

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

OF

Car Radio

Model No.: PMX0

Trademark: 

FCC ID: 2AA7S-PMX0

Report No.: ED151012040E

Issue Date: October 26, 2015

Prepared for

**Rockford Corporation
600 South Rockford Drive Tempe Arizona United States**

Prepared by

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EMTEK(Dongguan) Co., Ltd.**

VERIFICATION OF COMPLIANCE

Applicant:	Rockford Corporation 600 South Rockford Drive Tempe Arizona United States
Manufacturer:	SOUNDMAX ELECTRONICS LIMITED 17/F., Eu Yang Sang Tower, 11-15 Chatham Road South, Tsim Sha Tsui , Kowloon., Hong Kong
Product Description:	Car Radio
Trademark:	N/A
Model Number:	PMX0
Kind of Device:	Bluetooth Ver.2.1 +EDR
Date of Test:	October 12, 2015 to October 26, 2015

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(2015).

Approved By



Sam Lv / Q.A. Manager
EMTEK(Dongguan) Co., Ltd.

Modified Information

Version	Summary	Revision Date	Report No.
Ver.1.0	Original Report	/	ED151012040E

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1. GENERAL INFORMATION

1.1 Product Description

The Car Radio, Model: PMX0 (referred to as the EUT in this report) The EUT is an short range, lower power transmitter. It is designed by way of utilizing the following modulation achieves the system operating.

A major technical descriptions of EUT is described as following:

- A). Operation Frequency: 2402-2480MHz
- B). Kind of Device: Bluetooth Ver.2.1+EDR
- C). Modulation: GFSK, $\pi/4$ -DQPSK, 8DPSK
- D). Number of Channel: 79
- E). Channel space: 1MHz
- F). Measured RF Output Power: 1.02dBm(0. 001265W)
- G). Antenna Type: PCB Antenna
- H). Antenna Gain: 4dBi
- I). Power Supply: DC 12V
- J). Software Version: PMX0_V46_1007.MVA
- K). Hardware Version: VER1.2

The basic data rate of 1Mbps uses GFSK modulation and the enhanced data rate uses PSK modulation. For the enhanced data rate of 3Mbps 8DPSK modulation and of 2Mbps $\pi/4$ -DQPSK modulation is used.

1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: 2AA7S-PMX0 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

1.3 Test Methodology

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

1.4 Special Accessories

Not available for this EUT intended for grant.

1.5 Equipment Modifications

Not available for this EUT intended for grant.

1.6 Test Facility

Site Description

EMC Lab. : Registered on FCC, June 18, 2014
The Certificate Number is 247565

Registered on Industry Canada, February 19, 2014
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 Limitation

(1) Channel Separation test

FCC Part 15, Subpart C Section 15.247(a)(1). Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 Bandwidth of the hopping channel, whichever is greater.

Frequency Range (MHz)	Limit(kHz)
902-928	>25kHz
2400-2483.5	>25kHz
5725-5850	>25kHz

(2) 20dB Bandwidth

Frequency Range(MHz)	Quantity of Hopping Channel	Limit(kHz) 50	25	15	75
902-928		<250	>250	NA	NA
2400-2483.5		NA	NA	>1000	<1000

(3) Quantity of Hopping Channel

FCC Part 15, Subpart C Section 15.247

Frequency Range (MHz)	Limit(Quantity of Hopping Channel)			
	20dB bandwidth <250kHz	20dB bandwidth >250kHz	20dB bandwidth <1MHz	20dB bandwidth >1MHz
902-928	50	25	NA	NA
2400-2483.5	NA	NA	15	15
5725-5850	NA	NA	75	NA

(4) Time of Occupancy(Dwell Time)

FCC Part 15, Subpart C Section 15.247

Frequency Range (MHz)	20dB bandwidth <250kHz(50Channel)	LIMIT(rms)	
		20dB bandwidth >250kHz(25Channel)	20dB bandwidth <1MHz(75Channel)
902-928	400(20S)	400(10S)	NA
2400-2483.5	NA	NA	400(30S)
5725-5850	NA	NA	400(30S)

Note: The “()”is all channel's average time of occupancy.

(5) Maximum Peak Output Power

FCC Part 15, Subpart C Section 15.247

Frequency Range (MHz)	Quantity of Hopping Channel	LIMIT(W)			
		50	25	15	75
902-928	1(30dBm)	0.125(21dBm)	NA	NA	NA
2400-2483.5	NA	NA	0.125(21dBm)	1(30dBm)	

5725-5850	NA	NA	NA
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1(30dBm)

(6) Band edge

FCC Part15, Subpart C Section 15.247, In any 100kHz bandwidth outside the frequency band in with the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a).

Operating Frequency Range(MHz)	Spurious emission frequency	Limit	
		Peak power ration to emission(dBc)	Emission level(dBuV/m)
902-928	<902	>20	NA
	>928	>20	NA
	960-1240	NA	54
2400-2483.5	<2400	>20	NA
	>2483.5-2500	NA	54
5725-5850	<5350-5460	NA	54
	<5725	>20	NA
	>5850	>20	NA

(7) Conducted Emission

Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

Note:

1. The lower limit shall apply at the transition frequencies
- 2.The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

(8) Radiated Emission

FCC Part 15, Subpart C Section 15.209 limit of radiated emission for frequency below 1000GHz. The emissions from an intentional radiator shall not exceed the field strength level specified in the following table:

Frequency (MHz)	Field strength $\mu\text{V/m}$	Distance(m)	Field strength at 3m $\text{dB}\mu\text{V/m}$
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	40
88-216	150	3	43.5
216-960	200	3	46
Above 960	500	3	54

Remark 1. Emission level in $\text{dB}\mu\text{V/m} = 20 \log (\mu\text{V/m})$

: 2. Measurement was performed at an antenna to the closed point of EUT distance of meters.

FCC Part 15, Section 15.35(b) limit of radiated emission for frequency above 1000MHz

Frequency(MHz)	Class A($\text{dB}\mu\text{V/m}$)(at 3m)		Class B($\text{dB}\mu\text{V/m}$)(at 3m)	
	PEAK	AVERAGE	PEAK	AVERAGE
Above 1000	80.0	60.0	74.0	54.0

FCC Part 15, Subpart C Section 15.249. The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency(MHz)	Filed Strength of Fundamental(at 3m)		Filed Strength of Harmonics(at 3m)	
	PEAK	AVERAGE	PEAK	AVERAGE
902-928	114	94	74.0	54.0
2400-2483.5	114	94	74.0	54.0
5725-5875	114	94	74.0	54.0
24000-24250	128	108	88.0	68.0

2.5 Configuration of Tested System

Fig. 2-1 Configuration of Tested System

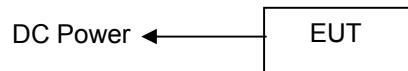


Table 2-1 Equipment Used in Tested System

Item	Equipment	Trademark	Model No.	FCC ID	Note
1.	Car Radio	N/A	PMX0	2AA7S-PMX0	EUT

Note:

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

3. Summary of Test Results

FCC Rules	Description Of Test	Result
§15.247(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
§15.207	AC Power Conducted Emission	N/A
§15.247(d),§15.209	Radiated Emission	Compliant
§15.203	Antenna Requirement	Compliant
§1.1310	RF Exposure	Compliant

Remark: The EUT is supplied by Battery, there is no need for AC Power Conducted Emission test to be performed on this product.

4. Description of test modes

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. Radiated Emission Test

5.1 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 beam width.

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:

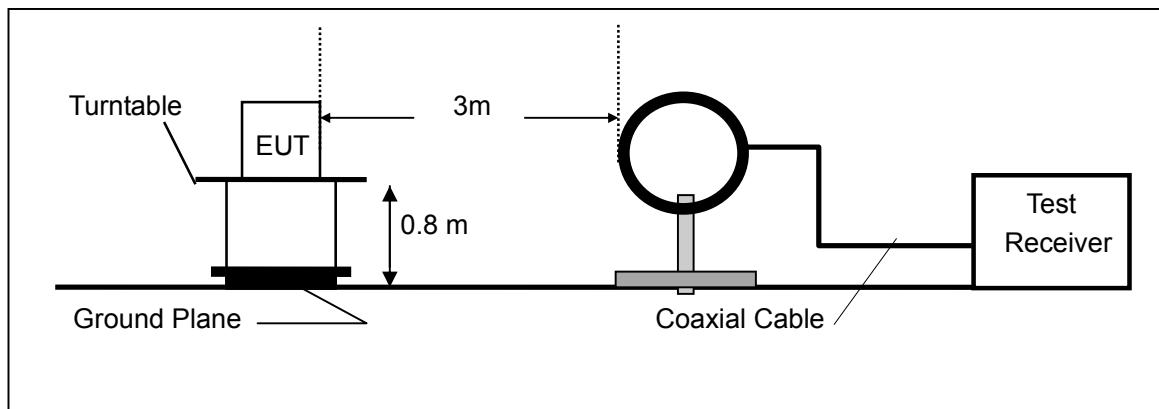
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	3MHz
Detector	Peak
Trace	Max hold

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

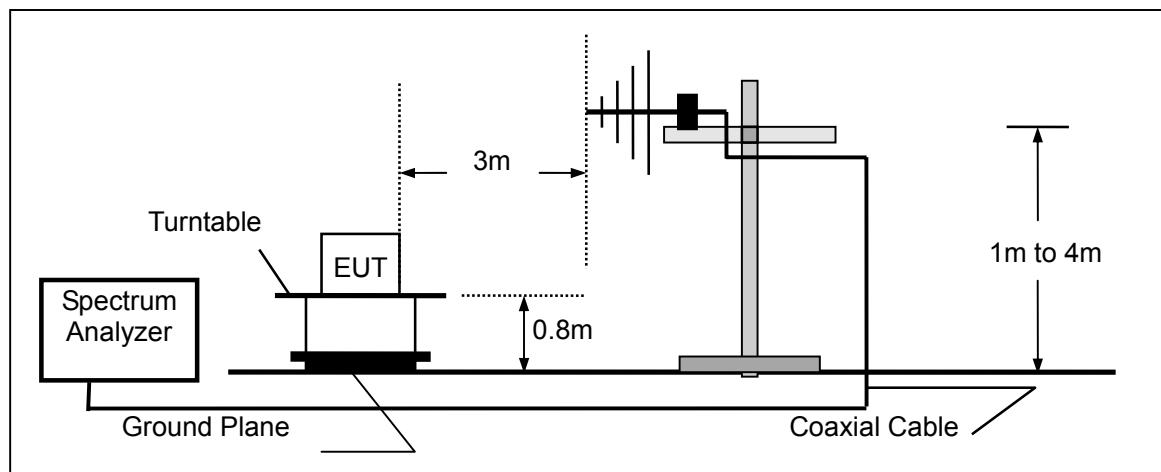
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Peak
Trace	Max hold

5.2 Test SET-UP (Block Diagram of Configuration)

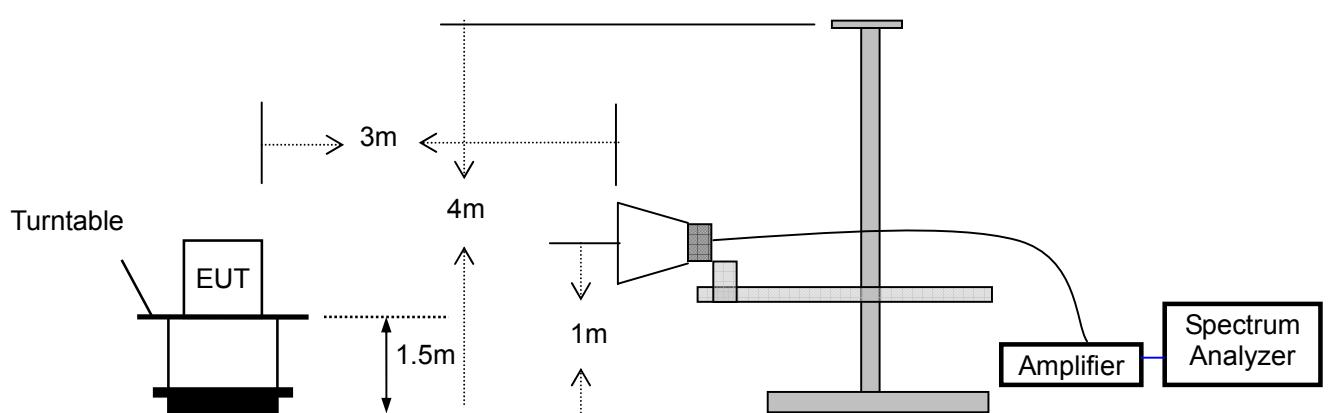
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



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



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



5.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	06/15/2015	06/14/2016
EMI Test Receiver	Rohde & Schwarz	ESU	1302.6005.26	06/15/2015	06/14/2016
Pre-Amplifier	HP	8447D	2944A07999	06/02/2015	06/01/2016
Bilog Antenna	SCHWARZBECK	VULB9163	142	06/03/2015	06/02/2016
Loop Antenna	ARA	PLA-1030/B	1029	06/03/2015	06/02/2016
Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170399	06/04/2015	06/03/2016
Horn Antenna	Schwarzbeck	BBHA9120D	D143	06/04/2015	06/03/2016
Cable	Schwarzbeck	AK9513	ACRX1	06/15/2015	06/14/2016
Cable	Schwarzbeck	AK9513	FP2RX2	05/15/2015	05/14/2016
Cable	Schwarzbeck	AK9513	CRPX1	05/17/2015	05/16/2016
Cable	Schwarzbeck	AK9513	CRRX2	05/22/2015	05/21/2016

5.4 Measurement Result

Below 30MHz:

All the modulation modes were tested the data of the test mode are recorded in the following pages.

Operation Mode:	TX Mode	Test Date :	October 13, 2015
Frequency Range:	9KHz~30MHz	Temperature :	28°C
Test Result:	PASS	Humidity :	60 %
Measured Distance:	3m	Test By:	Andy

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

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

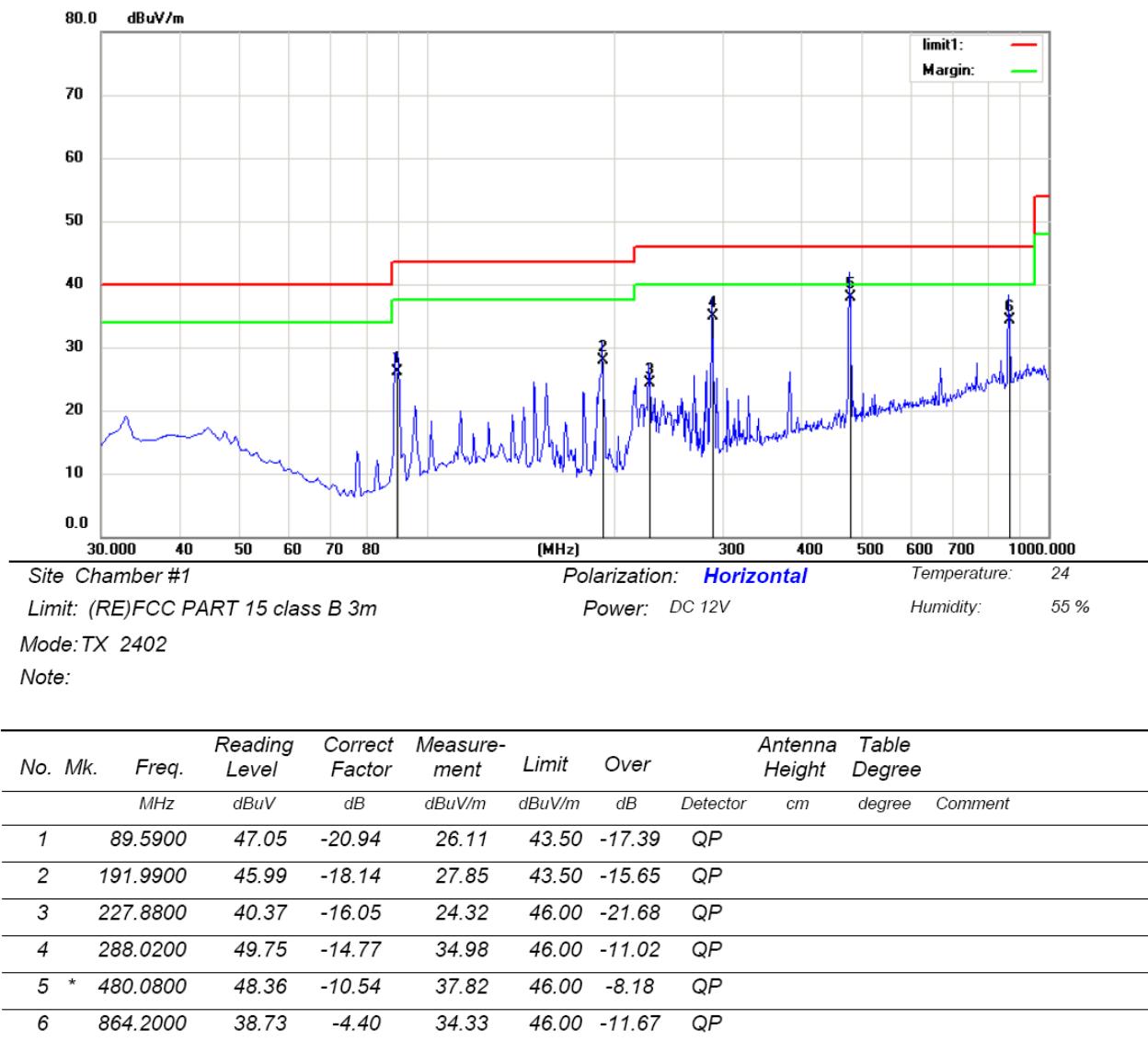
Distance extrapolation factor = $40\log(\text{Specific distance} / \text{test distance})$ (dB);
 Limit line=Specific limits(dBuV) + distance extrapolation factor.

Below 1000MHz:

Pass.

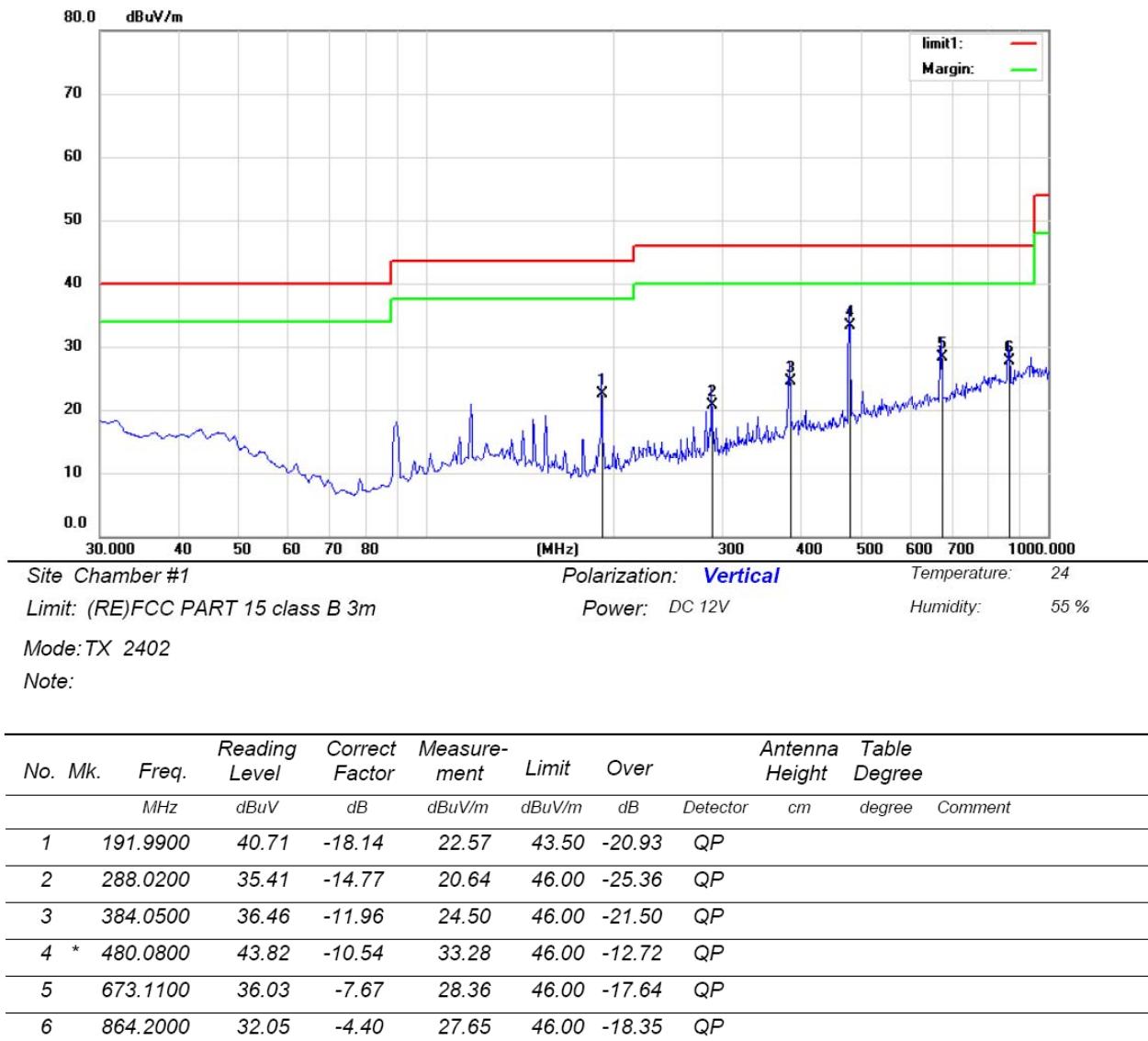
All the modulation modes were tested the data of the worst mode (GFSK) are recorded in the following pages and the others modulation methods do not exceed the limits.

Please refer to the following data.



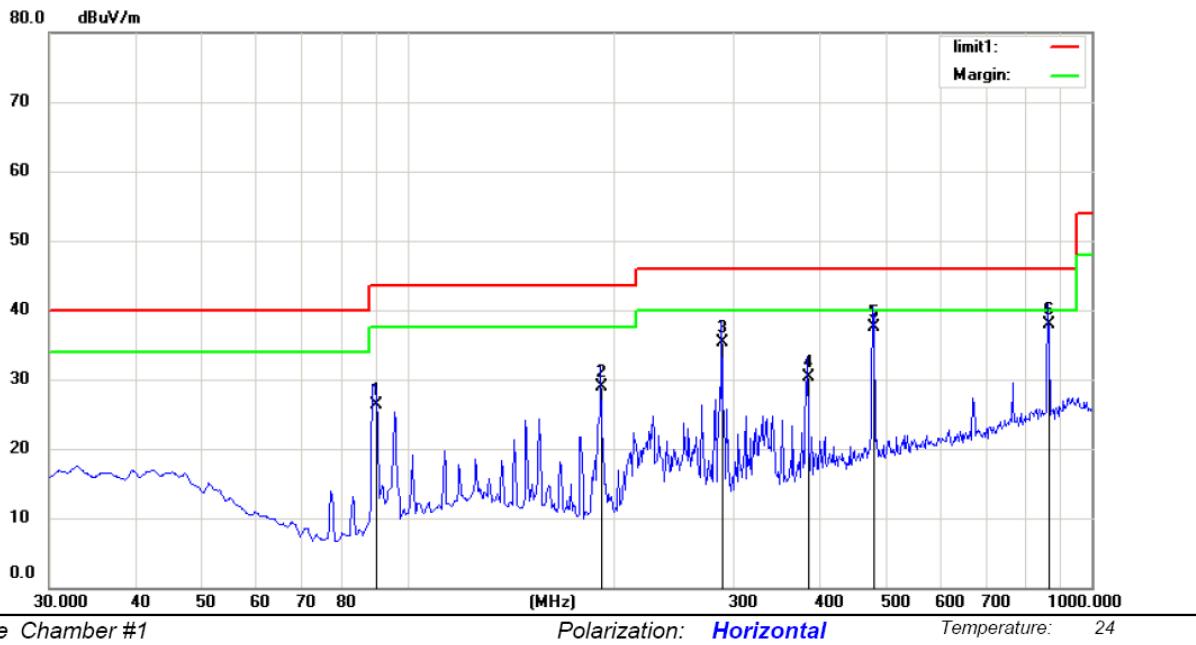
*:Maximum data x:Over limit !:over margin

Operator:



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

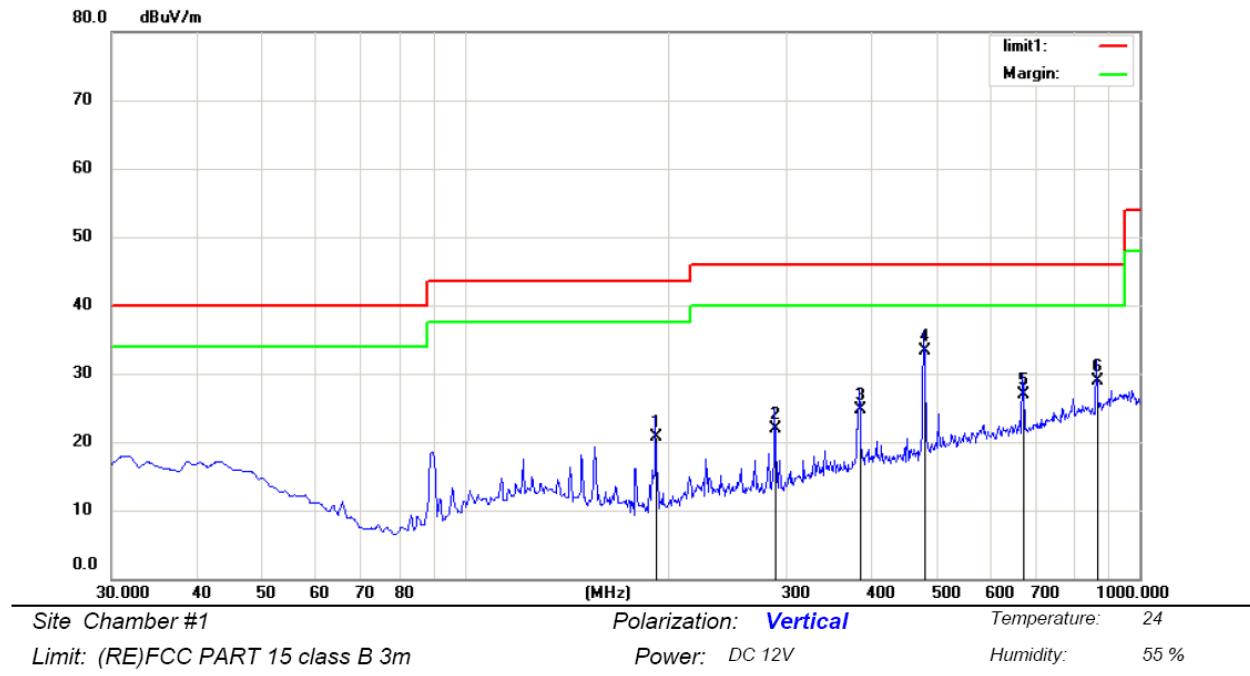
Operator:



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		90.1400	47.17	-20.85	26.32	43.50	-17.18	QP		
2		191.9900	46.95	-18.14	28.81	43.50	-14.69	QP		
3		288.0200	50.03	-14.77	35.26	46.00	-10.74	QP		
4		384.0500	42.27	-11.96	30.31	46.00	-15.69	QP		
5		480.0800	48.12	-10.54	37.58	46.00	-8.42	QP		
6	*	865.1700	42.23	-4.38	37.85	46.00	-8.15	QP		

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

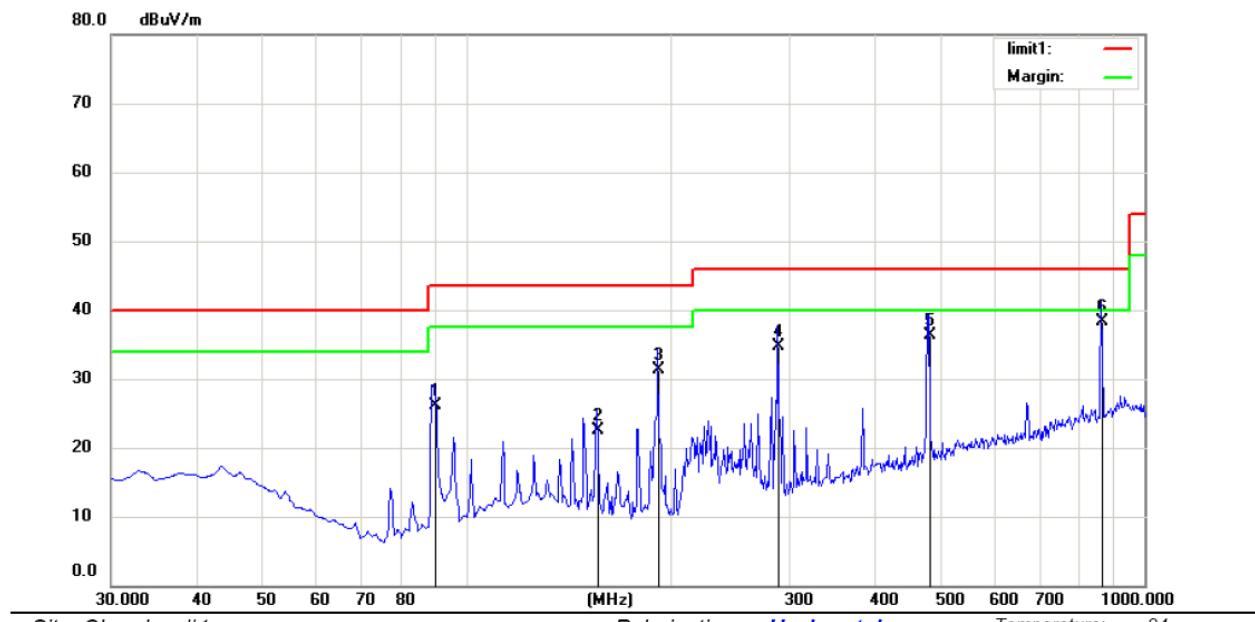
Operator:



No.	Mk.	Freq. MHz	Reading Level	Correct Factor	Measure- ment	Limit	Over	Antenna Height	Table Degree	Comment
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	
1		191.9900	38.89	-18.14	20.75	43.50	-22.75	QP		
2		288.0200	36.74	-14.77	21.97	46.00	-24.03	QP		
3		384.0500	36.76	-11.96	24.80	46.00	-21.20	QP		
4	*	480.0800	43.83	-10.54	33.29	46.00	-12.71	QP		
5		672.1400	34.69	-7.69	27.00	46.00	-19.00	QP		
6		864.2000	33.28	-4.40	28.88	46.00	-17.12	QP		

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

Operator:



Site Chamber #1

Polarization: **Horizontal**

Temperature: 24

Limit: (RE)FCC PART 15 class B 3m

Power: DC 12V

Humidity: 55 %

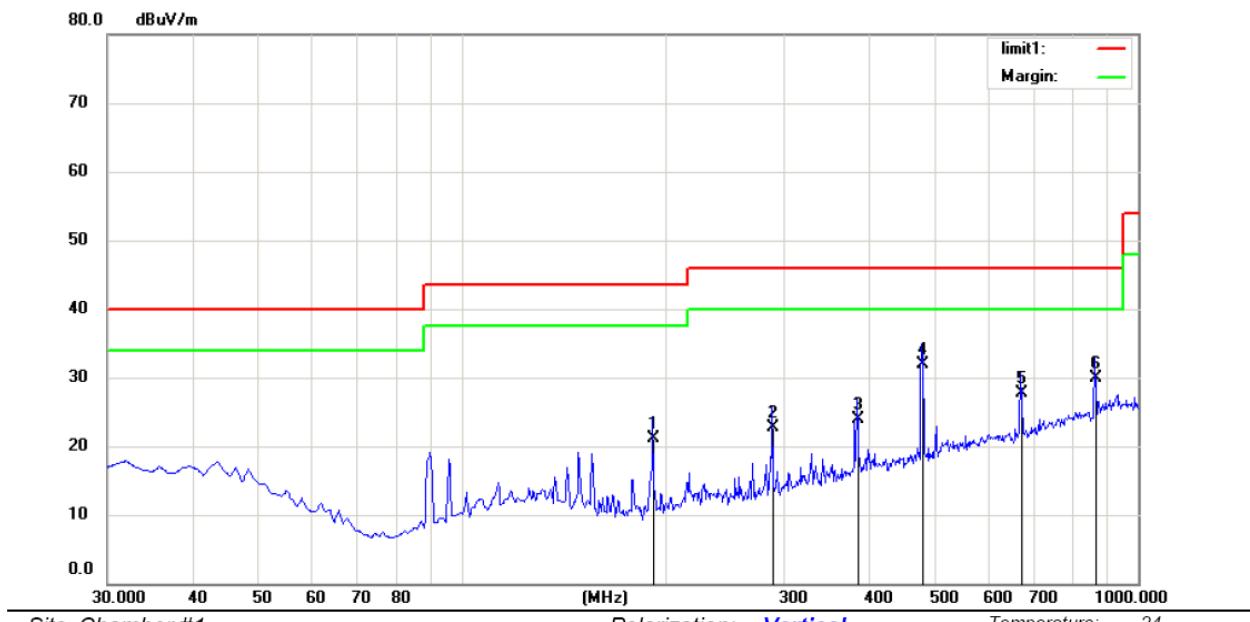
Mode: TX 2480

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
1		90.1400	46.93	-20.85	26.08	43.50	-17.42	QP		
2		156.1000	40.72	-18.25	22.47	43.50	-21.03	QP		
3		191.9900	49.49	-18.14	31.35	43.50	-12.15	QP		
4		288.0200	49.52	-14.77	34.75	46.00	-11.25	QP		
5		481.0500	46.85	-10.54	36.31	46.00	-9.69	QP		
6	*	864.2000	42.74	-4.40	38.34	46.00	-7.66	QP		

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

Operator:



Site Chamber #1

Polarization: **Vertical**

Temperature: 24

Limit: (RE)FCC PART 15 class B 3m

Power: DC 12V

Humidity: 55 %

Mode: TX 2480

Note:

No.	Mk.	Freq. MHz	Reading Level	Correct Factor	Measure- ment	Limit	Over	Antenna Height cm	Table Degree	Comment
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	degree	
1		191.9900	39.21	-18.14	21.07	43.50	-22.43	QP		
2		288.0200	37.45	-14.77	22.68	46.00	-23.32	QP		
3		384.0500	35.89	-11.96	23.93	46.00	-22.07	QP		
4	*	480.0800	42.51	-10.54	31.97	46.00	-14.03	QP		
5		672.1400	35.30	-7.69	27.61	46.00	-18.39	QP		
6		864.2000	34.35	-4.40	29.95	46.00	-16.05	QP		

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

Operator:

Above 1000MHz~10th Harmonics:

Operation Mode: GFSK (CH1: 2402MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4804	V	66.23	46.25	74	54	-7.77	-7.75
7206	V	65.21	45.21	74	54	-8.79	-8.79
9608	V	64.58	44.57	74	54	-9.42	-9.43
12010	V	63.26	43.26	74	54	-10.74	-10.74
14412	V	62.35	42.21	74	54	-11.65	-11.79
16814	V	59.61	41.29	74	54	-14.39	-12.71
4804	H	65.59	45.28	74	54	-8.41	-8.72
7206	H	64.27	44.59	74	54	-9.73	-9.41
9608	H	63.29	43.27	74	54	-10.71	-10.73
12010	H	62.51	42.28	74	54	-11.49	-11.72
14412	H	61.28	40.21	74	54	-12.72	-13.79
16814	H	60.24	39.29	74	54	-13.76	-14.71

Operation Mode: GFSK (CH40: 2441MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4882	V	65.21	46.62	74	54	-8.79	-7.38
7323	V	64.25	45.28	74	54	-9.75	-8.72
9764	V	63.59	44.21	74	54	-10.41	-9.79
12205	V	62.31	43.59	74	54	-11.69	-10.41
14646	V	61.24	42.58	74	54	-12.76	-11.42
17087	V	60.29	41.58	74	54	-13.71	-12.42
4882	H	64.28	46.59	74	54	-9.72	-7.41
7323	H	64.26	45.27	74	54	-9.74	-8.73
9764	H	63.59	44.57	74	54	-10.41	-9.43
12205	H	62.51	43.29	74	54	-11.49	-10.71
14646	H	61.51	42.61	74	54	-12.49	-11.39
17087	H	60.28	41.08	74	54	-13.72	-12.92

Operation Mode: TX Mode (CH79: 2480MHz) Test Date : October13, 2015

Freq. (MHz)	Ant. Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
4960	V	66.29	46.29	74	54	-7.71	-7.71
7440	V	65.21	45.21	74	54	-8.79	-8.79
9920	V	64.58	44.29	74	54	-9.42	-9.71
12400	V	63.58	43.29	74	54	-10.42	-10.71
14880	V	62.56	42.58	74	54	-11.44	-11.42
17360	V	61.29	41.24	74	54	-12.71	-12.76
4960	H	66.02	45.69	74	54	-7.98	-8.31
7440	H	65.06	44.29	74	54	-8.94	-9.71
9920	H	64.26	43.65	74	54	-9.74	-10.35
12400	H	63.21	42.51	74	54	-10.79	-11.49
14880	H	62.59	41.59	74	54	-11.41	-12.41
17360	H	61.28	40.29	74	54	-12.72	-13.71

Operation Mode: Pi/4-DQPSK (CH1: 2402MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
4804	V	65.29	45.31	74	54	-8.71	-8.69
7206	V	64.59	44.26	74	54	-9.41	-9.74
9608	V	63.26	43.62	74	54	-10.74	-10.38
12010	V	62.54	42.61	74	54	-11.46	-11.39
14412	V	61.28	40.25	74	54	-12.72	-13.75
16814	V	60.59	39.52	74	54	-13.41	-14.48
4804	H	64.26	44.21	74	54	-9.74	-9.79
7206	H	63.21	43.62	74	54	-10.79	-10.38
9608	H	62.54	42.26	74	54	-11.46	-11.74
12010	H	61.06	41.29	74	54	-12.94	-12.71
14412	H	60.29	40.59	74	54	-13.71	-13.41
16814	H	59.62	39.62	74	54	-14.38	-14.38

Operation Mode: Pi/4-DQPSK (CH40: 2441MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4882	V	65.26	45.62	74	54	-8.74	-8.38
7323	V	64.23	44.59	74	54	-9.77	-9.41
9764	V	63.21	43.26	74	54	-10.79	-10.74
12205	V	62.59	42.21	74	54	-11.41	-11.79
14646	V	61.24	39.62	74	54	-12.76	-14.38
17087	V	60.59	38.63	74	54	-13.41	-15.37
4882	H	64.21	45.26	74	54	-9.79	-8.74
7323	H	63.59	44.41	74	54	-10.41	-9.59
9764	H	62.51	43.62	74	54	-11.49	-10.38
12205	H	61.24	42.26	74	54	-12.76	-11.74
14646	H	60.25	41.21	74	54	-13.75	-12.79
17087	H	59.63	40.25	74	54	-14.37	-13.75

Operation Mode: Pi/4-DQPSK (CH79: 2480MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4960	V	64.52	46.52	74	54	-9.48	-7.48
7440	V	63.21	45.21	74	54	-10.79	-8.79
9920	V	62.59	44.52	74	54	-11.41	-9.48
12400	V	61.28	43.59	74	54	-12.72	-10.41
14880	V	60.29	42.51	74	54	-13.71	-11.49
17360	V	59.63	41.26	74	54	-14.37	-12.74
4960	H	63.59	45.68	74	54	-10.41	-8.32
7440	H	62.21	44.57	74	54	-11.79	-9.43
9920	H	63.59	43.26	74	54	-10.41	-10.74
12400	H	62.51	42.51	74	54	-11.49	-11.49
14880	H	61.59	41.27	74	54	-12.41	-12.73
17360	H	60.32	40.28	74	54	-13.68	-13.72

Operation Mode: 8DPSK (CH1: 2402MHz) Test Date : October13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4804	V	66.39	45.26	74	54	-7.61	-8.74
7206	V	65.27	44.21	74	54	-8.73	-9.79
9608	V	64.27	43.29	74	54	-9.73	-10.71
12010	V	63.59	42.51	74	54	-10.41	-11.49
14412	V	62.51	41.58	74	54	-11.49	-12.42
16814	V	61.57	40.29	74	54	-12.43	-13.71
4804	H	65.39	44.59	74	54	-8.61	-9.41
7206	H	64.27	43.61	74	54	-9.73	-10.39
9608	H	62.59	42.51	74	54	-11.41	-11.49
12010	H	61.24	41.27	74	54	-12.76	-12.73
14412	H	60.29	40.29	74	54	-13.71	-13.71
16814	H	59.62	39.65	74	54	-14.38	-14.35

Operation Mode: 8DPSK (CH40: 2441MHz) Test Date : October 13, 2015

Freq. (MHz)	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
	H/V	PK	AV	PK	AV	PK	AV
4882	V	66.26	46.52	74	54	-7.74	-7.48
7323	V	65.51	45.27	74	54	-8.49	-8.73
9764	V	64.15	44.59	74	54	-9.85	-9.41
12205	V	63.25	43.26	74	54	-10.75	-10.74
14646	V	62.51	42.51	74	54	-11.49	-11.49
17087	V	61.26	41.29	74	54	-12.74	-12.71
4882	H	65.45	45.51	74	54	-8.55	-8.49
7323	H	64.39	44.26	74	54	-9.61	-9.74
9764	H	63.25	43.21	74	54	-10.75	-10.79
12205	H	62.51	42.16	74	54	-11.49	-11.84
14646	H	61.59	41.25	74	54	-12.41	-12.75
17087	H	60.59	40.29	74	54	-13.41	-13.71

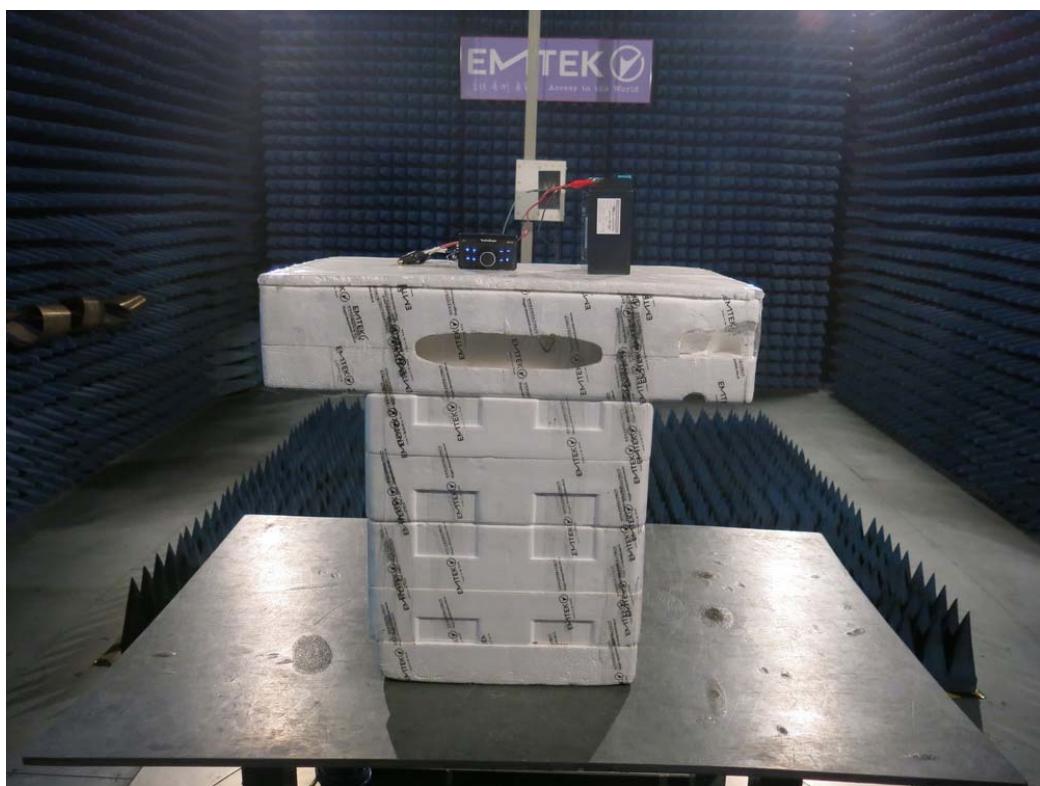
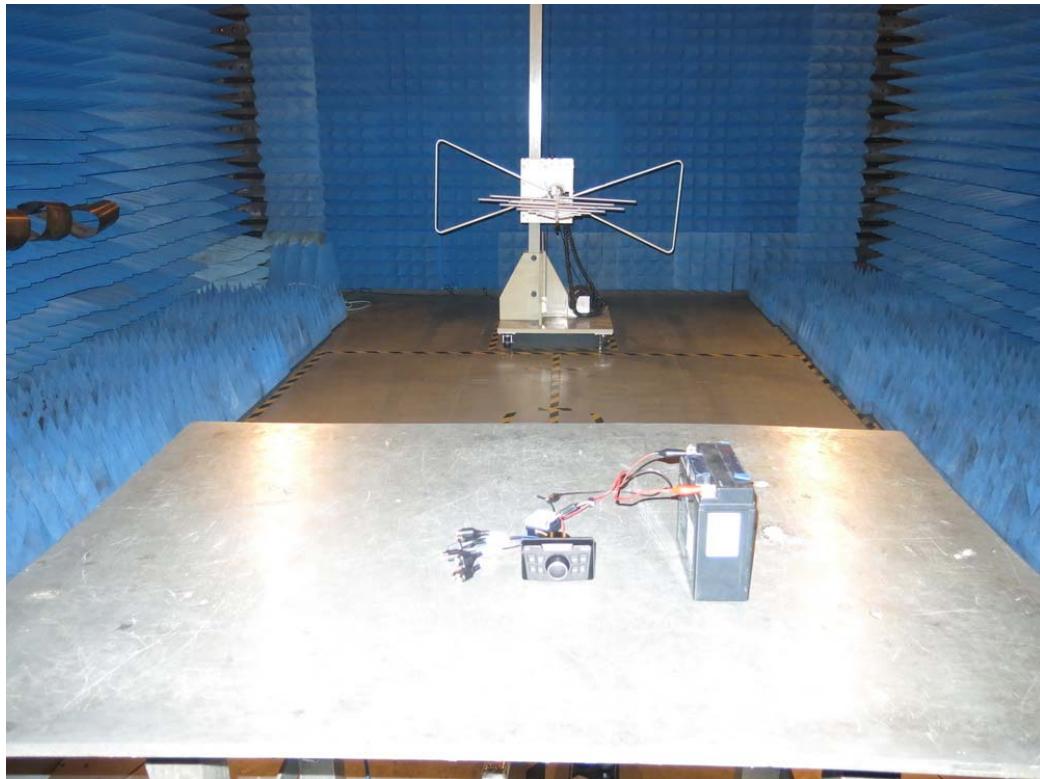
Operation Mode: 8DPSK (CH79: 2480MHz) Test Date : October 13, 2015

Freq.	Ant. Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	PK	AV	PK	AV
4960	V	66.59	45.62	74	54	-7.41	-8.38
7440	V	65.54	44.25	74	54	-8.46	-9.75
9920	V	64.52	43.26	74	54	-9.48	-10.74
12400	V	63.26	42.21	74	54	-10.74	-11.79
14880	V	62.51	41.15	74	54	-11.49	-12.85
17360	V	61.58	40.29	74	54	-12.42	-13.71
4960	H	65.26	44.27	74	54	-8.74	-9.73
7440	H	64.51	43.56	74	54	-9.49	-10.44
9920	H	63.25	42.21	74	54	-10.75	-11.79
12400	H	62.21	41.23	74	54	-11.79	-12.77
14880	H	61.59	40.21	74	54	-12.41	-13.79
17360	H	60.51	39.62	74	54	-13.49	-14.38

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.

5.5 Radiated Measurement Photos:

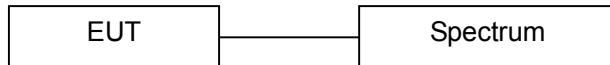


6. Channel Separation test

6.1 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.

6.2 Test SET-UP (Block Diagram of Configuration)



6.3 Measurement Equipment Used:

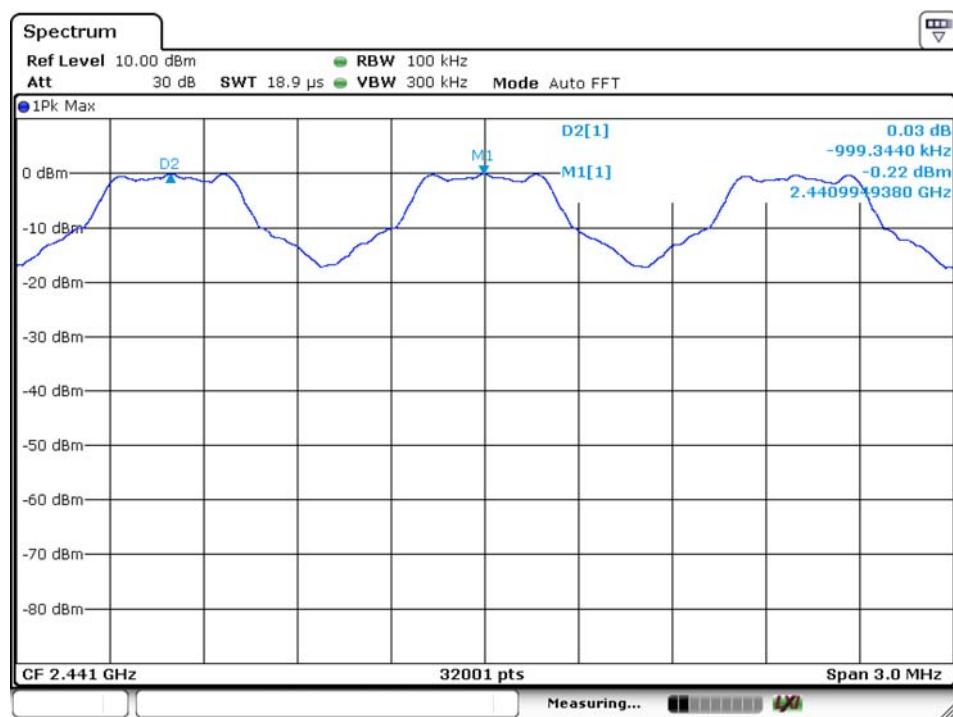
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.					

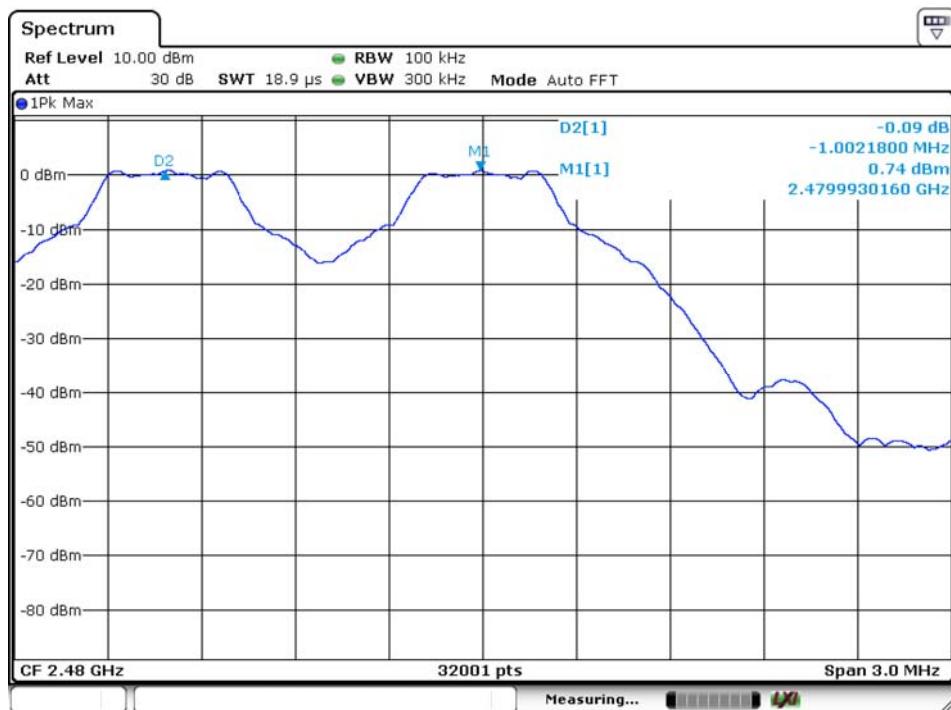
6.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	October 13, 2015
Test By:	Andy	Temperature :	24°C
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

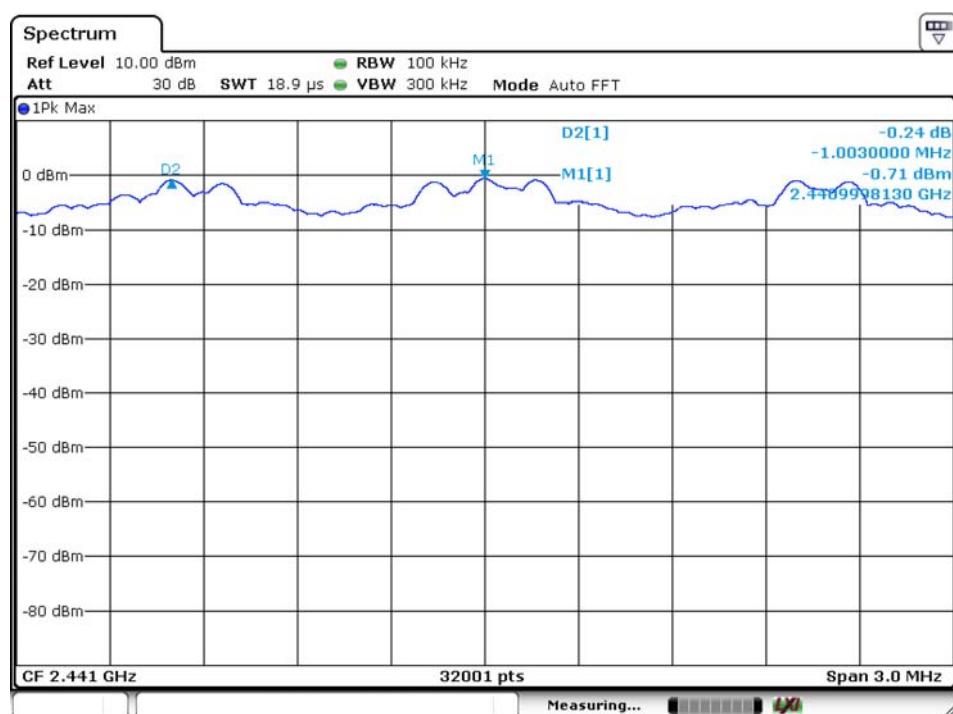
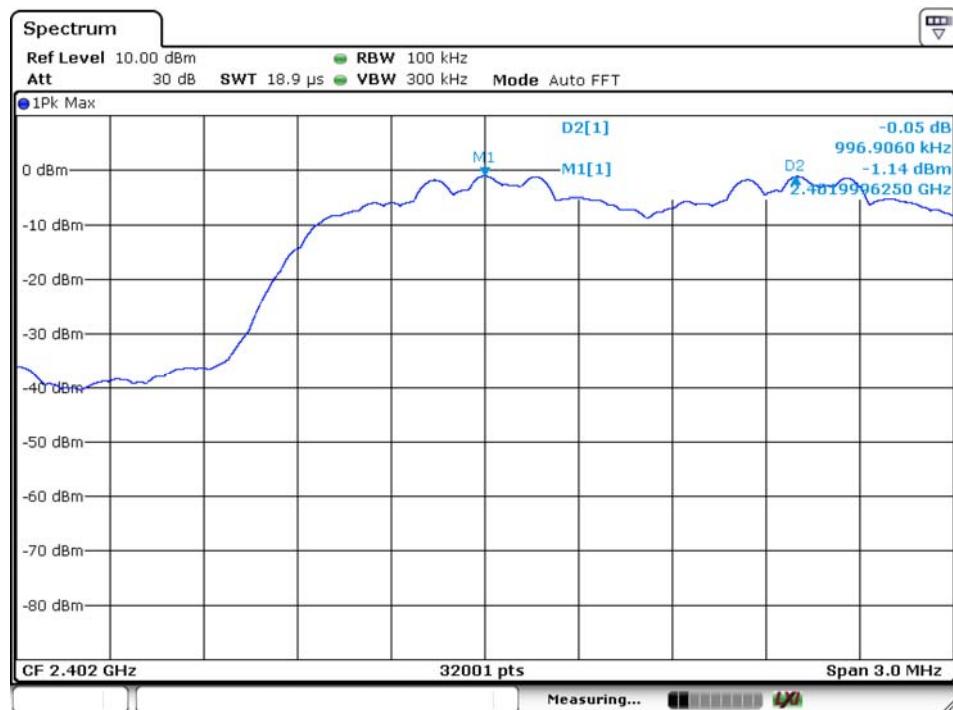
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 20dB Down BW(kHz)
1	2402	1001	>815
40	2441	999	>818
79	2480	1002	>815

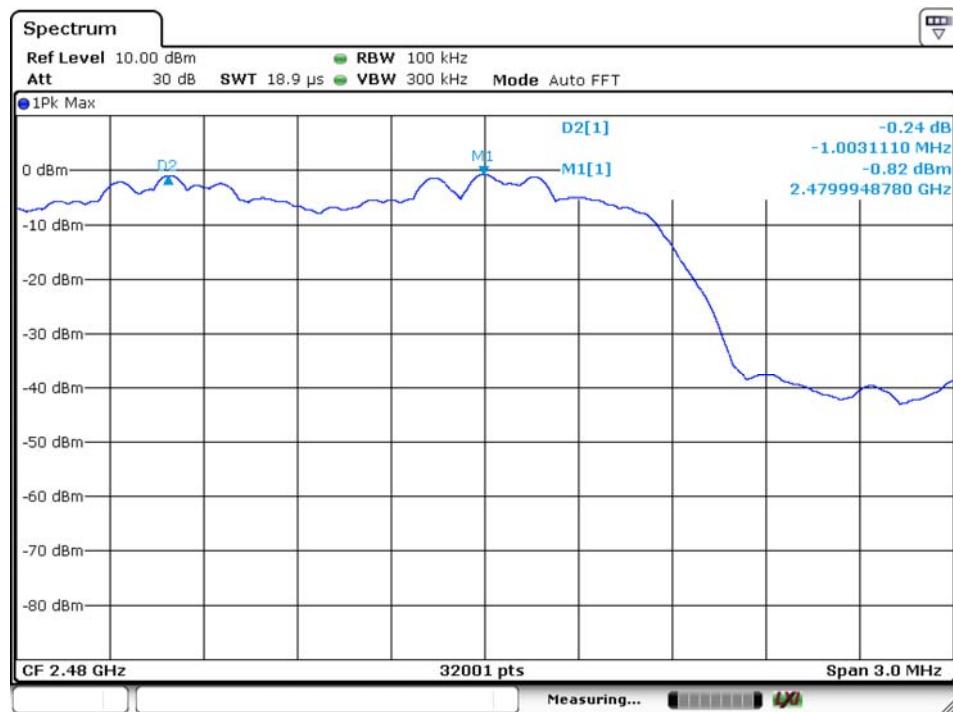




Spectrum Detector: PK Test Date : October 13, 2015
 Test By: Andy Temperature : 24 °C
 Test Result: PASS Humidity : 53 %
 Modulation: 1/4Π-DQPSK

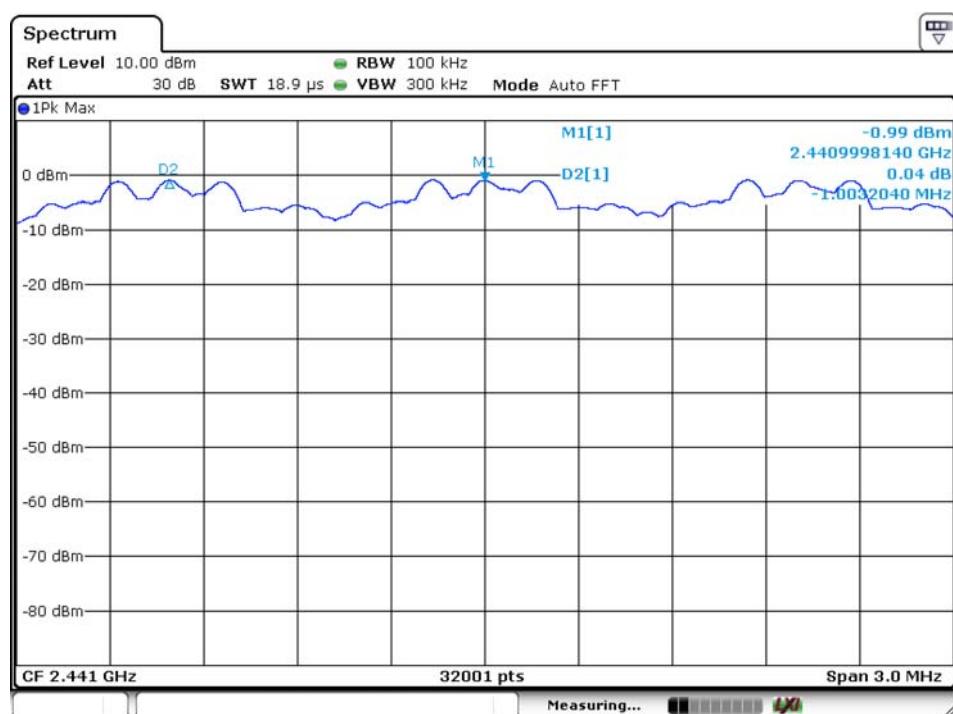
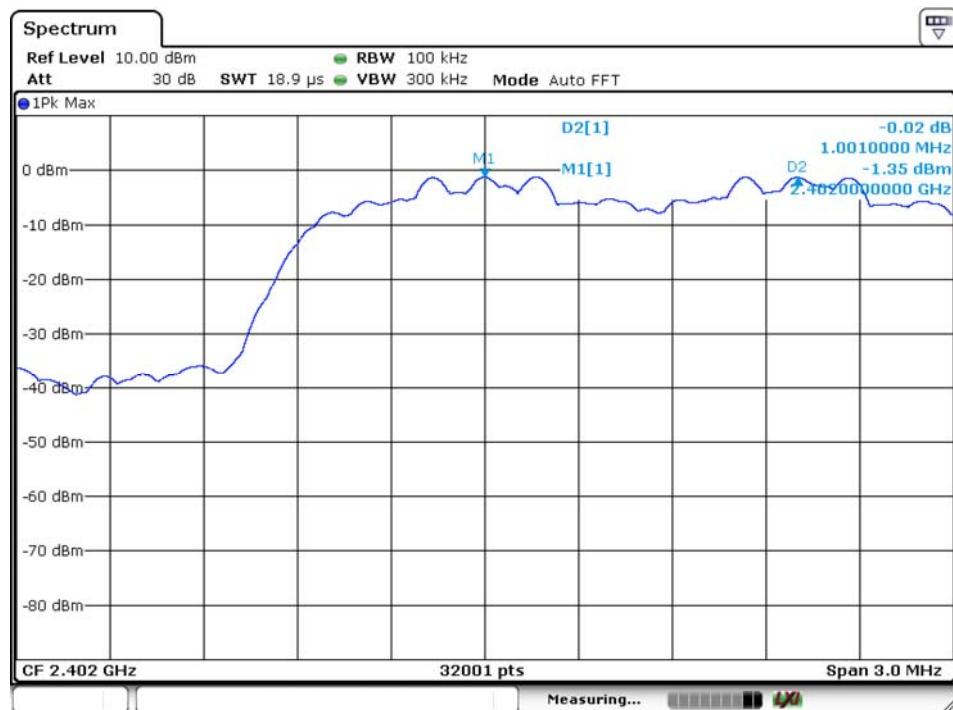
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	997	>831
40	2441	1003	>831
79	2480	1003	>827

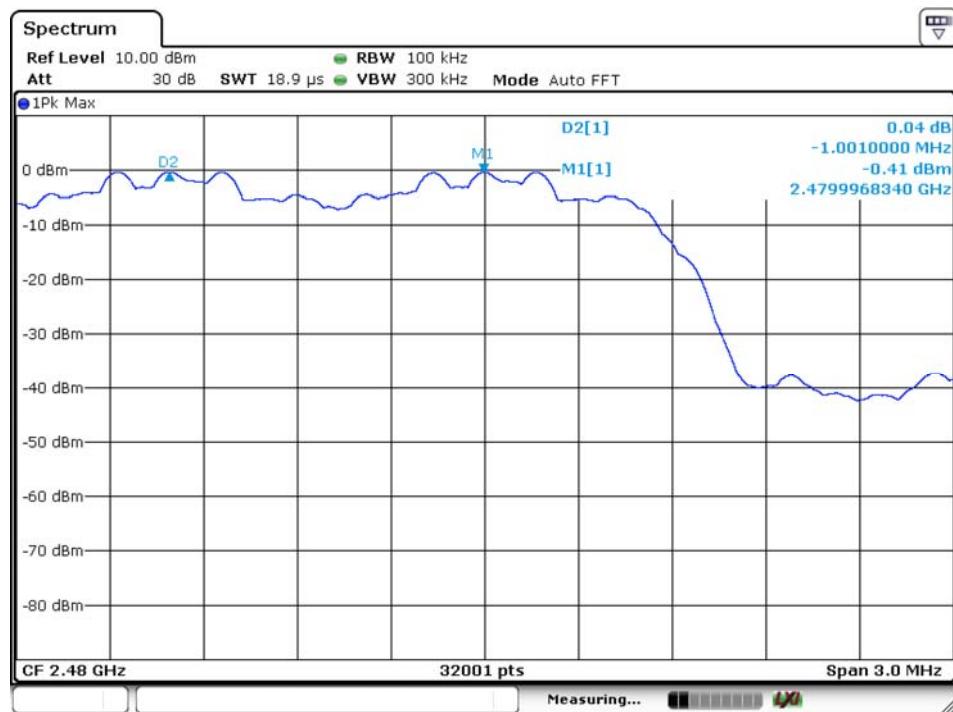




Spectrum Detector: PK Test Date : October 13, 2015
 Test By: Andy Temperature : 24°C
 Test Result: PASS Humidity : 53 %
 Modulation: 8DPSK

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	1001	>811
40	2441	1003	>815
79	2480	1001	>807



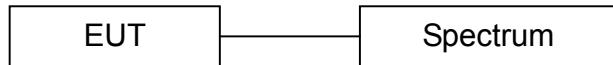


7. 20dB Bandwidth test

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:

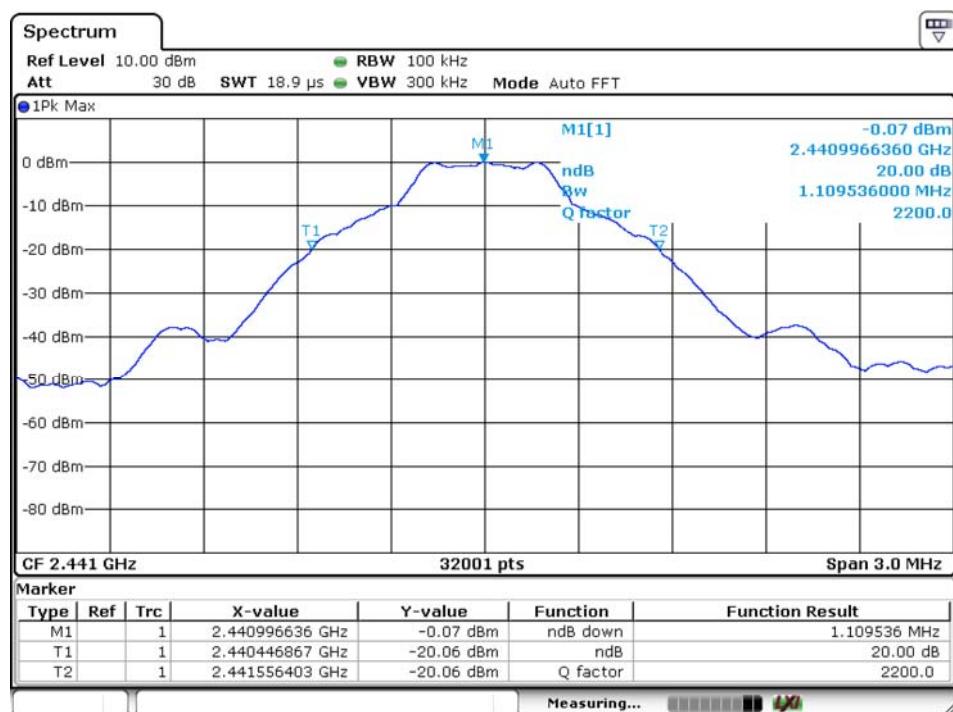
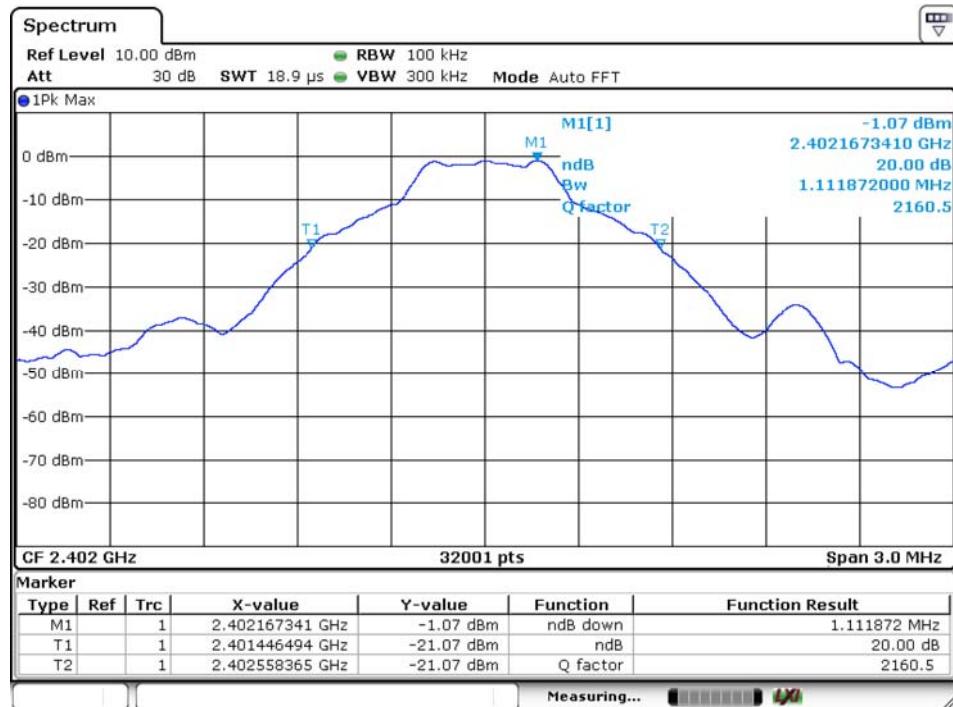
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.					

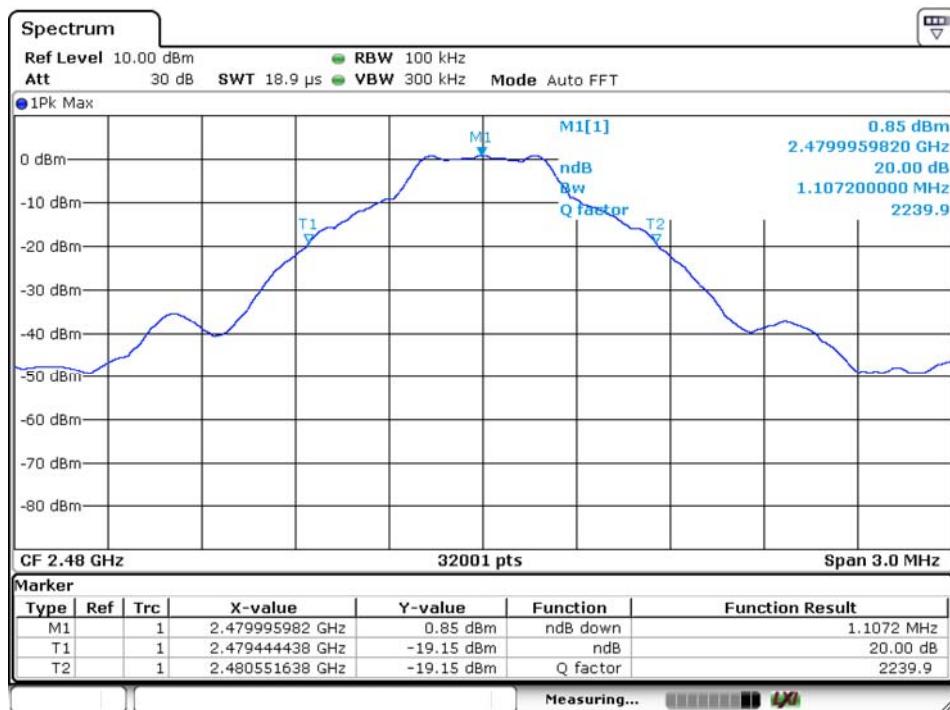
7.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	October 13, 2015
Test By:	Andy	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %
Modulation:	GFSK		

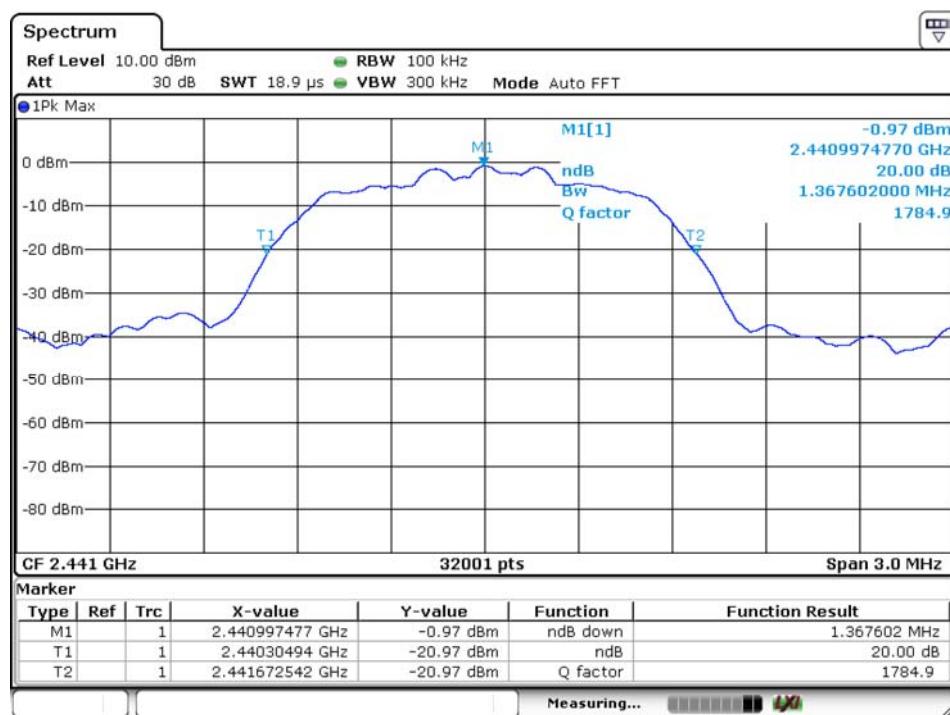
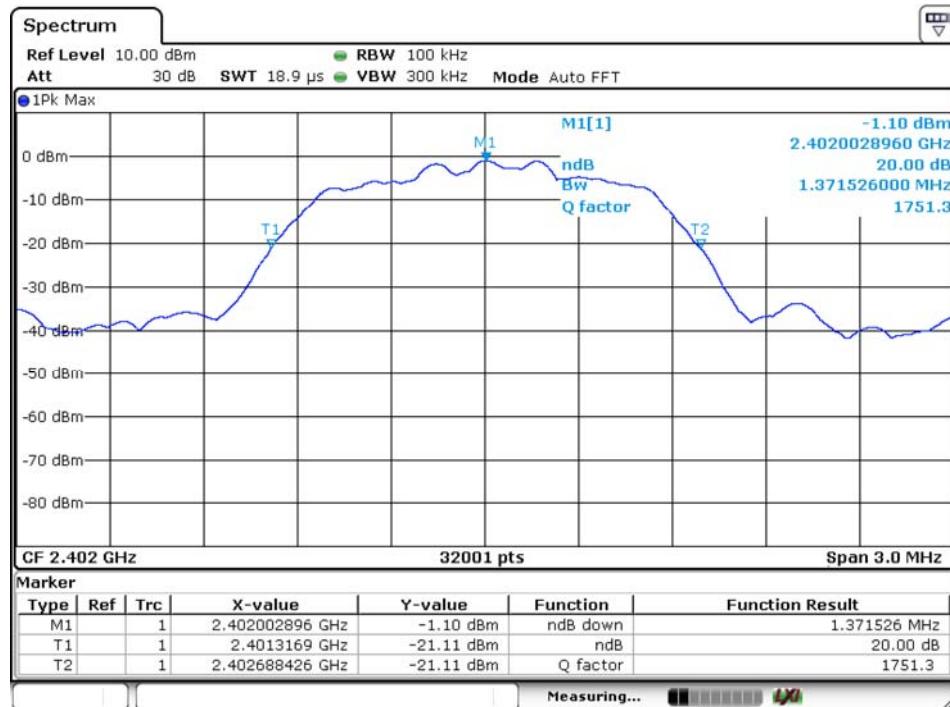
Channel number	Channel frequency (MHz)	20dB Down BW(KHz)
1	2402	1111
40	2441	1109
79	2480	1107

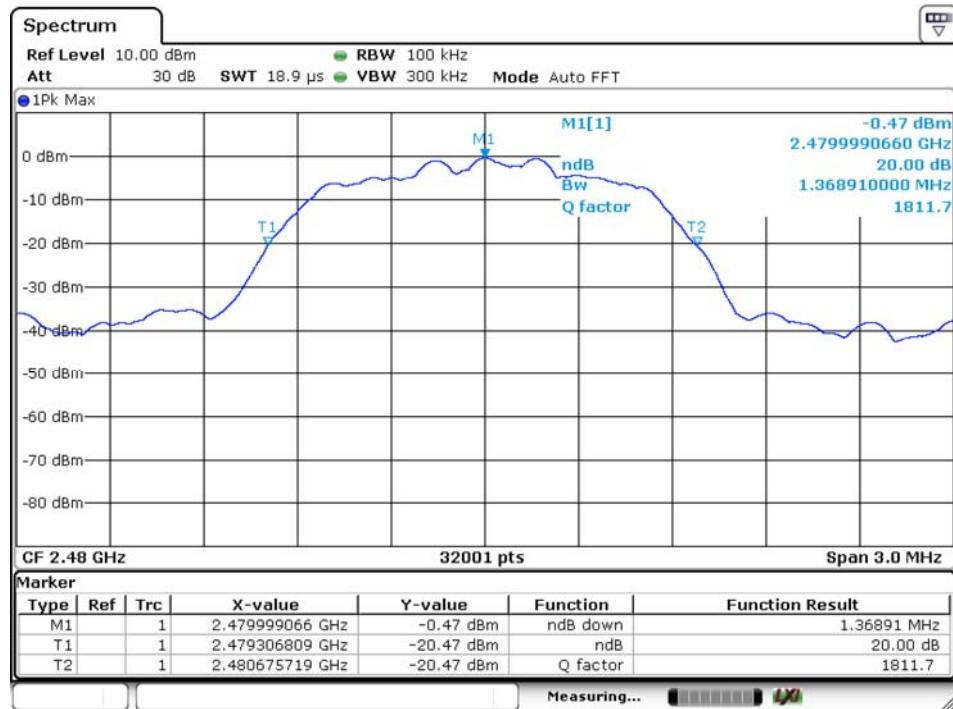




Spectrum Detector: PK Test Date : October 13, 2015
 Test By: Andy Temperature : 24°C
 Test Result: PASS Humidity : 53 %
 Modulation: Π/4-DQPSK

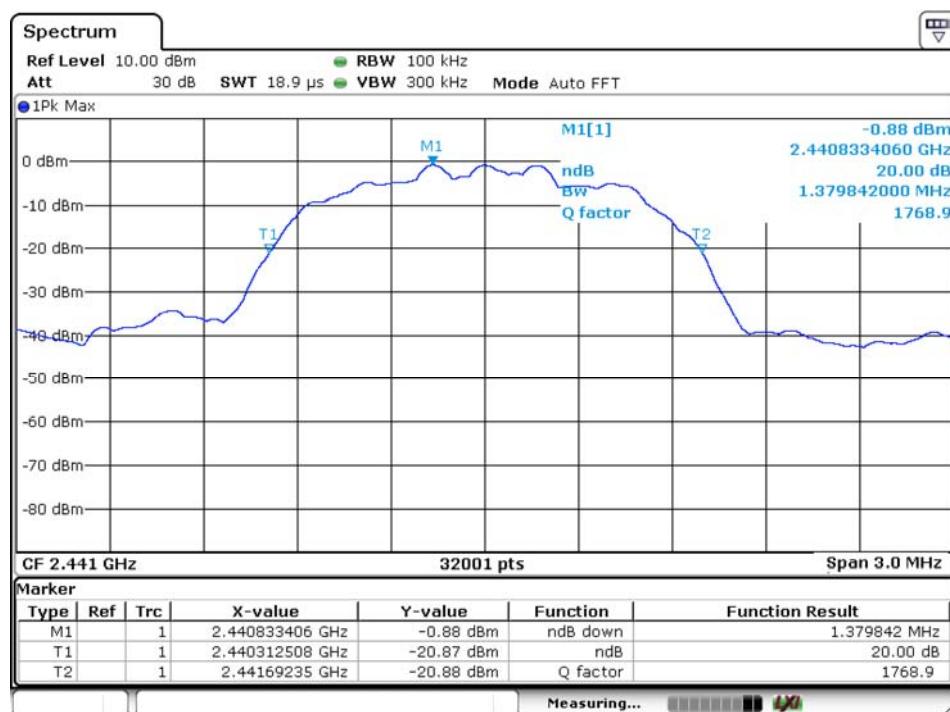
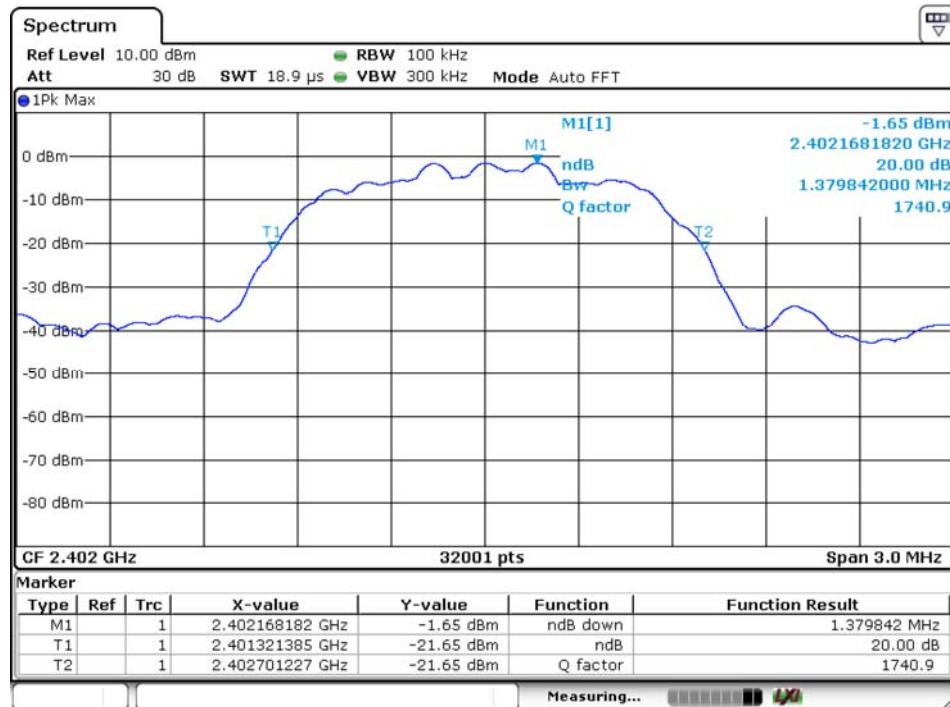
Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1371
40	2441	1367
79	2480	1369

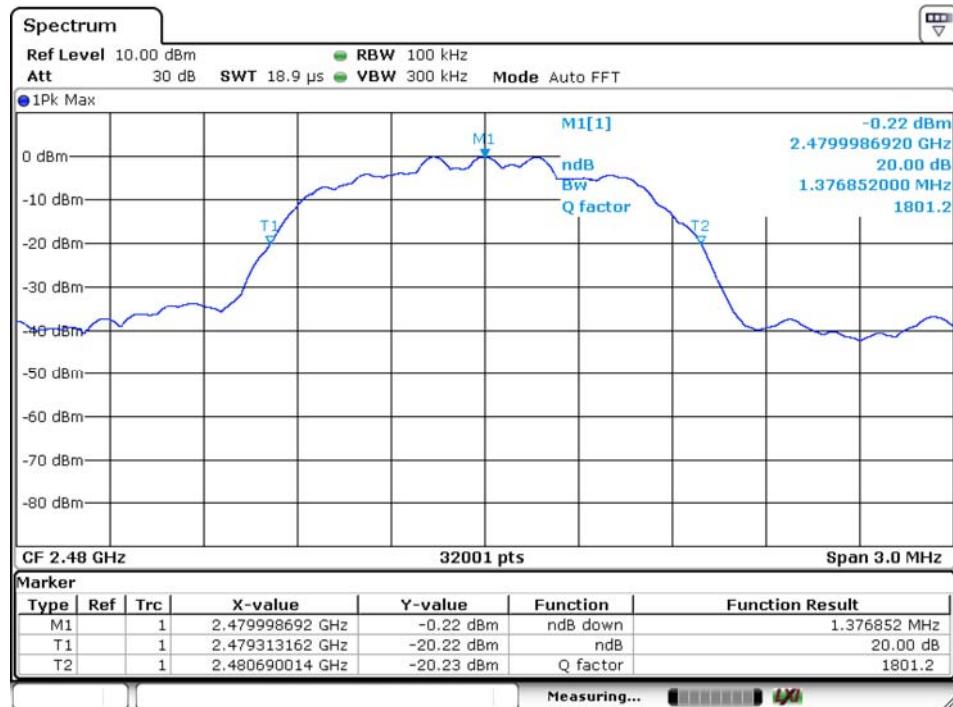




Spectrum Detector: PK Test Date : October 13, 2015
 Test By: Andy Temperature : 24 °C
 Test Result: PASS Humidity : 53 %
 Modulation: 8DPSK

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1380
40	2441	1380
79	2480	1377





8. Quantity of Hopping Channel 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:

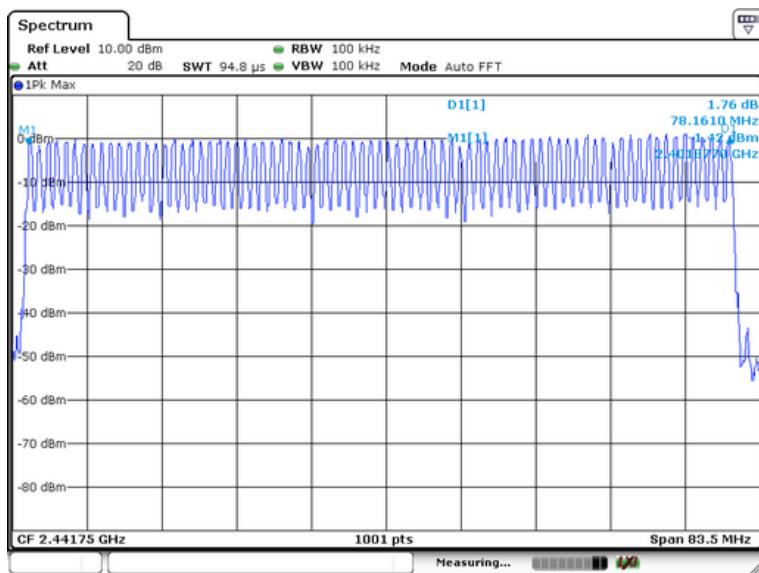
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: The temporary antenna connector is 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:

Worst test modulation GFSK

Spectrum Detector:	PK	Test Date :	October 13, 2015
Test By:	Andy	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %

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



9. Time of Occupancy (Dwell Time) test

9.1 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:

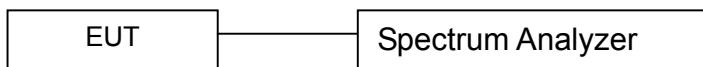
$$\text{Dwell time} = \text{time slot length} * \text{hop rate} / \text{number of hopping channels} * 31.6s$$

with:

- hop rate = $1600/2 * 1/s$ for DH1 packets = 1600 s^{-1}
- hop rate = $1600/4 * 1/s$ for DH3 packets = 533.33 s^{-1}
- hop rate = $1600/6 * 1/s$ for DH5 packets = 320 s^{-1}
- number of hopping channels = 79
- $31.6 \text{ s} = 0.4 \text{ seconds multiplied by the number of hopping channels} = 0.4 \text{ s} * 79$

The highest value of the dwell time is reported.

9.2 Test SET-UP (Block Diagram of Configuration)



9.3 Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: 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 Test Requirements / Limits

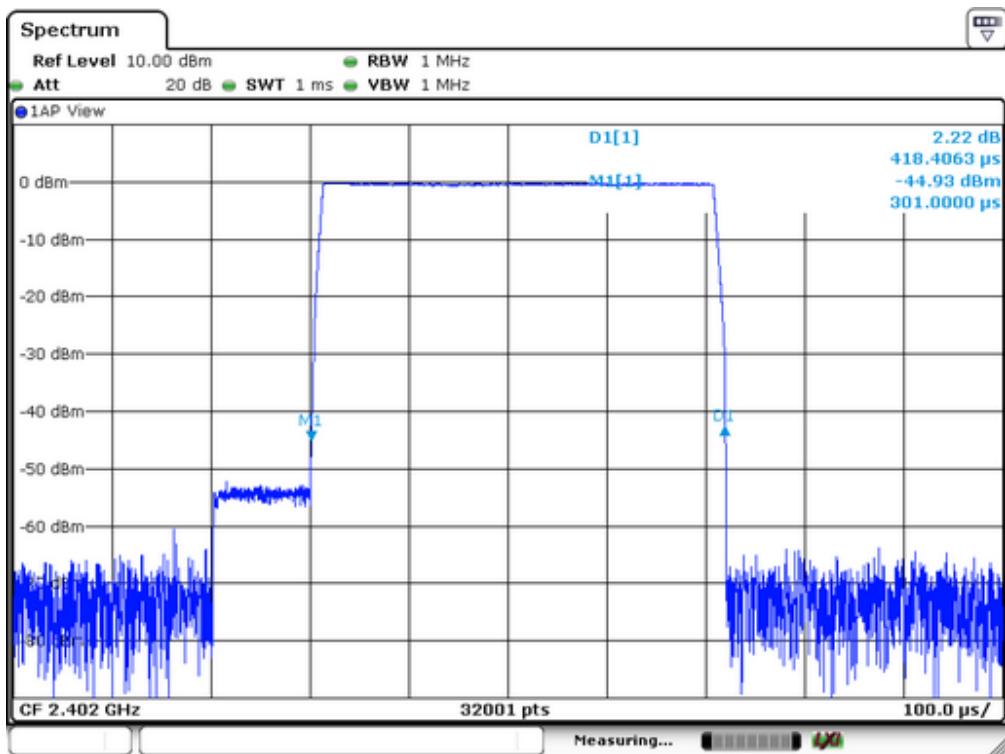
FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

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.

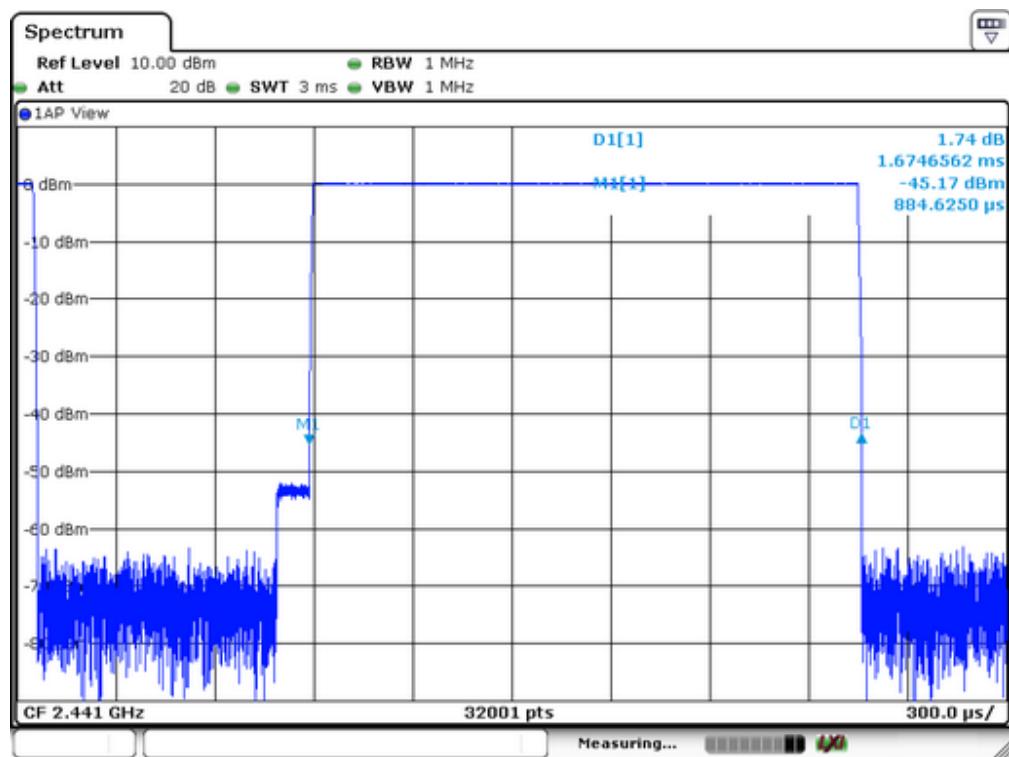
9.3 Measurement Results:

Packet type	Time slot length(ms)	Dwell time	Dwell time(ms)
DH1	0.418	time slot length *1600/2 /79 * 31.6	133.76
DH3	1.675	time slot length *1600/4 /79 * 31.6	268.00
DH5	2.921	time slot length *1600/6 /79 * 31.6	311.57

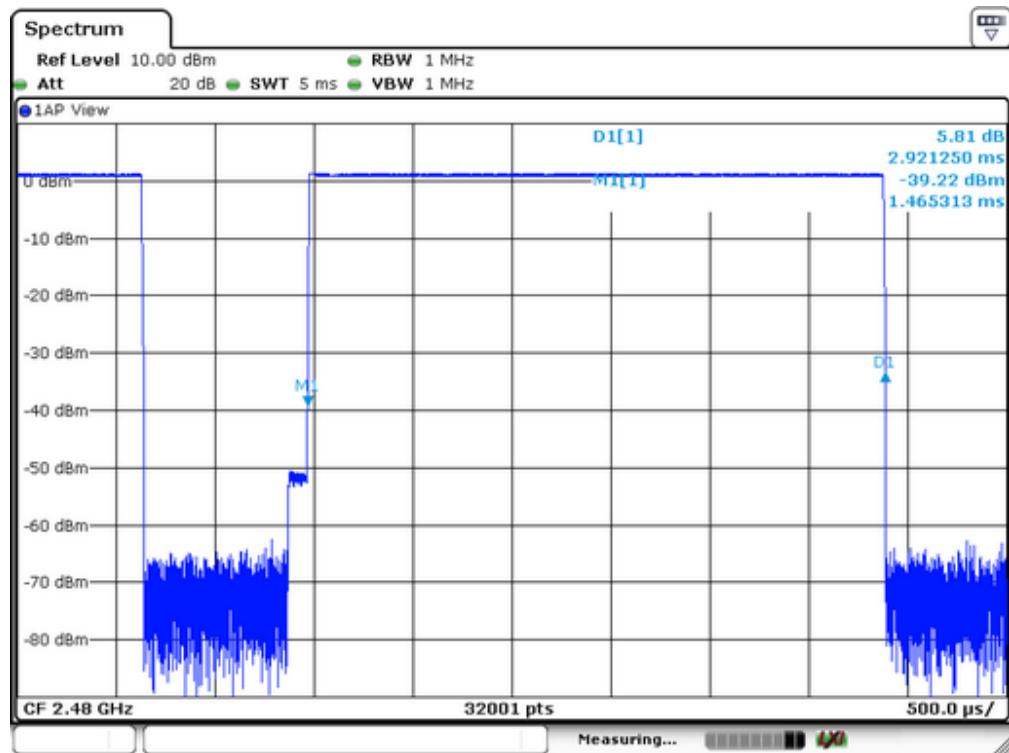
DH1:



DH3:



DH5:

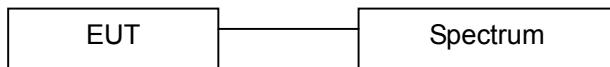


10. MAXIMUM PEAK OUTPUT POWER TEST

10.1 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.

10.2 Test SET-UP (Block Diagram of Configuration)



10.3 Measurement Equipment Used:

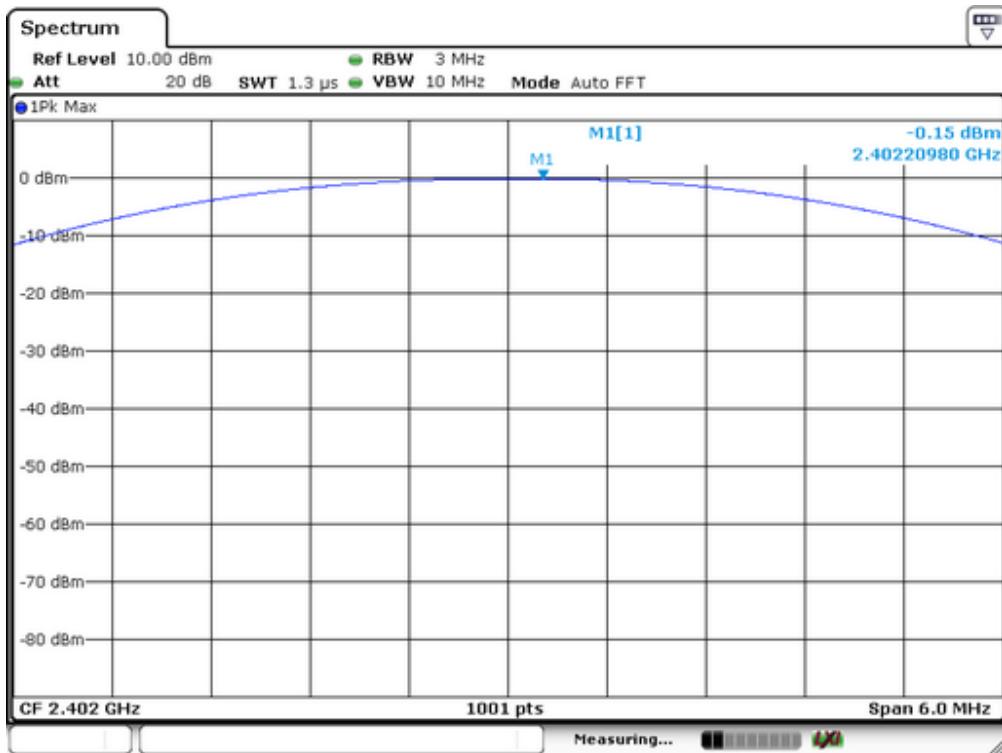
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.					

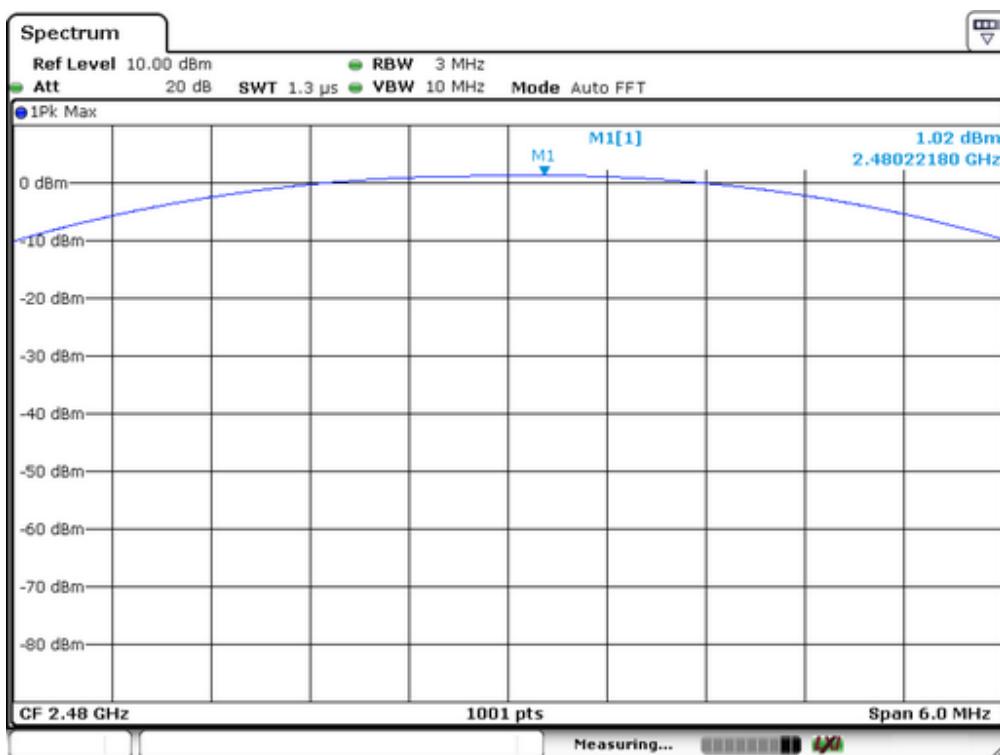
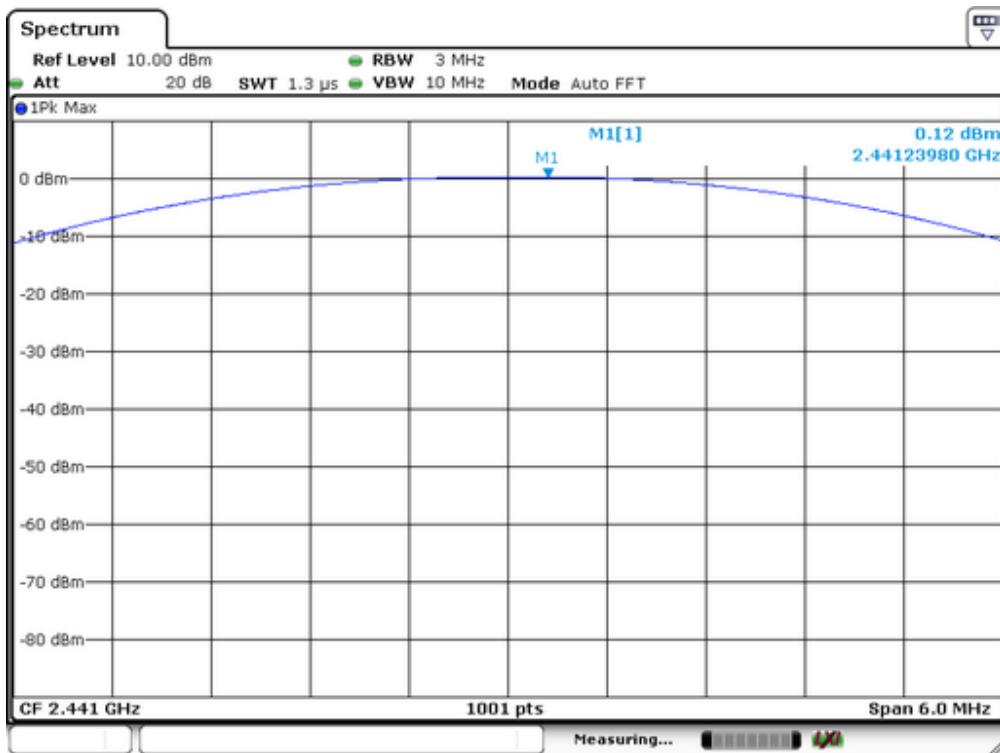
10.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	October 13, 2015
Test By:	Andy	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %
Modulation:	GFSK		

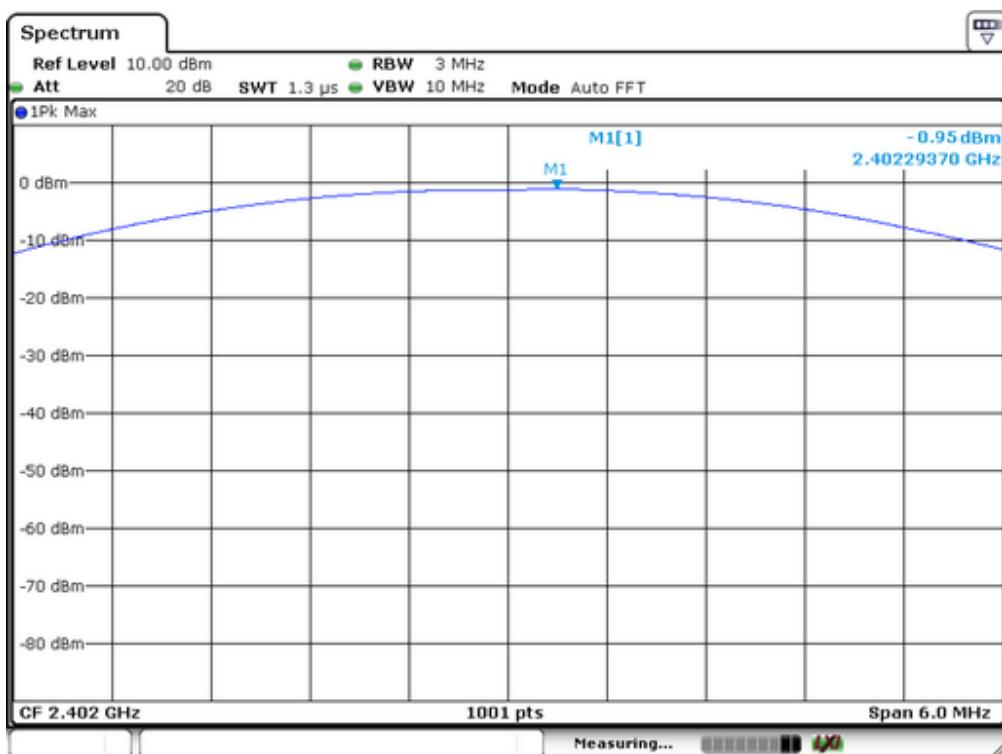
Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-0.15	0.966	1000	PASS
40	2441	0.12	1.028	1000	PASS
79	2480	1.02	1.265	1000	PASS

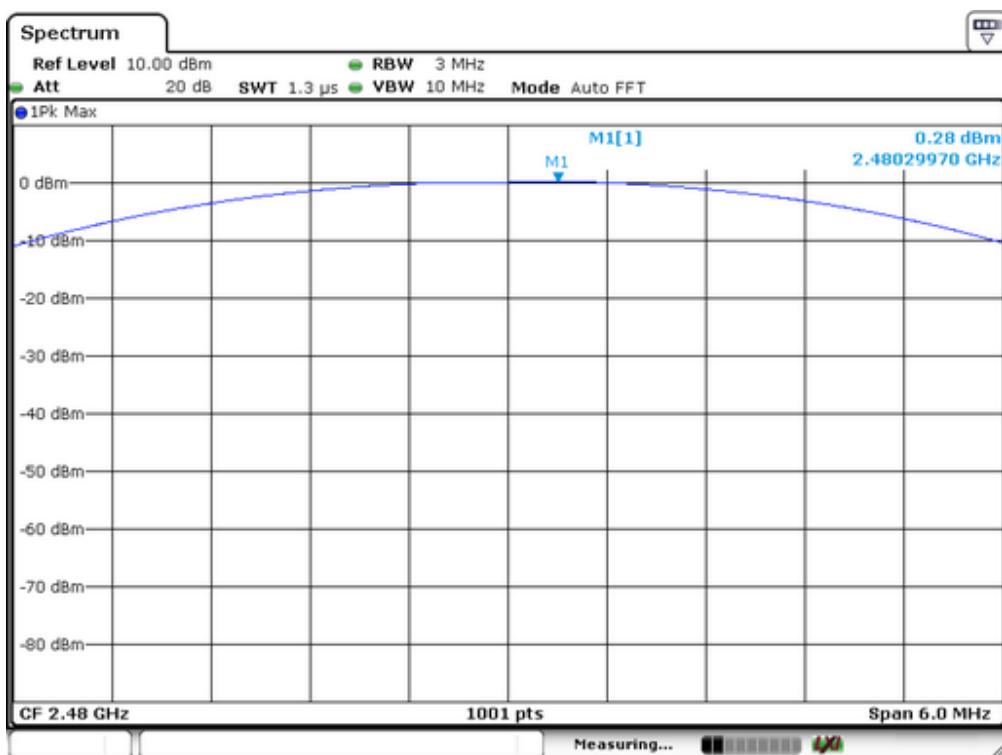
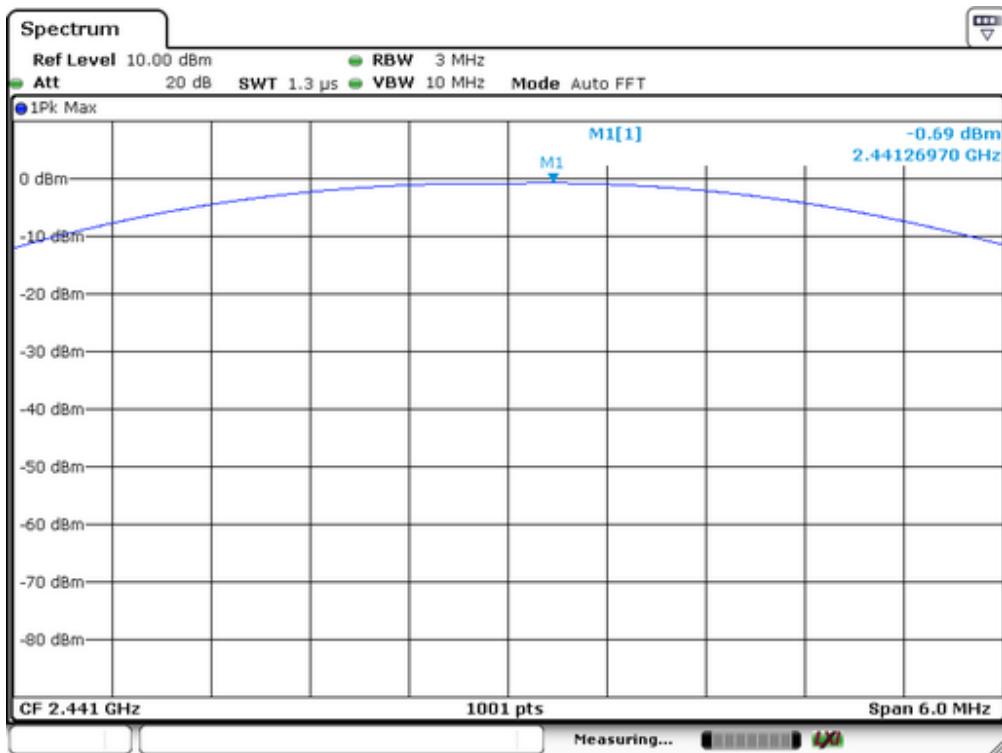




Spectrum Detector: PK Test Date : October 13, 2015
 Test By: Andy Temperature : 25 °C
 Test Result: PASS Humidity : 50 %
 Modulation: Π/4-DQPSK

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	-0.950	0.804	125	PASS
40	2441	-0.690	0.853	125	PASS
79	2480	0.280	1.067	125	PASS

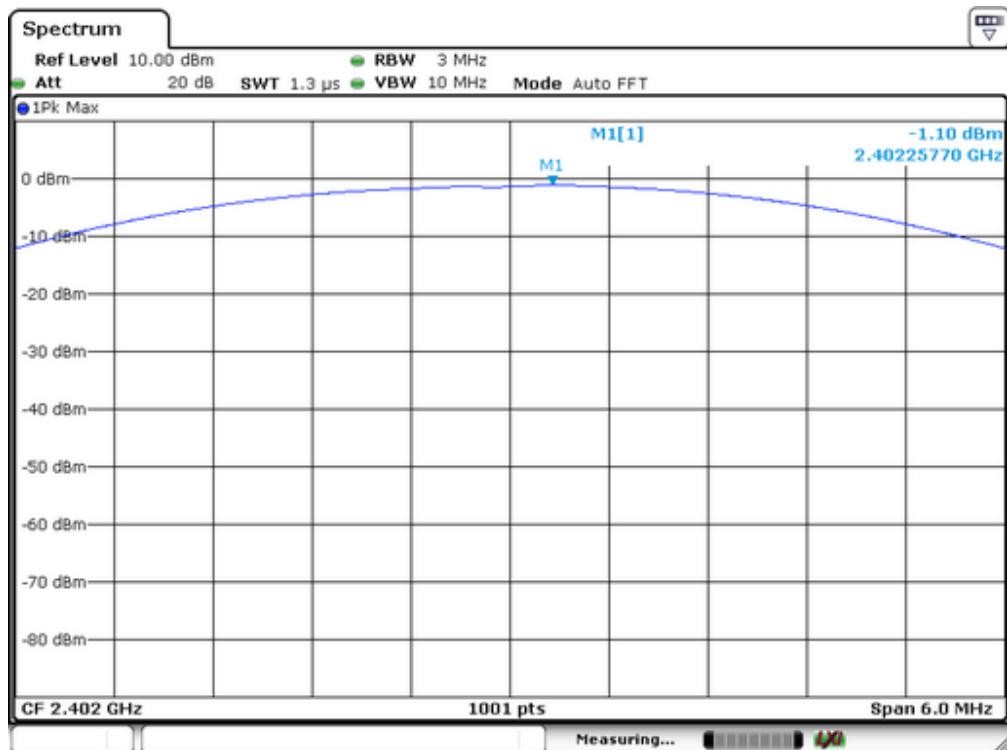


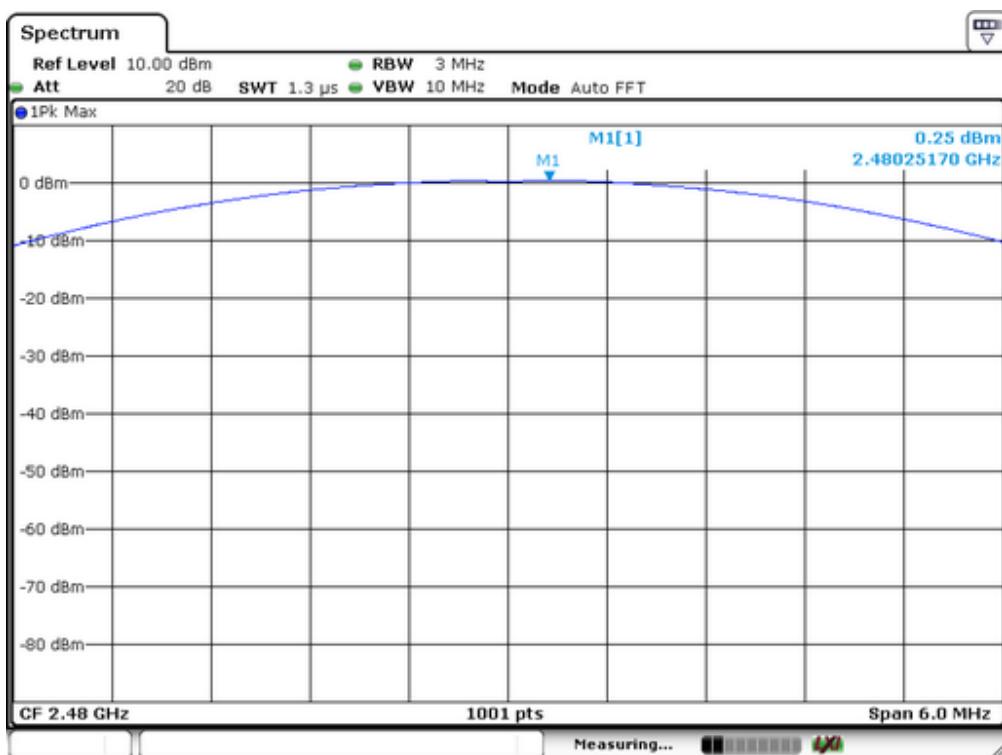
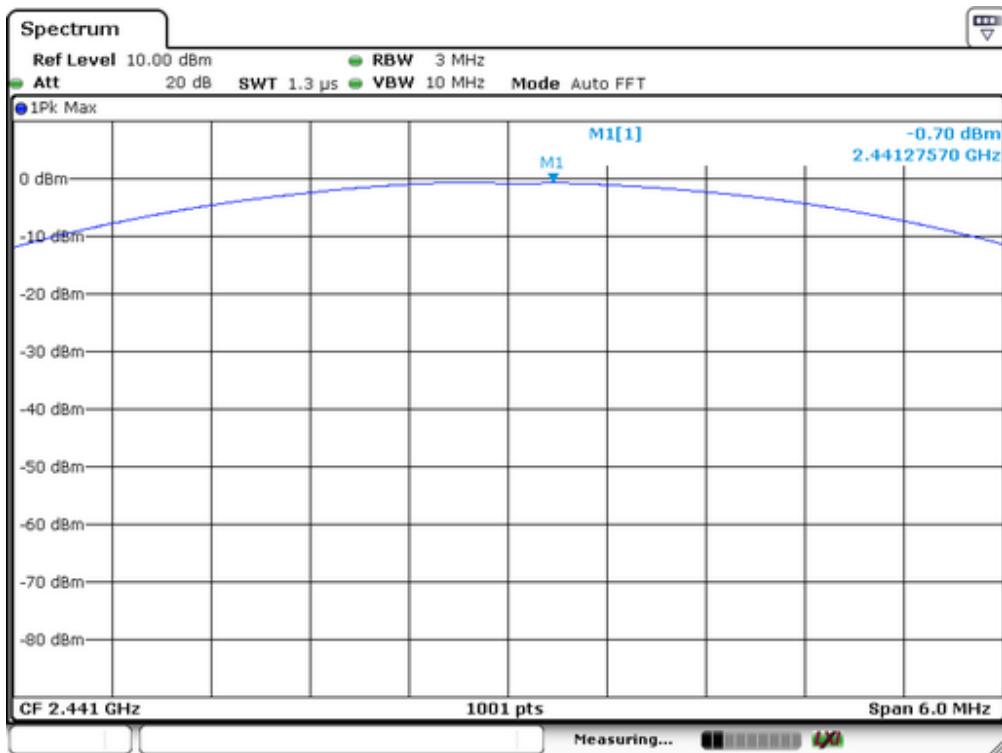


Spectrum Detector: PK
 Test By: Andy
 Test Result: PASS
 Modulation: 8DPSK

Test Date : October 13, 2015
 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	-1.100	0.776	125	PASS
40	2441	-0.700	0.851	125	PASS
79	2480	0.250	1.059	125	PASS





11. Band EDGE test

11.1 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:

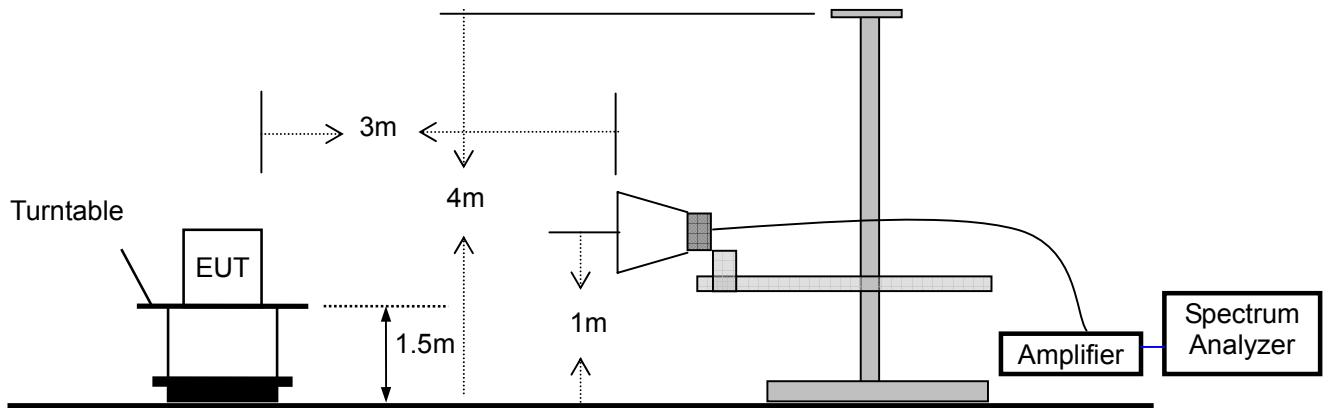
EMI Test Receiver	Setting
Attenuation	Auto
RBW	100KHz
VBW	300KHz
Detector	Peak
Trace	Max hold

11.2 Test SET-UP (Block Diagram of Configuration)

For Conducted Test



For Radiated emission Test



11.3 Measurement Equipment Used:

For Conducted Test

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	05/16/2015	05/15/2016
Coaxial Cable	CDS	79254	46107086	05/16/2015	05/15/2016
Antenna Connector	ARTHUR-YANG	2244-N1TG1	N/A	05/16/2015	05/15/2016
Note: 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.	Last Cal.	Cal. Interval
1	Signal Analyzer	Rohde & Schwarz	FSV30	103040	05/16/2015	1 Year
2	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	05/16/2015	1 Year
3	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	05/16/2015	1 Year
4	Cable	H+S	CBL-26	N/A	05/16/2015	1 Year
5	Cable	H+S	CBL-26	N/A	05/16/2015	1 Year
6	Cable	H+S	CBL-26	N/A	05/16/2015	1 Year

11.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	October 13, 2015
Test By:	Andy	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %

1. Conducted Test

For Non-Hopping Mode:

Frequency (MHz)	Modulation	Peak Power Output(dBm)	Emission read Value(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.99	GFSK	-0.2	-43.35	43.15	>20dBc
2398.65	pi/4-DQPSK	-1.87	-46.28	44.41	>20dBc
2400	8DPSK	-1.82	-46.3	44.48	>20dBc
2483.51	GFSK	1.27	-51.04	52.31	>20dBc
2483.52	pi/4-DQPSK	-0.29	-44.86	44.57	>20dBc
2483.51	8DPSK	-0.24	-45.69	45.45	>20dBc

For Hopping Mode:

Frequency (MHz)	Modulation	Peak Power Output(dBm)	Emission read Value(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.98	GFSK	-0.24	-43.98	43.74	>20dBc
2399.66	pi/4-DQPSK	-1.9	-48.17	46.27	>20dBc
2399.69	8DPSK	-1.86	-47.29	45.43	>20dBc
2483.51	GFSK	1.27	-52.38	53.65	>20dBc
2483.54	pi/4-DQPSK	-0.33	-46.78	46.45	>20dBc
2483.51	8DPSK	-0.28	-46.03	45.75	>20dBc

2.Radiated emission Test

Worst test modulation GFSK

For Non-Hopping Mode:

Frequency (MHz)	Antenna polarization (H/V)	Emission (dBuV/m)		Band edge Limit (dBuV/m)		Margin (dB)	
		PK	AV	PK	AV	PK	AV
2398.456	H	64.52	46.52	74	54	-9.48	-7.48
2399.157	V	58.62	44.51	74	54	-15.38	-9.49
2484.013	H	62.51	45.51	74	54	-11.49	-8.49
2483.895	V	56.26	39.62	74	54	-17.74	-14.38

Worst test modulation GFSK

For Hopping Mode:

Frequency (MHz)	Antenna polarization (H/V)	Emission (dBuV/m)		Band edge Limit (dBuV/m)		Margin (dB)	
		PK	AV	PK	AV	PK	AV
2399.369	H	66.26	45.61	74	54	-7.74	-8.39
2398.954	V	64.51	38.69	74	54	-9.49	-15.31
2484.123	H	65.52	44.62	74	54	-8.48	-9.38
2484.015	V	60.21	37.65	74	54	-13.79	-16.35

12. Antenna Application

12.1 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.

12.2 Result

The EUT used PCB Antenna. The antenna's gain is 4dBi and meets the requirement.

General Appearance of the EUT

