FCC TEST REPORT

FCC ID: 2AUW5-YUANGUO2

Product Name	:	Bluetooth headset
Model Name	:	Yuanguo2
Brand Name	:	N/A
Report No.	:	PTC19082402801E-FC01

Prepared for

Shenzhen Mute Green Electronic Technology Co., Ltd.

Building 301, Jintai Industrial Park, Hangcheng Avenue, Gushi Community, Xixiang Street, Baoan District, Shenzhen City

Prepared by

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1TEST RESULT CERTIFICATION

Applicant's name	:	Shenzhen Mute Green Electronic Technology Co., Ltd.
Address	:	Building 301, Jintai Industrial Park, Hangcheng Avenue, Gushi Community, Xixiang Street, Baoan District, Shenzhen City
Manufacture's name	:	Shenzhen Mute Green Electronic Technology Co., Ltd.
Address	:	Building 301, Jintai Industrial Park, Hangcheng Avenue, Gushi Community, Xixiang Street, Baoan District, Shenzhen City
Product name	:	Bluetooth headset
Model name	:	Yuanguo2
Standards	:	FCC CFR47 Part 15 Section 15.247
Test procedure	:	ANSI C63.10:2013
Test Date	:	Oct. 10, 2019 to Oct. 25, 2019
Date of Issue	:	Oct.28, 2019
Test Result	:	Pass

This device described above has been tested by PTC, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
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Test Engineer:

Leo Yang / Engineer

Technical Manager:

Chris Du / Manager

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2 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
Conduct 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	PASS

3 TEST FACILITY

Dongguan Precise Testing & Certification Corp., Ltd.

Address: Building D, Baoding Technology Park, Guangming Road2, Dongcheng District, Dongguan, Guangdong, China

FCC Registration Number: 790290

A2LA Certificate No.: 4408.01

IC Registration Number: 12191A-1

4 General Information

4.1 General Description of E.U.T.

Product Name	:	Bluetooth headset
Model Name	:	Yuanguo2
Bluetooth Version	:	BT 4.1
Operating frequency	:	2402-2480MHz
Numbers of Channel	:	79 channels
Antenna Type	:	ceramic Antenna
Antenna Gain	:	2 dBi
Type of Modulation	:	GFSK, Π/4-DQPSK, 8DPSK
Hardware Version	:	V1.0
Software Version	:	V1.0

4.2 Test Mode

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.

The EUT has been associated with peripherals pursuant to ANSI C63.10-2013 and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation (9 KHz to the 10th harmonics of the highest fundamental frequency or to 40 GHz, whichever is lower).

The EUT has been tested under TX operating condition.

This EUT is a FHSS system, were conducted to determine the final configuration from all possible combinations. We use software control the EUT, Let EUT hopping on and transmit with highest power, all the modes GFSK, Π/4-DQPSK, 8DPSK have been tested. 79 Channels are provided by EUT. The 3 channels of lower, medium and higher were chosen for test.

Pretest Mode	Description
Mode 1	CH00
Mode 2	CH39
Mode 3	CH78
Mode 4	Link BT

For Conducted Emission	
Final Test Mode	Description
Mode 4	Link BT

For Radiated Emission	
Final Test Mode	Description
Mode 1	CH00
Mode 2	CH39
Mode 3	CH78

Note:

(1) The measurements are performed at the highest, middle, lowest available channels.

(2) Measurements are performed according to the Public Notice-DA 00-705.

(3) Test perform on all mode(BDR and EDR), only records worse cases in the test report.

Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	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	-	-

Channel	**Frequency(MHz)**
0	2402
39	2441
78	2480

5 Equipment During Test

5.1 Equipments List

RF Conducted Test

Name of Equipment	Manufacturer	Model	Serial No.	Characteristics	Calibration Due
MXG Signal Analyzer	Agilent	N9020A	MY56070279	10Hz-30GHz	Sep.18, 2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	Sep.18, 2020
Antenna Connector	Florida RF Labs	N/A	RF01#	N/A	Sep.18, 2020
Power Meter	Anritsu	ML2495A	N/A	100k-65GHz	Sep.18, 2020
Power sensor	Anritsu	MA2411B	N/A	300MHz-40GHz	Sep.18, 2020

Remark: 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.

Radiated Emissions

Name of Equipment	Manufacturer	Model	Serial No.	Characteristics	Calibration Due
EMI Test Receiver	Rohde&Schwarz	ESCI	101417	9KHz-3GHz	Sep.18, 2020
Loop Antenna	Schwarzbeck	FMZB 1519	012	9 KHz -30MHz	Sep.18, 2020
Bilog Antenna	SCHWARZBECK	VULB9160	9160-3355	25MHz-2GHz	Sep.18, 2020
Preamplifier (low frequency)	SCHWARZBECK	BBV 9475	9745-0013	1MHz-1GHz	Sep.18, 2020
Cable	Schwarzbeck	PLF-100	549489	9KHz-3GHz	Sep.18, 2020
Spectrum Analyzer	Agilent	E4407B	MY45109572	9KHz-40GHz	Sep.18, 2020
Horn Antenna	SCHWARZBECK	9120D	9120D-1246	1GHz-18GHz	Sep.18, 2020
Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	Sep.18, 2020
Horn Antenna	SCHWARZBECK	BBHA 9170	9170-181	14GHz-40GHz	Sep.18, 2020
Amplifier	SCHWARZBECK	BBV 9721	9721-205	18GHz-40GHz	Sep.18, 2020
Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	Sep.18, 2020
RF Cable	R&S	R204	R21X	1GHz-40GHz	Sep.18, 2020

Conducted Emissions

Name of Equipment	Manufacturer	Model	Serial No.	Characteristics	Calibration Due
EMI Test Receiver	Rohde&Schwarz	ESCI	101417	9KHz-3GHz	Sep.18, 2020
Artificial Mains Network	Rohde&Schwarz	L2-16B	000WX31025	9KHz-300MHz	Sep.18, 2020
Artificial Mains Network	Rohde&Schwarz	ENV216	101342	9KHz-300MHz	Sep.18, 2020

5.2 Measurement Uncertainty

Parameter	Uncertainty
RF output power, conducted	±1.0dB
Power Spectral Density, conducted	±2.2dB
Radio Frequency	± 1 x 10^{-6}
Bandwidth	± 1.5 x 10^{-6}
Time	±2%
Duty Cycle	±2%
Temperature	±1°C
Humidity	±5%
DC and low frequency voltages	±3%
Conducted Emissions (150kHz~30MHz)	±3.64dB
Radiated Emission(30MHz~1GHz)	±5.03dB
Radiated Emission(1GHz~25GHz)	±4.74dB
Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95%	

5.3 Description of Support Units

Equipment	Model No.	Series No.
Adapter	Model: PS65B150Y3000S Input: AC100-240V, 50/60Hz, 1.5A Output: DC 5V, 3000mA	N/A

6 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
Detector:	:	Peak for pre-scan (9kHz Resolution Bandwidth)

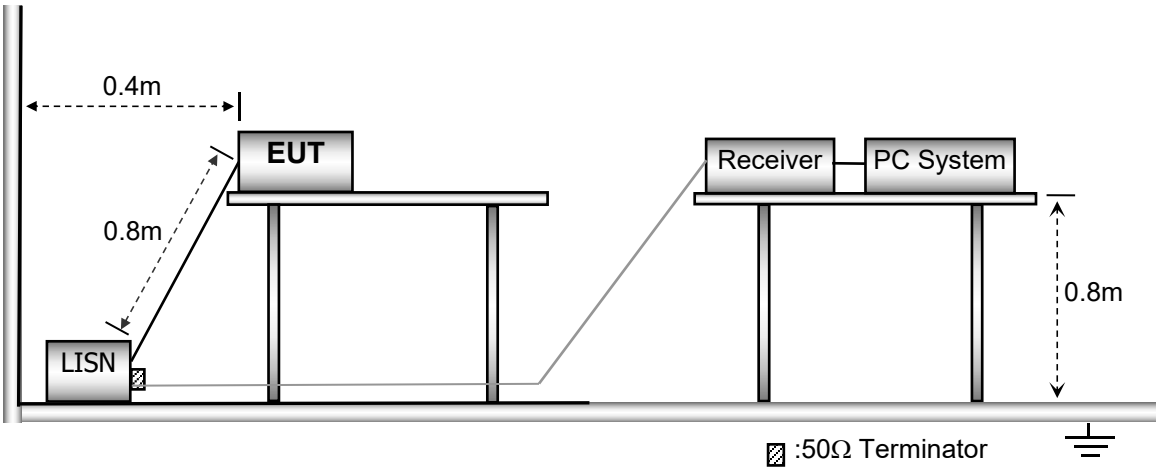
6.1 E.U.T. Operation

Operating Environment **:**

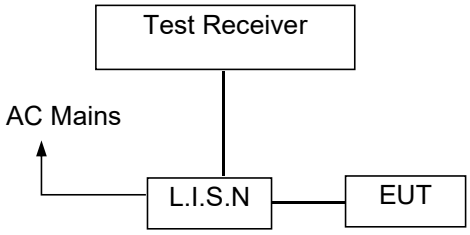
Temperature:	:	25.5 °C
Humidity:	:	51 % RH
Atmospheric Pressure:	:	101.2kPa

6.2 EUT Setup

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



6.3 Test SET-UP (Block Diagram of Configuration)



6.4 Measurement Procedure:

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured was complete.

6.5 Conducted Emission Limit

Conducted Emission

Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

Note:
1. The lower limit shall apply at the transition frequencies
2.The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

6.6 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.

6.7 Conducted Emission Test Result

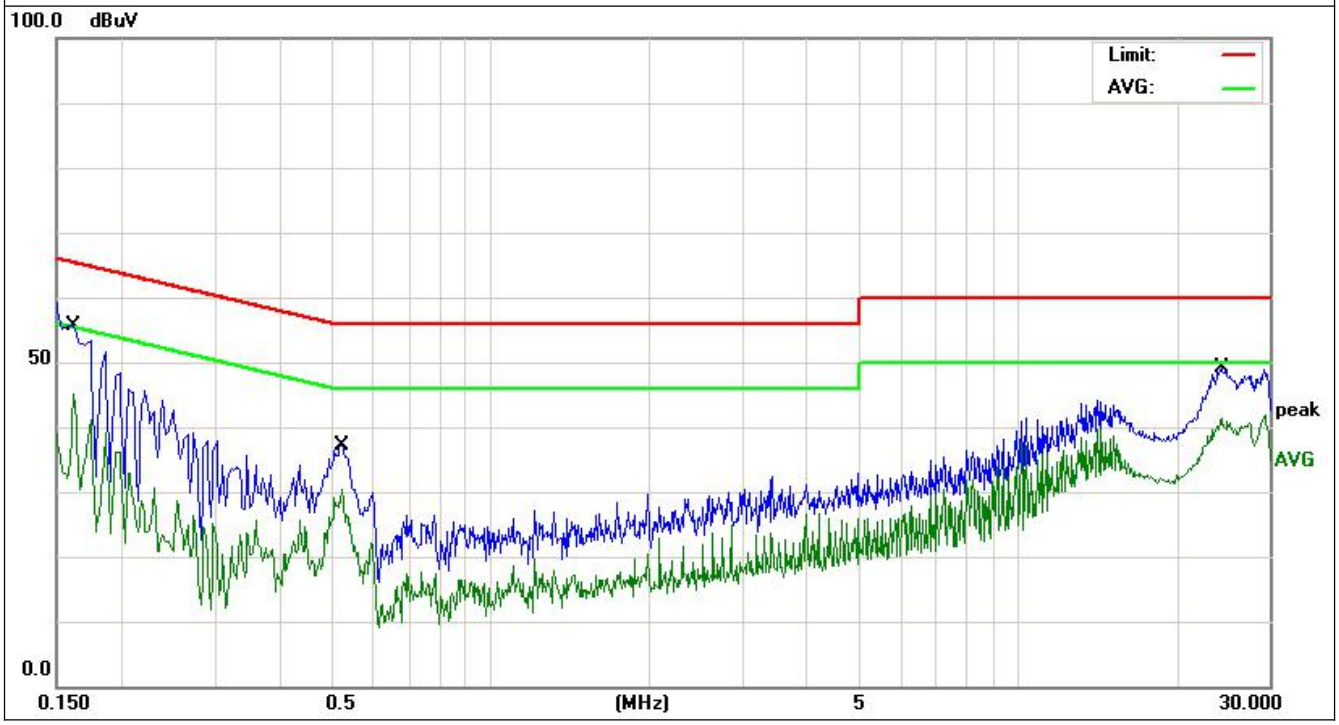
Pass.

All the modulation modes were tested the data of the worst mode (AC 120V/60Hz, GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Line -120V/60Hz:

Frequency (MHz)	Meter Reading (dBμV)	Factor(dB)	Emission Level (dBμV)	Limits (dBμV)	Margin (dB)	Detector
0.1620	44.03	11.68	55.71	65.36	-9.65	QP
0.1620	33.53	11.68	45.21	55.36	-10.15	Average
0.5220	27.11	10.01	37.12	56.00	-18.88	QP
0.5220	20.32	10.01	30.33	46.00	-15.67	Average
24.3220	37.90	11.21	49.11	60.00	-10.89	QP
24.3220	30.05	11.21	41.26	50.00	-8.74	Average

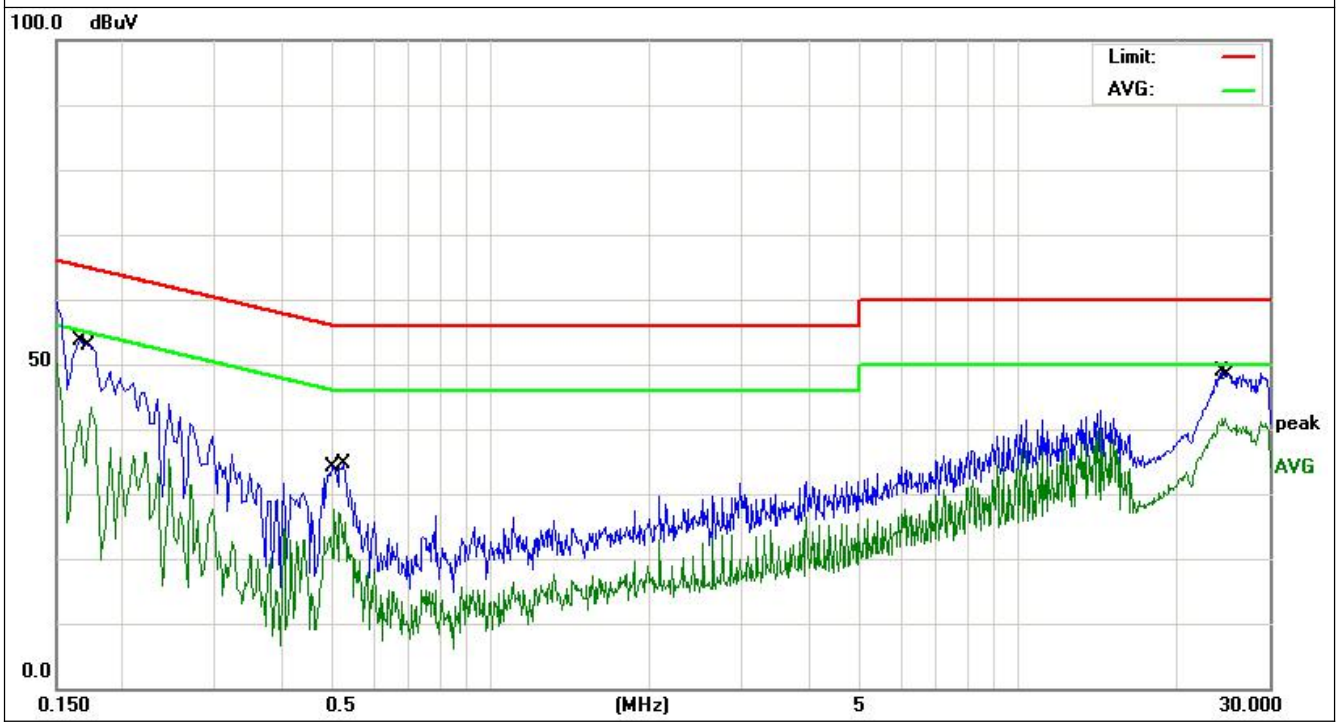
Remark: Factor = Absorbing clamp Factor + Cable Loss.



Neutral -120V/60Hz:

Frequency (MHz)	Meter Reading (dBμV)	Factor(dB)	Emission Level (dBμV)	Limits (dBμV)	Margin (dB)	Detector
0.1660	42.09	11.61	53.70	65.15	-11.45	QP
0.1740	31.86	11.48	43.34	54.76	-11.42	Average
0.5060	17.58	10.01	27.59	46.00	-18.41	QP
0.5260	24.71	10.01	34.72	56.00	-21.28	Average
24.2780	37.70	11.21	48.91	60.00	-11.09	QP
24.7180	30.52	11.23	41.75	50.00	-8.25	Average

Remark: Factor = Absorbing clamp Factor + Cable Loss.



7 Radiated Spurious Emissions

Test Requirement : FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method : ANSI C63.10:2013

Test Result : PASS

Measurement Distance : 3m

Limit : See the follow table

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

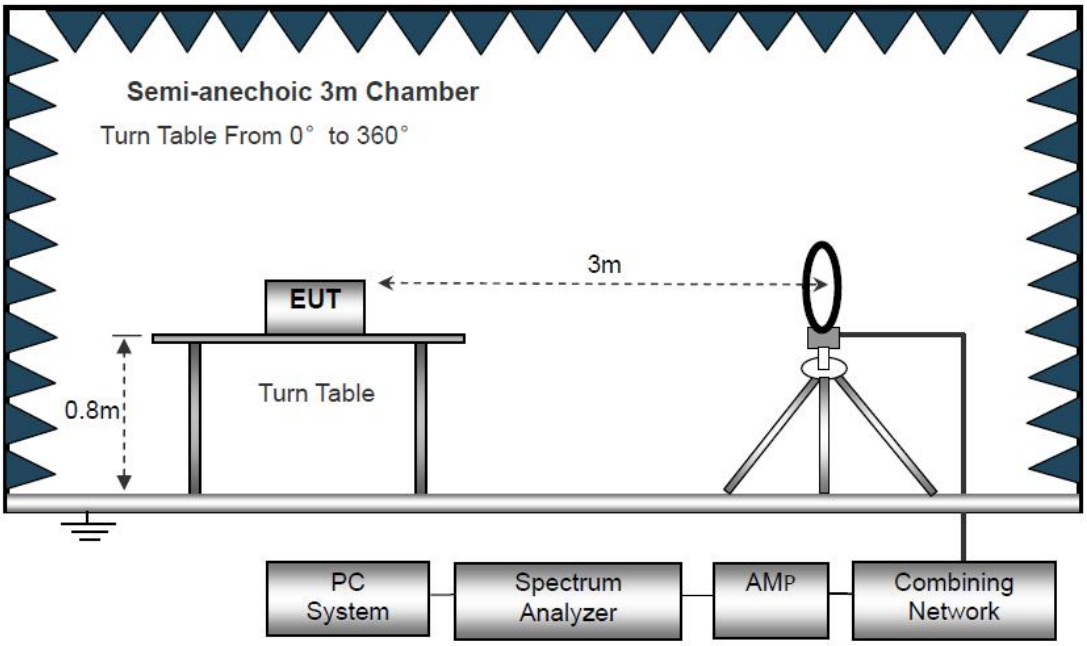
Humidity : 51.1 % RH

Atmospheric Pressure : 101.2kPa

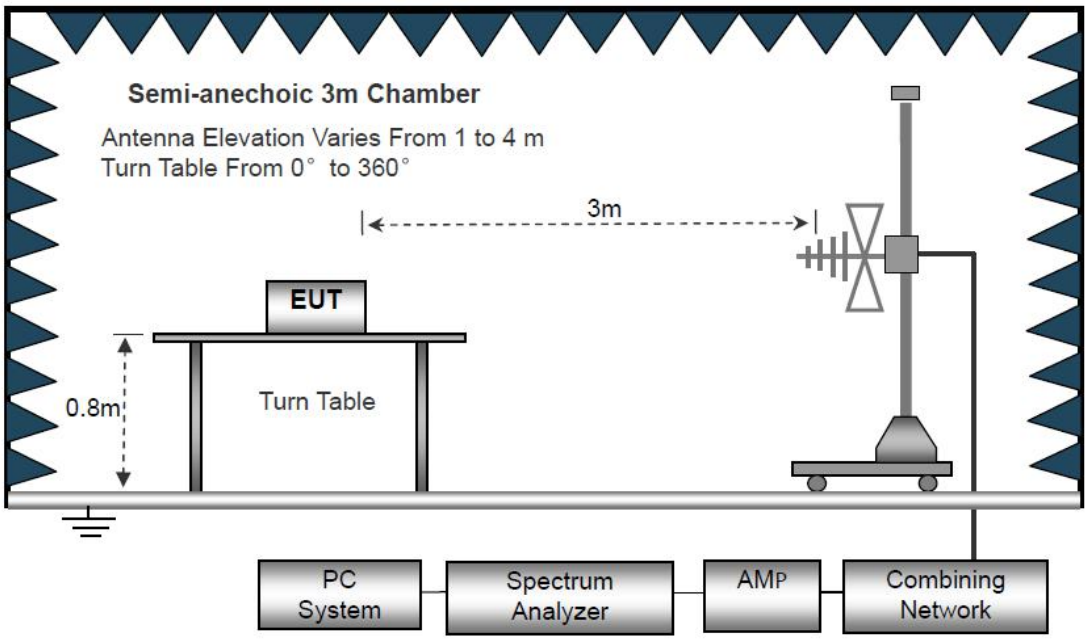
7.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site

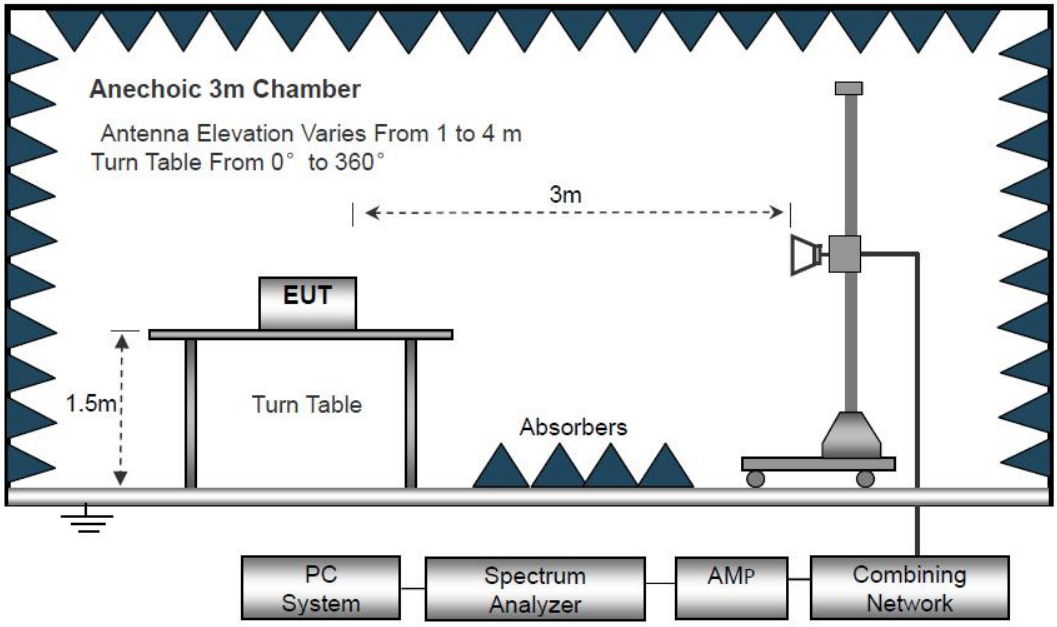
The test setup for emission measurement below 30MHz.



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

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (emission in restricted band)	1 MHz / 1 MHz for Peak, 1 MHz / *10Hz* for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

7.4 Test Procedure

1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.

2. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.

3. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (From 1m to 4m) and turntable (from 0 degree to 360 degree) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.

5. Set to the maximum power setting and enable the EUT transmit continuously.

6. Final measurement (Above 1GHz): The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 degree to 360 degree in order to have the antenna inside the cone of radiation.

7. Test Procedure of measurement (For Above 1GHz):

1) Monitor the frequency range at horizontal polarization and move the antenna over all sides of the EUT(if necessary move the EUT to another orthogonal axis).

2) Change the antenna polarization and repeat 1) with vertical polarization.

3) Make a hardcopy of the spectrum.

4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

5) Change the analyser mode to Clear/ Write and found the cone of emission.

6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3m and the antenna will be still inside the cone of emission.

7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarization and azimuth and the peak and average detector, which causes the maximum emission.

8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

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.

7.5 Summary of Test Results

Test Frequency: 9KHz-30MHz

Freq. (MHz)	Ant.Pol. H/V	Emission Level (dBuV/m)	Limit 3m (dBuV/m)	Over (dB)
--	--	--	--	>20

Note:

The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

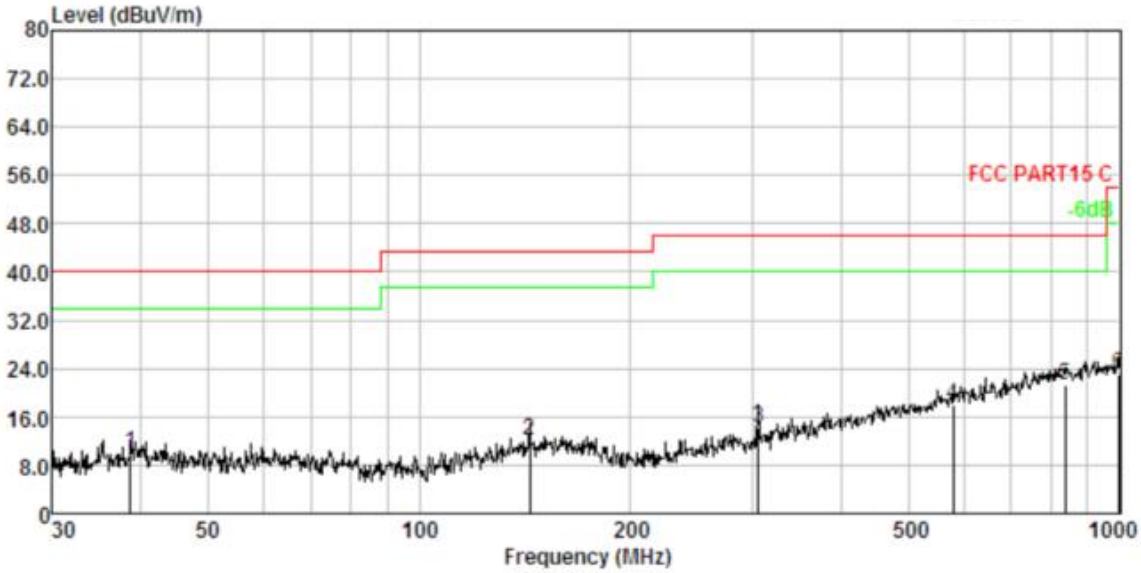
Distance extrapolation factor =40log(Specific distance/ test distance)(dB);
Limit line=Specific limits(dBuV) + distance extrapolation factor.

Test Frequency: 30MHz ~ 1GHz

Please refer to the following test plots:

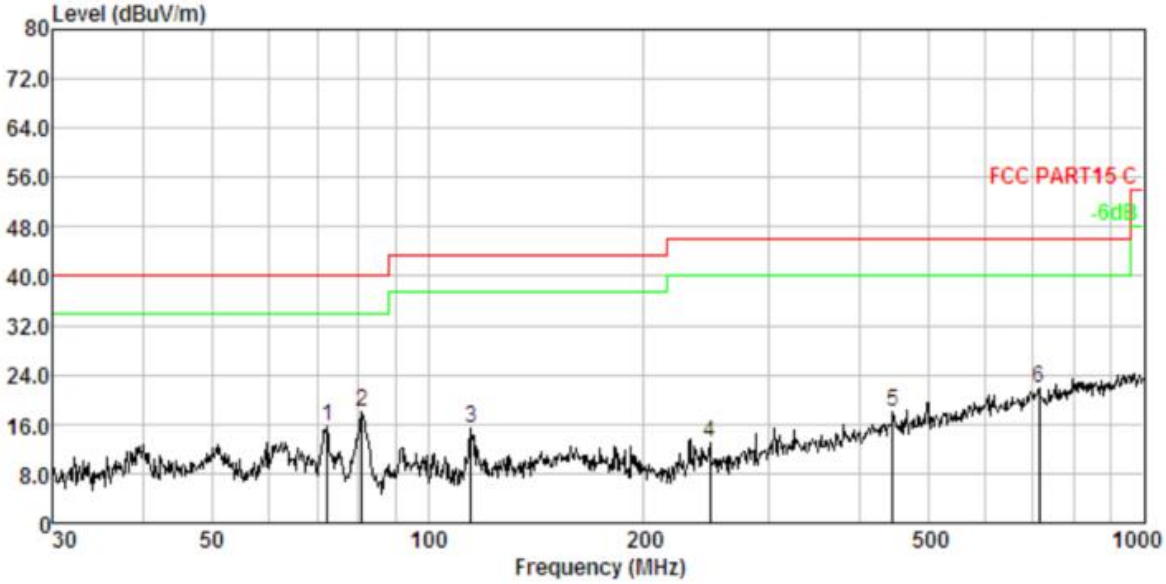
All the modulation modes were tested the data of the worst mode (AC 120V/60Hz, GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Test plot for Horizontal: GFSK(2402MHz)



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Receiver Reading dBuV	Preamp Factor dB	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	38.752	1.64	13.61	24.94	30.06	10.13	40.00	-29.87	QP
2.	143.830	3.90	13.57	25.08	30.52	12.03	43.50	-31.47	QP
3.	304.610	5.19	13.30	26.35	30.78	14.06	46.00	-31.94	QP
4.	578.670	6.29	18.59	24.17	31.00	18.05	46.00	-27.95	QP
5.	836.244	6.92	21.99	23.56	31.13	21.34	46.00	-24.66	QP
6.	996.500	7.22	23.44	23.57	31.19	23.04	54.00	-30.96	QP

Test plot for Vertical: GFSK(2402MHz)



No.	Freq MHz	Cable Loss dB	ANT Factor dB/m	Receiver Reading dBuV	Preamp Factor dB	Emission Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark
1.	72.338	2.72	9.93	33.25	30.28	15.62	40.00	-24.38	QP
2.	80.927	2.91	8.75	36.76	30.32	18.10	40.00	-21.90	QP
3.	114.917	3.51	11.55	30.82	30.44	15.44	43.50	-28.06	QP
4.	247.682	4.83	11.88	26.86	30.70	12.87	46.00	-33.13	QP
5.	446.414	5.84	16.31	26.82	30.91	18.06	46.00	-27.94	QP
6.	714.173	6.65	20.40	25.78	31.07	21.76	46.00	-24.24	QP

Test Frequency 1GHz-25GHz

Frequency (MHz)	Read Level (dBμV)	Cable loss (dB)	Antenna Factor dB/m	Preamp Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Remark	Comment
Low Channel (2402 MHz)(GFSK)--Above 1G									
4804.03	63.95	5.21	35.59	44.30	60.45	74.00	-13.55	Pk	Vertical
4804.03	41.66	5.21	35.59	44.30	38.16	54.00	-15.84	AV	Vertical
7206.27	61.54	6.48	36.27	44.60	59.69	74.00	-14.31	Pk	Vertical
7206.27	44.81	6.48	36.27	44.60	42.96	54.00	-11.04	AV	Vertical
4804.11	61.94	5.21	35.55	44.30	58.40	74.00	-15.60	Pk	Horizontal
4804.11	42.85	5.21	35.55	44.30	39.31	54.00	-14.69	AV	Horizontal
7206.22	63.58	6.48	36.27	44.52	61.81	74.00	-12.19	Pk	Horizontal
7206.22	47.75	6.48	36.27	44.52	45.98	54.00	-8.02	AV	Horizontal
Mid Channel (2441 MHz)(GFSK)--Above 1G									
4882.4	63.06	5.21	35.66	44.20	59.73	74.00	-14.27	Pk	Vertical
4882.4	42.28	5.21	35.66	44.20	38.95	54.00	-15.05	AV	Vertical
7323.24	60.39	7.10	36.50	44.43	59.56	74.00	-14.44	Pk	Vertical
7323.24	48.48	7.10	36.50	44.43	47.65	54.00	-6.35	AV	Vertical
4882.11	61.21	5.21	35.66	44.20	57.88	74.00	-16.12	Pk	Horizontal
4882.11	47.80	5.21	35.66	44.20	44.47	54.00	-9.53	AV	Horizontal
7323.13	59.86	7.10	36.50	44.43	59.03	74.00	-14.97	Pk	Horizontal
7323.13	42.05	7.10	36.50	44.43	41.22	54.00	-12.78	AV	Horizontal
High Channel (2480 MHz)(GFSK)-- Above 1G									
4960.4	66.15	5.21	35.52	44.21	62.67	74.00	-11.33	Pk	Vertical
4960.4	42.49	5.21	35.52	44.21	39.01	54.00	-14.99	AV	Vertical
7440.2	62.44	7.10	36.53	44.60	61.47	74.00	-12.53	Pk	Vertical
7440.2	45.48	7.10	36.53	44.60	44.51	54.00	-9.49	AV	Vertical
4960.23	67.30	5.21	35.52	44.21	63.82	74.00	-10.18	Pk	Horizontal
4960.23	47.23	5.21	35.52	44.21	43.75	54.00	-10.25	AV	Horizontal
7440.3	61.31	7.10	36.53	44.60	60.34	74.00	-13.66	Pk	Horizontal
7440.3	45.65	7.10	36.53	44.60	44.68	54.00	-9.32	AV	Horizontal

Note: 1. The testing has been conformed to 10*2480MHz=24800MHz.

2. All other emissions more than 30dB below the limit.

3. Emission Level= Antenna Factor + Cable Loss + Read Level - Preamp Factor

Margin=Emission Level-Limit

Spurious Emission in Restricted Band 2310-2390MHz and 2483.5-2500MHz

All the modulation modes have been tested, and the worst result was report as below:

Frequency	Meter Reading	Cable Loss	Antenna Factor	Preamp Factor	Emission Level	Limits	Margin	Detector	Comment
(MHz)	(dBμV)	(dB)	dB/m	(dB)	(dBμV/m)	(dBμV/m)	(dB)	Type	
1Mbps (GFSK)-hopping									
2310.00	56.36	2.97	27.80	43.80	43.33	74	-30.67	Pk	Horizontal
2310.00	44.48	2.97	27.80	43.80	31.45	54	-22.55	AV	Horizontal
2310.00	59.23	2.97	27.80	43.80	46.20	74	-27.80	Pk	Vertical
2310.00	42.78	2.97	27.80	43.80	29.75	54	-24.25	AV	Vertical
2390.00	59.61	3.14	27.21	43.80	46.16	74	-27.84	Pk	Vertical
2390.00	43.40	3.14	27.21	43.80	29.95	54	-24.05	AV	Vertical
2390.00	57.62	3.14	27.21	43.80	44.17	74	-29.83	Pk	Horizontal
2390.00	42.34	3.14	27.21	43.80	28.89	54	-25.11	AV	Horizontal
2483.50	58.14	3.58	27.70	44.00	45.42	74	-28.58	Pk	Vertical
2483.50	42.58	3.58	27.70	44.00	29.86	54	-24.14	AV	Vertical
2483.50	60.42	3.58	27.70	44.00	47.70	74	-26.30	Pk	Horizontal
2483.50	43.52	3.58	27.70	44.00	30.80	54	-23.20	AV	Horizontal
1Mbps(GFSK)- Non-hopping									
2310.00	56.36	2.97	27.80	43.80	43.33	74	-30.67	Pk	Horizontal
2310.00	43.74	2.97	27.80	43.80	30.71	54	-23.29	AV	Horizontal
2310.00	58.26	2.97	27.80	43.80	45.23	74	-28.77	Pk	Vertical
2310.00	42.65	2.97	27.80	43.80	29.62	54	-24.38	AV	Vertical
2390.00	58.96	3.14	27.21	43.80	45.51	74	-28.49	Pk	Vertical
2390.00	42.29	3.14	27.21	43.80	28.84	54	-25.16	AV	Vertical
2390.00	57.29	3.14	27.21	43.80	43.84	74	-30.16	Pk	Horizontal
2390.00	42.45	3.14	27.21	43.80	29.00	54	-25.00	AV	Horizontal
2483.50	58.67	3.58	27.70	44.00	45.95	74	-28.05	Pk	Vertical
2483.50	43.94	3.58	27.70	44.00	31.22	54	-22.78	AV	Vertical
2483.50	59.18	3.58	27.70	44.00	46.46	74	-27.54	Pk	Horizontal
2483.50	42.51	3.58	27.70	44.00	29.79	54	-24.21	AV	Horizontal

8 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGE

8.1 REQUIREMENT

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

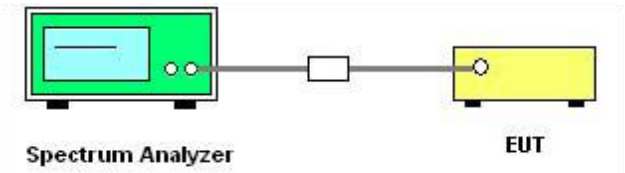
8.2 TEST PROCEDURE

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	30 MHz to 10th carrier harmonic
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

. For Band edge

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	Lower Band Edge: 2300 – 2403 MHz Upper Band Edge: 2479 – 2500 MHz
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

8.3 TEST SETUP



1. The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100KHz. The video bandwidth is set to 300KHz.

2. The spectrum from 30MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

8.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.GFSK ,8DPSK was tested and record.

8.5 TEST RESULTS

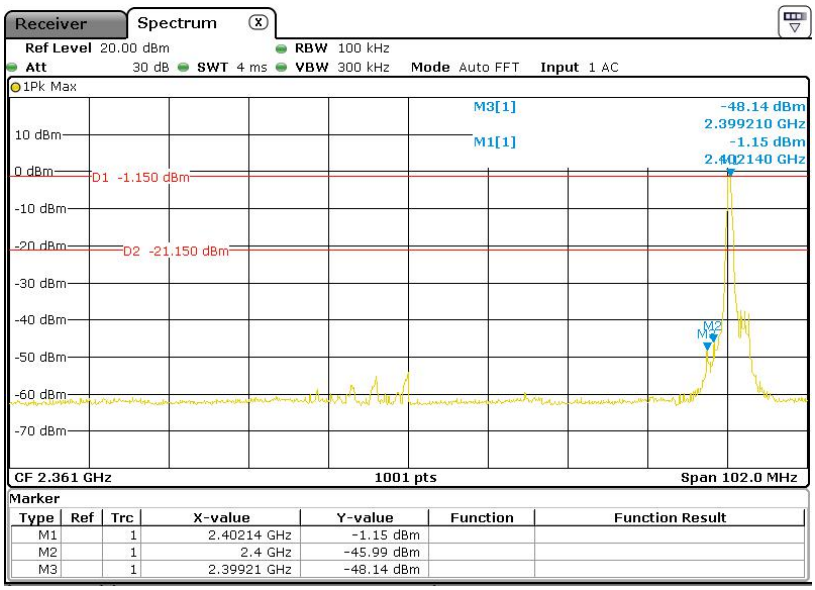
Frequency Band (MHz)	Delta Peak to band emission	＞Limit (dBc)	Result
1Mbps Non-hopping			
≤2400	44.84	20	Pass
≥2483.5	59.52	20	Pass
1Mbps hopping			
≤2400	48.63	20	Pass
≥2483.5	62.15	20	Pass

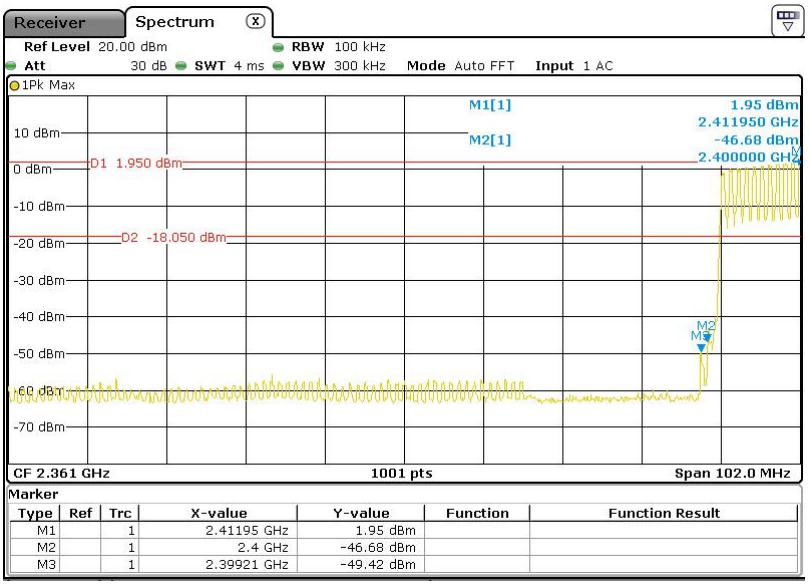
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type	Comment
1Mbps Non-hopping							
2390.0	56.14	-13.06	43.08	54.00	-10.92	peak	Vertical
2390.0	58.73	-13.06	45.67	54.00	-8.33	peak	Horizontal
2483.5	56.52	-12.78	43.74	54.00	-10.26	peak	Vertical
2483.5	57.11	-12.78	44.33	54.00	-9.67	peak	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type	Comment
1Mbps hopping							
2390.0	55.23	-13.06	42.17	54.00	-11.83	peak	Vertical
2390.0	54.17	-13.06	41.11	54.00	-12.89	peak	Horizontal
2483.5	53.52	-12.78	40.74	54.00	-13.26	peak	Vertical
2483.5	54.35	-12.78	41.57	54.00	-12.43	peak	Horizontal

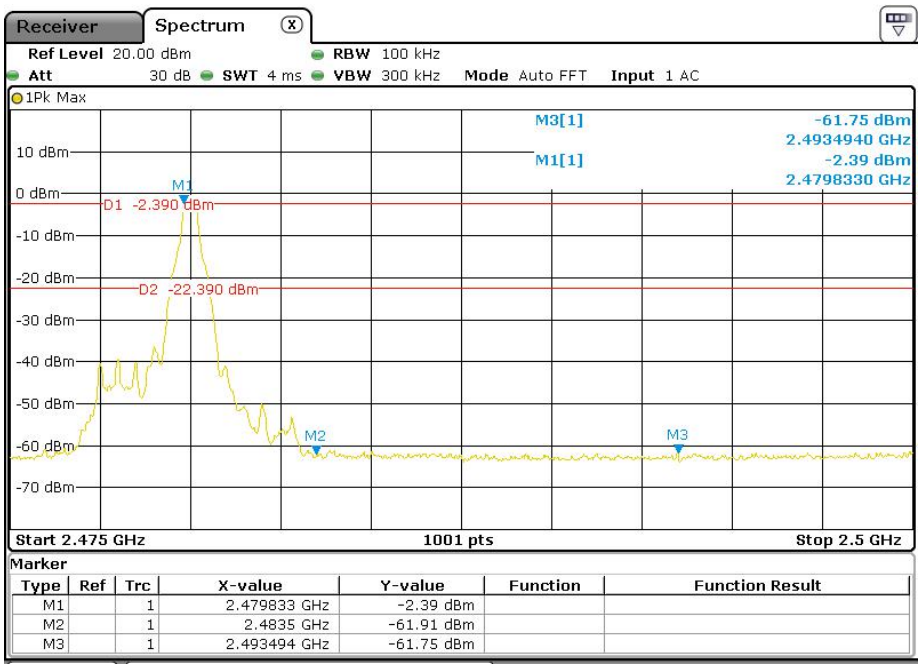
Note: When PK value is lower than the Average value limit, average didn't record.

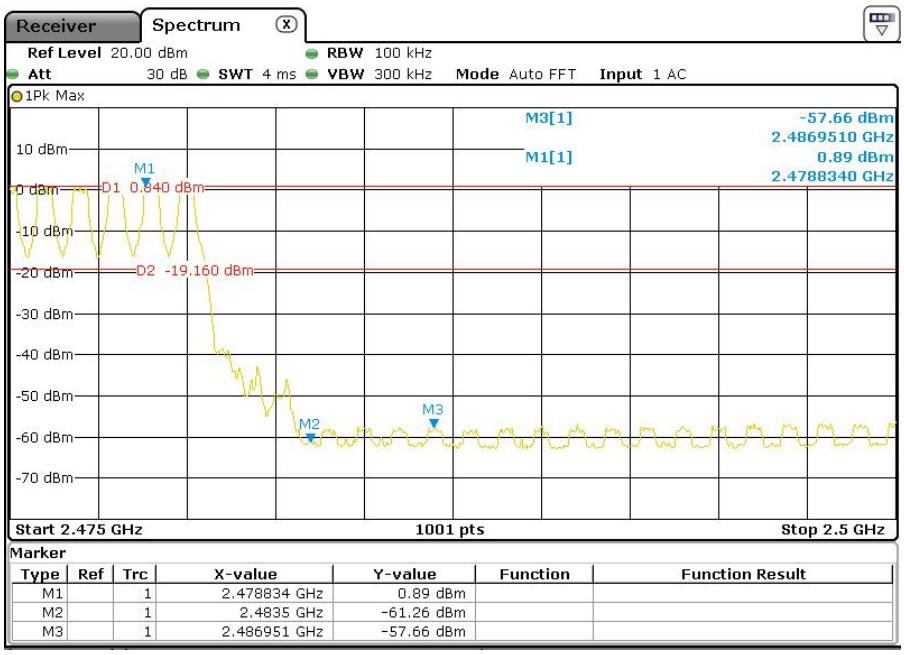
Band Edge, Left Side





Band Edge, Right Side





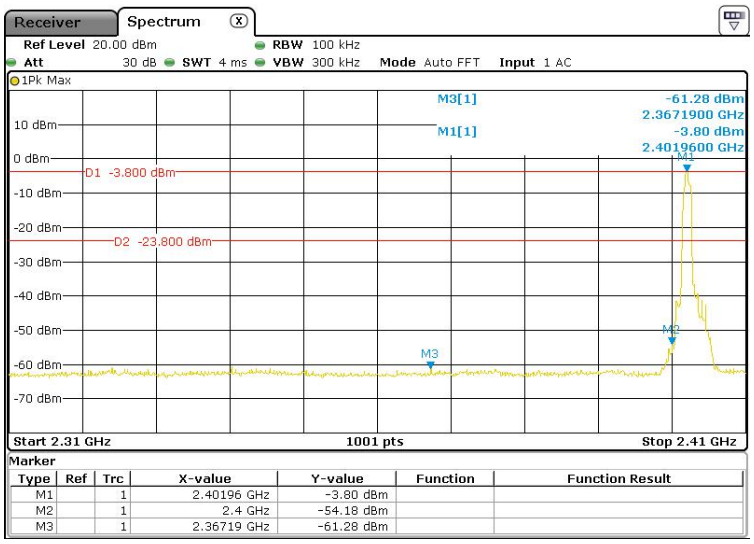
Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
3Mbps Non-hopping			
≤2400	50.38	20	Pass
≥2483.5	57.32	20	Pass
3Mbps hopping			
≤2400	55.55	20	Pass
≥2483.5	59.10	20	Pass

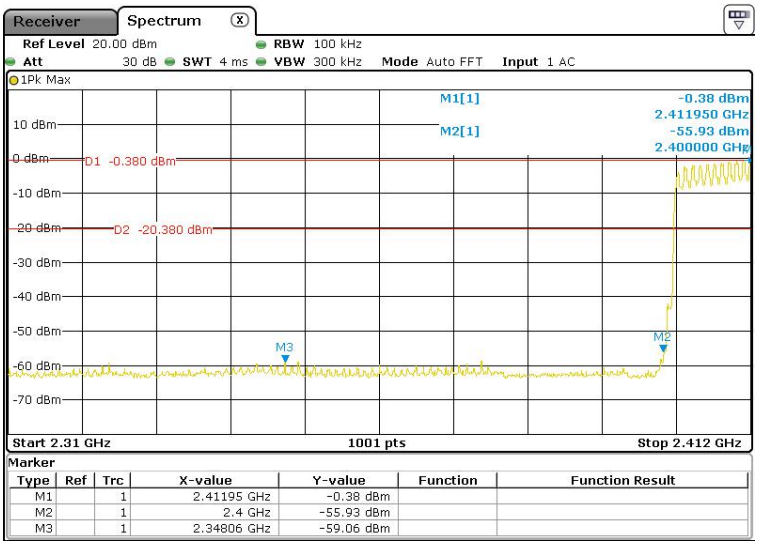
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type	Comment
3Mbps Non-hopping							
2390	55.23	-13.06	42.17	54.00	-11.83	peak	Vertical
2390	58.21	-13.06	45.15	54.00	-8.85	peak	Horizontal
2483.5	57.09	-12.78	44.31	54.00	-9.69	peak	Vertical
2483.5	57.16	-12.78	44.38	54.00	-9.62	peak	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type	Comment
3Mbps hopping							
2390	53.52	-13.06	40.46	54.00	-13.54	peak	Vertical
2390	55.17	-13.06	42.11	54.00	-11.89	peak	Horizontal
2483.5	54.49	-12.78	41.71	54.00	-12.29	peak	Vertical
2483.5	58.36	-12.78	45.58	54.00	-8.42	peak	Horizontal

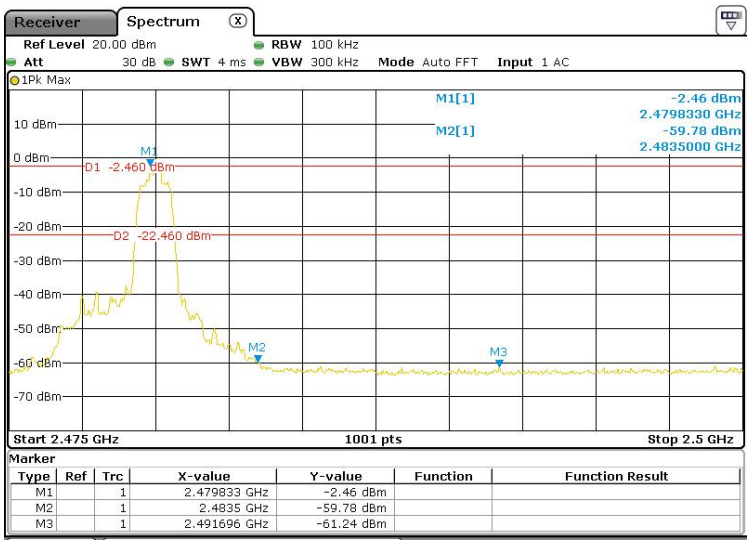
Note: When PK value is lower than the Average value limit, average didn't record.

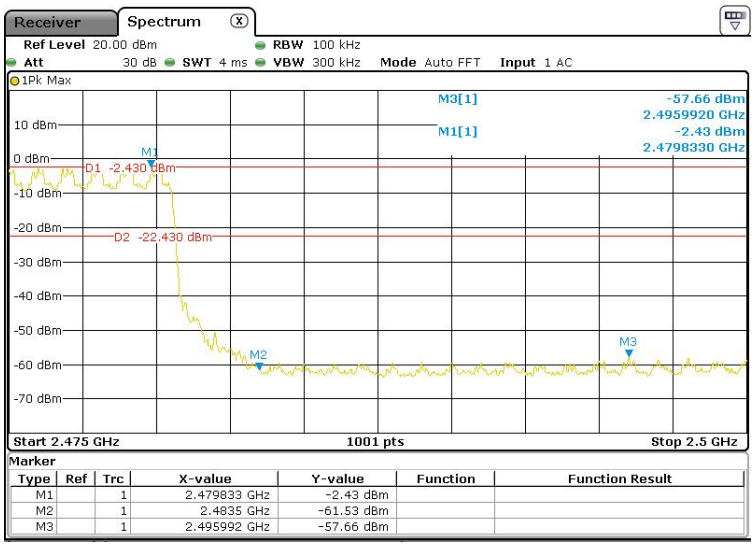
Band Edge, Left Side





Band Edge, Right Side




Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
M3[1] -57.66 dBm 2.4959920 GHz
M1[1] -2.43 dBm 2.4798330 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1 -2.430 dBm
D2 -22.430 dBm
M2
M3
Start 2.475 GHz
1001 pts
Stop 2.5 GHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479833 GHz -2.43 dBm
M2 1 2.4835 GHz -61.53 dBm
M3 1 2.495992 GHz -57.66 dBm

9 20 dB Bandwidth Measurement

Test Requirement : FCC CFR47 Part 15 Section 15.247

Test Method : ANSI C63.10:2013

9.1 Test Procedure

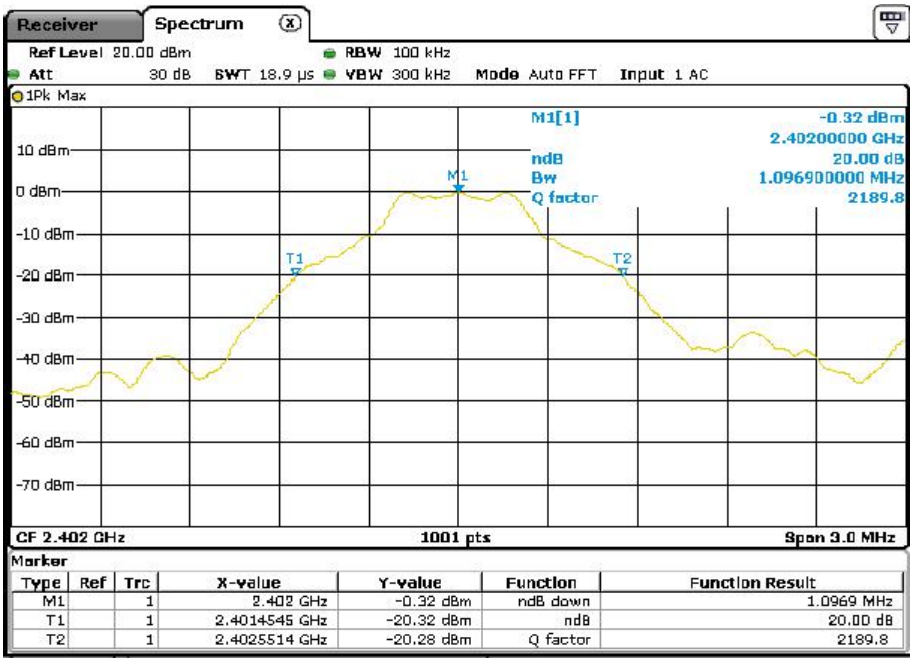
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

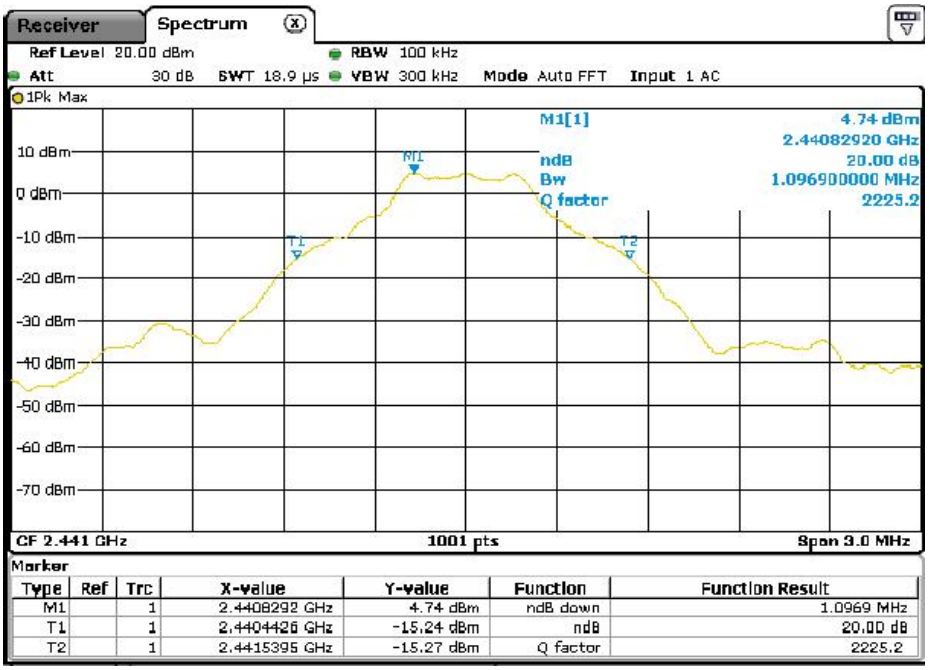
2. Set the spectrum analyzer: RBW =100kHz, VBW = 300kHz

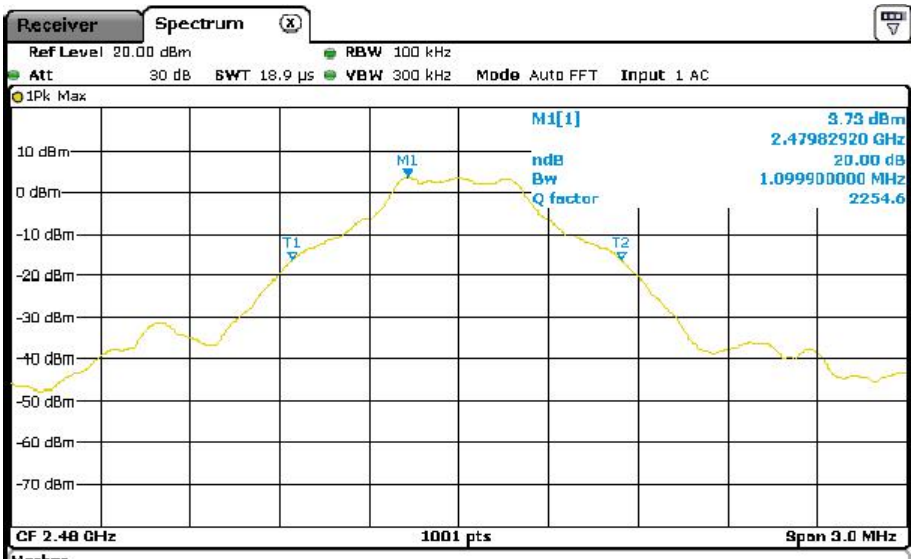
9.2 Test Result

Mode	Frequency (MHz)	20dB Bandwidth (MHz)	Limit (kHz)	Result
GFSK	2402	1.0969	N/A	Pass
	2441	1.0969	N/A	Pass
	2480	1.0999	N/A	Pass
8DPSK	2402	1.336	N/A	Pass
	2441	1.339	N/A	Pass
	2480	1.342	N/A	Pass

Test Mode: CH00 / CH39 / CH78 (GFSK/(1Mbps)Mode)



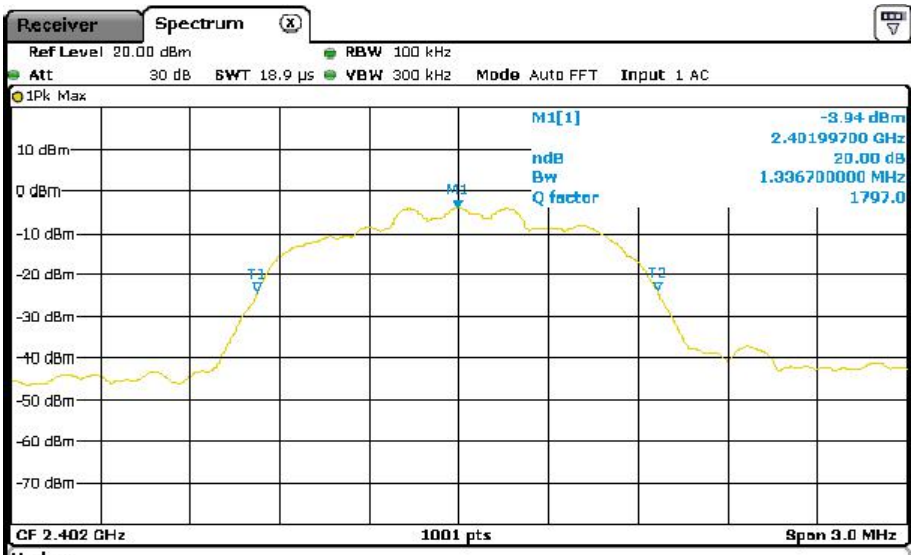




Marker

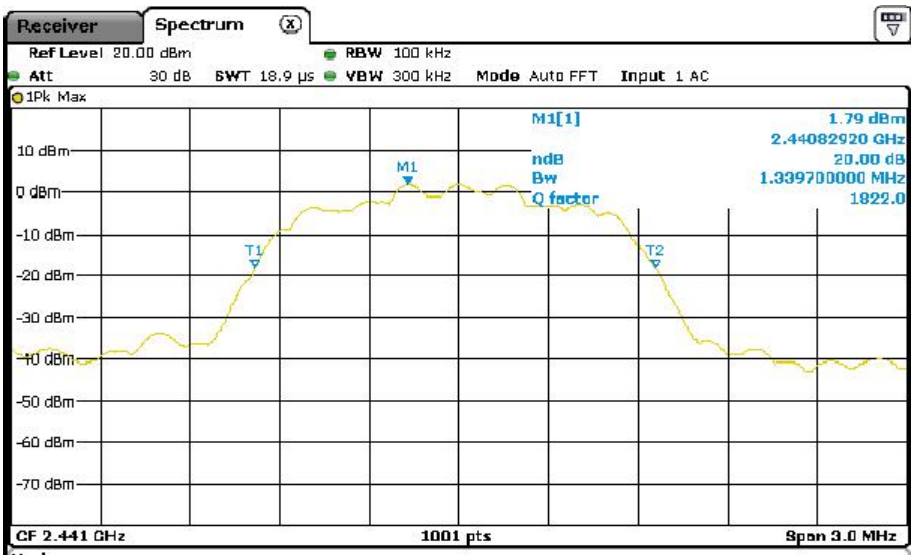
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4798292 GHz	3.73 dBm	ndB down	1.0999 MHz
T1		1	2.4794426 GHz	-16.26 dBm	ndB	20.00 dB
T2		1	2.4805425 GHz	-16.34 dBm	Q factor	2254.6

Test Mode: CH00 / CH39 / CH78 (8DPSK(3Mbps)Mode)



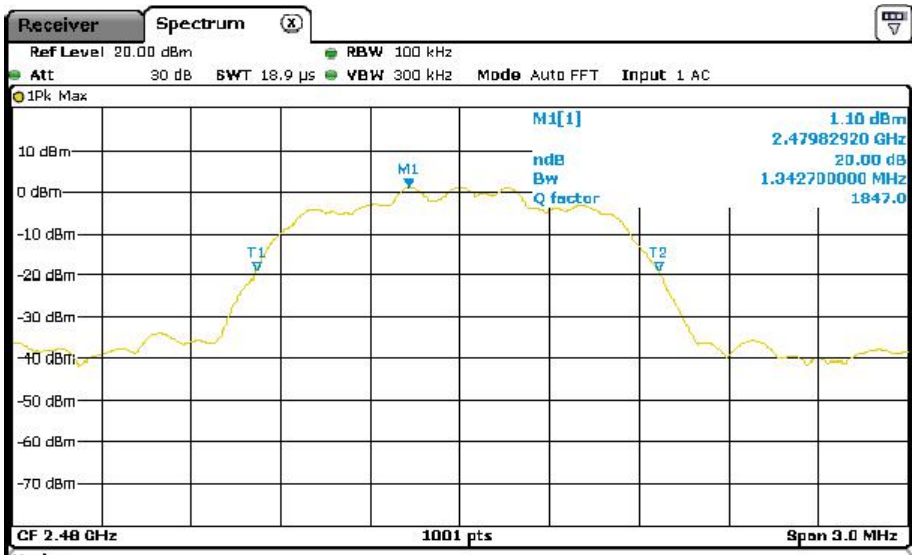
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401997 GHz	-3.94 dBm	ndB down	1.3367 MHz
T1		1	2.4013257 GHz	-24.09 dBm	ndB	20.00 dB
T2		1	2.4026623 GHz	-24.00 dBm	Q factor	1797.0



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4408292 GHz	1.79 dBm	ndB down	1.3397 MHz
T1		1	2.4403167 GHz	-18.25 dBm	ndB	20.00 dB
T2		1	2.4416563 GHz	-18.15 dBm	Q factor	1822.0



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4798292 GHz	1.10 dBm	ndB down	1.3427 MHz
T1		1	2.4793197 GHz	-18.84 dBm	ndB	20.00 dB
T2		1	2.4806623 GHz	-19.04 dBm	Q factor	1847.0

10 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 eploying at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt (30dBm). 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 0.125watts (20.97 dBm) limit applies.

10.1Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power Meter.GFSK,8DPSK was tested and record.

10.2Test Result

GFSK(1Mbps)					
Test Channel	Frequency	Conducted Output Peak Power	Conducted Output Peak Power	LIMIT	Pass/Fail
	(MHz)	(dBm)	(W)	(W)	
CH00	2402	2.15	0.0016	1	Pass
CH39	2441	2.29	0.0017	1	Pass
CH78	2480	2.23	0.0017	1	Pass

8DPSK(3Mbps)					
Test Channel	Frequency	Conducted Output Peak Power	Conducted Output Peak Power	LIMIT	Pass/Fail
	(MHz)	(dBm)	(W)	(W)	
CH00	2402	1.88	0.0015	1	Pass
CH39	2441	1.75	0.0015	1	Pass
CH78	2480	1.13	0.0013	1	Pass

11 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 2400-2483.5MHz 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	:	Hopping

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.

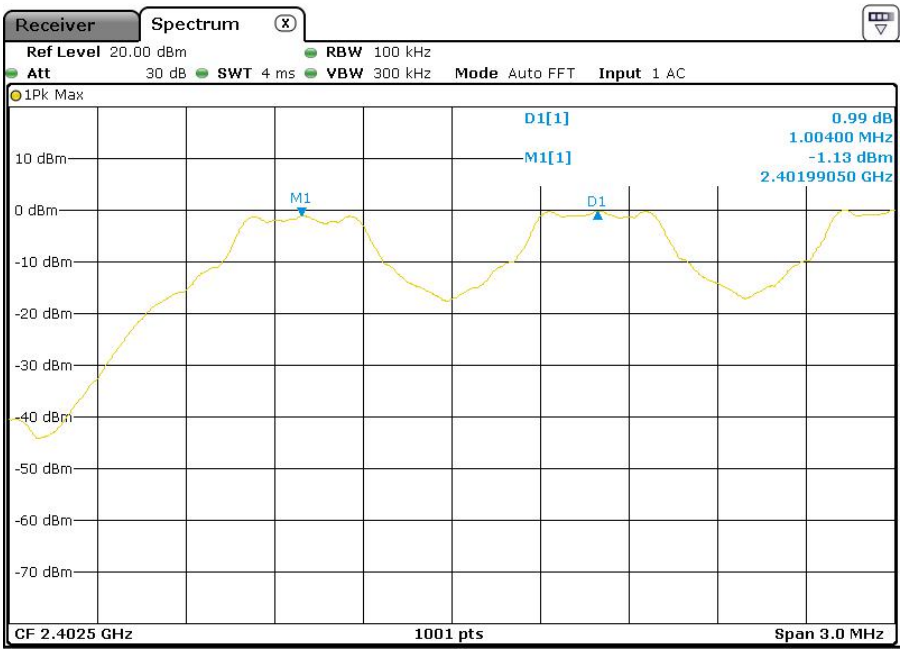
2. Set the spectrum analyzer: RBW = 100KHz. VBW =300KHz, Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

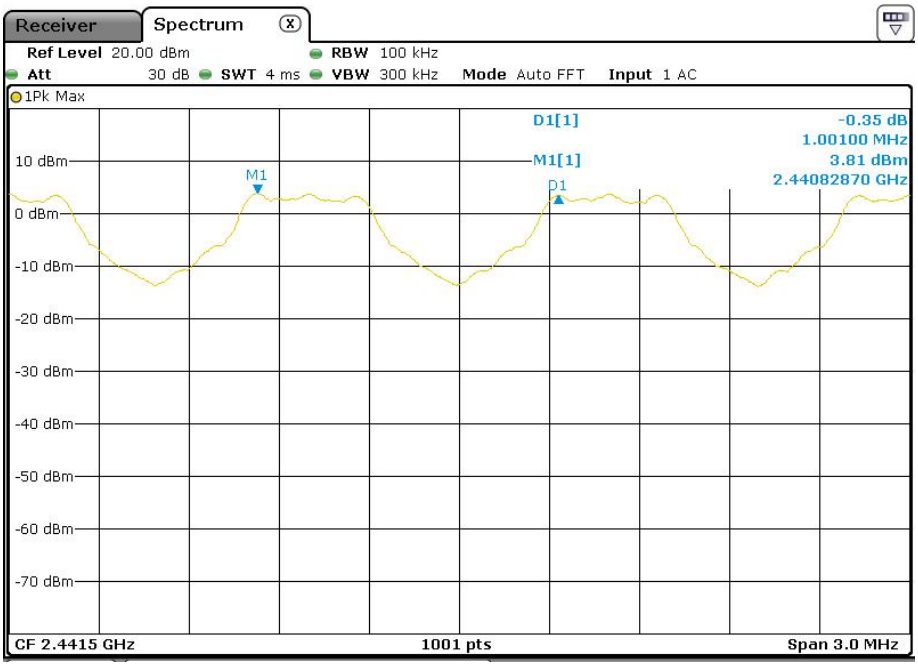
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

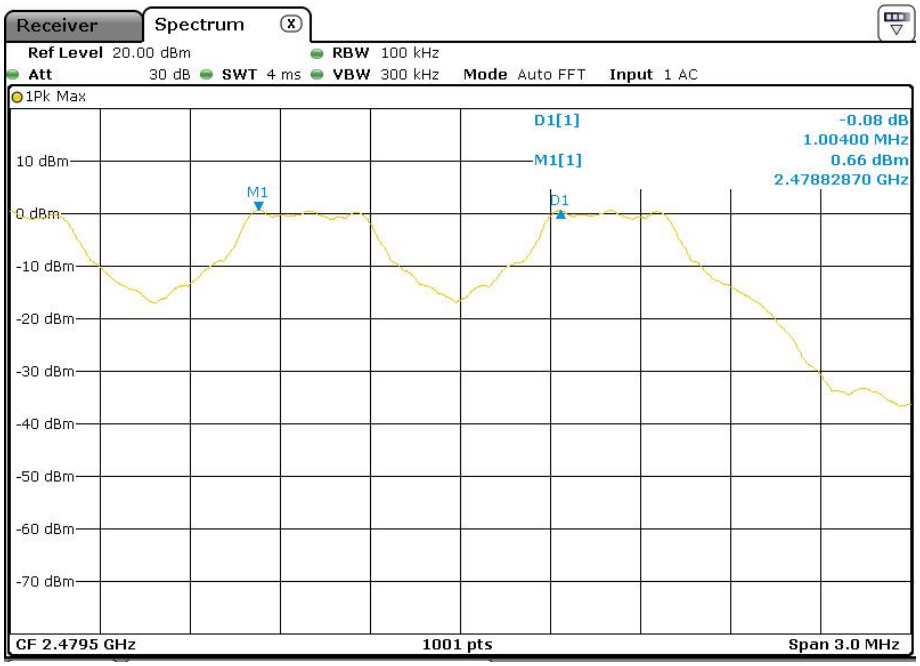
11.2 Test Result

Mode	Channel	Frequency (MHz)	Test Result (kHz)	Limit (kHz)		Result
GFSK	Low	2402	1004	669.333	2/3 of 20dB BW	Pass
	Middle	2441	1001	667.333	2/3 of 20dB BW	Pass
	High	2480	1004	669.333	2/3 of 20dB BW	Pass
8DPSK	Low	2402	1007	671.333	2/3 of 20dB BW	Pass
	Middle	2441	1013	447.555	2/3 of 20dB BW	Pass
	High	2480	1004	669.333	2/3 of 20dB BW	Pass

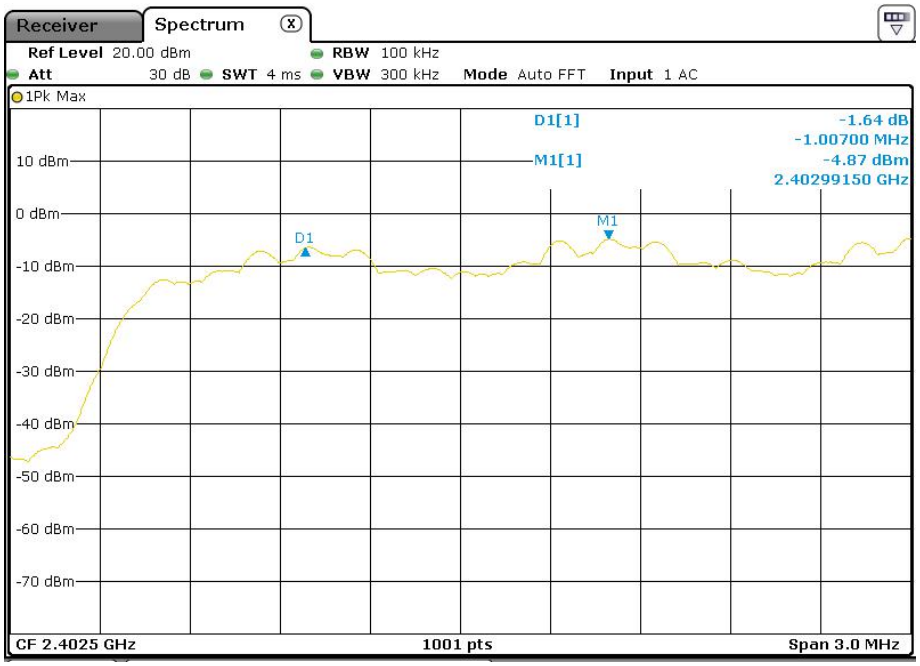
GFSK

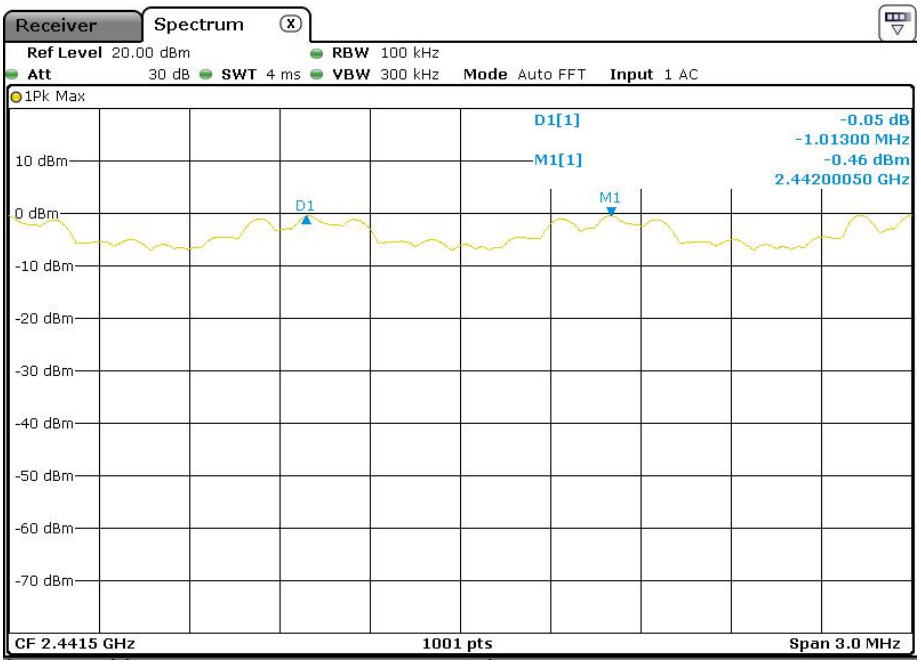


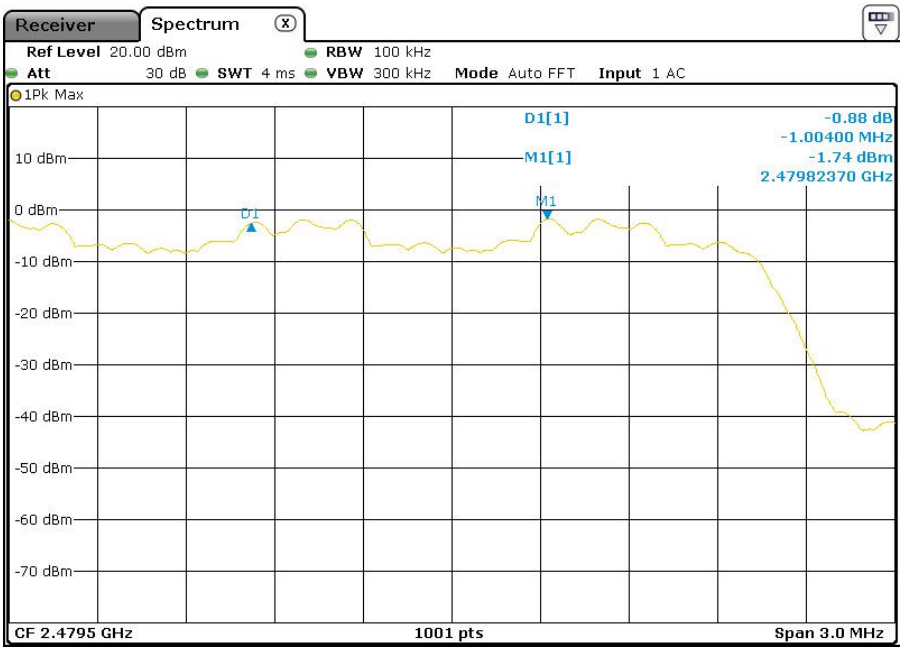

Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
D1[1]
-0.35 dB
1.00100 MHz
M1[1]
3.81 dBm
2.44082870 GHz
M1
D1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.4415 GHz
1001 pts
Span 3.0 MHz


Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
D1[1]
-0.08 dB
1.00400 MHz
M1[1]
0.66 dBm
2.47882870 GHz
M1
D1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.4795 GHz
1001 pts
Span 3.0 MHz

8DPSK


Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
D1[1]
-1.64 dB
-1.00700 MHz
M1[1]
-4.87 dBm
2.40299150 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
M1
CF 2.4025 GHz
1001 pts
Span 3.0 MHz


Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
D1[1]
-0.05 dB
-1.01300 MHz
M1[1]
-0.46 dBm
2.44200050 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
M1
CF 2.4415 GHz
1001 pts
Span 3.0 MHz


Receiver
Spectrum
Ref Level 20.00 dBm
RBW 100 kHz
Att 30 dB
SWT 4 ms
VBW 300 kHz
Mode Auto FFT
Input 1 AC
1Pk Max
D1[1]
-0.88 dB
-1.00400 MHz
M1[1]
-1.74 dBm
2.47982370 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
M1
CF 2.4795 GHz
1001 pts
Span 3.0 MHz

12 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	:	Hopping(GFSK)

12.1 Test Procedure

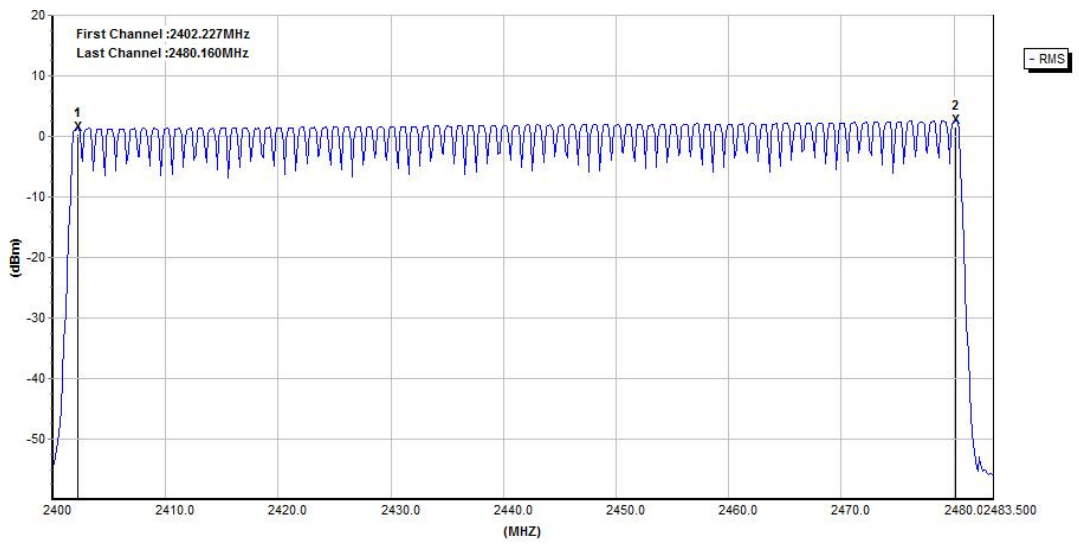
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100KHz. VBW = 300KHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to 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 = 2.483GHz. Sweep=auto;

12.2 Test Result

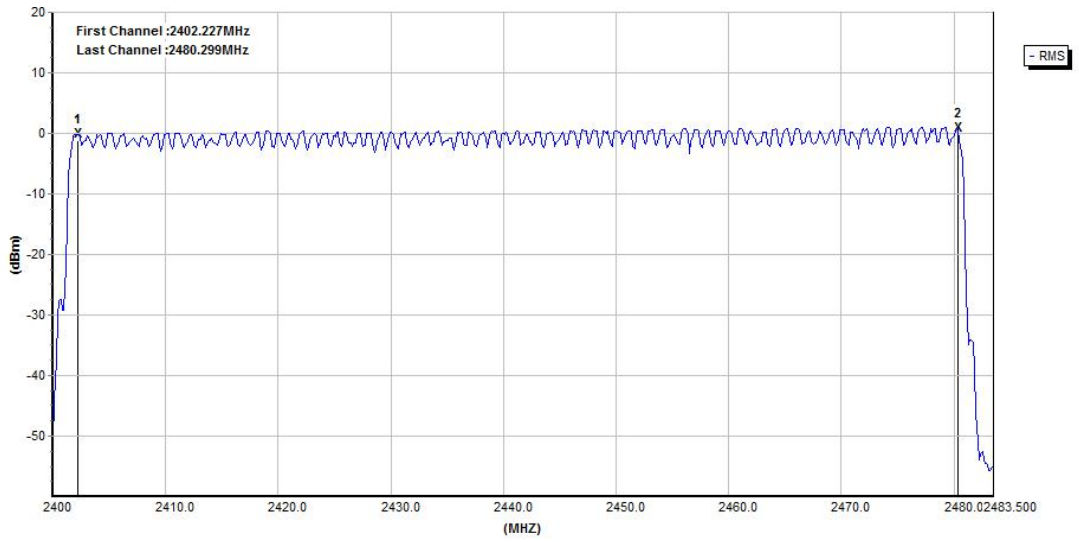
Mode	Quantity of Hopping Channel	Limit	Results
GFSK, π/4-DQPSK, 8DPSK	79	>15	Pass

Test plots

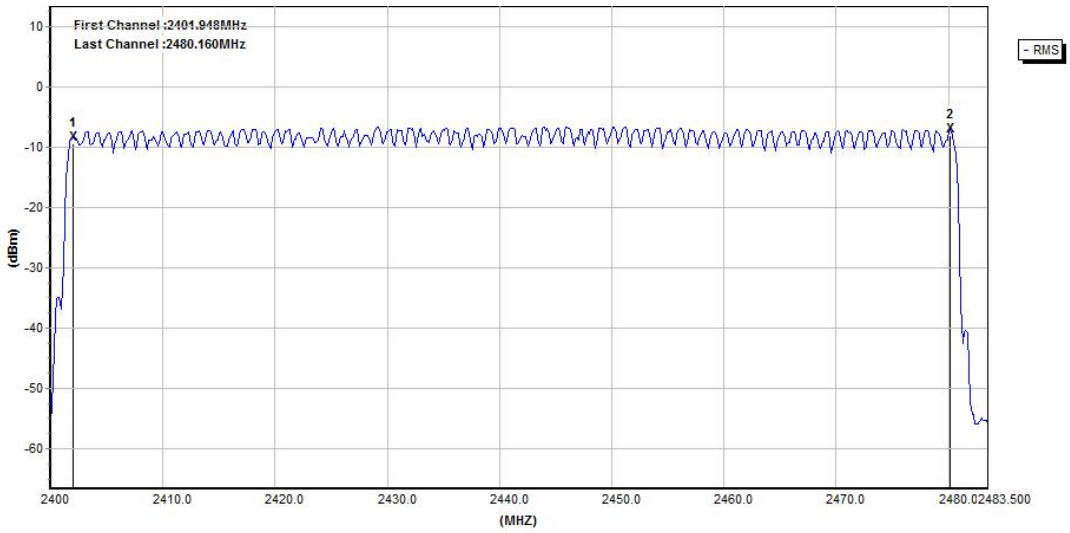
GFSK mode



π/4-DQPSK mode



8DPSK mode


First Channel :2401.948MHz
Last Channel :2480.160MHz
RMS
10
0
-10
-20
-30
-40
-50
-60
(dBm)
1
2
2400
2410.0
2420.0
2430.0
2440.0
2450.0
2460.0
2470.0
2480.02483.500
(MHZ)

13 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.
Test Mode	:	The test model GFSK and 8DPSK was recorded.

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.

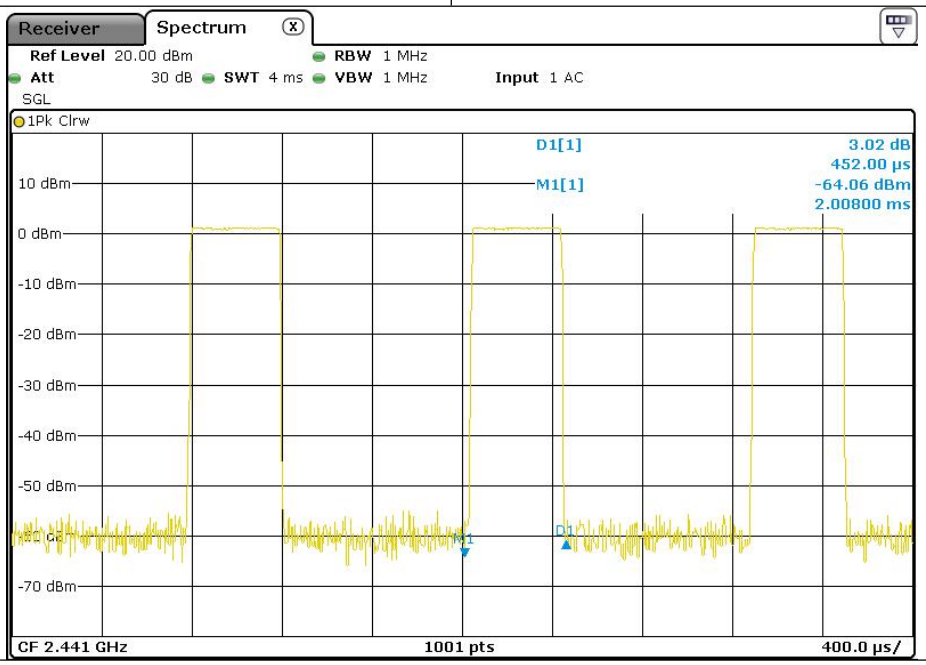
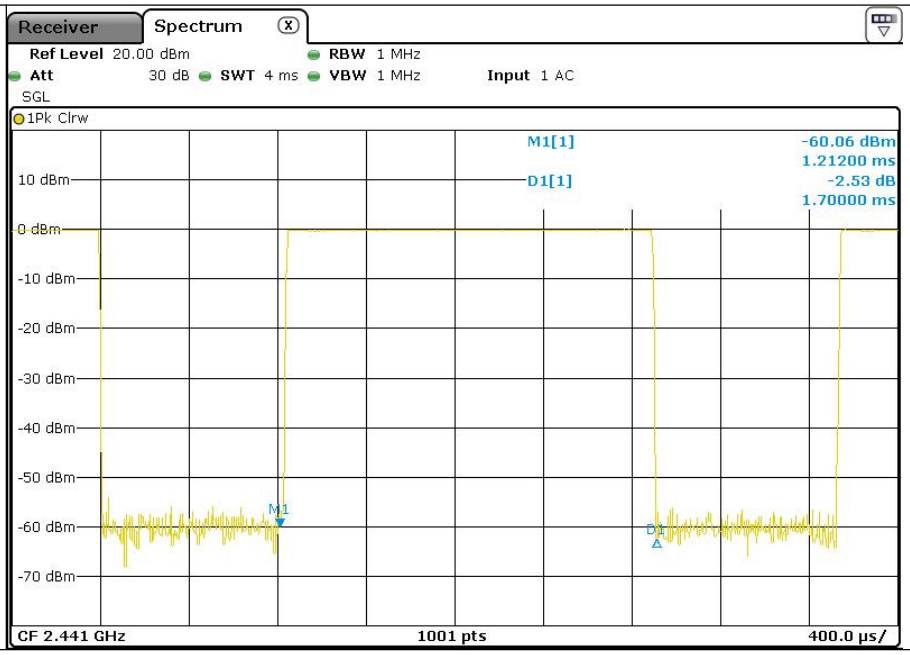
2. Set spectrum analyzer span = 0. Centred on a hopping channel;

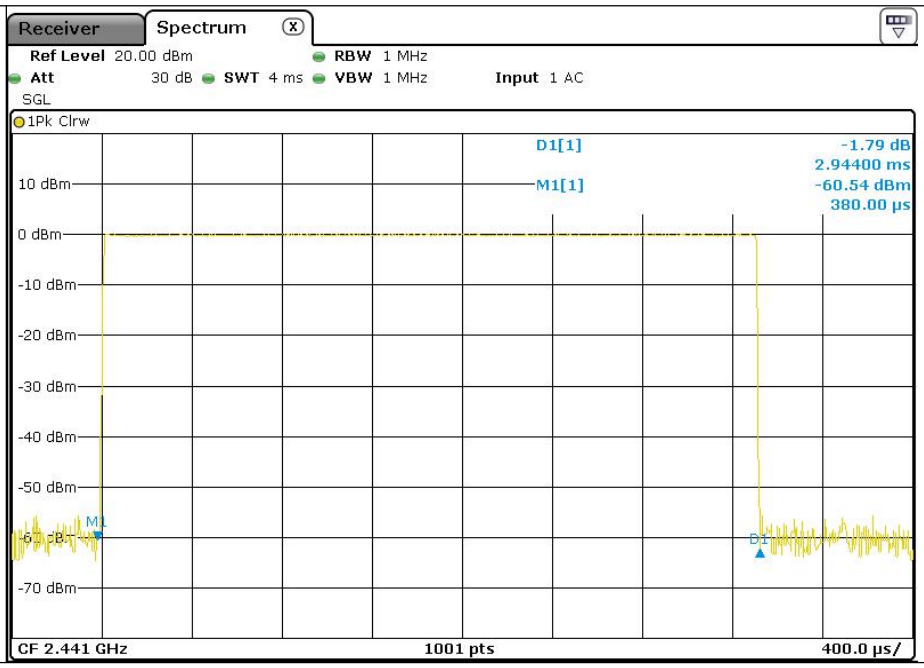
3. Set RBW = 1MHz and VBW = 1MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.

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).

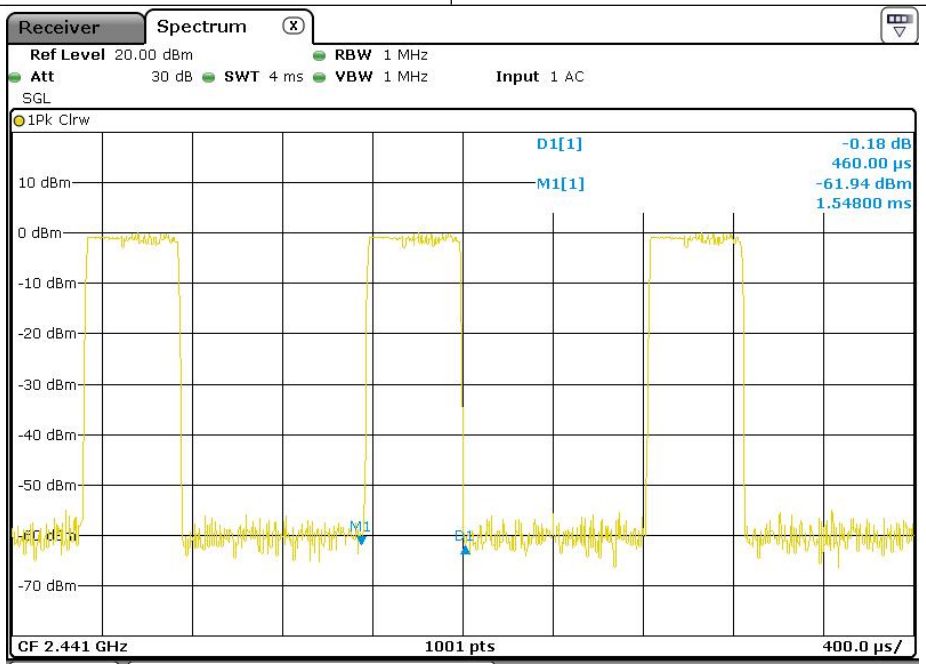
13.2 Test Result

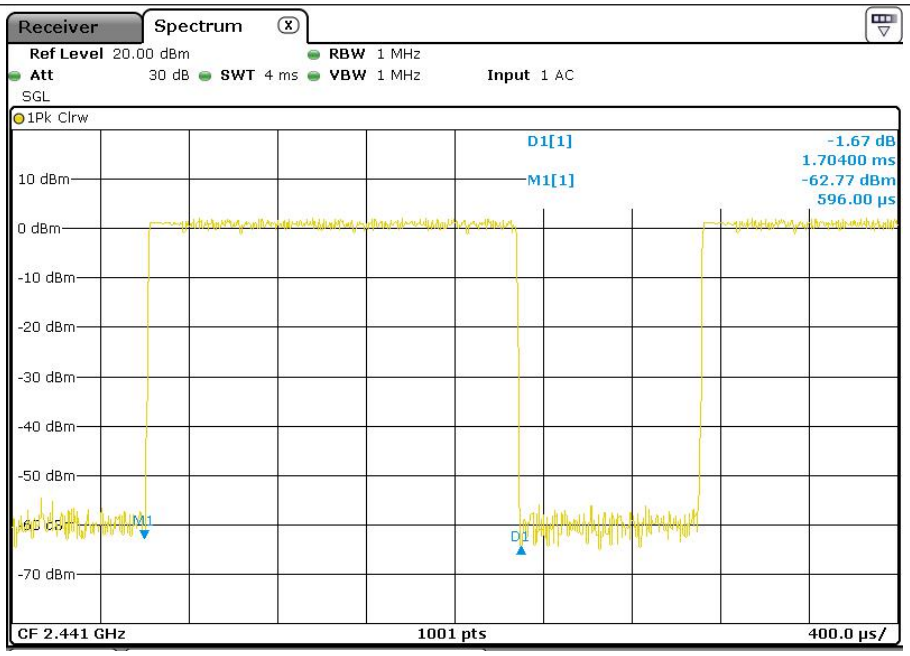
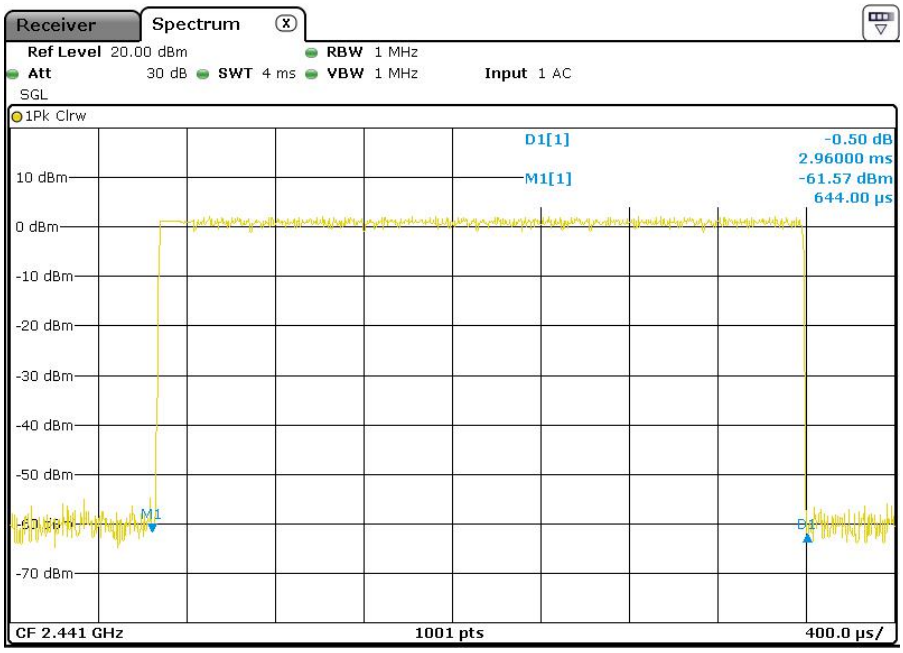
Data rate	Frequency	Plus Duration （ms）	Dwell Time （s）	Limits （s）
DH1	2441MHz	0.452	0.144	0.4
DH3	2441MHz	1.212	0.193	0.4
DH5	2441MHz	2.944	0.314	0.4

Modulation mode	GFSK mode
DH1	
DH3	

DH5	 Receiver Spectrum Ref Level 20.00 dBm RBW 1 MHz Att 30 dB SWT 4 ms VBW 1 MHz Input 1 AC SGL 1Pk Clrw D1[1] -1.79 dB 2.94400 ms M1[1] -60.54 dBm 380.00 µs 10 dBm 0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm M1 D1 CF 2.441 GHz 1001 pts 400.0 µs/

Data rate	Frequency	Plus Duration （ms）	Dwell Time （s）	Limits （s）
3DH1	2441MHz	0.460	0.147	0.4
3DH3	2441MHz	1.704	0.272	0.4
3DH5	2441MHz	2.960	0.315	0.4

Modulation mode	8DPSK mode
3-DH1	

3-DH3	 Receiver Spectrum Ref Level 20.00 dBm RBW 1 MHz Att 30 dB SWT 4 ms VBW 1 MHz Input 1 AC SGL 1Pk Clrw D1[1] -1.67 dB 1.70400 ms M1[1] -62.77 dBm 596.00 µs 10 dBm 0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm M1 D1 CF 2.441 GHz 1001 pts 400.0 µs/
3-DH5	 Receiver Spectrum Ref Level 20.00 dBm RBW 1 MHz Att 30 dB SWT 4 ms VBW 1 MHz Input 1 AC SGL 1Pk Clrw D1[1] -0.50 dB 2.96000 ms M1[1] -61.57 dBm 644.00 µs 10 dBm 0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm M1 D1 CF 2.441 GHz 1001 pts 400.0 µs/

14 Antenna Requirement

14.1 Antenna Requirement

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. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

14.2 Result

The EUT’S antenna, permanent attached antenna, is Internal ceramic Antenna. The antenna’s gain is 2dBi and meets the requirement.

********THE END REPORT********