

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

OF

Wireless speakers

Model No.: DALI ZENSOR 1 AX, DALI ZENSOR 5 AX

Trademark: DALI

FCC ID: 2AFD2-ZENSOR

Report No.: KAD150629097E1

Issue Date: October 21, 2015

Prepared for

DALI A/S

Dali Allé 1, DK-9610, Noerager, Denmark

Prepared by

DONGGUAN EMTEK CO., LTD.

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DONGGUAN EMTEK CO., LTD.**

VERIFICATION OF COMPLIANCE

Applicant:	DALI A/S Dali Allé 1, DK-9610, Noerager, Denmark
Manufacturer:	DALI AUDIO MANUFACTURING(NINGBO)CO.,LTD Building 7 No.1188, Zhongguan Road Ningbo zhejiang Province
Product Description:	Wireless Speakers
Trade Mark:	DALI
Model Number:	DALI ZENSOR 1 AX, DALI ZENSOR 5 AX (Note: The samples are the same except model number. So DALI ZENSOR 5 AX was selected for full test.)

We hereby certify that:

The above equipment was tested by DONGGUAN EMTEK 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).

Date of Test : June 29, 2015 to September 09, 2015

Prepared by : 
Ivy Huang/Editor

Reviewer : 
Alan He/Supervisor

Approved & Authorized
Signer : 
Sam Lv/Manager

Modified Information

Version	Summary	Revision Date	Report No.
Ver.1.0	Original Report	/	KAD150629097E1

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Appendix I (Photos of EUT) (7 pages)

1. GENERAL INFORMATION

1.1 Product Description

Product Name	Wireless Speakers	
Model number	DALI ZENSOR 5 AX	
Power Supply	AC 100-240V, 50W	
Product Software Version	V.5.0	
Product Hardware version	V.A2	
Radio Software Version	V2.02	
Radio Hardware version	V.B1	
Test Software Version	V1.0	
RF Power Setting in Test Software	0dbm	
Technical Description		
	Bluetooth 4.0	Bluetooth 2.1+EDR
Operation Frequency	2402-2480MHz	
Modulation	GFSK	GFSK, $\pi/4$ -DQPSK, 8DPSK
Number of Channel	40	79
Channel space	2MHz	1MHz
Max RF Output Power	5.48dBm(0.003532W)	5.31dBm(0.003396W)
Antenna Type	Internal PCB antenna	
Antenna Gain	0 dBi	

1.2 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 : DONGGUAN EMTEK 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 a placed on as turn table which is 0.1 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

The EUT is a placed on as turn table which is 0.1 m 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	Trade Mark	Model No.	FCC ID	Note
1.	Wireless Speaker	DALI	DALI ZENSOR 5 AX	2AFD2-ZENSOR	<i>EUT</i>

Note:

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

3. Summary of Test Results

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

4. Description of test modes

The EUT has been tested under 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.

Channel	Frequency(MHz)
1	2402
40	2441
79	2480

5. TEST SYSTEM UNCERTAINTY

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

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-5}$
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	$\pm 3\%$

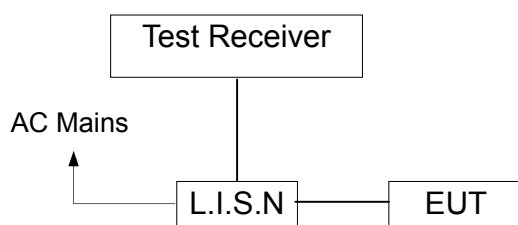
Measurement Uncertainty for a level of Confidence of 95%

6. Conducted Emissions Test

6.1 Measurement Procedure:

1. The EUT was placed on a table, which is 0.1m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured was complete.

6.2 Test SET-UP (Block Diagram of Configuration)



6.3 Measurement Equipment Used:

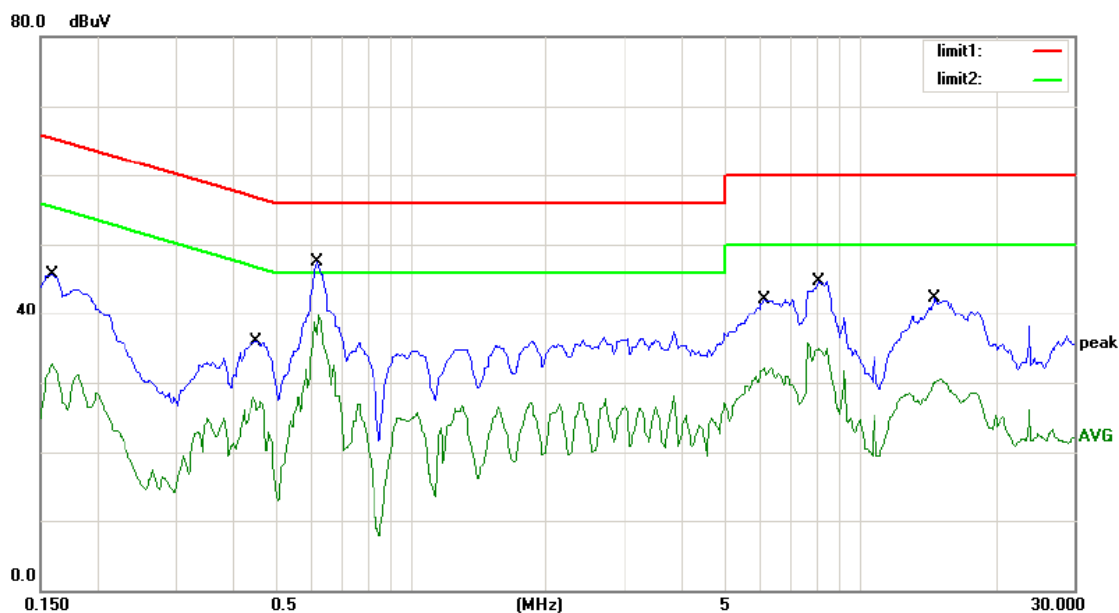
Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	Last Cal.	Due date
Test Receiver	Rohde & Schwarz	ESCS30	100018	03/16/2015	03/15/2016
L.I.S.N	Rohde & Schwarz	ENV216	100017	03/16/2015	03/15/2016
RF Switching Unit	CDS	RSU-M2	38401	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

6.4 Measurement Result:

Pass.

All the modulation modes were tested the data of the worst mode (GFSK TX 2402MHz) are recorded in the following pages and the others modulation methods do not exceed the limits.

Please refer to the following data.

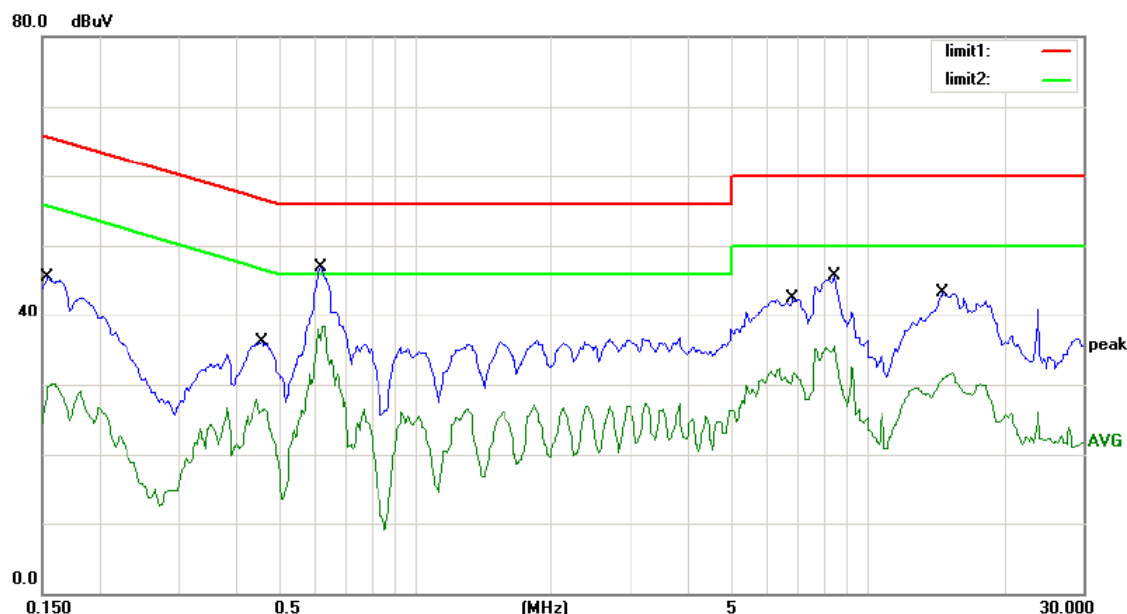


Site site #1
 Limit: (CE)FCC Part 15B_QP
 Mode: TX2402
 Note:

Phase: **L1**
 Power: AC 120V/60Hz
 Temperature: 24
 Humidity: 55 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.1590	43.54	0.00	43.54	65.52	-21.98	QP	
2		0.1590	32.62	0.00	32.62	55.52	-22.90	AVG	
3		0.4560	34.51	0.00	34.51	56.77	-22.26	QP	
4		0.4560	27.88	0.00	27.88	46.77	-18.89	AVG	
5		0.6180	45.34	0.00	45.34	56.00	-10.66	QP	
6	*	0.6180	39.73	0.00	39.73	46.00	-6.27	AVG	
7		6.1500	40.74	0.00	40.74	60.00	-19.26	QP	
8		6.1500	32.09	0.00	32.09	50.00	-17.91	AVG	
9		8.0700	42.64	0.00	42.64	60.00	-17.36	QP	
10		8.0700	34.90	0.00	34.90	50.00	-15.10	AVG	
11		14.6750	40.24	0.00	40.24	60.00	-19.76	QP	
12		14.6750	30.50	0.00	30.50	50.00	-19.50	AVG	

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

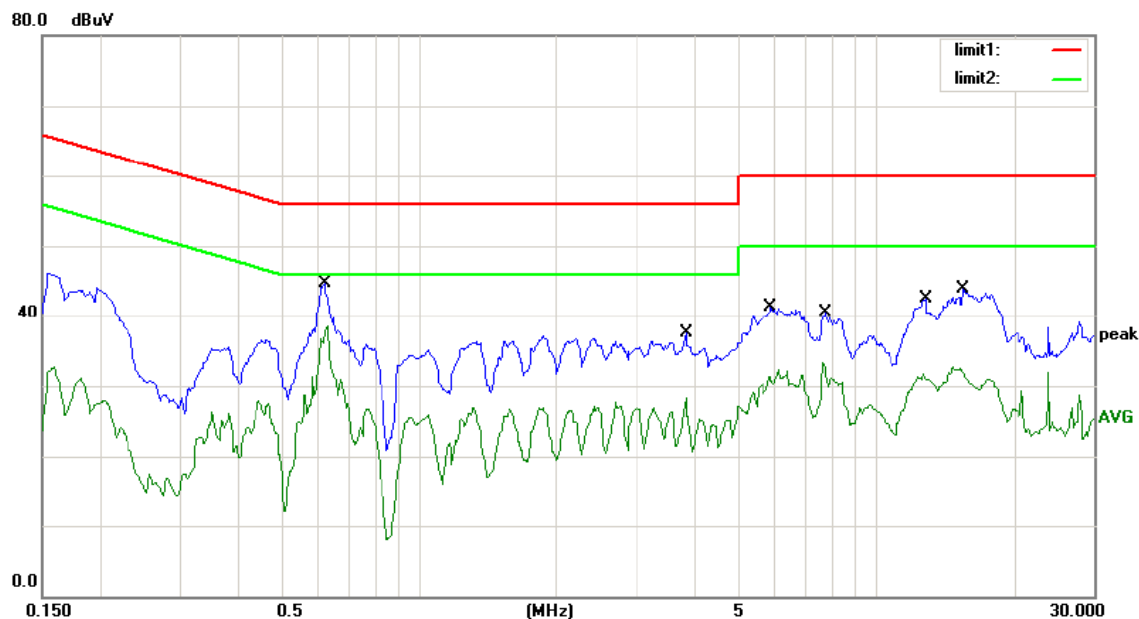


Site site #1
 Limit: (CE)FCC Part 15B_QP
 Mode: TX2402
 Note:

Phase: **N**
 Power: AC 120V/60Hz
 Temperature: 24
 Humidity: 55 %

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over		
		MHz	Level	Factor	ment			Detector	Comment
			dBuV	dB	dBuV	dBuV	dB		
1		0.1545	43.25	0.00	43.25	65.75	-22.50	QP	
2		0.1545	30.18	0.00	30.18	55.75	-25.57	AVG	
3		0.4605	34.84	0.00	34.84	56.68	-21.84	QP	
4		0.4605	27.88	0.00	27.88	46.68	-18.80	AVG	
5		0.6180	44.24	0.00	44.24	56.00	-11.76	QP	
6	*	0.6180	38.25	0.00	38.25	46.00	-7.75	AVG	
7		6.8500	40.14	0.00	40.14	60.00	-19.86	QP	
8		6.8500	32.24	0.00	32.24	50.00	-17.76	AVG	
9		8.4500	43.64	0.00	43.64	60.00	-16.36	QP	
10		8.4500	35.50	0.00	35.50	50.00	-14.50	AVG	
11		14.7250	41.78	0.00	41.78	60.00	-18.22	QP	
12		14.7250	31.64	0.00	31.64	50.00	-18.36	AVG	

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

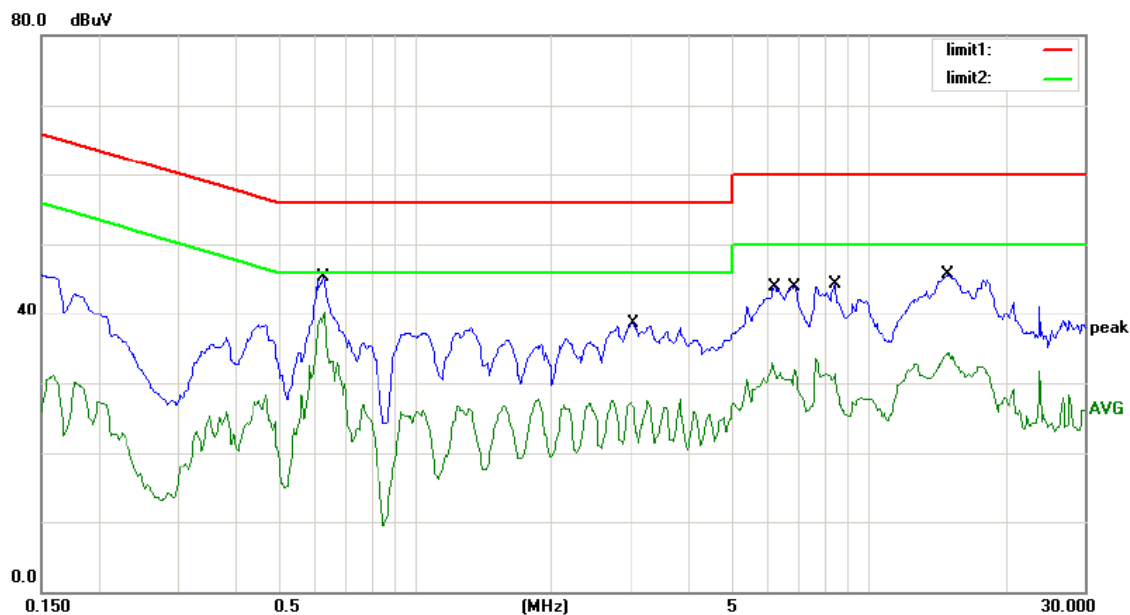


Site site #1
 Limit: (CE)FCC PART 15_QP
 Mode: TX2402
 Note:

Phase: **L1**
 Power: AC 240V/50Hz
 Temperature: 24
 Humidity: 55 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.6225	44.77	0.00	44.77	56.00	-11.23	QP	
2	*	0.6225	36.06	0.00	36.06	46.00	-9.94	AVG	
3		3.8400	37.43	0.00	37.43	56.00	-18.57	QP	
4		3.8400	28.37	0.00	28.37	46.00	-17.63	AVG	
5		5.9100	41.31	0.00	41.31	60.00	-18.69	QP	
6		5.9100	30.75	0.00	30.75	50.00	-19.25	AVG	
7		7.7278	40.47	0.00	40.47	60.00	-19.53	QP	
8		7.7278	33.25	0.00	33.25	50.00	-16.75	AVG	
9		12.9000	42.47	0.00	42.47	60.00	-17.53	QP	
10		12.9000	31.38	0.00	31.38	50.00	-18.62	AVG	
11		15.4750	43.82	0.00	43.82	60.00	-16.18	QP	
12		15.4750	31.41	0.00	31.41	50.00	-18.59	AVG	

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



Site site #1
 Limit: (CE)FCC PART 15_QP
 Mode: TX2402
 Note:

Phase: **N**
 Power: AC 240V/50Hz
 Temperature: 24
 Humidity: 55 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1		0.6270	45.38	0.00	45.38	56.00	-10.62	QP	
2	*	0.6270	40.24	0.00	40.24	46.00	-5.76	AVG	
3		3.0400	38.58	0.00	38.58	56.00	-17.42	QP	
4		3.0400	25.29	0.00	25.29	46.00	-20.71	AVG	
5		6.2400	43.89	0.00	43.89	60.00	-16.11	QP	
6		6.2400	31.01	0.00	31.01	50.00	-18.99	AVG	
7		6.9100	43.88	0.00	43.88	60.00	-16.12	QP	
8		6.9100	31.91	0.00	31.91	50.00	-18.09	AVG	
9		8.4500	44.38	0.00	44.38	60.00	-15.62	QP	
10		8.4500	30.78	0.00	30.78	50.00	-19.22	AVG	
11		15.0500	45.61	0.00	45.61	60.00	-14.39	QP	
12		15.0500	34.40	0.00	34.40	50.00	-15.60	AVG	

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

6.5 Conducted Measurement Photos:



7. Radiated Emission Test

7.1 Measurement Procedure

1. Below 1000MHz, The EUT was placed on a turn table which is 0.1m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 0.1m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measured were complete.
5. The following table is the setting of spectrum analyzer:

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:

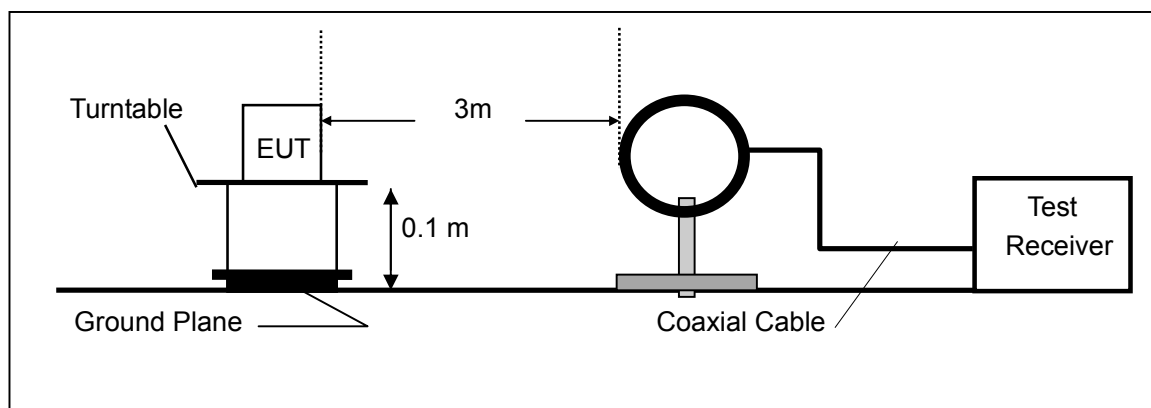
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	3MHz
Detector	Peak
Trace	Max hold

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

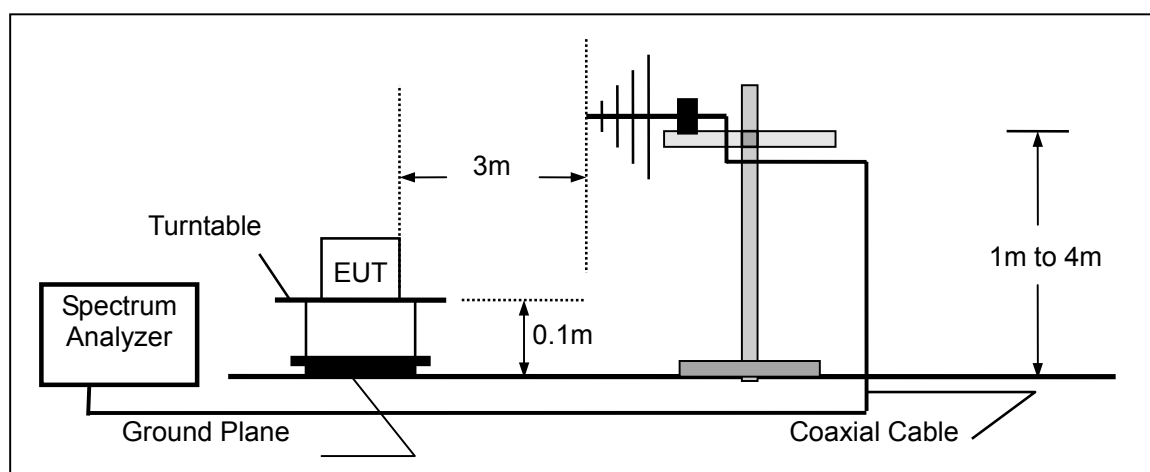
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Peak
Trace	Max hold

7.2 Test SET-UP (Block Diagram of Configuration)

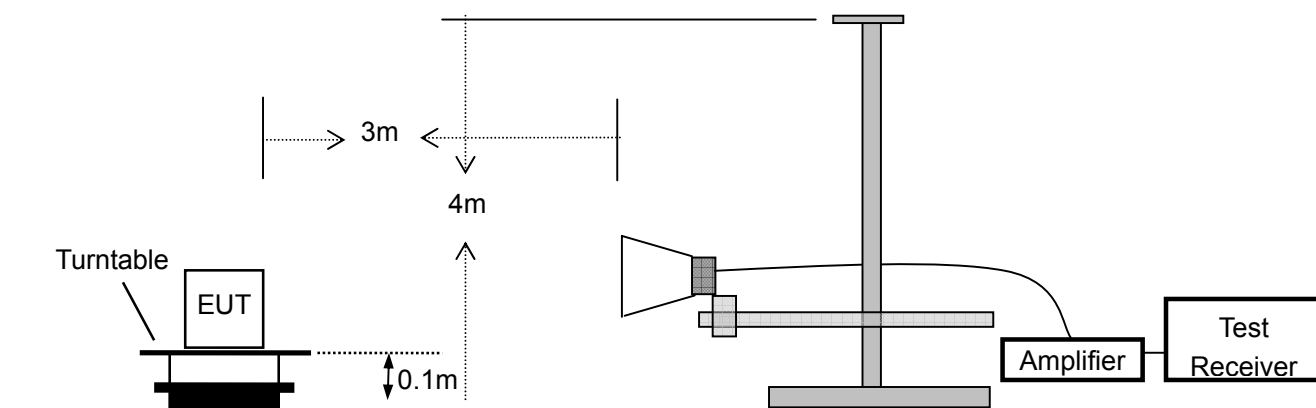
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



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



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



7.3 Measurement Equipment Used:

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Test Receiver	Rohde & Schwarz	ESCI	1166.5950.03	03/16/2015	1 Year
2.	Bilog Antenna	Schwarzbeck	VULB9163	000141	03/16/2015	1 Year
3.	Power Amplifier	CDS	RSU-M352	818	03/16/2015	1 Year
4.	Power Amplifier	HP	8447F	OPT H64	03/16/2015	1 Year
5.	Color Monitor	SUNSP0	SP-140A	N/A	03/16/2015	1 Year
6.	Single Line Filter	JIANLI	XL-3	N/A	03/16/2015	1 Year
7.	Single Phase Power Line Filter	JIANLI	DL-2X100B	N/A	03/16/2015	1 Year
8.	3 Phase Power Line Filter	JIANLI	DL-4X100B	N/A	03/16/2015	1 Year
9.	DC Power Filter	JIANLI	DL-2X50B	N/A	03/16/2015	1 Year
10.	Cable	Schwarzbeck	PLF-100	549489	03/16/2015	1 Year
11.	Cable	Rosenberger	CIL02	A0783566	03/16/2015	1 Year
12.	Cable	Rosenberger	RG 233/U	525178	03/16/2015	1 Year
13.	Signal Analyzer	Rohde & Schwarz	FSV30	103040	12/29/2014	1 Year
14.	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	12/29/2014	1 Year
15.	Power Amplifier	LUNAR EM	LNA1G18-40	J10100000081	12/29/2014	1 Year
16.	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year
17.	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year
18.	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year

7.4 Radiated Emission Limit

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

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

15.205 Restricted bands of operation

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

Remark 1. Emission level in dBuV/m=20 log (uV/m)

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

3. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of § 15.205, and the emissions located in restricted bands also comply with 15.209 limit.

7.5 Measurement Result

Below 30MHz:

Operation Mode:	TX	Test Date :	August 25, 2015
Frequency Range:	9KHz~30MHz	Temperature :	28℃
Test Result:	PASS	Humidity :	65 %
Measured Distance:	3m	Test By:	Andy

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

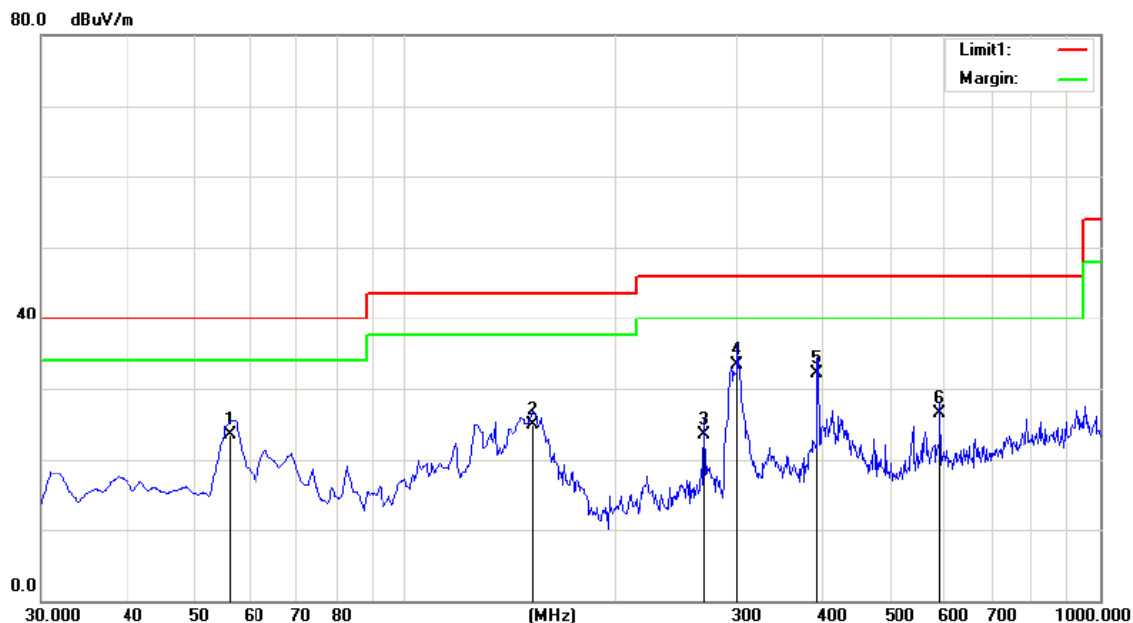
Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

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.

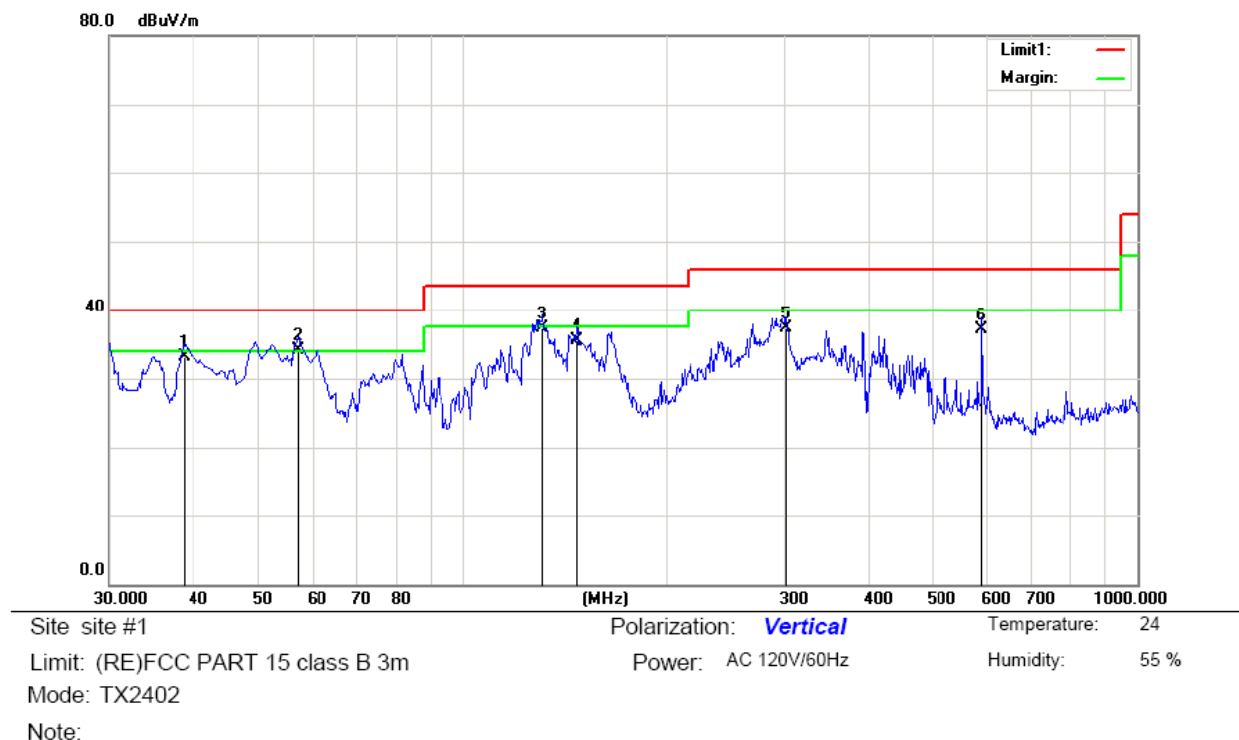


Site site #1 Polarization: **Horizontal** Temperature: 24
 Limit: (RE)FCC PART 15 class B 3m Power: AC 120V/60Hz Humidity: 55 %
 Mode: TX2402
 Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree
1		56.1900	41.25	-17.84	23.41	40.00	-16.59	QP	0
2		153.1900	43.03	-18.03	25.00	43.50	-18.50	QP	0
3		269.5900	38.64	-15.20	23.44	46.00	-22.56	QP	0
4	*	300.6300	47.65	-14.28	33.37	46.00	-12.63	QP	0
5		392.7800	43.64	-11.58	32.06	46.00	-13.94	QP	0
6		589.6900	34.98	-8.54	26.44	46.00	-19.56	QP	0

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

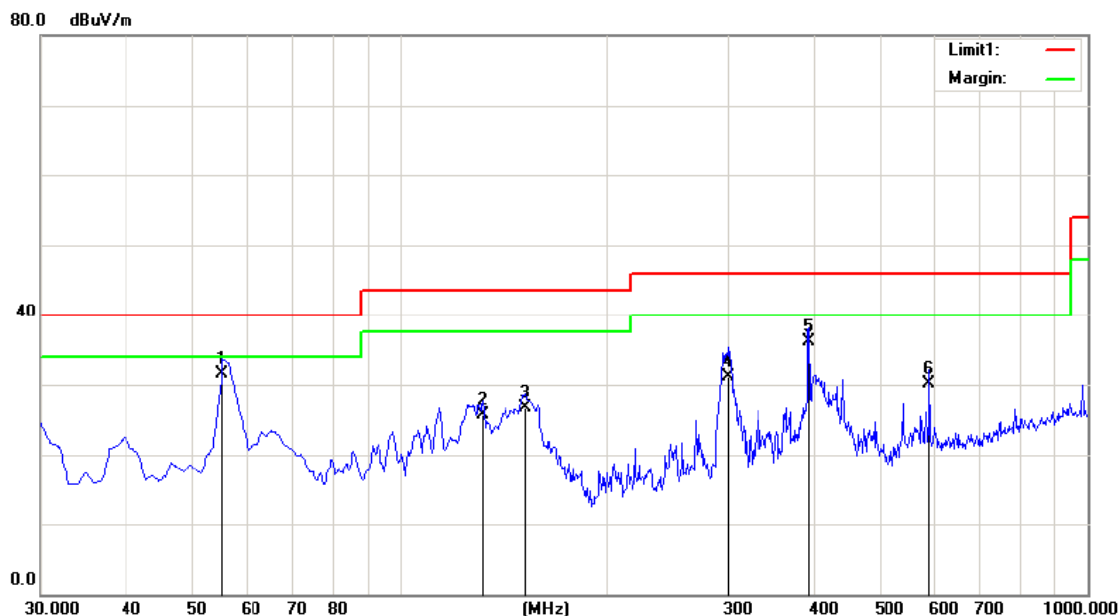
Operator: John



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		38.7300	46.88	-13.77	33.11	40.00	-6.89	QP	0	
2	*	57.1600	52.34	-18.26	34.08	40.00	-5.92	QP	0	
3		131.2965	53.65	-16.38	37.27	43.50	-6.23	QP	0	
4		148.3400	53.19	-17.63	35.56	43.50	-7.94	QP	0	
5		301.6000	51.49	-14.23	37.26	46.00	-8.74	QP	0	
6		589.6900	45.55	-8.54	37.01	46.00	-8.99	QP	0	

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

Operator: John



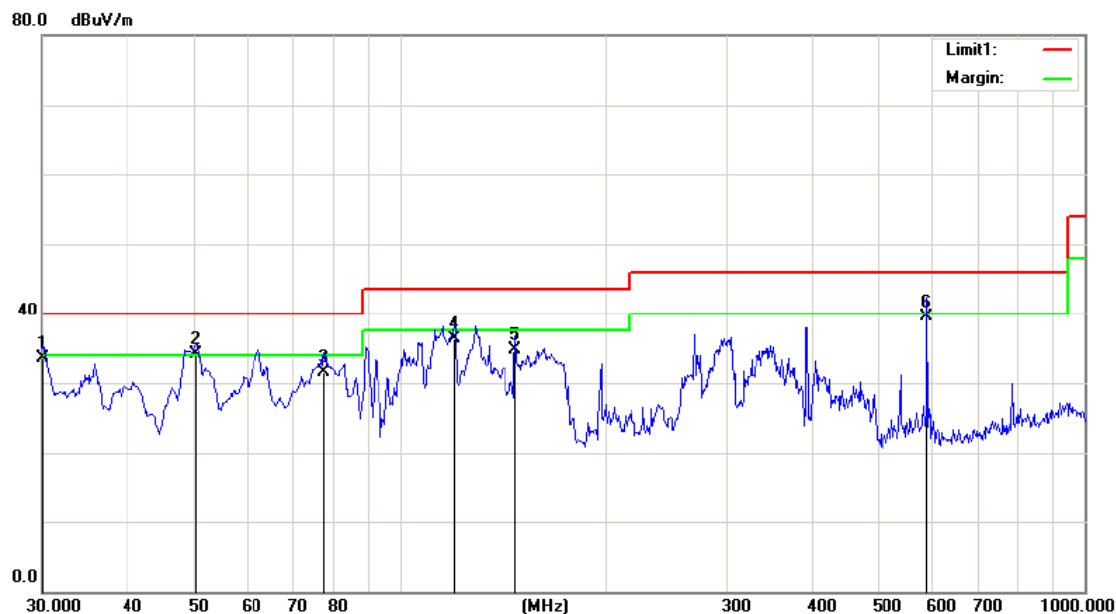
Site: site #1
 Limit: (RE)FCC PART 15 class B 3m
 Mode: TX2441
 Note:

Polarization: **Horizontal**
 Power: AC 120V/60Hz
 Temperature: 24
 Humidity: 55 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1	*	55.2200	49.06	-17.46	31.60	40.00	-8.40	QP	0	
2		131.8500	42.01	-16.34	25.67	43.50	-17.83	QP	0	
3		152.2200	44.60	-17.94	26.66	43.50	-16.84	QP	0	
4		300.6300	45.46	-14.28	31.18	46.00	-14.82	QP	0	
5		393.7500	47.65	-11.54	36.11	46.00	-9.89	QP	0	
6		589.6900	38.67	-8.54	30.13	46.00	-15.87	QP	0	

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

Operator: John

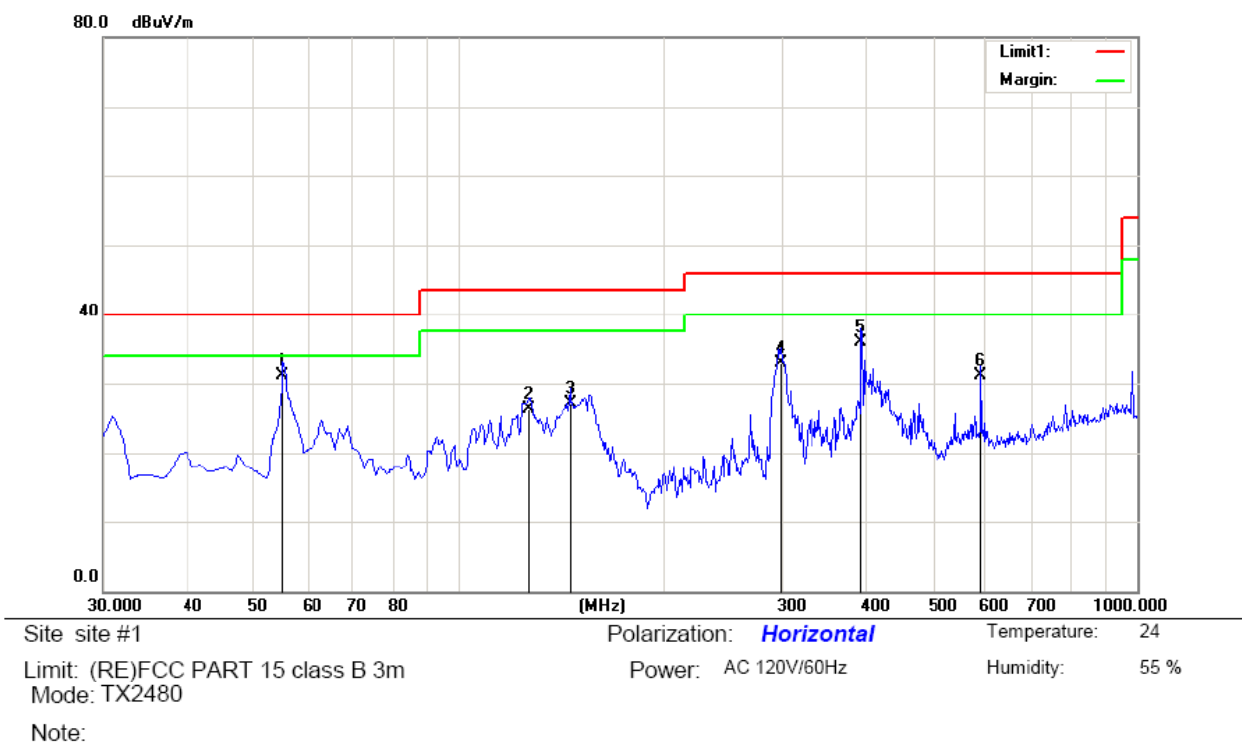


Site site #1 Polarization: **Vertical** Temperature: 24
 Limit: (RE)FCC PART 15 class B 3m Power: AC 120V/60Hz Humidity: 55 %
 Mode: TX2441
 Note:

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		30.0000	48.64	-15.15	33.49	40.00	-6.51		0	
2	*	50.3700	49.67	-15.58	34.09	40.00	-5.91		0	
3		77.5300	54.06	-22.60	31.46	40.00	-8.54		0	
4		120.2100	53.26	-16.93	36.33	43.50	-7.17		0	
5		147.4036	52.33	-17.56	34.77	43.50	-8.73		0	
6		589.6900	48.05	-8.54	39.51	46.00	-6.49		0	

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

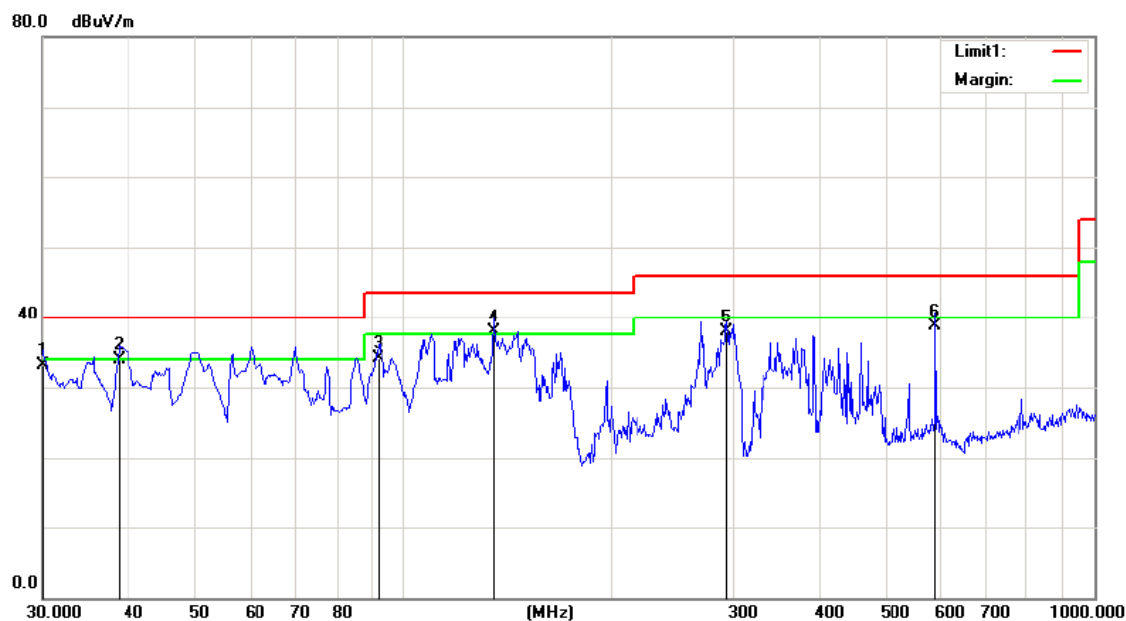
Operator: John



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	*	55.2200	48.48	-17.46	31.02	40.00	-8.98	QP	0	
2		127.0000	42.64	-16.34	26.30	43.50	-17.20	QP	0	
3		146.4000	44.67	-17.48	27.19	43.50	-16.31	QP	0	
4		298.6900	47.35	-14.42	32.93	46.00	-13.07	QP	0	
5		392.7800	47.40	-11.58	35.82	46.00	-10.18	QP	0	
6		589.6900	39.64	-8.54	31.10	46.00	-14.90	QP	0	

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

Operator: John



Site site #1

Polarization: Vertical

Temperature: 24

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

Power: AC 120V/60Hz

Humidity: 55 %

Mode: TX2480

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		30.0000	48.25	-15.15	33.10	40.00	-6.90	QP		0
2		38.7300	47.61	-13.77	33.84	40.00	-6.16	QP		0
3		92.0800	54.54	-20.52	34.02	43.50	-9.48	QP		0
4	*	134.7600	54.40	-16.49	37.91	43.50	-5.59	QP		0
5		293.8400	52.64	-14.67	37.97	46.00	-8.03	QP		0
6		589.6900	47.26	-8.54	38.72	46.00	-7.28	QP		0

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

Operator: John

Above 1000MHz

Worst Operation Mode: GFSK (CH1: 2402MHz) Test Date : August 25, 2015
 Frequency Range: 1-25GHz Temperature : 25 °C
 Test Result: PASS Humidity : 50 %
 Measured Distance: 3m Test By: Andy
 Test Voltage: AC 120V/60Hz

Freq. (MHz)	Ant. Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
		PK	AV	PK	AV	PK	AV
4804	V	66.02	45.35	74	54	-7.98	-8.65
7206	V	65.15	44.15	74	54	-8.85	-9.85
9608	V	64.35	43.05	74	54	-9.65	-10.95
12010	V	63.28	42.27	74	54	-10.72	-11.73
14412	V	62.75	41.62	74	54	-11.25	-12.38
16814	V	60.75	40.25	74	54	-13.25	-13.75
4804	H	65.36	44.35	74	54	-8.64	-9.65
7206	H	64.25	43.25	74	54	-9.75	-10.75
9608	H	63.59	42.1	74	54	-10.41	-11.9
12010	H	62.48	41.05	74	54	-11.52	-12.95
14412	H	61.05	40.9	74	54	-12.95	-13.1
16814	H	60.25	38.45	74	54	-13.75	-15.55

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) The results of worst cased (GFSK) was recorded.

Worst Operation Mode: GFSK (CH40: 2441MHz) Test Date : August 25, 2015
 Frequency Range: 1-25GHz Temperature : 25 °C
 Test Result: PASS Humidity : 50 %
 Measured Distance: 3m Test By: Andy
 Test Voltage: AC 120V/60Hz

Freq. (MHz)	Ant. Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
		PK	AV	PK	AV	PK	AV
4882	V	65.36	45.35	74	54	-8.64	-8.65
7323	V	64.25	44.15	74	54	-9.75	-9.85
9764	V	63.15	43.25	74	54	-10.85	-10.75
12205	V	62.04	42.01	74	54	-11.96	-11.99
14646	V	61.27	41.2	74	54	-12.73	-12.8
17087	V	60.36	39.57	74	54	-13.64	-14.43
4882	H	64.25	44.15	74	54	-9.75	-9.85
7323	H	63.24	43.62	74	54	-10.76	-10.38
9764	H	62.01	42.01	74	54	-11.99	-11.99
12205	H	61.74	41.27	74	54	-12.26	-12.73
14646	H	60.25	40.25	74	54	-13.75	-13.75
17087	H	59.35	38.46	74	54	-14.65	-15.54

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) The results of worst cased (GFSK) was recorded.

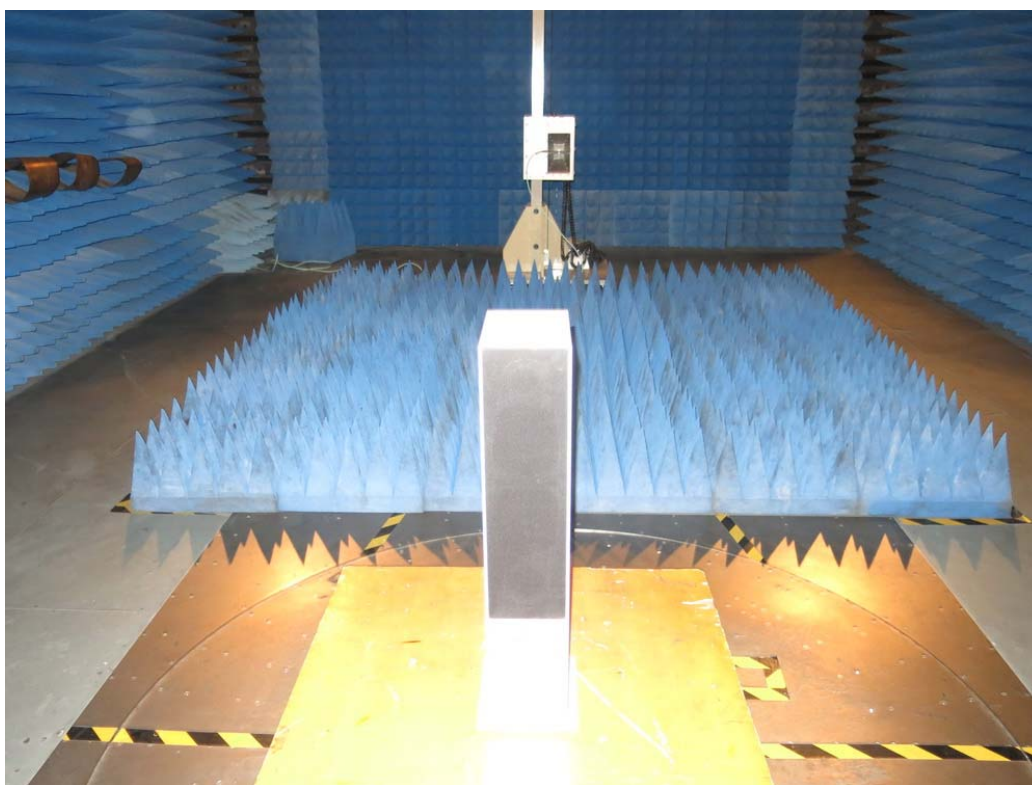
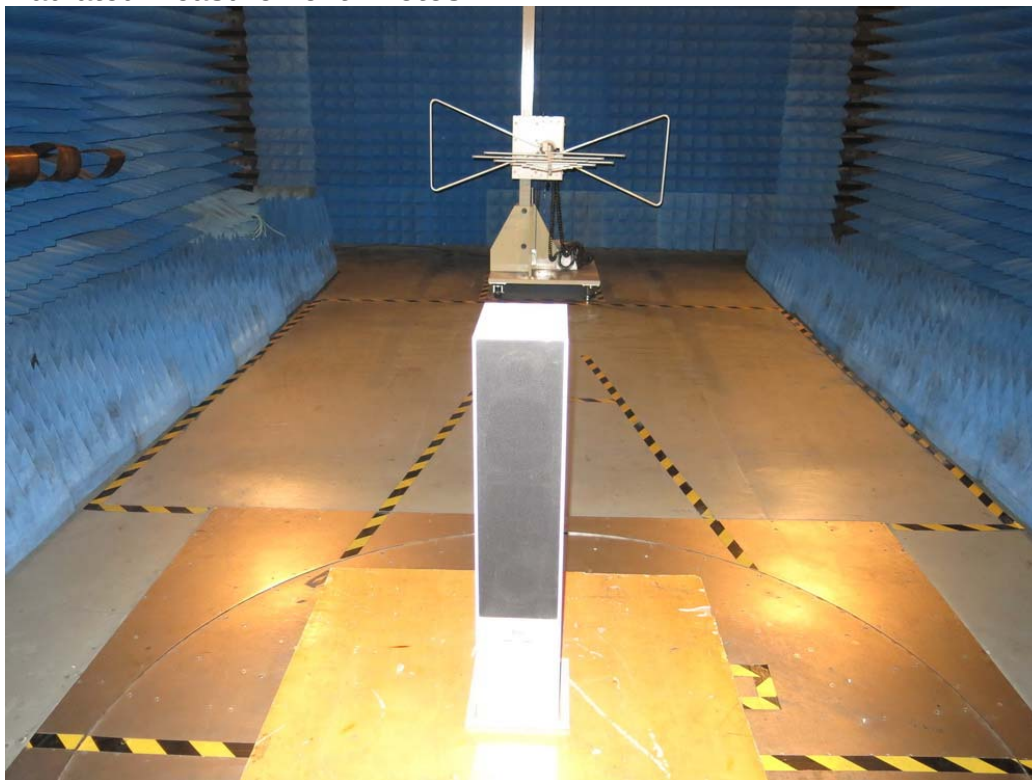
Worst Operation Mode: GFSK (CH79: 2480MHz) Test Date : August 25, 2015
Frequency Range: 1-25GHz Temperature : 25 °C
Test Result: PASS Humidity : 50 %
Measured Distance: 3m Test By: Andy
Test Voltage: AC 120V/60Hz

Freq. (MHz)	Ant. Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
		PK	AV	PK	AV	PK	AV
4960	V	65	45.35	74	54	-9	-8.65
7440	V	64.25	44.15	74	54	-9.75	-9.85
9920	V	63.15	42.05	74	54	-10.85	-11.95
12400	V	62.05	41.92	74	54	-11.95	-12.08
14880	V	61.24	40.27	74	54	-12.76	-13.73
17360	V	60.26	38.45	74	54	-13.74	-15.55
4960	H	65.3	44.15	74	54	-8.7	-9.85
7440	H	64.35	43	74	54	-9.65	-11
9920	H	63.2	42.17	74	54	-10.8	-11.83
12400	H	62.04	41.05	74	54	-11.96	-12.95
14880	H	60.25	40.39	74	54	-13.75	-13.61
17360	H	59.35	38.45	74	54	-14.65	-15.55

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) The results of worst cased (GFSK) was recorded.

7.5 Radiated Measurement Photos:

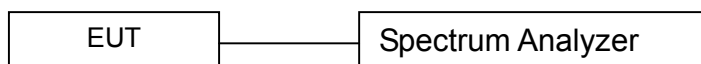


8. Channel Separation test

8.1 Measurement Procedure

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

8.2 Test SET-UP (Block Diagram of Configuration)



8.3 Measurement Equipment Used:

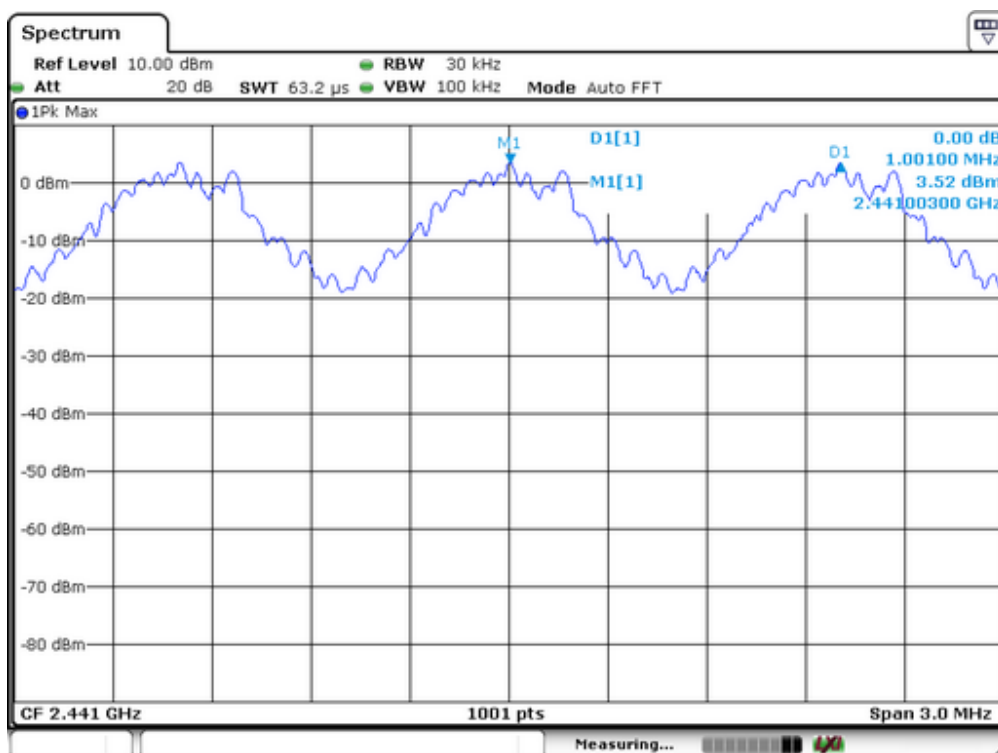
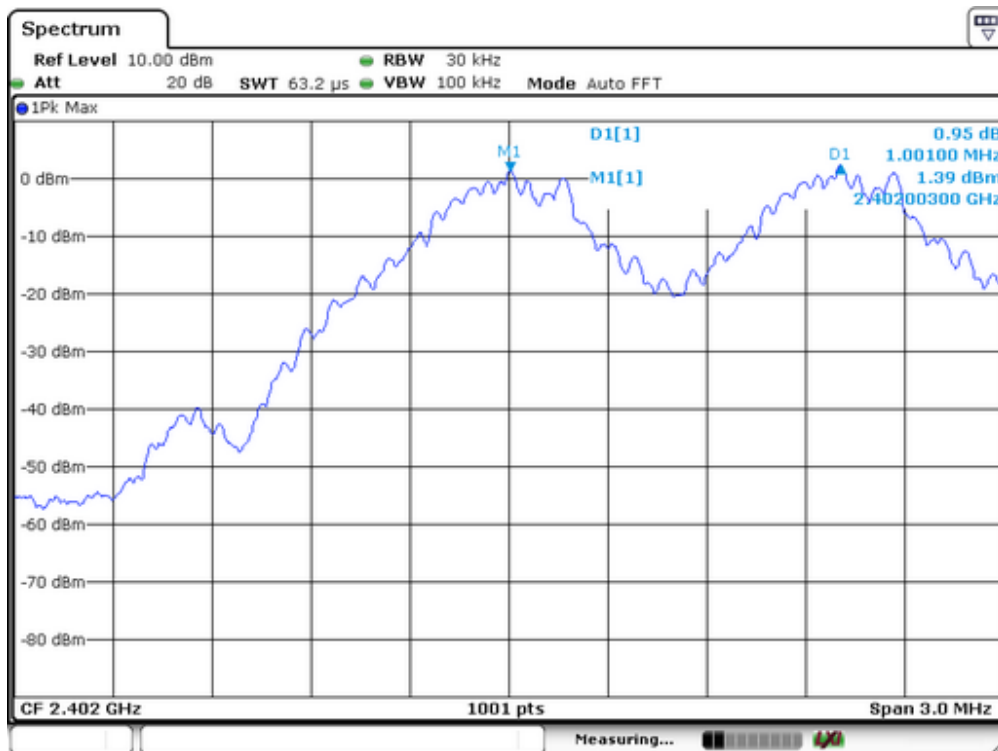
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

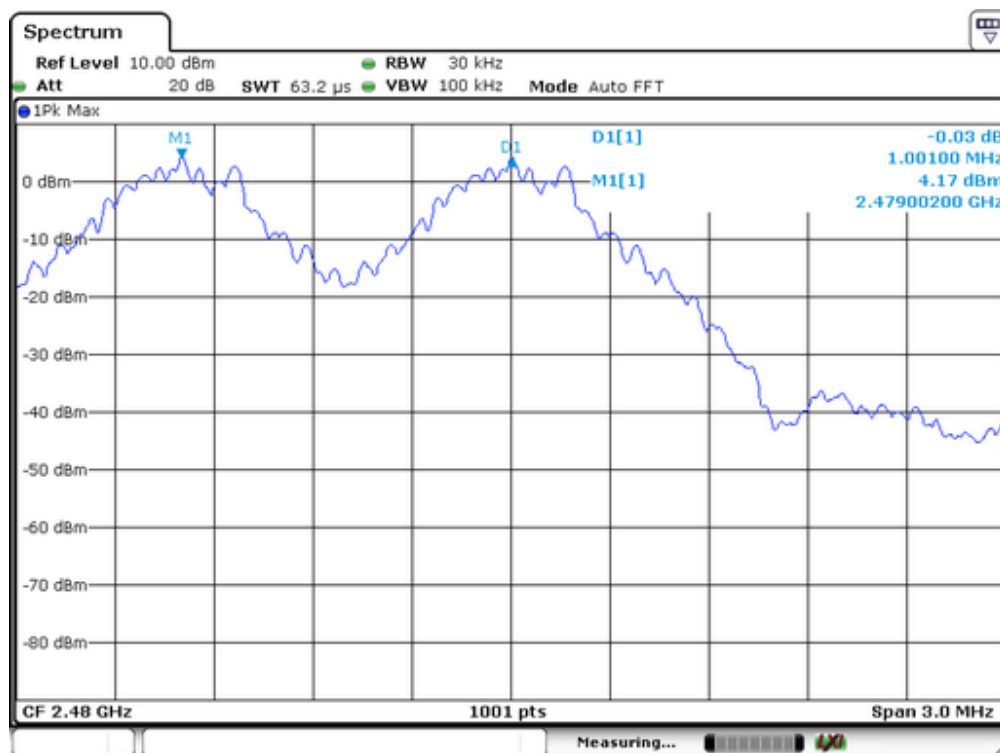
8.4 Measurement Results:

Refer to attached data chart.

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

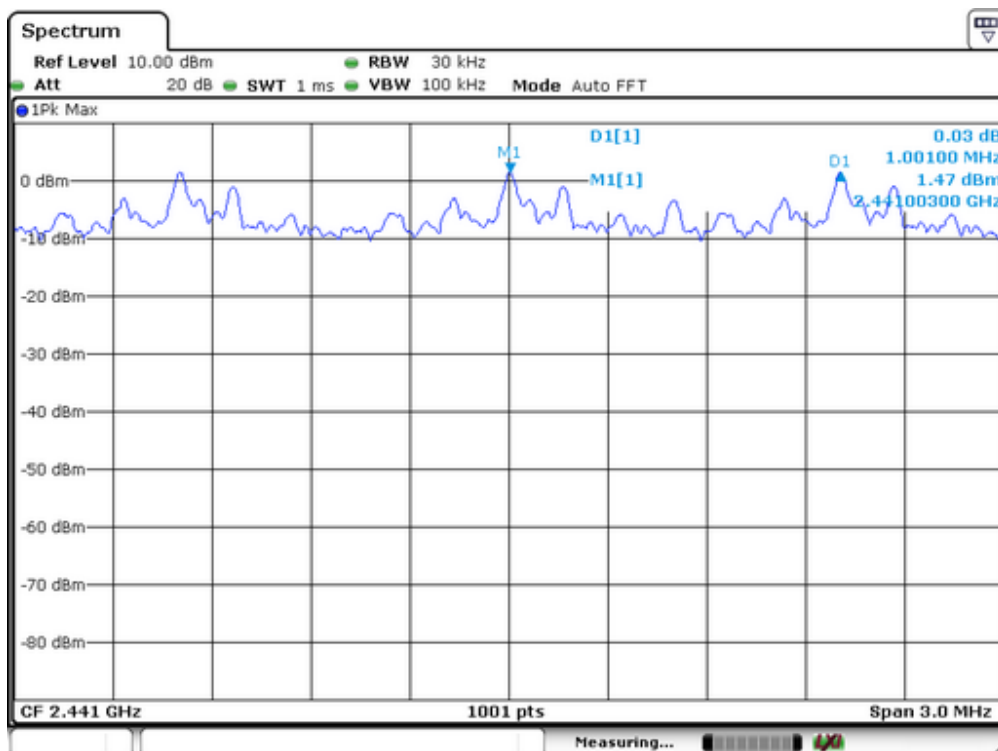
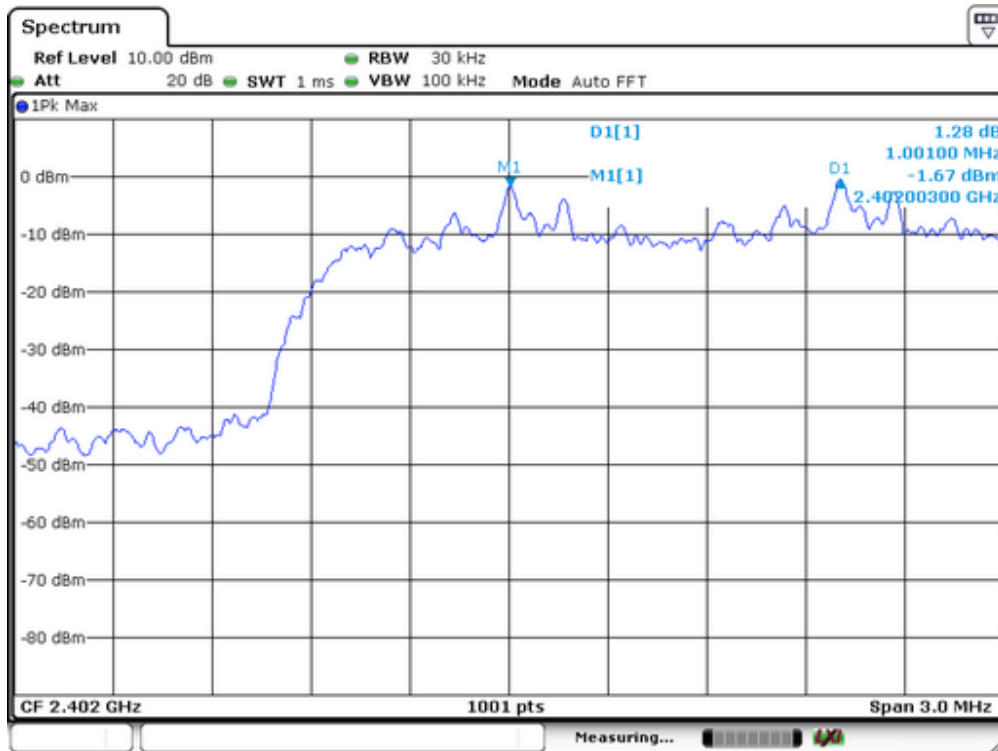
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit (kHz)
1	2402	1001	>839
40	2441	1001	>821
79	2480	1001	>821

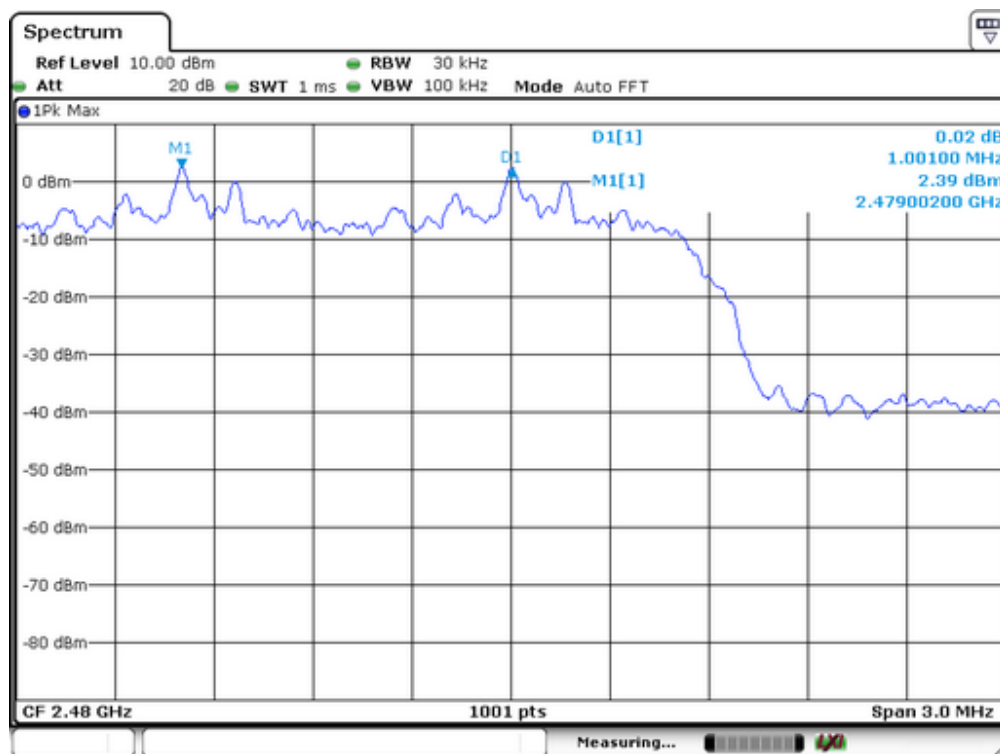




Spectrum Detector:	PK	Test Date :	August 25, 2015
Test By:	Andy	Temperature :	24°C
Test Result:	PASS	Humidity :	53 %
Modulation:	$\pi/4$ -DQPSK		

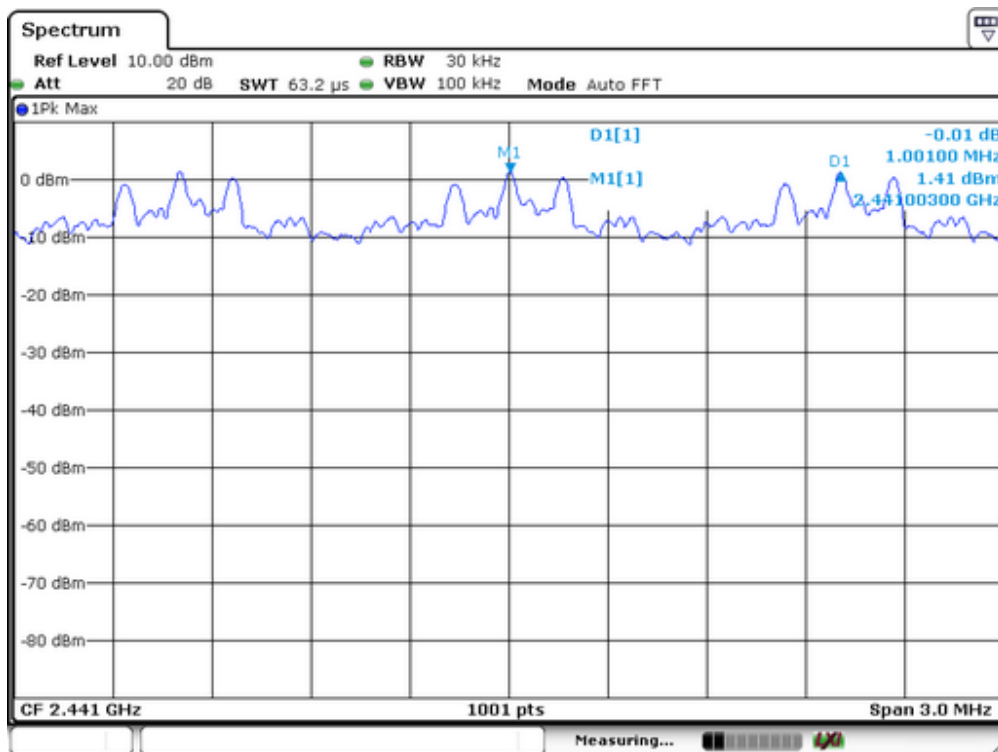
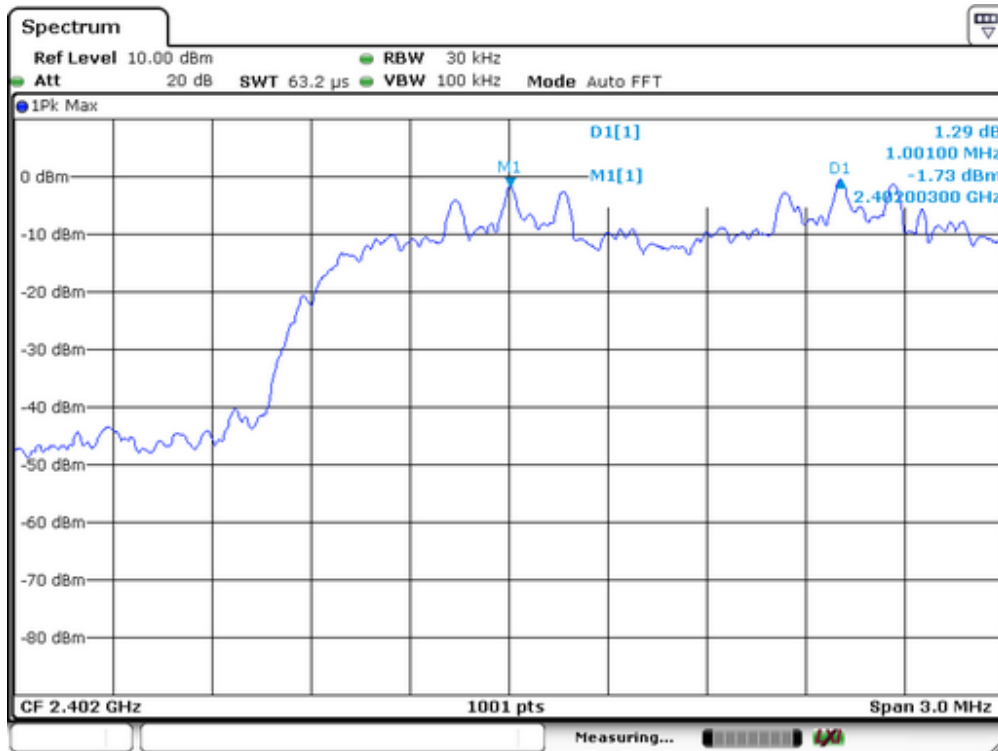
Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	1001	>845
40	2441	1001	>823
79	2480	1001	>825

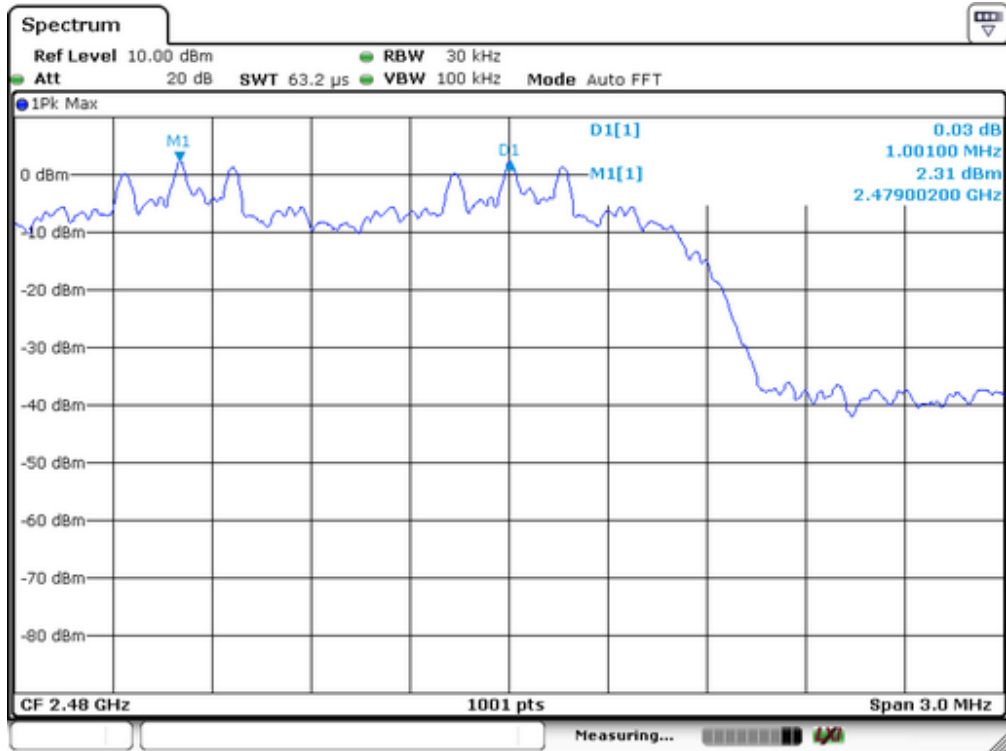




Spectrum Detector:	PK	Test Date :	August 25, 2015
Test By:	Andy	Temperature :	24°C
Test Result:	PASS	Humidity :	53 %
Modulation:	8DPSK		

Channel number	Channel frequency (MHz)	Separation Read Value (kHz)	Separation Limit 2/3 20dB Down BW(kHz)
1	2402	1001	>817
40	2441	1001	>837
79	2480	1001	>839



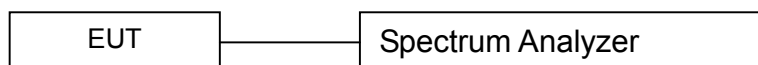


9. 20dB Bandwidth test

9.1 Measurement Procedure

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

9.2 Test SET-UP (Block Diagram of Configuration)



9.3 Measurement Equipment Used:

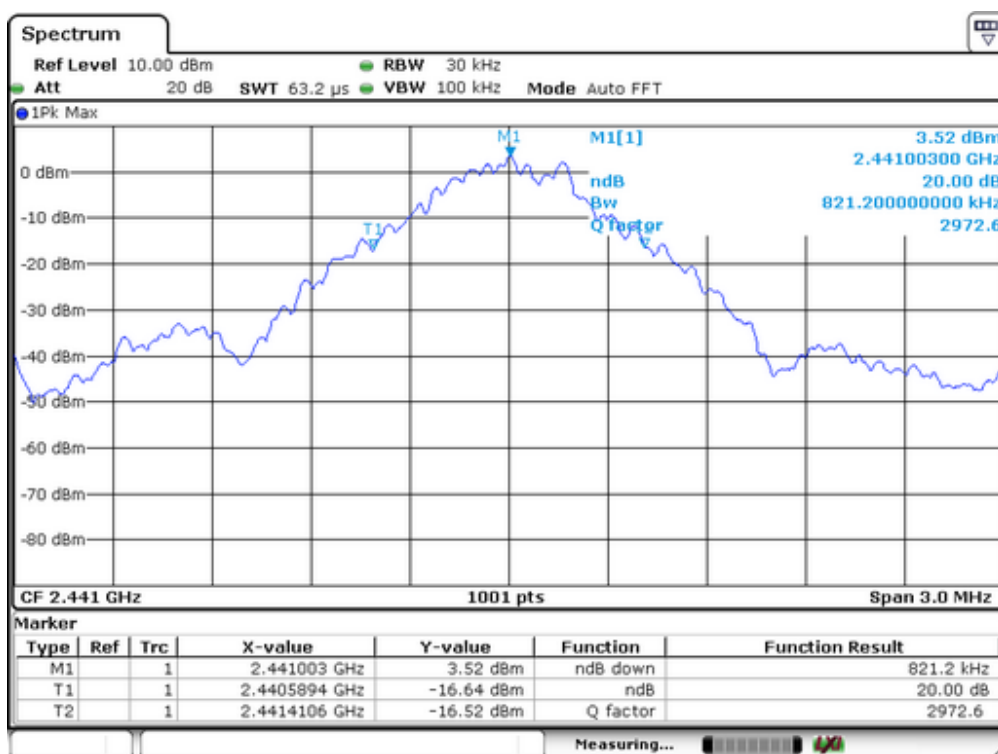
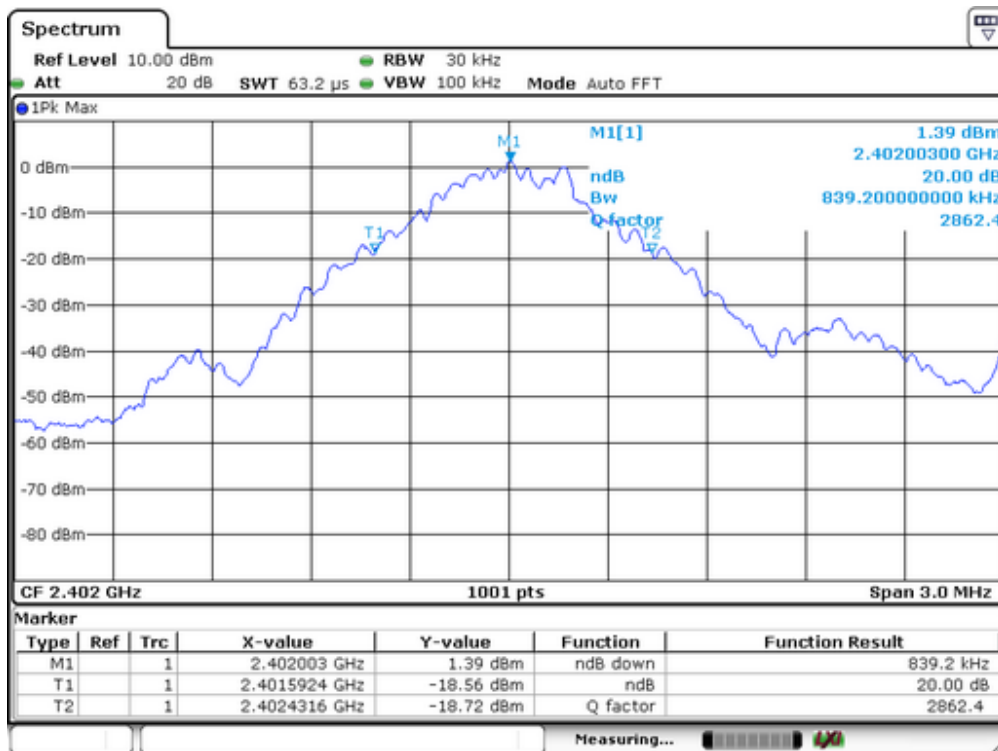
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

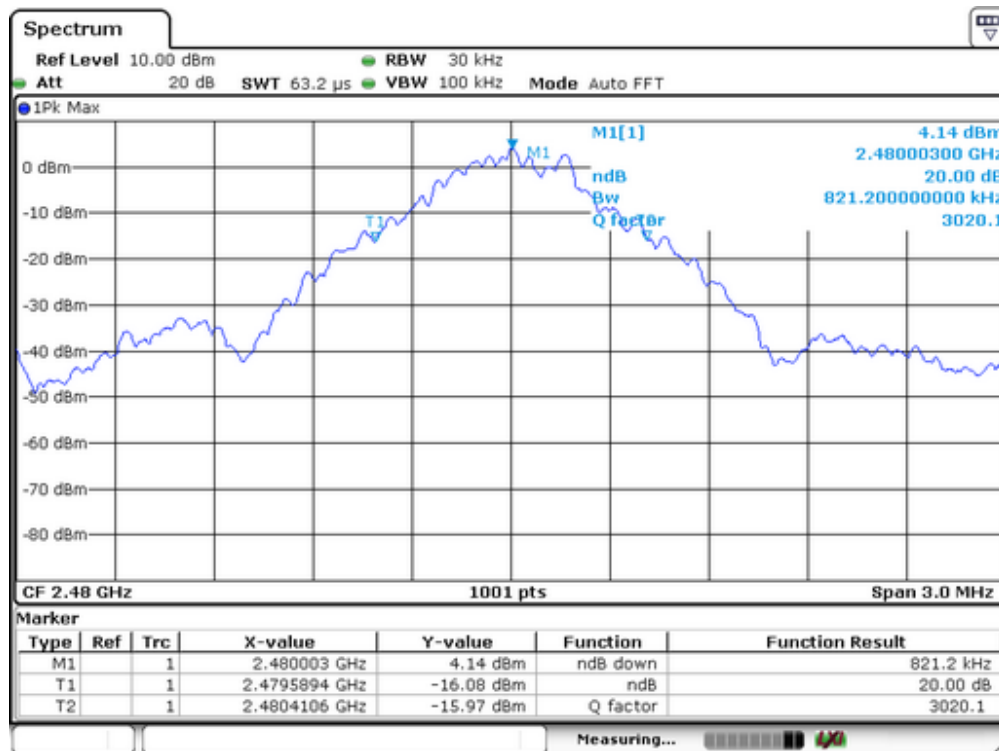
9.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	August 25, 2015
Test By:	Andy	Temperature :	24°C
Test Result:	PASS	Humidity :	53 %
Modulation:	GFSK		

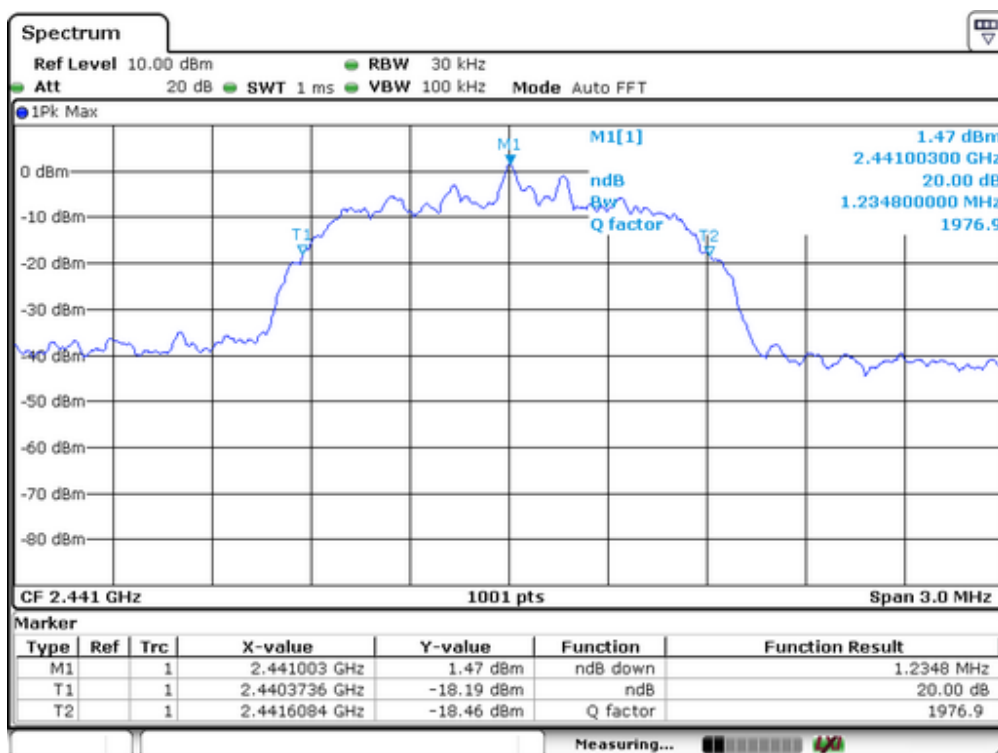
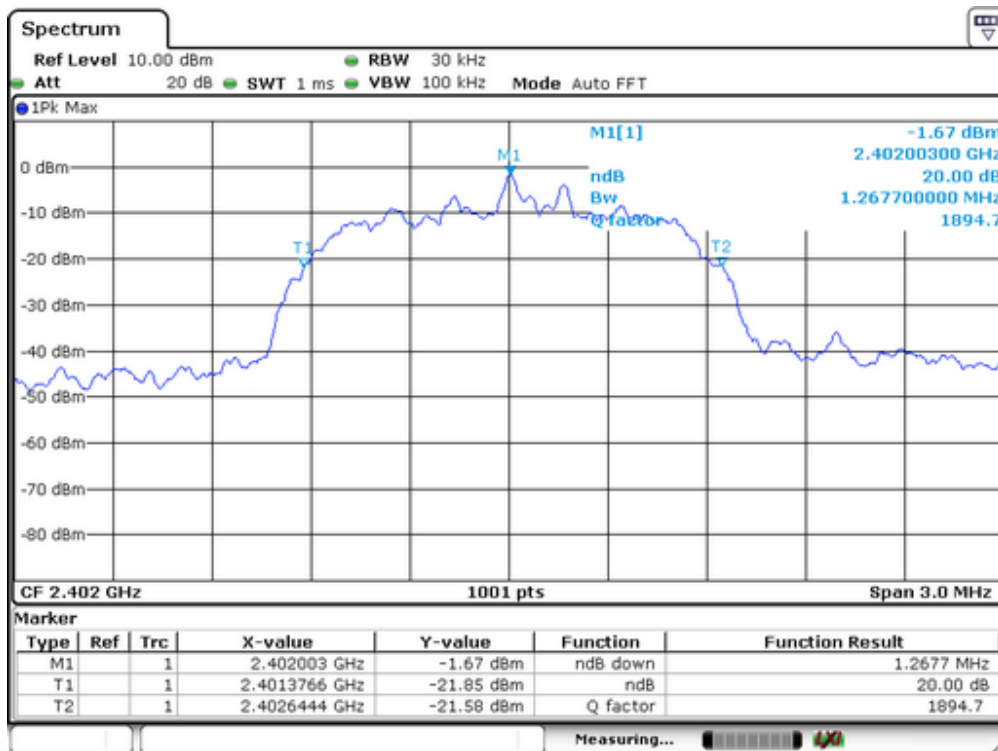
Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	839
40	2441	821
79	2480	821

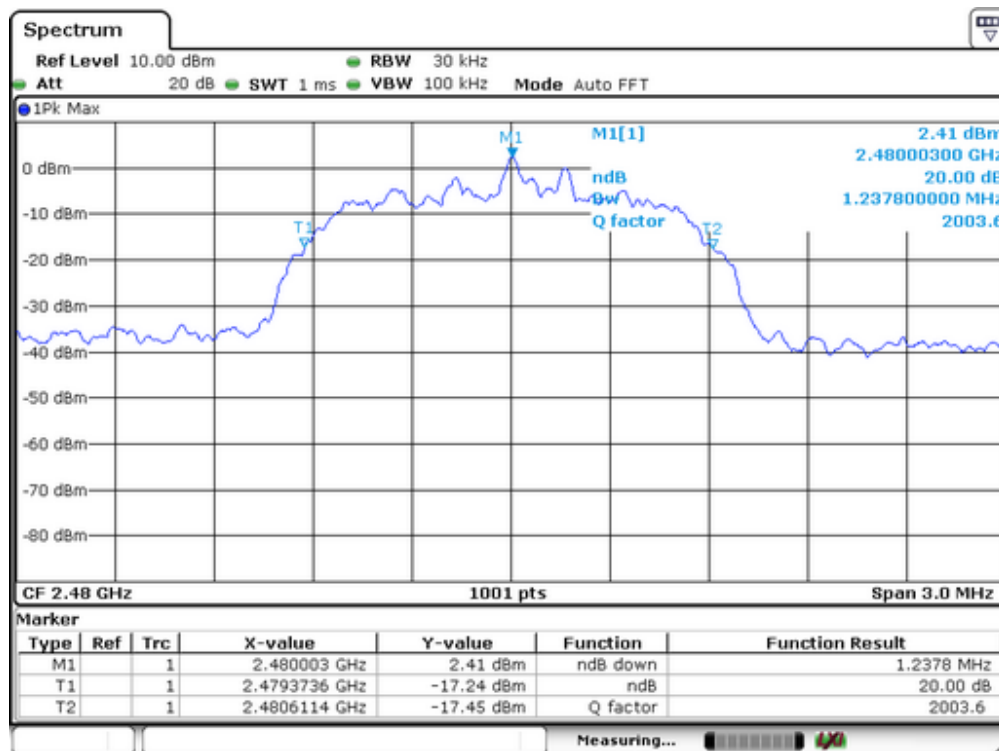




Spectrum Detector: PK Test Date : August 25, 2015
 Test By: Andy Temperature : 24°C
 Test Result: PASS Humidity : 53 %
 Modulation: $\pi/4$ -DQPSK

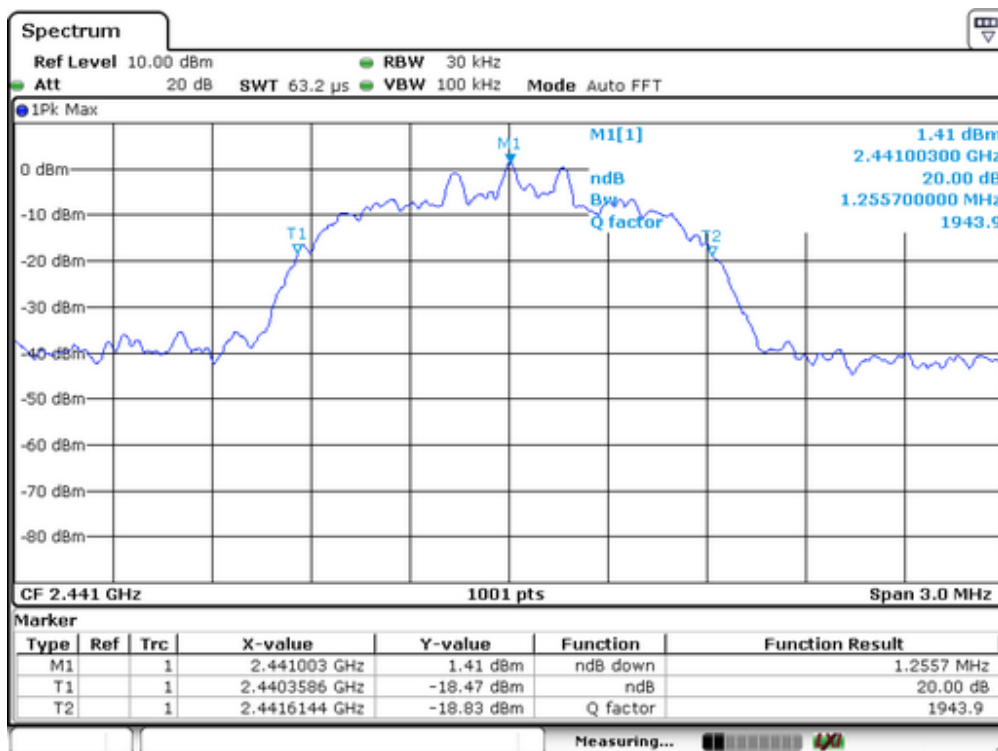
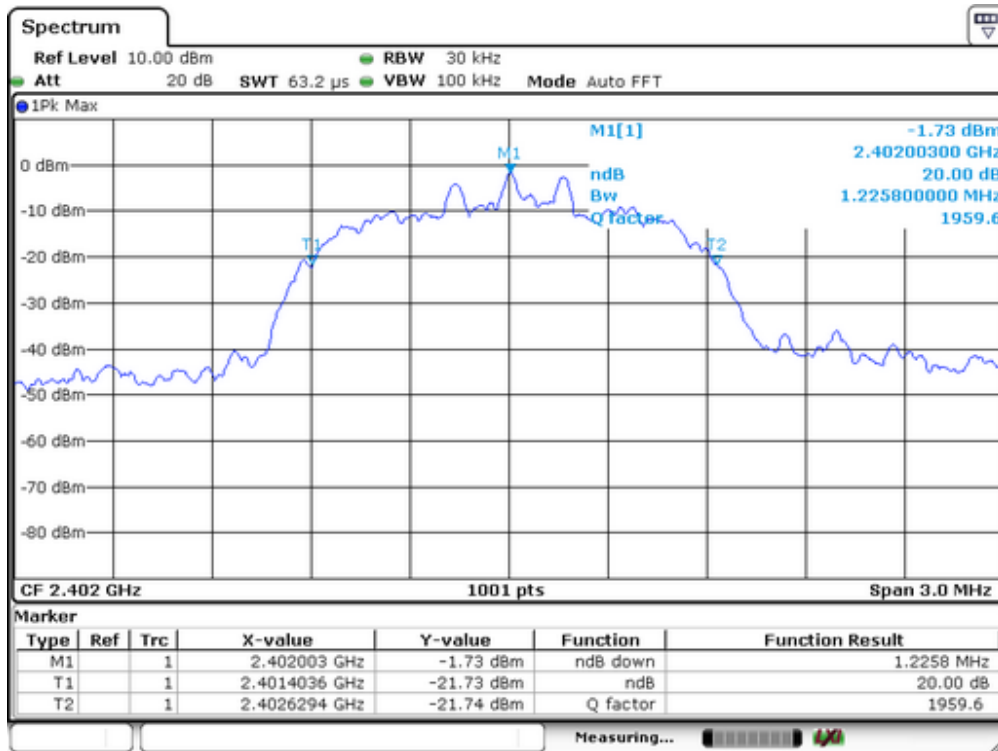
Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1268
40	2441	1235
79	2480	1238

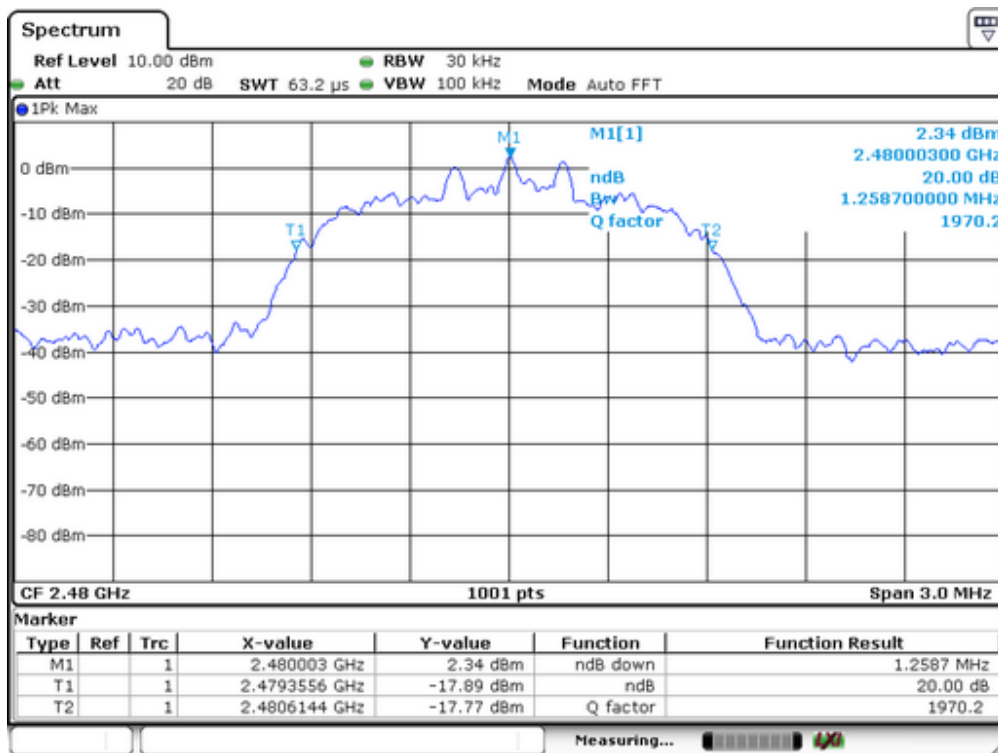




Spectrum Detector:	PK	Test Date :	August 25, 2015
Test By:	Andy	Temperature :	24 °C
Test Result:	PASS	Humidity :	53 %
Modulation:	8DPSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)
1	2402	1226
40	2441	1256
79	2480	1259



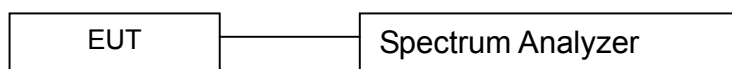


10. Quantity of Hopping Channel Test

10.1 Measurement Procedure

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

10.2 Test SET-UP (Block Diagram of Configuration)



10.3 Measurement Equipment Used:

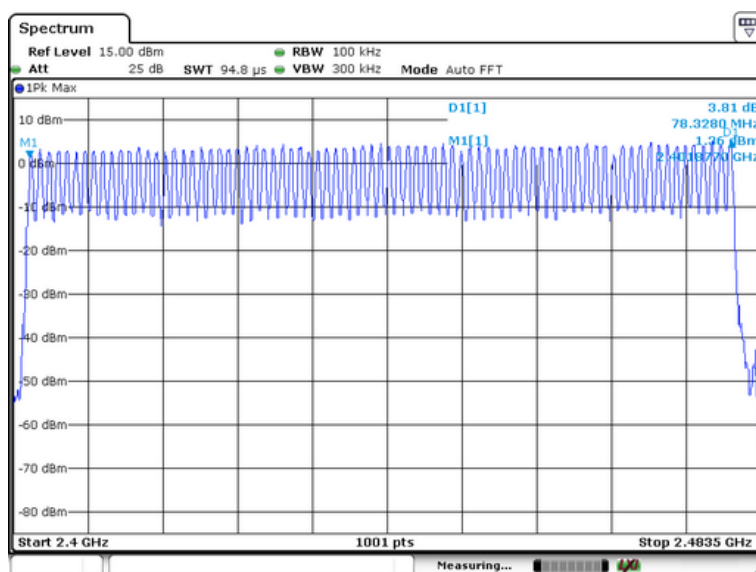
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

10.4 Measurement Results:

Refer to attached data chart.

Worst Test Mode	GFSK	Test Date :	August 25, 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



11. Time of Occupancy (Dwell Time) test

11.1 Test Description

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

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

with:

- hop rate = $1600 * 1/\text{s}$ for DH1 packets = 1600 s^{-1}
- hop rate = $1600/3 * 1/\text{s}$ for DH3 packets = 533.33 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.

11.2 Test Requirements / Limits

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

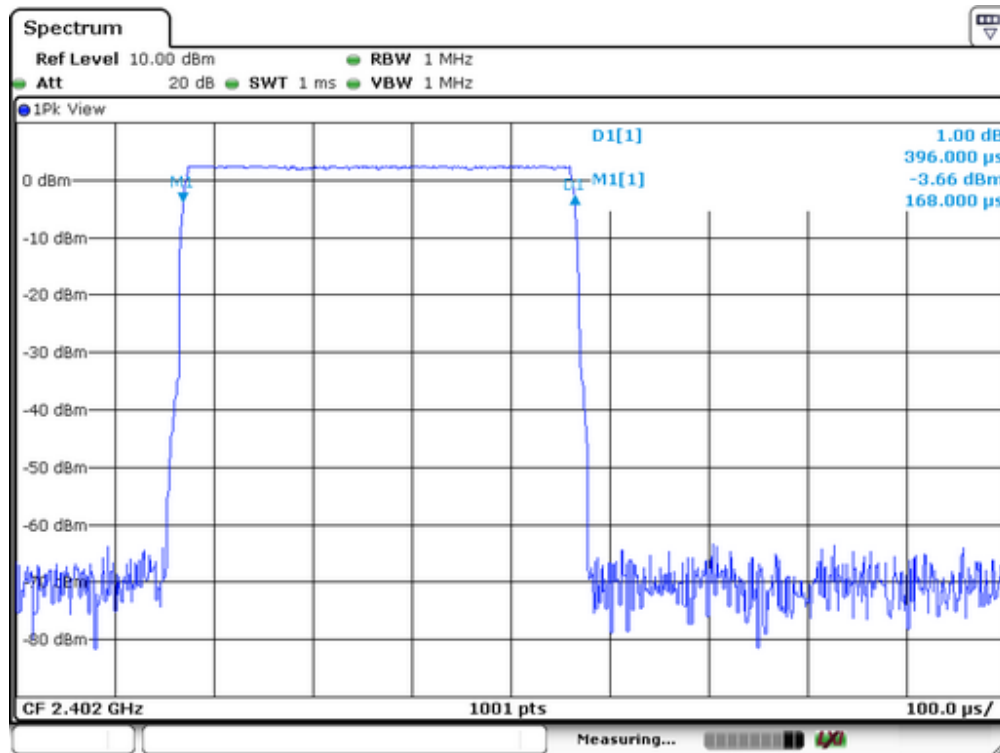
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Since the Bluetooth technology uses 79 channels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

11.3 Test result

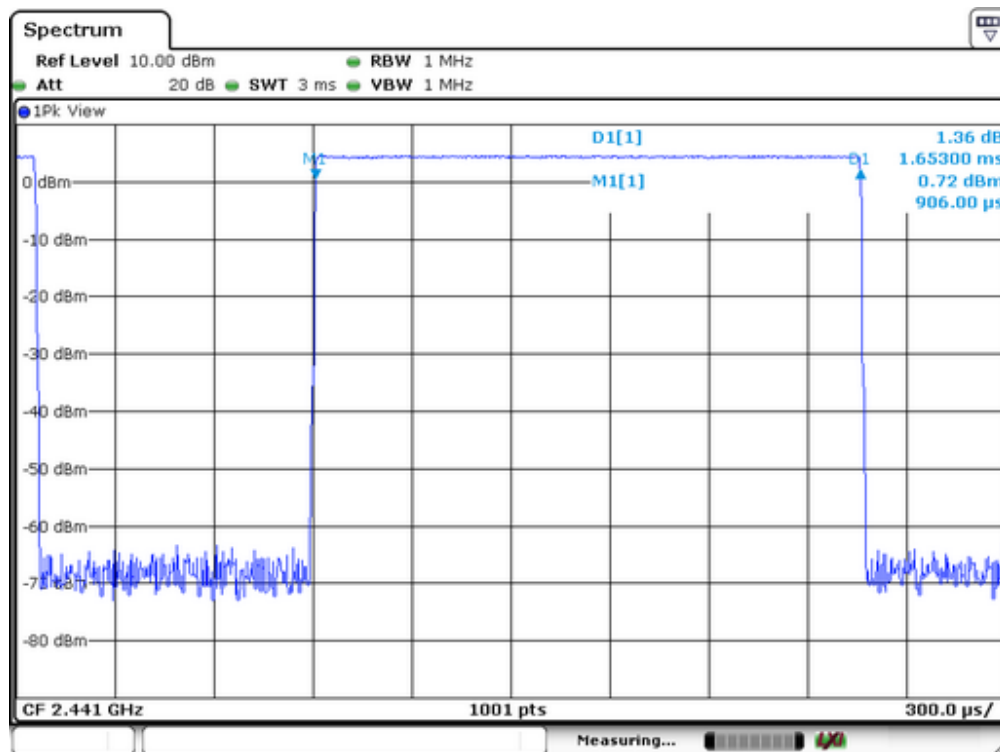
Mode	Number of transmission in a 31.6(79 Hopping*0.4)	Length of transmissions time(msec)	Result (msec)	Limit (msec)
DH1	$1600/(2*79) \times 31.6 = 320$	0.396	126.72	400
DH3	$1600/(4*79) \times 31.6 = 160$	1.653	264.48	400
DH5	$1600/(6*79) \times 31.6 = 106.67$	2.905	309.87	400

Remark: The results of worst cased was recorded.

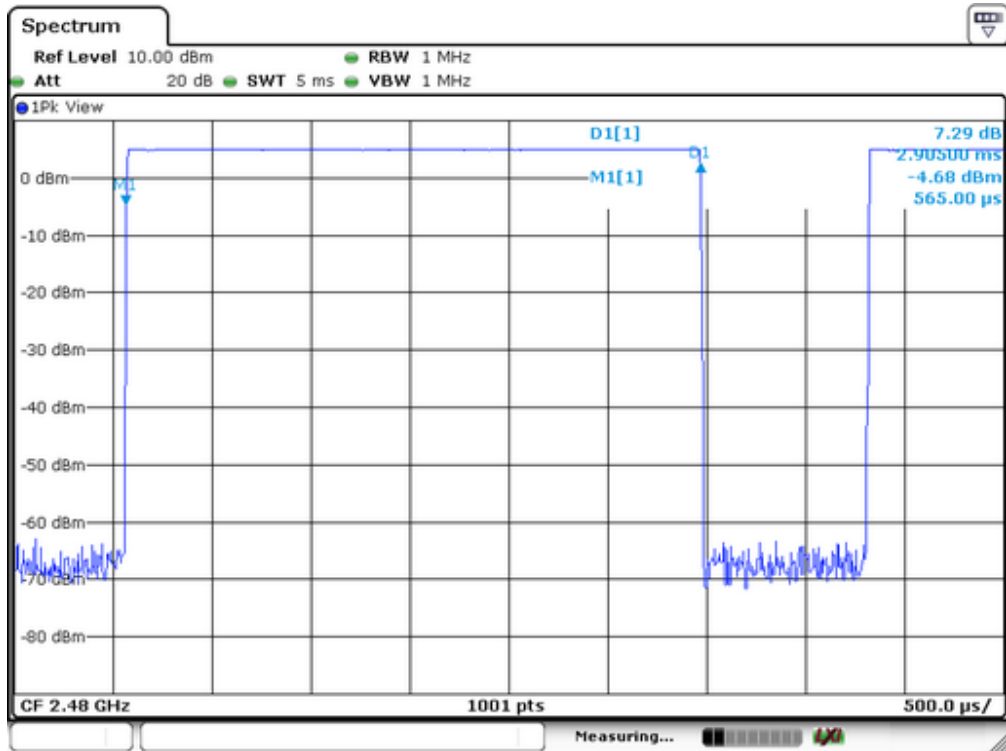
DH1:



DH3:



DH5:

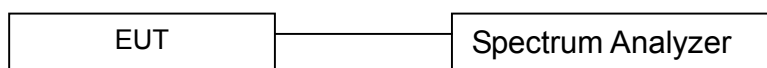


12. MAXIMUM PEAK OUTPUT POWER TEST

12.1 Measurement Procedure

- Check the calibration of the measuring instrument(SA) using either an internal calibrator or a known signal from an external generator.
- 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.
- The center frequency of the spectrum analyzer is set to the fundamental frequency and using proper RBW and VBW setting.
- Measure the captured power within the band and recording the plot.
- Repeat above procedures until all frequencies required were complete.

12.2 Test SET-UP (Block Diagram of Configuration)



12.3 Measurement Equipment Used:

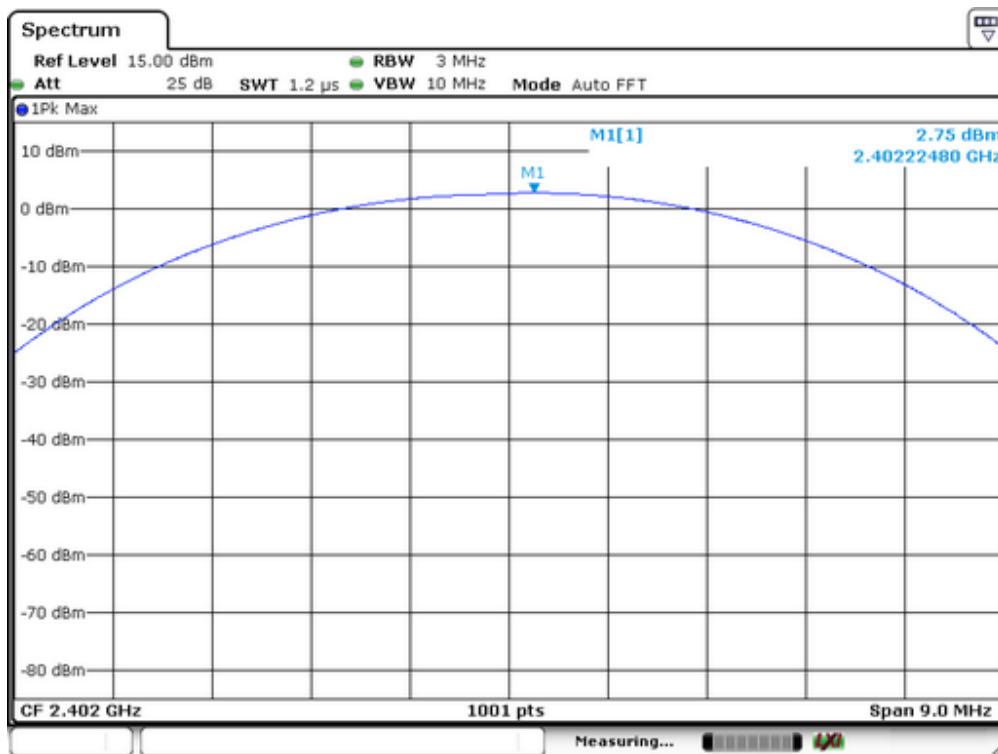
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

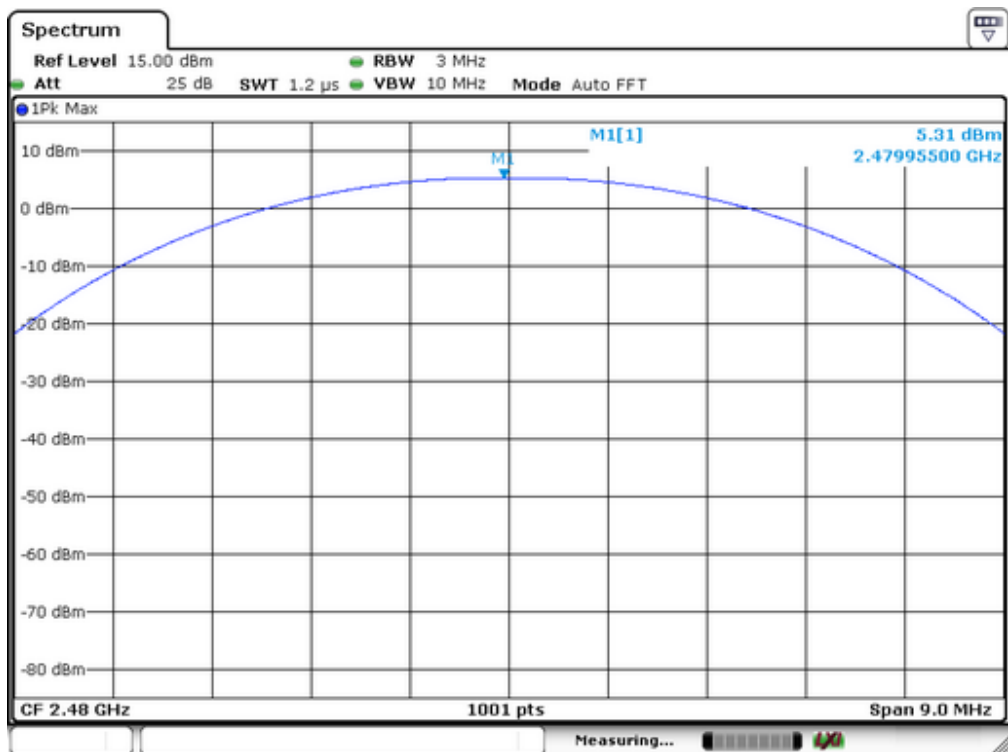
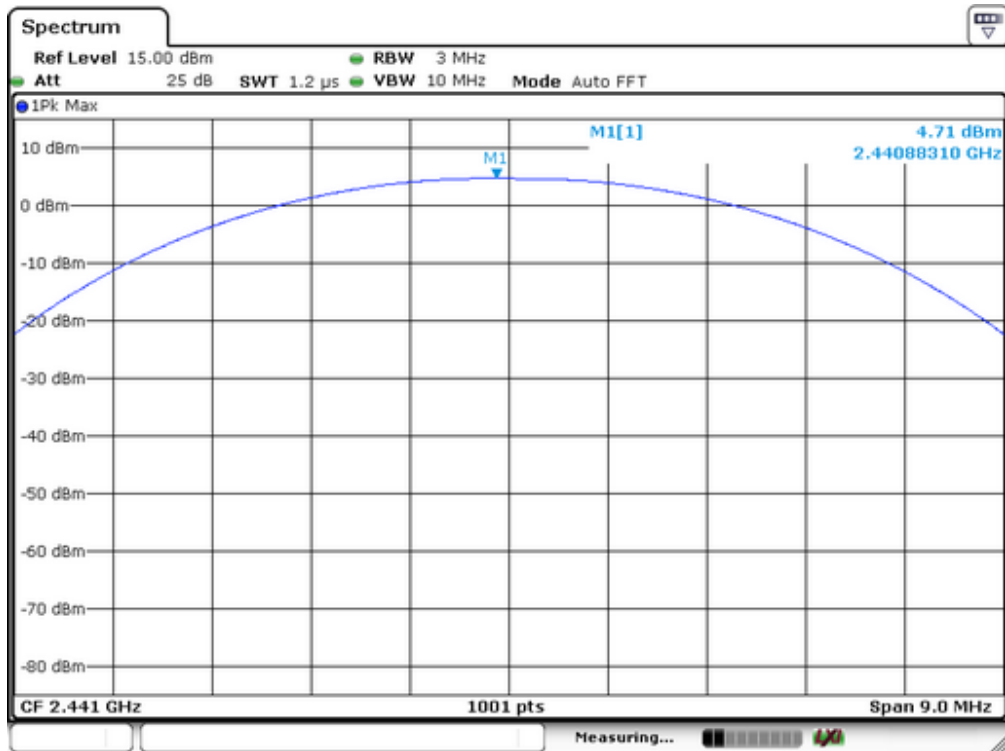
12.4 Measurement Results:

Refer to attached data chart.

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

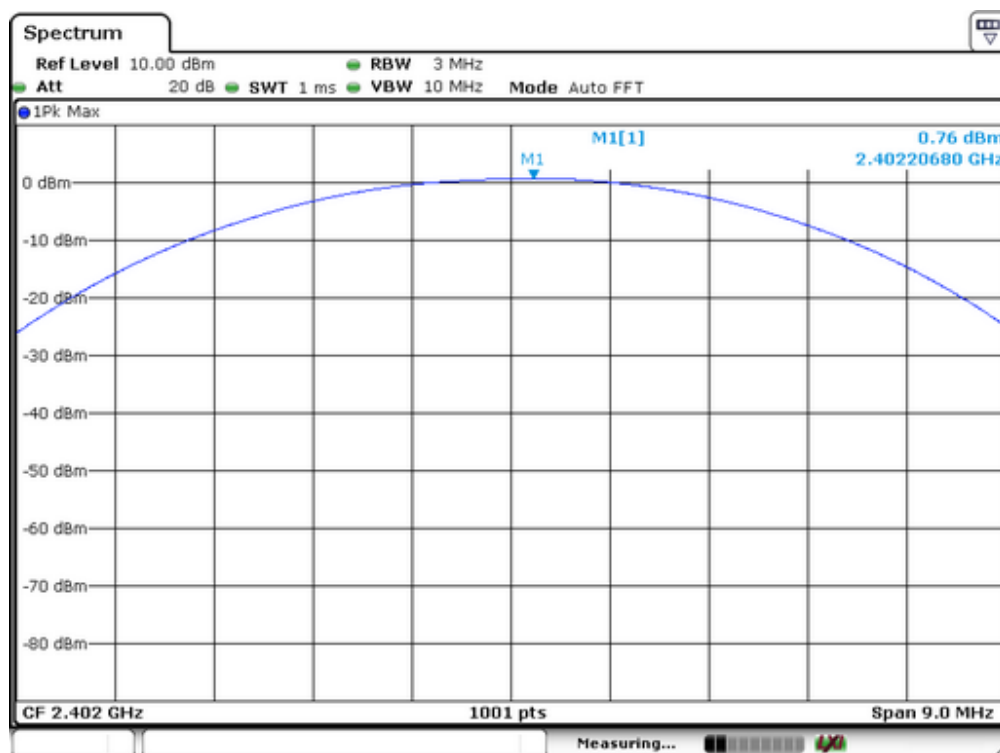
Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	2.75	1.884	1000	PASS
40	2441	4.71	2.958	1000	PASS
79	2480	5.31	3.396	1000	PASS

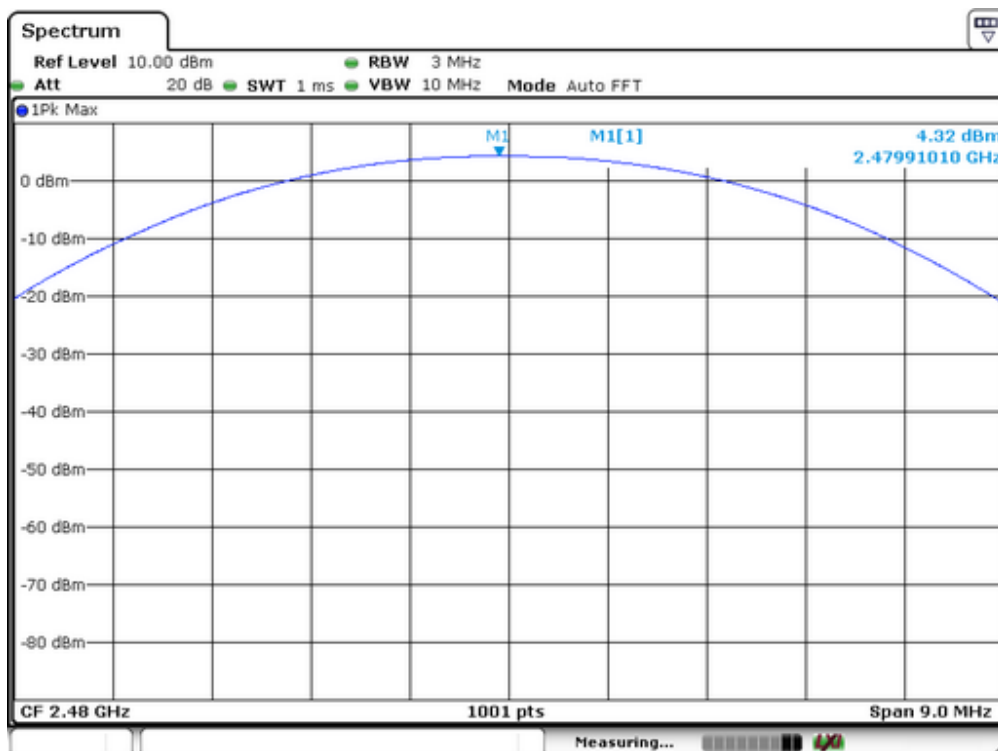
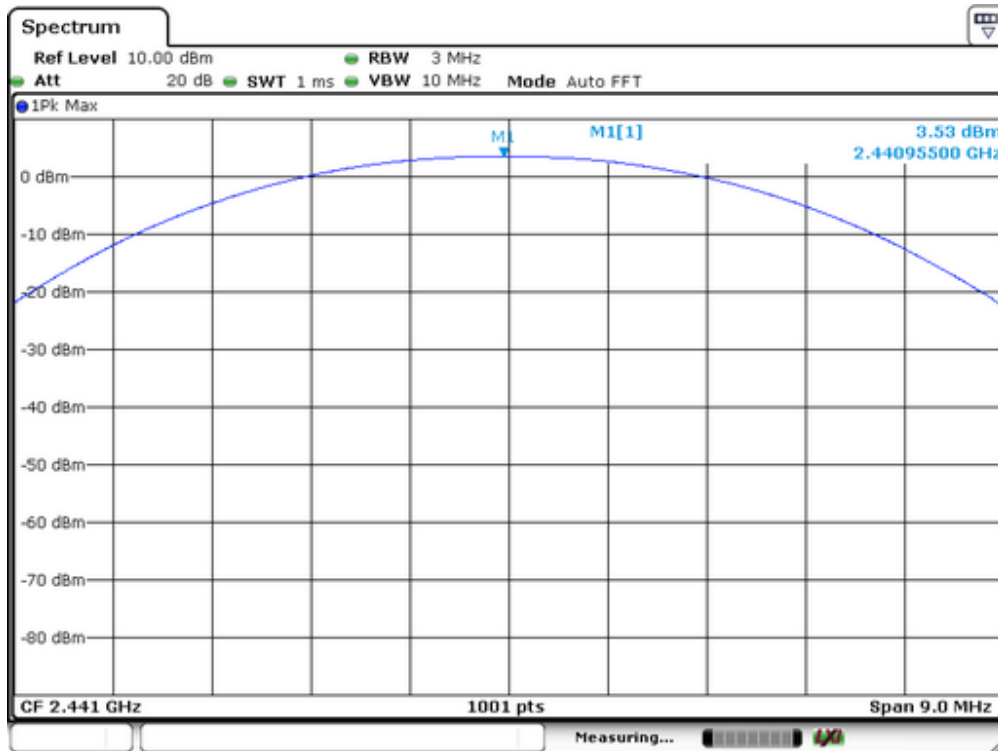




Spectrum Detector:	PK	Test Date :	August 25, 2015
Test By:	Andy	Temperature :	25 °C
Test Result:	PASS	Humidity :	50 %
Modulation:	Π/4-DQPSK		

Channel number	Channel Frequency (MHz)	Peak Power output(dBm)	Peak Power output(mW)	Peak Power Limit(mW)	Pass/Fail
01	2402	0.76	1.191	125	PASS
40	2441	3.53	2.254	125	PASS
79	2480	4.32	2.704	125	PASS

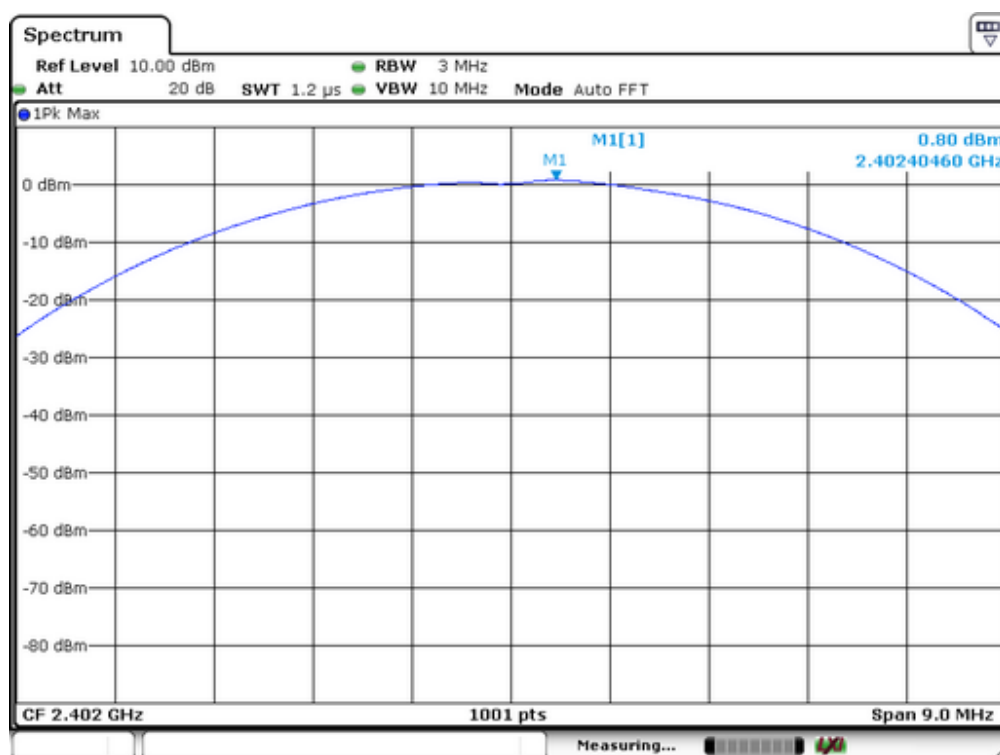


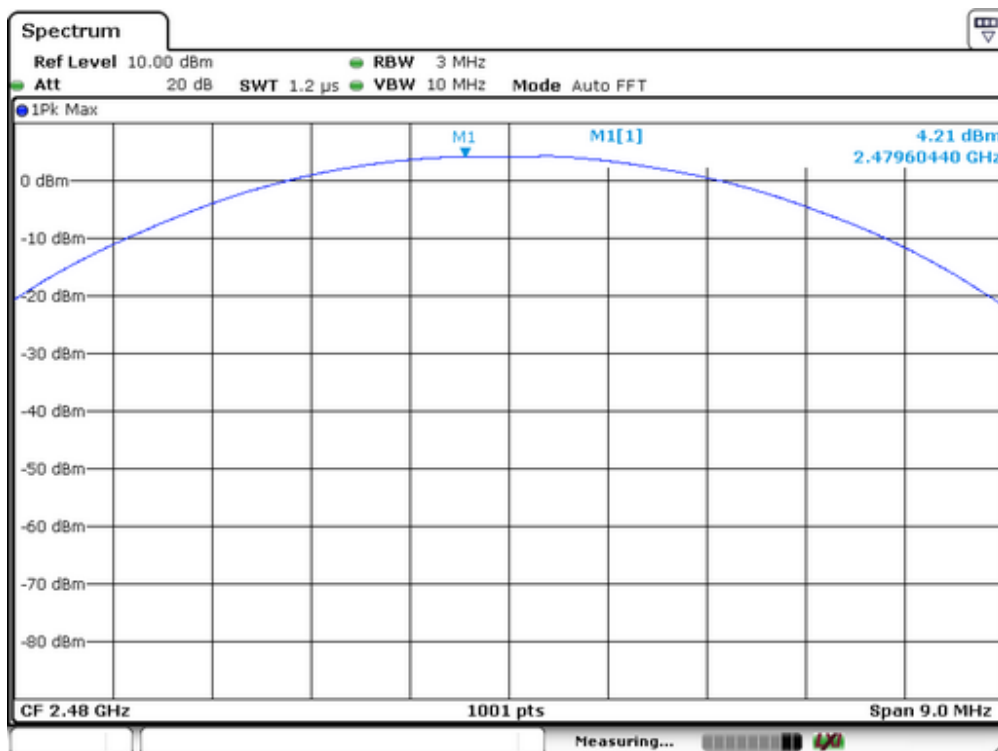
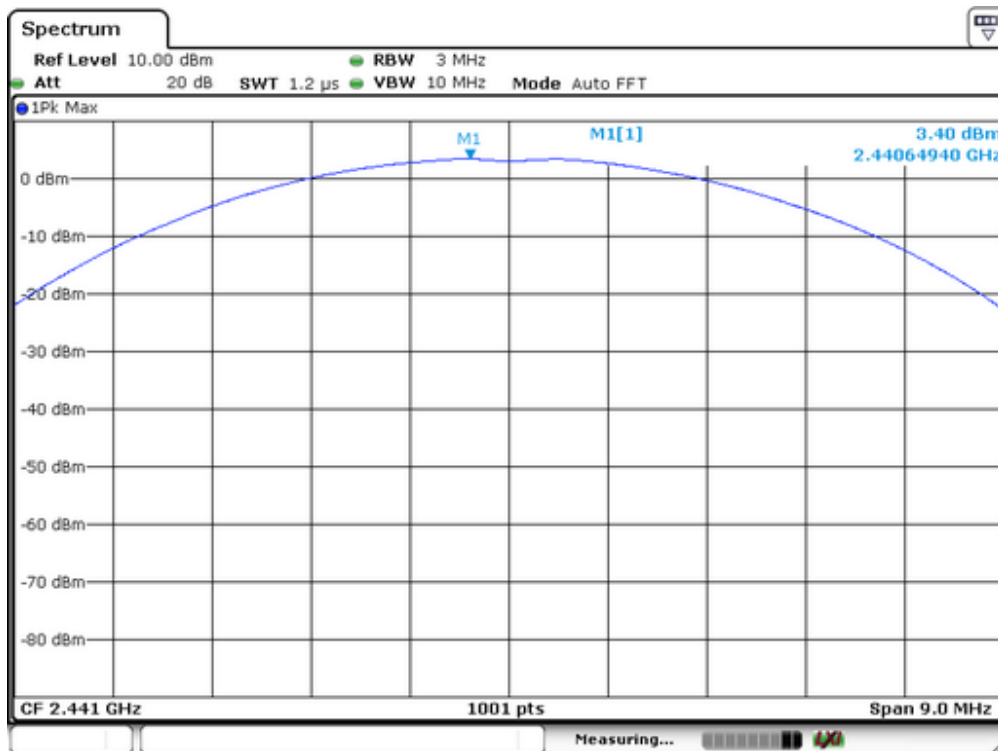


Spectrum Detector: PK
Test By: Andy
Test Result: PASS
Modulation: 8DPSK

Test Date : August 25, 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	0.8	1.202	125	PASS
40	2441	3.4	2.188	125	PASS
79	2480	4.21	2.636	125	PASS





13. Band EDGE test

13.1 Measurement Procedure

1. The EUT was Operating in hopping mode or could be controlled its channel. Printed out test result from the spectrum by hard copy function.
2. The EUT was placed on a turn table which is 0.1m above ground plane.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until all frequency measured were complete.
6. Use the following spectrum analyzer settings:

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:

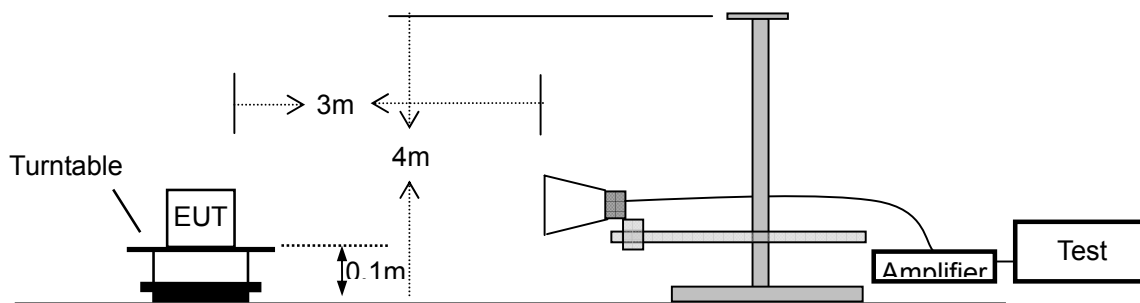
EMI Test Receiver	Setting
Attenuation	Auto
RB	1MHz
VB	10Hz
Detector	Peak
Trace	Max hold

13.2 Test SET-UP (Block Diagram of Configuration)

For Conducted Test



For Radiated emission Test



13.3 Measurement Equipment Used:

For Conducted Test

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSV30	1321.3008K	03/16/2015	03/15/2016
Coaxial Cable	CDS	79254	46107086	03/16/2015	03/15/2016

For Radiated emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1	Signal Analyzer	Rohde & Schwarz	FSV30	103040	12/29/2014	1 Year
2	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1272	12/29/2014	1 Year
3	Power Amplifier	LUNAR EM	LNA1G18-40	J1010000008 1	12/29/2014	1 Year
4	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year
5	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year
6	Cable	H+S	CBL-26	N/A	12/29/2014	1 Year

13.4 Measurement Results:

Refer to attached data chart.

Spectrum Detector:	PK	Test Date :	August 25, 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	2.42	-51.38	53.8	>20dBc
2399.99	pi/4-DQPSK	-0.92	-48.89	47.97	>20dBc
2399.99	8DPSK	-0.84	-49.58	48.74	>20dBc
2483.99	GFSK	5.14	-63.88	69.02	>20dBc
2483.53	pi/4-DQPSK	3.21	-62.05	65.26	>20dBc
2483.73	8DPSK	3.25	-61.7	64.95	>20dBc

For Hopping Mode:

Frequency (MHz)	Modulation	Peak Power Output(dBm)	Emission read Value(dBm)	Result of Band edge(dBc)	Band edge Limit(dBc)
2399.99	GFSK	3.38	-53.46	56.84	>20dBc
2399.99	pi/4-DQPSK	8.47	-5.73	14.2	>20dBc
2399.99	8DPSK	4.52	-54.24	58.76	>20dBc
2484.97	GFSK	5.11	-57.59	62.7	>20dBc
2484.99	pi/4-DQPSK	3.21	-56.63	59.84	>20dBc
2485.14	8DPSK	3.16	-56.88	60.04	>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
2399.89	H	65.03	45.15	74	54	-8.97	-8.85
2398.45	V	60.48	40.28	74	54	-13.52	-13.72
2484.04	H	64.24	44.39	74	54	-9.76	-9.61
2485.16	V	59.38	39.47	74	54	-14.62	-14.53

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
2399.85	H	64.05	45.35	74	54	-9.95	-8.65
2398.35	V	59.35	40.36	74	54	-14.65	-13.64
2485.15	H	63.15	44.15	74	54	-10.85	-9.85
2483.95	V	58.75	39.25	74	54	-15.25	-14.75

14. Antenna Application

14.1 Antenna requirement

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

FCC part 15C section 15.247 requirements:

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

14.2 Result

The EUT's antenna, permanent attached antenna, used a PCB antenna and integrated on PCB, The antenna's gain is 0 dBi and meets the requirement.

APPENDIX I (Photos of EUT)



