TEST REPORT

Reference No......	:	WTD21D08081902W001
FCC ID.....	:	2AVRWSP-MB-03
Applicant	:	Shenzhen Smart Power Electronics Co., Ltd
Address	:	No.6 in Shantang Industrial Park, Paibang Village, Henggang, Longgang District, Shenhzen, China.
Manufacturer	:	Shenzhen Smart Power Electronics Co., Ltd
Address	:	No.6 in Shantang Industrial Park, Paibang Village, Henggang, Longgang District, Shenhzen, China.
Product	:	2 in 1 Bluetooth Receiver/ Transmitter
Model(s).	:	SP-MB-03, XBA9-1017-BLK
Standards	:	FCC CFR47 Part 15 Section 15.247
Date of Receipt sample	:	2021-08-11
Date of Test	:	2021-08-11 to 2021-08-19
Date of Issue	:	2021-08-19
Test Result	:	**Pass**

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

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3 Revision History

Test Report No.	Date of Receipt Sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTD21D08081902W001	2021-08-11	2021-08-11 to 2021-08-19	2021-08-19	Original	-	Valid

4 General Information

4.1 General Description of E.U.T

Product:	2 in 1 Bluetooth Receiver/ Transmitter
Model(s):	SP-MB-03, XBA9-1017-BLK
Additional model(s):	Only the model name are difference.
Operation Frequency:	2402-2480MHz, 79 Channels in total
Max. RF output power:	0.14dBm
Antenna installation:	PCB Printed Antenna
Antenna Gain:	0dBi
Type of Modulation:	GFSK, π/4DQPSK, 8DPSK

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

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

4.2 Details of E.U.T

Ratings: DC 3.7V lithium battery

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2402	2	2403	3	2404	4	2405
5	2406	6	2407	7	2408	8	2409
9	2410	10	2411	11	2412	12	2413
13	2414	14	2415	15	2416	16	2417
17	2418	18	2419	19	2420	20	2421
21	2422	22	2423	23	2424	24	2425
25	2426	26	2427	27	2428	28	2429
29	2430	30	2431	31	2432	32	2433
33	2434	34	2435	35	2436	36	2437
37	2438	38	2439	39	2440	40	2441
41	2442	42	2443	43	2444	44	2445
45	2446	46	2447	47	2448	48	2449
49	2450	50	2451	51	2452	52	2453
53	2454	54	2455	55	2456	56	2457
57	2458	58	2459	59	2460	60	2461
61	2462	62	2463	63	2464	64	2465
65	2466	66	2467	67	2468	68	2469
69	2470	70	2471	71	2472	72	2473
73	2474	74	2475	75	2476	76	2477
77	2478	78	2479	79	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

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

4.5 Test Facility

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.
ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

5 Equipment Used during Test

5.1 Equipments List

Conducted Emissions Test Site 1#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	R&S	ESCI	100947	2021-07-26	2022-07-25
2.	LISN	R&S	ENV216	100115	2021-07-26	2022-07-25
3.	Cable	Top	TYPE16(3.5M)	-	2021-07-26	2022-07-25
Conducted Emissions Test Site 2#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	R&S	ESCI	101155	2021-07-26	2022-07-25
2.	LISN	SCHWARZBECK	NSLK 8128	8128-259	2021-07-26	2022-07-25
3.	Limiter	CYBERTEK	EM5010	261115-001-0024	2021-07-26	2022-07-25
4.	Cable	**Laplace**	RF300	-	2021-07-26	2022-07-25
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	2021-07-26	2022-07-25
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2020-08-22	2021-08-21
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2021-04-26	2022-04-25
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2021-04-30	2022-04-29
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2021-07-30	2022-07-20
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	2021-10-30
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2021-04-29	2022-04-28
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

5.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 1 x 10^{-6}
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Radiated Spurious Emissions test	± 5.03 dB (30M~1000MHz)
	± 5.47 dB (1000M~25000MHz)
Conducted Emissions test	± 3.64 dB (AC mains 150KHz~30MHz)
Confidence interval：95%. Confidence factor: k=2	

5.3 Subcontracted

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

☐ Yes ☒ No

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

Test Lab: N/A

Lab address: N/A

Test items: N/A

6 Test Summary

Test Items	Test Requirement	Result
Conduct Emission	15.207	N/A
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	PASS
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	Pass
Band edge	15.247(d) 15.205(a)	Pass
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	Pass
RF Exposure	1.1307(b)(1)	Pass
Note: Pass=Compliance; NC=Not Compliance; NT=Not Tested; N/A=Not Applicable.		

7 Radiated 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(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	$20\log^{(500)}$

7.1 EUT Operation

Operating Environment:

Temperature: 23.5 °C

Humidity: 54.3 % RH

Atmospheric Pressure: 101.6kPa

Test Voltage: DC 3.7

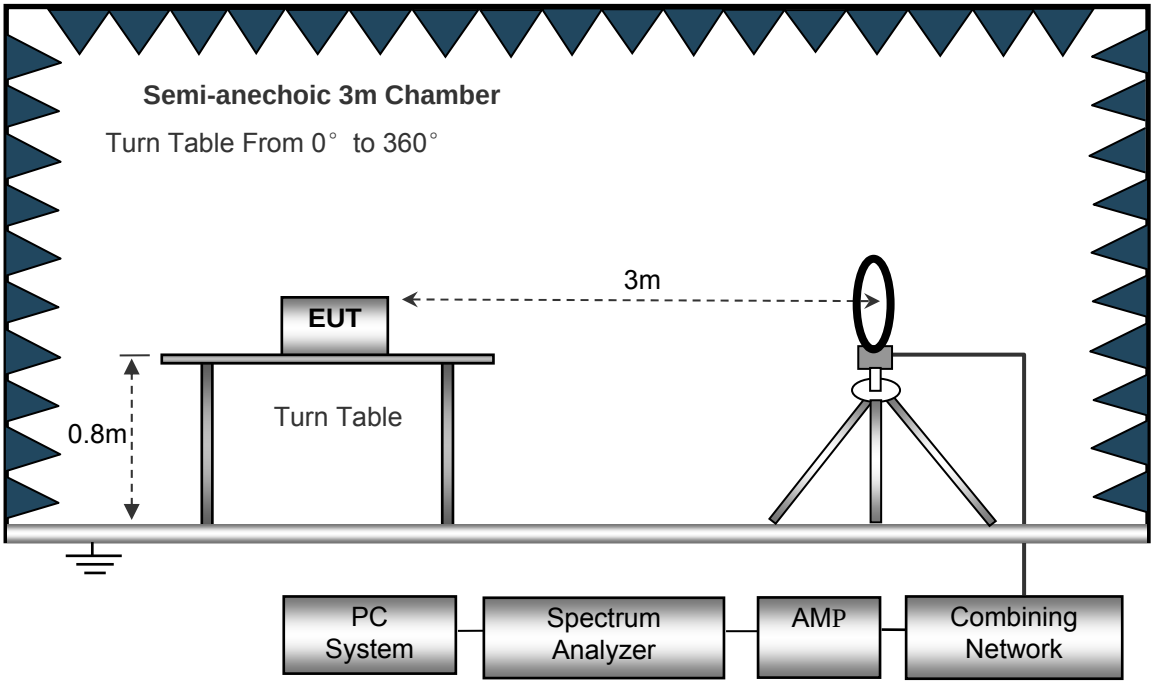
EUT Operation:

The test was performed in Transmitting mode, the worst test data (8DPSK modulation) were shown in the report.

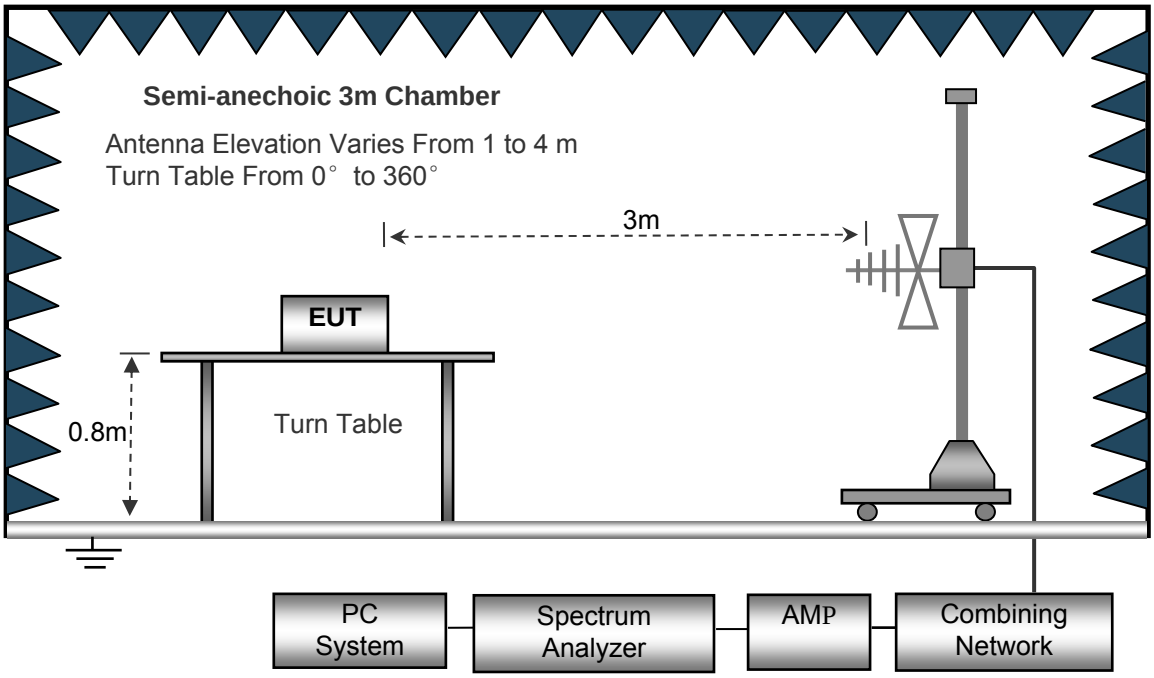
7.2 Test Setup

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

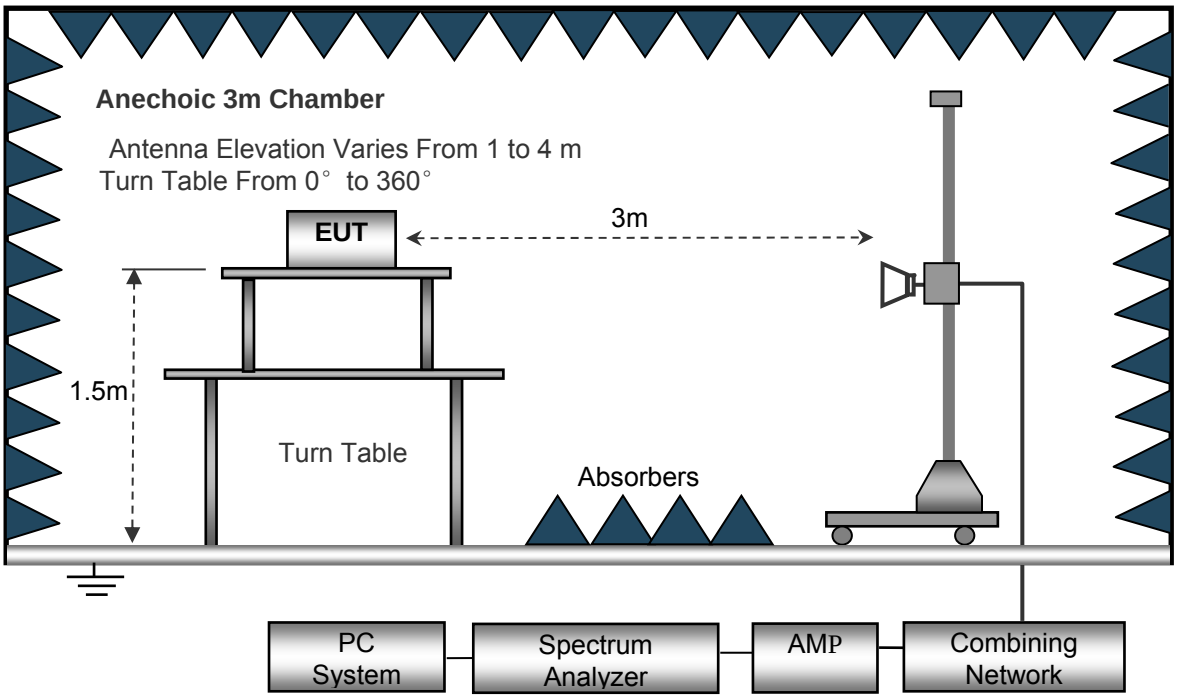
The test setup for emission measurement below 30MHz.



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..... 10 kHz
Video Bandwidth..... 10 kHz

Resolution Bandwidth ..... 10 kHz

30MHz ~ 1GHz

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

Above 1GHz

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

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 X position. So the data shown was the X position only.
8. For the radiated emission test above 1GHz:
   Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

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:

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

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 ~ 18GHz

Only the worst case 8DPSK mode were record in the report.

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
8DPSK Low Channel 2402MHz									
268.32	36.23	QP	166	1.8	H	-13.35	22.88	46.00	-23.12
268.32	41.25	QP	155	1.1	V	-13.35	27.90	46.00	-18.10
4804.00	46.61	PK	76	1.5	V	-1.06	45.55	74.00	-28.45
4804.00	44.22	Ave	76	1.5	V	-1.06	43.16	54.00	-10.84
7206.00	40.03	PK	310	1.8	H	1.33	41.36	74.00	-32.64
7206.00	36.51	Ave	310	1.8	H	1.33	37.84	54.00	-16.16
2340.60	46.75	PK	161	1.7	V	-13.19	33.56	74.00	-40.44
2340.60	39.92	Ave	161	1.7	V	-13.19	26.73	54.00	-27.27
2389.28	42.83	PK	314	1.1	H	-13.14	29.69	74.00	-44.31
2389.28	37.06	Ave	314	1.1	H	-13.14	23.92	54.00	-30.08
2497.05	44.90	PK	31	1.6	V	-13.08	31.82	74.00	-42.18
2497.05	37.75	Ave	31	1.6	V	-13.08	24.67	54.00	-29.33

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
8DPSK Middle Channel 2441MHz									
268.32	36.38	QP	70	1.6	H	-13.35	23.03	46.00	-22.97
268.32	40.62	QP	208	1.7	V	-13.35	27.27	46.00	-18.73
4882.00	45.25	PK	13	1.6	V	-0.62	44.63	74.00	-29.37
4882.00	42.93	Ave	13	1.6	V	-0.62	42.31	54.00	-11.69
7323.00	40.34	PK	337	1.3	H	2.21	42.55	74.00	-31.45
7323.00	36.72	Ave	337	1.3	H	2.21	38.93	54.00	-15.07
2313.02	46.46	PK	120	1.3	V	-13.19	33.27	74.00	-40.73
2313.02	37.09	Ave	120	1.3	V	-13.19	23.90	54.00	-30.10
2381.13	43.43	PK	239	1.8	H	-13.14	30.29	74.00	-43.71
2381.13	36.78	Ave	239	1.8	H	-13.14	23.64	54.00	-30.36
2491.90	44.74	PK	110	1.8	V	-13.08	31.66	74.00	-42.34
2491.90	37.31	Ave	110	1.8	V	-13.08	24.23	54.00	-29.77

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
8DPSK High Channel 2480MHz									
268.32	36.30	QP	107	1.6	H	-13.35	22.95	46.00	-23.05
268.32	40.87	QP	195	1.5	V	-13.35	27.52	46.00	-18.48
4960.00	44.55	PK	151	1.5	V	-0.24	44.31	74.00	-29.69
4960.00	42.79	Ave	151	1.5	V	-0.24	42.55	54.00	-11.45
7440.00	39.49	PK	15	1.4	H	2.84	42.33	74.00	-31.67
7440.00	36.86	Ave	15	1.4	H	2.84	39.70	54.00	-14.30
2347.90	45.52	PK	156	1.6	V	-13.19	32.33	74.00	-41.67
2347.90	39.15	Ave	156	1.6	V	-13.19	25.96	54.00	-28.04
2365.65	44.62	PK	114	1.6	H	-13.14	31.48	74.00	-42.52
2365.65	37.19	Ave	114	1.6	H	-13.14	24.05	54.00	-29.95
2499.25	43.94	PK	19	1.9	V	-13.08	30.86	74.00	-43.14
2499.25	38.13	Ave	19	1.9	V	-13.08	25.05	54.00	-28.95

Test Frequency: 18GHz~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:

Blow 1GHz:

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

Detector function = peak, Trace = max hold

Above 1GHz:

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

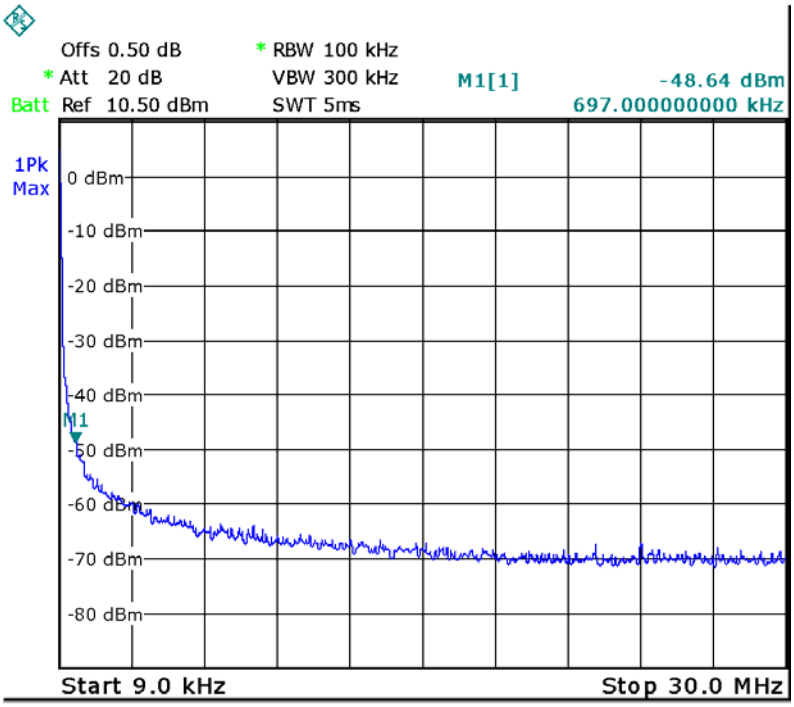
Detector function = peak, Trace = max hold

8.2 Test Result

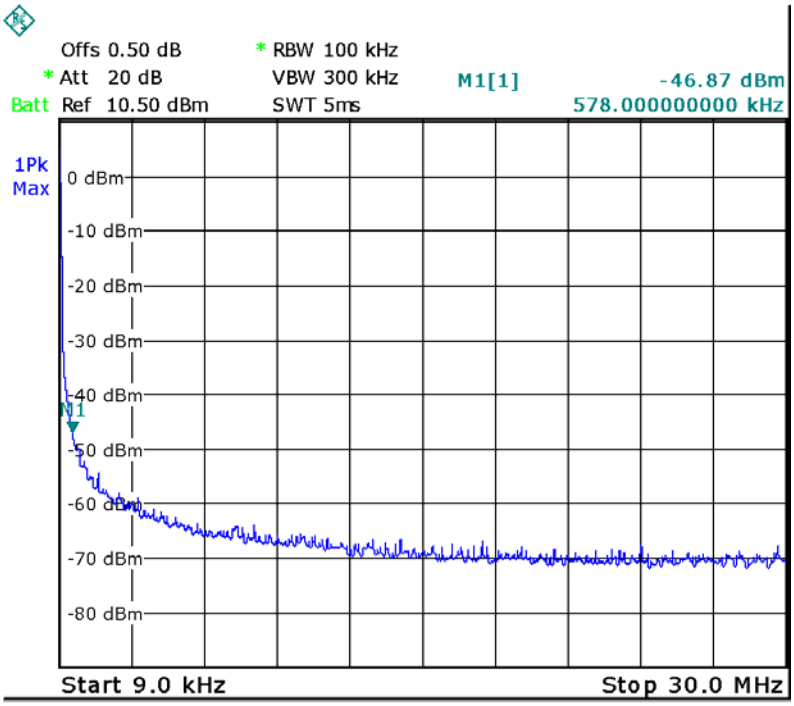
9KHz - 30MHz

GFSK

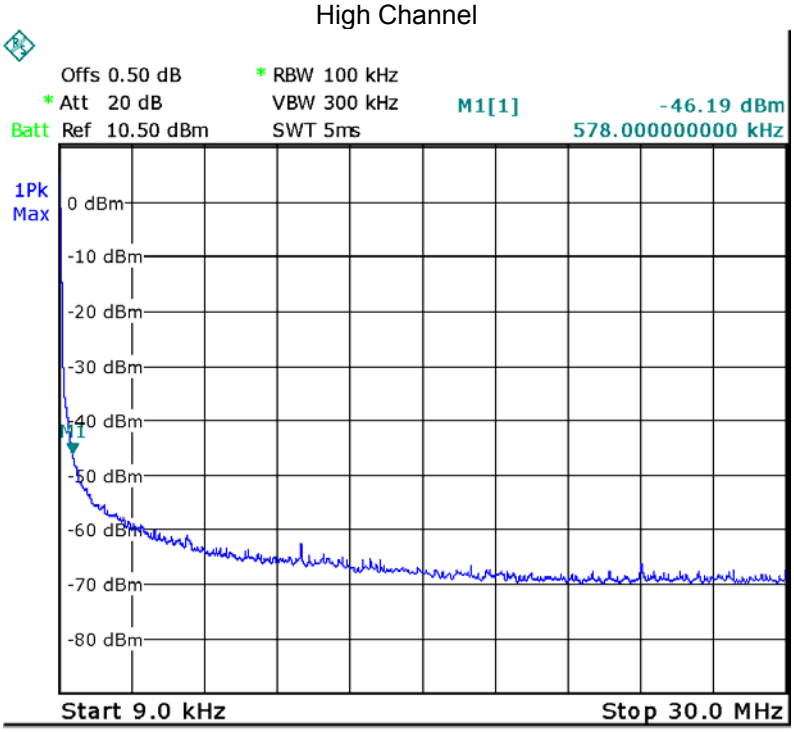
Low Channel



Middle Channel

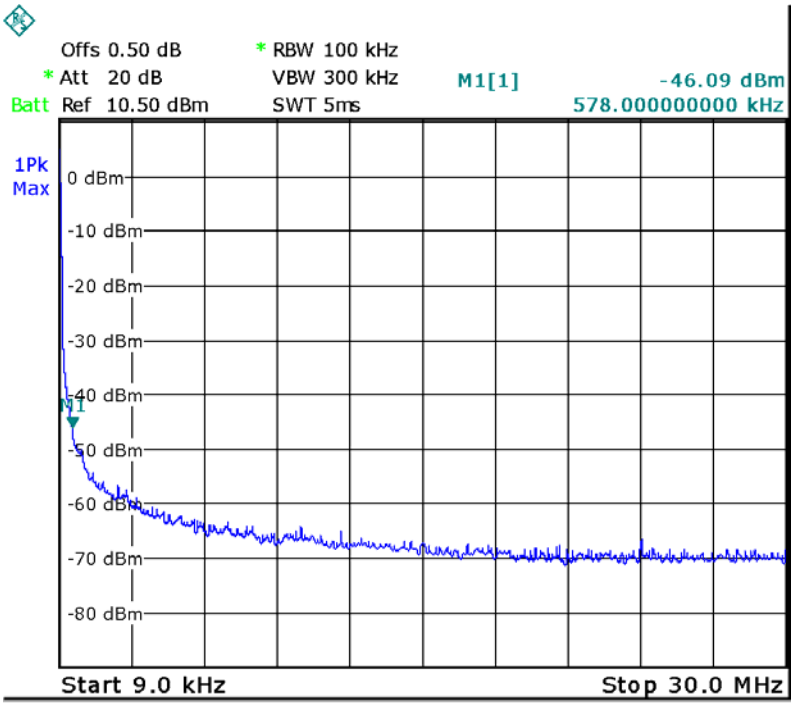


High Channel

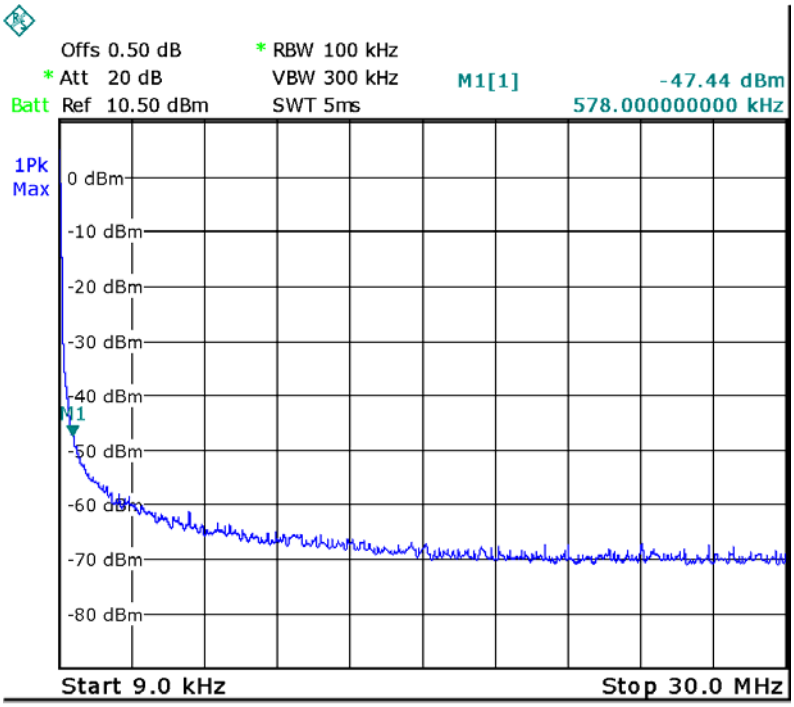


Pi/4DQPSK

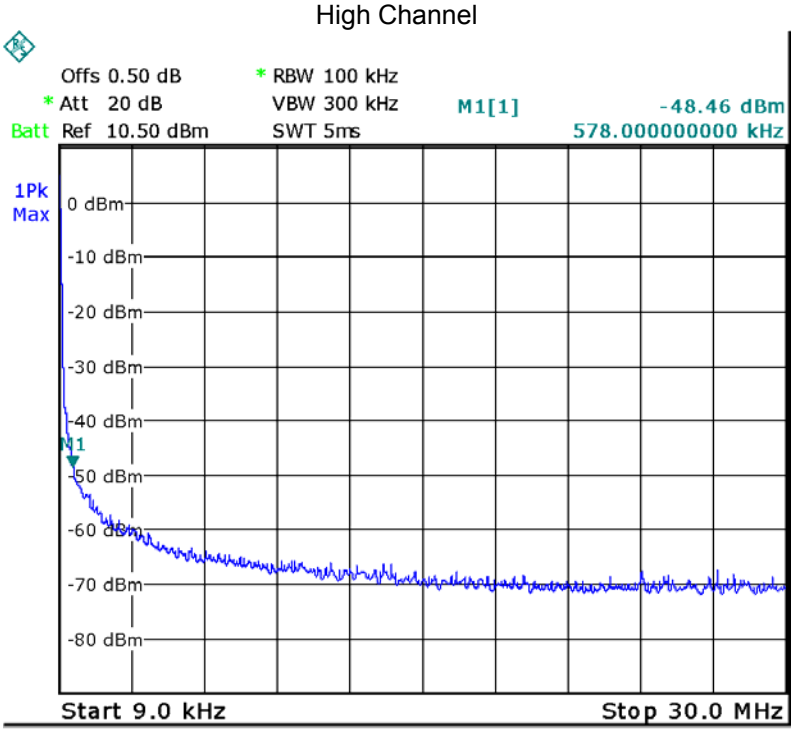
Low Channel



Middle Channel

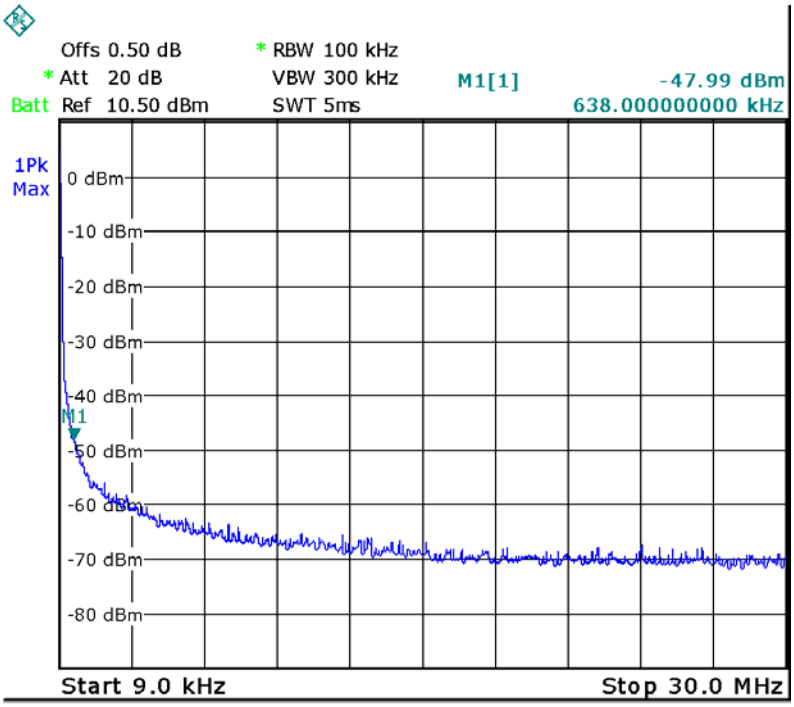


High Channel

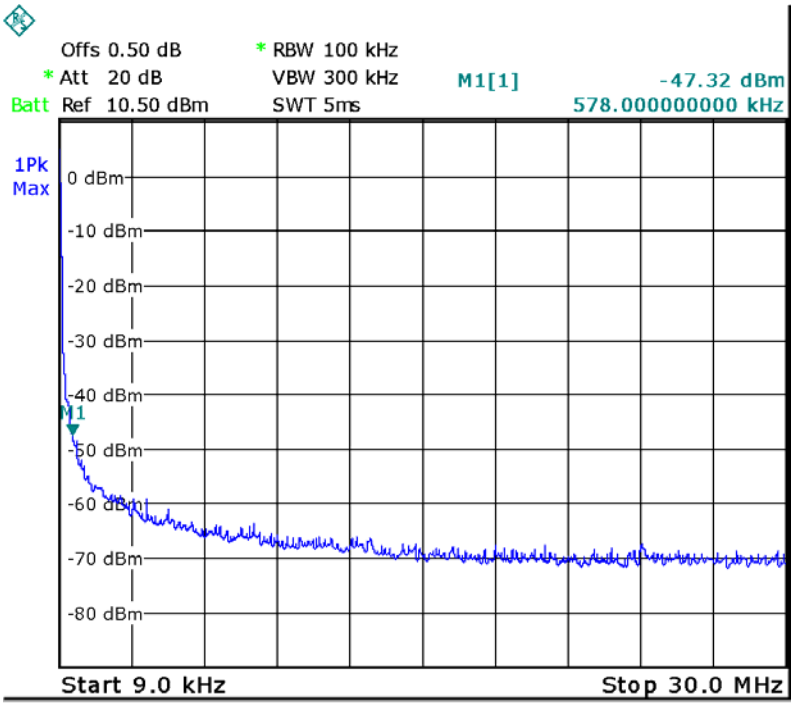


8DPSK

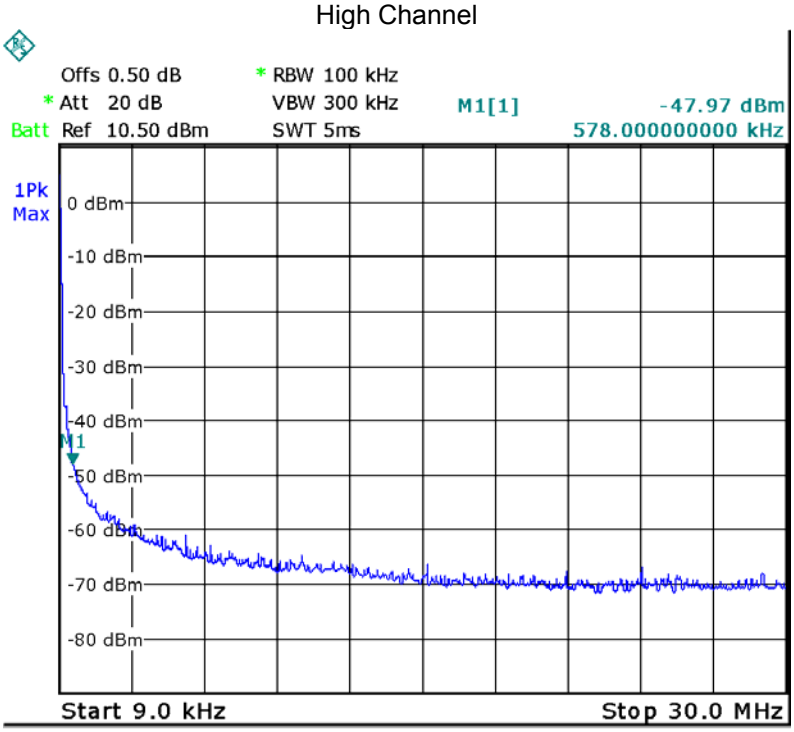
Low Channel



Middle Channel

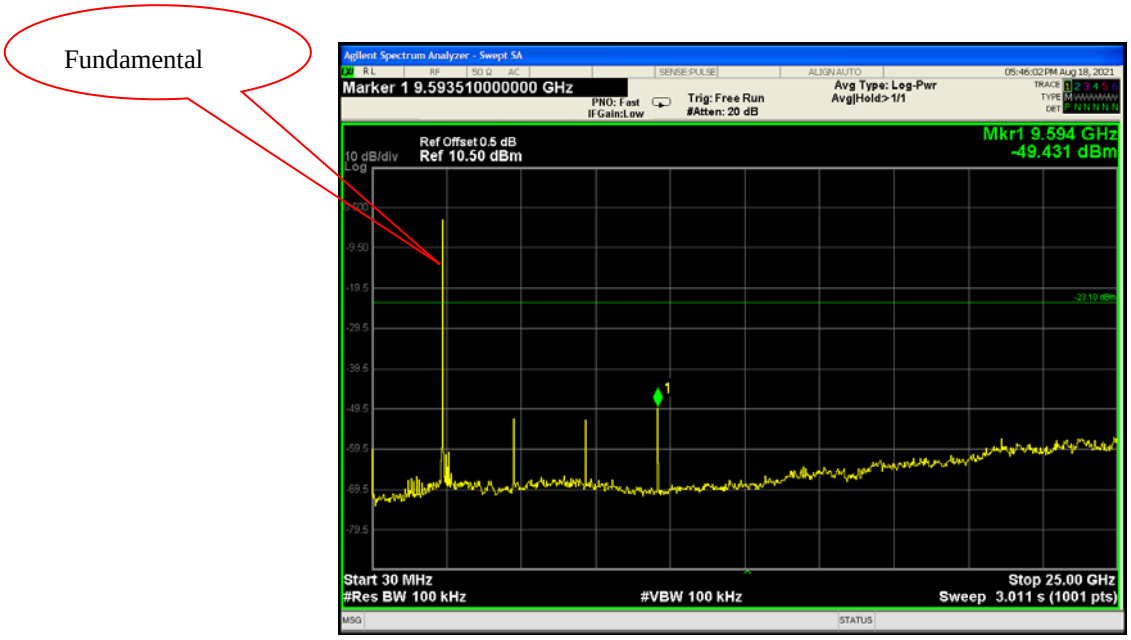


High Channel

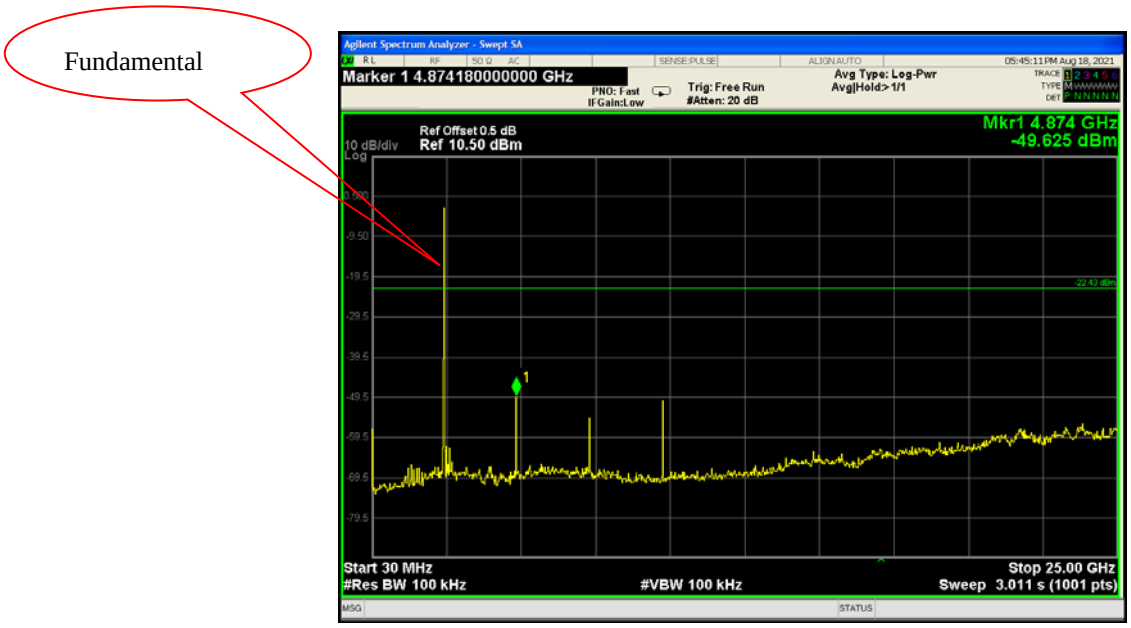


30MHz – 25GHz

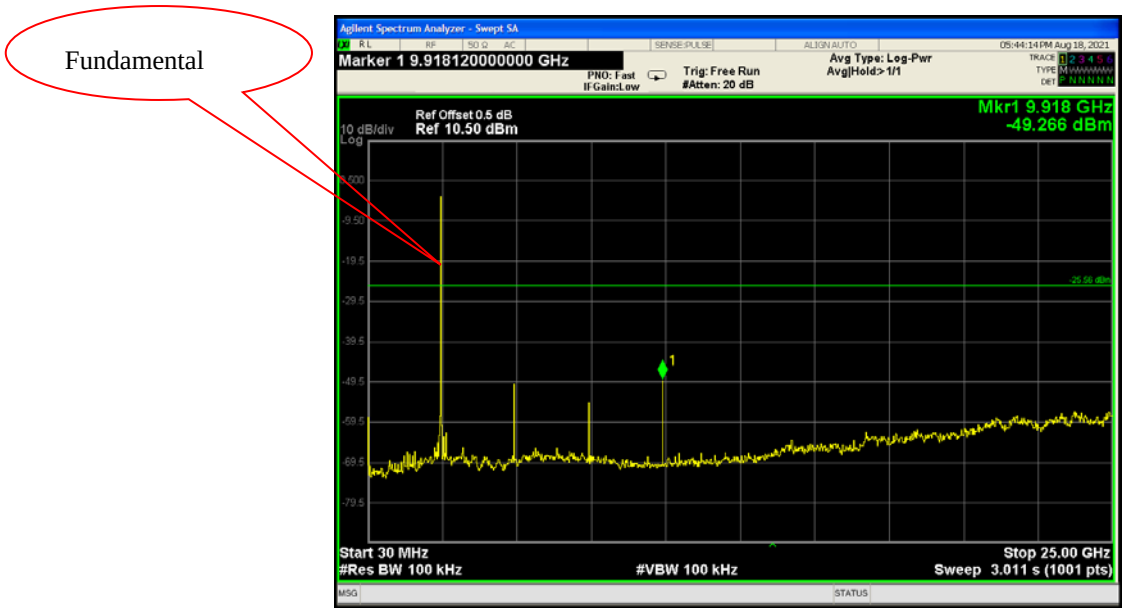
GFSK Low Channel



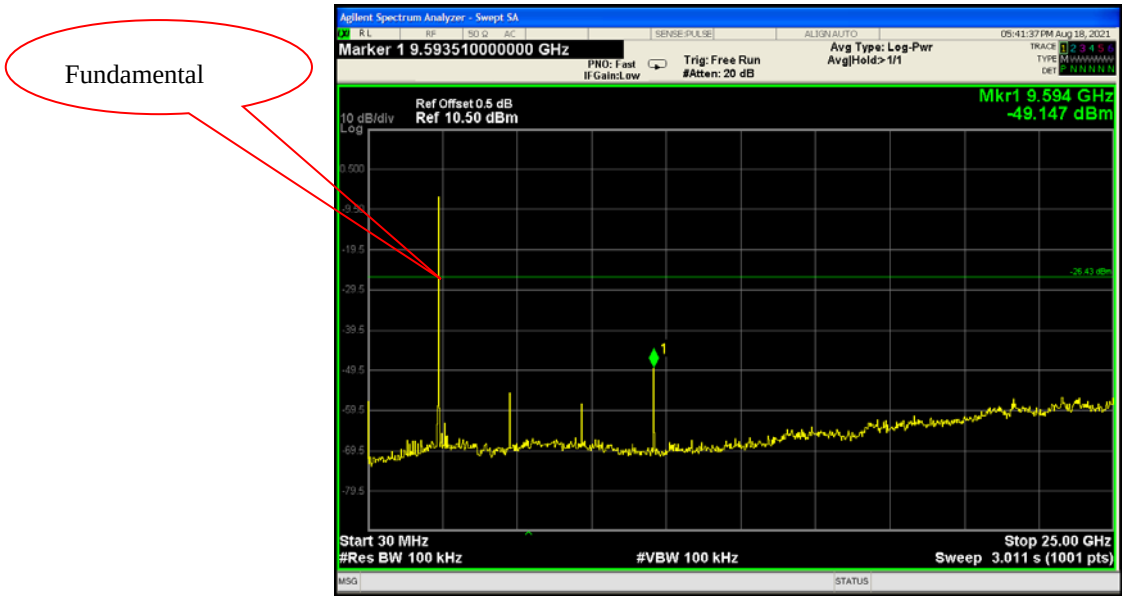
GFSK Middle Channel



GFSK High Channel

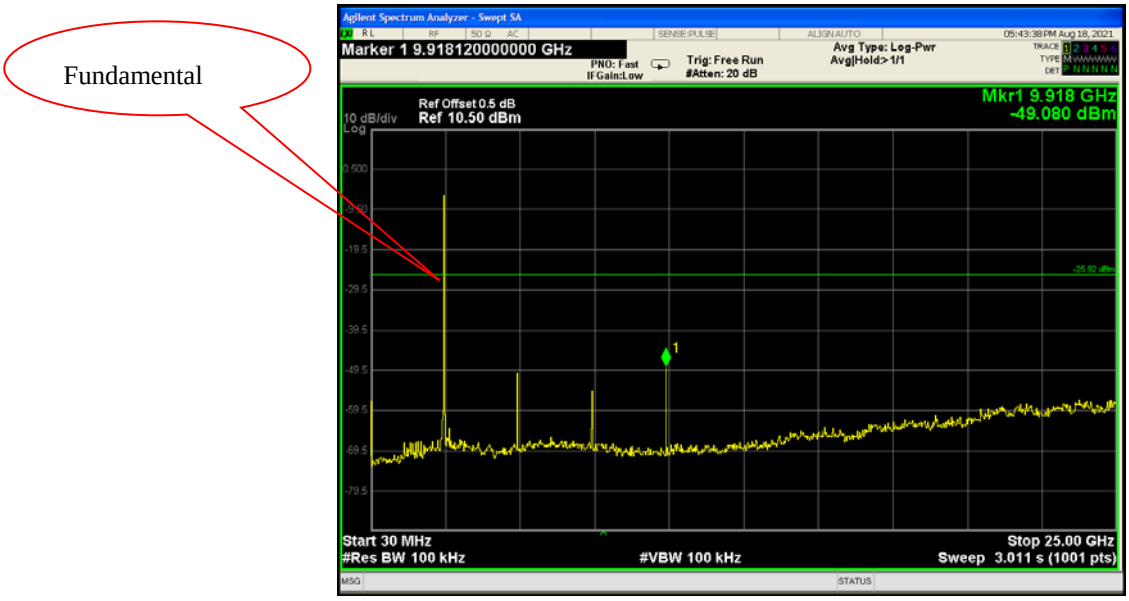


Pi/4 DQPSK Low Channel

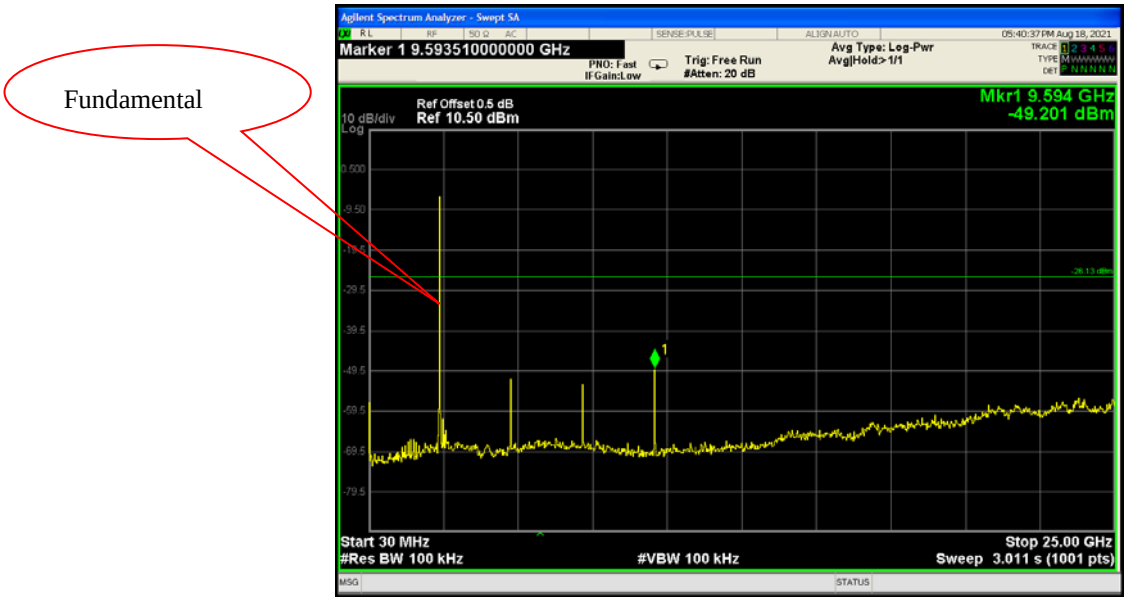


Pi/4 DQPSK Middle Channel

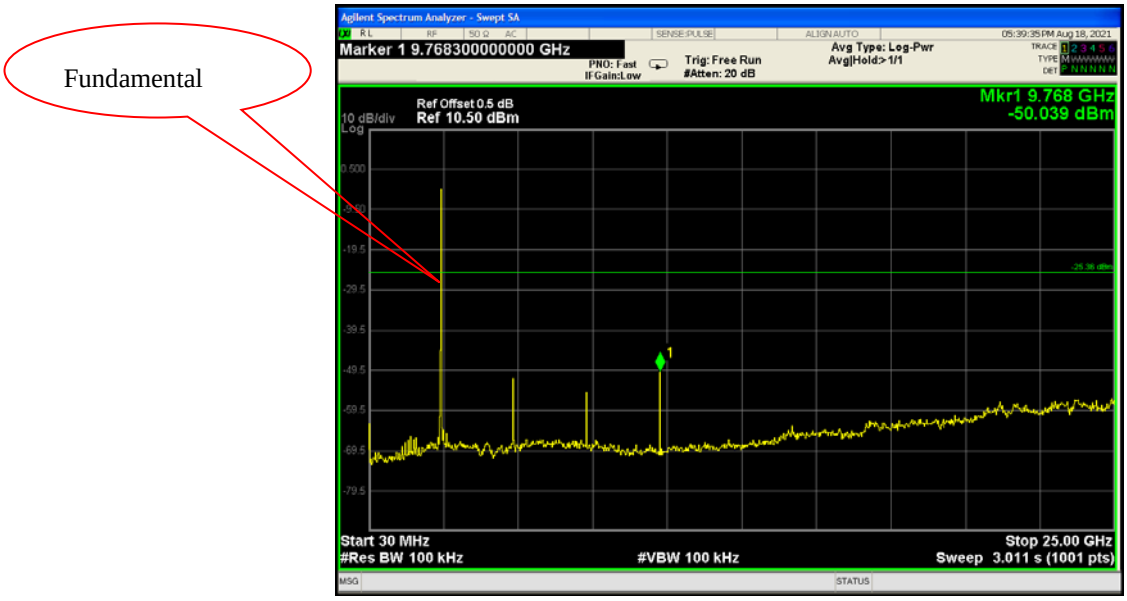
Pi/4 DQPSK High Channel



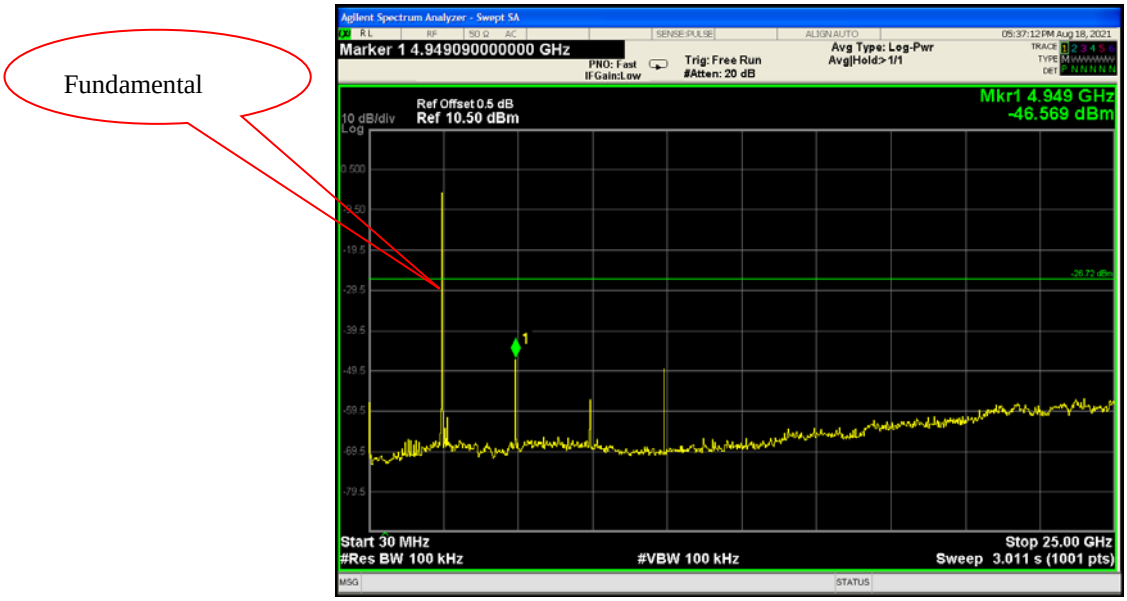
8DPSK Low Channel



8DPSK Middle Channel



8DPSK High Channel



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

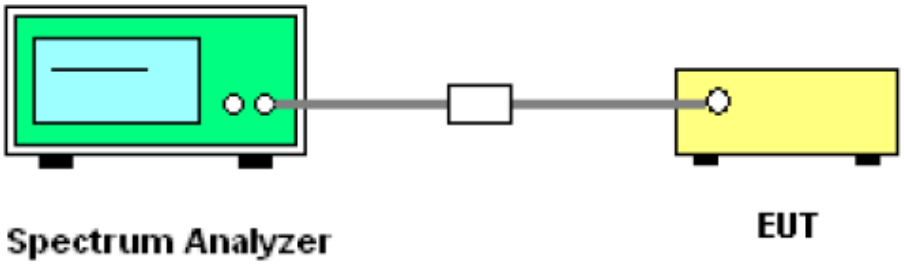
Test Limit: Regulation 15.247 (d),In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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 = 100 kHz, VBW = 300 kHz, Sweep = auto
   Detector function = peak, Trace = max hold

9.2 Test Setup

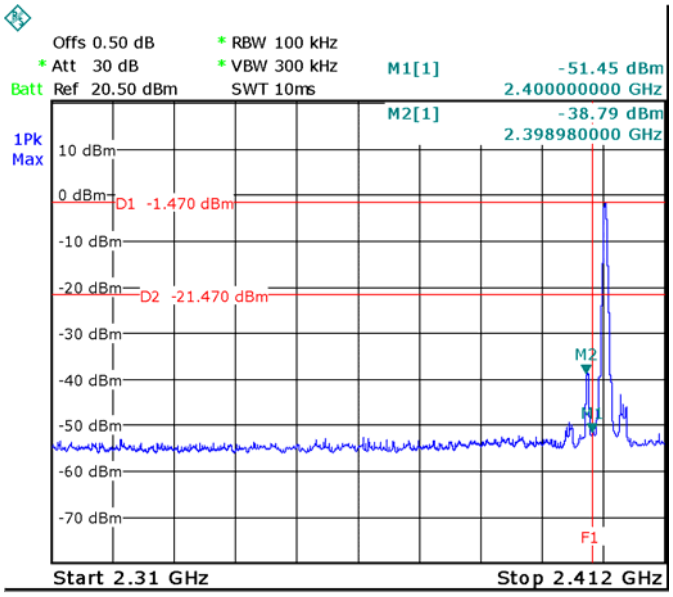


9.3 Test Result

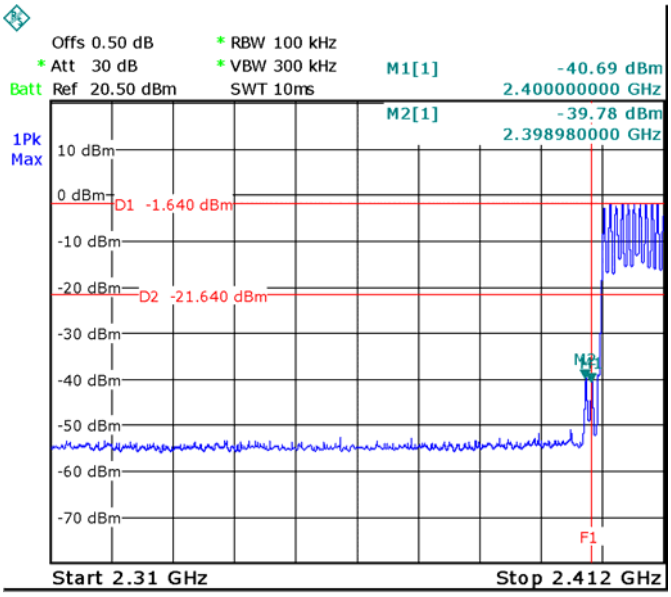
Test plots

Modulation: GFSK

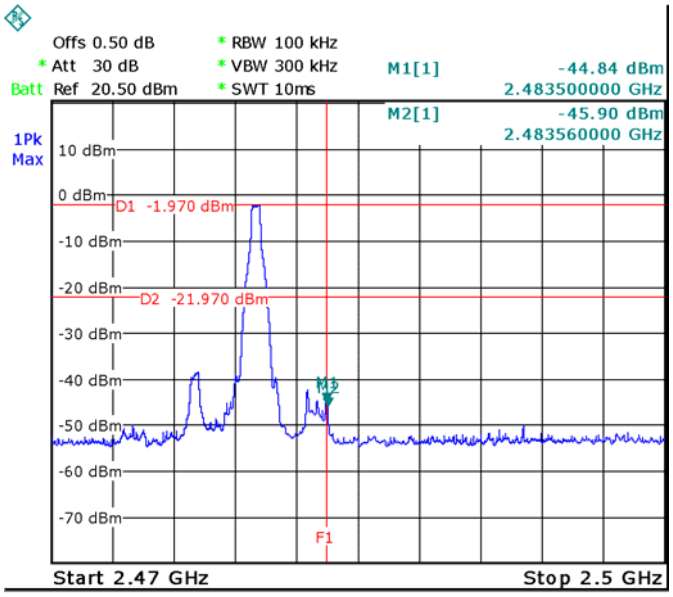
Transmitting Band edge-left side



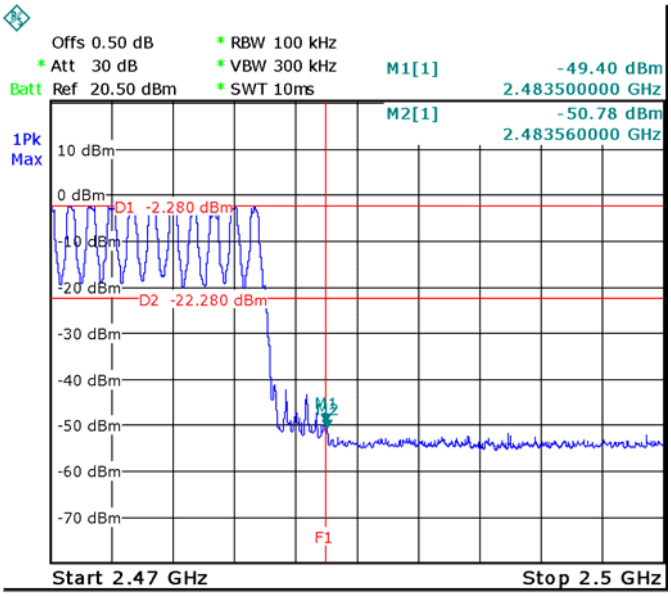
Hopping Band edge-left side



Transmitting Band edge-right side

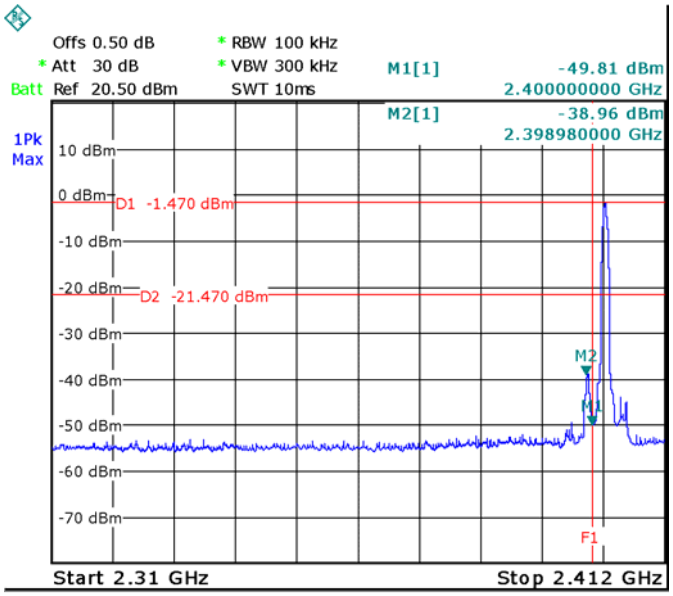


Hopping Band edge-right side

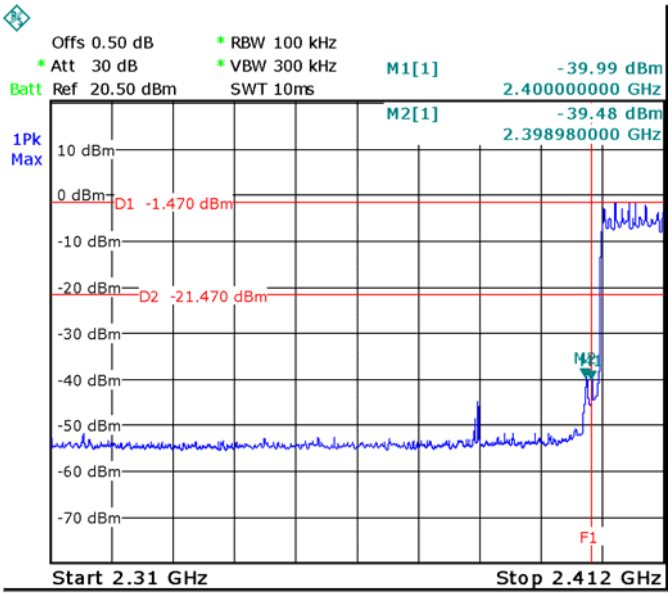


Modulation: π /4 DQPSK

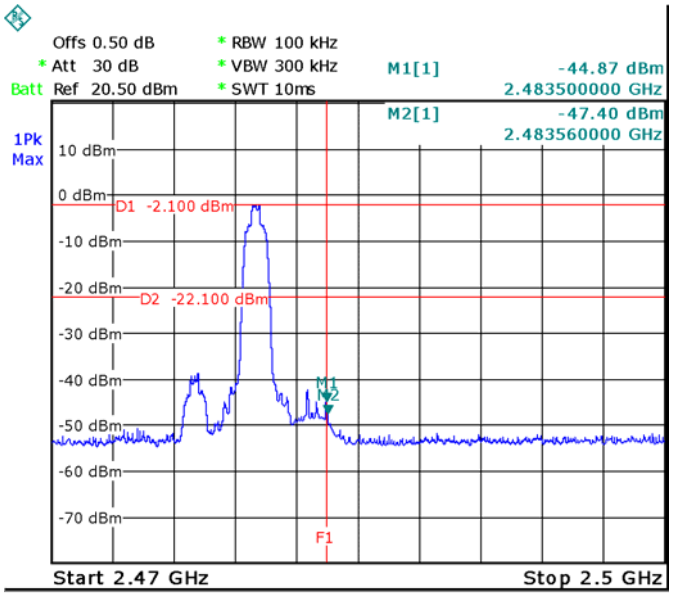
Transmitting Band edge-left side



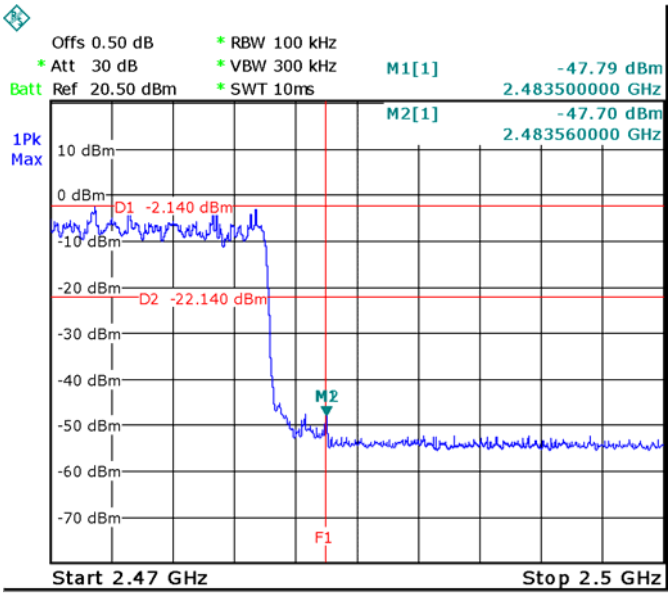
Hopping Band edge-left side



Transmitting Band edge-right side

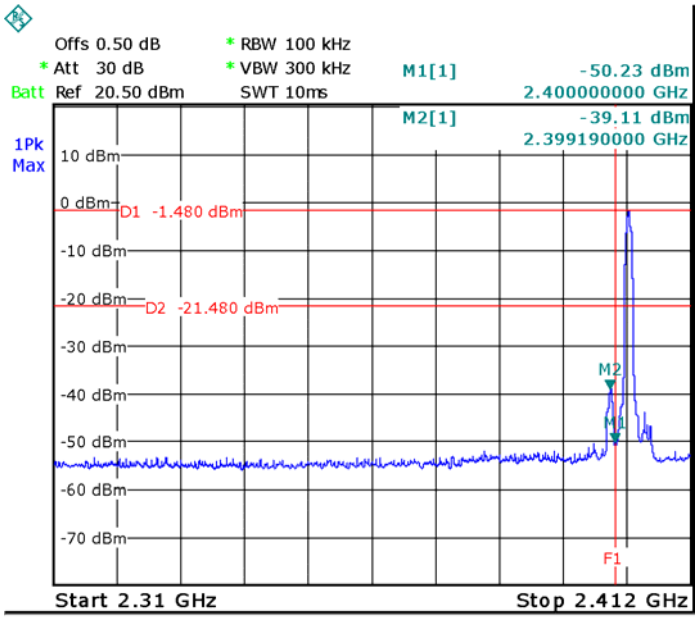


Hopping Band edge-right side

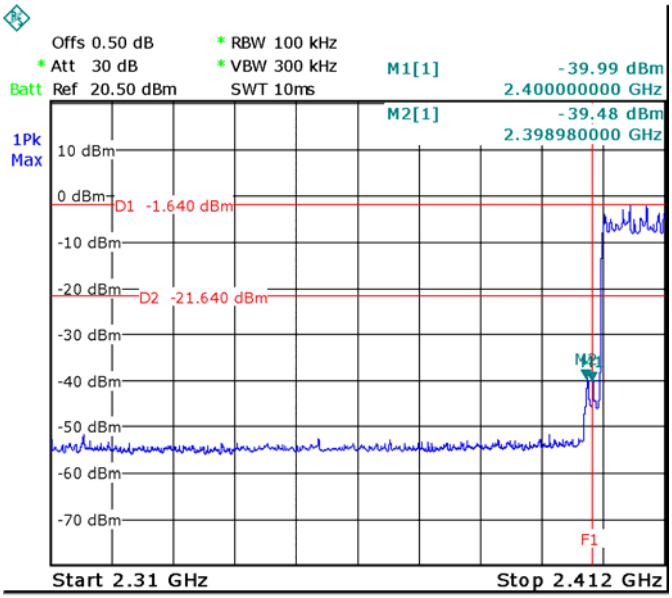


Modulation: 8DPSK

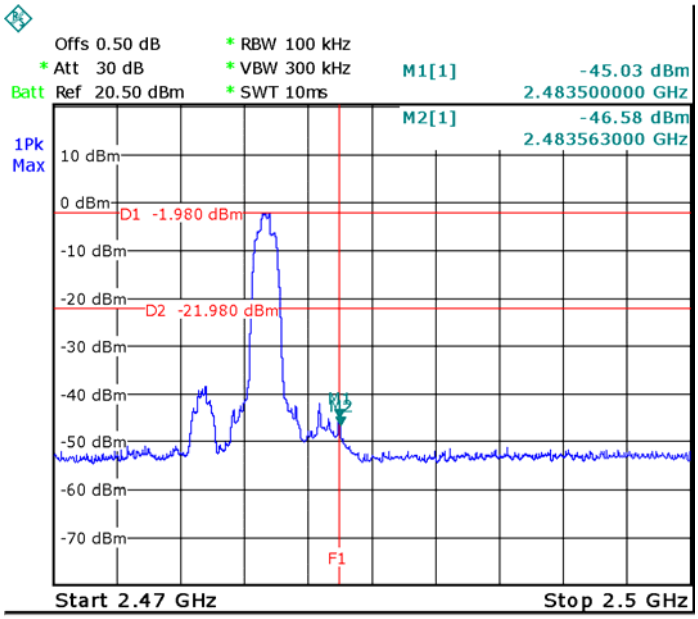
Transmitting Band edge-left side



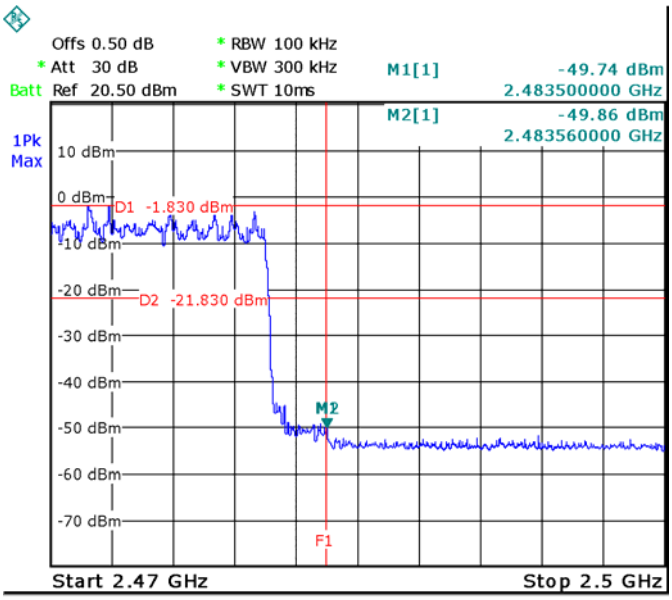
Hopping Band edge-left side



Transmitting Band edge-right side



Hopping Band edge-right side



10 Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

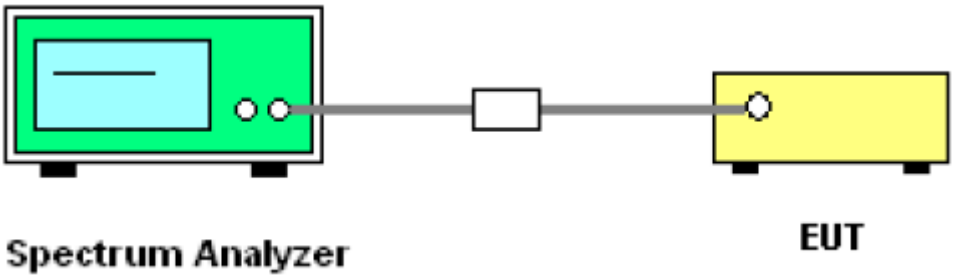
Test Mode: Test in fixing operating frequency at low, Middle, high channel.

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 Setup



10.3 Test Result

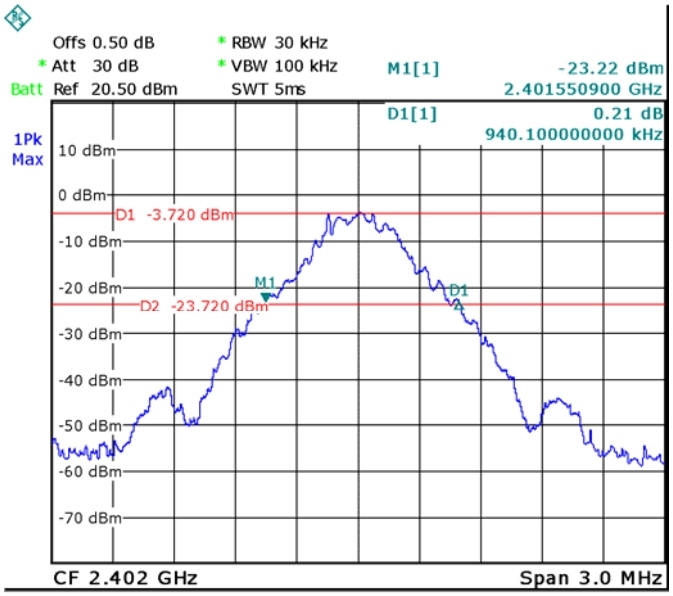
Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
GFSK	Low	0.940	0.850
GFSK	Middle	0.946	0.856
GFSK	High	0.958	0.856
π /4 DQPSK	Low	1.305	1.168
π 4 DQPSK	Middle	1.305	1.168
π /4 DQPSK	High	1.305	1.168
8DPSK	Low	1.264	1.180
8DPSK	Middle	1.293	1.186
8DPSK	High	1.287	1.180

Test plots

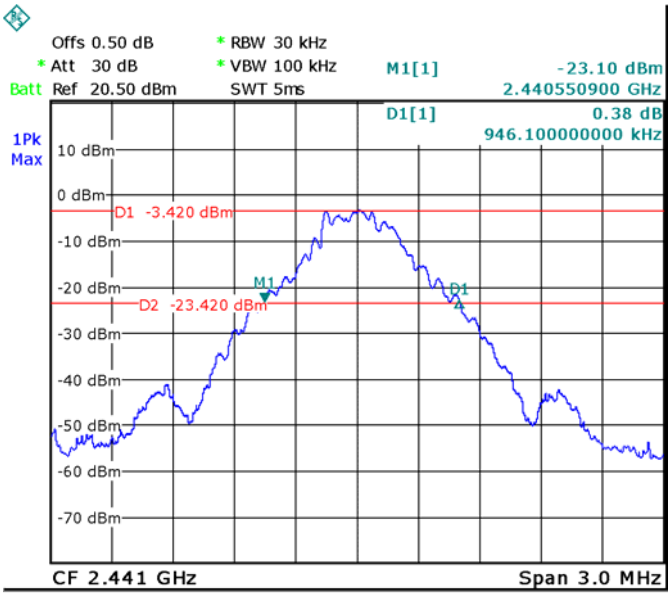
20 dB Bandwidth

Modulation: GFSK

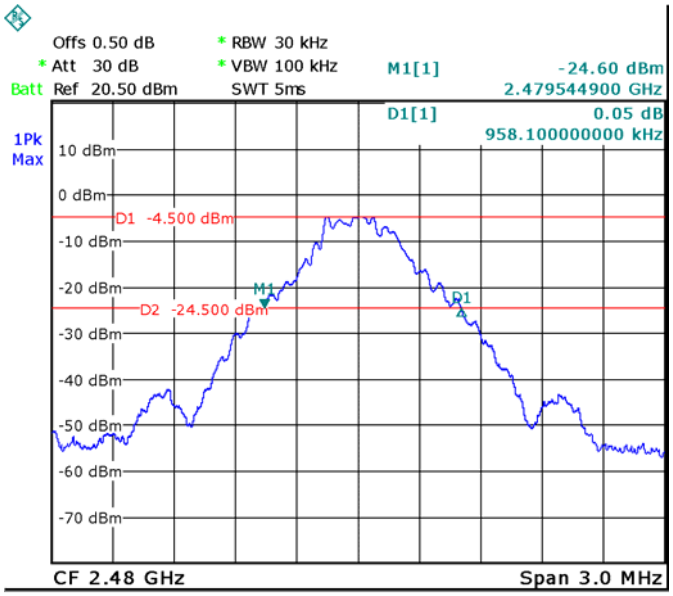
Low Channel



Middle Channel

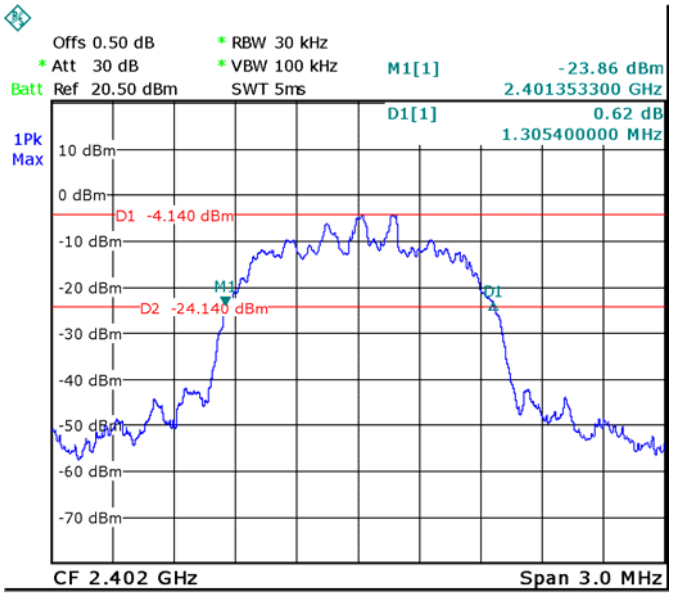


High Channel

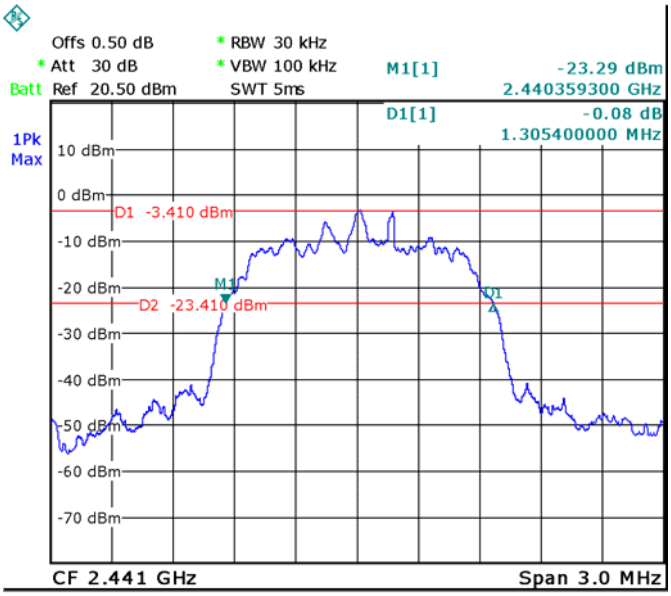


Modulation: π /4 DQPSK

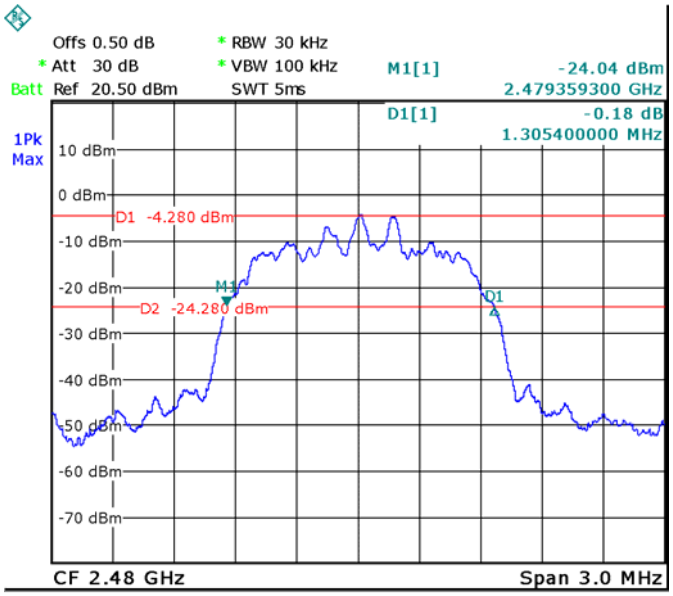
Low Channel



Middle Channel

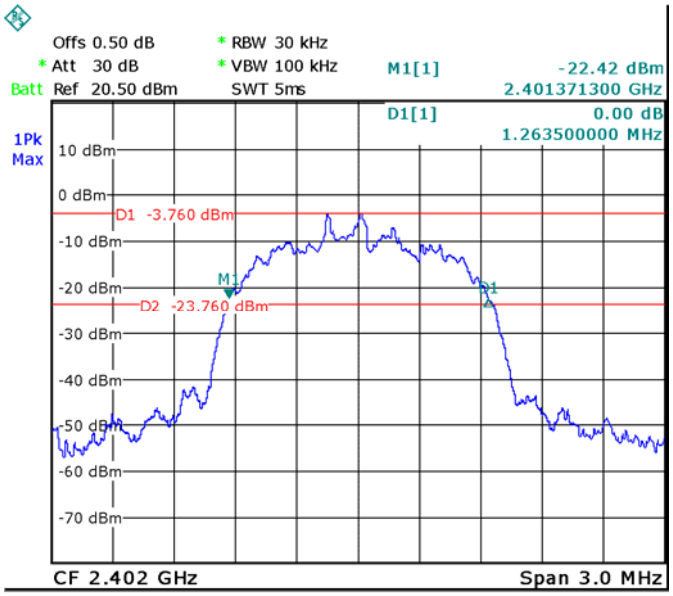


High Channel

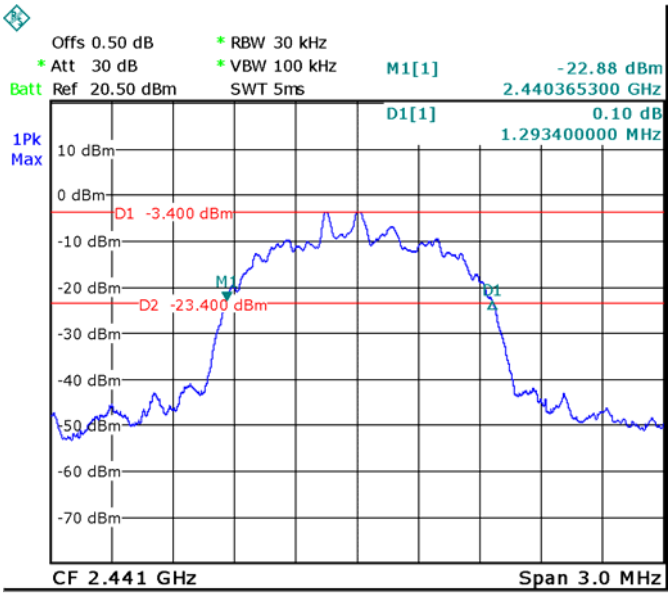


Modulation: 8DPSK

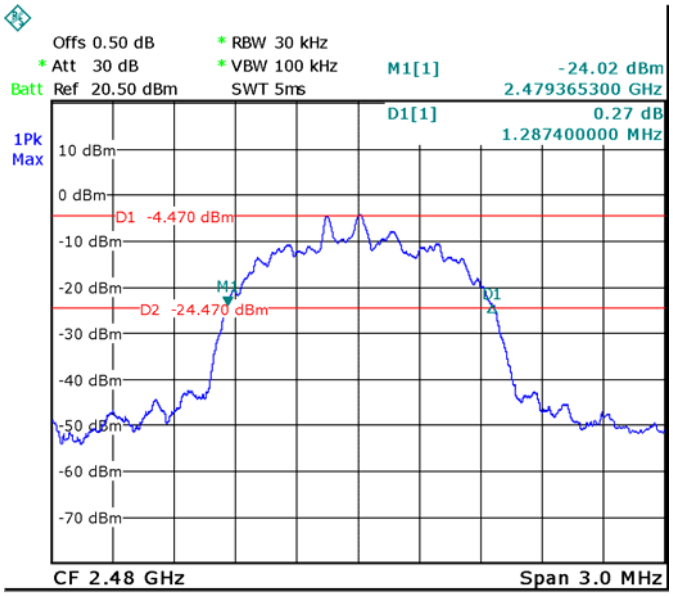
Low Channel



Middle Channel



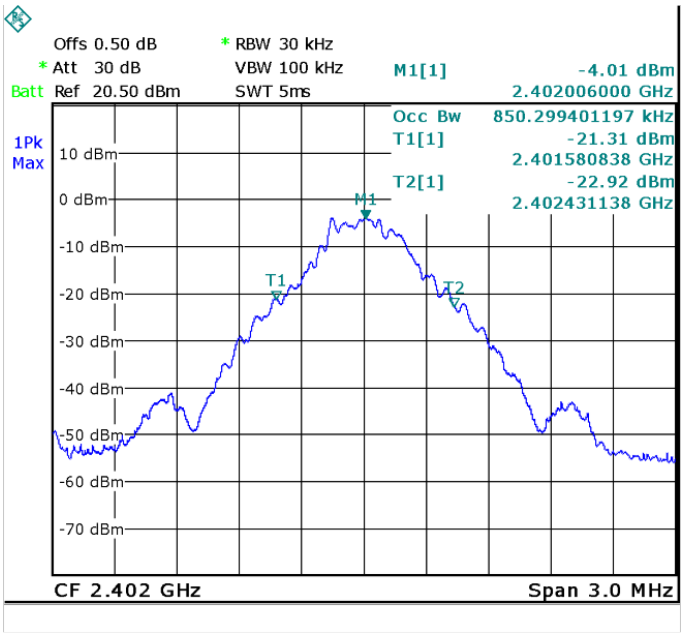
High Channel



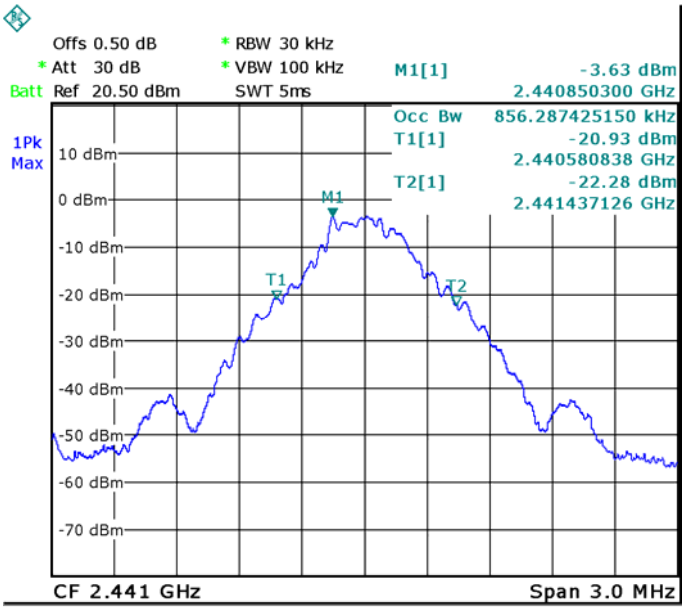
99% Bandwidth

Modulation: GFSK

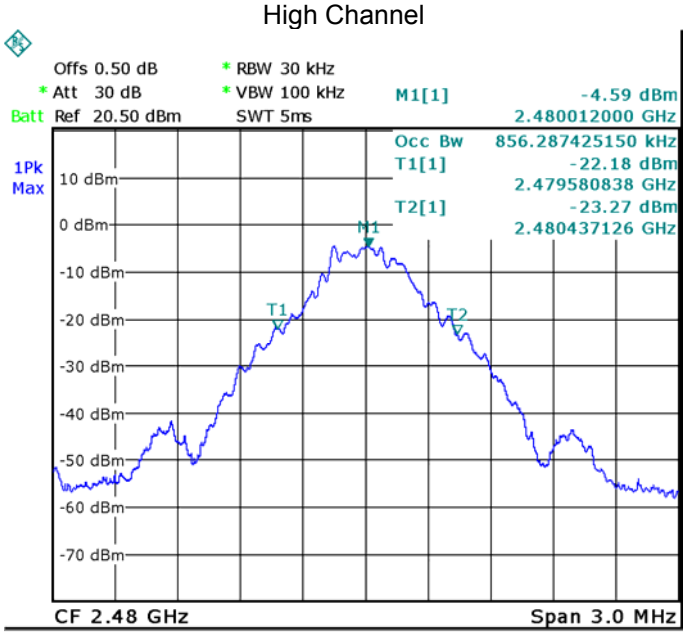
Low Channel



Middle Channel

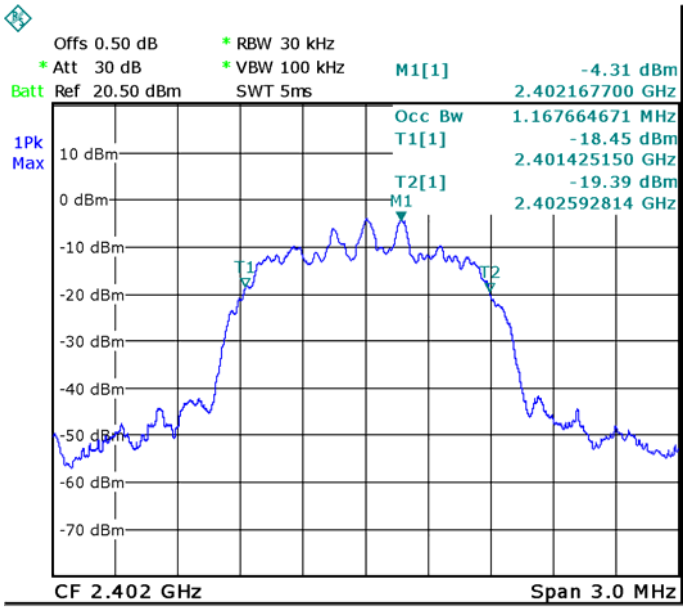


High Channel

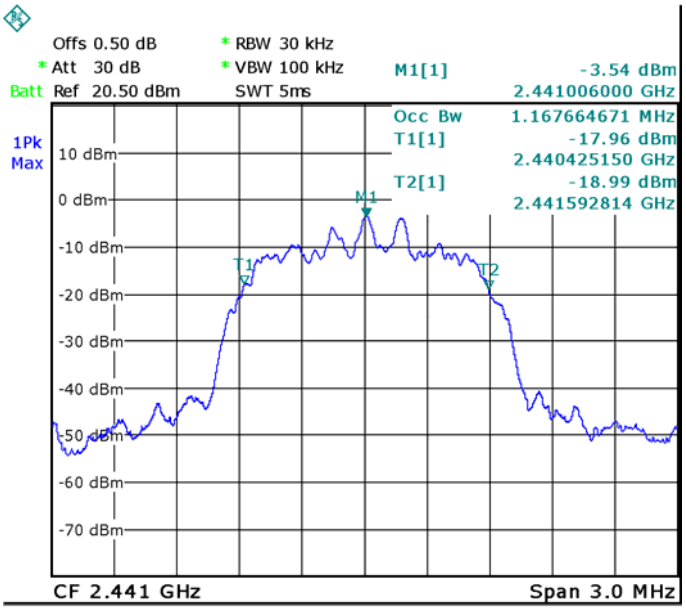


Modulation: π /4 DQPSK

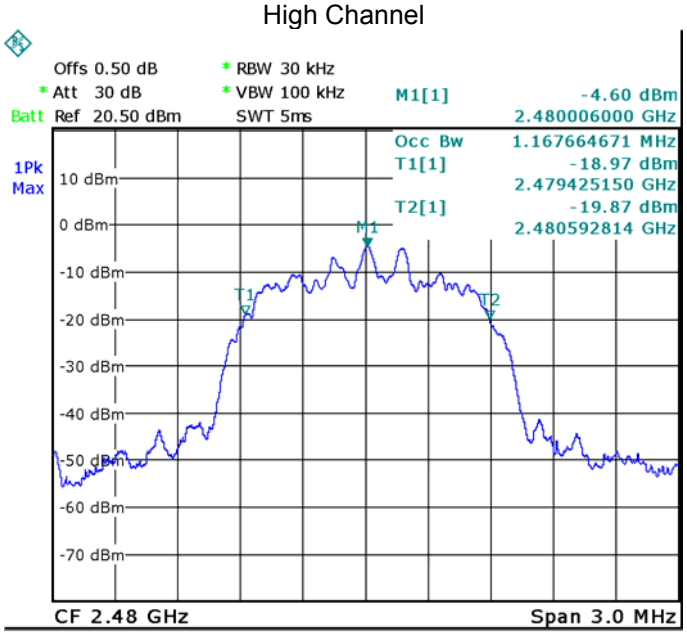
Low Channel



Middle Channel

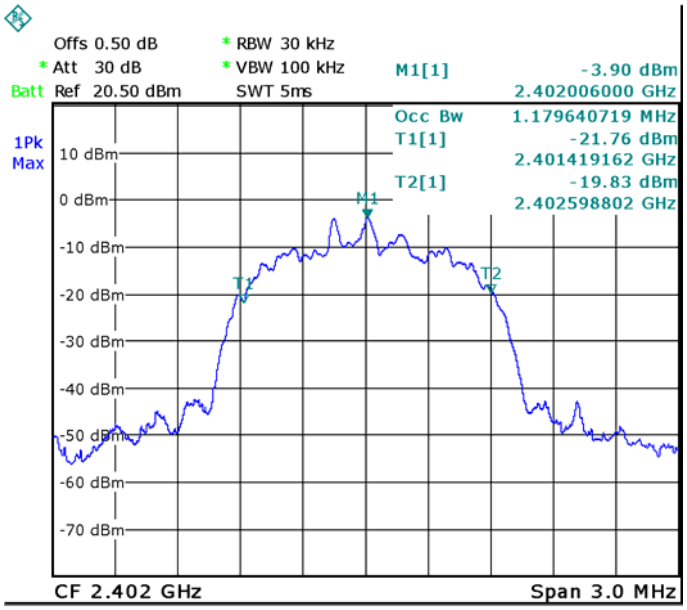


High Channel

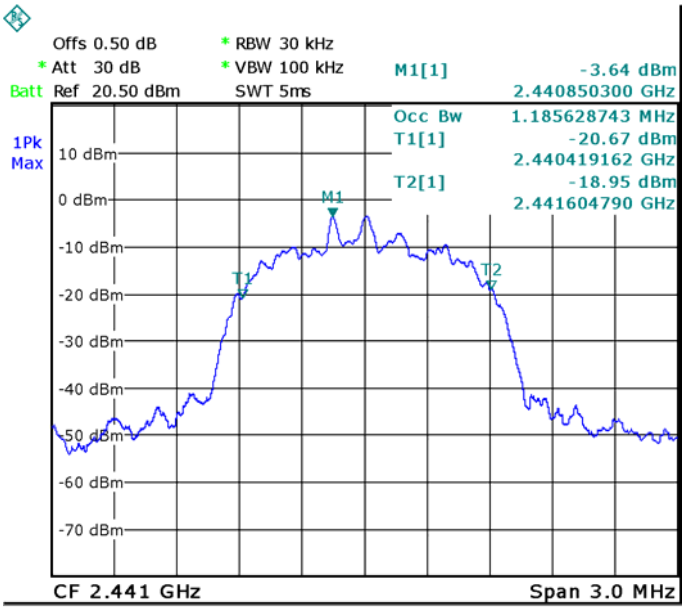


Modulation: 8DPSK

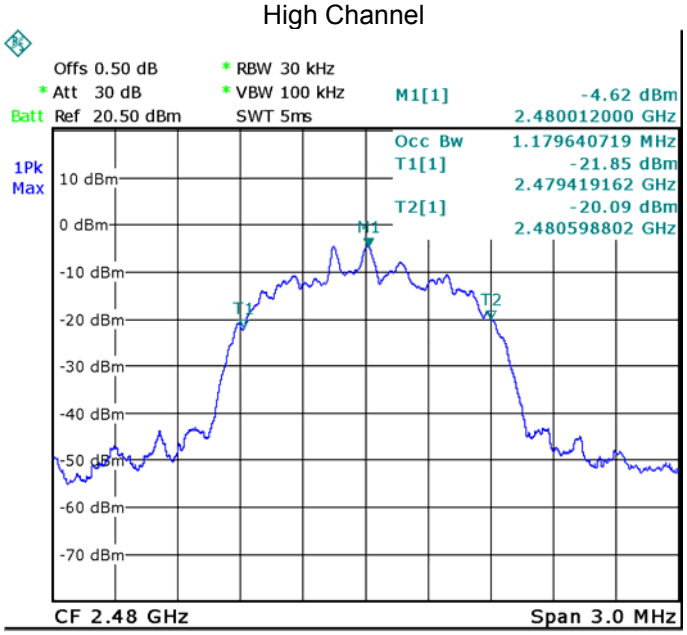
Low Channel



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.

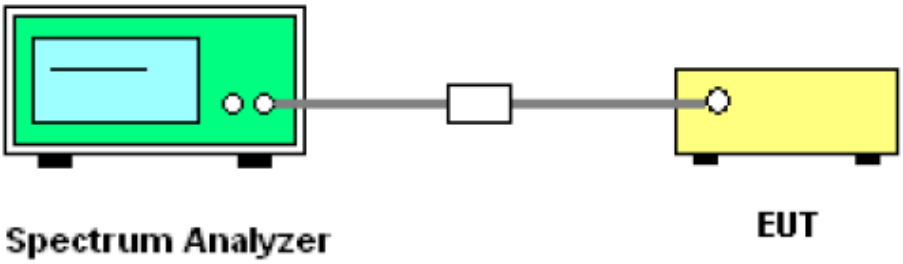
Refer to the result "Number of Hopping Frequency" of this document. The 1watts (30 dBm) limit applies.

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 = 3 MHz. VBW =3 MHz. 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 Setup



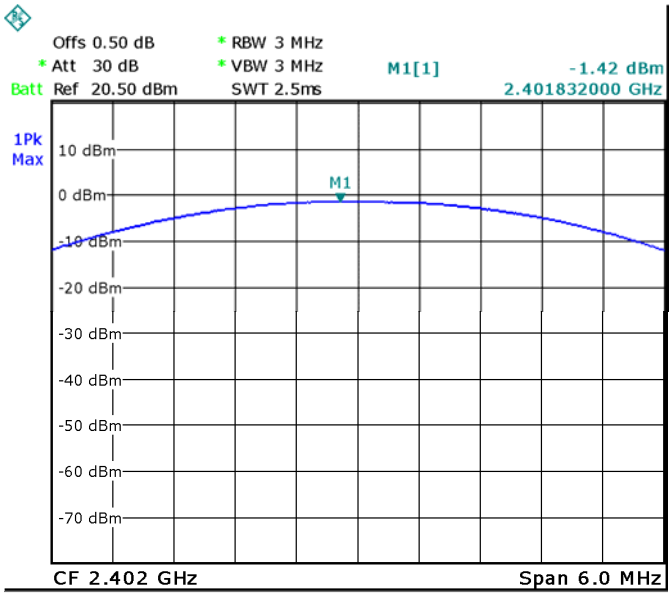
11.3 Test Result

Test Mode	Data Rate	Peak Power(dBm)			Limit (dBm)
		Low Channel	Middle Channel	High Channel	
GFSK	1Mbps	-1.42	**0.14**	-2.02	30
π /4 DQPSK	2Mbps	-0.68	0.14	-1.25	30
8DPSK	3Mbps	-0.32	0.06	-0.84	30

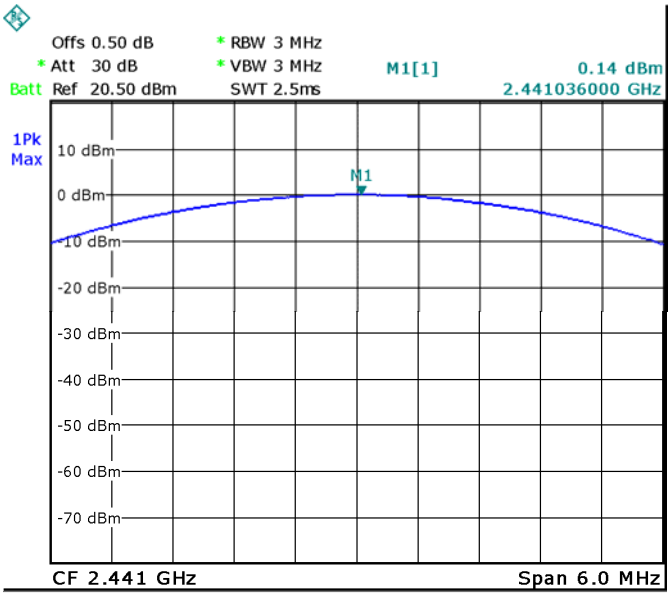
Test plots

Modulation: GFSK

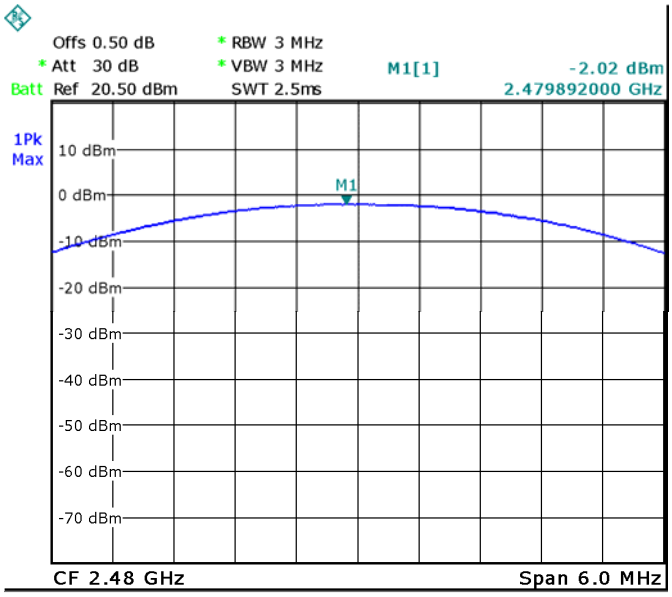
Low Channel



Middle Channel

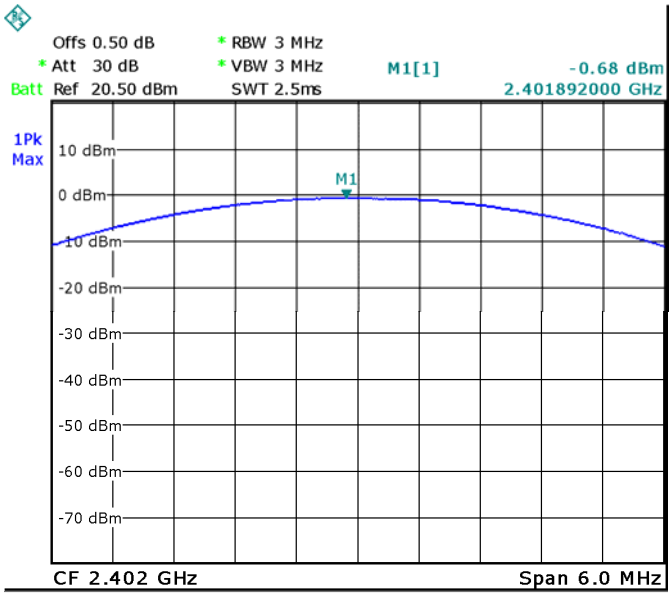


High Channel

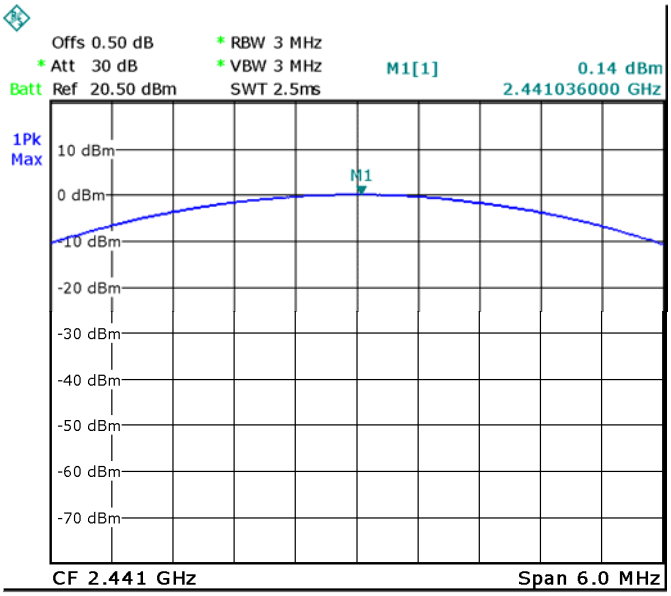


Modulation: π /4 DQPSK

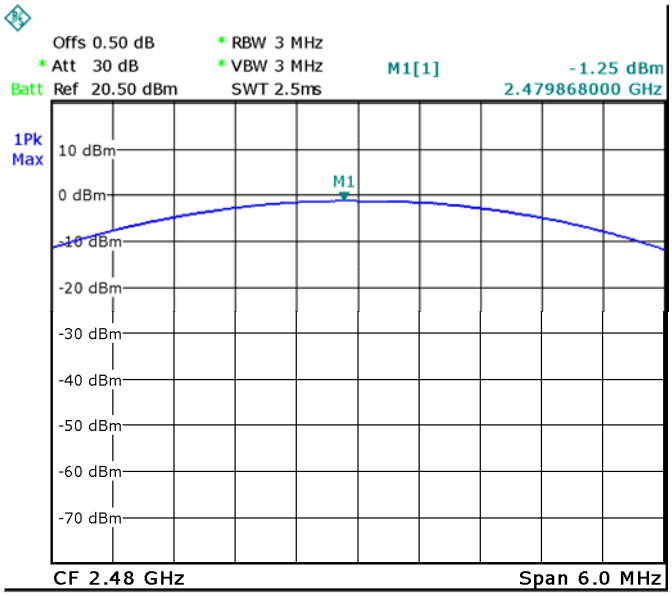
Low Channel



Middle Channel

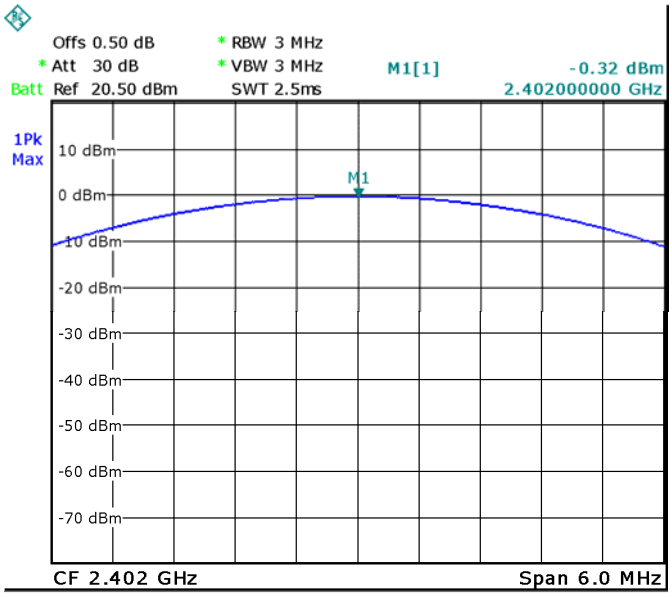


High Channel

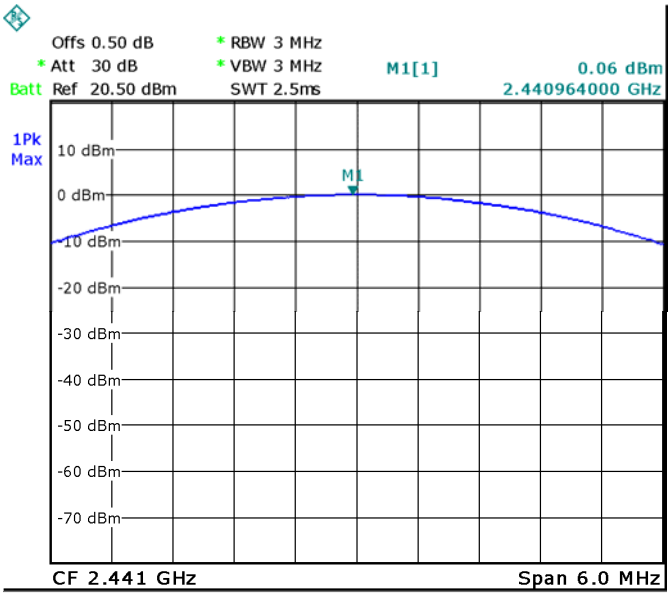


Modulation: 8DPSK

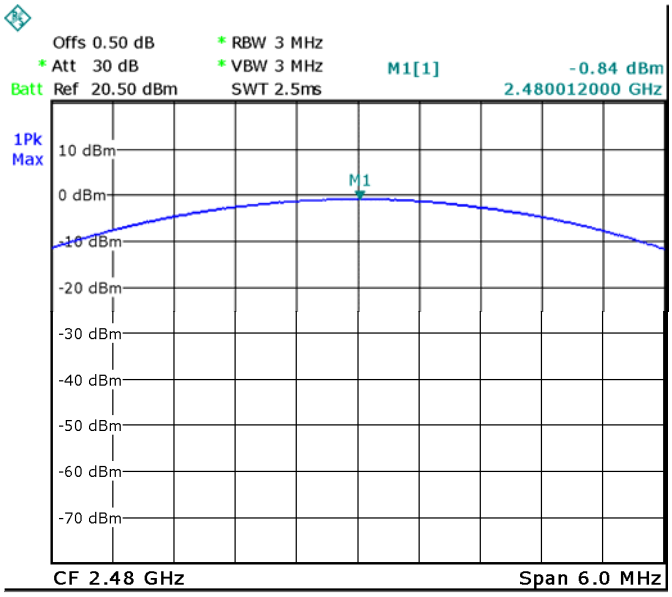
Low Channel



Middle Channel



High 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 1W.
Test Mode:	Test in hopping transmitting operating mode.

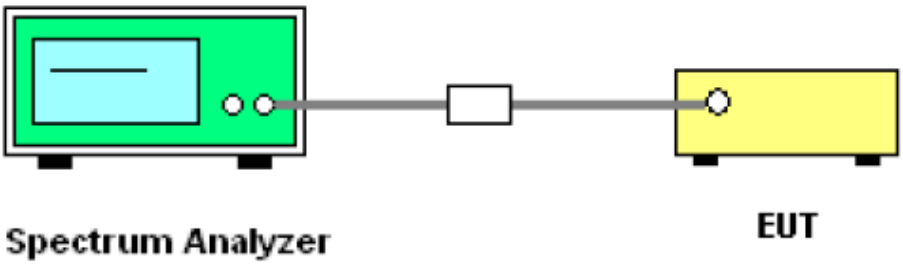
12.1 Test Procedure

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 = 30 kHz. VBW = 100 kHz, Span = 3MHz. 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 Setup



12.3 Test Result

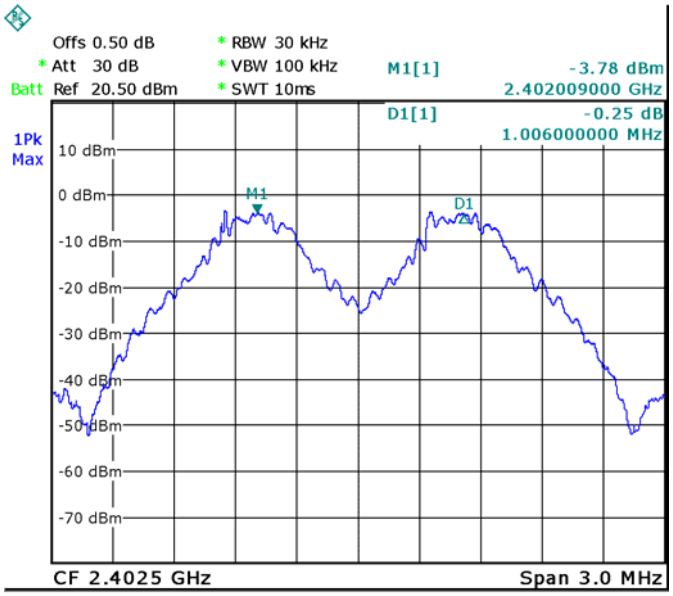
Test result plot as follows:

Modulation	Test Channel	Test Result MHz	20dB Bandwidth MHz	Limits (2/3 20dB Bandwidth) MHz
GFSK	Low	1.006	0.940	0.627
GFSK	Middle	1.000	0.946	0.631
GFSK	High	1.006	0.958	0.639
π /4 DQPSK	Low	1.006	1.305	0.870
π /4 DQPSK	Middle	1.000	1.305	0.870
π /4 DQPSK	High	1.000	1.305	0.870
8DPSK	Low	1.006	1.264	0.843
8DPSK	Middle	1.000	1.293	0.862
8DPSK	High	1.000	1.287	0.858

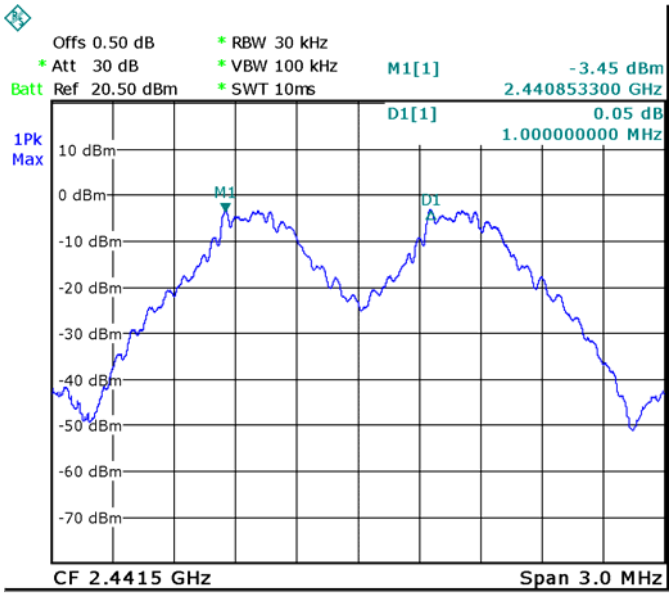
Test plots

Modulation: GFSK

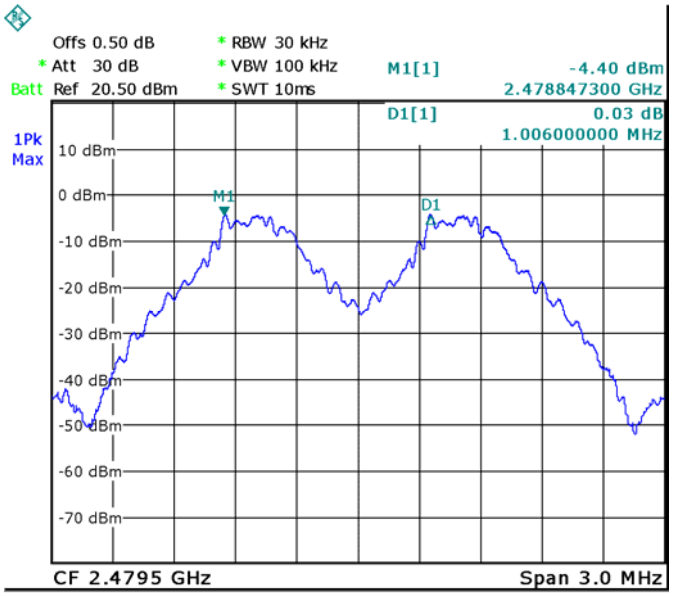
Low Channel



Middle Channel

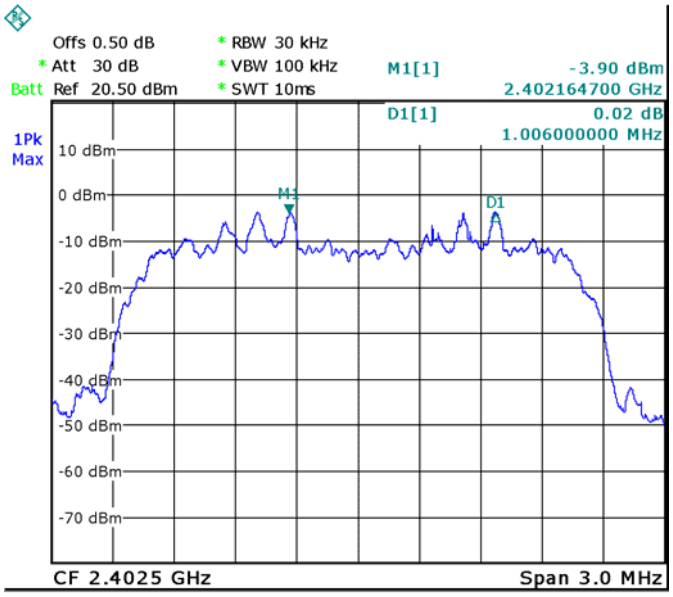


High Channel

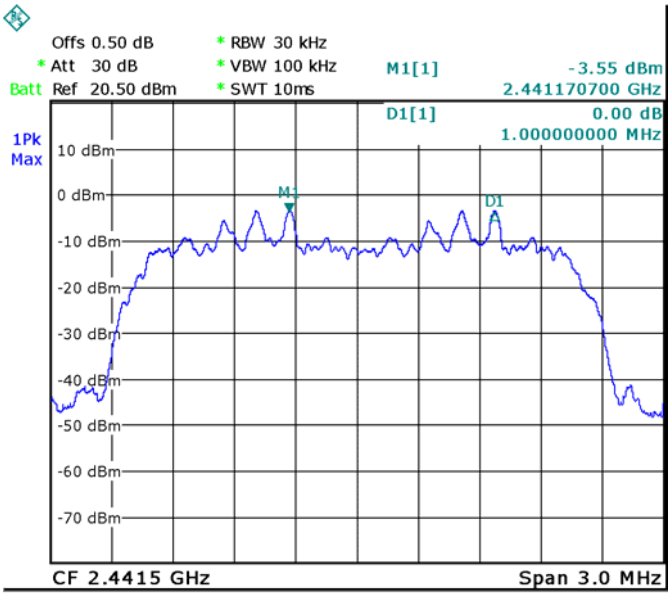


Modulation: π /4 DQPSK

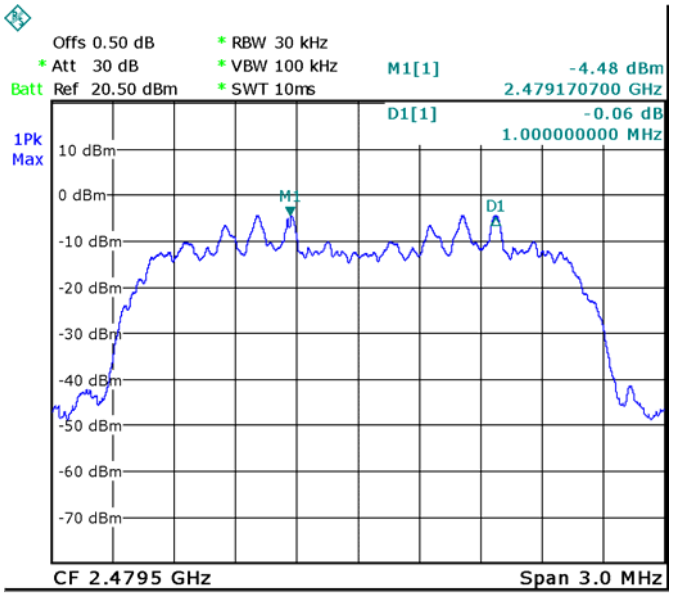
Low Channel



Middle Channel

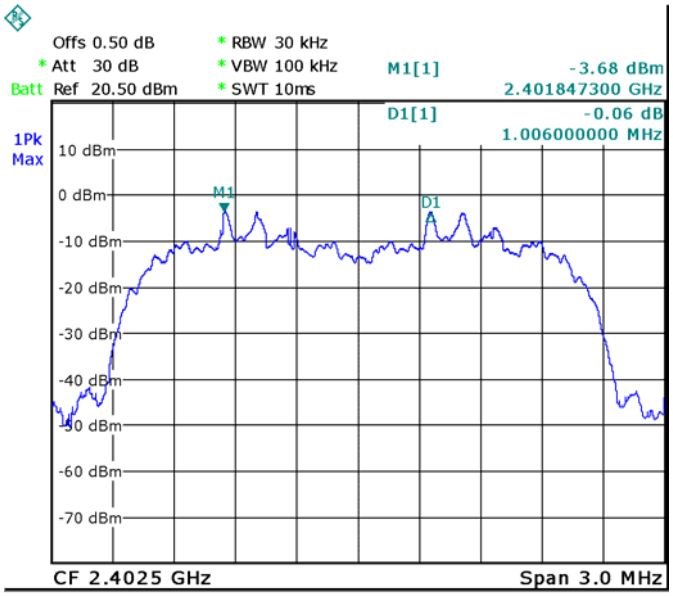


High Channel

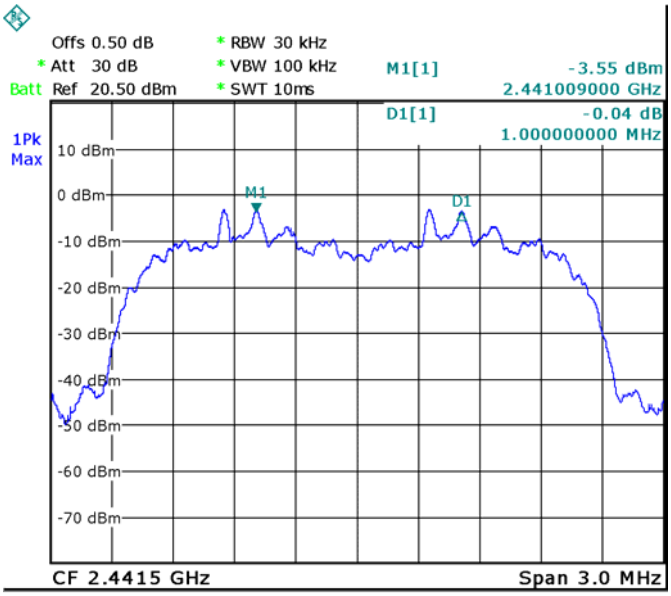


Modulation: 8DPSK

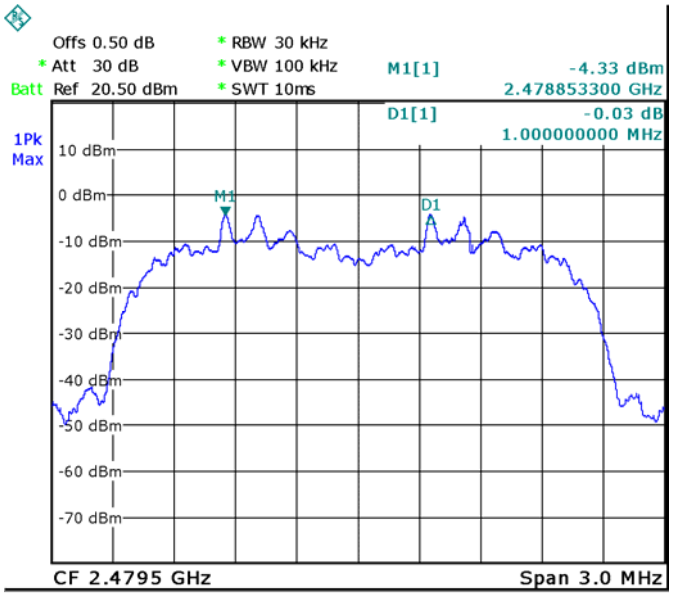
Low Channel



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

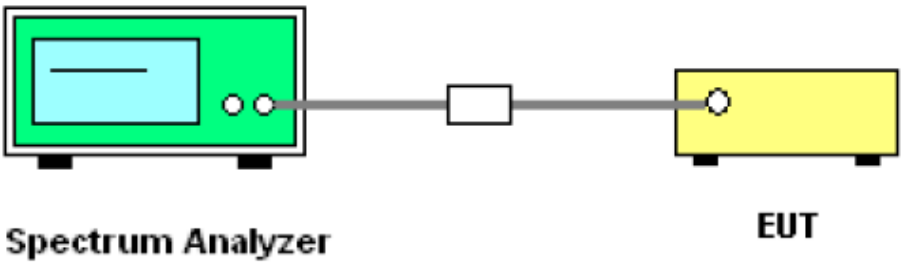
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 100 kHz. VBW = 300 kHz. 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 Setup

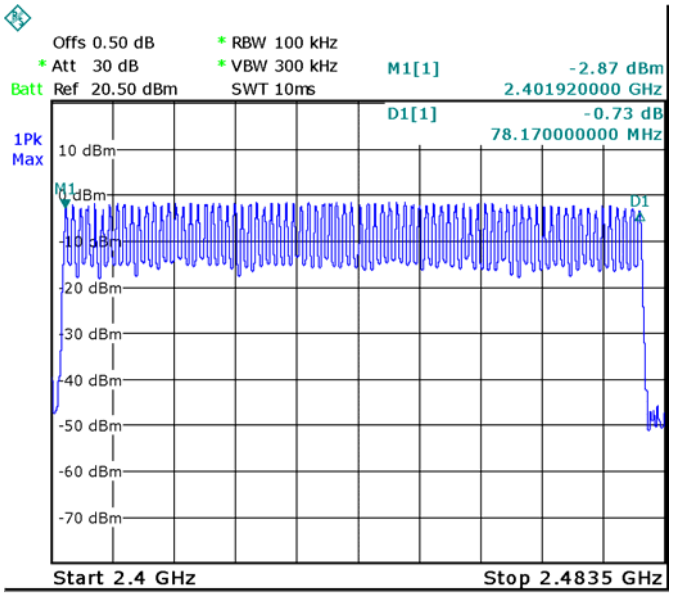


13.3 Test Result

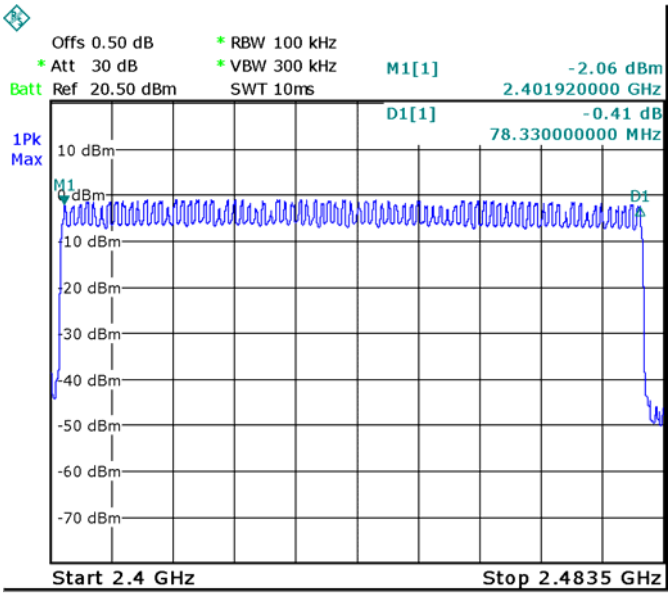
Total Channels are 79 Channels.

Test Plot

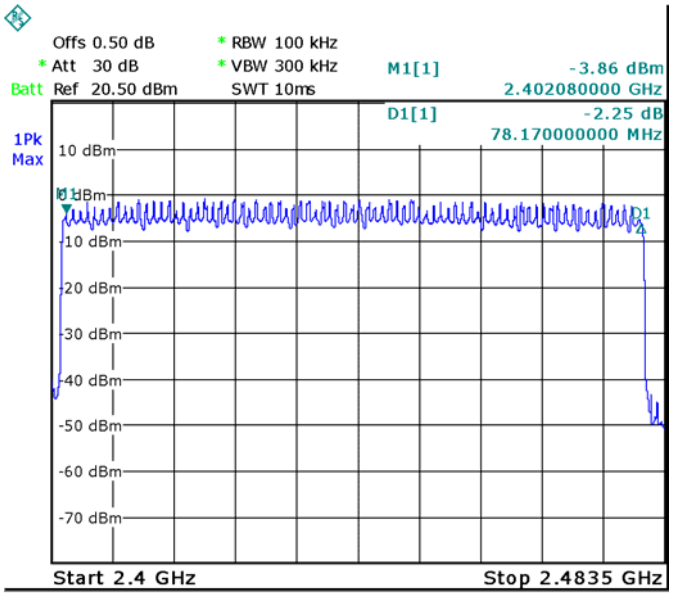
Modulation: GFSK



Modulation: π /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

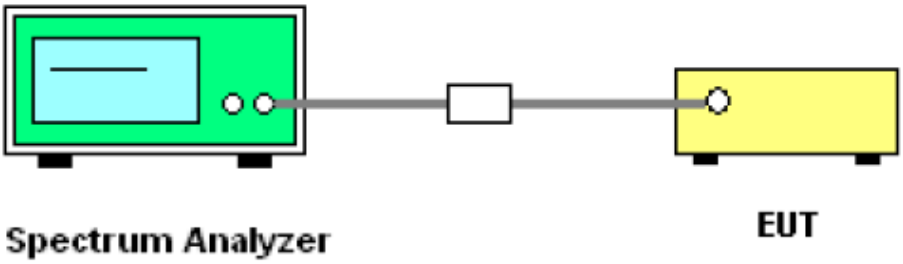
1.Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2.Set spectrum analyzer span = 0. centred on a hopping channel;

3.Set RBW = 1 MHz and VBW = 3 MHz. Sweep = as necessary to capture the entire dwell time per hopping channel.

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 Setup



14.3 Test Result

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period
The test period: T= 0.4(s) * 79 = 31.6 (s)
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*31.6*(MkrDelta)/1000
DH3	1600/79/4*31.6*(MkrDelta)/1000
DH1	1600/79/2*31.6*(MkrDelta)/1000
Remark	Mkr Delta is single pulse time.

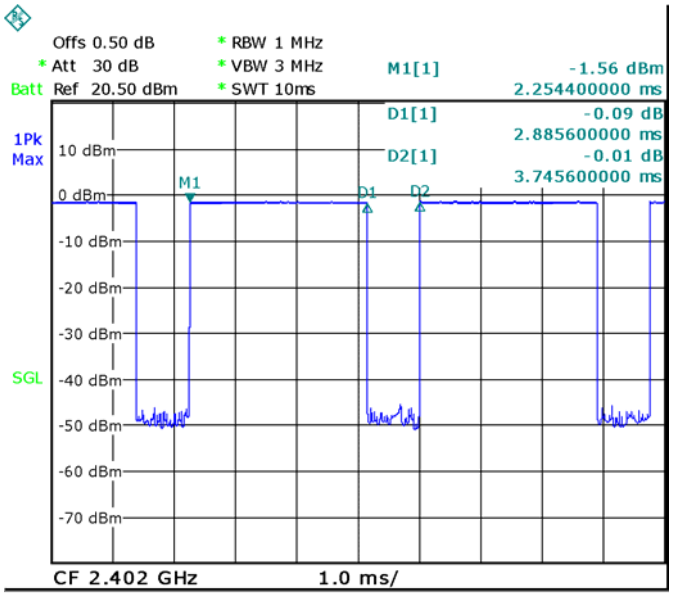
Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	DH5	Low	2.886	0.308	<0.4
		Middle	2.886	0.308	<0.4
		High	2.886	0.308	<0.4
π /4 DQPSK	2DH5	Low	2.880	0.307	<0.4
		Middle	2.886	0.308	<0.4
		High	2.880	0.307	<0.4
8DPSK	3DH5	Low	2.880	0.307	<0.4
		Middle	2.880	0.307	<0.4
		High	2.880	0.307	<0.4

Test Plot

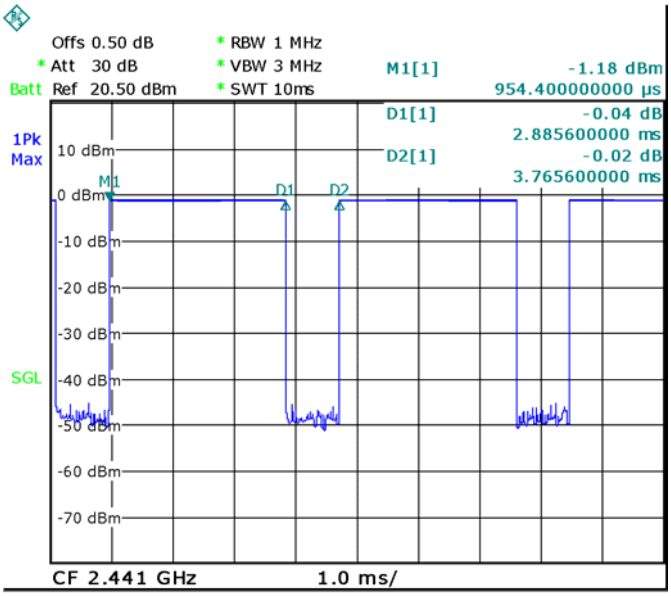
Modulation: GFSK

Data Packet: DH5

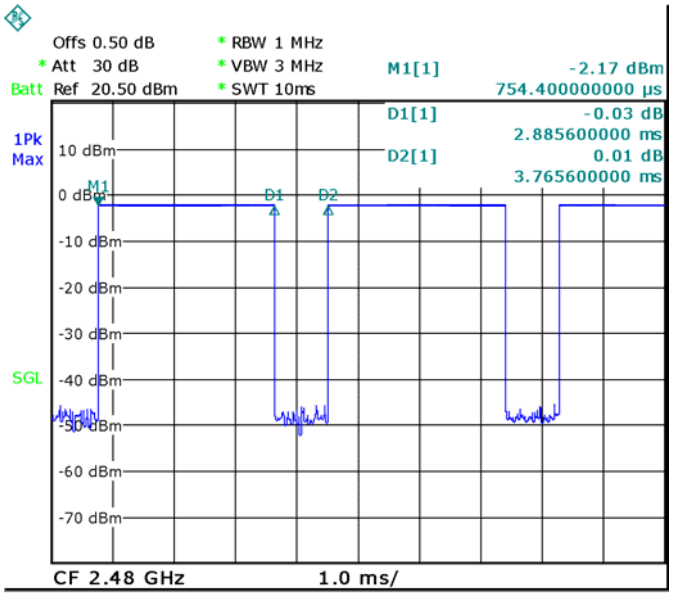
Low Channel



Middle Channel



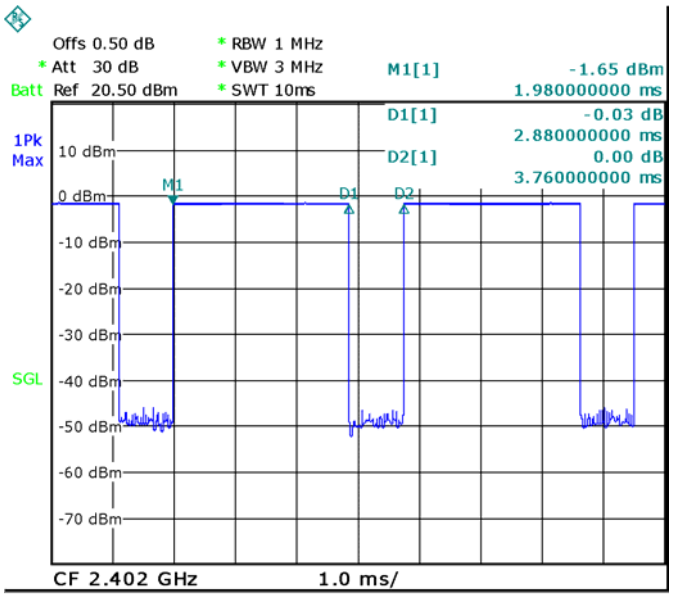
High Channel



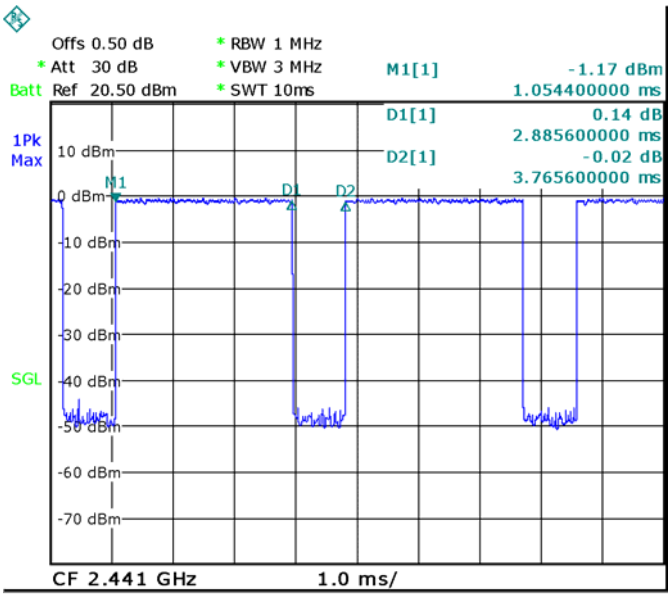
Modulation: π/4 DQPSK

Data Packet: 2DH5

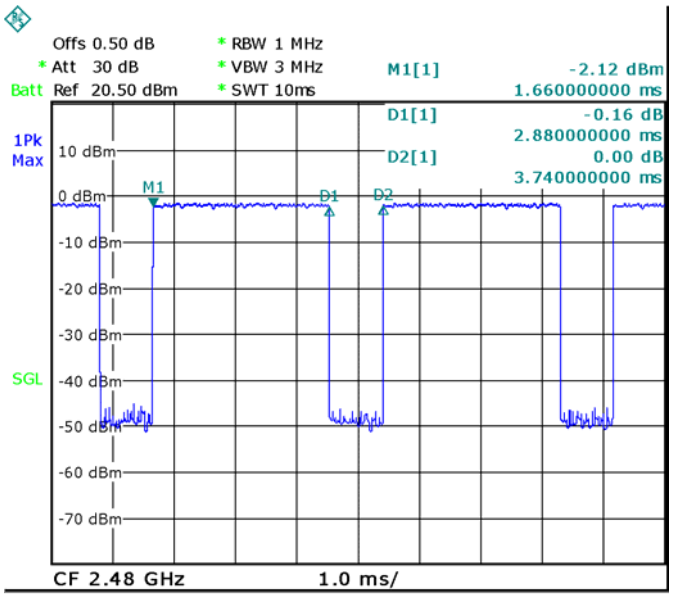
Low Channel



Middle Channel



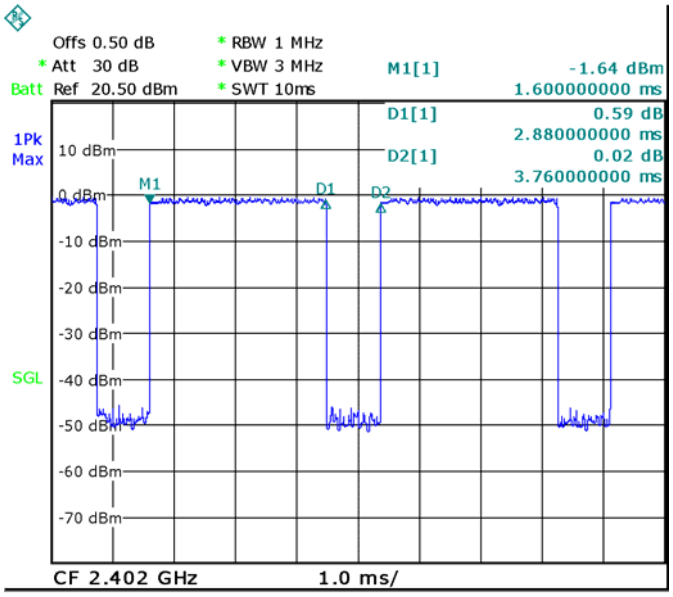
High Channel



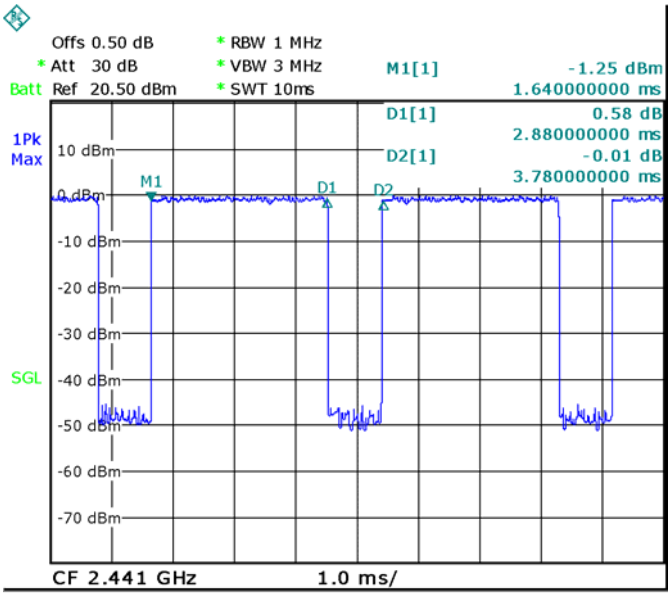
Modulation: 8DPSK

Data Packet: 3DH5

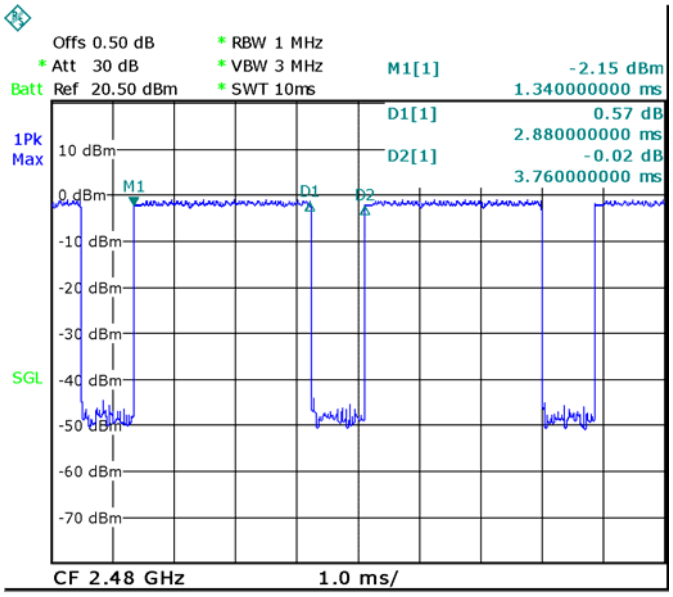
Low Channel



Middle Channel



High Channel



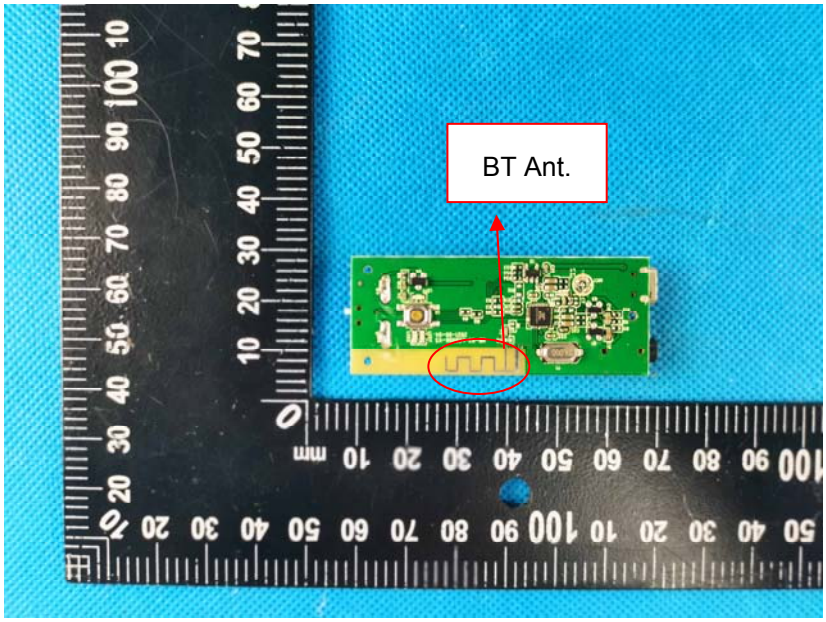
15 Antenna Requirement

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 for Bluetooth Antenna, meets the requirements of FCC 15.203.



16 RF Exposure

Note: Please refer to RF Exposure Report: WTD21D08081902W002_FCC MPE report.

17 Photographs –Test Setup and EUT Photos

Note: Please refer to appendix: Appendix- SP-MB-03- Photos.

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