FCC TEST REPORT

Test report
On Behalf of
KINGRAY ELECTRONICS Co., LTD
For
Wireless Headphones
Model No.: BB489, BB490, KR603
FCC ID: 2AML6KR603

Prepared for :	**KINGRAY ELECTRONICS Co., LTD** **Building B, Ge Tailong Industrial Park,No.445 Bulong Rd,BanTian,LongGang, Shenzhen, Guangdong, China**
Prepared By :	**Shenzhen HUAK Testing Technology Co., Ltd.** **1F, B2 Building, Junfeng Zhongcheng Zhizao Innovation Park, Fuhai Street, Bao'an District, Shenzhen City, China**

TEST REPORT

Applicant's name.....:	**KINGRAY ELECTRONICS Co., LTD**
Address.....:	Building B, Ge Tailong Industrial Park,No.445 Bulong Rd,BanTian,LongGang, Shenzhen, Guangdong, China
Manufacture's Name .....:	**KINGRAY ELECTRONICS Co., LTD**
Address.....:	Building B, Ge Tailong Industrial Park,No.445 Bulong Rd,BanTian,LongGang, Shenzhen, Guangdong, China

Product description

Trade Mark:	N/A
Product name.....:	Wireless Headphones
Model and/or type reference ..:	BB489, BB490, KR603
Standards.....:	FCC Rules and Regulations Part 15 Subpart C Section 15.247 ANSI C63.10: 2013

Date of Test..... :	
Date (s) of performance of tests ..... :	Feb. 18, 2019 ~ Feb. 25, 2019
Date of Issue ..... :	Feb. 26, 2019
Test Result ..... :	**Pass**

Testing Engineer	:	Gary Qian
		(Gary Qian)
Technical Manager	:	Eden Hu
		(Eden Hu)
Authorized Signatory	:	Jason Zhou
		(Jason Zhou)

Contents

1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
KDB558074 D01 v05r01: Guidance for Compliance Measurements on Digital Transmission Systems (DTS) ,Frequency Hopping Spread Spectrum System(HFSS), and Hybrid System Devices Operating Under §15.247 of The FCC rules.

2. SUMMARY

2.1. Product Description

Name of EUT:	Wireless Headphones
Trade Mark:	N/A
Model Number:	BB489
List Model:	BB490, KR603
Power Rating:	DC 3.7V and DC 5V From Adapter
Adapter(Auxiliary test Provided by the laborator):	Mode:EP-TA20CBC Input:AC100-240V-50/60Hz，0.5A Output:DC 5V,2A
FCC ID:	2AML6KR603
Operation frequency:	2402MHz-2480MHz
Modulation:	GFSK,8DPSK,π/4DQPSK
Antenna Type:	PCB antenna
Antenna gain:	0.0dBi

2.2. Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 3.7V and DC 5V From Adapter

2.3. Short description of the Equipment under Test (EUT)

This is a Wireless Headphones.

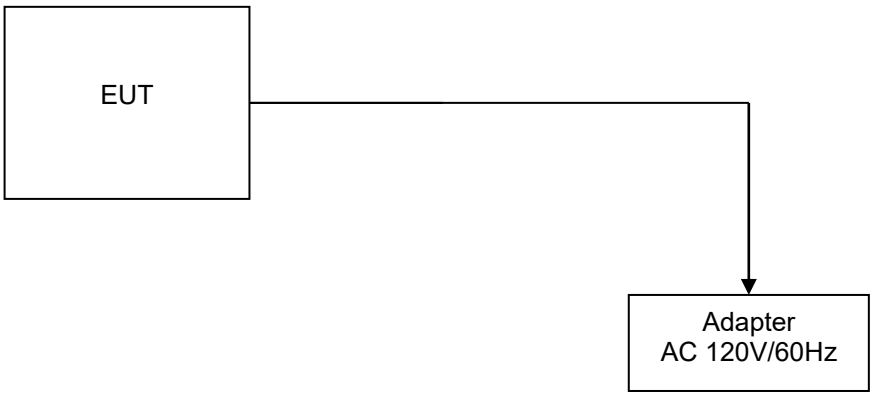
For more details, refer to the user's manual of the EUT.

2.4. EUT operation mode

The Applicant provides test software (FCCAssist.exe) to control the EUT for staying in continuous transmitting and receiving mode for testing .There are 79 channels provided to the EUT. Channel 00/39/78 was selected to test.

Channel	Frequency(MHz)	Channel	Frequency(MHz)
00	**2402**	40	2442
01	2403	41	2443
02	2404	42	2444
03	2405	43	2445
04	2406	44	2446
05	2407	45	2447
06	2408	46	2448
07	2409	47	2449
08	2410	48	2450
09	2411	49	2451
10	2412	50	2452
11	2413	51	2453
12	2414	52	2454
13	2415	53	2455
14	2416	54	2456
15	2417	55	2457
16	2418	56	2458
17	2419	57	2459
18	2420	58	2460
19	2421	59	2461
20	2422	60	2462
21	2423	61	2463
22	2424	62	2464
23	2425	63	2465
24	2426	64	2466
25	2427	65	2467
26	2428	66	2468
27	2429	67	2469
28	2430	68	2470
29	2431	69	2471
30	2432	70	2472
31	2433	71	2473
32	2434	72	2474
33	2435	73	2475
34	2436	74	2476
35	2437	75	2477
36	2438	76	2478
37	2439	77	2479
38	2440	**78**	**2480**
39	**2441**		

2.5. Block Diagram of Test Setup



2.6. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: 2AML6KR603 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.7. Modifications

No modifications were implemented to meet testing criteria.

3. TEST ENVIRONMENT

3.1. TEST FACILITY

Test Firm : Shenzhen HUAK Testing Technology Co., Ltd.

Address 1F, B2 Building, Junfeng Zhongcheng Zhizao Innovation Park, Fuhai Street, Bao'an District, Shenzhen City, China

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

3.3. Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Pass	Fail	NA	NP	Remark
§15.247(a)(1)	Carrier Frequency separation	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	☒	☐	☐	☐	complies
§15.247(a)(1)	Number of Hopping channels	GFSK Π/4DQPSK 8DPSK	☒ Full	GFSK 8DPSK	☒ Full	☒	☐	☐	☐	complies
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	☒	☐	☐	☐	complies
§15.247(a)(1)	Spectrum bandwidth of a FHSS system 20dB bandwidth	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.247(b)(1)	Maximum output power	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.247(d)	Band edge compliance conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	☒	☐	☐	☐	complies
§15.205	Band edge compliance radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK	☒ Lowest ☒ Highest	☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.209(a)	TX spurious Emissions radiated Below 1GHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Middle	☒	☐	☐	☐	complies
§15.107(a) §15.207	Conducted Emissions 9KHz-30 MHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Middle	☒	☐	☐	☐	complies

Remark:
1. The measurement uncertainty is not included in the test result.
2. NA = Not Applicable; NP = Not Performed
3. We tested all test mode and recorded worst case in report

3.4. Statement of the measurement uncertainty

Measurement Uncertainty

Conducted Emission Expanded Uncertainty	=	2.23dB, k=2
Radiated emission expanded uncertainty(9kHz-30MHz)	=	3.08dB, k=2
Radiated emission expanded uncertainty(30MHz-1000MHz)	=	4.42dB, k=2
Radiated emission expanded uncertainty(Above 1GHz)	=	4.06dB, k=2

3.5. Equipments Used during the Test

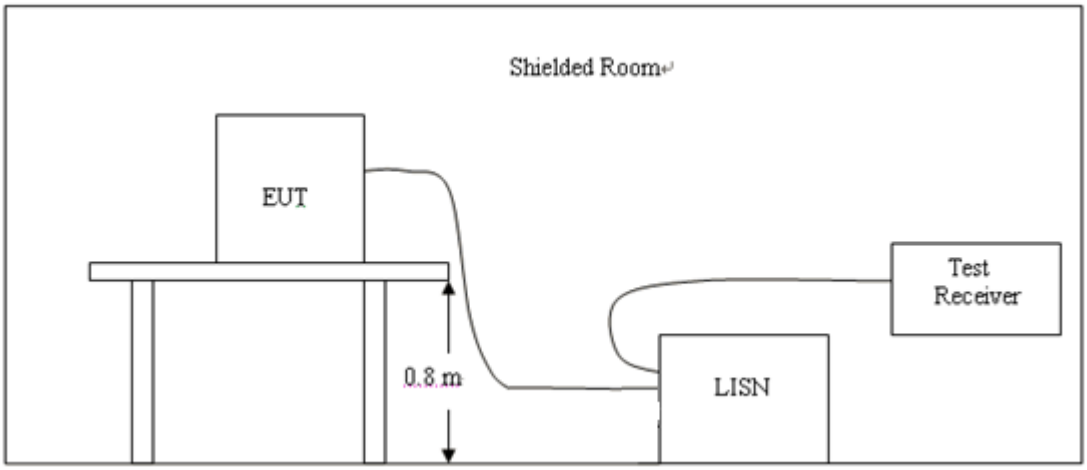
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	L.I.S.N. Artificial Mains Network	R&S	ENV216	HKE-002	Dec. 27, 2018	1 Year
2.	Receiver	R&S	ESCI 7	HKE-010	Dec. 27, 2018	1 Year
3.	RF automatic control unit	Tonscend	JS0806-2	HKE-060	Dec. 27, 2018	1 Year
4.	Spectrum analyzer	R&S	FSP40	HKE-025	Dec. 27, 2018	1 Year
5.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 27, 2018	1 Year
6.	Preamplifier	Schwarzbeck	BBV 9743	HKE-006	Dec. 27, 2018	1 Year
7.	EMI Test Receiver	Rohde & Schwarz	ESCI 7	HKE-010	Dec. 27, 2018	1 Year
8.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	HKE-012	Dec. 27, 2018	1 Year
9.	Loop Antenna	Schwarzbeck	FMZB 1519 B	HKE-014	Dec. 27, 2018	1 Year
10.	Horn Antenna	Schewarzbeck	9120D	HKE-013	Dec. 27, 2018	1 Year
11.	Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	HKE-017	Dec. 27, 2018	1 Year
12.	Pre-amplifier	EMCI	EMC051845 SE	HKE-015	Dec. 27, 2018	1 Year
13.	Pre-amplifier	Agilent	83051A	HKE-016	Dec. 27, 2018	1 Year
14.	EMI Test Software EZ-EMC	Tonscend	JS1120-B Version	HKE-083	Dec. 27, 2018	N/A
15.	Power Sensor	Agilent	E9300A	HKE-086	Dec. 27, 2018	1 Year
16.	Spectrum analyzer	Agilent	N9020A	HKE-048	Dec. 27, 2018	1 Year
17.	Signal generator	Agilent	N5182A	HKE-029	Dec. 27, 2018	1 Year
18.	Signal Generator	Agilent	83630A	HKE-028	Dec. 27, 2018	1 Year
19.	Shielded room	Shiel Hong	4*3*3	HKE-039	Dec. 27, 2018	3 Year
20.	RF Cable(below 1GHz)	HUBER+SUHNER	RG214	HKE-055	Dec. 27, 2018	1 Year
21.	RF Cable(above 1GHz)	HUBER+SUHNER	RG214	HKE-056	Dec. 27, 2018	1 Year

Note: 1. The Cal.Interval was one year.

4. TEST CONDITIONS AND RESULTS

4.1. AC Power Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

1, The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10.
2, Support equipment, if needed, was placed as per ANSI C63.10.
3, All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.
4, If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5, All support equipments received AC power from a second LISN, if any.
6, The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7, Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.

AC Power Conducted Emission Limit

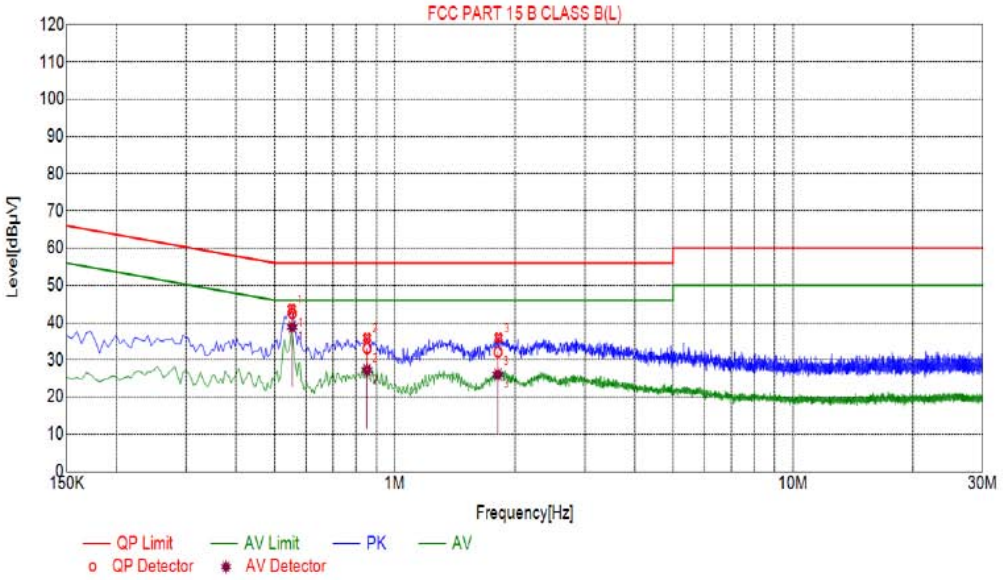
For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

TEST RESULTS

Remark:
1. All modes of GFSK, Pi/4 DQPSK, and 8DPSK were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:
2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:.

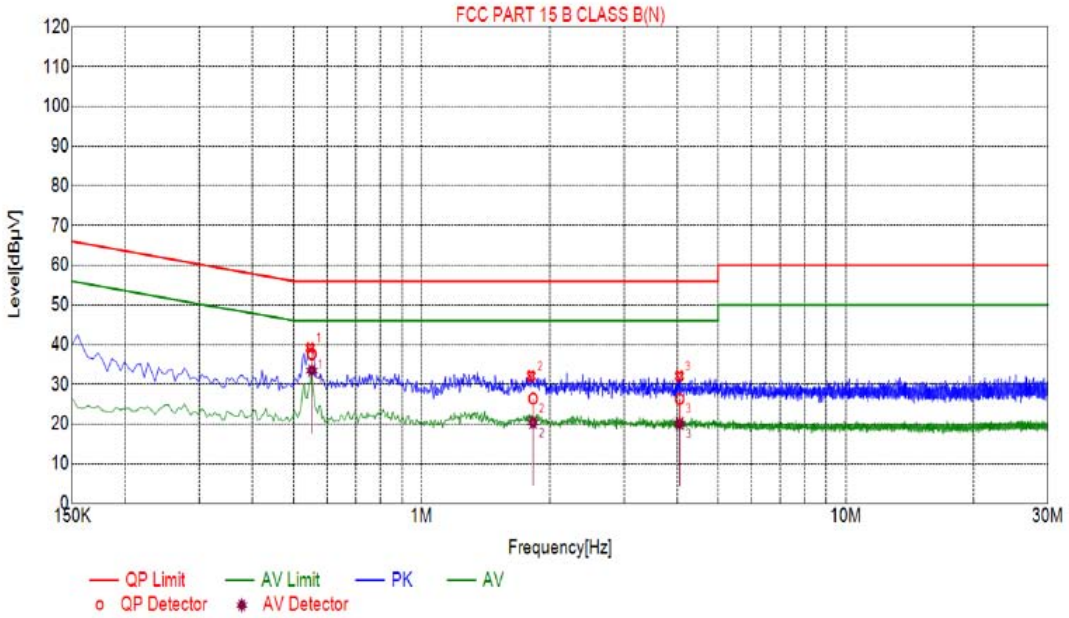
Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	L



Final Data List

NO.	Freq. [MHz]	Factor [dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]
1	0.5522	10.06	42.50	56.00	13.50	38.83	46.00	7.17
2	0.8517	10.06	33.12	56.00	22.88	27.29	46.00	18.71
3	1.8186	10.14	32.16	56.00	23.84	26.10	46.00	19.90

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	N



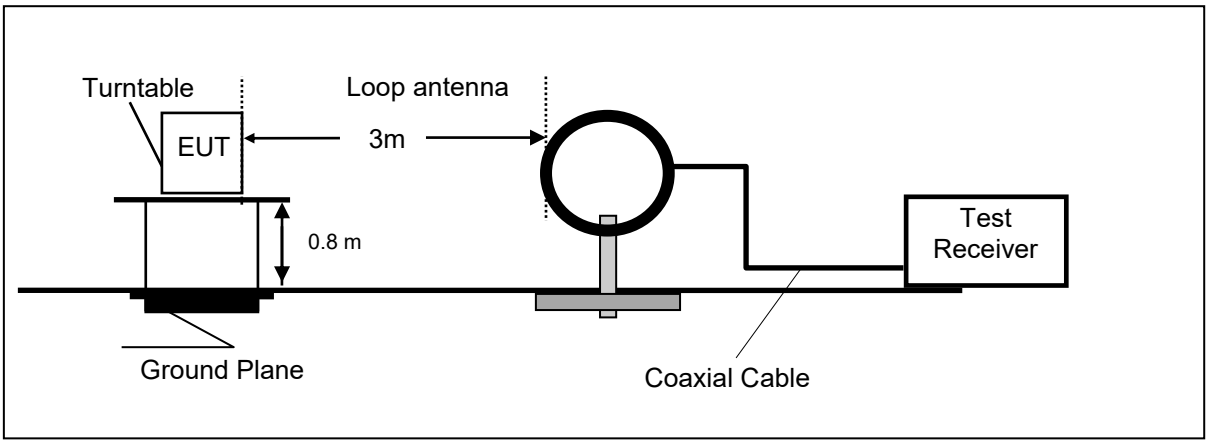
Final Data List

NO.	Freq. [MHz]	Factor [dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]
1	0.5507	10.06	37.62	56.00	18.38	33.48	46.00	12.52
2	1.8331	10.14	26.44	56.00	29.56	20.40	46.00	25.60
3	4.0560	10.25	26.36	56.00	29.64	20.14	46.00	25.86

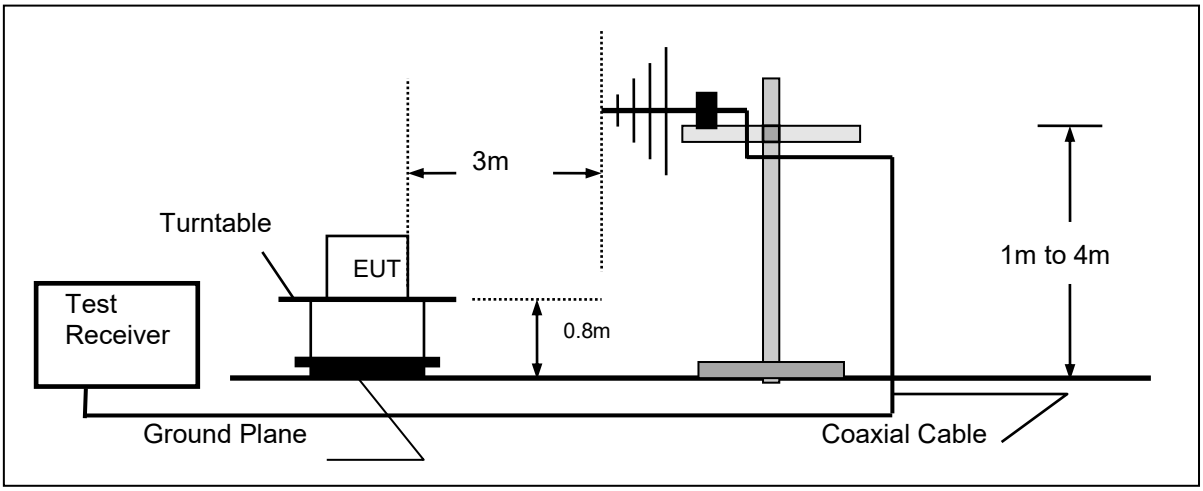
4.2. Radiated Emission

TEST CONFIGURATION

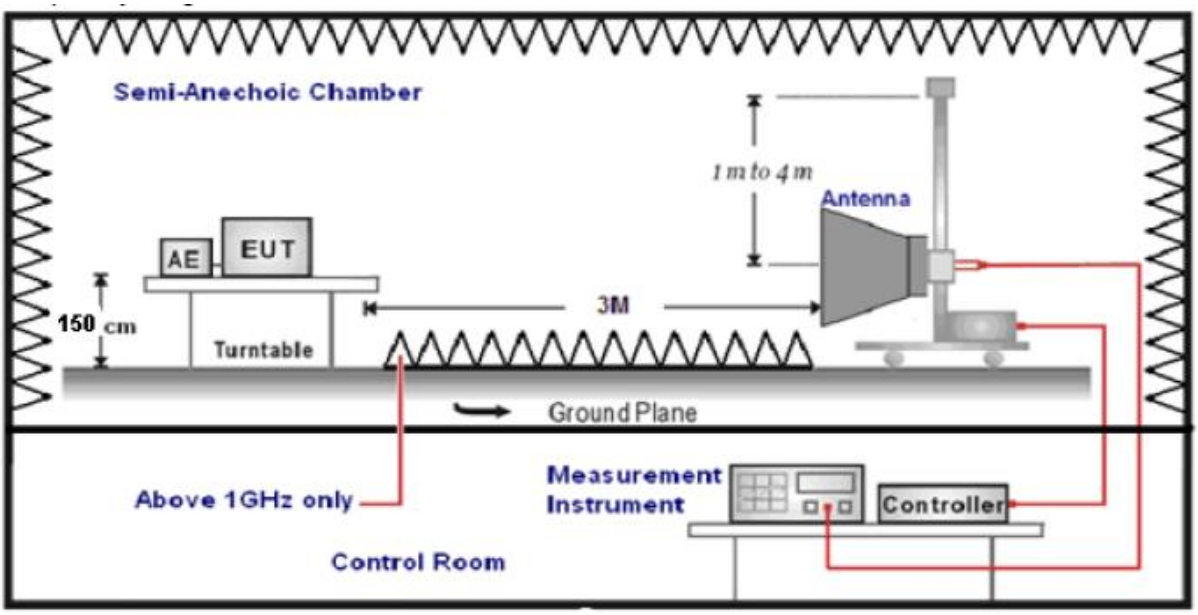
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 12mm above ground plane when testing frequency range 9 KHz –25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Anternna	1

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

Transd=AF +CL-AG

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.
The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

TEST RESULTS

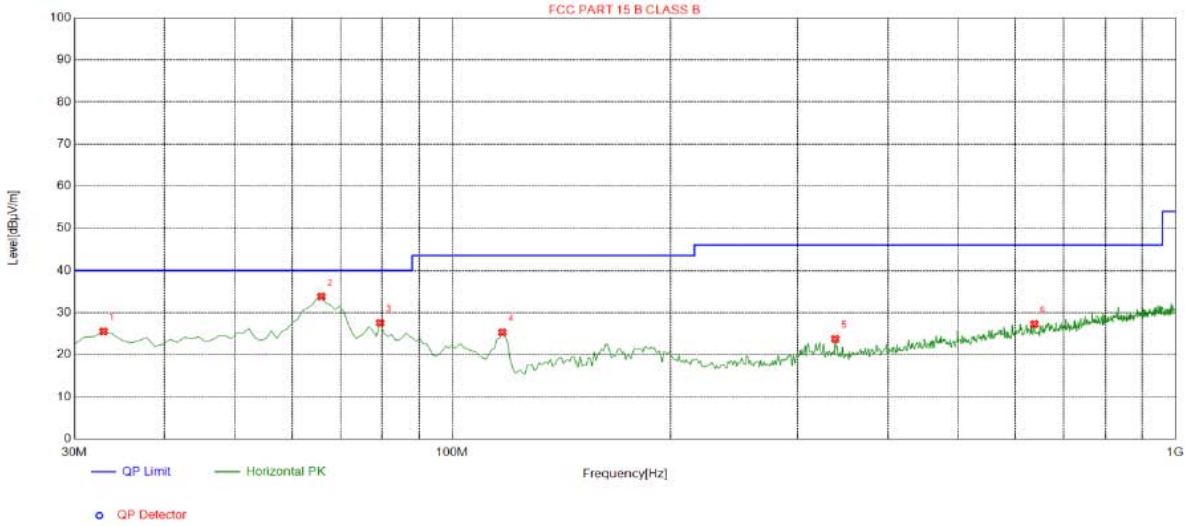
Remark: For test below 1GHz all modes of GFSK, Pi/4 DQPSK, and 8DPSK were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:

For 9 KHz-30MHz

Frequency (MHz)	Corrected Reading (dBuV/m)@3m	FCC Limit (dBuV/m) @3m	Margin (dB)	Detector	Result
0.42	51.58	95.14	43.56	QP	PASS
1.59	48.23	63.58	15.35	QP	PASS
15.75	52.88	69.54	16.66	QP	PASS
20.67	49.83	69.54	19.71	QP	PASS

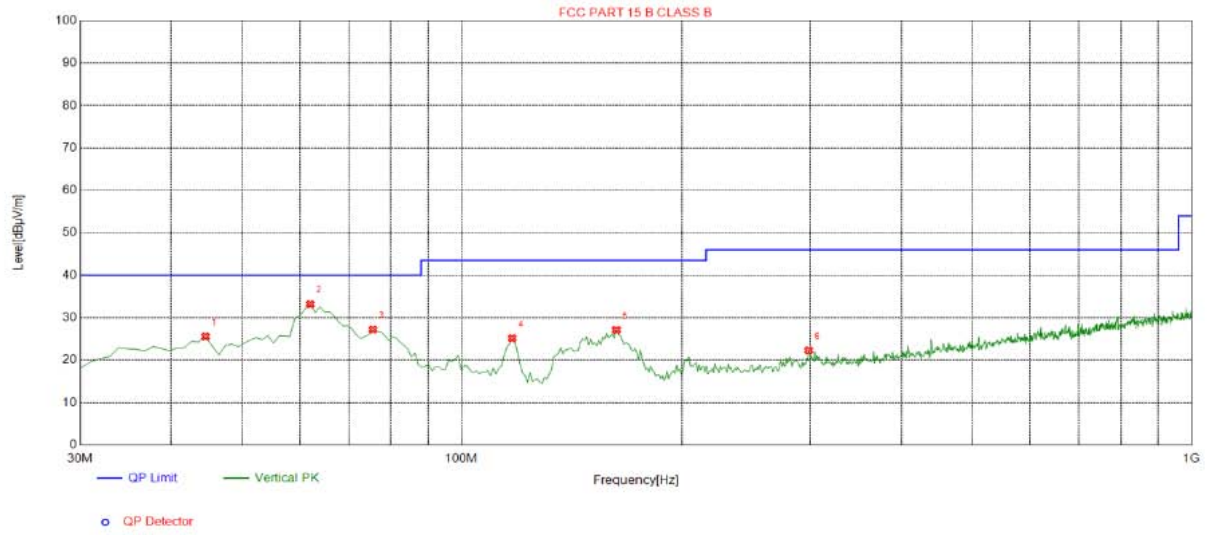
For 30MHz-1GHz

Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	32.9100	25.57	-16.23	40.00	14.43	100	102	Horizontal
2	65.8900	33.86	-16.64	40.00	6.14	100	70	Horizontal
3	79.4700	27.59	-19.37	40.00	12.41	100	8	Horizontal
4	117.300	25.33	-16.65	43.50	18.17	100	236	Horizontal
5	338.460	23.78	-11.63	46.00	22.22	100	252	Horizontal
6	638.190	27.30	-5.62	46.00	18.70	100	153	Horizontal

Vertical



Suspected List

NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	44.5500	25.57	-13.73	40.00	14.43	100	44	Vertical
2	62.0100	33.19	-15.66	40.00	6.81	100	235	Vertical
3	75.5900	27.21	-18.68	40.00	12.79	100	76	Vertical
4	117.300	25.14	-16.65	43.50	18.36	100	181	Vertical
5	162.890	27.12	-17.95	43.50	16.38	100	207	Vertical
6	298.690	22.29	-12.75	46.00	23.71	100	12	Vertical

For 1GHz to 25GHz

Remark: For test above 1GHz GFSK, Pi/4 DQPSK, and 8DPSK were test at Low, Middle, and High channel; only the worst result of GFSK was reported as below:

CH Low (2402MHz)

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804	59.89	-3.64	56.25	74	-17.75	peak
4804	51.19	-3.64	47.55	54	-6.45	AVG
7206	49.49	-0.95	48.54	74	-25.46	peak
7206	40.43	-0.95	39.48	54	-14.52	AVG
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Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4804	62.76	-3.64	59.12	74	-14.88	peak
4804	53.88	-3.64	50.24	54	-3.76	AVG
7206	50.8	-0.95	49.85	74	-24.15	peak
7206	41.32	-0.95	40.37	54	-13.63	AVG
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Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH Middle (2441MHz)

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882	60.77	-3.51	57.26	74	-16.74	peak
4882	51.92	-3.51	48.41	54	-5.59	AVG
7326	50.15	-0.82	49.33	74	-24.67	peak
7326	41.06	-0.82	40.24	54	-13.76	AVG
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Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4882	63.74	-3.51	60.23	74	-13.77	peak
4882	54.76	-3.51	51.25	54	-2.75	AVG
7326	50.93	-0.82	50.11	74	-23.89	peak
7326	41.97	-0.82	41.15	54	-12.85	AVG
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Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH High (2480MHz)

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960	61.28	-3.43	57.85	74	-16.15	peak
4960	52.65	-3.43	49.22	54	-4.78	AVG
7440	49.11	-0.75	48.36	74	-25.64	peak
7440	41.32	-0.75	40.57	54	-13.43	AVG
---	---	---	---	---	---	---
---	---	---	---	---	---	---
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

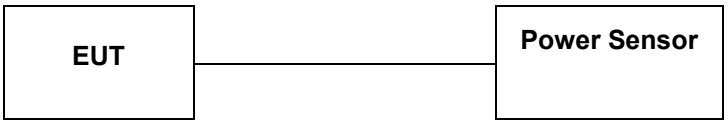
Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
4960	62.87	-3.43	59.44	74	-14.56	peak
4960	53.71	-3.43	50.28	54	-3.72	AVG
7440	50.38	-0.75	49.63	74	-24.37	peak
7440	42.02	-0.75	41.27	54	-12.73	AVG
---	---	---	---	---	---	---
---	---	---	---	---	---	---
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Remark：
(1) Data of measurement within this frequency range shown “--- ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
(2) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed.

4.3. Maximum Peak Output Power

TEST CONFIGURATION



TEST PROCEDURE

According to ANSI C63.10:2013 Maximum peak conducted output power for HFSS devices:
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the HFSS bandwidth and shall utilize a fast-responding diode detector.

LIMIT

For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

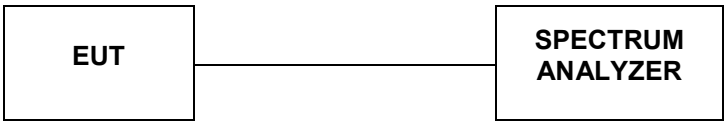
TEST RESULTS

Type	Channel	Peak Output power (dBm)	Limit (dBm)	Result
GFSK	00	4.311	21	Pass
	39	4.354		
	78	4.652		
π/4DQPSK	00	4.205	21	Pass
	39	4.125		
	78	4.741		
8DPSK	00	4.236	21	Pass
	39	4.547		
	78	4.418		

Note: 1.The test results including the cable lose.

4.4. 20dB Bandwidth

TEST CONFIGURATION



TEST PROCEDURE

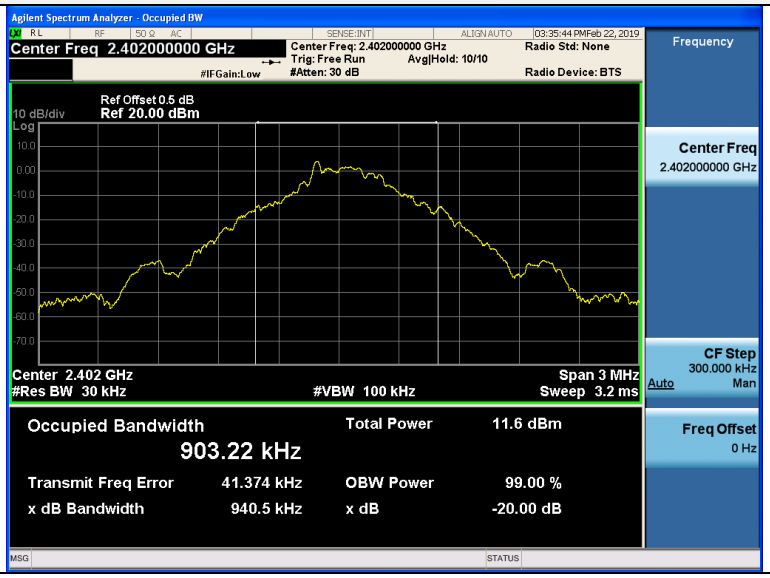
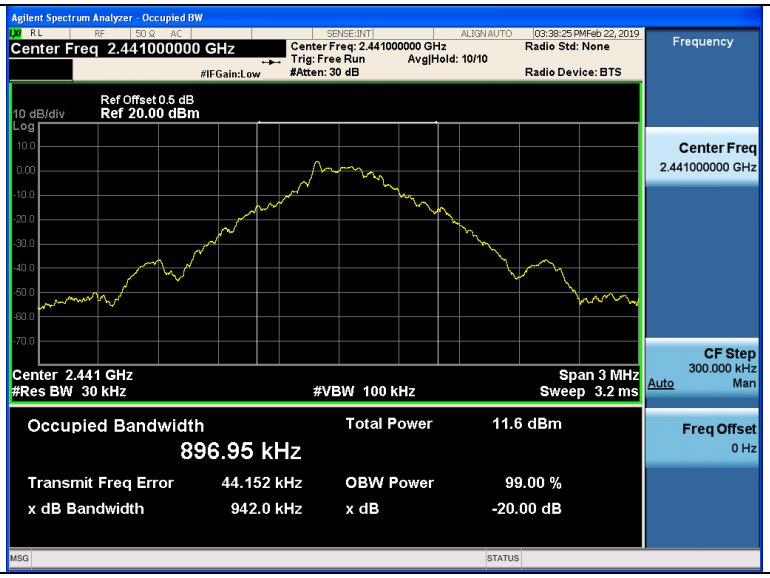
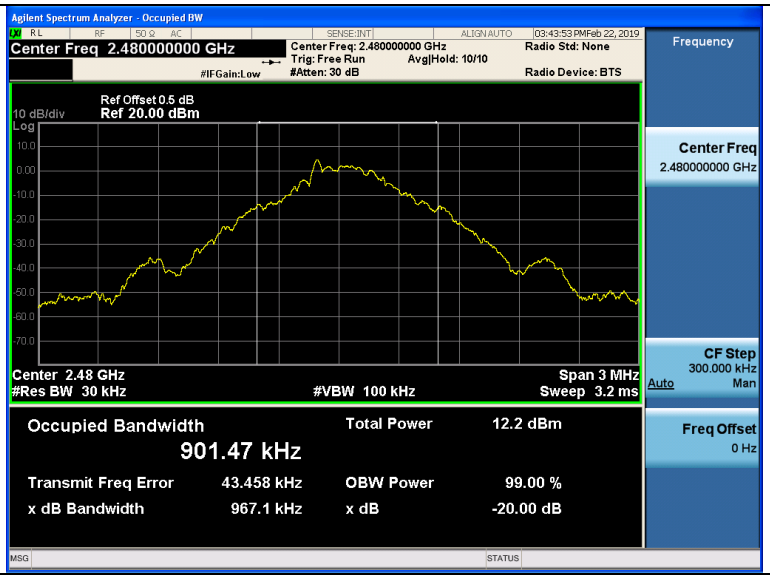
The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=30 KHz and VBW=100KHz.
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

LIMIT

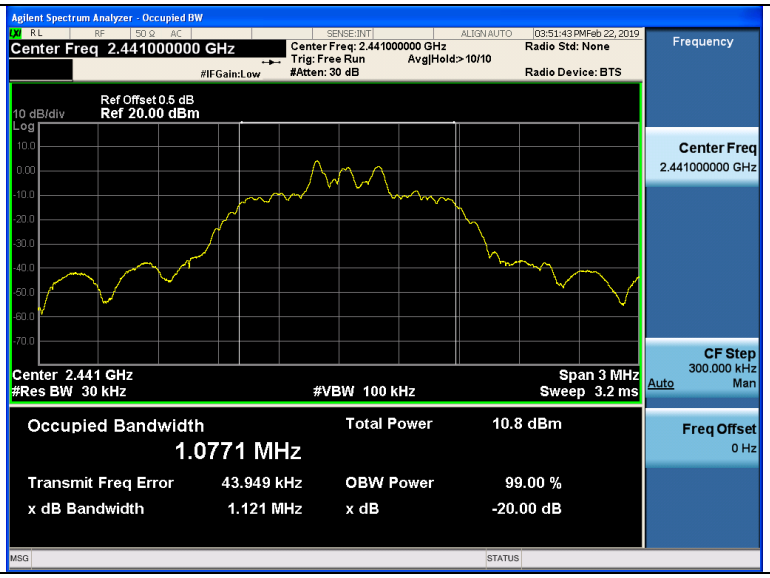
For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwith.

TEST RESULTS

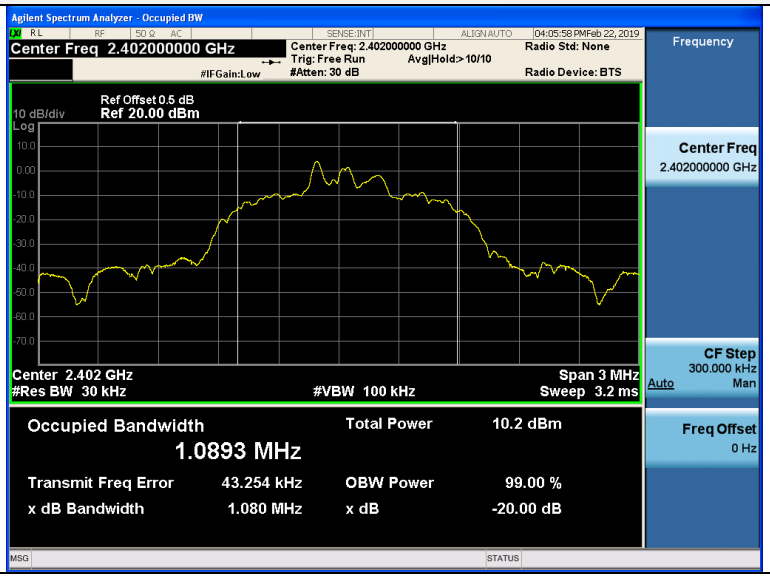
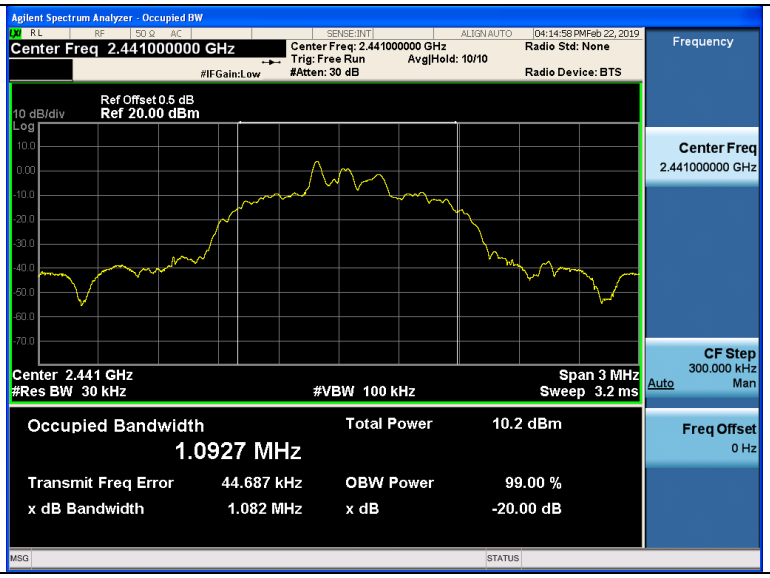
Modulation	Channel	20dB bandwidth (MHz)	99% OBW (MHz)	Result
GFSK	CH00	0.9405	0.90322	Pass
	CH39	0.9420	0.89695	
	CH78	0.9671	0.90147	
π/4DQPSK	CH00	1.121	1.0783	
	CH39	1.121	1.0771	
	CH78	1.121	1.0799	
8DPSK	CH00	1.080	1.0893	
	CH39	1.082	1.0927	
	CH78	1.125	1.0959	

GFSK Modulation

CH00

CH39

CH78

π/4DQPSK Modulation

CH00

CH39

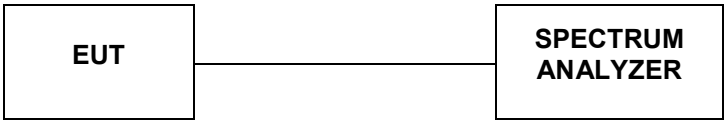
CH78

8DPSK Modulation

CH00

CH39

CH78

4.5. Frequency Separation

TEST CONFIGURATION



TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=30 KHz and VBW=100KHz.

LIMIT

According to 15.247(a)(1),frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

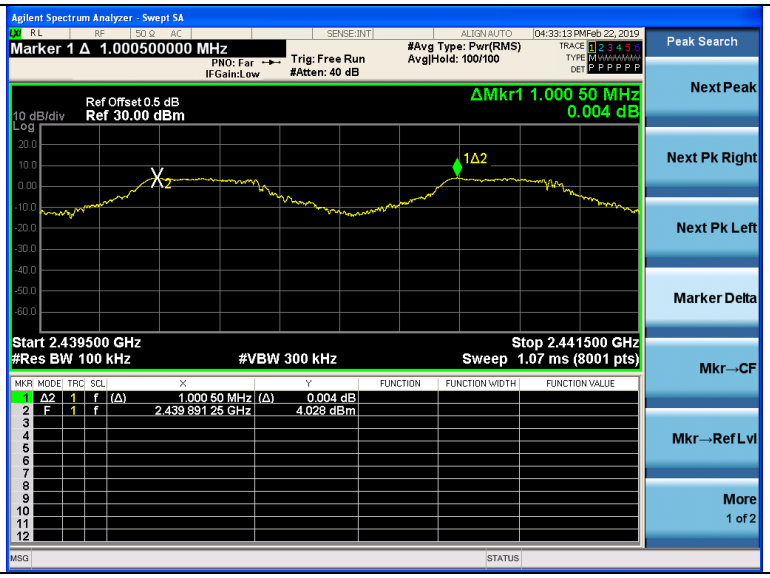
TEST RESULTS

4.5.1 GFSK Test Mode

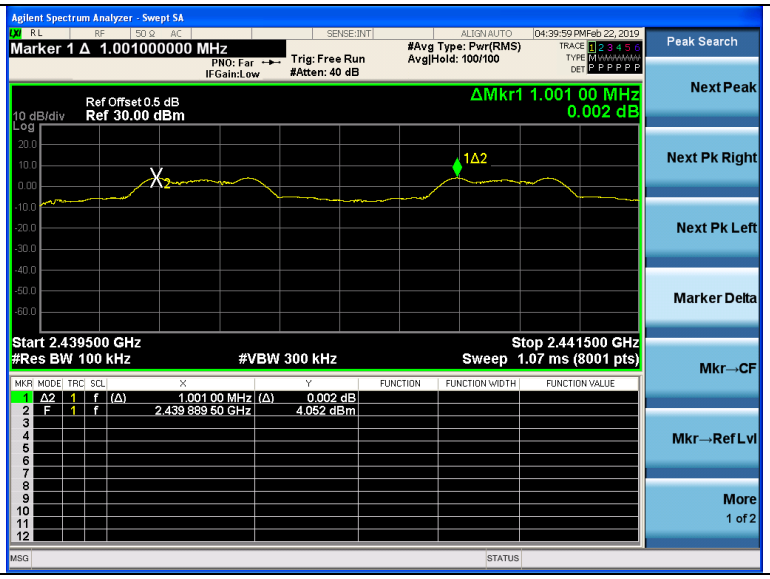
Modulation	Channel	Channel Separation (MHz)	20dB Bandwidth (MHz)	Limit(MHz) 2/3* 20dB BW	Result
GFSK	CH38	1.000	0.89695	0.598	Pass
	CH39				
π/4DQPSK	CH38	1.001	1.0771	0.718	Pass
	CH39				
8DPSK	CH38	1.000	1.0927	0.728	Pass
	CH39				

Remark: We have tested all mode at high, middle and low channel, and recorded worst case at middle

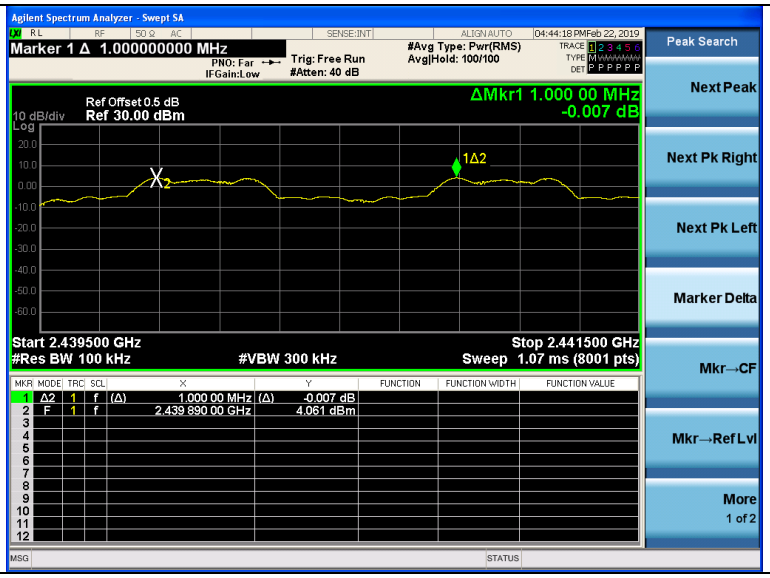
GFSK Modulation



π/4DQPSK Modulation



8DPSK Modulation



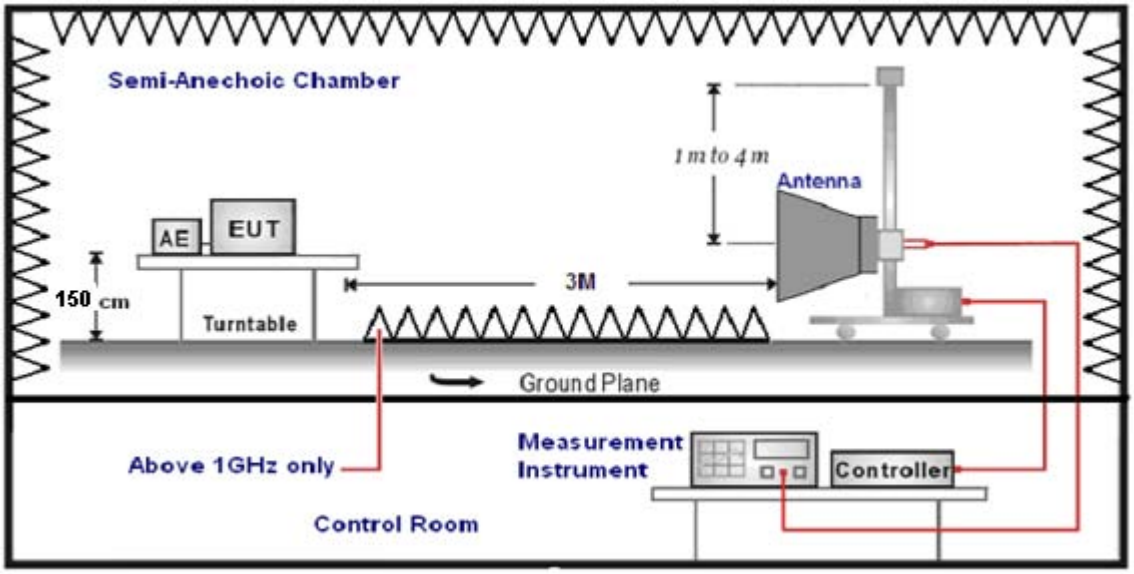
4.6. Band Edge Compliance of RF Emission

TEST REQUIREMENT

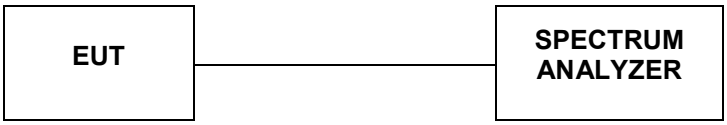
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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 CONFIGURATION

For Radiated



For Conducted



TEST PROCEDURE

1. The EUT was placed on a turn table which is 1.5m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed..
5. The distance between test antenna and EUT was 3 meter:
6. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

LIMIT

Below -20dB of the highest emission level in operating band.
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)

TEST RESULTS

4.6.1 For Radiated Bandedge Measurement

Remark: GFSK, Pi/4 DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.

Operation Mode: GFSK TX Low channel(2402MHz)
Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2390	56.03	-5.81	50.22	74	-23.78	peak
2390	47.39	-5.81	41.58	54	-12.42	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2390	57.5	-5.81	51.69	74	-22.31	peak
2390	48.68	-5.81	42.87	54	-11.13	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Operation Mode: GFSK TX High channel (2480MHz)
Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.5	55.23	-5.65	49.58	74	-24.42	peak
2483.5	45.92	-5.65	40.27	54	-13.73	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

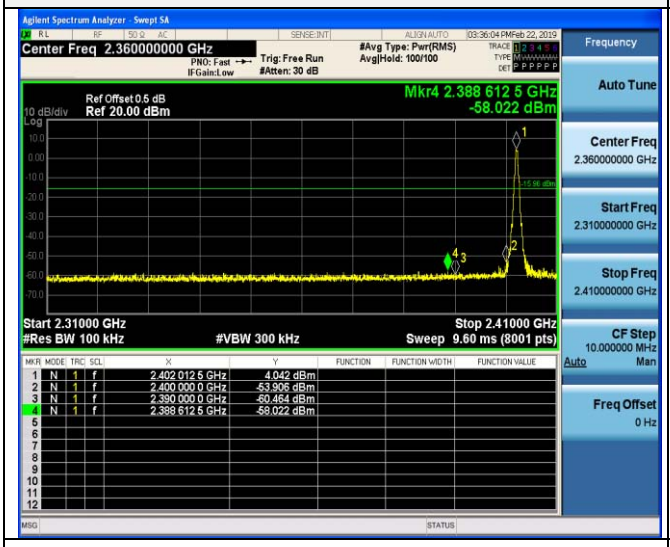
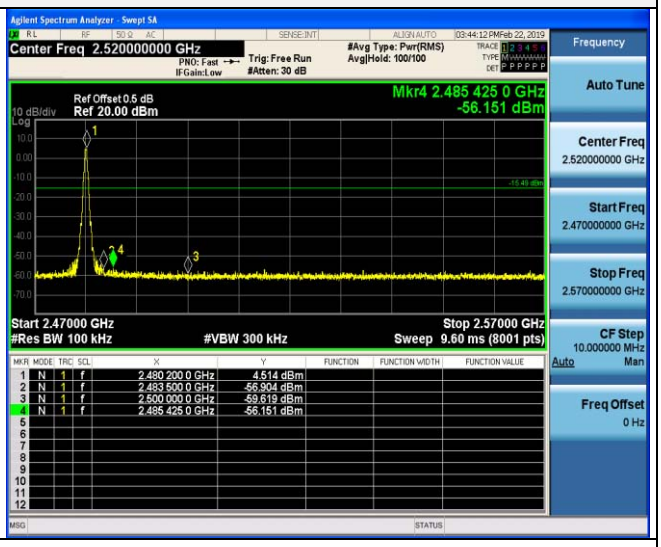
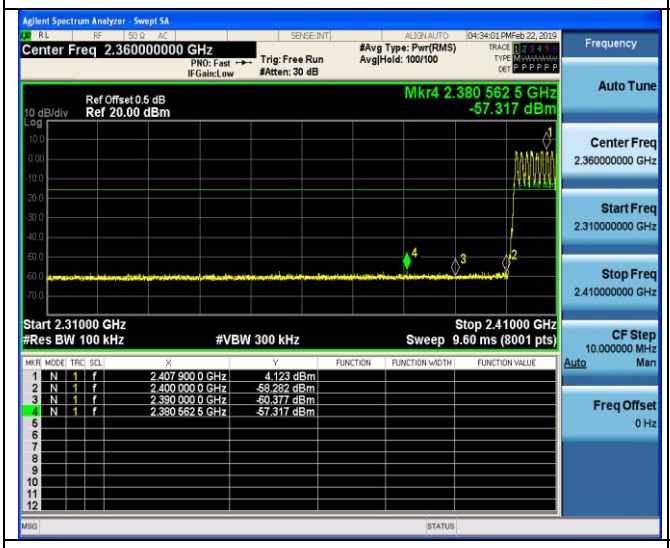
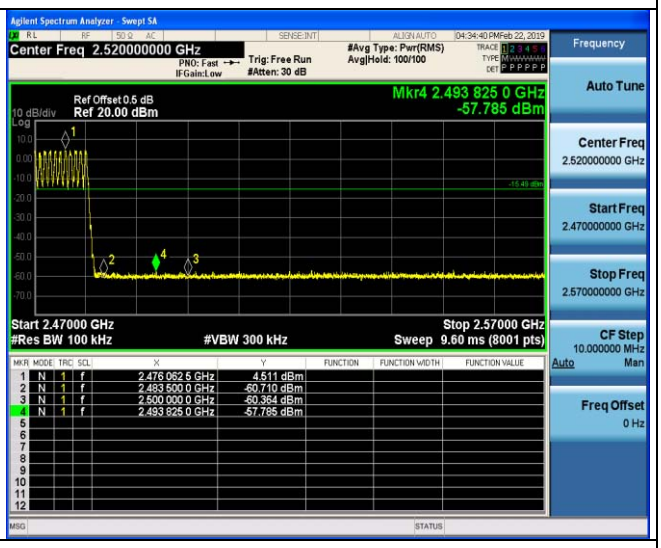
Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2483.5	56.34	-5.65	50.69	74	-23.31	peak
2483.5	47.42	-5.65	41.77	54	-12.23	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

4.6.2 For Conducted Bandedge Measurement

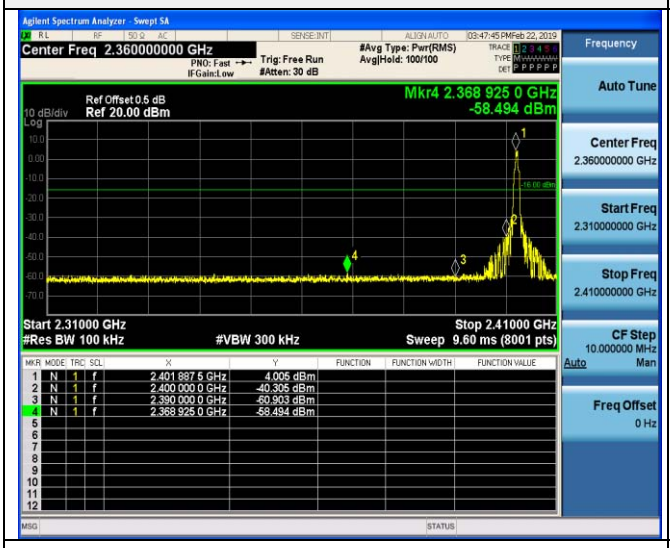
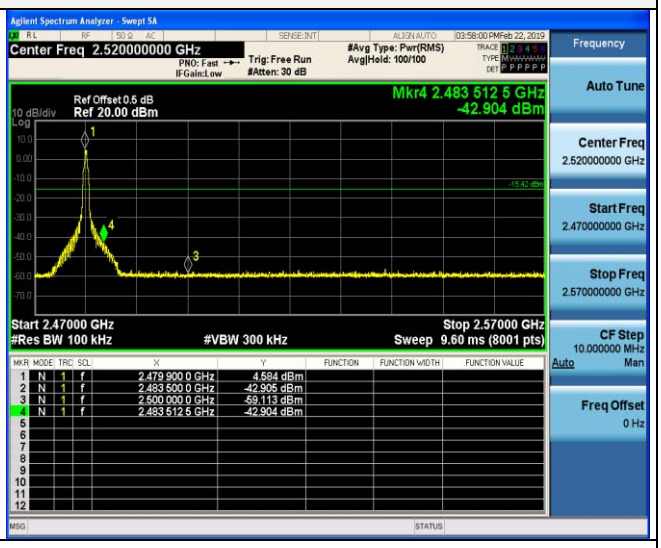
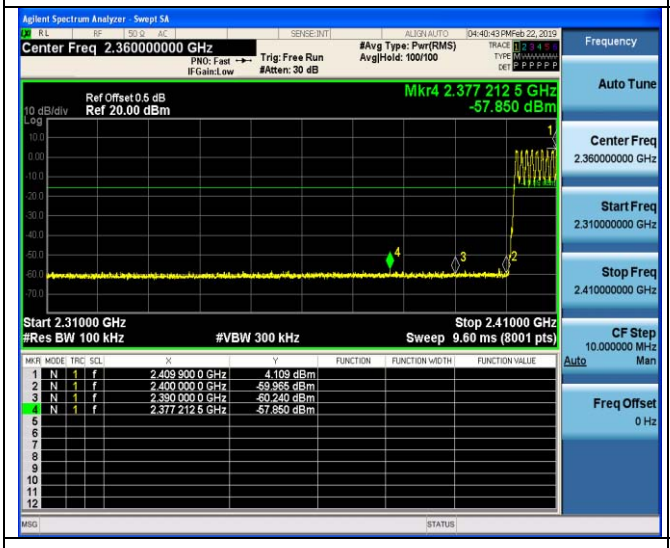
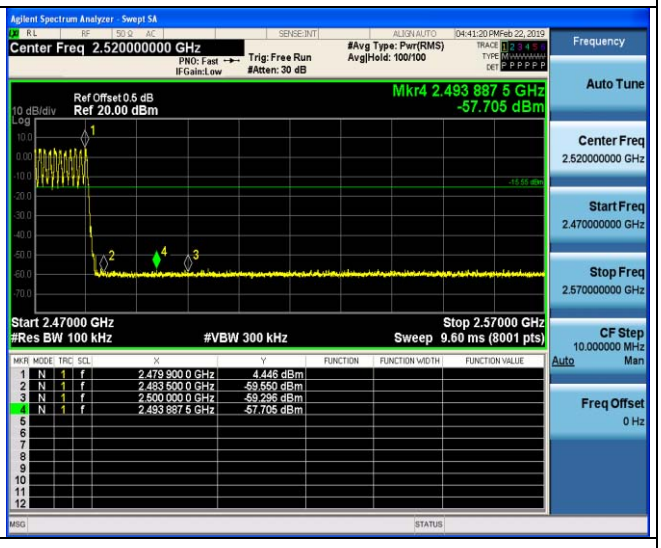
GFSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hoping Mode	Limit (dBc)	Verdict
2400.00	-57.948	OFF	-20	PASS
2400.00	-62.405	ON	-20	PASS
2483.50	-61.418	OFF	-20	PASS
2483.50	-65.221	ON	-20	PASS

2402	2480
	
Hoping Off	Hoping Off
	
Hoping On	Hoping On

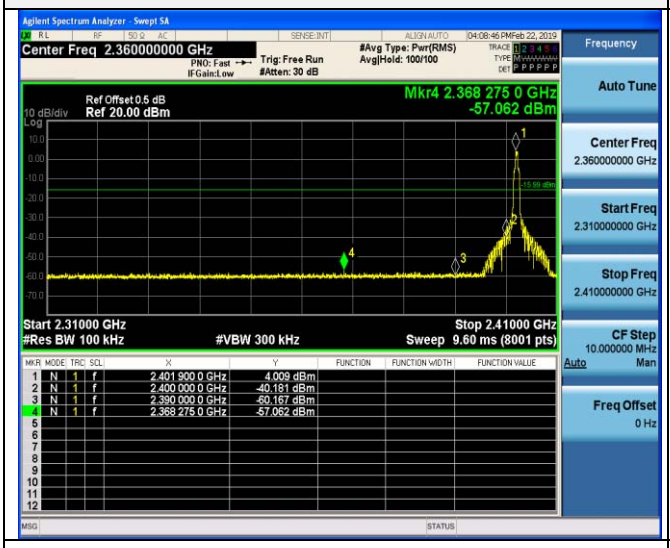
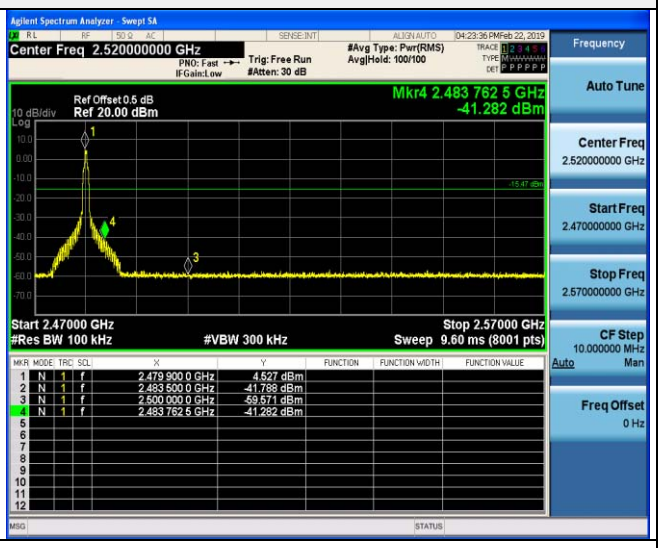
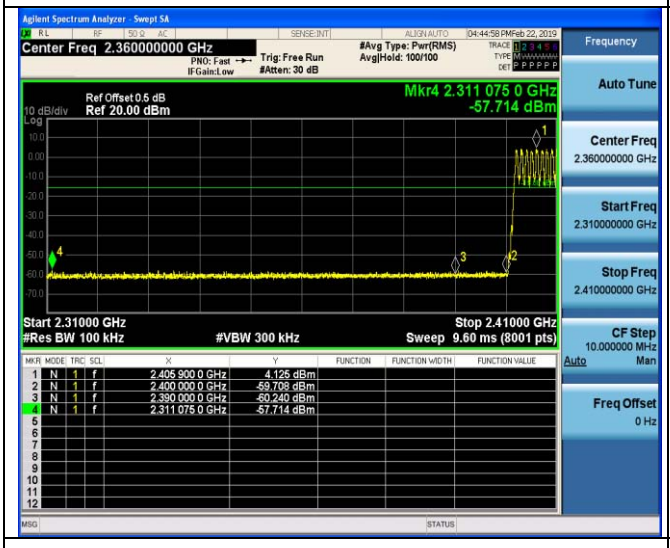
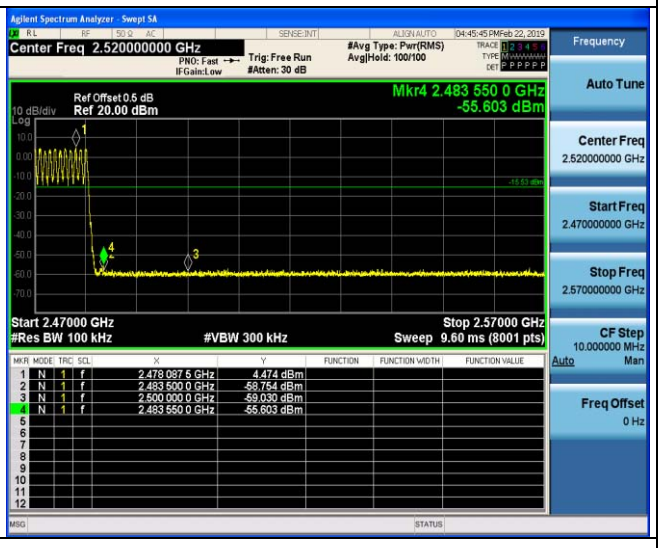
π/4 DQPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hoping Mode	Limit (dBc)	Verdict
2400.00	-44.310	OFF	-20	PASS
2400.00	-64.074	ON	-20	PASS
2483.50	-47.489	OFF	-20	PASS
2483.50	-63.996	ON	-20	PASS

2402	2480
	
Hoping Off	Hoping Off
	
Hoping On	Hoping On

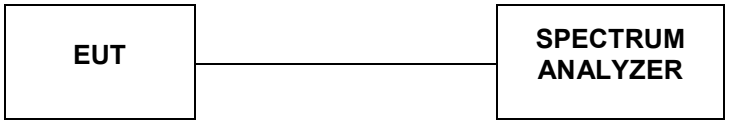
8DPSK

Frequency (MHz)	Delta Peak to Band emission (dBc)	Hoping Mode	Limit (dBc)	Verdict
2400.00	-44.190	OFF	-20	PASS
2400.00	-63.833	ON	-20	PASS
2483.50	-46.315	OFF	-20	PASS
2483.50	-63.228	ON	-20	PASS

2402	2480
	
Hoping Off	Hoping Off
	
Hoping On	Hoping On

4.7. Spurious RF Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

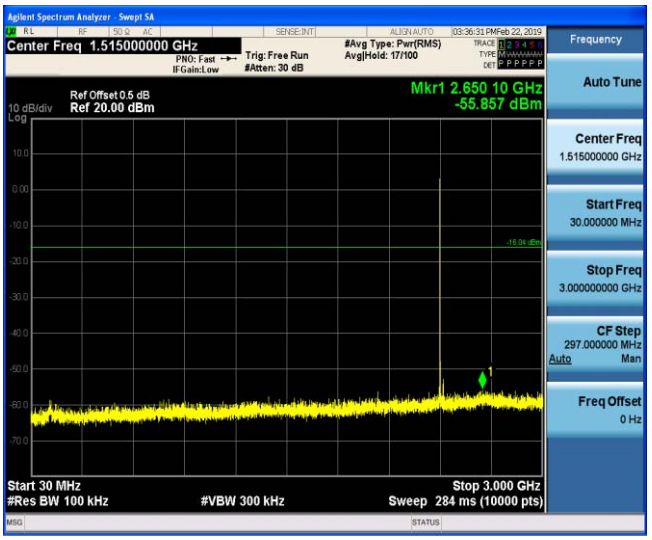
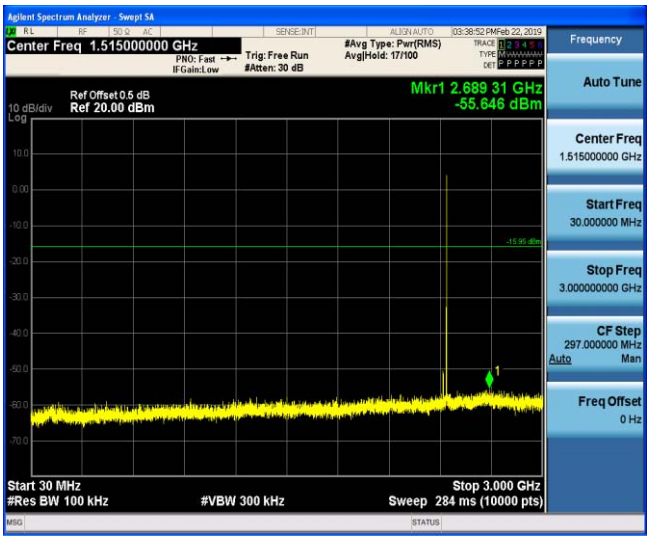
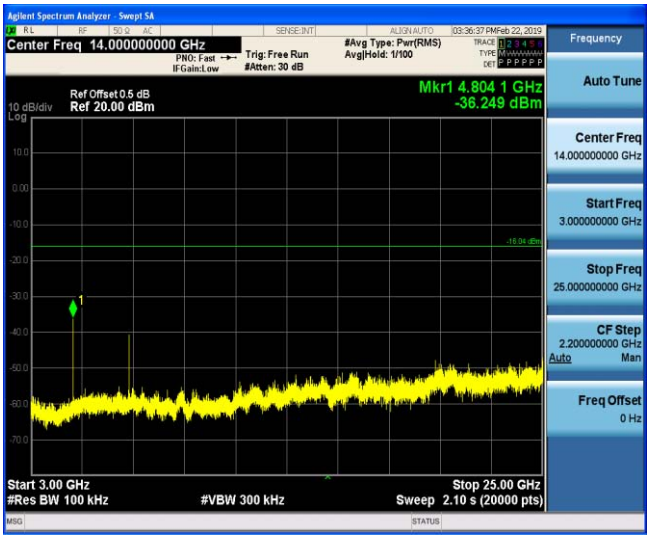
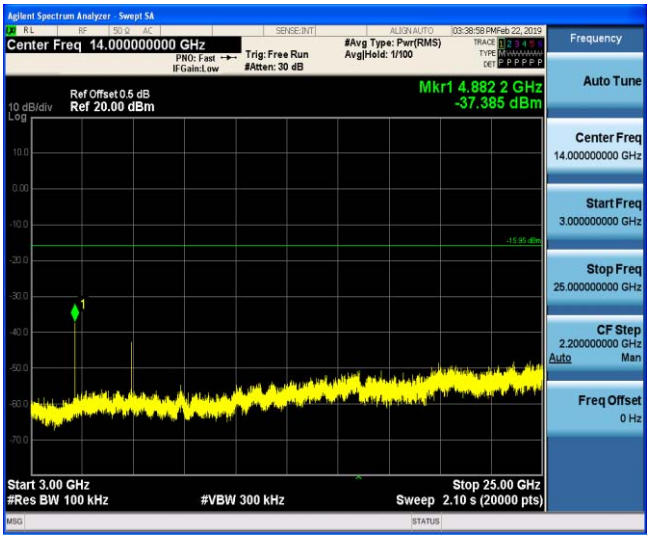
The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100kHz and VBW= 300KHz to measure the peak field strength , and mwasure frequeny range from 9KHz to 25GHz.

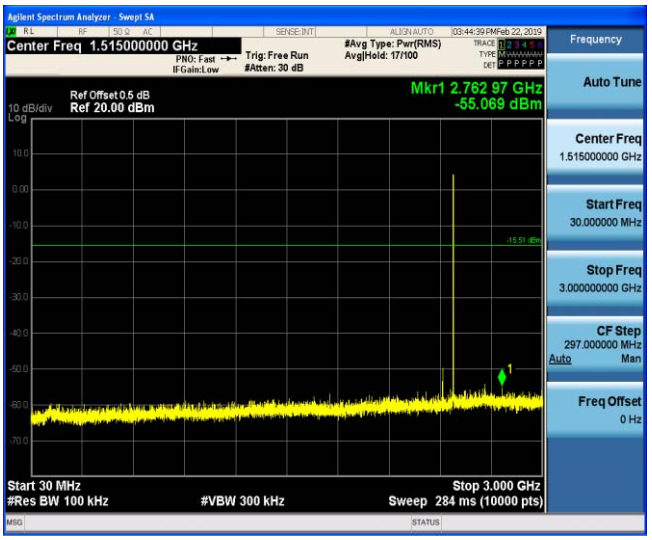
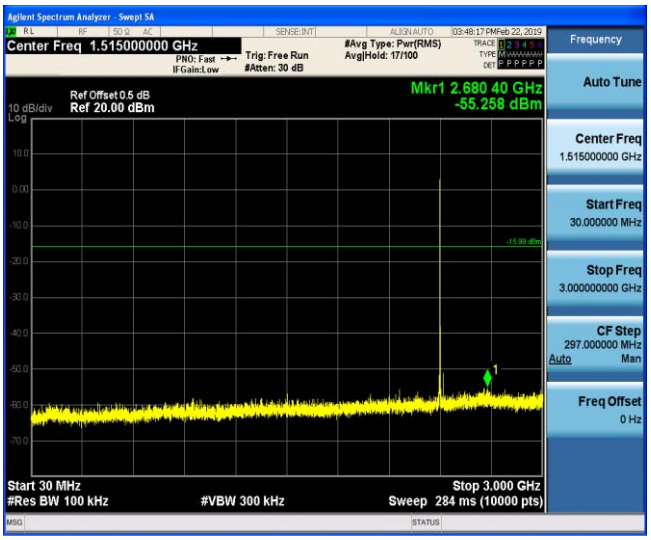
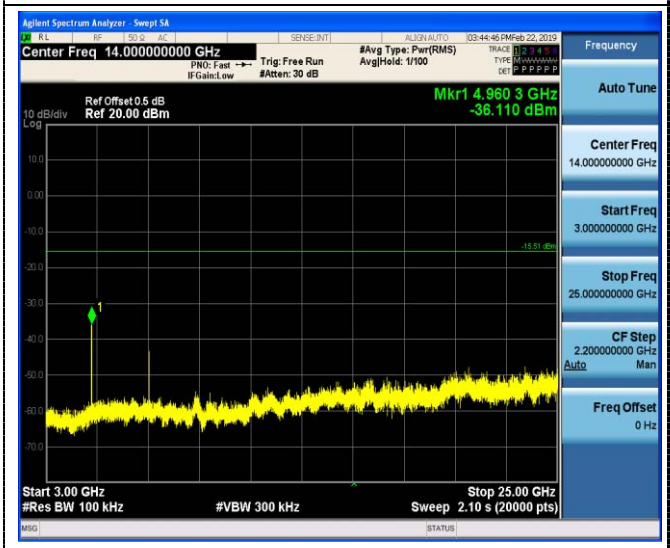
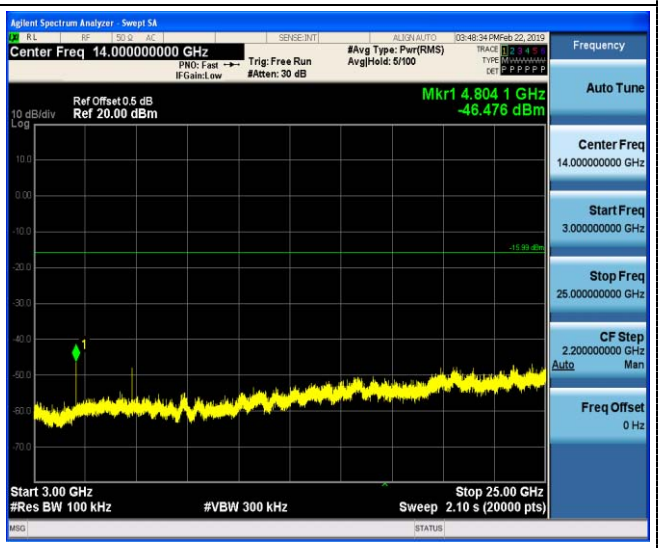
LIMIT

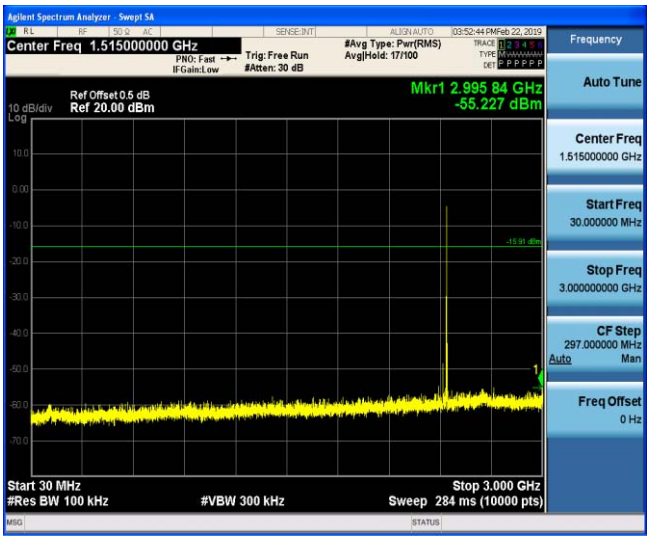
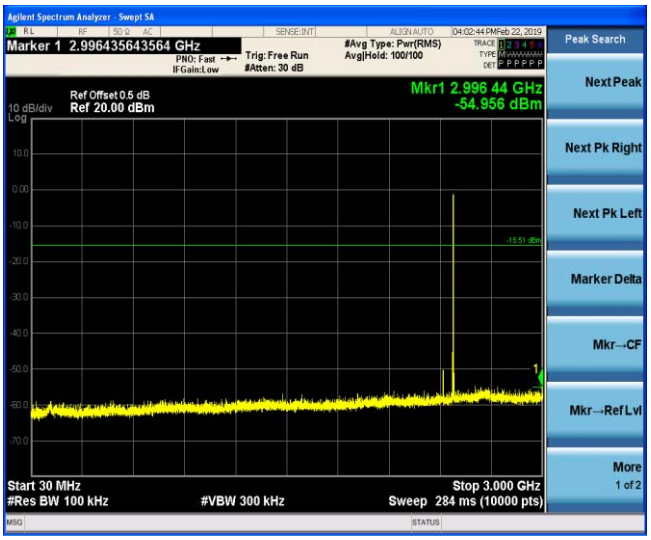
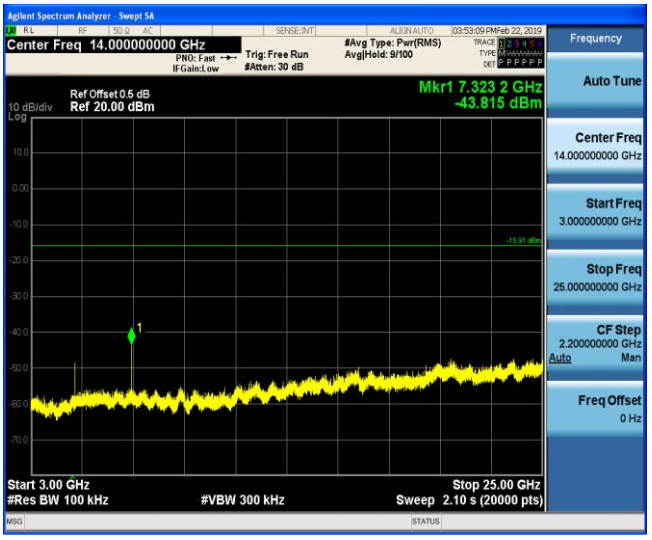
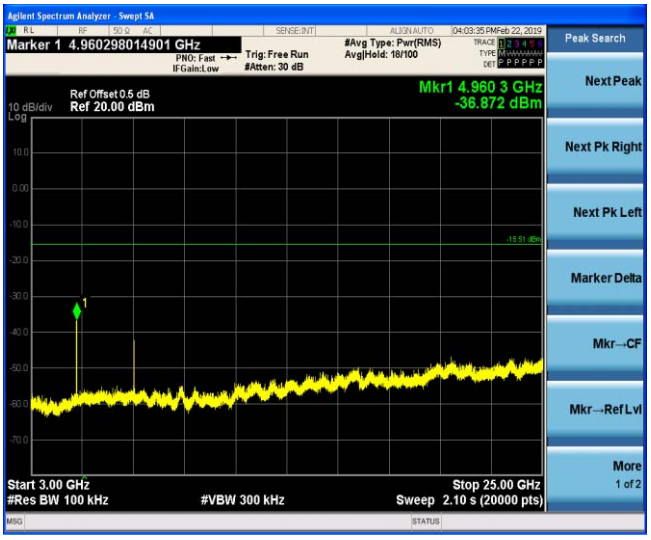
1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

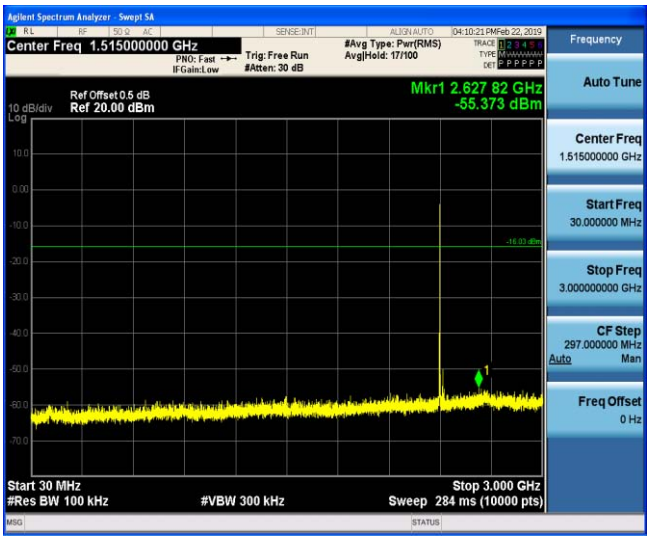
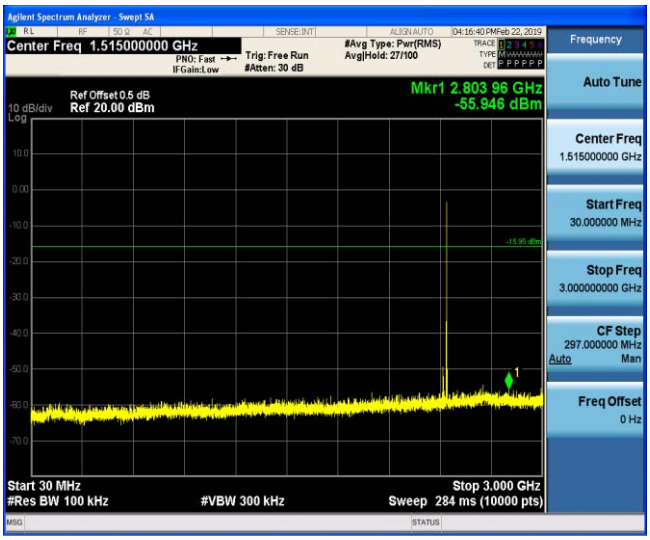
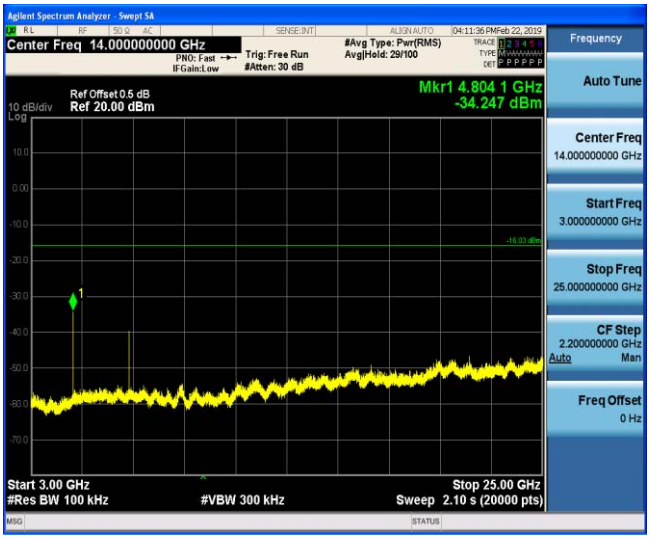
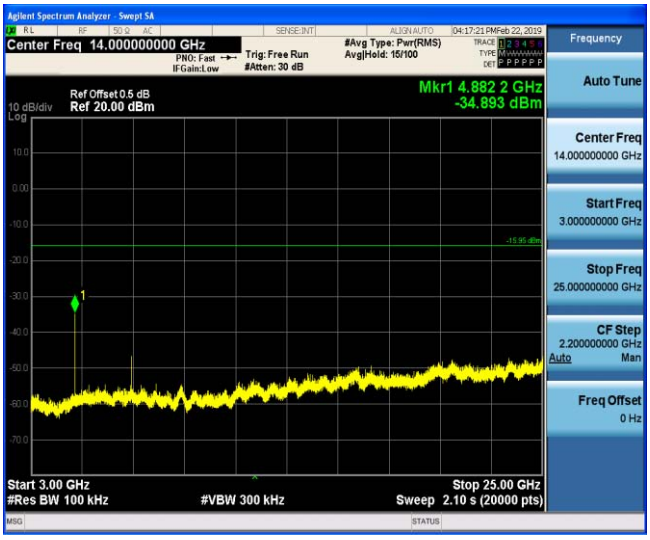
TEST RESULTS

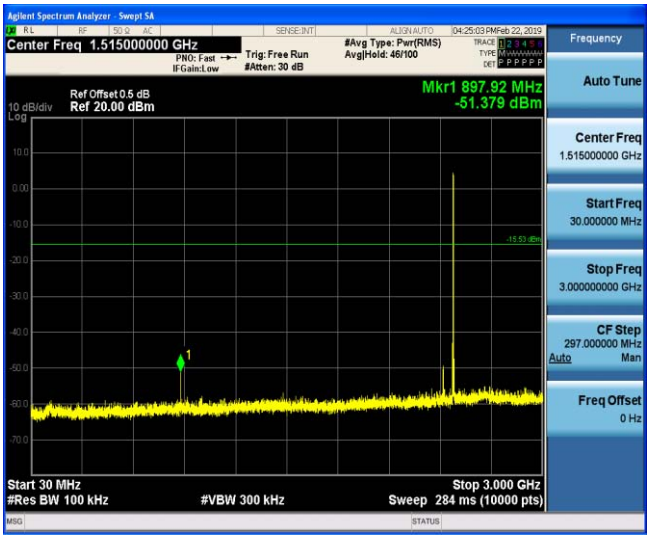
Remark: The measurement frequency range is from 30MHz to the 10^{th} harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandege measurement data.

GFSK CH00	GFSK CH39
	
Reference	Reference
	
30MHz-3GHz	30MHz-3GHz
	
3GHz-25GHz	3GHz-25GHz

GFSK CH78	π/4DQPSK CH00
	
Reference	Reference
	
30MHz-3GHz	30MHz-3GHz
	
3GHz-25GHz	3GHz-25GHz

π/4DQPSK CH39	π/4DQPSK CH78
	
Reference	Reference
	
30MHz-3GHz	30MHz-3GHz
	
3GHz-25GHz	3GHz-25GHz

8DPSK CH00	8DPSK CH39
	
Reference	Reference
	
30MHz-3GHz	30MHz-3GHz
	
3GHz-25GHz	3GHz-25GHz

8DPSK CH78	
	
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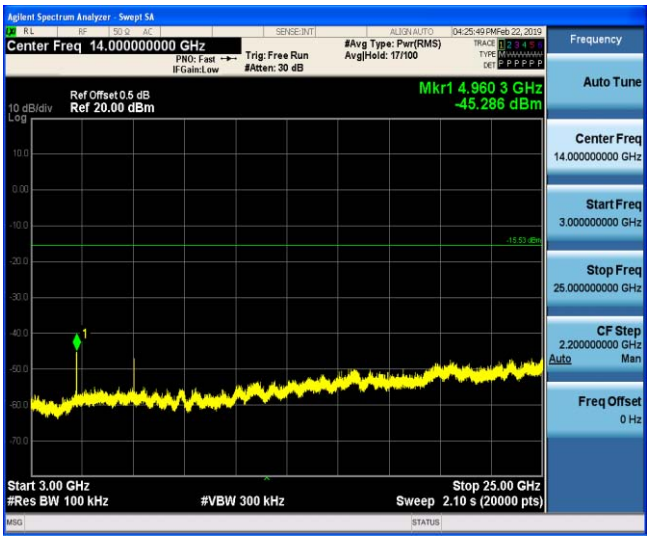
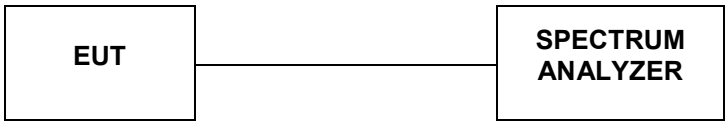
	
3GHz-25GHz	

4.8. Number of hopping frequency

TEST CONFIGURATION



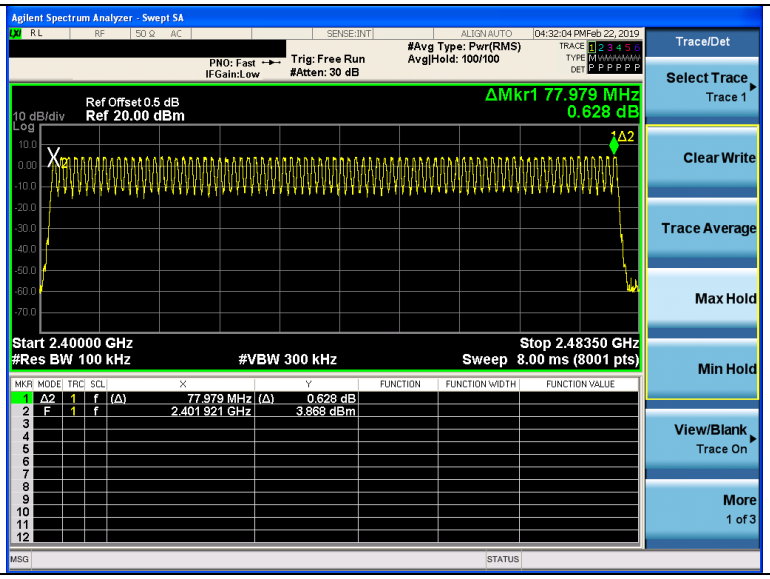
TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator.Set spectrum analyzer start 2400MHz to 2483.5MHz with RBW=1MHz and VBW=3MHz.

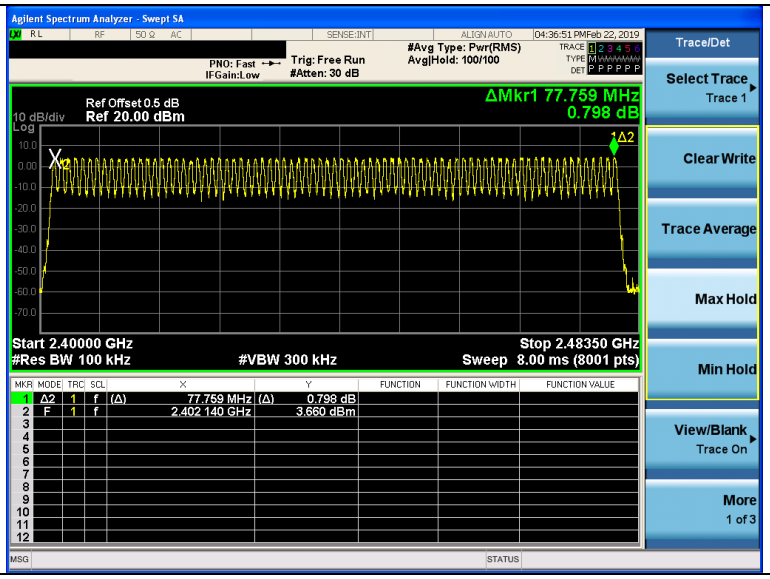
LIMIT

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

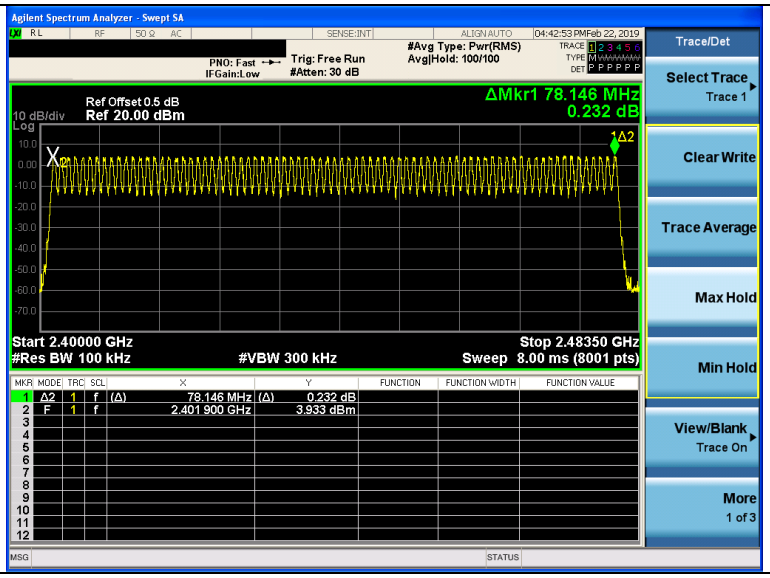
Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
π/4 DQPSK	79		
8DPSK	79		



GFSK Modulation



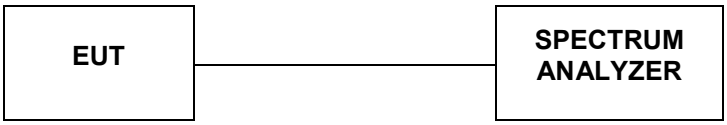
π/4 DQPSK



8DPSK Modulation

4.9. Time Of Occupancy(Dwell Time)

TEST CONFIGURATION



TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with RBW=1MHz and VBW=3MHz,Span=0Hz.

LIMIT

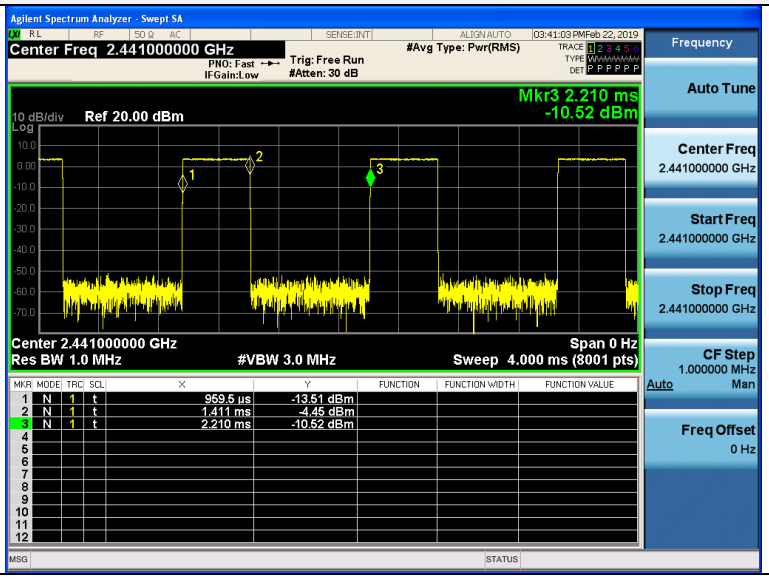
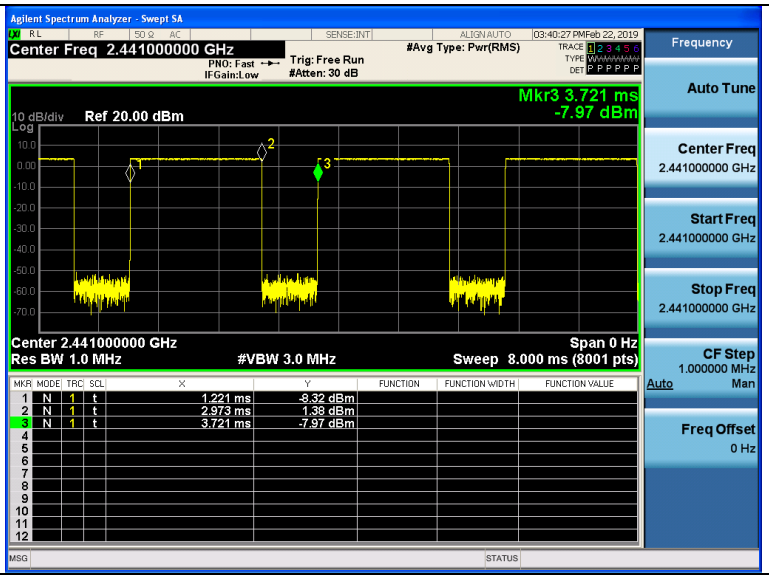
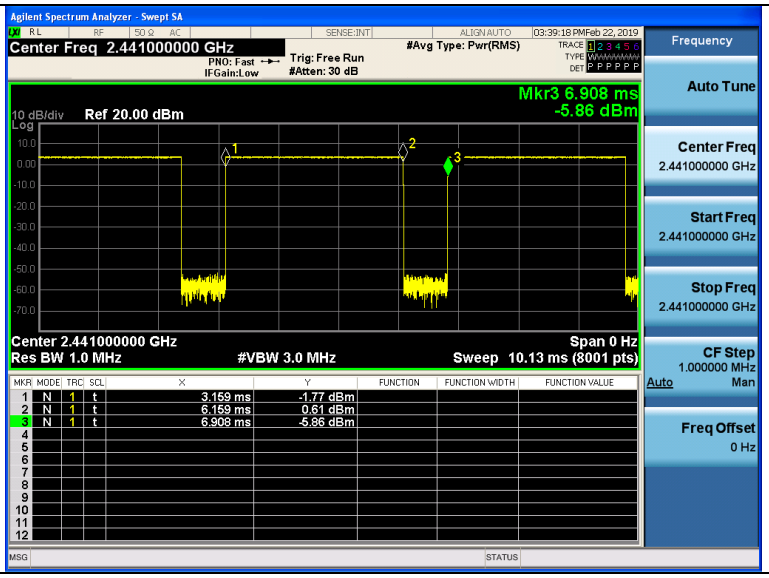
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a pe-riod of 0.4 seconds multiplied by the number of hopping channels employed.

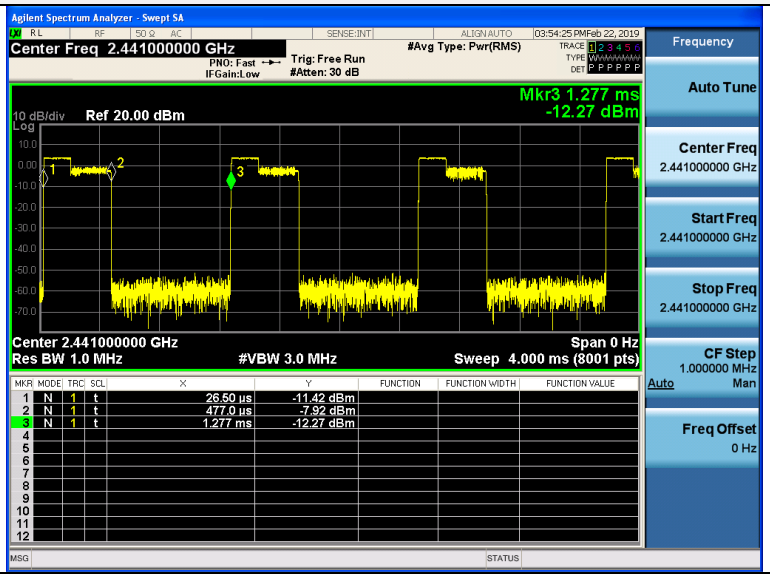
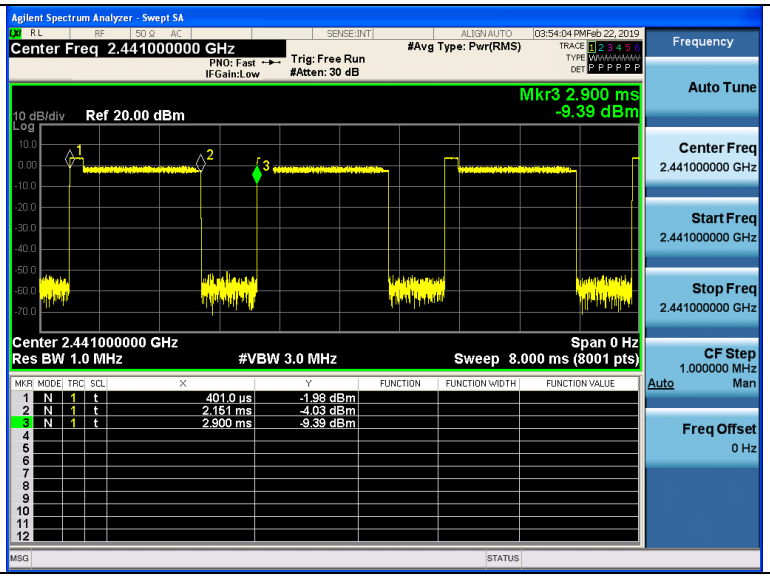
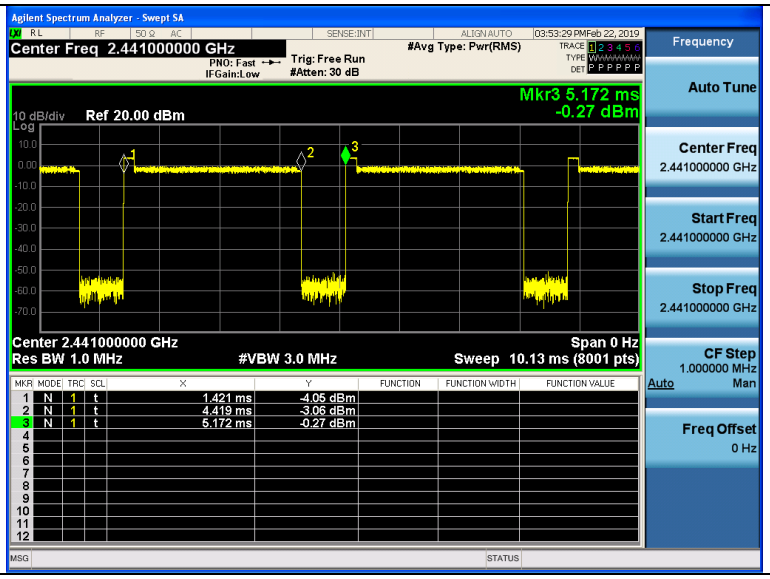
TEST RESULTS

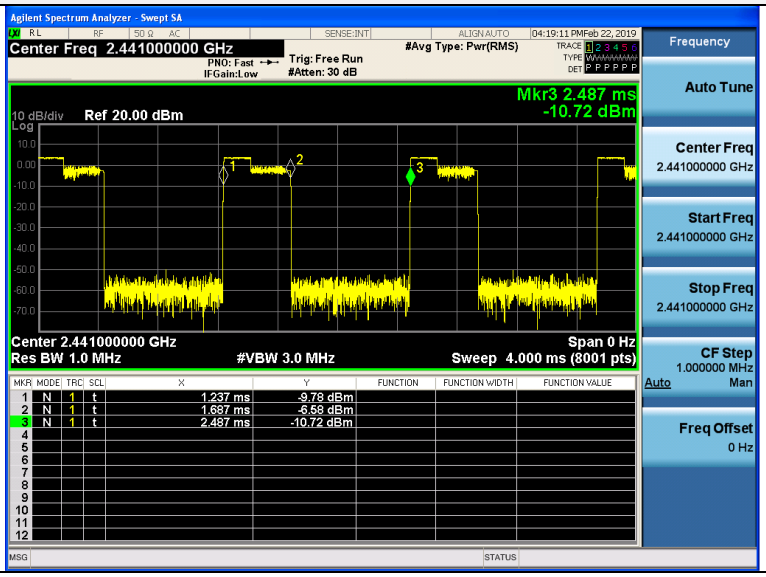
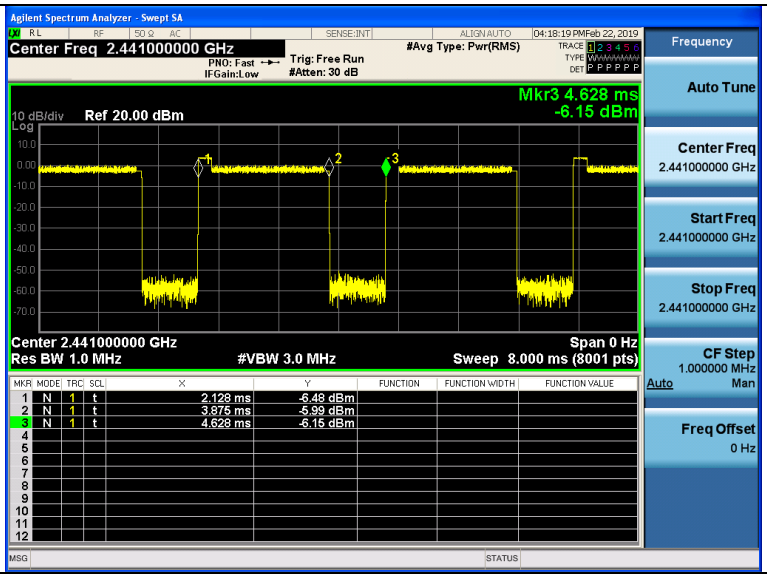
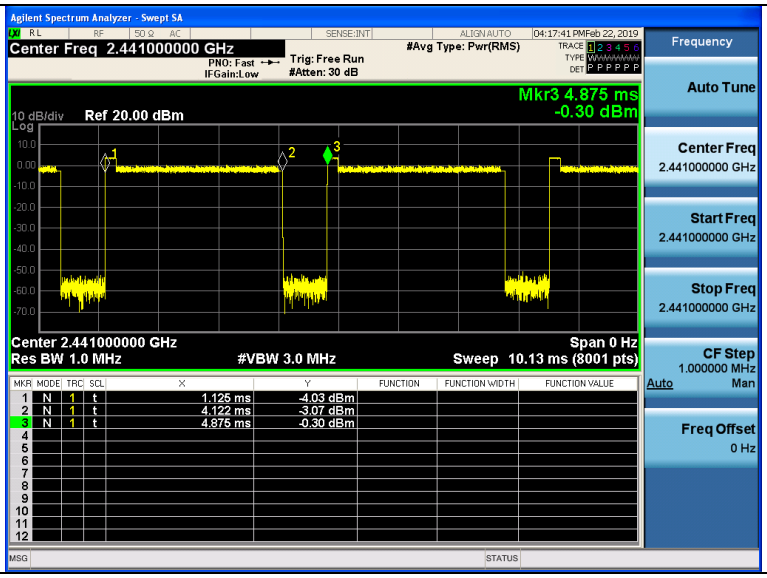
Modulation	Packet	Pulse time (ms)	Dwell time (second)	Limit (second)	Result
GFSK	DH1	0.452	0.145	0.40	Pass
	DH3	1.752	0.280		
	DH5	3.000	0.320		
π/4 DQPSK	DH1	0.451	0.144	0.40	Pass
	DH3	1.750	0.280		
	DH5	2.998	0.320		
8DSPSK	3-DH1	0.450	0.144	0.40	Pass
	3-DH3	1.747	0.280		
	3-DH5	2.997	0.320		

Note:

1. We have tested all mode at high,middle and low channel,and recoreded worst case at middle channel.
2. Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1, 3-DH1
   Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3
   Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5, 3-DH5

GFSK Modulation

DH1

DH3

DH5

π/4DQPSK Modulation

2-DH1

2-DH3

2-DH5

8DPSK Modulation

3-DH1

3-DH3

3-DH5

4.10. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

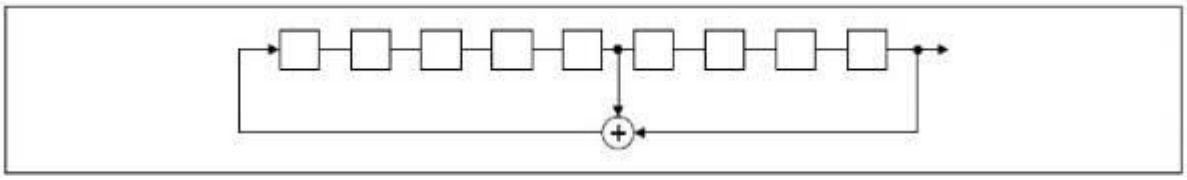
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier fre-quencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Al-ternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier fre-quencies 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 125 mW. The system shall hop to chan-nel frequencies that are selected at the system hopping rate from a pseudo ran-domly ordered list of hopping fre-quencies. Each frequency must be used equally on the average by each trans-mitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their cor-responding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence Requirement

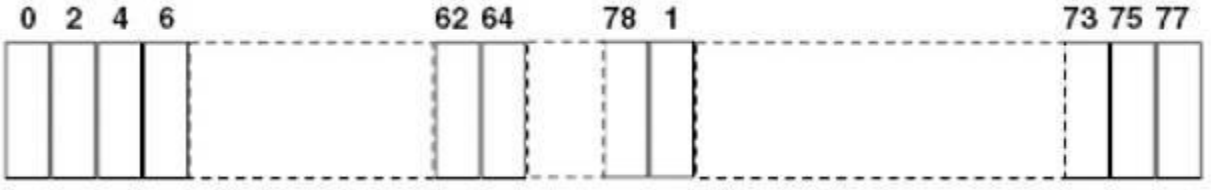
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage.And the result is fed back to the input of the frist stage.The sequence begins with the frist one of 9 consecutive ones,for example:the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An explame of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.
The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

4.11. Antenna Requirement

Standard Applicable

Standard Applicable

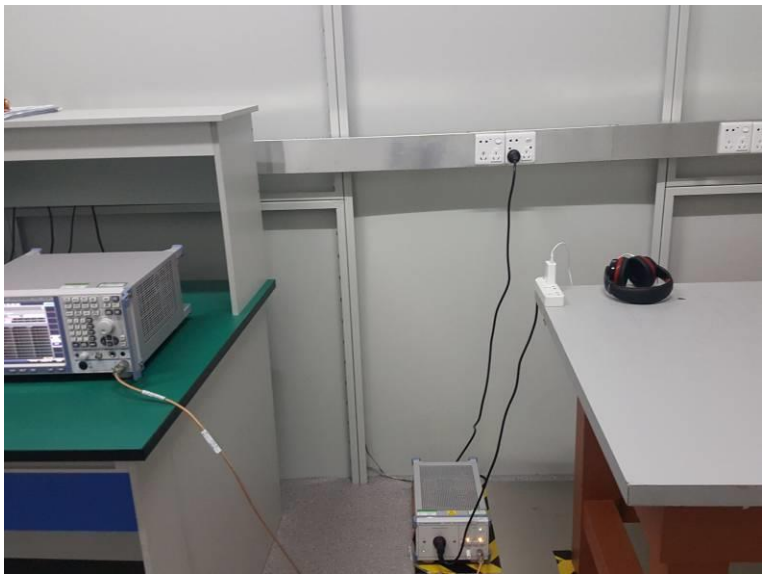
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

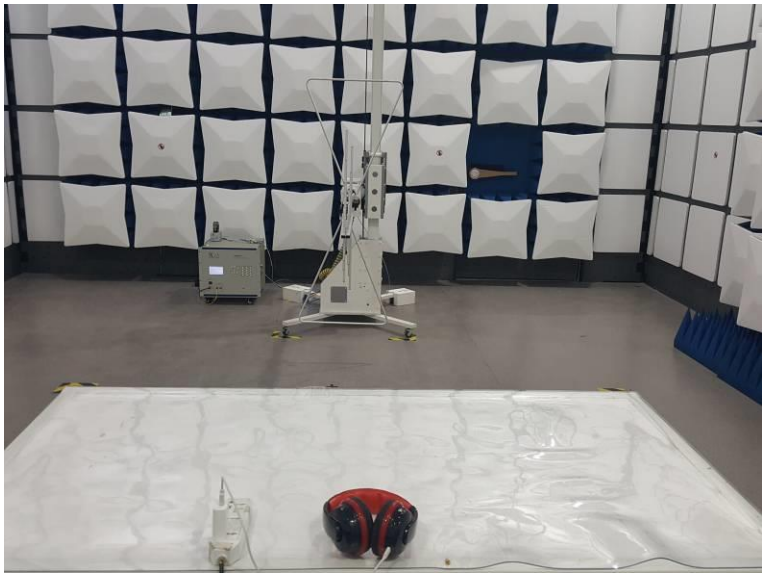
And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

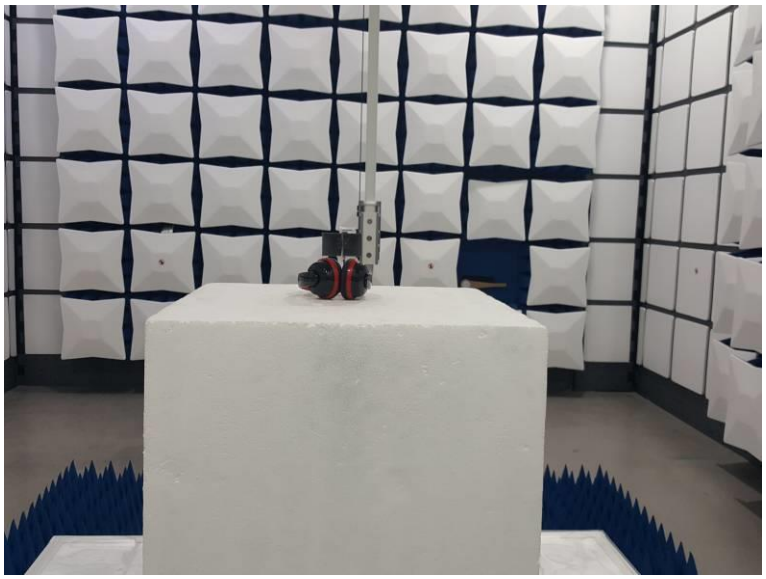
Antenna Information

The directional gains of antenna used for transmitting is 0.00 dBi.

5. Test Setup Photos of the EUT



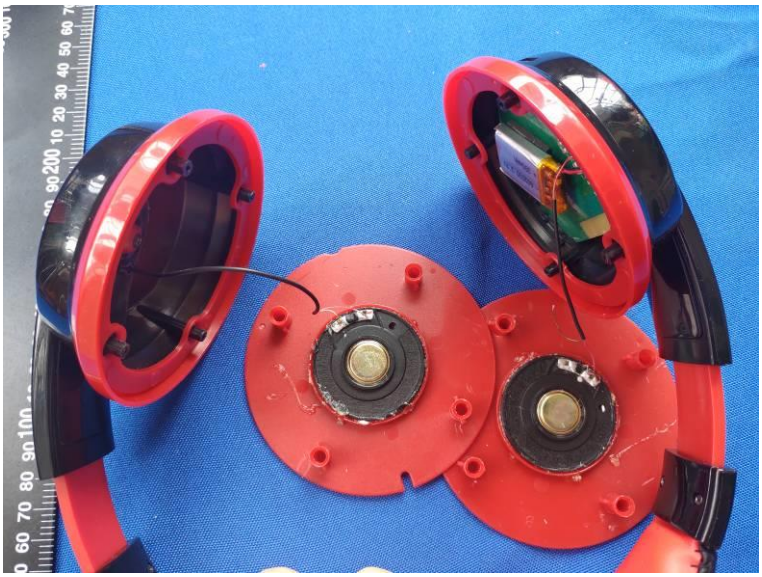


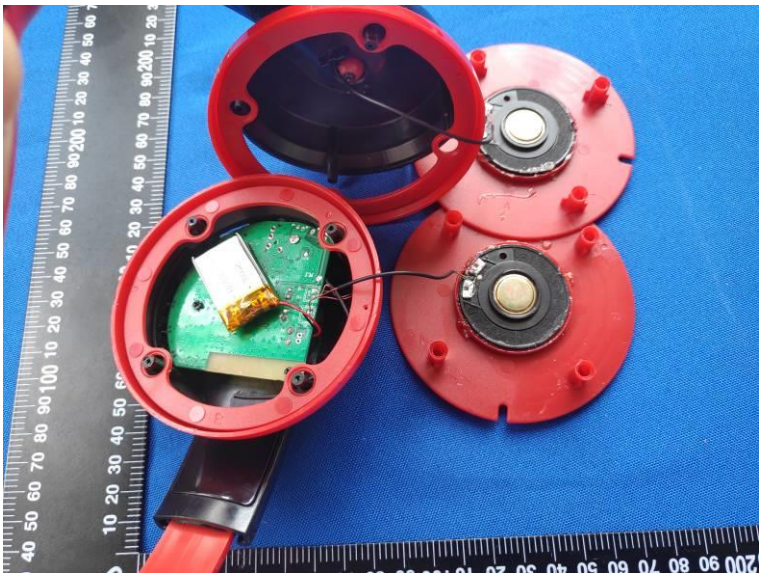


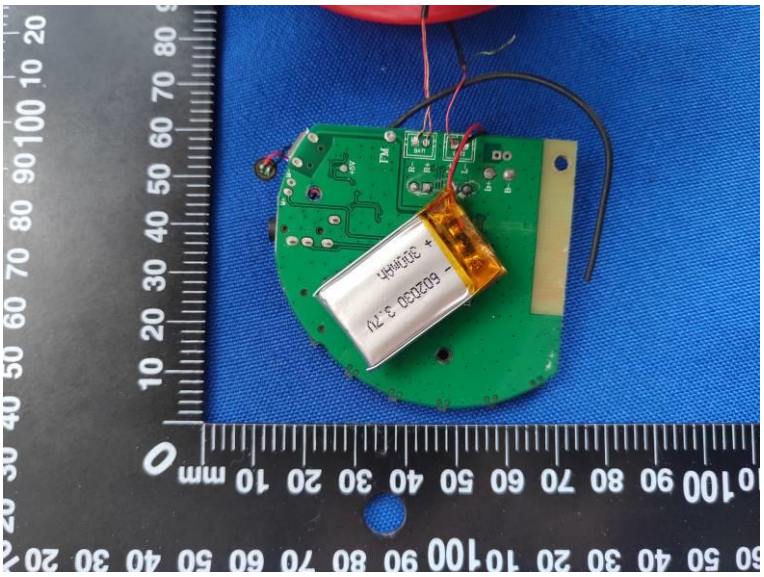
6. PHOTOS OF THE EUT

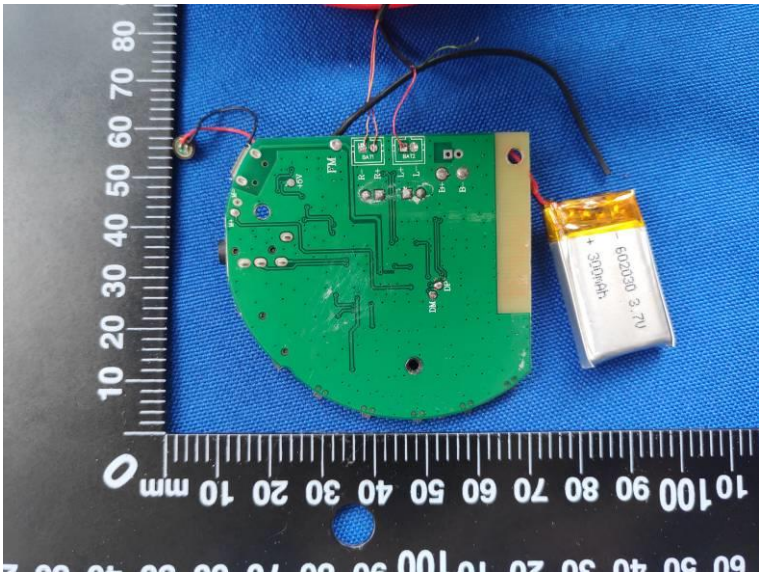
External Photos of EUT

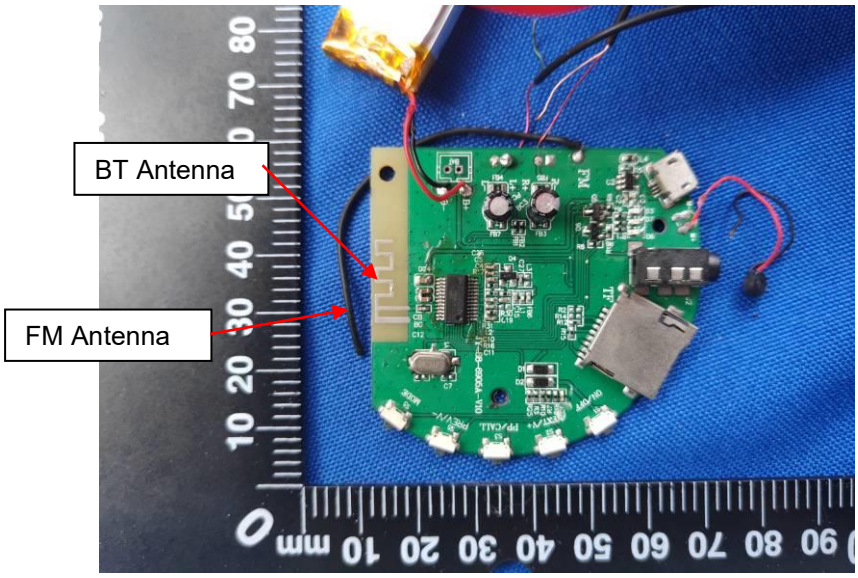
Internal Photos of EUT











.....End of Report.....