Report No: VT1311180025E-2

FCC REPORT

Applicant:	MANOVA INTERNATIONAL LTD.
Address of Applicant:	Flat A, 13/F., Century Industrial Centre, 33~35 Au Pui Wan Street, Fo Tan, N.T., H.K.

Equipment Under Test (EUT)

Product Name:	"DRUMi" Portable Bluetooth Speaker
Model No.:	BT-18N
FCC ID:	UKWMANOVA-BT-18N
Applicable standards:	FCC CFR Title 47 Part 15 Subpart C Section 15.247:2013
Date of sample receipt:	November.18, 2013
Date of Test:	November. 18, 2013 ~ December.04, 2013
Date of report issued:	December.05, 2013
Test Result :	PASS *

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

Authorized Signature:

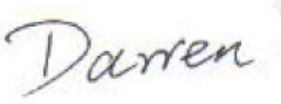
Jason
Manager

2 Version

Version No.	Date	Description
00	*December.05, 2013*	*Original*

Prepared By:  ***Date:*** December.05, 2013

Project Engineer

Check By:  ***Date:*** December.05, 2013

Reviewer

3 Contents

Page

1 COVER PAGE 1

2 VERSION 3

3 CONTENTS 3

4 TEST SUMMARY 4

5 GENERAL INFORMATION 5

5.1 CLIENT INFORMATION 5
5.2 GENERAL DESCRIPTION OF E.U.T. 5
5.3 TEST ENVIRONMENT AND MODE 7
5.4 TEST FACILITY 7
5.5 TEST LOCATION 7
5.6 DESCRIPTION OF SUPPORT UNITS 7
5.7 DEVIATION FROM STANDARDS 7
5.8 ABNORMALITIES FROM STANDARD CONDITIONS 7
5.9 OTHER INFORMATION REQUESTED BY THE CUSTOMER 7
5.10 DESCRIPTION OF EUT ATTACHMENT 7
5.11 TEST INSTRUMENTS LIST 8

6 TEST RESULTS AND MEASUREMENT DATA 9

6.1 ANTENNA REQUIREMENT: 9
6.2 CONDUCTED EMISSIONS 10
6.3 CONDUCTED PEAK OUTPUT POWER 13
6.4 20DB OCCUPY BANDWIDTH 20
6.5 CARRIER FREQUENCIES SEPARATION 26
6.6 HOPPING CHANNEL NUMBER 33
6.7 DWELL TIME 35
6.8 BAND EDGE 41
6.8.1 Conducted Emission 41
6.8.2 Radiated Emission 44
6.9 SPURIOUS EMISSION 47
6.9.1 Conducted Spurious Emission 47
6.9.2 Radiated Spurious Emission 51
6.9.2.1 Radiated emission below 1GHz 51
6.9.2.2 Transmitter emission above 1GHz 53
6.10 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE 56

4 Test Summary

Test Item	Section in CFR 47	Result
Antenna Requirement	15.203/15.247 (c)	PASS
AC Power Line Conducted Emission	15.207	PASS
Conducted Peak Output Power	15.247 (b)(1)	PASS
20dB Occupied Bandwidth	15.247 (a)(1)	PASS
Carrier Frequencies Separation	15.247 (a)(1)	PASS
Hopping Channel Number	15.247 (a)(1)	PASS
Dwell Time	15.247 (a)(1)	PASS
Band Edge	15.247(d)/15.205/15.209	PASS
Radiated Emission	15.247(d)/15.205/15.209	PASS
Pseudorandom Frequency Hopping Sequence	15.247(b)(4)&TCB Exclusion List (7 July 2002)	PASS

Remark:

- *Pass: The EUT complies with the essential requirements in the standard.*
- *Tx: In this whole report Tx (or tx) means Transmitter.*
- *Rx: In this whole report Rx (or rx) means Receiver.*

5 General Information

5.1 Client Information

Applicant:	MANOVA INTERNATIONAL LTD.
Address of Applicant:	Flat A, 13/F., Century Industrial Centre, 33~35 Au Pui Wan Street, Fo Tan, N.T., H.K.
Manufacturer/Factory:	MANOVA INTERNATIONAL LTD.
Address of Manufacturer /Factory:	Flat A, 13/F., Century Industrial Centre, 33~35 Au Pui Wan Street, Fo Tan, N.T., H.K.

5.2 General Description of E.U.T.

Product Name:	“DRUMi” Portable Bluetooth Speaker
Model No.:	BT-18N
Operation Frequency:	2402MHz~2480MHz
Channel numbers:	79
Channel separation:	1MHz
Modulation type:	Frequency Hopping Spread Spectrum (FHSS)
Modulation Technology:	GFSK, π/4 PSK, 8DPSK
Antenna Type:	PCB Antenna
Antenna gain:	0dBi (Declare by manufacturer)
Power supply:	DC 3.7V/400mAh by Battery
Remark:	N/A

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2402MHz	21	2422MHz	41	2442MHz	61	2462MHz
2	2403MHz	22	2423MHz	42	2443MHz	62	2463MHz
3	2404MHz	23	2424MHz	43	2444MHz	63	2464MHz
4	2405MHz	24	2425MHz	44	2445MHz	64	2465MHz
5	2406MHz	25	2426MHz	45	2446MHz	65	2466MHz
6	2407MHz	26	2427MHz	46	2447MHz	66	2467MHz
7	2408MHz	27	2428MHz	47	2448MHz	67	2468MHz
8	2409MHz	28	2429MHz	48	2449MHz	68	2469MHz
9	2410MHz	29	2430MHz	49	2450MHz	69	2470MHz
10	2411MHz	30	2431MHz	50	2451MHz	70	2471MHz
11	2412MHz	31	2432MHz	51	2452MHz	71	2472MHz
12	2413MHz	32	2433MHz	52	2453MHz	72	2473MHz
13	2414MHz	33	2434MHz	53	2454MHz	73	2474MHz
14	2415MHz	34	2435MHz	54	2455MHz	74	2475MHz
15	2416MHz	35	2436MHz	55	2456MHz	75	2476MHz
16	2417MHz	36	2437MHz	56	2457MHz	76	2477MHz
17	2418MHz	37	2438MHz	57	2458MHz	77	2478MHz
18	2419MHz	38	2439MHz	58	2459MHz	78	2479MHz
19	2420MHz	39	2440MHz	59	2460MHz	79	2480MHz
20	2421MHz	40	2441MHz	60	2461MHz		

Note:
In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
The lowest channel	2402MHz
The middle channel	2441MHz
The Highest channel	2480MHz

5.3 Test environment and mode

Operating Environment:	
Temperature:	24.0 °C
Humidity:	52 % RH
Atmospheric Pressure:	1010 mbar
Test mode:	
Transmitting mode:	Keep the EUT in communicating mode on transmitter function.

5.4 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

● **FCC —Registration No.: 987723**

Dongguan Volt Compliance Testing Service Co.,Ltd. EMC Laboratory has been registered and fuly described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in files. Registration 987723, July 08, 2013.

● **Industry Canada (IC) —Submission No.: 169466**

The 3m Semi-anechoic chamber of Dongguan Volt Compliance Testing Service Co.,Ltd. has been Registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Submission No.: 169466.

5.5 Test Location

All tests were performed at:

Dongguan Volt Compliance Testing Service Co.,Ltd.
Address: 6/F,Fuwei Buiding,No.88 Hongtu Road,Nancheng District,Dongguan, Guangdong, P.R.China.
Tel: +86-769-21663588, Fax:+86-769-21660978

5.6 Description of Support Units

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last cal date (mm-dd-yy)	Cal Interval
1	Desktop Computers	HP	Pro 3005 MT	4CV1324FBS	N/A	N/A

5.7 Deviation from Standards

None.

5.8 Abnormalities from Standard Conditions

None.

5.9 Other Information Requested by the Customer

None.

5.10 Description of EUT attachment

Item	Appellation	Model No.	Length (m)	Shielding performance
1.	Mini USB (Charger + Audio) Line	N/A	0.25	Unshielded

5.11 Test Instruments list

Conducted Emission:

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last cal date (mm-dd-yy)	Cal Interval
1	Test Receiver	Rohde & Schwarz	ESCI	101152	Oct.25,2013	1 year
2	L.I.S.N	Rohde & Schwarz	ENV 216	101317	Oct.09,2013	1 year
3	L.I.S.N	Schwarzbeck	NNLK8129	8129-212	Oct.09,2013	1 year
4	RF Switching Unit	Compliance Direction Systems Inc.	RSU-M2	38311	Oct.09,2013	1 year
5	Pulse Limiter	MTS-systemtechnik	MTS-IMP-136	261115-010-0022	Oct.09,2013	1 year

Radiated Emission:

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last cal date (mm-dd-yy)	Cal Interval
1	Loop Antenna	COM-Power	AL-130	AL-142	Oct.28,2013	1 year
2	Log-periodic Antenna	Schwarzbeck	VULB9162	9162-010	Oct.28,2013	1 year
3	Horn Antenna	COM-Power	AH-118	071078	Oct.28,2013	1 year
4	Horn Antenna	Schwarzbeck	BBHA9170	9170-372	Oct.28,2013	1 year
5	Power Amplifier	HP	HP 8447D	1145A00203	Oct.09,2013	1 year
6	Pre-Amplifier	Agilent	8449B	3008A02964	Oct.09,2013	1 year
7	Test Receiver	Rohde & Schwarz	ESCI7	100837	Oct.25,2013	1 year
8	Spectrum Analyzer	Agilent	E4408B	MY41440717	Oct.25,2013	1 year
9	Cable	Huber + Suhner	CBL2-NN-9M	22390001	Oct.09,2013	1 year
10	Cable	Huber + Suhner	CIL02	N/A	Oct.09,2013	1 year
11	Positioning Controller	UC	UC 3000	N/A	N/A	N/A
12	Single Phase Power Line Filter	SAEMC	PF201A-32	110210	N/A	N/A
13	3 Phase Power Line Filter	SAEMC	PF401A-200	110318	N/A	N/A
14	DC Power Filter	SAEMC	PF301A-200	110245	N/A	N/A
15	Color Monitor	SUNSPO	SP-140A	N/A	N/A	N/A

RF conducted:

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last cal date (mm-dd-yy)	Cal Interval
1	Test Receiver	Rohde & Schwarz	ESCI7	100837	Oct.25,2013	1 year
2	Spectrum Analyzer	Agilent	E4408B	MY41440717	Oct.25,2013	1 year
3	Coaxial cable	Volt	20cm	N/A	N/A	N/A

6 Test results and Measurement Data

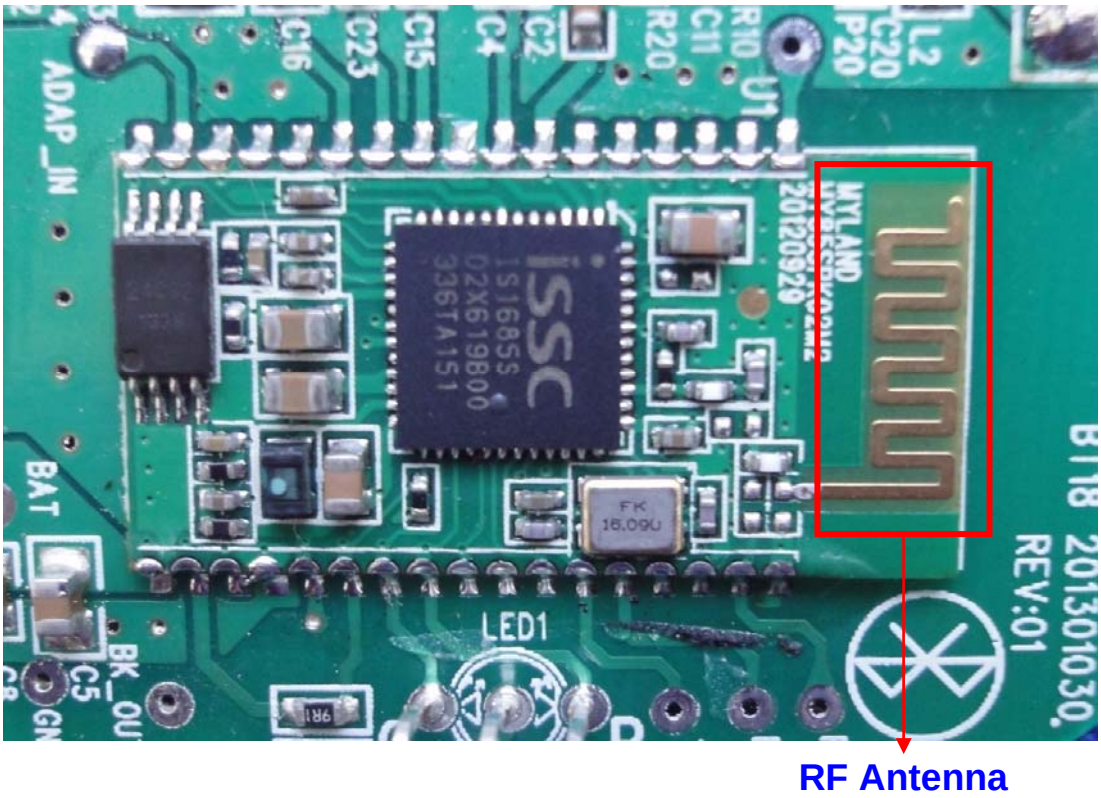
6.1 Antenna requirement:

Standard requirement:	FCC Part15 C Section 15.203 /247(c)

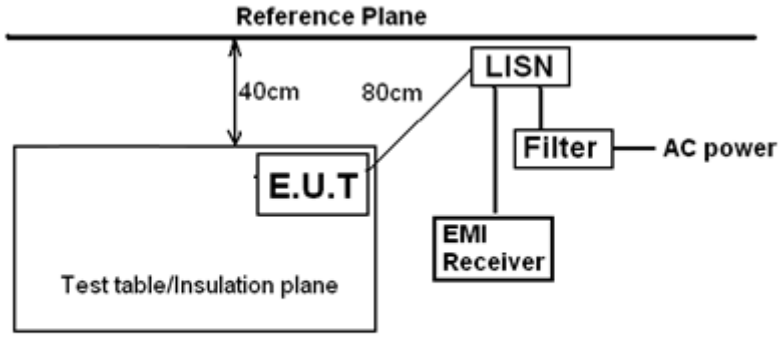
15.203 requirement:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer 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.
15.247(c) (1)(i) requirement:
(i) 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 6dBi.

E.U.T Antenna:	

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 0dBi.



6.2 Conducted Emissions

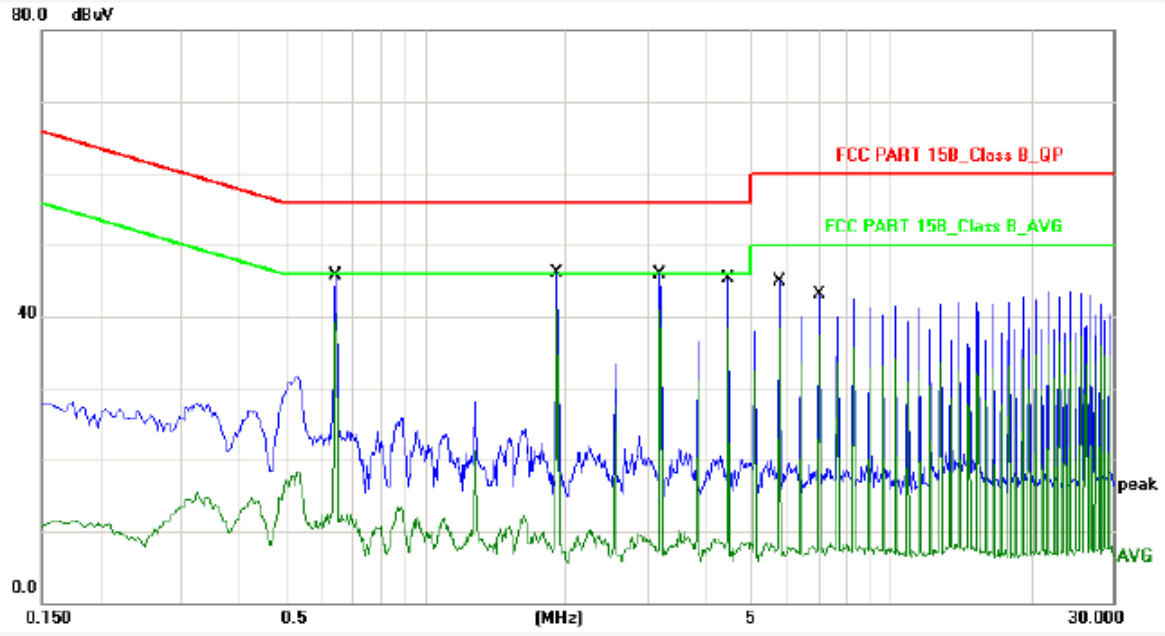
Test Requirement:	FCC Part15 C Section 15.207
Test Method:	ANSI C63.4:2003
Test Frequency Range:	150KHz to 30MHz
Class / Severity:	Class B
Receiver setup:	RBW=9KHz, VBW=30KHz
Limit:	Frequency range (MHz) / Limit (dBuV): Quasi-peak / Average 0.15-0.5: 66 to 56* / 56 to 46* 0.5-5: 56 / 46 5-30: 60 / 50 * Decreases with the logarithm of the frequency.
Test procedure	The E.U.T and simulators are connected to the main power through a line impedance stabilization network(L.I.S.N.). The provide a 50ohm/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refers to the block diagram of the test setup and photographs). Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2003 on conducted measurement.
Test setup:	 *Remark* *E.U.T: Equipment Under Test* *LISN: Line Impedence Stabilization Network* *Test table height=0.8m*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Live Line:

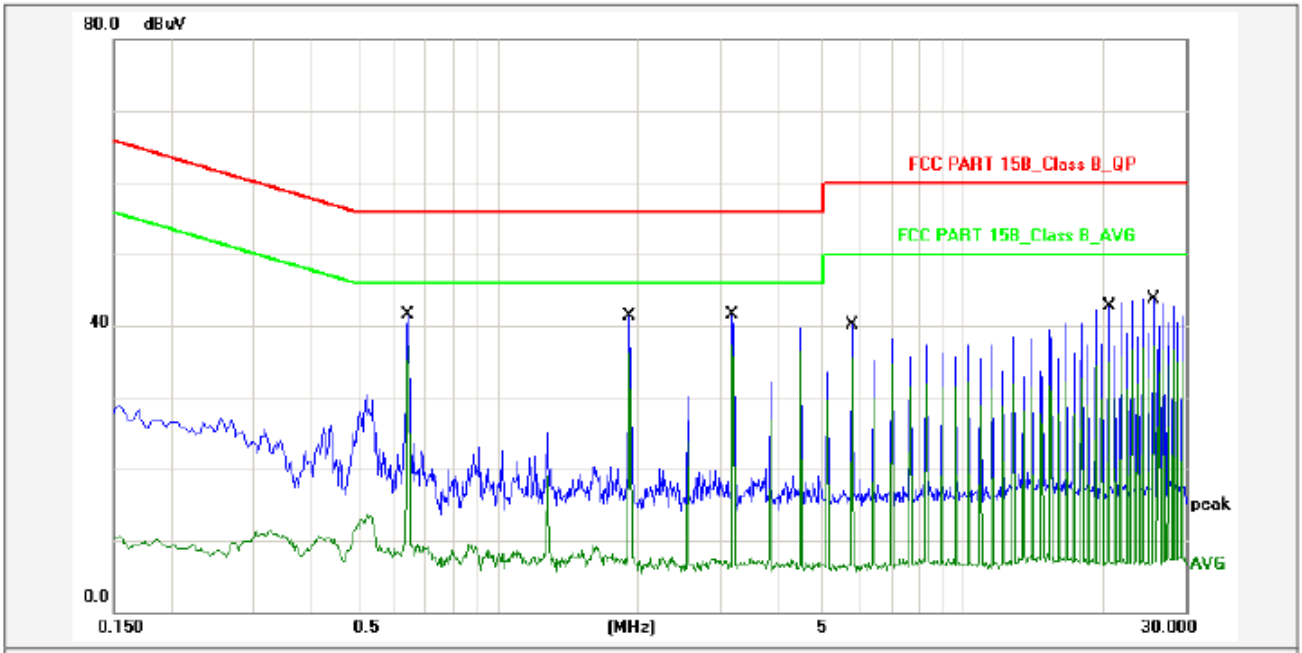


Report No.:	EV1311180025-2		
Test Standard:	FCC PART 15B_Class B_QP		
Test item:	Conducted Emission	Phase:	L1
Applicant:	MANOVA	Temp.( )/Hum.(%):	24(C) / 54 %
Product:	"DRUMi" Portable Bluetooth Speaker	Power Rating:	AC 120V/60Hz
Model No.:	BT-18N	Test Engineer:	Peter
Test Mode:	Charging+BT mode		
Remark:			

No.	Frequency (MHz)	Factor (dBuV)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.6419	10.80	34.30	45.10	56.00	-10.90	QP	P	
2	0.6419	10.80	30.20	41.00	46.00	-5.00	AVG	P	
3	1.9220	10.80	33.80	44.60	56.00	-11.40	QP	P	
4	1.9220	10.80	29.50	40.30	46.00	-5.70	AVG	P	
5	3.2060	10.80	33.40	44.20	56.00	-11.80	QP	P	
6	3.2060	10.80	30.16	40.96	46.00	-5.04	AVG	P	
7	4.4860	10.80	33.70	44.50	56.00	-11.50	QP	P	
8	4.4860	10.80	25.40	36.20	46.00	-9.80	AVG	P	
9	5.7700	10.80	31.70	42.50	60.00	-17.50	QP	P	
10	5.7700	10.80	25.70	36.50	50.00	-13.50	AVG	P	
11	7.0540	10.80	30.40	41.20	60.00	-18.80	QP	P	
12	7.0540	10.80	24.80	35.60	50.00	-14.40	AVG	P	

Notes: Level=Reading+Factor. Margin=Level-Limit.

Neutral Line:



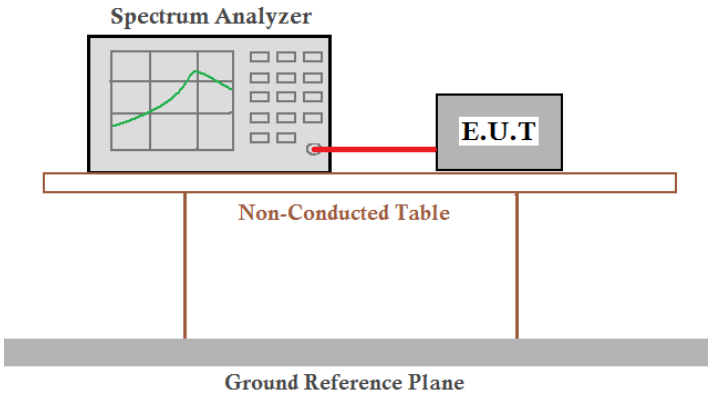
Report No.: EV1311180025-2
Test Standard: FCC PART 15B_Class B_QP
Test item: Conducted Emission
Phase: N
Applicant: MANOVA
Temp.( )/Hum.(%): 24C) / 54 %
Product: "DRUMi" Portable Bluetooth Speaker
Power Rating: AC 120V/60Hz
Model No.: BT-18N
Test Engineer: Peter

Test Mode: Charging+BT mode
Remark:

No.	Frequency (MHz)	Factor (dBuV)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1606	10.80	45.17	55.97	65.43	-9.46	QP	P	
2	0.1606	10.80	23.26	34.06	55.43	-21.37	AVG	P	
3	0.4979	10.80	39.04	49.84	56.03	-6.19	QP	P	
4	0.4979	10.80	21.77	32.57	46.03	-13.46	AVG	P	
5	0.5700	10.80	34.79	45.59	56.00	-10.41	QP	P	
6	0.5700	10.80	17.39	28.19	46.00	-17.81	AVG	P	
7	1.2016	10.80	32.73	43.53	56.00	-12.47	QP	P	
8	1.2016	10.80	12.95	23.75	46.00	-22.25	AVG	P	
9	5.9378	10.80	32.07	42.87	60.00	-17.13	QP	P	
10	5.9378	10.80	13.09	23.89	50.00	-26.11	AVG	P	
11	27.7140	10.80	30.60	41.40	60.00	-18.60	QP	P	
12	27.7140	10.80	15.14	25.94	50.00	-24.06	AVG	P	

Notes: Level=Reading+Factor. Margin=Level-Limit.

6.3 Conducted Peak Output Power

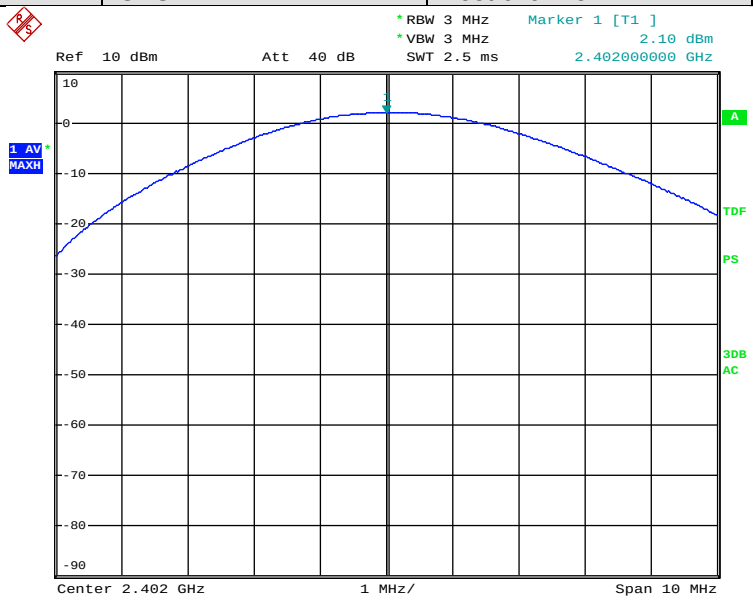
Test Requirement:	FCC Part15 C Section 15.247 (b)(3)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=3MHz, VBW=3MHz, Detector=Peak
Limit:	30dBm
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer. Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Measurement Data:

GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	2.10	30.00	Pass
Middle	2.70	30.00	Pass
Highest	3.23	30.00	Pass
Π/4 PSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	0.25	30.00	Pass
Middle	0.86	30.00	Pass
Highest	1.52	30.00	Pass
8DPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	0.22	30.00	Pass
Middle	0.90	30.00	Pass
Highest	1.52	30.00	Pass

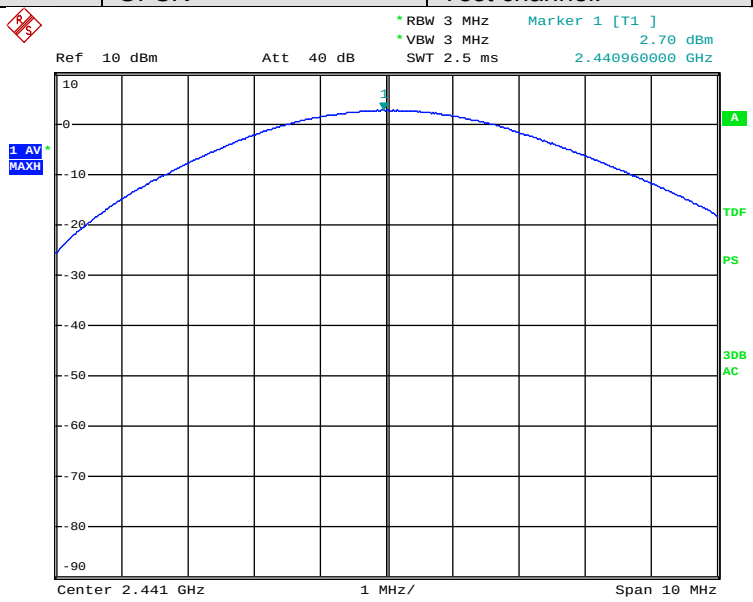
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



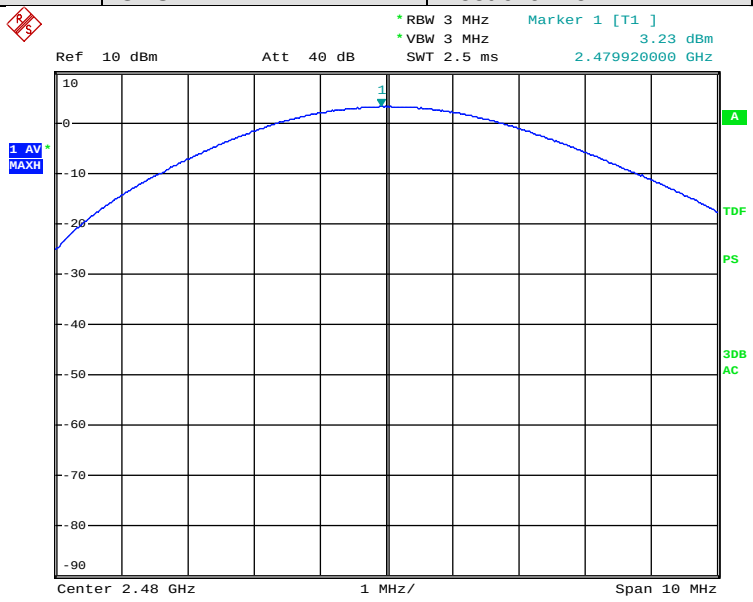
Date: 2.DEC.2013 11:21:51

Test mode:	GFSK	Test channel:	Middle



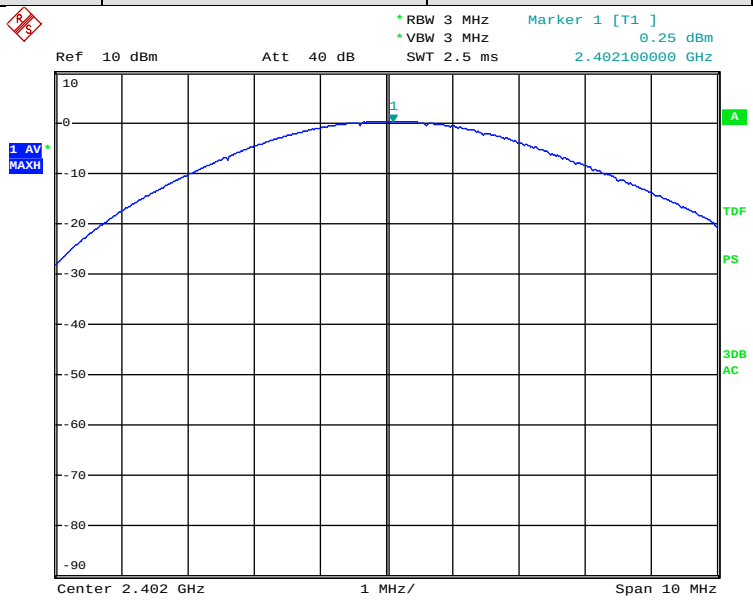
Date: 2.DEC.2013 11:22:09

Test mode:	GFSK	Test channel:	Highest



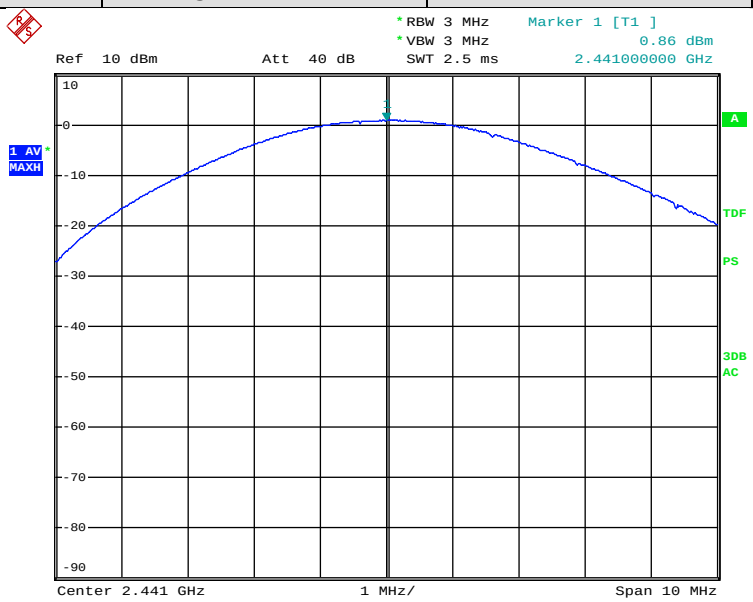
Date: 2.DEC.2013 11:22:27

Test mode:	Π/4 PSK	Test channel:	Lowest



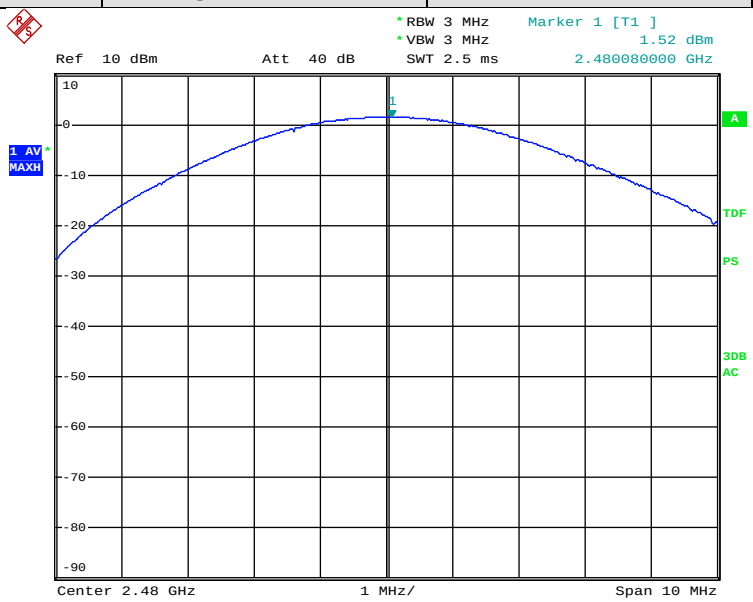
Date: 2.DEC.2013 11:23:05

Test mode:	Π/4 PSK	Test channel:	Middle



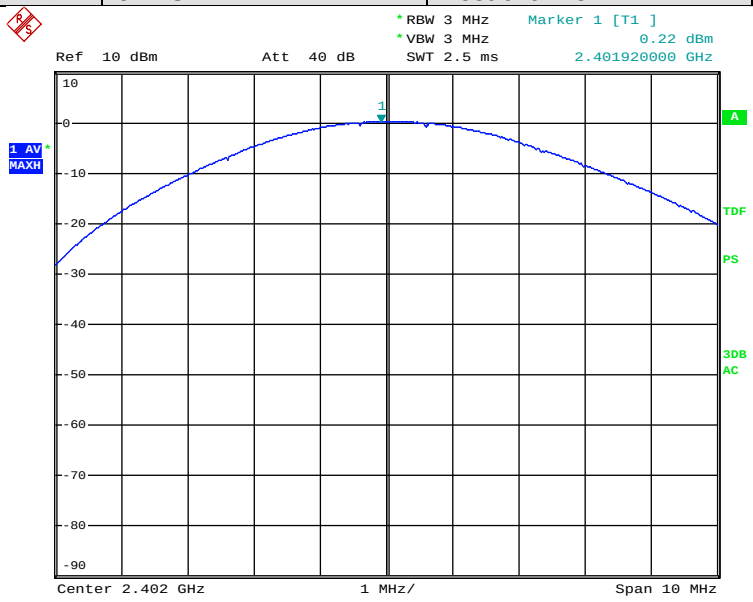
Date: 2.DEC.2013 11:23:32

Test mode:	Π/4 PSK	Test channel:	Highest



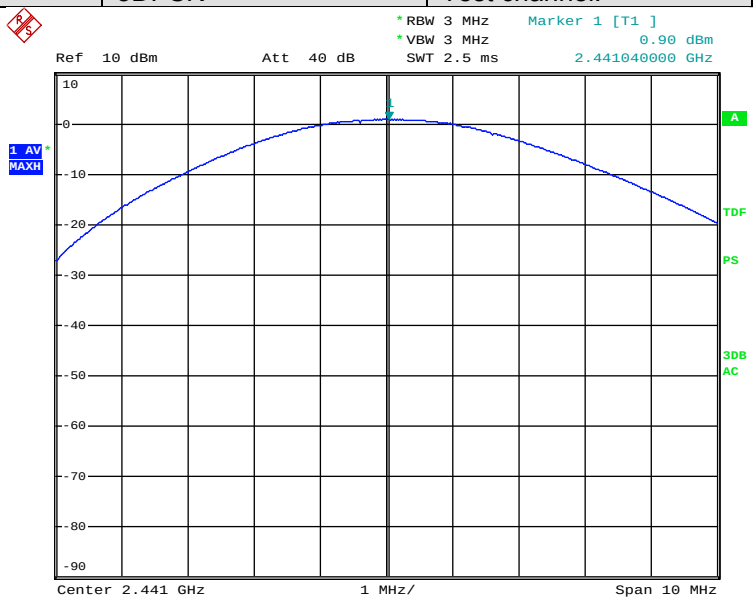
Date: 2.DEC.2013 11:24:02

Test mode:	8DPSK	Test channel:	Lowest



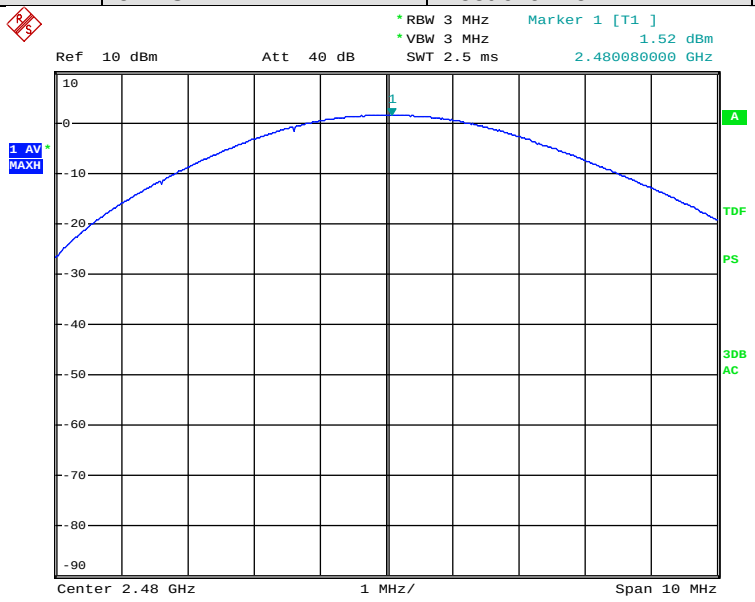
Date: 2.DEC.2013 11:24:34

Test mode:	8DPSK	Test channel:	Middle



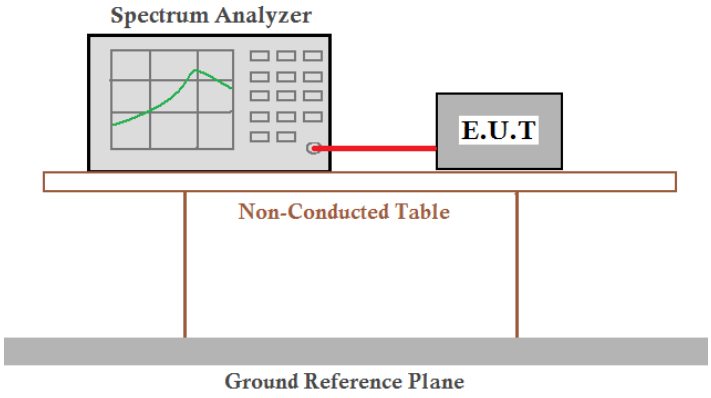
Date: 2.DEC.2013 11:25:51

Test mode:	8DPSK	Test channel:	Highest



Date: 2.DEC.2013 11:26:30

6.4 20dB Occupy Bandwidth

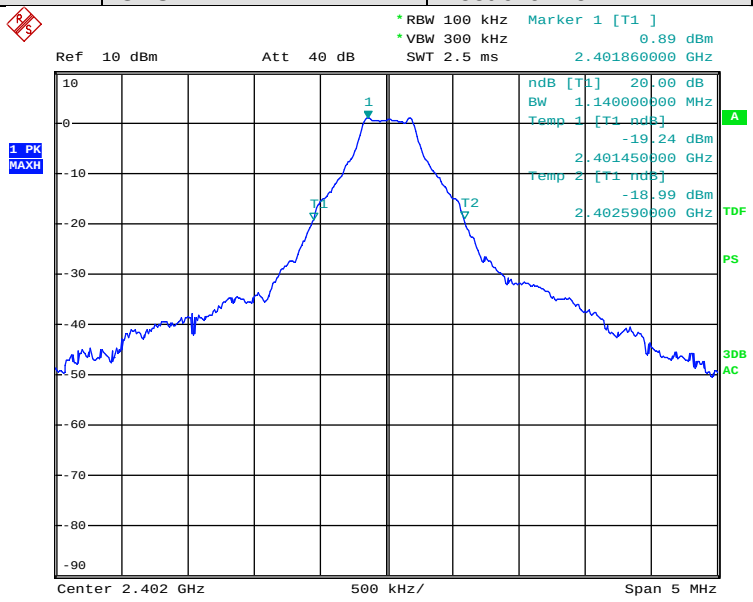
Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=30KHz, VBW=100KHz,detector=Peak
Limit:	N/A
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer. Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Measurement Data:

Test Channel	20dB Occupy Bandwidth (KHz)		
	GFSK	Π/4 PSK	8DPSK
Lowest	1140	1360	1370
Middle	1140	1360	1380
Highest	1140	1350	1370

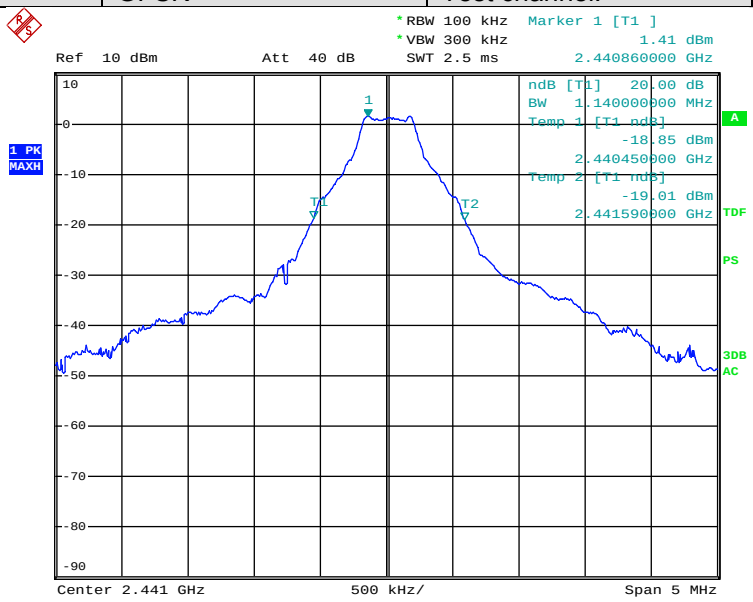
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



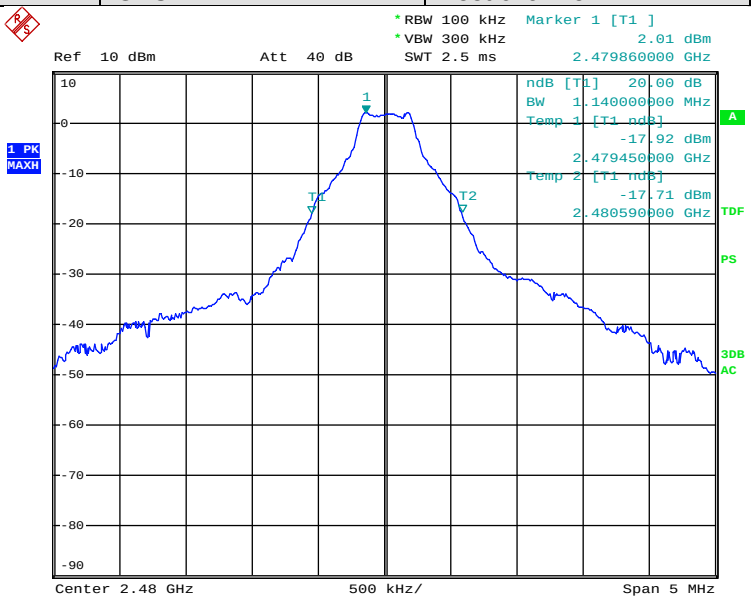
Date: 2.DEC.2013 10:06:52

Test mode:	GFSK	Test channel:	Middle



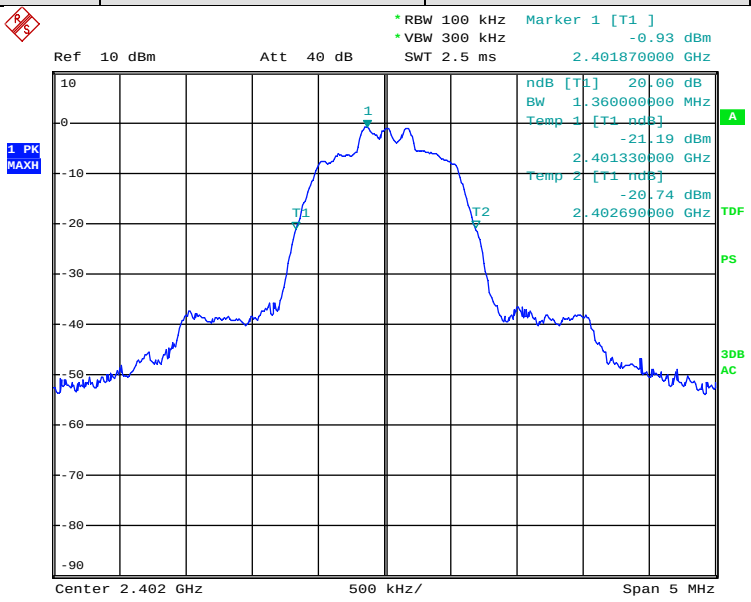
Date: 2.DEC.2013 10:10:36

Test mode:	GFSK	Test channel:	Highest



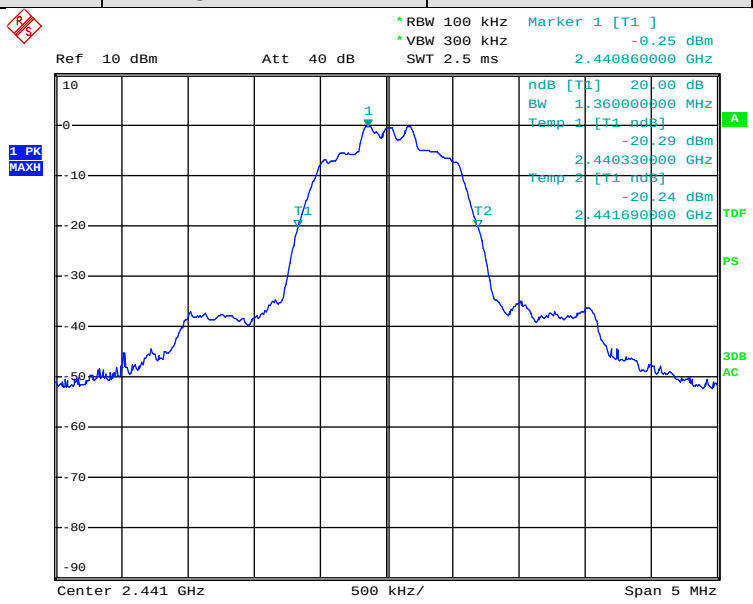
Date: 2.DEC.2013 10:14:10

Test mode:	Π/4 PSK	Test channel:	Lowest



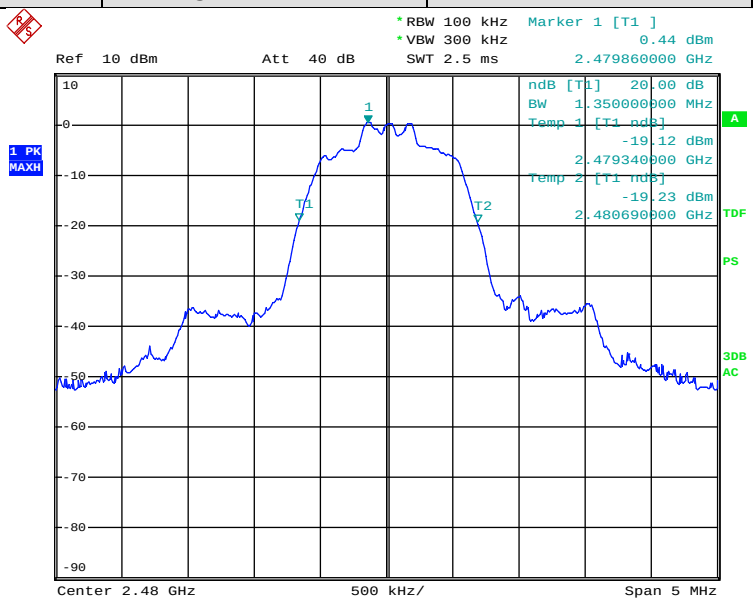
Date: 2.DEC.2013 10:16:18

Test mode:	Π/4 PSK	Test channel:	Middle



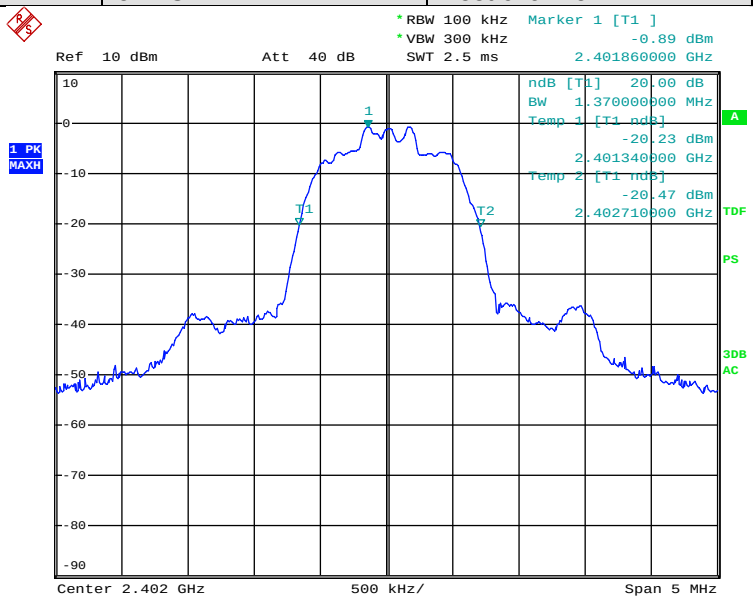
Date: 2.DEC.2013 10:19:28

Test mode:	Π/4 PSK	Test channel:	Highest



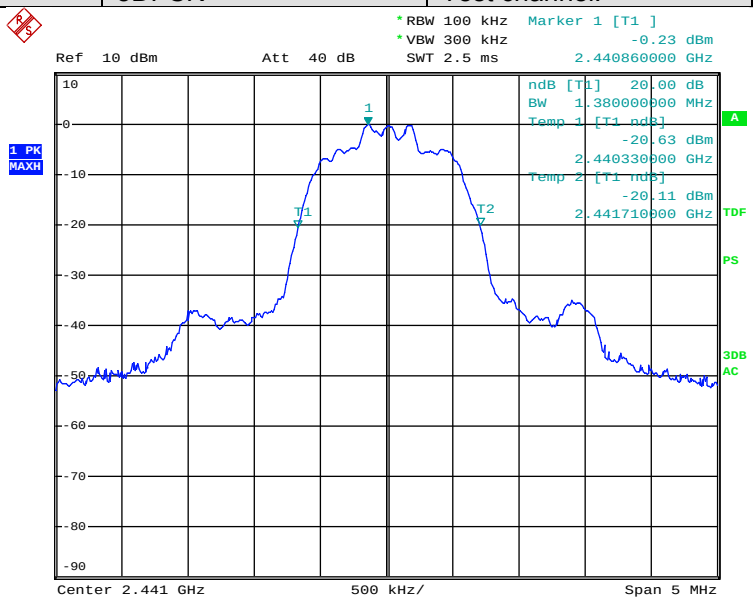
Date: 2.DEC.2013 10:22:56

Test mode:	8DPSK	Test channel:	Lowest



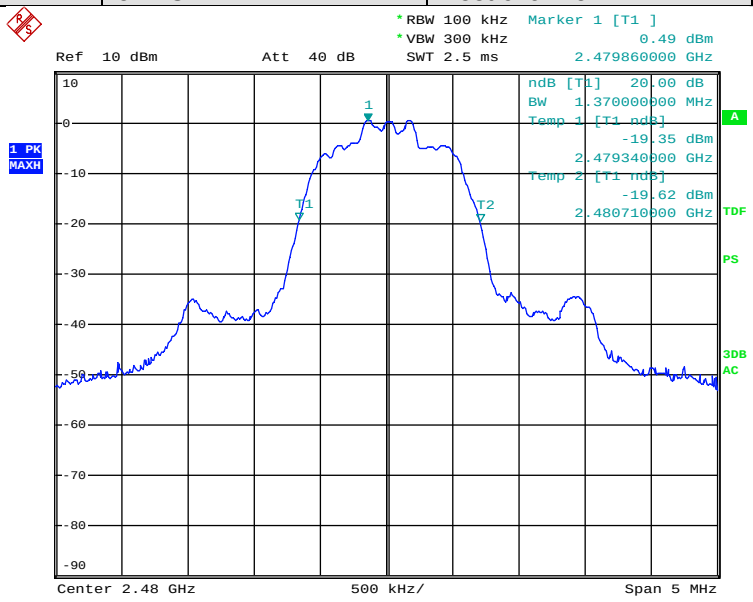
Date: 2.DEC.2013 10:25:18

Test mode:	8DPSK	Test channel:	Middle



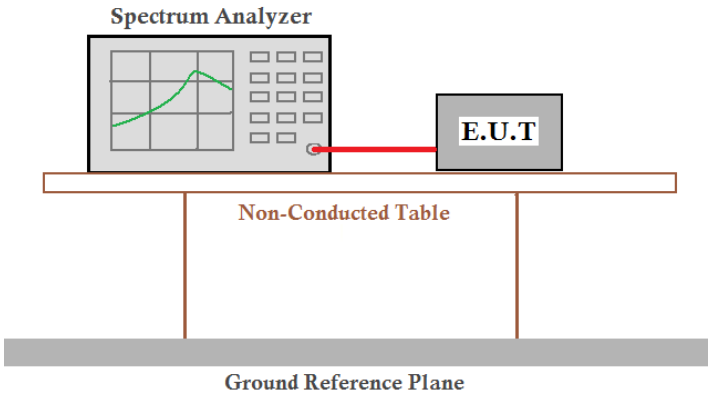
Date: 2.DEC.2013 10:28:25

Test mode:	8DPSK	Test channel:	Highest



Date: 2.DEC.2013 10:32:22

6.5 Carrier Frequencies Separation

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=100KHz, VBW=300KHz, detector=Peak
Limit:	0.025MHz or 2/3 of the 20dB bandwidth (whichever is greater)
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer. Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

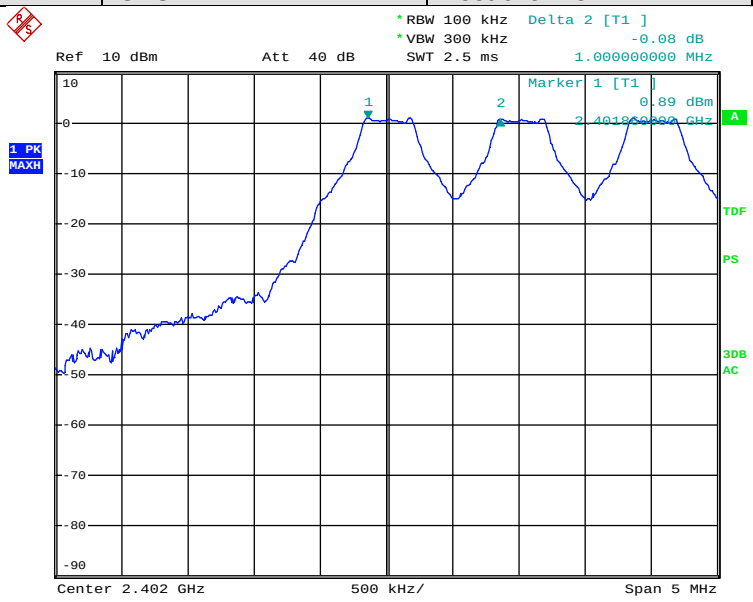
Measurement Data			
GFSK mode			
Test channel	Carrier Frequencies Separation (KHz)	Limit (KHz)	Result
Lowest	1000	920	Pass
Middle	1000	920	Pass
Highest	1000	920	Pass
Π/4 PSK mode			
Test channel	Carrier Frequencies Separation (KHz)	Limit (KHz)	Result
Lowest	1000	920	Pass
Middle	1000	920	Pass
Highest	1000	920	Pass
8DPSK mode			
Test channel	Carrier Frequencies Separation (KHz)	Limit (KHz)	Result
Lowest	1000	920	Pass
Middle	1000	920	Pass
Highest	1000	920	Pass

Note: According to section 5.4,

Mode	*20dB bandwidth (KHz) (worse case)*	*Limit (KHz) (Carrier Frequencies Separation)*
GFSK	*1140*	*760*
Π/4 PSK	*1360*	*907*
8DPSK	*1380*	*920*

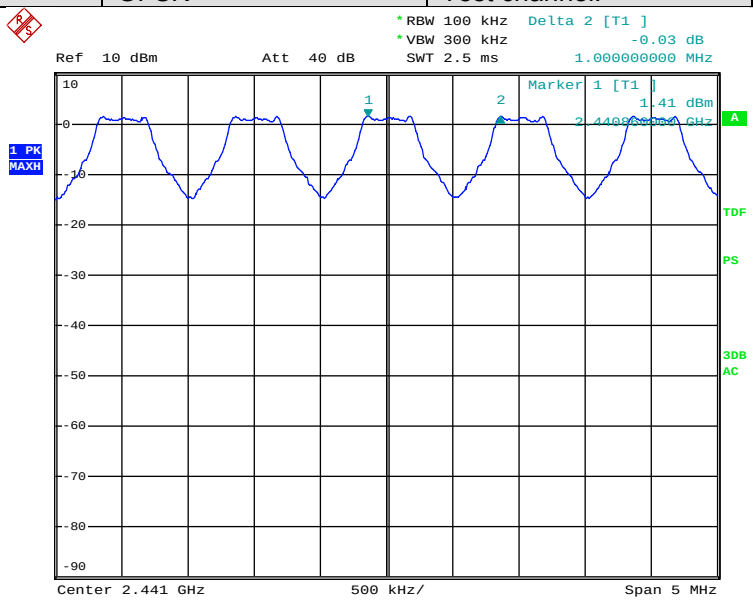
Test plot as follows:

Test mode:	GFSK	Test channel:	Lowest



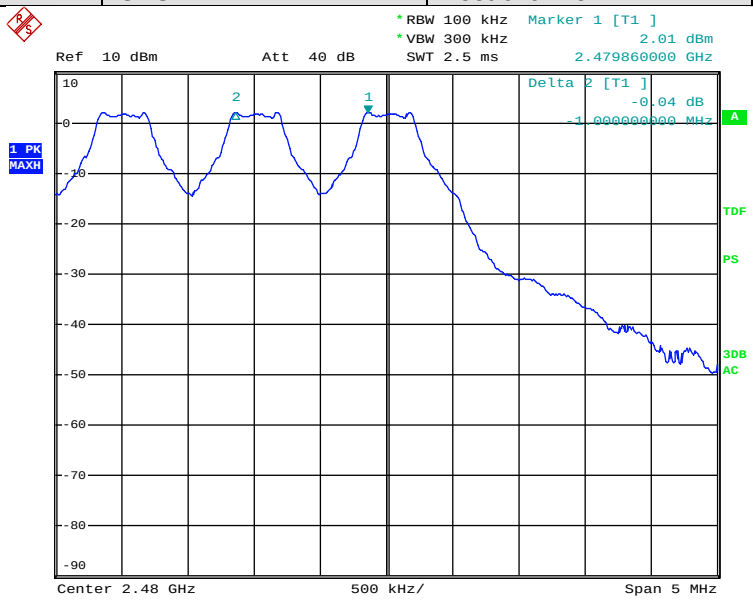
Date: 2.DEC.2013 10:08:08

Test mode:	GFSK	Test channel:	Middle



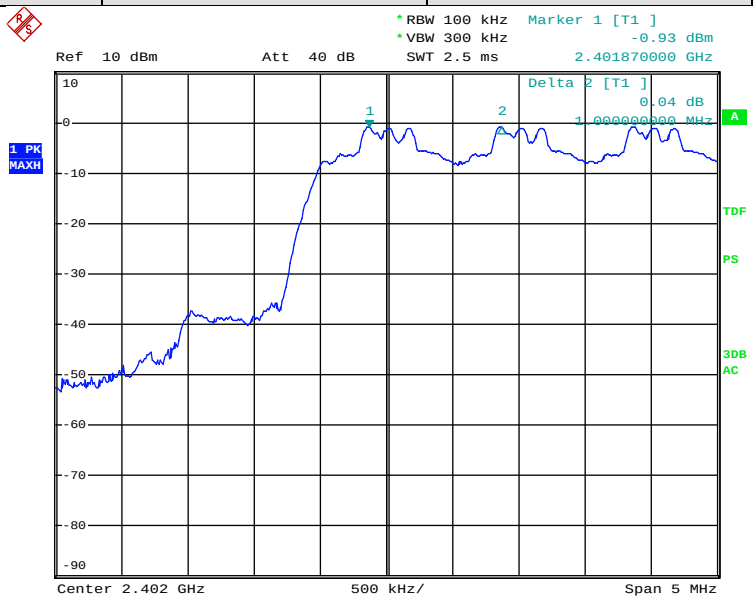
Date: 2.DEC.2013 10:12:47

Test mode:	GFSK	Test channel:	Highest



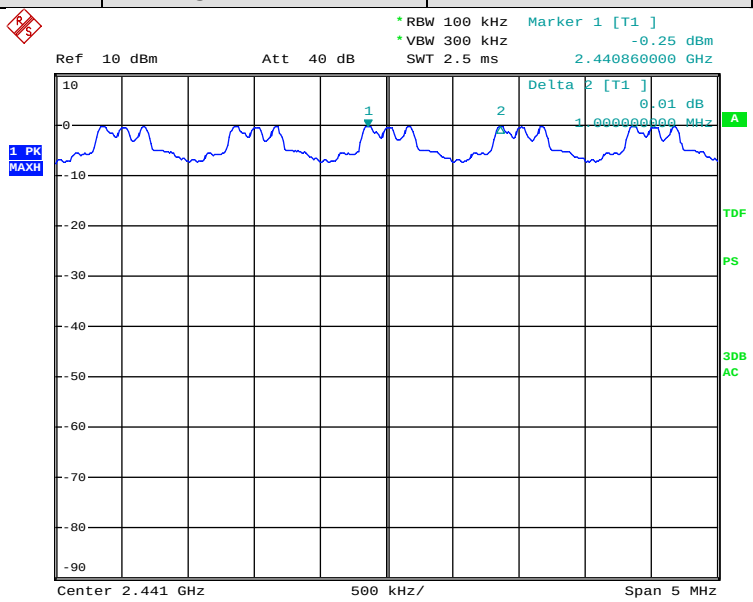
Date: 2.DEC.2013 10:15:17

Test mode:	Π/4 PSK	Test channel:	Lowest



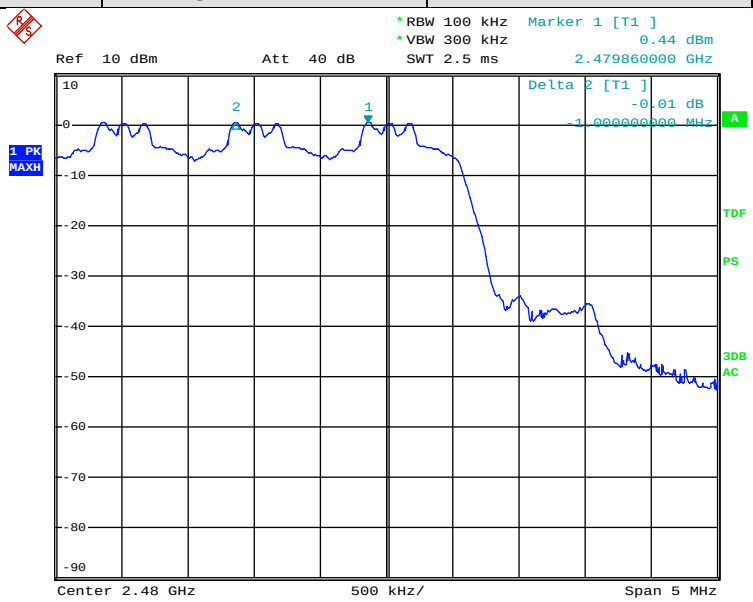
Date: 2.DEC.2013 10:18:13

Test mode:	Π/4 PSK	Test channel:	Middle



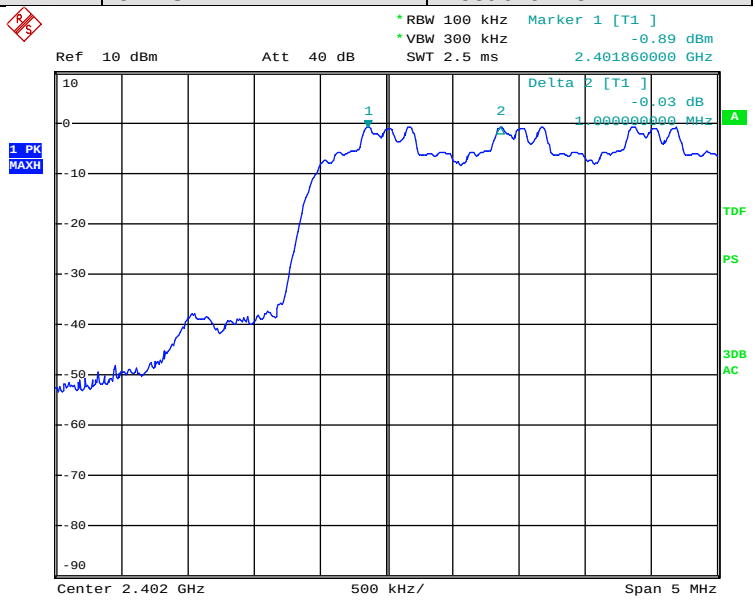
Date: 2.DEC.2013 10:22:02

Test mode:	Π/4 PSK	Test channel:	Highest



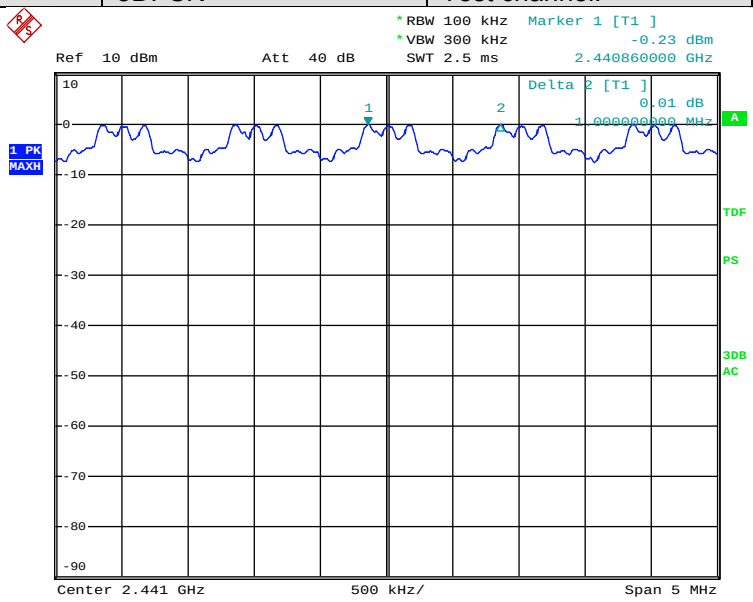
Date: 2.DEC.2013 10:24:22

Test mode:	8DPSK	Test channel:	Lowest



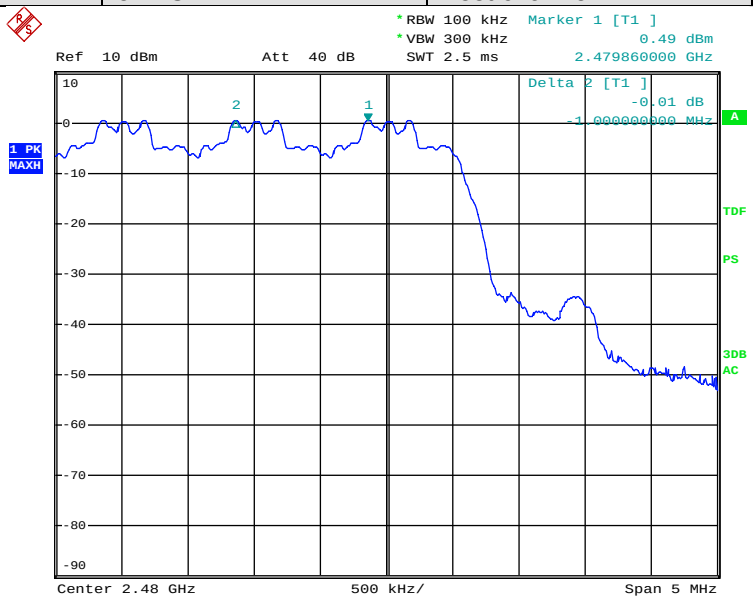
Date: 2.DEC.2013 10:27:07

Test mode:	8DPSK	Test channel:	Middle



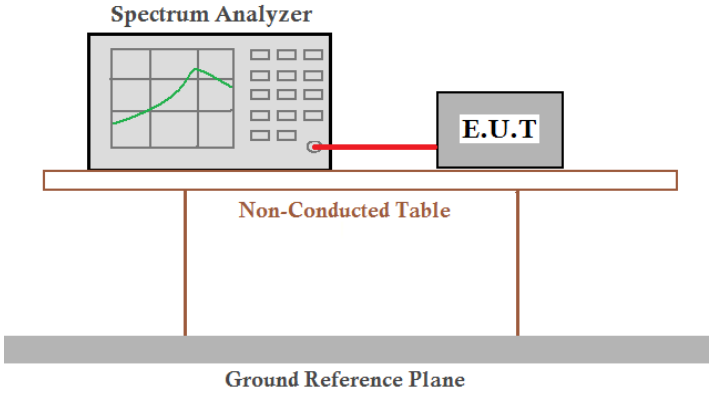
Date: 2.DEC.2013 10:30:51

Test mode:	8DPSK	Test channel:	Highest



Date: 2.DEC.2013 10:34:18

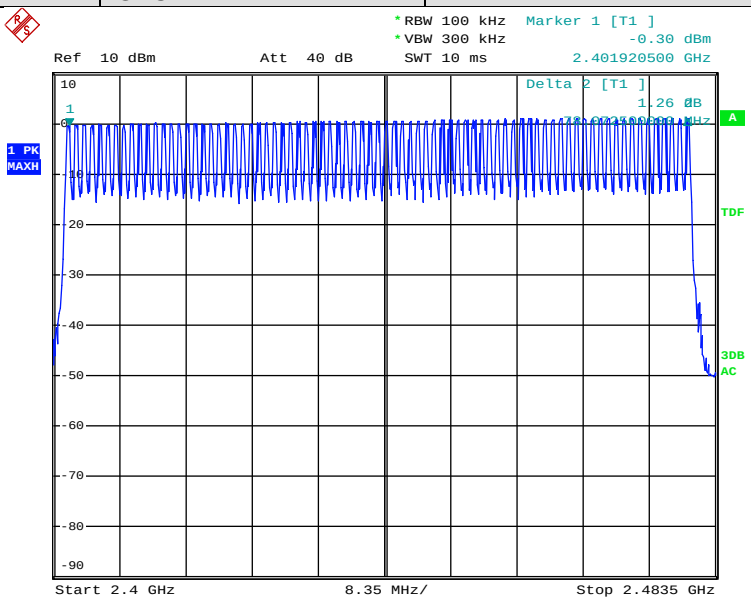
6.6 Hopping Channel Number

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=100KHz, VBW=300KHz, Frequency range=2400MHz-2483.5MHz, Detector=Peak
Limit:	75 Channels.
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer. Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Measurement Data		
Mode	Hopping channel numbers	Limit
GFSK	79	75
8DPSK	79	75

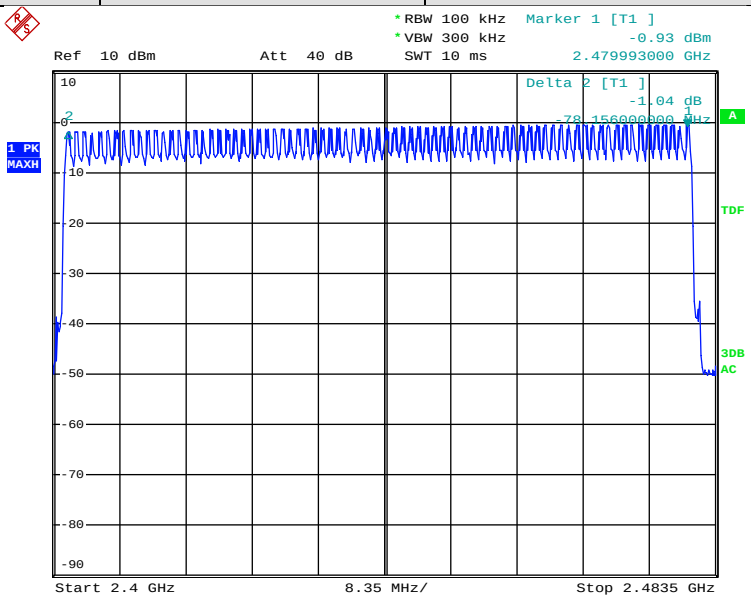
Test plot as follows:

Test mode:	GFSK	



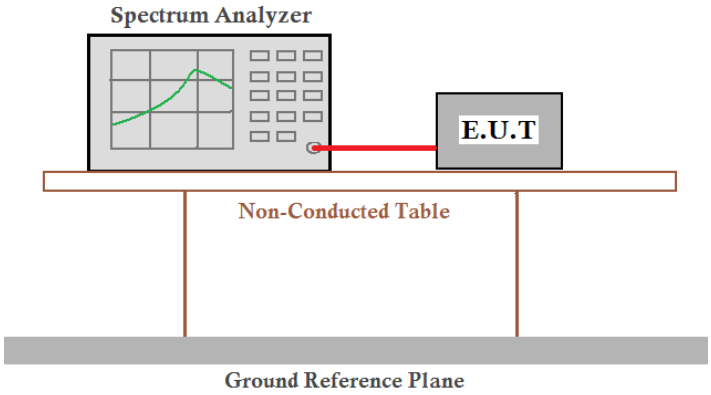
Date: 2.DEC.2013 11:51:10

Test mode:	8DPSK	



Date: 2.DEC.2013 12:21:24

6.7 Dwell Time

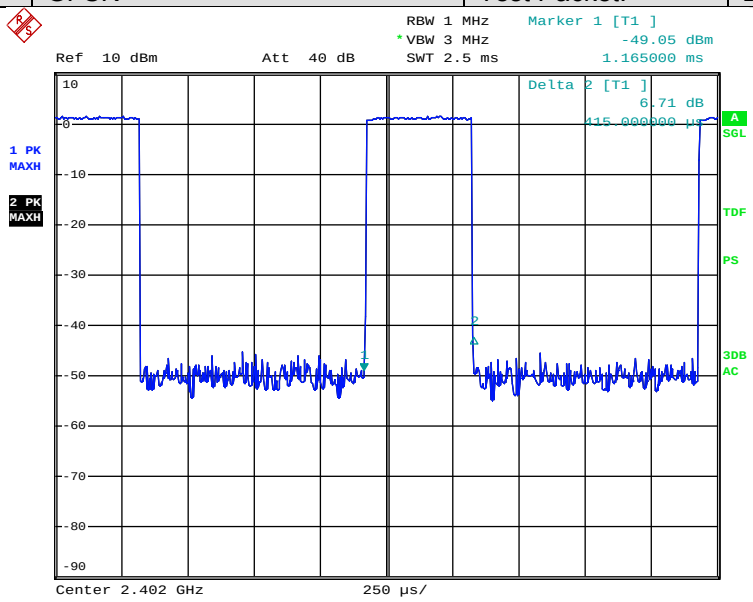
Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=1MHz, VBW=1MHz, Span=0Hz, Detector=Peak
Limit:	0.4 Second
Test mode:	Hopping transmitting with all kind of modulation.
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.* *Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed
Remark: The test period: T = 0.4 Second * 79 Channel = 31.6 s. Dwell time = time slot length * (Hopping rate / Number of hopping channels) * Period.	

Measurement Data:

Mode	Packet	Dwell time (second)	Limit (second)
GFSK	DH1	0.133	0.4
	DH3	0.266	0.4
	DH5	0.312	0.4
Π/4 PSK	2-DH1	0.134	0.4
	2-DH3	0.269	0.4
	2-DH5	0.312	0.4
8DPSK	3-DH1	0.134	0.4
	3-DH3	0.269	0.4
	3-DH5	0.314	0.4

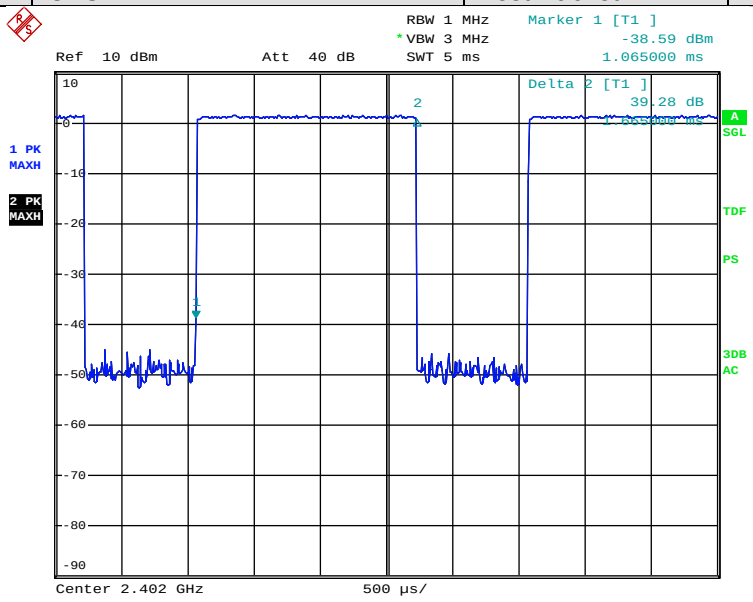
Test plot as follows:

Test mode:	GFSK	Test Packet:	DH1



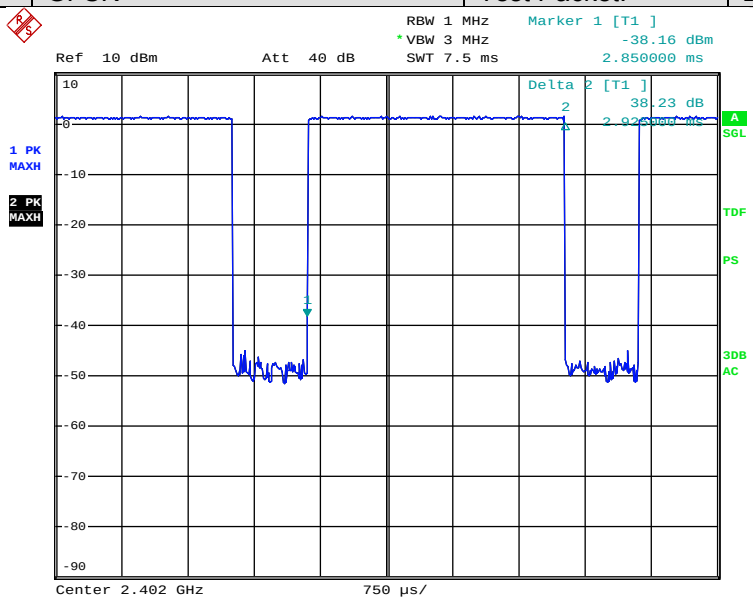
Date: 2.DEC.2013 10:58:55

Test mode:	GFSK	Test Packet:	DH3



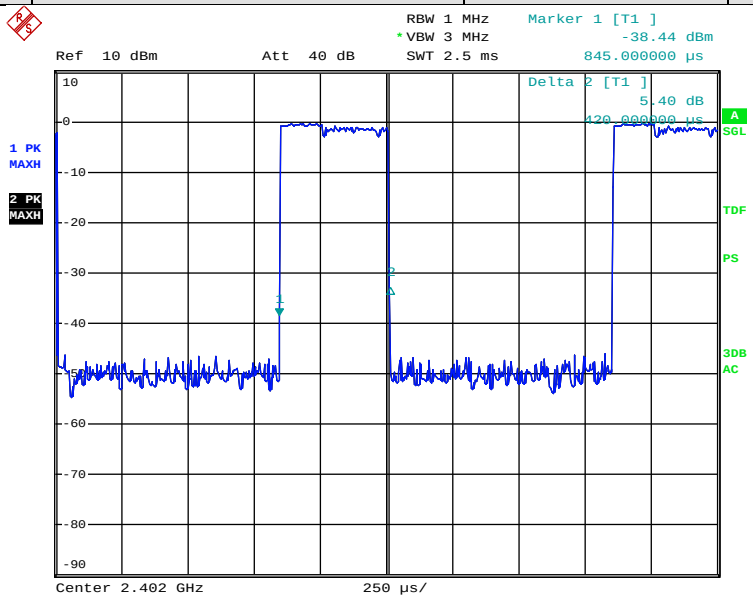
Date: 2.DEC.2013 10:59:27

Test mode:	GFSK	Test Packet:	DH5



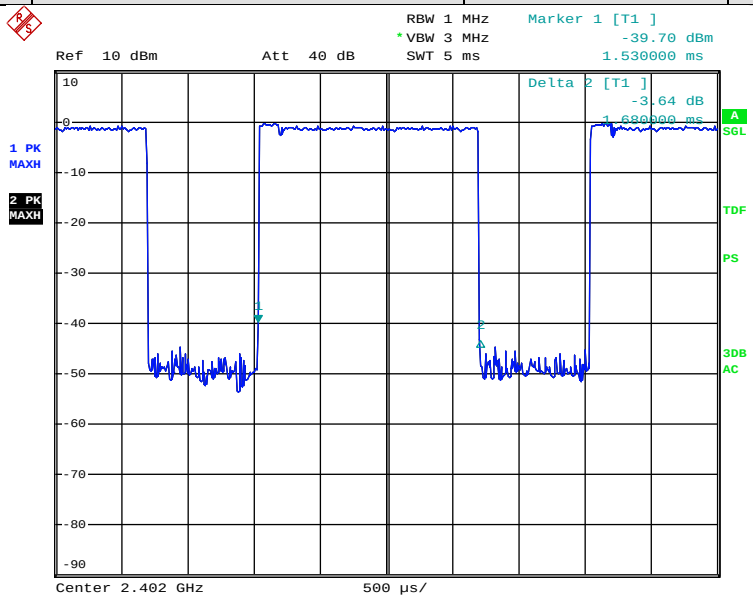
Date: 2.DEC.2013 11:00:04

Test mode:	Π/4 PSK	Test Packet:	2-DH1



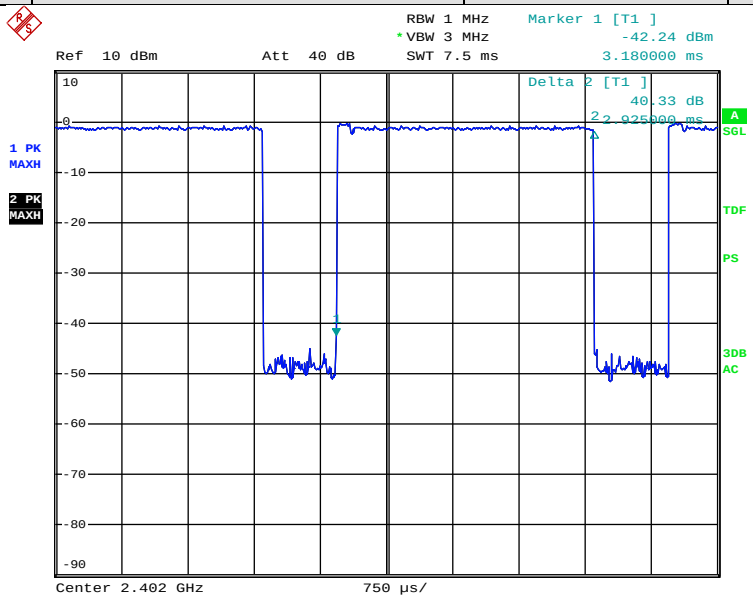
Date: 2.DEC.2013 11:00:34

Test mode:	Π/4 PSK	Test Packet:	2-DH3



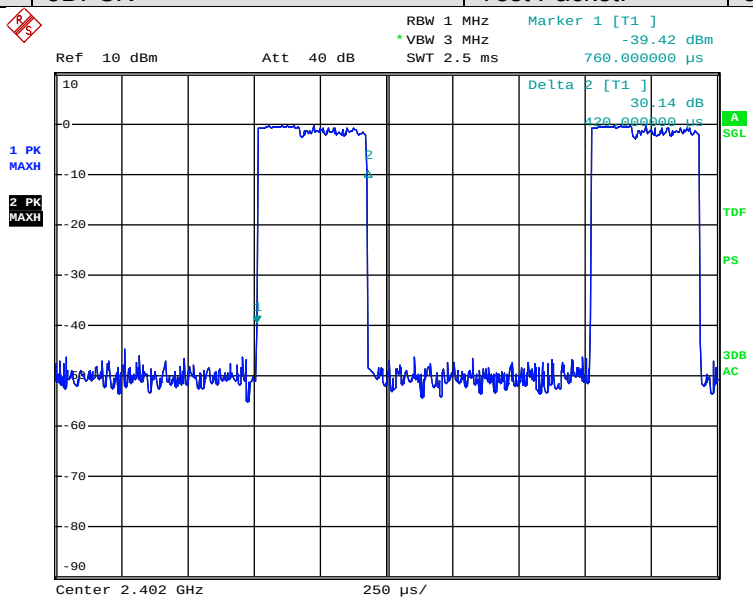
Date: 2.DEC.2013 11:01:16

Test mode:	Π/4 PSK	Test Packet:	2-DH5



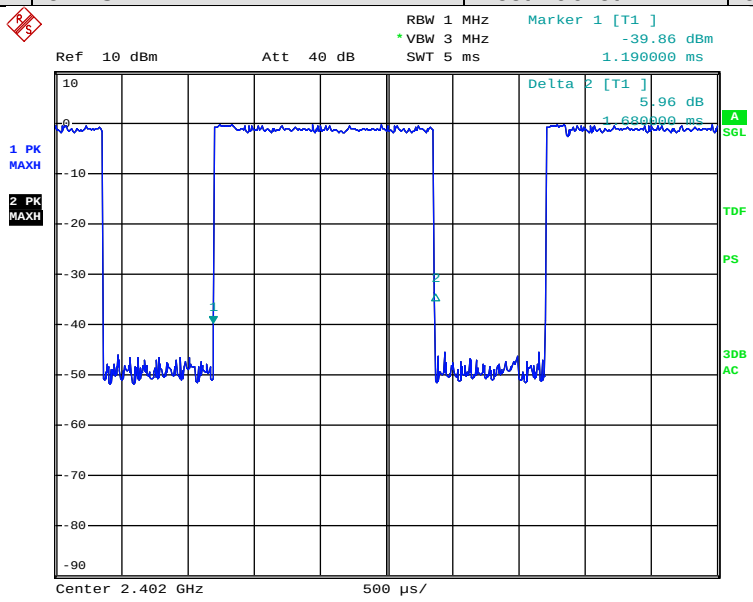
Date: 2.DEC.2013 11:01:55

Test mode:	8DPSK	Test Packet:	3-DH1



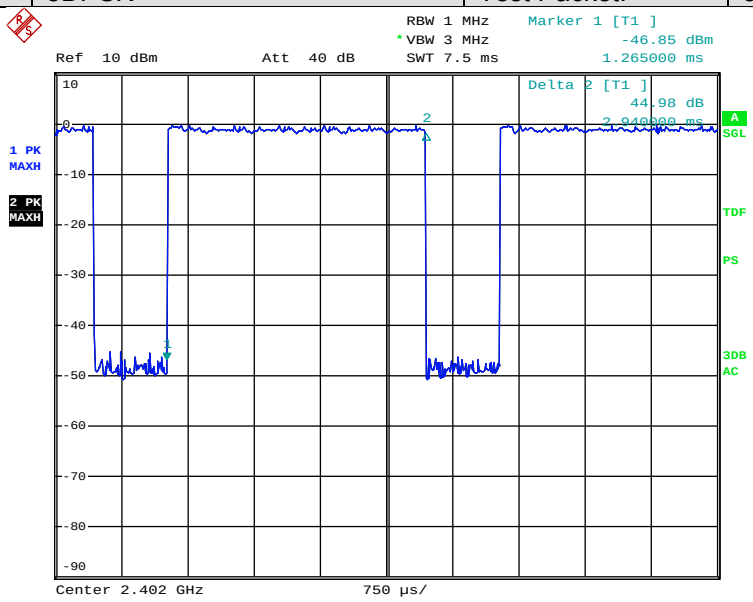
Date: 2.DEC.2013 11:02:32

Test mode:	8DPSK	Test Packet:	3-DH3



Date: 2.DEC.2013 11:02:58

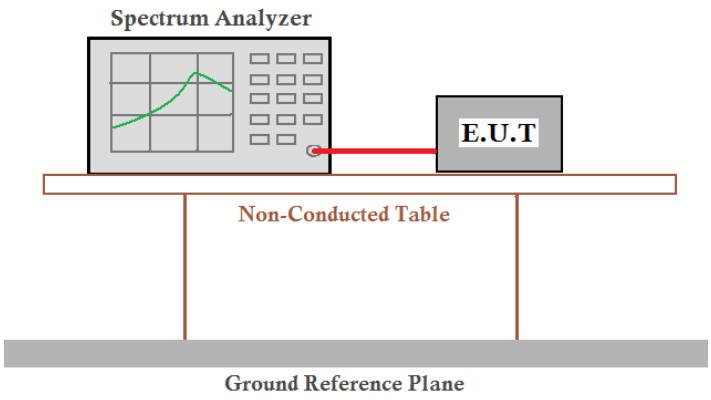
Test mode:	8DPSK	Test Packet:	3-DH5



Date: 2.DEC.2013 11:03:23

6.8 Band Edge

6.8.1 Conducted Emission

Test Requirement:	FCC Part15 C Section 15.247 (d)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Receiver setup:	RBW=100KHz, VBW=300KHz, Detector=Peak
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.
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.* *Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Hopping transmitting with all kind of modulation.
Test results:	Passed

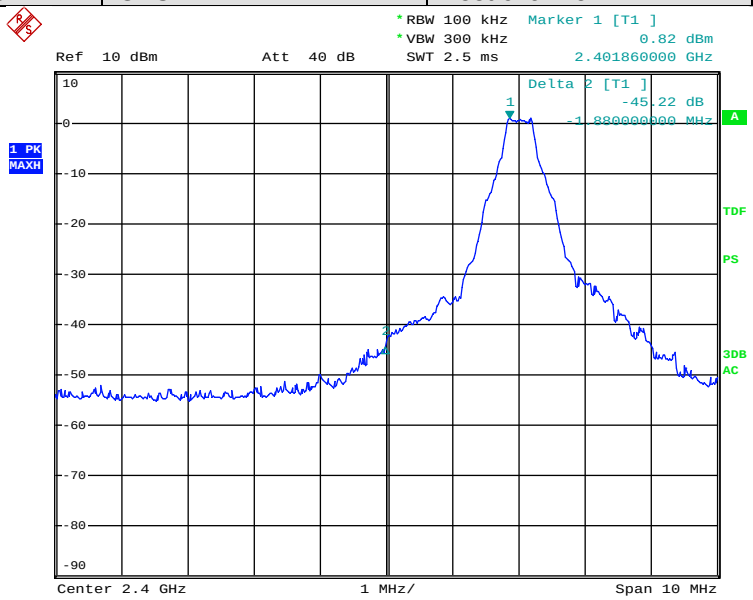
Remark:

During test the item, Pre-scan the GFSK, Π/4 PSK, 8DPSK modulation, and found the GFSK modulation which it is worse case.

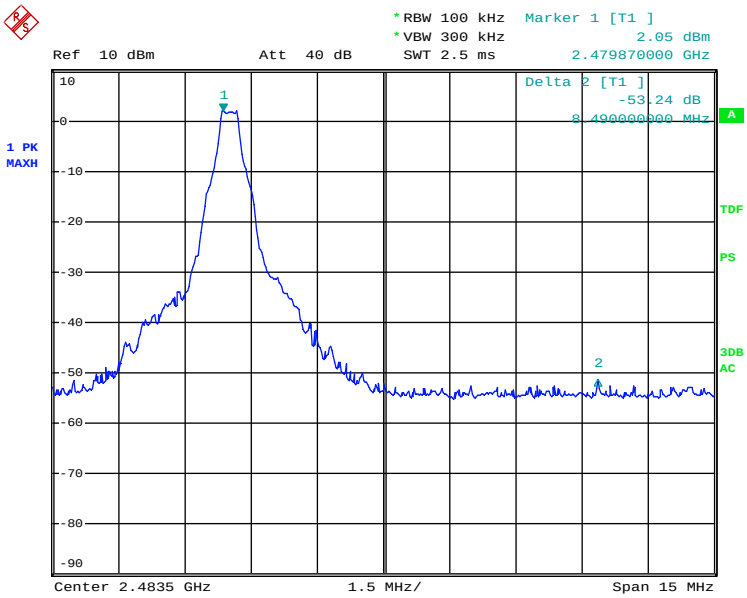
Report No: VT1311180025E-2

Test plot as follows:

Worse case mode:	GFSK	Test channel:	Lowest

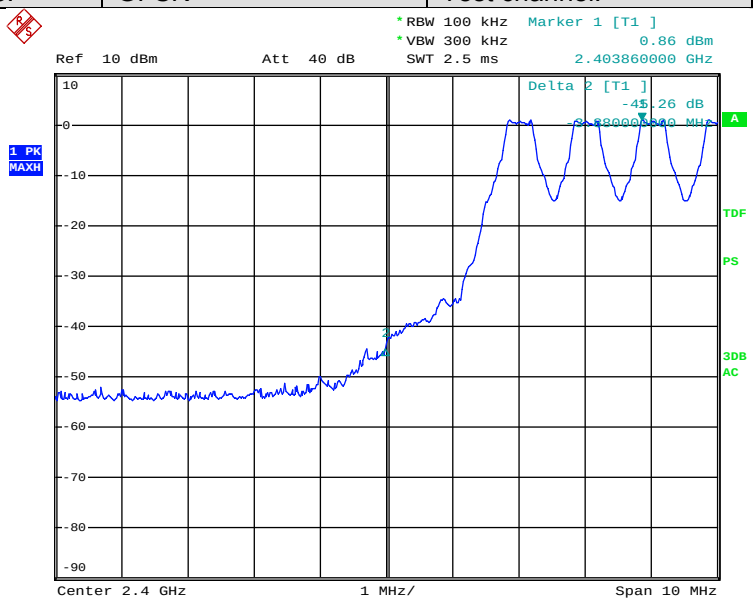


Date: 2.DEC.2013 10:36:58

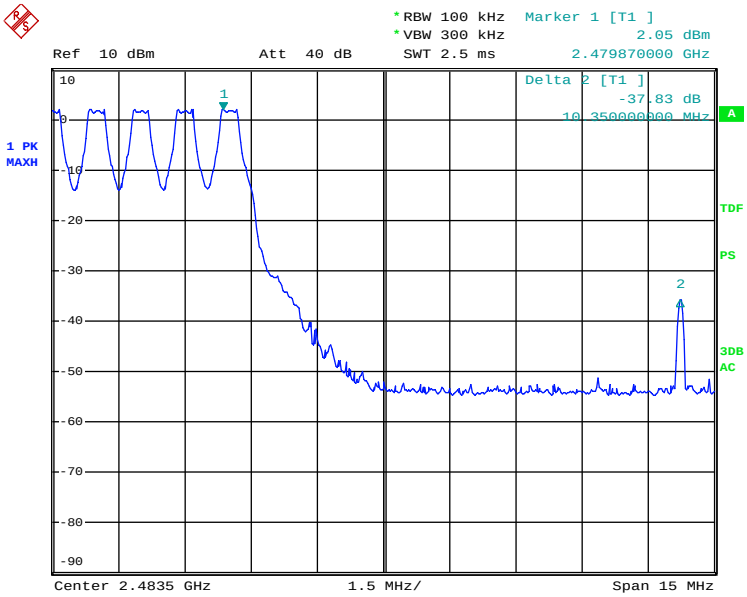


Date: 2.DEC.2013 10:47:15

Worse case mode:	GFSK	Test channel:	Highest



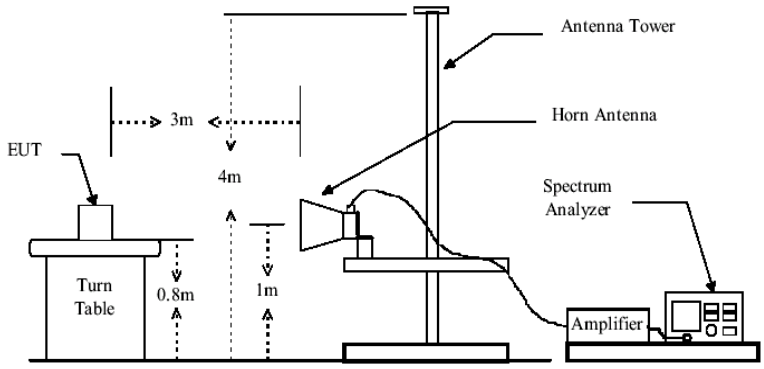
Date: 2.DEC.2013 10:39:14



Date: 2.DEC.2013 10:48:21

6.8.2 Radiated Emission

<table>
<tr><td>Test Requirement:</td><td>FCC Part15 C Section 15.209 and 15.205</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.4: 2003</td></tr>
<tr><td>Test Frequency Range:</td><td>2.3GHz to 2.5GHz</td></tr>
<tr><td>Test site:</td><td>Measurement Distance: 3m (Semi-Anechoic Chamber)</td></tr>
<tr><td>Receiver setup:</td><td>
<table>
<tr><th>Frequency</th><th>Detector</th><th>RBW</th><th>VBW</th><th>Remark</th></tr>
<tr><td rowspan="2">Above 1GHz</td><td>Peak</td><td>1MHz</td><td>3MHz</td><td>Peak Value</td></tr>
<tr><td>Peak</td><td>1MHz</td><td>10Hz</td><td>Average Value</td></tr>
</table>
</td></tr>
<tr><td>Limit:</td><td>
<table>
<tr><th>Frequency</th><th>Limit (dBuV/m @3m)</th><th>Remark</th></tr>
<tr><td rowspan="2">Above 1GHz</td><td>54.0</td><td>Average Value</td></tr>
<tr><td>74.0</td><td>Peak Value</td></tr>
</table>
</td></tr>
<tr><td>Test Procedure:</td><td>
a. 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.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. 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.
d. 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 rotable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
f. 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.
</td></tr>
</table>

Test setup:	
Test Instruments:	Refer to section 5.7 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed

Note:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

Measurement data:

Test mode:	Transmitting	Test channel:	Lowest	Remark:	Peak

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2390.00	8.04	43.48	51.52	74.00	-22.48	Peak	Vertical	P	
2	2400.00	8.09	48.04	56.13	74.00	-17.87	Peak	Vertical	P	
3	2390.00	8.04	43.98	52.02	74.00	-21.98	Peak	Horizontal	P	
4	2400.00	8.09	51.60	59.69	74.00	-14.31	Peak	Horizontal	P	

Test mode:	Transmitting	Test channel:	Lowest	Remark:	Average

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2390.00	8.04	28,74	36.78	54.00	-17.22	AVG	Vertical	P	
2	2400.00	8.09	33.70	41.79	54.00	-12.21	AVG	Vertical	P	
3	2390.00	8.04	26.93	34.97	54.00	-19.03	AVG	Horizontal	P	
4	2400.00	8.09	31.90	39.99	54.00	-14.01	AVG	Horizontal	P	

Test mode:	Transmitting	Test channel:	Highest	Remark:	Peak

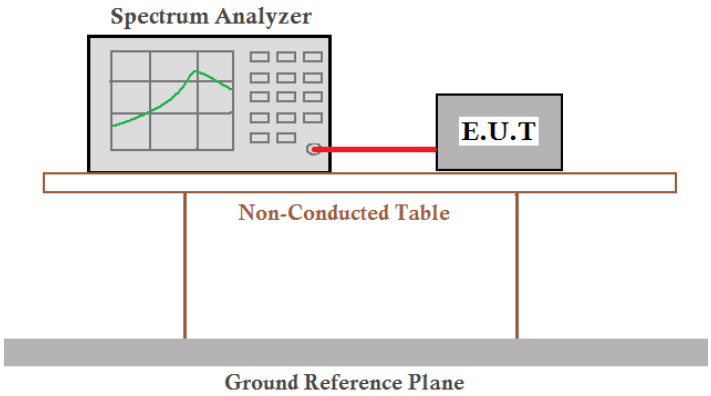
No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2483.50	8.24	48.96	57.20	74.00	-16.80	Peak	Vertical	P	
2	2500.00	8.96	45.75	54.71	74.00	-19.29	Peak	Vertical	P	
3	2483.50	8.24	46.68	54.92	74.00	-19.08	Peak	Horizontal	P	
4	2500.00	8.96	43.40	52.36	74.00	-21.64	Peak	Horizontal	P	

Test mode:	Transmitting	Test channel:	Highest	Remark:	Average

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2483.50	8.24	29.42	37.66	54.00	-16.34	AVG	Vertical	P	
2	2500.00	8.96	25.91	34.87	54.00	-19.13	AVG	Vertical	P	
3	2483.50	8.24	27.60	35.84	54.00	-18.16	AVG	Horizontal	P	
4	2500.00	8.96	23.55	32.51	54.00	-21.49	AVG	Horizontal	P	

6.9 Spurious Emission

6.9.1 Conducted Spurious Emission

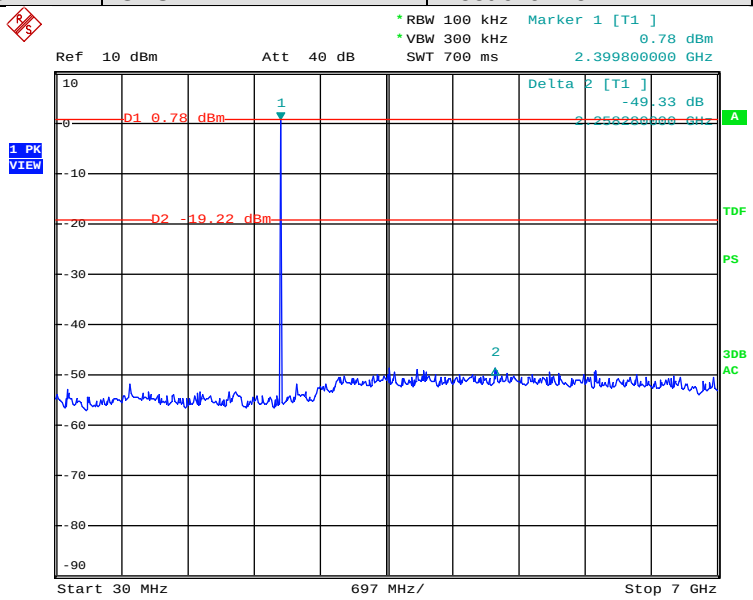
Test Requirement:	FCC Part15 C Section 15.247 (d)
Test Method:	ANSI C63.4:2003 and KDB DA00-705
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at 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.
Test setup:	 *Remark:* *Offset the High-Frequency cable loss 1.5dB in the spectrum analyzer.* *Cable loss was compensated from the measured value.*
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Remark:

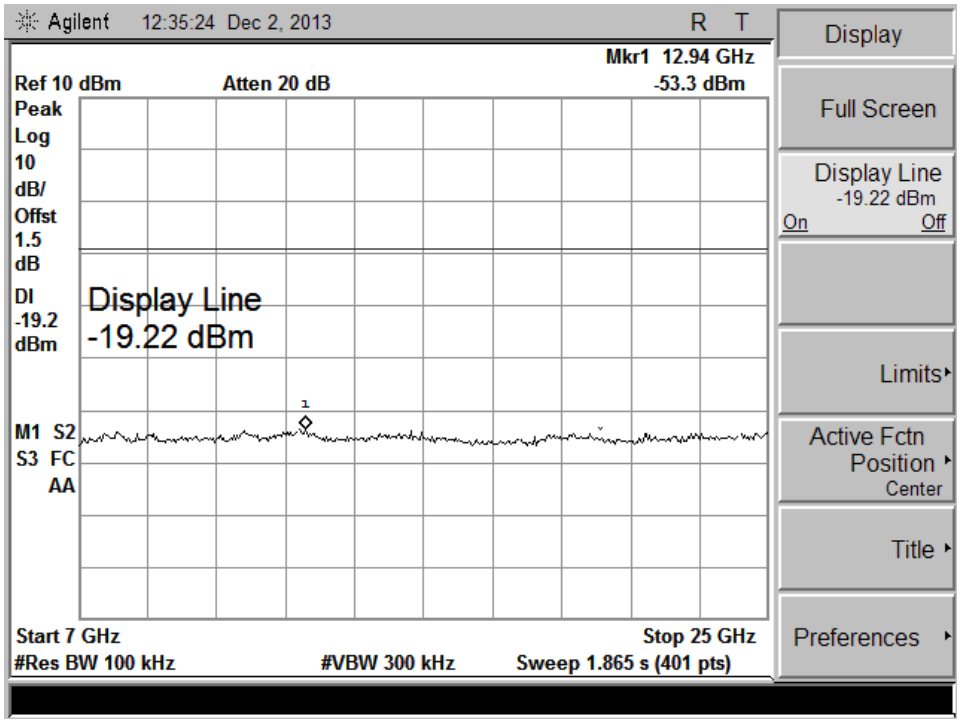
During test the item, Pre-scan the GFSK, Π/4 PSK, 8DPSK modulation, and found the GFSK modulation which it is worse case.

Test plot as follows:

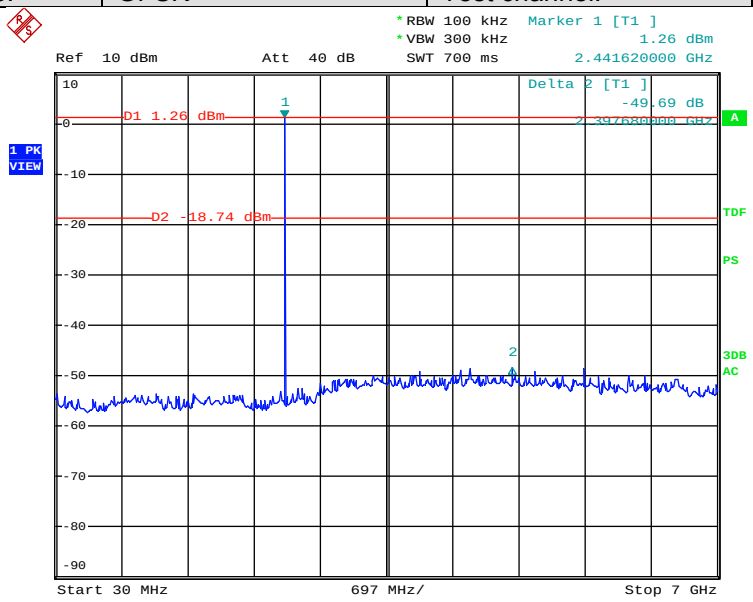
Worse case mode:	GFSK	Test channel:	Lowest



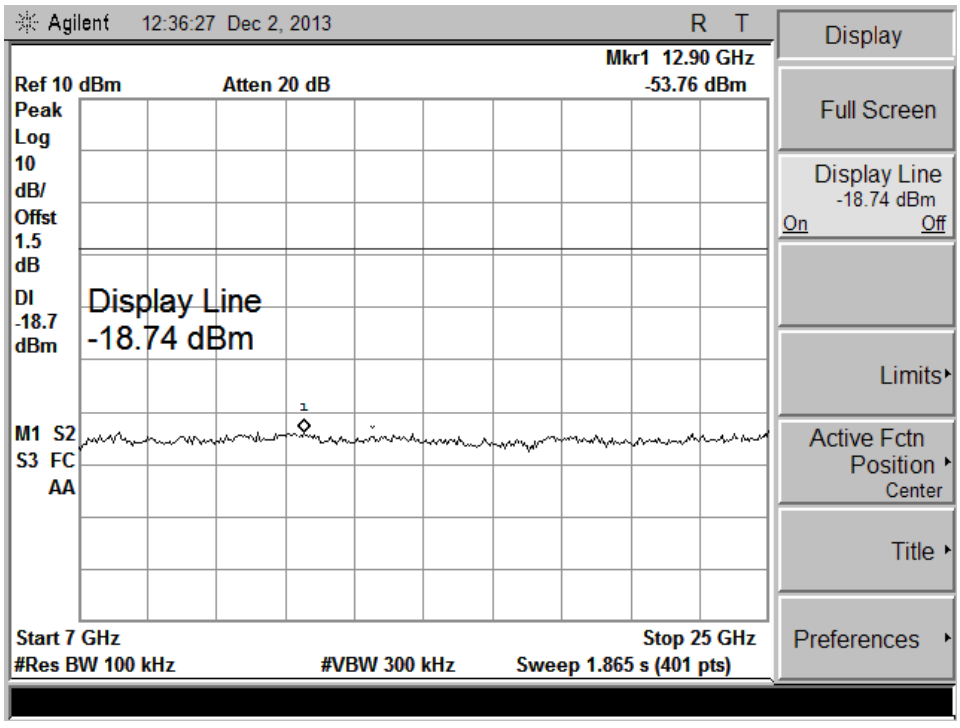
Date: 2.DEC.2013 11:12:13



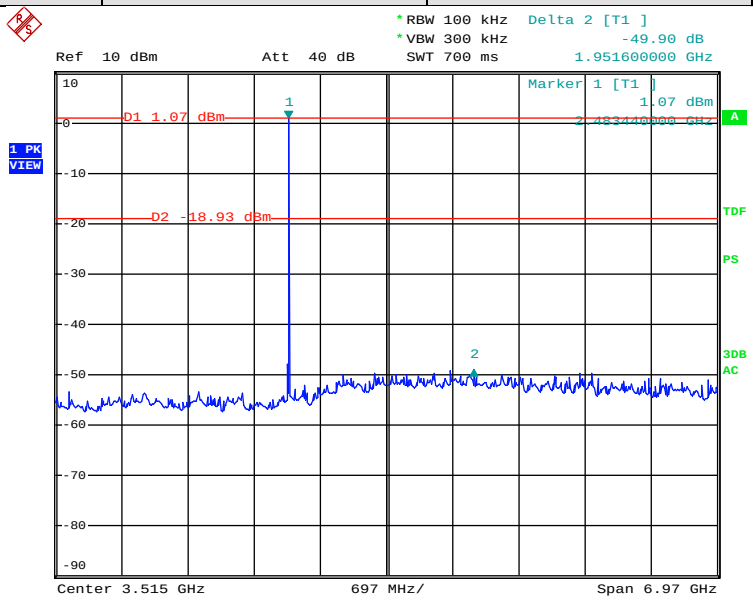
Worse case mode:	GFSK	Test channel:	Middle



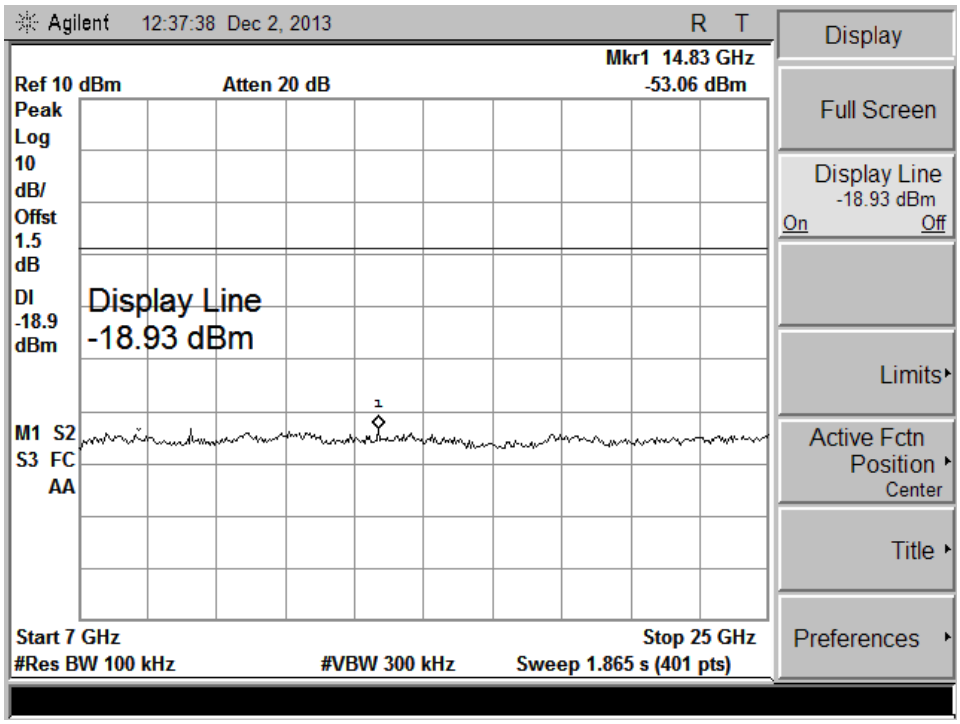
Date: 2.DEC.2013 11:13:33



Worse case mode:	GFSK	Test channel:	Highest

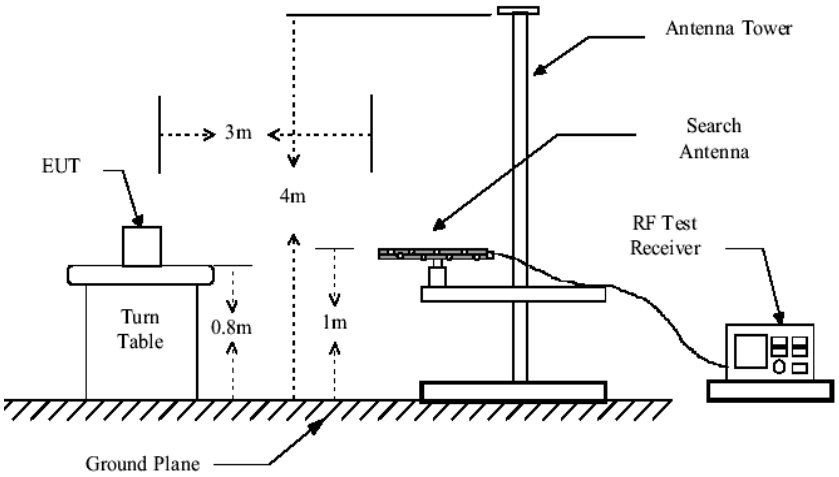
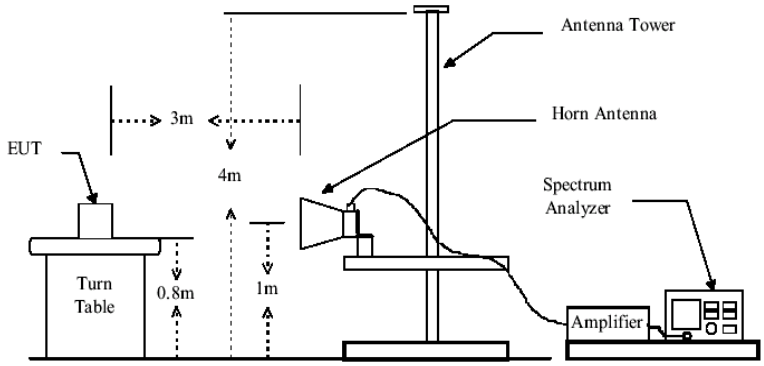


Date: 2.DEC.2013 11:14:56



6.9.2 Radiated Spurious Emission

<table>
<tr><td>Test Requirement:</td><td>FCC Part15 C Section 15.209 and 15.205</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.4: 2003</td></tr>
<tr><td>Test Frequency Range:</td><td>9KHz to 25GHz</td></tr>
<tr><td>Test site:</td><td>Measurement Distance: 3m (Semi-Anechoic Chamber)</td></tr>
<tr><td>Receiver setup:</td><td>
<table>
<tr><td>Frequency</td><td>Detector</td><td>RBW</td><td>VBW</td><td>Remark</td></tr>
<tr><td>30MHz-1GHz</td><td>Quasi-peak</td><td>100KHz</td><td>300KHz</td><td>Quasi-peak Value</td></tr>
<tr><td rowspan="2">Above 1GHz</td><td>Peak</td><td>1MHz</td><td>3MHz</td><td>Peak Value</td></tr>
<tr><td>Peak</td><td>1MHz</td><td>10Hz</td><td>Average Value</td></tr>
</table>
</td></tr>
<tr><td>Limit:</td><td>
<table>
<tr><td>Frequency</td><td>Limit (dBuV/m @3m)</td><td>Remark</td></tr>
<tr><td>30MHz-88MHz</td><td>40.0</td><td>Quasi-peak Value</td></tr>
<tr><td>88MHz-216MHz</td><td>43.5</td><td>Quasi-peak Value</td></tr>
<tr><td>216MHz-960MHz</td><td>46.0</td><td>Quasi-peak Value</td></tr>
<tr><td>960MHz-1GHz</td><td>54.0</td><td>Quasi-peak Value</td></tr>
<tr><td rowspan="2">Above 1GHz</td><td>54.0</td><td>Average Value</td></tr>
<tr><td>74.0</td><td>Peak Value</td></tr>
</table>
</td></tr>
<tr><td>Test Procedure:</td><td>g. 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.
h. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
i. 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.
j. 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 rotable table was turned from 0 degrees to 360 degrees to find the maximum reading.
k. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
l. 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.
m. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.</td></tr>
</table>

Test setup:	Below 1GHz  Above 1GHz 
Test Instruments:	Refer to section 4.7 for details
Test mode:	Refer to section 4.3 for details
Test results:	Passed

Note:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

6.9.2.1 Radiated emission below 1GHz

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	30.0000	-15.90	35.10	19.20	40.00	-20.80	QP	Vertical	P	
2	42.6100	-14.28	33.68	19.40	40.00	-20.60	QP	Vertical	P	
3	48.4300	-13.42	30.92	17.50	40.00	-22.50	QP	Vertical	P	
4	100.8100	-12.11	28.31	16.20	43.50	-27.30	QP	Horizontal	P	
5	218.1800	-13.02	27.82	14.80	46.00	-31.20	QP	Horizontal	P	
6	307.4200	-10.26	26.46	16.20	46.00	-29.80	QP	Horizontal	P	

Notes: For radiation emission below 30MHz, The measured value haven't been reported for down 20dB under the limit.
Level=Reading+Factor. Margin=Level-Limit.

6.9.2.2 Transmitter emission above 1GHz

Worse case mode:	GFSK	Test channel:	Lowest	Remark:	Peak

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2394.650	8.06	33.73	41.79	74.00	-32.21	Peak	Vertical	P	
2	4804.000	14.63	40.83	55.46	74.00	-18.54	Peak	Vertical	P	
3	7206.000	20.68	45.08	65.76	74.00	-8.24	Peak	Vertical	P	
4	2395.400	8.06	33.78	41.84	74.00	-32.16	Peak	Horizontal	P	
5	4804.000	14.63	41.14	55.77	74.00	-18.23	Peak	Horizontal	P	
6	7206.000	20.68	44.18	64.86	74.00	-9.14	Peak	Horizontal	P	

Worse case mode:	GFSK	Test channel:	Lowest	Remark:	Average

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2394.650	8.06	22.06	30.12	54.00	-23.88	AVG	Vertical	P	
2	4804.000	14.63	29.05	43.68	54.00	-10.32	AVG	Vertical	P	
3	7206.000	20.68	27.67	48.35	54.00	-5.65	AVG	Vertical	P	
4	2395.400	8.06	21.26	29.32	54.00	-24.68	AVG	Horizontal	P	
5	4804.000	14.63	29.76	44.39	54.00	-9.61	AVG	Horizontal	P	
6	7206.000	20.68	28.07	48.75	54.00	-5.25	AVG	Horizontal	P	

Worse case mode:	GFSK	Test channel:	Middle	Remark:	Peak

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2452.500	8.27	33.62	41.89	74.00	-32.11	Peak	Vertical	P	
2	4882.000	14.97	40.69	55.66	74.00	-18.34	Peak	Vertical	P	
3	7323.000	20.91	44.82	65.73	74.00	-8.27	Peak	Vertical	P	
4	2452.500	8.27	33.68	41.95	74.00	-32.05	Peak	Horizontal	P	
5	4882.000	14.97	41.31	56.28	74.00	-17.72	Peak	Horizontal	P	
6	7323.000	20.91	44.35	65.26	74.00	-8.74	Peak	Horizontal	P	

Worse case mode:	GFSK	Test channel:	Middle	Remark:	Average

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2452.500	8.27	21.19	29.46	54.00	-24.54	AVG	Vertical	P	
2	4882.000	14.97	28.79	43.76	54.00	-10.24	AVG	Vertical	P	
3	7323.000	20.91	27.95	48.86	54.00	-5.14	AVG	Vertical	P	
4	2452.500	8.27	21.46	29.73	54.00	-24.27	AVG	Horizontal	P	
5	4882.000	14.97	29.33	44.30	54.00	-9.70	AVG	Horizontal	P	
6	7323.000	20.91	27.96	48.87	54.00	-5.13	AVG	Horizontal	P	

Worse case mode:	GFSK	Test channel:	Highest	Remark:	Peak

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2486.050	8.38	33.73	42.11	74.00	-31.89	Peak	Vertical	P	
2	4960.000	15.30	41.37	56.67	74.00	-17.33	Peak	Vertical	P	
3	7440.000	21.16	44.81	65.97	74.00	-8.03	Peak	Vertical	P	
4	2489.650	8.38	34.16	42.54	74.00	-31.46	Peak	Horizontal	P	
5	4960.000	15.30	40.52	55.82	74.00	-18.18	Peak	Horizontal	P	
6	7440.000	21.16	44.45	65.61	74.00	-8.39	Peak	Horizontal	P	

Worse case mode:	GFSK	Test channel:	Highest	Remark:	Average

No.	Frequency (MHz)	Factor (dB/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Polarization	P/F	Remark
1	2486.050	8.38	20.60	28.98	54.00	-25.02	AVG	Vertical	P	
2	4960.000	15.30	28.42	43.72	54.00	-10.28	AVG	Vertical	P	
3	7440.000	21.16	28.01	49.17	54.00	-4.83	AVG	Vertical	P	
4	2489.650	8.38	20.60	28.98	54.00	-25.02	AVG	Horizontal	P	
5	4960.000	15.30	28.95	44.25	54.00	-9.75	AVG	Horizontal	P	
6	7440.000	21.16	27.99	49.15	54.00	-4.85	AVG	Horizontal	P	

Remark:

Which above 5th Harmonics are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

6.10 Pseudorandom Frequency Hopping Sequence

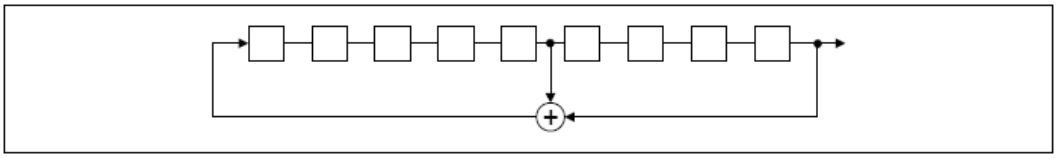
Test Requirement:	FCC Part15 C Section 15.247 (a)(1) requirement:

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.

EUT Pseudorandom Frequency Hopping Sequence

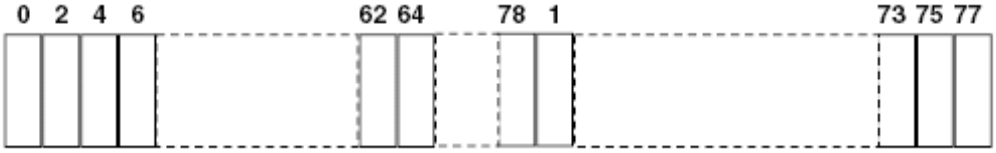
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized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

********End of Test Report********