



**ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT  
INTENTIONAL RADIATOR CERTIFICATION TO  
FCC PART 15 SUBPART C REQUIREMENT**

OF

**TwinS TWS Bluetooth Sporty Earphone Set**

**Model No.: BH-289**

**Trademark: MANOVA**

**FCC ID: UKWMANOVABH289**

**Report No.: ED170717009E**

**Issue Date: July 11, 2017**

*Prepared for*

**MANOVA INTERNATIONAL LTD.  
FLAT A, 13th FLOOR, CENTURY INDUSTRIAL CENTRE, 33-35 AU PUI WAN  
STREET, FO TAN, N.T., HONG KONG**

*Prepared by*

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EMTEK(DONGGUAN) CO., LTD.**

## VERIFICATION OF COMPLIANCE

Applicant:	MANOVA INTERNATIONAL LTD. FLAT A, 13th FLOOR, CENTURY INDUSTRIAL CENTRE, 33-35 AU PUI WAN STREET, FO TAN, N.T., HONG KONG
Manufacturer:	MANOVA INTERNATIONAL LTD. FLAT A, 13th FLOOR, CENTURY INDUSTRIAL CENTRE, 33-35 AU PUI WAN STREET, FO TAN, N.T., HONG KONG
Product Description:	TwinS TWS Bluetooth Sporty Earphone Set
Trade Mark:	MANOVA
Model Number:	BH-289

### We hereby certify that:

The above equipment was tested by EMTEK(DONGGUAN) 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(2016).

Date of Test : July 06, 2017 to July 11, 2017

Prepared by :

Abby Li/Editor

Reviewer :

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Approved & Authorized  
Signer :

## Modified Information

Version	Summary	Revision Date	Report No.
Ver.1.0	Original Report	/	ED170717009E

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## 1. GENERAL INFORMATION

### 1.1 Product Description

Characteristics	Description
<b>Product Name</b>	TwinS TWS Bluetooth Sporty Earphone Set
<b>Model number</b>	BH-289
<b>Power Supply</b>	DC 5V from adapter, DC 3.7V Battery
<b>Kind of Device</b>	Bluetooth Ver.4.2+EDR
<b>Modulation</b>	GFSK, π/4-DQPSK, 8DPSK
<b>Operating Frequency Range</b>	2402-2480MHz
<b>Number of Channels</b>	79
<b>Transmit Power Max(PK)</b>	-2.50dBm(0.000562W)
<b>Antenna Type</b>	Internal Antenna
<b>Antenna Gain</b>	3.09dBi

### 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. : Registered on FCC, July 06, 2016  
The Certificate Number is 247565.

Registered on Industry Canada, January 13, 2017  
The Certificate Number is 9444A

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

Site Location : No.281, Guantai Road, Nancheng District,  
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 placed on a 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 rotated through three orthogonal axes 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.	TwinS TWS Bluetooth Sporty Earphone Set	MANOVA	BH-289	UKWMANOV ABH289	<b>EUT</b>
2.	Adapter	N/A	YSV6-0501000	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	N/A(see note 1)
§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

Remark: The product was tested under the battery fully charged.

Note 1: During the charging proceed, the Bluetooth function of this device is inactive and EUT can't operate. And the report of FCC VOC include test data of the AC Power Conducted Emission, so the radio report don't need to add the data of AC Power Conducted Emission.

#### **4. Description of test modes**

The EUT has been tested under its typical operating condition. 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,  $\Pi/4$ -DQPSK, 8DPSK have been tested. 79 Channels are provided by EUT. The 3 channels of lower, medium and higher were chosen for test.

<b>Channel</b>	<b>Frequency(MHz)</b>
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	$\pm 1 \times 10^{-5}$
Maximum Peak Output Power Test	$\pm 1.0 \text{dB}$
Conducted Emissions Test	$\pm 2.0 \text{dB}$
Radiated Emission Test	$\pm 2.0 \text{dB}$
Power Density	$\pm 2.0 \text{dB}$
Occupied Bandwidth Test	$\pm 1.0 \text{dB}$
Band Edge Test	$\pm 3 \text{dB}$
All emission, radiated	$\pm 3 \text{dB}$
Antenna Port Emission	$\pm 3 \text{dB}$
Temperature	$\pm 0.5^\circ\text{C}$
Humidity	$\pm 3\%$

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

## 6. Radiated Emission Test

### 6.1 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:

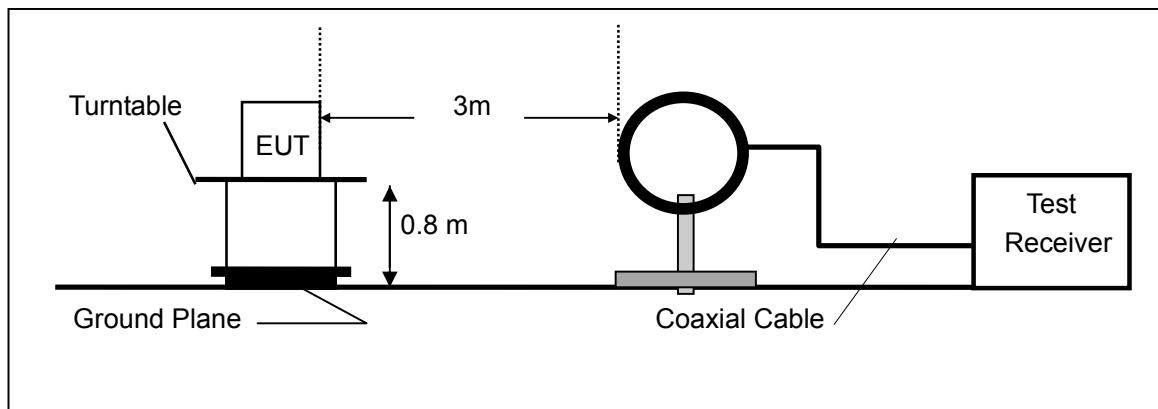
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	3MHz
Detector	Peak+AV
Trace	Max hold

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

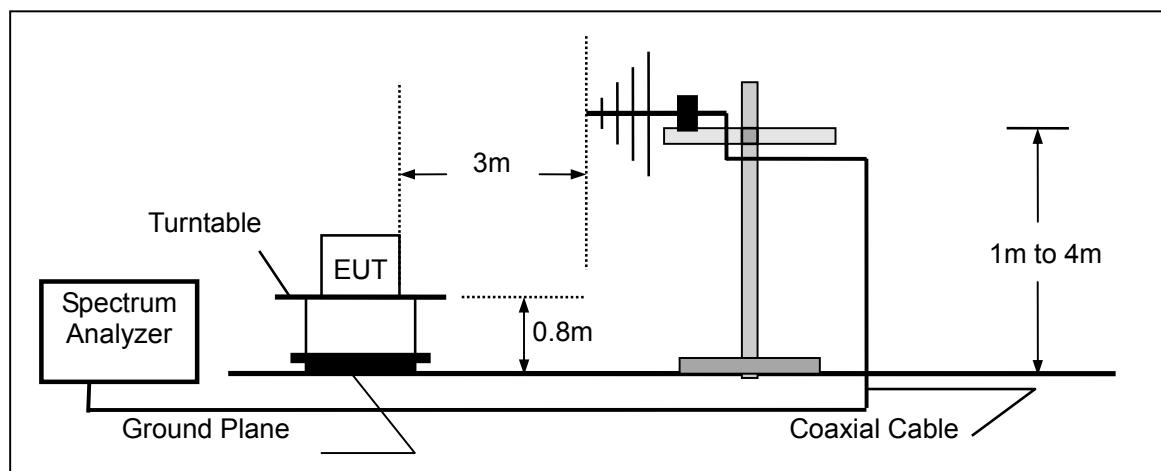
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Peak
Trace	Max hold

## 6.2 Test SET-UP (Block Diagram of Configuration)

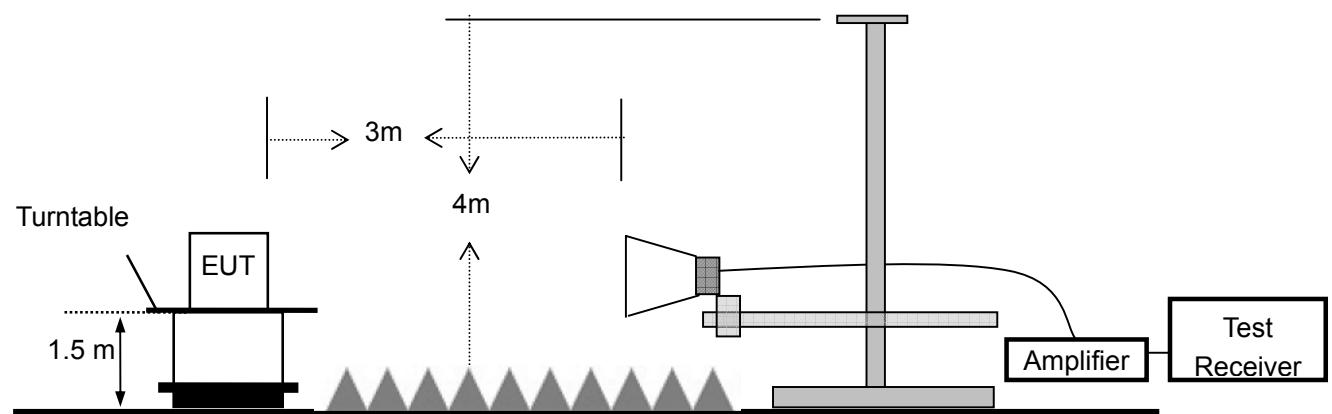
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



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



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



### 6.3 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	5/16/2017	1 Year
2.	Loop Antenna	Schwarzbeck	FMZB 1519	012	9 KHz -30MHz	5/16/2017	1 Year
3.	Bilog Antenna	Schwarzbeck	VULB9163	000141	25MHz-2GHz	5/16/2017	1 Year
4.	Power Amplifier	CDS	RSU-M352	818	1MHz-1GHz	5/16/2017	1 Year
5.	Power Amplifier	HP	8447F	OPT H64	1GHz-26.5GHz	5/16/2017	1 Year
6.	Color Monitor	SUNSPO	SP-140A	N/A	--	5/16/2017	1 Year
7.	Single Line Filter	JIANLI	XL-3	N/A	--	5/16/2017	1 Year
8.	Single Phase Power Line Filter	JIANLI	DL-2X100B	N/A	--	5/16/2017	1 Year
9.	3 Phase Power Line Filter	JIANLI	DL-4X100B	N/A	--	5/16/2017	1 Year
10.	DC Power Filter	JIANLI	DL-2X50B	N/A	--	5/16/2017	1 Year
11.	Cable	Schwarzbeck	PLF-100	549489	9KHz-3GHz	5/16/2017	1 Year
12.	Cable	Rosenberger	CIL02	A0783566	9KHz-3GHz	5/16/2017	1 Year
13.	Cable	Rosenberger	RG 233/U	525178	9KHz-3GHz	5/16/2017	1 Year
14.	Signal Analyzer	Rohde & Schwarz	FSV30	103040	9KHz-40GHz	5/16/2017	1 Year
15.	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	1GHz-18GHz	5/16/2017	1 Year
16.	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	14GHz -26.5GHz	5/16/2017	1 Year
17.	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	1GHz-26.5GHz	5/16/2017	1 Year
18.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year
19.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year
20.	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year

## 6.4 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
<sup>1</sup> 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	( <sup>2</sup> )

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  $\xi$  15.205, and the emissions located in restricted bands also comply with 15.209 limit.

## 6.5 Measurement Result

### Below 30MHz:

Operation Mode:	TX	Test Date :	July 11, 2017
Frequency Range:	9KHz~30MHz	Temperature :	28°C
Test Result:	PASS	Humidity :	65 %
Measured Distance:	3m	Test By:	Lin

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

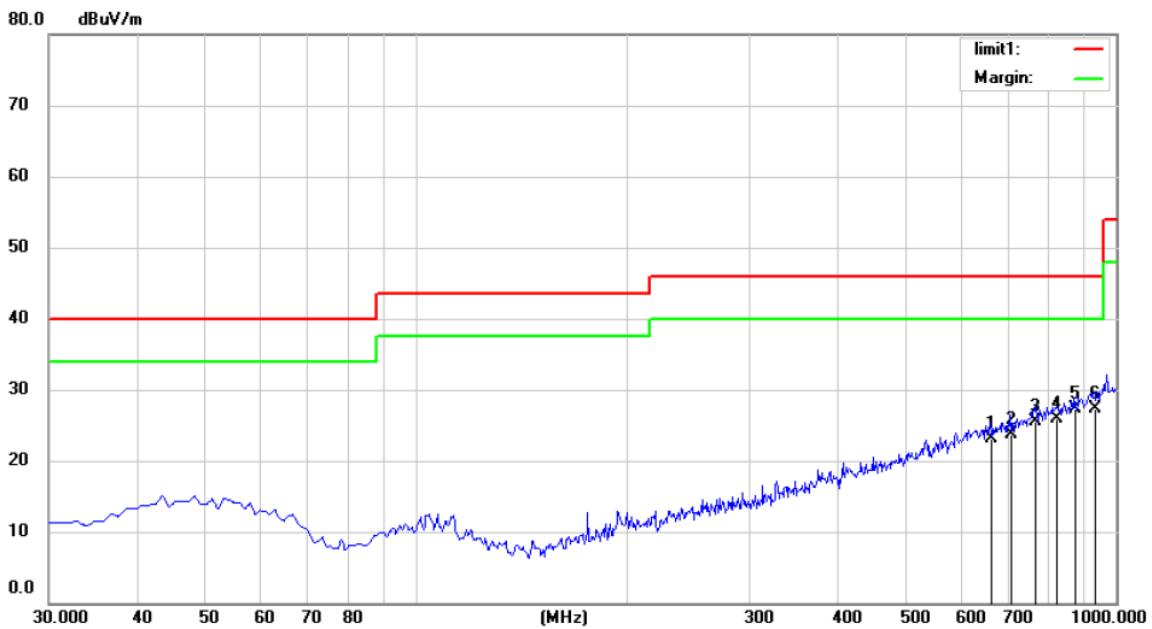
Note: The low frequency, which started from 9KHz-30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

### Below 1000MHz:

Pass.

All the modulation modes were tested the data of the worst mode (TX GFSK) are recorded in the following pages and the others modulation methods do not exceed the limits.

Please refer to the following data.



Site Chamber #1

Polarization: **Horizontal**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

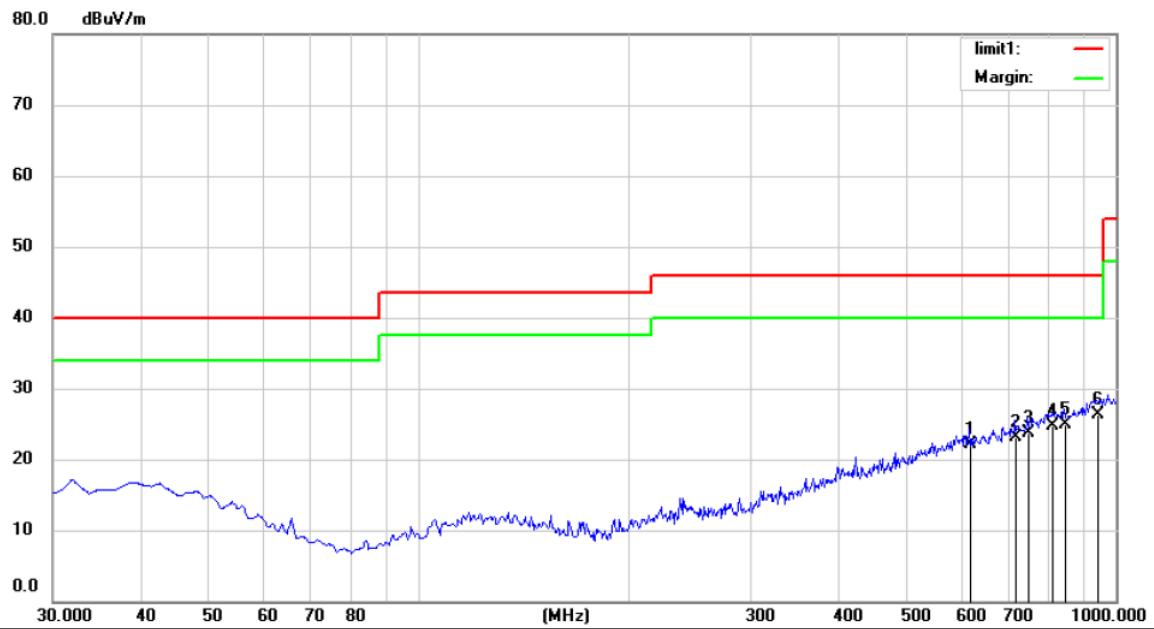
Mode: TX2402

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Antenna Height	Table Degree	Comment
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		663.4100	28.30	-5.16	23.14	46.00	-22.86	QP		
2		707.0600	28.10	-4.42	23.68	46.00	-22.32	QP		
3		768.1700	28.50	-3.09	25.41	46.00	-20.59	QP		
4		822.4900	28.20	-2.24	25.96	46.00	-20.04	QP		
5		873.9000	28.60	-1.39	27.21	46.00	-18.79	QP		
6	*	930.1600	27.13	0.18	27.31	46.00	-18.69	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Vertical**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

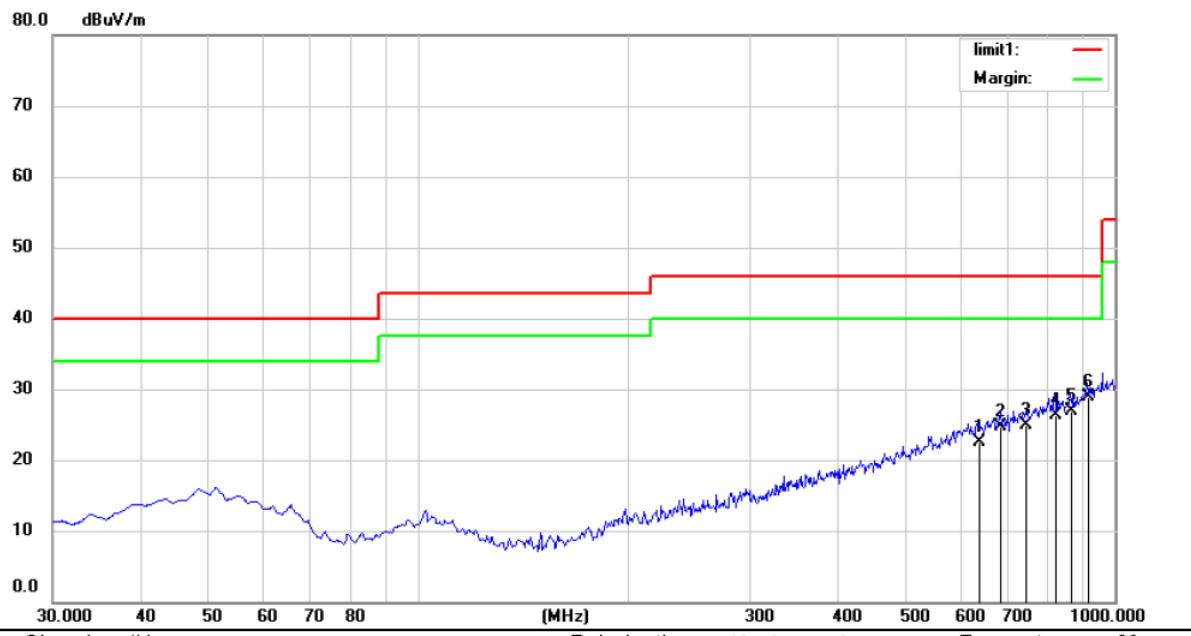
Mode:TX2402

Note:

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Antenna	Table		
			Level	Factor	ment					Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		616.8500	29.35	-7.23	22.12	46.00	-23.88	QP			
2		717.7300	28.60	-5.53	23.07	46.00	-22.93	QP			
3		749.7400	28.22	-4.51	23.71	46.00	-22.29	QP			
4		810.8500	28.05	-3.38	24.67	46.00	-21.33	QP			
5		843.8300	28.23	-3.27	24.96	46.00	-21.04	QP			
6	*	941.8000	27.10	-0.83	26.27	46.00	-19.73	QP			

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Horizontal**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

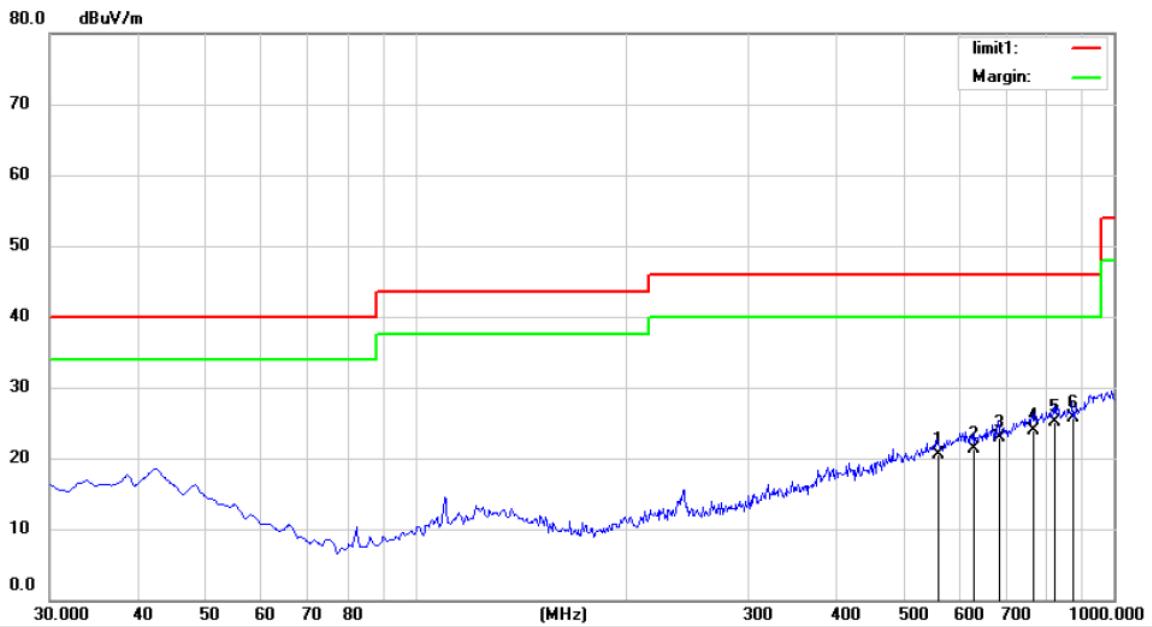
Mode: TX2441

Note:

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Antenna	Table		
			Level	Factor	ment					Degree	Comment
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	
1		638.1900	28.11	-5.52	22.59	46.00	-23.41	QP			
2		684.7500	29.52	-4.85	24.67	46.00	-21.33	QP			
3		745.8600	28.30	-3.43	24.87	46.00	-21.13	QP			
4		821.5200	28.65	-2.25	26.40	46.00	-19.60	QP			
5		864.2000	28.45	-1.60	26.85	46.00	-19.15	QP			
6	*	915.6100	29.20	-0.20	29.00	46.00	-17.00	QP			

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Vertical**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

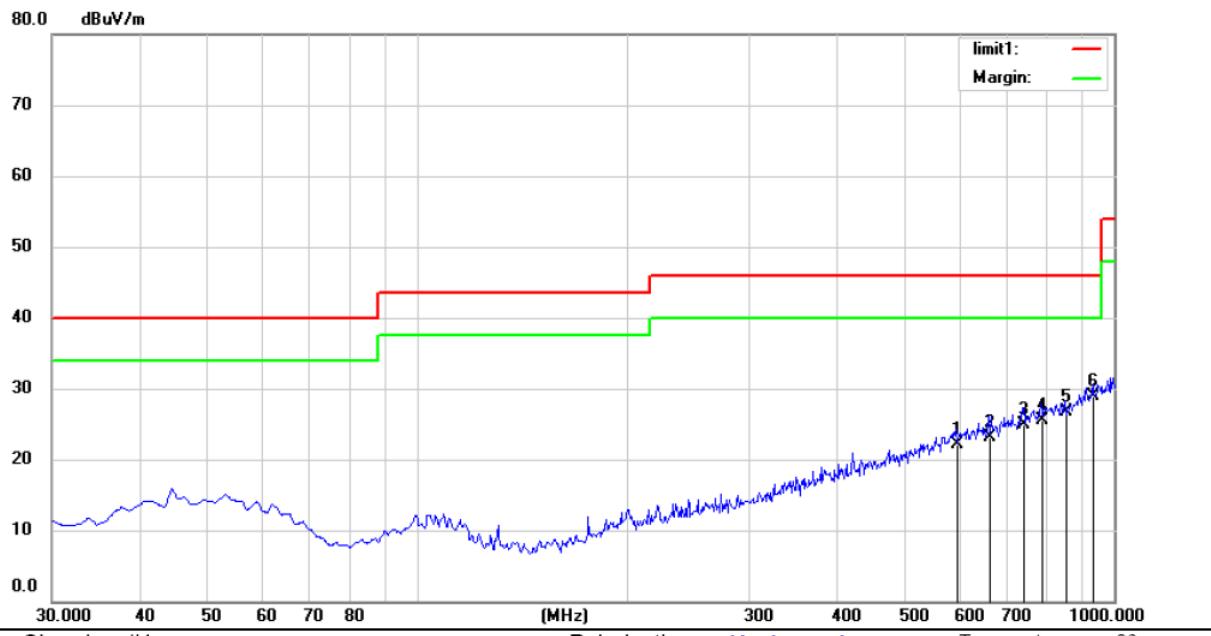
Mode:TX2441

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree degree	Comment
1		559.6200	28.56	-7.99	20.57	46.00	-25.43	QP		
2		630.4300	28.40	-7.08	21.32	46.00	-24.68	QP		
3		683.7800	29.35	-6.38	22.97	46.00	-23.03	QP		
4		765.2600	28.22	-4.41	23.81	46.00	-22.19	QP		
5		823.4600	28.23	-3.10	25.13	46.00	-20.87	QP		
6	*	874.8700	28.60	-2.94	25.66	46.00	-20.34	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Horizontal**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

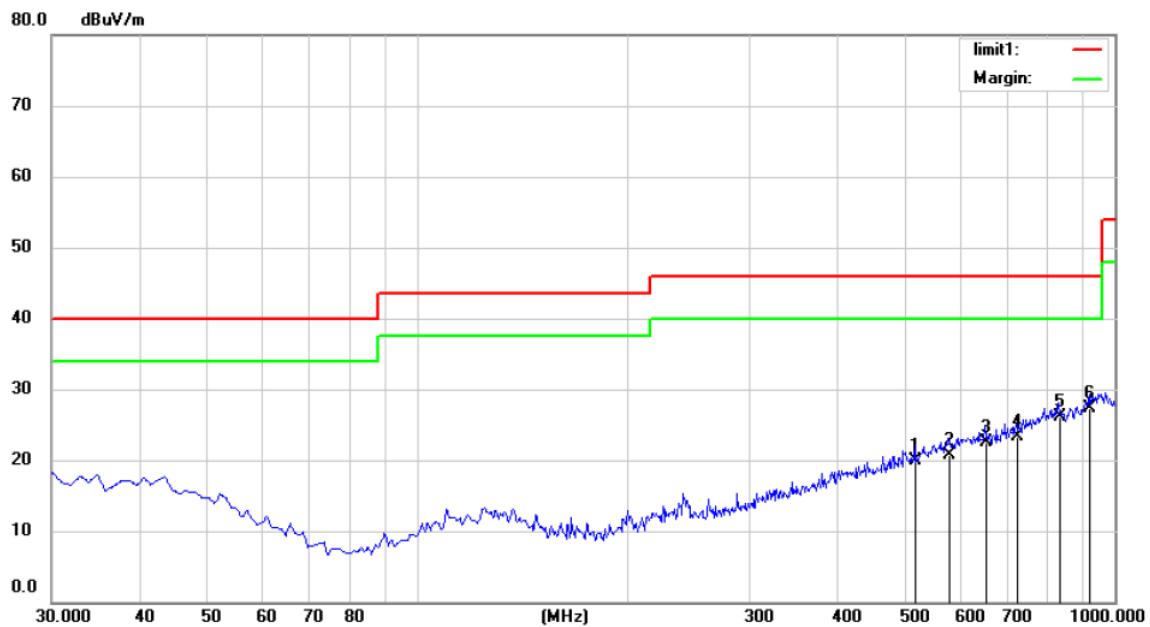
Mode:TX2480

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Antenna Height	Table Degree	Comment
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		593.5700	28.59	-6.48	22.11	46.00	-23.89	QP		
2		662.4400	28.35	-5.18	23.17	46.00	-22.83	QP		
3		741.0100	28.55	-3.58	24.97	46.00	-21.03	QP		
4		786.6000	28.35	-2.78	25.57	46.00	-20.43	QP		
5		852.5600	28.59	-1.86	26.73	46.00	-19.27	QP		
6	*	935.0100	28.65	0.33	28.98	46.00	-17.02	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Vertical**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m

Power: Battery 3.7V

Humidity: 55 %

Mode: TX2480

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Antenna Height	Table Degree	
									cm	degree
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector		Comment
1		518.8800	29.12	-9.28	19.84	46.00	-26.16	QP		
2		578.0500	28.52	-7.72	20.80	46.00	-25.20	QP		
3		652.7400	29.30	-6.80	22.50	46.00	-23.50	QP		
4		723.5500	28.56	-5.34	23.22	46.00	-22.78	QP		
5		831.2200	29.35	-3.16	26.19	46.00	-19.81	QP		
6	*	919.4900	28.65	-1.33	27.32	46.00	-18.68	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: washington

**Above 1000MHz~10<sup>th</sup> Harmonics:**

Operation Mode: GFSK (CH1: 2402MHz) Test Date : July 11, 2017

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
4804	V	95.55	75.85	-32.3	66.64	45.37	74	54	-7.36	-8.63
7206	V	103.11	81.48	-37.2	65.91	44.28	74	54	-8.09	-9.72
9608	V	104.26	83.17	-39.8	64.46	43.37	74	54	-9.54	-10.63
12010	V	104.44	83.45	-40.5	63.94	42.95	74	54	-10.06	-11.05
14412	V	104.04	83.34	-41.7	62.34	41.64	74	54	-11.66	-12.36
16814	V	101.46	80.95	-40	61.46	40.95	74	54	-12.54	-13.05
4804	H	96.95	75.95	-31.6	65.35	44.35	74	54	-8.65	-9.65
7206	H	100.18	79.45	-35.5	64.68	43.95	74	54	-9.32	-10.05
9608	H	102.26	81.29	-38.3	63.96	42.99	74	54	-10.04	-11.01
12010	H	101.37	81.01	-39	62.37	42.01	74	54	-11.63	-11.99
14412	H	103.82	83.36	-42	61.82	41.36	74	54	-12.18	-12.64
16814	H	99.97	80.19	-39.3	60.67	40.89	74	54	-13.33	-13.11

Operation Mode: GFSK (CH40: 2441MHz) Test Date : July 11, 2017

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	97.28	77.64	-32.3	64.98	45.34	74	54	-9.02	-8.66
7323	V	100.84	81.56	-37.2	63.64	44.36	74	54	-10.36	-9.64
9764	V	102.56	83.76	-39.8	62.76	43.96	74	54	-11.24	-10.04
12205	V	102.45	82.23	-40.5	61.95	41.73	74	54	-12.05	-12.27
14646	V	101.86	81.37	-41	60.86	40.37	74	54	-13.14	-13.63
17087	V	101.07	81.54	-41.1	59.97	40.44	74	54	-14.03	-13.56
4882	H	96.56	75.97	-31.6	64.96	44.37	74	54	-9.04	-9.63
7323	H	98.82	79.46	-35.5	63.32	43.96	74	54	-10.68	-10.04
9764	H	102.32	81.06	-38.3	64.02	42.76	74	54	-9.98	-11.24
12205	H	102.37	80.62	-39	63.37	41.62	74	54	-10.63	-12.38
14646	H	102.53	85.96	-42	60.53	43.96	74	54	-13.47	-10.04
17087	H	103.46	81.97	-41.5	61.96	40.47	74	54	-12.04	-13.53

Operation Mode: GFSK (CH79: 2480MHz) Test Date : July 11, 2017

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	96.99	77.62	-32.3	64.69	45.32	74	54	-9.31	-8.68
7440	V	101.06	81.16	-37.2	63.86	43.96	74	54	-10.14	-10.04
9920	V	102.66	84.66	-39.8	62.86	44.86	74	54	-11.14	-9.14
12400	V	101.45	83.46	-40.5	60.95	42.96	74	54	-13.05	-11.04
14880	V	104.85	82.67	-41	63.85	41.67	74	54	-10.15	-12.33
17360	V	102.44	81.47	-41.1	61.34	40.37	74	54	-12.66	-13.63
4960	H	95.69	76.56	-31.6	64.09	44.96	74	54	-9.91	-9.04
7440	H	99.32	79.26	-35.5	63.82	43.76	74	54	-10.18	-10.24
9920	H	101.34	80.26	-38.3	63.04	41.96	74	54	-10.96	-12.04
12400	H	101.43	81.95	-39	62.43	42.95	74	54	-11.57	-11.05
14880	H	105.66	82.35	-42	63.66	40.35	74	54	-10.34	-13.65
17360	H	104.08	82.26	-41.5	62.58	40.76	74	54	-11.42	-13.24

Operation Mode: Pi/4-DQPSK (CH1: 2402MHz) Test Date : July 11, 2017

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4804	V	98.26	76.92	-32.3	65.96	44.62	74	54	-8.04	-9.38
7206	V	101.57	80.16	-37.2	64.37	42.96	74	54	-9.63	-11
9608	V	103.56	83.56	-39.8	63.76	43.76	74	54	-10.24	-10.2
12010	V	104.58	82.14	-40.5	64.08	41.64	74	54	-9.92	-12.4
14412	V	105.13	82.32	-41.7	63.43	40.62	74	54	-10.57	-13.4
16814	V	102.85	81.95	-40	62.85	41.95	74	54	-11.15	-12.1
4804	H	96.59	75.56	-31.6	64.99	43.96	74	54	-9.01	-10
7206	H	98.26	78.14	-35.5	62.76	42.64	74	54	-11.24	-11.4
9608	H	103.26	81.67	-38.3	64.96	43.37	74	54	-9.04	-10.6
12010	H	99.37	83.86	-39	60.37	44.86	74	54	-13.63	-9.14
14412	H	106.38	85.76	-42	64.38	43.76	74	54	-9.62	-10.2
16814	H	100.23	79.97	-39.3	60.93	40.67	74	54	-13.07	-13.3

Operation Mode: Pi/4-DQPSK (CH40: 2441MHz) Test Date : July 11, 2017

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4882	V	96.26	76.3	-32.3	63.96	44	74	54	-10.04	-10
7323	V	98.93	80.82	-37.2	61.73	43.62	74	54	-12.27	-10.38
9764	V	104.41	82.83	-39.8	64.61	43.03	74	54	-9.39	-10.97
12205	V	102.87	82.65	-40.5	62.37	42.15	74	54	-11.63	-11.85
14646	V	104.86	82.32	-41	63.86	41.32	74	54	-10.14	-12.68
17087	V	102.74	81.47	-41.1	61.64	40.37	74	54	-12.36	-13.63
4882	H	95.6	75.23	-31.6	64	43.63	74	54	-10	-10.37
7323	H	99.26	77.83	-35.5	63.76	42.33	74	54	-10.24	-11.67
9764	H	101.22	81.97	-38.3	62.92	43.67	74	54	-11.08	-10.33
12205	H	102.76	80.96	-39	63.76	41.96	74	54	-10.24	-12.04
14646	H	104.37	82.76	-42	62.37	40.76	74	54	-11.63	-13.24
17087	H	101.96	80.69	-41.5	60.46	39.19	74	54	-13.54	-14.81

Operation Mode: Pi/4-DQPSK (CH79: 2480MHz) Test Date : July 11, 2017

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4960	V	96.67	75.94	-32.3	64.37	43.64	74	54	-9.63	-10.36
7440	V	101.16	79.54	-37.2	63.96	42.34	74	54	-10.04	-11.66
9920	V	104.19	82.17	-39.8	64.39	42.37	74	54	-9.61	-11.63
12400	V	103.26	83.66	-40.5	62.76	43.16	74	54	-11.24	-10.84
14880	V	105	82.91	-41	64	41.91	74	54	-10	-12.09
17360	V	102.95	81.45	-41.1	61.85	40.35	74	54	-12.15	-13.65
4960	H	95.71	74.65	-31.6	64.11	43.05	74	54	-9.89	-10.95
7440	H	98.36	78.14	-35.5	62.86	42.64	74	54	-11.14	-11.36
9920	H	102.06	79.64	-38.3	63.76	41.34	74	54	-10.24	-12.66
12400	H	100.24	79.37	-39	61.24	40.37	74	54	-12.76	-13.63
14880	H	102.96	82.36	-42	60.96	40.36	74	54	-13.04	-13.64
17360	H	100.87	81.26	-41.5	59.37	39.76	74	54	-14.63	-14.24

Operation Mode: 8DPSK (CH1: 2402MHz) Test Date : July 11, 2017

Freq. (MHz)	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4804	V	96.67	75.92	-32.3	64.37	43.62	74	54	-9.63	-10.4
7206	V	101.16	81.89	-37.2	63.96	44.69	74	54	-10.04	-9.31
9608	V	103.14	86.14	-39.8	63.34	46.34	74	54	-10.66	-7.66
12010	V	103.26	86.06	-40.5	62.76	45.56	74	54	-11.24	-8.44
14412	V	103.05	86.37	-41.7	61.35	44.67	74	54	-12.65	-9.33
16814	V	100.16	82.95	-40	60.16	42.95	74	54	-13.84	-11.1
4804	H	94.36	74.24	-31.6	62.76	42.64	74	54	-11.24	-11.4
7206	H	98.61	78.26	-35.5	63.11	42.76	74	54	-10.89	-11.2
9608	H	101.06	83.67	-38.3	62.76	45.37	74	54	-11.24	-8.63
12010	H	100.52	85.91	-39	61.52	46.91	74	54	-12.48	-7.09
14412	H	102.64	85.56	-42	60.64	43.56	74	54	-13.36	-10.4
16814	H	98.85	81.66	-39.3	59.55	42.36	74	54	-14.45	-11.6

Operation Mode: 8DPSK (CH40: 2441MHz) Test Date : July 11, 2017

Freq. (MHz)	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4882	V	96.67	76.66	-32.3	64.37	44.36	74	54	-9.63	-9.64
7323	V	99.96	80.82	-37.2	62.76	43.62	74	54	-11.24	-10.38
9764	V	104.53	82.96	-39.8	64.73	43.16	74	54	-9.27	-10.84
12205	V	104.38	83.17	-40.5	63.88	42.67	74	54	-10.12	-11.33
14646	V	105.96	83.16	-41	64.96	42.16	74	54	-9.04	-11.84
17087	V	103.68	81.86	-41.1	62.58	40.76	74	54	-11.42	-13.24
4882	H	92.06	74.03	-31.6	60.46	42.43	74	54	-13.54	-11.57
7323	H	97.06	78.87	-35.5	61.56	43.37	74	54	-12.44	-10.63
9764	H	102.06	80.91	-38.3	63.76	42.61	74	54	-10.24	-11.39
12205	H	103.02	79.25	-39	64.02	40.25	74	54	-9.98	-13.75
14646	H	102.56	82.37	-42	60.56	40.37	74	54	-13.44	-13.63
17087	H	102.93	81.27	-41.5	61.43	39.77	74	54	-12.57	-14.23

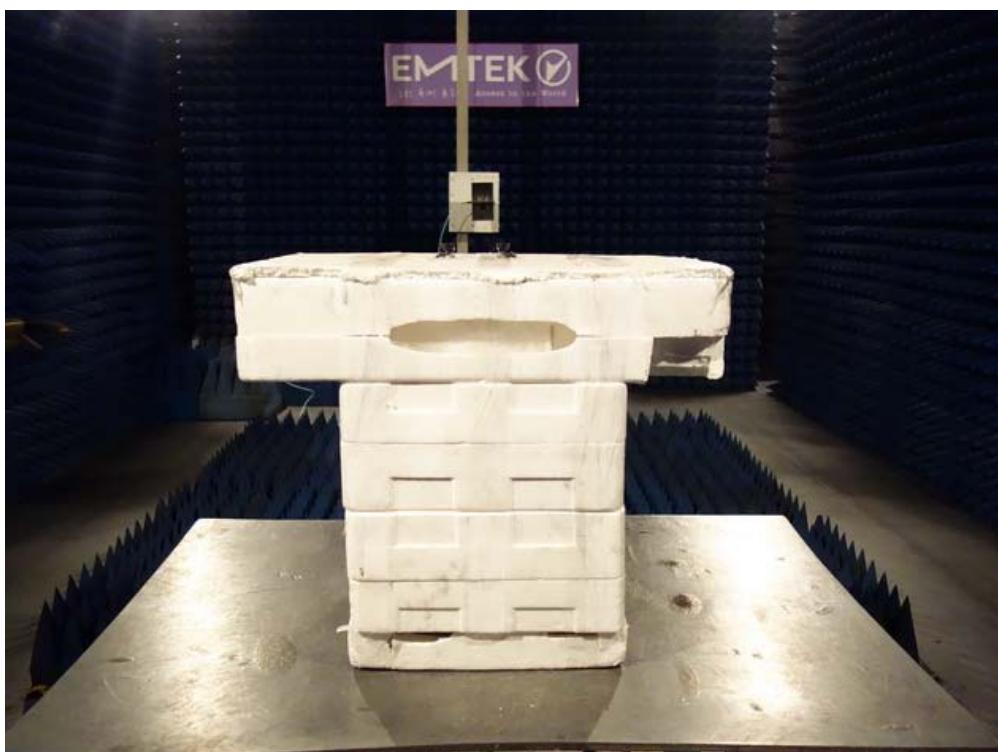
Operation Mode: 8DPSK (CH79: 2480MHz) Test Date : July 11, 2017

Freq.	Ant. Pol.	Reading Level(dBuV/m)		Correct Factor	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	dB	PK	AV	PK	AV	PK	AV
4960	V	94.67	77.69	-32.3	62.37	45.39	74	54	-11.63	-8.61
7440	V	102.66	83.45	-37.2	65.46	46.25	74	54	-8.54	-7.75
9920	V	102.16	85.68	-39.8	62.36	45.88	74	54	-11.64	-8.12
12400	V	105.14	84.69	-40.5	64.64	44.19	74	54	-9.36	-9.81
14880	V	104.46	84.68	-41	63.46	43.68	74	54	-10.54	-10.32
17360	V	102.86	84.09	-41.1	61.76	42.99	74	54	-12.24	-11.01
4960	H	96.06	75.97	-31.6	64.46	44.37	74	54	-9.54	-9.63
7440	H	99.42	78.96	-35.5	63.92	43.46	74	54	-10.08	-10.54
9920	H	100.52	81.35	-38.3	62.22	43.05	74	54	-11.78	-10.95
12400	H	100.62	81.69	-39	61.62	42.69	74	54	-12.38	-11.31
14880	H	102.29	83.92	-42	60.29	41.92	74	54	-13.71	-12.08
17360	H	102.66	82.86	-41.5	61.16	41.36	74	54	-12.84	-12.64

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.

### 6.5 Radiated Measurement Photos:



## 7. Channel Separation test

### 7.1 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.

### 7.2 Test SET-UP (Block Diagram of Configuration)



### 7.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

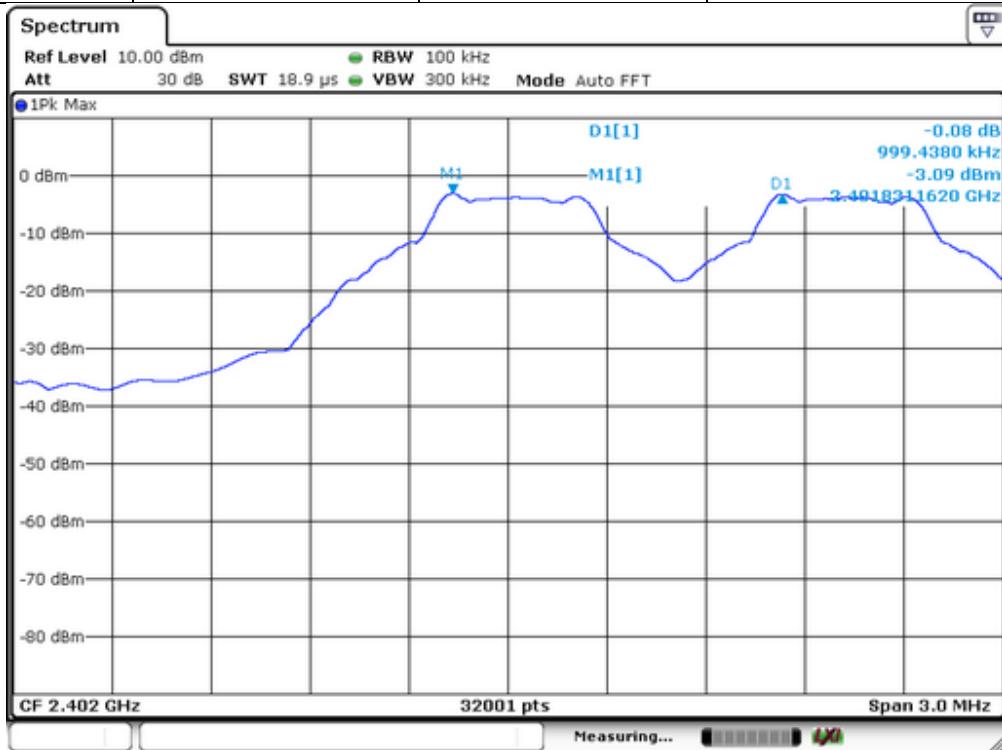
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

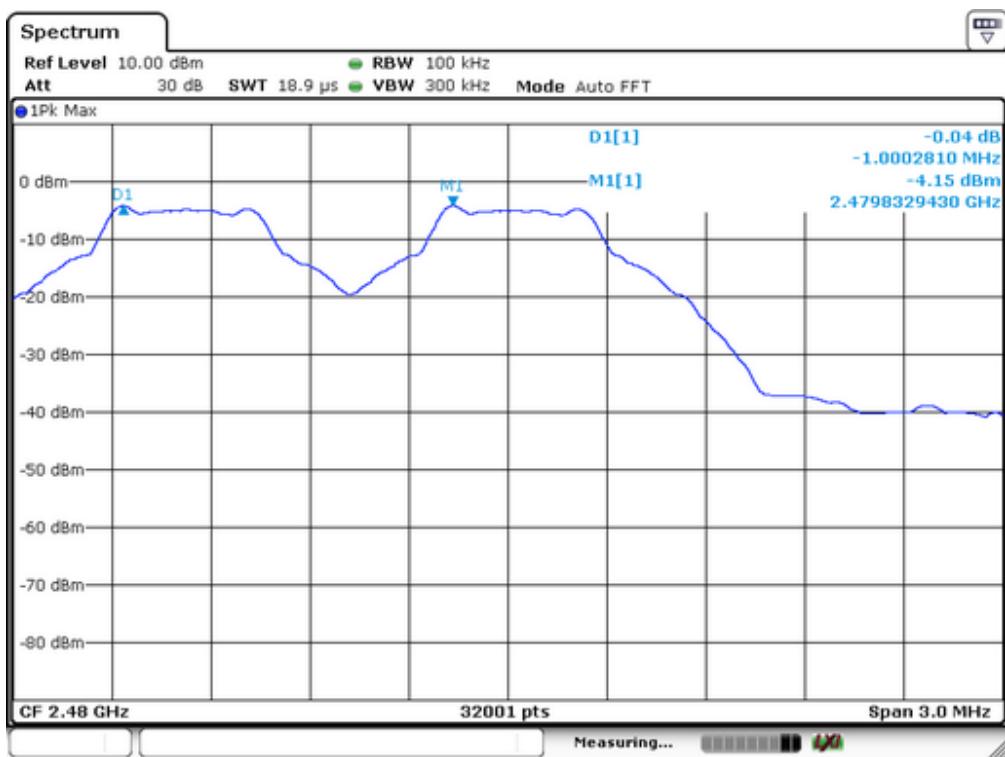
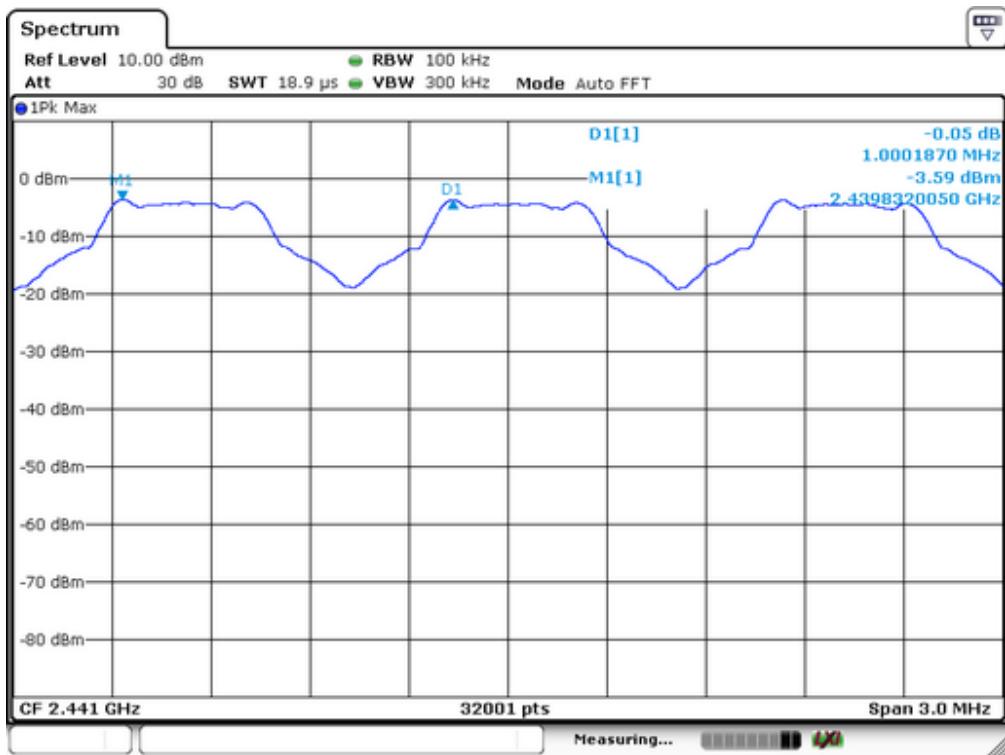
### 7.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 24°C  
 Test Result: PASS      Humidity : 53 %  
 Modulation: GFSK

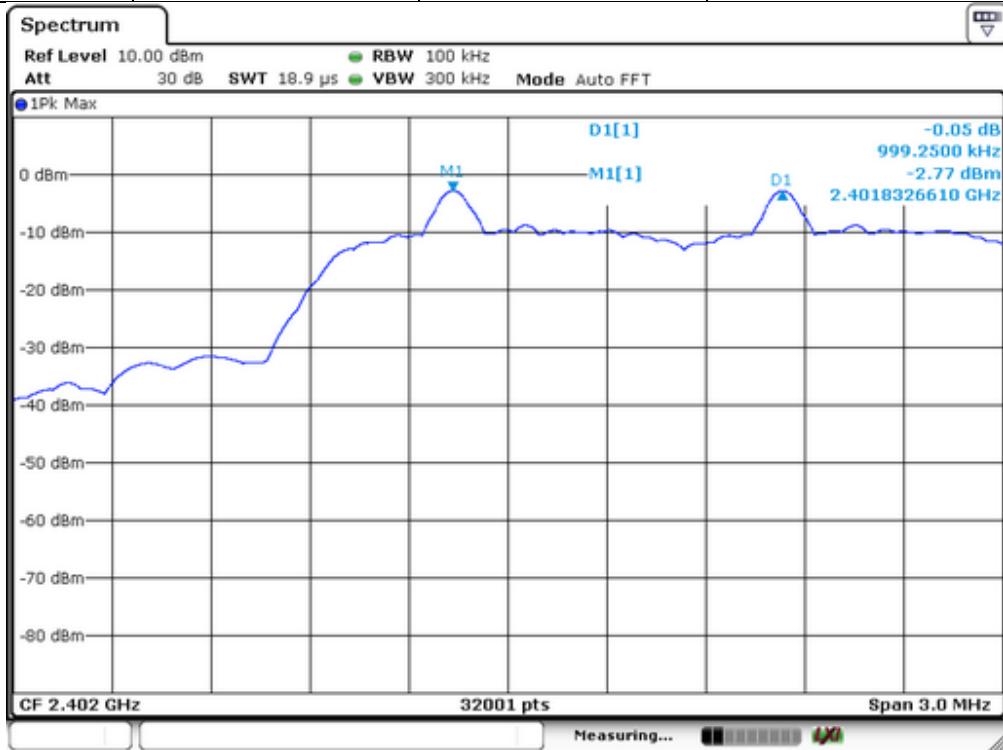
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	999	>767
40	2441	1000	>765
79	2480	1000	>770

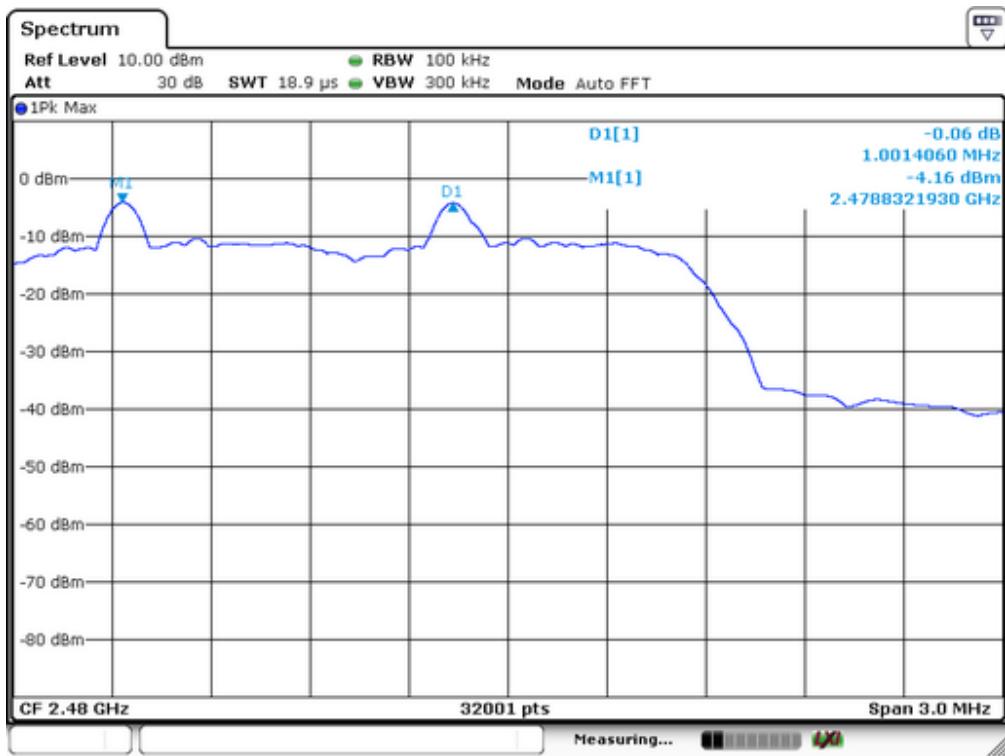
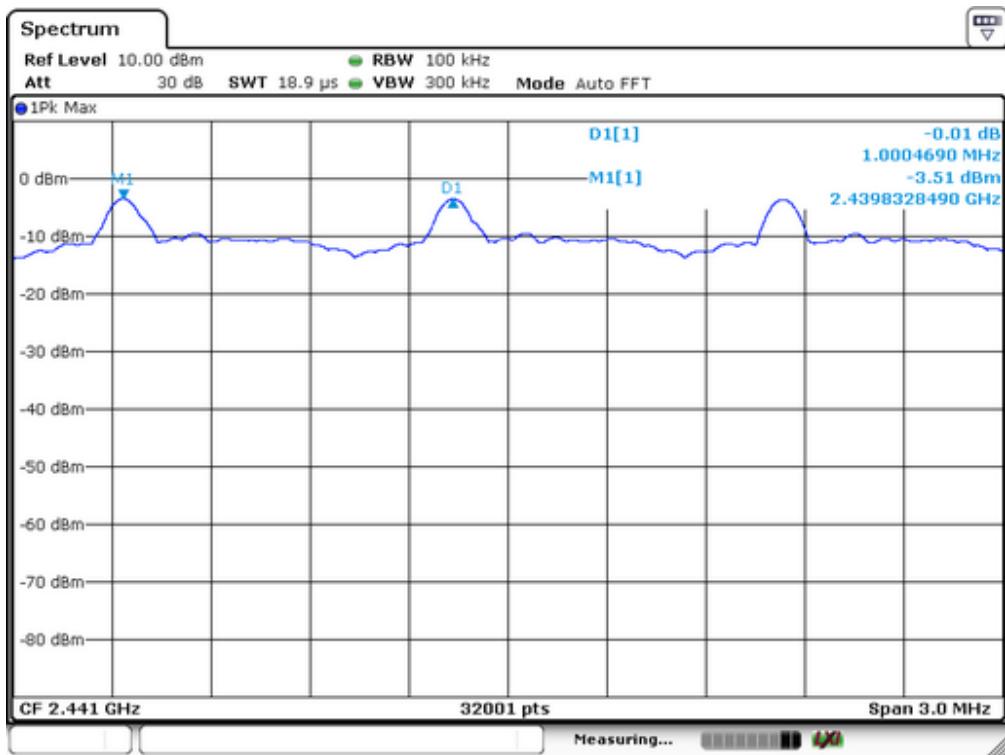




Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 24°C  
 Test Result: PASS      Humidity : 53 %  
 Modulation: Π/4-DQPSK

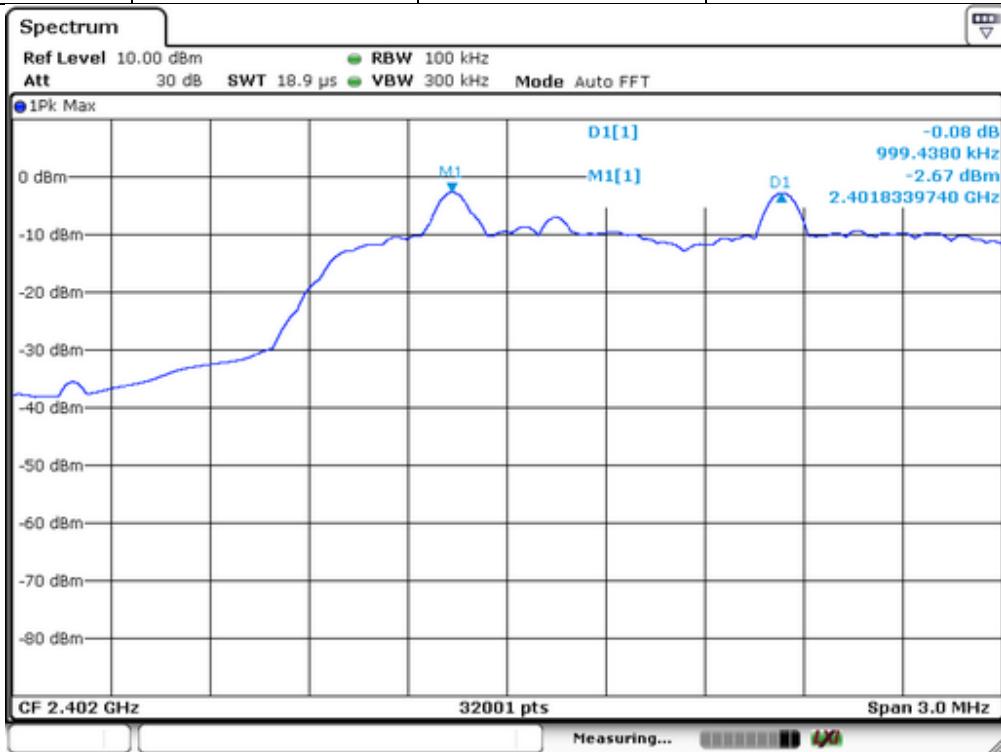
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	1000	>864
40	2441	999	>865
79	2480	1001	>863

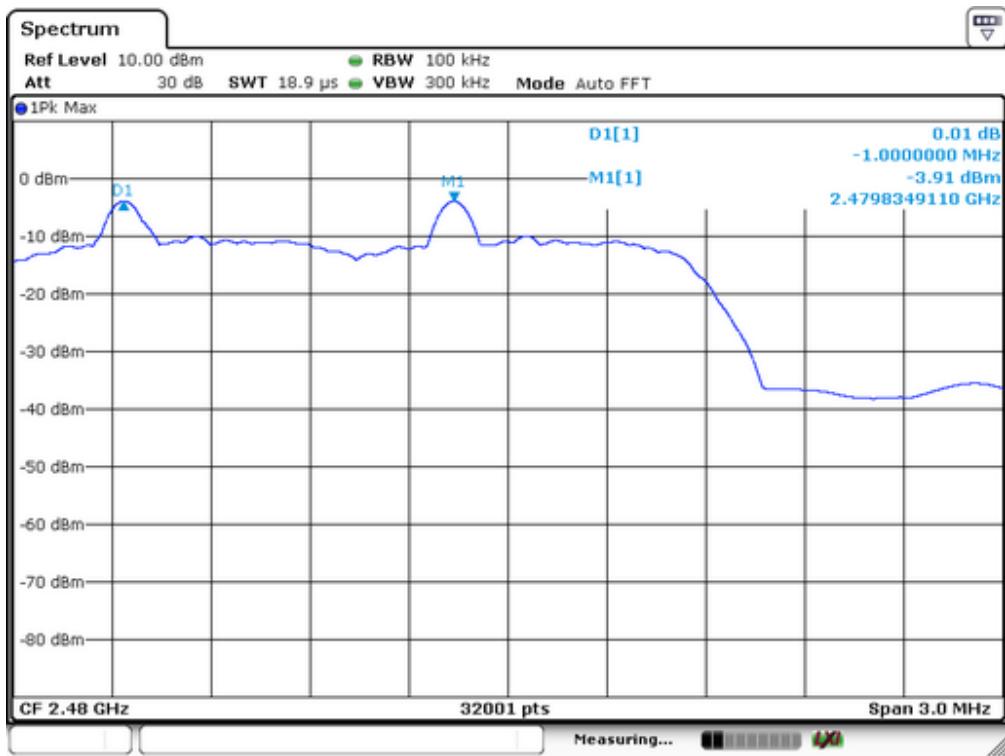
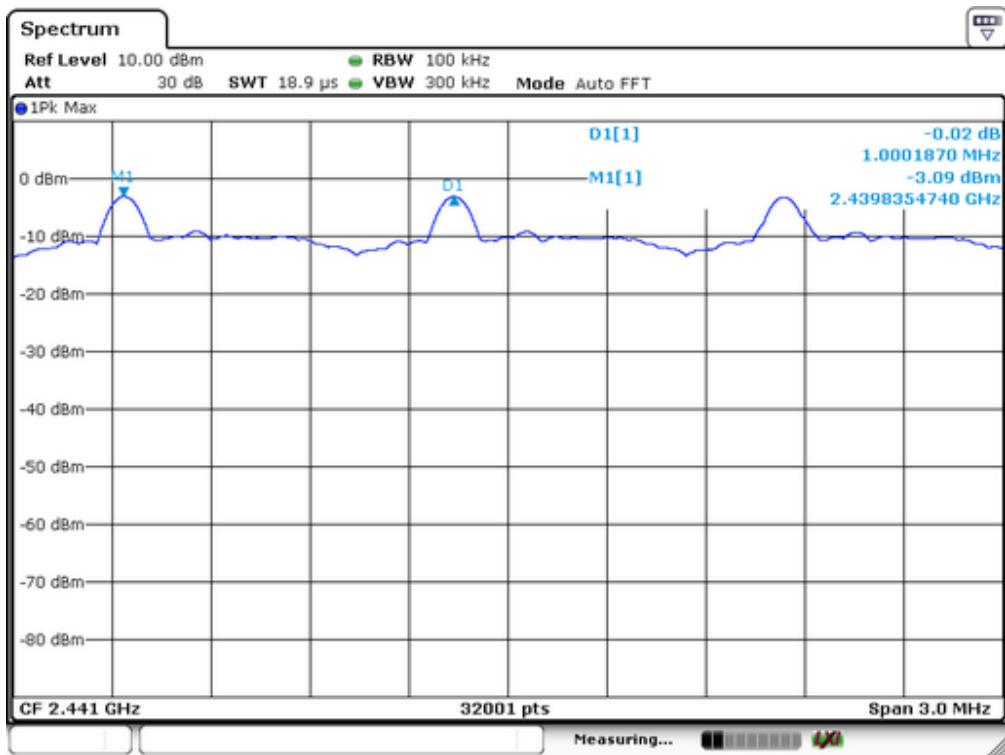




Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 24°C  
 Test Result: PASS      Humidity : 53 %  
 Modulation: 8DPSK

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	999	>867
40	2441	1000	>865
79	2480	1000	>864



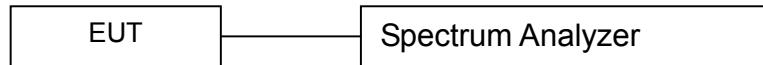


## 8. 20dB Bandwidth test

### 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.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

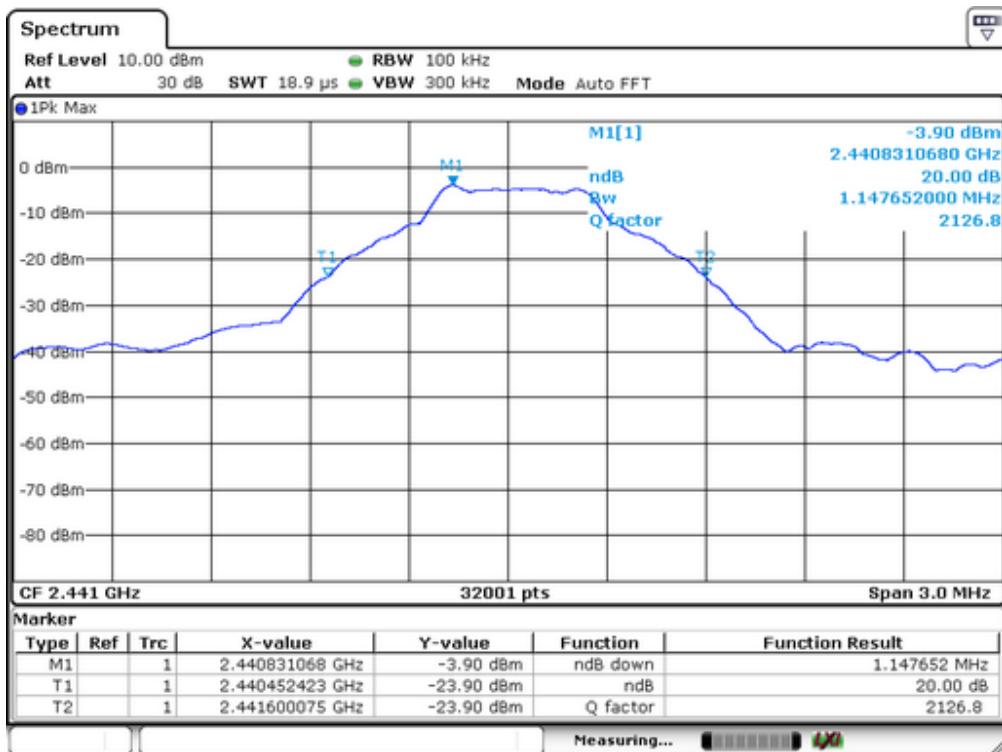
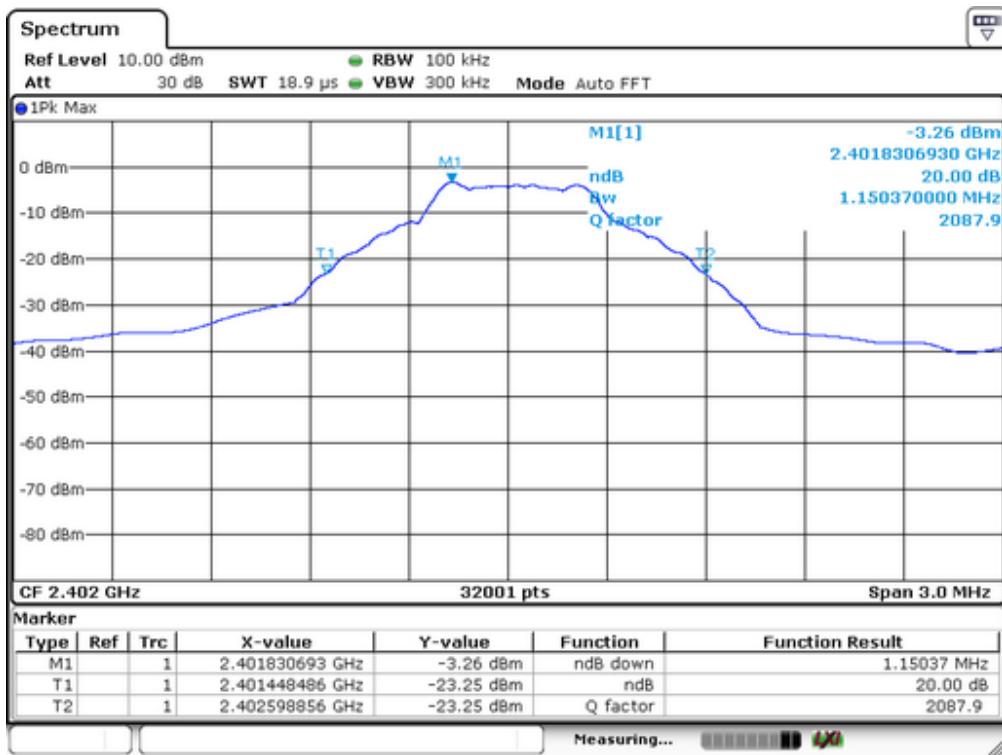
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

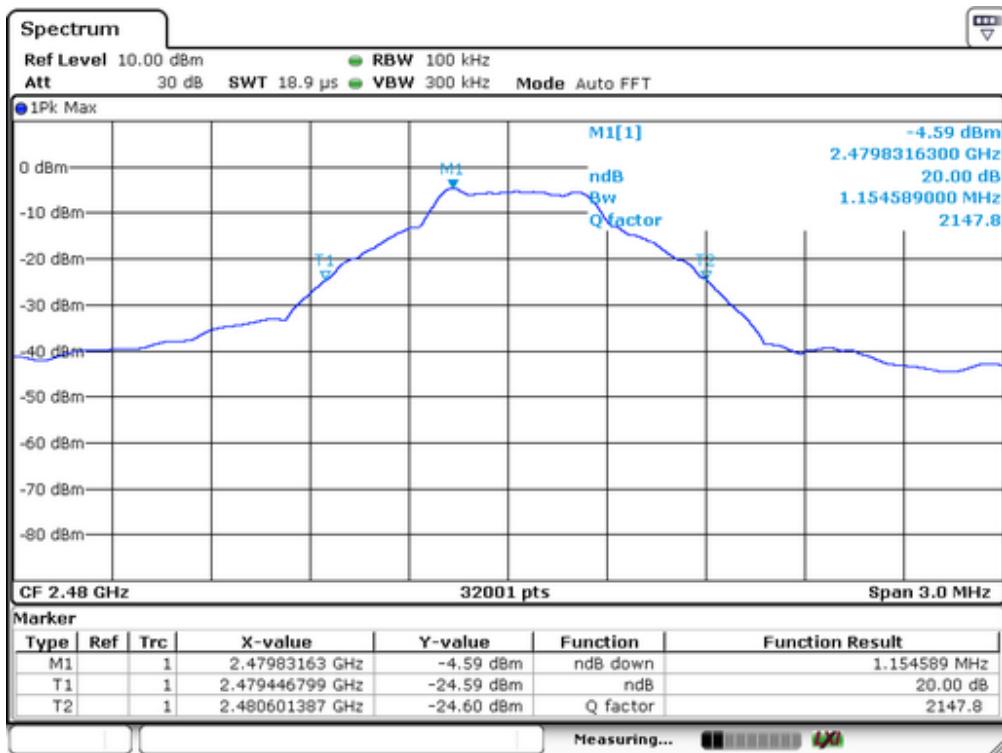
### 8.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	July 11, 2017
Test By:	YF	Temperature :	24 °C
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

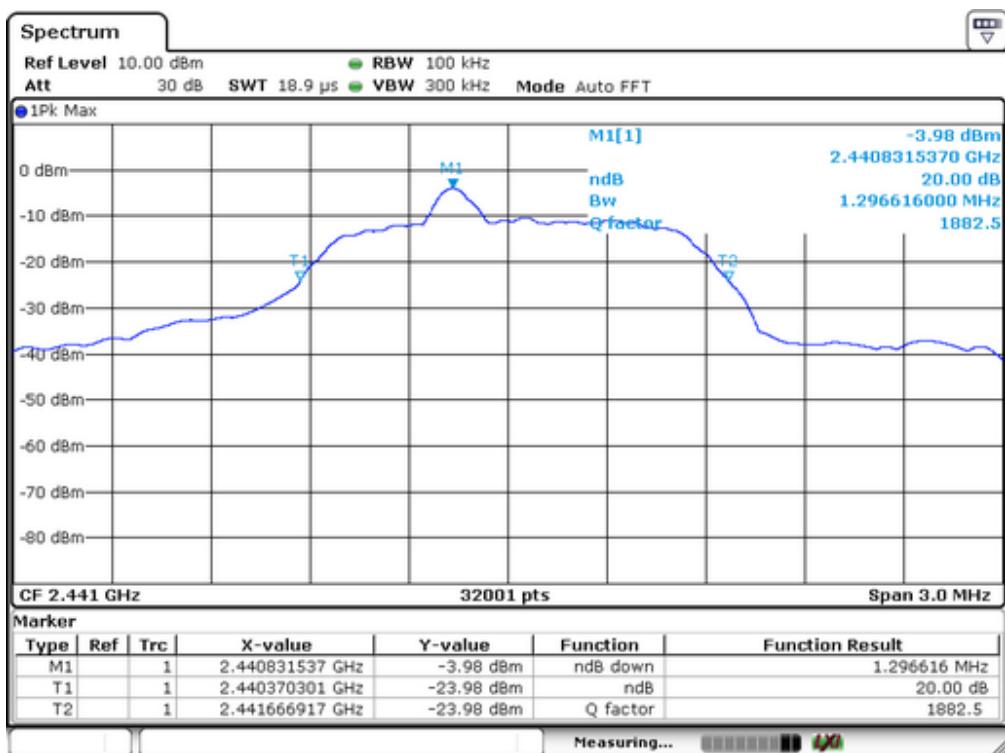
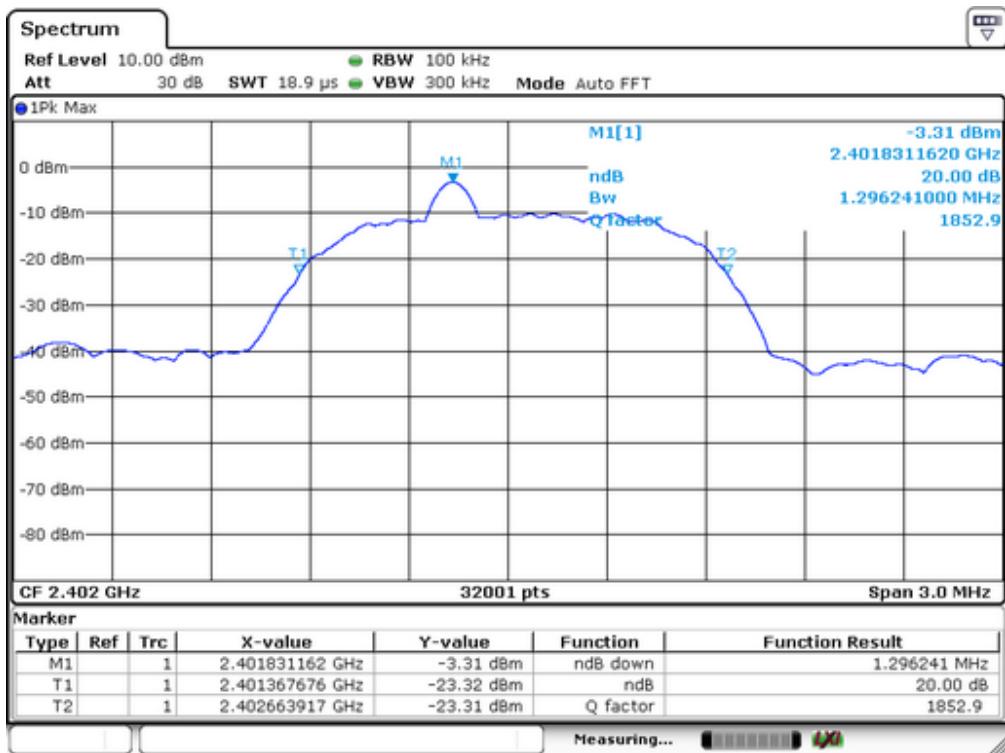
Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1150
40	2441	1148
79	2480	1155

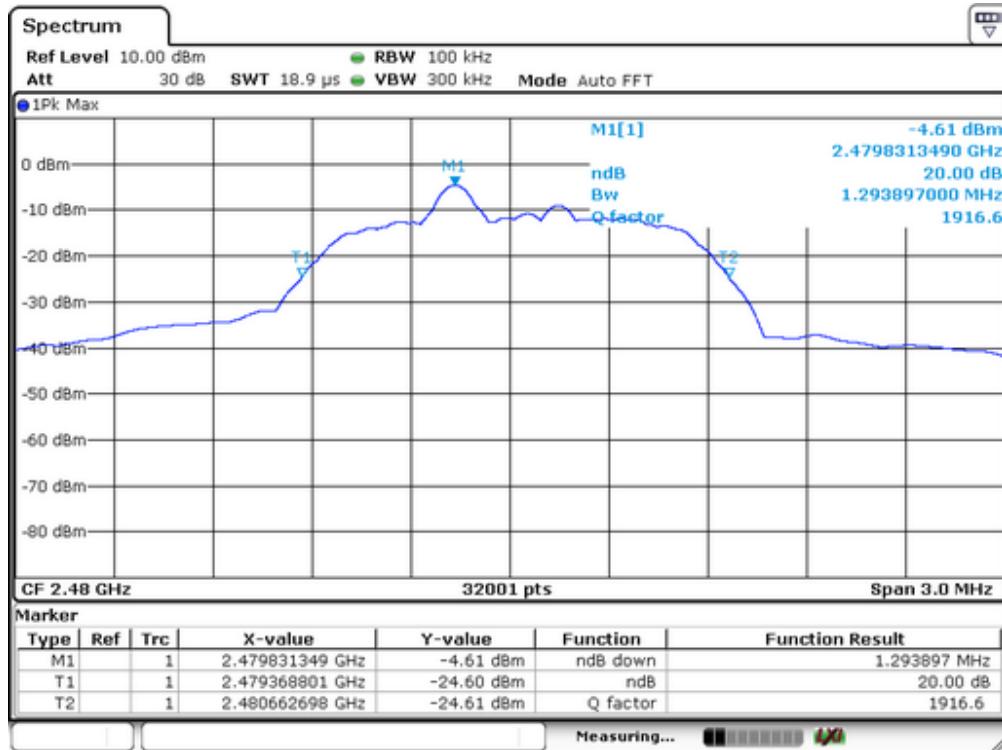




Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 24 °C  
 Test Result: PASS      Humidity : 53 %  
 Modulation: Π/4-DQPSK

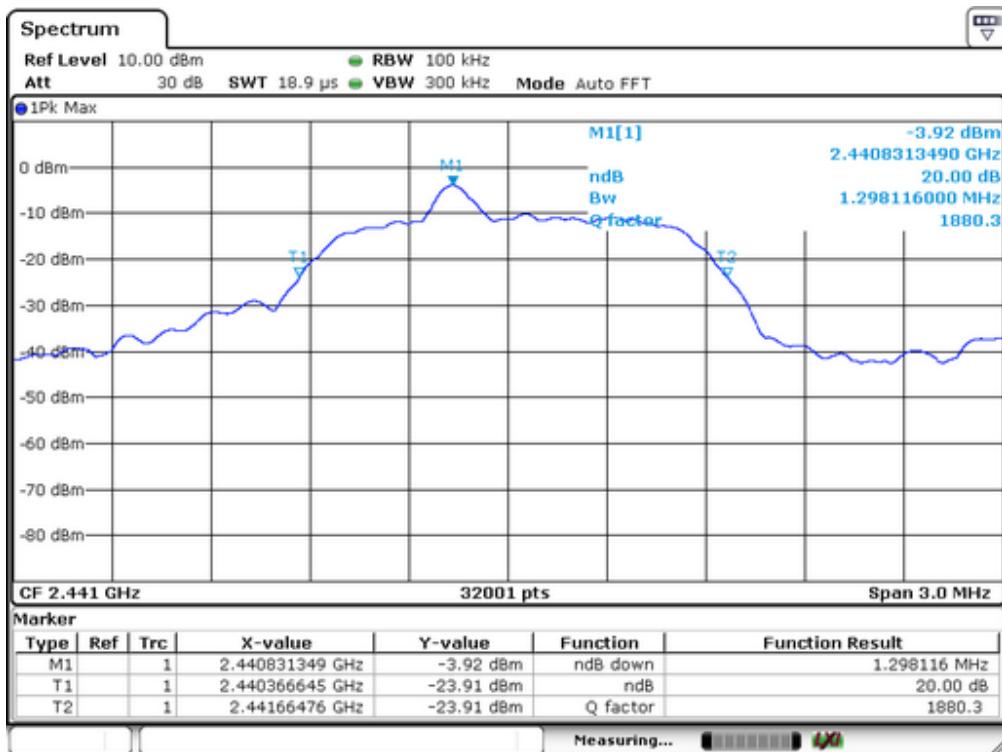
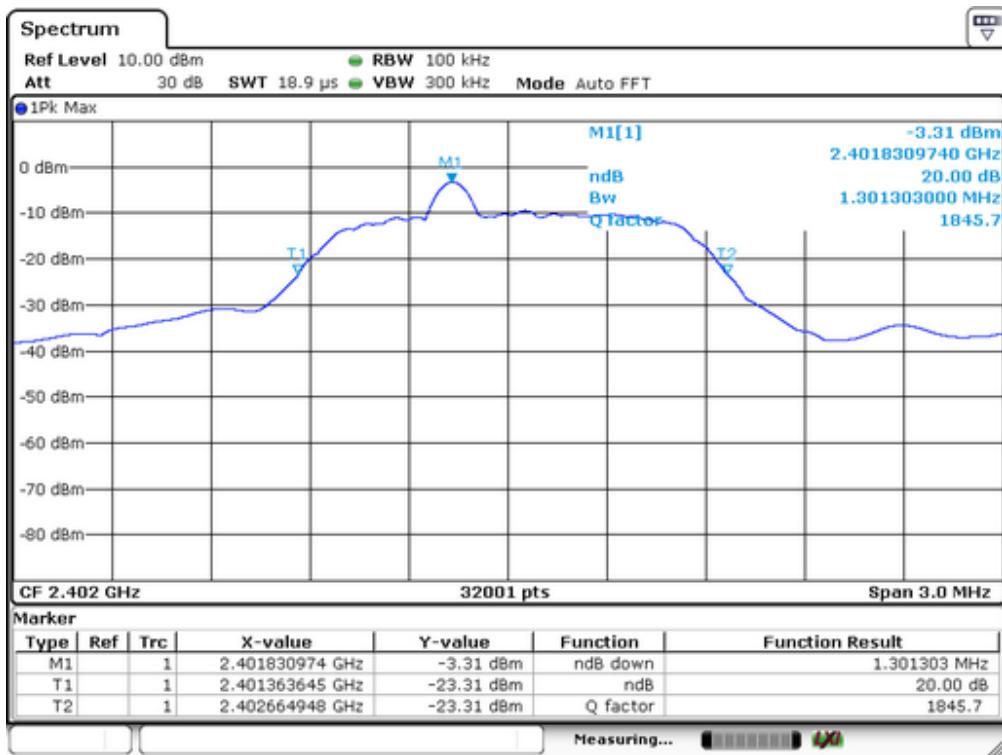
Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1296
40	2441	1297
79	2480	1294

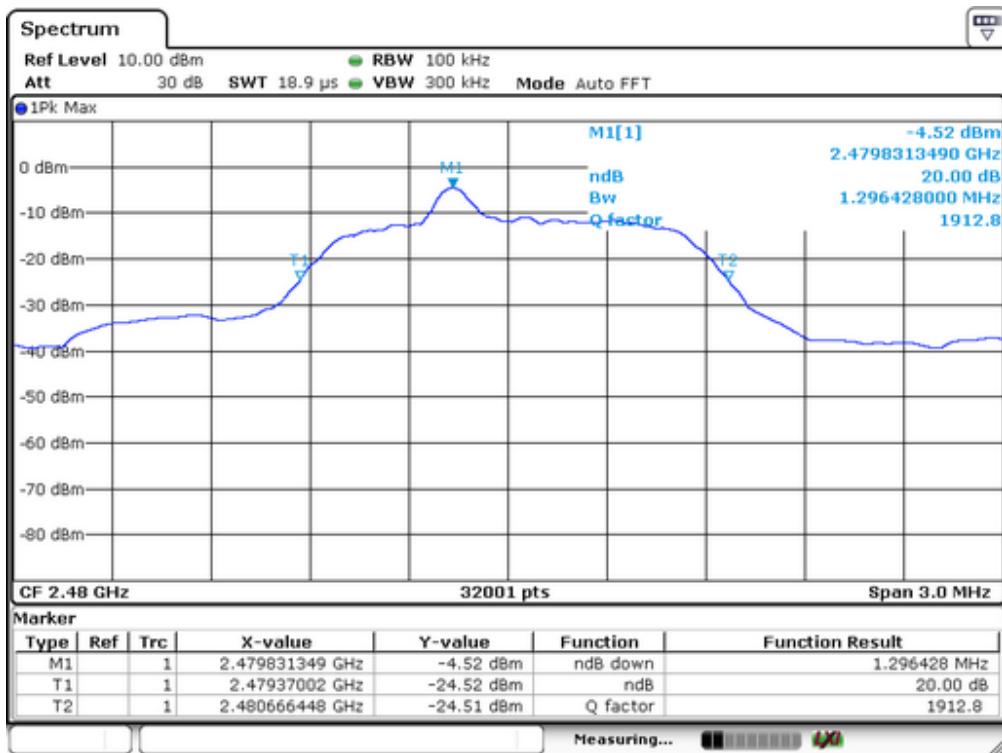




Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 24°C  
 Test Result: PASS      Humidity : 53 %  
 Modulation: 8DPSK

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1301
40	2441	1298
79	2480	1296



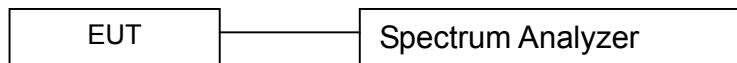


## 9. Quantity of Hopping Channel Test

### 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.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

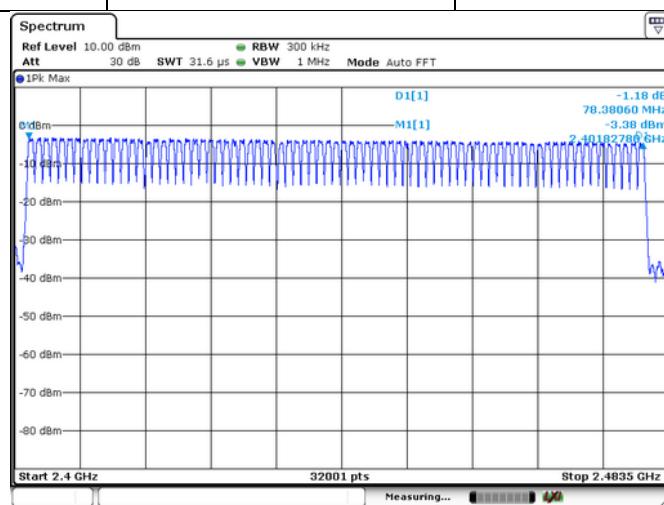
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

### 9.4 Measurement Results:

Refer to attached data chart.

Worst Test Mode	GFSK	Test Date :	July 11, 2017
Test By:	YF	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %

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



## 10. Time of Occupancy (Dwell Time) test

### 10.1 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:

$$\text{Dwell time} = \text{time slot length} * \text{hop rate} / \text{number of hopping channels} * 31.6s$$

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.

### 10.2 Test SET-UP (Block Diagram of Configuration)



### 10.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

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 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

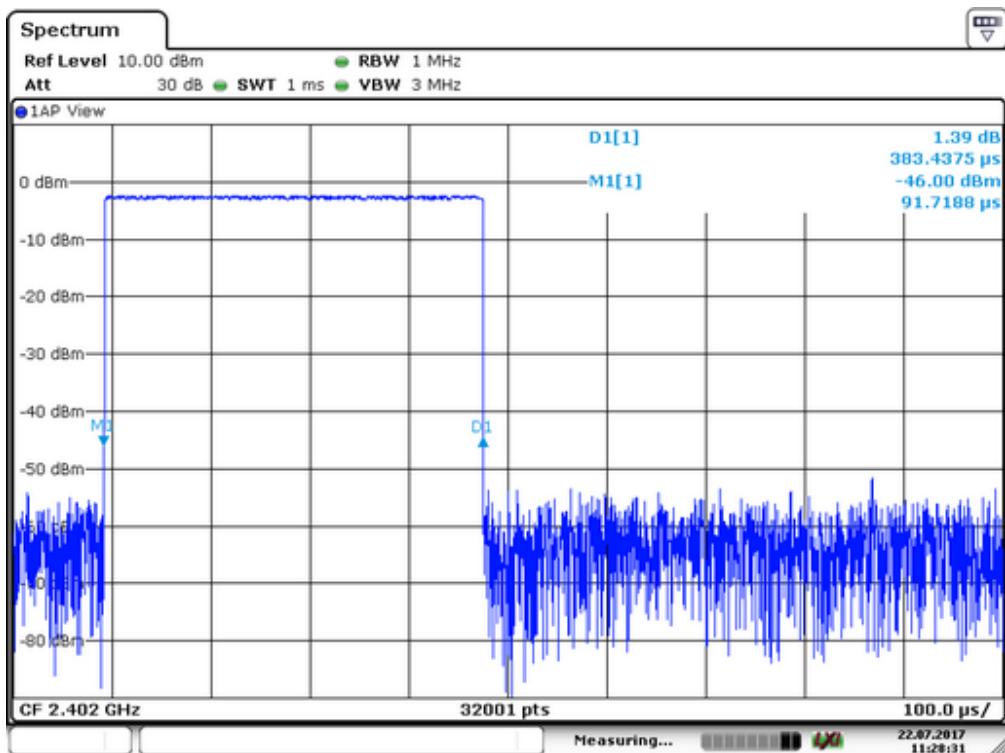
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6seconds. Refer to attached data chart.

## 10.5 Test result

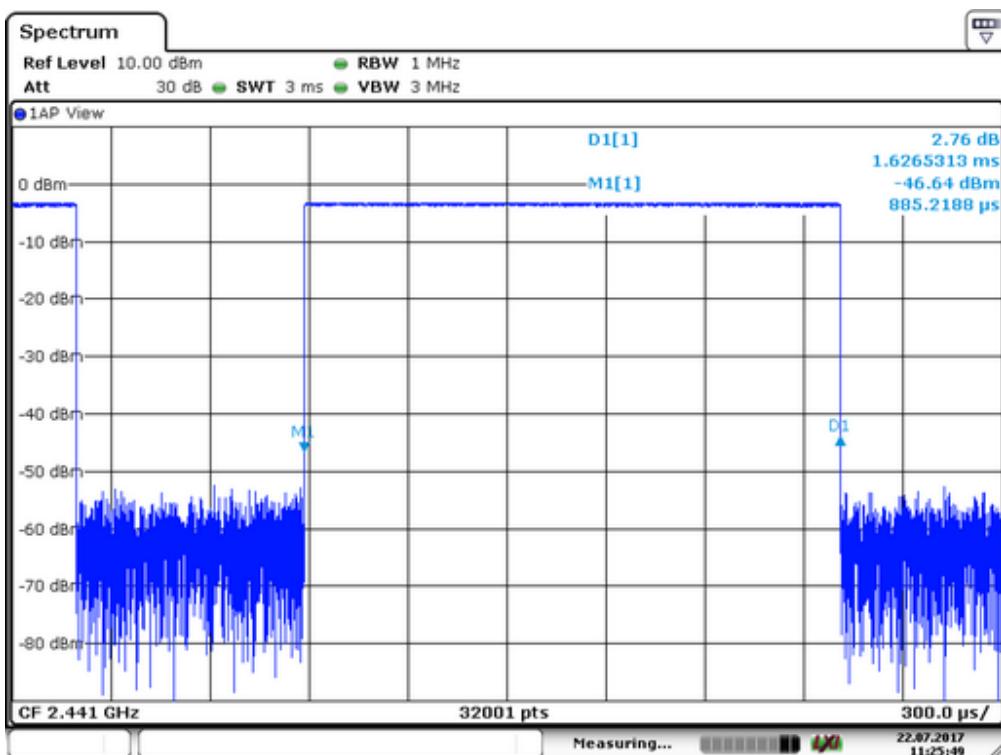
Mode	Number of transmission in a 31.6( 79 Hopping*0.4)	Length of transmissions time(msec)	Result (msec)	Limit (msec)
DH1	$1600/(2*79) \times 31.6 = 320$	0.383	122.56	400
DH3	$1600/(4*79) \times 31.6 = 160$	1.627	263.32	400
DH5	$1600/(6*79) \times 31.6 = 106.67$	2.907	310.09	400

Remark: The results of worst cased was recorded.

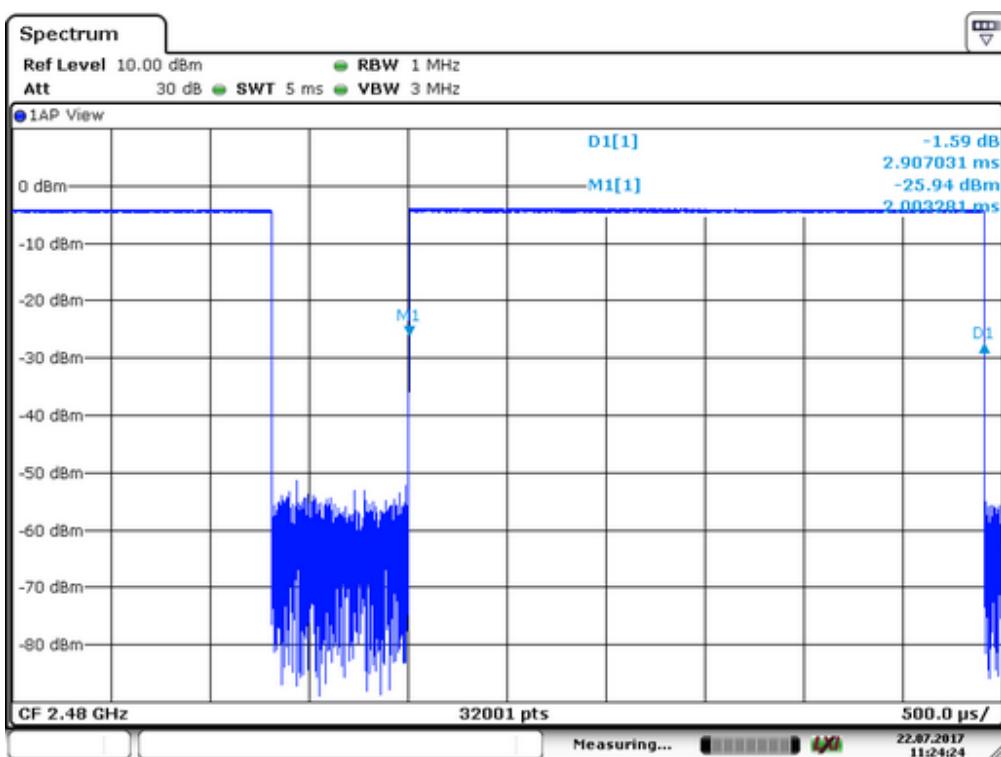
DH1:



DH3:



DH5:

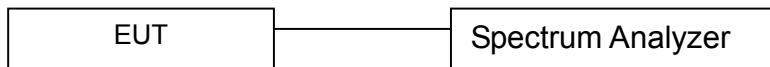


## 11. MAXIMUM PEAK OUTPUT POWER TEST

### 11.1 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.

### 11.2 Test SET-UP (Block Diagram of Configuration)



### 11.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

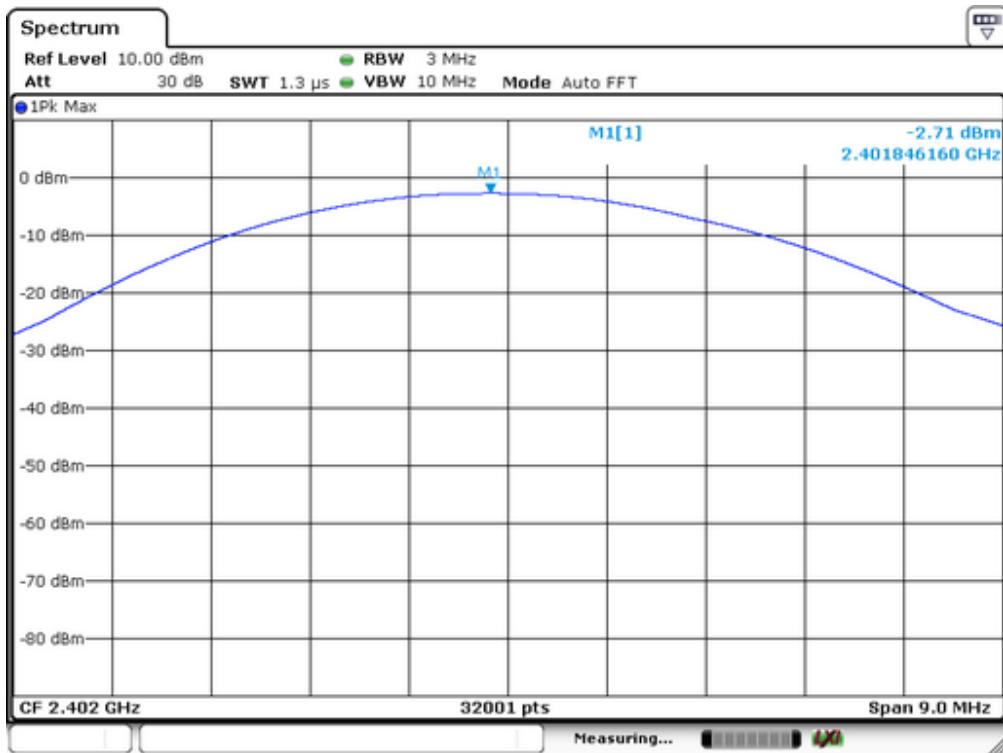
Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

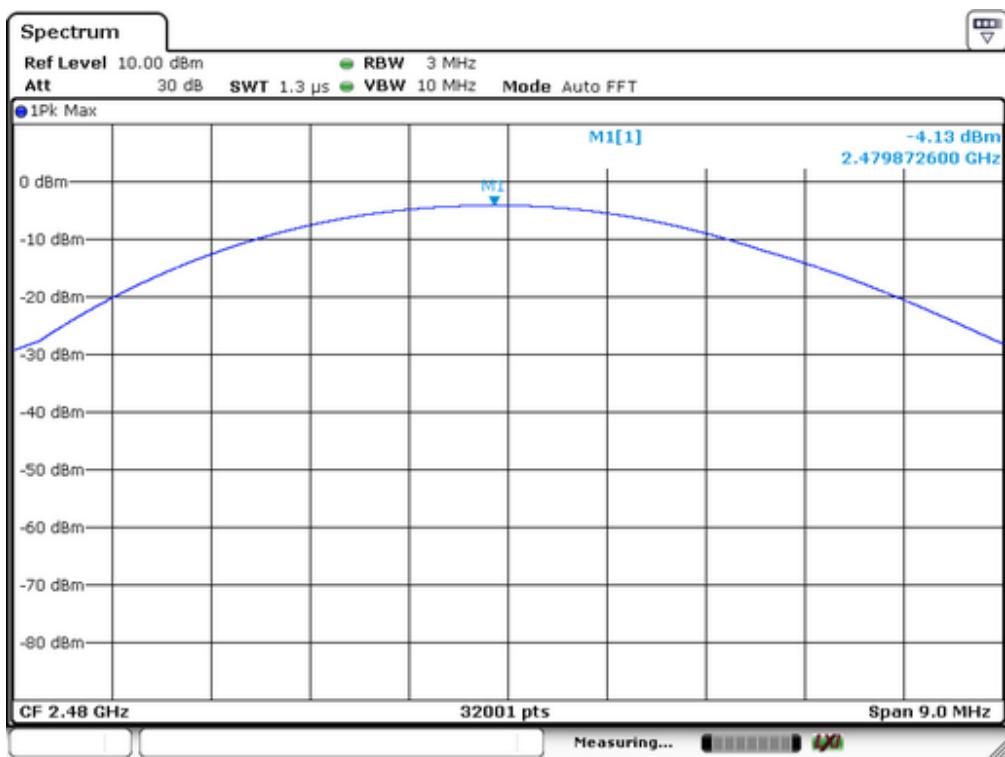
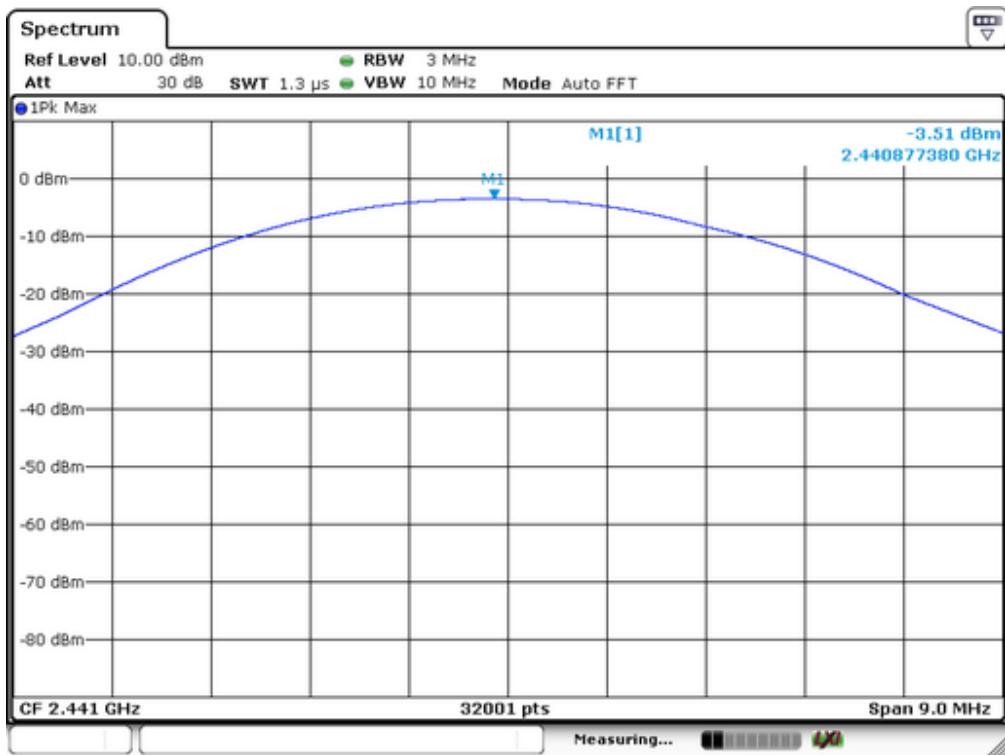
### 11.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	July 11, 2017
Test By:	YF	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %
Modulation:	GFSK		

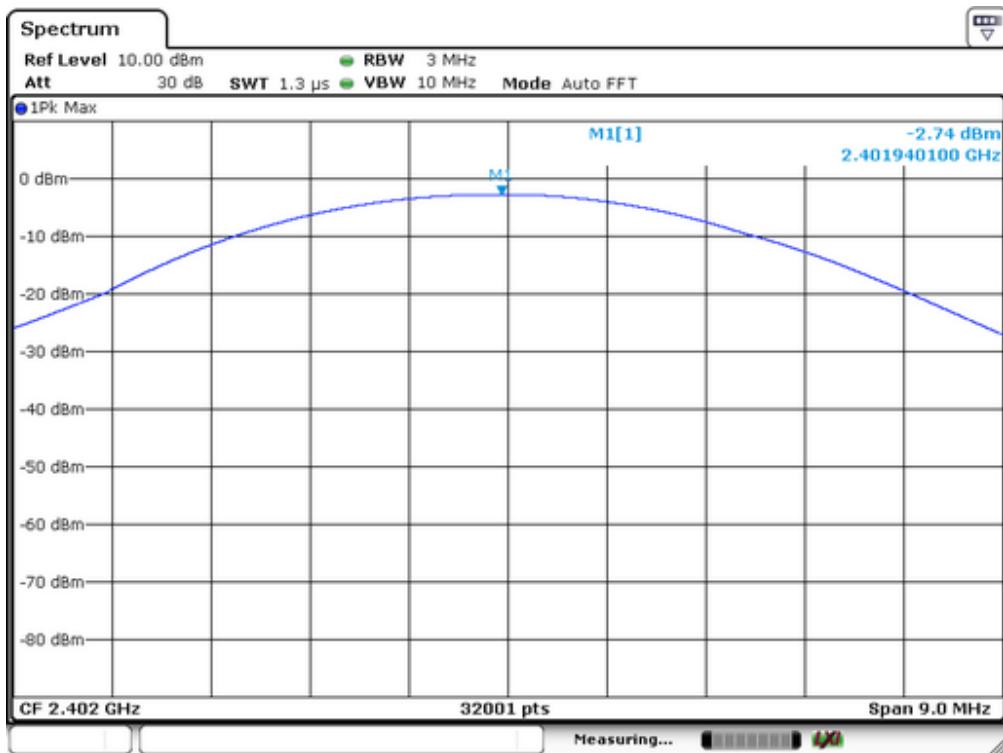
Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-2.71	0.536	1000	PASS
40	2441	-3.51	0.446	1000	PASS
79	2480	-4.13	0.386	1000	PASS

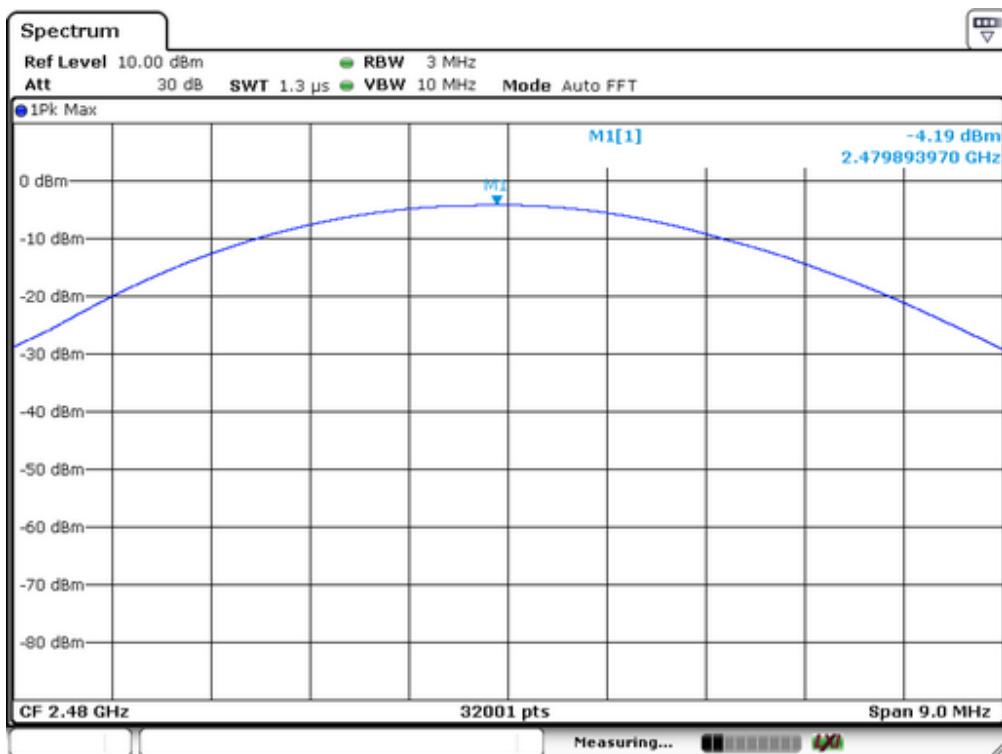
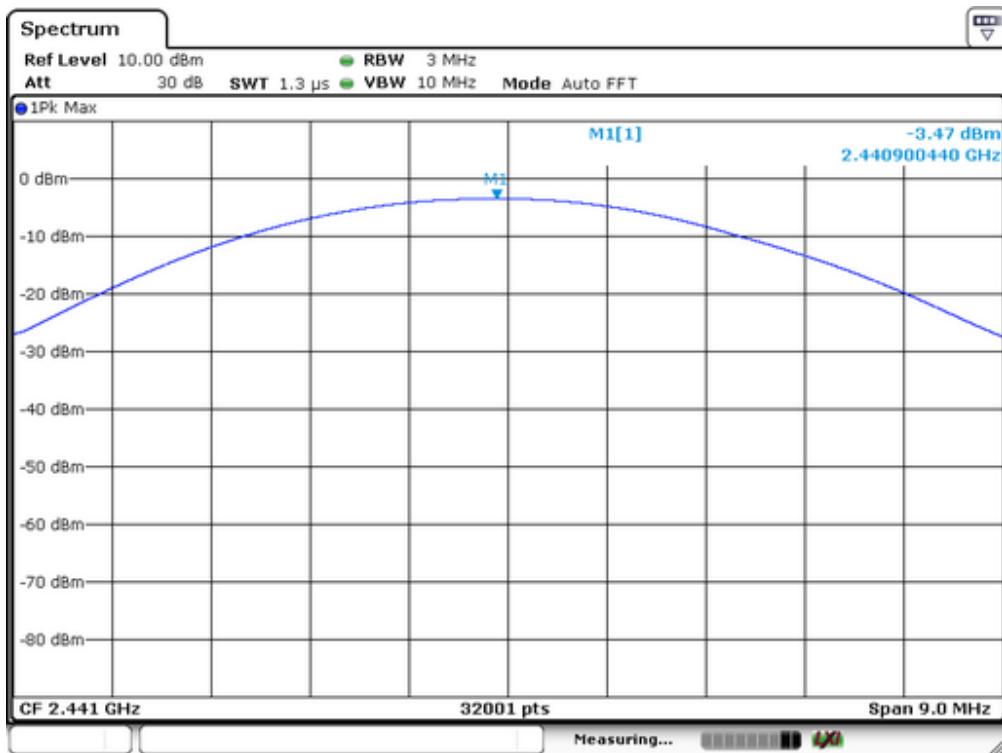




Spectrum Detector: PK      Test Date : July 11, 2017  
 Test By: YF      Temperature : 25 °C  
 Test Result: PASS      Humidity : 50 %  
 Modulation: Π/4-DQPSK

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-2.74	0.532	125	PASS
40	2441	-3.47	0.450	125	PASS
79	2480	-4.19	0.381	125	PASS

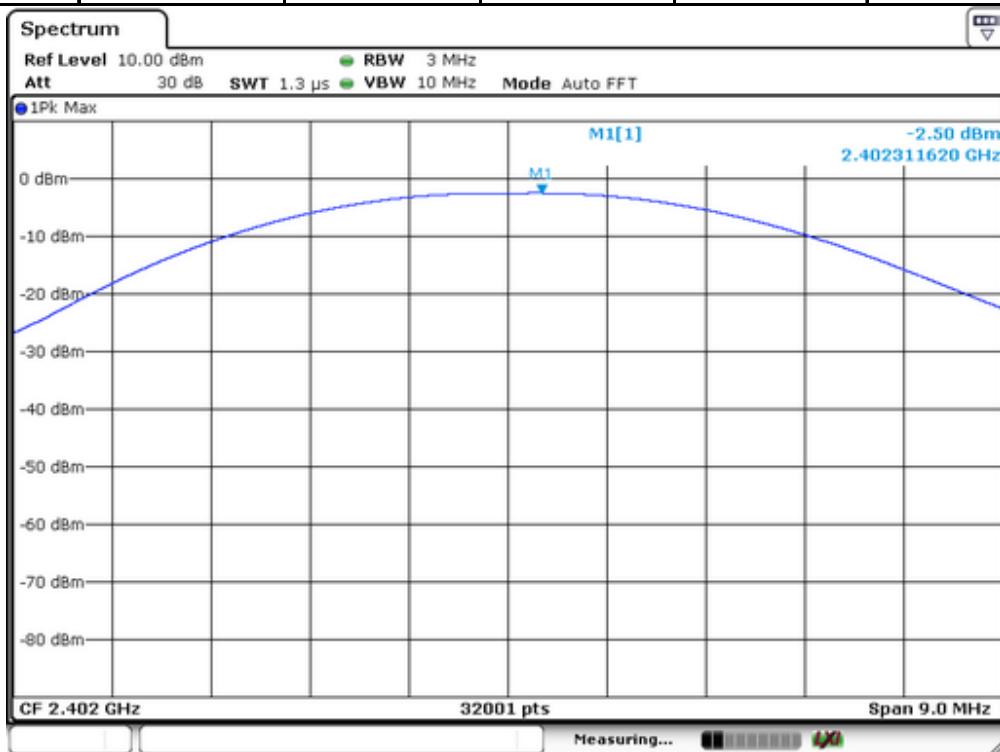


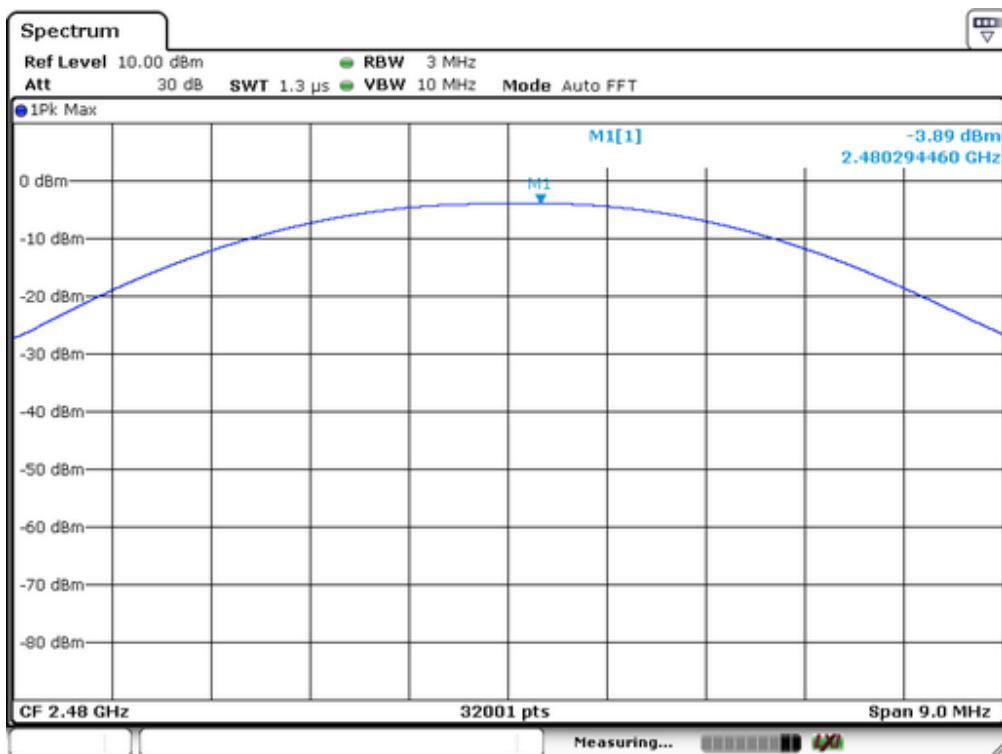
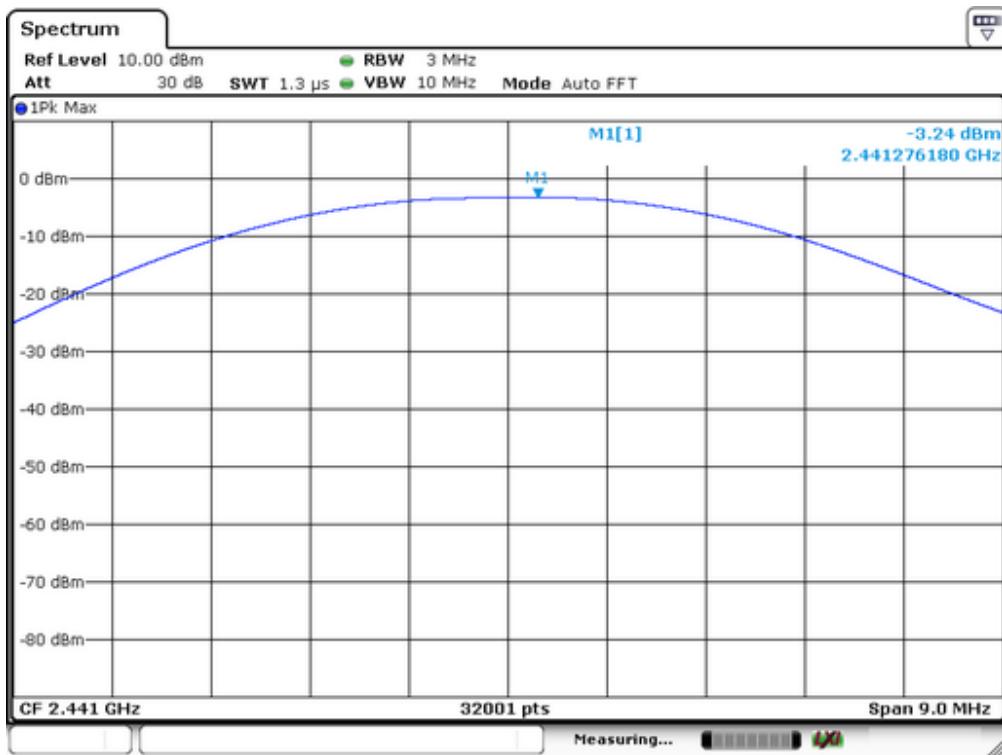


Spectrum Detector: PK  
 Test By: YF  
 Test Result: PASS  
 Modulation: 8DPSK

Test Date : July 11, 2017  
 Temperature : 25 °C  
 Humidity : 50 %

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	<b>-2.5</b>	<b>0.562</b>	125	PASS
40	2441	-3.24	0.474	125	PASS
79	2480	-3.89	0.408	125	PASS





## 12. Band EDGE test

### 12.1 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:

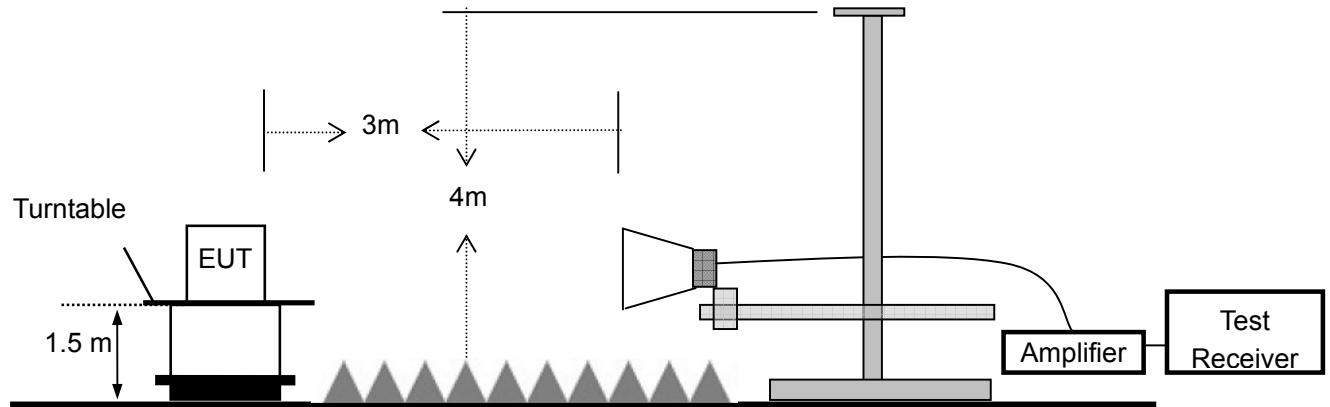
EMI Test Receiver	Setting
Attenuation	Auto
RBW	100KHz
VBW	300KHz
Detector	Peak
Trace	Max hold

## 12.2 Test SET-UP (Block Diagram of Configuration)

For Conducted Test



For Radiated emission Test



## 12.3 Measurement Equipment Used:

For Conducted Test

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Characteristics	LAST CAL.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	10Hz-30GHz	05/16/2017
Coaxial Cable	CDS	79254	46107086	10Hz-30GHz	05/16/2017
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	10Hz-30GHz	05/16/2017

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	5/16/2017	1 Year
2	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-12 72	1GHz-18GHz	5/16/2017	1 Year
3	Power Amplifier	LUNAR EM	LNA1G18-40	J1010000 0081	1GHz-26.5GHz	5/16/2017	1 Year
4	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year
5	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year
6	Cable	H+S	CBL-26	N/A	1GHz-26.5GHz	5/16/2017	1 Year

#### **12.4 Measurement Results:**

Refer to attached data chart.

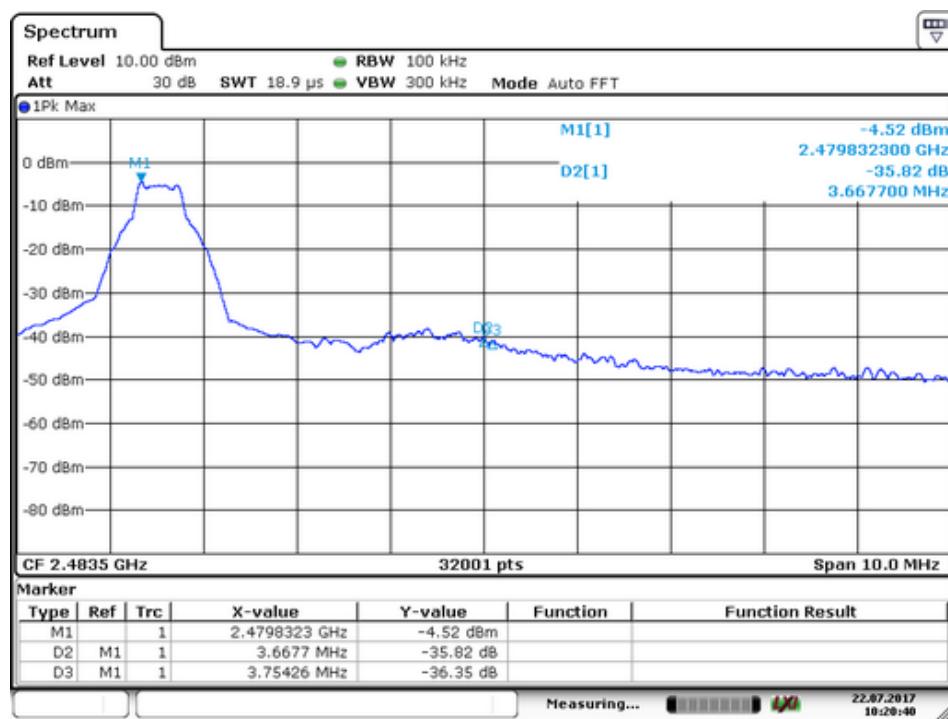
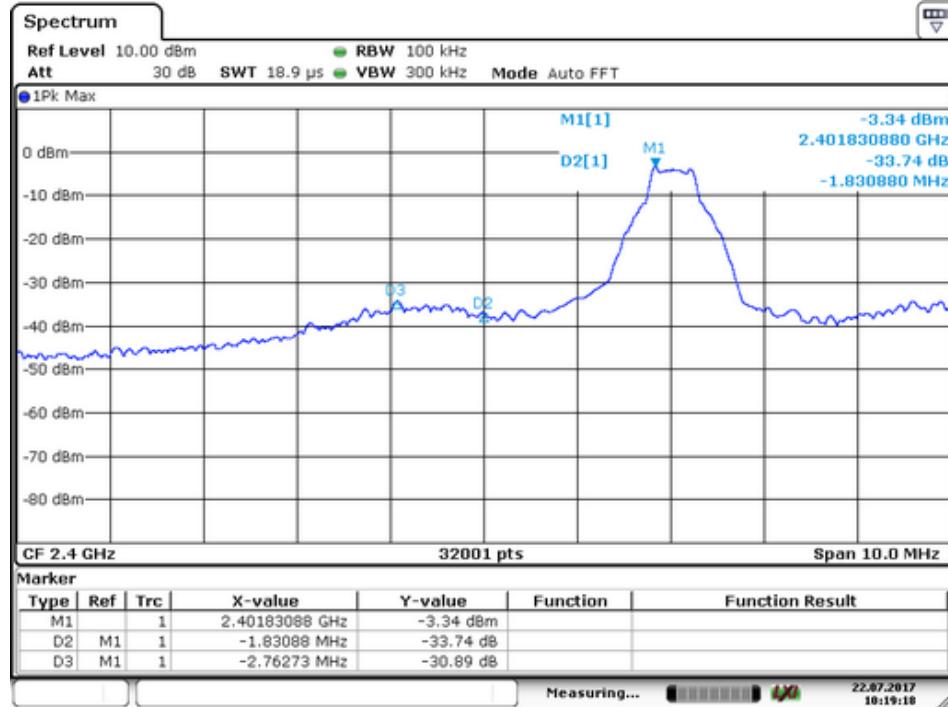
Spectrum Detector:	PK	Test Date :	July 11, 2017
Test By:	YF	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %

##### **1. Conducted Test**

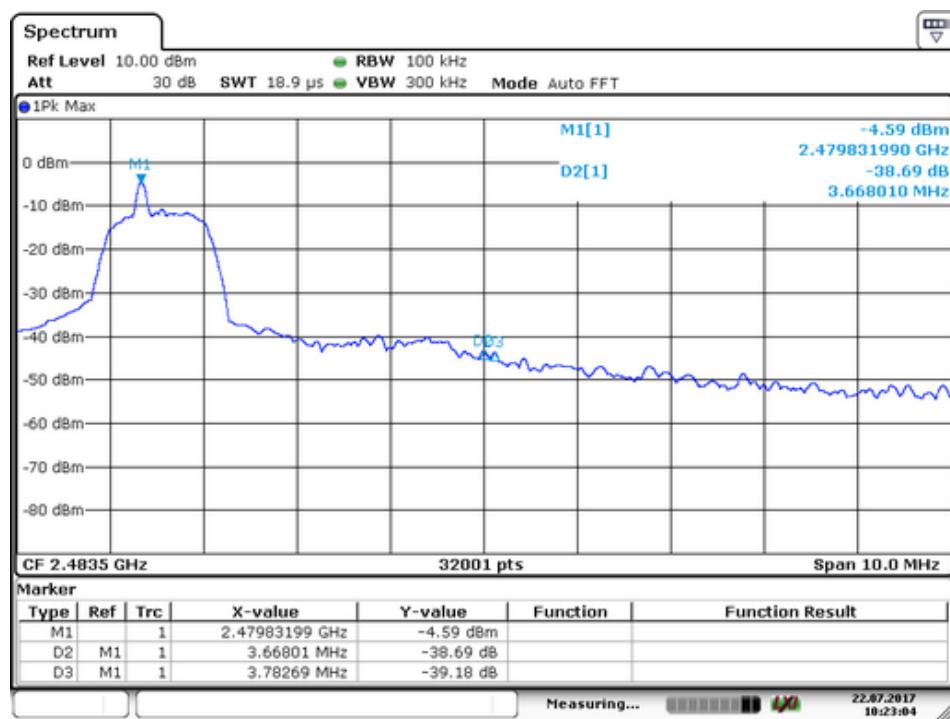
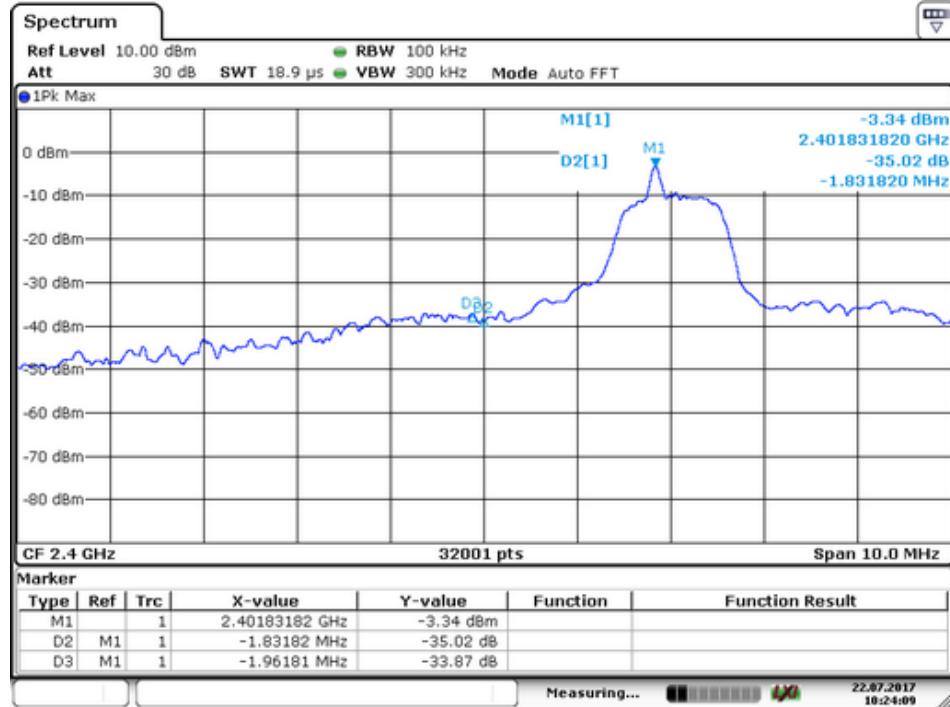
For Non-Hopping Mode:

Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.07	GFSK	-3.34	30.89	>20dBc
2483.59	pi/4-DQPSK	-4.52	36.35	>20dBc
2399.87	8DPSK	-3.34	33.87	>20dBc
2483.61	GFSK	-4.59	39.18	>20dBc
2399.74	pi/4-DQPSK	-3.35	34.61	>20dBc
2483.78	8DPSK	-4.53	37.95	>20dBc

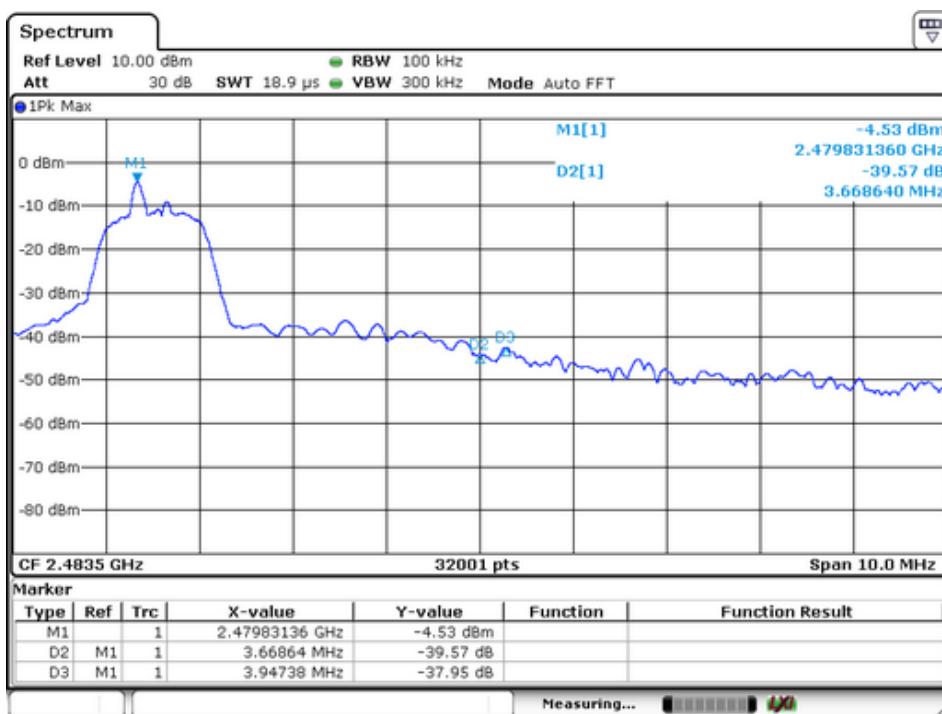
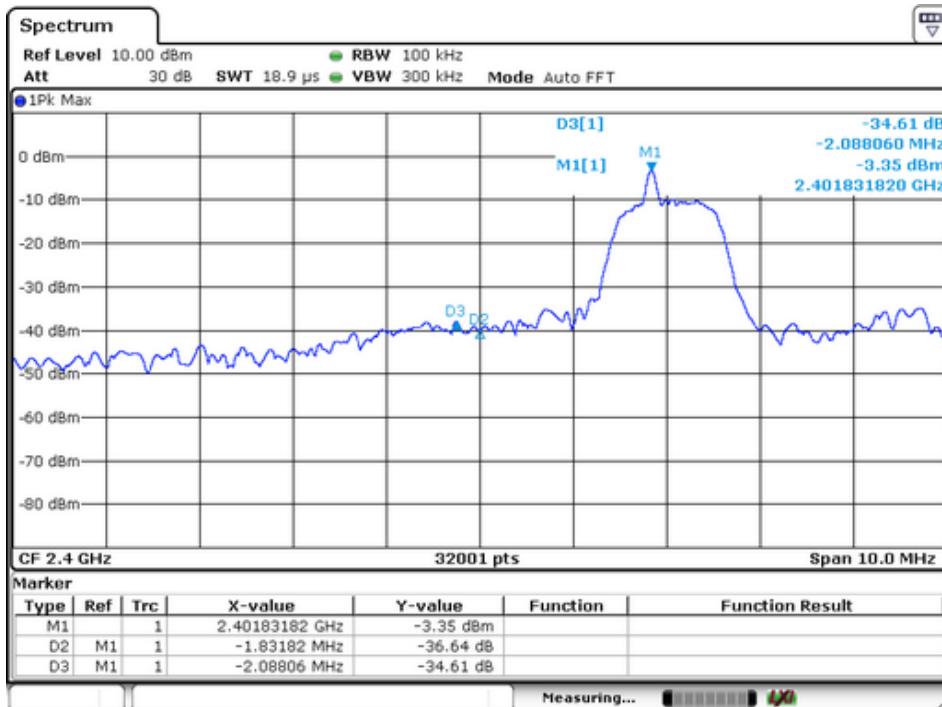
## Test plots of GFSK



### Test plots of pi/4-DQPSK



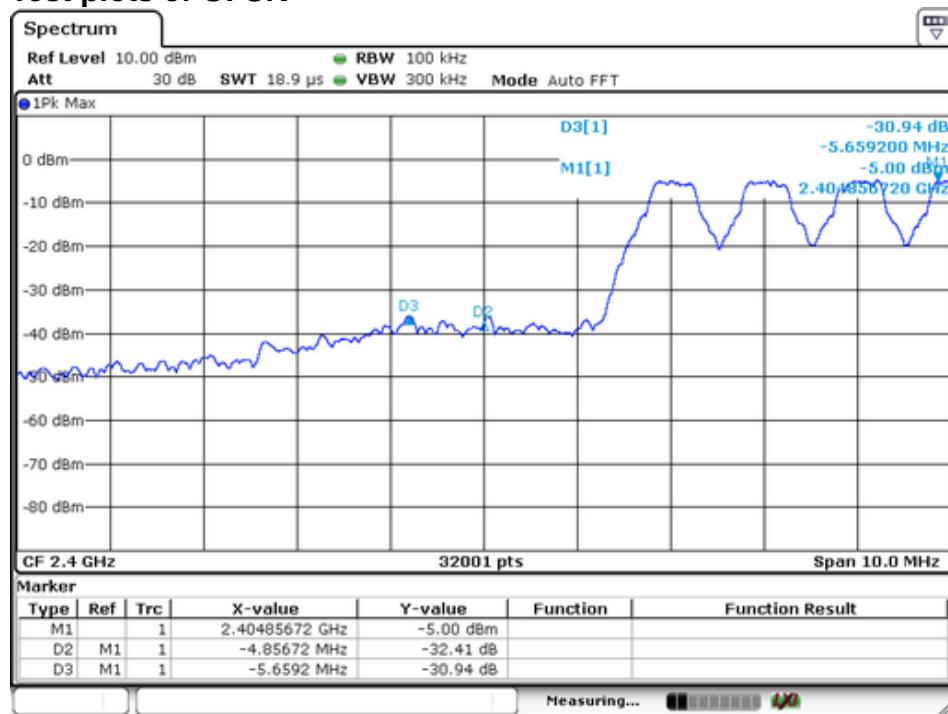
## Test plots of 8DPSK

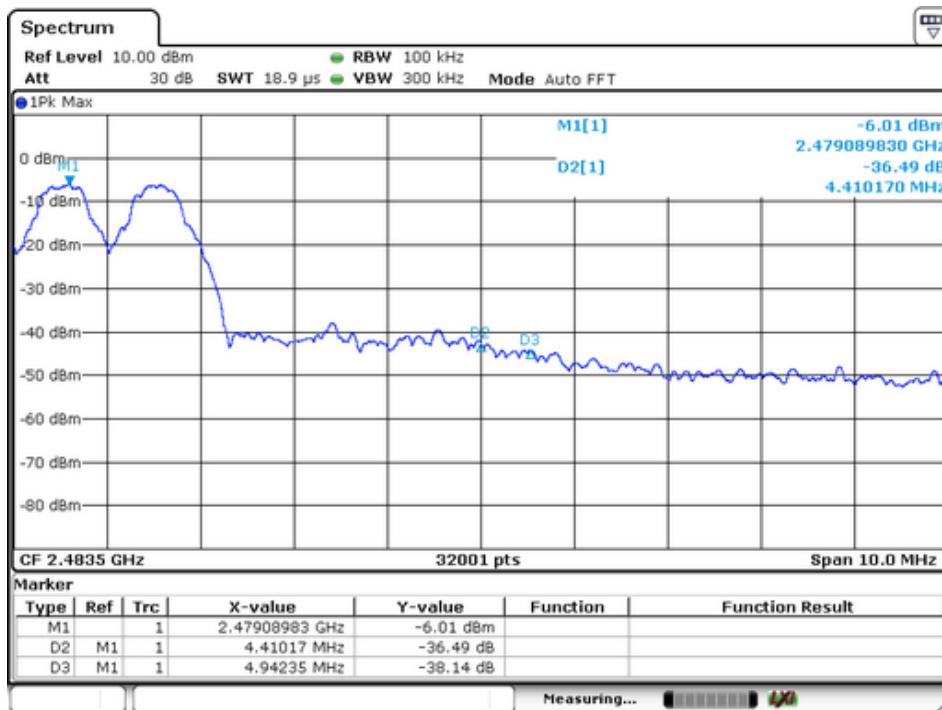


For Hopping Mode:

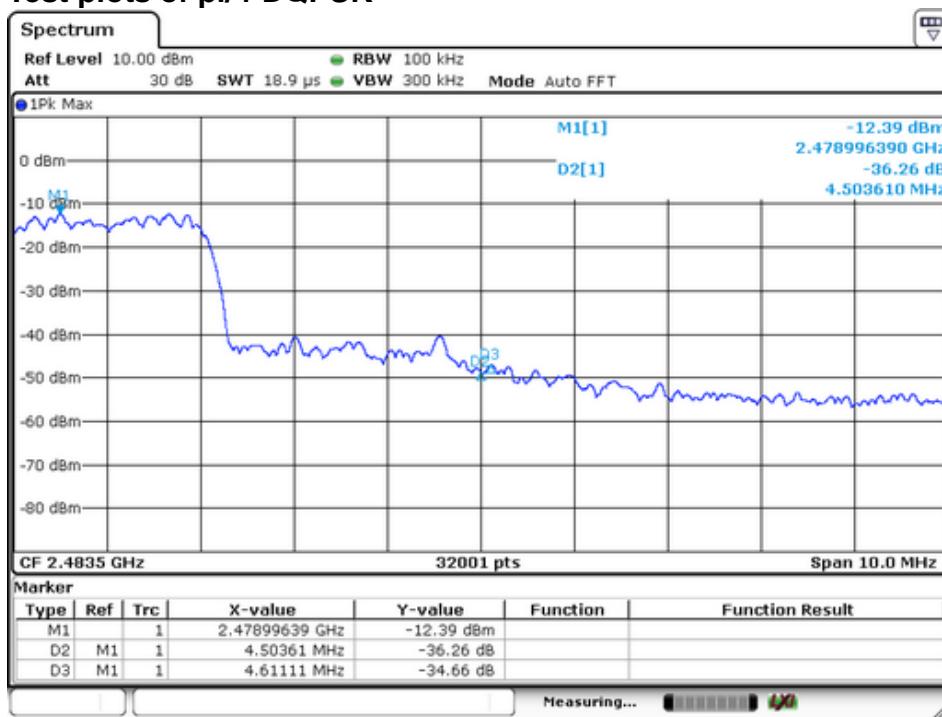
Frequency (MHz)	Modulation	Peak Power Output(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.2	GFSK	-5	30.94	>20dBc
2484.03	pi/4-DQPSK	-6.01	38.14	>20dBc
2483.61	8DPSK	-12.39	34.66	>20dBc
2399.14	GFSK	-10.75	30.88	>20dBc
2483.67	pi/4-DQPSK	-8.83	39.42	>20dBc
2399.51	8DPSK	-7.18	29.34	>20dBc

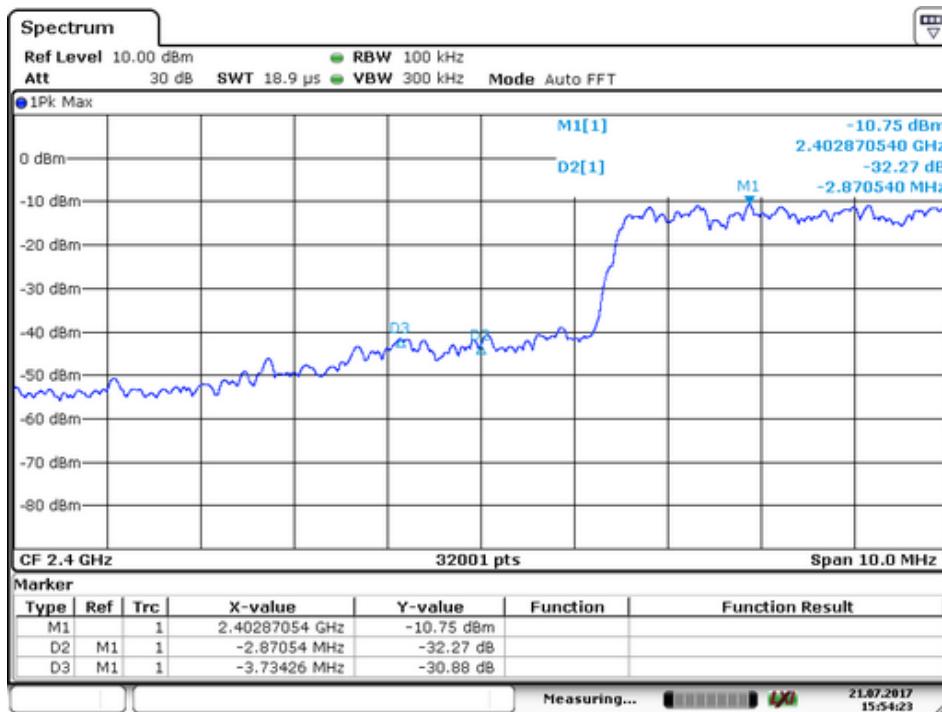
### Test plots of GFSK



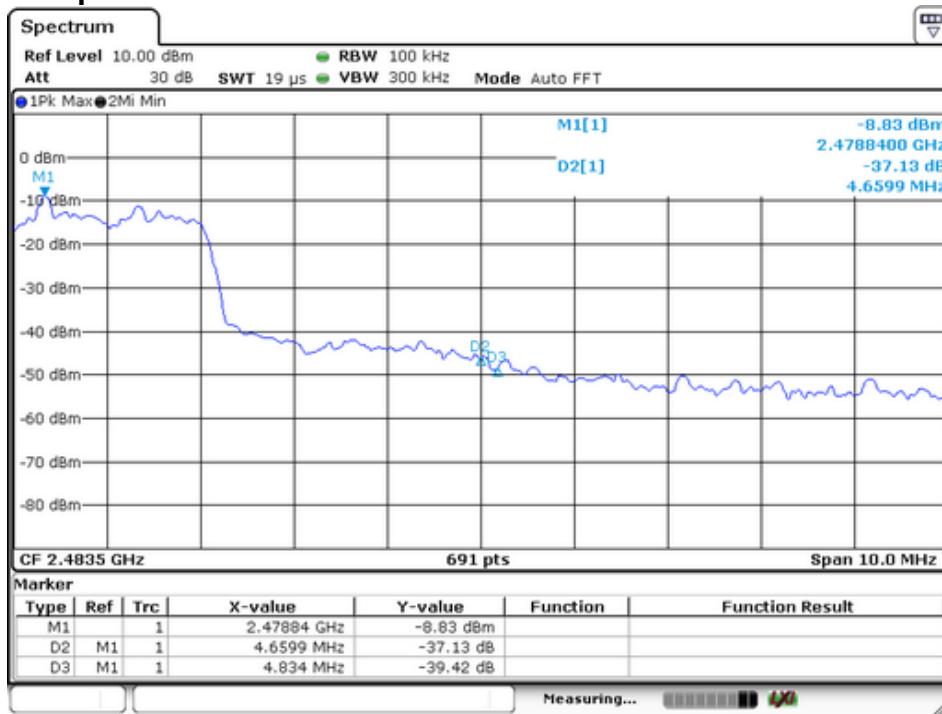


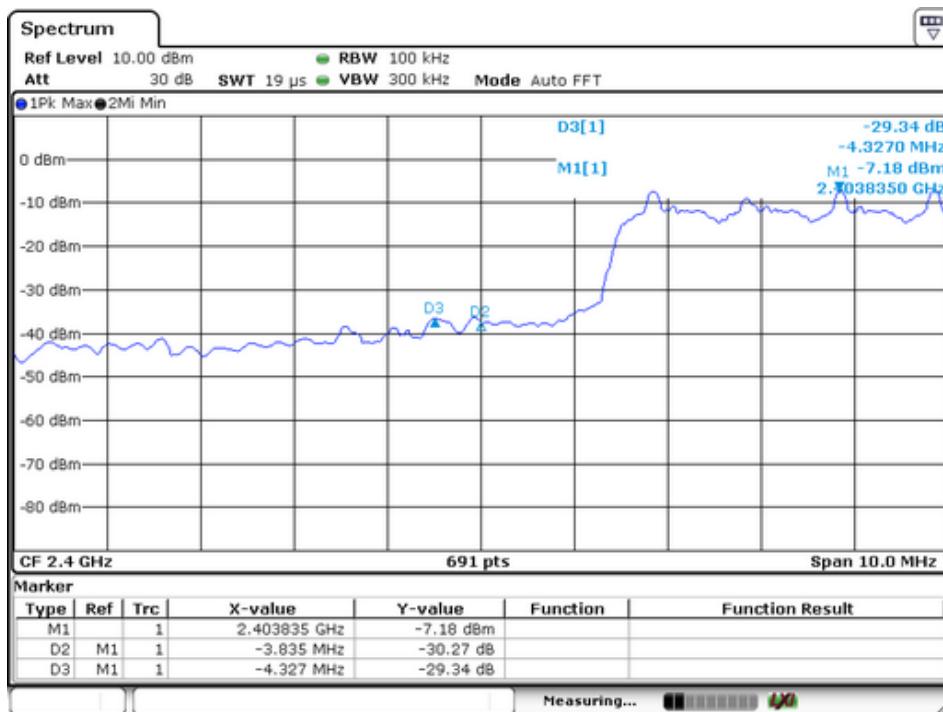
### Test plots of pi/4-DQPSK



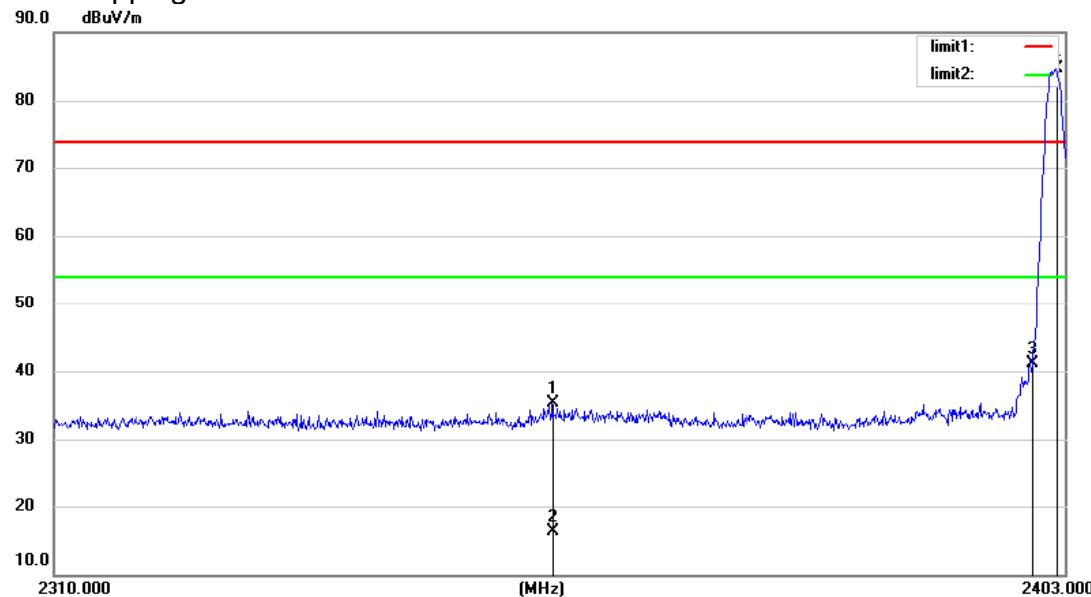


### Test plots of 8DPSK





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	Correct	Measure-	Limit	Over	Antenna	Table		
			Level	Factor	ment					Degree	Comment
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	
1		2355.477	54.01	-18.76	35.25	74.00	-38.75	peak			
2		2355.477	35.00	-18.76	16.24	54.00	-37.76	AVG			
3		2400.000	59.59	-18.50	41.09	74.00	-32.91	peak			
4	*	2402.163	103.11	-18.49	84.62	74.00	10.62	peak			

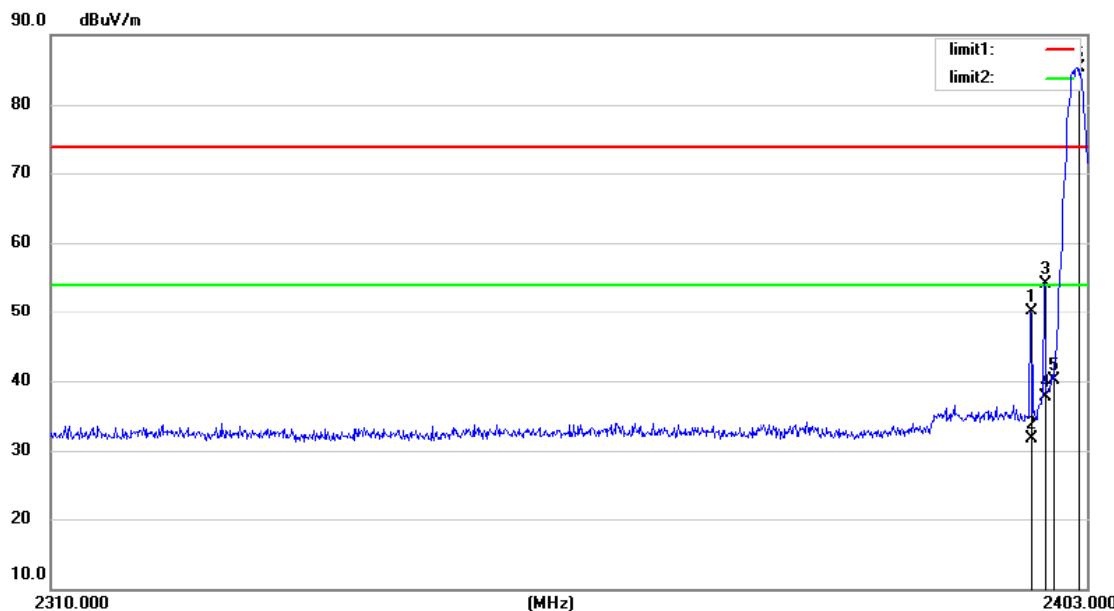
\*:Maximum data    x:Over limit    l:over margin

Operator: washington

TRF No.: FCC 15.247/A

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Report No.: ED170717009E Ver.1.0



Site Chamber #1

Polarization: **Vertical**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m\_PEAK

Power: Battery 3.7V

Humidity: 55 %

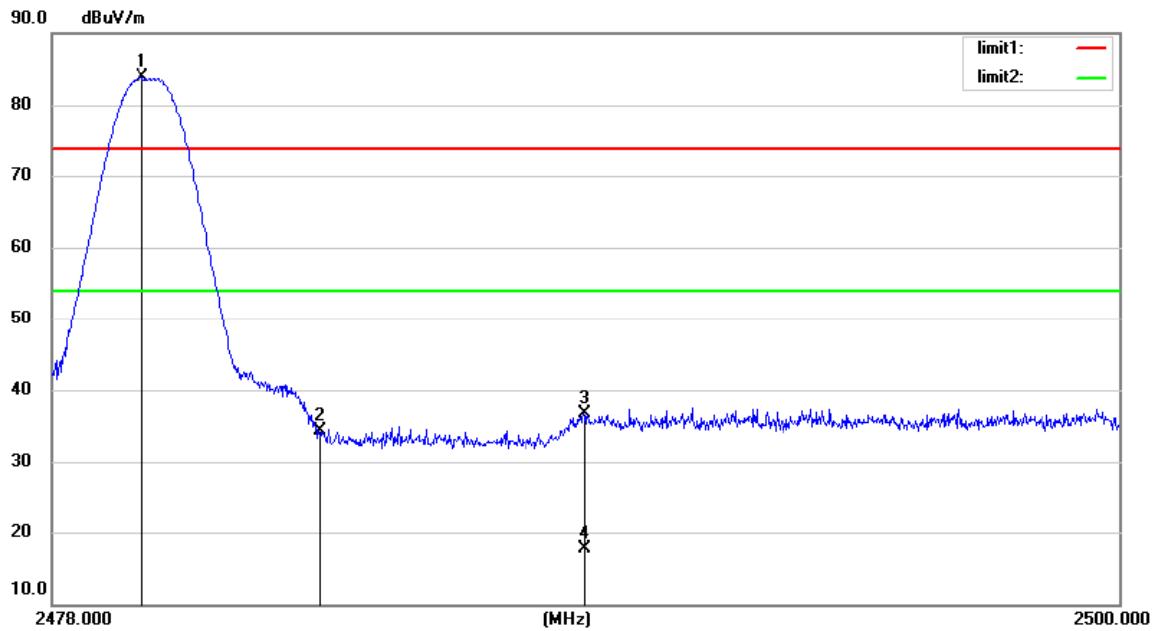
Mode: TX2402

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm		Table Degree	Comment
								Detector	degree		
1		2397.885	68.53	-18.51	50.02	74.00	-23.98	peak			
2		2397.885	50.12	-18.51	31.61	54.00	-22.39	AVG			
3		2399.187	72.51	-18.50	54.01	74.00	-19.99	peak			
4		2399.187	56.25	-18.50	37.75	54.00	-16.25	AVG			
5		2400.000	58.55	-18.50	40.05	74.00	-33.95	peak			
6	*	2402.163	103.76	-18.49	85.27	74.00	11.27	peak			

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Horizontal**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m\_PEAK

Power: Battery 3.7V

Humidity: 55 %

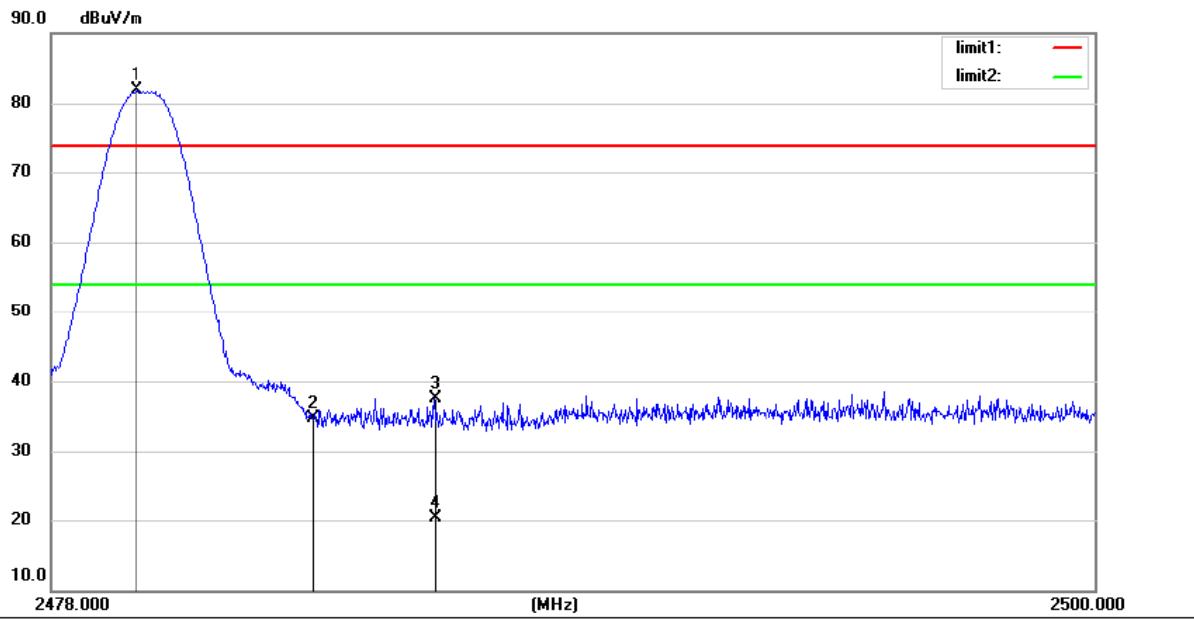
Mode: TX2480

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree degree	Comment
1	*	2479.826	101.89	-18.03	83.86	74.00	9.86	peak		
2		2483.500	52.21	-18.01	34.20	74.00	-39.80	peak		
3		2488.934	54.75	-17.98	36.77	74.00	-37.23	peak		
4		2488.934	35.69	-17.98	17.71	54.00	-36.29	AVG		

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



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. MHz	Reading Level	Correct Factor	Measure- ment	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree	Comment
			dBuV	dB	dBuV/m					
1	*	2479.782	99.84	-18.03	81.81	74.00	7.81	peak		
2		2483.500	52.79	-18.01	34.78	74.00	-39.22	peak		
3		2486.052	55.52	-18.00	37.52	74.00	-36.48	peak		
4		2486.052	38.25	-18.00	20.25	54.00	-33.75	AVG		

\*:Maximum data    x:Over limit    !:over margin

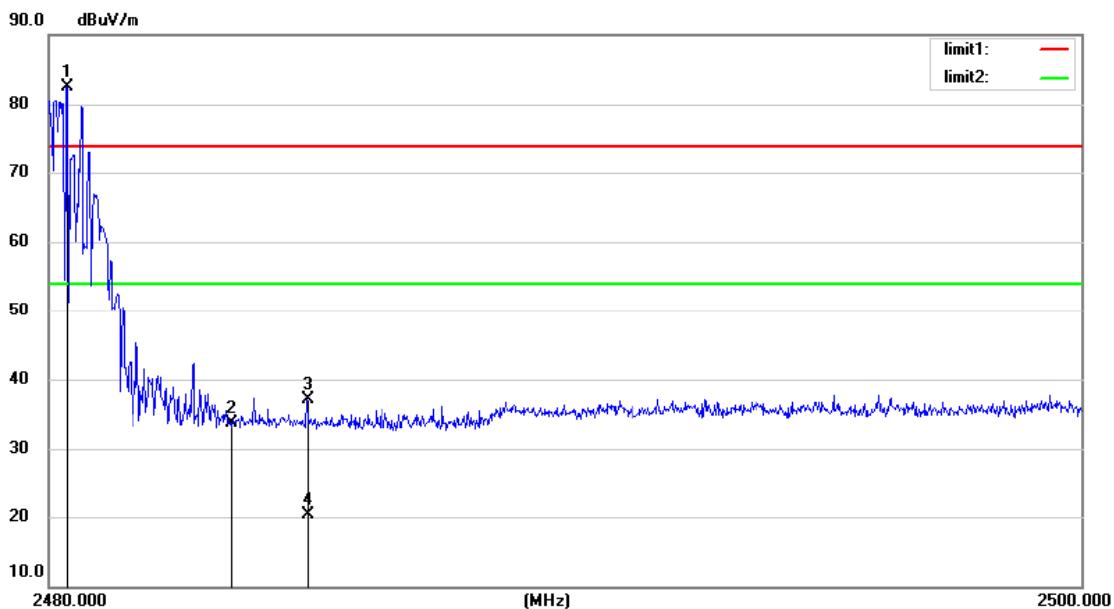
Operator: washington

For Hopping Mode:

TRF No.: FCC 15.247/A

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Report No.: ED170717009E Ver.1.0



Site Chamber #1

Polarization: **Horizontal**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m\_PEAK

Power: Battery 3.7V

Humidity: 55 %

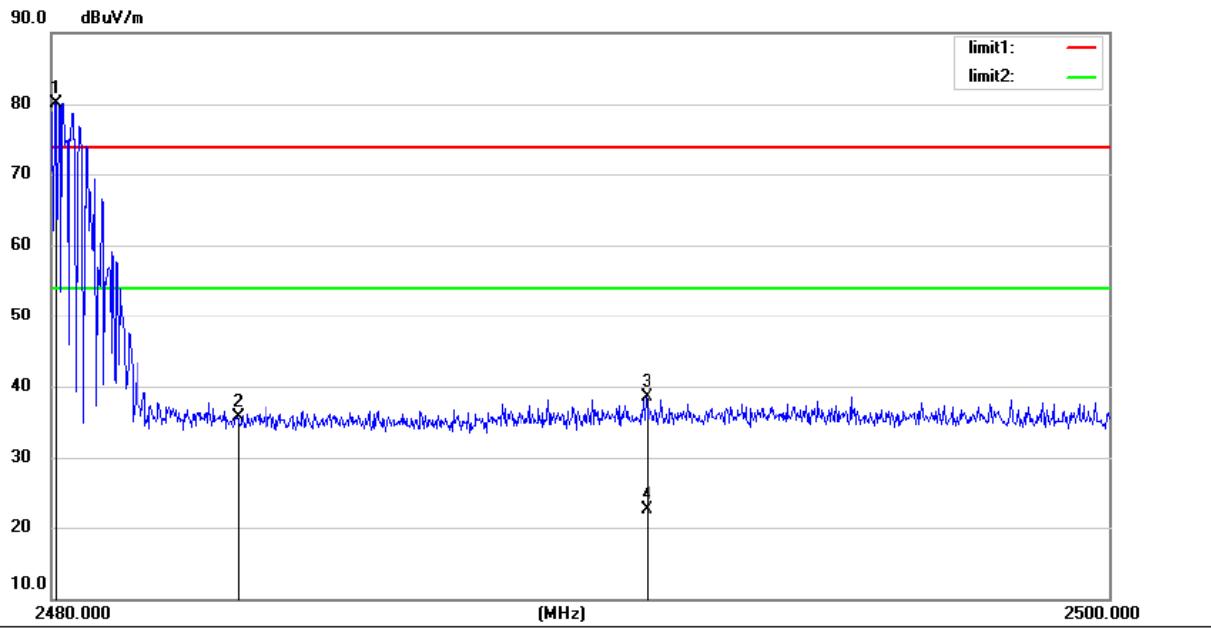
Mode: Hopping

Note:

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Antenna	Table		
			Level	Factor	ment			Height	Degree		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	2480.340	100.53	-18.03	82.50	74.00	8.50	peak			
2		2483.500	51.78	-18.01	33.77	74.00	-40.23	peak			
3		2485.000	55.14	-18.00	37.14	74.00	-36.86	peak			
4		2485.000	38.26	-18.00	20.26	54.00	-33.74	AVG			

\*:Maximum data    x:Over limit    !:over margin

Operator: washington



Site Chamber #1

Polarization: **Vertical**

Temperature: 26

Limit: (RE)FCC PART 15 C 3m\_PEAK

Power: Battery 3.7V

Humidity: 55 %

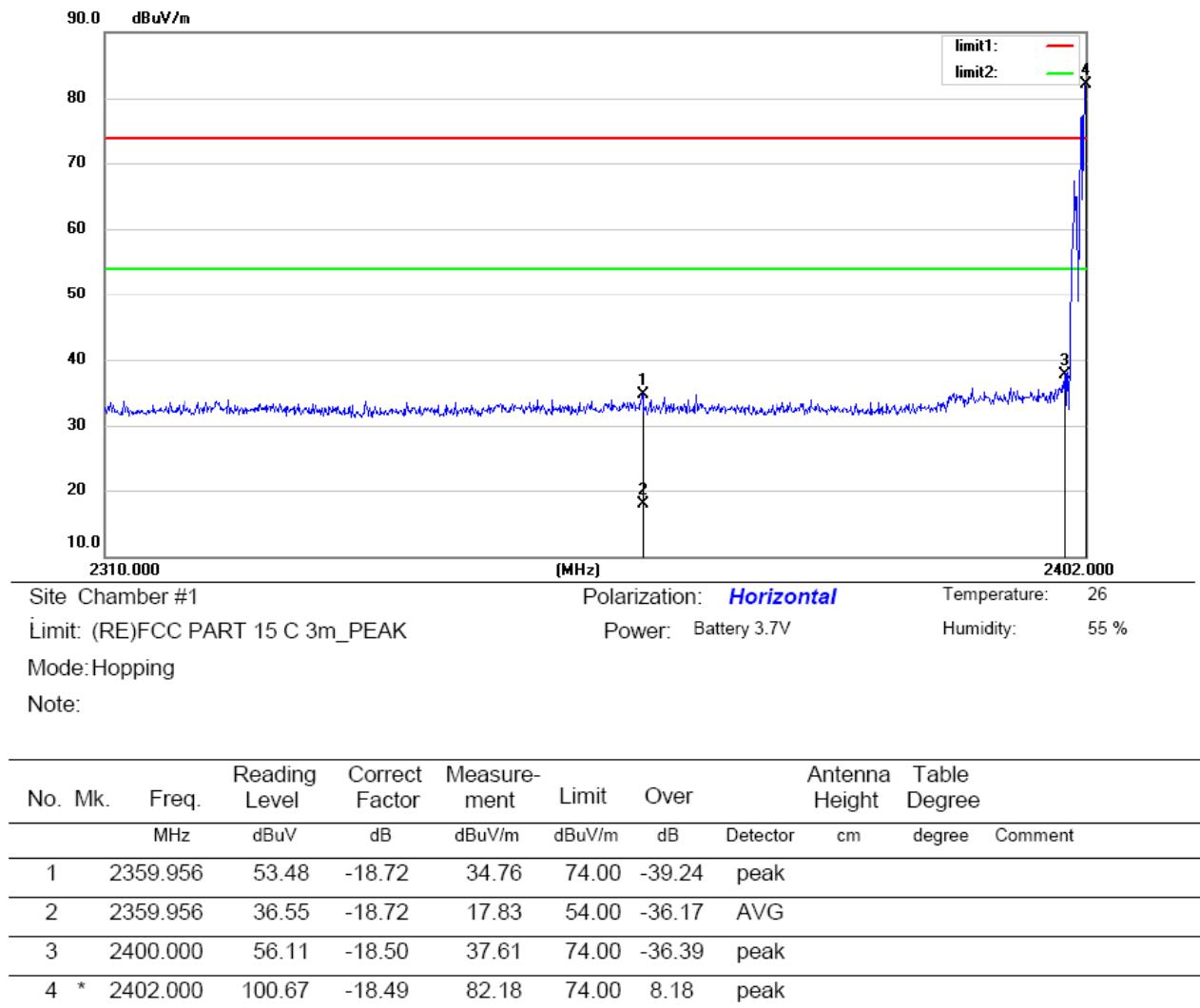
Mode:Hopping

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Antenna Height cm	Table Degree degree	Comment
1	*	2480.080	98.18	-18.03	80.15	74.00	6.15	peak			
2		2483.500	53.72	-18.01	35.71	74.00	-38.29	peak			
3		2491.240	56.40	-17.96	38.44	74.00	-35.56	peak			
4		2491.240	40.50	-17.96	22.54	54.00	-31.46	AVG			

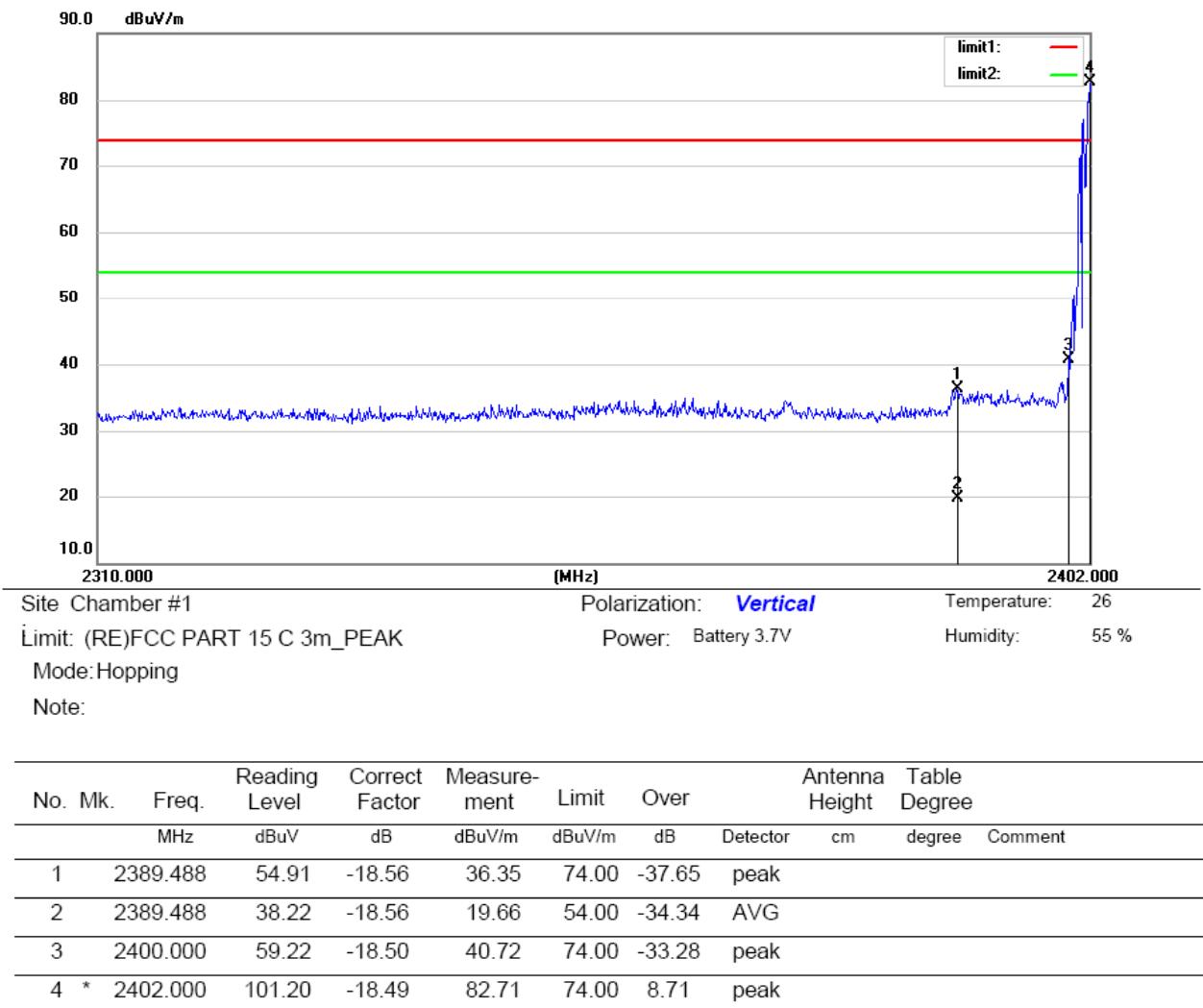
\*:Maximum data    x:Over limit    !:over margin

Operator: washington



\*:Maximum data    x:Over limit    !:over margin

Operator: washington



\*:Maximum data    x:Over limit    !:over margin

Operator: washington

## 13. Antenna Port Emission

### 13.1 Test Equipment

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	FSV30	1321.3008K	05/16/2017	05/15/2018

### 13.2 Measuring Instruments and Setting

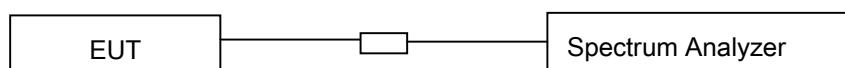
The following table is the setting of spectrum analyzer.

Spectrum analyzer	Setting
Attenuation	Auto
RB	100kHz
VB	300kHz
Detector	Peak
Trace	Max hold

### 13.3 Test Procedures

The conducted spurious emissions were measured conducted using a spectrum analyzer at low, Middle, and high channels, the limit was determined by attenuation 20dB of the RF peak power output.

### 13.4 Block Diagram of Test setup

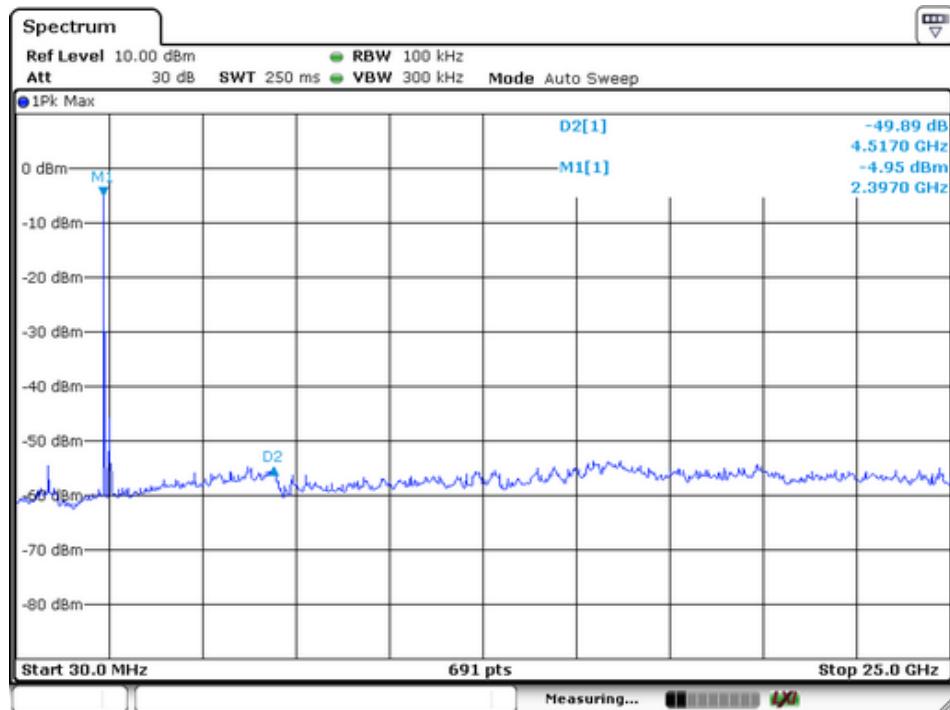


### 13.5 Test Result

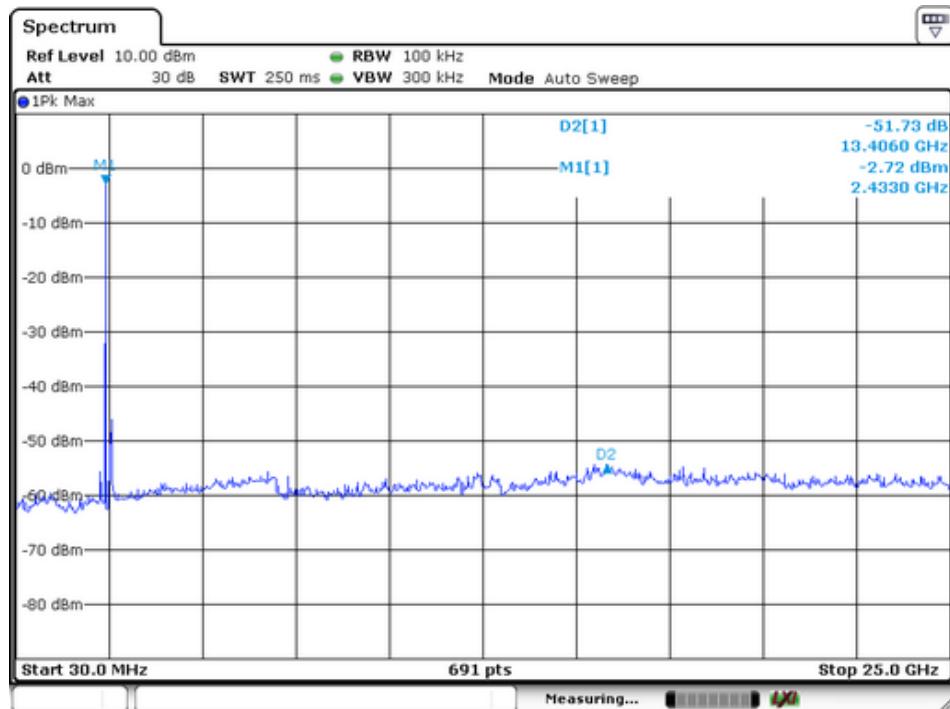
**PASS.**

Please refer to following pages.

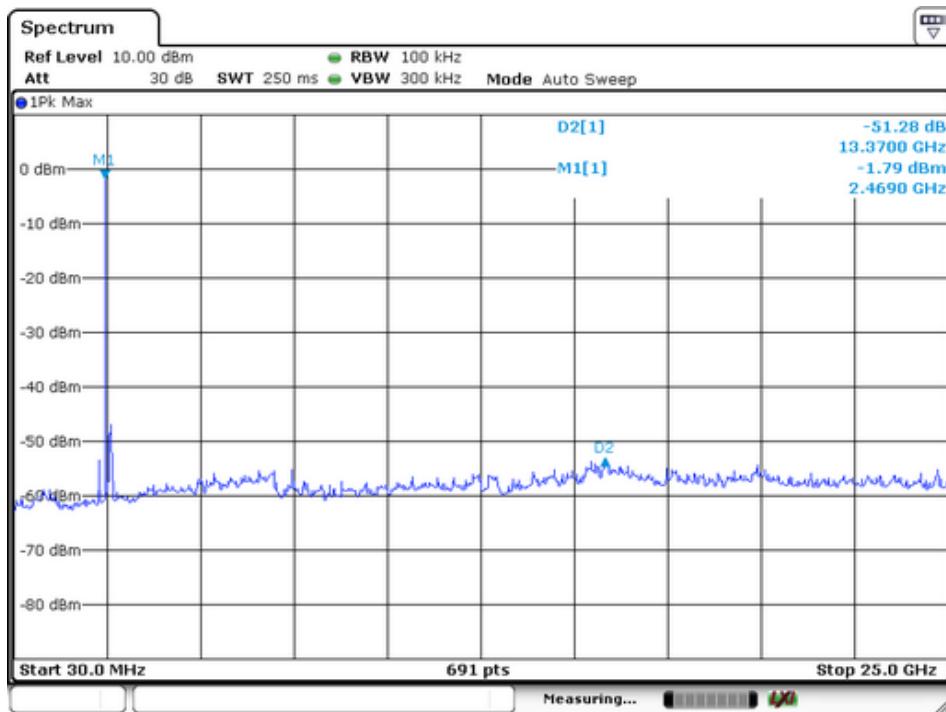
Test Mode: GFSK



Lowest Channel

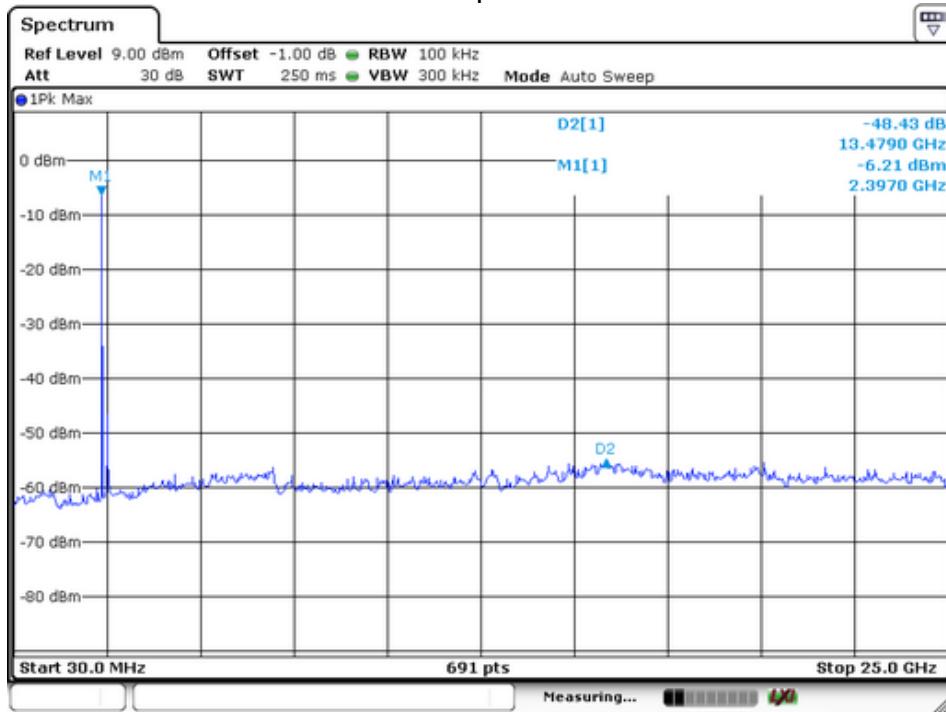


Middle Channel

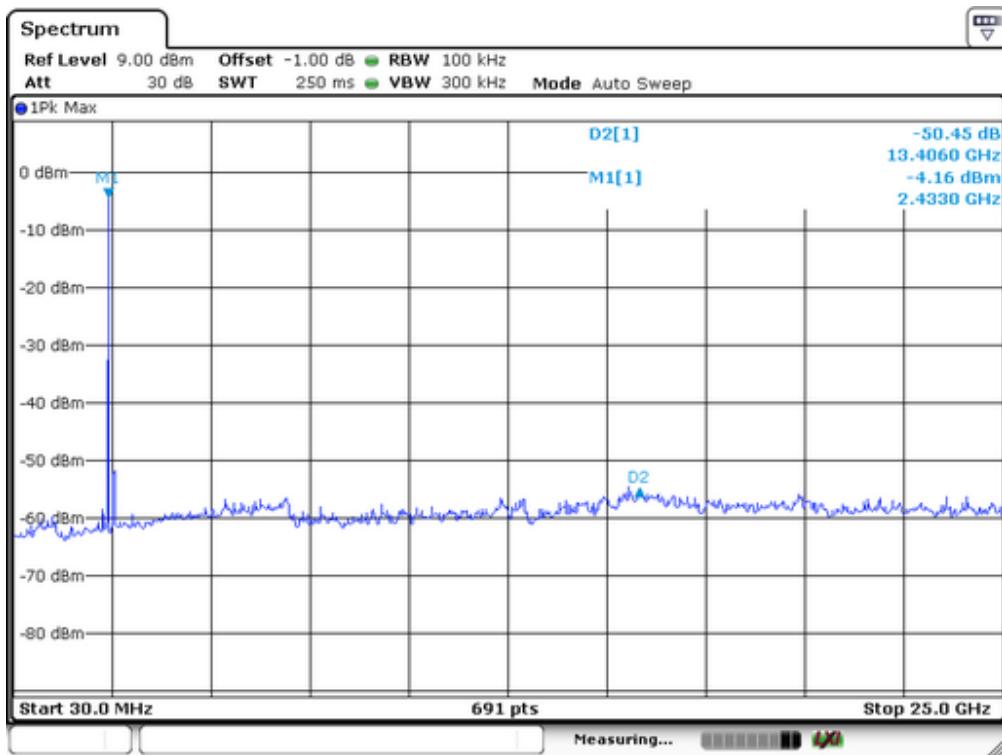


Highest Channel

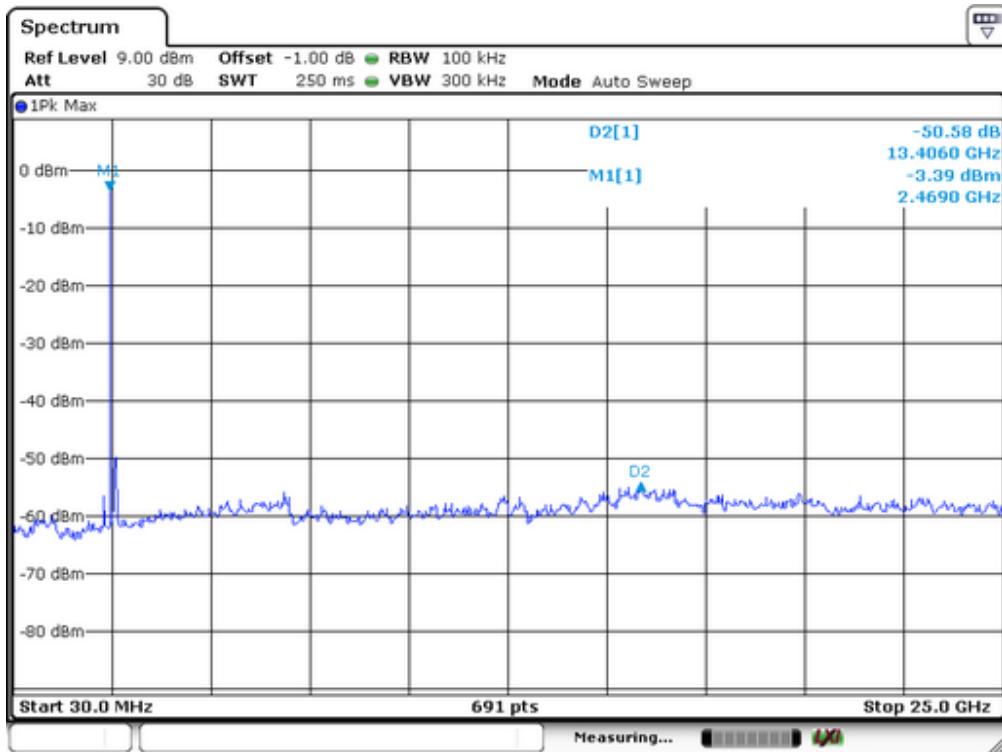
Test Mode: pi/4-DQPSK



Lowest Channel

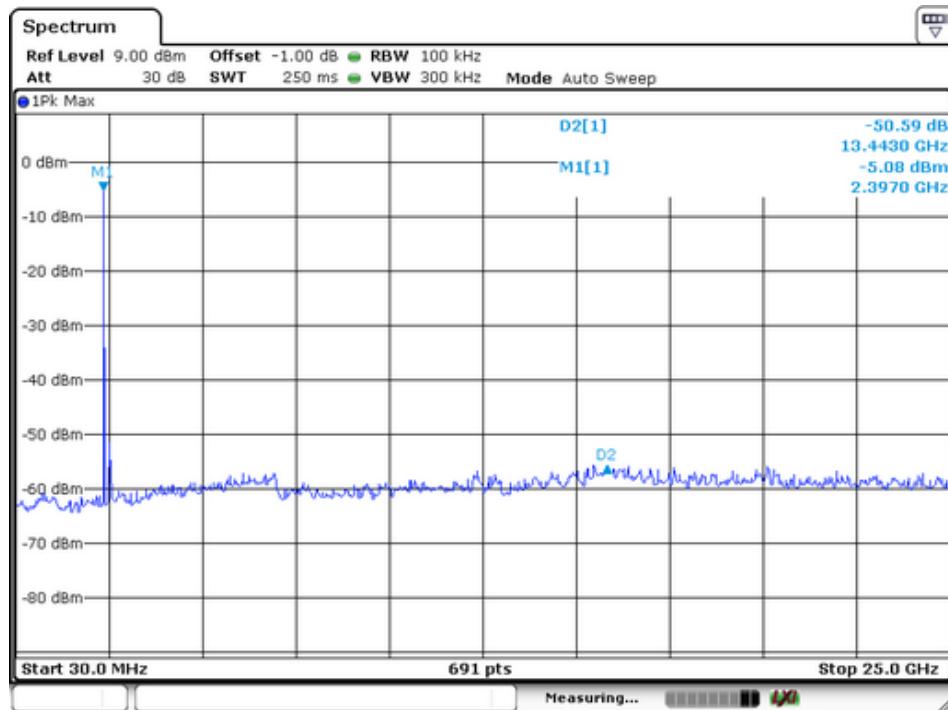


Middle Channel

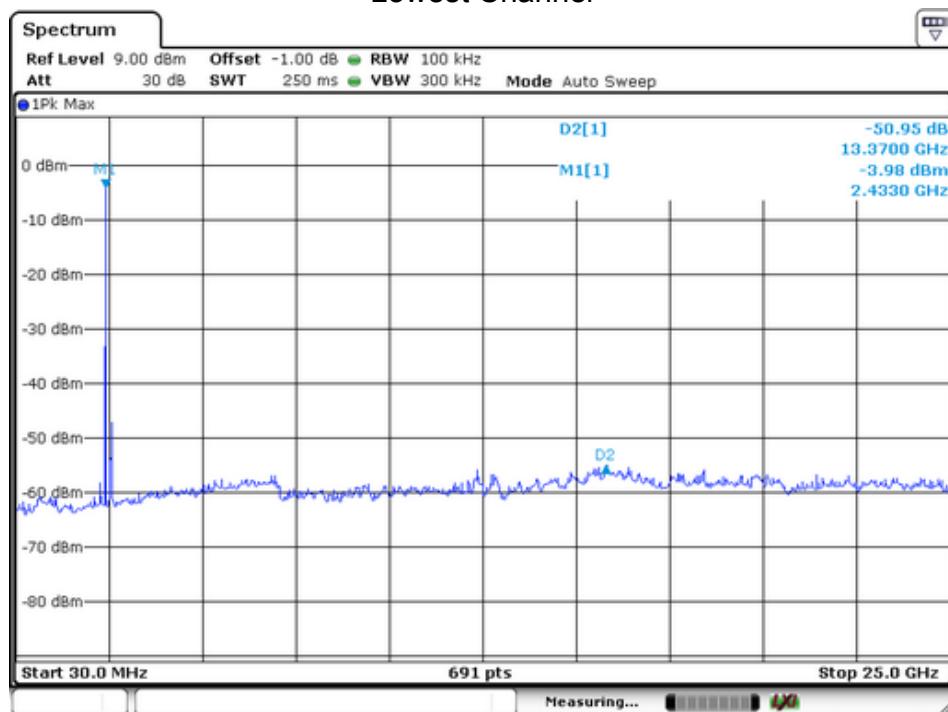


Highest Channel

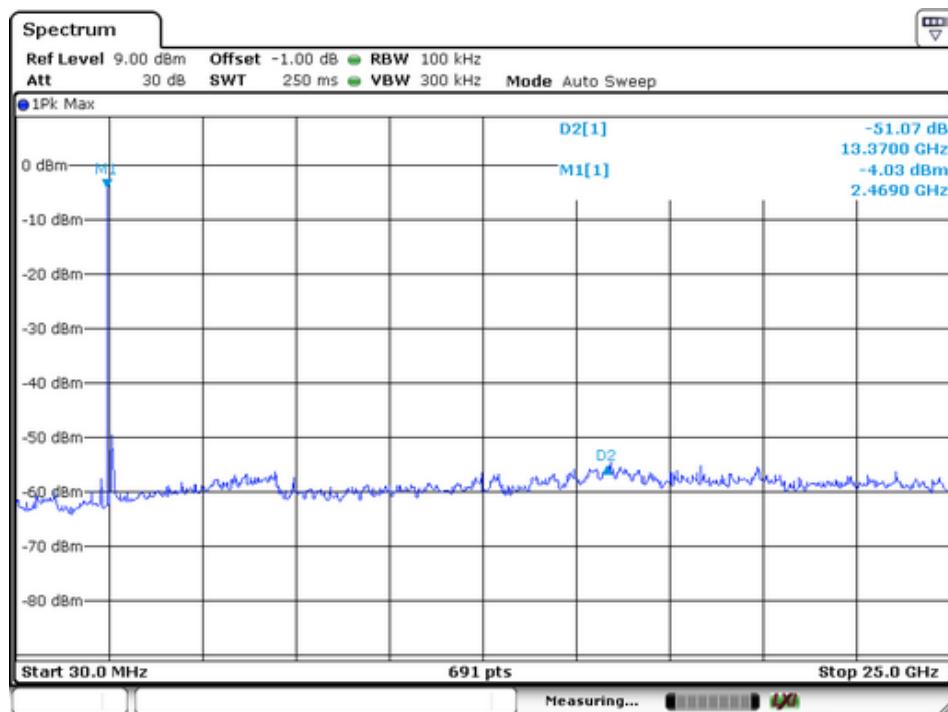
Test Mode: 8DPSK



Lowest Channel



Middle Channel



Highest Channel

## 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 3.09dBi and meets the requirement.



## APPENDIX (Photos of EUT)



