Shenzhen Global Test Service Co.,Ltd.
No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No......:	**GTSR18100076-EDR**
FCC ID..... **:**	**2ADDH-MM3**
Compiled by (position+printed name+signature)..:	File administrators Jimmy Wang
Supervised by (position+printed name+signature)..:	Test Engineer Aaron Tan
Approved by (position+printed name+signature)..:	Manager Jason Hu
Date of issue.....:	Oct. 17, 2018

Representative Laboratory Name .:	**Shenzhen Global Test Service Co., Ltd.**
Address.....**:**	No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

Applicant's name.....:	**Monoprice, Inc.**
Address .....:	1 Pointe Dr Suite# 400, Brea, CA 92821, United States

Test specification .....**:**	
Standard .....:	**FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz**
TRF Originator.....:	Shenzhen Global Test Service Co., Ltd.
Master TRF.....:	Dated 2014-12

Test item description .....:	Bluetooth Speaker System
Trade Mark .....:	Monoprice, MONOLITH
Manufacturer .....:	Monoprice, Inc.
Model/Type reference.....:	35373
Listed Models .....:	35374, MM-3
Difference .....:	All models have same circuits diagram, PCB Layout, construction and rated power,only different is the model name.
Modulation Type .....:	GFSK, Π/4DQPSK, 8DPSK
Operation Frequency.....:	From 2402MHz to 2480MHz
Rating .....:	DC 24V from Adapter
Result.....:	**PASS**

T E S T R E P O R T

Test Report No. :	**GTSR18100076-EDR**	Oct. 17, 2018 Date of issue

Equipment under Test	:	Bluetooth Speaker System
Model /Type	:	35373
Listed Models	:	35374, MM-3
Applicant	:	**Monoprice, Inc.**
Address	:	1 Pointe Dr Suite# 400, Brea, CA 92821, United States
Manufacturer	:	**Monoprice, Inc.**
Address	:	1 Pointe Dr Suite# 400, Brea, CA 92821, United States

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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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
KDB 558074 V05 : GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

2 . SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	Oct. 11, 2018
Testing commenced on	:	Oct. 12, 2018
Testing concluded on	:	Oct. 16, 2018

2.2. Product Description

Name of EUT	Bluetooth Speaker System
Trade Mark:	Monoprice, MONOLITH
Model Number	35373
List Model:	35374, MM-3
FCC ID	2ADDH-MM3
Antenna Type	PCB Antenna
Bluetooth FCC Operation frequency	2402MHz-2480MHz
Bluetooth Modulation	GFSK, π /4DQPSK,8DPSK
Bluetooth	BT V4.2
Antenna gain	2.5dBi
Adapter	
Manufacturer	DONGGUAN LIYANG ELECTRICAL TECHNOLOGY CO., LTD
Trade Mark	lyangel™
M/N	LY001SPS-240250W2
Input	AC 100-240V, 50-60Hz, 2A
Output	DC 24V/2.5A

2.3. 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)		

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

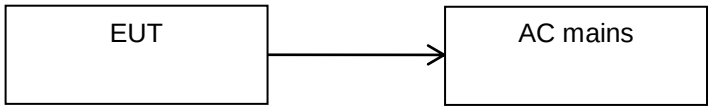
This is a Bluetooth Speaker System For more details, refer to the user's manual of the EUT.

2.5. EUT operation mode

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 79 channels provided to the EUT. Channel 00/38/78 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**		

2.6. Block Diagram of Test Setup



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

This submittal(s) (test report) is intended for **FCC ID: 2ADDH-MM3** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.8. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - Supplied by the lab

○		M/N:	
		Manufacturer:	

2.9. Modifications

No modifications were implemented to meet testing criteria.

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen Global Test Service Co.,Ltd.
No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

3.2. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

FCC-Registration No.: 165725

Shenzhen Global Test Service Co.,Ltd EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

A2LA-Lab Cert. No.: 4758.01

Shenzhen Global Test Service Co.,Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

CNAS-Lab Code: L8169

Shenzhen Global Test Service Co.,Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories. Date of Registration: Dec. 11, 2015. Valid time is until Dec. 10, 2018.

3.3. Environmental conditions

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

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

3.4. Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Pass	Fail	NA	NP	Remark
§15.247(b)(4)	Antenna gain	GFSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.247(e)	Power spectral density	-/-	-/-	-/-	-/-	☐	☐	☒	☐	Not applicable for FHSS
§15.247(a)(1)	Carrier Frequency separation	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Number of Hopping channels	GFSK 8DPSK	☒ Full	GFSK 8DPSK	☒ Full	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Spectrum bandwidth of a FHSS system 20dB bandwidth	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 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 8DPSK	☒ Lowest ☒ Highest	GFSK 8DPSK	☒ Lowest ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.205	Band edge compliance radiated	GFSK 8DPSK	☒ Lowest ☒ Highest	GFSK	☒ Lowest ☒ Highest	☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions conducted	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions radiated	GFSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.109	RX spurious emissions radiated	-/-	-/-	-/-	-/-	☐	☐	☒	☐	complies
§15.209(a)	TX spurious Emissions radiated < 30 MHz	GFSK	-/-	GFSK	-/-	☒	☐	☐	☐	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	GFSK	-/-	GFSK	-/-	☒	☐	☐	☐	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
4. For π/4 QPSK its same modulation type with 8-DPSK, and based exploratory test, there is no significant difference of that two types test result, so except output power, all other items final test were only performed with the worse case 8-DPSK and GFSK.

3.5. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen Global Test Service Co.,Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen GTS laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.10 dB	(1)
Radiated Emission	1~18GHz	4.32 dB	(1)
Radiated Emission	18-40GHz	5.54 dB	(1)
Conducted Disturbance	0.15~30MHz	3.12 dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3.6. Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.08	2018/09/20	2019/09/19
LISN	R&S	ESH2-Z5	893606/008	2018/09/20	2019/09/19
Bilog Antenna	Schwarzbeck	VULB9163	976	2016/09/20	2019/09/19
EMI Test Receiver	R&S	ESCI7	101102	2018/09/20	2019/09/19
Spectrum Analyzer	Agilent	N9020A	MY48010425	2018/09/20	2019/09/19
Spectrum Analyzer	R&S	FSP40	100019	2018/06/05	2019/06/04
Controller	EM Electronics	Controller EM 1000	N/A	N/A	N/A
Horn Antenna	Schwarzbeck	BBHA 9120D	01622	2016/09/20	2019/09/19
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/09/20	2019/09/19
Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	971	2016/09/20	2019/09/19
Amplifier	Schwarzbeck	BBV 9743	#202	2018/09/20	2019/09/19
Amplifier	EMCI	EMC051845B	980355	2018/09/20	2019/09/19
Temperature/Humidity Meter	Gangxing	CTH-608	02	2018/09/20	2019/09/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	KL142031	2018/09/20	2019/09/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	KL142032	2018/09/20	2019/09/19
RF Cable(below 1GHz)	HUBER+SUHNER	RG214	RE01	2018/09/20	2019/09/19
RF Cable(above 1GHz)	HUBER+SUHNER	RG214	RE02	2018/09/20	2019/09/19
Data acquisition card	Agilent	U2531A	TW53323507	2018/09/20	2019/09/19
Power Sensor	Agilent	U2021XA	MY5365004	2018/09/20	2019/09/19

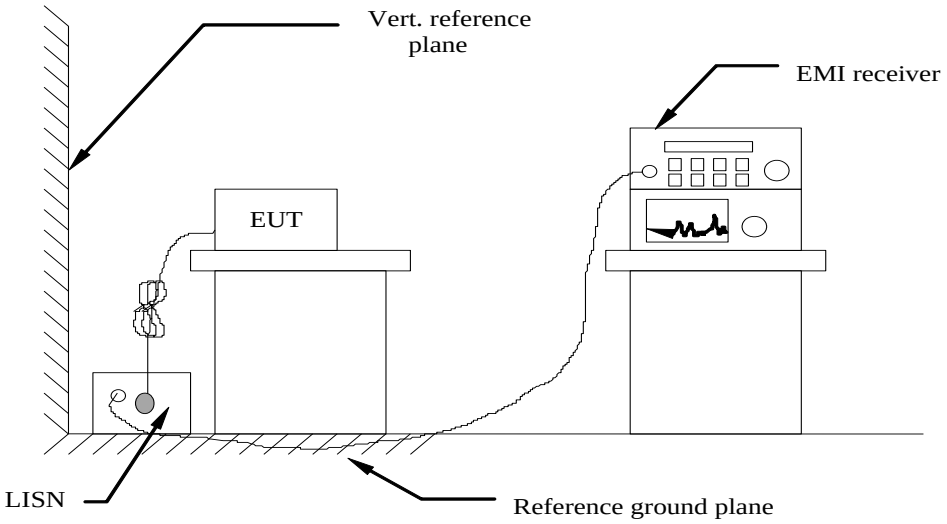
EMI Test Software	R&S	ES-K1	V1.7.1	2018/09/20	2019/09/19
EMI Test Software	JS Tonscend	JS32-RE	2.0.1.5	2018/09/20	2019/09/19
EMI Test Software	Audix	E3	2..1.1	2018/09/20	2019/09/19

Note: 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 C63.10-2013.
2 Support equipment, if needed, was placed as per ANSI C63.10-2013.
3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013.
4 The EUT received DC 5V power, the adapter received AC120V/60Hz or AC 240V/50Hz 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.
8 During the above scans, the emissions were maximized by cable manipulation.

AC Power Conducted Emission Limit

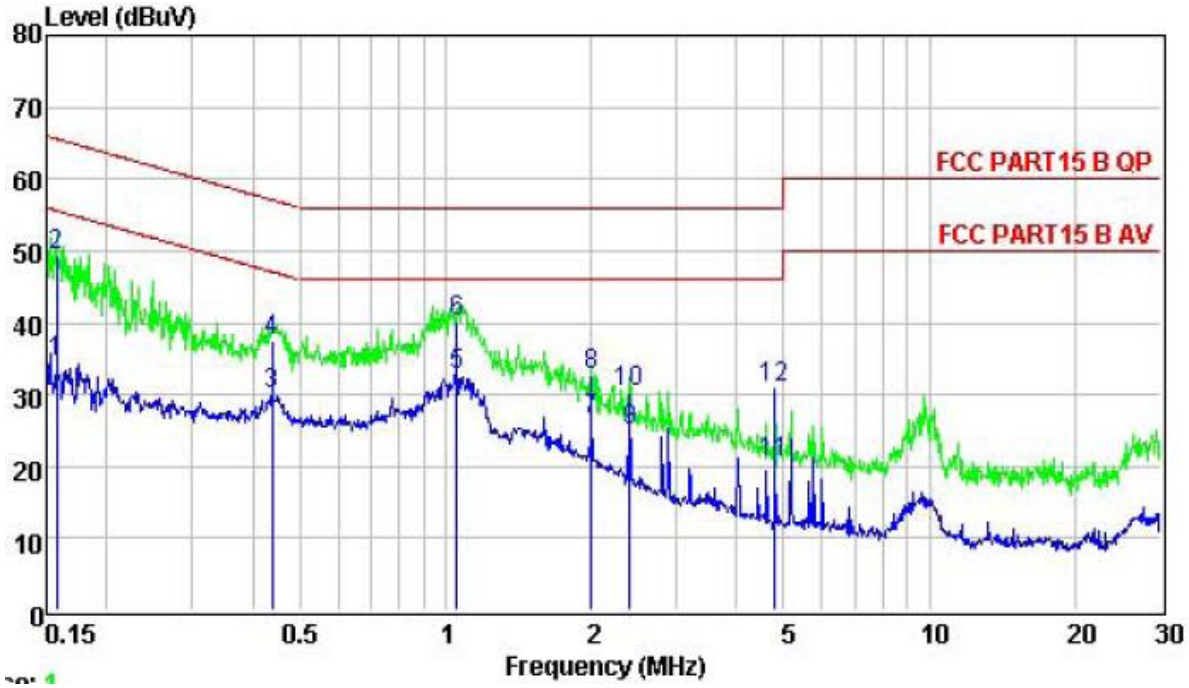
For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

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

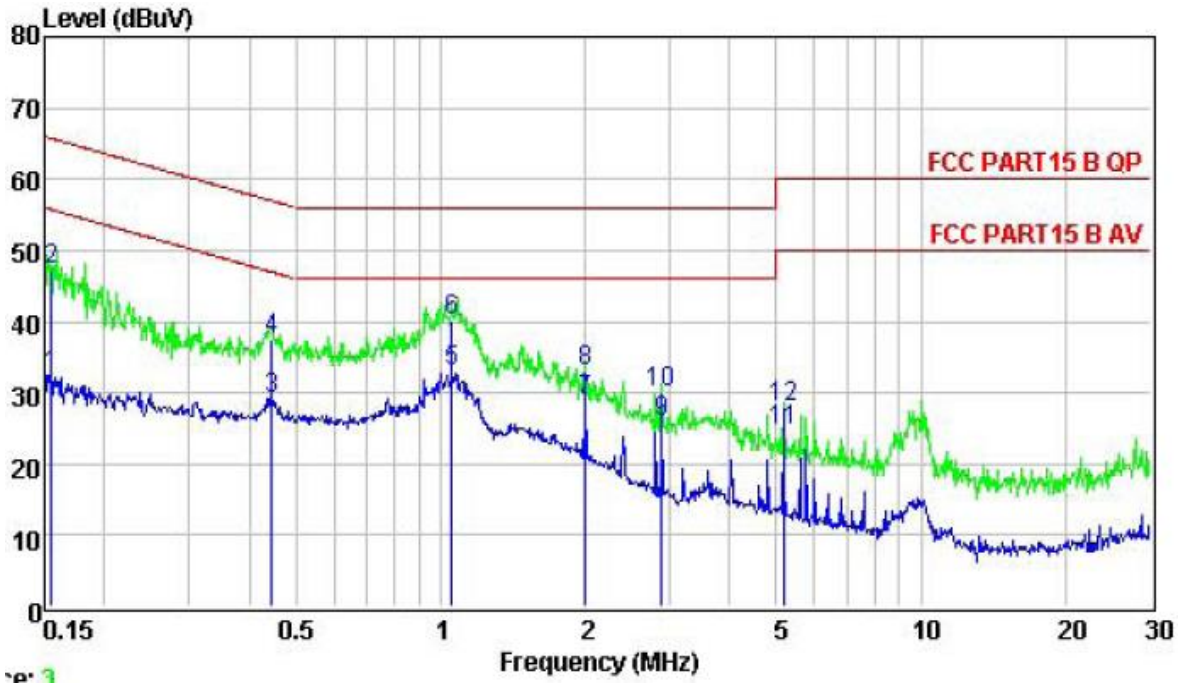
Remark: We measured Conducted Emission at GFSK, π/4 DQPSK and 8DPSK mode in DC 24V form adapter, the worst case was recorded .

Power supply:	AC 120V/60Hz	Polarization	L



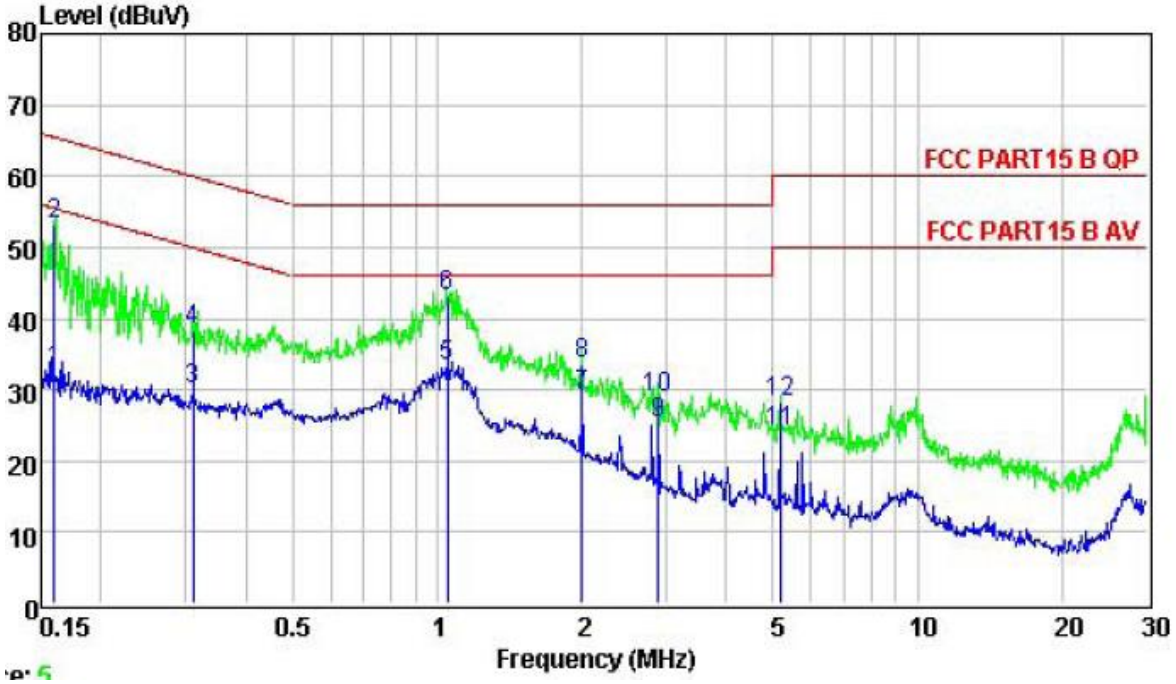
	Freq	Level	Cable Loss	LISN Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dB	
1	0.157	34.55	0.24	9.69	55.60	-21.05	Average
2	0.157	49.50	0.24	9.69	65.60	-16.10	QP
3	0.440	30.03	0.25	9.59	47.07	-17.04	Average
4	0.440	37.55	0.25	9.59	57.07	-19.52	QP
5	1.054	32.75	0.26	9.59	46.00	-13.25	Average
6	1.054	40.15	0.26	9.59	56.00	-15.85	QP
7	2.001	26.37	0.28	9.61	46.00	-19.63	Average
8	2.001	32.65	0.28	9.61	56.00	-23.35	QP
9	2.396	25.03	0.28	9.62	46.00	-20.97	Average
10	2.396	30.47	0.28	9.62	56.00	-25.53	QP
11	4.797	20.39	0.31	9.64	46.00	-25.61	Average
12	4.797	30.90	0.31	9.64	56.00	-25.10	QP

Power supply:	AC 120V/60Hz	Polarization	N



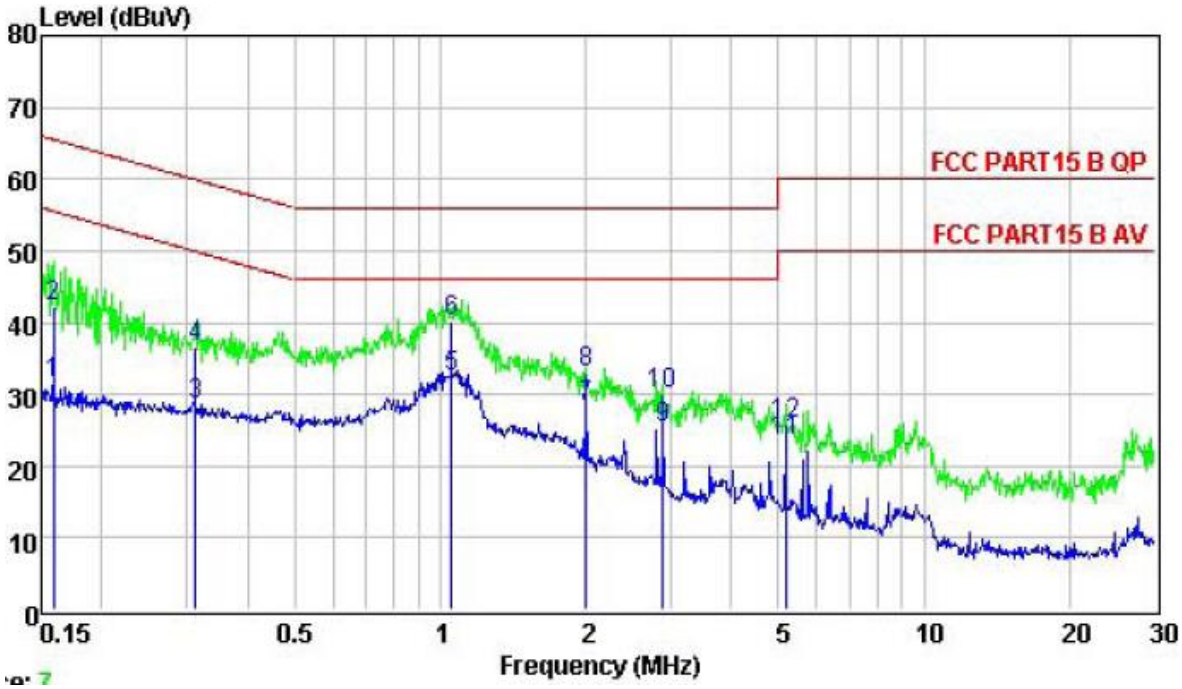
	Freq	Level	Cable Loss	LISN Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dB	
1	0.155	32.53	0.24	9.46	55.74	-23.21	Average
2	0.155	47.15	0.24	9.46	65.74	-18.59	QP
3	0.444	29.14	0.25	9.59	46.98	-17.84	Average
4	0.444	37.50	0.25	9.59	56.98	-19.48	QP
5	1.054	33.01	0.26	9.60	46.00	-12.99	Average
6	1.054	40.14	0.26	9.60	56.00	-15.86	QP
7	2.001	28.99	0.28	9.57	46.00	-17.01	Average
8	2.001	32.98	0.28	9.57	56.00	-23.02	QP
9	2.884	25.97	0.29	9.61	46.00	-20.03	Average
10	2.884	30.02	0.29	9.61	56.00	-25.98	QP
11	5.166	24.80	0.31	9.67	50.00	-25.20	Average
12	5.166	28.05	0.31	9.67	60.00	-31.95	QP

Power supply:	AC 240V/50Hz	Polarization	L



	Freq	Level	Cable Loss	LISN Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dB	
1	0.160	32.69	0.24	9.69	55.47	-22.78	Average
2	0.160	53.12	0.24	9.69	65.47	-12.35	QP
3	0.310	30.18	0.25	9.61	49.97	-19.79	Average
4	0.310	38.42	0.25	9.61	59.97	-21.55	QP
5	1.049	33.28	0.26	9.59	46.00	-12.72	Average
6	1.049	43.15	0.26	9.59	56.00	-12.85	QP
7	2.001	29.02	0.28	9.61	46.00	-16.98	Average
8	2.001	33.69	0.28	9.61	56.00	-22.31	QP
9	2.884	25.28	0.29	9.62	46.00	-20.72	Average
10	2.884	28.99	0.29	9.62	56.00	-27.01	QP
11	5.166	23.98	0.31	9.64	50.00	-26.02	Average
12	5.166	28.27	0.31	9.64	60.00	-31.73	QP

Power supply:	AC 240V/50Hz	Polarization	N

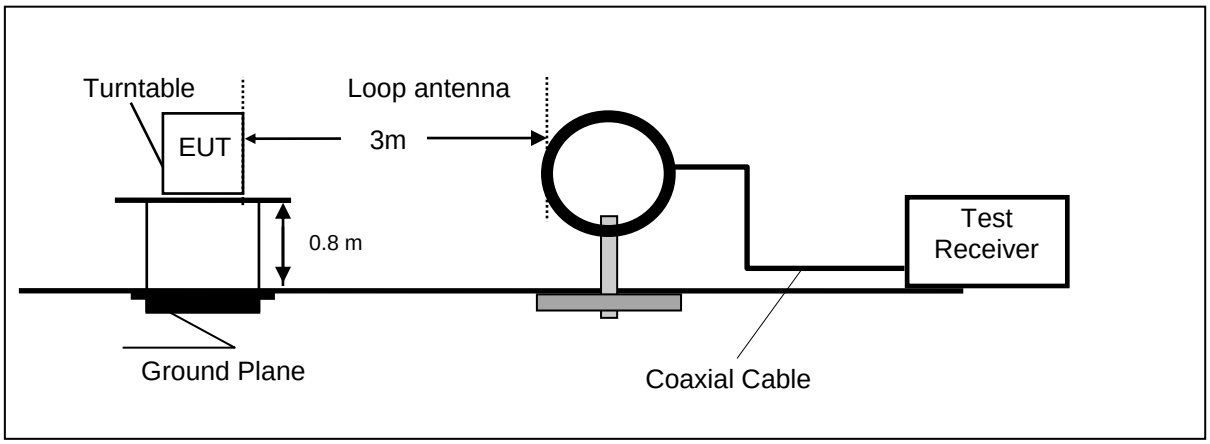


	Freq	Level	Cable Loss	LISN Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dB	
1	0.159	31.46	0.24	9.47	55.52	-24.06	Average
2	0.159	42.15	0.24	9.47	65.52	-23.37	QP
3	0.312	28.56	0.25	9.58	49.93	-21.37	Average
4	0.312	36.52	0.25	9.58	59.93	-23.41	QP
5	1.054	32.52	0.26	9.60	46.00	-13.48	Average
6	1.054	40.16	0.26	9.60	56.00	-15.84	QP
7	2.001	28.34	0.28	9.57	46.00	-17.66	Average
8	2.001	33.01	0.28	9.57	56.00	-22.99	QP
9	2.884	25.15	0.29	9.61	46.00	-20.85	Average
10	2.884	30.00	0.29	9.61	56.00	-26.00	QP
11	5.166	23.53	0.31	9.67	50.00	-26.47	Average
12	5.166	26.01	0.31	9.67	60.00	-33.99	QP

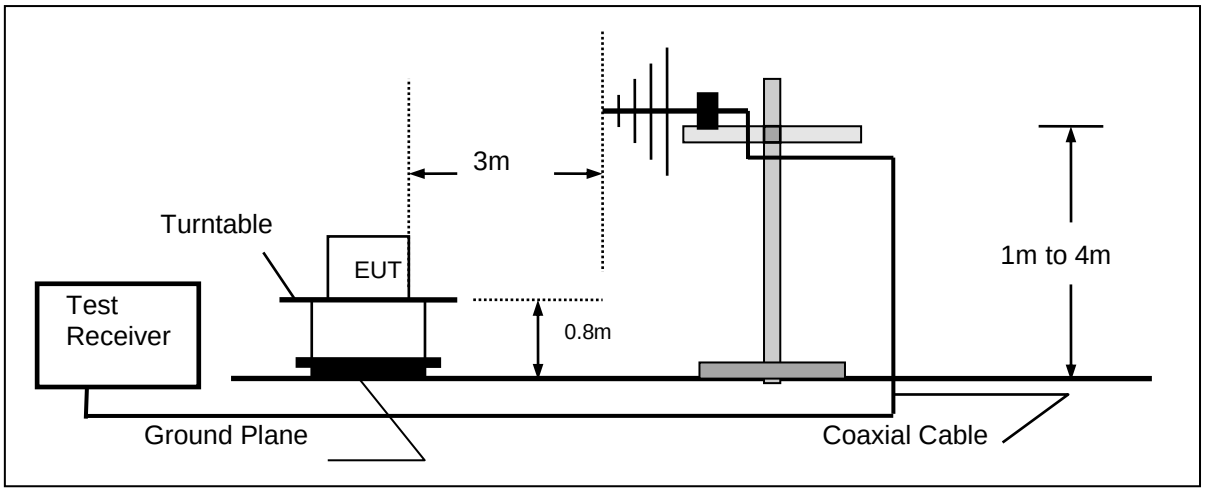
4.2. Radiated Emission

TEST CONFIGURATION

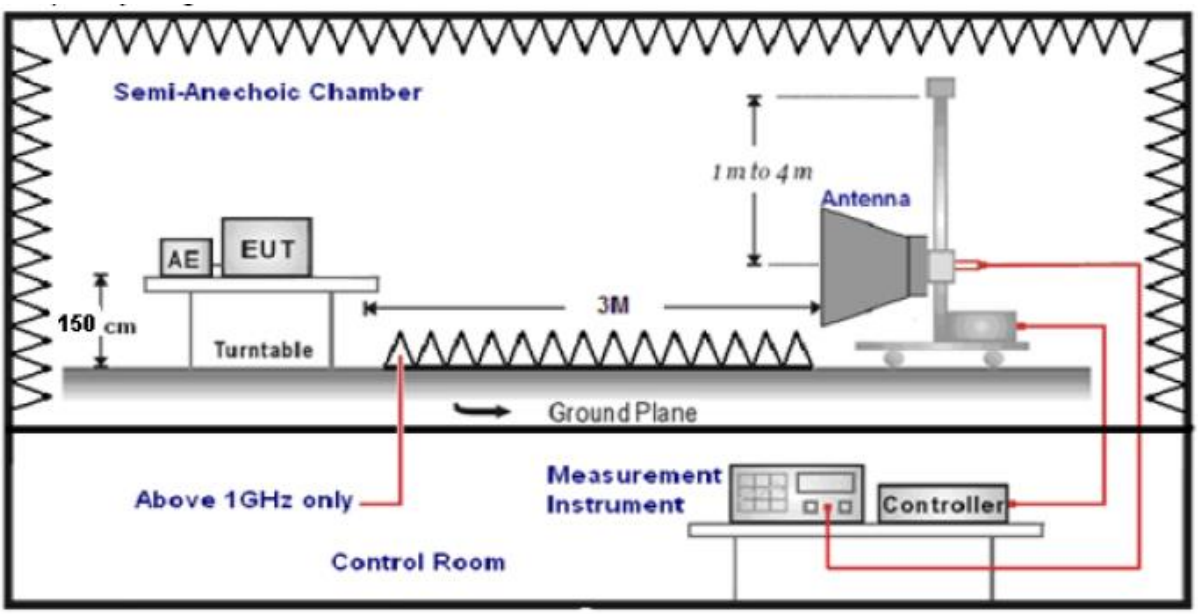
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 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

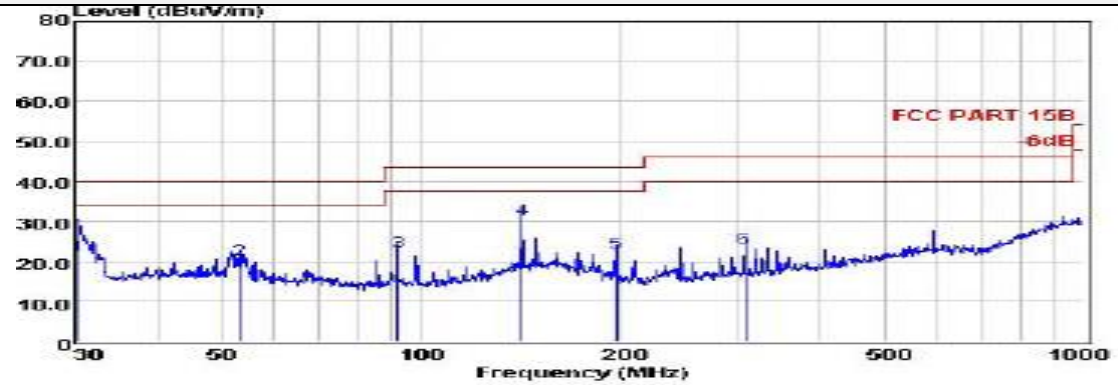
Remark: We measured Radiated Emission at GFSK, π/4 DQPSK and 8DPSK mode from 9 KHz to 25GHz and recorded worst case at GFSK mode.

For 9 KHz-30MHz

Remark:The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits(dBuv) + distance extrapolation factor.

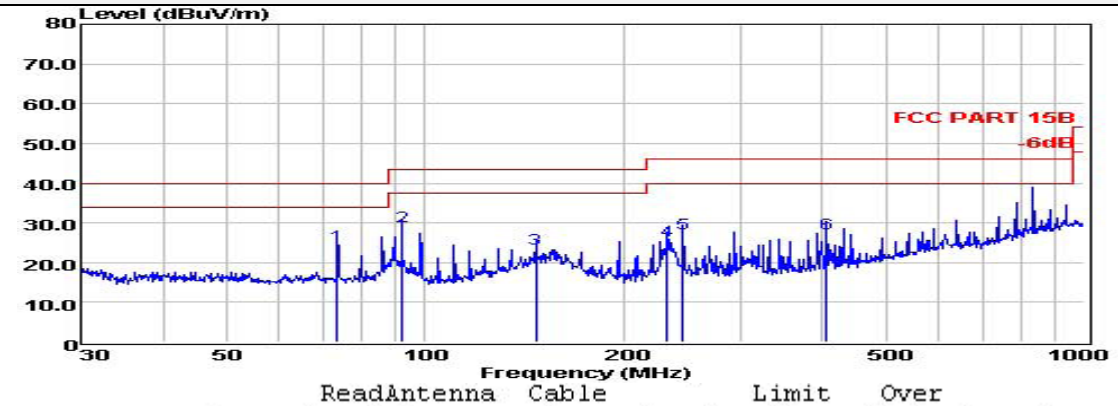
For 30MHz-1GHz

Vertical



	Freq	Read Level	Antenna Factor	Cable Loss	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dBuV/m	dBuV/m	dB	
1	30.53	12.26	14.57	0.33	27.16	40.00	-12.84	QP
2	53.32	7.78	12.62	0.12	20.52	40.00	-19.48	QP
3	92.14	10.97	11.35	0.16	22.48	43.50	-21.02	QP
4	142.32	15.11	15.27	0.23	30.61	43.50	-12.89	QP
5	196.51	10.31	11.62	0.30	22.23	43.50	-21.27	QP
6	307.83	9.83	13.02	0.66	23.51	46.00	-22.49	QP

Horizontal



	Freq	Read Level	Antenna Factor	Cable Loss	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dBuV/m	dBuV/m	dB	
1	73.62	11.41	12.91	0.14	24.46	40.00	-15.54	QP
2	92.14	16.78	12.12	0.16	29.06	43.50	-14.44	QP
3	147.40	7.90	15.40	0.23	23.53	43.50	-19.97	QP
4	233.35	13.08	12.11	0.40	25.59	46.00	-20.41	QP
5	245.95	14.81	12.19	0.40	27.40	46.00	-18.60	QP
6	406.09	11.93	14.43	0.92	27.28	46.00	-18.72	QP

For 1GHz to 25GHz

Frequency(MHz):				2402			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4804	49.58	PK	74	24.42	1.00 H	52	47.33	31.42	6.98	36.5	1.9
1	4804	42.78	AV	54	11.22	1.00 H	52	40.47	31.42	6.98	36.5	1.9
2	7206	52.69	PK	74	21.31	1.00 H	201	41.62	37.03	8.87	35.3	10.6
2	7206	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2402			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4806	48.01	PK	74	25.99	1.00 V	59	46.26	31.42	6.98	36.5	1.9
1	4806	39.99	AV	54	14.01	1.00 V	59	37.75	31.42	6.98	36.5	1.9
2	7201	48.04	PK	74	25.96	1.00 V	155	38.36	37.03	8.87	35.3	10.6
2	7201	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2441			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4886	50.51	PK	74	23.49	1.00 H	129	48.34	30.98	7.58	36.5	2.06
1	4886	41.22	AV	54	12.78	1.00 H	129	39.81	30.98	7.58	36.5	2.06
2	7325	49.91	PK	74	24.09	1.00 H	130	38.48	37.66	8.56	35.3	10.92
2	7325	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2441			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4887	51.36	PK	74	22.64	1.00 V	125	49.92	30.98	7.58	36.5	2.06
1	4887	42.12	AV	54	11.88	1.00 V	125	40.75	30.98	7.58	36.5	2.06
2	7329	33.55	PK	74	40.45	1.00 V	354	22.16	37.66	8.56	35.3	10.92
2	7329	--	AV	--	--	--	--	--	--	--	--	--

Frequency(MHz):				2480			Polarity:			HORIZONTAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4965	50.42	PK	74	23.58	1.00 H	95	47.31	31.47	7.8	36.2	3.07
1	4965	40.84	AV	54	13.16	1.00 H	95	37.48	31.47	7.8	36.2	3.07
2	7442	49.36	PK	74	24.64	1.00 H	233	38.24	38.32	8.72	35.3	11.74
2	7442	--	AV	--	--	--	--	--	--	--	--	--

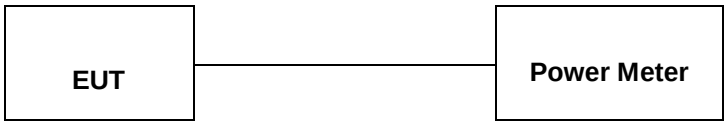
Frequency(MHz):				2480			Polarity:			VERTICAL		
No.	Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	4967	51.29	PK	74	22.71	1.00 V	108	48.85	31.47	7.8	36.2	3.07
1	4967	41.11	AV	54	12.89	1.00 V	108	38.49	31.47	7.8	36.2	3.07
2	7441	51.06	PK	74	22.94	1.00 V	326	39.39	38.32	8.72	35.3	11.74
2	7441	--	AV	--	--	--	--	--	--	--	--	--

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

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.
The maximum Average conducted output power may be measured using a wideband RF power meter with a thermocouple derector or equivalent. 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.

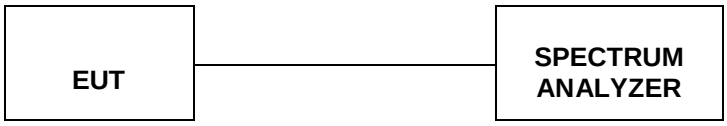
TEST RESULTS

Type	Channel	Peak Output power (dBm)	Limit (dBm)	Result
GFSK	Low	4.072	30	Pass
	Mid	4.226		
	High	**4.711**		
π/4DQPSK	Low	3.970	21	Pass
	Mid	4.041		
	High	4.192		
8DPSK	Low	3.928	21	Pass
	Mid	3.981		
	High	4.238		

Note: The test results including the cable lose.

4.4. 20dB Bandwidth

TEST CONFIGURATION



TEST PROCEDURE

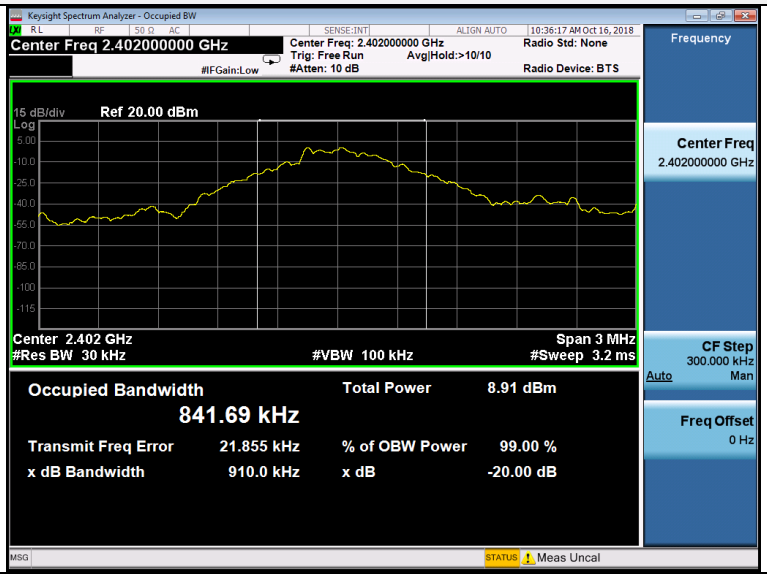
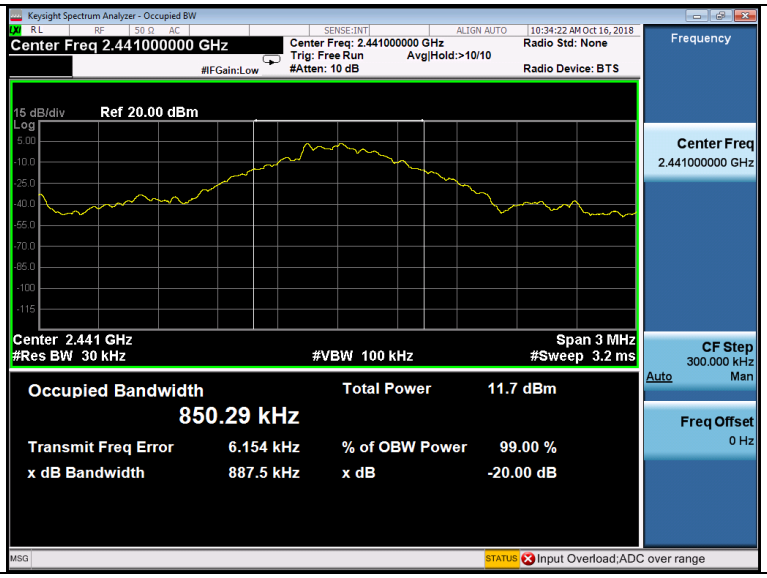
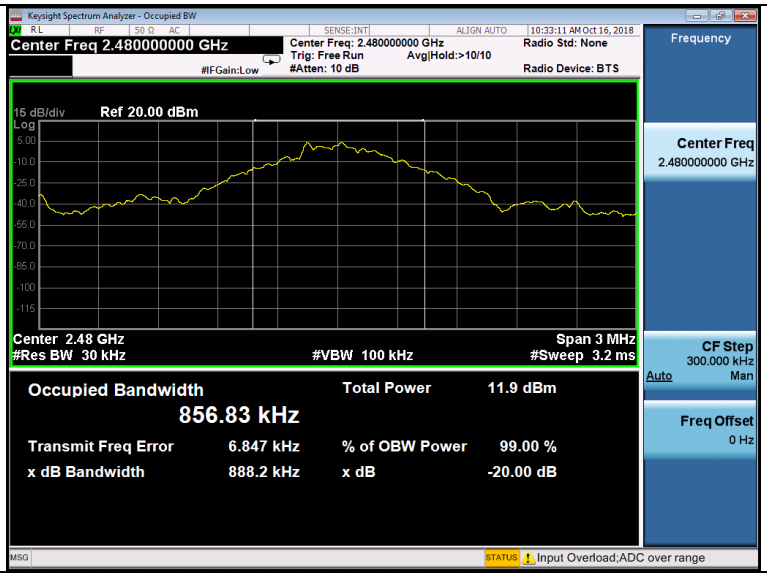
The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=30KHz and VBW=100KHz.
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

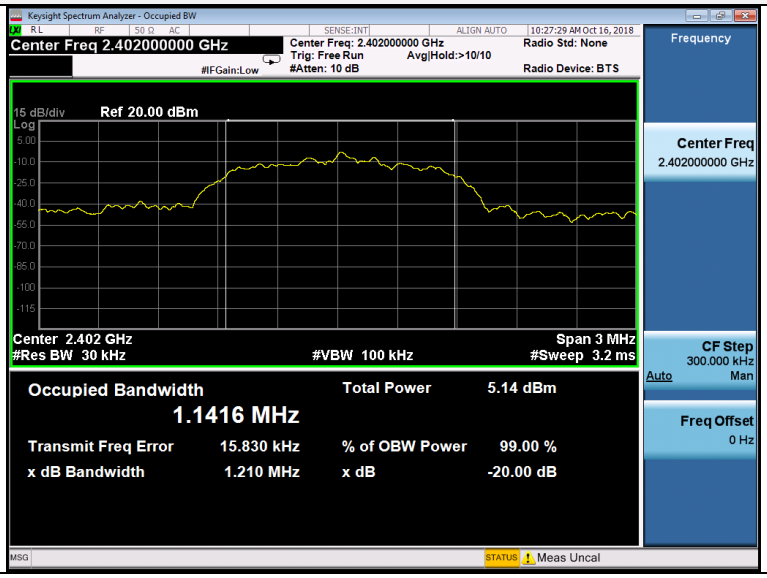
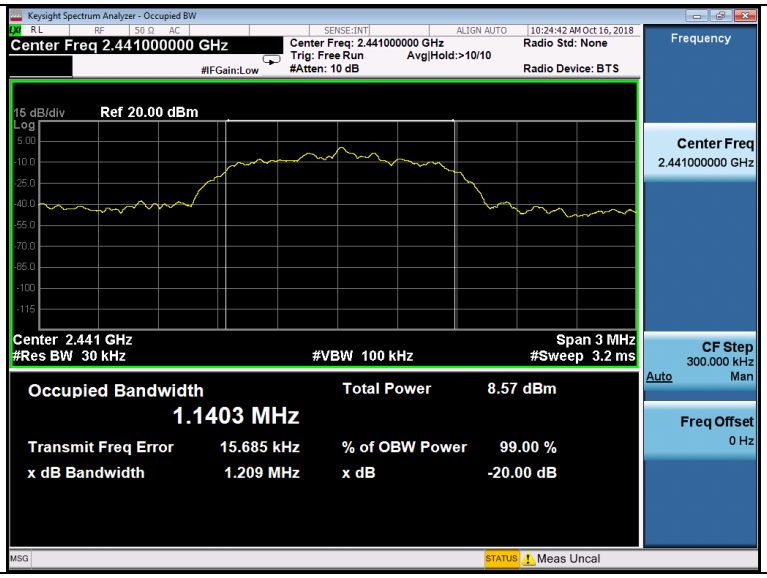
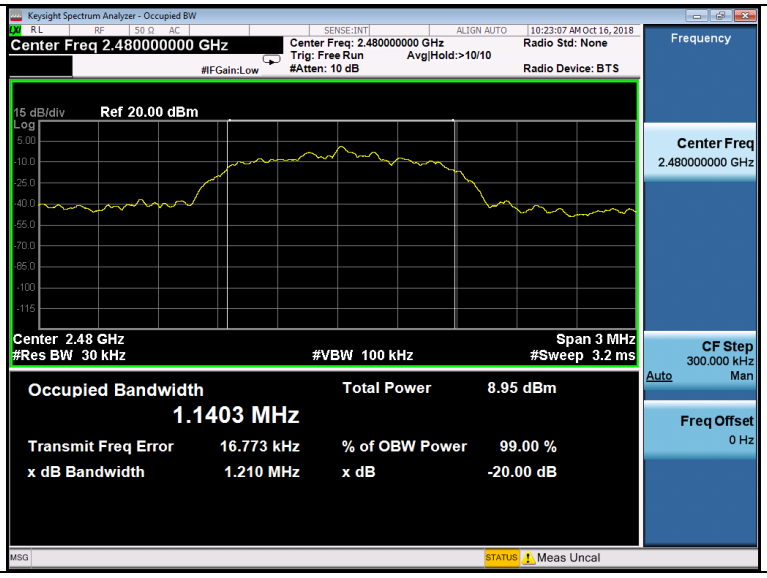
LIMIT

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

TEST RESULTS

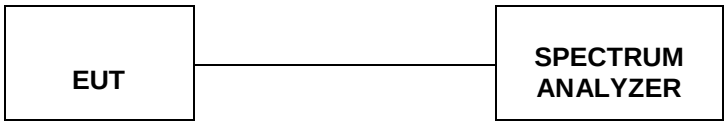
Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	Low	0.9100	Pass
	Mid	0.8875	
	High	0.8882	
8DSPSK	Low	1.210	
	Mid	1.209	
	High	1.210	

GFSK Modulation

Low

Mid

High

8DSPSK Modulation

Low

Mid

High

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=30KHz 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 Test Data

Type/Modulation	CH	CH Frequency (MHz)	CH Separation (MHz)	Limit (MHz)	Result
CH Separation GFSK	Low Channel	2402	1.000	0.910	pass
	Adjacency Channel	2403			
	Mid Channel	2441	1.006	0.888	pass
	Adjacency Channel	2442			
	High Channel	2480	0.988	0.888	pass
	Adjacency Channel	2479			
CH Separation 8DPSK	Low Channel	2402	0.996	0.807	pass
	Adjacency Channel	2403			
	Mid Channel	2441	1.000	0.806	pass
	Adjacency Channel	2442			
	High Channel	2480	1.000	0.807	pass
	Adjacency Channel	2479			

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

GFSK - Low channel	8DPSK - Low channel
	
GFSK - Middle channel	**8DPSK - Middle channel**
	
GFSK - High channel	**8DPSK - High channel**
	

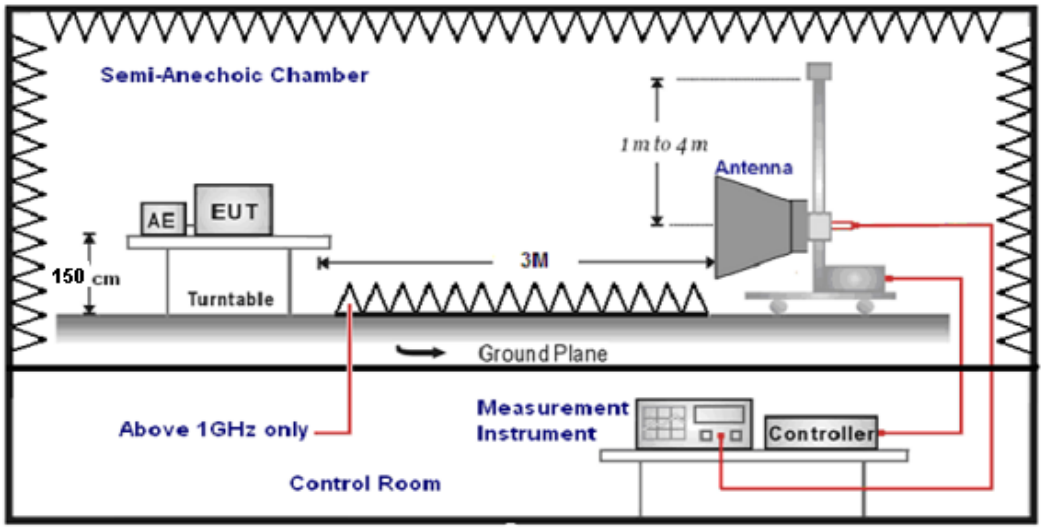
4.6. Band Edge Compliance of RF Emission

TEST REQUIREMENT

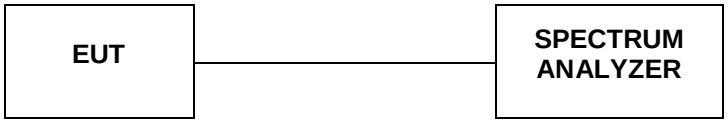
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the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

Remark: we measured all conditions(DH1,DH3,DH5) and recorded worst case at DH1.

4.6.1 For Radiated Bandedge Measurement

Remark: we tested radiated bandedge at both hopping and no-hopping modes,recorded worst case at no-hopping mode

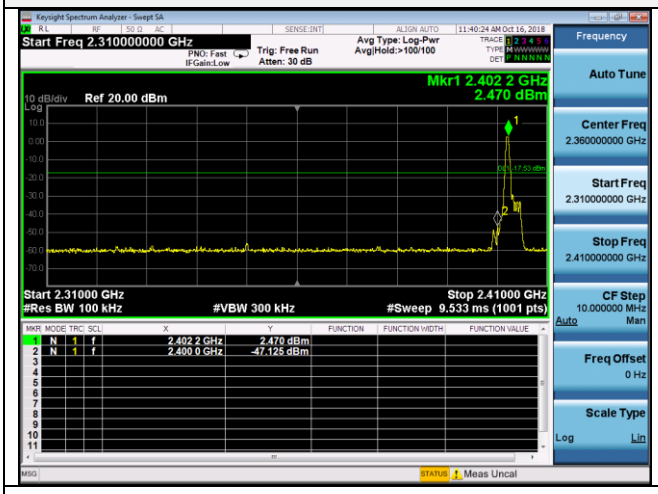
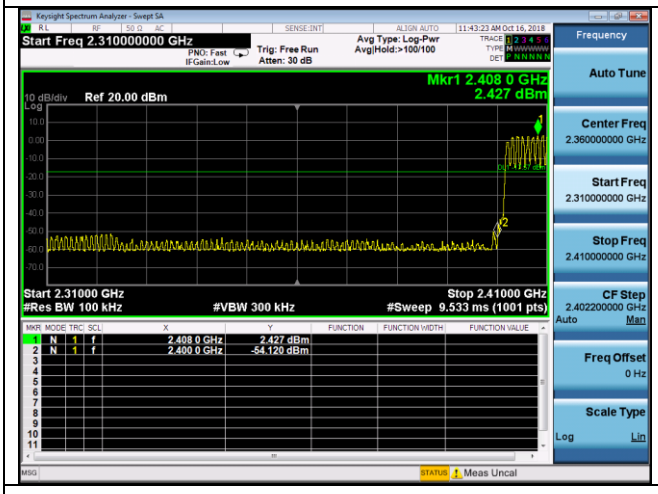
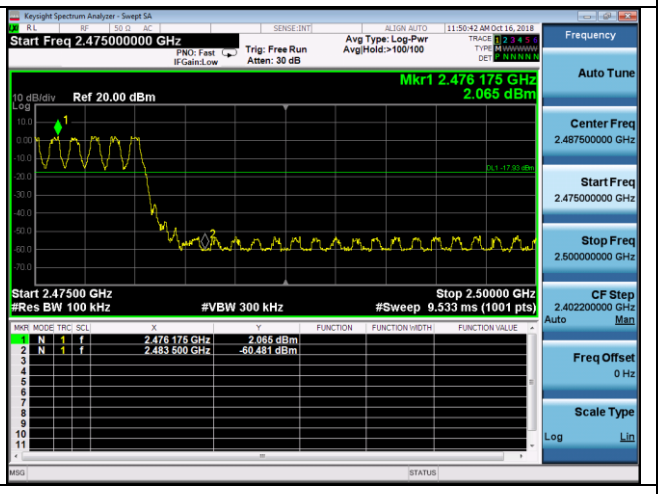
GFSK

Frequency(MHz):			**2402**			**Polarity:**			**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
2390	50.11	PK	74	23.89	1	122	56.16	27.49	3.32	36.22	-5.41
2390	40.27	AV	54	13.73	1	122	46.37	27.49	3.32	36.22	-5.41
Frequency(MHz):			**2402**			**Polarity:**			**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
2390	50.84	PK	74	23.16	1	97	55.41	27.49	3.32	36.22	-5.41
2390	40.89	AV	54	13.11	1	97	46.34	27.49	3.32	36.22	-5.41
Frequency(MHz):			**2480**			**Polarity:**			**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
2483.5	51.09	PK	74	22.91	1	157	56.57	27.45	3.38	36.34	-5.51
2483.5	40.36	AV	54	13.64	1	157	45.63	27.45	3.38	36.34	-5.51
Frequency(MHz):			**2480**			**Polarity:**			**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
2483.5	52.56	PK	74	21.44	1	324	57.71	27.45	3.38	36.34	-5.51
2483.5	41.9	AV	54	12.1	1	324	47.26	27.45	3.38	36.34	-5.51

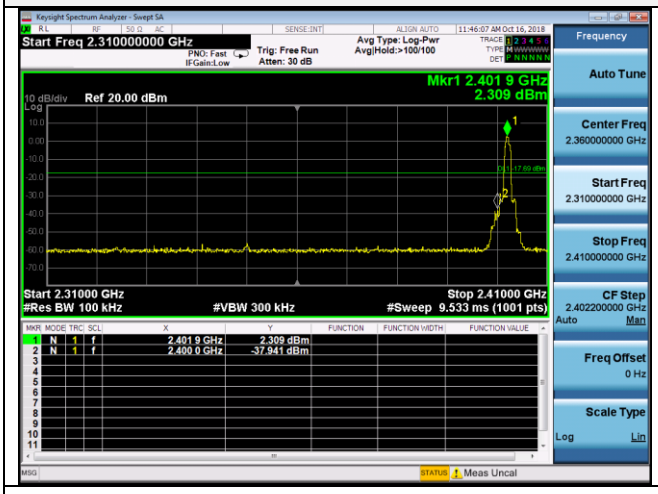
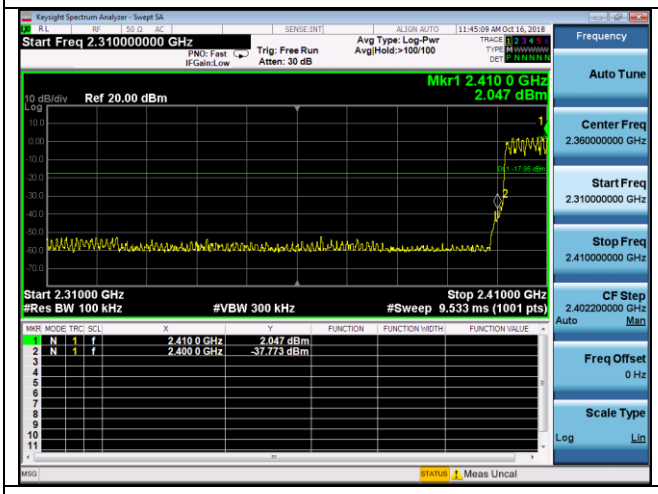
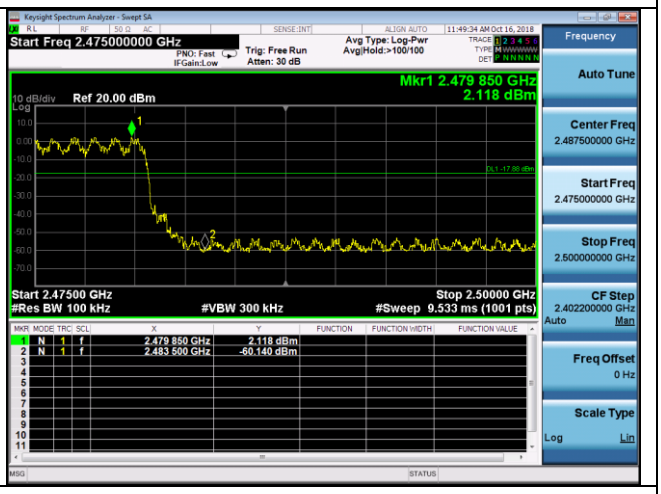
4.6.2 For Conducted Bandedge Measurement

Modulation		Frequency Band	Delta Peak to band emission (dBc)	＞Limit (dBc)	Result
GFSK	Non-hopping	Left Band	49.47	20	Pass
		Right Band	54.49	20	Pass
	hopping	Left Band	56.55	20	Pass
		Right Band	62.55	20	Pass
8DPSK	Non-hopping	Left Band	40.25	20	Pass
		Right Band	59.42	20	Pass
	hopping	Left Band	39.82	20	Pass
		Right Band	62.26	20	Pass

GFSK

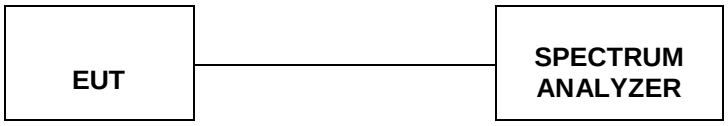
2402	2480
	
Hoping Off	Hoping Off
	
Hoping On	Hoping On

8DPSK

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 measure frequency range from 9KHz to 25GHz.

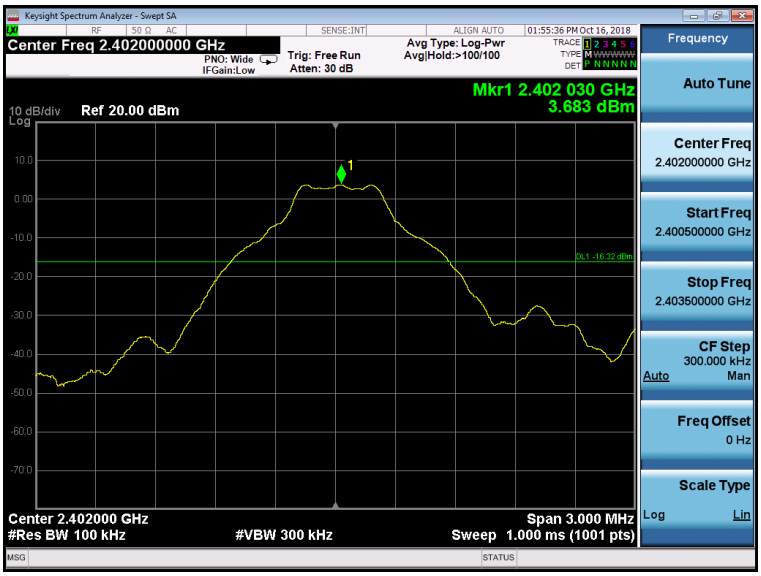
LIMIT

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.
3.For below 30MHz,For 9KHz-150kHz,150K-10MHz,We use the RBW 1KHz,10KHz, So the limit need to calculated by “10lg(BW1/BW2)“. for example For9KHz-150kHz,RBW 1KHz, The Limit= the highest emission level-20-10log(100/1)= the highest emission level-40.

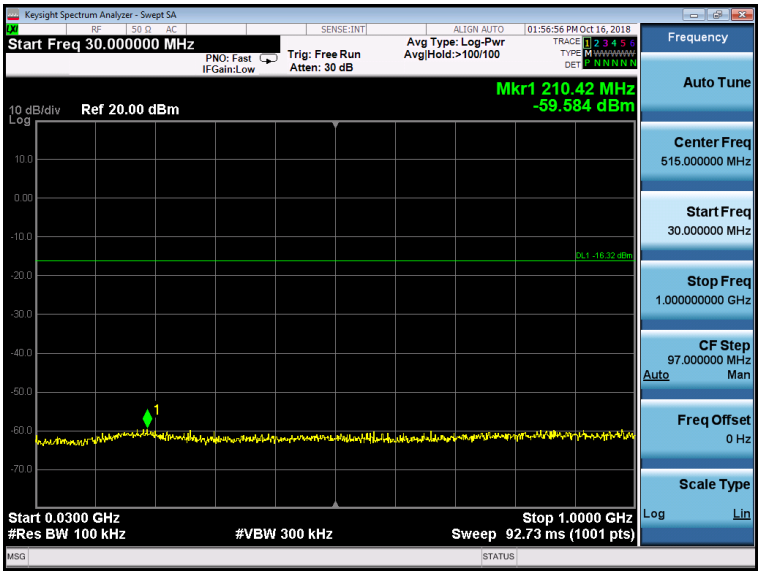
TEST RESULTS

Remark: The measurement frequency range is from 9KHz 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.

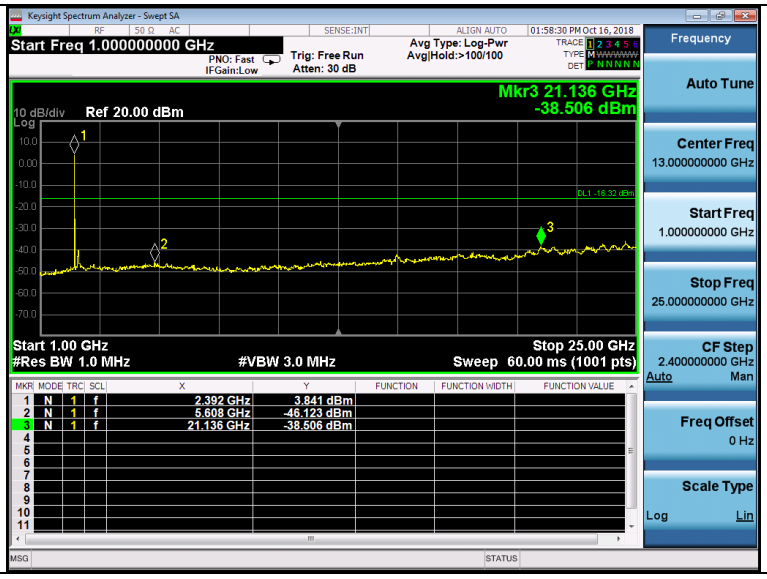
Test Mode:	GFSK	Test channel :	Low



Channel 0

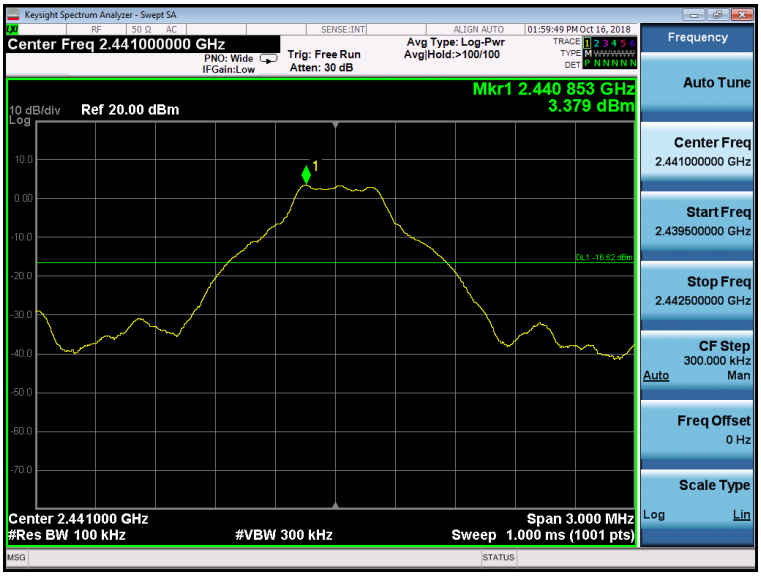


30MHz~1GHz

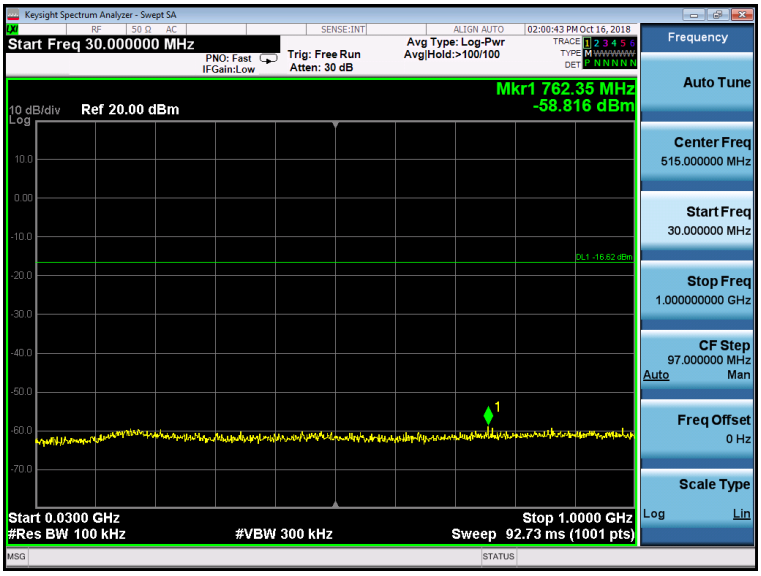


1GHz~25GHz

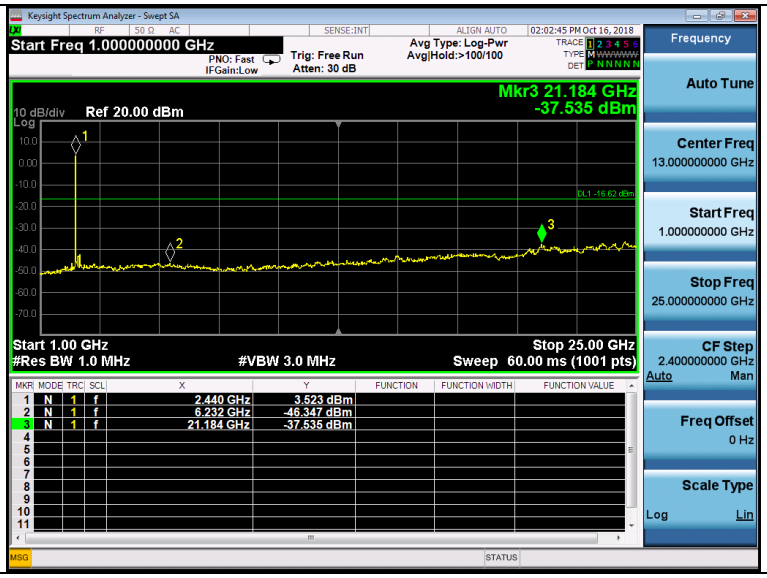
Test Mode:	GFSK	Test channel :	Mid



Channel 39



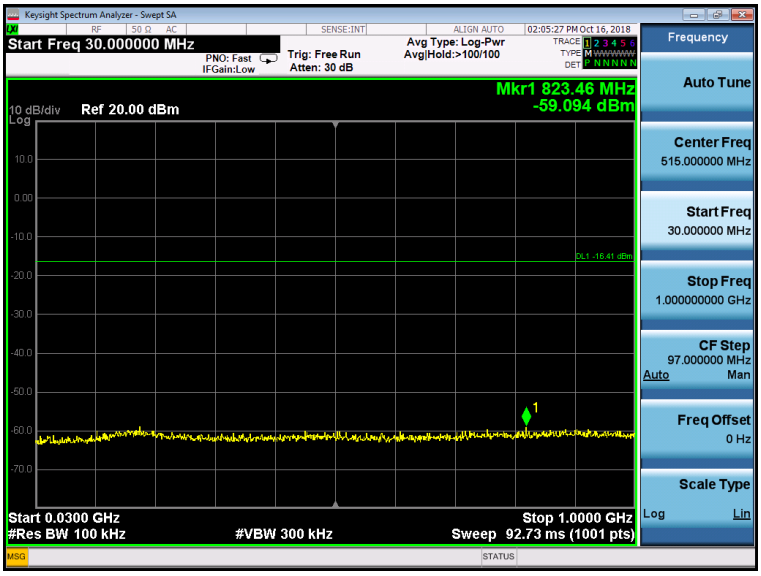
30MHz~1GHz



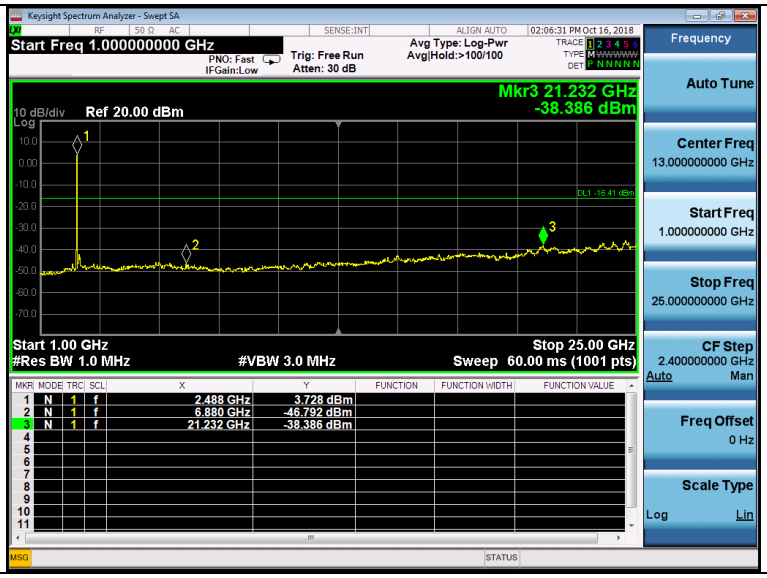
1GHz~25GHz

Test Mode:	GFSK	Test channel :	High

Channel 78



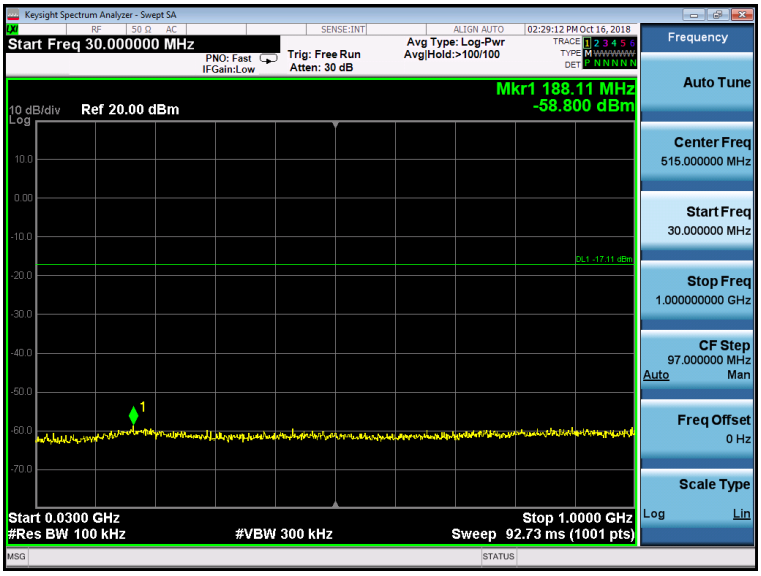
30MHz~1GHz



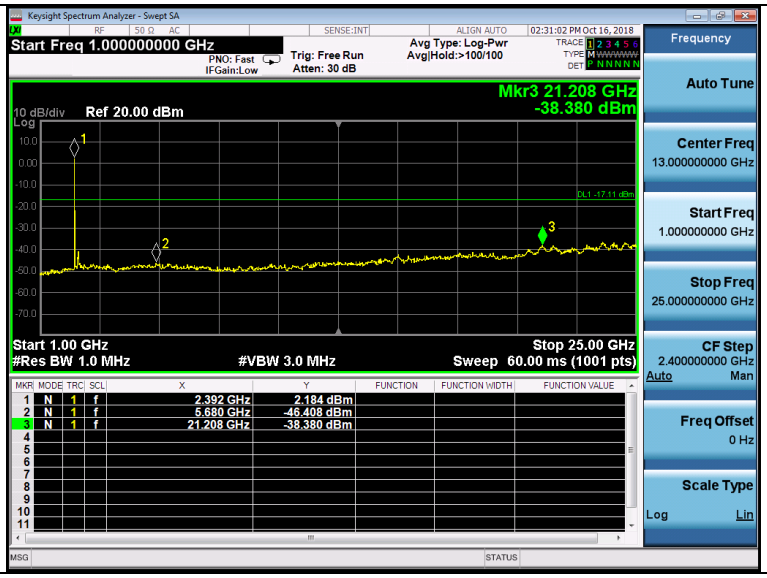
1GHz~25GHz

Test Mode:	8DPSK	Test channel :	Low

Channel 0



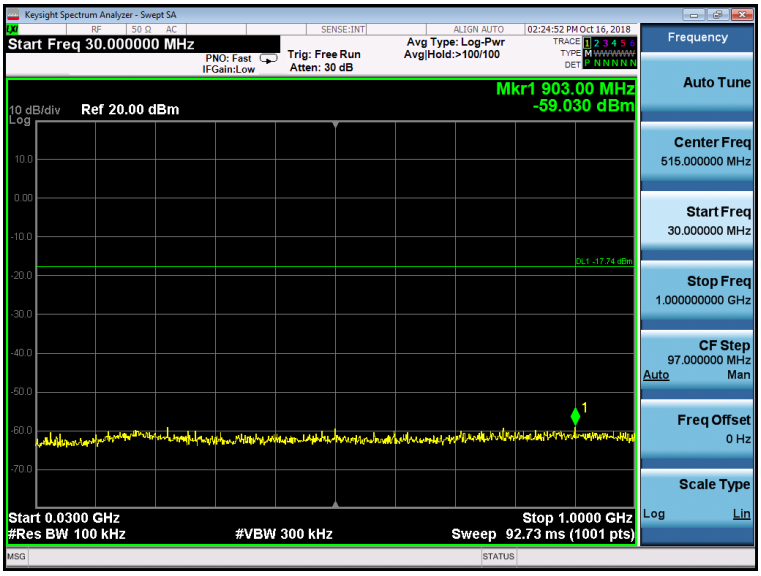
30MHz~1GHz



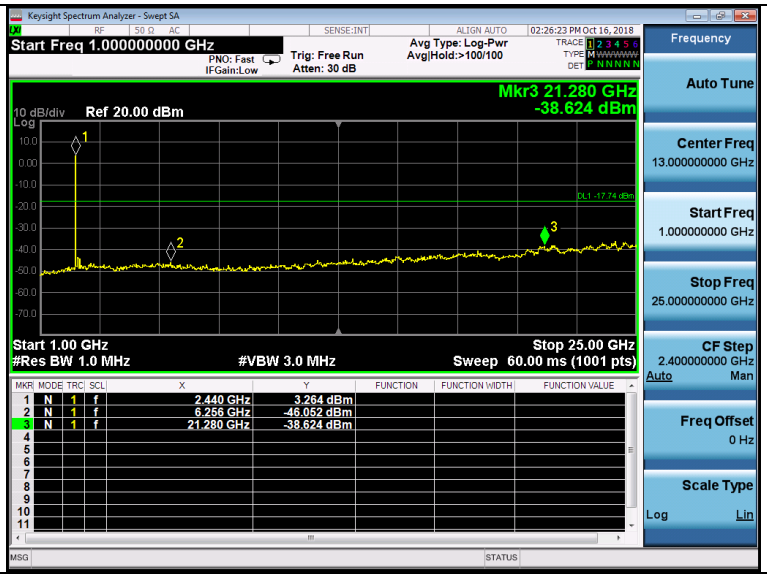
1GHz~25GHz

Test Mode:	8DPSK	Test channel :	Mid

Channel 0

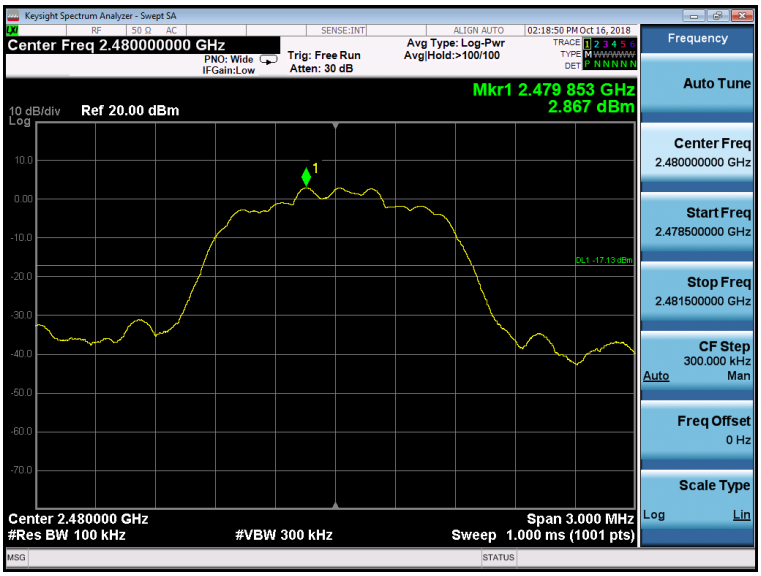


30MHz~1GHz

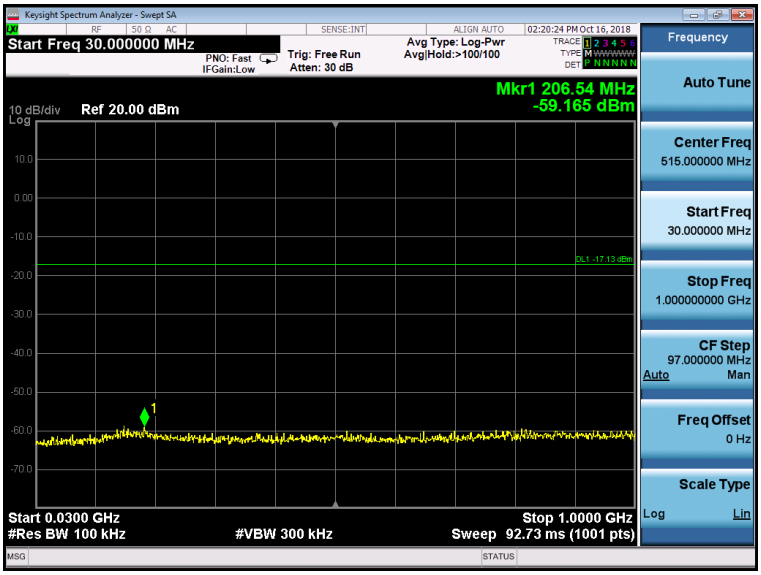


1GHz~25GHz

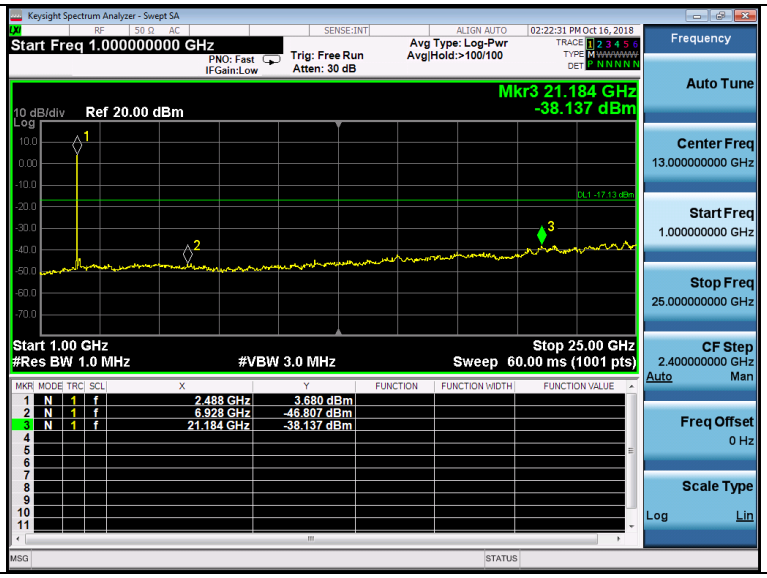
Test Mode:	8DPSK	Test channel :	High



Channel 0



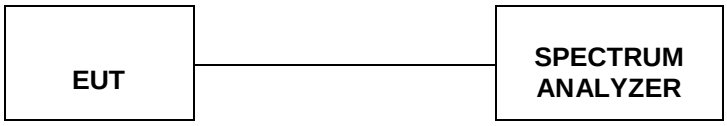
30MHz~1GHz



1GHz~25GHz

4.8. Number of hopping frequency

TEST CONFIGURATION



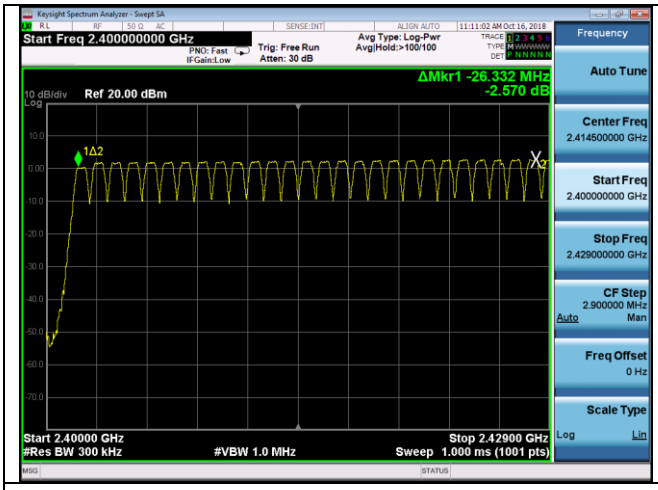
TEST PROCEDURE

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.

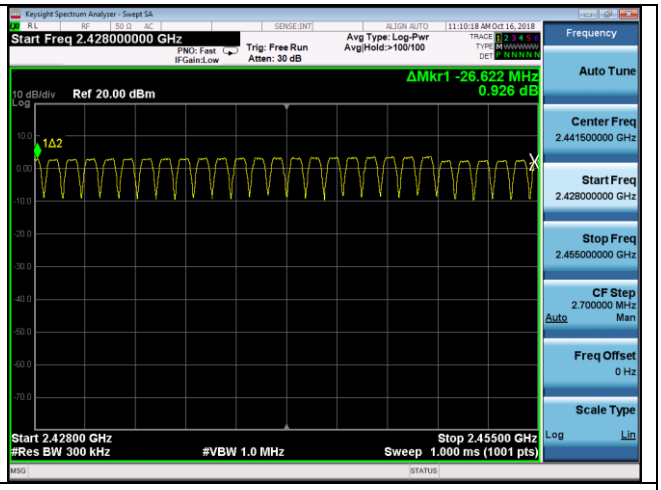
LIMIT

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

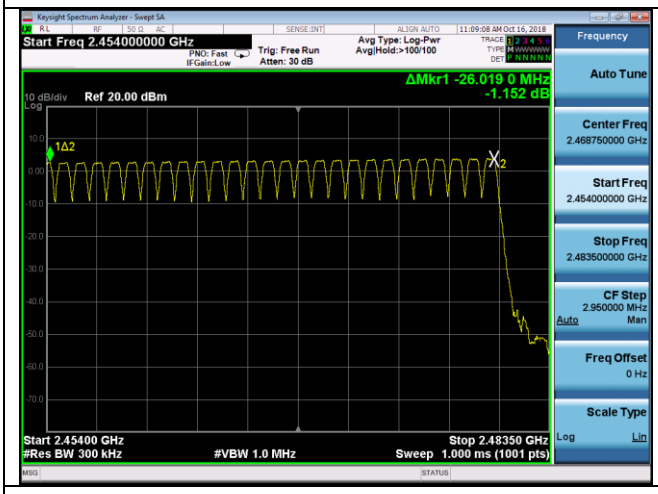
Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
8DPSK	79		



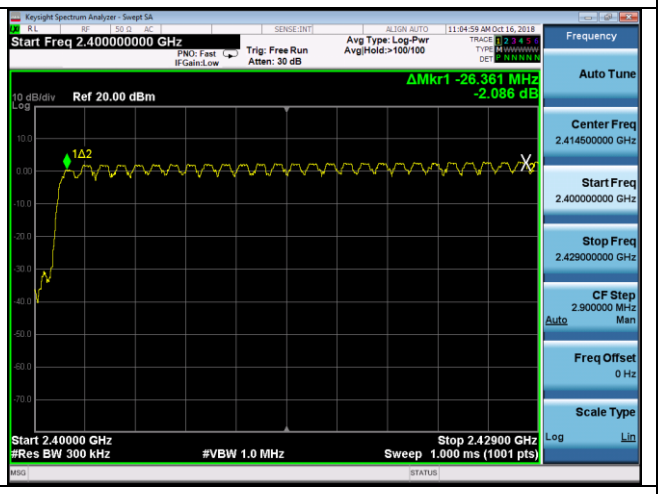
GFSK Modulation



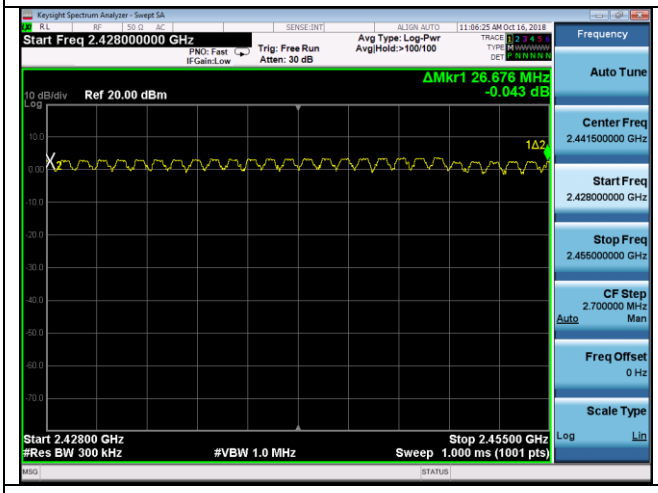
GFSK Modulation



GFSK Modulation



8DPSK Modulation

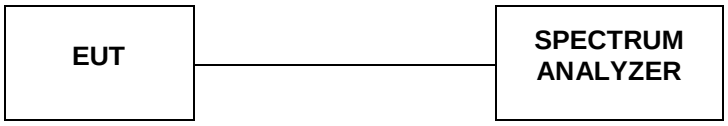


8DPSK Modulation

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.

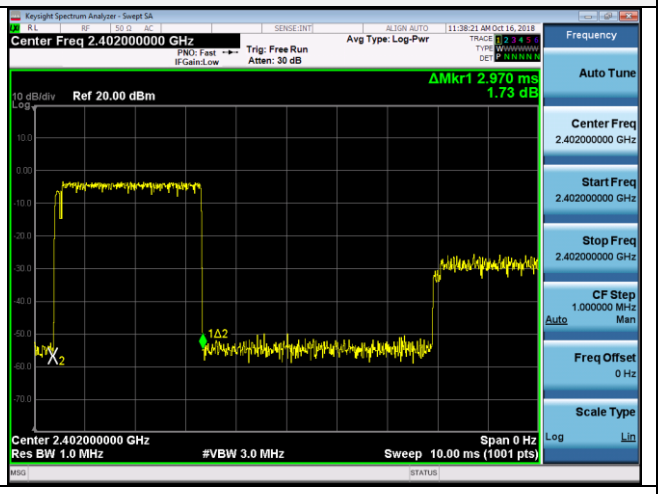
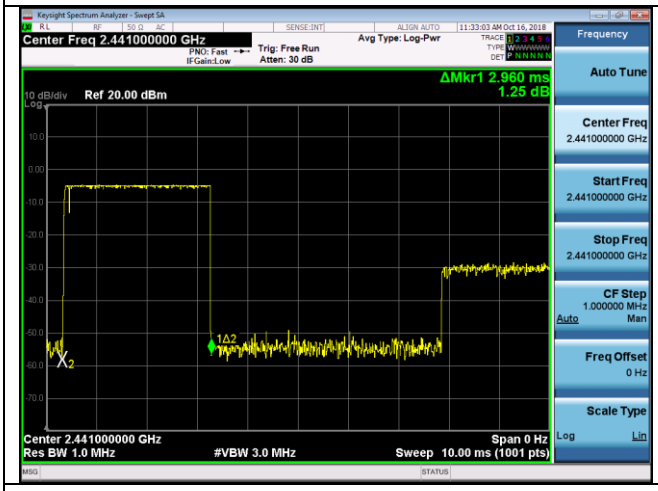
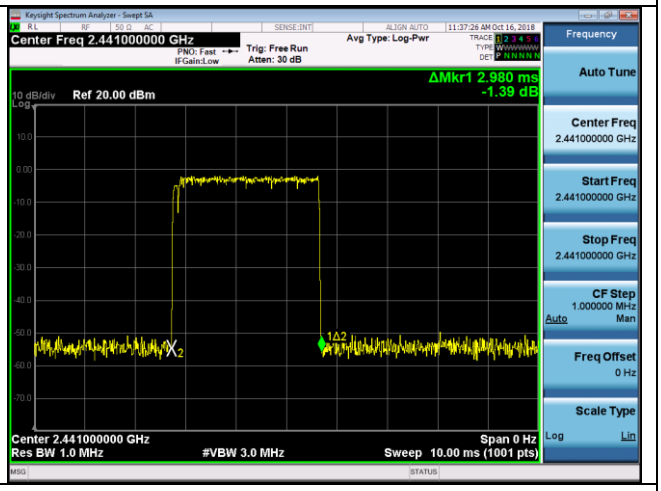
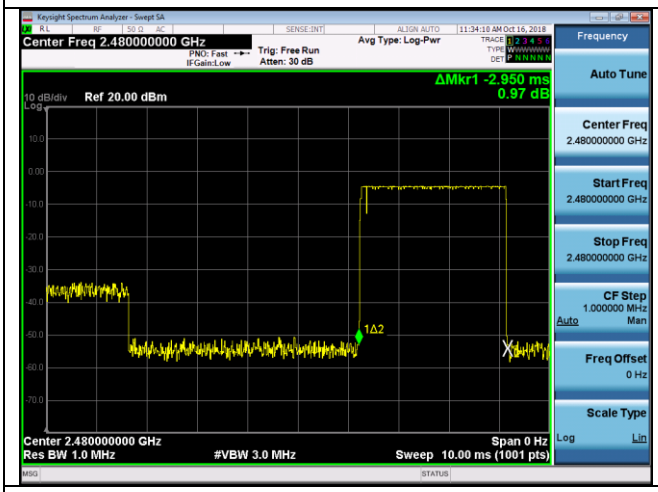
LIMIT

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

Type	Modulation	CH	Pulse time(ms)	Dwell Time(ms)	Limit(ms)	Result
Dwell Time	GFSK	Low	2.95	314.667	400	Pass
		Mid	2.96	315.733	400	Pass
		High	2.95	314.667	400	Pass
	8DPSK	Low	2.97	316.800	400	Pass
		Mid	2.98	317.867	400	Pass
		High	2.96	315.733	400	Pass
Note:Dwell time=Pulse time(ms)*(1600/6/79)*31.6						

Note:The worst case at DH5/3DH5.

GFSK Modulation	8DSPSK Modulation
	
Low	Low
	
Mid	Mid
	
High	High

4.10. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

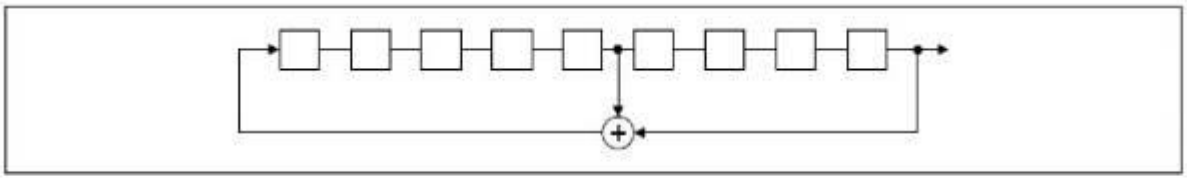
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

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

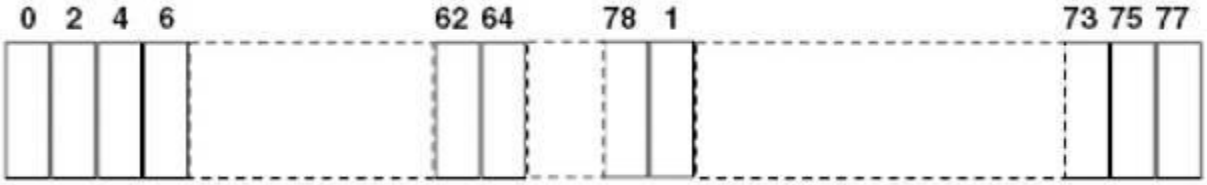
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage.And the result is fed back to the input of the frist stage.The sequence begins with the frist one of 9 consecutive ones,for example:the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

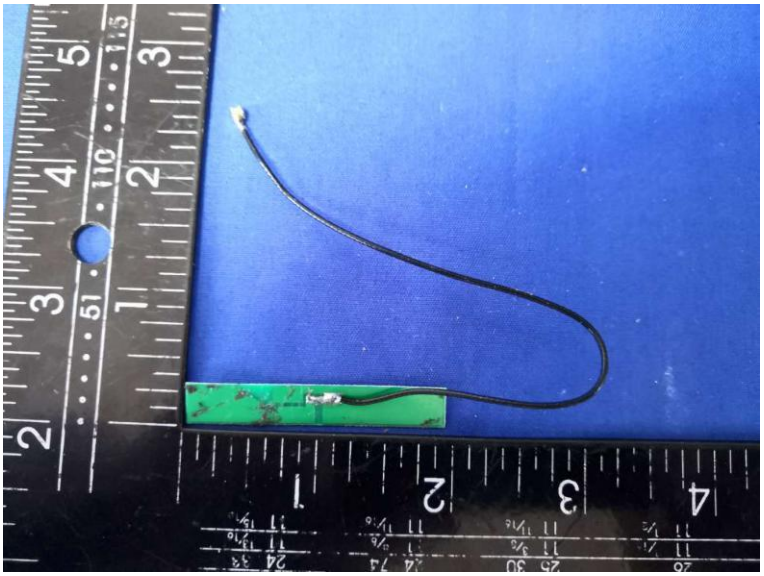
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

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 internal antenna for BT, The directional gains of antenna used for transmitting is 2.5dBi.

ANT

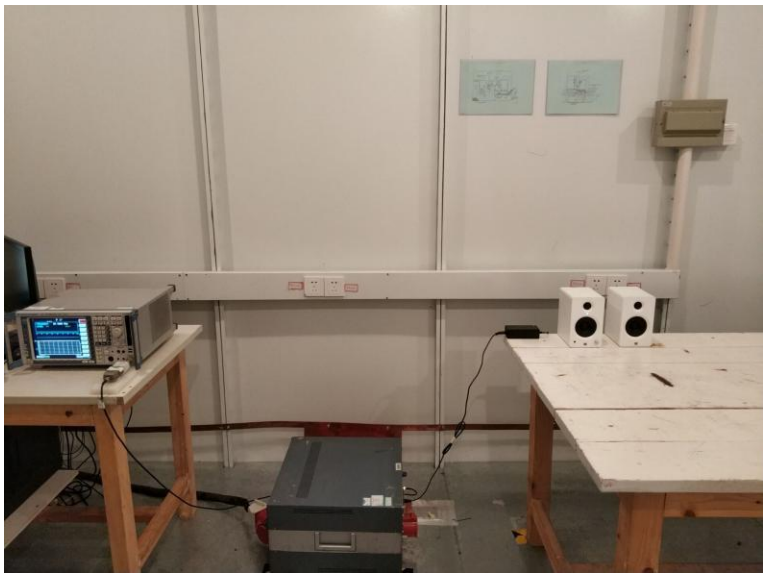


5. Test Setup Photos of the EUT

Radiated Emission
(Below 1G)

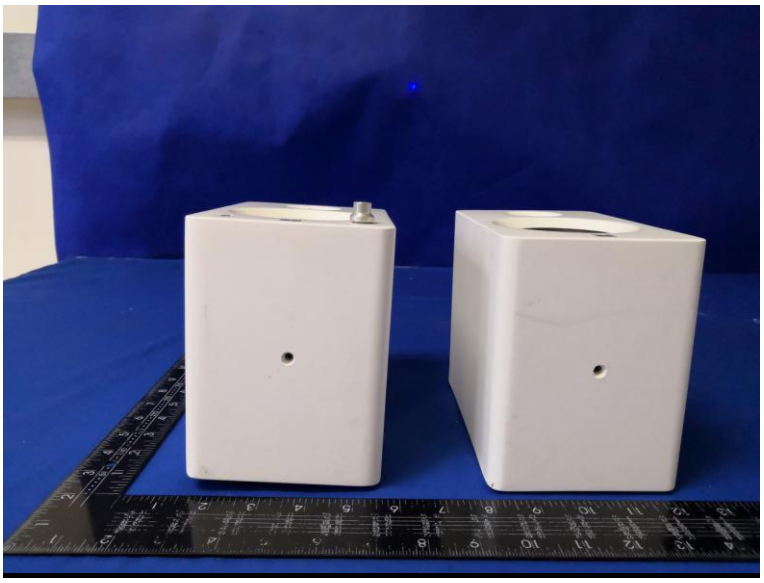
Radiated Emission
(Above 1G)

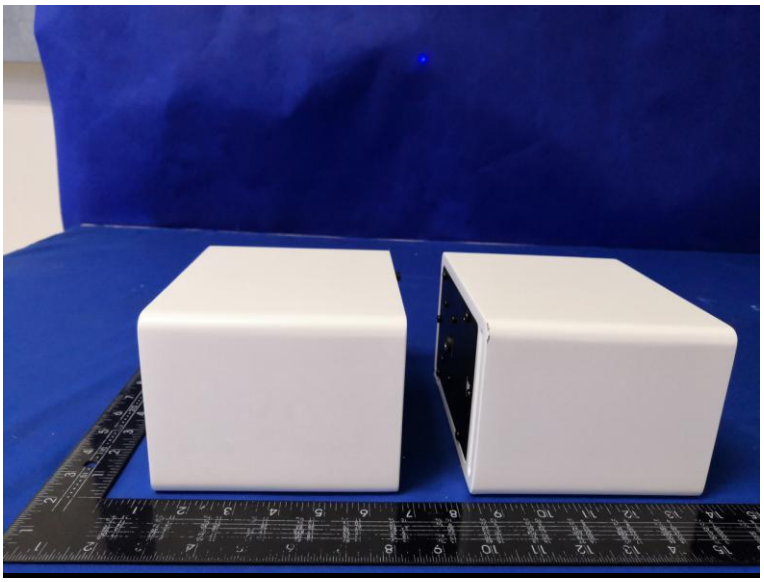
Conducted Emission

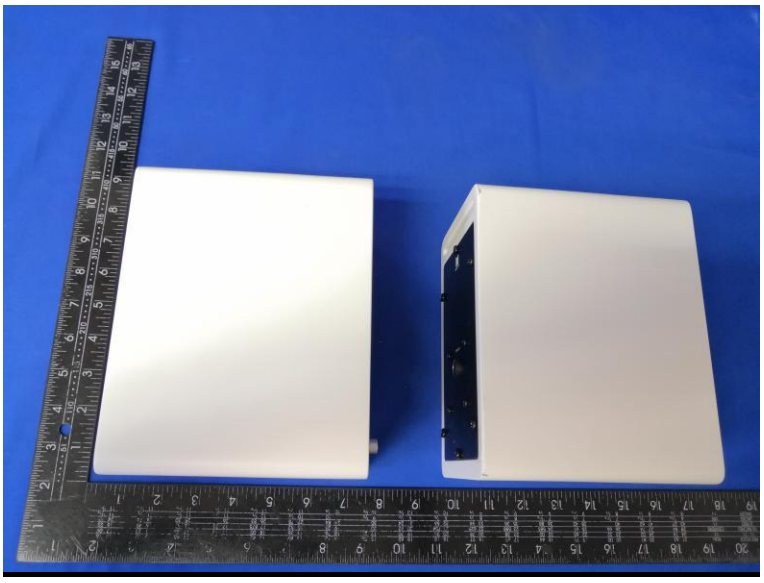


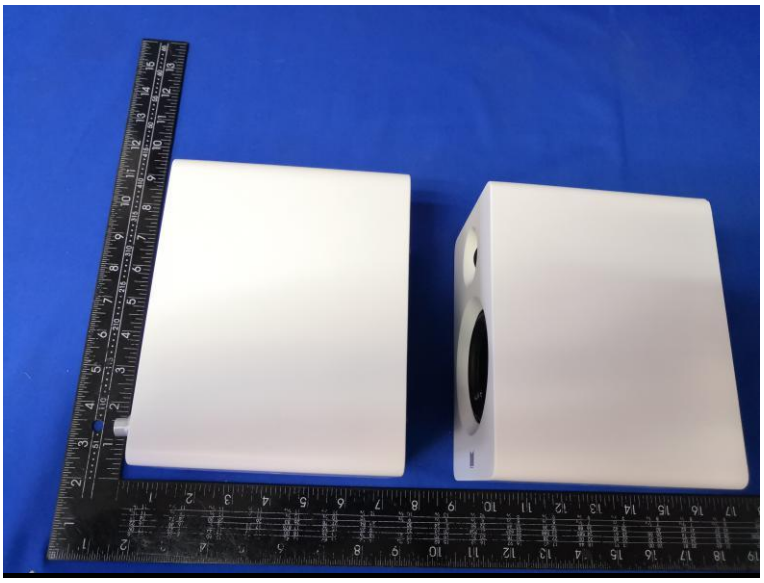
6. External and Internal Photos of the EUT

External Photos

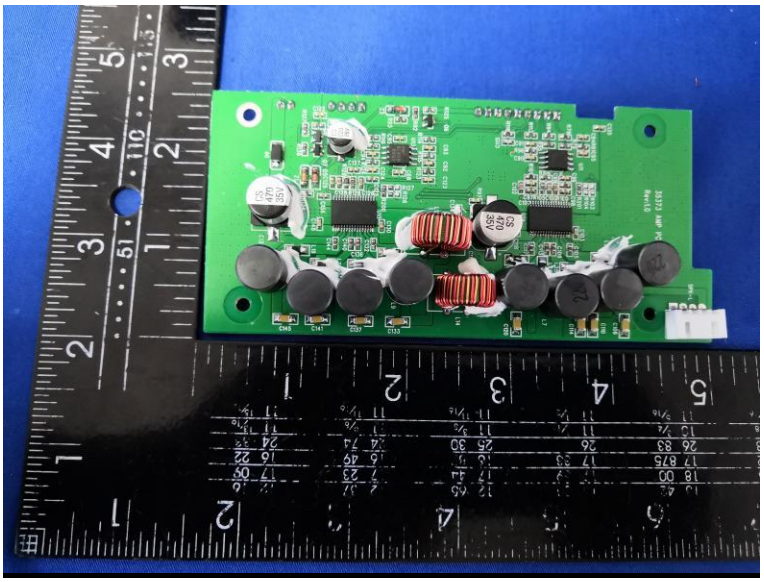


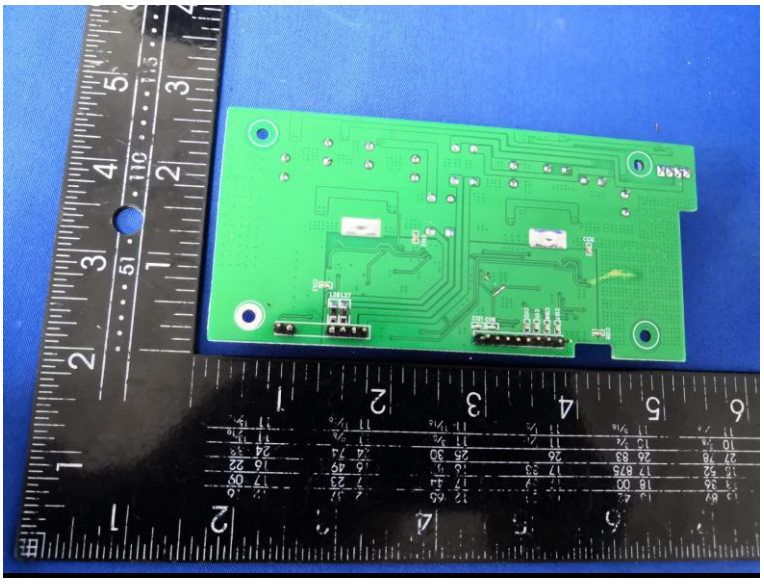


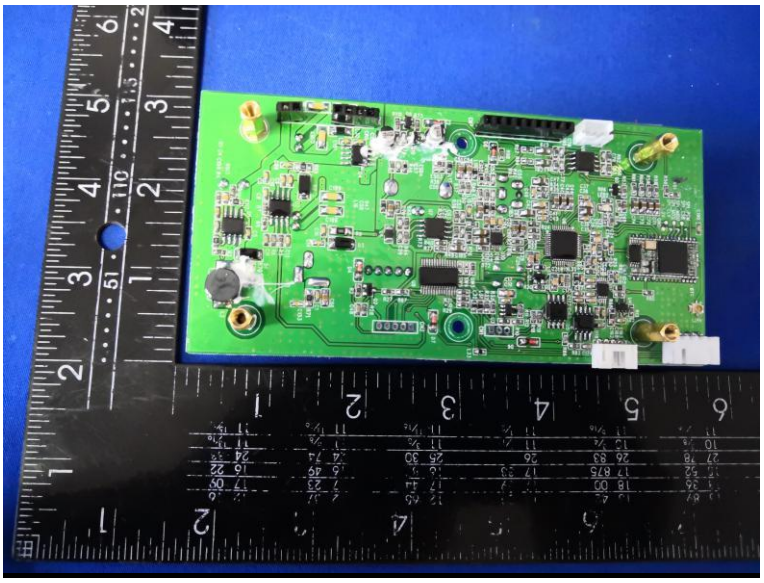


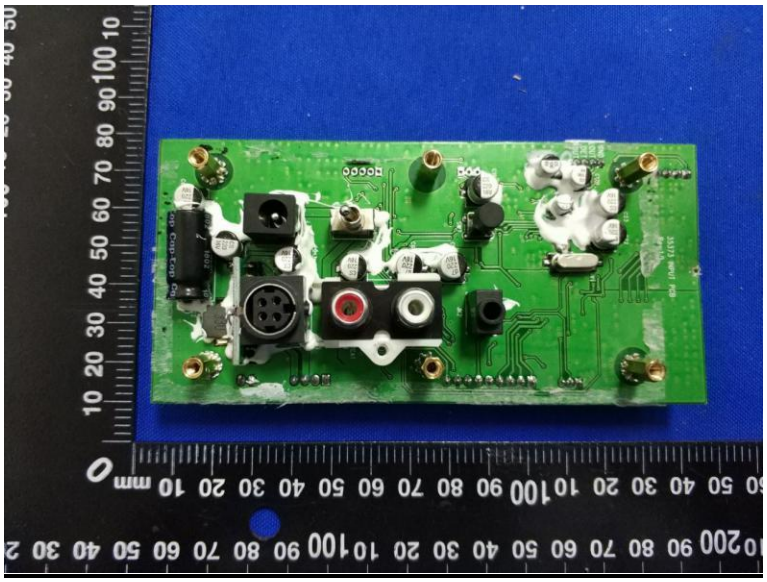


Internal Photos









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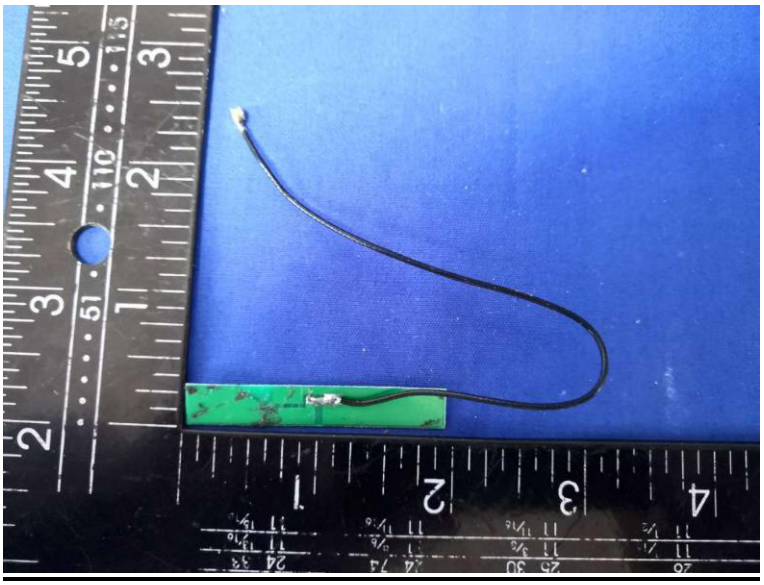

.....End of Report.....