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. ..... :	**GTS20191025009-1-1**
FCC ID. ..... :	**2AUYH-P1**
Compiled by (position+printed name+signature). :	File administrators Tracy Hu
Supervised by (position+printed name+signature). :	Test Engineer Moon Tan
Approved by (position+printed name+signature). :	Manager Simon Hu
Date of issue ..... :	Oct. 30, 2019
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,China
Applicant's name ..... :	**Shenzhen Hengyi Huacai Industrial Co., Ltd.**
Address ..... :	Room 201, Building A, No.1, Qianwan 1st Road, Qianhai-Hong Kong Cooperation Zone, Shenzhen, China
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

Shenzhen Global Test Service Co.,Ltd. All rights reserved.
This publication may be reproduced in whole or in part for non-commercial purposes as long as the Shenzhen Global Test Service Co.,Ltd. is acknowledged as copyright owner and source of the material. Shenzhen Global Test Service Co.,Ltd. takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Test item description..... :	**True Wireless Earbuds**
Trade Mark..... :	Lykoug
Manufacturer..... :	Shenzhen Hengyi Huacai Industrial Co., Ltd.
Model/Type reference..... :	P1
Listed Models ..... :	N/A
Modulation Type ..... :	GFSK,π/4-DQPSK,8DPSK
Operation Frequency..... :	From 2402MHz to 2480MHz
Hardware Version ..... :	N/A
Software Version ..... :	N/A
Rating..... :	DC 3.7V from battery
Result..... :	**PASS**

TEST REPORT

Test Report No. :	GTS20191025009-1-1	Oct. 30, 2019 Date of issue

Equipment under Test	:	True Wireless Earbuds
Model /Type	:	P1
Listed Models	:	N/A
Applicant	:	**Shenzhen Hengyi Huacai Industrial Co., Ltd.**
Address	:	Room 201, Building A, No.1, Qianwan 1st Road, Qianhai-Hong Kong Cooperation Zone, Shenzhen, China
Manufacturer	:	**Shenzhen Hengyi Huacai Industrial Co., Ltd.**
Address	:	Room 201, Building A, No.1, Qianwan 1st Road, Qianhai-Hong Kong Cooperation Zone, Shenzhen, China

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.

Contents

1. TEST STANDARDS **4**

2. SUMMARY **5**

2.1. General Remarks 5
2.2. Product Description 5
2.3. Equipment Under Test 5
2.4. Short description of the Equipment under Test (EUT) 5
2.5. EUT operation mode 6
2.6. Block Diagram of Test Setup 6
2.7. Related Submittal(s) / Grant (s) 6
2.8. Special Accessories 6
2.9. Modifications 6

3. TEST ENVIRONMENT **7**

3.1. Address of the test laboratory 7
3.2. Test Facility 7
3.3. Environmental conditions 7
3.4. Summary of measurement results 8
3.5. Statement of the measurement uncertainty 9
3.6. Equipments Used during the Test 10

4. TEST CONDITIONS AND RESULTS **11**

4.1. AC Power Conducted Emission 11
4.2. Radiated Emission 13
4.3. Maximum Peak Output Power 17
4.4. 20dB Bandwidth 18
4.5. Frequency Separation 22
4.6. Band Edge Compliance of RF Emission 26
4.7. Number of hopping frequency 34
4.8. Time Of Occupancy(Dwell Time) 36
4.9. Pseudorandom Frequency Hopping Sequence 40
4.10. Antenna Requirement 41

5. TEST SETUP PHOTOS OF THE EUT **42**

6. EXTERNAL AND INTERNAL PHOTOS OF THE EUT **43**

6.1. External photos of the EUT 43
6.2. Internal photos of the EUT 46

1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

2. SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	Oct. 25, 2019
Testing commenced on	:	Oct. 29, 2019
Testing concluded on	:	Oct. 30, 2019

2.2. Product Description

Product Name:	True Wireless Earbuds
Trade Mark:	Lykoug
Model/Type reference:	P1
Power supply:	DC 3.7V from battery
BT	
Operation frequency	2402-2480MHz
Channel Number	79 channels for Bluetooth (DSS)
Channel Spacing	1MHz for Bluetooth (DSS)
Modulation Type	GFSK, π/4-DQPSK, 8DPSK for Bluetooth (DSS)
Antenna Description	Chip Antenna,1.9dBi Max

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)		

DC 3.7V from battery

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

This is a True Wireless Earbuds

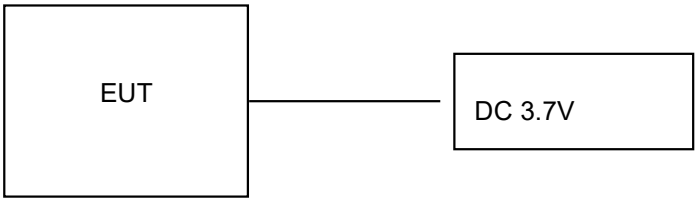
For more details, refer to the user's manual of the EUT.

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
--	--	--	--
--	--	--	--
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: 2AUYH-P1** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.8. Special Accessories

Manufacturer	Description	Model	Serial Number	Certificate
Shenzhen Mingxin power Technology Co.,Ltd	Adapter	JHD-AP036U-050300AA-A	--	SDOC

The adapter is provided by the laboratory.

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

3.2. Test Facility

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

CNAS (No. CNAS 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 17025:2019 General Requirements) for the Competence of Testing and Calibration Laboratories.

A2LA (Certificate No. 4758.01)
Shenzhen Global Test Service Co., Ltd. has been assessed by the American Association for Laboratory Accreditation (A2LA). Certificate No. 4758.01.

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 π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK π/4-DQPSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Number of Hopping channels	GFSK π/4-DQPSK 8DPSK	☒ Full	GFSK π/4-DQPSK 8DPSK	☒ Full	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK π/4-DQPSK 8DPSK	☒ Middle	☒ ☒	☐	☐	☐	complies
§15.247(a)(1)	Spectrum bandwidth of a FHSS system 20dB bandwidth	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.247(b)(1)	Maximum output power	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	☒ ☒ ☒	☐	☐	☐	complies
§15.247(d)	Band edge compliance conducted	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.205	Band edge compliance radiated	GFSK π/4-DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK	☒ Lowest ☒ Highest	☒	☐	☐	☐	complies
§15.247(d)	TX spurious emissions conducted	-/-	-/-	-/-	-/-	☐	☐	☐	☐	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	-/-	-/-	-/-	-/-	☐	☐	☐	☐	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-DQPSK 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

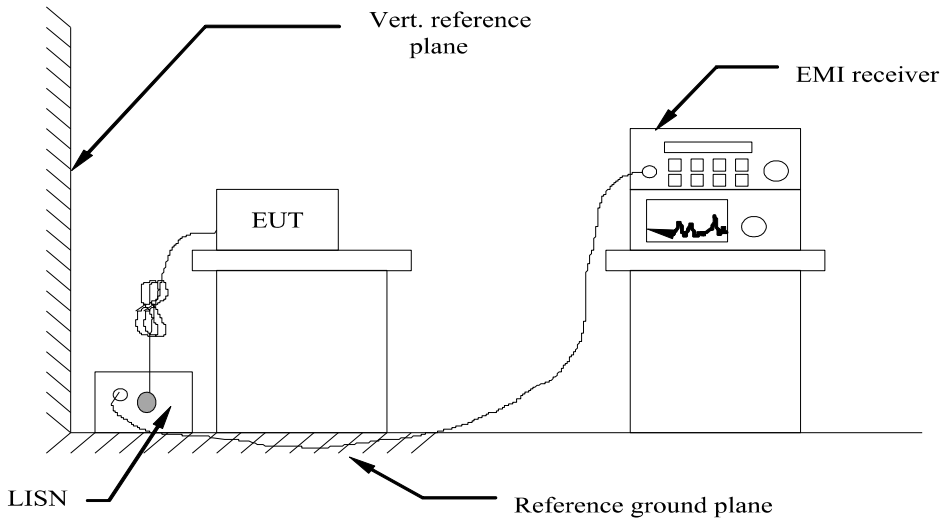
Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.08	2019/09/28	2020/09/27
LISN	R&S	ESH2-Z5	893606/008	2019/09/27	2020/09/26
By-log Antenna	SCHWARZBECK	VULB9163	000976	2019/09/29	2020/09/28
EMI Test Receiver	R&S	ESCI	101102	2019/09/26	2020/09/25
Spectrum Analyzer	Agilent	N9020A	MY48010425	2019/09/17	2020/09/16
Spectrum Analyzer	R&S	FSV40-N	101800	2019/09/17	2020/09/16
Controller	EM Electronics	Controller EM 1000	N/A	2019/09/21	2020/09/20
Double Ridged Horn Antenna (1~18GHz)	SCHWARZBECK	BBHA 9120D	01622	2019/09/19	2020/09/18
Double Ridged Horn Antenna	Rohde&Schwarz	HF907	100265	2019/09/19	2020/09/18
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2019/09/19	2020/09/18
Horn Antenna (18GHz~40GHz)	ETS	3116	00086467	2018/12/29	2019/12/28
Amplifier (26.5GHz~40GHz)	EMCI	EMC2654045	980028	2019/09/18	2020/09/17
Amplifier (0.1GHz~26.5GHz)	EMCI	EMC012645SE	980355	2019/09/19	2020/09/18
Temperature/Humidity Meter	Gangxing	CTH-608	02	2019/09/20	2020/09/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	N/A	2019/09/20	2020/09/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	N/A	2019/09/20	2020/09/19
Data acquisition card	Agilent	U2531A	TW53323507	2019/09/20	2020/09/19
Power Sensor	Agilent	U2021XA	MY5365004	2019/09/20	2020/09/19
RF Cable	HUBER+SUHNER	RG214	N/A	2019/09/20	2020/09/19
Broadband Antenna	SCHWARZBECK	VULB 9163	00976	2019/09/29	2020/09/28
Conducted Emission	JS32-CE	V2.5	N/A	N/A	N/A
Radiated Emission	JS32-RE	V2.5.0.9	N/A	N/A	N/A

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：

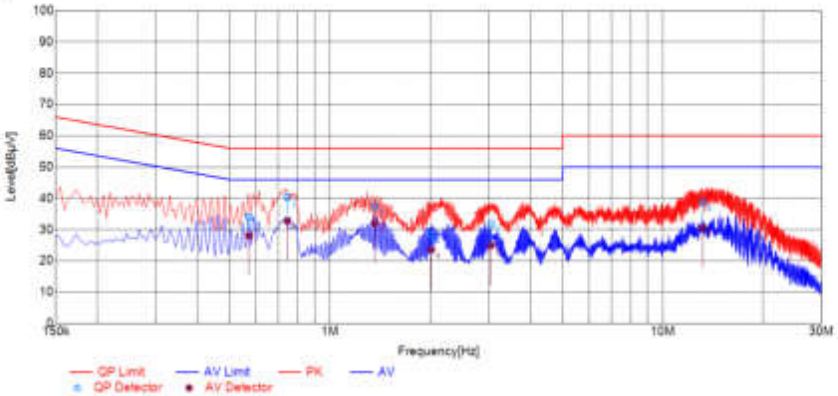
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

TEST RESULTS

Remark: We measured Conducted Emission at GFSK, π/4-DQPSK and 8DPSK mode in AC 120V/60Hz and AC 240V/50Hz, the worst case was recorded .

Power supply:	AC 120V/60Hz	Polarization	L

Test Graph

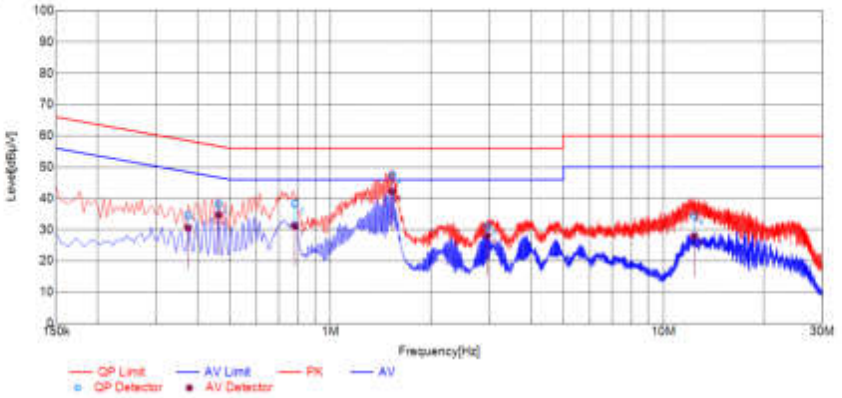


Final Data List

NO.	Frequency [MHz]	QP Reading [dBμV]	AVG. Reading [dBμV]	Factor [dB]	QP Result [dBμV]	AVG. Result [dBμV]	QP Limit [dBμV]	AVG. Limit [dBμV]	QP Margin [dB]	AVG. Margin [dB]	Line	Remark
1	0.5705	23.90	17.89	10.20	34.10	28.09	56.00	46.00	21.90	17.91	L1	PASS
2	0.7445	30.17	22.60	10.24	40.41	32.84	56.00	46.00	15.59	13.16	L1	PASS
3	1.3633	27.37	21.83	10.23	37.60	32.06	56.00	46.00	18.40	13.94	L1	PASS
4	2.0151	18.34	13.34	10.27	28.61	23.61	56.00	46.00	27.39	22.39	L1	PASS
5	3.0467	21.39	14.66	10.34	31.73	25.00	56.00	46.00	24.27	21.00	L1	PASS
6	13.1927	27.93	19.78	10.90	38.83	30.68	60.00	50.00	21.17	19.32	L1	PASS

Power supply:	AC 120V/60Hz	Polarization	N

Test Graph



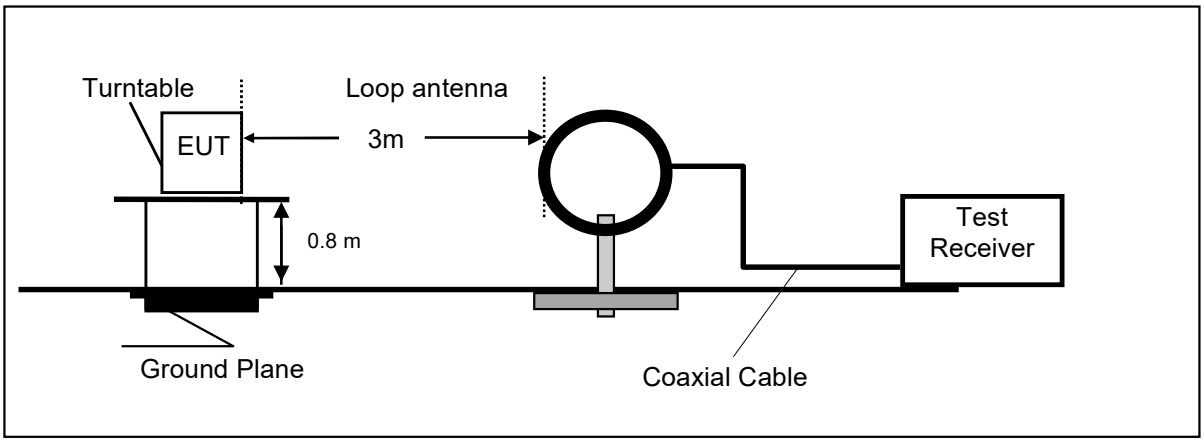
Final Data List

NO.	Frequency [MHz]	QP Reading [dBμV]	AVG. Reading [dBμV]	Factor [dB]	QP Result [dBμV]	AVG. Result [dBμV]	QP Limit [dBμV]	AVG. Limit [dBμV]	QP Margin [dB]	AVG. Margin [dB]	Line	Remark
1	0.3736	24.48	20.37	10.15	34.63	30.52	58.42	48.42	23.79	17.90	N	PASS
2	0.4613	28.00	24.52	10.23	38.23	34.75	56.67	46.67	18.44	11.92	N	PASS
3	0.7816	28.05	20.89	10.25	38.30	31.14	56.00	46.00	17.70	14.86	N	PASS
4	1.5322	37.21	31.90	10.24	47.45	42.14	56.00	46.00	8.55	3.86	N	PASS
5	2.9580	20.72	17.71	10.34	31.06	28.05	56.00	46.00	24.94	17.95	N	PASS
6	12.3640	23.52	17.07	10.85	34.37	27.92	60.00	50.00	25.63	22.08	N	PASS

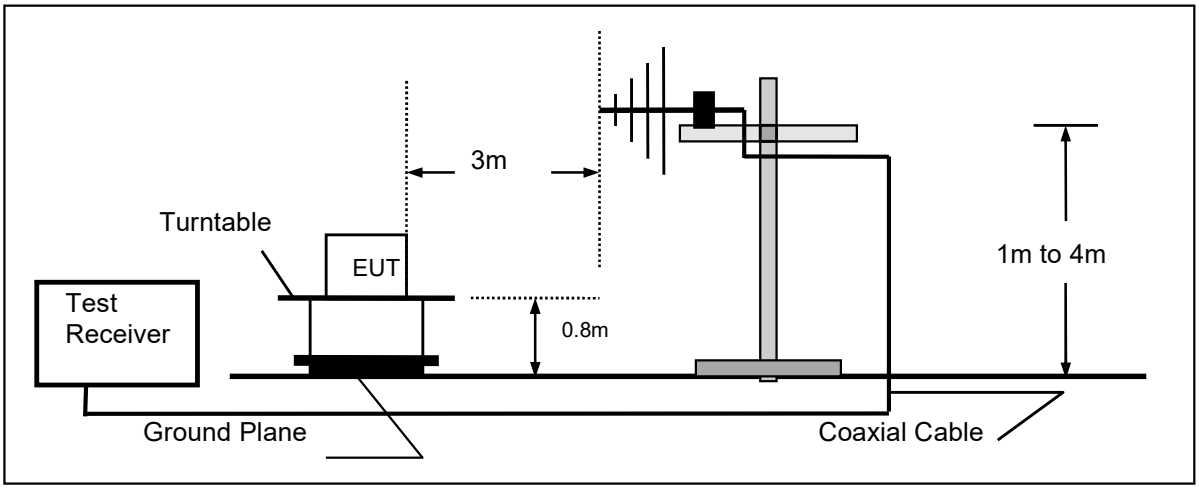
4.2. Radiated Emission

TEST CONFIGURATION

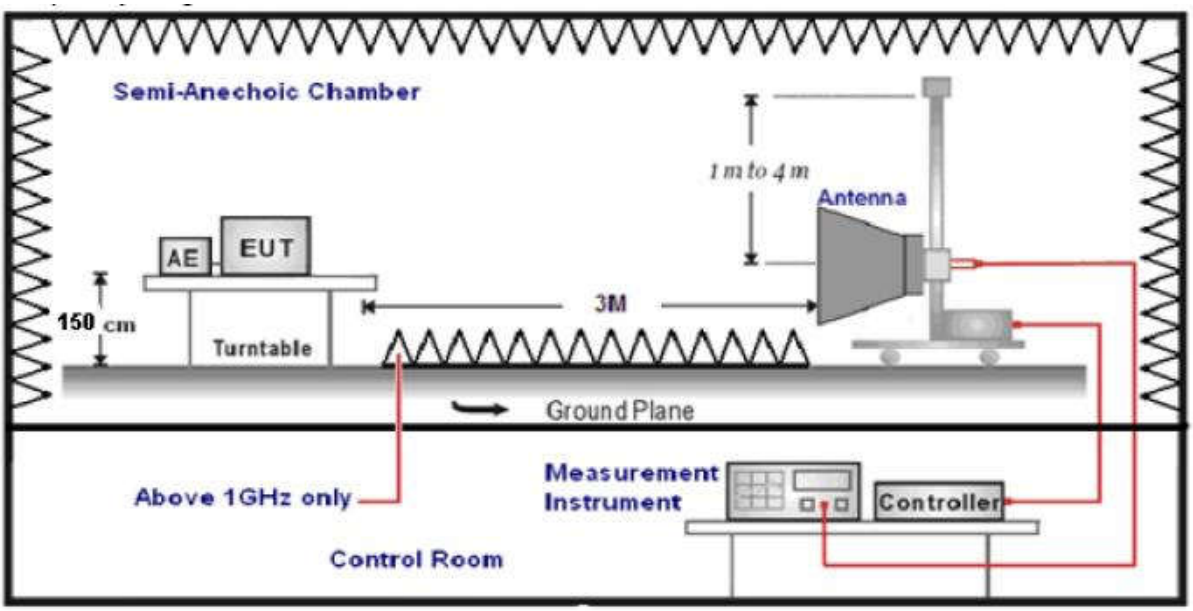
Frequency range 9 KHz – 30MHz



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

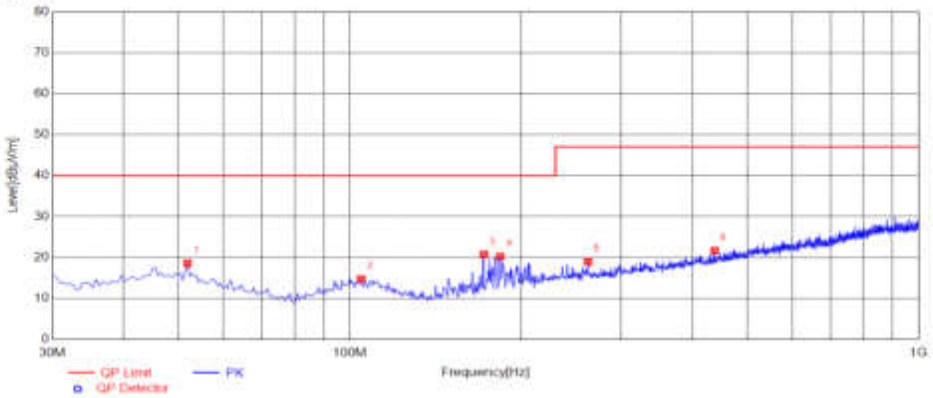
TEST RESULTS

Remark: We measured Radiated Emission at GFSK, π/4-DQPSK and 8DPSK mode from 30MHz to 25GHz and recorded worst case at GFSK mode.

For 30MHz-1GHz

Horizontal

Test Graph

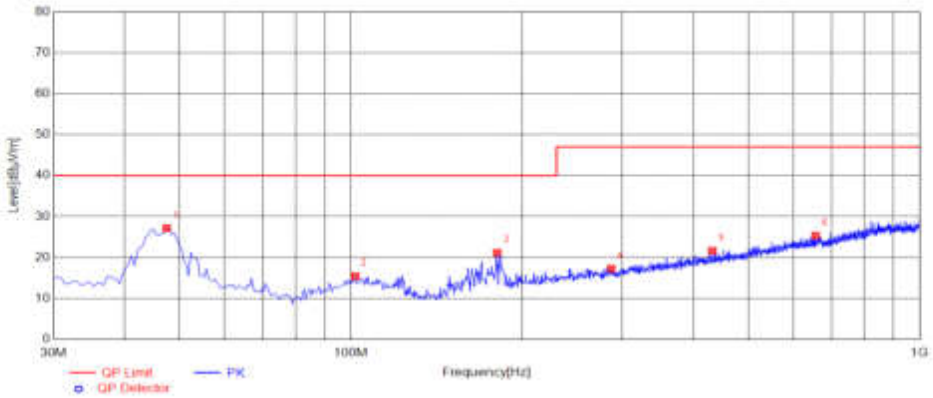


Suspected List

NO.	Frequency [MHz]	Reading [dBμV/m]	Factor [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	51.8250	33.77	-15.20	18.57	40.00	21.43	100	74	PK	Horizonta	PASS
2	104.6900	31.68	-16.95	14.73	40.00	25.27	100	79	PK	Horizonta	PASS
3	172.1050	39.61	-18.88	20.73	40.00	19.27	100	93	PK	Horizonta	PASS
4	183.7450	38.36	-18.12	20.24	40.00	19.76	100	144	PK	Horizonta	PASS
5	262.3150	33.84	-14.85	18.99	47.00	28.01	100	6	PK	Horizonta	PASS
6	437.8850	32.75	-11.08	21.67	47.00	25.33	100	306	PK	Horizonta	PASS

Vertical

Test Graph



Suspected List

NO.	Frequency [MHz]	Reading [dBμV/m]	Factor [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Polarity	Remark
1	47.4600	41.97	-14.81	27.16	40.00	12.84	100	20	PK	Vertical	PASS
2	101.7800	32.38	-16.95	15.43	40.00	24.57	100	84	PK	Vertical	PASS
3	180.8350	39.53	-18.36	21.17	40.00	18.83	100	137	PK	Vertical	PASS
4	287.0500	31.65	-14.40	17.25	47.00	29.75	100	22	PK	Vertical	PASS
5	432.0650	32.80	-11.15	21.65	47.00	25.35	100	25	PK	Vertical	PASS
6	656.1350	32.61	-7.28	25.33	47.00	21.67	100	170	PK	Vertical	PASS

For 1GHz to 25GHz

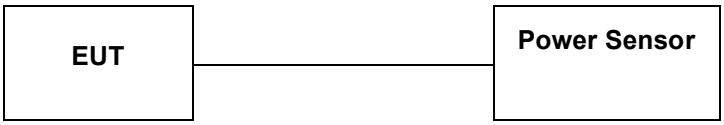
Frequency	Meter Reading	Antenna Factor	Cable loss	Preamp factor	Emission Level	Limits	Margin	Detector Type	Comment
(MHz)	(dBμV)	(dB)	(dB)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		
TX-2402									
4804	45.78	32.44	30.25	7.95	55.92	74	18.08	Pk	Vertical
4804	35.78	32.44	30.25	7.95	45.92	54	8.08	AV	Vertical
4804	39.83	32.44	30.25	7.95	49.97	74	24.03	Pk	Horizontal
4804	32.18	32.44	30.25	7.95	42.32	54	11.68	AV	Horizontal
TX-2441									
4882	45.75	32.52	30.31	8.12	56.08	74	17.92	Pk	Vertical
4882	34.88	32.52	30.31	8.12	45.21	54	8.79	AV	Vertical
4882	40.16	32.52	30.31	8.12	50.49	74	23.51	Pk	Horizontal
4882	30.59	32.52	30.31	8.12	40.92	54	13.08	AV	Horizontal
TX-2480									
4960	44.79	32.68	30.27	7.88	55.08	74	18.92	Pk	Vertical
4960	35.44	32.68	30.27	7.88	45.73	54	8.27	AV	Vertical
4960	38.20	32.68	30.27	7.88	48.49	74	25.51	Pk	Horizontal
4960	31.00	32.68	30.27	7.88	41.29	54	12.71	AV	Horizontal

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 Factor
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.

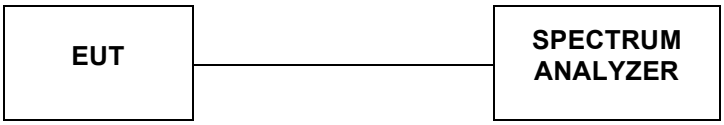
TEST RESULTS

Type	Channel	Peak Output power (dBm)	Limit (dBm)	Result
GFSK	00	5.48	21	Pass
	39	6.28		
	78	6.10		
π/4-DQPSK	00	4.71	21	Pass
	39	5.41		
	78	5.21		
8DPSK	00	4.89	21	Pass
	39	5.70		
	78	5.52		

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.

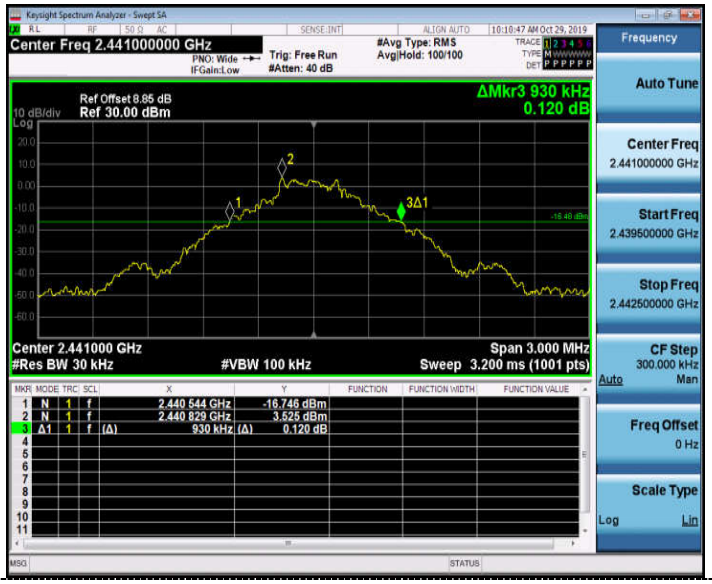
TEST RESULTS

	Frequency	20dB Bandwidth (MHz)	Result
GFSK	2402 MHz	0.939	**PASS**
	2441 MHz	0.930	**PASS**
	2480 MHz	0.876	**PASS**
π/4-DQPSK	2402 MHz	1.233	**PASS**
	2441 MHz	1.266	**PASS**
	2480 MHz	1.245	**PASS**
8-DPSK	2402 MHz	1.266	**PASS**
	2441 MHz	1.272	**PASS**
	2480 MHz	1.251	**PASS**

Test plot as follows:

CH00-1Mbps

CH39 -1Mbps



CH78 -1Mbps

CH00-2Mbps

CH39-2Mbps

CH78-2Mbps

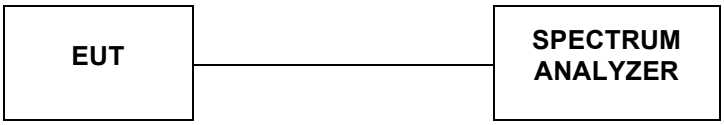
CH00-3Mbps

CH39-3Mbps

CH78-3Mbps

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

	Frequency	Ch. Separation (MHz)	Limit (MHz)	Result
GFSK	2402 MHz	0.992	0.626	**Complies**
	2441 MHz	1.010	0.620	**Complies**
	2480 MHz	0.992	0.584	**Complies**
π/4-DQPSK	2402 MHz	0.996	0.822	**Complies**
	2441 MHz	0.996	0.844	**Complies**
	2480 MHz	0.996	0.830	**Complies**
8-DPSK	2402 MHz	1.004	0.844	**Complies**
	2441 MHz	0.996	0.848	**Complies**
	2480 MHz	1.002	0.834	**Complies**

Ch. Separation Limits: > 2/3 of 20dB bandwidth

CH00 -1Mbps

CH39-1Mbps

CH78-1Mbps

CH00 -2Mbps

CH39 -2Mbps

CH78 -2Mbps

CH00 -3Mbps

CH39 -3Mbps

CH78 -3Mbps

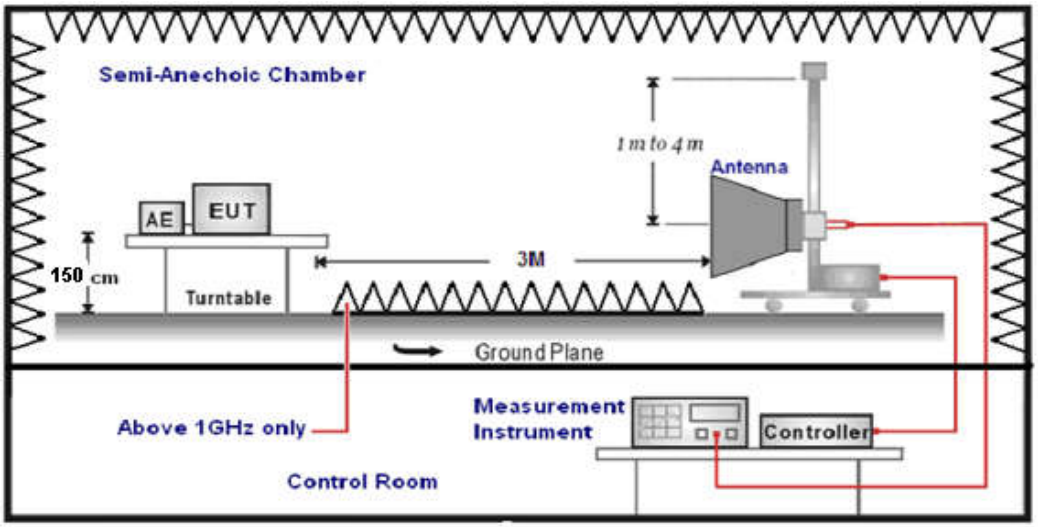
4.6. Band Edge Compliance of RF Emission

TEST REQUIREMENT

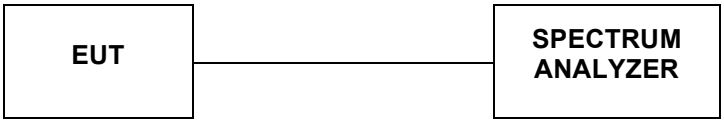
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the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

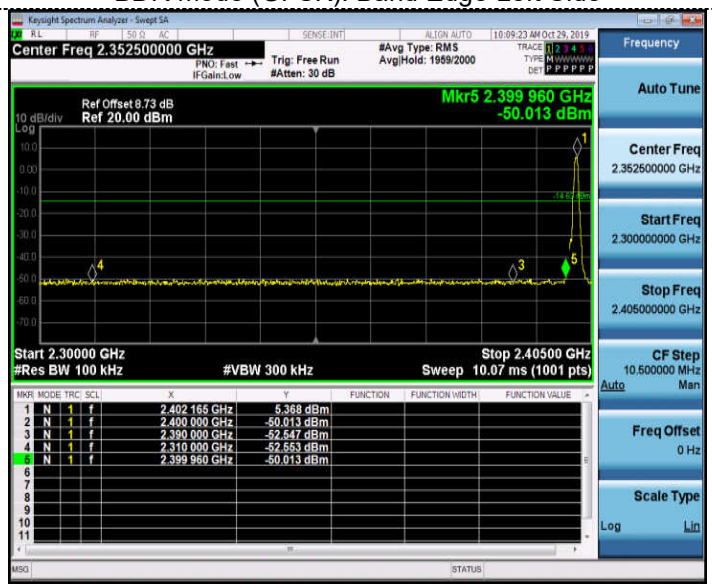
Remark: we tested radiated bandedge at both hopping and no-hopping modes,recorded worst case at no-hopping mode

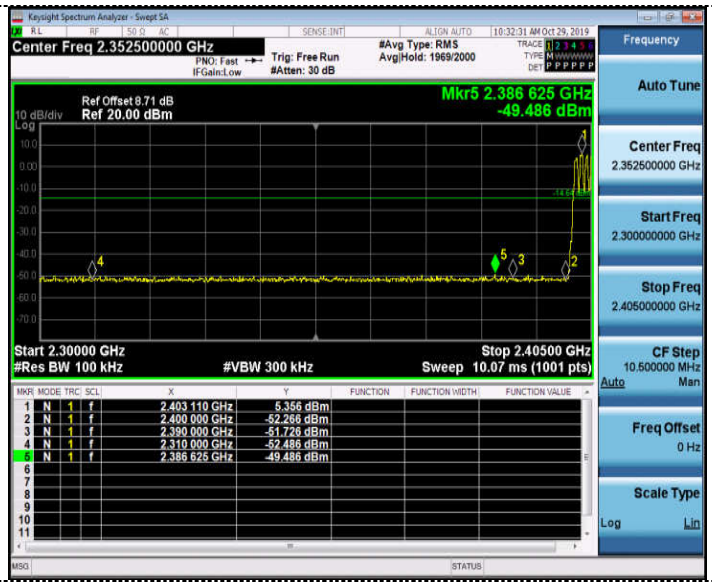
GFSK

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)
2390.00	48.65	PK	74	25.35	1	134	53.96	27.49	3.32	36.12	-5.31
2390.00	38.32	AV	54	15.68	1	134	43.63	27.49	3.32	36.12	-5.31
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)
2390.00	48.31	PK	74	25.69	1	183	53.62	27.49	3.32	36.12	-5.31
2390.00	39.25	AV	54	14.75	1	183	44.56	27.49	3.32	36.12	-5.31
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)
2483.50	48.08	PK	74	24.67	1	105	53.80	27.45	3.38	36.55	-5.72
2483.50	37.82	AV	54	12.37	1	105	43.54	27.45	3.38	36.55	-5.72
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)
2483.50	48.60	PK	74	24.67	1	149	54.32	27.45	3.38	36.55	-5.72
2483.50	38.74	AV	54	12.37	1	149	44.46	27.45	3.38	36.55	-5.72

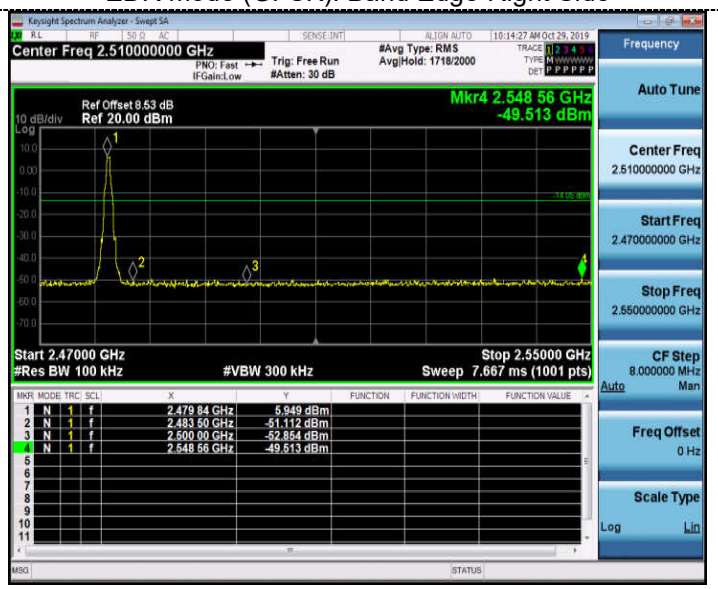
4.6.2 For Conducted Bandedge Measurement

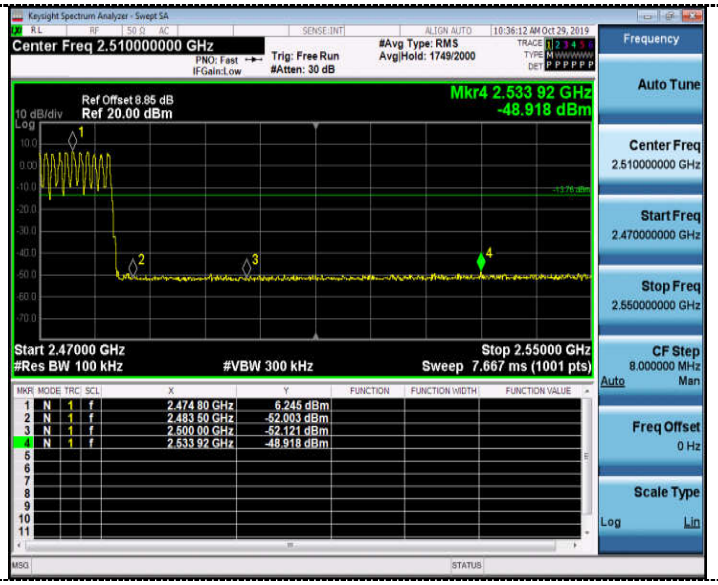
BDR mode (GFSK): Band Edge-Left Side



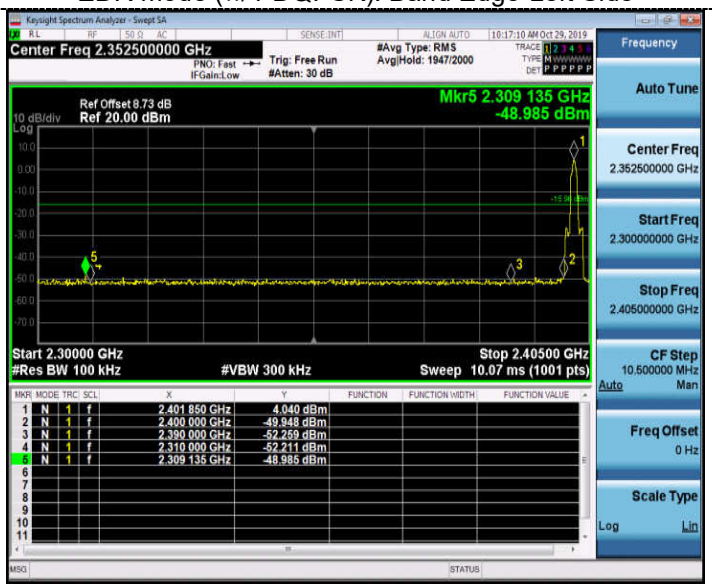


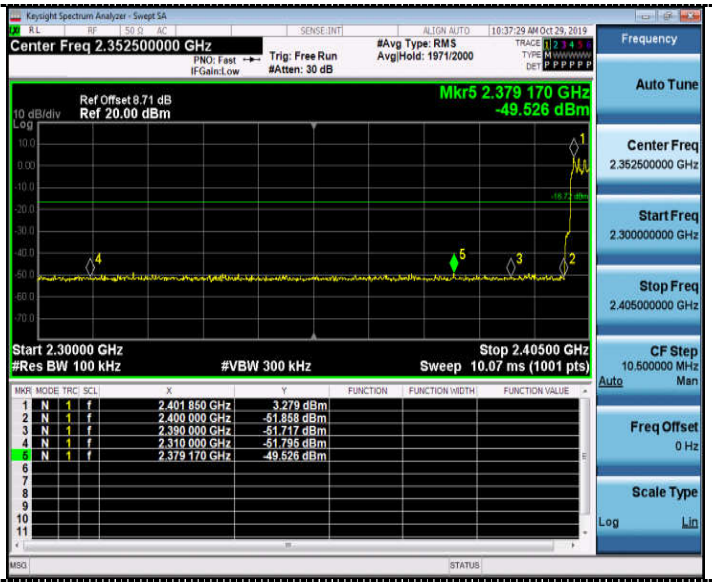
EDR mode (GFSK): Band Edge-Right Side



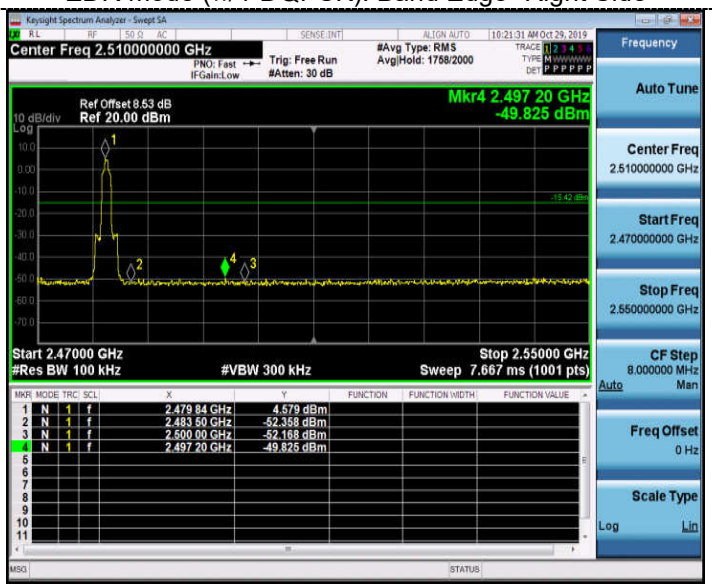


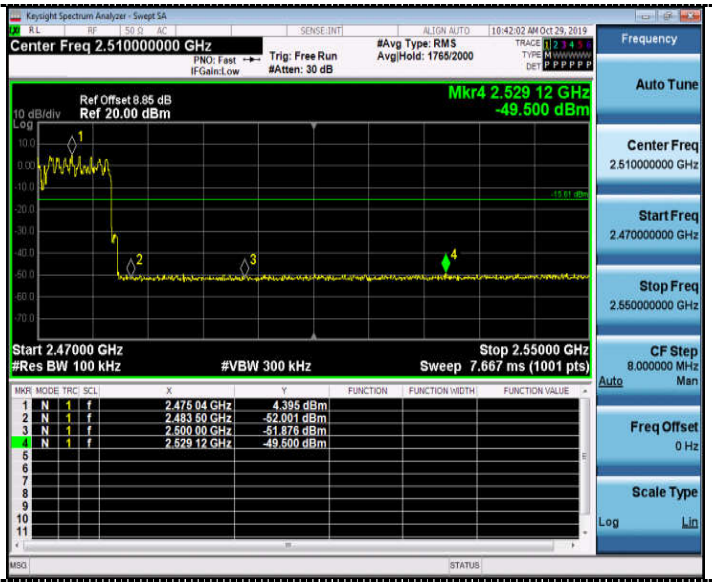
EDR mode (π/4-DQPSK): Band Edge-Left Side



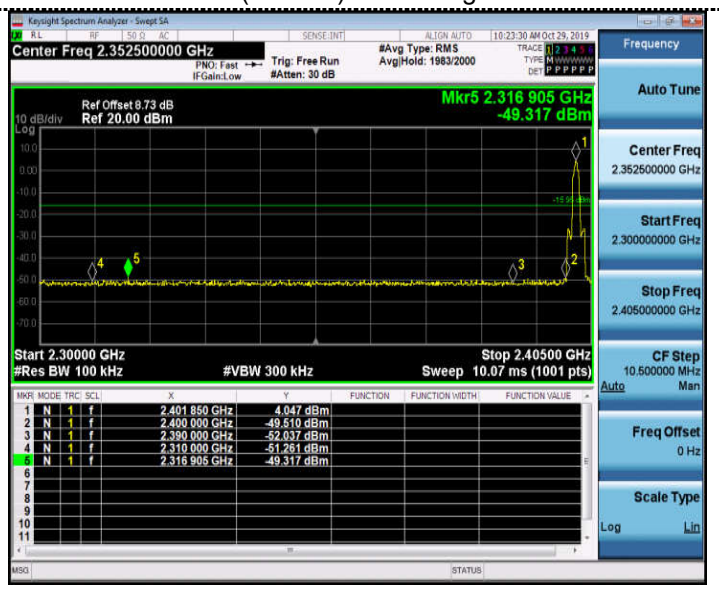


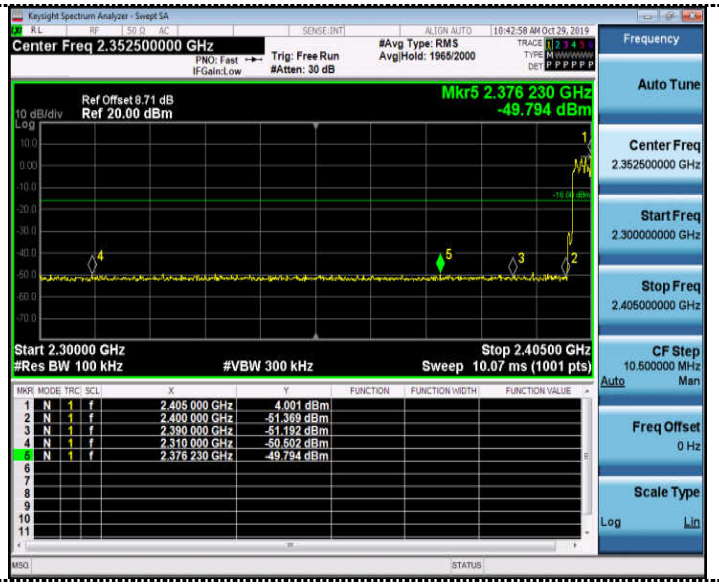
EDR mode (π/4-DQPSK): Band Edge- Right Side



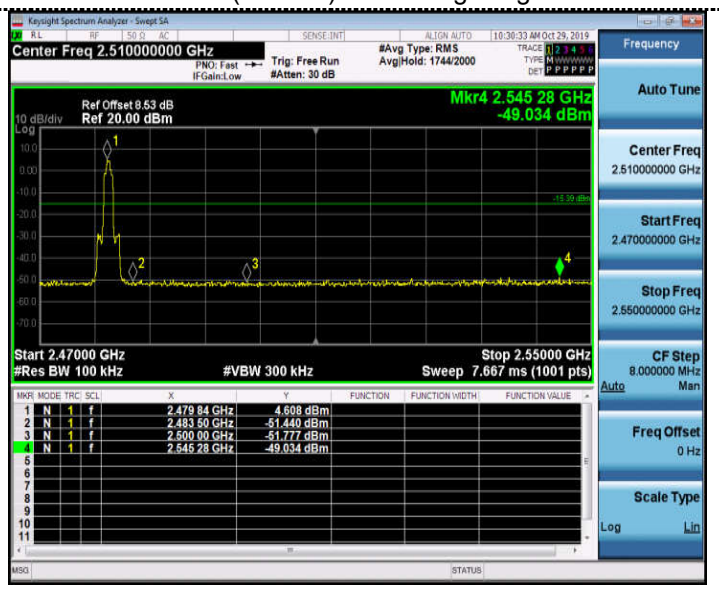


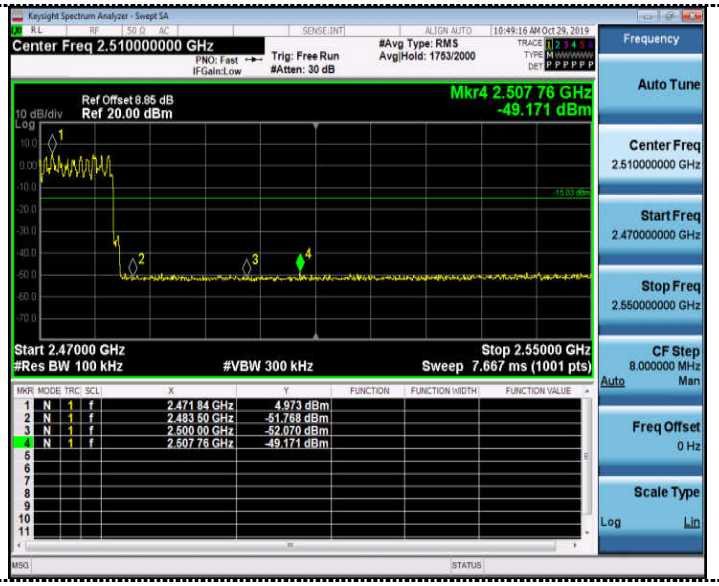
EDR mode(8DPSK): Band Edge-Left Side





EDR mode(8DPSK): Band Edge-Right Side

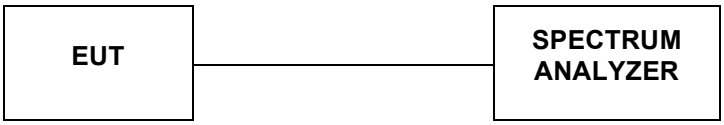




NOTE: Hopping enabled and disabled have evaluated, and the worst data was reported.

4.7. Number of hopping frequency

TEST CONFIGURATION



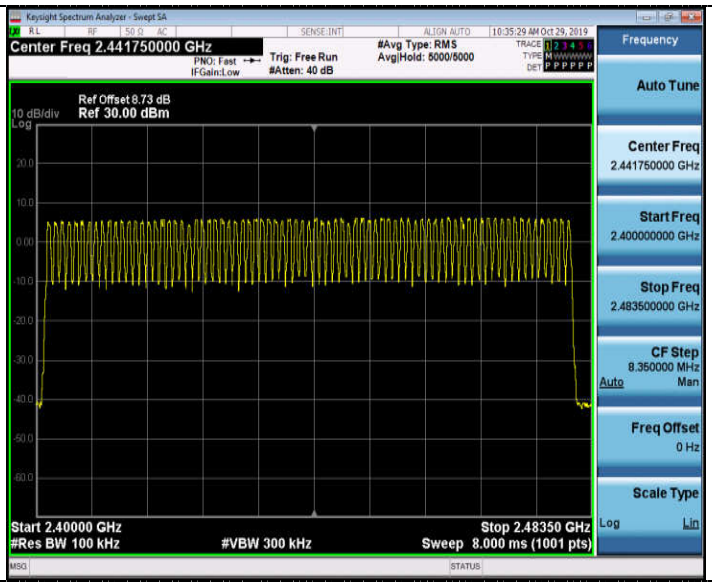
TEST PROCEDURE

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.

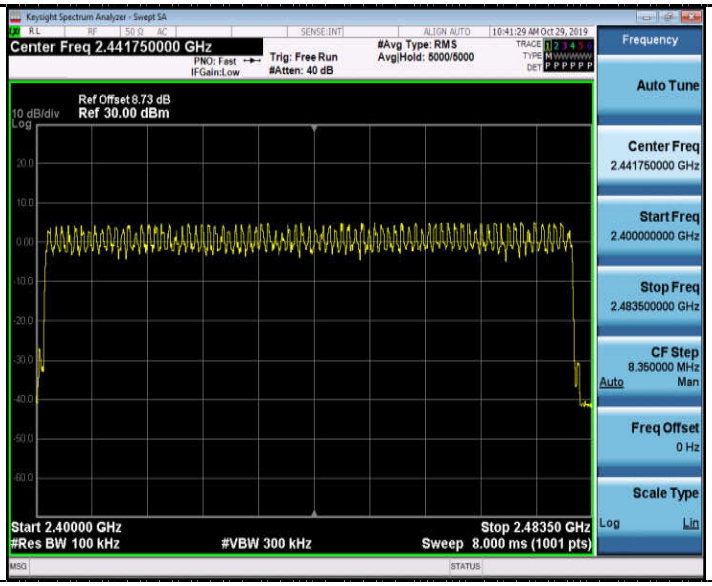
LIMIT

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

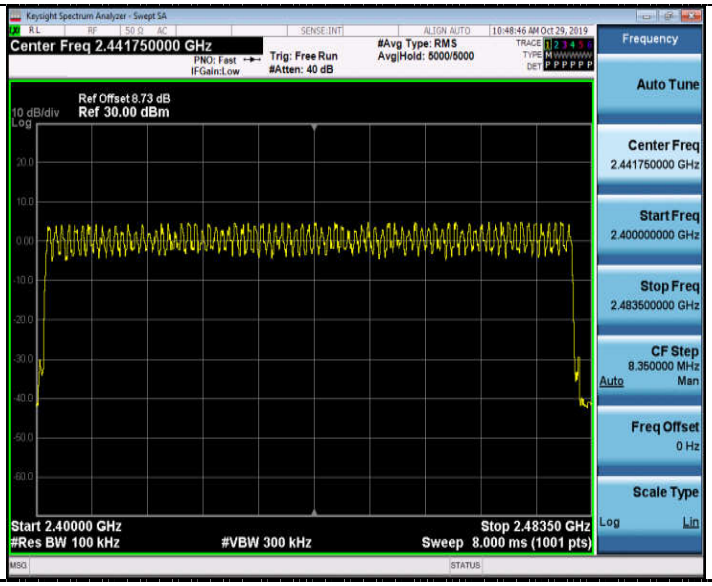
Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
π/4-DQPSK	79	≥15	Pass
8DPSK	79	≥15	Pass



GFSK Modulation



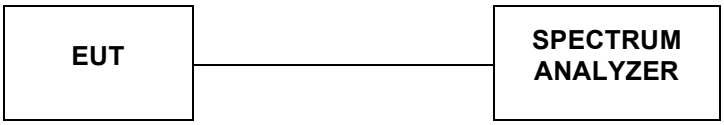
π/4-DQPSK Modulation



8DPSK Modulation

4.8. 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

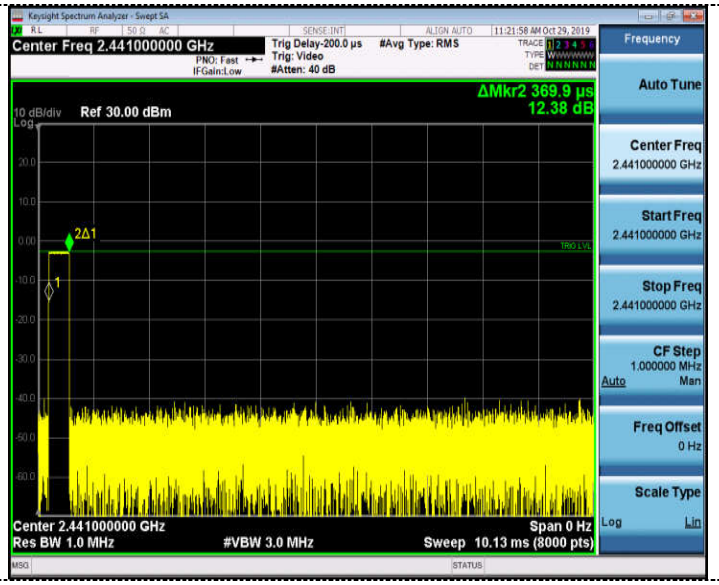
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a pe-riod of 0.4 seconds multiplied by the number of hopping channels employed.

TEST RESULTS

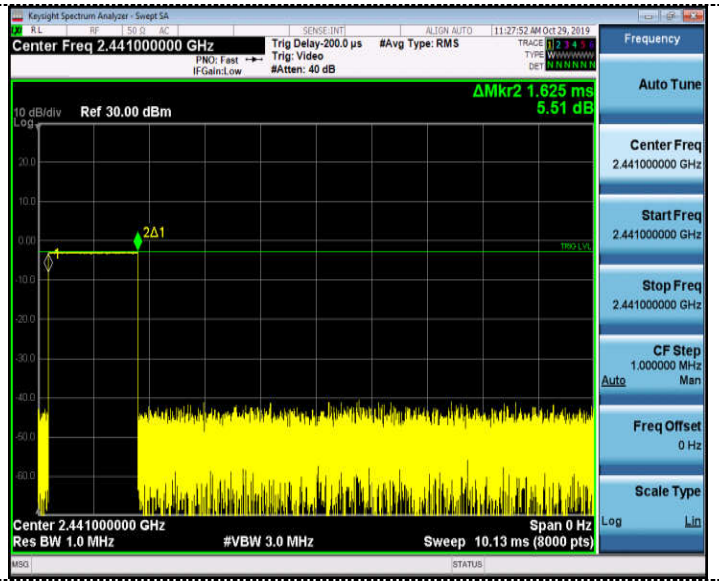
	Data Packet	Frequency	Pulse Duration	Dwell Time	Limits
			(ms)	(s)	(s)
GFSK	DH1	2441 MHz	0.37	0.122	0.4
	DH3	2441 MHz	1.63	0.276	0.4
	DH5	2441 MHz	2.87	0.287	0.4
π/4-DQPSK	2DH1	2441 MHz	0.38	0.125	0.4
	2DH3	2441 MHz	1.63	0.260	0.4
	2DH5	2441 MHz	2.89	0.231	0.4
8-DPSK	3DH1	2441 MHz	0.38	0.121	0.4
	3DH3	2441 MHz	1.65	0.231	0.4
	3DH5	2441 MHz	2.89	0.318	0.4

Test plot as follows:

CH39-DH1

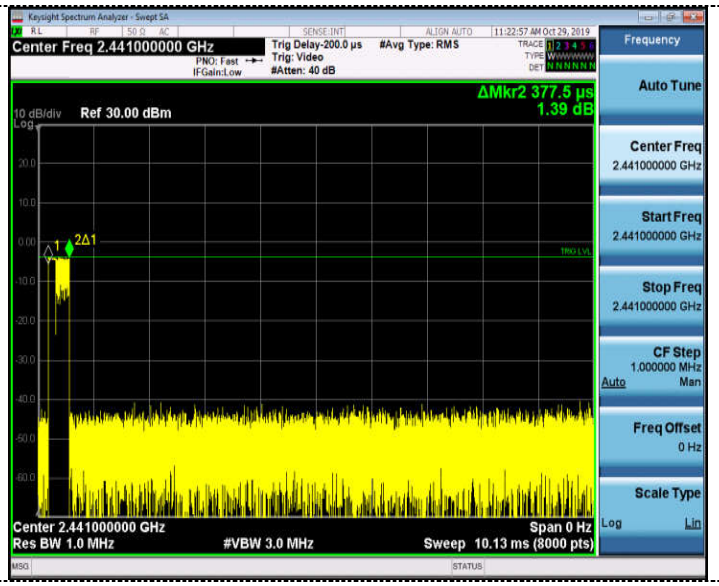


CH39-DH3

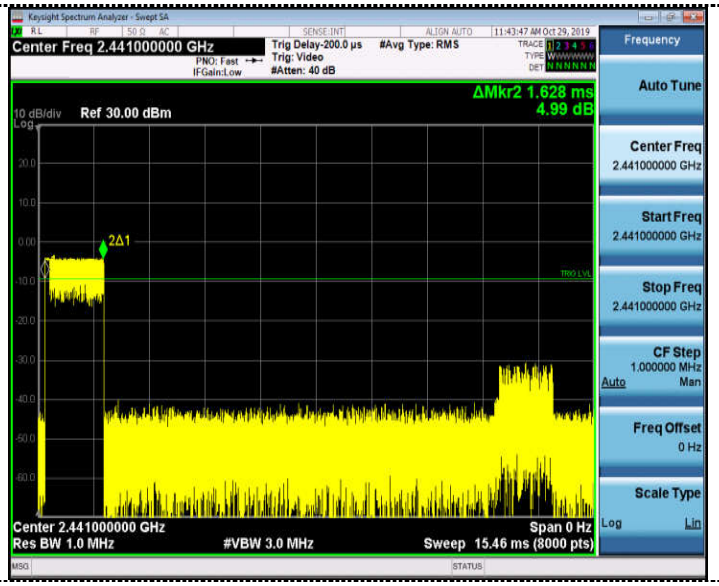


CH39-DH5

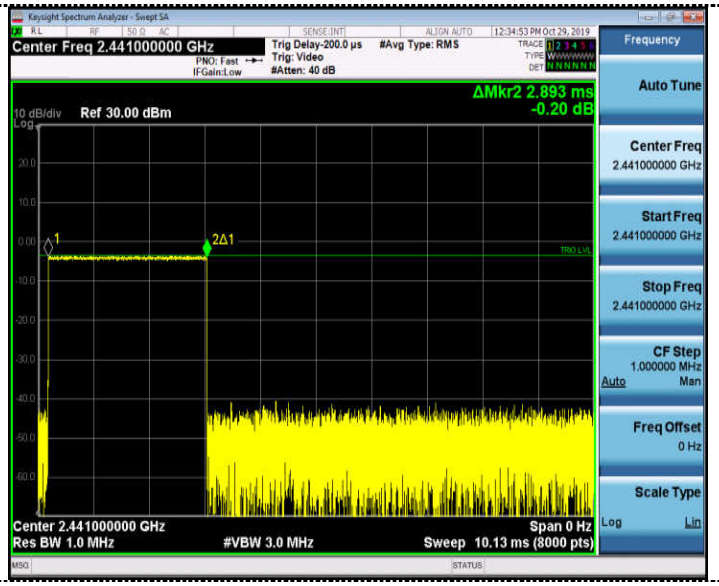
CH39-2DH1



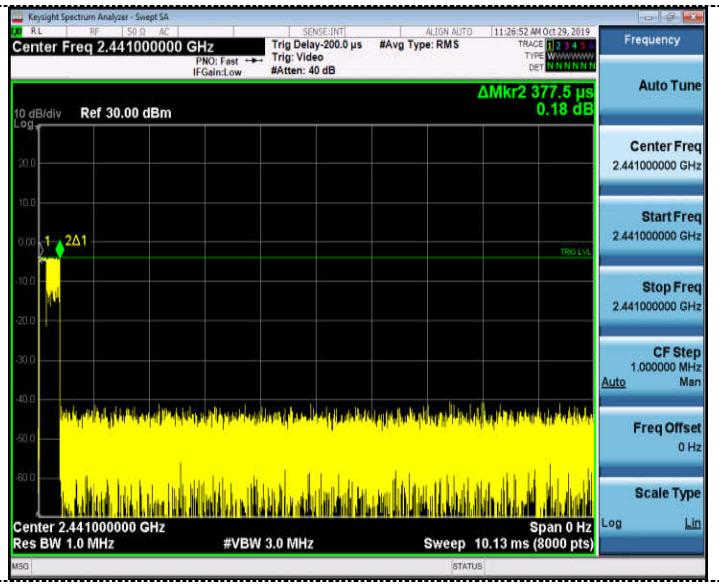
CH39-2DH3



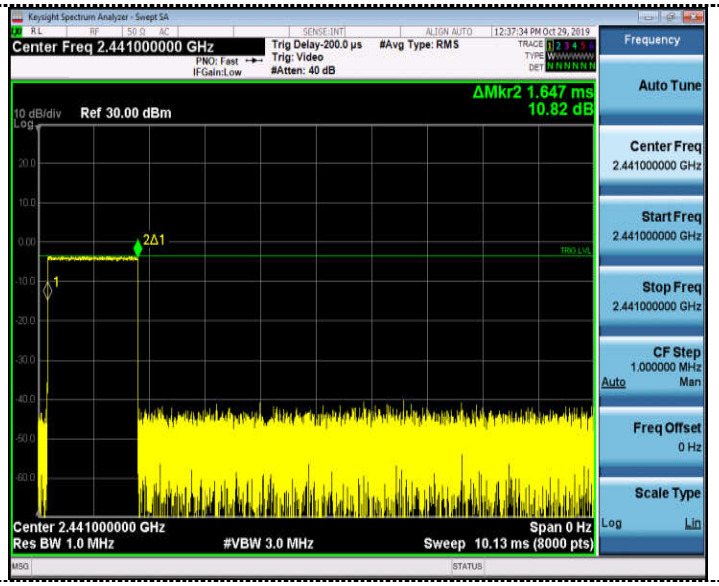
CH39-2DH5



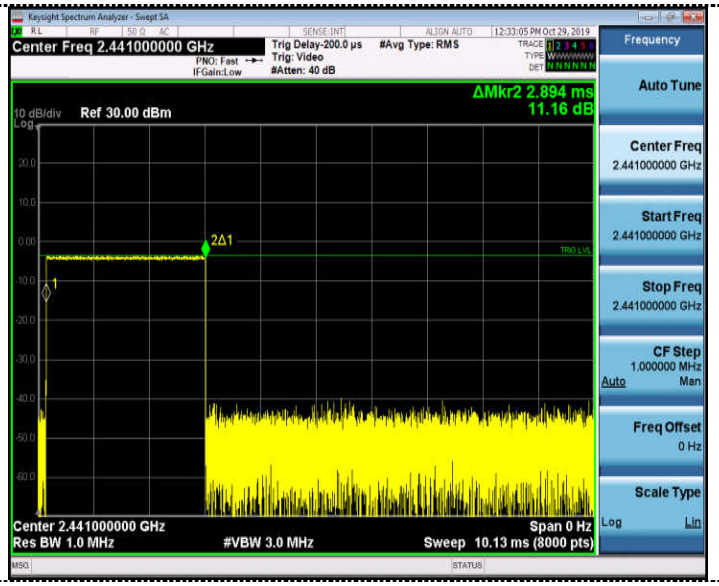
CH39-3DH1



CH39-3DH3



CH39-3DH5



4.9. Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

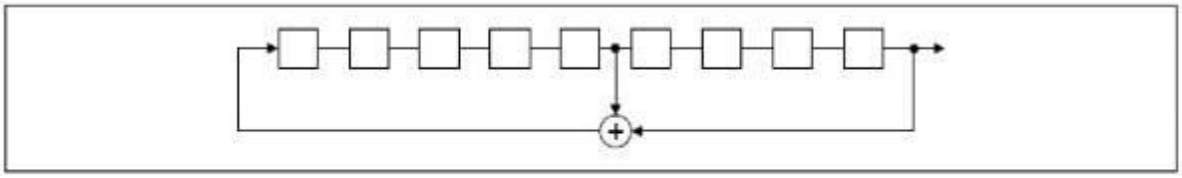
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

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

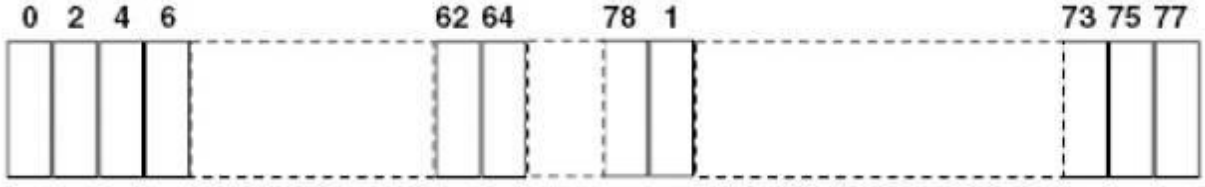
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage.And the result is fed back to the input of the frist stage.The sequence begins with the frist one of 9 consecutive ones,for example:the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

4.10. 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.

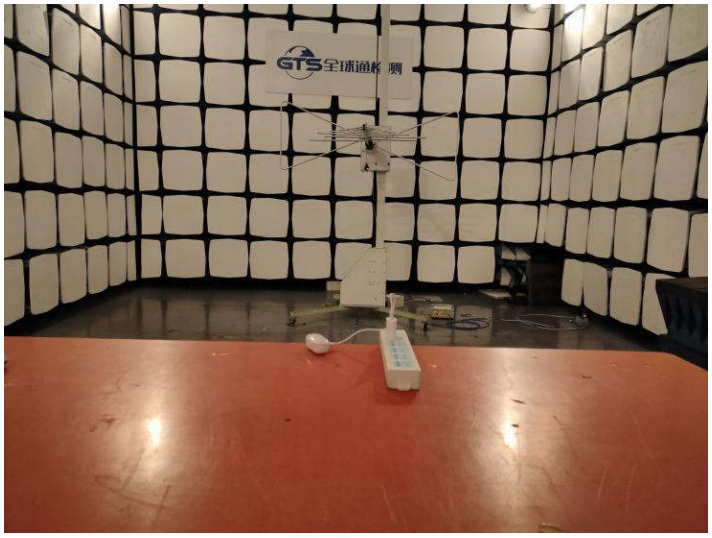
And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

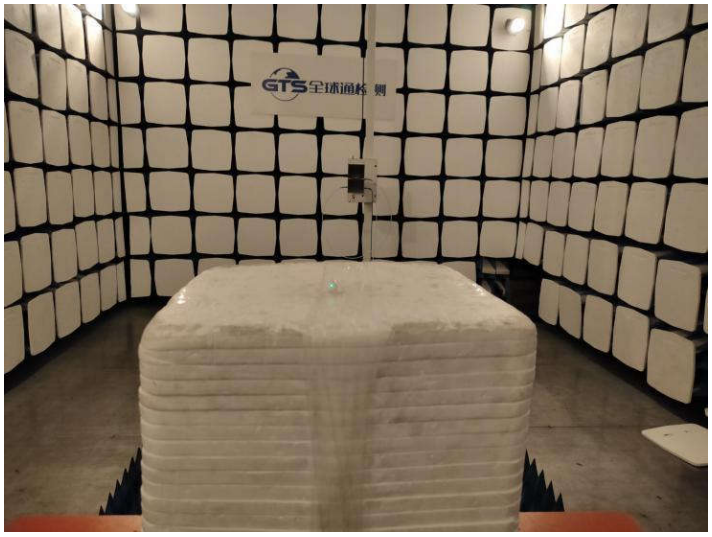
Test Result

The antenna used for this product is Chip Antenna and that no antenna other than that furnished by the responsible party shall be used with the device, the maximum peak gain of the transmit antenna is only 1.9dBi.

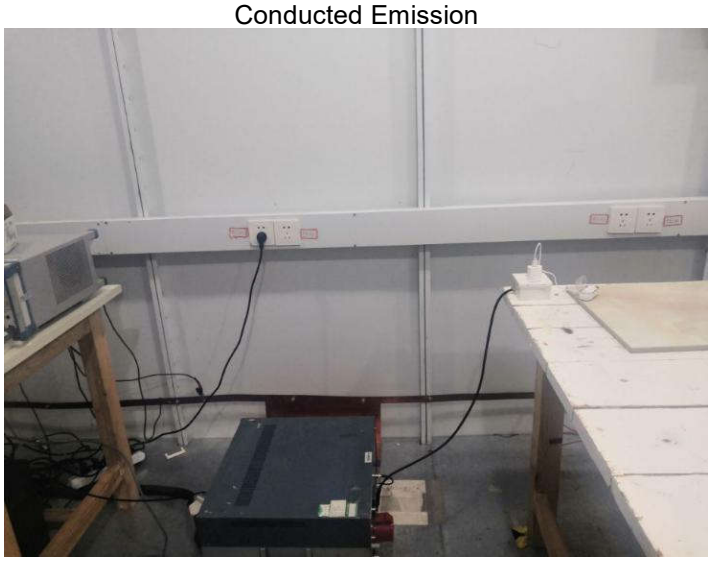
5. TEST SETUP PHOTOS OF THE EUT

Radiated Emission Test





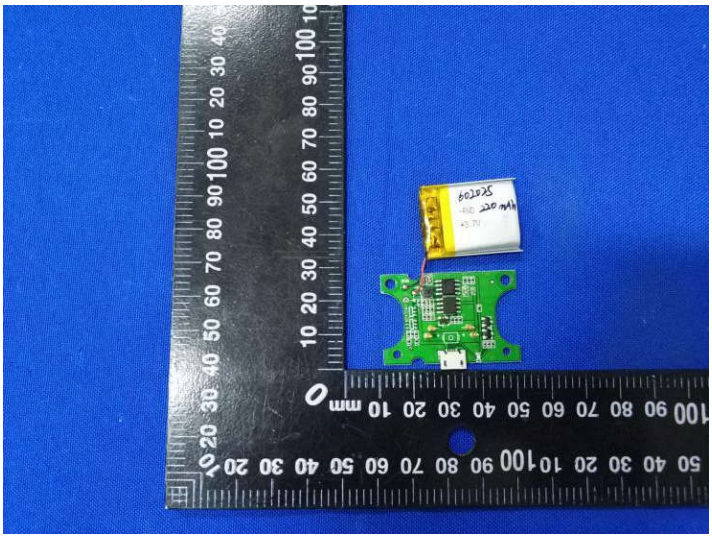
Conducted Emission

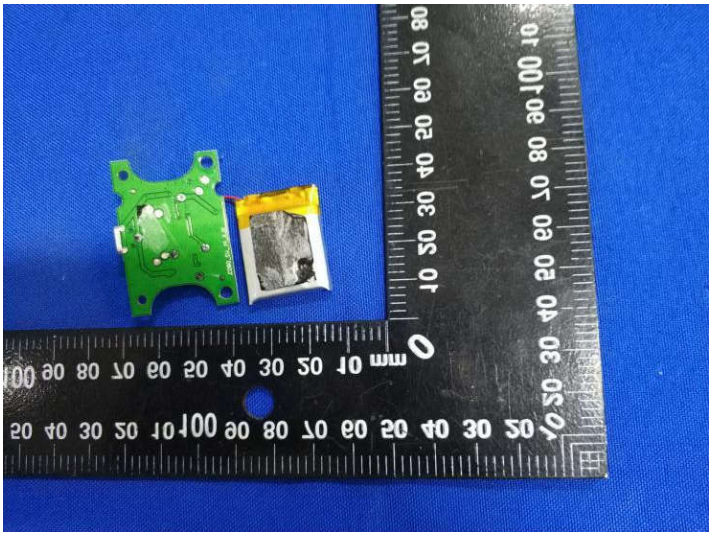


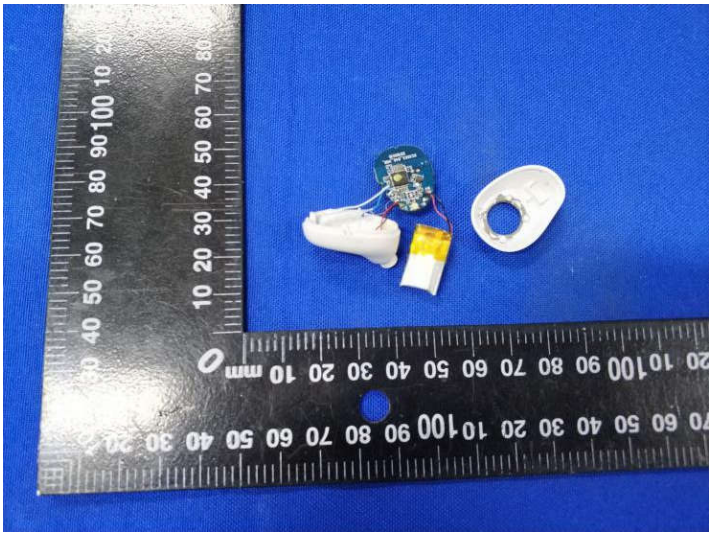
6. EXTERNAL AND INTERNAL PHOTOS OF THE EUT

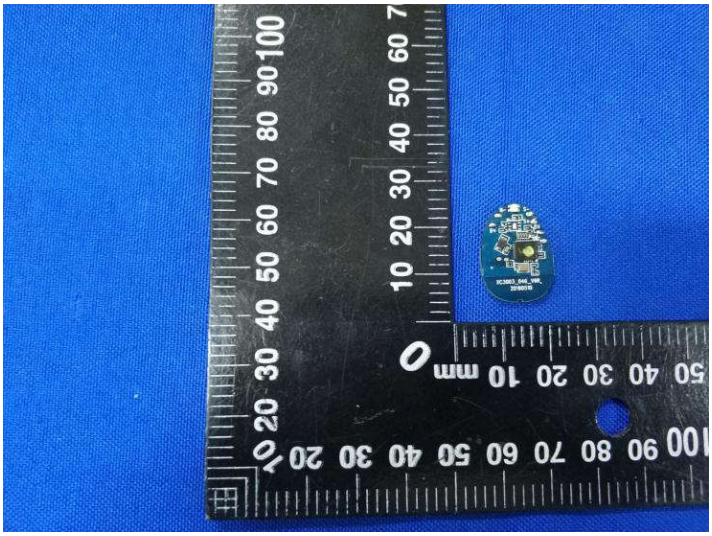
6.1. External photos of the EUT

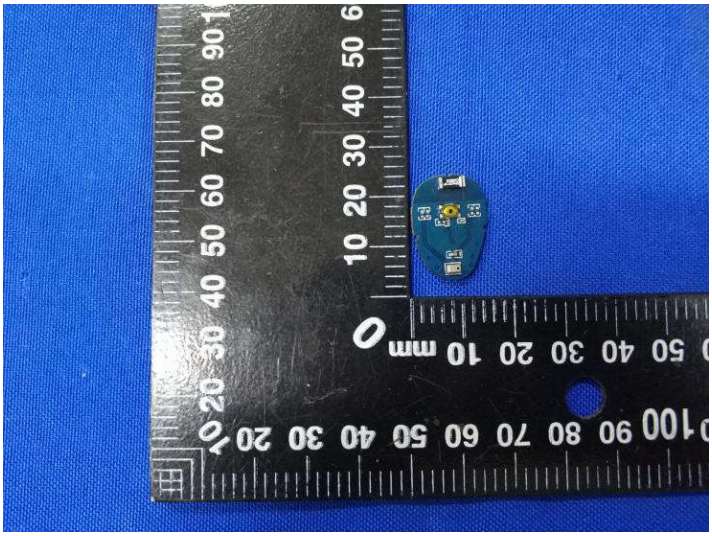
6.2. Internal photos of the EUT

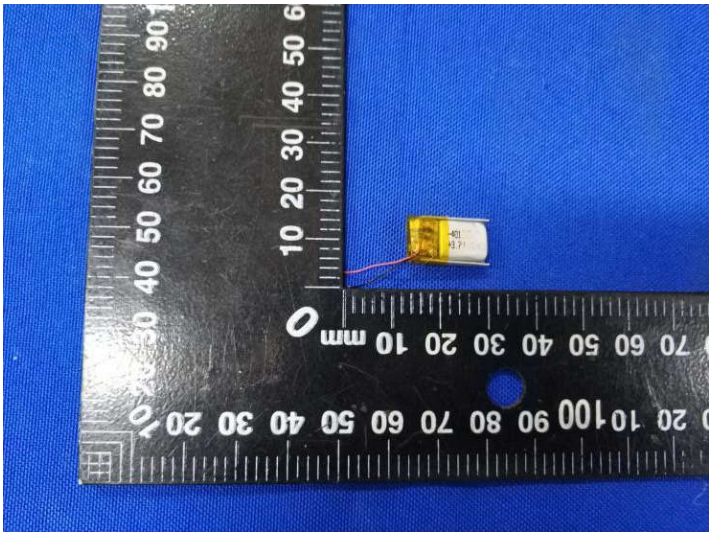












.....End of Report.....