TEST REPORT

Reference No.	:	WTS18S10127657W
FCC ID.....	:	2ARQE-20649
Applicant	:	Kaper Industrial Ltd.
Address	:	5A-B,16/F, Well Fung Ind. Centre, 68 Ta chuen Ping St. Kwai Chung N.T. Hong Kong, China
Manufacturer	:	Dong Guan Kee Fu Plastic & Metal Ltd
Address	:	No. 53 of Qiling Zhong Lu, Dabandi Industrial Zone, Daning villiage, Humen Town, Dongguan City, Guangdong Province, China
Product	:	Ozark Trail 1000 Lumen Rechargeable Bluetooth Lantern
Model(s).....	:	795, 20649
Standards	:	FCC CFR47 Part 15 Section 15.247: 2018
Date of Receipt sample	:	2018-10-31
Date of Test	:	2018-10-31 to 2018-11-19
Date of Issue	:	2018-11-19
Test Result	:	**Pass**

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

Prepared By:
Waltek Services (Shenzhen) Co., Ltd.
Address: 1/F., Fukangtai Building, West Baima Road, Songgang Street, Baoan District, Shenzhen, Guangdong, China
Tel :+86-755-83551033
Fax:+86-755-83552400

Tested by:

Jack Wen

Jack Wen / Project Engineer

Approved by:

Philo Zhong

Philo Zhong / Manager

2 Laboratories Introduction

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

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

2.1 Test Facility

A. Accreditations for Conformity Assessment (International)

Country/Region	Scope Covered By	Scope	Note
USA	ISO/IEC 17025	FCC ID \ DOC \ VOC	1
Canada		IC ID \ VOC	2
Japan		MIC-T \ MIC-R	-
Europe		EMCD \ RED	-
Taiwan		NCC	-
Hong Kong		OFCA	-
Australia		RCM	-
India		WPC	-
Thailand		NTC	-
Singapore		IDA	-

Note:

1. FCC Designation No.: CN1201. Test Firm Registration No.: 523476.
2. ISED Canada Registration No.: 7760A

B.TCBs and Notify Bodies Recognized Testing Laboratory.

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

3 Contents

Page

1 COVER PAGE 1

2 LABORATORIES INTRODUCTION 2

2.1 TEST FACILITY 3

3 CONTENTS 4

4 REVISION HISTORY 6

5 GENERAL INFORMATION 7

5.1 GENERAL DESCRIPTION OF E.U.T 7
5.2 DETAILS OF E.U.T 7
5.3 CHANNEL LIST 7
5.4 TEST MODE 8

6 EQUIPMENT USED DURING TEST 9

6.1 EQUIPMENTS LIST 9
6.2 MEASUREMENT UNCERTAINTY 10
6.3 TEST EQUIPMENT CALIBRATION 10

7 TEST SUMMARY 11

8 CONDUCTED EMISSION 12

8.1 E.U.T. OPERATION 12
8.2 EUT SETUP 12
8.3 MEASUREMENT DESCRIPTION 12
8.4 CONDUCTED EMISSION TEST RESULT 13

9 RADIATED EMISSIONS 15

9.1 EUT OPERATION 15
9.2 TEST SETUP 16
9.3 SPECTRUM ANALYZER SETUP 17
9.4 TEST PROCEDURE 18
9.5 SUMMARY OF TEST RESULTS 19

10 BAND EDGE MEASUREMENT 22

10.1 TEST PROCEDURE 22
10.2 TEST RESULT: 23

11 BANDWIDTH MEASUREMENT 27

11.1 TEST PROCEDURE: 27
11.2 TEST RESULT: 27

12 MAXIMUM PEAK OUTPUT POWER 31

12.1 TEST PROCEDURE: 31
12.2 TEST RESULT: 31

13 HOPPING CHANNEL SEPARATION 35

13.1 TEST PROCEDURE: 35
13.2 TEST RESULT: 35

14 NUMBER OF HOPPING FREQUENCY 39

14.1 TEST PROCEDURE: 39
14.2 TEST RESULT: 39

15 DWELL TIME 41

15.1 TEST PROCEDURE: 41
15.2 TEST RESULT: 41
16 ANTENNA REQUIREMENT 46
17 RF EXPOSURE EVALUATION 47
TEST REQUIREMENT: FCC PART 1.1307 47
17.1 REQUIREMENTS 47
17.2 TEST RESULT 47
18 PHOTOGRAPHS -TEST SETUP PHOTOS 48
18.1 PHOTOGRAPH-CONDUCTED EMISSIONS TEST SETUP 48
18.2 PHOTOGRAPH-RADIATED EMISSIONS 48
19 PHOTOGRAPHS – CONSTRUCTIONAL DETAILS 50
19.1 EUT –EXTERNAL PHOTOS 50
19.2 EUT – INTERNAL PHOTOS 55

4 Revision History

Test report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTS18S10127657W	2018-10-31	2018-10-31 to 2018-11-19	2018-11-19	original	-	Valid

5 General Information

5.1 General Description of E.U.T

Product: Ozark Trail 1000 Lumen Rechargeable Bluetooth Lantern

Model(s): 795, 20649

Model descriptions: Only the model names are different.

Operation Frequency: 2402-2480MHz, 79(EDR) Channels in total

RF out Power: 0.19dBm

Antenna installation: PCB Printed Antenna

Antenna Gain: 1.9dBi

Type of Modulation: GFSK, Pi/4DQPSK

5.2 Details of E.U.T

Ratings: Input: DC 5V
Battery: DC 3.7V 14.8Wh

5.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2402	2	2403	3	2404	4	2405
5	2406	6	2407	7	2408	8	2409
9	2410	10	2411	11	2412	12	2413
13	2414	14	2415	15	2416	16	2417
17	2418	18	2419	19	2420	20	2421
21	2422	22	2423	23	2424	24	2425
25	2426	26	2427	27	2428	28	2429
29	2430	30	2431	31	2432	32	2433
33	2434	34	2435	35	2436	36	2437
37	2438	38	2439	39	2440	40	2441
41	2442	42	2443	43	2444	44	2445
45	2446	46	2447	47	2448	48	2449
49	2450	50	2451	51	2452	52	2453
53	2454	54	2455	55	2456	56	2457
57	2458	58	2459	59	2460	60	2461
61	2462	62	2463	63	2464	64	2465
65	2466	66	2467	67	2468	68	2469
69	2470	70	2471	71	2472	72	2473
73	2474	74	2475	75	2476	76	2477
77	2478	78	2479	79	2480	-	-

5.4 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Table 1 Tests Carried Out Under FCC part 15.247

Test mode	Low channel	Middle channel	High channel
Transmitting	2402MHz	2441MHz	2480MHz

Table 2 Tests Carried Out Under FCC part 15.207 and 15.209

Test Item	Test Mode
Radiated Emissions	Transmitting
Conducted Emissions	Transmitting

6 Equipment Used during Test

6.1 Equipments List

Conducted Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1	EMI Test Receiver	R&S	ESCI	101155	2018.09.15	2019.09.14
2	LISN	SCHWARZBECK	NSLK 8128	8128-289	2018.09.15	2019.09.14
3	Limiter	York	MTS-IMP-136	261115-001-0024	2018.09.15	2019.09.14
4	Cable	LARGE	RF300	-	2018.07.18	2019.07.17
3m Semi-anechoic Chamber for Radiation Emissions						
1	Spectrum Analyzer	R&S	FSP	100091	2018.04.20	2019.04.19
2	Amplifier	Agilent	8447D	2944A10178	2018.01.10	2019.01.09
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2018.05.18	2019.05.17
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2018.10.15	2019.10.14
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2018.05.18	2019.05.17
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2018-10.24	2019.10.23
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2018.04.07	2019.04.06
8	Coaxial Cable (above 1GHz)	Top	1GHz-18GHz	EW02014-7	2018.04.07	2019.04.06
9	Signal Generater	R&S	SMP22	100102	2018.09.15	2019.09.14
10	Spectrum Analyzer	R&S	FSP	100091	2018.04.20	2019.04.19
3m Semi-anechoic Chamber for Radiation Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No**	**Last Calibration Date**	**Calibration Due Date**
1	Test Receiver	R&S	ESCI	101296	2018.04.20	2019.04.19
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2018.04.19	2019.04.18
3	Amplifier	ANRITSU	MH648A	M43381	2018.04.20	2019.04.19
4	Cable	HUBER+SUHNER	CBL2	525178	2018.04.20	2019.04.19
5	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2018.04.17	2019.04.16
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMC Analyzer (9k~26.5GHz)	Agilent	E7405A	MY45114943	2018-09-13	2019-09-12

2.	Spectrum Analyzer (9k-6GHz)	R&S	FSL6	100959	2018-09-11	2019-09-10
3.	Signal Analyzer (9k~26.5GHz)	Agilent	N9010A	MY50520207	2018-09-11	2019-09-10

6.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 1 x 10^{-6}
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Radiated Spurious Emissions test	± 5.03 dB (30M~1000MHz)
	± 5.47 dB (1000M~25000MHz)
Conducted Spurious Emissions test	± 3.64 dB (AC mains 150KHz~30MHz)

6.3 Test Equipment Calibration

All the test equipments used are valid and calibrated by GUANG ZHOU GRG METROLOGY & TEST CO., L TD. address is No.163, Pingyun Rd. West of Huangpu Ave,Tianhe District, Guangzhou, Guangdong, China.

7 Test Summary

Test Items	Test Requirement	Result
Conduct Emission	15.207	C
Spurious Radiated Emissions	15.205(a) 15.209 15.247(d)	C
Band edge	15.247(d) 15.205(a)	C
Bandwidth	15.247(a)(1)	C
Maximum Peak Output Power	15.247(b)(1)	C
Frequency Separation	15.247(a)(1)	C
Number of Hopping Frequency	15.247(a)(1)(iii)	C
Dwell time	15.247(a)(1)(iii)	C
SAR	1.1307(b)(1)	C
Antenna Requirement	15.203	C
Note: C=Compliance; NC=Not Compliance; NT=Not Tested; N/A=Not Applicable.		

8 Conducted Emission

Test Requirement: FCC CFR 47 Part 15 Section 15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Class/Severity: Class B

Limit:

Frequency (MHz)	Conducted Limit (dBμV)	
	Qsi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5.0	56	46
5.0 to 30	60	50
*Decreases with the logarithm of the frequency.		

8.1 E.U.T. Operation

Operating Environment :

Temperature: 22.8 °C

Humidity: 52.6 % RH

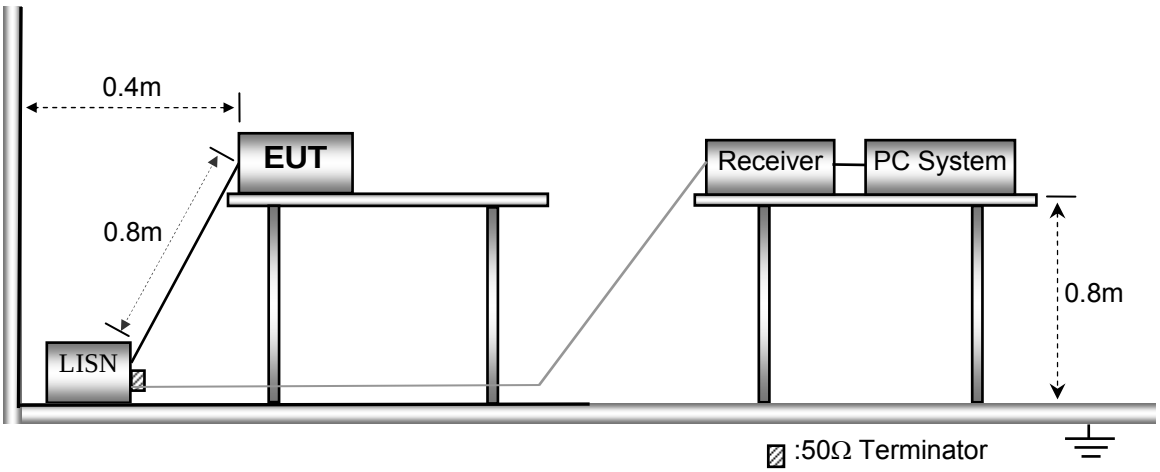
Atmospheric Pressure: 101.2kPa

EUT Operation :

Refer to Section 5.4.

8.2 EUT Setup

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



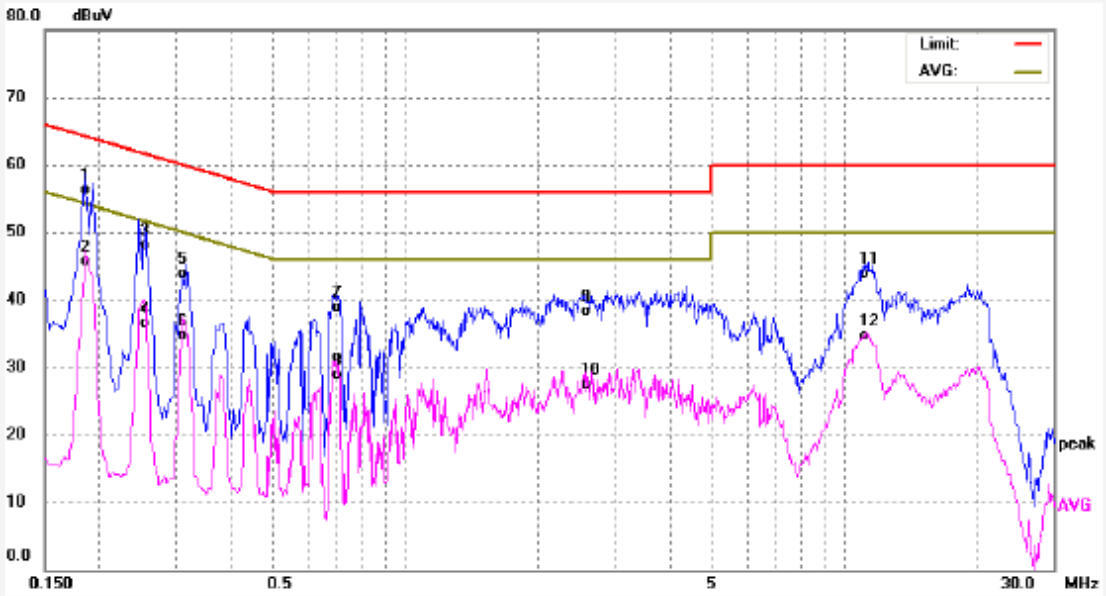
8.3 Measurement Description

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

8.4 Conducted Emission Test Result

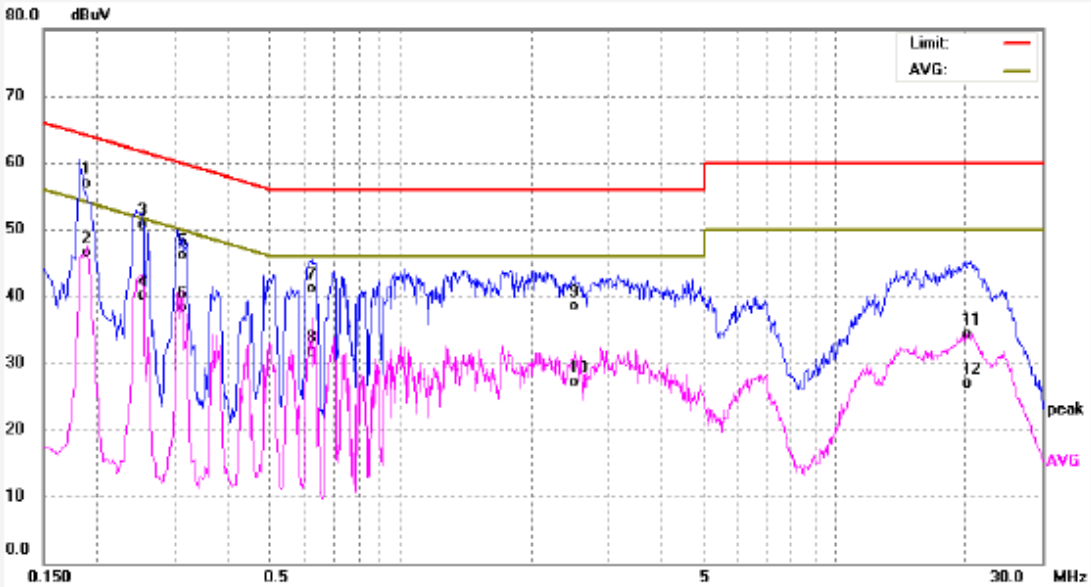
An initial pre-scan was performed on the live and neutral lines.

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1860	46.08	10.31	56.39	64.21	-7.82	QP	
2	0.1860	35.30	10.31	45.61	54.21	-8.60	AVG	
3	0.2540	37.67	10.39	48.06	61.62	-13.56	QP	
4	0.2540	26.05	10.39	36.44	51.62	-15.18	AVG	
5	0.3100	33.42	10.41	43.83	59.97	-16.14	QP	
6	0.3100	24.31	10.41	34.72	49.97	-15.25	AVG	
7	0.6980	28.50	10.44	38.94	56.00	-17.06	QP	
8	0.6980	18.46	10.44	28.90	46.00	-17.10	AVG	
9	2.5940	27.63	10.67	38.30	56.00	-17.70	QP	
10	2.5940	16.75	10.67	27.42	46.00	-18.58	AVG	
11	11.2020	32.84	11.15	43.99	60.00	-16.01	QP	
12	11.2020	23.57	11.15	34.72	50.00	-15.28	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1900	46.53	10.31	56.84	64.03	-7.19	QP	
2	0.1900	36.22	10.31	46.53	54.03	-7.50	AVG	
3	0.2540	40.29	10.39	50.68	61.62	-10.94	QP	
4	0.2540	29.66	10.39	40.05	51.62	-11.57	AVG	
5	0.3140	35.73	10.41	46.14	59.86	-13.72	QP	
6	0.3140	27.89	10.41	38.30	49.86	-11.56	AVG	
7	0.6260	30.64	10.48	41.12	56.00	-14.88	QP	
8	0.6260	21.13	10.48	31.61	46.00	-14.39	AVG	
9	2.5140	27.90	10.66	38.56	56.00	-17.44	QP	
10	2.5140	16.51	10.66	27.17	46.00	-18.83	AVG	
11	20.2340	23.47	10.74	34.21	60.00	-25.79	QP	
12	20.2340	16.15	10.74	26.89	50.00	-23.11	AVG	

9 Radiated Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method: ANSI C63.10:2013

Test Result: PASS

Measurement Distance: 3m

Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

9.1 EUT Operation

Operating Environment **:**

Temperature: 23.5 °C

Humidity: 52.1 % RH

Atmospheric Pressure: 101.2kPa

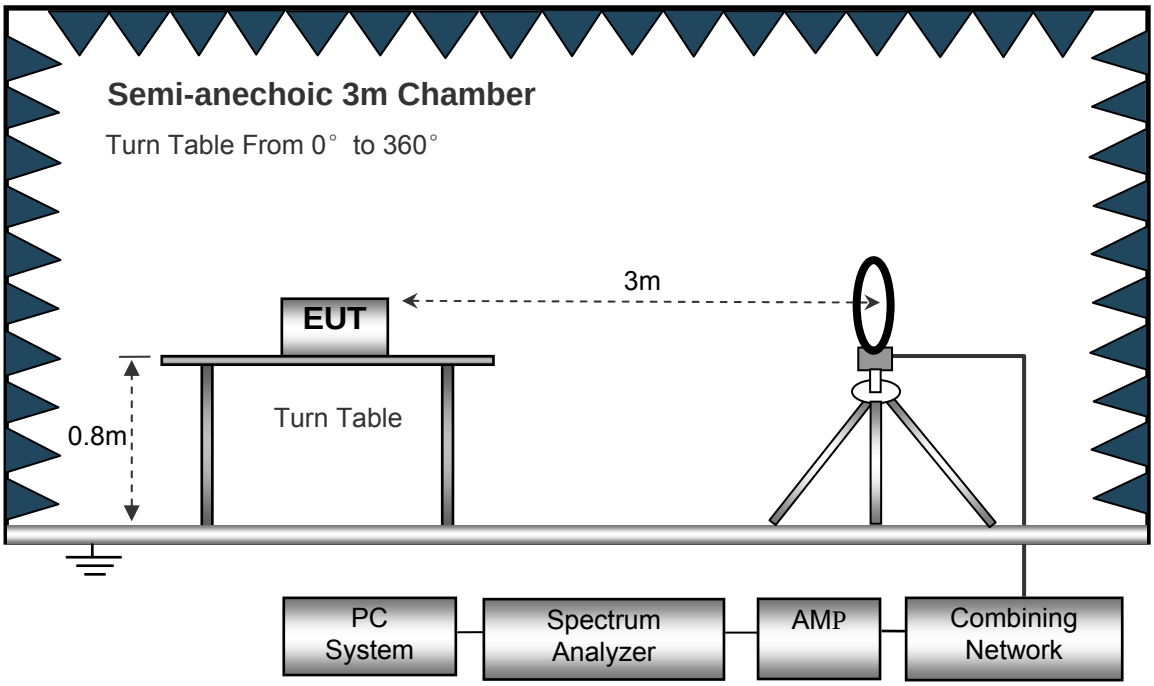
EUT Operation **:**

Refer to Section 5.4.

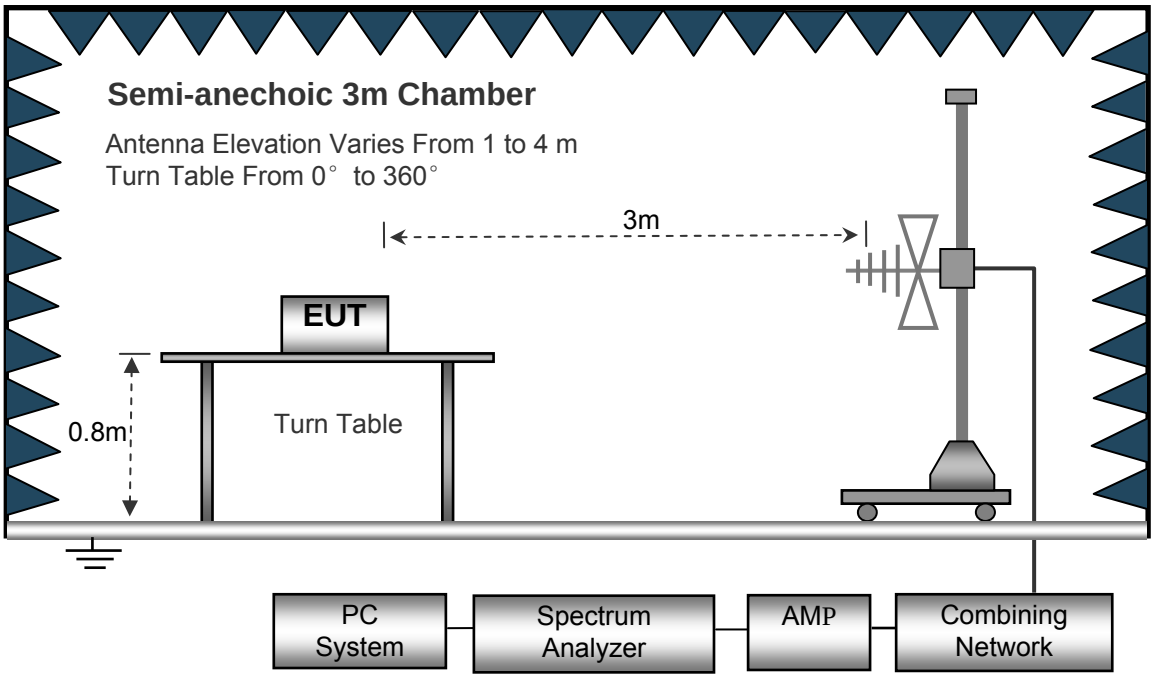
9.2 Test Setup

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

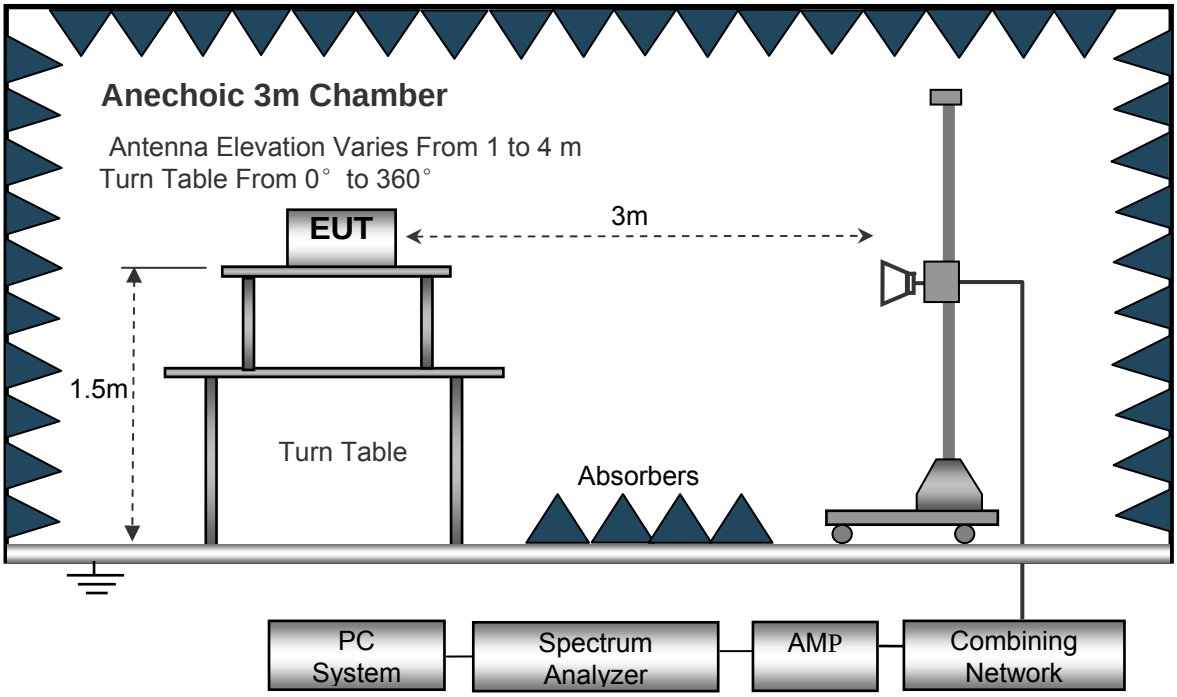
The test setup for emission measurement below 30MHz.



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



The test setup for emission measurement above 1 GHz.



9.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz

Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

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

Above 1GHz

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

9.4 Test Procedure

1. The EUT is placed on a turntable. For below 1GHz, the EUT is 0.8m above ground plane; For above1GHz, the EUT is 1.5m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.

9.5 Summary of Test Results

Test Frequency: 9kHz ~ 30MHz

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

Test Frequency: 30MHz ~ 18GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
255.89	15.81	QP	110	1.4	H	10.54	26.35	39.44	-13.10
255.89	15.10	QP	213	1.6	V	10.54	25.64	39.44	-13.80
4804.00	46.26	PK	124	1.4	V	-1.08	45.18	74.00	-28.82
4804.00	41.44	Ave	124	1.4	V	-1.08	40.36	54.00	-13.64
7206.00	54.35	PK	140	1.9	H	1.34	55.69	74.00	-18.31
7206.00	40.27	Ave	140	1.9	H	1.34	41.61	54.00	-12.39
2323.90	47.04	PK	82	1.1	V	-13.20	33.84	74.00	-40.16
2323.90	38.32	Ave	82	1.1	V	-13.20	25.12	54.00	-28.88
2360.54	50.92	PK	298	1.6	H	-13.12	37.80	74.00	-36.20
2360.54	38.54	Ave	298	1.6	H	-13.12	25.42	54.00	-28.58
2498.84	48.95	PK	348	1.2	V	-13.02	35.93	74.00	-38.07
2498.84	37.89	Ave	348	1.2	V	-13.02	24.87	54.00	-29.13

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Middle Channel 2441MHz									
255.89	13.14	QP	293	1.9	H	10.54	23.68	39.44	-15.77
255.89	14.00	QP	188	1.9	V	10.54	24.54	39.44	-14.90
4882.00	43.87	PK	41	1.1	V	-0.62	43.25	74.00	-30.75
4882.00	40.68	Ave	41	1.1	V	-0.62	40.06	54.00	-13.94
7323.00	54.94	PK	225	1.9	H	2.21	57.15	74.00	-16.85
7323.00	44.24	Ave	225	1.9	H	2.21	46.45	54.00	-7.55
2339.71	46.24	PK	319	1.3	V	-13.19	33.05	74.00	-40.95
2339.71	38.37	Ave	319	1.3	V	-13.19	25.18	54.00	-28.82
2357.32	45.81	PK	150	1.6	H	-13.14	32.67	74.00	-41.33
2357.32	37.39	Ave	150	1.6	H	-13.14	24.25	54.00	-29.75
2487.44	49.51	PK	275	1.7	V	-13.08	36.43	74.00	-37.57
2487.44	38.09	Ave	275	1.7	V	-13.08	25.01	54.00	-28.99

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK High Channel 2480MHz									
255.89	21.06	QP	93	1.7	H	10.54	31.60	39.44	-7.84
255.89	19.44	QP	238	1.1	V	10.54	29.98	39.44	-9.46
4960.00	51.38	PK	158	1.1	V	-0.24	51.14	74.00	-22.86
4960.00	43.08	Ave	158	1.1	V	-0.24	42.84	54.00	-11.16
7440.00	51.98	PK	108	1.4	H	2.84	54.82	74.00	-19.18
7440.00	43.90	Ave	108	1.4	H	2.84	46.74	54.00	-7.26
2323.53	46.34	PK	314	1.7	V	-13.19	33.15	74.00	-40.85
2323.53	37.76	Ave	314	1.7	V	-13.19	24.57	54.00	-29.43
2383.68	44.76	PK	52	1.5	H	-13.14	31.62	74.00	-42.38
2383.68	36.34	Ave	52	1.5	H	-13.14	23.20	54.00	-30.80
2487.28	44.74	PK	323	1.2	V	-13.08	31.66	74.00	-42.34
2487.28	37.20	Ave	323	1.2	V	-13.08	24.12	54.00	-29.88

Test Frequency: 18GHz~25GHz

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

10 Band Edge Measurement

Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10
Test Limit:	Regulation 15.247 (d),In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
Test Mode:	Transmitting

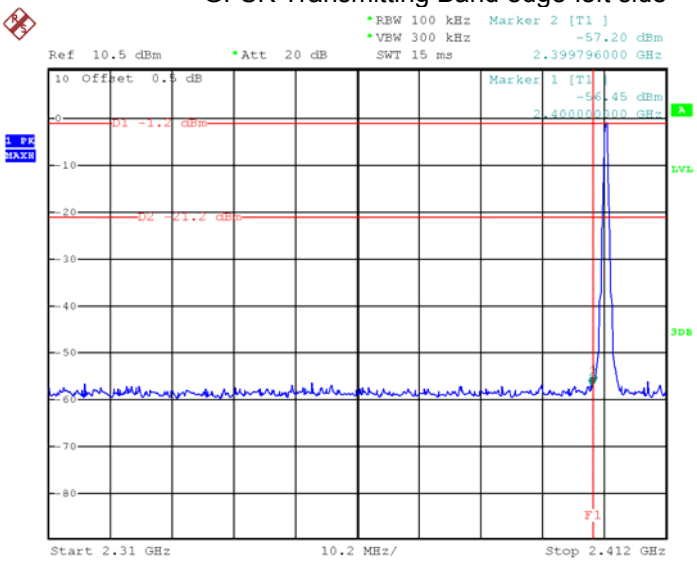
10.1 Test Procedure

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

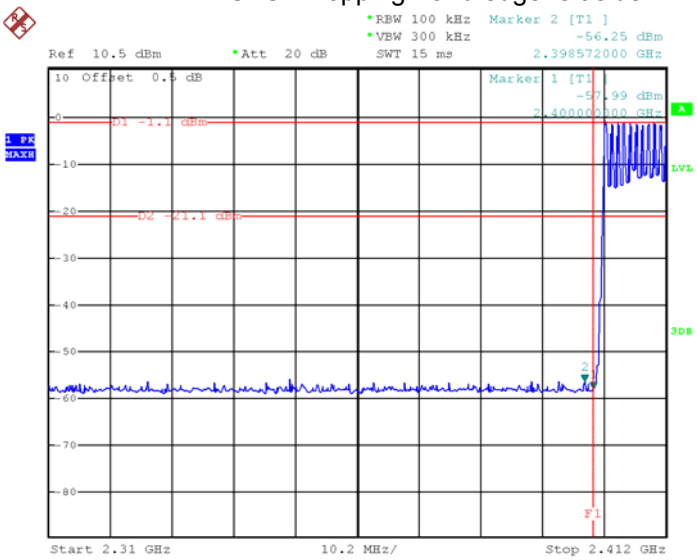
10.2 Test Result:

Test plots

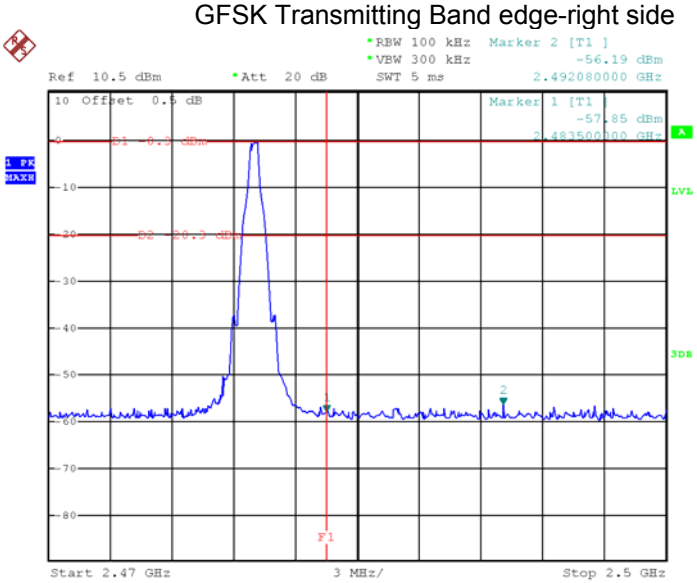
GFSK Transmitting Band edge-left side



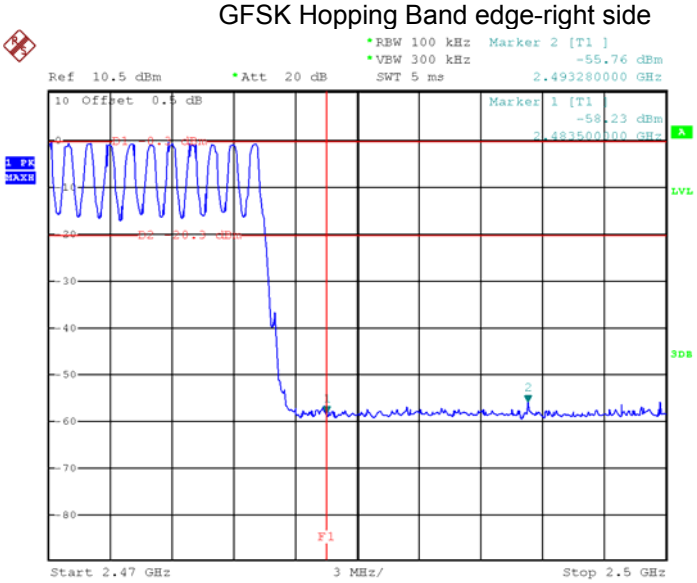
GFSK Hopping Band edge-left side



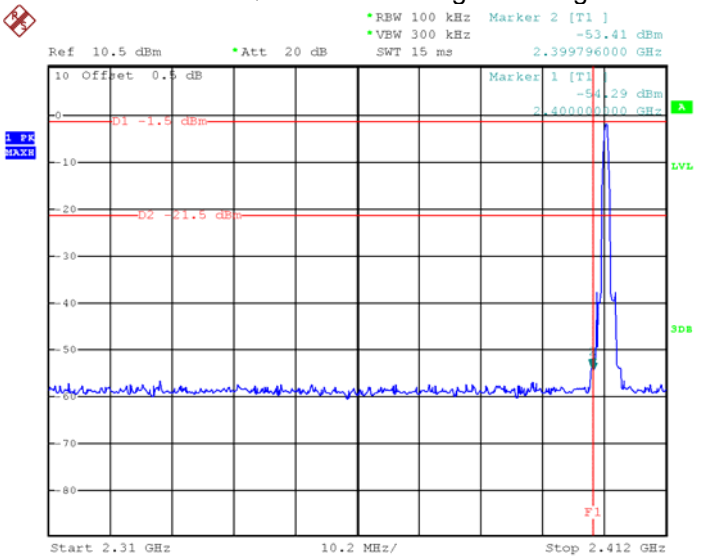
GFSK Transmitting Band edge-right side



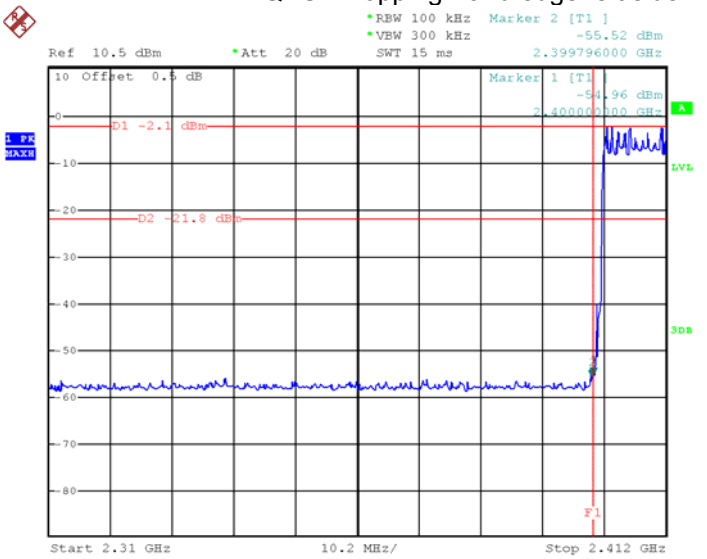
GFSK Hopping Band edge-right side



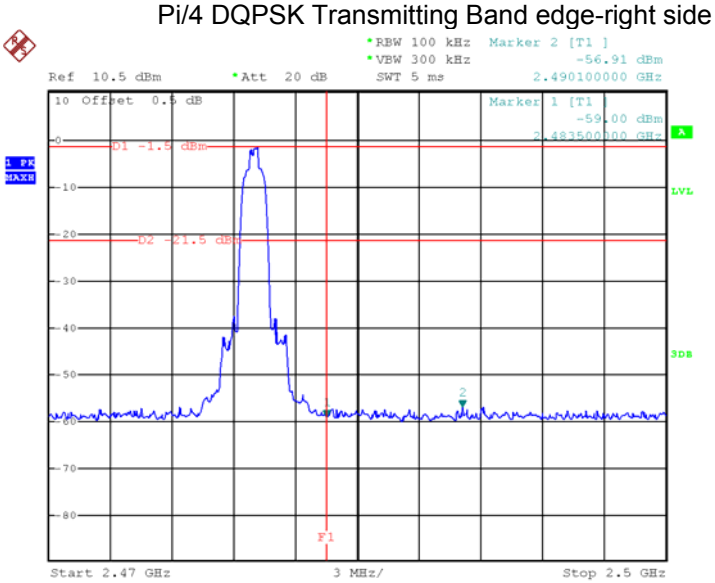
Pi/4 DQPSK Transmitting Band edge-left side



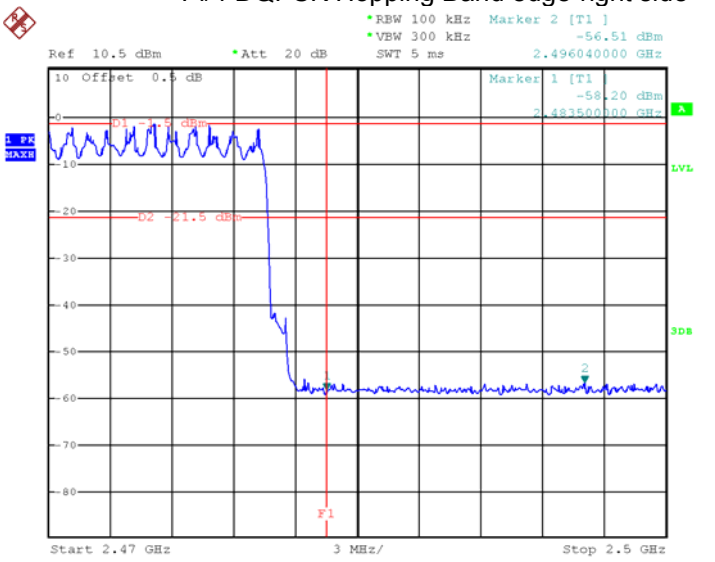
Pi/4 DQPSK Hopping Band edge-left side



Pi/4 DQPSK Transmitting Band edge-right side



Pi/4 DQPSK Hopping Band edge-right side



11 Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: C63.10: 2013

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

11.1 Test Procedure:

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

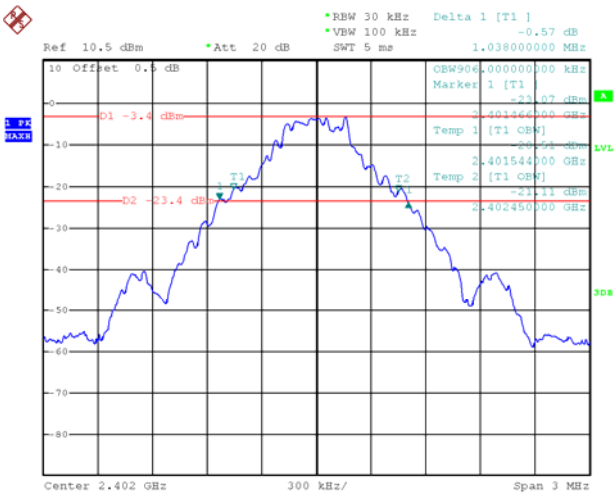
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

11.2 Test Result:

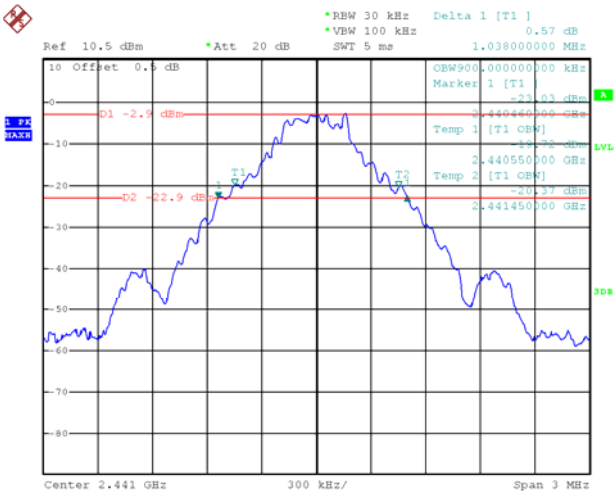
Modulation	Test Channel	20 dB Bandwidth(MHz)	99% Bandwidth(MHz)
GFSK	Low	1.038	0.906
GFSK	Middle	1.038	0.900
GFSK	High	1.038	0.900
Pi/4 DQPSK	Low	1.290	1.176
Pi/4 DQPSK	Middle	1.290	1.164
Pi/4 DQPSK	High	1.290	1.164

Test result plot as follows:

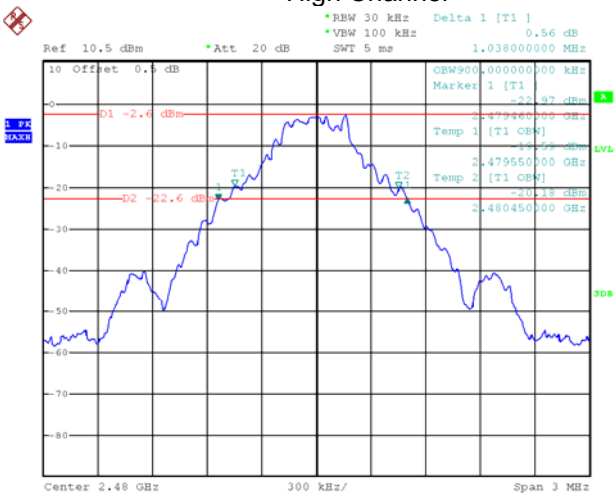
Modulation: GFSK Low Channel



Middle Channel

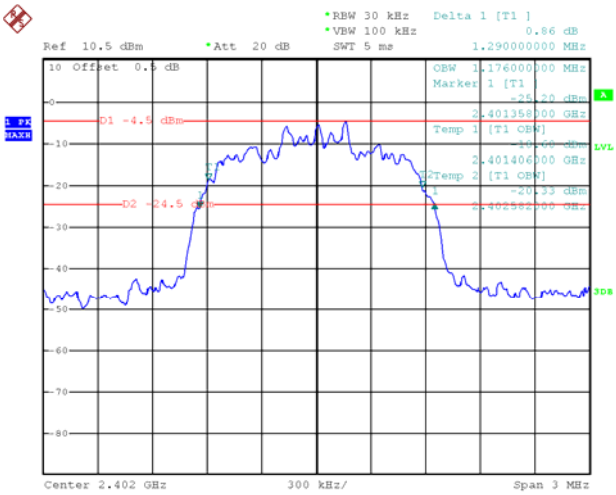


High Channel

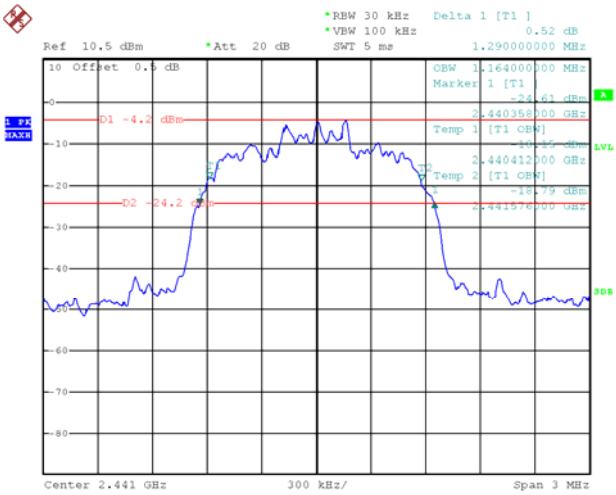


Modulation: Pi/4 DQPSK

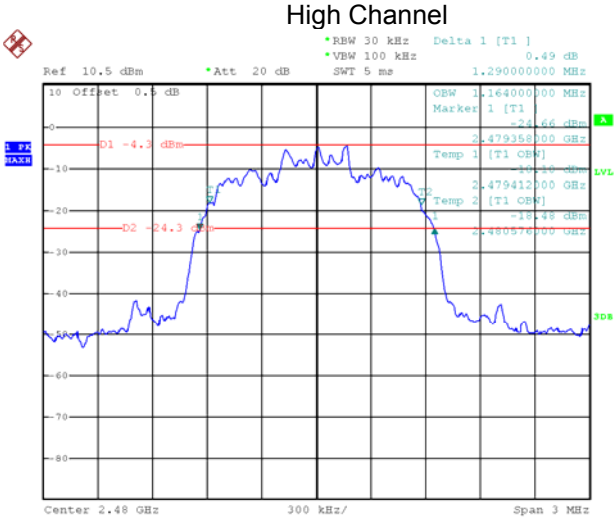
Low Channel



Middle Channel



High Channel



12 Maximum Peak Output Power

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: C63.10:2013

Test Limit: Regulation 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

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

Test mode: Test in fixing frequency transmitting mode.

12.1 Test Procedure:

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

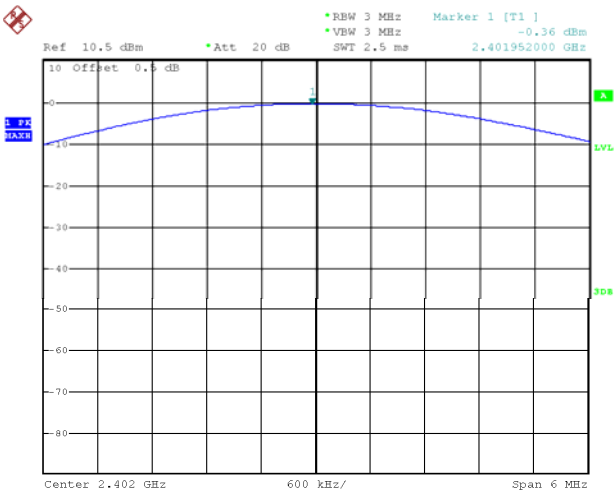
12.2 Test Result:

Test Mode	Data Rate	Peak Power(dBm)			Limit (dBm)
		Low Channel	Middle Channel	High Channel	
GFSK	1Mbps	-0.36	0.09	0.19	20.97
Pi/4 DQPSK	2Mbps	-0.58	-0.46	-0.02	20.97

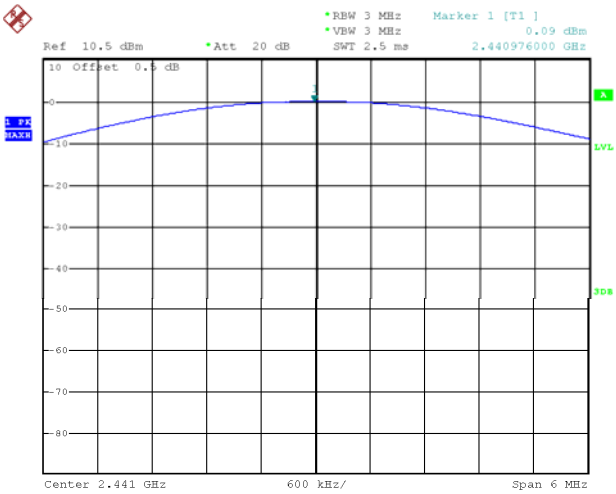
Test result plot as follows:

Modulation: GFSK

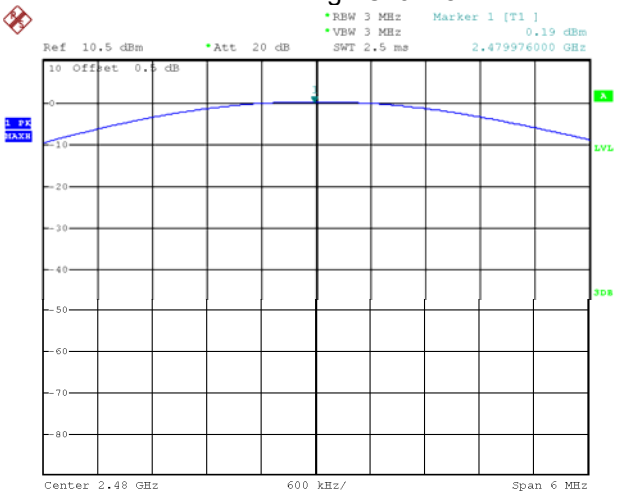
Low Channel



Middle Channel

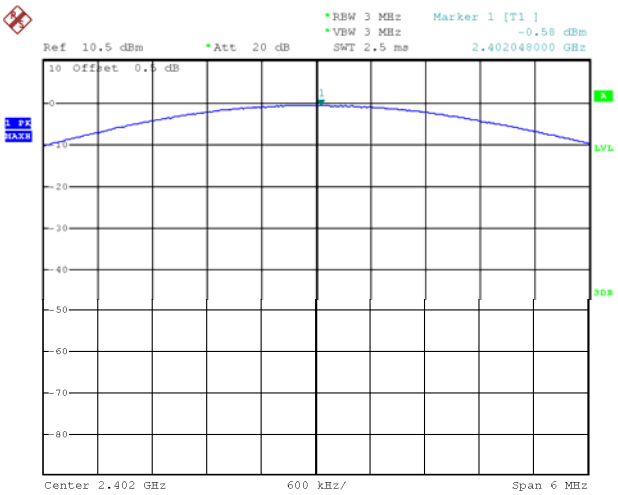


High Channel

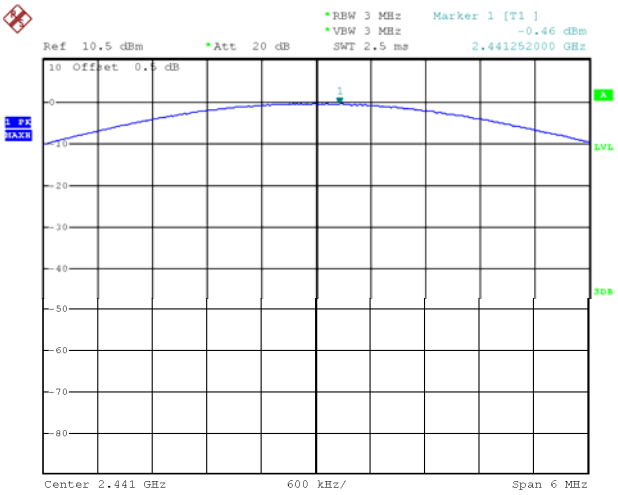


Modulation: Pi/4 DQPSK Low Channel

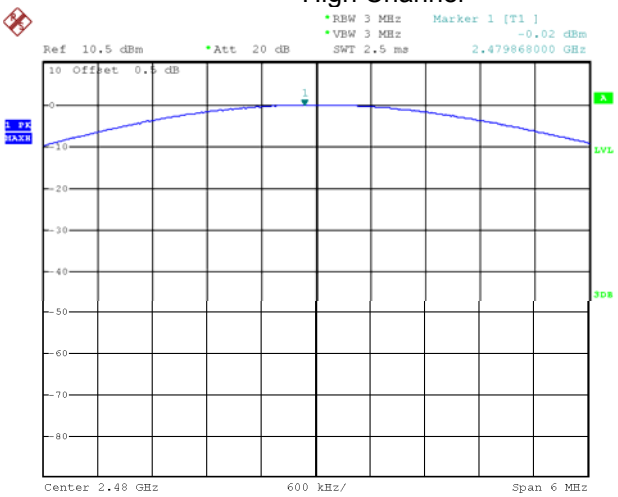
Low Channel



Middle Channel



High Channel



13 Hopping Channel Separation

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: C63.10:2013

Test Limit: Regulation 15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 1W.

Test Mode: Test in hopping transmitting operating mode.

13.1 Test Procedure:

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

2. Set the spectrum analyzer: RBW = 30KHz. VBW = 100KHz , Span = 3MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

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

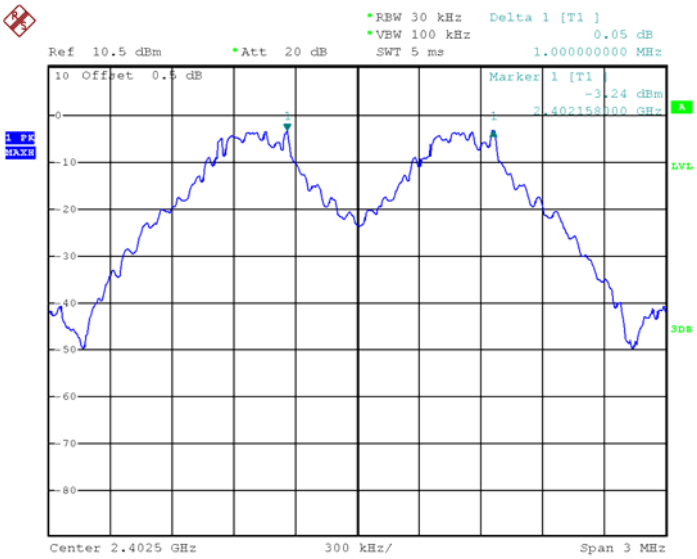
13.2 Test Result:

Test result plot as follows:

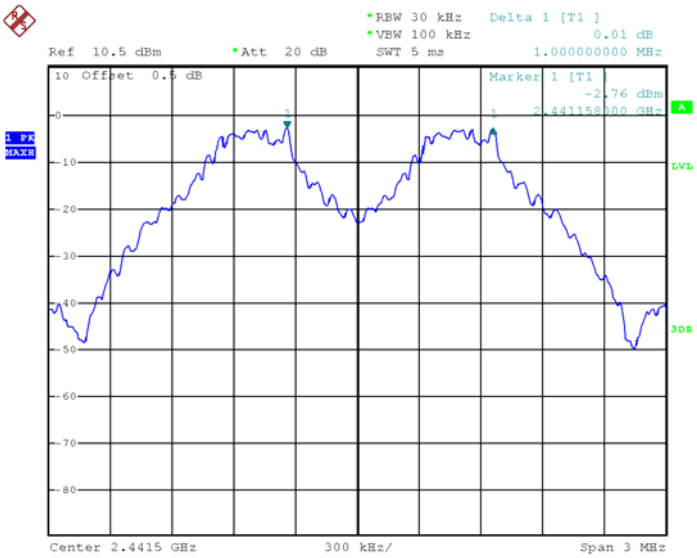
Modulation	Test Channel	Separation (MHz)	Result
GFSK	Low	1.000 MHz	PASS
GFSK	Middle	1.000 MHz	PASS
GFSK	High	1.000 MHz	PASS
Pi/4 DQPSK	Low	1.000 MHz	PASS
Pi/4 DQPSK	Middle	1.000 MHz	PASS
Pi/4 DQPSK	High	1.000 MHz	PASS

Test plots

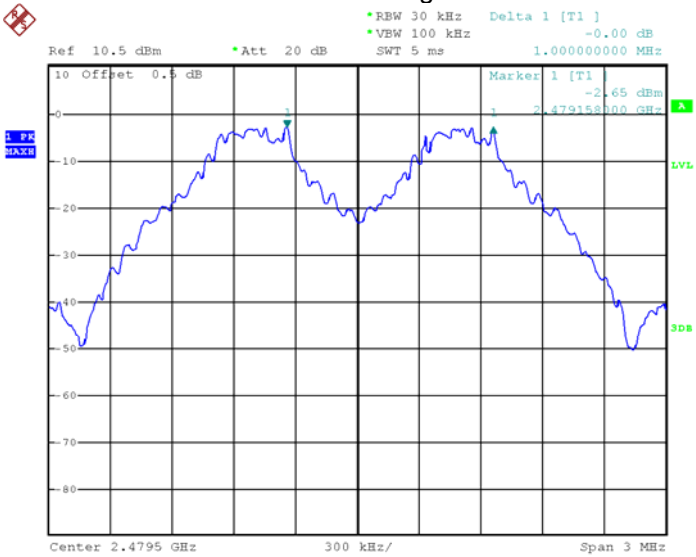
GFSK Low Channel



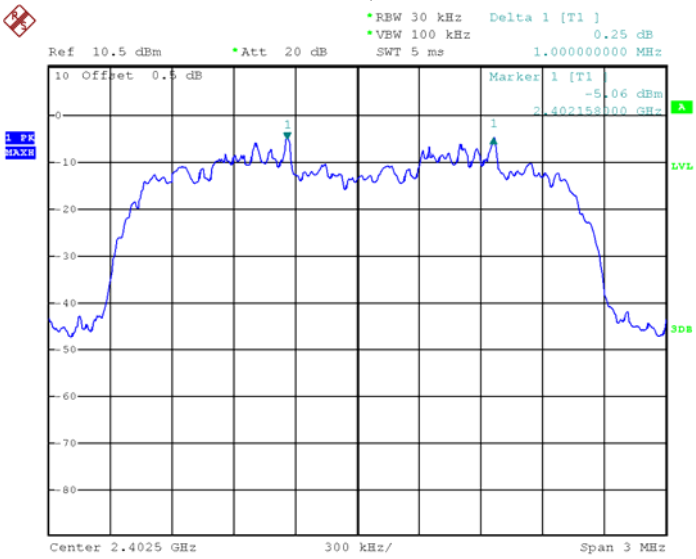
GFSK Middle Channel



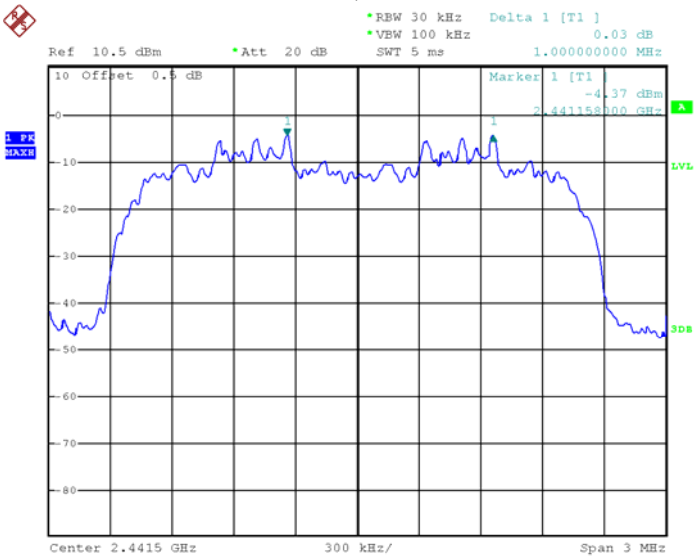
GFSK High Channel



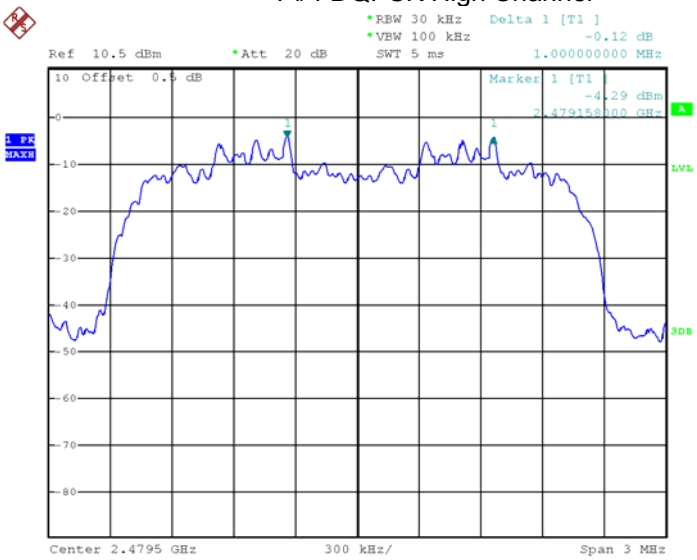
Pi/4 DQPSK Low Channel



Pi/4 DQPSK Middle Channel



Pi/4 DQPSK High Channel



14 Number of Hopping Frequency

Test Requirement:	FCC CFR47 Part 15 Section 15.247
Test Method:	C63.10:2013
Test Limit:	Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Mode:	Test in hopping transmitting operating mode.

14.1 Test Procedure:

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

2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

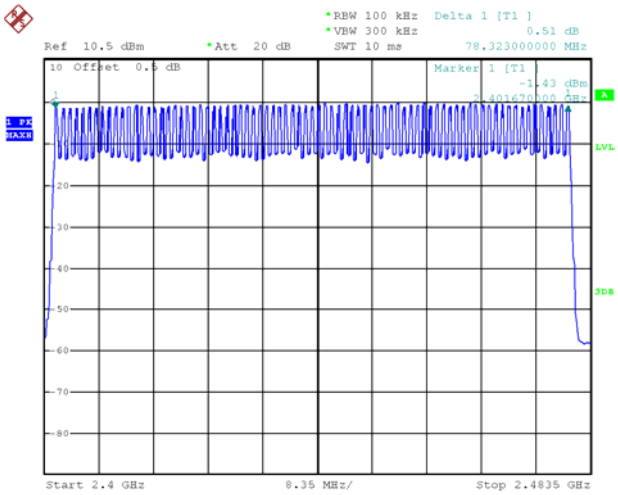
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

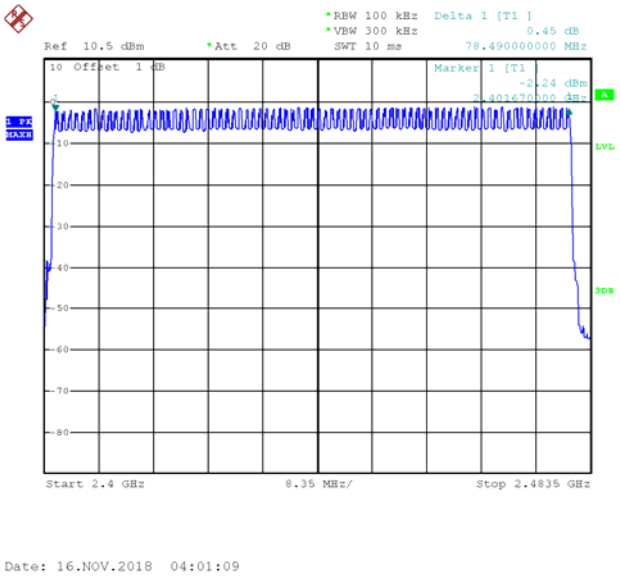
14.2 Test Result:

Total Channels are 79 Channels.

GFSK



Pi/4 DQPSK


RBW 100 kHz
VBW 300 kHz
SWT 10 ms
Delta 1 [T1]
0.45 dB
78.490000000 MHz
Ref 10.5 dBm
Att 20 dB
10 Offset 1 dB
Marker 1 [T1
-2.24 dBm
2.401670000 GHz
1 PK
MAXH
A
LVL
3DB
Start 2.4 GHz
8.35 MHz/
Stop 2.4835 GHz
Date: 16.NOV.2018 04:01:09

15 Dwell Time

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: C63.10:2013

Test Limit: Regulation 15.247(a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Mode: Test in hopping transmitting operating mode.

15.1 Test Procedure:

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

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

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

4.Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

15.2 Test Result:

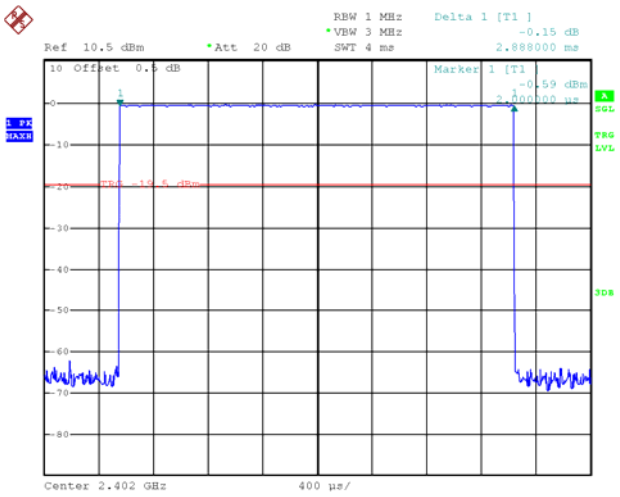
Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period
The test period: T= 0.4(s) * 79 = 31.6 (s)
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

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

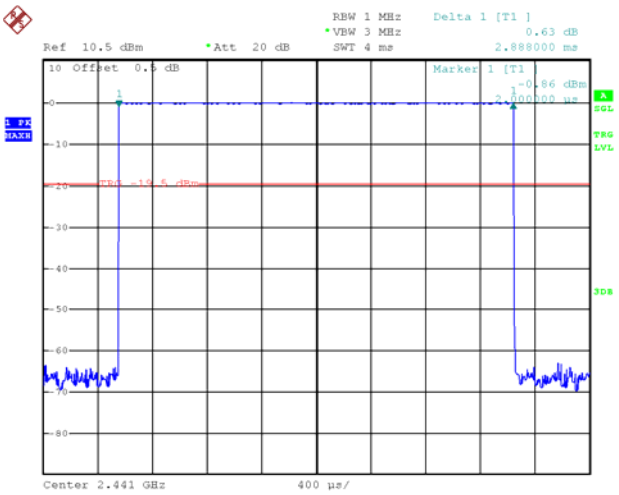
Data Packet	Dwell Time(s)
DH5	1600/79/6*31.6*(MkrDelta)/1000
DH3	1600/79/4*31.6*(MkrDelta)/1000
DH1	1600/79/2*31.6*(MkrDelta)/1000
Remark	Mkr Delta is single pulse time.

Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	DH5	Low	2.888	0.308	0.4
		middle	2.888	0.308	0.4
		High	2.888	0.308	0.4
Pi/4DQPSK	2DH5	Low	2.888	0.308	0.4
		middle	2.888	0.308	0.4
		High	2.888	0.308	0.4

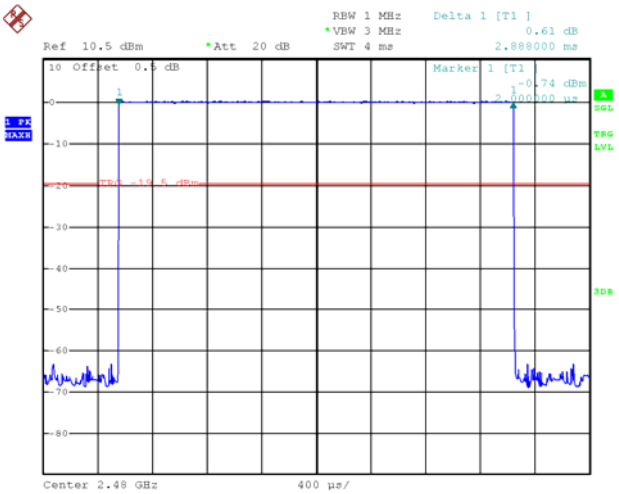
DH5.Low channel



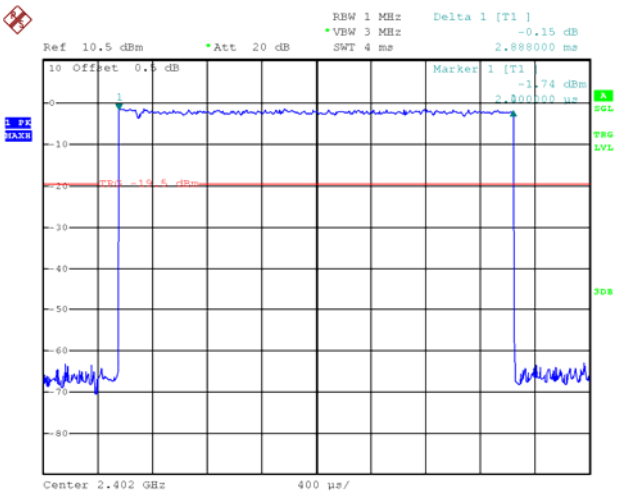
DH5.Middle channel



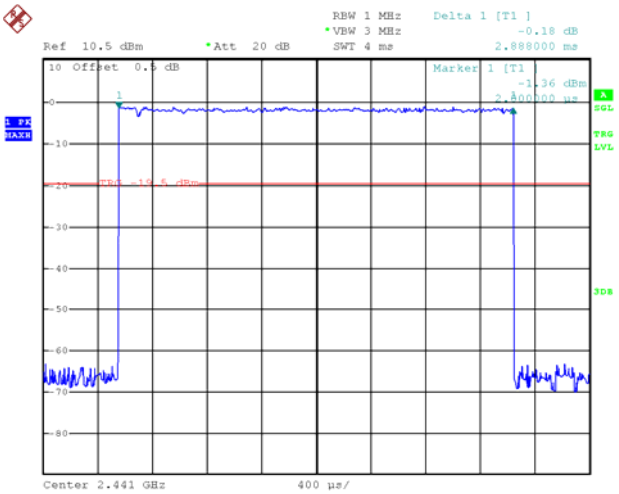
DH5,High channel



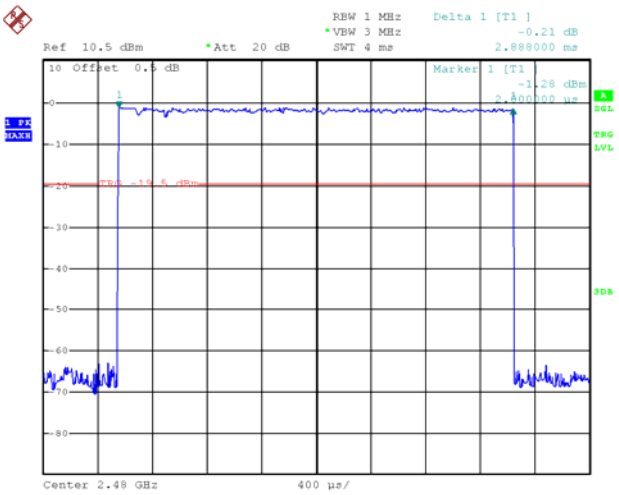
2DH5 Low channel



2DH5.Middle channel



2DH5,High channel



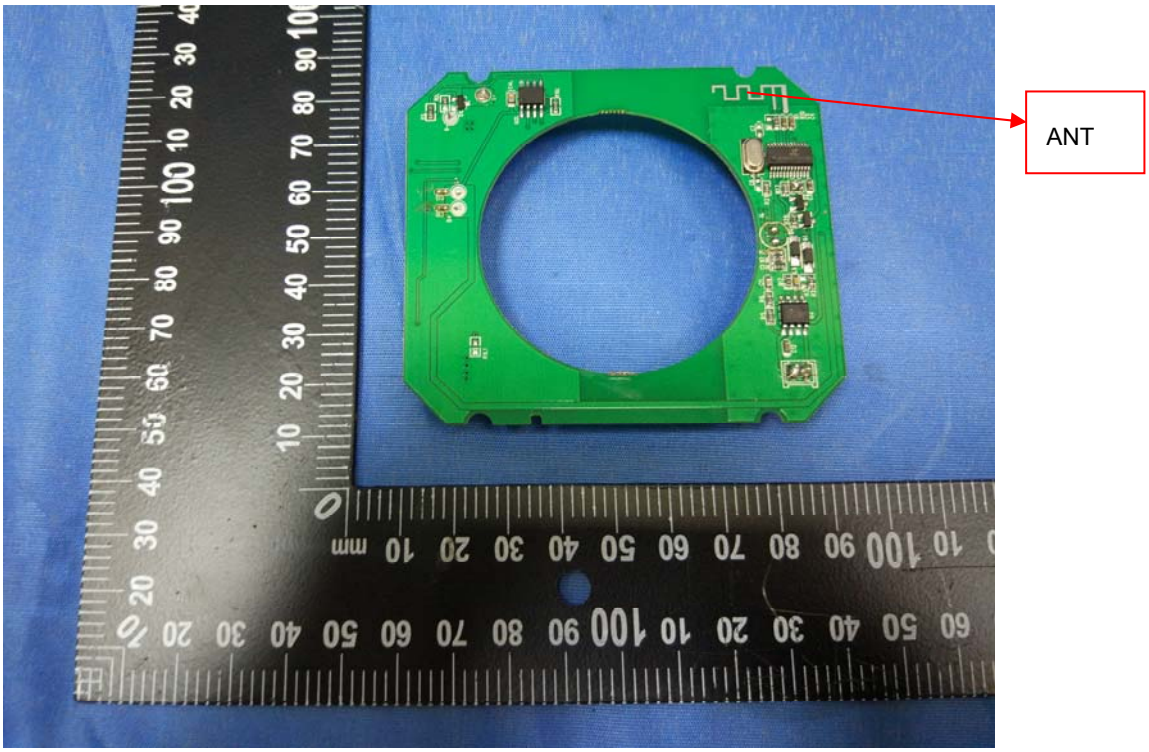
16 Antenna Requirement

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

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

Result:

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



17 RF Exposure Evaluation

Test Requirement: FCC Part 1.1307

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

17.1 Requirements

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

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

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

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

17.2 Test result

Conducted Peak power(dBm)	Conducted Peak power(mW)	Source-based time-averaged maximum conducted output power(mW)	Minimum test separation distance required for the exposure conditions (mm)	SAR Test Exclusion Thresholds Calculation Value	SAR Test Exclusion Thresholds Limit	Result
0.19	1.04	1.04	5	0.328	3.0	Compliance
Note: No SAR measurement is required.						

Remark: Max. duty factor is 100%

Result: Compliance

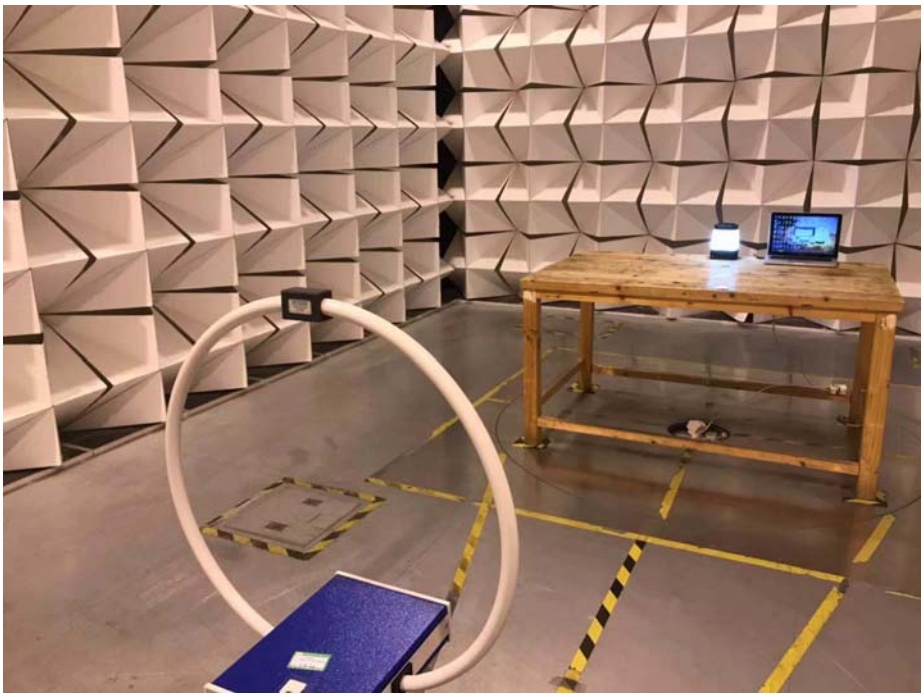
No SAR measurement is required.

18 Photographs -Test Setup Photos

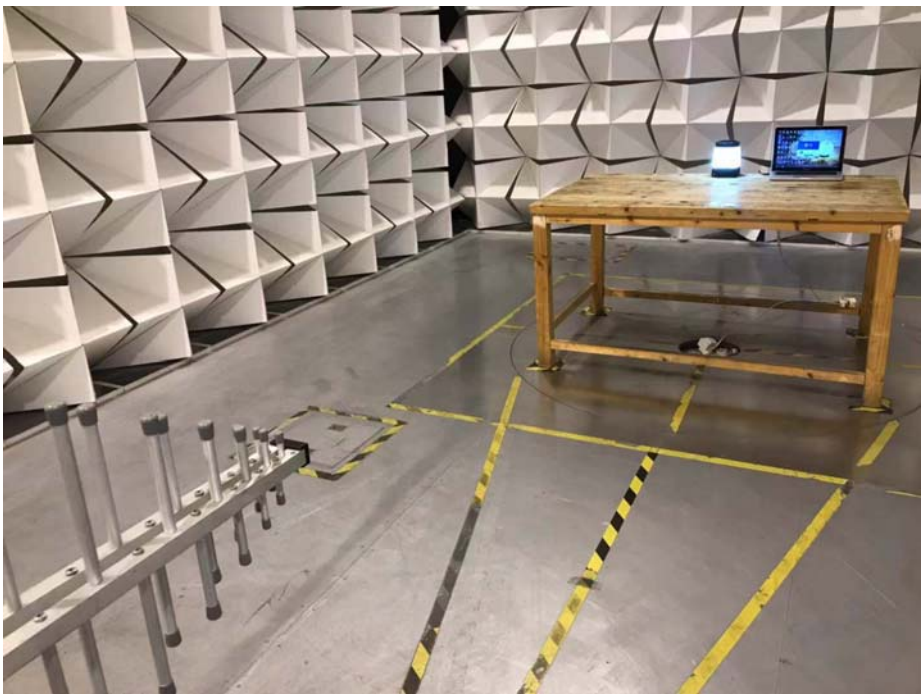
18.1 Photograph-Conducted Emissions Test Setup

18.2 Photograph-Radiated Emissions

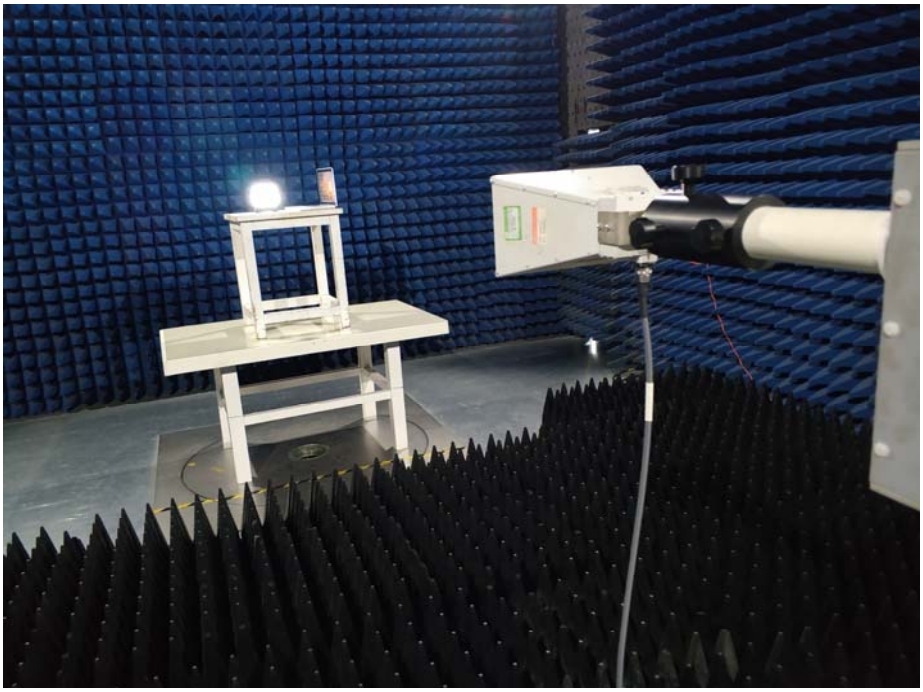
Test Frequency Below 30MHz



Test Frequency 30MHz to 1000MHz

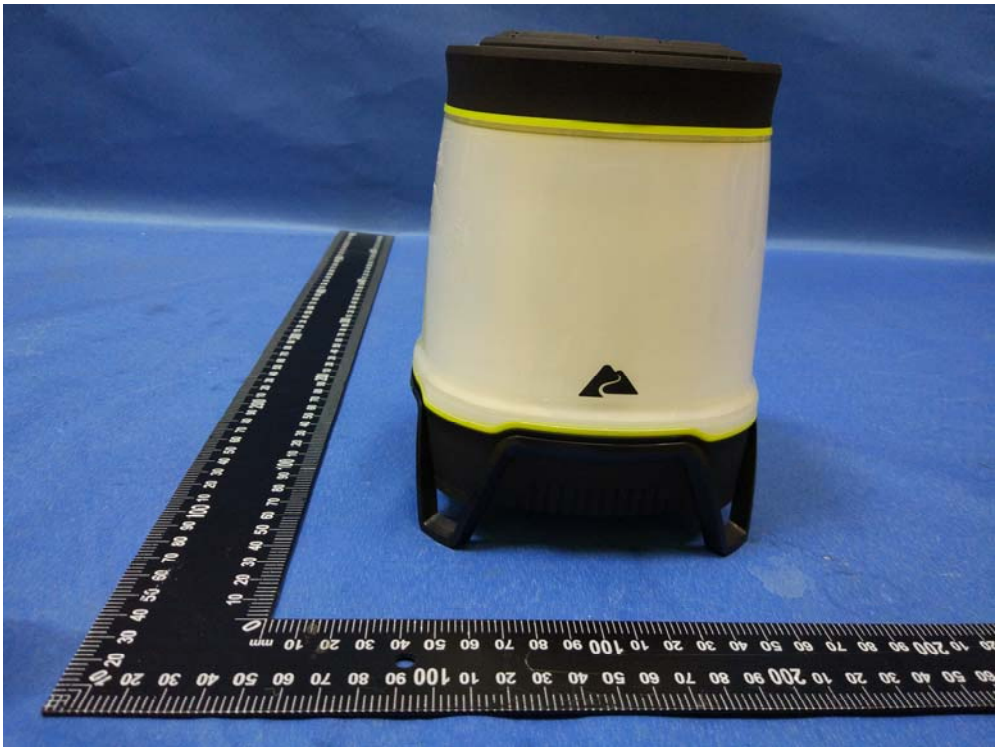


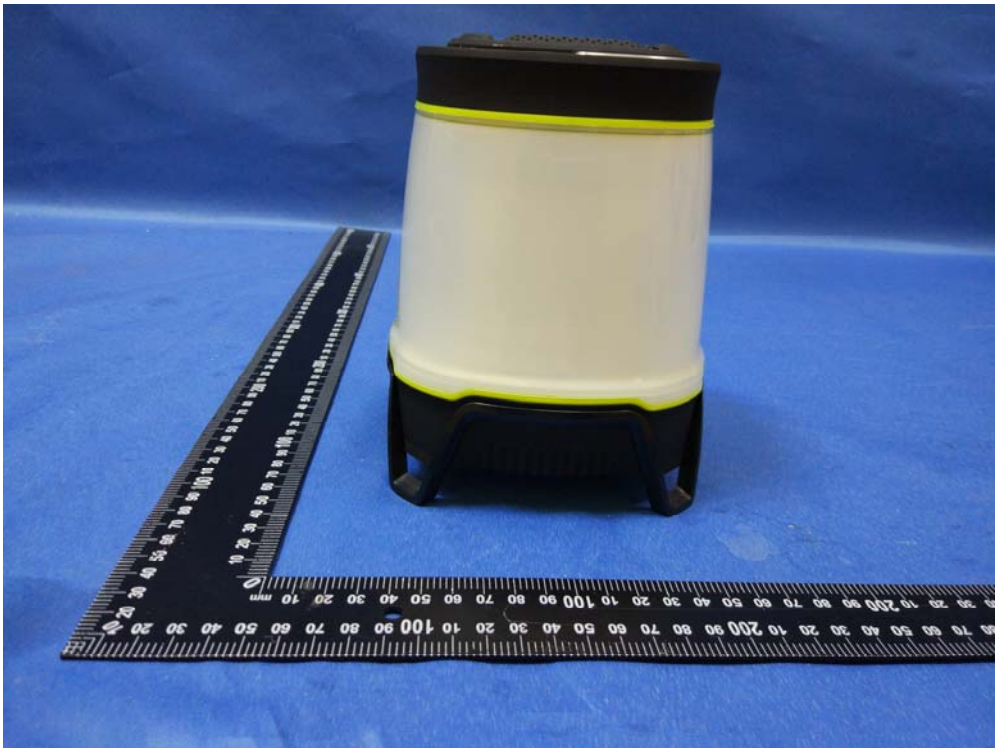
Test Frequency Above 1GHz

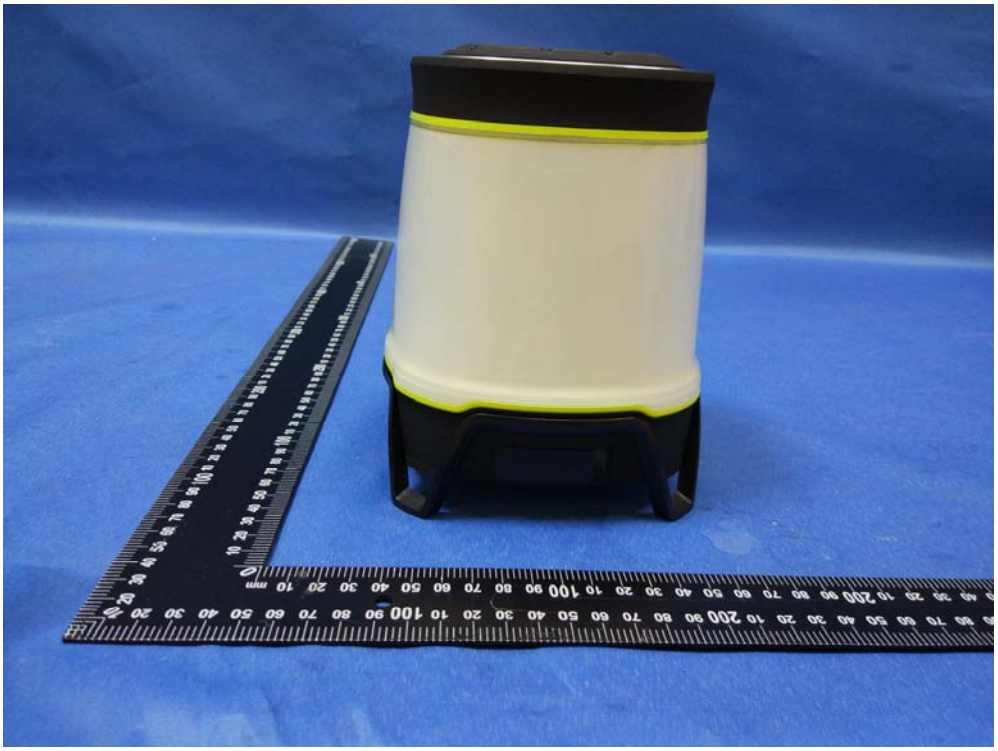


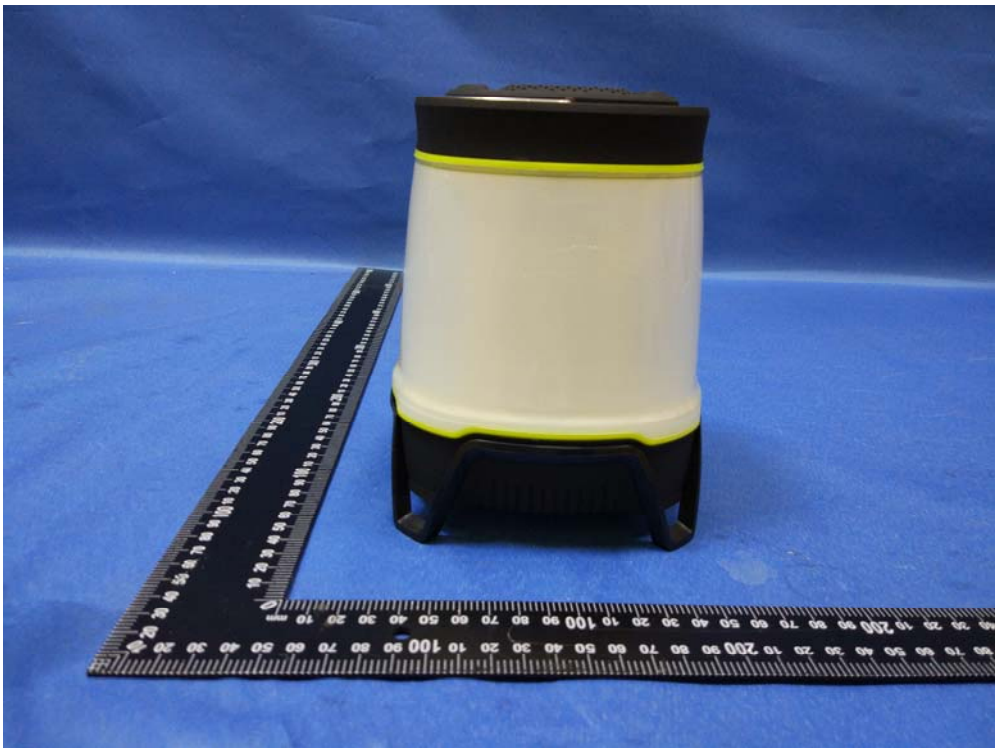
19 Photographs – Constructional Details

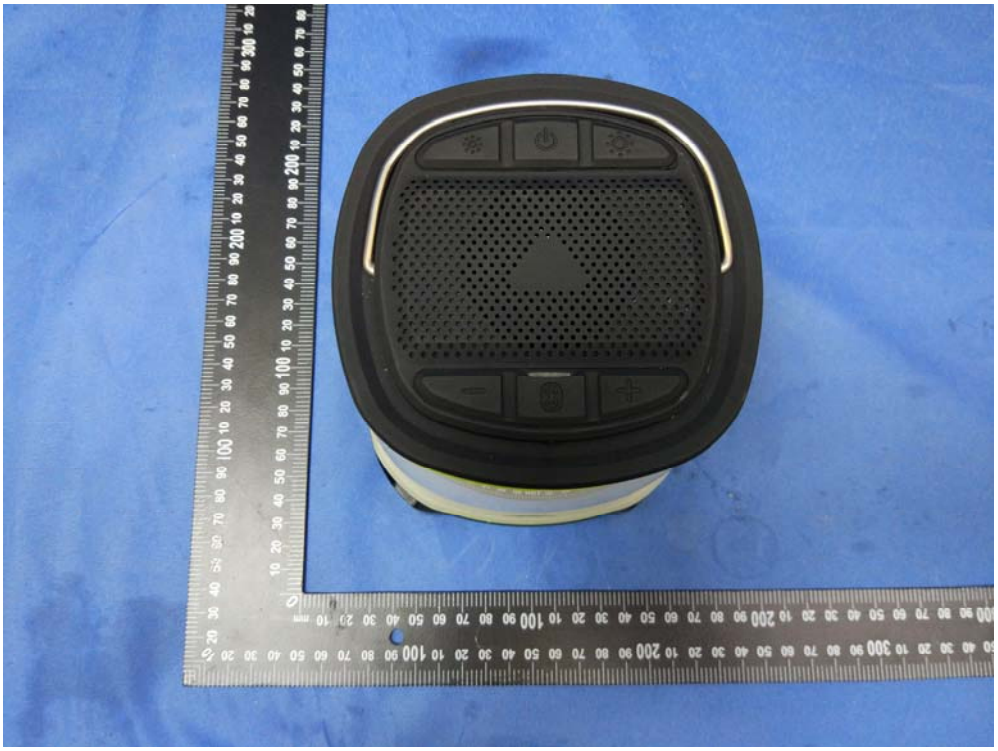
19.1 EUT –External Photos

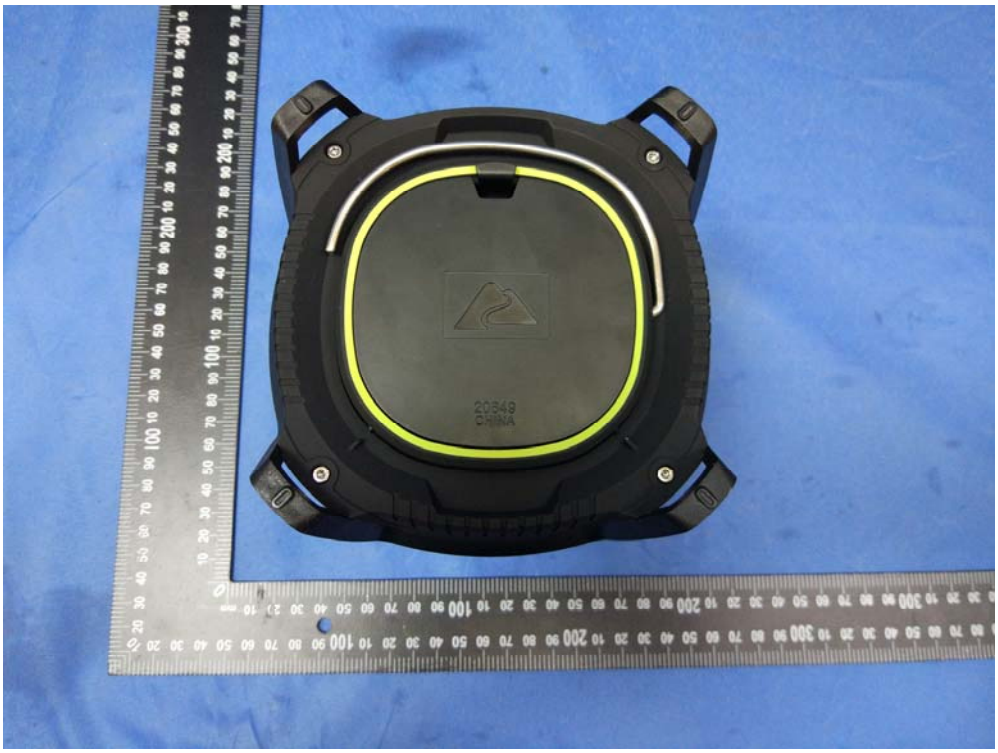


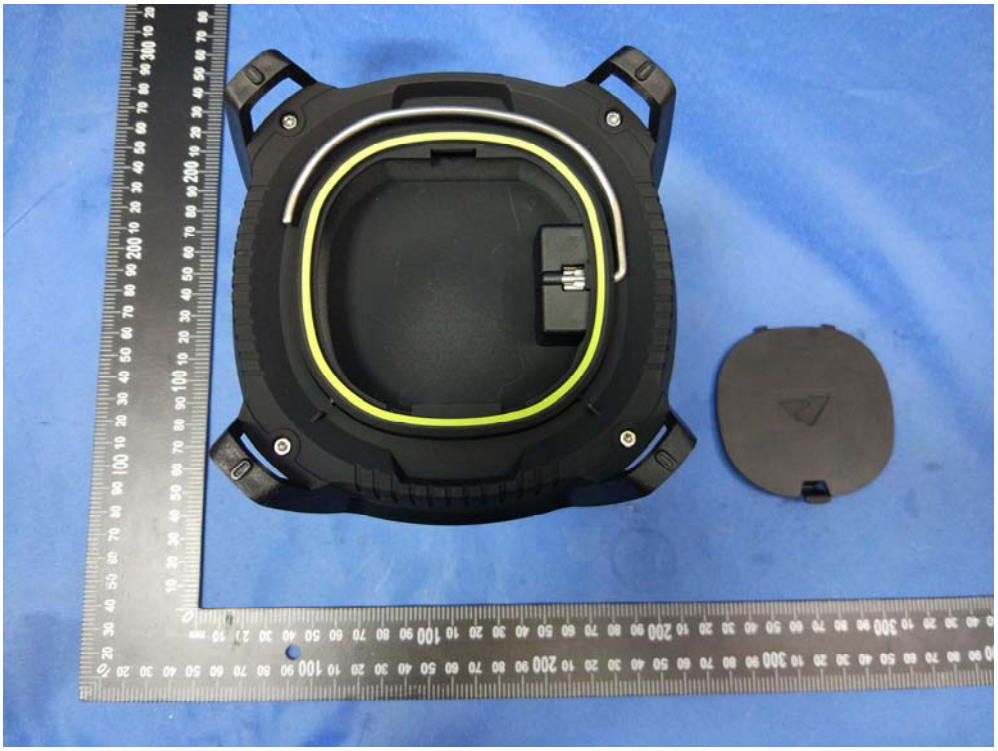




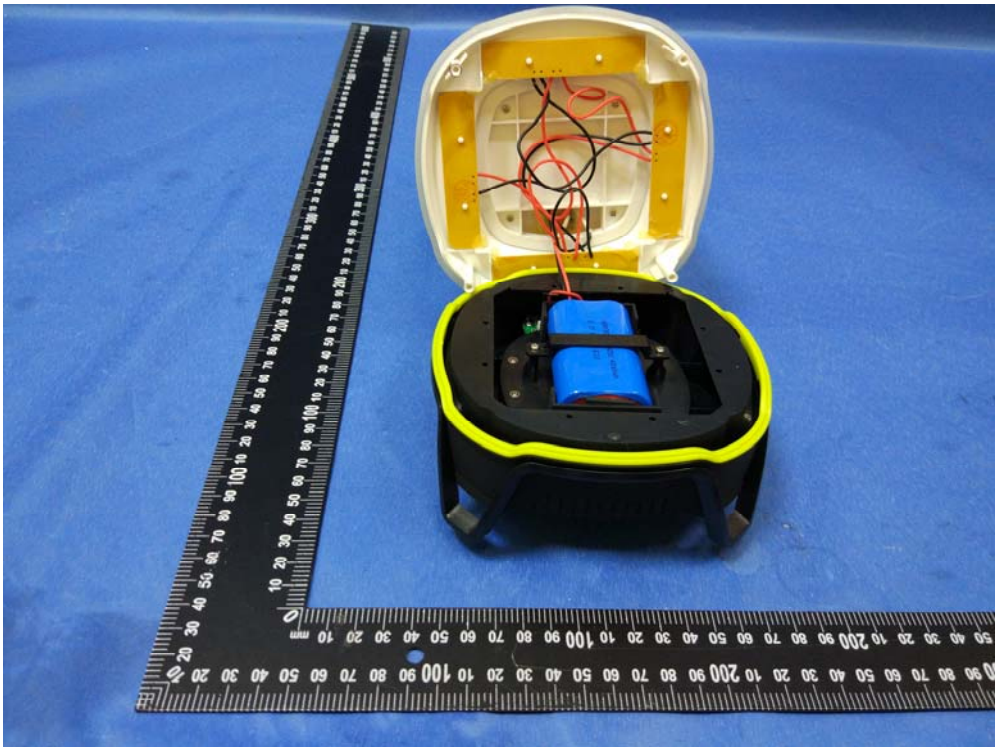


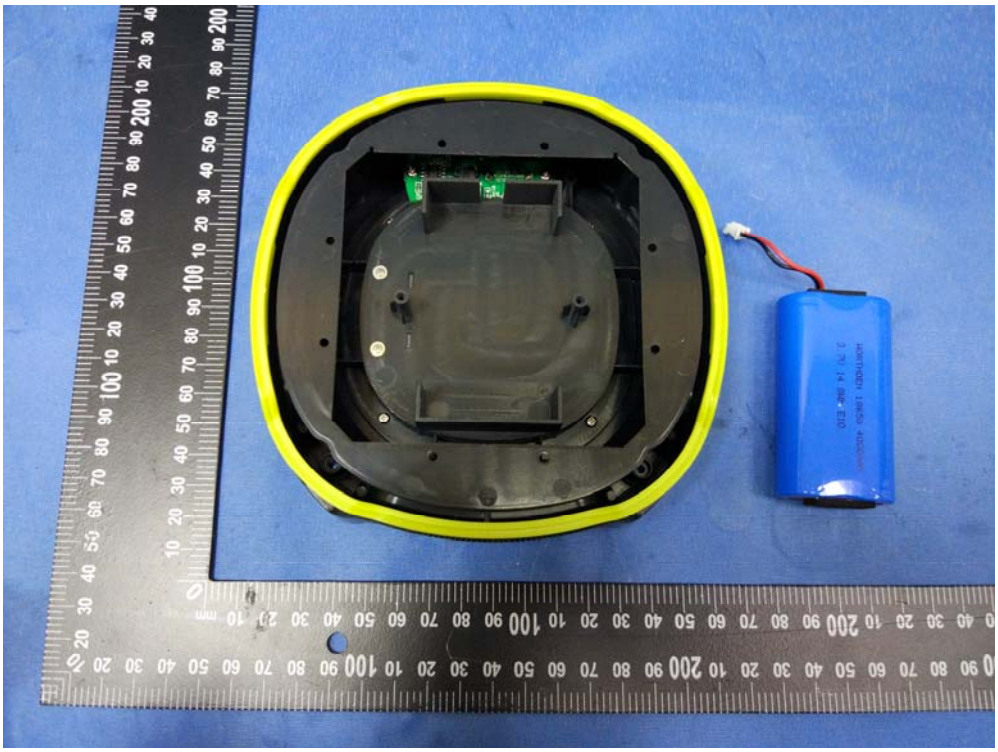



20549
CHINA

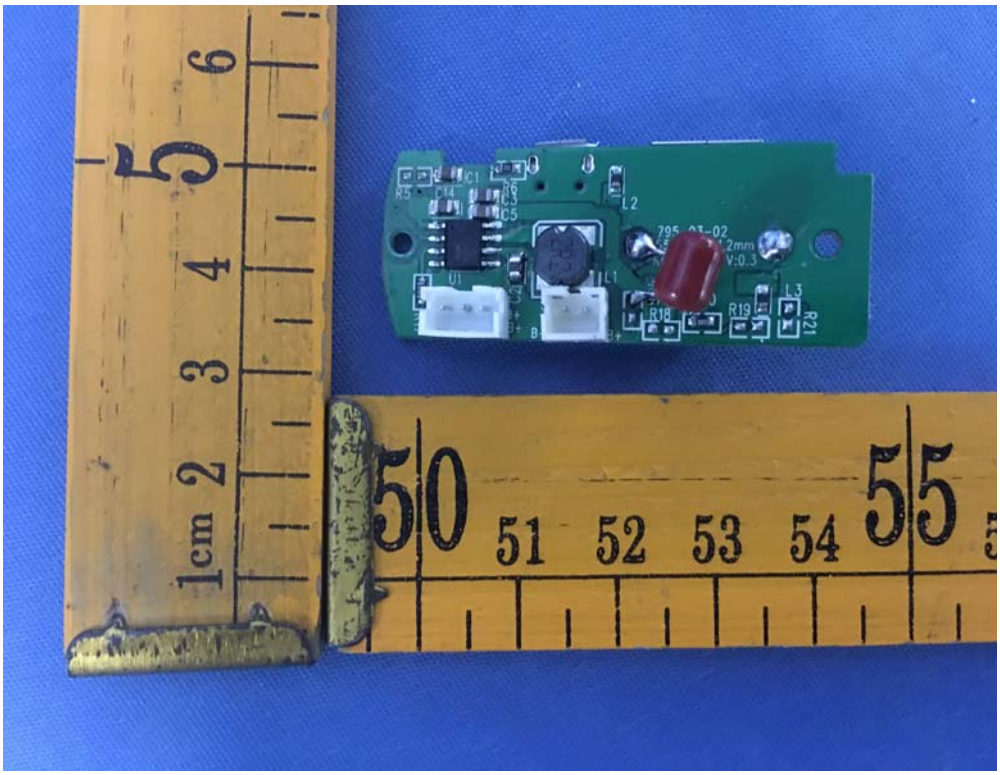


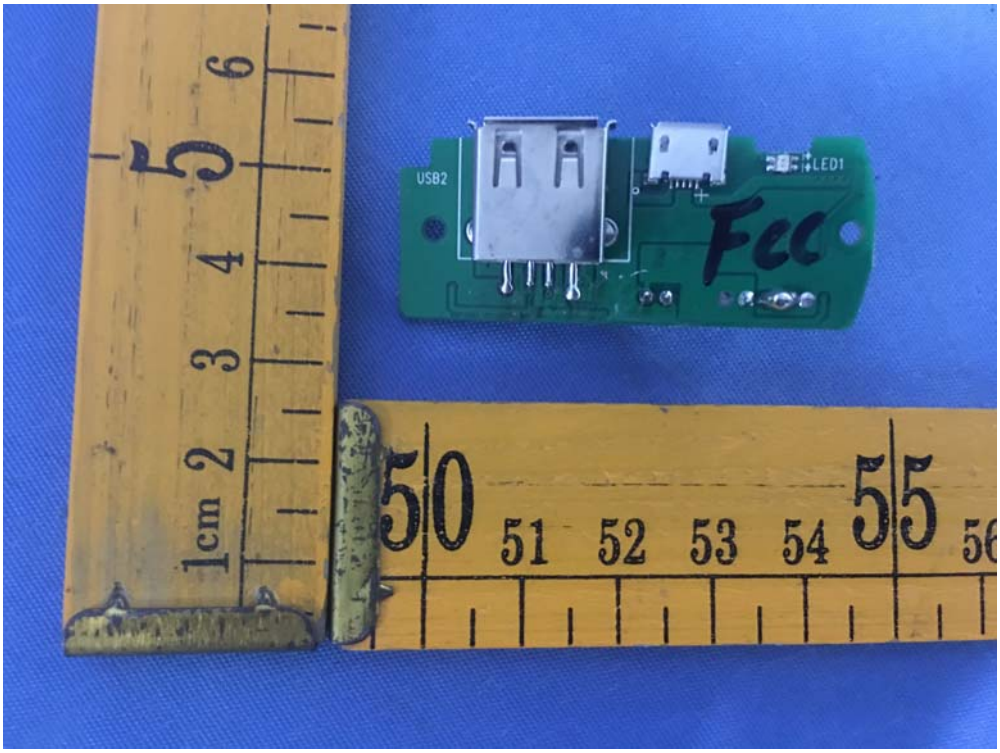
19.2 EUT – Internal Photos

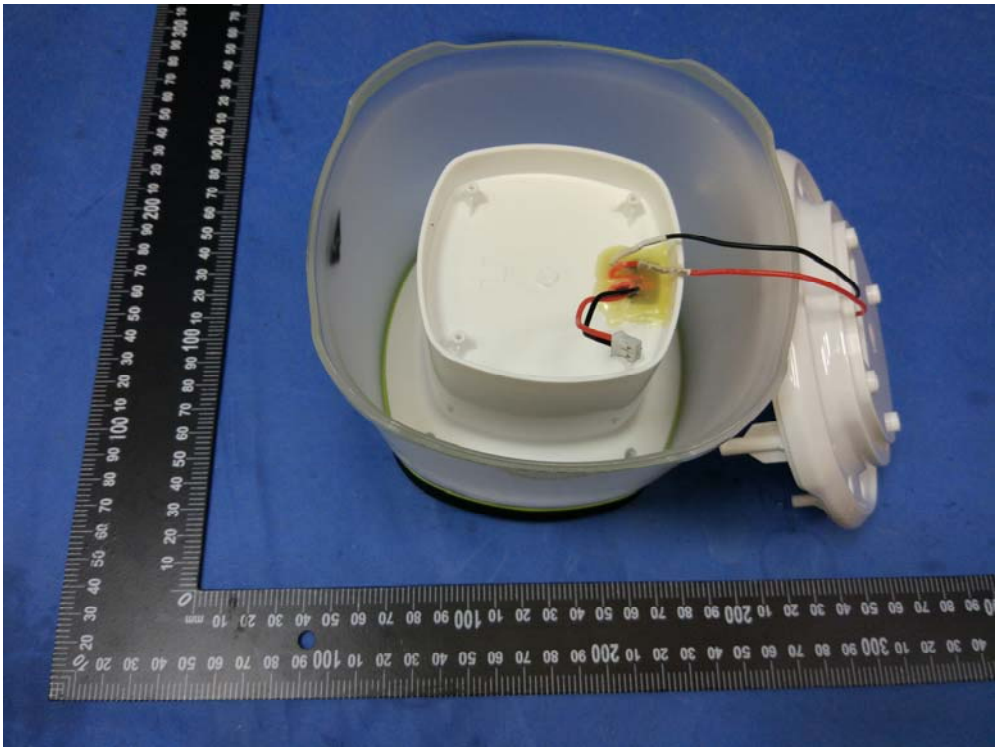


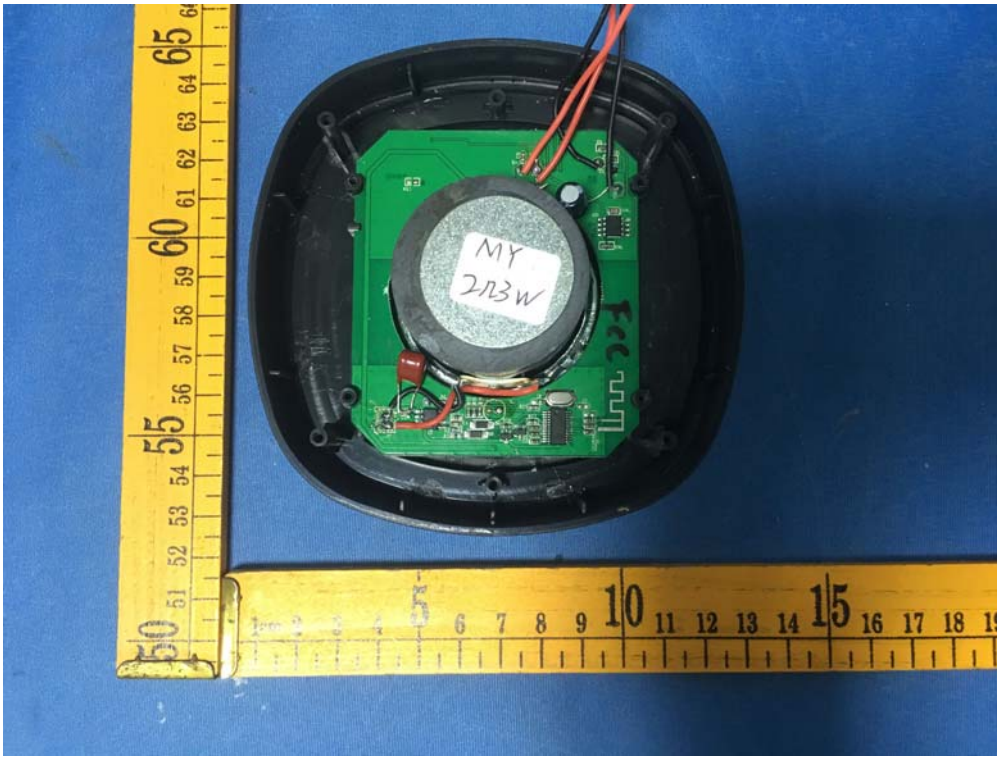


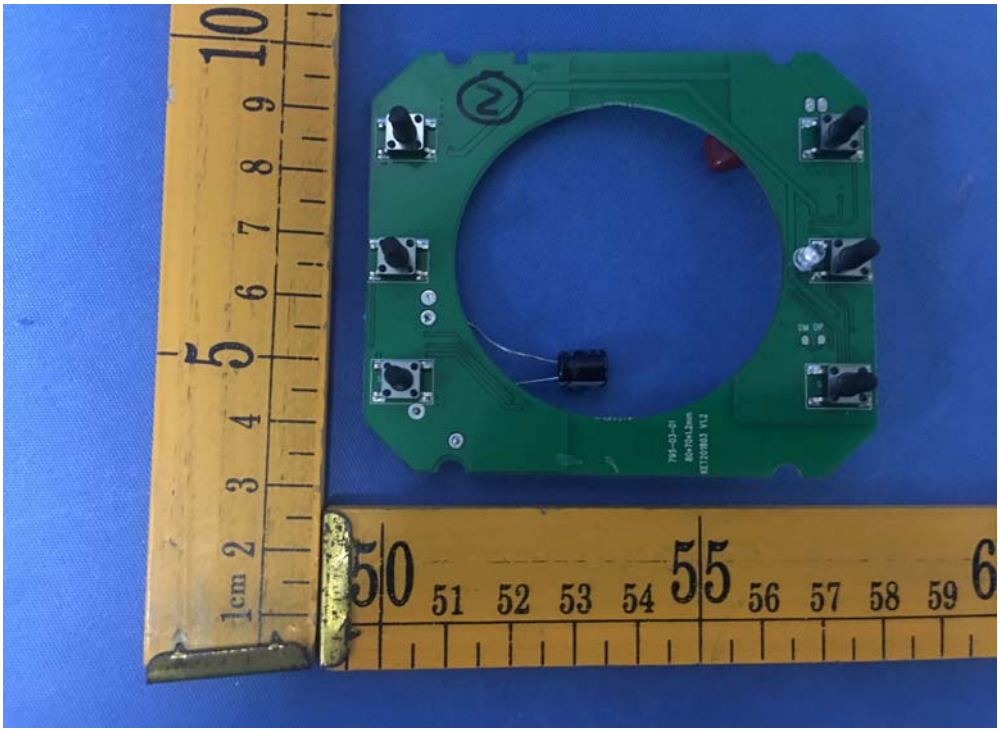
WORTHDEN 18650 4000mAh
3.7V 14.8Wh E10

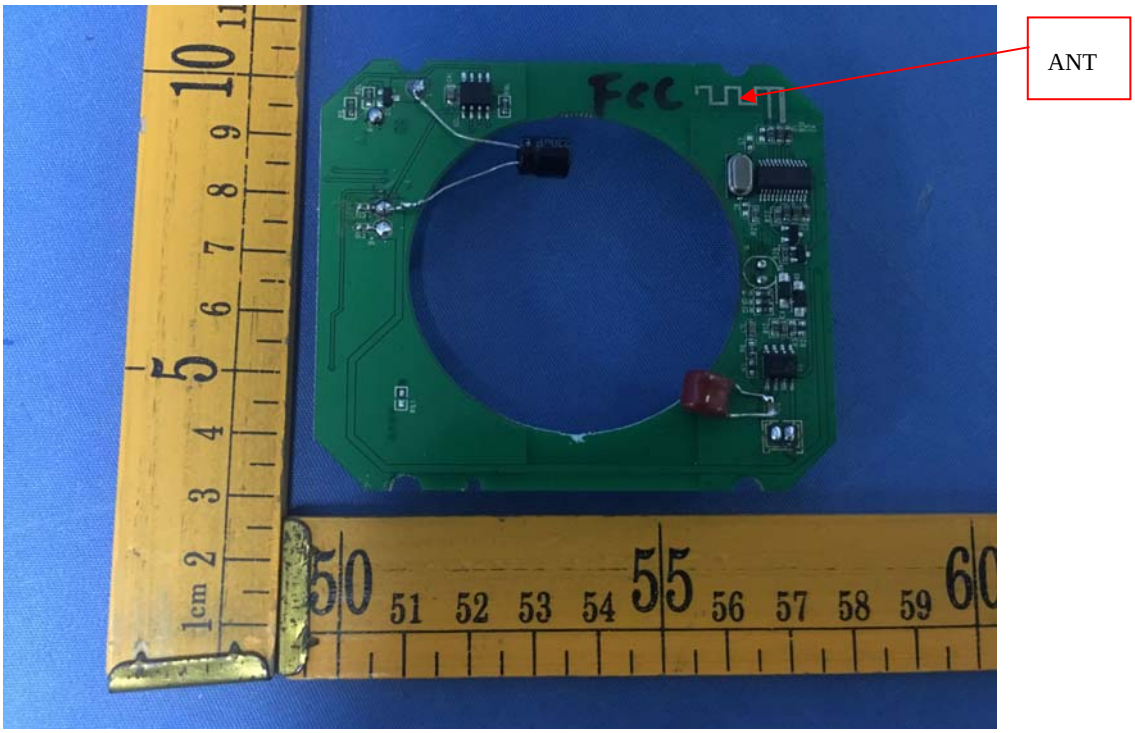



USB2
LED1
Fcc
1cm 2 3 4 5 6
50 51 52 53 54 55 56




MY
2/3W





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