TEST REPORT

Product Name	:	**Bluetooth Speaker**
Model Number	:	**SPK-2N1-FD**
FCC ID	:	**2AHQL-SPK-2N1-FD**

Prepared for	:	Li Ang Industrial Co., Limited
Address	:	4/F, Building 7, Lijincheng Industrial Park, Gongye Road, Longhua District, Shenzhen, China
Prepared by	:	EMTEK (SHENZHEN) CO., LTD.
Address	:	Building 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China Tel: (0755) 26954280 Fax: (0755) 26954282

Report Number	:	ES200508015W
Date(s) of Tests	:	May 08, 2020 to May 18, 2020
Date of issue	:	May 18, 2020

VERIFICATION OF COMPLIANCE

Applicant:	Li Ang Industrial Co., Limited 4/F, Building 7, Lijincheng Industrial Park, Gongye Road, Longhua District, Shenzhen, China
Manufacturer:	DONGGUAN YUNLONG ELECTRONICS CO., LTD 3/F,BUILDING A, FENGHUA INDUSTRIAL AREA NO.36, GONG'AO 1ST RD, XINIUPO, DALANG, DONGGUAN, GUANGDONG, CHINA
Product Description:	Bluetooth Speaker
Trade Mark:	N/A
Model Number:	SPK-2N1-FD

We hereby certify that:

The above equipment was tested by EMTEK(SHENZHEN) CO., LTD. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10-2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15.247(2018).

Date of Test : May 08, 2020 to May 18, 2020

Prepared by : Loren Luo

Loren Luo /Editor

Reviewer : Tim Dong

Tim Dong /Supervisor

Approved & Authorized Signer :

Lisa Wang /Manager

Modified Information

Version	Summary	Revision Date	Report No.
Ver.1.0	Original Report	/	ES200508015W

Table of Contents

1. GENERAL INFORMATION

1.1 Product Description

Characteristics	Description
Product Name	Bluetooth Speaker
Model number	SPK-2N1-FD
Test Voltage	DC 5V from adapter, DC 3.7V Battery
Kind of Device	Bluetooth Ver.5.0
Modulation	GFSK, π/4-DQPSK
Operating Frequency Range	2402-2480MHz
Number of Channels	79
Transmit Power Max(PK)	0.45dBm(0.001109W)
Antenna Type	PCB antenna
Antenna Gain	-0.58dBi

1.2 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10-2013. Radiated testing was performed at an antenna to EUT distance 3 meters.

1.3 Test Facility

Site Description

EMC Lab. : Accredited by CNAS, 2016.10.24
The certificate is valid until 2022.10.28
The Laboratory has been assessed and proved to be in compliance with CNAS-CL01:2006 (identical to ISO/IEC 17025:2005)
The Certificate Registration Number is L2291.

Accredited by TUV Rheinland Shenzhen 2018.3.30
The Laboratory has been assessed according to the requirements ISO/IEC 17025.

Accredited by FCC, August 06, 2018
The certificate is valid until August 07, 2020
Designation Number: CN1204
Test Firm Registration Number: 882943

Accredited by Industry Canada, November 09, 2018
The Conformity Assessment Body Identifier is CN0008

Name of Firm : EMTEK(SHENZHEN) CO., LTD.

Site Location : Building 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China

2. System Test Configuration

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The Transmitter was operated in the normal operating mode. The Tx frequency was fixed which was for the purpose of the measurements.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak and average detector mode.

2.3.2 Radiated Emissions

Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of EUT was fixed in a particular direction according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013.

2.4 Configuration of Tested System

Fig. 2-1 Configuration of Tested System

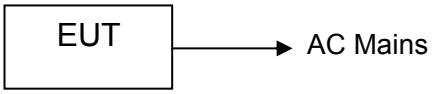


Table 2-1 Equipment Used in Tested System

Item	Equipment	Trademark	Model No.	FCC ID	Note
1.	Bluetooth Speaker	N/A	SPK-2N1-FD	2AHQL-SPK-2N1-FD	***EUT***

Note:

(1) Unless otherwise denoted as EUT in 『Remark』 column , device(s) used in tested system is a support equipment.

3. Summary of Test Results

FCC Rules	Description Of Test	Result
§15.207	AC Power Conducted Emission	Compliant
§15.247(d),§15.209	Radiated Emission	Compliant
§15.247(a)(1)	Channel Separation test	Compliant
§15.247(a)(1)	20dB Bandwidth	Compliant
§15.247(a)(1)(iii)	Quantity of Hopping Channel	Compliant
§15.247(a)(1)(iii)	Time of Occupancy(Dwell Time)	Compliant
§15.247(b)	Max Peak output Power test	Compliant
§15.247(d)	Band edge test	Compliant
§15.203	Antenna Requirement	Compliant

4. Description of test modes

The EUT has been tested under its typical operating condition and fully-charged battery for EUT tested alone. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst case data were reported.

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

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

Channel	Frequency(MHz)
1	2402
40	2441
79	2480

5. TEST SYSTEM UNCERTAINTY

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Radio Frequency	±1x10^-5
Maximum Peak Output Power Test	±1.0dB
Conducted Emissions Test	±2.0dB
Radiated Emission Test	±2.0dB
Power Density	±2.0dB
Occupied Bandwidth Test	±1.0dB
Band Edge Test	±3dB
All emission, radiated	±3dB
Antenna Port Emission	±3dB
Temperature	±0.5℃
Humidity	±3%

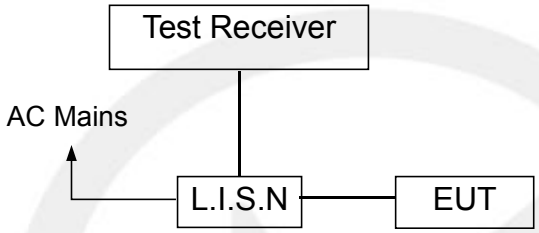
Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95%

6. Conducted Emissions Test

6.1 Measurement Procedure:

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

6.2 Test SET-UP (Block Diagram of Configuration)



6.3 Measurement Equipment Used:

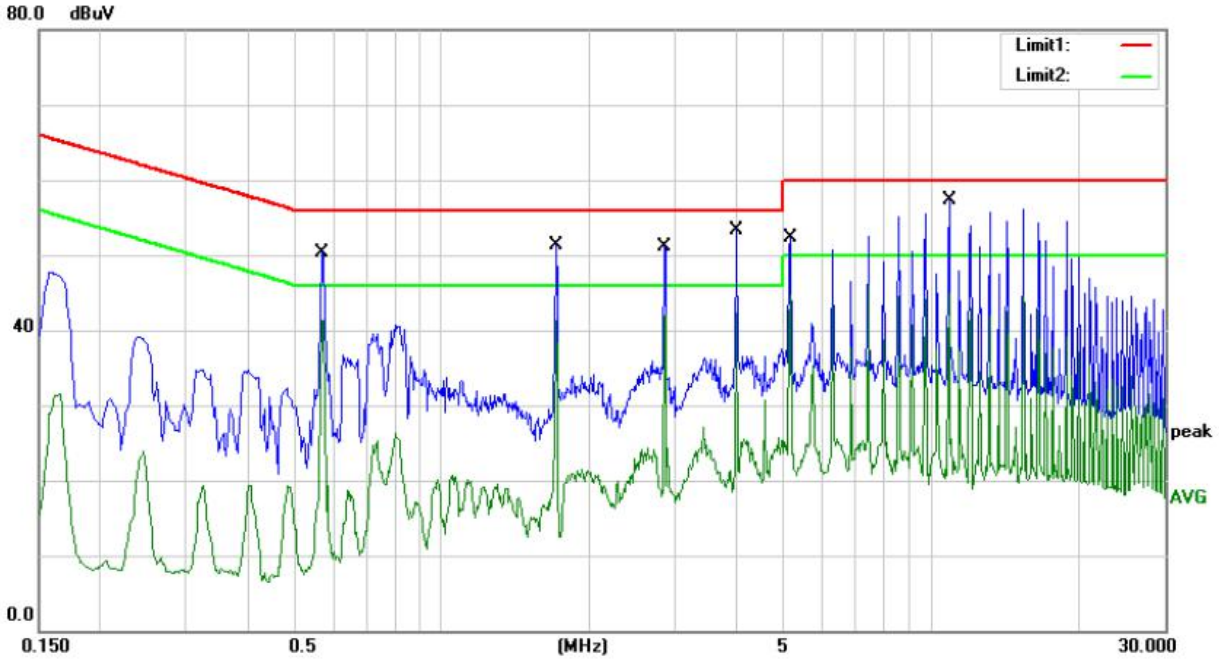
Conducted Emission Test Site						
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**Characteristics**	**Last Cal.**	**Due date**
Test Receiver	Rohde & Schwarz	ESCS30	100018	9kHz~3GHz	05/23/2019	05/22/2020
L.I.S.N	Rohde & Schwarz	ENV216	100017	9KHz-300MHz	05/23/2019	05/22/2020
RF Switching Unit	CDS	RSU-M2	38401	9KHz-300MHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	9kHz~3GHz	05/23/2019	05/22/2020

6.4 Measurement Result:

Operation Mode:	TX	Test Date :	May 15, 2020
Frequency Range:	0.15MHz~30MHz	Temperature :	28℃
Test Result:	PASS	Humidity :	65 %
Test By:	Loren		

Pass.
Conducted emission at both AC 120V &AC 240V, and emission at AC 120V represents the worst case. All the modulation modes were tested the data of the worst mode (GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Please refer to the following data.



Site site #1 Phase: N Temperature: 25

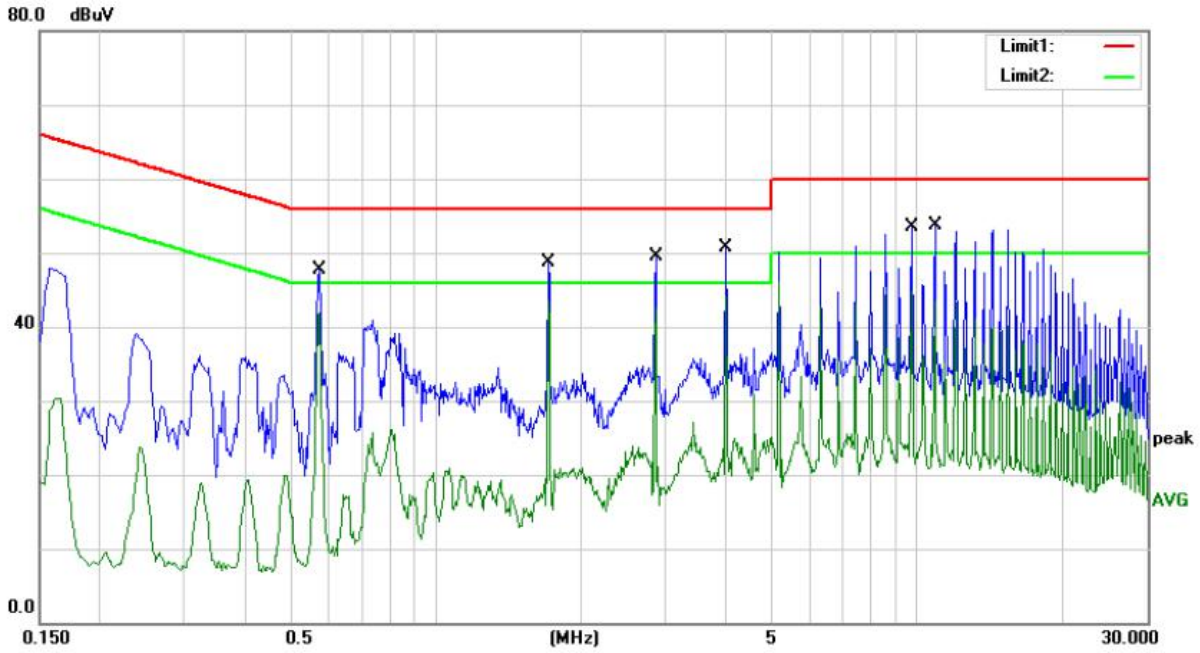
Limit: FCC PART 15.247_QP (CE) Power: AC 120V/60Hz Humidity: 55 %

Mode: BT TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.5700	40.13	10.18	50.31	56.00	-5.69	QP	
2		0.5700	31.06	10.18	41.24	46.00	-4.76	AVG	
3		1.7140	41.12	10.18	51.30	56.00	-4.70	QP	
4		1.7140	31.04	10.18	41.22	46.00	-4.78	AVG	
5		2.8540	40.95	10.18	51.13	56.00	-4.87	QP	
6		2.8540	31.73	10.18	41.91	46.00	-4.09	AVG	
7		3.9980	42.03	10.18	52.21	56.00	-3.79	QP	
8		3.9980	32.12	10.18	42.30	46.00	-3.70	AVG	
9		5.1420	42.21	10.18	52.39	60.00	-7.61	QP	
10		5.1420	34.46	10.18	44.64	50.00	-5.36	AVG	
11	*	10.8540	47.08	10.22	57.30	60.00	-2.70	QP	
12		10.8540	34.63	10.22	44.85	50.00	-5.15	AVG	

*:Maximum data x:Over limit !:over margin Comment: Factor build in receiver. Operator: Jason



Site site #1 Phase: L1 Temperature: 25

Limit: FCC PART 15.247_QP (CE) Power: AC 120V/60Hz Humidity: 55 %

Mode: BT TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.5740	37.45	10.18	47.63	56.00	-8.37	QP	
2		0.5740	31.76	10.18	41.94	46.00	-4.06	AVG	
3		1.7140	38.43	10.18	48.61	56.00	-7.39	QP	
4		1.7140	32.24	10.18	42.42	46.00	-3.58	AVG	
5		2.8580	39.33	10.18	49.51	56.00	-6.49	QP	
6	*	2.8580	32.28	10.18	42.46	46.00	-3.54	AVG	
7		4.0020	40.48	10.18	50.66	56.00	-5.34	QP	
8		4.0020	31.91	10.18	42.09	46.00	-3.91	AVG	
9		9.7180	43.37	10.21	53.58	60.00	-6.42	QP	
10		9.7180	34.51	10.21	44.72	50.00	-5.28	AVG	
11		10.8620	43.56	10.22	53.78	60.00	-6.22	QP	
12		10.8620	33.20	10.22	43.42	50.00	-6.58	AVG	

*:Maximum data x:Over limit !:over margin Comment: Factor build in receiver. Operator: Jason

6.5 Conducted Measurement Photos:

7. Radiated Emission Test

7.1 Measurement Procedure

1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.
2. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.
3. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (From 1m to 4m) and turntable (from 0 degree to 360 degree) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Final measurement (Above 1GHz): The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 degree to 360 degree in order to have the antenna inside the cone of radiation.
7. Test Procedure of measurement (For Above 1GHz):
   1) Monitor the frequency range at horizontal polarization and move the antenna over all sides of the EUT(if necessary move the EUT to another orthogonal axis).
   2) Change the antenna polarization and repeat 1) with vertical polarization.
   3) Make a hardcopy of the spectrum.
   4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
   5) Change the analyser mode to Clear/ Write and found the cone of emission.
   6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3m and the antenna will be still inside the cone of emission.
   7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarization and azimuth and the peak and average detector, which causes the maximum emission.
   8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

Use the following spectrum analyzer settings:

When spectrum scanned from 30MHz to 1GHz setting resolution bandwidth 120KHz and video bandwidth 300KHz:

EMI Test Receiver	Setting
Attenuation	Auto
RB	120KHz
VB	300KHz
Detector	QP
Trace	Max hold

When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 3MHz:

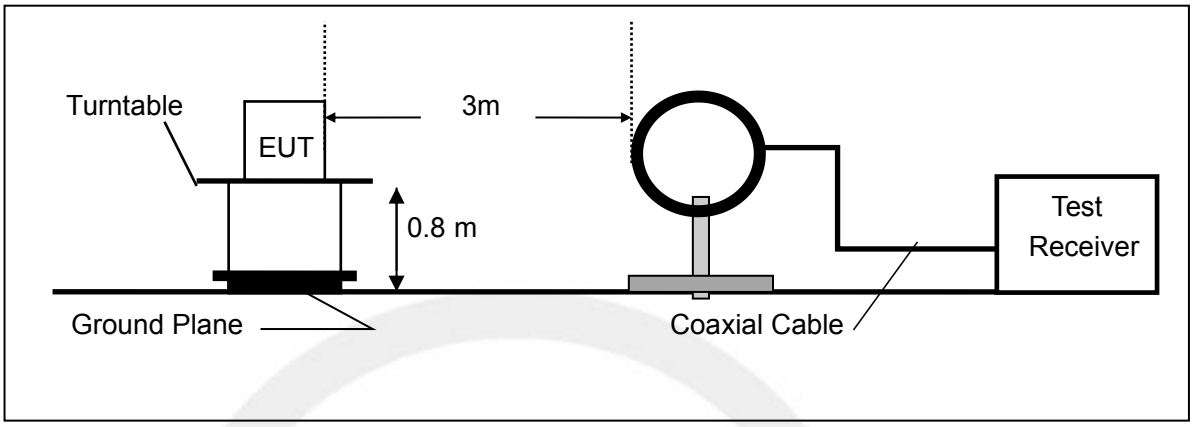
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	3MHz
Detector	Peak
Trace	Max hold

When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 10Hz:

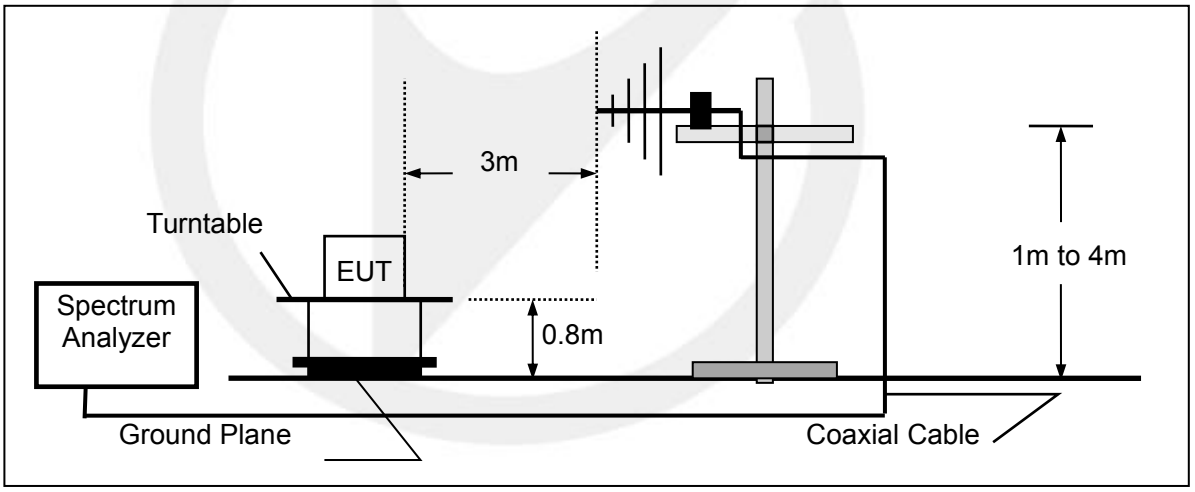
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Average
Trace	Max hold

7.2 Test SET-UP (Block Diagram of Configuration)

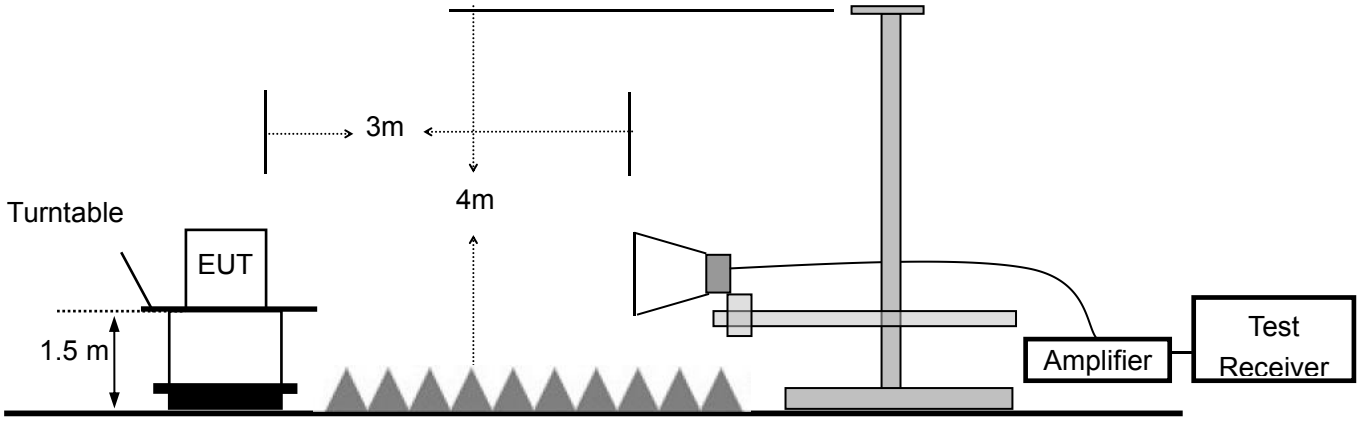
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



7.3 Measurement Equipment Used:

Item	Equipment	Manufacturer	Model No.	Serial No.	Characteristics	Last Cal.	Cal. Interval
1.	Test Receiver	Rohde & Schwarz	ESCI	1166.5950.03	9KHz-3GHz	05/23/2019	1 Year
2.	Loop Antenna	Schwarzbeck	FMZB 1519	012	9 KHz -30MHz	05/23/2019	1 Year
3.	Bilog Antenna	Schwarzbeck	VULB9163	000141	25MHz-2GHz	05/23/2019	1 Year
4.	Power Amplifier	CDS	RSU-M352	818	1MHz-1GHz	05/23/2019	1 Year
5.	Power Amplifier	HP	8447F	OPT H64	1GHz-26.5GHz	05/23/2019	1 Year
6.	Color Monitor	SUNSPO	SP-140A	N/A	--	05/23/2019	1 Year
7.	Single Line Filter	JIANLI	XL-3	N/A	--	05/23/2019	1 Year
8.	Single Phase Power Line Filter	JIANLI	DL-2X100B	N/A	--	05/23/2019	1 Year
9.	3 Phase Power Line Filter	JIANLI	DL-4X100B	N/A	--	05/23/2019	1 Year
10.	DC Power Filter	JIANLI	DL-2X50B	N/A	--	05/23/2019	1 Year
11.	Cable	Schwarzbeck	PLF-100	549489	9KHz-3GHz	05/23/2019	1 Year
12.	Cable	Rosenberger	CIL02	A0783566	9KHz-3GHz	05/23/2019	1 Year
13.	Cable	Rosenberger	RG 233/U	525178	9KHz-3GHz	05/23/2019	1 Year
14.	Signal Analyzer	Rohde & Schwarz	FSV30	103040	9KHz-40GHz	05/23/2019	1 Year
15.	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	1GHz-18GHz	05/23/2019	1 Year
16.	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	14GHz -26.5GHz	05/23/2019	1 Year
17.	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	05/23/2019	1 Year
18.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year
19.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year
20.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year

7.4 Radiated Emission Limit

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table 15.209(a):

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

15.205 Restricted bands of operation

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])

Remark : 1. Emission level in dBuV/m=20 log (uV/m)
2. Measurement was performed at an antenna to the closed point of EUT distance of meters.
3. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of ξ 15.205, and the emissions located in restricted bands also comply with 15.209 limit.

7.5 Measurement Result

Operation Mode:	TX	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	28℃
Test Result:	PASS	Humidity :	65 %
Measured Distance:	3m		

Below 30MHz:

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

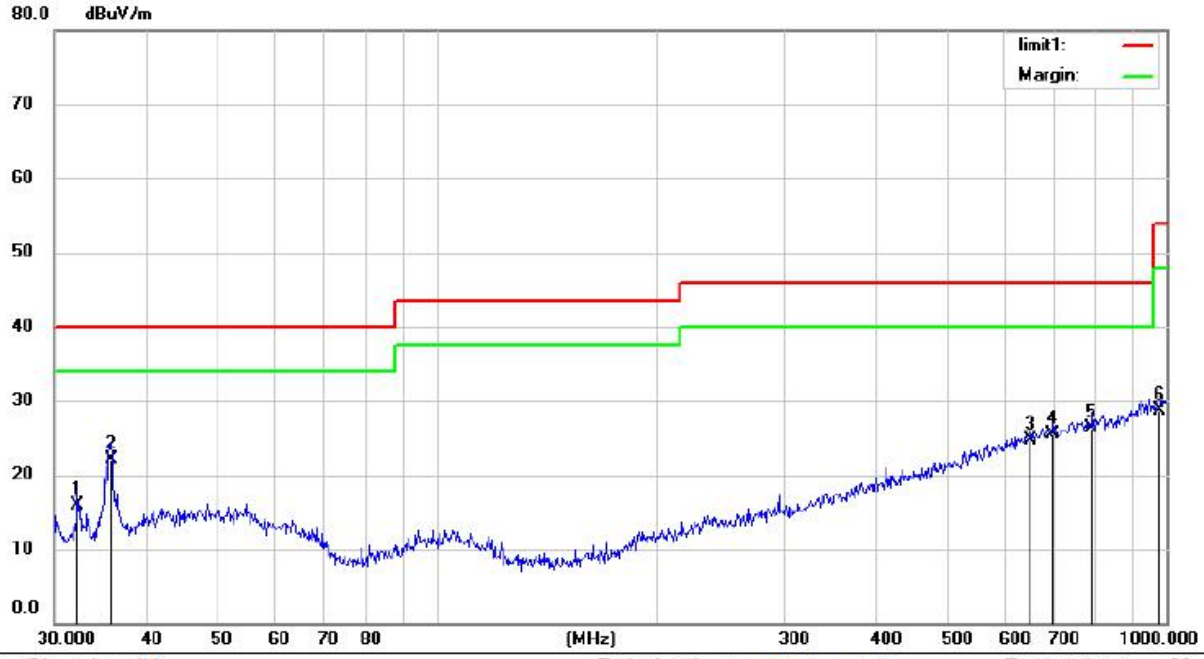
Note: The low frequency, which started from 9KHz-30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

Below 1000MHz:

Pass.

All modulation modes have been tested, the worst mode is (GFSK TX 2402MHz), the data is recorded on the following page, other modulation modes do not exceed this limit.

Please refer to the following data.



Site Chamber #1 Polarization: *Horizontal* Temperature: 26

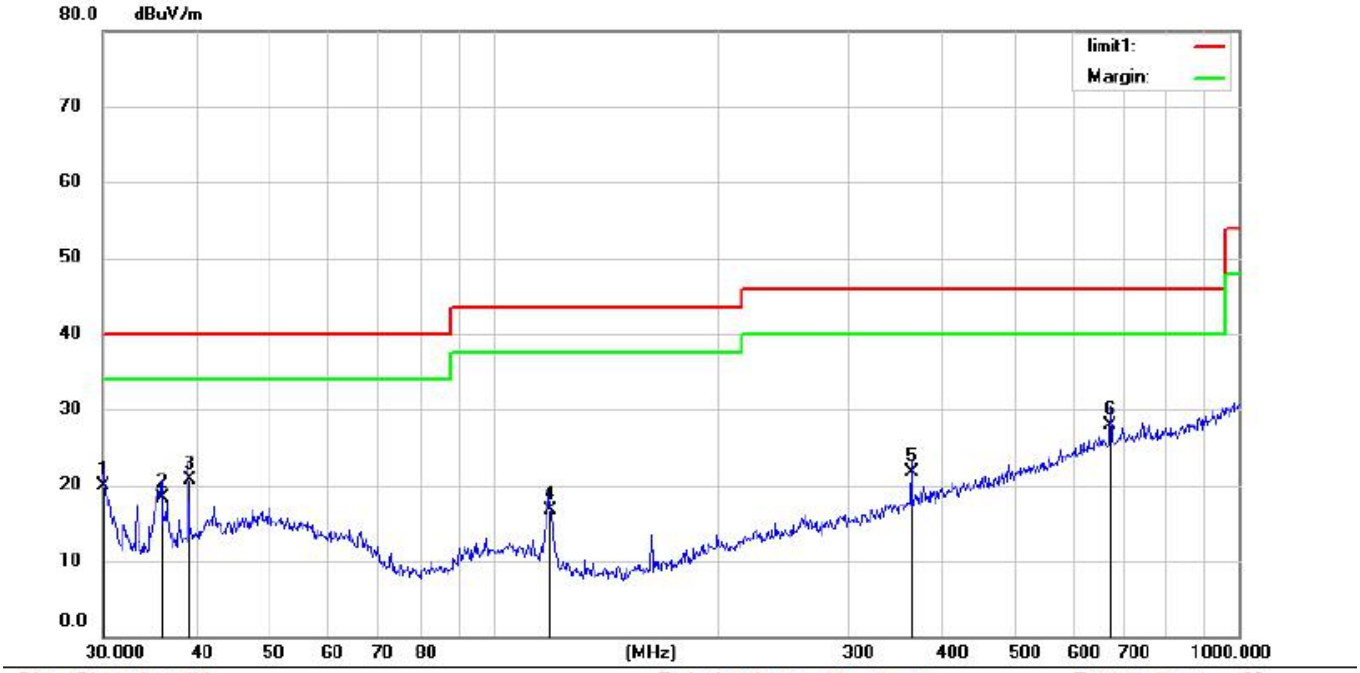
Limit: (RE)FCC PART 15 B 3m Power: AC 120V/60Hz Humidity: 55 %

Mode:BT TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		32.2925	34.86	-19.00	15.86	40.00	-24.14	QP			
2	*	35.8746	40.36	-18.24	22.12	40.00	-17.88	QP			
3		651.9417	29.80	-5.14	24.66	46.00	-21.34	QP			
4		699.3045	29.74	-4.22	25.52	46.00	-20.48	QP			
5		790.6187	29.63	-3.40	26.23	46.00	-19.77	QP			
6		979.1804	28.74	-0.02	28.72	54.00	-25.28	QP			

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Vertical* Temperature: 26

Limit: (RE)FCC PART 15 B 3m Power: AC 120V/60Hz Humidity: 55 %

Mode:BT TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		30.0000	38.65	-18.76	19.89	40.00	-20.11	QP			
2		36.0007	36.47	-18.20	18.27	40.00	-21.73	QP			
3		39.0245	37.80	-17.02	20.78	40.00	-19.22	QP			
4		119.0180	36.43	-19.79	16.64	43.50	-26.86	QP			
5		364.2595	33.60	-11.98	21.62	46.00	-24.38	QP			
6	*	672.8444	32.80	-4.81	27.99	46.00	-18.01	QP			

*:Maximum data x:Over limit !:over margin Operator: Lian

Above 1000MHz~10th Harmonics:

All modulation modes have been tested, the worst mode is (GFSK), the data is recorded on the following page, other modulation modes do not exceed this limit.Please refer to the following data.

Operation Mode: GFSK (CH1: 2402MHz) Test Date : May 15, 2020

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m		Margin(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4804	V	92.17	71.17	-32.3	59.87	38.87	74	54	-14.13	-15.13
7206	V	93.19	76.39	-37.2	55.99	39.19	74	54	-18.01	-14.81
9608	V	97.81	71.53	-39.8	58.01	31.73	74	54	-15.99	-22.27
12010	V	91.13	72.34	-40.5	50.63	31.84	74	54	-23.37	-22.16
14412	V	93.53	73.48	-41.7	51.83	31.78	74	54	-22.17	-22.22
16814	V	98.53	76.95	-40.0	58.53	36.95	74	54	-15.47	-17.05
4804	H	98.97	75.03	-31.6	67.37	43.43	74	54	-6.63	-10.57
7206	H	98.54	76.22	-35.5	63.04	40.72	74	54	-10.96	-13.28
9608	H	92.05	71.49	-38.3	53.75	33.19	74	54	-20.25	-20.81
12010	H	98.93	74.25	-39.0	59.93	35.25	74	54	-14.07	-18.75
14412	H	98.80	70.60	-42.0	56.80	28.60	74	54	-17.20	-25.40
16814	H	94.10	72.12	-39.3	54.80	32.82	74	54	-19.20	-21.18

Operation Mode: GFSK (CH40: 2441MHz) Test Date : May 15, 2020

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4882	V	92.13	76.92	-32.3	59.83	44.62	74	54	-14.17	-9.38
7323	V	97.35	73.45	-37.2	60.15	36.25	74	54	-13.85	-17.75
9764	V	96.97	74.76	-39.8	57.17	34.96	74	54	-16.83	-19.04
12205	V	97.62	74.67	-40.5	57.12	34.17	74	54	-16.88	-19.83
14646	V	96.73	74.07	-41.0	55.73	33.07	74	54	-18.27	-20.93
17087	V	96.69	74.75	-41.1	55.59	33.65	74	54	-18.41	-20.35
4882	H	95.89	74.15	-31.6	64.29	42.55	74	54	-9.71	-11.45
7323	H	95.42	72.75	-35.5	59.92	37.25	74	54	-14.08	-16.75
9764	H	98.85	76.92	-38.3	60.55	38.62	74	54	-13.45	-15.38
12205	H	93.92	70.33	-39.0	54.92	31.33	74	54	-19.08	-22.67
14646	H	92.36	71.84	-42.0	50.36	29.84	74	54	-23.64	-24.16
17087	H	95.16	74.24	-41.5	53.66	32.74	74	54	-20.34	-21.26

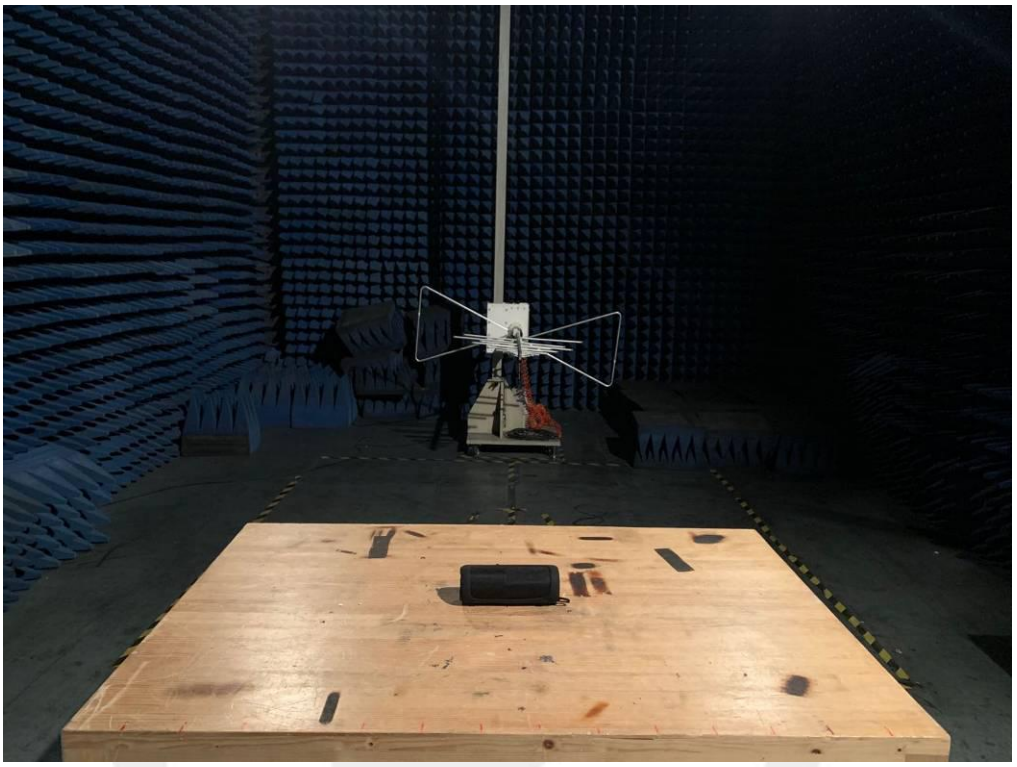
Operation Mode: GFSK (CH79: 2480MHz) Test Date : May 15, 2020

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4960	V	92.30	70.69	-32.3	60	38.39	74	54	-14.00	-15.61
7440	V	91.11	75.05	-37.2	53.91	37.85	74	54	-20.09	-16.15
9920	V	92.89	76.80	-39.8	53.09	37	74	54	-20.91	-17.00
12400	V	92.09	76.95	-40.5	51.59	36.45	74	54	-22.41	-17.55
14880	V	94.91	70.69	-41.0	53.91	29.69	74	54	-20.09	-24.31
17360	V	93.93	75.67	-41.1	52.83	34.57	74	54	-21.17	-19.43
4960	H	95.51	70.80	-31.6	63.91	39.2	74	54	-10.09	-14.80
7440	H	95.97	74.42	-35.5	60.47	38.92	74	54	-13.53	-15.08
9920	H	95.47	72.14	-38.3	57.17	33.84	74	54	-16.83	-20.16
12400	H	96.28	71.88	-39.0	57.28	32.88	74	54	-16.72	-21.12
14880	H	93.22	74.14	-42.0	51.22	32.14	74	54	-22.78	-21.86
17360	H	95.94	73.60	-41.5	54.44	32.1	74	54	-19.56	-21.90

Other harmonics emissions are lower than 20dB below the allowable limit.

Note: (1) All Readings are Peak Value and AV.
(2) Emission Level= Reading Level+ Probe Factor +Cable Loss.
(3) The average measurement was not performed when the peak measured data under the limit of average detection.
(4) Measuring frequencies from 1GHz to 25GHz.

7.5 Radiated Measurement Photos:

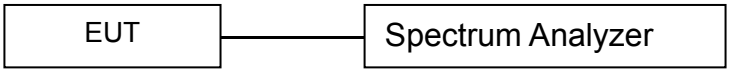


8. Channel Separation test

8.1 Measurement Procedure

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

8.2 Test SET-UP (Block Diagram of Configuration)



8.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

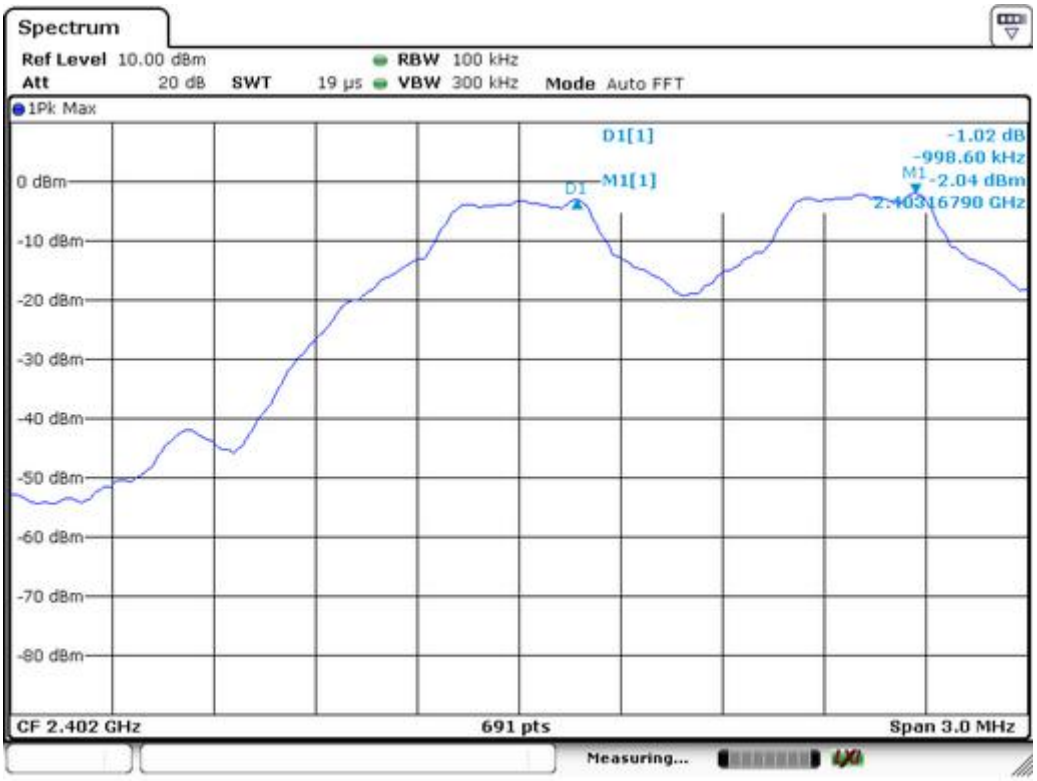
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

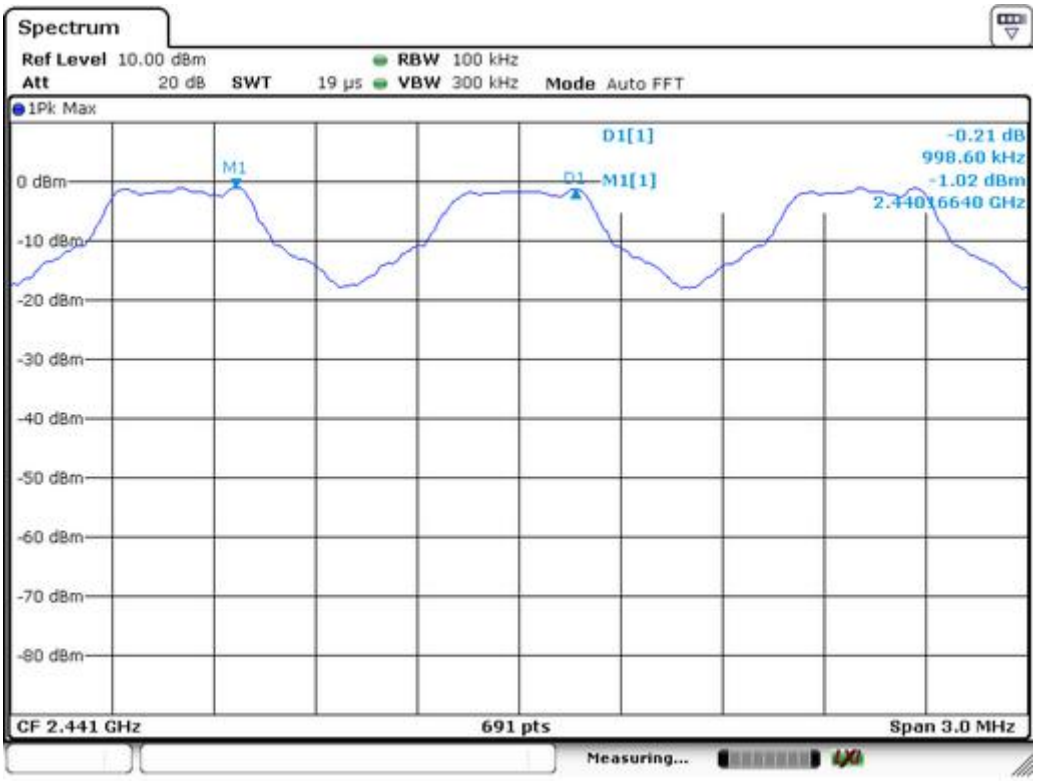
8.4 Measurement Results:

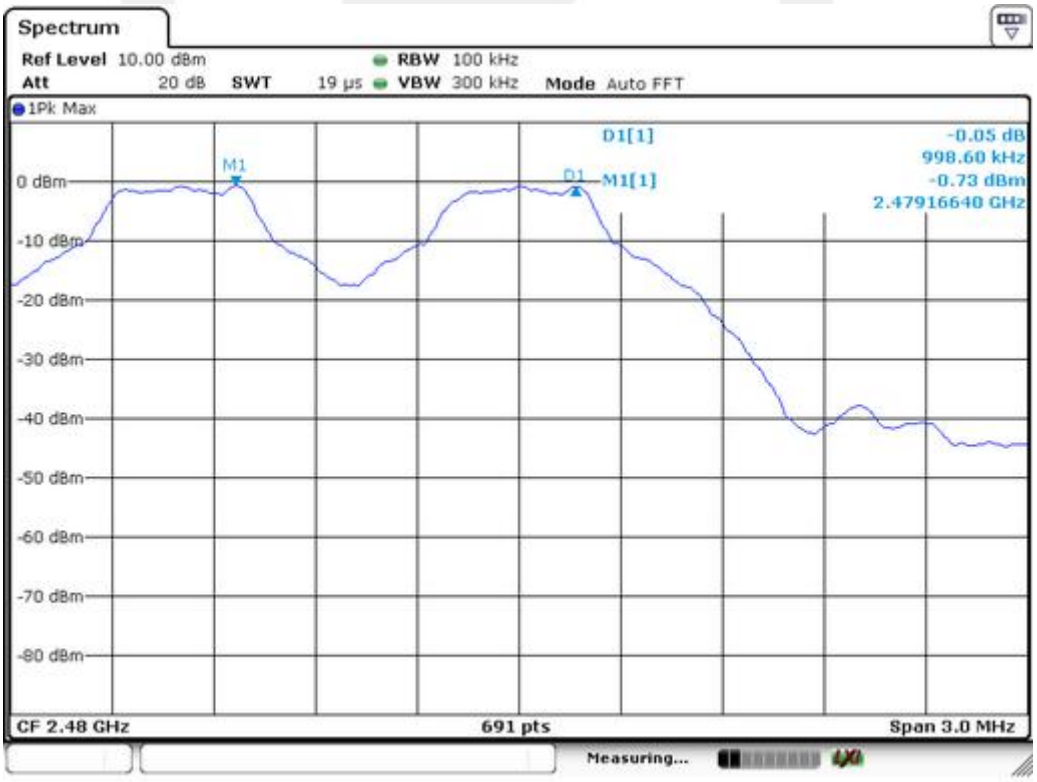
Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	998	>740
40	2441	998	>740
79	2480	998	>738

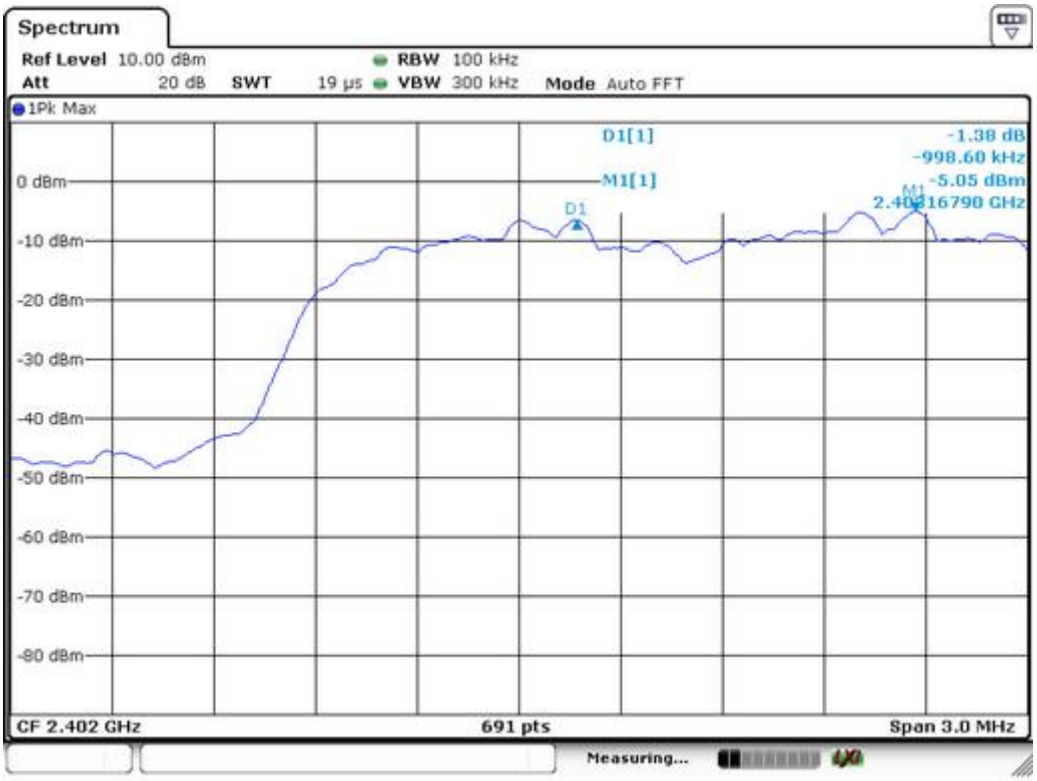


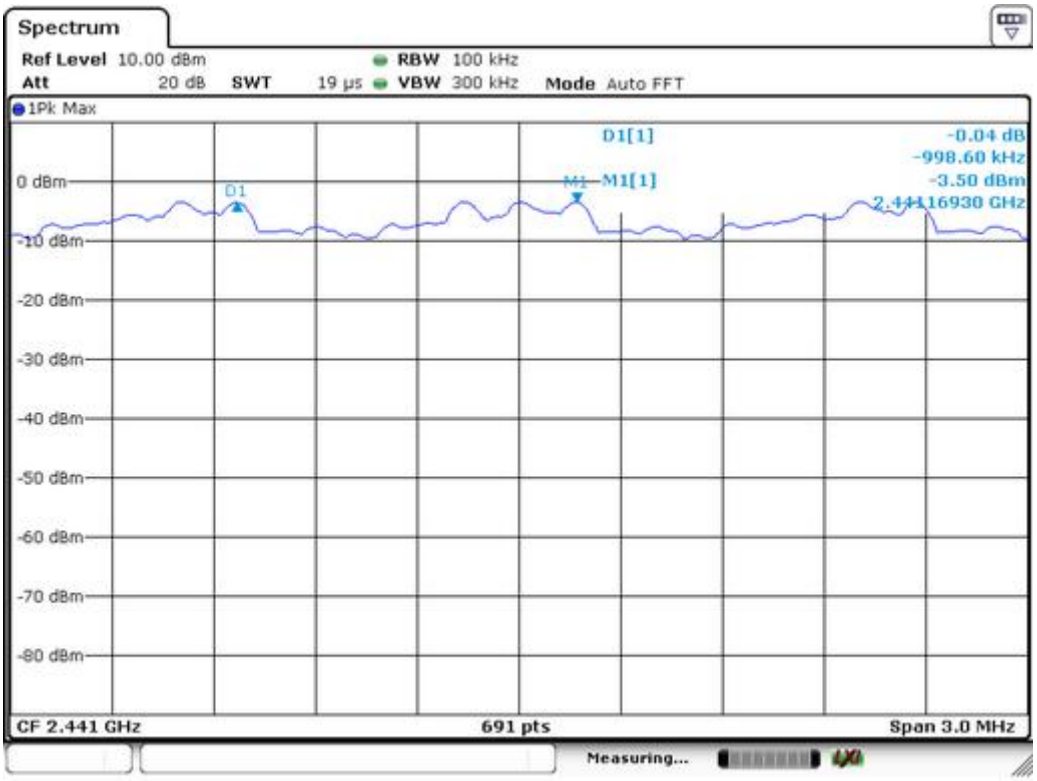

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1]
-0.21 dB
998.60 kHz
M1[1]
-1.02 dBm
2.44016640 GHz
M1
D1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
691 pts
Span 3.0 MHz
Measuring...

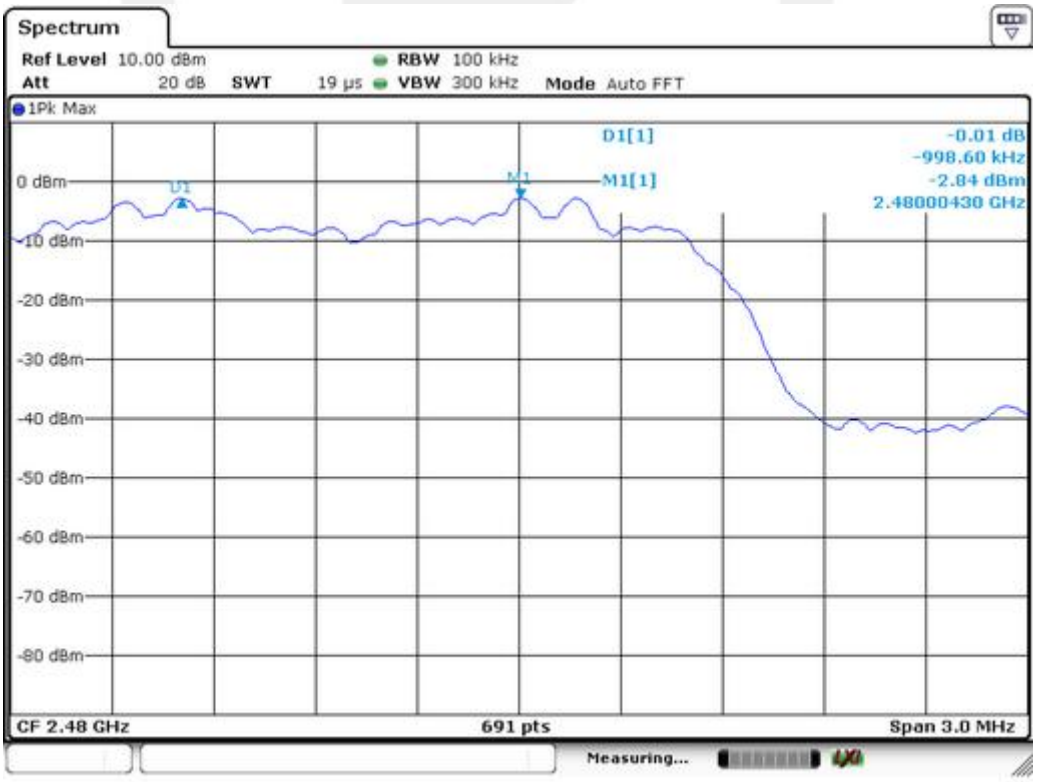

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1]
-0.05 dB
998.60 kHz
M1[1]
-0.73 dBm
2.47916640 GHz
M1
D1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
691 pts
Span 3.0 MHz
Measuring...

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	Π/4-DQPSK		

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	998	>911
40	2441	998	>911
79	2480	998	>914




Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -0.04 dB
-998.60 kHz
M1[1] -3.50 dBm
2.44116930 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
691 pts
Span 3.0 MHz
Measuring...

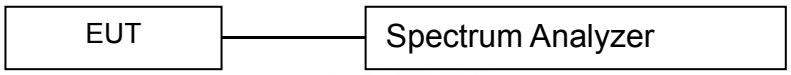

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -0.01 dB
-998.60 kHz
M1[1] -2.84 dBm
2.48000430 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
691 pts
Span 3.0 MHz
Measuring...

9. 20dB Bandwidth test

9.1 Measurement Procedure

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

9.2 Test SET-UP (Block Diagram of Configuration)



9.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

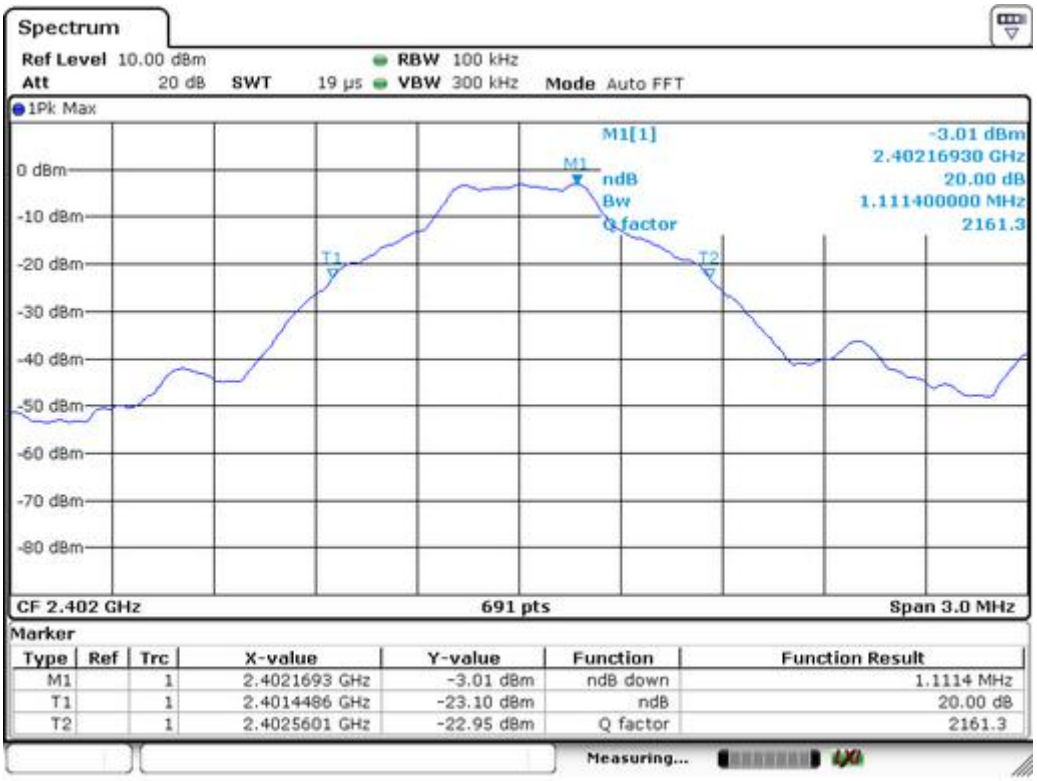
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

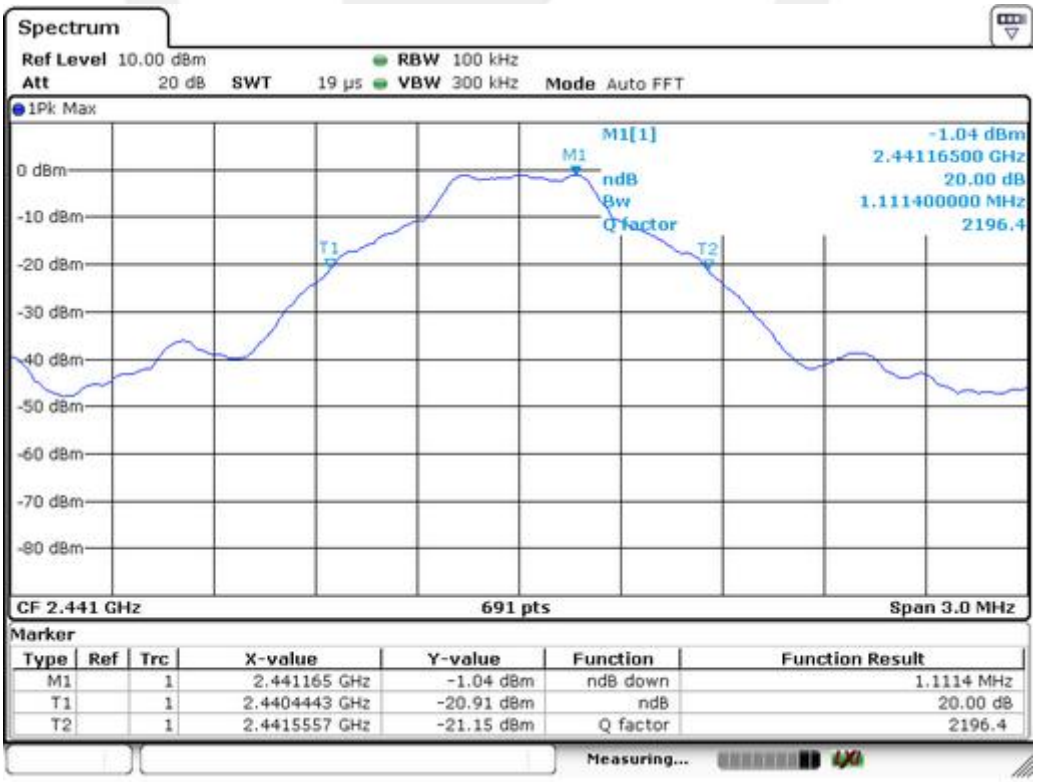
9.4 Measurement Results:

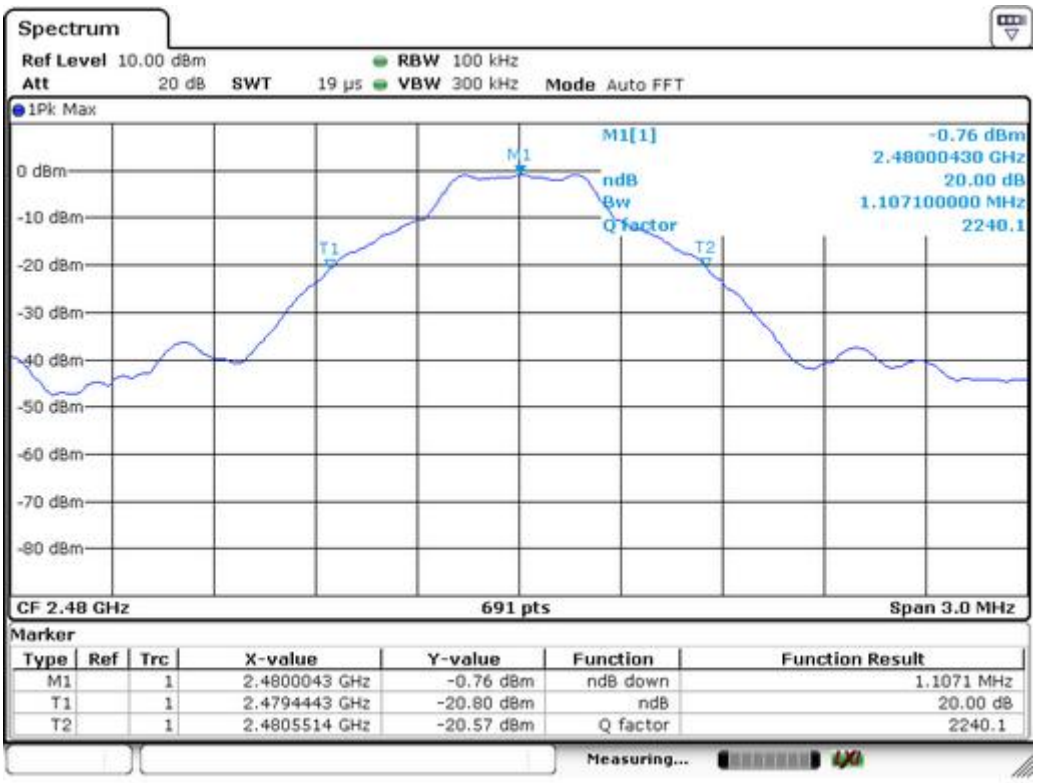
Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1111
40	2441	1111
79	2480	1107

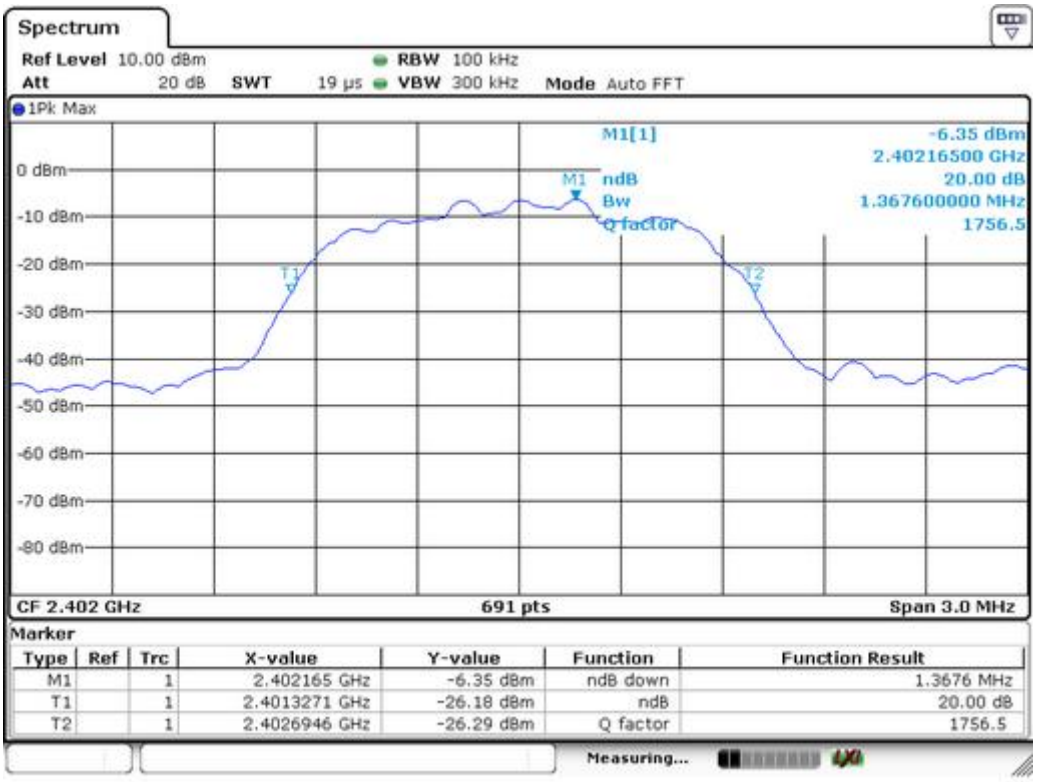

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-3.01 dBm
2.40216930 GHz
ndB 20.00 dB
Bw 1.111400000 MHz
Q factor 2161.3
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
T1
T2
CF 2.402 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4021693 GHz -3.01 dBm ndB down 1.1114 MHz
T1 1 2.4014486 GHz -23.10 dBm ndB 20.00 dB
T2 1 2.4025601 GHz -22.95 dBm Q factor 2161.3
Measuring...

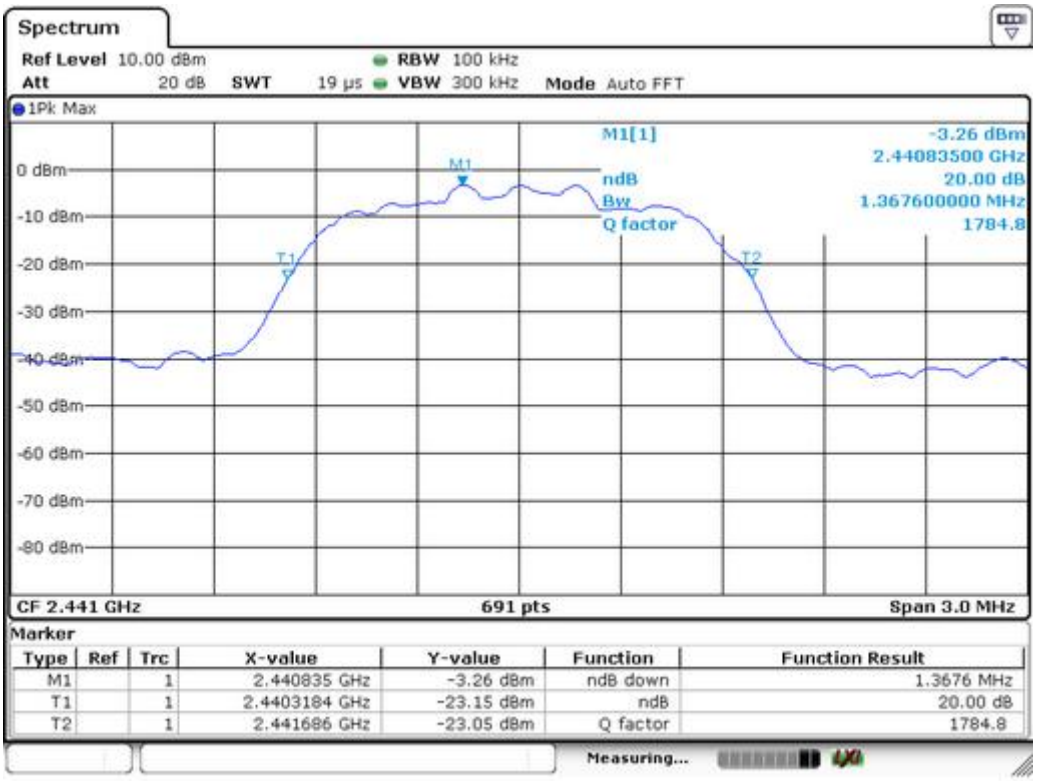

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-1.04 dBm
2.44116500 GHz
ndB 20.00 dB
Bw 1.111400000 MHz
Q factor 2196.4
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
T1
T2
CF 2.441 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.441165 GHz -1.04 dBm ndB down 1.1114 MHz
T1 1 2.4404443 GHz -20.91 dBm ndB 20.00 dB
T2 1 2.4415557 GHz -21.15 dBm Q factor 2196.4
Measuring...

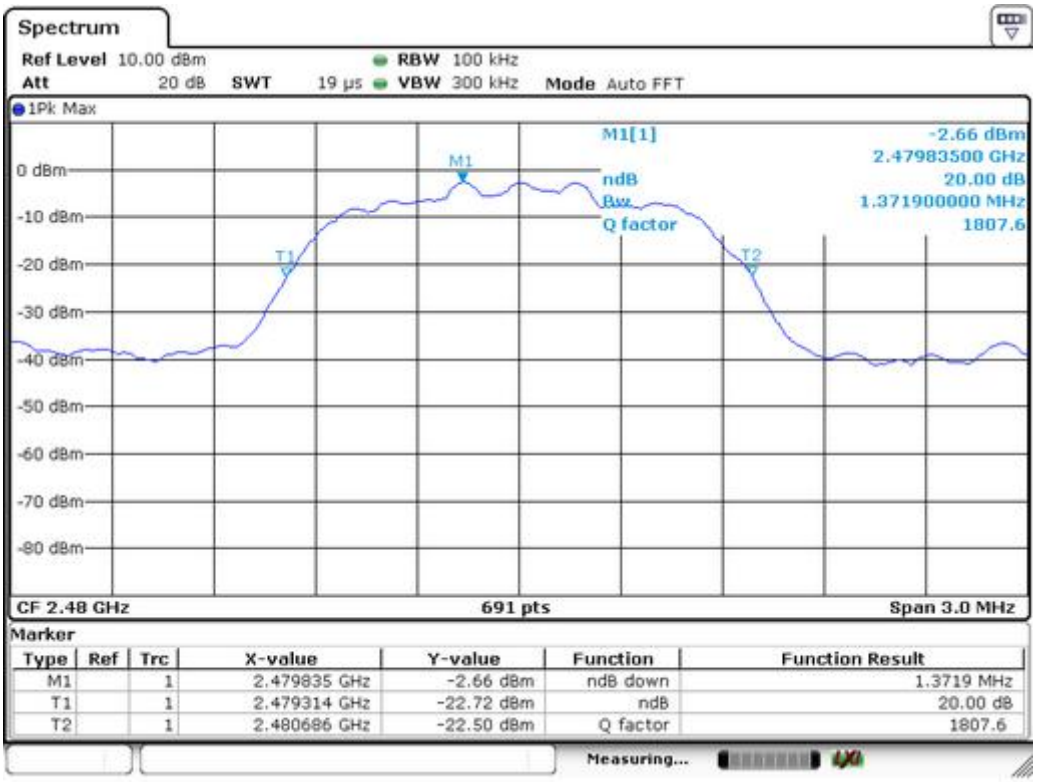

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-0.76 dBm
2.48000430 GHz
ndB 20.00 dB
Bw 1.107100000 MHz
Q factor 2240.1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
T1
T2
CF 2.48 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4800043 GHz -0.76 dBm ndB down 1.1071 MHz
T1 1 2.4794443 GHz -20.80 dBm ndB 20.00 dB
T2 1 2.4805514 GHz -20.57 dBm Q factor 2240.1
Measuring...

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	Π/4-DQPSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1367
40	2441	1367
79	2480	1371




Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-3.26 dBm
2.44083500 GHz
ndB 20.00 dB
Bw 1.367600000 MHz
Q factor 1784.8
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
T1
T2
CF 2.441 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.440835 GHz -3.26 dBm ndB down 1.3676 MHz
T1 1 2.4403184 GHz -23.15 dBm ndB 20.00 dB
T2 1 2.441686 GHz -23.05 dBm Q factor 1784.8
Measuring...

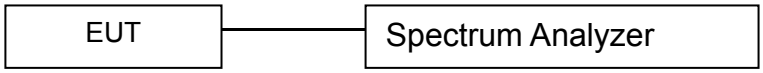

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 20 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-2.66 dBm
2.47983500 GHz
ndB 20.00 dB
Bw 1.371900000 MHz
Q factor 1807.6
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
T1
T2
CF 2.48 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479835 GHz -2.66 dBm ndB down 1.3719 MHz
T1 1 2.479314 GHz -22.72 dBm ndB 20.00 dB
T2 1 2.480686 GHz -22.50 dBm Q factor 1807.6
Measuring...

10. Quantity of Hopping Channel Test

10.1 Measurement Procedure

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

10.2 Test SET-UP (Block Diagram of Configuration)



10.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

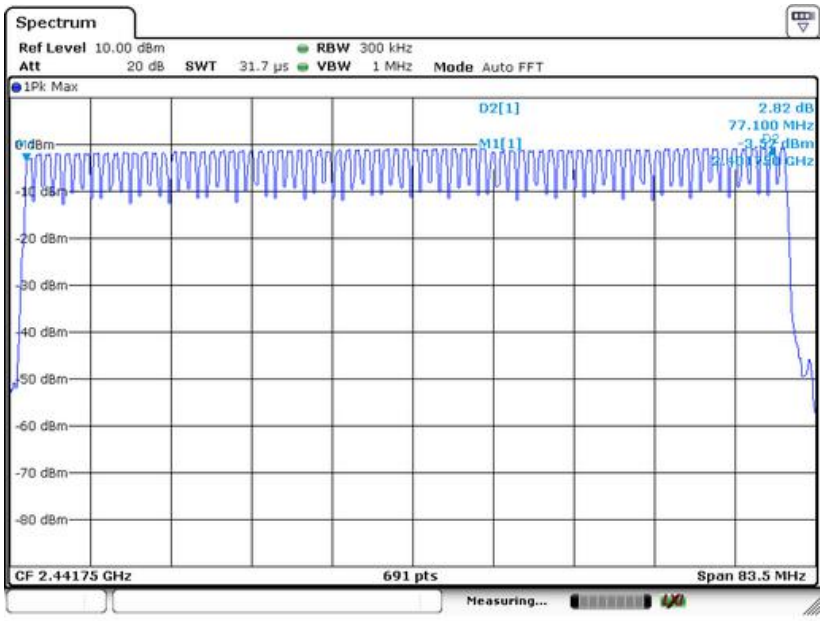
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

10.4 Measurement Results:

Refer to attached data chart.

Worst Test Mode	GFSK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %

Hopping Channel Frequency Range	Quantity of Hopping Channel	Quantity of Hopping Channel
2402-2480	79	＞15


Spectrum
Ref Level 10.00 dBm
RBW 300 kHz
Att 20 dB SWT 31.7 µs VBW 1 MHz Mode Auto FFT
1Pk Max
D2[1] 2.82 dB
77.100 MHz
M1[1]
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.44175 GHz
691 pts
Span 83.5 MHz
Measuring...

11. Time of Occupancy (Dwell Time) test

11.1 Test Description

The Equipment Under Test (EUT) was set up to perform the dwell time measurements. The EUT was connected to the spectrum analyzer via a short coax cable. The dwell time is calculated by:

Dwell time = time slot length * hop rate / number of hopping channels * 31.6s

with:
- hop rate = 1600 * 1/s for DH1 packets = 1600 s^{-1}
- hop rate = 1600/3 * 1/s for DH3 packets = 533.33 s^{-1}
- number of hopping channels = 79
- 31.6 s = 0.4 seconds multiplied by the number of hopping channels = 0.4 s * 79

The highest value of the dwell time is reported.

11.2 Test SET-UP (Block Diagram of Configuration)

11.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

11.4 Test Requirements / Limits

FCC Part 15, Subpart C, §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. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6seconds. Refer to attached data chart.

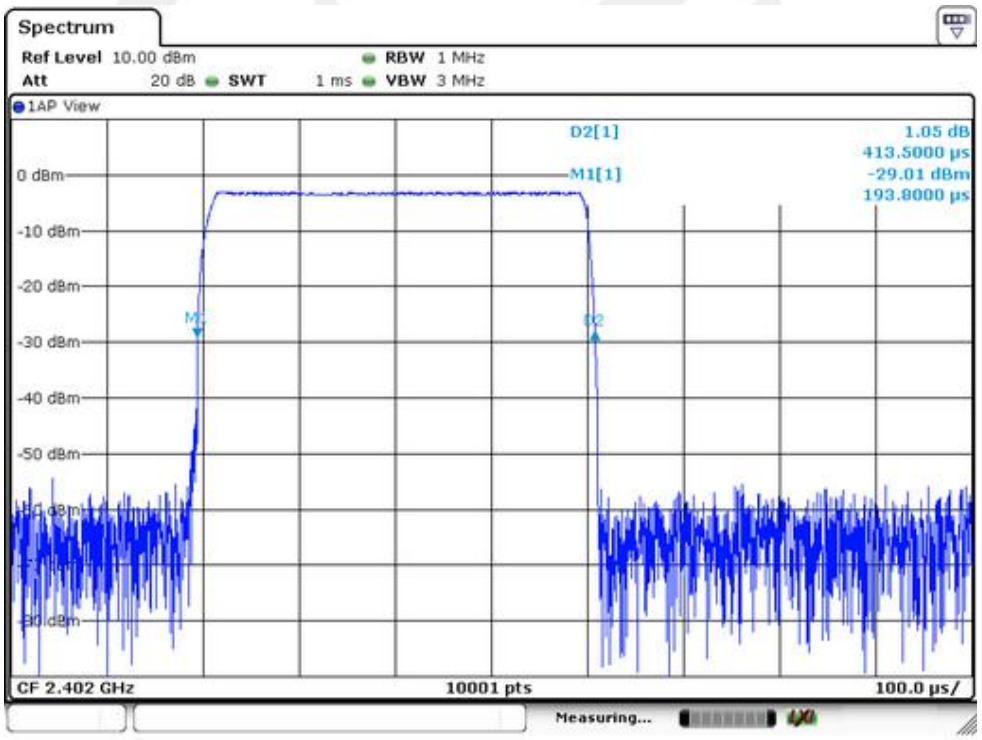
Modulation:	GFSK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %

11.5 Test result

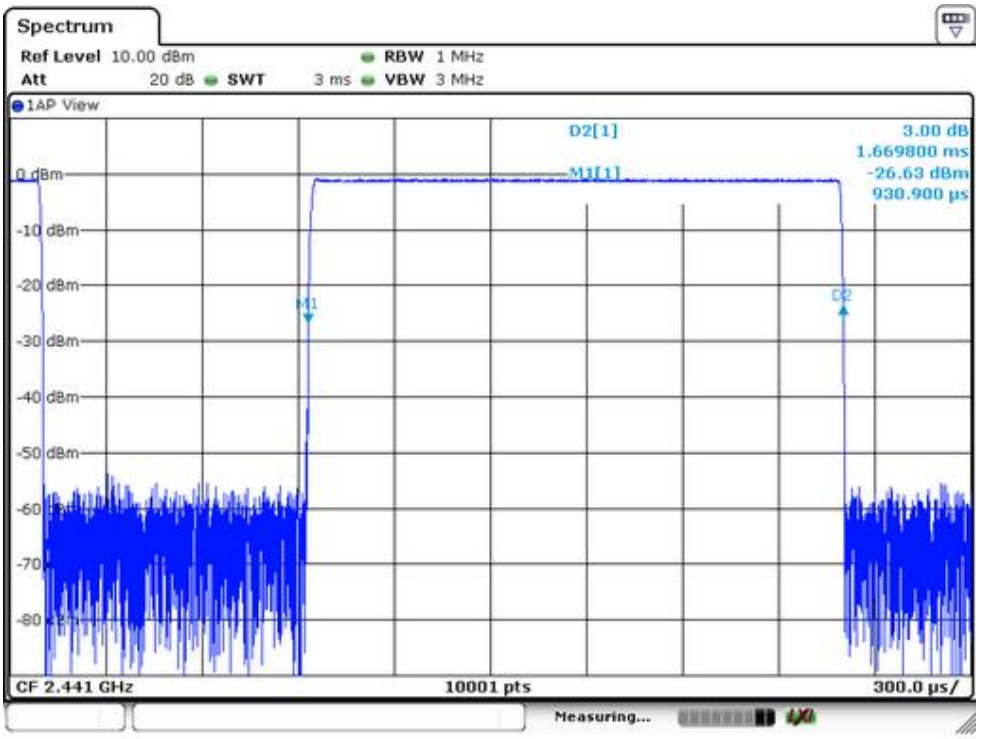
Mode	Number of transmission in a 31.6(79 Hopping*0.4)	Length of transmissions time(msec)	Result (msec)	Limit (msec)
DH1	1600/(2*79) x 31.6 = 320	0.413	131.20	400
DH3	1600/(4*79) x 31.6 =160	1.669	267.04	400
DH5	1600/(6*79) x 31.6 =106.67	2.916	311.04	400

Remark: The results of worst cased was recorded.

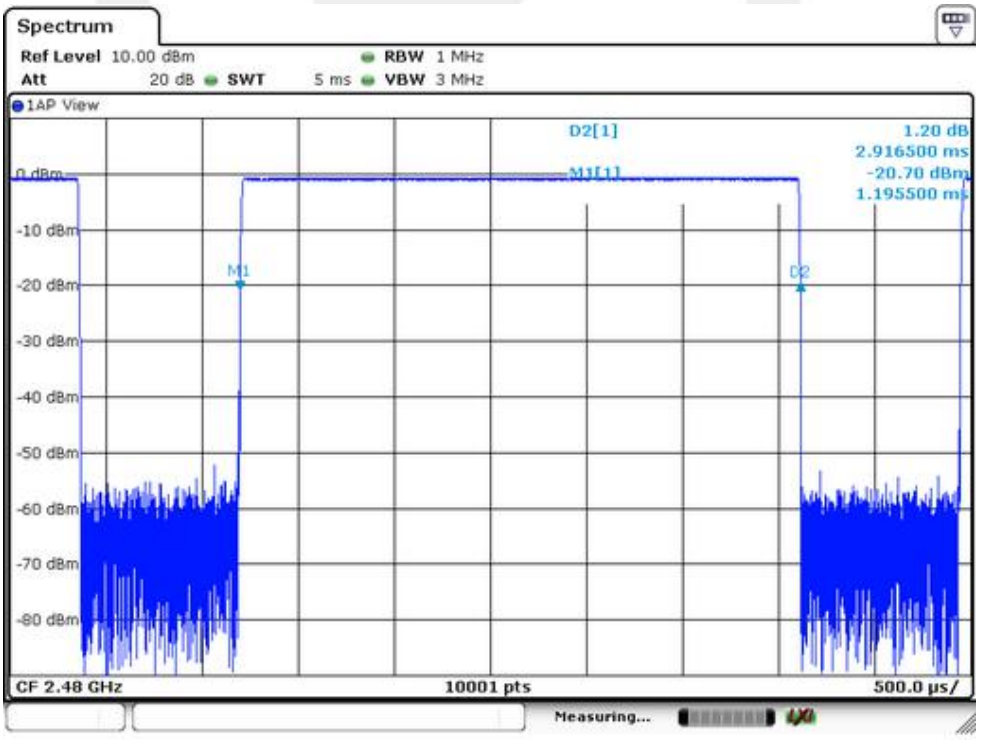
DH1:



DH3:


Spectrum
Ref Level 10.00 dBm
RBW 1 MHz
Att 20 dB SWT 3 ms VBW 3 MHz
1AP View
D2[1] 3.00 dB
1.669800 ms
M1[1] -26.63 dBm
930.900 µs
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
D2
CF 2.441 GHz
10001 pts
300.0 µs/
Measuring...

DH5:


Spectrum
Ref Level 10.00 dBm
RBW 1 MHz
Att 20 dB SWT 5 ms VBW 3 MHz
1AP View
D2[1] 1.20 dB
2.916500 ms
M1[1] -20.70 dBm
1.195500 ms
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
D2
CF 2.48 GHz
10001 pts
500.0 µs/
Measuring...

12. MAXIMUM PEAK OUTPUT POWER TEST

12.1 Measurement Procedure

a. Check the calibration of the measuring instrument(SA) using either an internal calibrator or a known signal from an external generator.

b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.

c. The center frequency of the spectrum analyzer is set to the fundamental frequency and using proper RBW and VBW setting.

d. Measure the captured power within the band and recording the plot.

e. Repeat above procedures until all frequencies required were complete.

12.2 Test SET-UP (Block Diagram of Configuration)

12.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

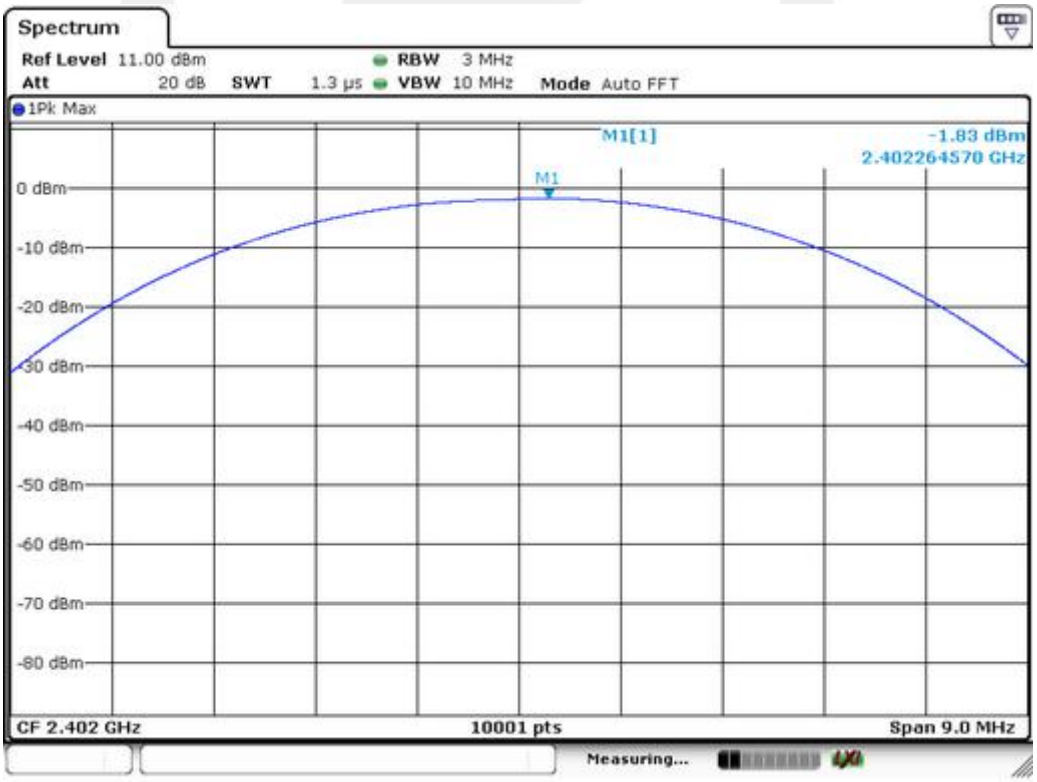
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

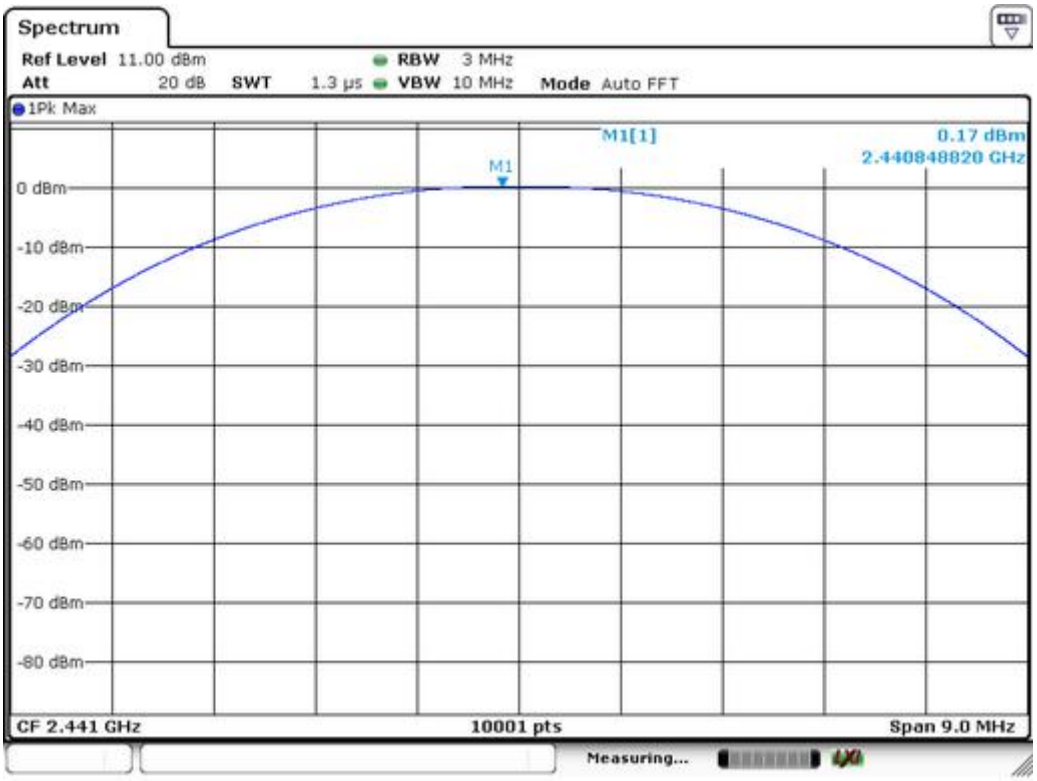
12.4 Measurement Results:

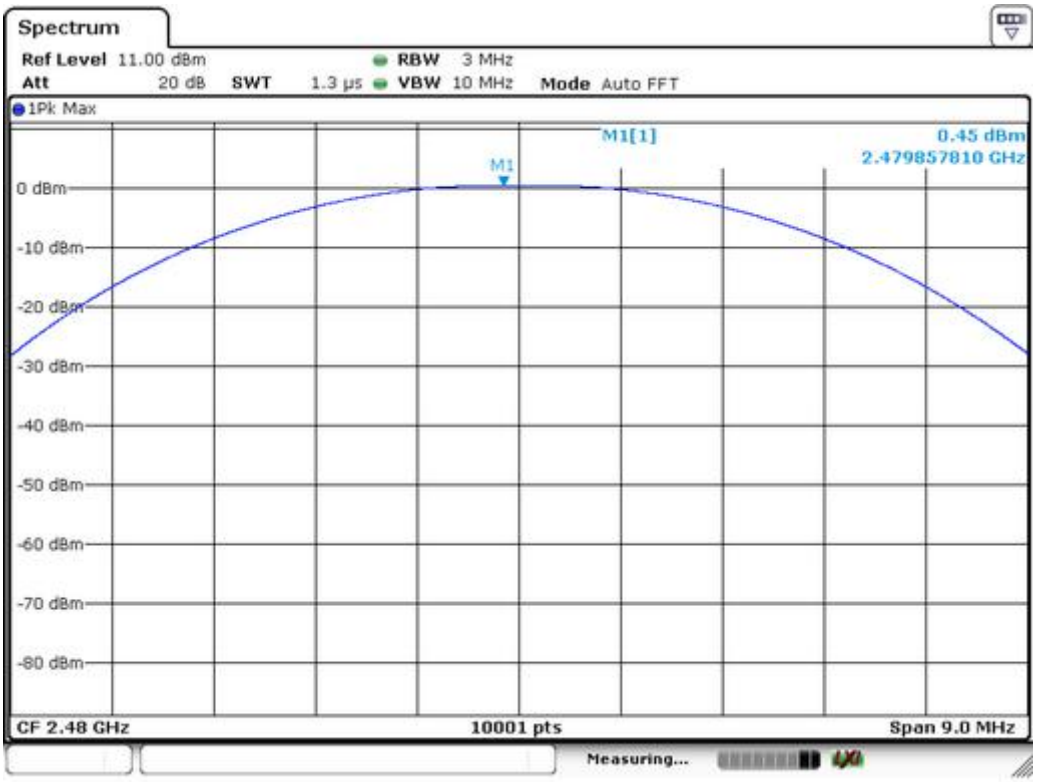
Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %
Modulation:	GFSK		

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-1.83	0.656	1000	PASS
40	2441	0.17	1.040	1000	PASS
79	2480	**0.45**	**1.109**	1000	PASS

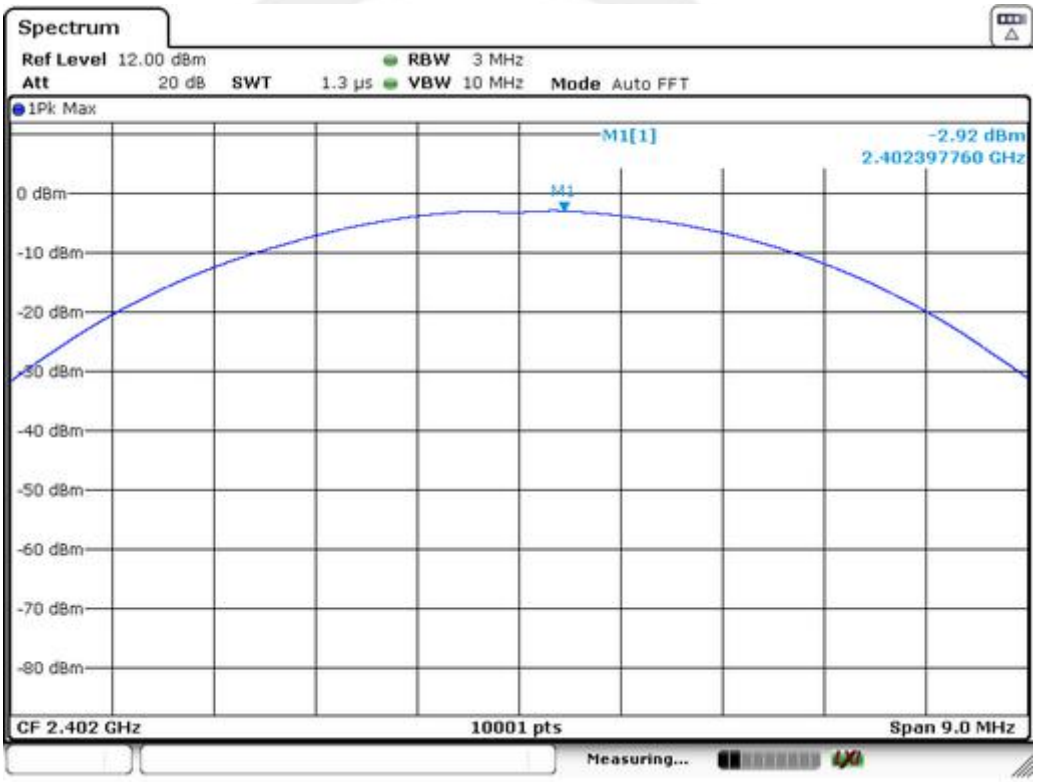


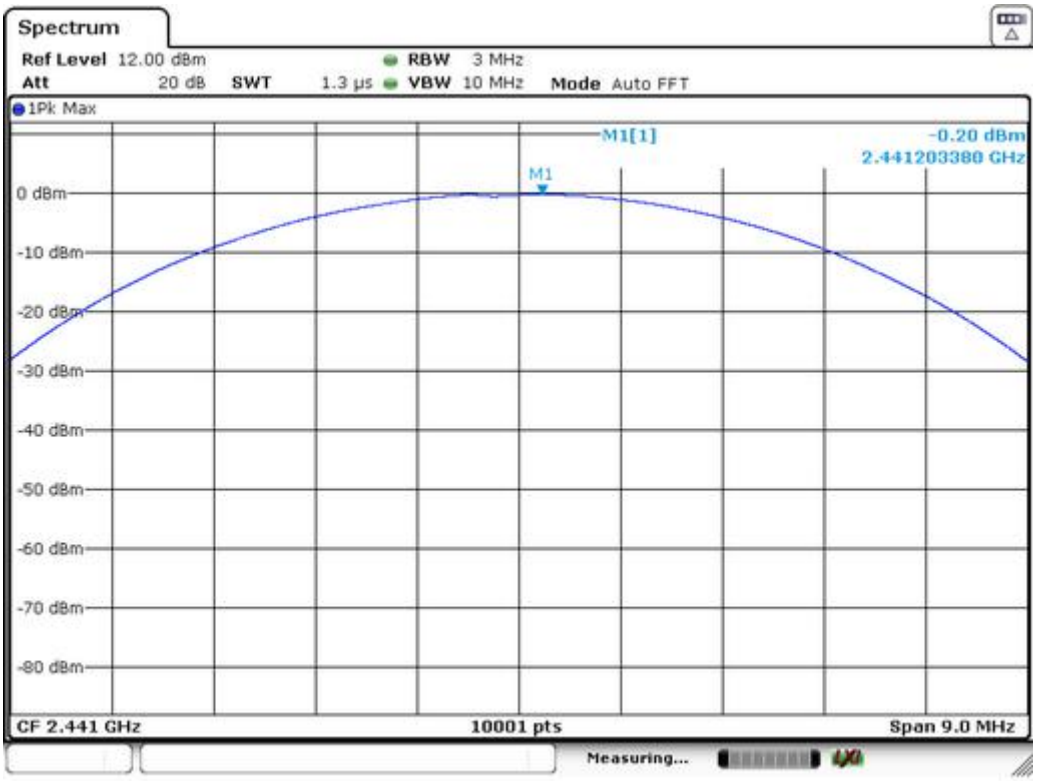

Spectrum
Ref Level 11.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.17 dBm
2.440848820 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
10001 pts
Span 9.0 MHz
Measuring...

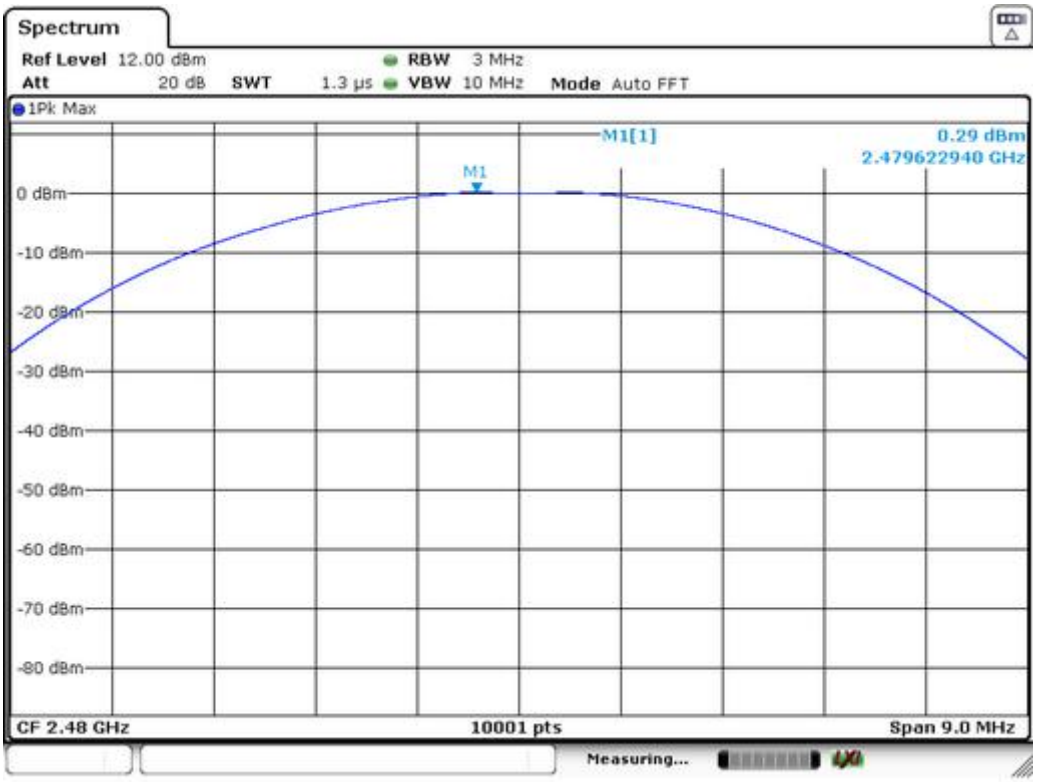

Spectrum
Ref Level 11.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.45 dBm
2.479857810 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
10001 pts
Span 9.0 MHz
Measuring...

Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %
Modulation:	Π/4-DQPSK		

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-2.92	0.511	125	PASS
40	2441	-0.20	0.955	125	PASS
79	2480	0.29	1.069	125	PASS




Spectrum
Ref Level 12.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
-0.20 dBm
2.441203380 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
10001 pts
Span 9.0 MHz
Measuring...


Spectrum
Ref Level 12.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.29 dBm
2.479622940 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
10001 pts
Span 9.0 MHz
Measuring...

13. Band EDGE test

13.1 Measurement Procedure

For Conducted Test

1. The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100KHz. The video bandwidth is set to 300KHz.
2. The spectrum from 30MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

EMI Test Receiver	Setting
Attenuation	Auto
RBW	100KHz
VBW	300KHz
Detector	Peak
Trace	Max hold

For Radiated emission Test

The EUT was placed on a styrofoam table which is 1.5m above ground plane.

The measurement procedure at the ban edges was simplified by performing the measurement in just one plot. Both, the in-band-emission and the unwanted emission were be encompassed by the span. After trace stabilization, the maximum peak was be determined by a peak detector and the value was marked by an appropriate limit line. The second limit line, which is 20dB below the first, marks the limit for the emissions in the unrestricted band. A maximum-peak-detector marks the highest emission in the unrestricted band next to the band edge.

The measurements were performed at the lower end of the 2.4GHz band.

Use the following spectrum analyzer settings:

For Restricted Band, When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 3MHz:

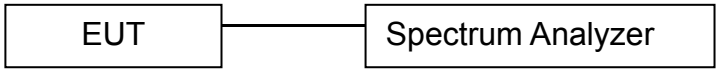
EMI Test Receiver	Setting
Attenuation	Auto
RBW	1MHz
VBW	3MHz
Detector	Peak
Trace	Max hold

For Non-Restricted Band, When spectrum scanned above 1GHz setting resolution bandwidth 100KHz, video bandwidth 300KHz:

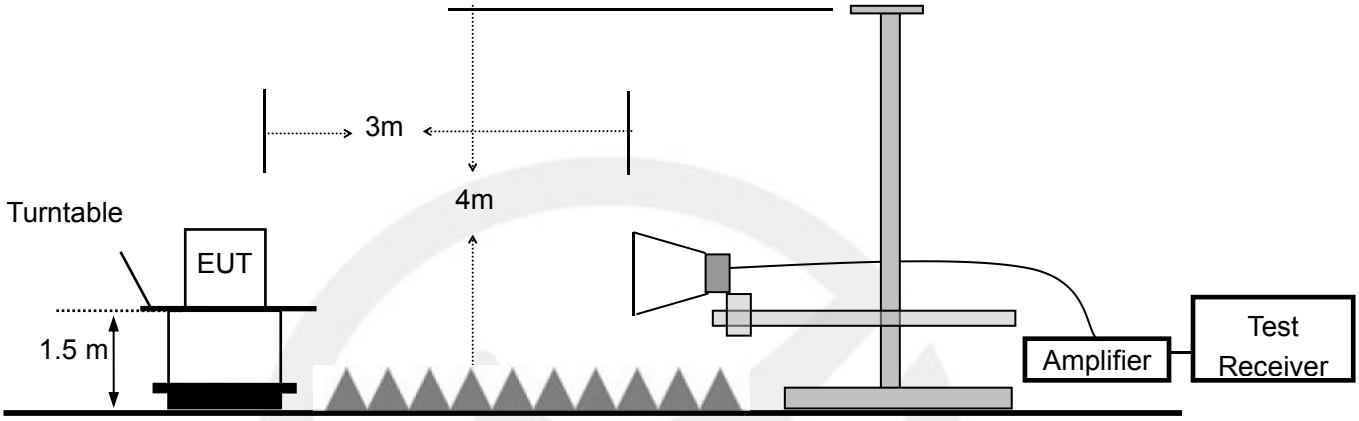
EMI Test Receiver	Setting
Attenuation	Auto
RBW	100KHz
VBW	300KHz
Detector	Peak
Trace	Max hold

13.2 Test SET-UP (Block Diagram of Configuration)

For Conducted Test



For Radiated emission Test



13.3 Measurement Equipment Used:

For Conducted Test

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/23/2019	05/22/2020
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/23/2019	05/22/2020
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/23/2019	05/22/2020

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

For Radiated emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Characteristics	Last Cal.	Cal. Interval
1	Signal Analyzer	Rohde & Schwarz	FSV30	103040	9KHz-40GHz	05/23/2019	1 Year
2	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	1GHz-18GHz	05/23/2019	1 Year
3	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	05/23/2019	1 Year
4	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year
5	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year
6	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/23/2019	1 Year

13.4 Measurement Results:

Refer to attached data chart.

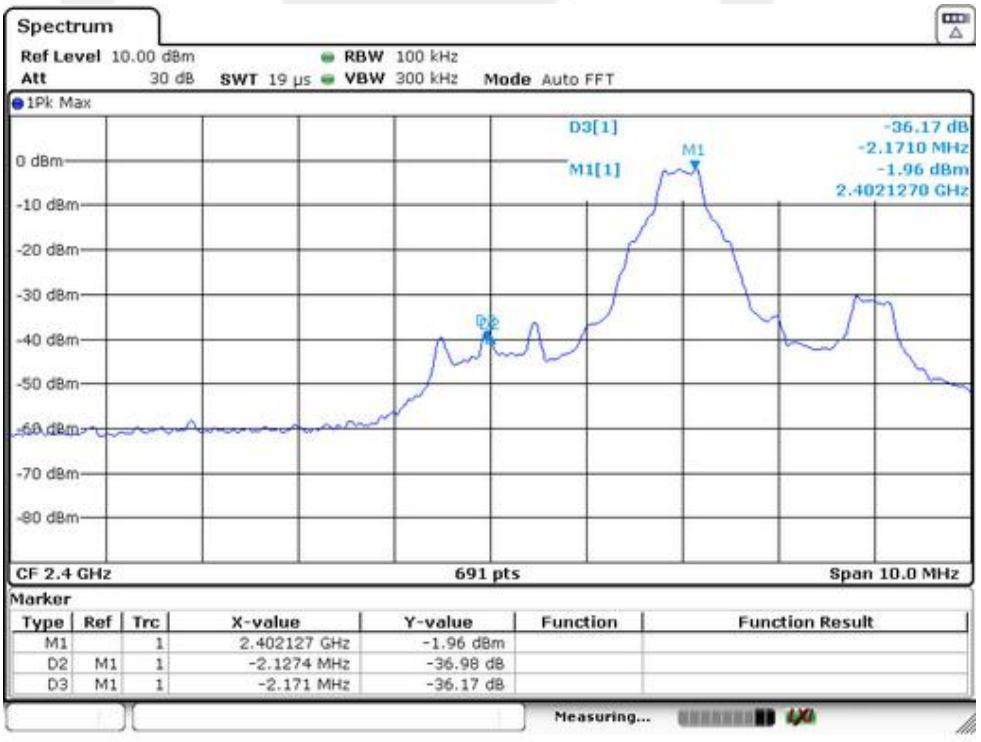
Spectrum Detector:	PK	Test Date :	May 15, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %

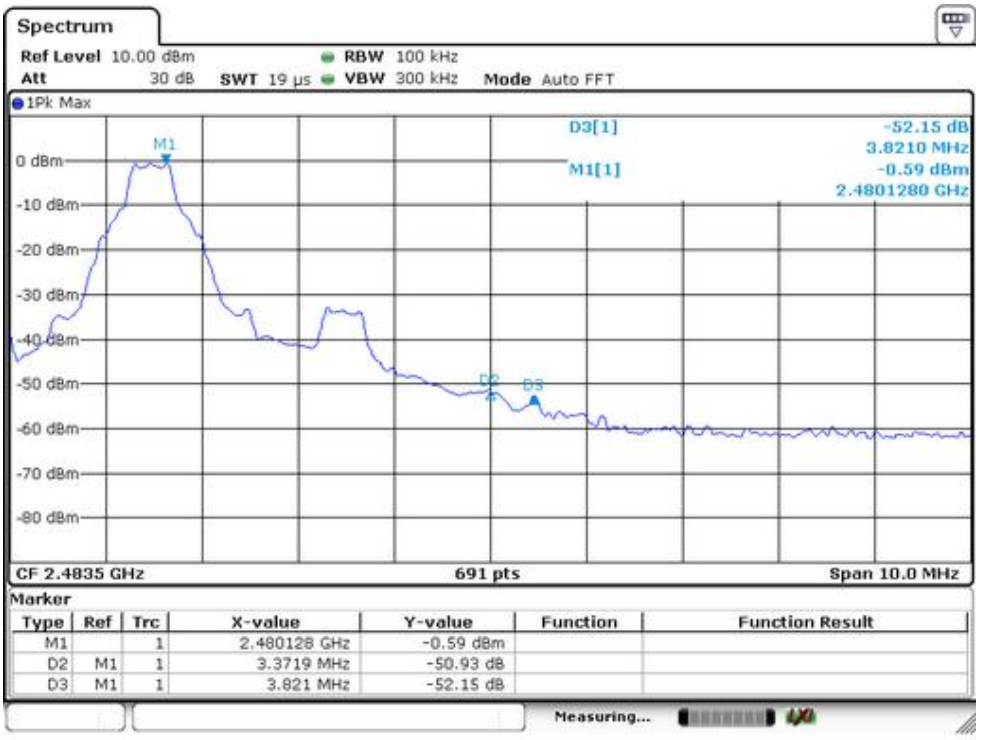
1. Conducted Test

For Non-Hopping Mode:

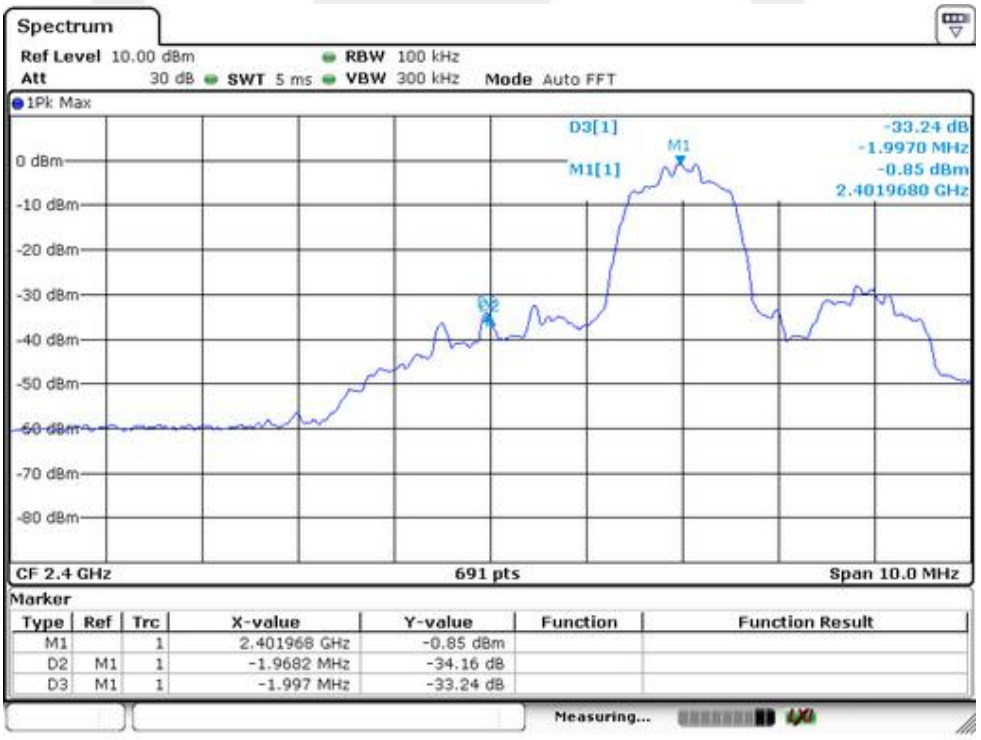
Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.96	GFSK	-1.96	36.17	>20dBc
2399.97	pi/4-DQPSK	-0.85	33.24	>20dBc
2483.96	GFSK	-0.59	52.15	>20dBc
2483.96	pi/4-DQPSK	0.46	52.39	>20dBc

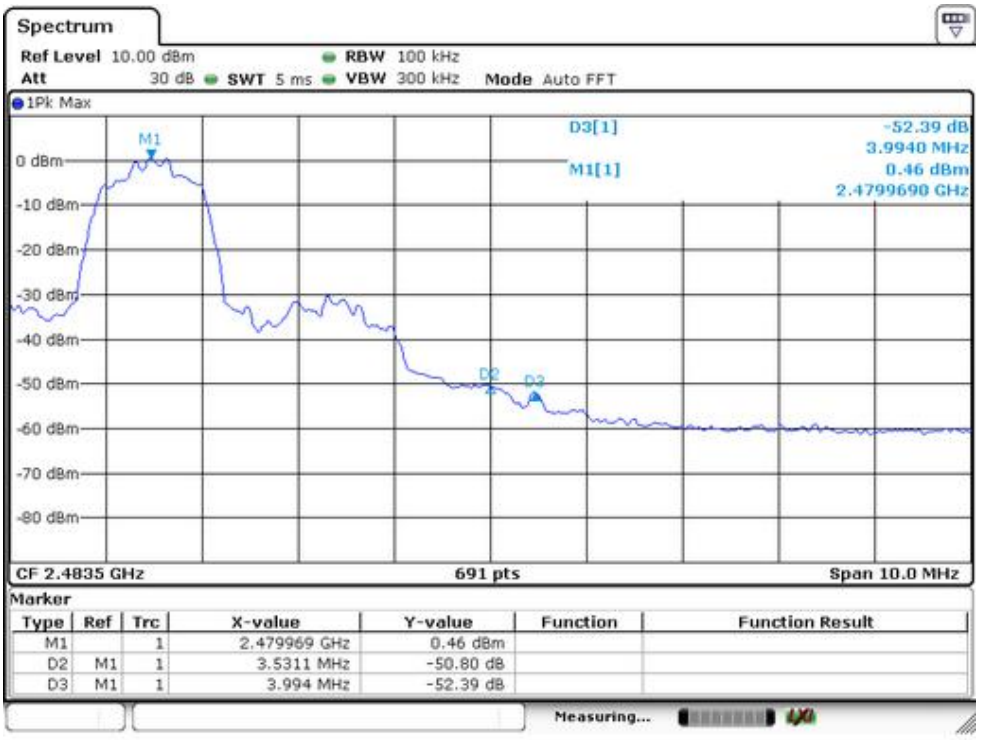
Test plots of GFSK





Test plots of pi/4-DQPSK

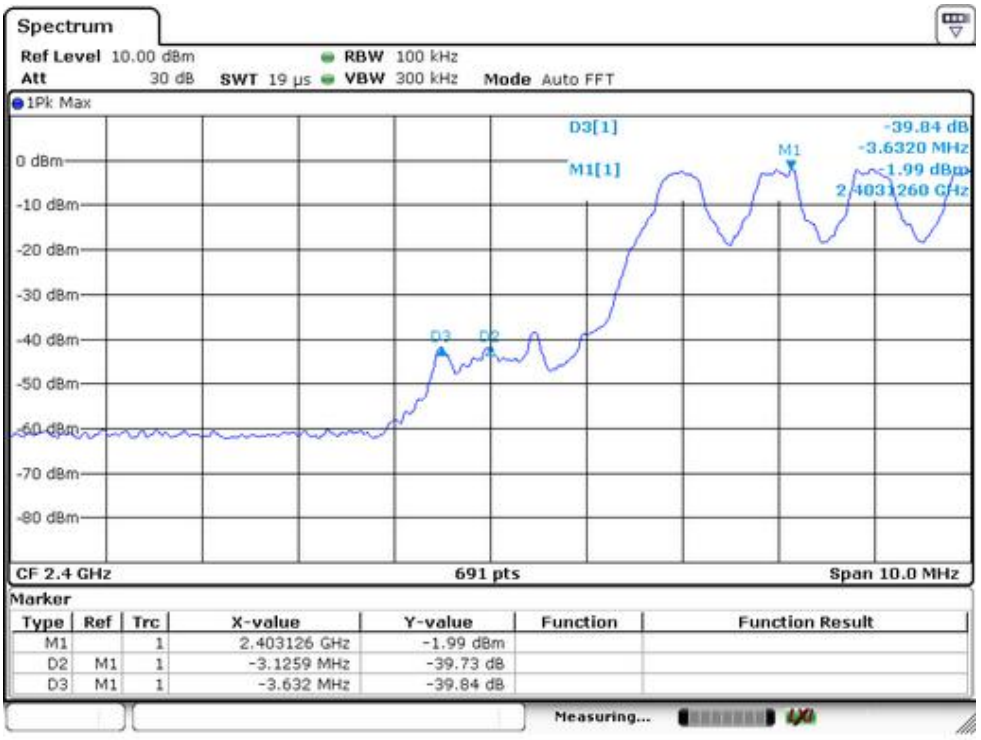


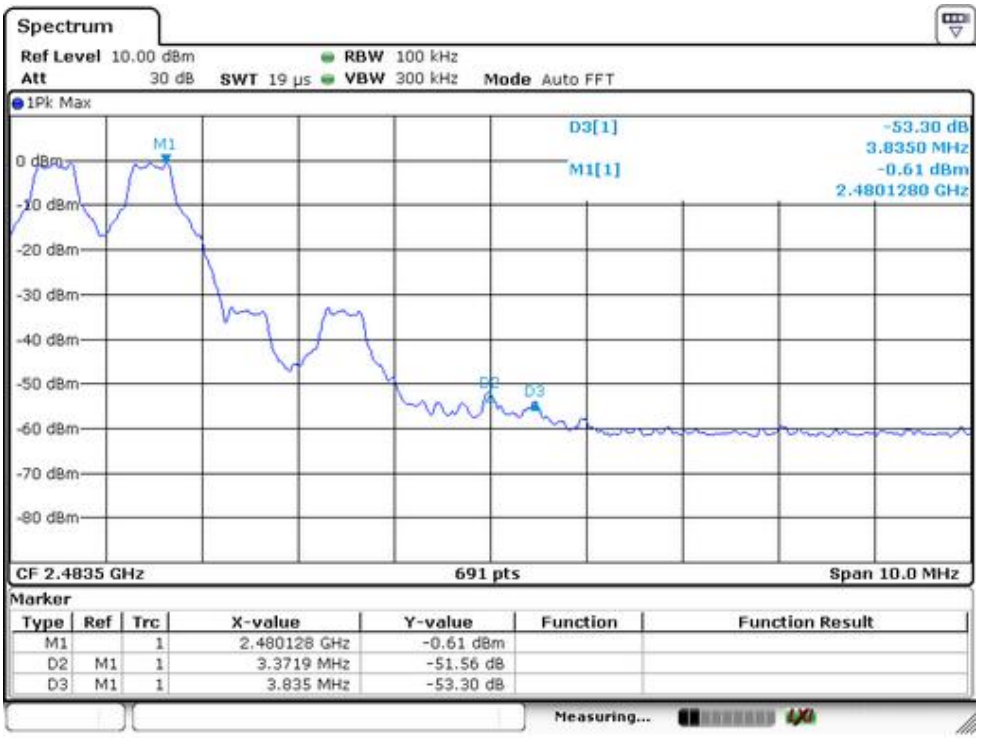

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB SWT 5 ms VBW 300 kHz Mode Auto FFT
1Pk Max
M1
D3[1]
-52.39 dB
3.9940 MHz
M1[1]
0.46 dBm
2.4799690 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
D2
D3
CF 2.4835 GHz
691 pts
Span 10.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479969 GHz 0.46 dBm
D2 M1 1 3.5311 MHz -50.80 dB
D3 M1 1 3.994 MHz -52.39 dB
Measuring...

For Hopping Mode:

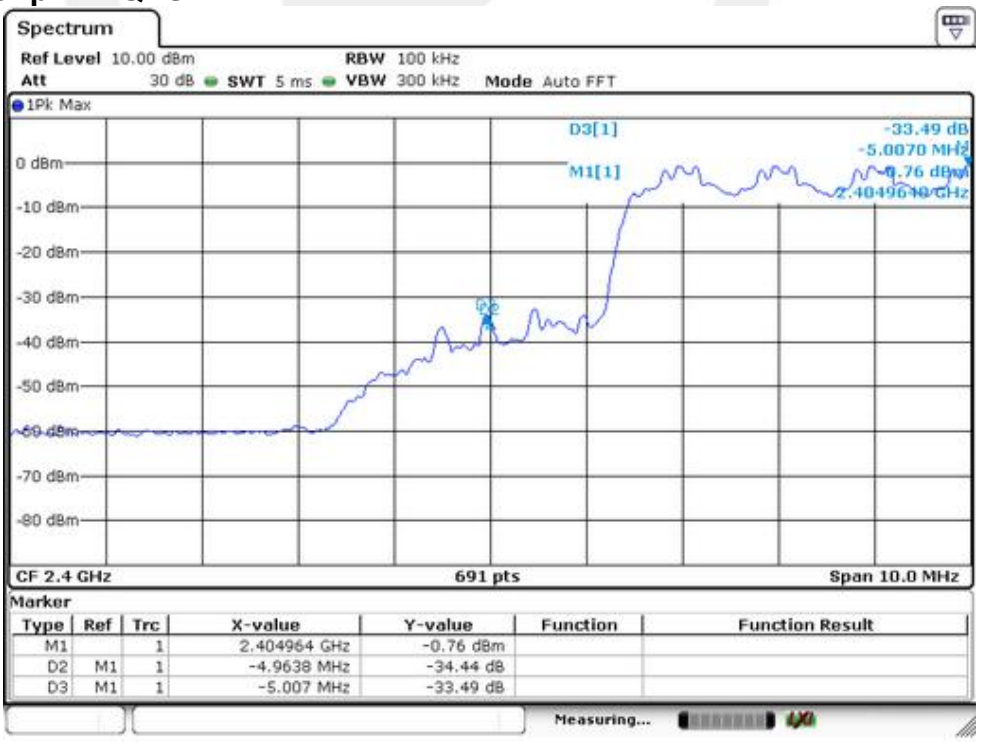
Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.49	GFSK	-1.99	39.84	>20dBc
2399.96	pi/4-DQPSK	-0.76	33.49	>20dBc
2483.96	GFSK	-0.61	53.30	>20dBc
2483.98	pi/4-DQPSK	0.46	53.18	>20dBc

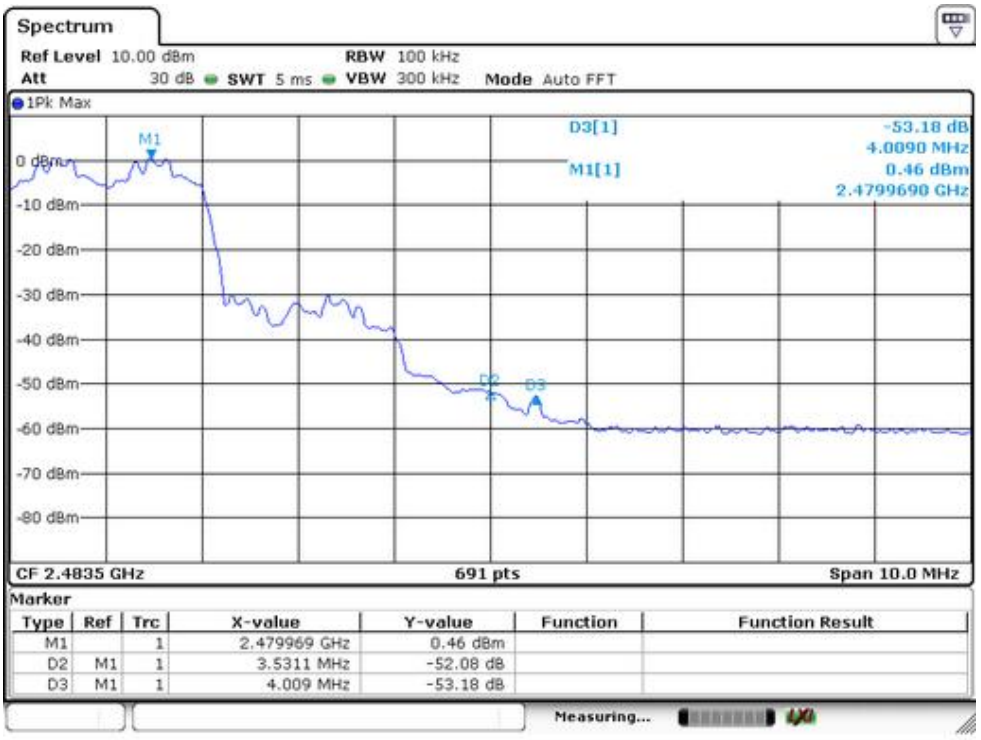
Test plots of GFSK





Test plots of pi/4-DQPSK

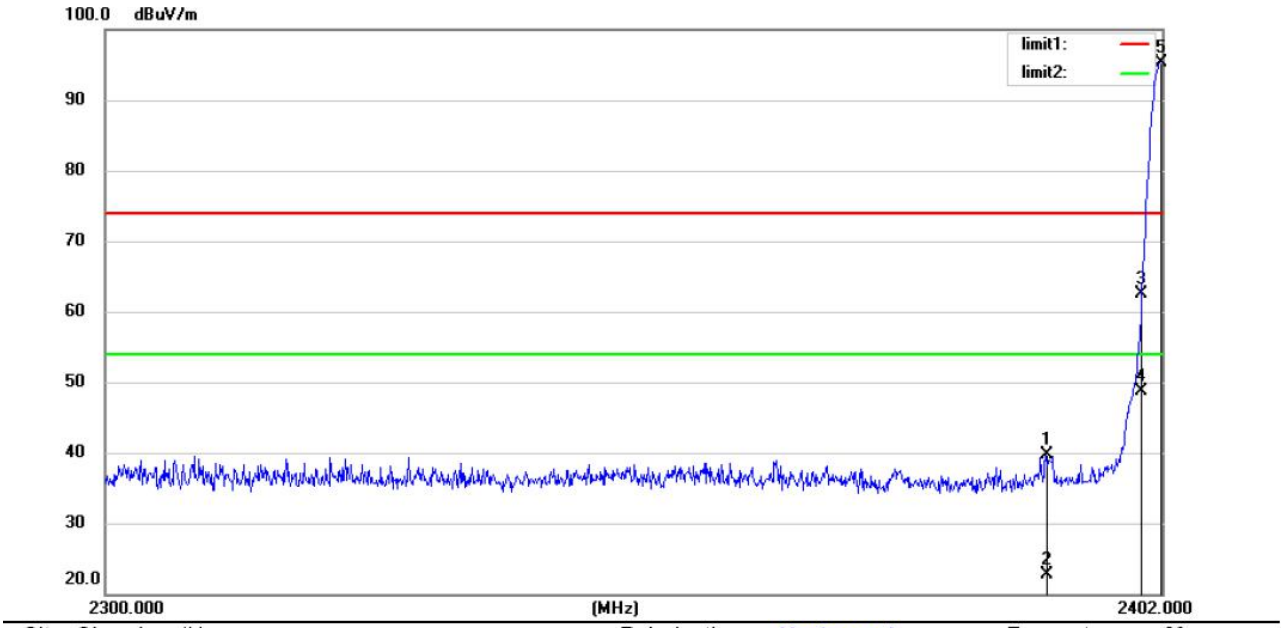



Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB SWT 5 ms VBW 300 kHz Mode Auto FFT
1Pk Max
M1
D3[1]
-53.18 dB
4.0090 MHz
M1[1]
0.46 dBm
2.4799690 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
D2
D3
CF 2.4835 GHz
691 pts
Span 10.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479969 GHz 0.46 dBm
D2 M1 1 3.5311 MHz -52.08 dB
D3 M1 1 4.009 MHz -53.18 dB
Measuring...

2. Radiated emission Test

Worst test modulation GFSK

For Non-Hopping Mode:



Site Chamber #1 Polarization: *Horizontal* Temperature: 26

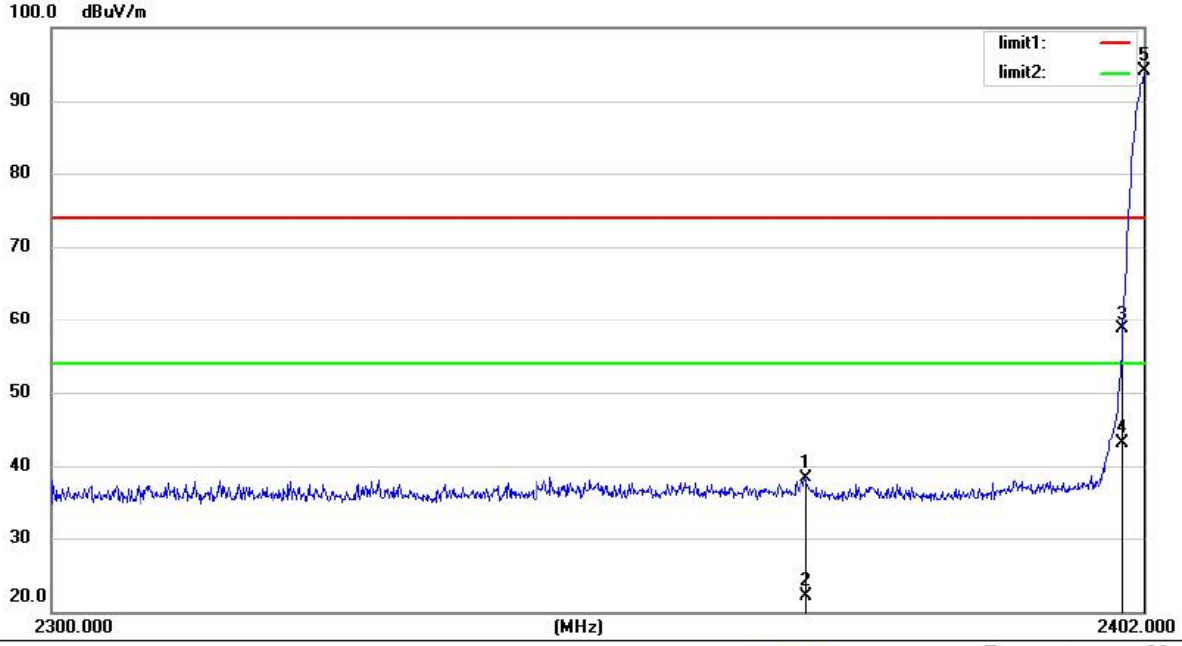
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode:TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2390.576	58.18	-18.55	39.63	74.00	-34.37	peak		0	
2		2390.576	41.26	-18.55	22.71	54.00	-31.29	AVG		0	
3		2400.000	81.09	-18.50	62.59	74.00	-11.41	peak		0	
4		2400.000	67.25	-18.50	48.75	54.00	-5.25	AVG		0	
5	*	2401.796	113.73	-18.49	95.24	74.00	21.24	peak		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Vertical* Temperature: 26

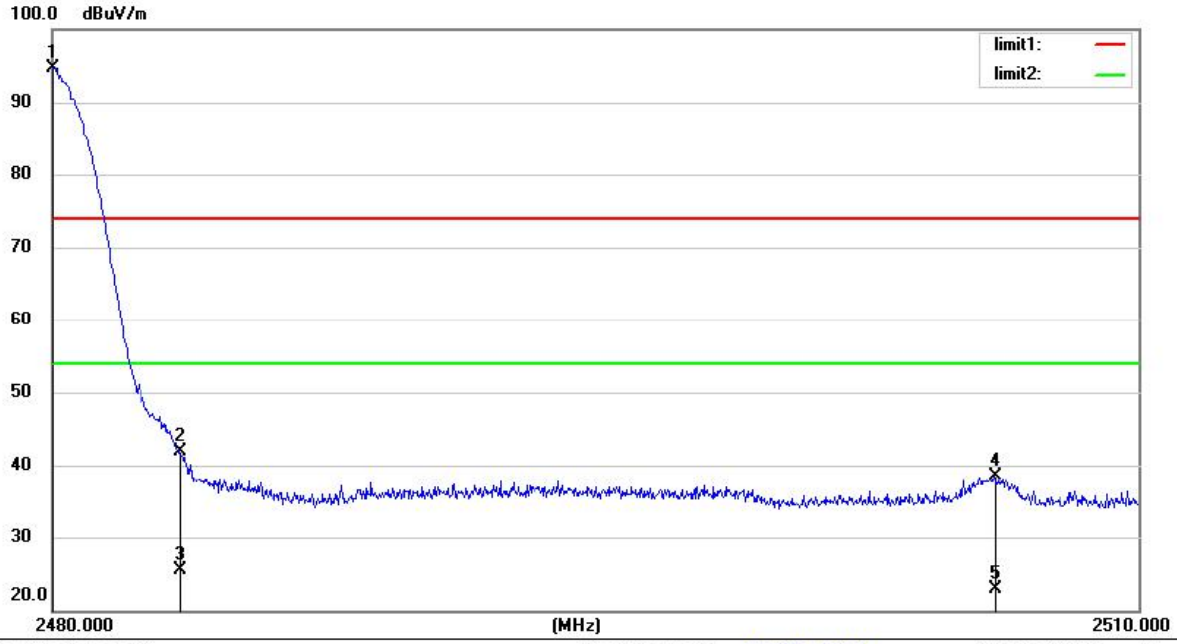
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode: TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2369.972	57.02	-18.68	38.34	74.00	-35.66	peak		0	
2		2369.972	40.70	-18.68	22.02	54.00	-31.98	AVG		0	
3		2400.000	77.14	-18.50	58.64	74.00	-15.36	peak		0	
4		2400.000	61.56	-18.50	43.06	54.00	-10.94	AVG		0	
5	*	2402.000	112.65	-18.49	94.16	74.00	20.16	peak		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Horizontal* Temperature: 26

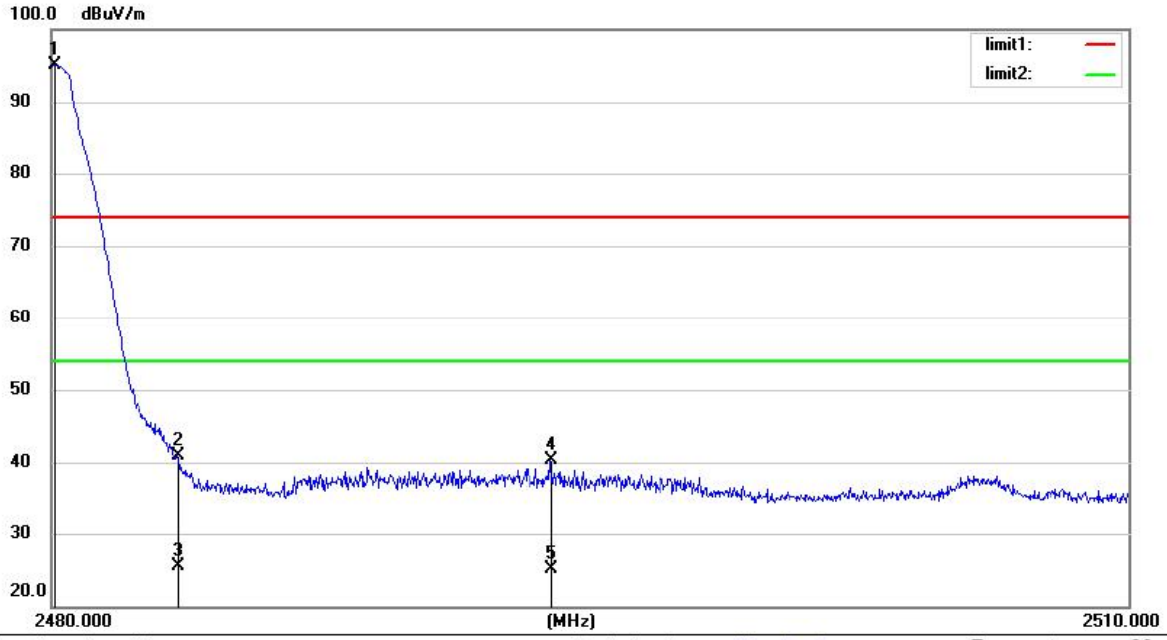
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode:TX2480

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	2480.000	112.77	-18.03	94.74	74.00	20.74	peak		0	
2		2483.500	59.99	-18.01	41.98	74.00	-32.02	peak		0	
3		2483.500	43.60	-18.01	25.59	54.00	-28.41	AVG		0	
4		2506.010	56.37	-17.89	38.48	74.00	-35.52	peak		0	
5		2506.010	40.87	-17.89	22.98	54.00	-31.02	AVG		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Vertical* Temperature: 26

Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

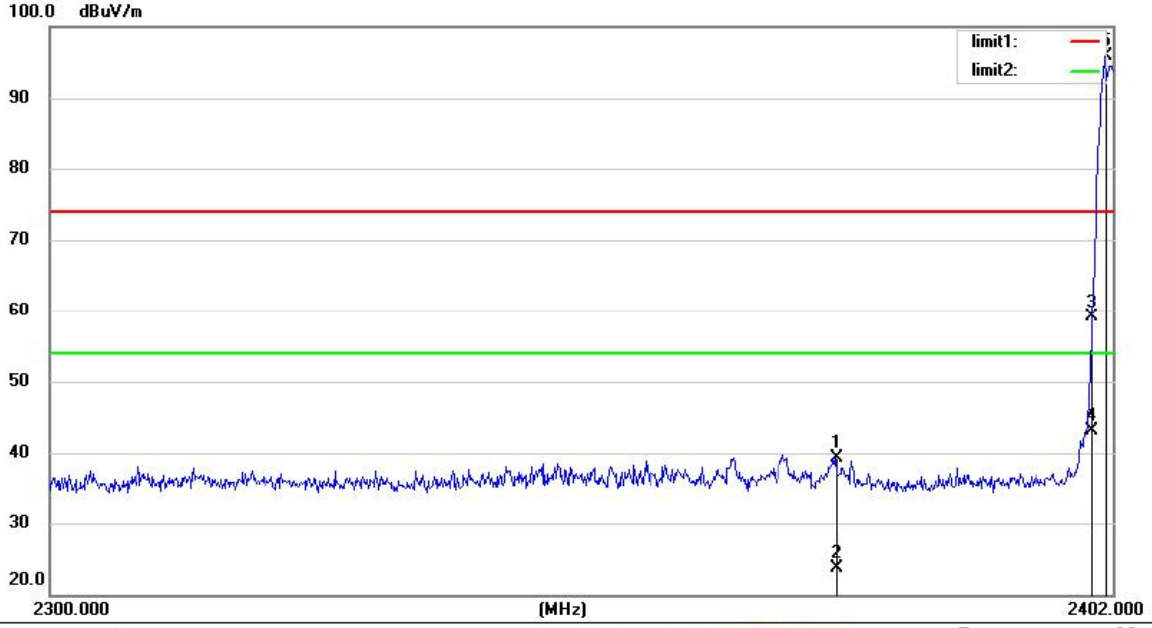
Mode: TX2480

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	2480.060	113.05	-18.03	95.02	74.00	21.02	peak		0	
2		2483.500	58.94	-18.01	40.93	74.00	-33.07	peak		0	
3		2483.500	43.60	-18.01	25.59	54.00	-28.41	AVG		0	
4		2493.860	58.32	-17.95	40.37	74.00	-33.63	peak		0	
5		2493.860	42.98	-17.95	25.03	54.00	-28.97	AVG		0	

*:Maximum data x:Over limit !:over margin Operator: Lian

For Hopping Mode:



Site Chamber #1 Polarization: *Horizontal* Temperature: 26

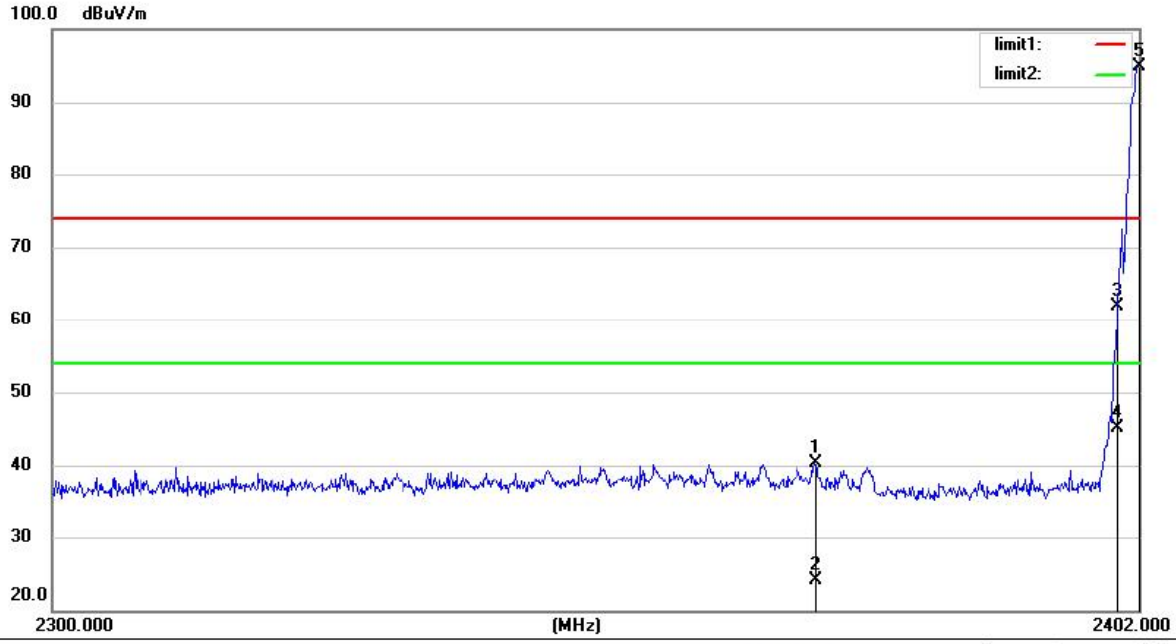
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode: Hopping

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2374.970	57.90	-18.64	39.26	74.00	-34.74	peak		0	
2		2374.970	42.30	-18.64	23.66	54.00	-30.34	AVG		0	
3		2400.000	77.70	-18.50	59.20	74.00	-14.80	peak		0	
4		2400.000	61.69	-18.50	43.19	54.00	-10.81	AVG		0	
5	*	2401.286	114.45	-18.49	95.96	74.00	21.96	peak		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Vertical* Temperature: 26

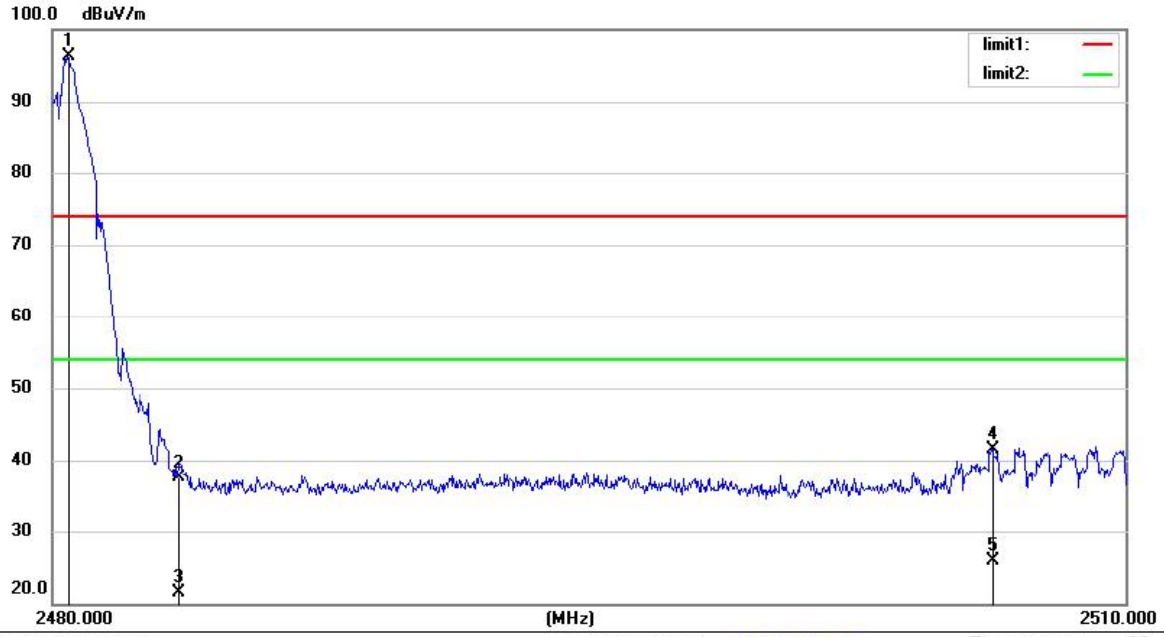
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode: Hopping

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2371.196	58.96	-18.67	40.29	74.00	-33.71	peak		0	
2		2371.196	42.69	-18.67	24.02	54.00	-29.98	AVG		0	
3		2400.000	80.42	-18.50	61.92	74.00	-12.08	peak		0	
4		2400.000	63.58	-18.50	45.08	54.00	-8.92	AVG		0	
5	*	2402.000	113.41	-18.49	94.92	74.00	20.92	peak		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: ***Horizontal*** Temperature: 26

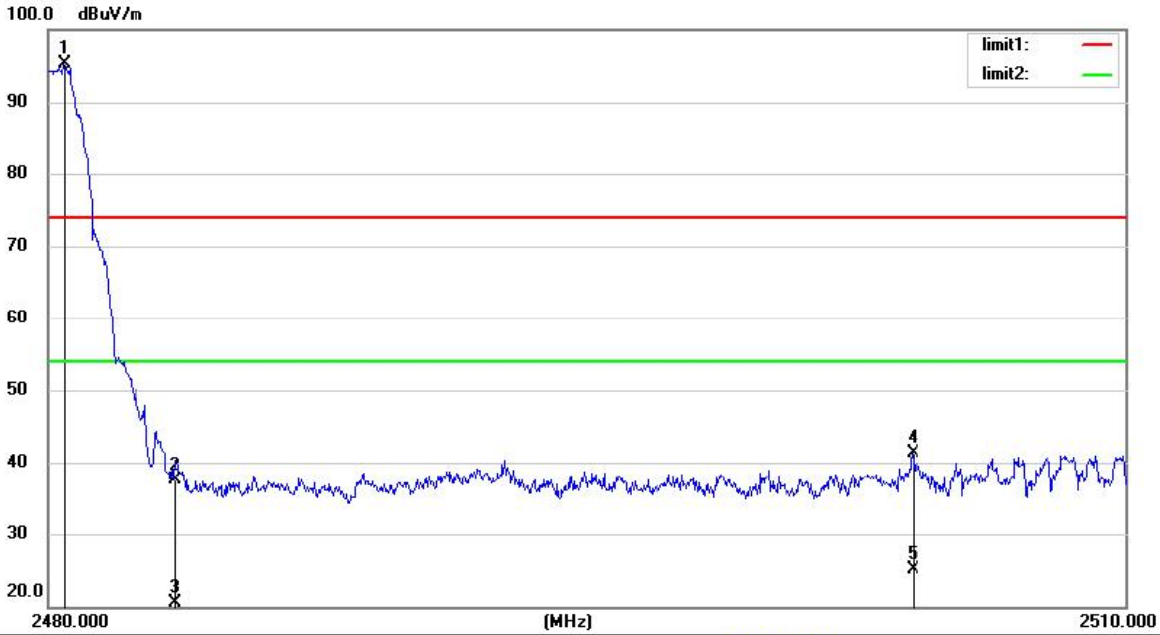
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode: Hopping

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	2480.420	114.31	-18.03	96.28	74.00	22.28	peak		0	
2		2483.500	55.55	-18.01	37.54	74.00	-36.46	peak		0	
3		2483.500	39.58	-18.01	21.57	54.00	-32.43	AVG		0	
4		2506.280	59.44	-17.89	41.55	74.00	-32.45	peak		0	
5		2506.280	43.88	-17.89	25.99	54.00	-28.01	AVG		0	

*:Maximum data x:Over limit !:over margin Operator: Lian



Site Chamber #1 Polarization: *Vertical* Temperature: 26

Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

Mode: Hopping

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	2480.420	113.31	-18.03	95.28	74.00	21.28	peak			
2		2483.500	55.55	-18.01	37.54	74.00	-36.46	peak			
3		2483.500	38.50	-18.01	20.49	54.00	-33.51	AVG			
4		2504.060	59.17	-17.90	41.27	74.00	-32.73	peak			
5		2504.060	42.96	-17.90	25.06	54.00	-28.94	AVG			

*:Maximum data x:Over limit !:over margin Operator: Lian

14. Antenna Application

14.1 Antenna requirement

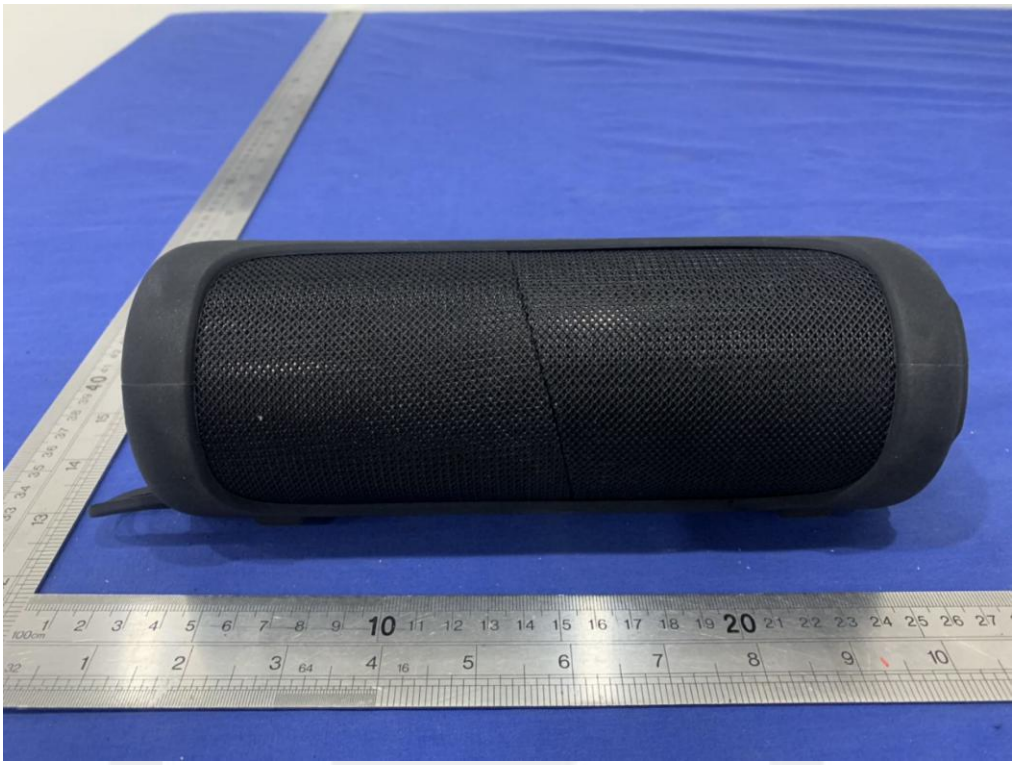
The EUT'S antenna is met the requirement of FCC part 15C section 15.203 and 15.247.

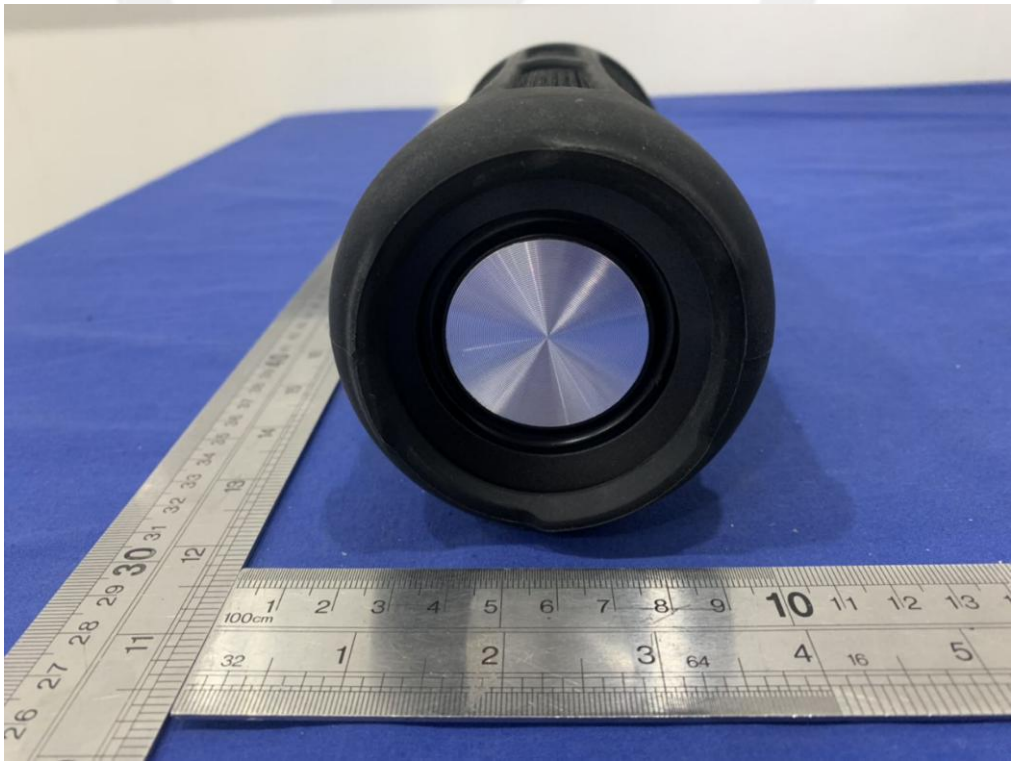
FCC part 15C section 15.247 requirements:
Systems operating in the 2402-2480MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

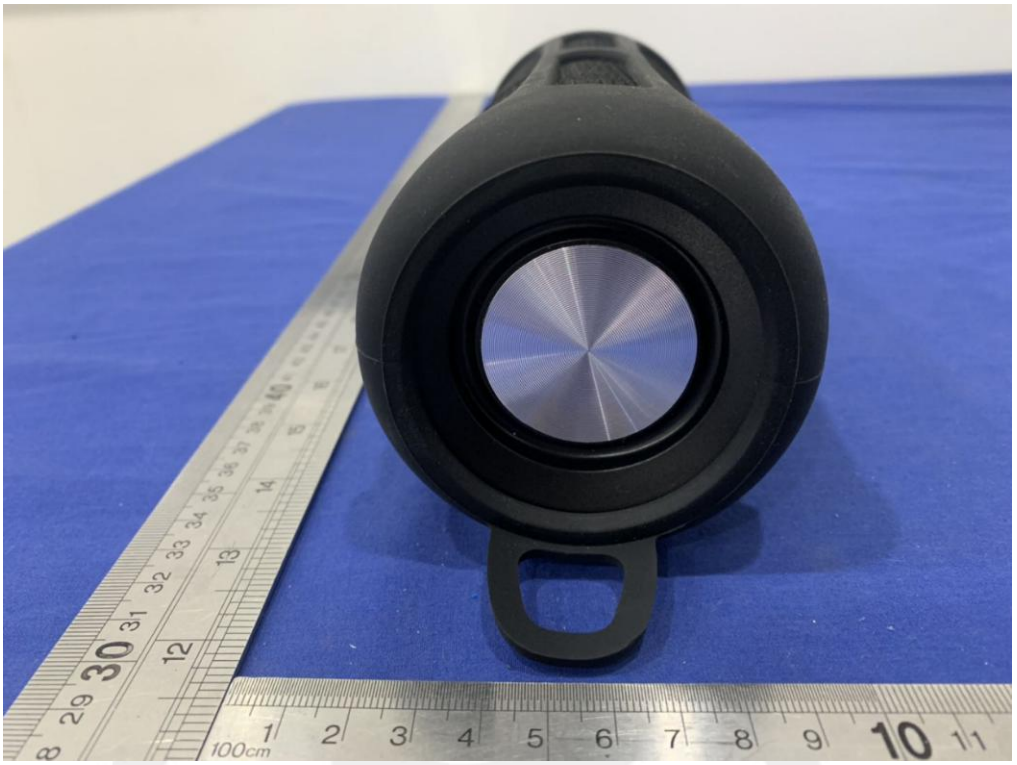
14.2 Result

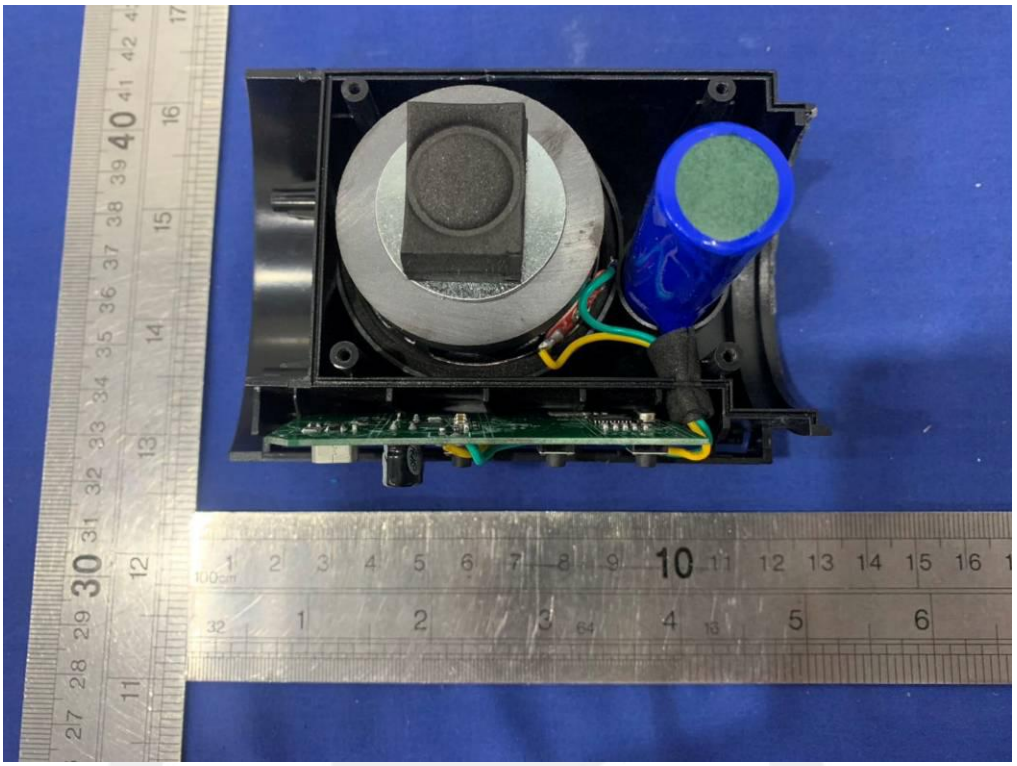
The EUT's antenna, permanent attached antenna, used a PCB antenna and integrated on PCB, The antenna's gain is -0.58dBi and meets the requirement.

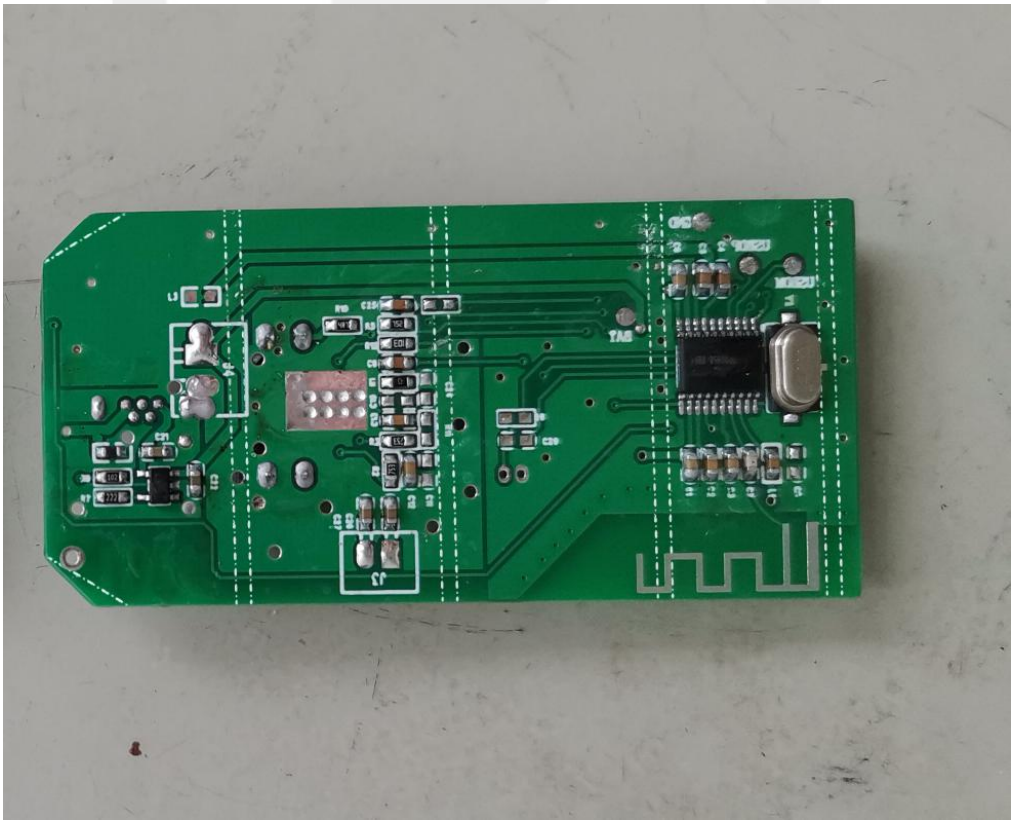
15. Photos of EUT

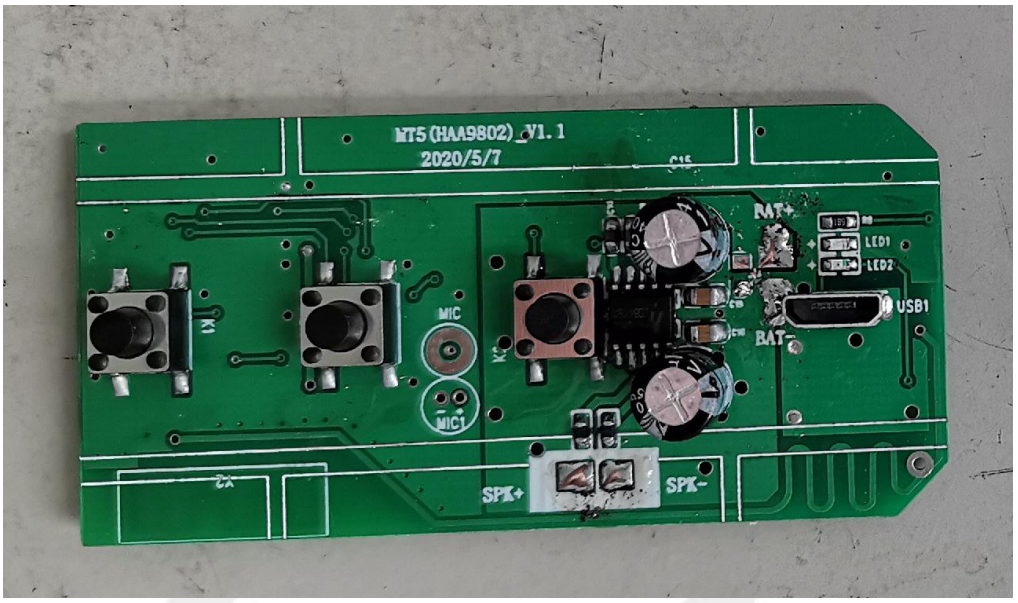


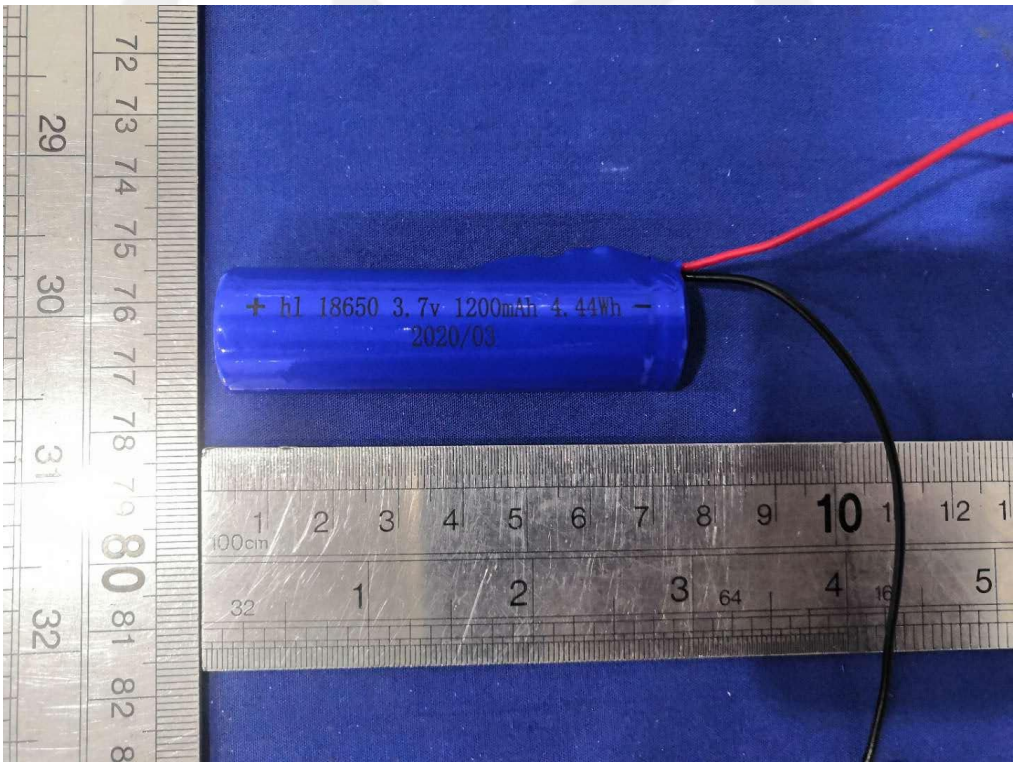



100cm









*** End of Report ***

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