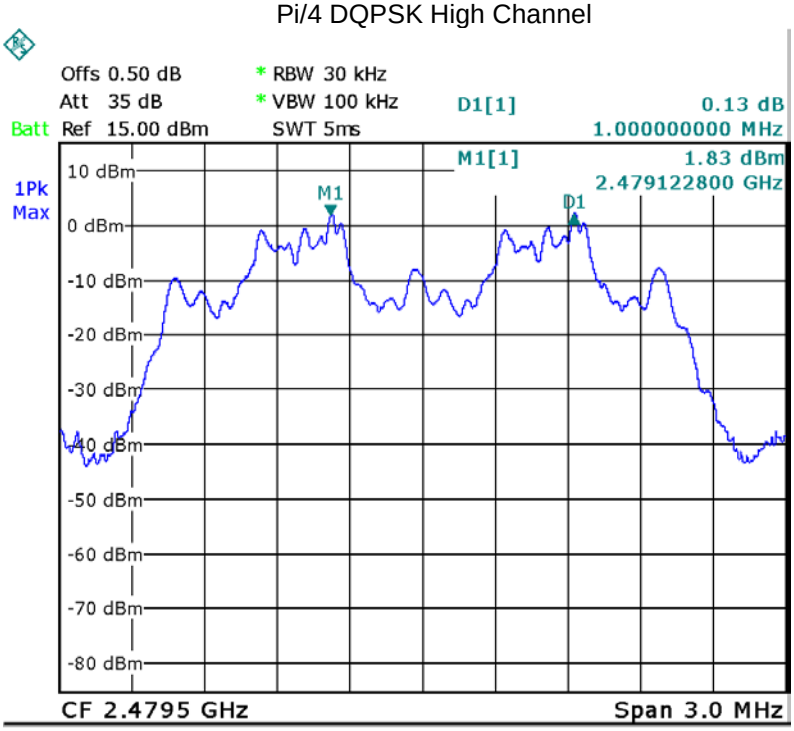
Pi/4 DQPSK Low Channel



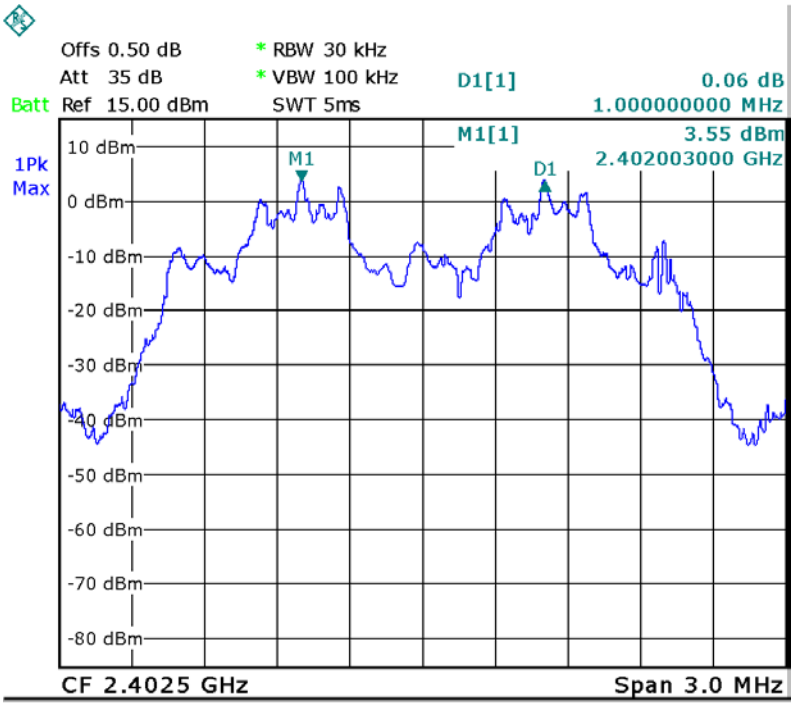
Pi/4 DQPSK Middle Channel



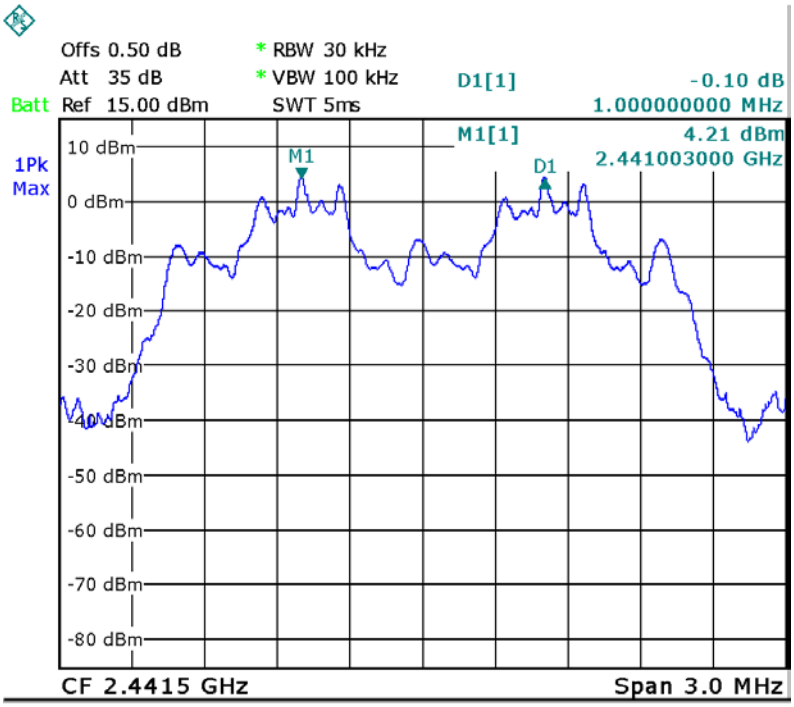
Pi/4 DQPSK High Channel



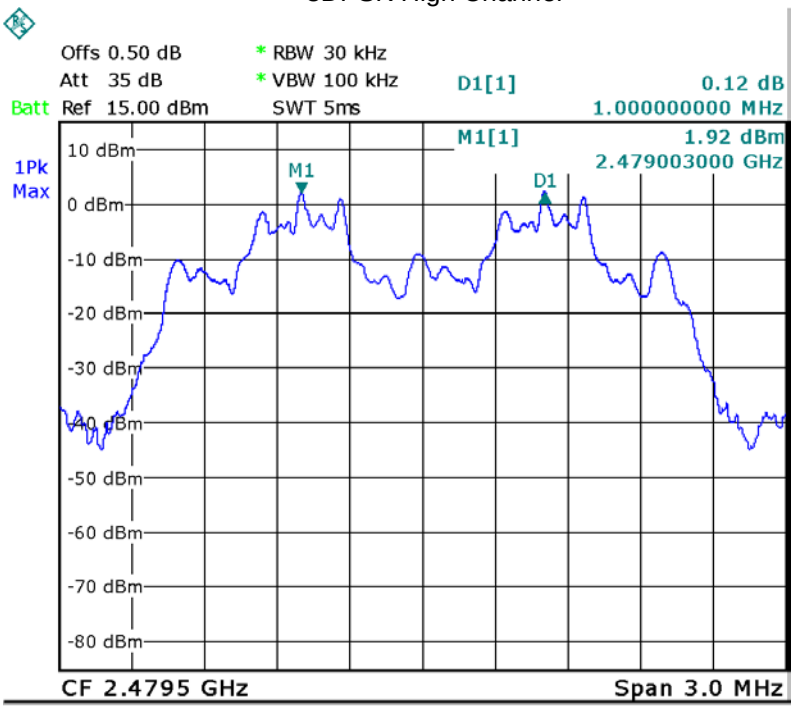
8DPSK Low Channel



8DPSK Middle Channel



8DPSK High Channel



14 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.

14.1 Test Procedure

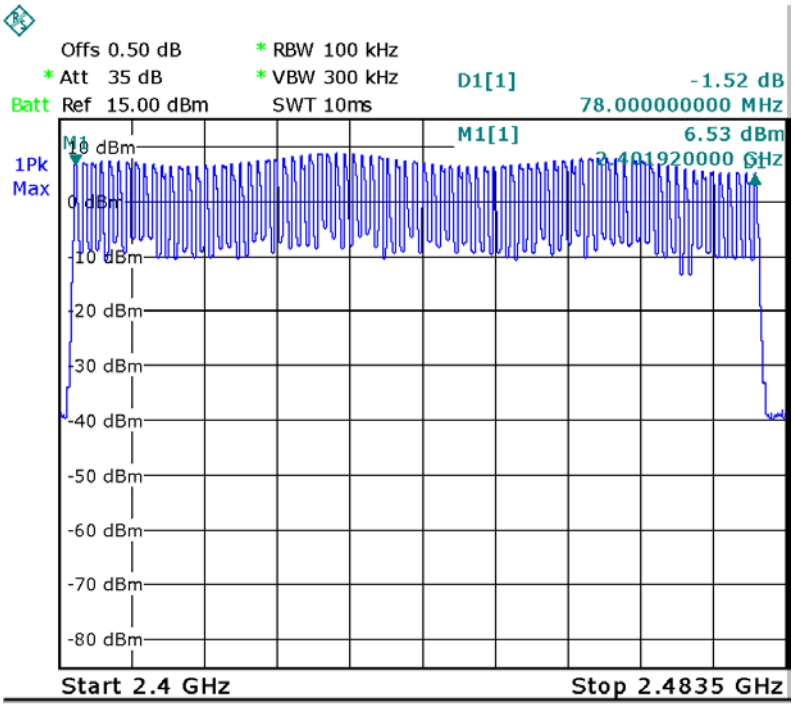
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to 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;

14.2 Test Result

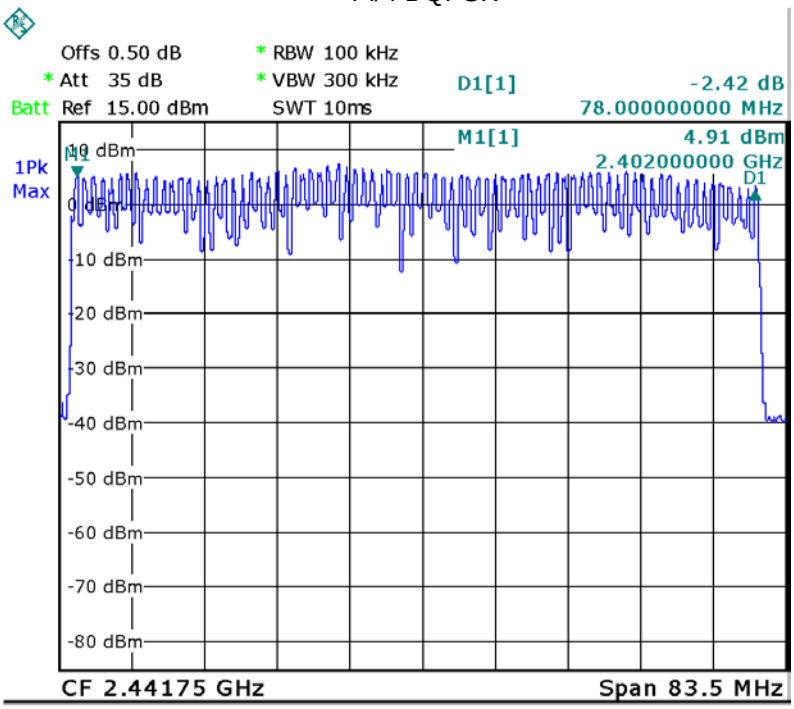
Test Plots:

79 Channels in total

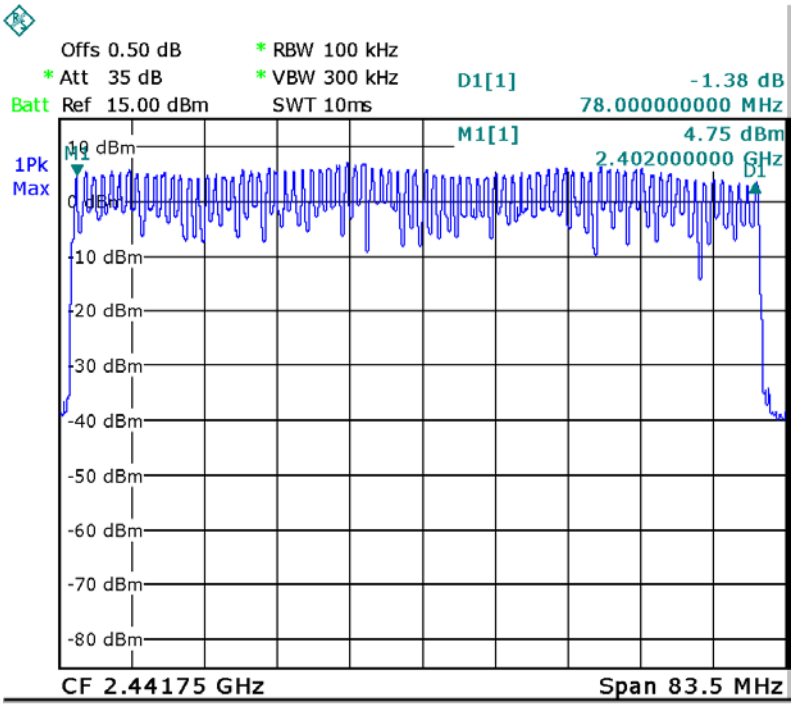
GFSK



Pi/4 DQPSK



8DPSK



15 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.

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).

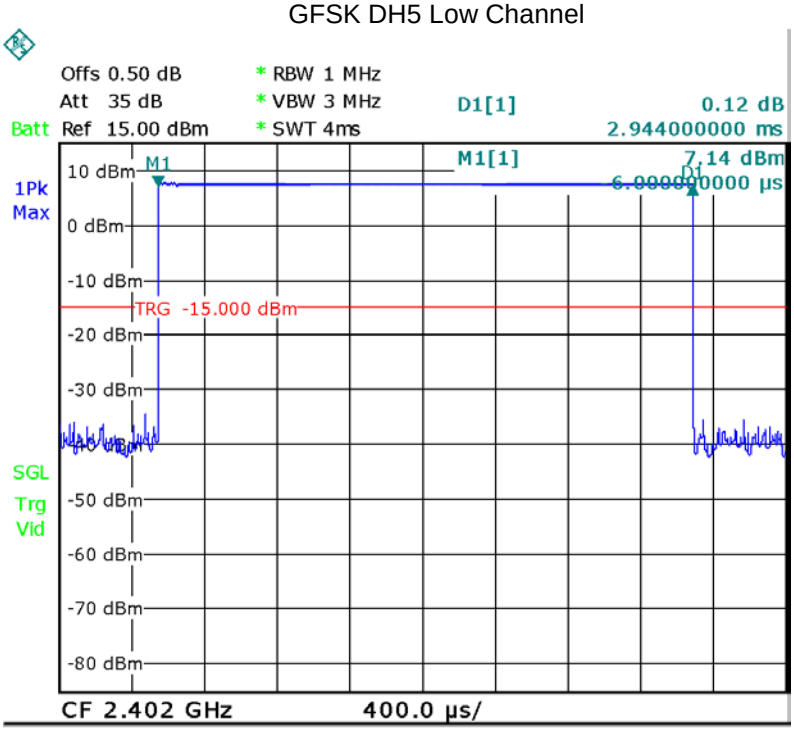
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

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.	

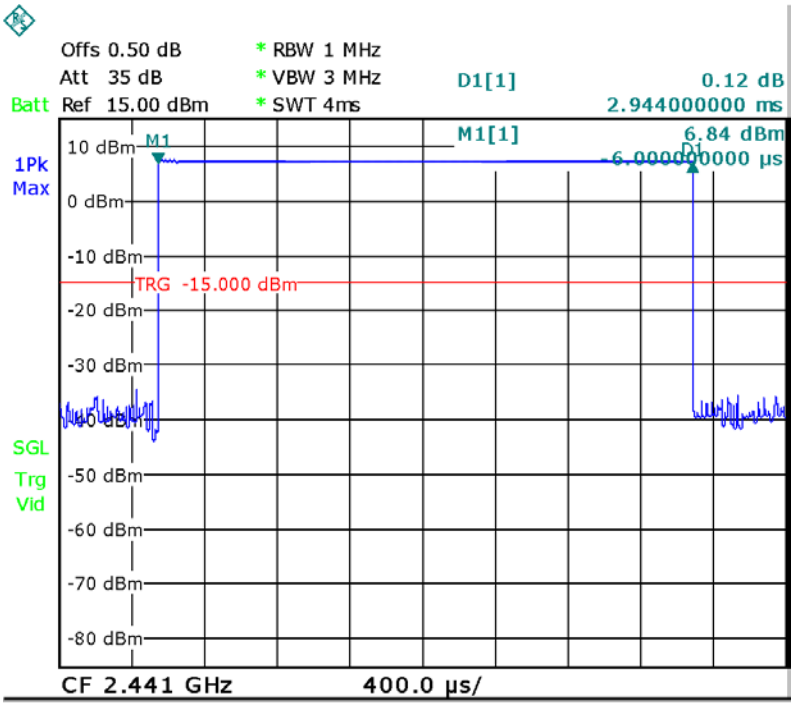
Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	DH5	Low	2.944	0.314	0.4
		middle	2.944	0.314	0.4
		High	2.944	0.314	0.4
Pi/4DQPSK	DH5	Low	2.946	0.314	0.4
		middle	2.946	0.314	0.4
		High	2.946	0.314	0.4
8DPSK	DH5	Low	2.946	0.314	0.4
		middle	2.946	0.314	0.4
		High	2.946	0.314	0.4

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

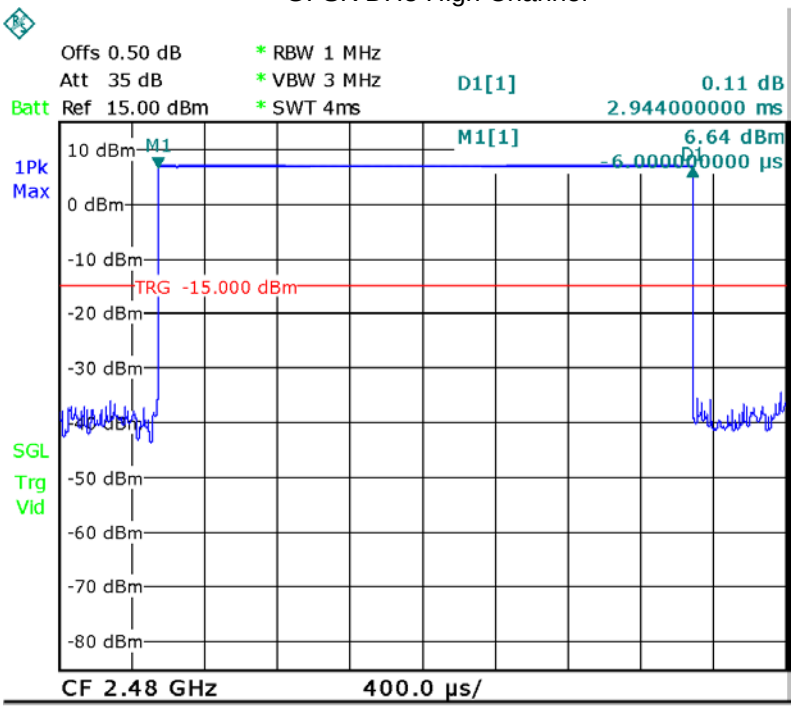
Test Plots
GFSK DH5 Low Channel



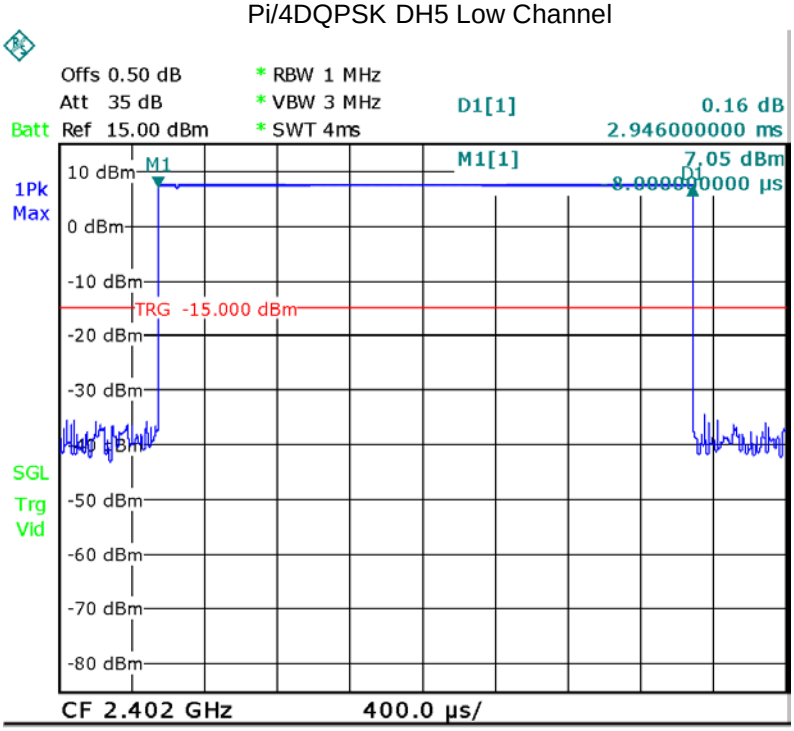
GFSK DH5 Middle Channel



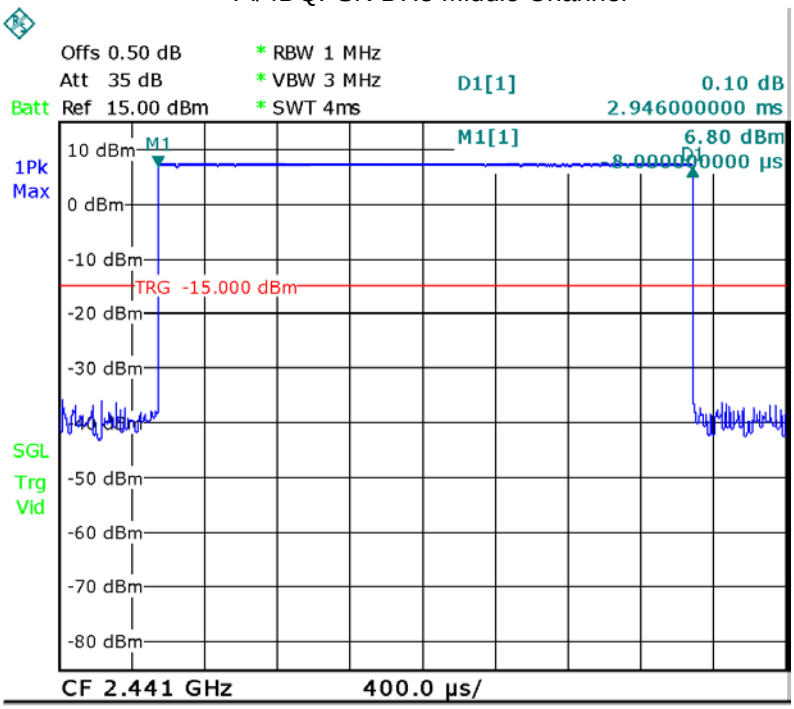
GFSK DH5 High Channel



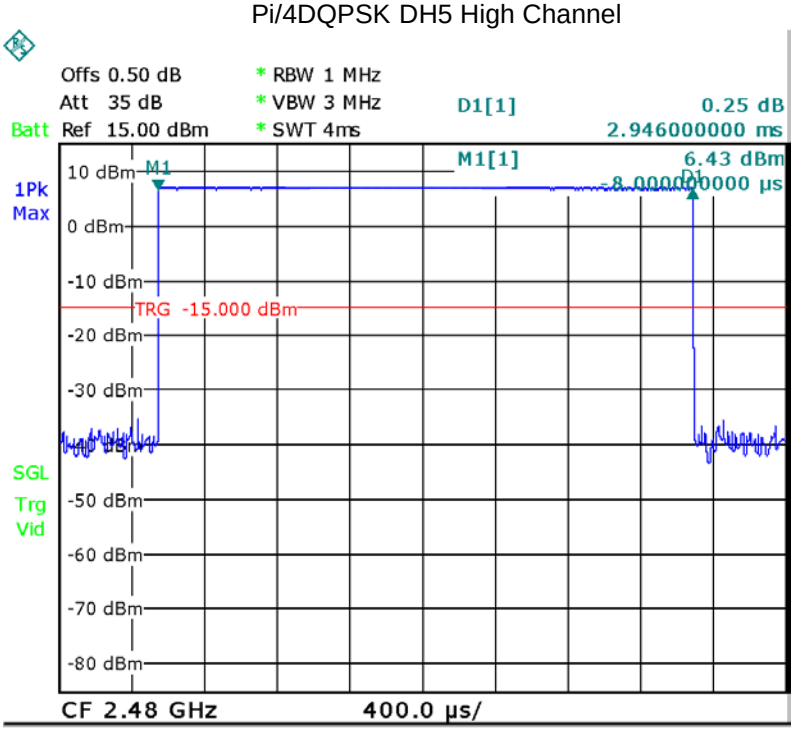
Pi/4DQPSK DH5 Low Channel



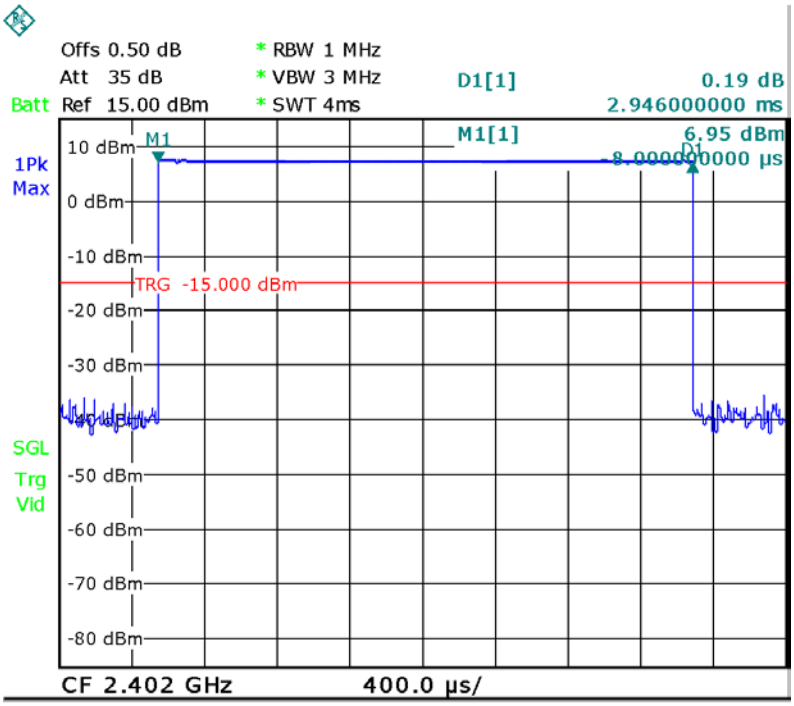
Pi/4DQPSK DH5 Middle Channel



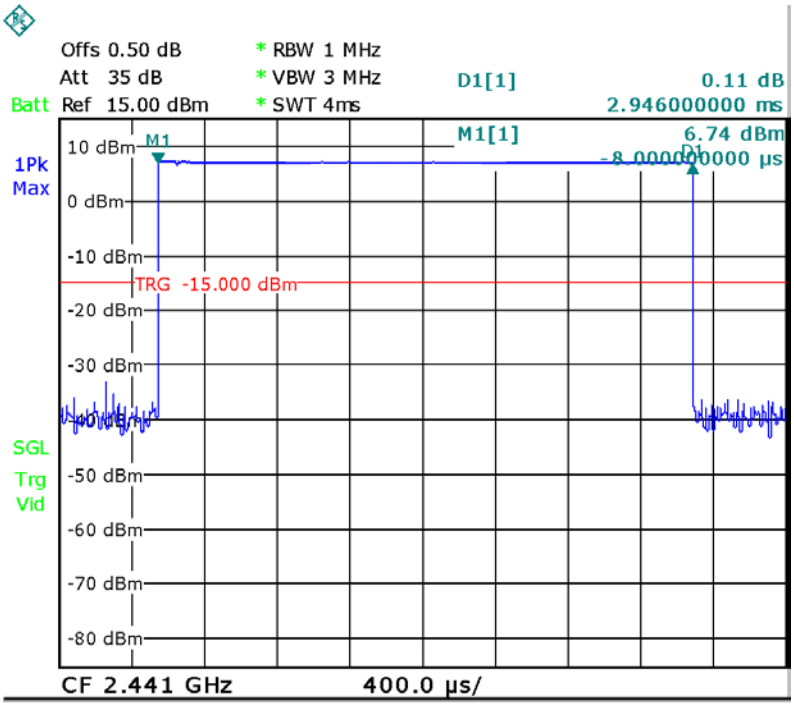
Pi/4DQPSK DH5 High Channel



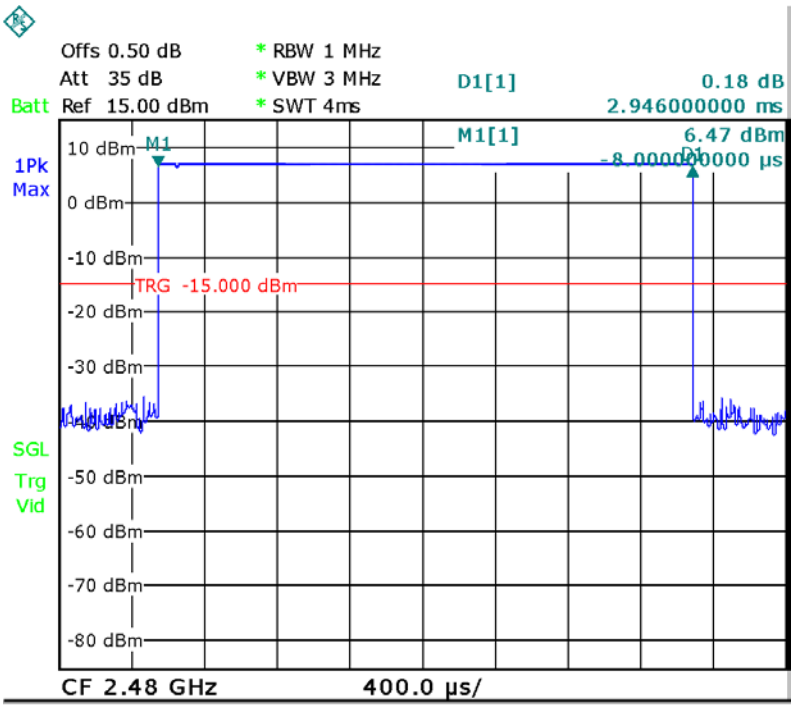
8DPSK DH5 Low Channel



8DPSK DH5 Middle Channel



8DPSK DH5 High Channel



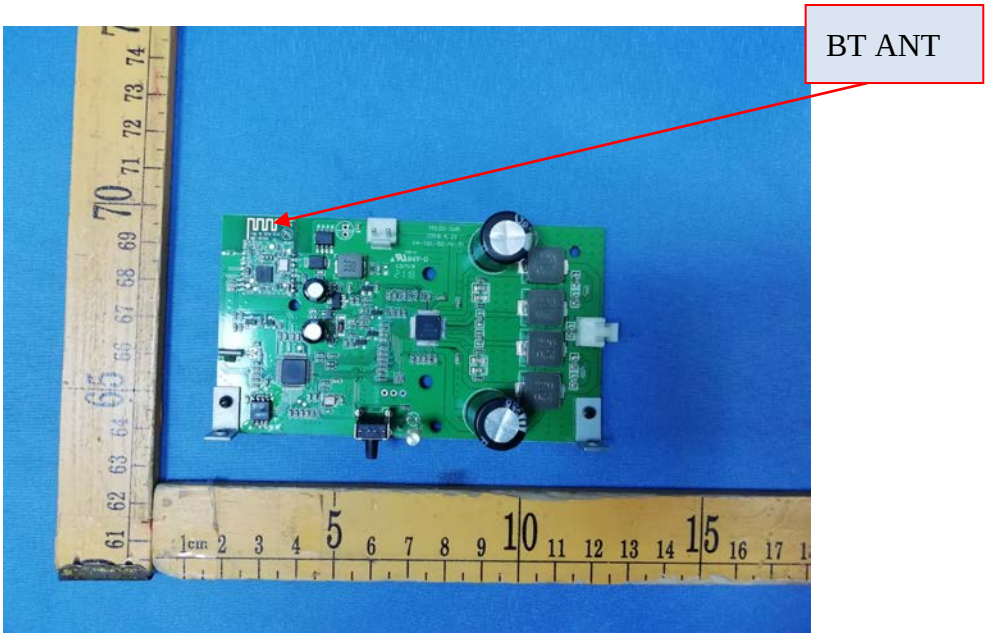
16 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

For intentional device, according to FCC 47 CFR Section 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.

Result:

The EUT has a PCB Printed Antenna, meets the requirements of FCC 15.203.



17 RF Exposure

Test Requirement: FCC Part 1.1307

Evaluation Method: FCC Part2.1093 & KDB 447498 D01 General RF Exposure Guidance v06

17.1 Requirements

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√ f(GHz)] ≤3.0 for 1-g SAR and ≤7.5 for 10-g extremity SAR where

1. f(GHz) is the RF channel transmit frequency in GHz
2. Power and distance are rounded to the nearest mW and mm before calculation
3. The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Test result

Conducted Peak power(dBm)	Conducted Peak power(mW)	Source-based time-averaged maximum conducted output power(mW)	Minimum test separation distance required for the exposure conditions (mm)	SAR Test Exclusion Thresholds Calculation Value	SAR Test Exclusion Thresholds Limit	Result
8.14	6.52	6.52	5	2.04	3.0	Compliance
Note: No SAR measurement is required.						

18 Photographs – Test Setup Photos

Note: Please refer to report: WTS18S04108768-2W.

19 Photographs - Constructional Details

19.1 External Photos

Note: Please refer to report: WTS18S04108768-2W.

19.2 Internal Photos

Note: Please refer to report: WTS18S04108768-2W.

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