FCC Test Report (Bluetooth)

FCC ID	:	**A8IVOOMBOX-TRAVEL**
Applicant	:	Shenzhen DIVOOM Technology Co., Ltd. 1506 Block C, Tiley Central Plaza, Nanshan District, Shenzhen, Guangdong, China
Sample Description		
Product Name	:	**Rugged Portable Bluetooth Speaker**
Model No.	:	Voombox-Travel
Serial No.	:	N/A
Trademark	:	DIVOOM
Receipt Date	:	2014-04-01
Test Date	:	2014-04-01 to 2014-04-09
Issue Date	:	2014-04-09
Test Standard(s)	:	**FCC CFR Title 47 Part 15 Subpart C Section 15.247**
Conclusions	:	**PASSED***

*In the configuration tested, the EUT complied with the standards specified above.

Test/Witness Engineer : Jason Deng

Approved & Authorized : Winkey Wang

This report details the results of the testing carried out on one sample. The results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in the report.

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1. General Information

1.1. Client Information

Applicant	:	Shenzhen DIVOOM Technology Co., Ltd.
Address	:	1506 Block C, Tiley Central Plaza, Nanshan District, Shenzhen, Guangdong, China
Manufacturer	:	Shenzhen DIVOOM Technology Co., Ltd.
Address	:	1506 Block C, Tiley Central Plaza, Nanshan District, Shenzhen, Guangdong, China

1.2. General Description of EUT (Equipment Under Test)

Product Name	:	Rugged Portable Bluetooth Speaker	
Models No.	:	Voombox-Travel	
Serial No.	:	N/A	
Trademark	:	DIVOOM	
Product Description	:	Operation Frequency:	2402MHz~2480MHz
		Transfer Rate:	1/2/3 Mbits/s
		Number of Channel:	79 Channels
		Modulation Type:	GFSK, π/4-DQPSK, 8-DPSK
		Modulation Technology:	FHSS
		Antenna Type:	Integral PCB Antenna
		Antenna Gain:	0 dBi
Power Supply	:	USB DC 5V from PC, DC 3.7V from Li-ion battery	

Note:

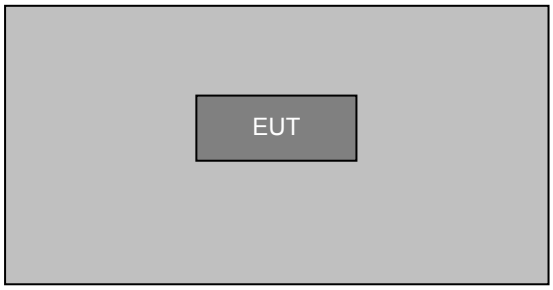
(1) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

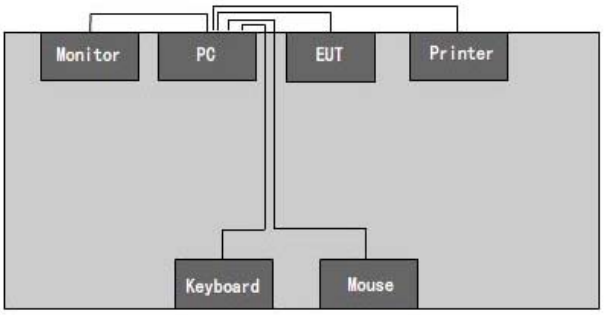
(2) Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	27	2429	54	2456
01	2403	28	2430	55	2457
02	2404	29	2431	56	2458
03	2405	30	2432	57	2459
04	2406	31	2433	58	2460
05	2407	32	2434	59	2461

06	2408	33	2435	60	2462
07	2409	34	2436	61	2463
08	2410	35	2437	62	2464
09	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		
Remark: Channel 0, 39 &78 selected for GFSK, π/4-DQPSK and 8DPSK.					

1.3. Block Diagram Showing The Configuration of System Tested





1.4. Description of Support Units

Name	Model	Serial Number	Manufacturer
Printer	HP1020	CNCJ410726	HP
LCD Monitor	G205HV	10306738385	ACER
PC	ASPIREM1830	PTSF90C00305005CAC3000	ACER
Keyboard	SK-9625	KBUSB1580500037E0100	ACER
Mouse	MS.11200.014	M-UAY-ACR2	ACER

1.5. External I/O Cable

Cable Description	Length(m)	From/ Port	To
Shielding Detachable USB Cable	1.5	Host PC	Mouse
Shielding Detachable K/B Cable	1.5	Host PC	Keyboard
Shielding Detachable serial Cable	1.5	Host PC	Printer
Shielding Detachable VGA Cable	1.5	Host PC	LCD Monitor
Unshielding Detachable USB &AV Cable	0.5	EUT	Host PC

1.6. Description of Test Mode

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned follow was evaluated respectively.

Test Mode	Description
Charging & Playing mode	Keep the EUT in Charging& Playing mode
Transmitting mode	Keep the EUT in Transmitting mode with worst case data rate
Remark	GFSK(1Mbps) is the worst case mode

Remark: The sample was placed 0.8m above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

1.7. Test Instruments List

Item	Test Equipment	Manufacturer	Model No.	Cal. Date	Cal. Due date
1	Bilog Antenna	SCHWARZBECK MESS-ELEKTRONIK	VULB9163	Mar. 28, 2014	Mar. 27, 2015
2	Double -ridged waveguide horn	SCHWARZBECK MESS-ELEKTRONIK	BBHA9120D	Mar. 28, 2014	Mar. 27, 2015
3	Coaxial Cable	N/A	N/A	Mar. 28, 2014	Mar. 27, 2015
4	Coaxial Cable	N/A	N/A	Mar. 28, 2014	Mar. 27, 2015
5	Coaxial cable	N/A	N/A	Mar. 28, 2014	Mar. 27, 2015
6	Coaxial Cable	N/A	N/A	Mar. 28, 2014	Mar. 27, 2015
7	Coaxial Cable	N/A	N/A	Mar. 28, 2014	Mar. 27, 2015
8	Amplifier (10kHz-1.3GHz)	HP	8447D	Mar. 28, 2014	Mar. 27, 2015
9	Amplifier (1GHz-18GHz)	Compliance Direction Systems Inc.	PAP-1G18	Mar. 28, 2014	Mar. 27, 2015
10	Pre-amplifier (18-26GHz)	Rohde & Schwarz	AFS33-18002 650-30-8P-44	Mar. 28, 2014	Mar. 27, 2015
11	Horn Antenna	ETS-LINDGREN	3160	Mar. 28, 2014	Mar. 27, 2015
12	Positioning Controller	UC	UC3000	N/A	N/A
13	Spectrum analyzer 9kHz-30GHz	Rohde & Schwarz	FSP	Mar. 28, 2014	Mar. 27, 2015
14	EMI Test Receiver	Rohde & Schwarz	ESPI	Mar. 28, 2014	Mar. 27, 2015
15	Loop antenna	Laplace instrument	RF300	Mar. 28, 2014	Mar. 27, 2015
16	Universal radio communication tester	Rhode & Schwarz	CMU200	Mar. 28, 2014	Mar. 27, 2015
17	Signal Analyzer	Rohde & Schwarz	FSIQ3	Mar. 28, 2014	Mar. 27, 2015
18	EMI Test Receiver	Rohde & Schwarz ESCI	ESCI	Mar. 28, 2014	Mar. 27, 2015
19	LISN	CHASE	MN2050D	Mar. 28, 2014	Mar. 27, 2015

1.8. Laboratory Location

Shenzhen Certification Technology Service Co., Ltd.

Address: 2F, Building B, East Area of Nanchang Second Industrial Zone, Gushu 2nd Road, Bao'an District, Shenzhen 518126, P.R. China

At the time of testing, the Laboratory is accredited. It is listed in the United States of American Federal Communications Commission (FCC), and the registration number is 197647.

Tel:86-755-86375552 Fax: 86-755-26736857

2. Test Summary

Standard Section	Test Item	Judgment
15.203/15.247(c)	Antenna Requirement	PASSED
15.207	Conducted Emission	PASSED
15.247(b)(1)	Conducted Peak Output Power	PASSED
15.247(a)(1)	20dB Occupied Bandwidth	PASSED
15.247(a)(1)	Carrier Frequencies Separation	PASSED
15.247(a)(1)	Hopping Channel Number	PASSED
15.247(a)(1)	Dwell Time	PASSED
15.247(b)(4)&TCB Exclusion List (7 July 2002)	Pseudorandom Frequency Hopping Sequence	PASSED
15.205/15.209	Spurious Emission	PASSED
15.247(d)	Band Edge	PASSED
Remark: “N/A” is an abbreviation for Not Applicable.		

3. Antenna Requirement

3.1. Standard Requirement

3.1.1 Test standard

FCC Part15 Section 15.203 /247(c)

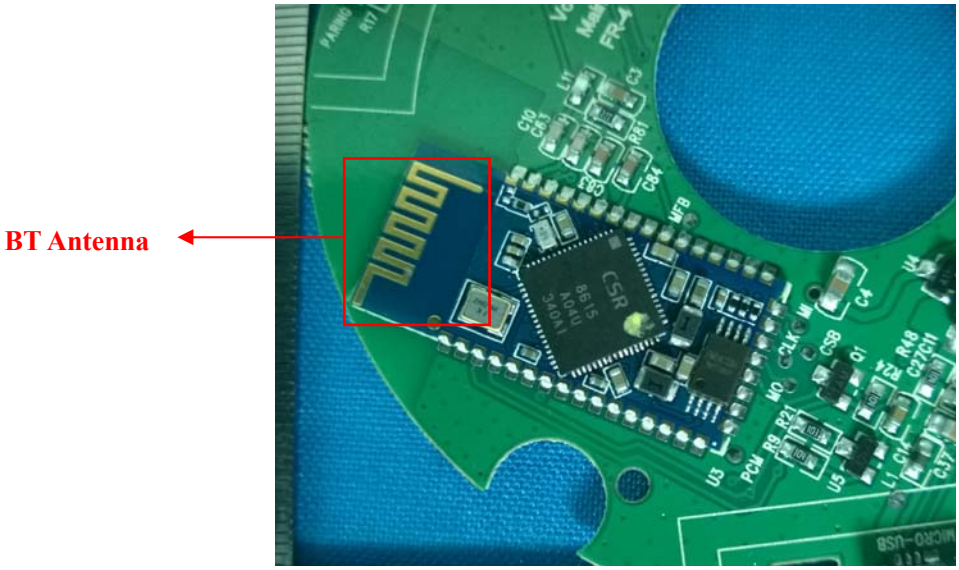
3.1.2 Requirement

1) 15.203 requirement:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

2) 15.247(c) (1)(i) requirement:
Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

3.2. Antenna Connected Construction

The bluetooth antenna is an integral antenna which permanently attached, and the best case gain of the antenna is 0 dBi. It complies with the standard requirement.



4. Conducted Emission Test

4.1. Test Standard and Limit

4.1.1 Test Standard

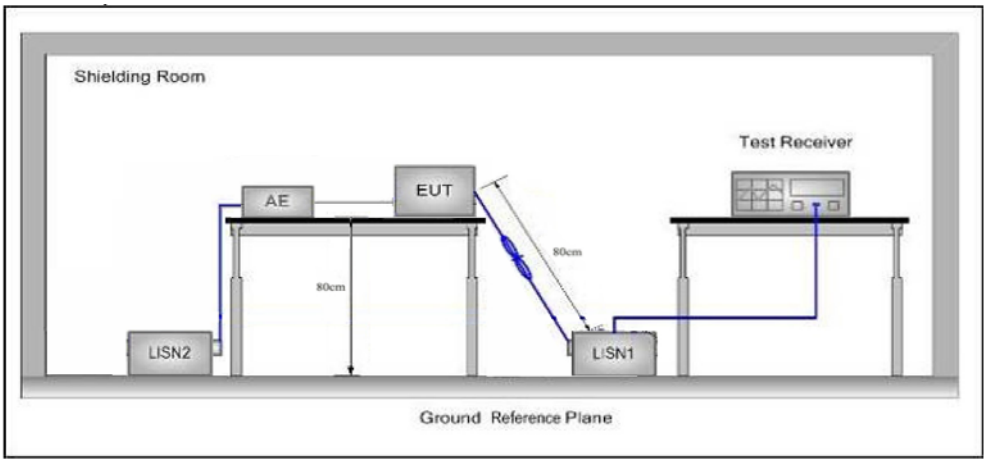
FCC Part15 Section 15.207

4.1.2 Test Limit

Conducted Emission Test Limit

Frequency	Maximum RF Line Voltage (dBμV)	
	Quasi-peak Level	Average Level
150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
500kHz~5MHz	56	46
5MHz~30MHz	60	50
Remark: (1) *Decreasing linearly with logarithm of the frequency. (2) The lower limit shall apply at the transition frequencies.		

4.2. Test Setup



4.3. Test Procedure

1) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

2) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane.

The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal

ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

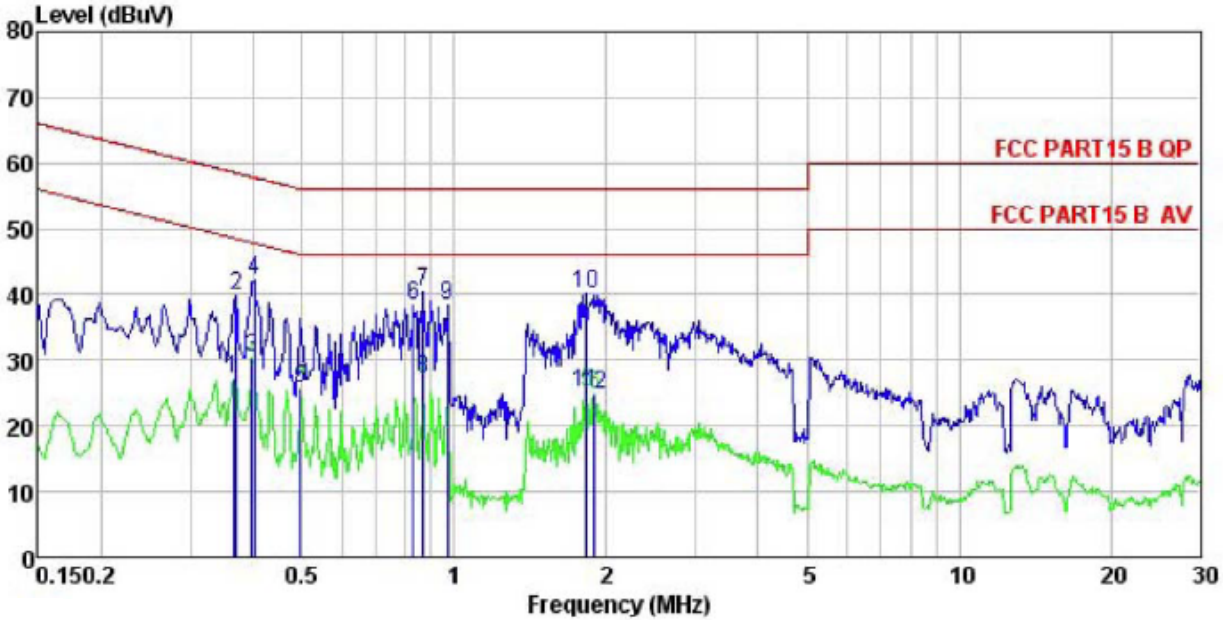
The Test Receiver setup: RBW=9kHz, VBW=30kHz, Sweep time= auto

4.4. Test Data

Please to see the following pages

Conducted Emission Test Data

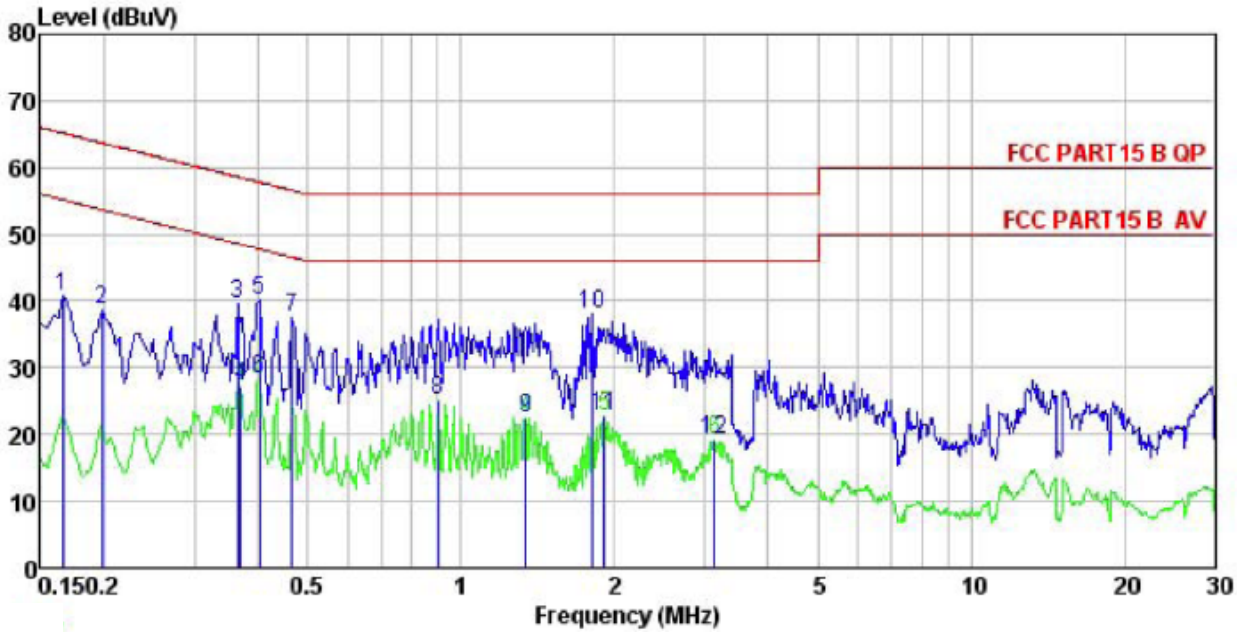
EUT:	Rugged Portable Bluetooth Speaker	M/N: Voombox-Travel
Operating Condition:	Charging & Playing mode	
Test Site:	Shielded room	
Operator:	Jason	
Test Specification:	AC120V/60Hz	
Polarization:	Line	
Note	Tem:25℃ Hum:50%	



	Freq	Read Level	LISN Factor	Cable Loss	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dBuV	dB	
1	0.365	16.28	10.25	0.73	27.26	48.61	-21.35	Average
2	0.369	28.74	10.25	0.73	39.72	58.52	-18.80	QP
3	0.398	19.48	10.26	0.72	30.46	47.90	-17.44	Average
4	0.402	31.13	10.26	0.72	42.11	57.81	-15.70	QP
5	0.497	14.77	10.28	0.76	25.81	46.05	-20.24	Average
6	0.830	27.43	10.18	0.82	38.43	56.00	-17.57	QP
7	0.866	29.44	10.18	0.83	40.45	56.00	-15.55	QP
8	0.866	16.22	10.18	0.83	27.23	46.00	-18.77	Average
9	0.968	27.39	10.20	0.86	38.45	56.00	-17.55	QP
10	1.829	29.00	10.26	0.95	40.21	56.00	-15.79	QP
11	1.829	14.01	10.26	0.95	25.22	46.00	-20.78	Average
12	1.898	13.70	10.27	0.95	24.92	46.00	-21.08	Average

Conducted Emission Test Data

EUT:	Rugged Portable Bluetooth Speaker	M/N: Voombox-Travel
Operating Condition:	Charging & Playing mode	
Test Site:	Shielded room	
Operator:	Jason	
Test Specification:	AC 120V/60Hz	
Polarization:	Neutral	
Note	Tem:25℃ Hum:50%	



	Freq	Read Level	LISN Factor	Cable Loss	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dBuV	dB	
1	0.166	29.67	10.24	0.78	40.69	65.16	-24.47	QP
2	0.198	27.83	10.21	0.76	38.80	63.71	-24.91	QP
3	0.365	28.65	10.27	0.73	39.65	58.61	-18.96	QP
4	0.369	16.23	10.27	0.73	27.23	48.52	-21.29	Average
5	0.402	29.16	10.28	0.72	40.16	57.81	-17.65	QP
6	0.402	17.23	10.28	0.72	28.23	47.81	-19.58	Average
7	0.466	26.48	10.27	0.75	37.50	56.58	-19.08	QP
8	0.904	13.94	10.20	0.84	24.98	46.00	-21.02	Average
9	1.338	11.30	10.24	0.91	22.45	46.00	-23.55	Average
10	1.810	26.99	10.27	0.95	38.21	56.00	-17.79	QP
11	1.908	11.40	10.28	0.95	22.63	46.00	-23.37	Average
12	3.140	7.94	10.29	0.91	19.14	46.00	-26.86	Average

5. Conducted Peak Output Power Test

5.1. Test Standard and Limit

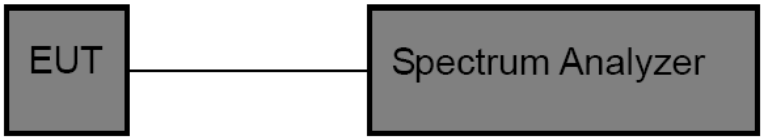
5.1.1 Test Standard

FCC Part15 C Section 15.247 (b)(3)

5.1.2 Test Limit

FCC Part 15 Subpart C(15.247)		
Test Item	Limit	Frequency Range (MHz)
Peak Output Power	Hopping Channels>75 Power<1W(30dBm) Other <125 mW(21dBm)	2400~2483.5

5.2. Test Setup



5.3. Test Procedure

(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

(2) Spectrum Setting:

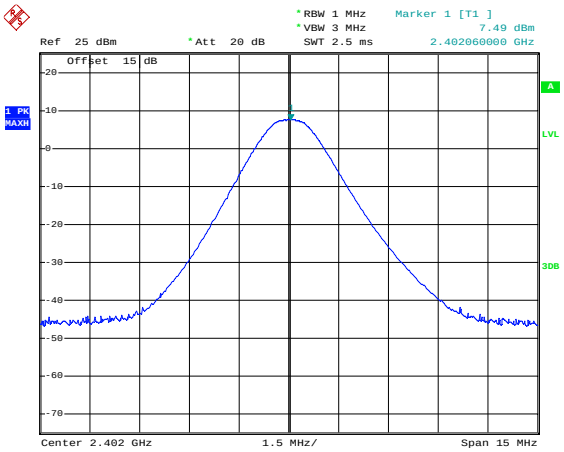
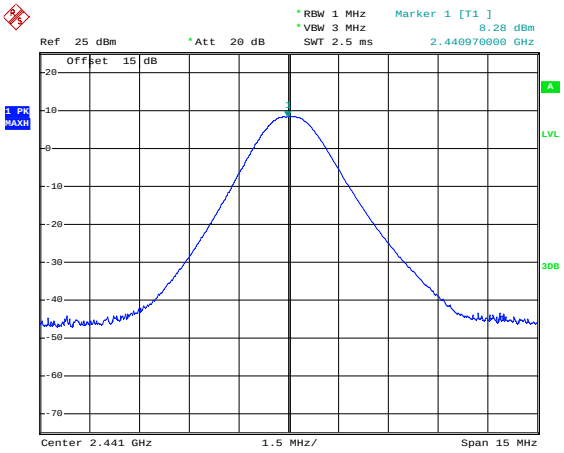
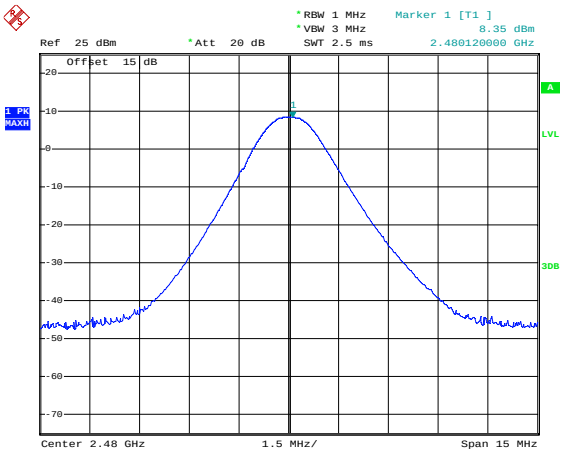
RBW=1MHz, VBW=3MHz, Detector=Peak (If 20dB BW ≤1 MHz)

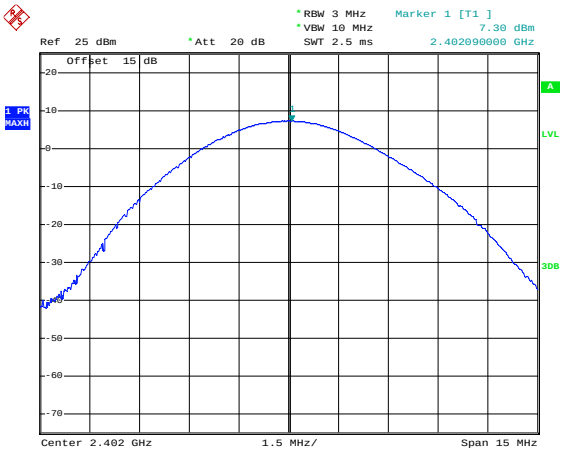
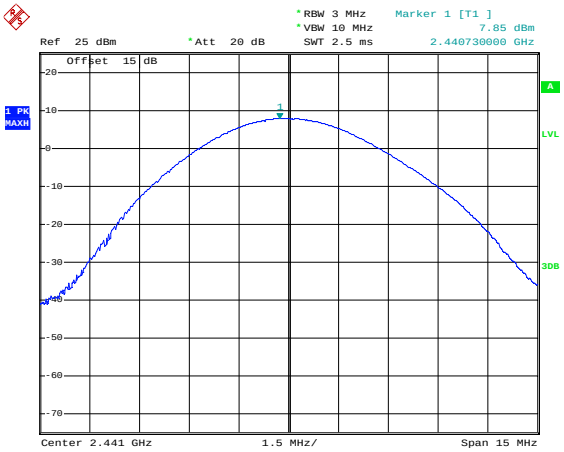
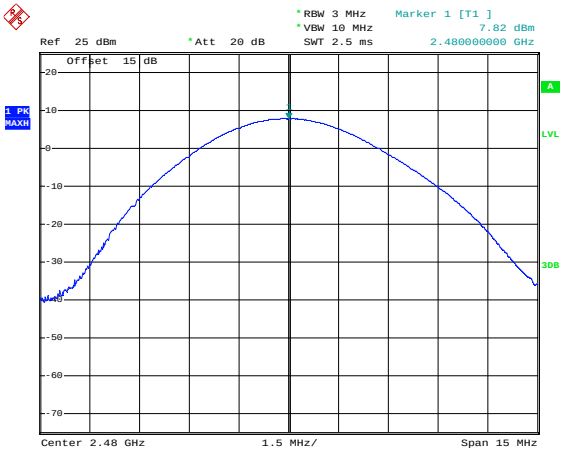
RBW=3MHz, VBW=10MHz, Detector=Peak (If 20dB BW > 1 MHz)

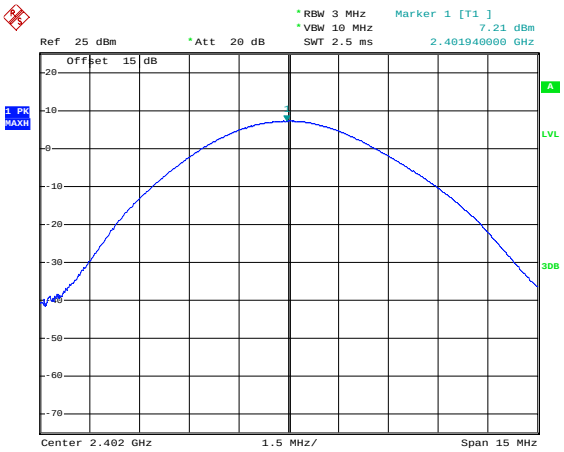
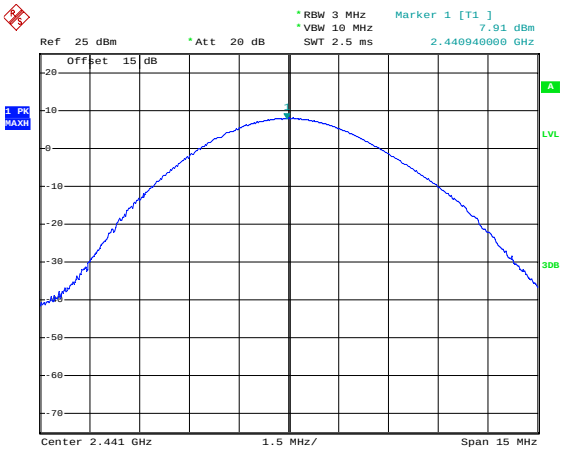
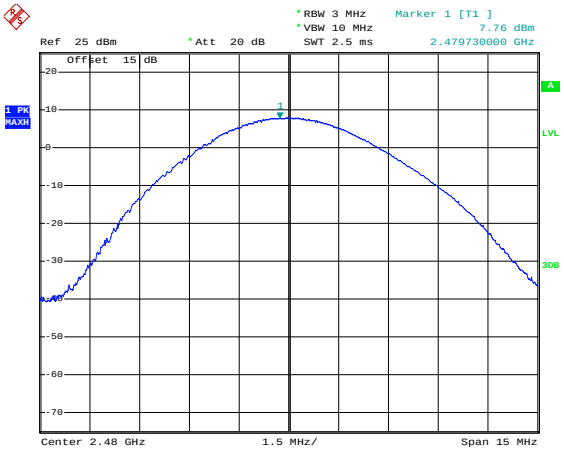
(3) The EUT was set to continuously transmitting in the max power during the test.

5.4. Test Data

GFSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	7.49	21	PASSED
CH 39	2441	8.28	21	PASSED
CH 78	2480	8.35	21	PASSED
π/4-DQPSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	7.30	21	PASSED
CH 39	2441	7.85	21	PASSED
CH 78	2480	7.82	21	PASSED
8DPSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	7.21	21	PASSED
CH 39	2441	7.91	21	PASSED
CH 78	2480	7.76	21	PASSED
Remark: Test plot as follows				

Modulation mode	GFSK mode
2402MHz	
2441MHz	
2480MHz	

Modulation mode	π/4-DQPSK
2402MHz	 Date: 02.APR.2014 16:09:39
2441MHz	 Date: 02.APR.2014 15:42:20
2480MHz	 Date: 02.APR.2014 15:37:29

Modulation mode	8DPSK
2402MHz	
2441MHz	
2480MHz	

6. 20dB Occupy Bandwidth Test

6.1. Test Standard and Limit

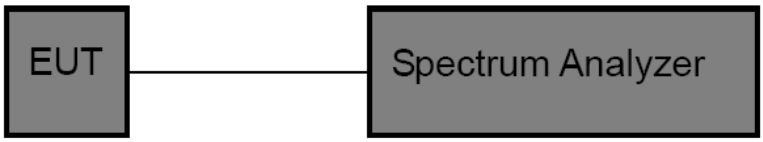
6.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

6.1.2 Test Limit

FCC Part 15 Subpart C(15.247)		
Test Item	Limit	Frequency Range (MHz)
Bandwidth	20dB bandwidth	2400~2483.5

6.2. Test Setup



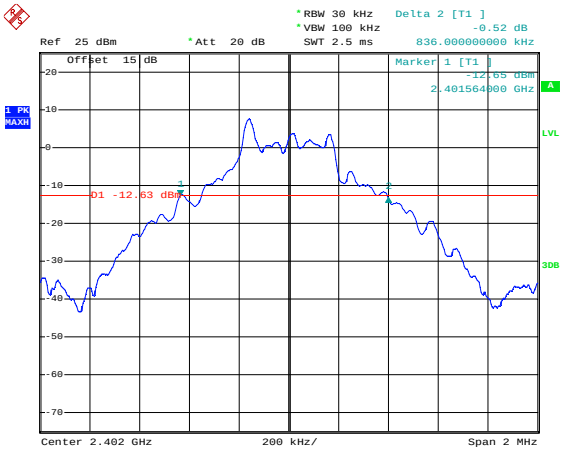
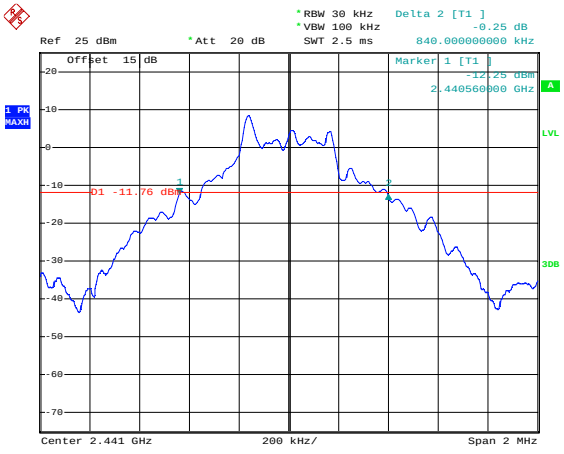
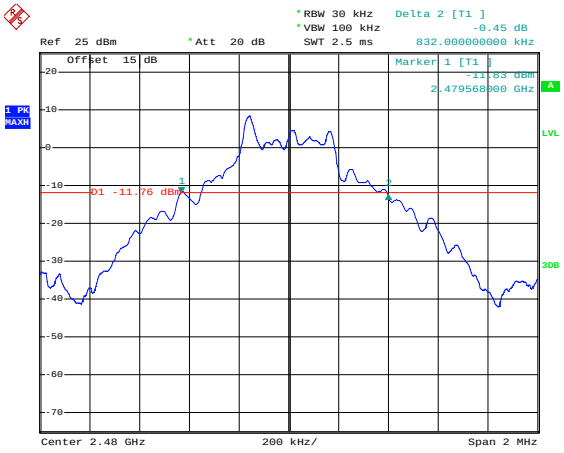
6.3. Test Procedure

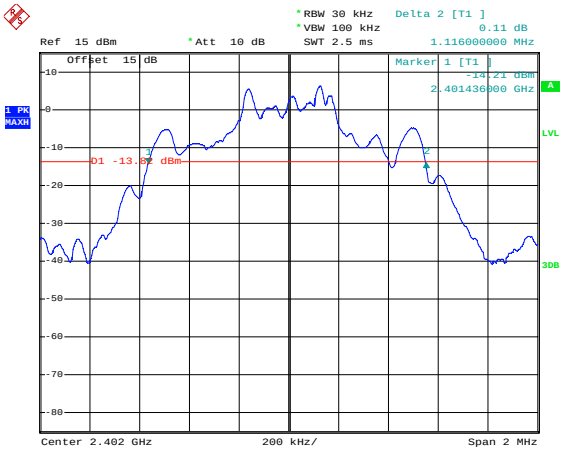
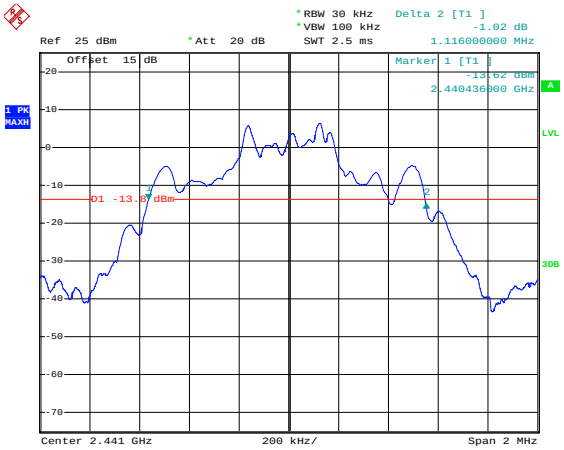
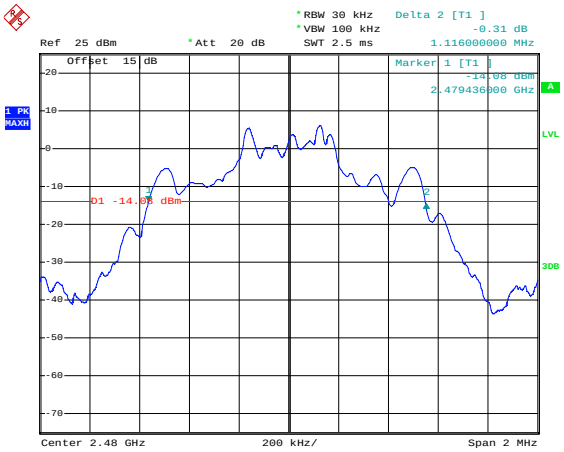
(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

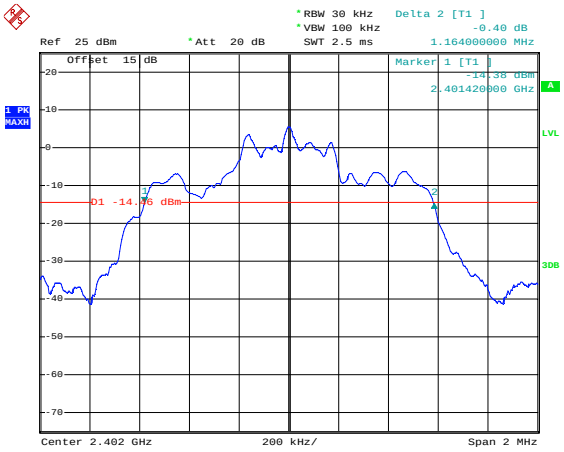
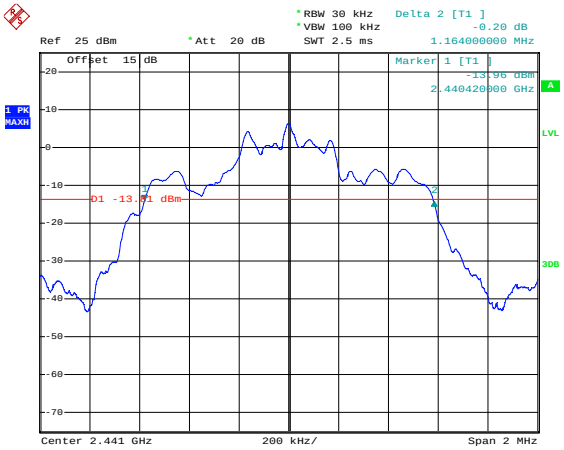
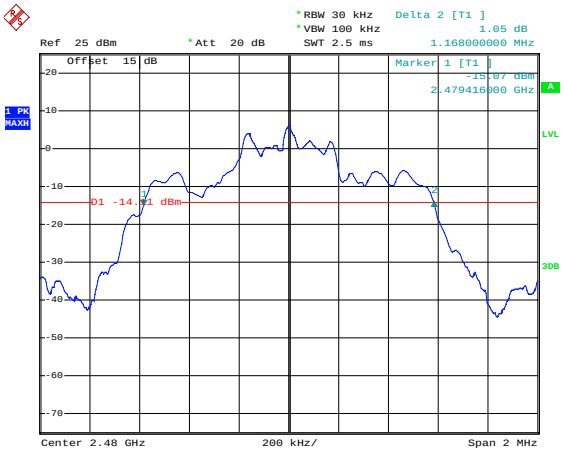
(2) Spectrum Setting:
Bandwidth: RBW=30 kHz, VBW=100 kHz, detector= Peak

6.4. Test Data

Channel Number	Channel Frequency	20dB Bandwidth (kHz)		
		GFSK	π/4-DQPSK	8DPSK
CH 00	2402(MHz)	836	1116	1220
CH 39	2441(MHz)	840	1116	1220
CH 78	2480(MHz)	832	1116	1220
Remark: Test plot as follows				

Modulation mode	GFSK mode
2402MHz	
2441MHz	
2480MHz	

Modulation mode	π/4-DQPSK
2402MHz	 Date: 03.APR.2014 10:03:09
2441MHz	 Date: 02.APR.2014 15:42:02
2480MHz	 Date: 02.APR.2014 15:38:25

Modulation mode	8DPSK
2402MHz	 Date: 02.APR.2014 16:07:58
2441MHz	 Date: 02.APR.2014 16:17:38
2480MHz	 Date: 02.APR.2014 16:13:38

7. Carrier Frequency Separation Test

7.1. Test Standard and Limit

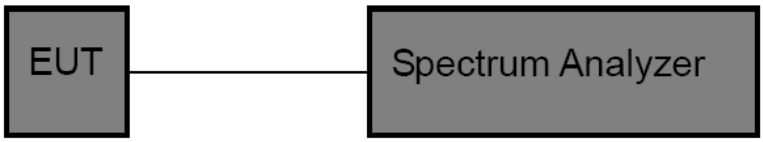
7.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

7.1.2 Test Limit

FCC Part 15 Subpart C(15.247)		
Test Item	Limit	Frequency Range (MHz)
Channel Separation	>25KHz or >two-thirds of the 20 dB bandwidth (Which is greater)	2400~2483.5

7.2. Test Setup



7.3. Test Procedure

(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

(2) Spectrum Setting:
RBW=100 kHz, VBW=300 kHz, detector= Peak, Sweep Time =auto.

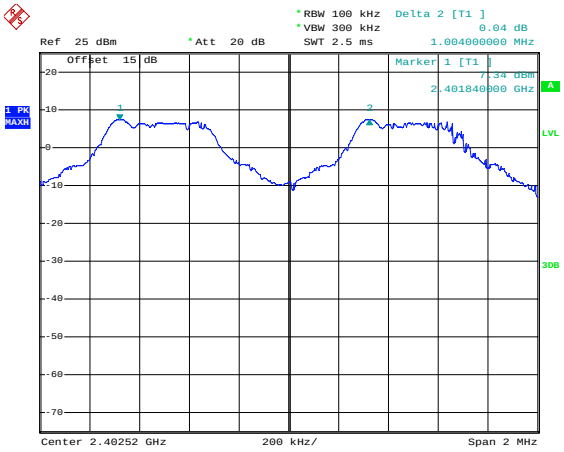
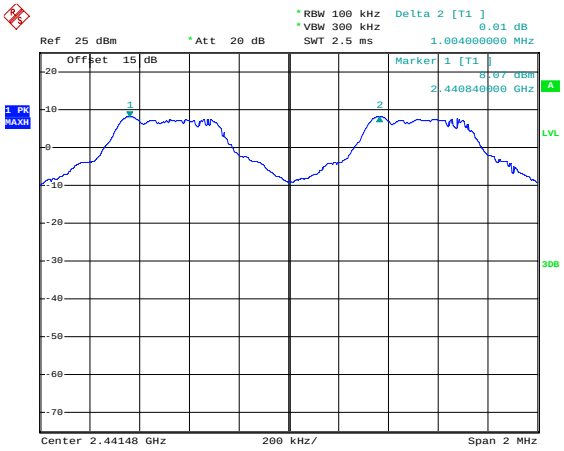
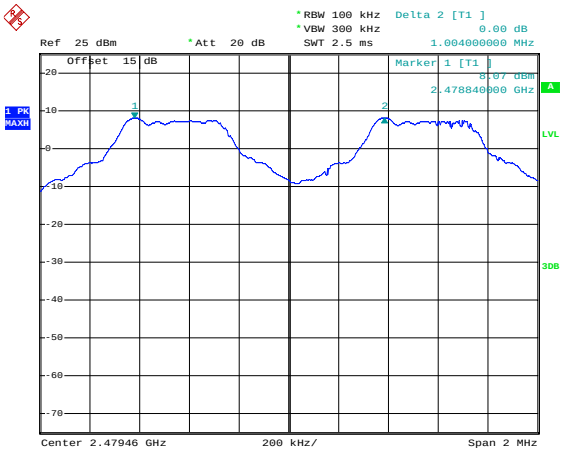
(3) The EUT was set to the Hopping Mode for Channel Separation Test and continuously transmitting for the Test.

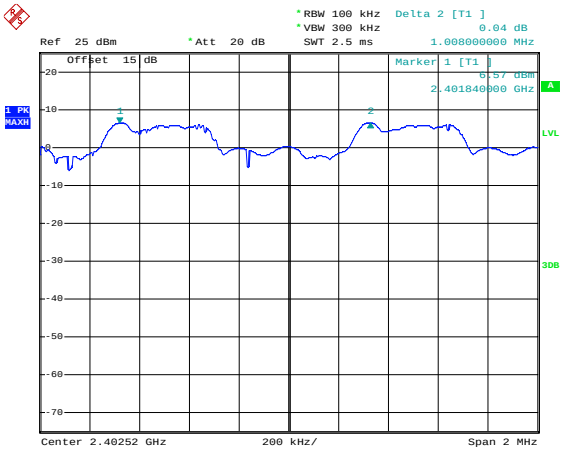
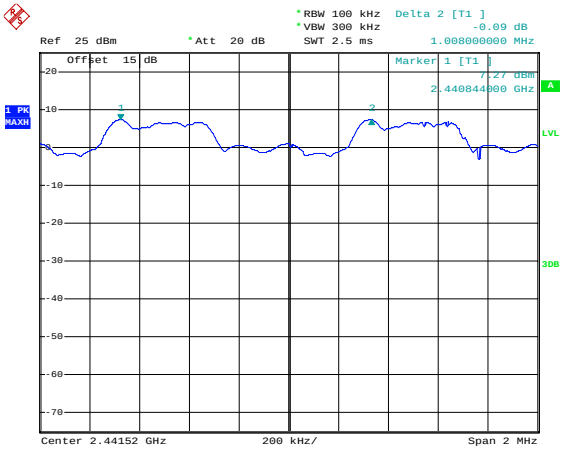
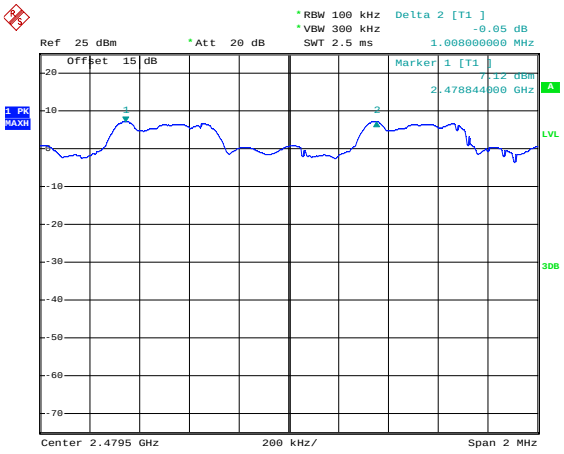
7.4. Test Data

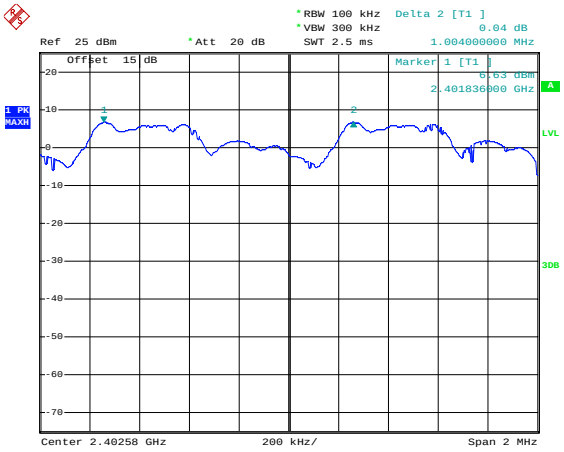
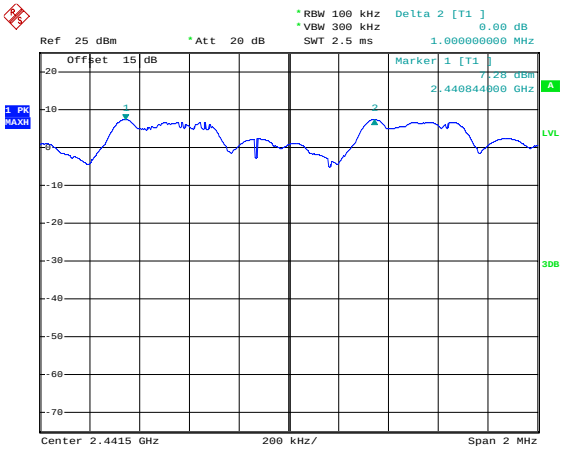
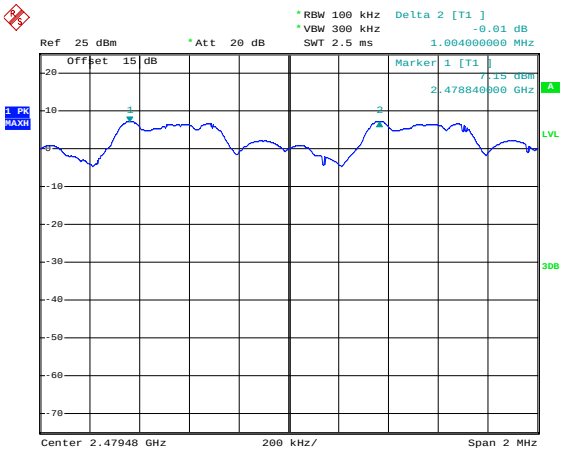
GFSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	1004	560.000	PASSED
CH 39	2441	1004	560.000	PASSED
CH 78	2480	1004	560.000	PASSED
π/4-DQPSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	1008	744.000	PASSED
CH 39	2441	1008	744.000	PASSED
CH 78	2480	1008	744.000	PASSED
8DPSK mode				
Channel Number	**Channel Frequency (MHz)**	**Test Result (dBm)**	**Limit (30dBm)**	**Judgment**
CH 00	2402	1004	778.667	PASSED
CH 39	2441	1000	778.667	PASSED
CH 78	2480	1004	778.667	PASSED
Remark: Test plot as follows				

According to section 6.4

Test Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequency Separation)
GFSK	840.00	560.000
π/4-DQPSK	1116.00	744.000
8DPSK	1168.00	778.667

Modulation mode	GFSK mode
2402MHz	
2441MHz	
2480MHz	

Modulation mode	π/4-DQPSK
2402MHz	 Date: 02.APR.2014 15:44:04
2441MHz	 Date: 02.APR.2014 15:43:09
2480MHz	 Date: 02.APR.2014 15:44:53

Modulation mode	8DPSK
2402MHz	 Date: 02.APR.2014 16:10:24
2441MHz	 Date: 02.APR.2014 16:11:32
2480MHz	 Date: 02.APR.2014 16:12:22

8. Number of Hopping Channel

8.1. Test Standard and Limit

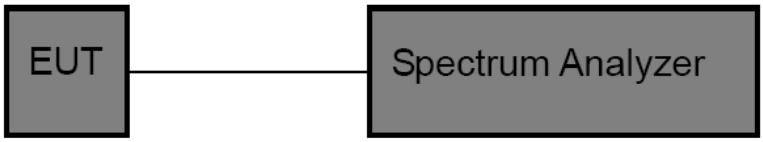
8.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

8.1.2 Test Limit

FCC Part 15 Subpart C (15.247)		
Test Item	Limit	Frequency Range (MHz)
Number of Hopping Channel	>15 channels	2400~2483.5

8.2. Test Setup



8.3. Test Procedure

(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

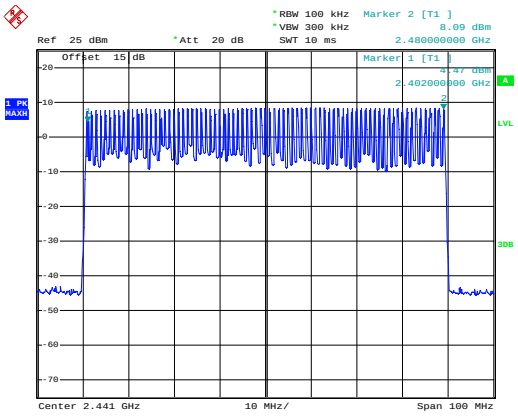
(2) Spectrum Setting: RBW=100 kHz, VBW=300 kHz, Detector=Peak, Sweep time= Auto.

(3) The EUT was set to the Hopping Mode for Channel Separation Test and continuously transmitting for the Test.

8.4. Test Data

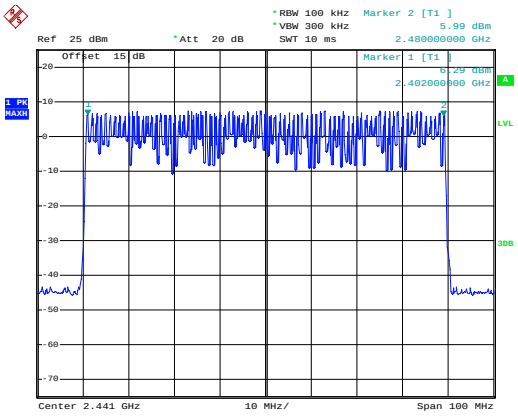
Mode	Quantity of Hopping Channel	Limit	Judgment
GFSK, π/4-DQPSK, 8DPSK	79	>15	PASSED

Modulation mode	GFSK mode



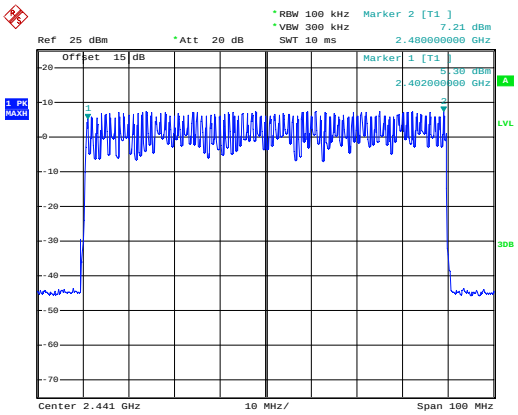
Date: 02.APR.2014 15:31:55

Modulation mode	π/4-DQPSK



Date: 02.APR.2014 15:34:09

Modulation mode	8DPSK



Date: 02.APR.2014 15:36:27

9. Dwell Time Test

9.1. Test Standard and Limit

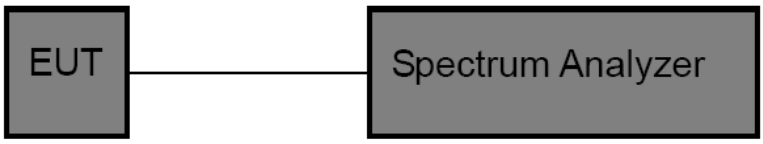
9.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

9.1.2 Test Limit

FCC Part 15 Subpart C(15.247)		
Section	Test Item	Limit
15.247(a)(1)	Dwell time	0.4 sec

9.2. Test Setup



9.3. Test Procedure

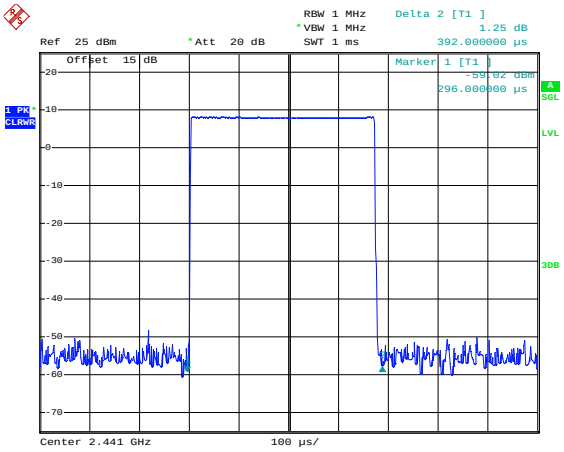
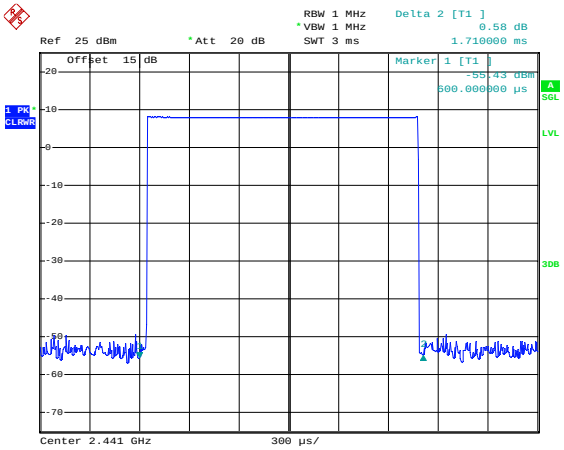
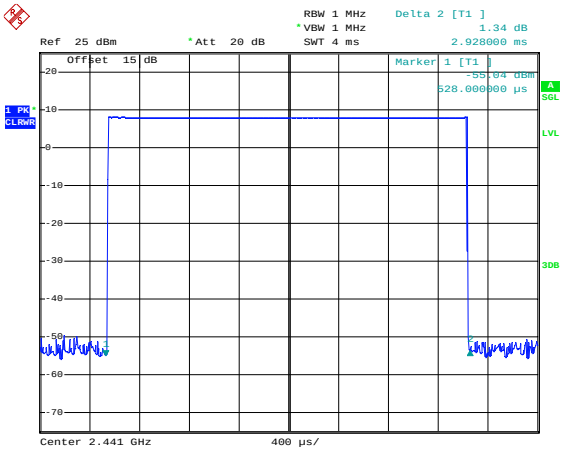
(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
(2) Spectrum Setting: RBW=1MHz, VBW=1MHz, Span=0Hz, Detector=Peak
(3) Use video trigger with the trigger level set to enable triggering only on full pulses.
(4) Sweep Time is more than once pulse time.
(5) Set the center frequency on any frequency would be measure and set the frequency span to zero span.
(6) Measure the maximum time duration of one single pulse.
(7) Set the EUT for packet transmitting.
(8) Measure the maximum time duration of one single pulse.
(9) The EUT was set to the Hopping Mode for Dwell Time Test

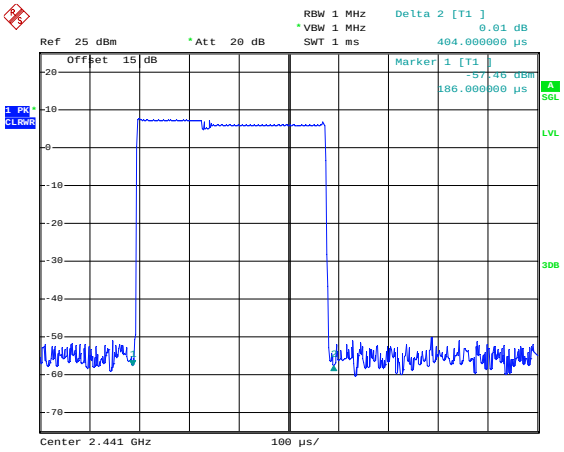
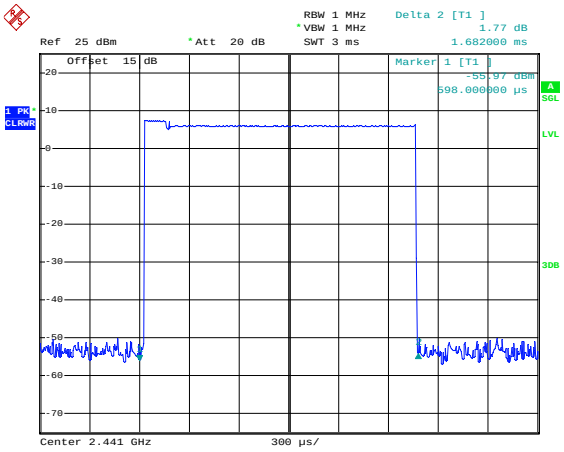
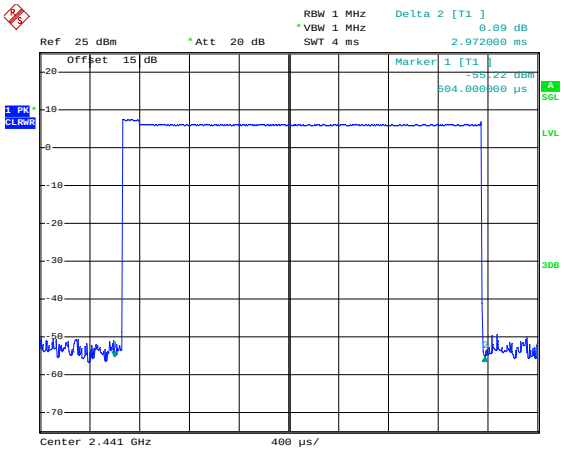
9.4. Test Data

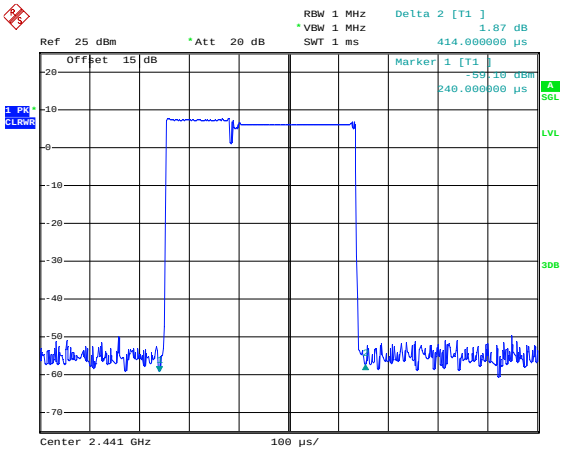
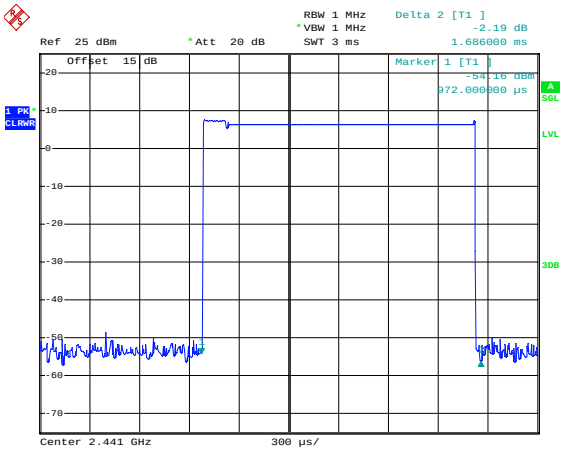
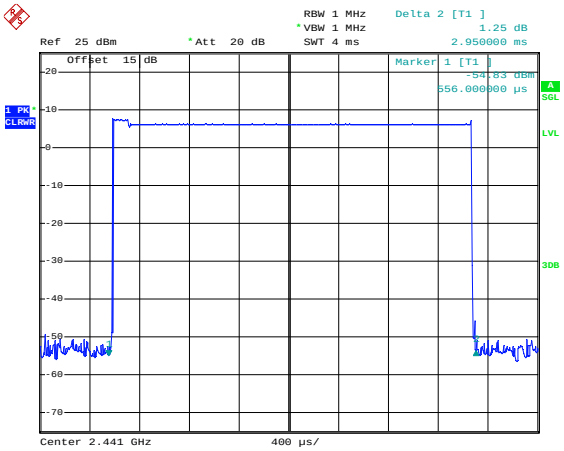
For GFSK, π/4-DQPSK and 8DPSK:
The test period: T= 0.4 Second/Channel x 79 Channel = 31.6 s
The lowest channel (2402MHz), middle channel (2441MHz), highest channel (2480MHz) as below

DH1 time slot=0.392*(1600/ (2*79))*31.6=125.44ms
DH3 time slot=1.710*(1600/ (4*79))*31.6=273.60ms
DH5 time slot=2.928*(1600/ (6*79))*31.6=312.32ms
2-DH1 time slot=0.404*(1600/ (2*79))*31.6=129.28ms
2-DH3 time slot=1.682*(1600/ (4*79))*31.6=269.12ms
2-DH5 time slot=2.972(1600/ (6*79))*31.6=317.01ms
3-DH1 time slot=0.414*(1600/ (2*79))*31.6=132.48ms
3-DH3 time slot=1.686*(1600/ (4*79))*31.6=268.76ms
3-DH5 time slot=2.950(1600/ (6*79))*31.6=314.67ms

Mode	Packet	Total of Dwell (ms)	Period Time (s)	Limit (s)	Judgment
GFSK	DH1	0.12544	31.60	0.4	PASS
	DH3	0.27360	31.60		PASS
	DH5	0.31232	31.60		PASS
π/4-DQPSK	2-DH1	0.12928	31.60		PASS
	2-DH3	0.26912	31.60		PASS
	2-DH5	0.31701	31.60		PASS
8DPSK	3-DH1	0.13248	31.60		PASS
	3-DH3	0.26876	31.60		PASS
	3-DH5	0.31467	31.60		PASS
Remark: Test plot as follows					

Modulation mode	GFSK mode
DH1	 Date: 02.APR.2014 16:27:41
DH3	 Date: 02.APR.2014 16:26:57
DH5	 Date: 02.APR.2014 16:26:12

Modulation mode	π/4-DQPSK
2-DH1	
2-DH3	
2-DH5	

Modulation mode	8DPSK
3-DH1	 Date: 02.APR.2014 16:18:48
3-DH3	 Date: 02.APR.2014 16:21:50
3-DH5	 Date: 02.APR.2014 16:22:29

10. Pseudorandom Frequency Hopping Sequence

10.1. Standard Requirement

10.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

10.1.2 Requirement

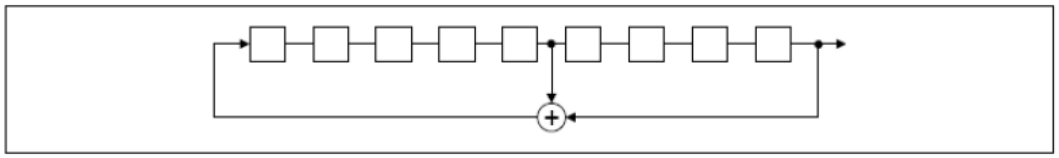
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

10.2. EUT Pseudorandom Frequency Hopping Sequence

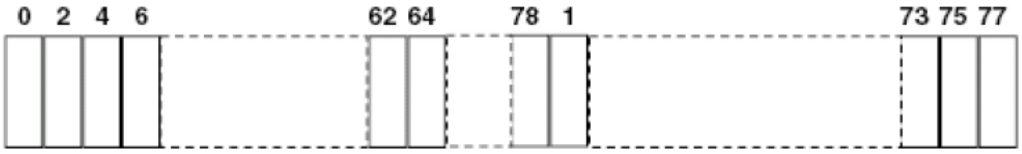
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS Sequence.

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter. The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

11. Band Edge Requirement (Conducted Emission Method)

11.1. Test Standard and Limit

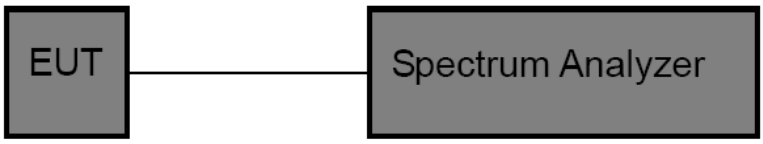
11.1.1 Test Standard

FCC Part15 C Section 15.247 (d)

11.1.2 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

11.2. Test Setup



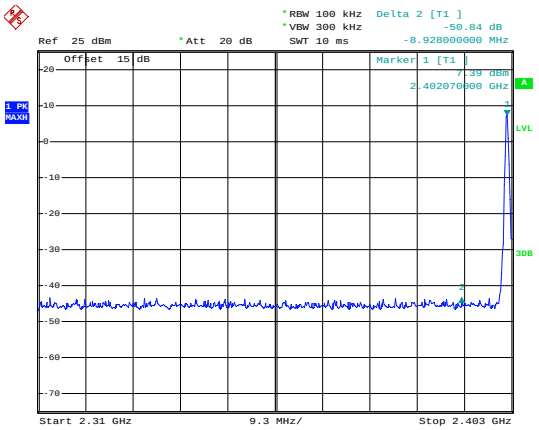
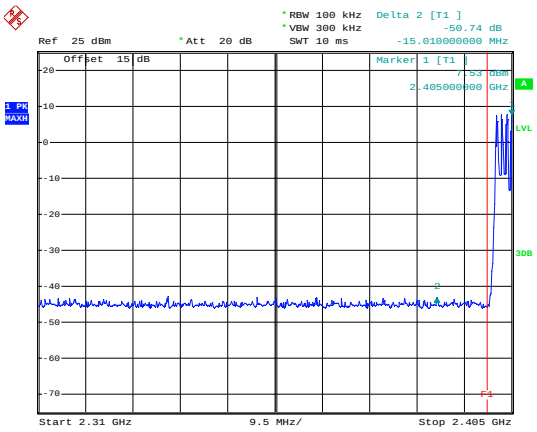
11.3. Test Procedure

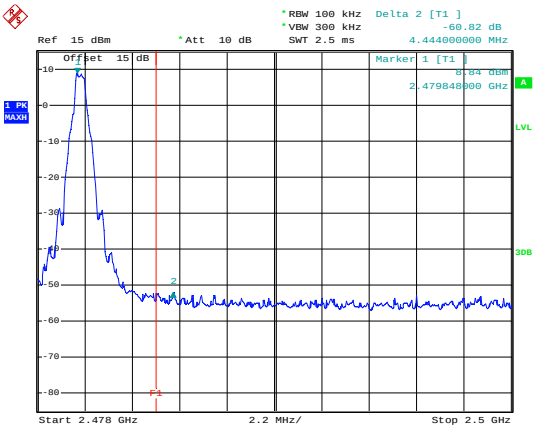
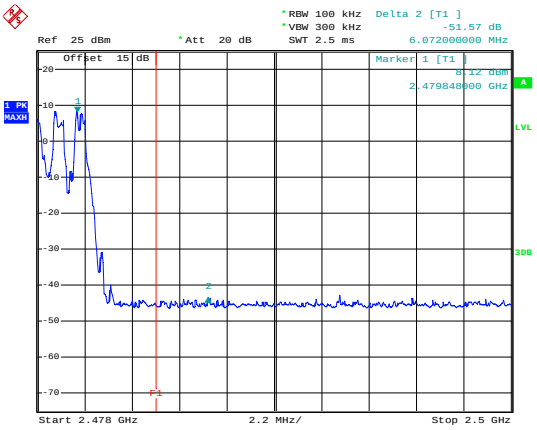
(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

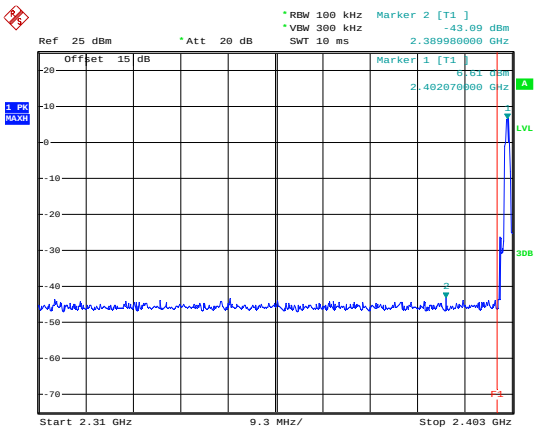
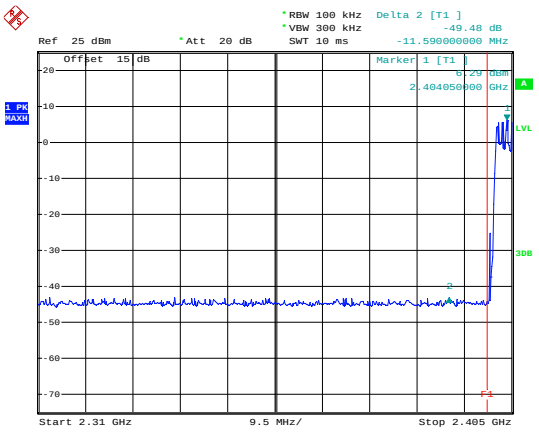
(2) Spectrum Setting: RBW=100 kHz, VBW=300 kHz, Detector=Peak

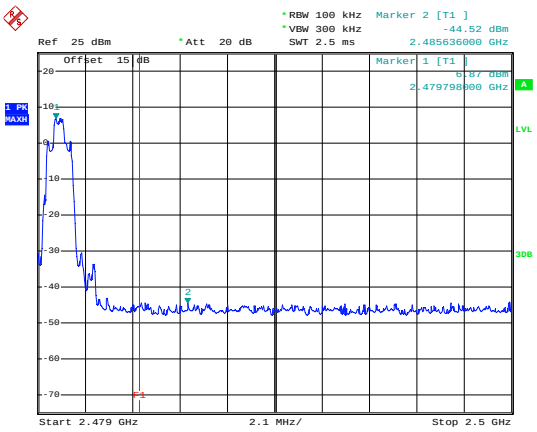
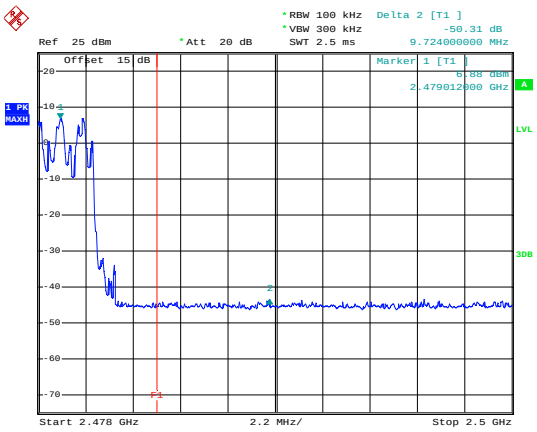
11.4. Test Data

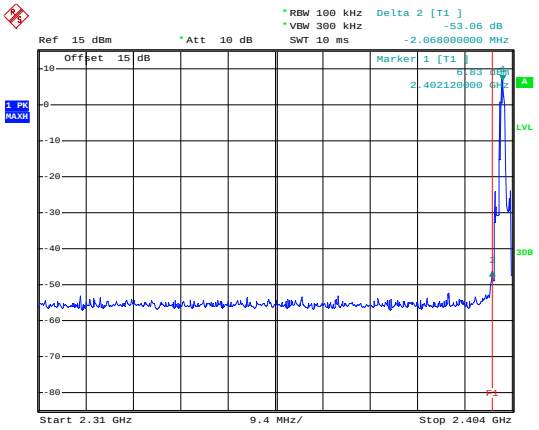
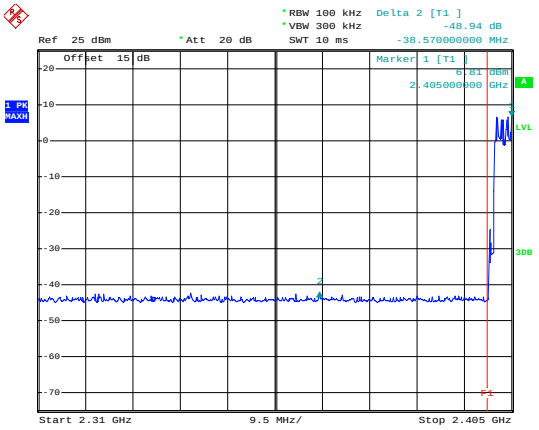
Test plot as follows

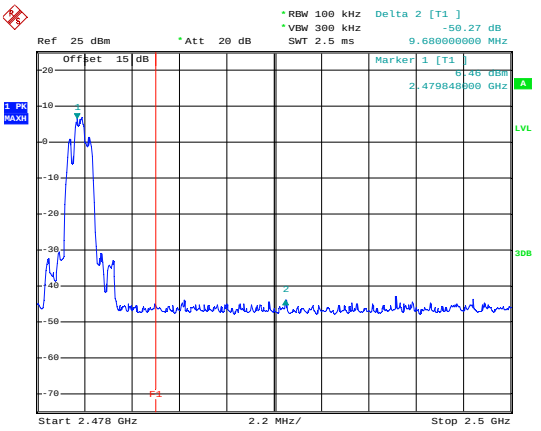
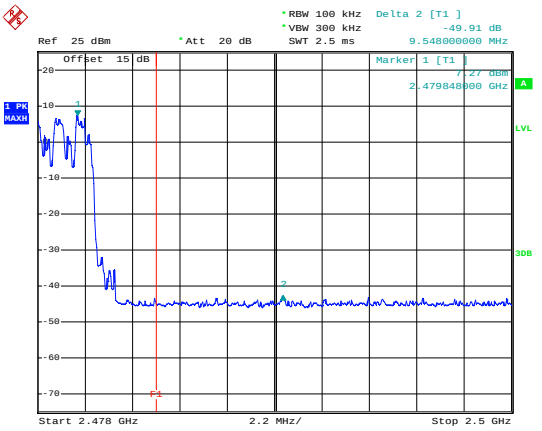
Modulation mode	GFSK	Test channel	Lowest
 Date: 02.APR.2014 15:20:47	 Date: 02.APR.2014 15:53:55		
No-hopping mode		Hopping mode	

Modulation mode	GFSK	Test channel	Highest
 Date: 03.APR.2014 10:01:11	 Date: 02.APR.2014 15:52:50		
No-hopping mode		Hopping mode	

Modulation mode	π/4-DQPSK	Test channel	Lowest
 Date: 02.APR.2014 15:47:26		 Date: 02.APR.2014 15:49:35	
No-hopping mode		Hopping mode	

Modulation mode	π/4-DQPSK	Test channel	Highest
 Date: 02.APR.2014 15:46:04		 Date: 02.APR.2014 15:51:33	
No-hopping mode		Hopping mode	

Modulation mode	8DPSK	Test channel	Lowest
 Date: 03.APR.2014 10:01:59		 Date: 02.APR.2014 16:01:26	
No-hopping mode		Hopping mode	

Modulation mode	8DPSK	Test channel	Highest
 Date: 02.APR.2014 16:14:25		 Date: 02.APR.2014 16:04:35	
No-hopping mode		Hopping mode	

12. Band Edge Requirement (Radiated Emission Method)

12.1. Test Standard and Limit

12.1.1 Test Standard

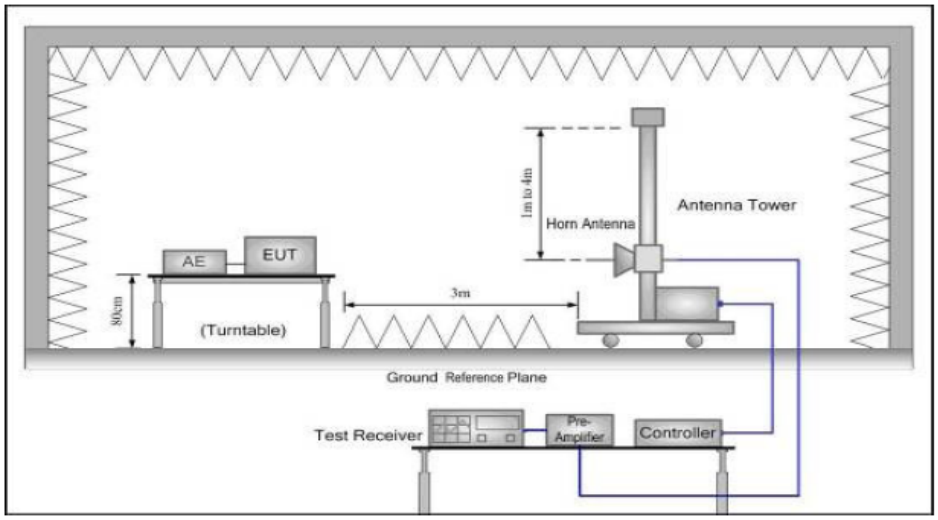
FCC Part15 C Section 15.209 and 15.205

12.1.2 Test Limit

Radiated Emission Test Limit

Frequency	Limit (dBμV/m @3m)	Remark
Above 1GHz	54.00	Average value
	74.00	Peak value

12.2. Test Setup



12.3. Test Procedure

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. Peak Value: RBW=1MHz, VBW=3MHz; Average value: RBW=1MHz, VBW=10Hz

6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

12.4. Test Data

Remark:

1. During the test, pre-scan the GFSK, π/4-DQPSK, 8DPSK, and all data were shown in the report.
2. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis is the worst case.

Test mode: GFSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	23.97	27.58	5.67	0.00	57.22	74.00	-16.78	H	PEAK
2400.00	23.82	27.58	5.67	0.00	57.07	74.00	-16.93	V	PEAK
2400.00	16.20	27.58	5.67	0.00	40.89	54.00	-4.55	H	AVG.
2400.00	16.16	27.58	5.67	0.00	40.86	54.00	-4.59	V	AVG.
Test mode: GFSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	24.58	27.52	5.70	0.00	57.80	74.00	-16.20	H	PEAK
2483.50	23.78	27.52	5.70	0.00	57.00	74.00	-17.00	V	PEAK
2483.50	15.83	27.52	5.70	0.00	49.05	54.00	-4.95	H	AVG.
2483.50	15.82	27.52	5.70	0.00	49.04	54.00	-4.96	V	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss - Preamplifier Factor
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Test mode: π/4-DQPSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	21.02	27.58	5.67	0.00	52.27	74.00	-19.73	H	PEAK
2400.00	21.15	27.58	5.67	0.00	53.40	74.00	-19.60	V	PEAK
2400.00	11.62	27.58	5.67	0.00	40.87	54.00	-9.13	H	AVG.
2400.00	11.63	27.58	5.67	0.00	40.88	54.00	-9.12	V	AVG.
Test mode: π/4-DQPSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	22.32	27.52	5.70	0.00	55.63	74.00	-18.46	H	PEAK
2483.50	23.51	27.52	5.70	0.00	56.73	74.00	-17.27	V	PEAK
2483.50	11.40	27.52	5.70	0.00	42.62	54.00	-9.38	H	AVG.
2483.50	10.15	27.52	5.70	0.00	43.37	54.00	-10.63	V	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss - Preamplifier Factor
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Test mode: 8DPSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	22.08	27.58	5.67	0.00	52.33	74.00	-18.67	H	PEAK
2400.00	21.11	27.58	5.67	0.00	53.36	74.00	-19.64	V	PEAK
2400.00	11.67	27.58	5.67	0.00	40.92	54.00	-9.08	H	AVG.
2400.00	11.62	27.58	5.67	0.00	40.87	54.00	-9.13	V	AVG.
Test mode: 8DPSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	23.19	27.52	5.70	0.00	56.41	74.00	-17.59	H	PEAK
2483.50	21.79	27.52	5.70	0.00	57.01	74.00	-18.99	V	PEAK
2483.50	10.29	27.52	5.70	0.00	42.51	54.00	-10.49	H	AVG.
2483.50	10.12	27.52	5.70	0.00	43.43	54.00	-10.66	V	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss - Preamplifier Factor
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

13. Spurious Emission (Conducted Emission Method)

13.1. Test Standard and Limit

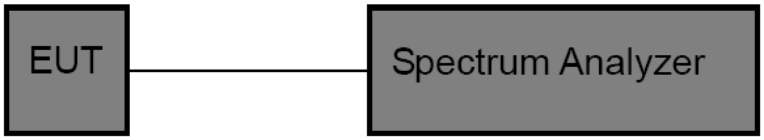
13.1.1 Test Standard

FCC Part15 C Section 15.247 (d)

13.1.2 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

13.2. Test Setup

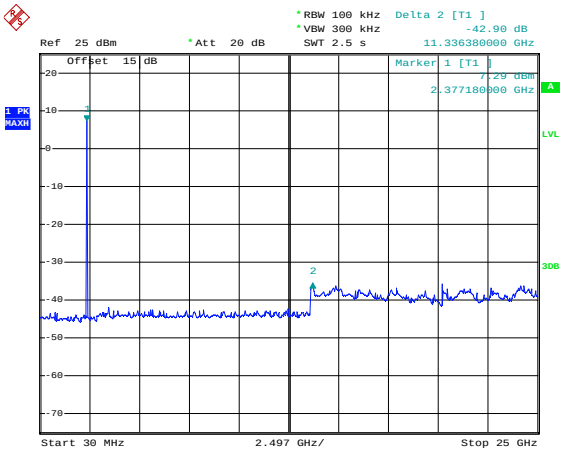
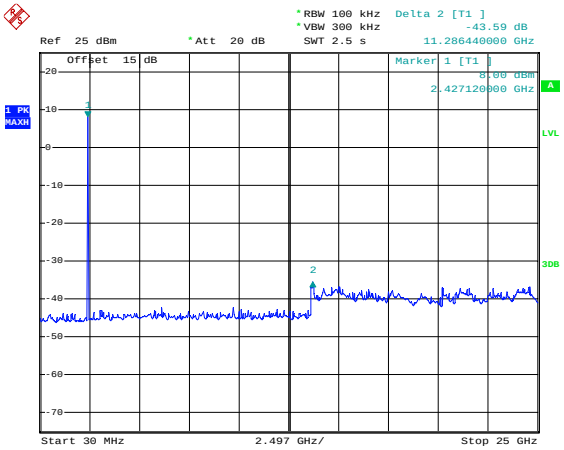
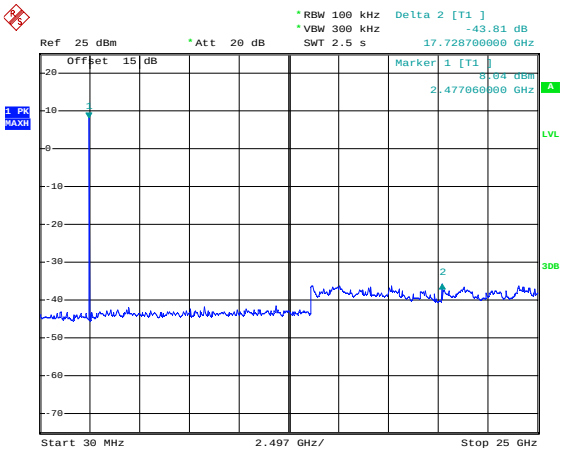


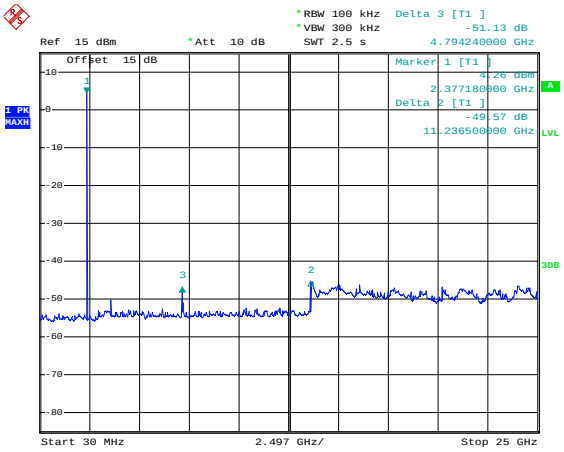
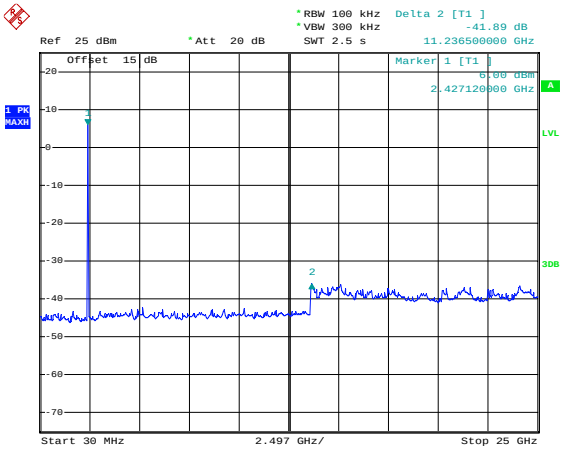
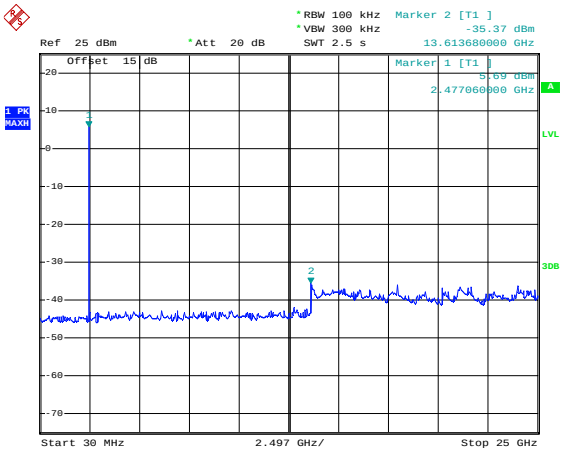
13.3. Test Procedure

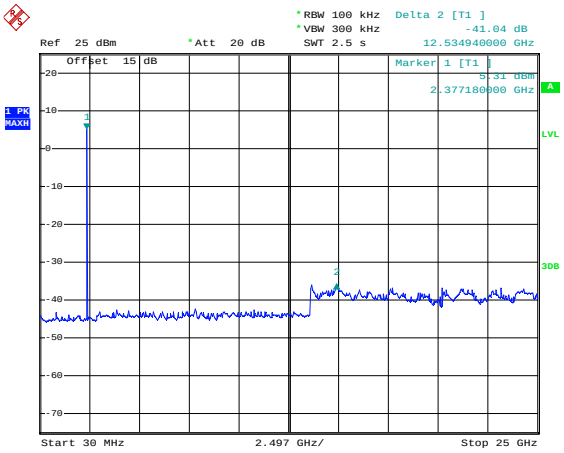
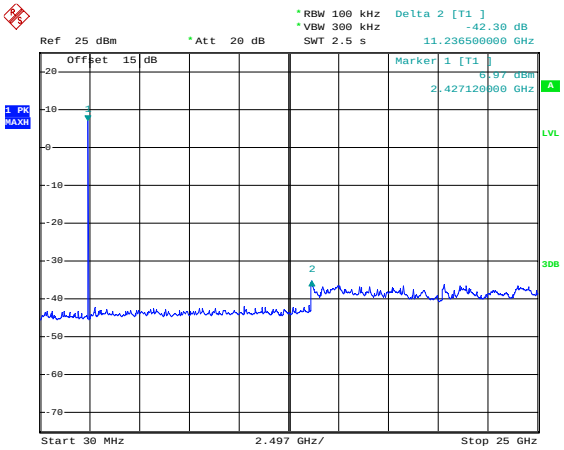
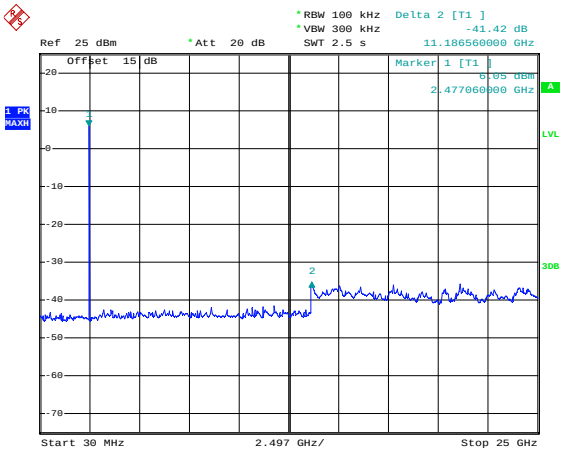
(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

(2) Spectrum Setting: RBW=100 KHz, VBW=300 KHz.
Frequency range from 30MHz to 25 GHz.

13.4. Test Data

Modulation mode	GFSK	Frequency range	30MHz~25GHz
Lowest	 Date: 02.APR.2014 15:21:48		
Middle	 Date: 02.APR.2014 15:22:19		
Highest	 Date: 02.APR.2014 15:28:48		

Modulation mode	π/4-DQPSK	Frequency range	30MHz~25GHz
Lowest	 Date: 03.APR.2014 10:04:03		
Middle	 Date: 02.APR.2014 15:41:28		
Highest	 Date: 02.APR.2014 15:40:40		

Modulation mode	8DPSK	Frequency range	30MHz~25GHz
Lowest	 Date: 02.APR.2014 16:09:13		
Middle	 Date: 02.APR.2014 16:17:00		
Highest	 Date: 02.APR.2014 16:15:26		

14. Spurious Emission (Radiated Emission Method)

14.1. Test Standard and Limit

14.1.1 Test Standard

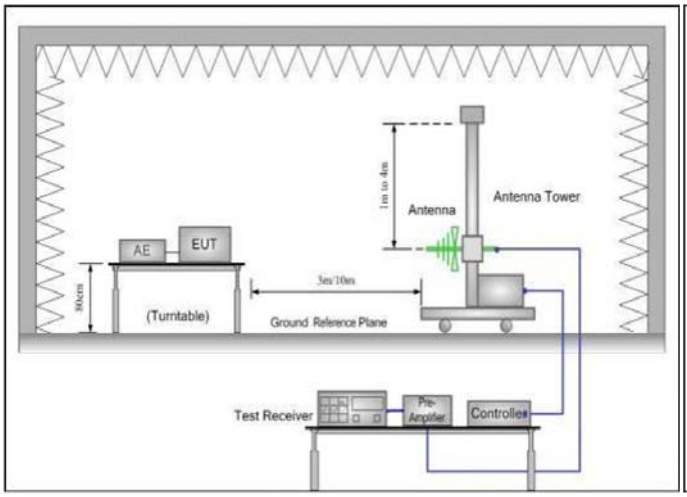
FCC Part15 C Section 15.209

14.1.2 Test Limit

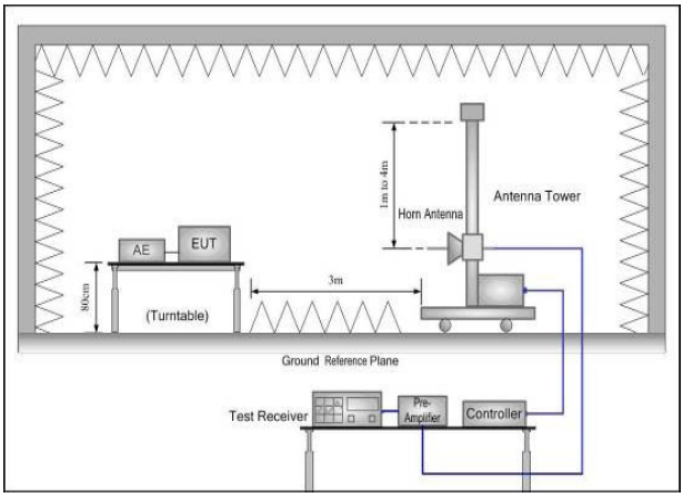
Frequency (MHz)	Limit (dBμV/m) At 3m Distance	
30MHz~88MHz	40	Quasi-peak
88MHz~216MHz	43.5	Quasi-peak
216MHz~960MHz	46	Quasi-peak
960MHz~1000MHz	54	Quasi-peak
Above 1000MHz	54	Average
	74	Peak
Remark: 1. The lower limit shall apply at the transition frequency.		

14.2. Test Setup

Below 1GHz



Above 1GHz



14.3. Test Procedure

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set

to make the measurement.

4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Peak value: RBW=1MHz, VBW=3MHz;

Average value: RBW=1MHz, VBW=10Hz;

QP Value: RBW=120kHz, VBW=300kHz

6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

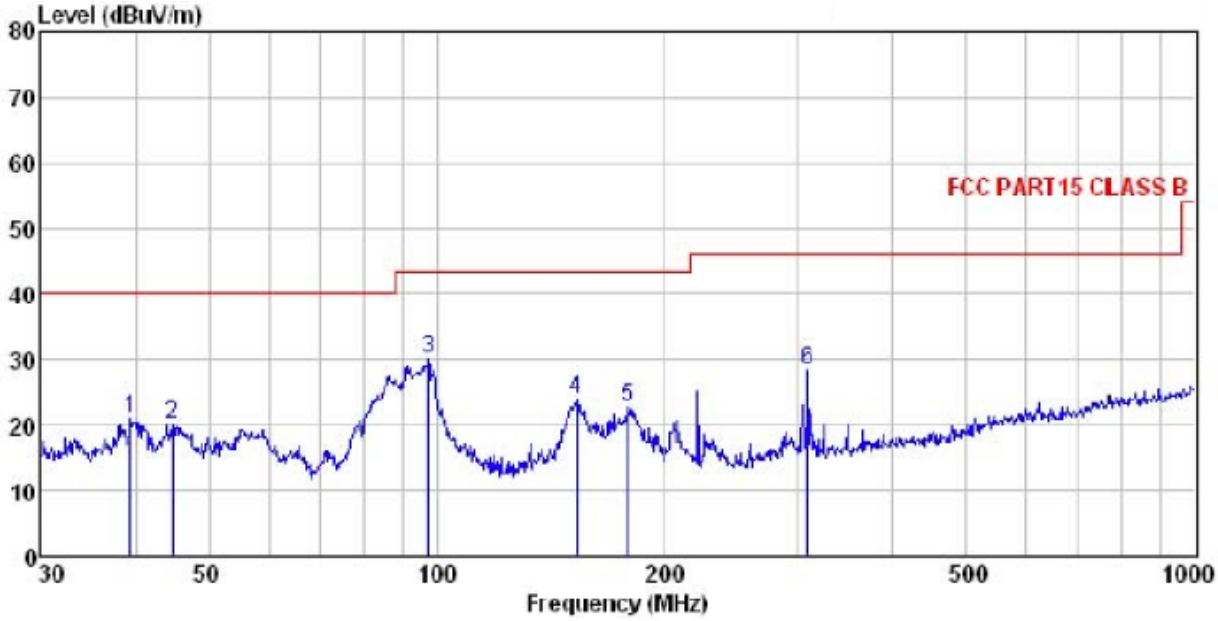
14.4. Test Data

Remark:

1. During the test, pre-scan the GFSK, π/4-DQPSK, 8-DPSK modulation, and found the GFSK modulation is the worst case.
2. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis is the worst case.
3. 9 kHz to 30 MHz is noise floor, so only shows the data of above 30MHz in this report.

Radiated Emission Test Data (Below 1GHz)

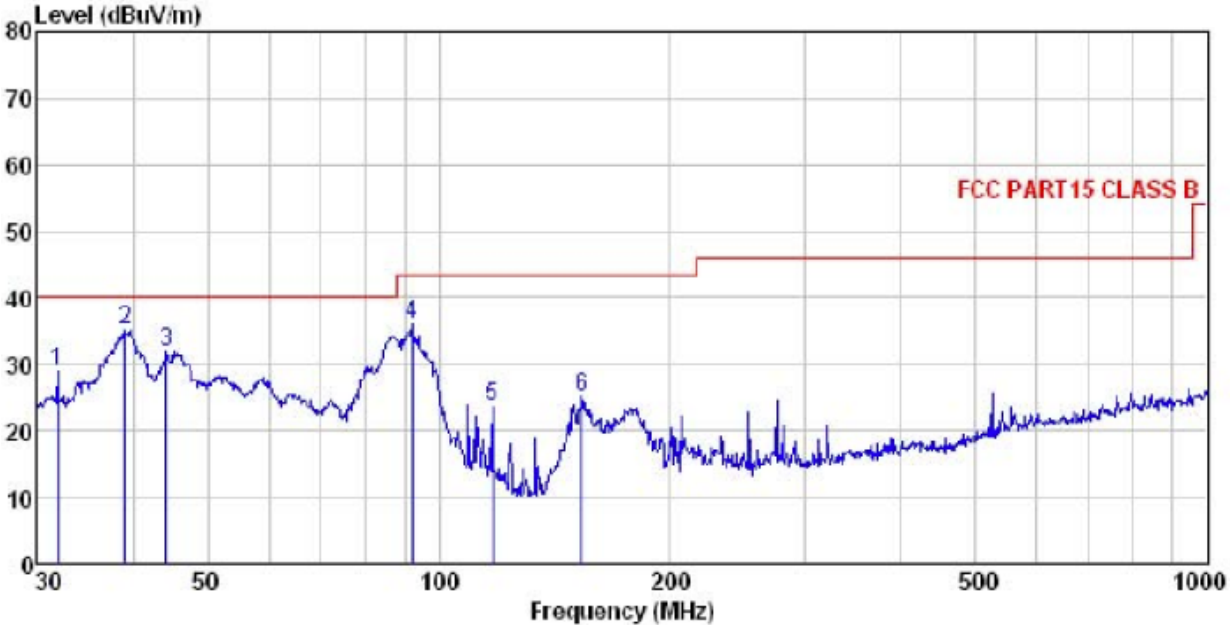
EUT:	Rugged Portable Bluetooth Speaker	M/N: Voombox-Travel
Operating Condition:	Bluetooth TX mode	
Test Site:	3m chamber	
Operator:	Jason	
Test Specification:	AC120V/60Hz	
Polarization:	Horizontal	
Note	Tem:23℃ Hum:50%	



	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	39.437	33.61	13.44	1.21	27.21	21.05	40.00	-18.95	QP
2	44.743	33.07	13.55	1.28	27.77	20.13	40.00	-19.87	QP
3	97.456	45.27	13.00	1.98	30.09	30.16	43.50	-13.34	QP
4	152.664	42.54	8.39	2.53	29.44	24.02	43.50	-19.48	QP
5	178.758	37.21	9.62	2.72	26.81	22.74	43.50	-20.76	QP
6	308.913	41.55	13.17	2.97	29.48	28.21	46.00	-17.79	QP

Radiated Emission Test Data (Below 1GHz)

EUT:	Rugged Portable Bluetooth Speaker	M/N: Voombox-Travel
Operating Condition:	Bluetooth TX mode	
Test Site:	3m chamber	
Operator:	Jason	
Test Specification:	AC120V/60Hz	
Polarization:	Vertical	
Note	Tem:23℃ Hum:50%	



	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	31.843	42.28	12.32	0.85	26.47	28.98	40.00	-11.02	QP
2	39.024	47.89	13.34	1.18	27.17	35.24	40.00	-4.76	QP
3	44.120	44.82	13.56	1.28	27.70	31.96	40.00	-8.04	QP
4	92.139	51.79	12.33	2.03	30.07	36.08	43.50	-7.42	QP
5	117.360	40.44	10.90	2.13	29.75	23.72	43.50	-19.78	QP
6	153.200	43.75	8.39	2.54	29.44	25.24	43.50	-18.26	QP

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4804.00	48.14	31.53	8.90	40.24	48.33	74.00	-25.67	V	PEAK
7206.00	46.47	36.47	10.59	41.24	52.29	74.00	-21.71	V	PEAK
9608.00	*					74.00		V	PEAK
12010.00	*					74.00		V	PEAK
14412.00	*					74.00		V	PEAK
16814.00	*					74.00		V	PEAK
4804.00	46.75	31.53	8.90	40.24	46.94	74.00	-27.06	H	PEAK
7206.00	47.42	36.47	10.59	41.24	53.24	74.00	-20.76	H	PEAK
9608.00	*					74.00		H	PEAK
12010.00	*					74.00		H	PEAK
14412.00	*					74.00		H	PEAK
16814.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4804.00	37.17	31.53	8.90	40.24	37.36	54.00	-16.64	V	AVG.
7206.00	38.14	36.47	10.59	41.24	43.96	54.00	-10.04	V	AVG.
9608.00	*					54.00		V	AVG.
12010.00	*					54.00		V	AVG.
14412.00	*					54.00		V	AVG.
16814.00	*					54.00		V	AVG.
4804.00	37.06	31.53	8.90	40.24	37.25	54.00	-16.75	H	AVG.
7206.00	36.86	36.47	10.59	41.24	42.68	54.00	-11.32	H	AVG.
9608.00	*					54.00		H	AVG.
12010.00	*					54.00		H	AVG.
14412.00	*					54.00		H	AVG.
16814.00	*					54.00		H	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss – Preamplifier Factor
2. “*”, means this data is the too weak instrument of signal is unable to test.
3. The emission levels of other frequencies are very lower than the limit and not show in test report.

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Middle				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4882.00	46.77	31.58	8.98	40.15	47.18	74.00	-26.82	V	PEAK
7323.00	46.64	36.47	10.69	41.15	52.65	74.00	-21.35	V	PEAK
9764.00	*					74.00		V	PEAK
12205.00	*					74.00		V	PEAK
14646.00	*					74.00		V	PEAK
17087.00	*					74.00		V	PEAK
4882.00	45.73	31.58	8.98	40.15	46.14	74.00	-27.86	H	PEAK
7323.00	47.73	36.47	10.69	41.15	53.75	74.00	-20.25	H	PEAK
9764.00	*					74.00		H	PEAK
12205.00	*					74.00		H	PEAK
14646.00	*					74.00		H	PEAK
17087.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4882.00	36.13	31.58	8.98	40.15	36.54	54.00	-17.46	V	AVG.
7323.00	37.64	36.47	10.69	41.15	43.65	54.00	-10.35	V	AVG.
9764.00	*					54.00		V	AVG.
12205.00	*					54.00		V	AVG.
14646.00	*					54.00		V	AVG.
17087.00	*					54.00		V	AVG.
4882.00	37.24	31.58	8.98	40.15	37.65	54.00	-16.35	H	AVG.
7323.00	36.36	36.47	10.69	41.15	42.37	54.00	-11.63	H	AVG.
9764.00	*					54.00		H	AVG.
12205.00	*					54.00		H	AVG.
14646.00	*					54.00		H	AVG.
17087.00	*					54.00		H	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss – Preamplifier Factor
2. "*", means this data is the too weak instrument of signal is unable to test.
3. The emission levels of other frequencies are very lower than the limit and not show in test report.

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4960.00	45.04	31.69	9.08	40.03	45.78	74.00	-28.22	V	PEAK
7440.00	46.65	36.60	10.80	41.05	53.00	74.00	-21.00	V	PEAK
9920.00	*					74.00		V	PEAK
12400.00	*					74.00		V	PEAK
14880.00	*					74.00		V	PEAK
17360.00	*					74.00		V	PEAK
4960.00	45.83	31.69	9.08	40.03	46.57	74.00	-27.43	H	PEAK
7440.00	46.49	36.60	10.80	41.05	52.84	74.00	-21.16	H	PEAK
9920.00						74.00		H	PEAK
12400.00	*					74.00		H	PEAK
14880.00	*					74.00		H	PEAK
17360.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4960.00	34.46	31.69	9.08	40.03	35.20	54.00	-18.80	V	AVG.
7440.00	37.31	36.60	10.80	41.05	43.65	54.00	-10.34	V	AVG.
9920.00	*					54.00		V	AVG.
12400.00	*					54.00		V	AVG.
14880.00	*					54.00		V	AVG.
17360.00	*					54.00		V	AVG.
4960.00	34.73	31.69	9.08	40.03	35.47	54.00	-18.53	H	AVG.
7440.00	37.23	36.60	10.80	41.05	43.58	54.00	-10.42	H	AVG.
9920.00	*					54.00		H	AVG.
12400.00	*					54.00		H	AVG.
14880.00	*					54.00		H	AVG.
17360.00	*					54.00		H	AVG.

Remark:

1. Final Level = Read Level + Antenna Factor + Cable Loss – Preamplifier Factor
2. “*”, means this data is the too weak instrument of signal is unable to test.
3. The emission levels of other frequencies are very lower than the limit and not show in test report.