TEST REPORT

Product Name : Bluetooth speaker
Model Number : 989BT, V60055BT-BLK
FCC ID : 2AZM9-989BT

Prepared for	:	Shenzhen Qualitronic Technology Co., LTD
Address	:	Room 1402, No. 3 YiLuan Building, Xixiang Avenue No. 230, Bao'an District, Shenzhen China
Prepared by	:	EMTEK (DONGGUAN) CO., LTD.
Address	:	-1&2/F.,Building 2, Zone A, Zhongda Marine Biotechnology Reserch and Development Base, No.9, Xincheng Avenue, Songshanhu High-technology Industrial Development Zone, Dongguan, Guangdong, China TEL: +86-0769-22807078 FAX: +86-0769-22807079

Report Number	:	ED210527057W
Date(s) of Tests	:	May 27, 2021 to June 3, 2021
Date of issue	:	June 3, 2021

VERIFICATION OF COMPLIANCE

Applicant:	Shenzhen Qualitronic Technology Co., LTD Room 1402, No. 3 YiLuan Building, Xixiang Avenue No. 230, Bao'an District, Shenzhen China
Manufacturer:	Dongguan Qualitronic Industrial Co.,Ltd Building B, Pengtai industrial park , No 49 Ludong road, Humen town ,Dongguan
Factory:	Dongguan Qualitronic Industrial Co.,Ltd Building B, Pengtai industrial park , No 49 Ludong road, Humen town ,Dongguan
Product Description:	Bluetooth speaker
Trade Mark:	N/A
Model Number:	989BT, V60055BT-BLK

We hereby certify that:

The above equipment was tested by EMTEK(DONGUAN) 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 27, 2021 to June 3, 2021

Prepared by : Loren Luo /Editor

Reviewer : Tim Dong /Supervisor

Approved & Authorized Signer : Lisa Wang /Manager

Modified Information

Version	Summary	Revision Date	Report No.
Ver.1.0	Original Report	June 3, 2021	ED210527057W

Table of Contents

1. GENERAL INFORMATION

1.1 Product Description

Characteristics	Description
Product Name	Bluetooth speaker
Model number	989BT, V60055BT-BLK These model are the same expect the model name and appearance, Here select 989BT for test.
Power Supply	DC 5V from adapter, DC 3.7V Battery
Kind of Device	Bluetooth Ver.5.0
Modulation	GFSK, π/4-DQPSK, 8DPSK
Operating Frequency Range	2402-2480MHz
Number of Channels	79
Transmit Power Max(PK)	1.21dBm(0.001321W)
Antenna Type	Internal PCB antenna
Antenna Gain	-0.58 dBi

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, 2020.08.27
The certificate is valid until 2024.07.05
The Laboratory has been assessed and proved to be in compliance with CNAS/CL01:2018
The Certificate Registration Number is L3150

Accredited by FCC
Designation Number: CN1300
Test Firm Registration Number: 945551

Accredited by A2LA, April 05, 2021
The Certificate Registration Number is 4321.02

Accredited by Industry Canada
The Certificate Registration Number is CN0113

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

Site Location : -1&2/F.,Buiding 2,Zone A,Zhongda Marine Biotechnology Research and Development Base,N.9,Xincheng Avenue,Songshanhu High-technology Industrial Development Zone, Dongguan, 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

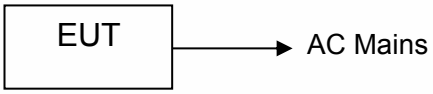


Table 2-1 Equipment Used in Tested System

Item	Equipment	Trademark	Model No.	FCC ID	Note
1.	Bluetooth speaker	N/A	989BT	2AZM9-989BT	EUT
2	Adapter	N/A	Model:ASSA44A-050230 Input:100-240V 50/60Hz 0.5A Max Output:5V	N/A	Support Equipment

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, 8DPSK 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%

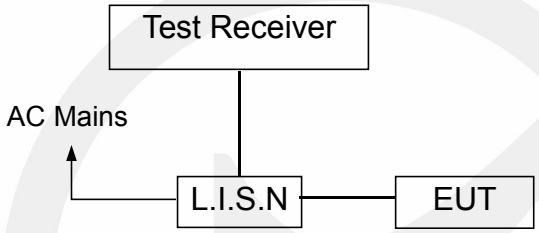
Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95%

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:

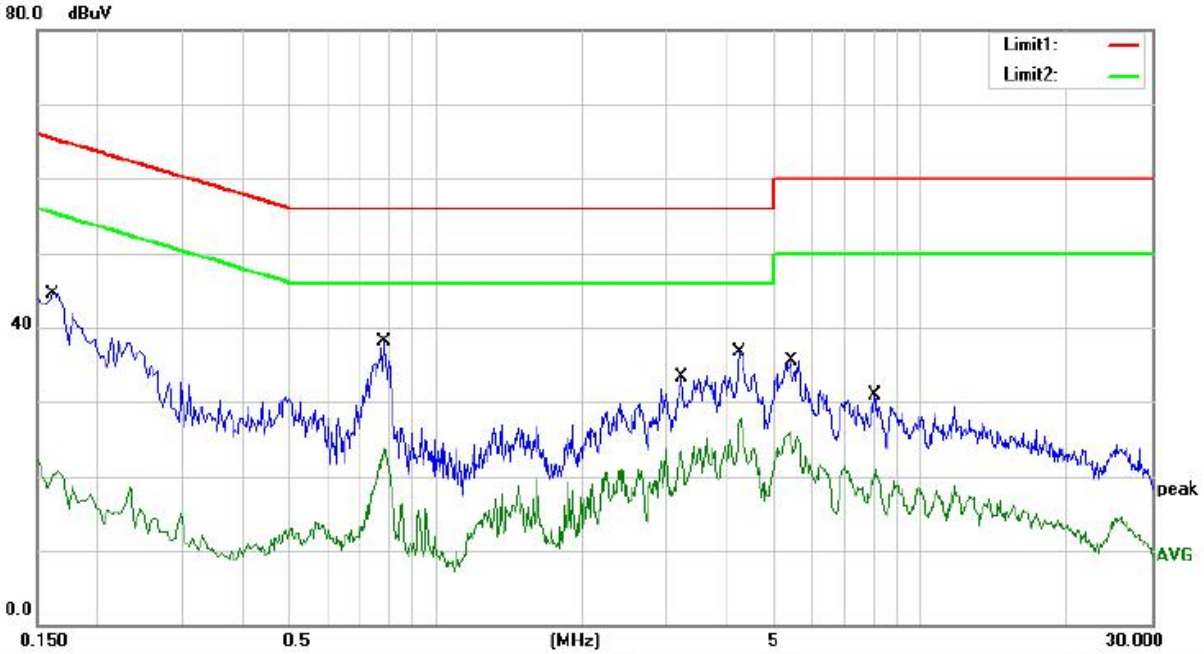
Conducted Emission Test Site						
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**Characteristics**	**Last Cal.**	**Due date**
Test Receiver	Rohde & Schwarz	ESCS30	100018	9kHz~3GHz	05/20/2021	05/19/2022
L.I.S.N	Rohde & Schwarz	ENV216	100017	9KHz-300MHz	05/20/2021	05/19/2022
RF Switching Unit	CDS	RSU-M2	38401	9KHz-300MHz	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	9kHz~3GHz	05/20/2021	05/19/2022

6.4 Measurement Result:

Operation Mode:	TX	Test Date :	May 31, 2020
Frequency Range:	0.15MHz~30MHz	Temperature :	28℃
Test Result:	PASS	Humidity :	65 %
Test By:	Loren		

Pass.
Conducted emission at both 120V & 240V, and emission at 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

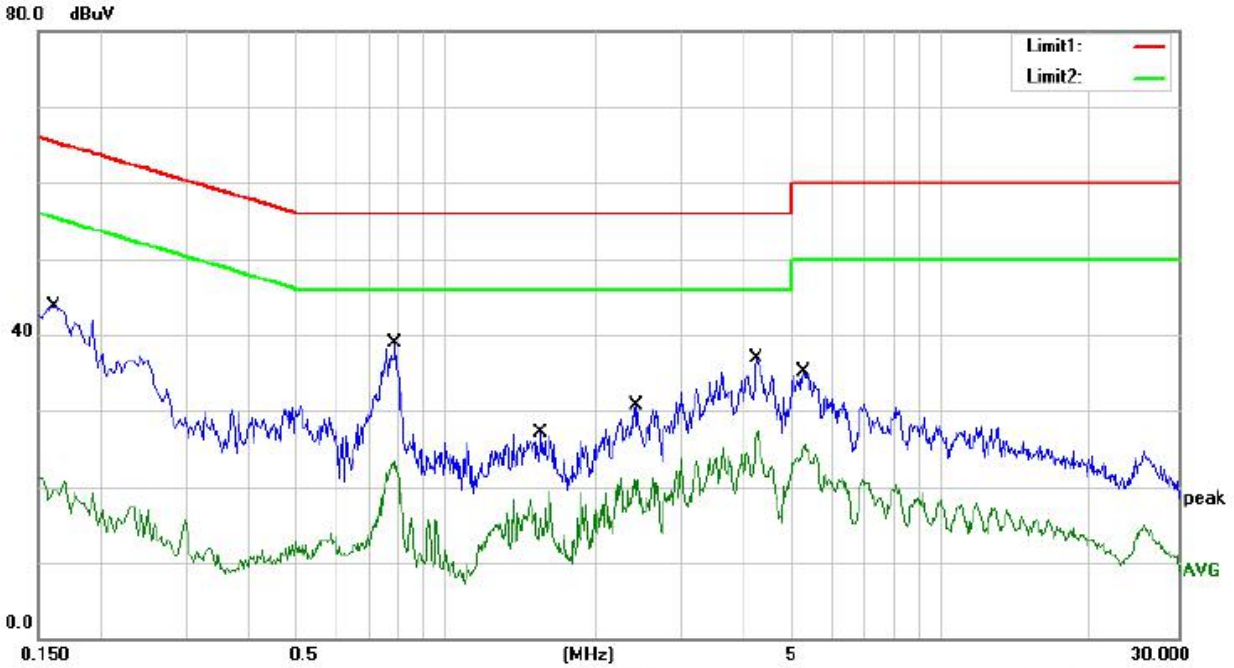
Limit: (CE)FCC PART 15 C_QP Power: AC 120V/60Hz Humidity: 55 %

Mode: TX 2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1620	34.46	10.02	44.48	65.36	-20.88	QP	
2		0.1620	10.71	10.02	20.73	55.36	-34.63	AVG	
3	*	0.7820	28.00	10.18	38.18	56.00	-17.82	QP	
4		0.7820	13.46	10.18	23.64	46.00	-22.36	AVG	
5		3.2140	23.09	10.18	33.27	56.00	-22.73	QP	
6		3.2140	13.58	10.18	23.76	46.00	-22.24	AVG	
7		4.2420	26.49	10.18	36.67	56.00	-19.33	QP	
8		4.2420	17.42	10.18	27.60	46.00	-18.40	AVG	
9		5.4060	25.42	10.18	35.60	60.00	-24.40	QP	
10		5.4060	15.86	10.18	26.04	50.00	-23.96	AVG	
11		8.0460	20.62	10.20	30.82	60.00	-29.18	QP	
12		8.0460	10.67	10.20	20.87	50.00	-29.13	AVG	

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



Site site #1 Phase: L1 Temperature: 25

Limit: (CE)FCC PART 15 C_QP Power: AC 120V/60Hz Humidity: 55 %

Mode: TX 2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1620	33.74	10.02	43.76	65.36	-21.60	QP	
2		0.1620	10.78	10.02	20.80	55.36	-34.56	AVG	
3	*	0.7900	28.64	10.18	38.82	56.00	-17.18	QP	
4		0.7900	13.16	10.18	23.34	46.00	-22.66	AVG	
5		1.5540	16.99	10.18	27.17	56.00	-28.83	QP	
6		1.5540	9.12	10.18	19.30	46.00	-26.70	AVG	
7		2.4340	20.53	10.18	30.71	56.00	-25.29	QP	
8		2.4340	10.92	10.18	21.10	46.00	-24.90	AVG	
9		4.2460	26.81	10.18	36.99	56.00	-19.01	QP	
10		4.2460	17.12	10.18	27.30	46.00	-18.70	AVG	
11		5.2580	24.90	10.18	35.08	60.00	-24.92	QP	
12		5.2580	15.23	10.18	25.41	50.00	-24.59	AVG	

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

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:

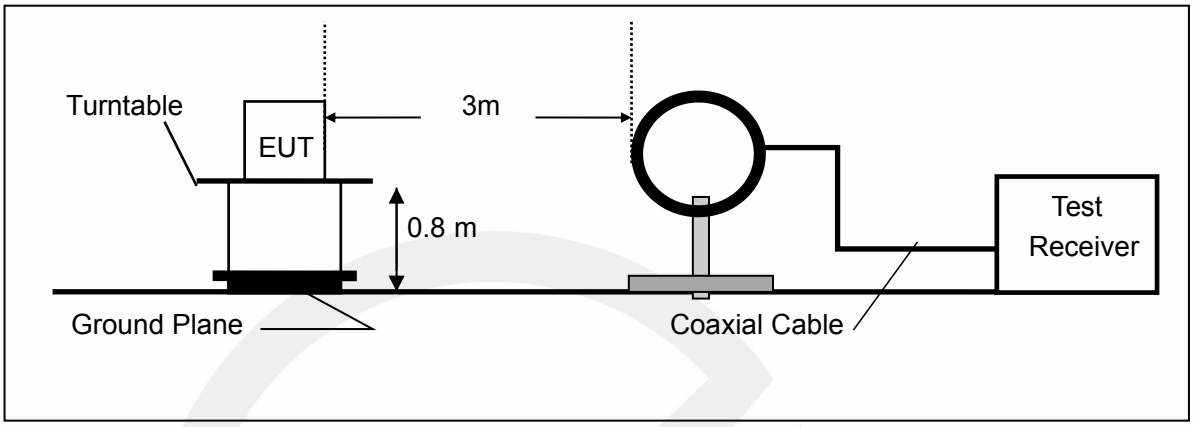
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	3MHz
Detector	Peak
Trace	Max hold

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

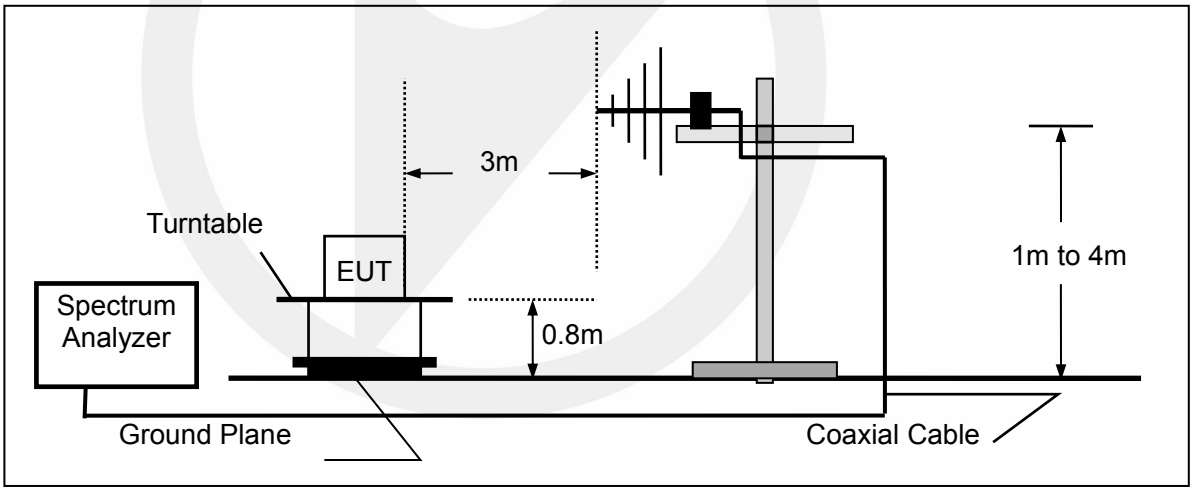
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Average
Trace	Max hold

7.2 Test SET-UP (Block Diagram of Configuration)

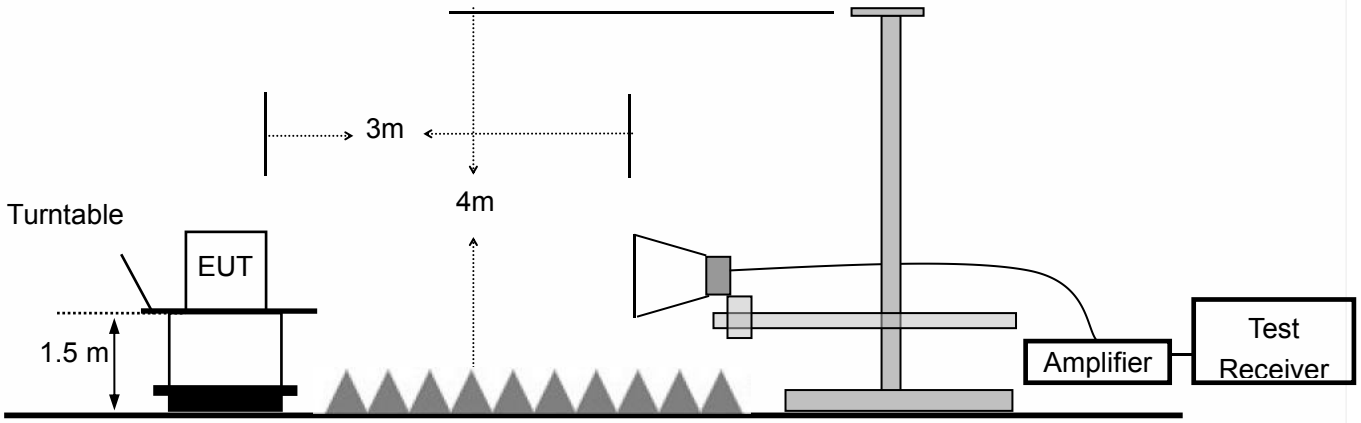
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(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	05/20/2021	1 Year
2.	Loop Antenna	Schwarzbeck	FMZB 1519	012	9 KHz -30MHz	05/20/2021	1 Year
3.	Bilog Antenna	Schwarzbeck	VULB9163	000141	25MHz-2GHz	05/20/2021	1 Year
4.	Power Amplifier	CDS	RSU-M352	818	1MHz-1GHz	05/20/2021	1 Year
5.	Power Amplifier	HP	8447F	OPT H64	1GHz-26.5GHz	05/20/2021	1 Year
6.	Color Monitor	SUNSPO	SP-140A	N/A	--	05/20/2021	1 Year
7.	Single Line Filter	JIANLI	XL-3	N/A	--	05/20/2021	1 Year
8.	Single Phase Power Line Filter	JIANLI	DL-2X100B	N/A	--	05/20/2021	1 Year
9.	3 Phase Power Line Filter	JIANLI	DL-4X100B	N/A	--	05/20/2021	1 Year
10.	DC Power Filter	JIANLI	DL-2X50B	N/A	--	05/20/2021	1 Year
11.	Cable	Schwarzbeck	PLF-100	549489	9KHz-3GHz	05/20/2021	1 Year
12.	Cable	Rosenberger	CIL02	A0783566	9KHz-3GHz	05/20/2021	1 Year
13.	Cable	Rosenberger	RG 233/U	525178	9KHz-3GHz	05/20/2021	1 Year
14.	Signal Analyzer	Rohde & Schwarz	FSV30	103040	9KHz-40GHz	05/20/2021	1 Year
15.	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	1GHz-18GHz	05/20/2021	1 Year
16.	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	14GHz -26.5GHz	05/20/2021	1 Year
17.	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	05/20/2021	1 Year
18.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	1 Year
19.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	1 Year
20.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	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 31, 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)
--	--	--	--	--

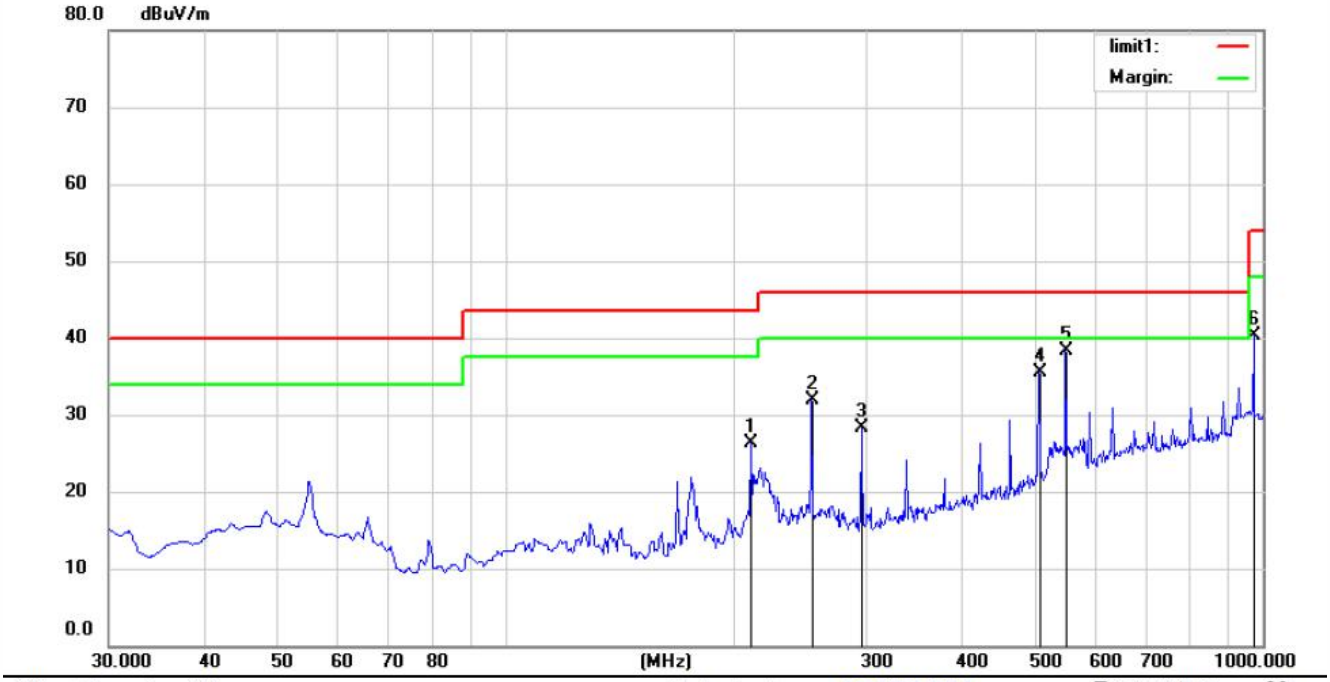
Note: The low frequency, which started from 9KHz-30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

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

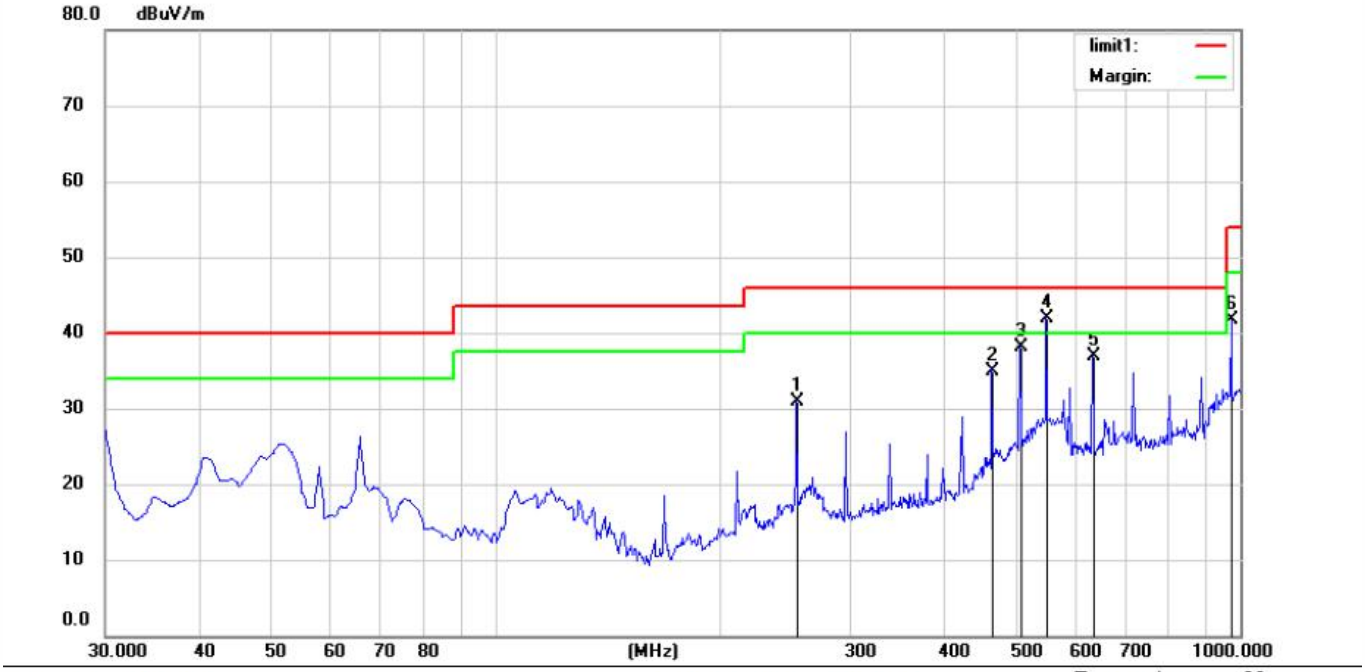
Limit: (RE)FCC PART 15 C 3m Power: AC 120V/60Hz Humidity: 55 %

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		211.3900	43.60	-17.38	26.22	43.50	-17.28	QP			
2		254.0700	47.32	-15.51	31.81	46.00	-14.19	QP			
3		295.7800	42.07	-13.81	28.26	46.00	-17.74	QP			
4		508.2100	44.20	-8.71	35.49	46.00	-10.51	QP			
5	*	550.8900	46.00	-7.71	38.29	46.00	-7.71	QP			
6		974.7800	40.44	-0.09	40.35	54.00	-13.65	QP			

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



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

Limit: (RE)FCC PART 15 C 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		254.0700	46.43	-15.51	30.92	46.00	-15.08	QP			
2		465.5300	44.67	-9.78	34.89	46.00	-11.11	QP			
3		508.2100	46.80	-8.71	38.09	46.00	-7.91	QP			
4	*	550.8900	49.70	-7.71	41.99	46.00	-4.01	QP			
5		635.2800	42.30	-5.45	36.85	46.00	-9.15	QP			
6		974.7800	41.79	-0.09	41.70	54.00	-12.30	QP			

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

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 31, 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	92.27	73.63	-32.3	59.97	41.33	74	54	-14.03	-12.67
7206	V	94.15	70.09	-37.2	56.95	32.89	74	54	-17.05	-21.11
9608	V	91.97	72.90	-39.8	52.17	33.10	74	54	-21.83	-20.90
12010	V	98.14	76.64	-40.5	57.64	36.14	74	54	-16.36	-17.86
14412	V	94.38	72.34	-41.7	52.68	30.64	74	54	-21.32	-23.36
16814	V	97.93	74.17	-40.0	57.93	34.17	74	54	-16.07	-19.83
4804	H	91.09	75.01	-31.6	59.49	43.41	74	54	-14.51	-10.59
7206	H	98.62	72.08	-35.5	63.12	36.58	74	54	-10.88	-17.42
9608	H	98.46	70.93	-38.3	60.16	32.63	74	54	-13.84	-21.37
12010	H	98.22	75.57	-39.0	59.22	36.57	74	54	-14.78	-17.43
14412	H	94.49	76.37	-42.0	52.49	34.37	74	54	-21.51	-19.63
16814	H	95.44	74.66	-39.3	56.14	35.36	74	54	-17.86	-18.64

Operation Mode: GFSK (CH40: 2441MHz) Test Date : May 31, 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	91.60	70.53	-32.3	59.3	38.23	74	54	-14.70	-15.77
7323	V	93.44	70.85	-37.2	56.24	33.65	74	54	-17.76	-20.35
9764	V	96.04	76.80	-39.8	56.24	37	74	54	-17.76	-17.00
12205	V	91.97	70.97	-40.5	51.47	30.47	74	54	-22.53	-23.53
14646	V	94.97	75.40	-41.0	53.97	34.4	74	54	-20.03	-19.60
17087	V	97.10	73.95	-41.1	56	32.85	74	54	-18.00	-21.15
4882	H	97.95	71.81	-31.6	66.35	40.21	74	54	-7.65	-13.79
7323	H	96.04	73.12	-35.5	60.54	37.62	74	54	-13.46	-16.38
9764	H	92.02	76.03	-38.3	53.72	37.73	74	54	-20.28	-16.27
12205	H	93.07	74.44	-39.0	54.07	35.44	74	54	-19.93	-18.56
14646	H	92.10	76.89	-42.0	50.1	34.89	74	54	-23.90	-19.11
17087	H	95.47	70.63	-41.5	53.97	29.13	74	54	-20.03	-24.87

Operation Mode: GFSK (CH79: 2480MHz) Test Date : May 31, 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	95.51	76.67	-32.3	63.21	44.37	74	54	-10.79	-9.63
7440	V	94.04	70.42	-37.2	56.84	33.22	74	54	-17.16	-20.78
9920	V	93.90	75.20	-39.8	54.1	35.4	74	54	-19.90	-18.60
12400	V	97.46	71.92	-40.5	56.96	31.42	74	54	-17.04	-22.58
14880	V	95.88	76.10	-41.0	54.88	35.1	74	54	-19.12	-18.90
17360	V	98.02	74.70	-41.1	56.92	33.6	74	54	-17.08	-20.40
4960	H	93.94	71.93	-31.6	62.34	40.33	74	54	-11.66	-13.67
7440	H	98.47	70.35	-35.5	62.97	34.85	74	54	-11.03	-19.15
9920	H	91.38	75.75	-38.3	53.08	37.45	74	54	-20.92	-16.55
12400	H	97.89	70.50	-39.0	58.89	31.5	74	54	-15.11	-22.50
14880	H	93.13	70.74	-42.0	51.13	28.74	74	54	-22.87	-25.26
17360	H	94.10	70.90	-41.5	52.6	29.4	74	54	-21.40	-24.60

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

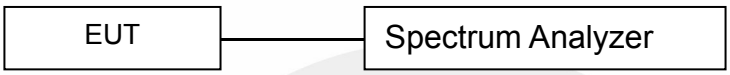
Note: (1) All Readings are Peak Value and AV.
(2) Emission Level= Reading Level+ Probe Factor +Cable Loss.
(3) The average measurement was not performed when the peak measured data under the limit of average detection.
(4) Measuring frequencies from 1GHz to 25GHz.

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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

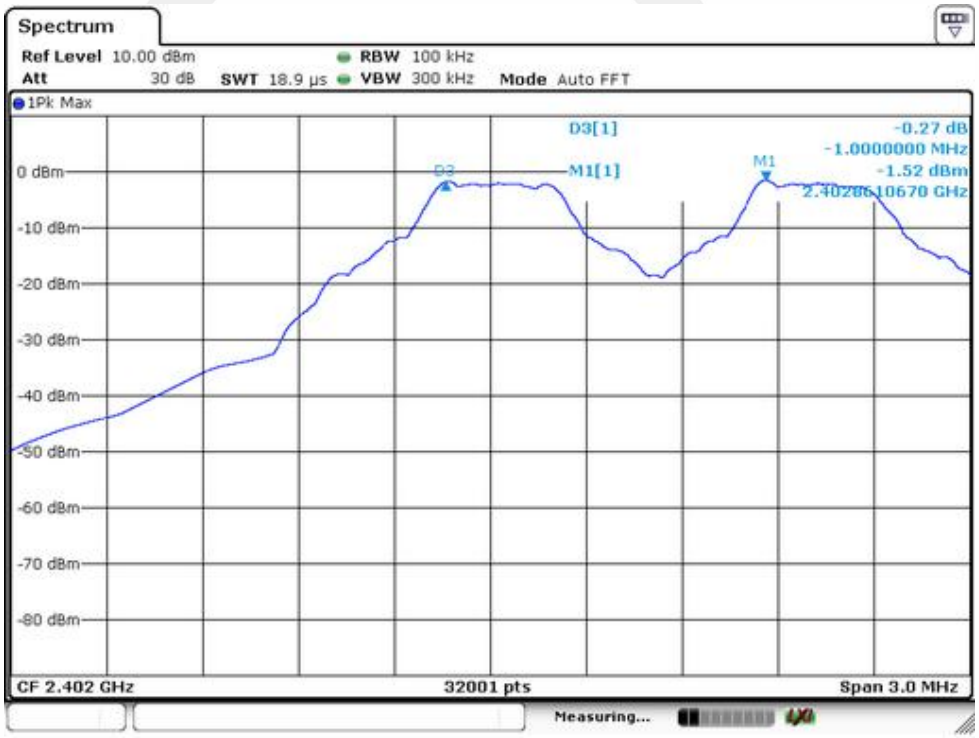
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

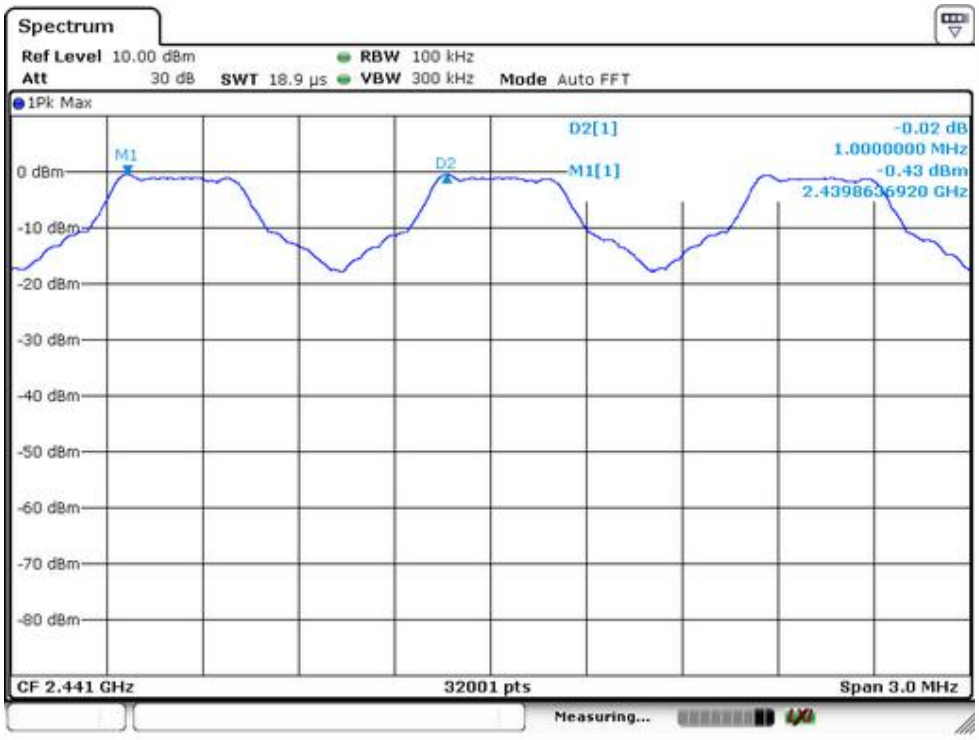
8.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 31, 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	1000	>757
40	2441	1000	>750
79	2480	1000	>741

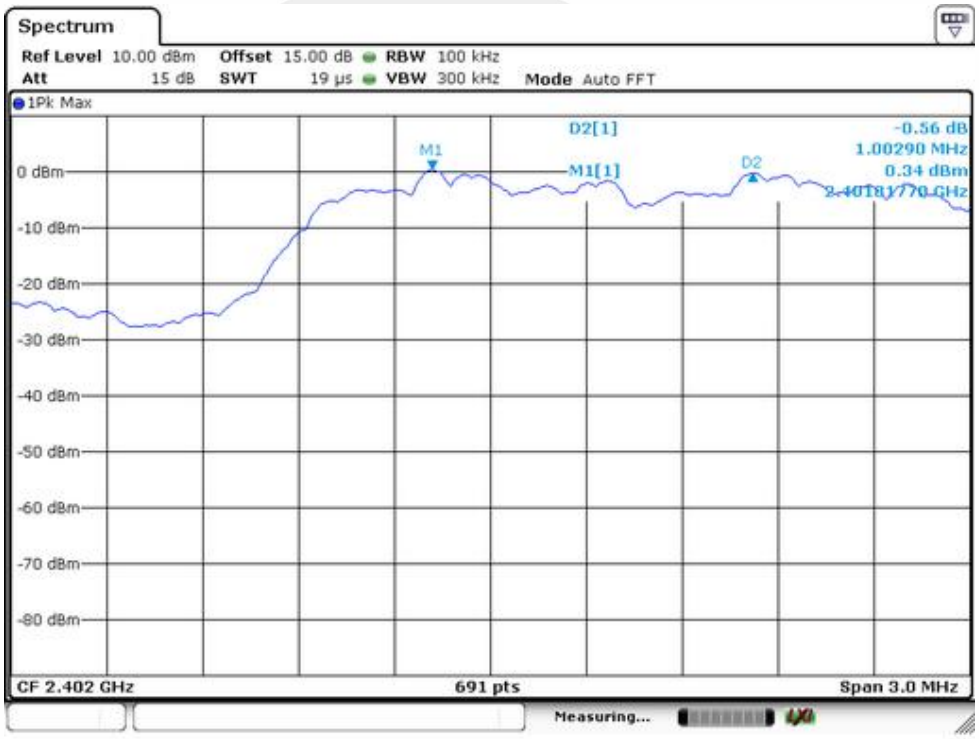


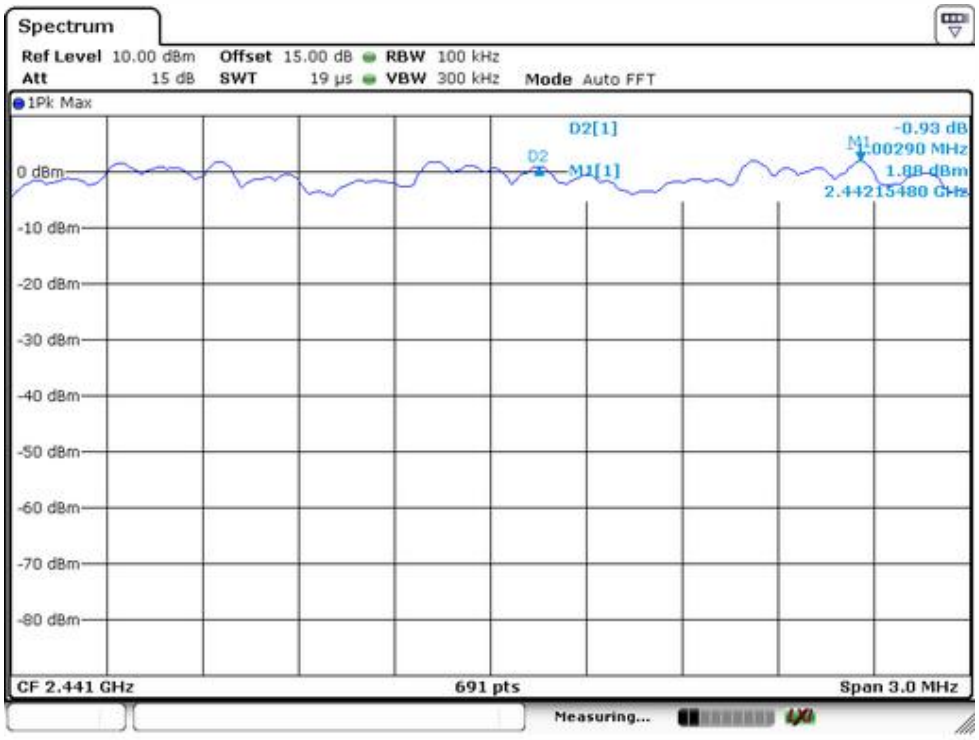

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB SWT 18.9 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D2[1] -0.02 dB
1.0000000 MHz
M1[1] -0.43 dBm
2.4398636920 GHz
M1
D2
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
32001 pts
Span 3.0 MHz
Measuring...


Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB SWT 18.9 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D2[1] -0.09 dB
1.0000940 MHz
M1[1] 0.65 dBm
2.4788652850 GHz
M1
D2
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
32001 pts
Span 3.0 MHz
Measuring...

Spectrum Detector:	PK	Test Date :	May 31, 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	1003	>941
40	2441	1003	>935
79	2480	1003	>926

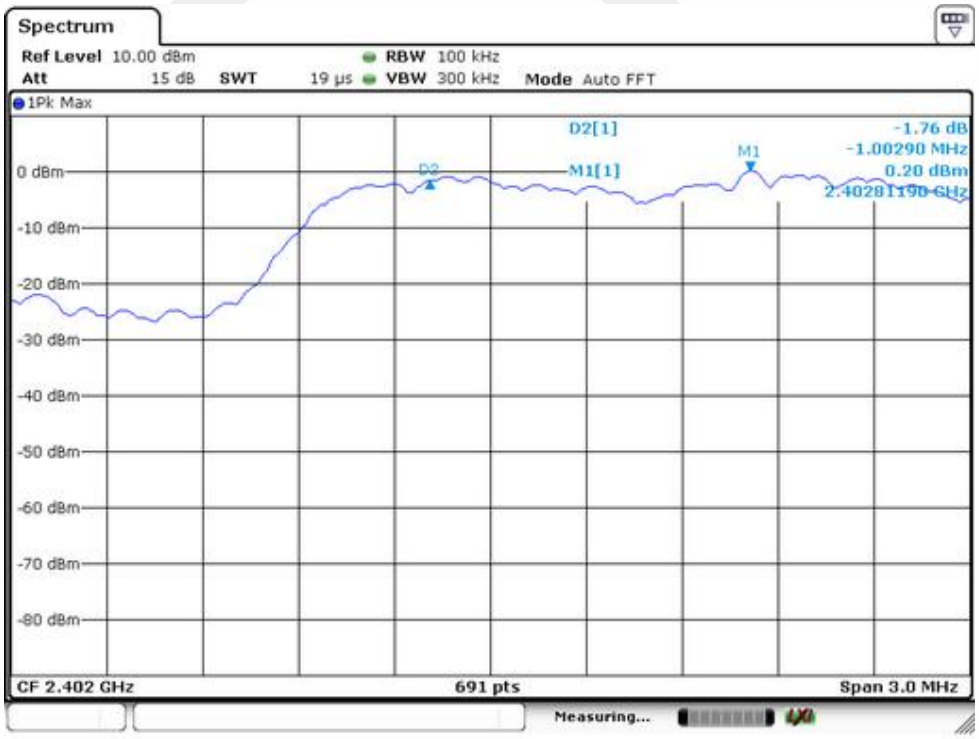


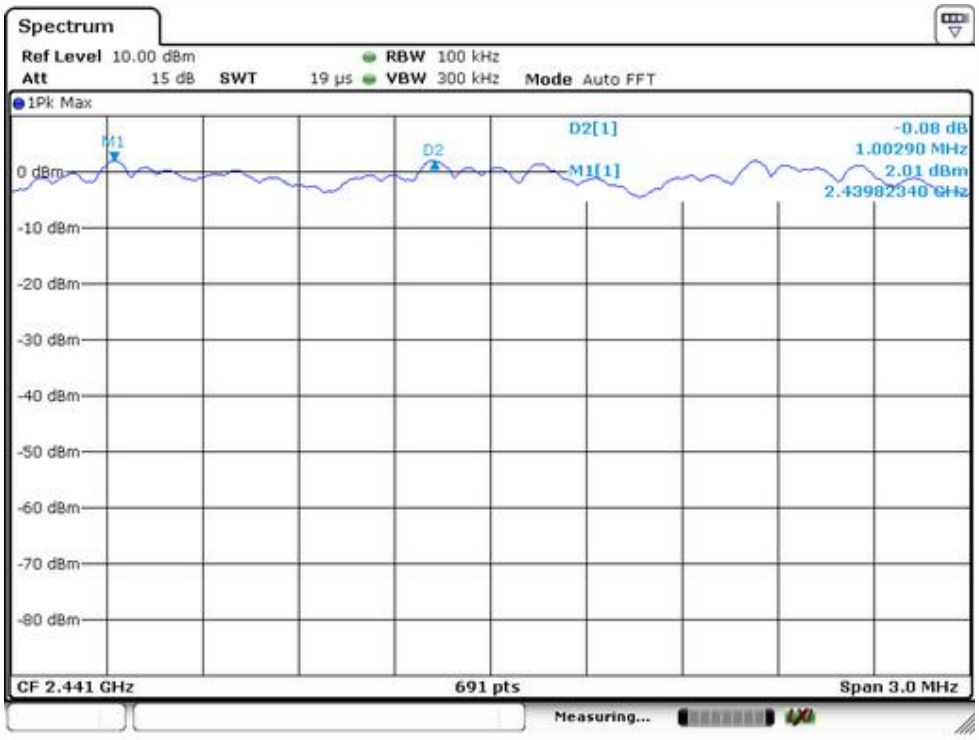

Spectrum
Ref Level 10.00 dBm Offset 15.00 dB RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D2[1] -0.93 dB
2.00290 MHz
D2 M1[1] 1.88 dBm
2.44215480 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
691 pts
Span 3.0 MHz
Measuring...


Spectrum
Ref Level 10.00 dBm Offset 15.00 dB RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D2[1] -1.15 dB
M1 -1.00290 MHz
D2 M1[1] 0.81 dBm
2.47982630 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...

Spectrum Detector:	PK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	8DPSK		

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	1003	>958
40	2441	1003	>958
79	2480	1000	>947




Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1
D2
D2[1]
-0.08 dB
1.00290 MHz
M1[1]
2.01 dBm
2.43982340 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...

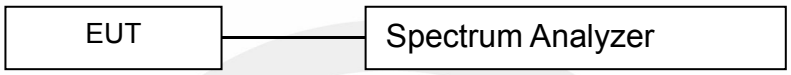

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB SWT 18.9 µs VBW 300 kHz Mode Auto FFT
1Pk Max 2Pk Max
D1
D1[1]
M1
M1[1]
-0.01 dB
-1.0000000 MHz
0.86 dBm
2.4801391210 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
32001 pts
Span 3.0 MHz
Measuring...

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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

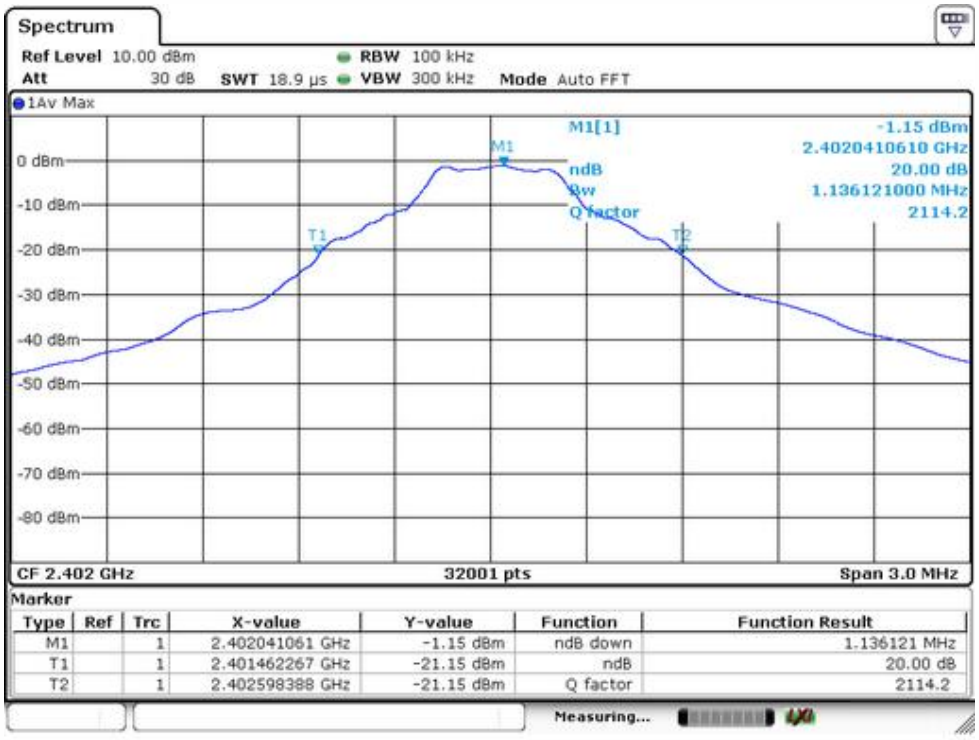
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

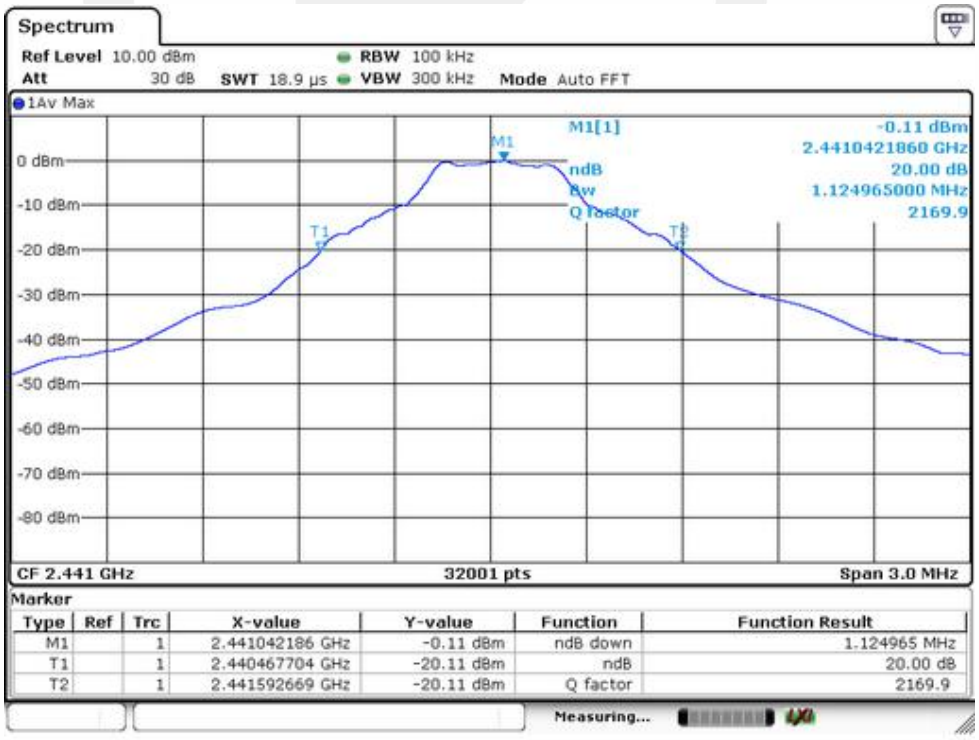
9.4 Measurement Results:

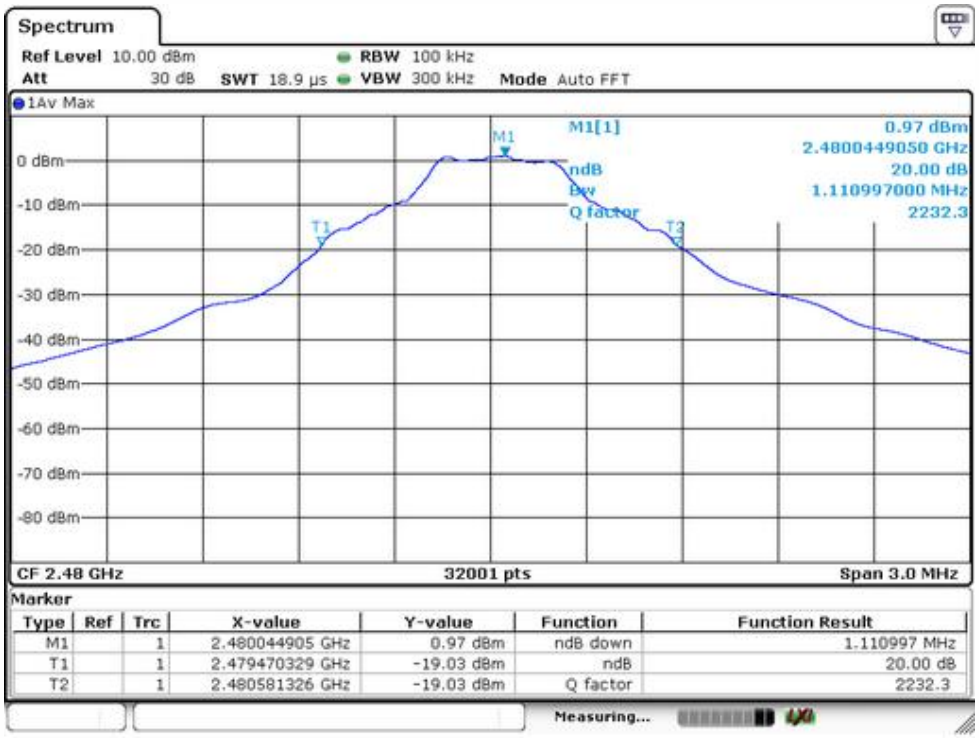
Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1136
40	2441	1125
79	2480	1111

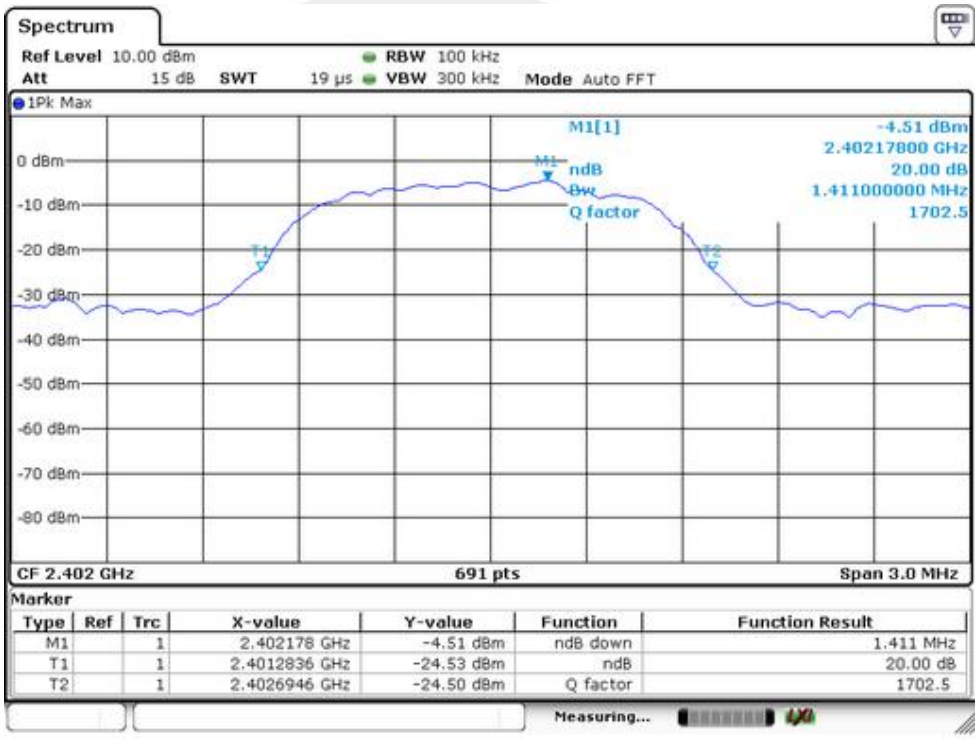

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB
SWT 18.9 µs
VBW 300 kHz
Mode Auto FFT
1Av Max
M1[1]
-1.15 dBm
2.4020410610 GHz
ndB 20.00 dB
Bw 1.136121000 MHz
Q factor 2114.2
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.402 GHz
32001 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.402041061 GHz -1.15 dBm ndB down 1.136121 MHz
T1 1 2.401462267 GHz -21.15 dBm ndB 20.00 dB
T2 1 2.402598388 GHz -21.15 dBm Q factor 2114.2
Measuring...

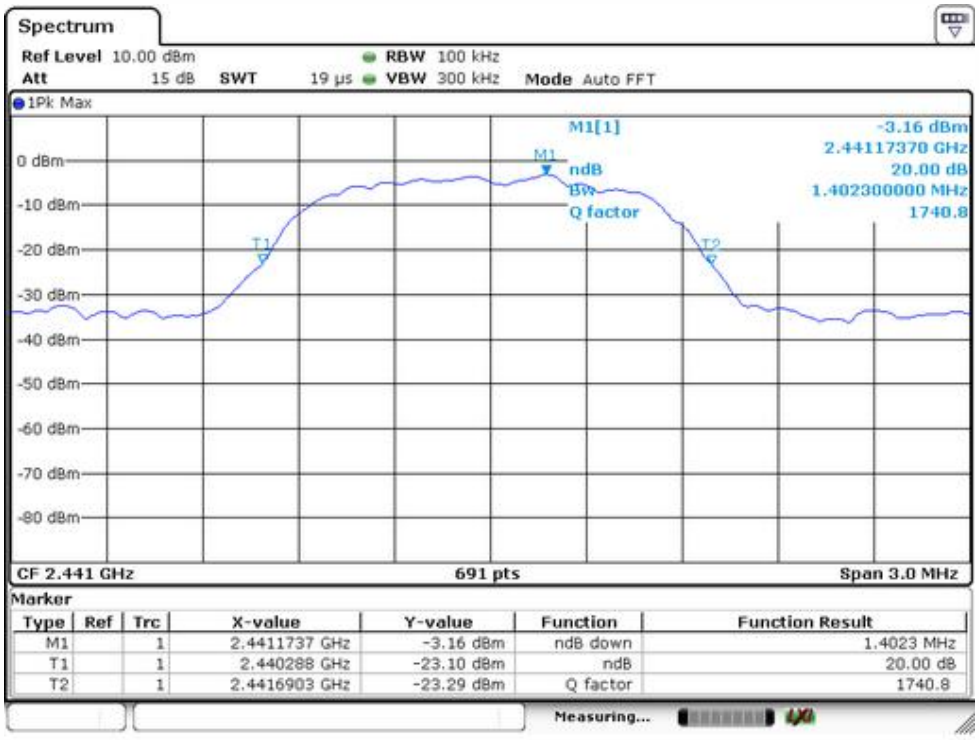

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB
SWT 18.9 µs
VBW 300 kHz
Mode Auto FFT
1Av Max
M1[1]
-0.11 dBm
2.4410421860 GHz
ndB 20.00 dB
Bw 1.124965000 MHz
Q factor 2169.9
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
32001 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.441042186 GHz -0.11 dBm ndB down 1.124965 MHz
T1 1 2.440467704 GHz -20.11 dBm ndB 20.00 dB
T2 1 2.441592669 GHz -20.11 dBm Q factor 2169.9
Measuring...

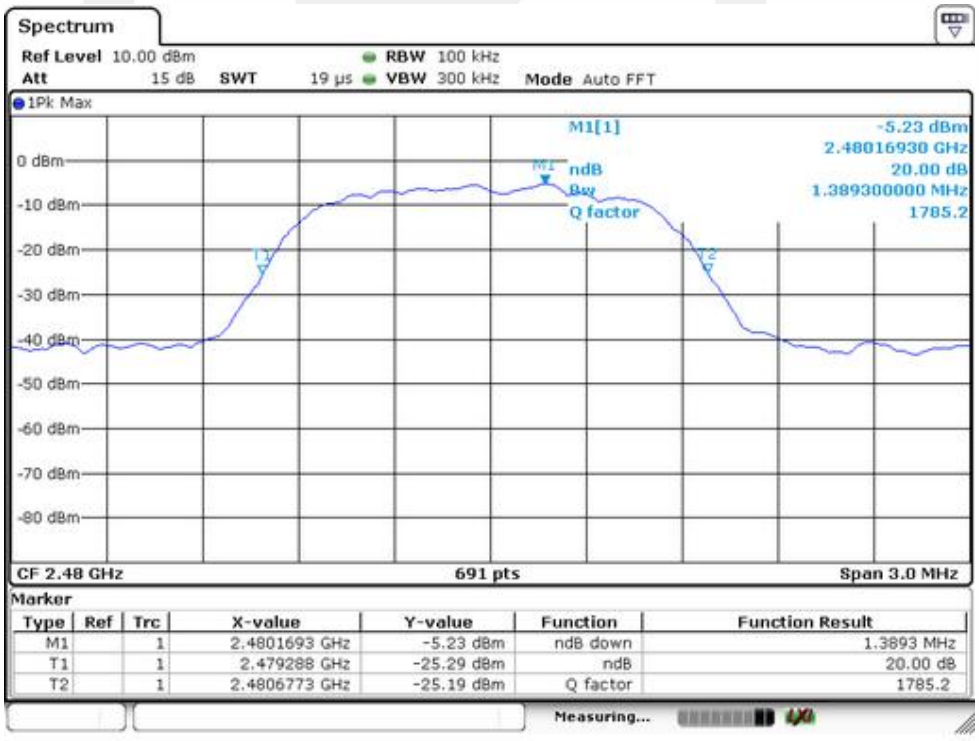

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 30 dB
SWT 18.9 µs
VBW 300 kHz
Mode Auto FFT
1Av Max
M1[1]
0.97 dBm
2.4800449050 GHz
ndB 20.00 dB
Bw 1.110997000 MHz
Q factor 2232.3
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
32001 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.480044905 GHz 0.97 dBm ndB down 1.110997 MHz
T1 1 2.479470329 GHz -19.03 dBm ndB 20.00 dB
T2 1 2.480581326 GHz -19.03 dBm Q factor 2232.3
Measuring...

Spectrum Detector:	PK	Test Date :	May 31, 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	1411
40	2441	1402
79	2480	1389

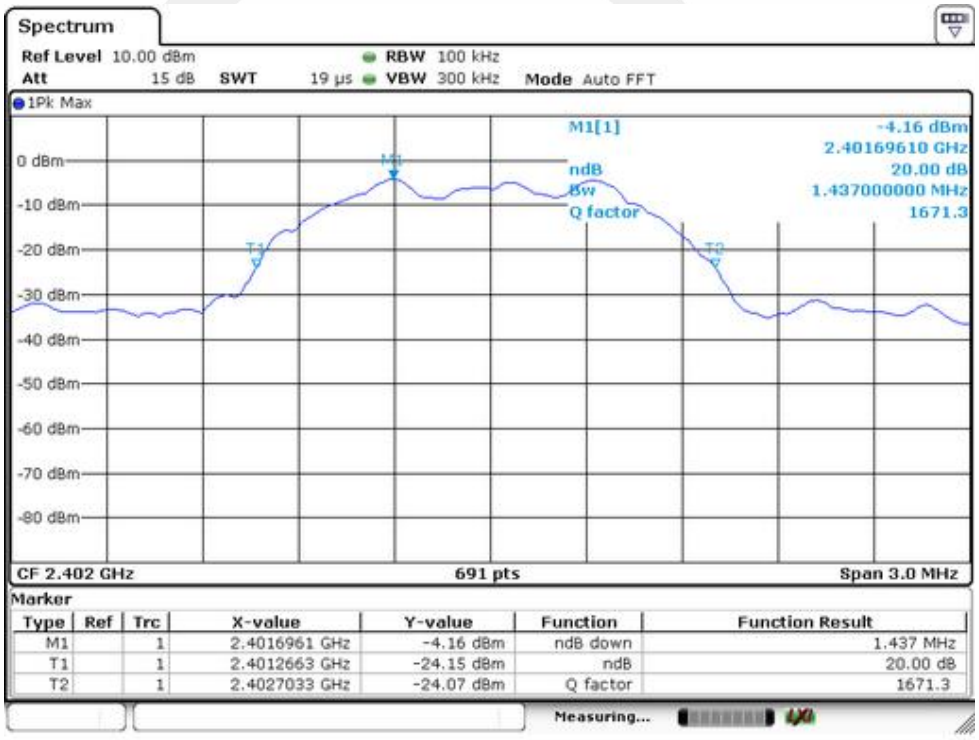


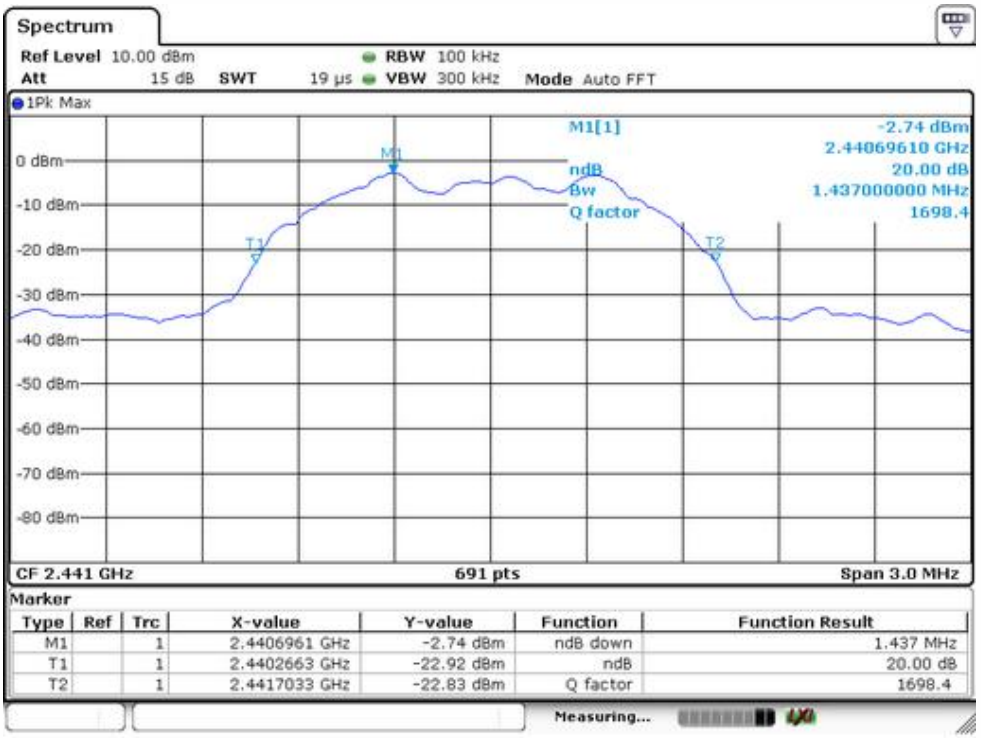

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-3.16 dBm
2.44117370 GHz
ndB 20.00 dB
Bw 1.402300000 MHz
Q factor 1740.8
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4411737 GHz -3.16 dBm ndB down 1.4023 MHz
T1 1 2.440288 GHz -23.10 dBm ndB 20.00 dB
T2 1 2.4416903 GHz -23.29 dBm Q factor 1740.8
Measuring...

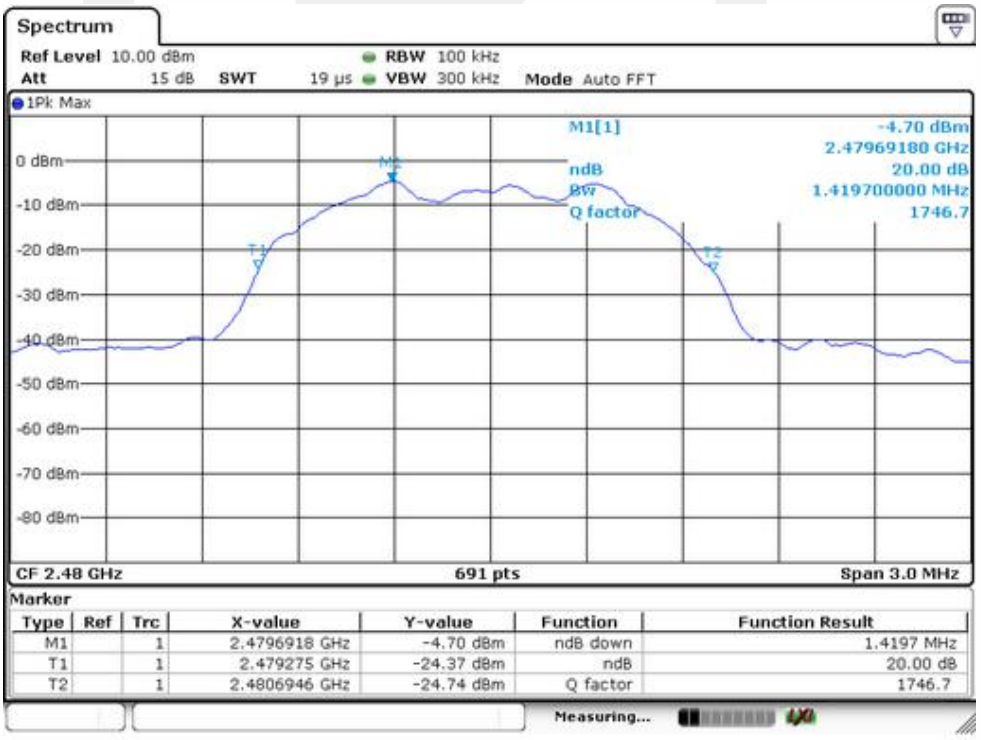

Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-5.23 dBm
2.48016930 GHz
ndB 20.00 dB
Bw 1.389300000 MHz
Q factor 1785.2
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4801693 GHz -5.23 dBm ndB down 1.3893 MHz
T1 1 2.479288 GHz -25.29 dBm ndB 20.00 dB
T2 1 2.4806773 GHz -25.19 dBm Q factor 1785.2
Measuring...

Spectrum Detector:	PK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	24℃
Test Result:	PASS	Humidity :	53 %
Modulation:	8DPSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1437
40	2441	1437
79	2480	1420




Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-2.74 dBm
2.44069610 GHz
ndB 20.00 dB
Bw 1.437000000 MHz
Q factor 1698.4
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
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4406961 GHz -2.74 dBm ndB down 1.437 MHz
T1 1 2.4402663 GHz -22.92 dBm ndB 20.00 dB
T2 1 2.4417033 GHz -22.83 dBm Q factor 1698.4
Measuring...


Spectrum
Ref Level 10.00 dBm
RBW 100 kHz
Att 15 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1[1]
-4.70 dBm
2.47969180 GHz
ndB 20.00 dB
Bw 1.419700000 MHz
Q factor 1746.7
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
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.4796918 GHz -4.70 dBm ndB down 1.4197 MHz
T1 1 2.479275 GHz -24.37 dBm ndB 20.00 dB
T2 1 2.4806946 GHz -24.74 dBm Q factor 1746.7
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)

EUT —— Spectrum Analyzer

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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

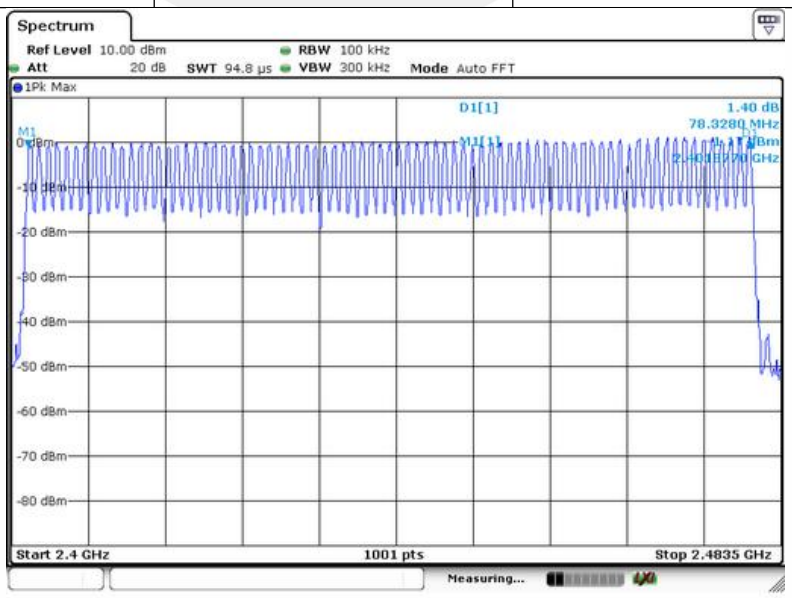
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

10.4 Measurement Results:

Refer to attached data chart.

Worst Test Mode	GFSK	Test Date :	May 31, 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



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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

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.

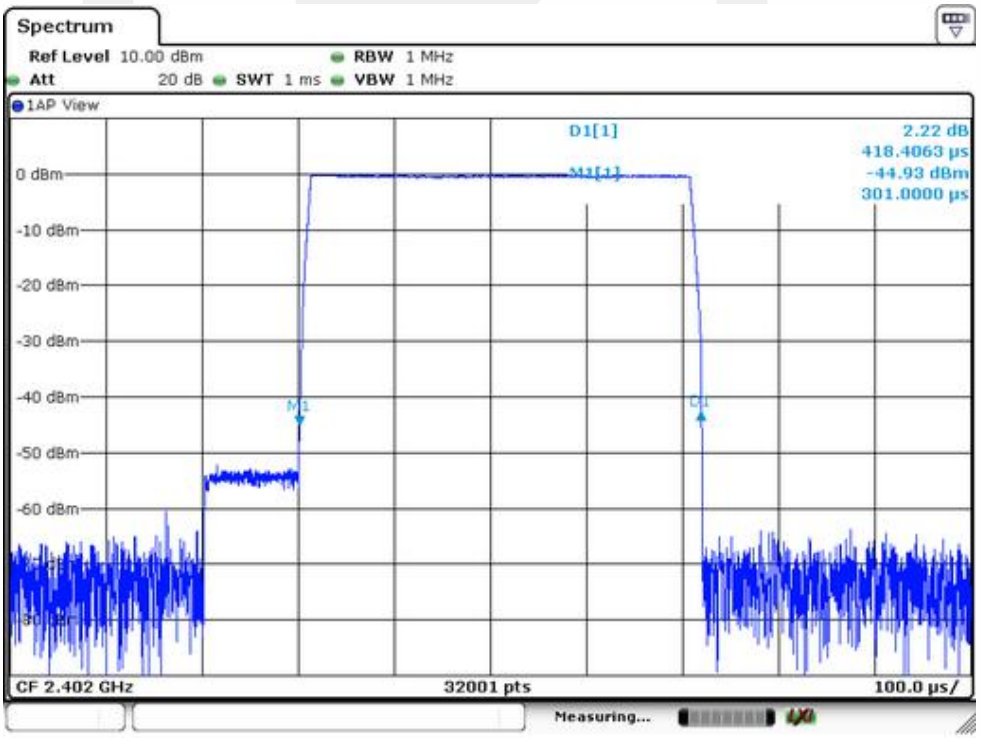
Modulation:	GFSK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %

11.5 Test result

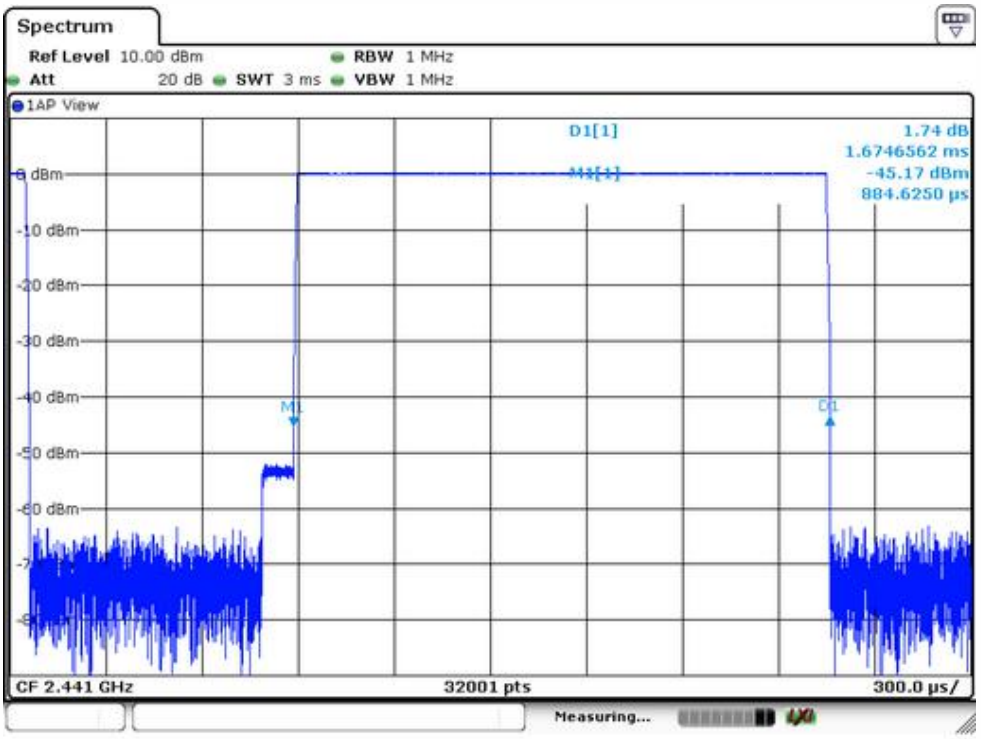
Mode	Number of transmission in a 31.6(79 Hopping*0.4)	Length of transmissions time(msec)	Result (msec)	Limit (msec)
DH1	1600/(2*79) x 31.6 = 320	0.418	133.76	400
DH3	1600/(4*79) x 31.6 =160	1.675	268.00	400
DH5	1600/(6*79) x 31.6 =106.67	2.921	311.58	400

Remark: The results of worst cased was recorded.

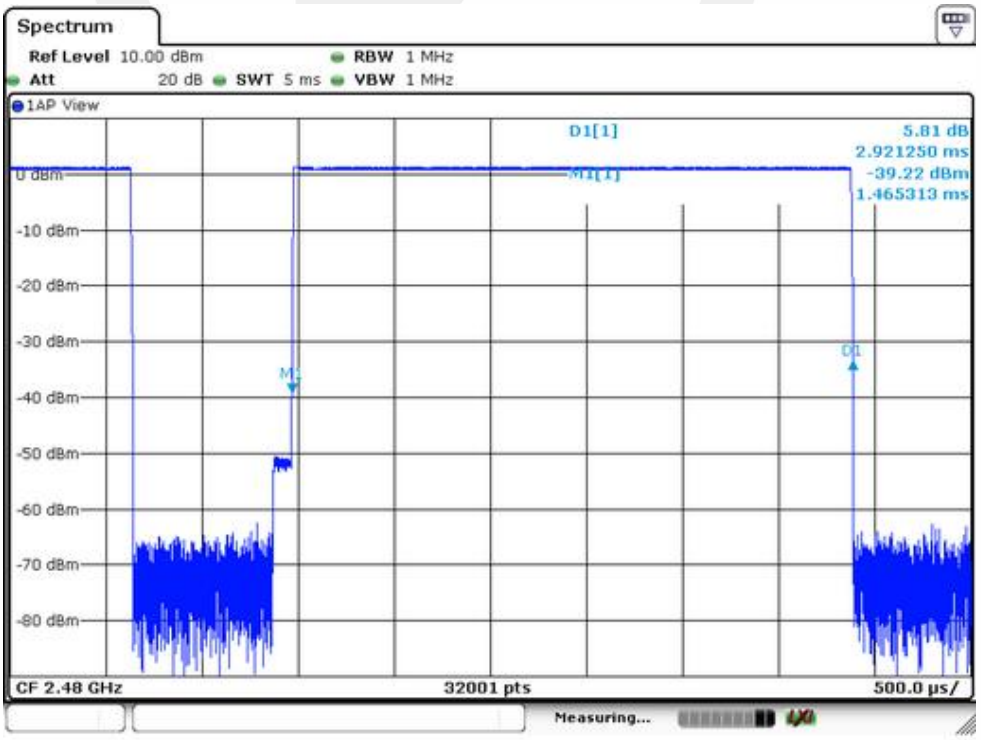
DH1:



DH3:


Spectrum
Ref Level 10.00 dBm
RBW 1 MHz
Att 20 dB SWT 3 ms VBW 1 MHz
1AP View
D1[1]
1.74 dB
1.6746562 ms
M1[1]
-45.17 dBm
884.6250 µs
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
M1
D1
CF 2.441 GHz
32001 pts
300.0 µs/
Measuring...

DH5:


Spectrum
Ref Level 10.00 dBm
RBW 1 MHz
Att 20 dB SWT 5 ms VBW 1 MHz
1AP View
D1[1]
5.81 dB
2.921250 ms
M1[1]
-39.22 dBm
1.465313 ms
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
M1
D1
CF 2.48 GHz
32001 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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

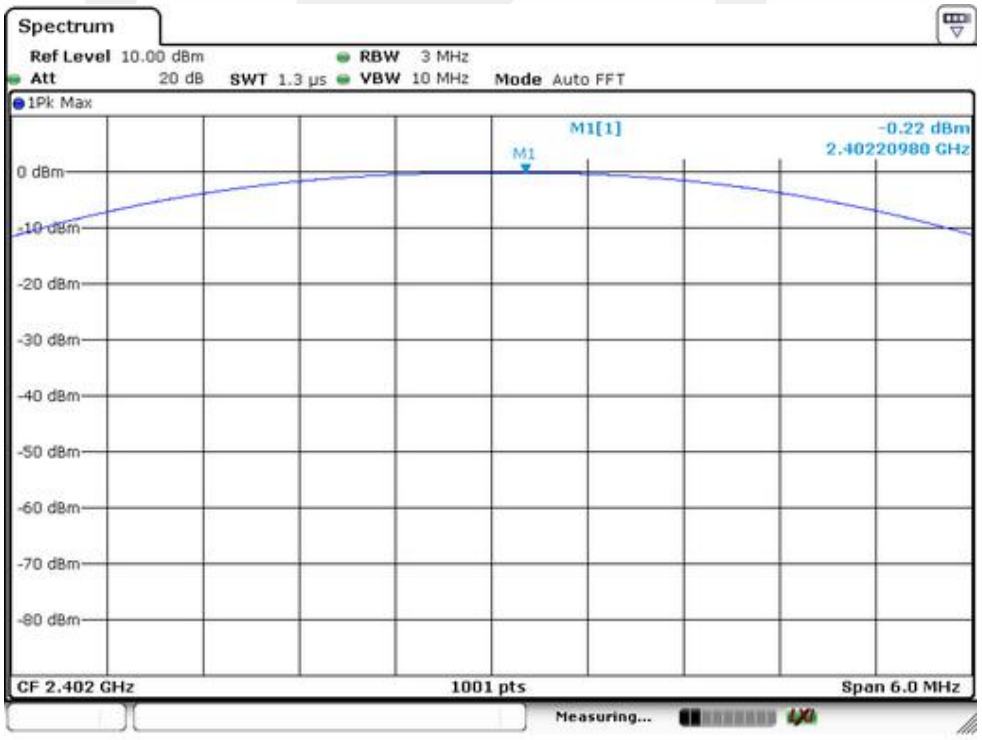
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

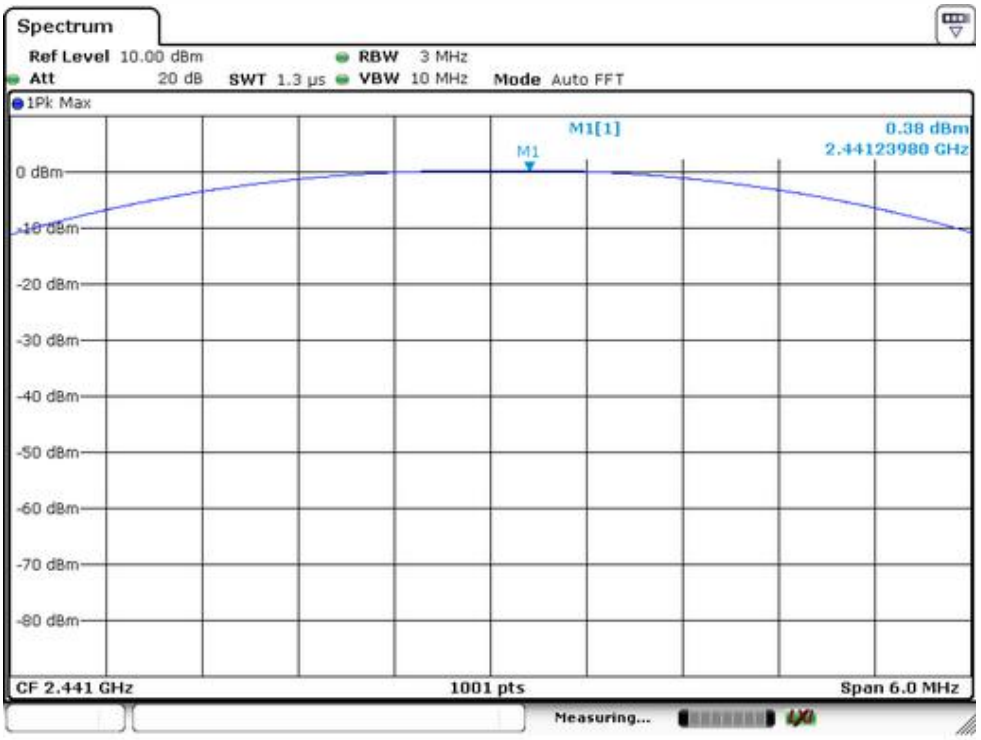
12.4 Measurement Results:

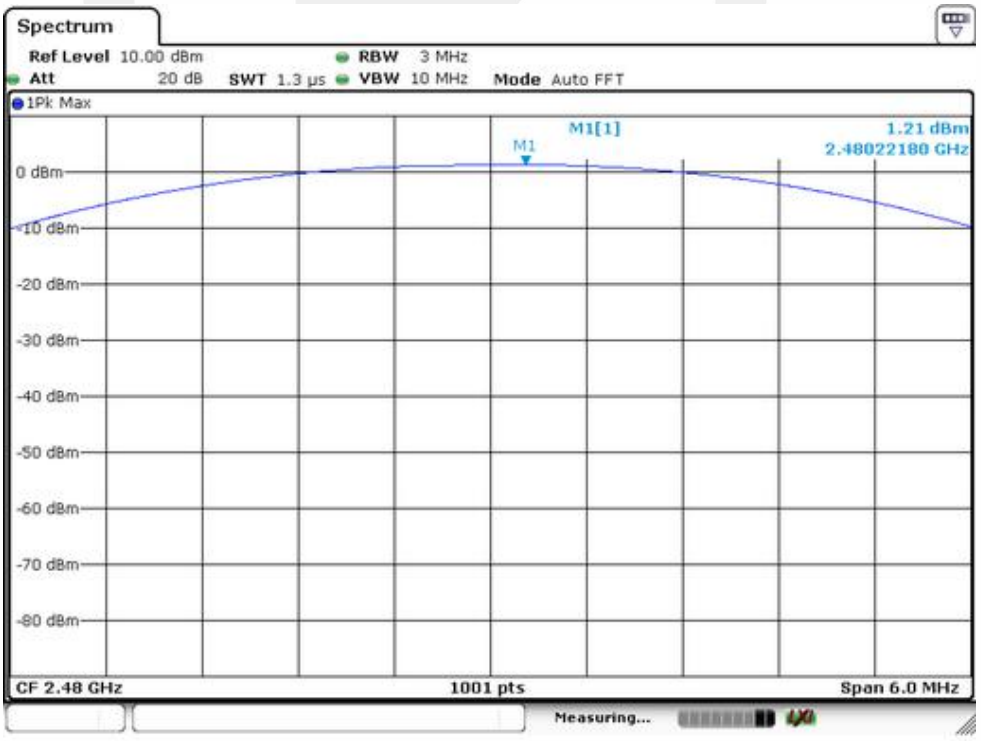
Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	May 31, 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	-0.22	0.951	1000	PASS
40	2441	0.38	1.091	1000	PASS
79	2480	1.21	1.321	1000	PASS

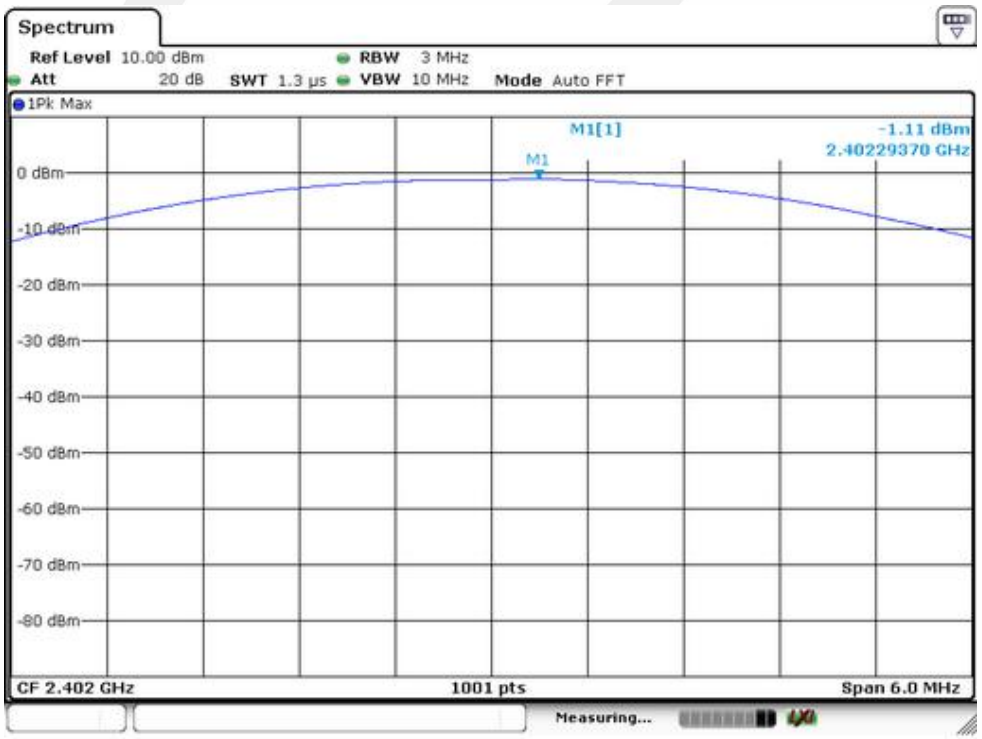


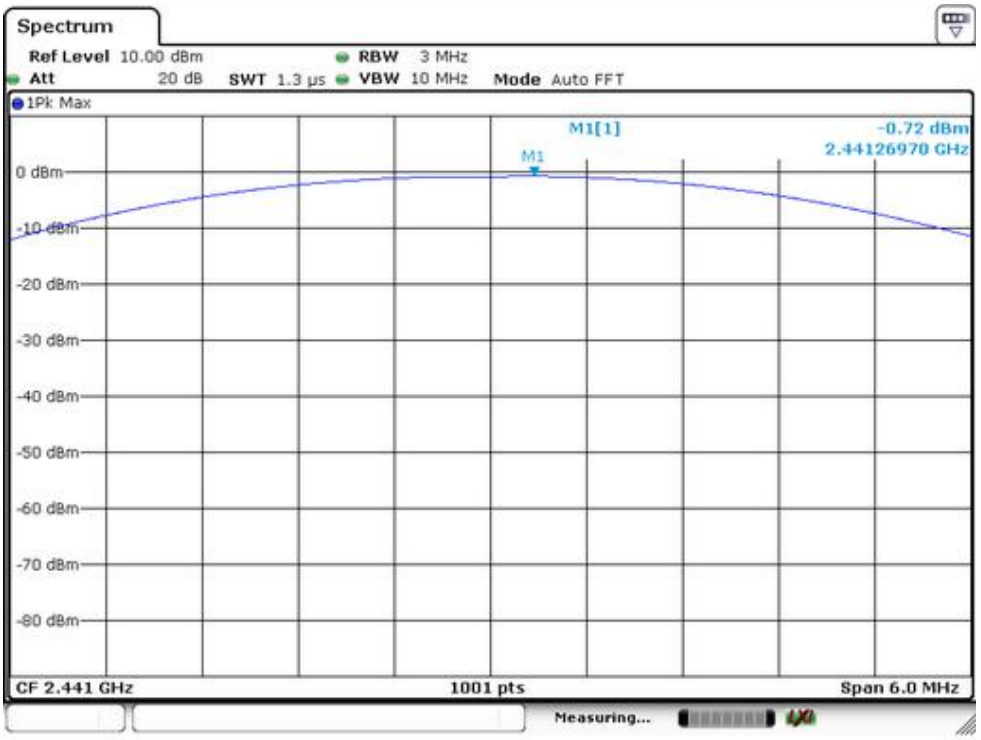

Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.38 dBm
2.44123980 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
1001 pts
Span 6.0 MHz
Measuring...

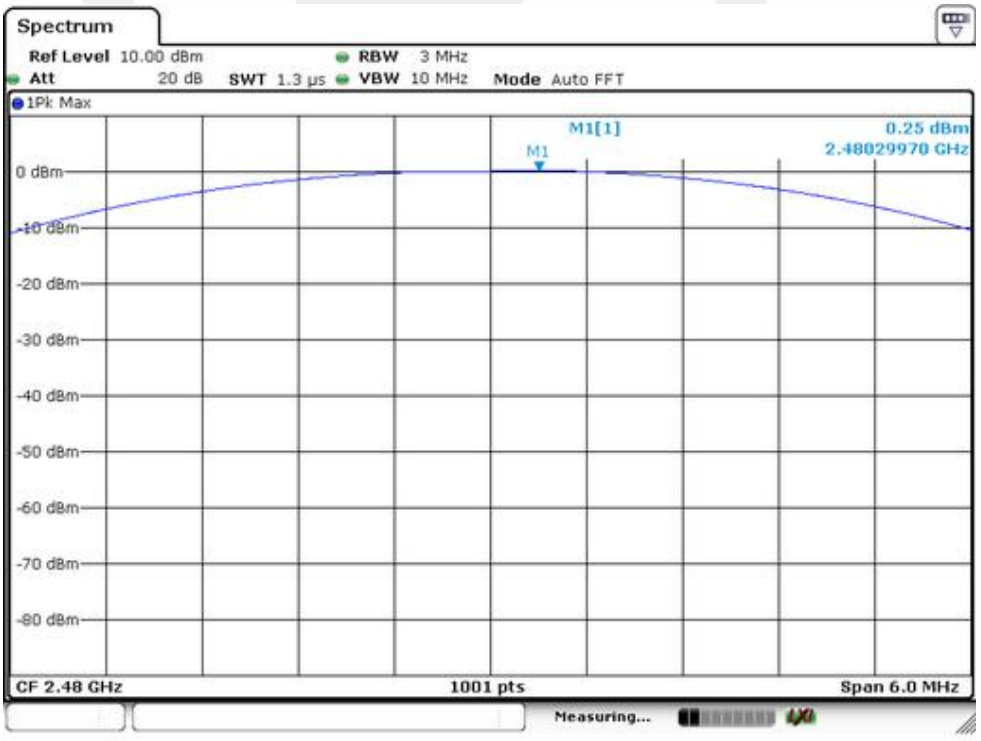

Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
1.21 dBm
2.48022180 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
1001 pts
Span 6.0 MHz
Measuring...

Spectrum Detector:	PK	Test Date :	May 31, 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	-1.11	0.774	125	PASS
40	2441	-0.72	0.847	125	PASS
79	2480	0.25	1.059	125	PASS

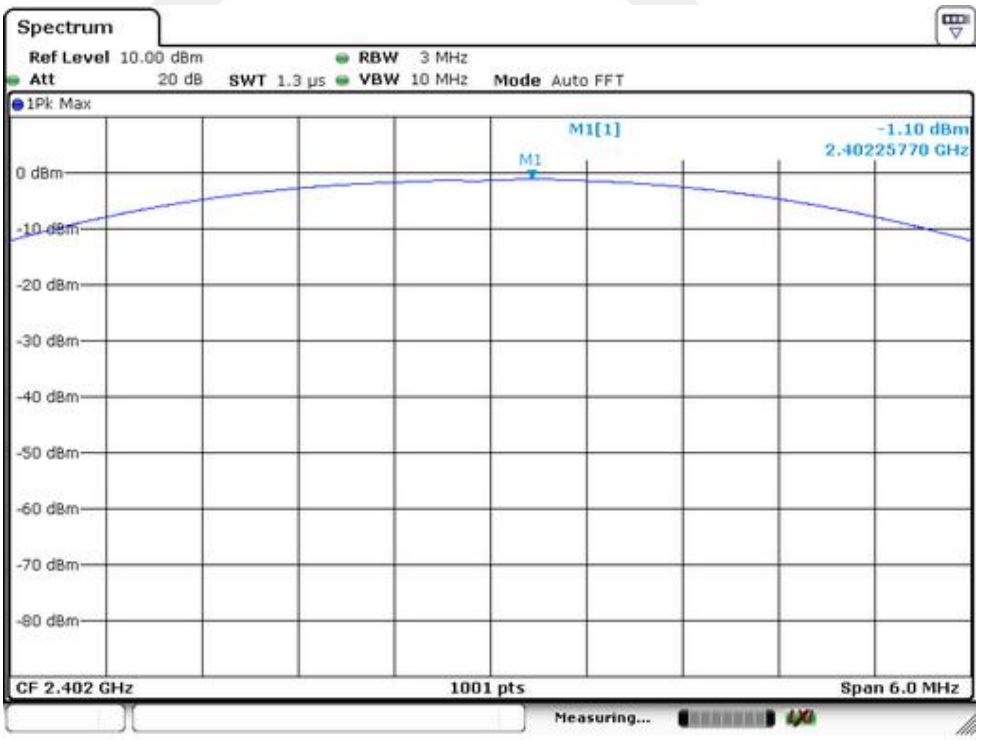


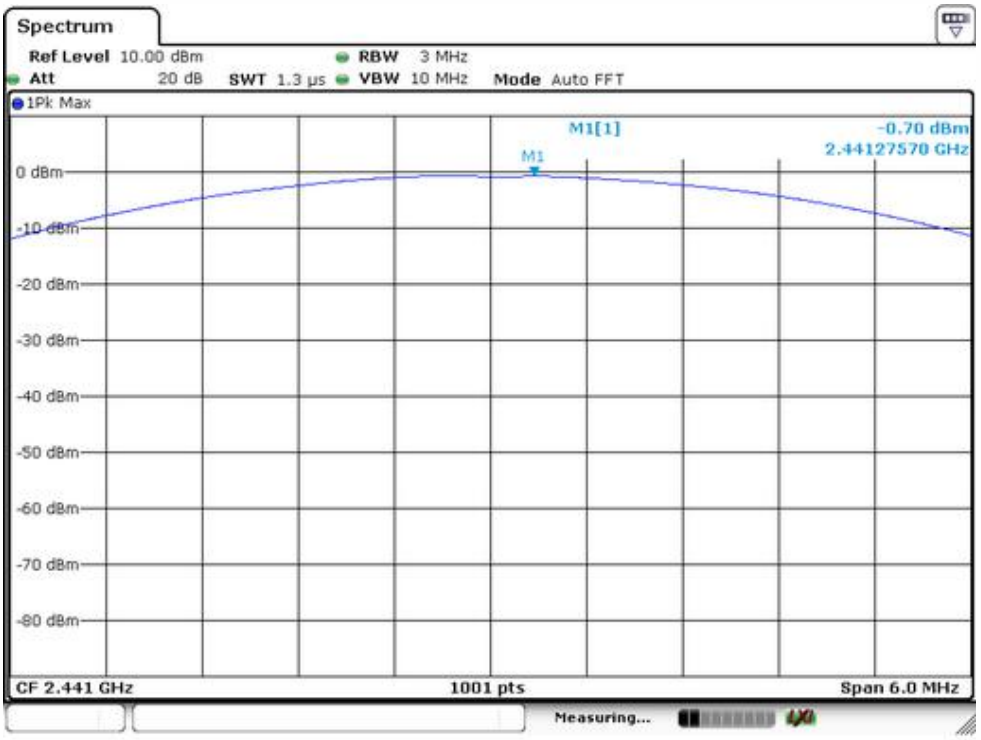

Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
-0.72 dBm
2.44126970 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
1001 pts
Span 6.0 MHz
Measuring...

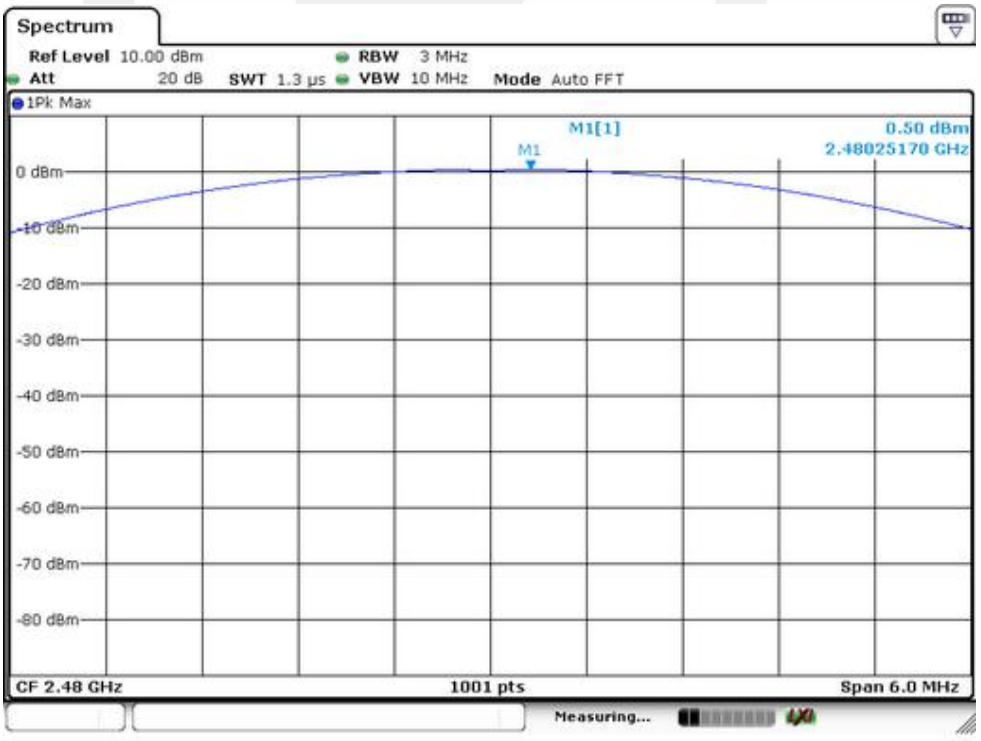

Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.25 dBm
2.48029970 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
1001 pts
Span 6.0 MHz
Measuring...

Spectrum Detector:	PK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %
Modulation:	8DPSK		

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-1.10	0.776	125	PASS
40	2441	-0.70	0.851	125	PASS
79	2480	0.50	1.122	125	PASS




Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
-0.70 dBm
2.44127570 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.441 GHz
1001 pts
Span 6.0 MHz
Measuring...


Spectrum
Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 1.3 µs VBW 10 MHz Mode Auto FFT
1Pk Max
M1[1]
0.50 dBm
2.48025170 GHz
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
1001 pts
Span 6.0 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:

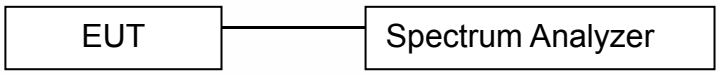
EMI Test Receiver	Setting
Attenuation	Auto
RBW	1MHz
VBW	3MHz
Detector	Peak
Trace	Max hold

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

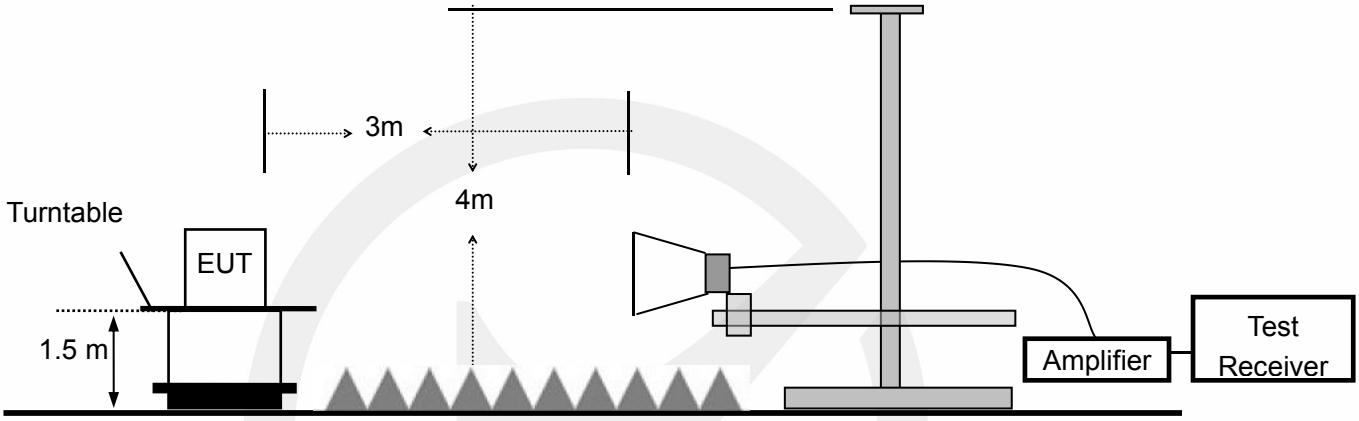
EMI Test Receiver	Setting
Attenuation	Auto
RBW	100KHz
VBW	300KHz
Detector	Peak
Trace	Max hold

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	05/20/2021	05/19/2022
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/20/2021	05/19/2022
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/20/2021	05/19/2022

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	05/20/2021	1 Year
2	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	1GHz-18GHz	05/20/2021	1 Year
3	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	05/20/2021	1 Year
4	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	1 Year
5	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	1 Year
6	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	05/20/2021	1 Year

13.4 Measurement Results:

Refer to attached data chart.

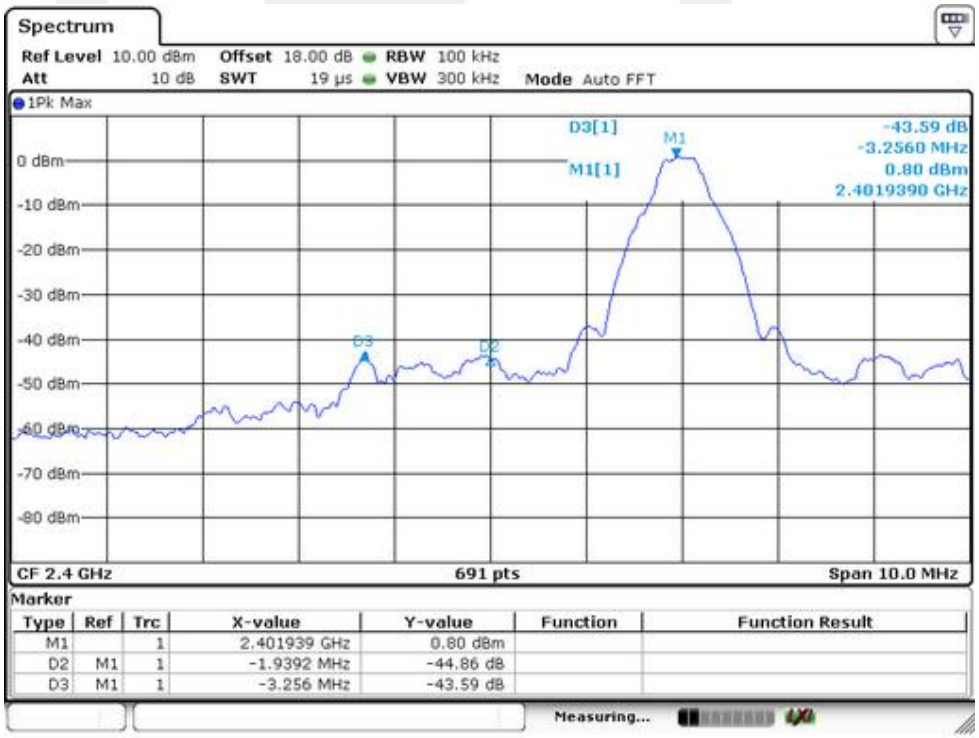
Spectrum Detector:	PK	Test Date :	May 31, 2020
Test By:	Loren	Temperature :	25 ℃
Test Result:	PASS	Humidity :	50 %

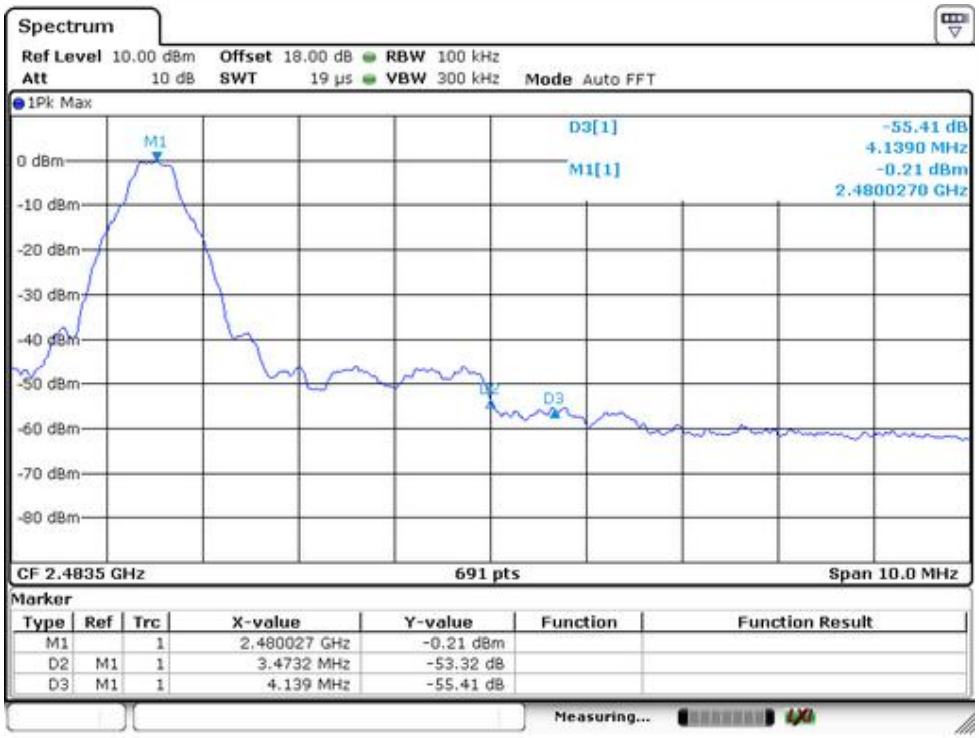
1. Conducted Test

For Non-Hopping Mode:

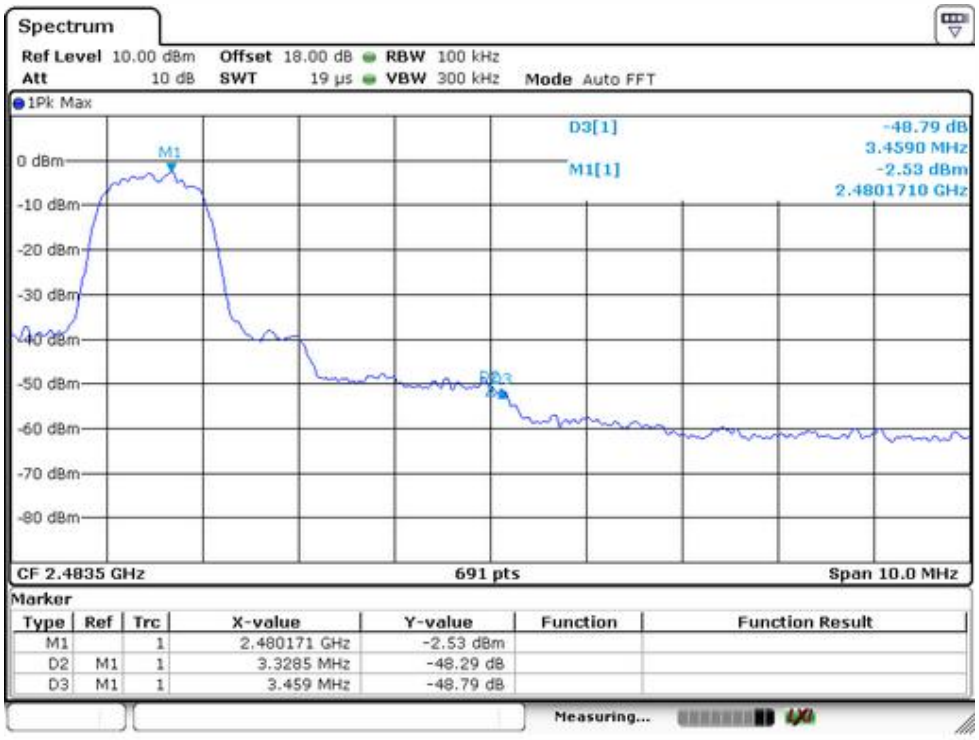
Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2401.82	GFSK	0.80	43.59	>20dBc
2401.82	pi/4-DQPSK	-1.42	42.1	>20dBc
2401.82	8DPSK	-1.06	41.39	>20dBc
2479.82	GFSK	-0.21	55.41	>20dBc
2479.82	pi/4-DQPSK	-2.53	48.79	>20dBc
2479.82	8DPSK	-2.09	45.65	>20dBc

Test plots of GFSK

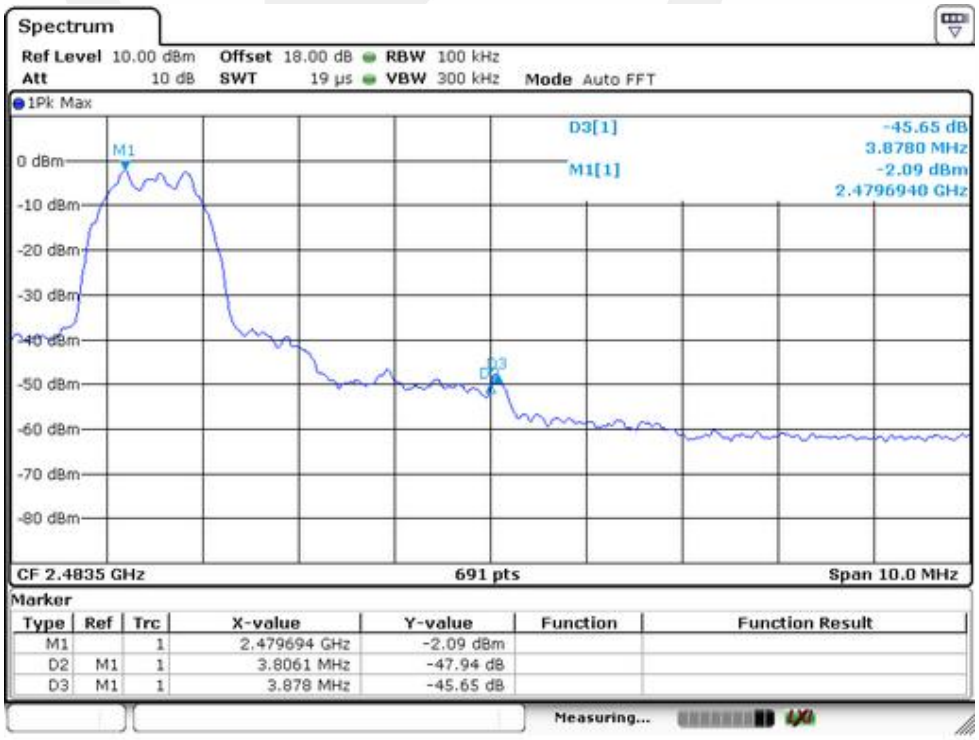


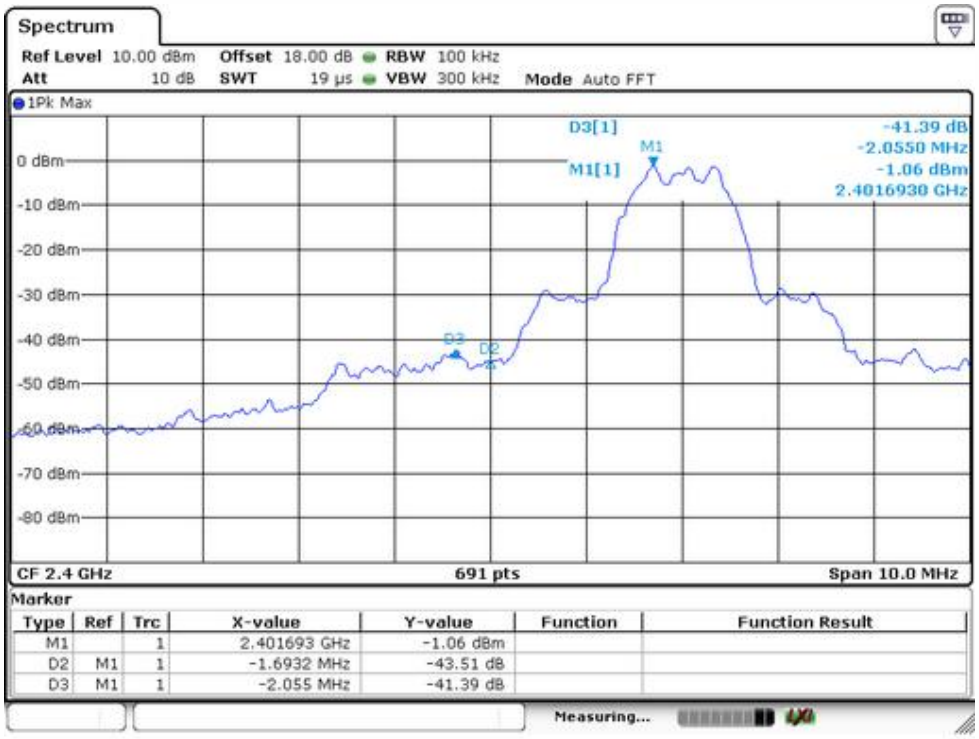


Test plots of pi/4-DQPSK



Test plots of 8DPSK

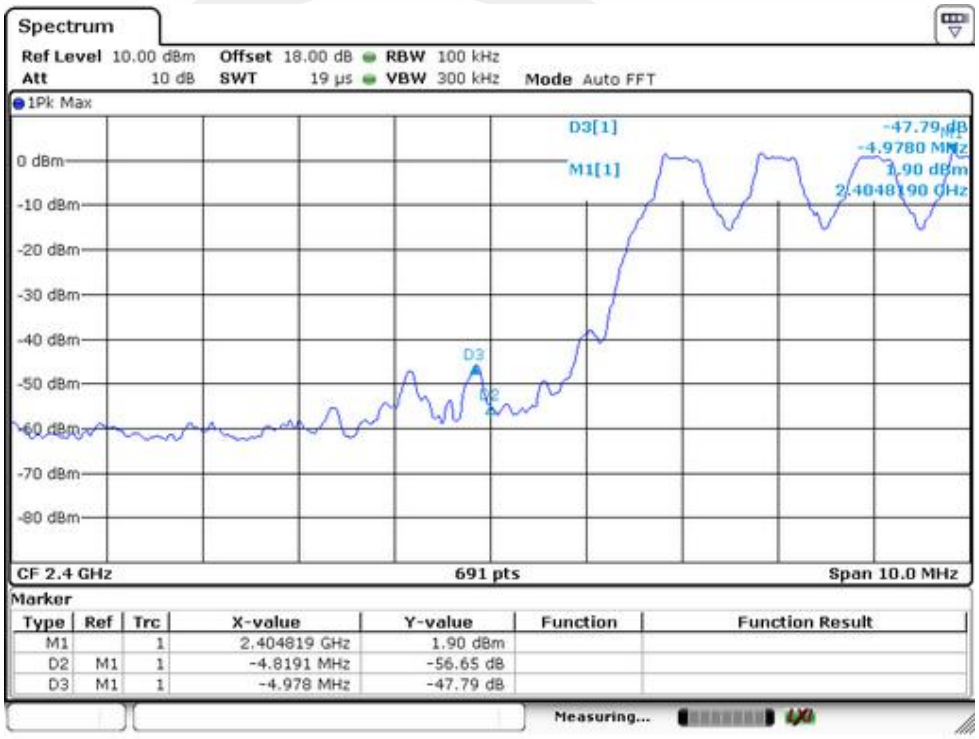


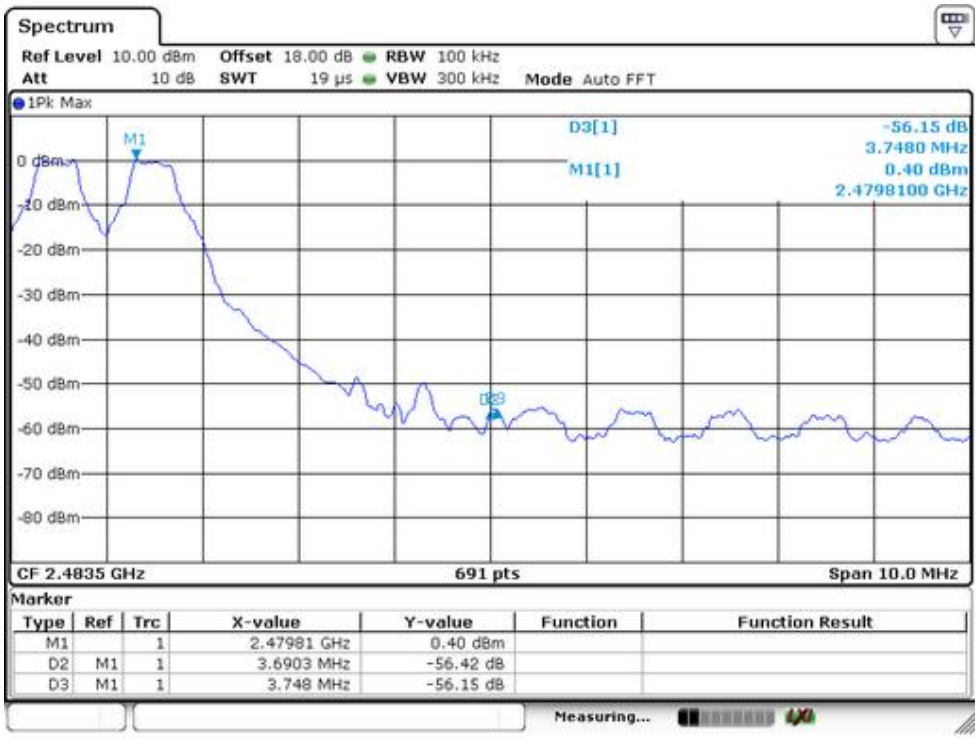

Spectrum
Ref Level 10.00 dBm Offset 18.00 dB RBW 100 kHz
Att 10 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
D3[1] -41.39 dB
-2.0550 MHz
M1[1] -1.06 dBm
2.4016930 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.4 GHz
691 pts
Span 10.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.401693 GHz -1.06 dBm
D2 M1 1 -1.6932 MHz -43.51 dB
D3 M1 1 -2.055 MHz -41.39 dB
Measuring...

For Hopping Mode:

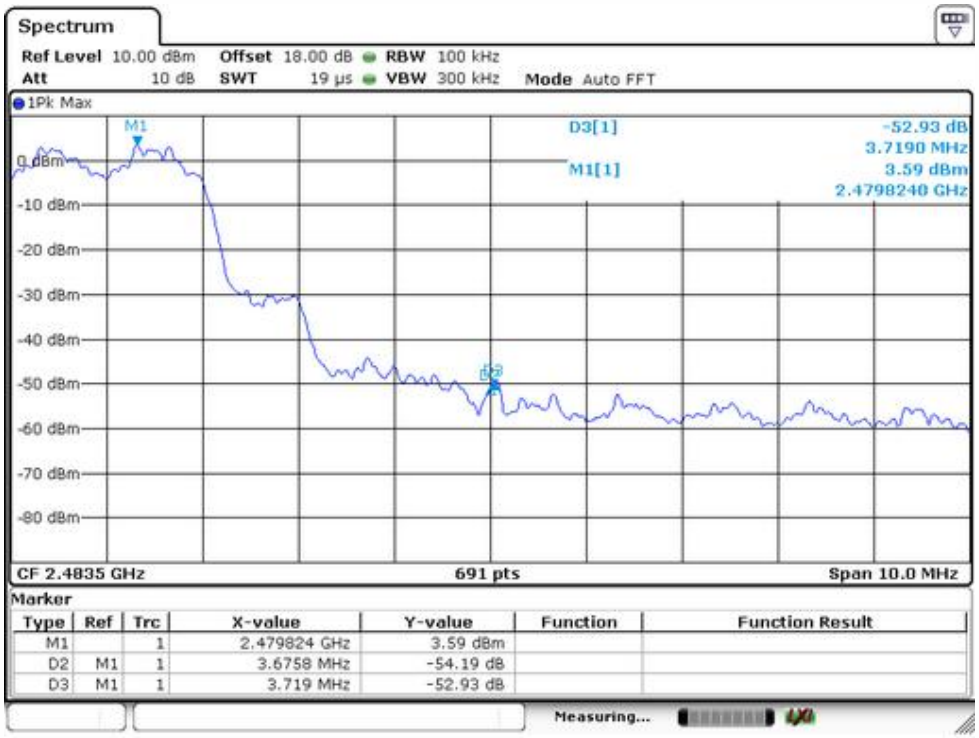
Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2401.82	GFSK	1.90	47.79	>20dBc
2401.82	pi/4-DQPSK	3.68	41.14	>20dBc
2401.82	8DPSK	3.49	38.7	>20dBc
2479.82	GFSK	0.40	56.15	>20dBc
2479.82	pi/4-DQPSK	3.59	52.93	>20dBc
2479.82	8DPSK	3.54	55.98	>20dBc

Test plots of GFSK

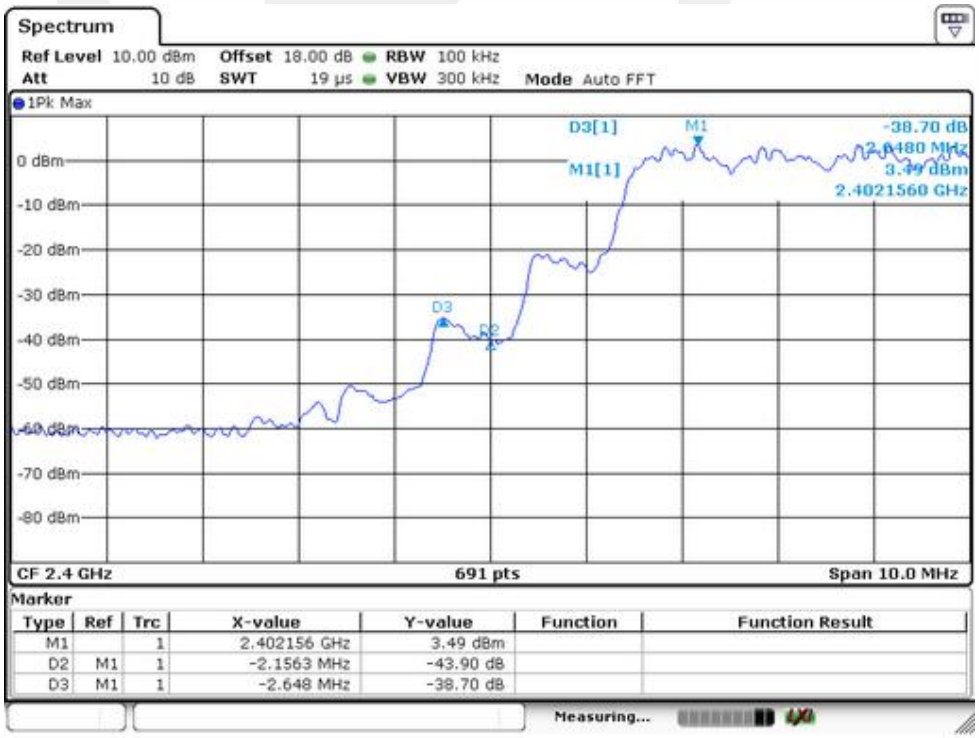


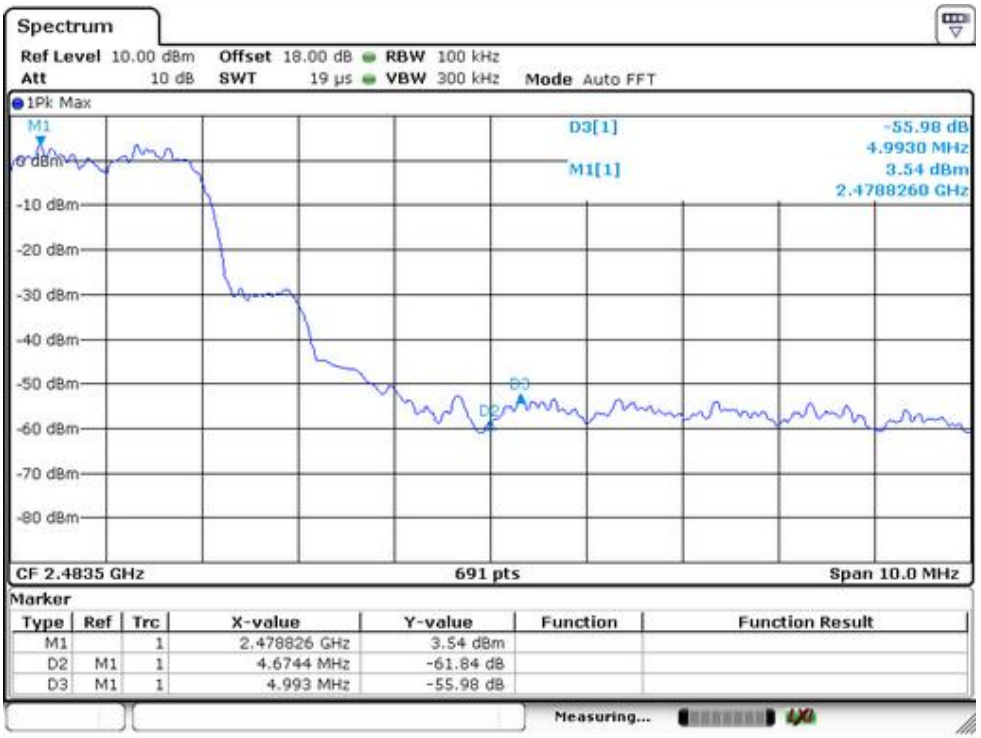


Test plots of pi/4-DQPSK



Test plots of 8DPSK

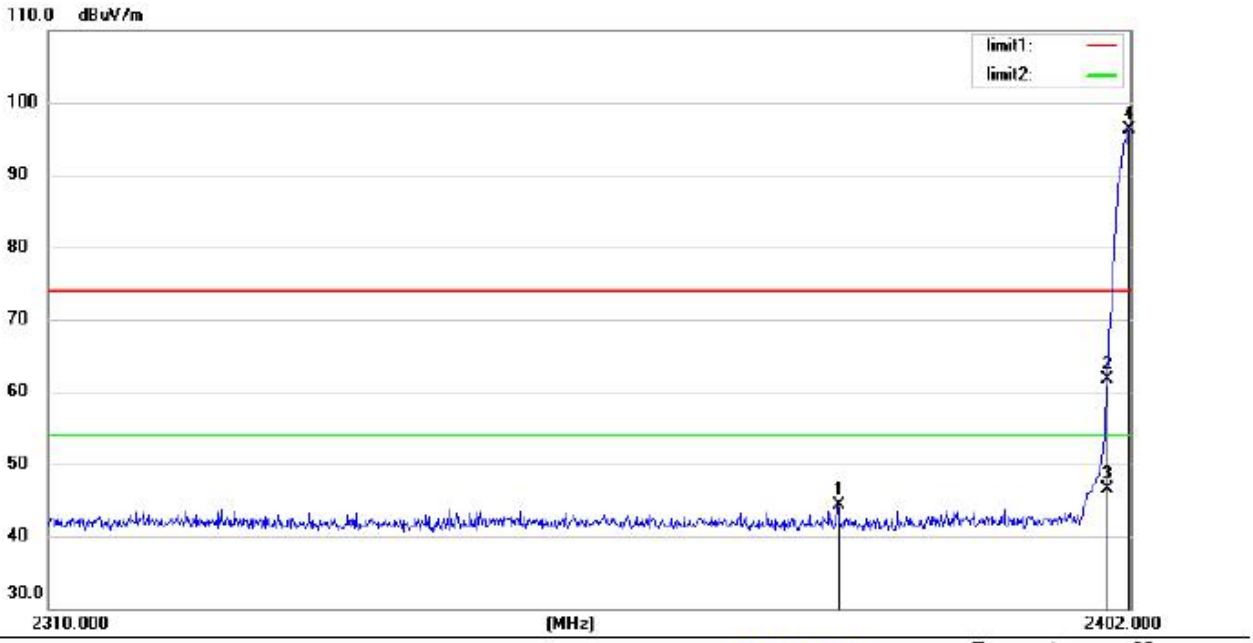



Spectrum
Ref Level 10.00 dBm Offset 18.00 dB RBW 100 kHz
Att 10 dB SWT 19 µs VBW 300 kHz Mode Auto FFT
1Pk Max
M1
D3[1] -55.98 dB
4.9930 MHz
M1[1] 3.54 dBm
2.4788260 GHz
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.4835 GHz
691 pts
Span 10.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.478826 GHz 3.54 dBm
D2 M1 1 4.6744 MHz -61.84 dB
D3 M1 1 4.993 MHz -55.98 dB
Measuring...

2. Radiated emission Test

Worst test modulation 8DPSK

For Non-Hopping Mode:



Site Chamber #1 Polarization: *Horizontal* Temperature: 25

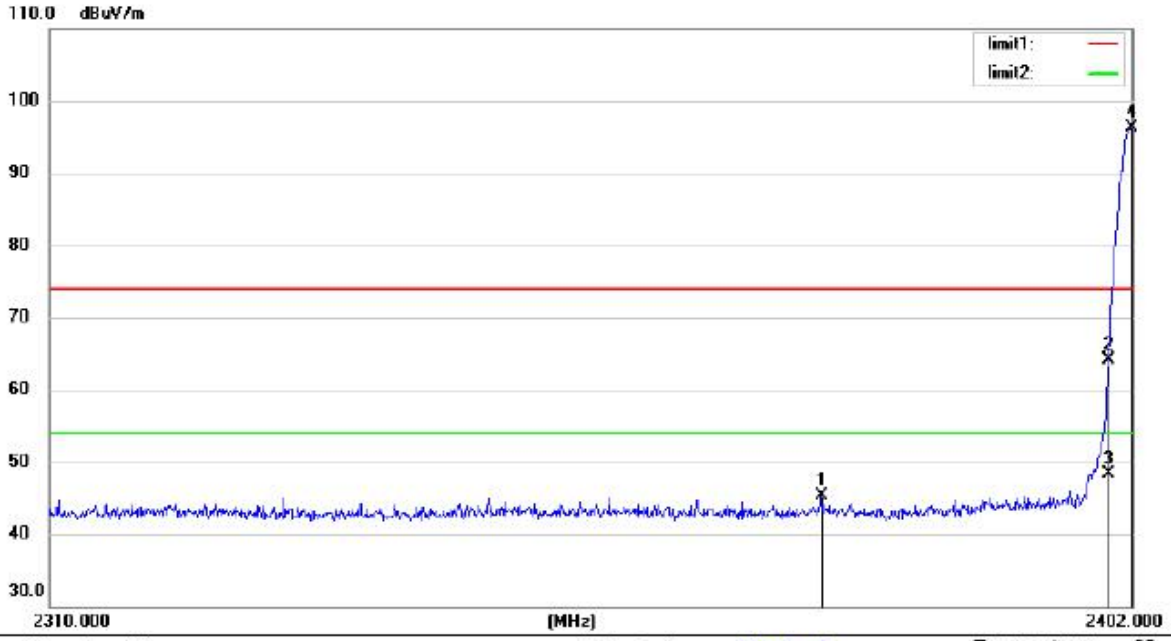
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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		2376.884	55.92	-11.68	44.24	74.00	-29.76	peak			
2		2400.000	73.27	-11.63	61.64	74.00	-12.36	peak			
3		2400.000	58.15	-11.63	46.52	54.00	-7.48	AVG			
4	*	2401.816	108.00	-11.63	96.37	74.00	22.37	peak			

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



Site Chamber #1 Polarization: *Vertical* Temperature: 25

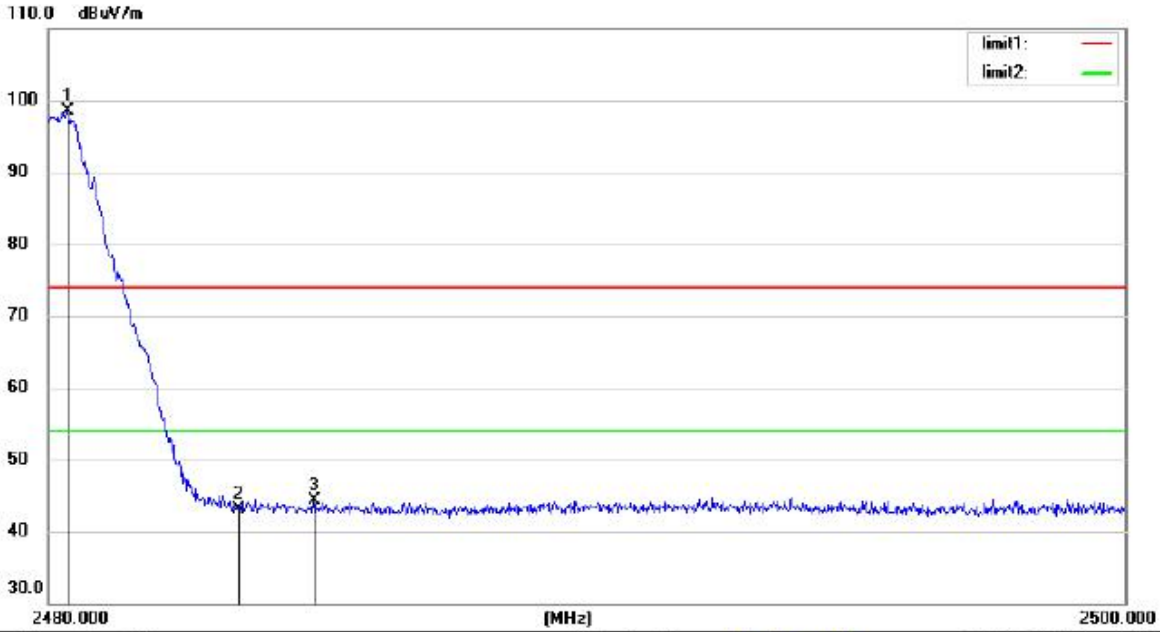
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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		2375.228	55.92	-10.61	45.31	74.00	-28.69	peak			
2		2400.000	74.54	-10.47	64.07	74.00	-9.93	peak			
3		2400.000	58.69	-10.47	48.22	54.00	-5.78	AVG			
4	*	2401.908	106.81	-10.46	96.35	74.00	22.35	peak			

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



Site Chamber #1 Polarization: *Horizontal* Temperature: 25

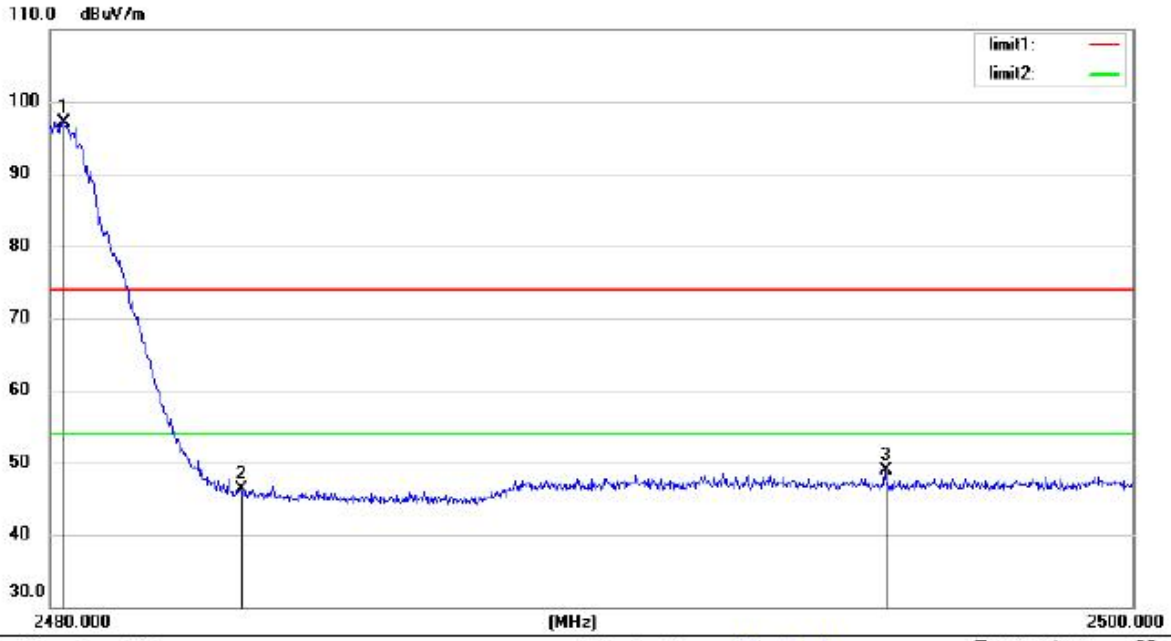
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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	*	2480.340	110.01	-11.45	98.56	74.00	24.56	peak			
2		2483.500	54.49	-11.46	43.03	74.00	-30.97	peak			
3		2484.920	55.79	-11.44	44.35	74.00	-29.65	peak			

*:Maximum data x:Over limit I:over margin Operator: HUANG



Site Chamber #1 Polarization: *Vertical* Temperature: 25

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

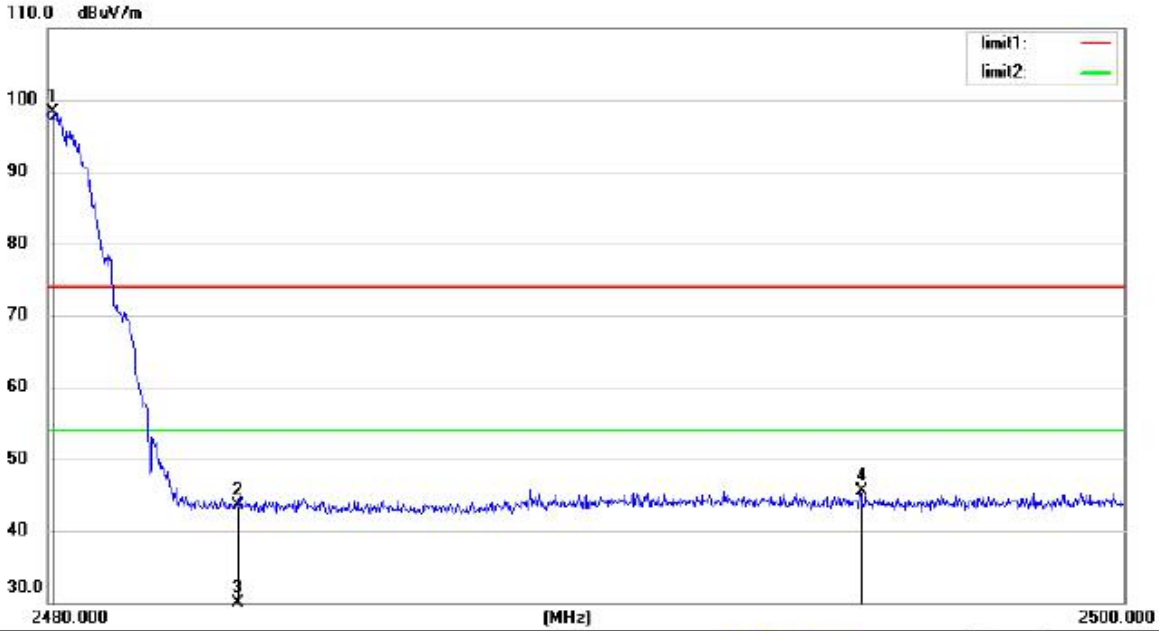
Mode: TX2480

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	*	2480.240	107.19	-10.02	97.17	74.00	23.17	peak			
2		2483.500	56.30	-10.01	46.29	74.00	-27.71	peak			
3		2495.420	58.88	-9.95	48.93	74.00	-25.07	peak			

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

For Hopping Mode:



Site Chamber #1 Polarization: *Horizontal* Temperature: 25

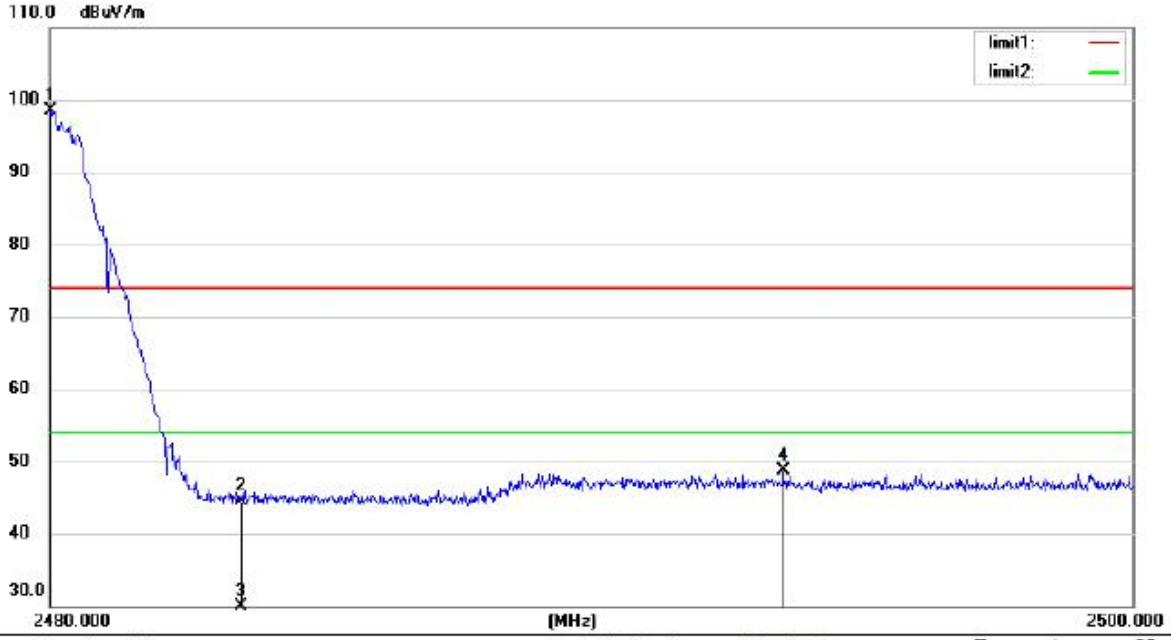
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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	*	2480.080	109.73	-11.45	98.28	74.00	24.28	peak			
2		2483.500	54.89	-11.46	43.43	74.00	-30.57	peak			
3		2483.500	38.66	-11.46	27.20	54.00	-26.80	AVG			
4		2495.100	56.98	-11.43	45.55	74.00	-28.45	peak			

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



Site Chamber #1 Polarization: *Vertical* Temperature: 25

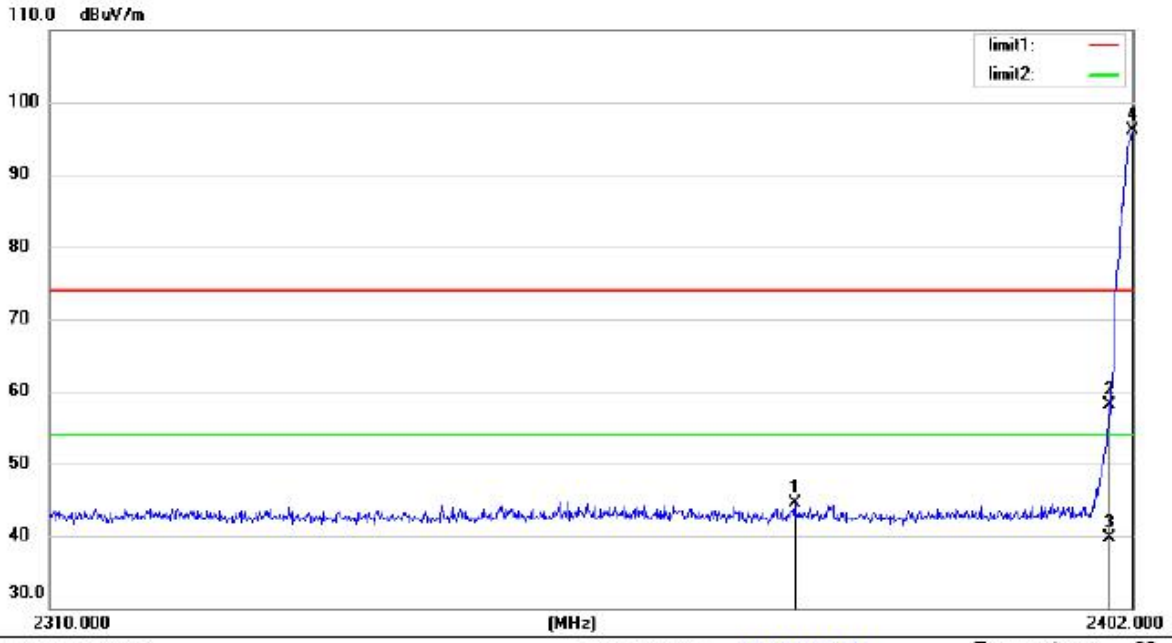
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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	*	2480.000	108.57	-10.02	98.55	74.00	24.55	peak			
2		2483.500	54.49	-10.01	44.48	74.00	-29.52	peak			
3		2483.500	37.98	-10.01	27.97	54.00	-26.03	AVG			
4		2493.540	58.57	-9.95	48.62	74.00	-25.38	peak			

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



Site Chamber #1 Polarization: *Horizontal* Temperature: 25

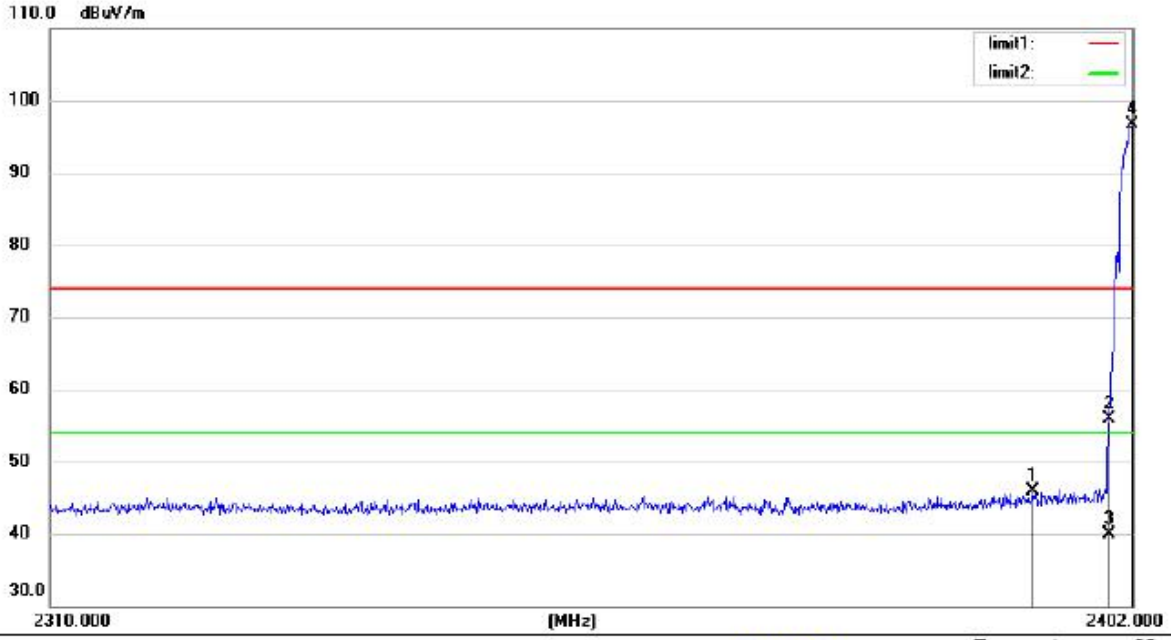
Limit: (RE)FCC PART 15 C 3m_PEAK Power: Battery 3.7V Humidity: 55 %

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		2372.928	56.11	-11.69	44.42	74.00	-29.58	peak			
2		2400.000	69.69	-11.63	58.06	74.00	-15.94	peak			
3		2400.000	51.36	-11.63	39.73	54.00	-14.27	AVG			
4	*	2402.000	107.73	-11.63	96.10	74.00	22.10	peak			

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



Site Chamber #1 Polarization: *Vertical* Temperature: 25

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		2393.444	56.41	-10.51	45.90	74.00	-28.10	peak			
2		2400.000	66.45	-10.47	55.98	74.00	-18.02	peak			
3		2400.000	50.36	-10.47	39.89	54.00	-14.11	AVG			
4	*	2402.000	107.22	-10.46	96.76	74.00	22.76	peak			

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

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 -0.58 Bi and meets the requirement.

*** End of Report ***

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