

# EMC TEST REPORT

**Report No.:** TS12010105-EME  
**Model No.:** RB4000HM-a, RB4000HM-c,  
RB4000, H4000CE  
**Issued Date:** May. 16, 2012

**Applicant:** Radicom Research Inc.  
2148 Bering Dr., San Jose, CA. 95131, USA

**Test Method/ Standard:** FCC Part 15 Subpart C Section §15.205 、 §15.207 、 §15.209 、  
§15.247, DA 00-705 and ANSI C63.4/2003.

**Test By:** Intertek Testing Services Taiwan Ltd.  
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**The test report was reviewed by:**

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## Table of Contents

Summary of Tests.....	3
1. General information .....	4
2. Test specifications .....	6
3. 20dB Bandwidth test.....	8
4. Carrier Frequency Separation test.....	14
5. Number of hopping frequencies test .....	17
6. Time of Occupancy (dwell time) & Duty Cycle Correction Factor test .....	20
7. Maximum Output Power test .....	31
8. RF Antenna Conducted Spurious test.....	32
9. Radiated Emission test .....	38
10. Emission on the band edge §FCC 15.247(d).....	53
11. Power Line Conducted Emission test §FCC 15.207 .....	63



### Summary of Tests

Test	Reference	Results
20dB Bandwidth test	15.247(a)(1)	Pass
Carrier Frequency Separation test	15.247(a)(1)	Pass
Number of hopping frequencies test	15.247(a)(1)	Pass
Time of Occupancy (dwell time) test	15.247(a)(1)	Pass
Maximum Output Power test	15.247(b)	Pass
RF Antenna Conducted Spurious test	15.247(d)	Pass
Radiated Spurious Emission test	15.205, 15.209	Pass
Emission on the Band Edge test	15.247(d)	Pass
AC Power Line Conducted Emission test	15.207	Pass



## 1. General information

### 1.1 Identification of the EUT

Product:	Bluetooth Module
Model No.:	RB4000HM-a, RB4000HM-c
FCC ID.:	K7T-RB4000
Frequency Range:	2402 MHz ~ 2480 MHz
Channel Number:	79 channels
Frequency of Each Channel:	2402 + k MHz; k = 0~78
Type of Modulation:	GFSK, $\pi/4$ DPSK, 8DPSK
Rated Power:	DC 5 V
Power Cord:	N/A
Sample Received:	Jan. 04, 2012
Test Date(s):	Jan. 04, 2012 ~ May. 15, 2012
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Note 2:	When determining the test conclusion, the Measurement Uncertainty of test has been considered.



## 1.2 Additional information about the EUT

The EUT is a Bluetooth Module, and was defined as information technology equipment.

The customer confirmed the models listed as below were series model to model RB4000HM-a, RB4000HM-c (EUT), the difference between main model and series model are listed as below.

Model Number	Product Description
RB4000HM-a	Modules (with on- board antenna)
RB4000HM-c	Modules (with two antenna connectors)
RB4000	Modules (with on- board antenna)
H4000CE	Identical model to RB4000

For more detail features, please refer to User's manual as file name "Installation guide.pdf"

## 1.3 Antenna description

### (1) Antenna 1

The EUT uses a permanently connected antenna.

Antenna Gain : 1 dBi  
Antenna Type : Printed antenna  
Connector Type : N/A

### (2) Antenna 2

The antenna is affixed to the EUT using a unique connector, which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector.

Antenna Gain : 2 dBi  
Antenna Type : Dipole antenna  
Connector Type : IPX

## 1.4 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Description of Data Cable
Notebook PC	DELL	Latitude D610	JXWZK1S	1. USB shielded cable 1.8 meter × 1 2. LPT console cable 0.2 meter × 1
Carrier board	N/A	N/A	N/A	N/A

## 2. Test specifications

### 2.1 Test standard

The EUT was performed according to the procedures in FCC Part 15 Subpart C Section § 15.205、§15.207、§15.209、§15.247, DA 00-705 and ANSI C63.4/2003.

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of this frequency band were all meet limit requirement, thus we evaluate the EUT pass the specified test.

### 2.2 Operation mode

The EUT was supplied with DC 5 V from adapter (Test voltage: 120 Vac, 60 Hz) and the transmission mode was tested by using a software named “CSR Bluetest 3” program.

### 2.3 Test equipment

Equipment	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	Rohde & Schwarz	ESCI	100018	2011/12/6	2012/12/4
Spectrum Analyzer	Rohde&schwarz	FSP30	100137	2011/6/29	2012/6/28
Spectrum Analyzer	Rohde&schwarz	FSEK30	100186	2012/2/6	2013/2/5
Horn Antenna (1-18G)	Schwarzbeck	BBHA 9120 D	9120D-456	2010/8/31	2012/8/30
Horn Antenna (14-42G)	SHWARZBECK	BBHA 9170	BBHA9170159	2010/9/3	2012/9/2
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-172	2011/7/26	2013/7/25
Pre-Amplifier	MITEQ	AFS44-00102650--42-10P-44	1495287	2011/10/27	2013/10/26
Pre-Amplifier	MITEQ	JS4-26004000--27-8A	828825	2010/9/8	2012/9/7
Power Meter	Anritsu	ML2495A	0844001	2011/10/13	2012/10/12
Power Sensor	Anritsu	MA2411B	0738452	2011/10/13	2012/10/12
Temperature&Humidity Test Chamber	TERCHY	MHU-225LRU (SA)	950838	2011/6/17	2012/6/16
Two-Line V-Network	Rohde&schwarz	ESH3-Z5	838979/014	2011/10/19	2012/10/18

Note: The above equipments are within the valid calibration period.



### 3. 20dB Bandwidth test

#### 3.1 Operating environment

Temperature: 23 °C  
Relative Humidity: 55 %  
Atmospheric Pressure: 1008 hPa

#### 3.2 Test setup & procedure

**The test procedure was according to FCC measurement guidelines DA 00-705.**

The 20dB bandwidth per FCC §15.247(a)(1) was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 100 kHz, the video bandwidth  $\geq$  RBW, and the SPAN may equal to approximately 2 to 3 times the 20dB bandwidth. The test was performed at 3 channels (lowest, middle and highest channel). The maximum 20dB modulation bandwidth is in the following Table.

#### 3.3 Measured data of modulated bandwidth test results

EUT : RB4000HM-a & RB4000HM-c

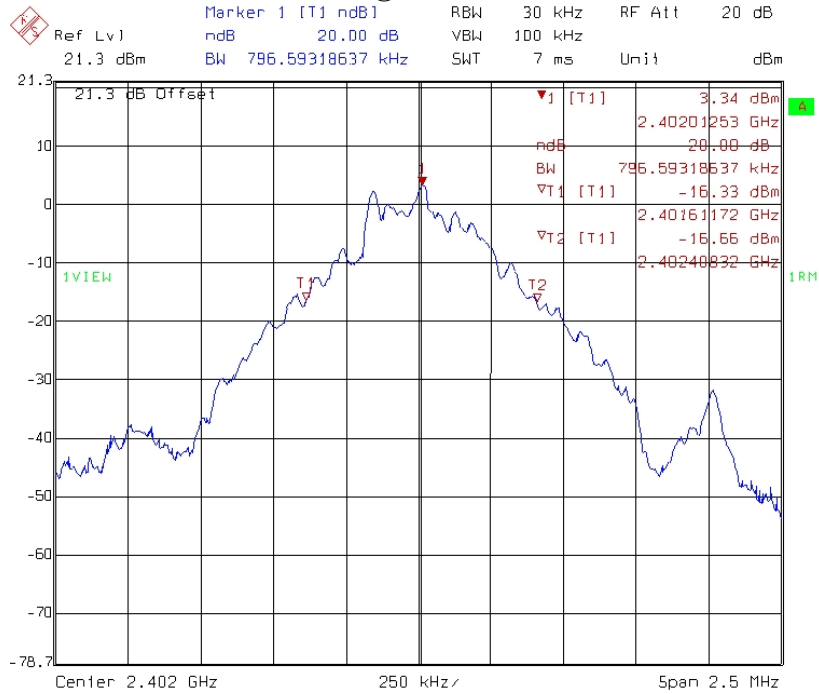
Mode	Channel	Frequency (MHz)	20dB Bandwidth (kHz)
GFSK	0	2402	797
	39	2441	812
	78	2480	817
$\pi/4$ DPSK	0	2402	1222.44
	39	2441	1227.45
	78	2480	1222.44
8DPSK	0	2402	1212.42
	39	2441	1207.41
	78	2480	1272.54

Please see the plot below.



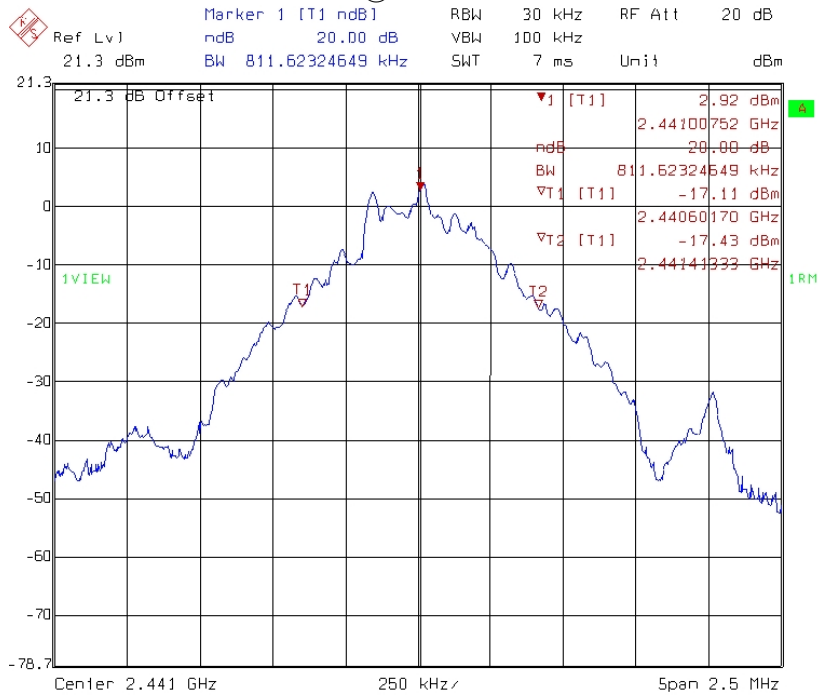
**For RB4000HM-a & RB4000HM-c**

**20 dB Bandwidth @ GFSK mode channel 0**



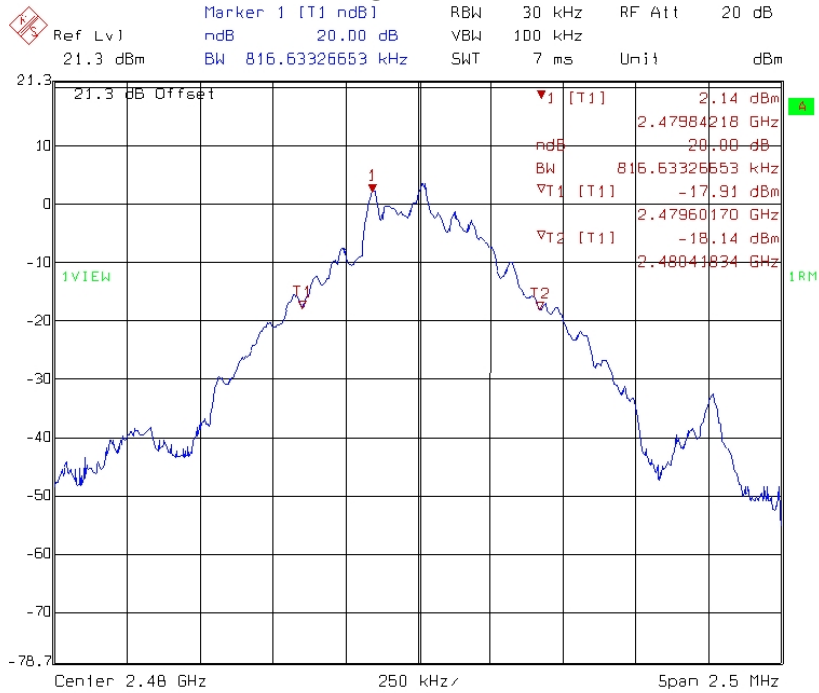
Title: 20dB Bandwidth  
 Comment A: GFSK ch0 2402 DH1  
 Date: 22.FEB.2012 10:29:19

**20 dB Bandwidth @ GFSK mode channel 39**



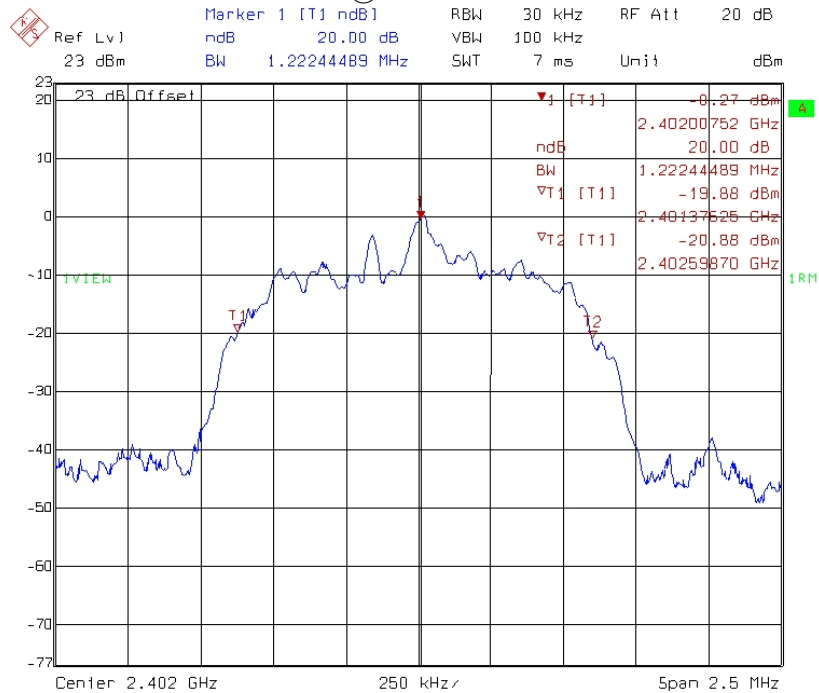
Title: 20dB Bandwidth  
 Comment A: GFSK ch39 2441 DH1  
 Date: 22.FEB.2012 10:45:11

**20 dB Bandwidth @ GFSK mode channel 78**



Title: 20dB Bandwidth  
 Comment A: GFSK ch78 2480 DH1  
 Date: 22.FEB.2012 10:50:43

**20 dB Bandwidth @  $\pi/4$ DPSK mode channel 0**



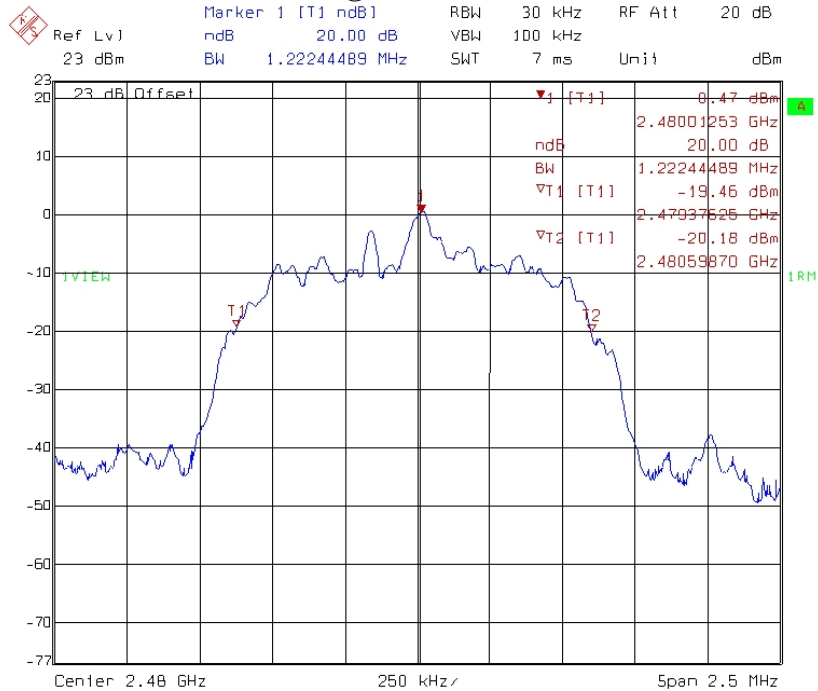
Title: 20dB Bandwidth  
 Comment A: pi/4-DPSK ch0 2402 DH1  
 Date: 26.MAR.2012 11:01:29

**20 dB Bandwidth @  $\pi/4$ DPSK mode channel 39**



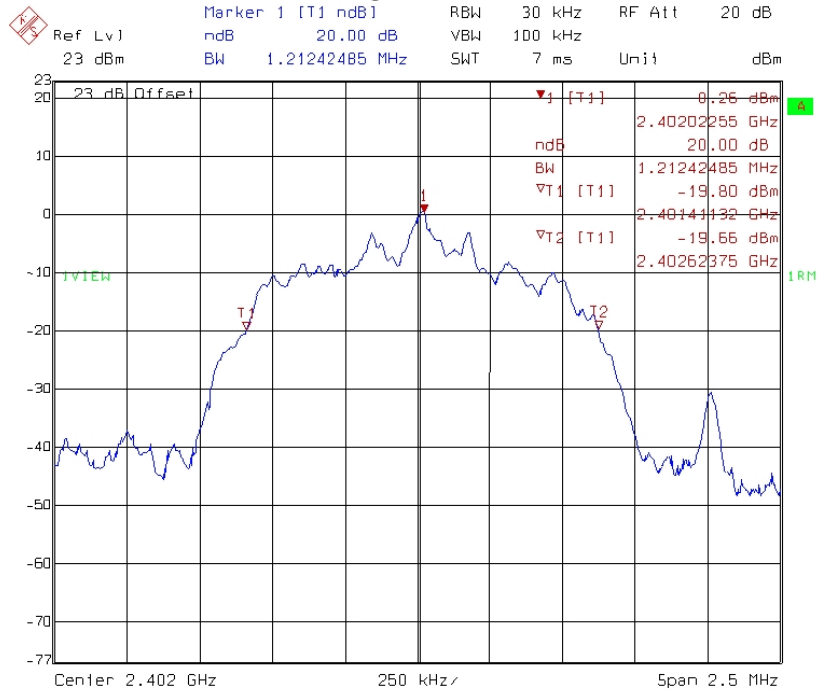
Title: 20dB Bandwidth  
 Comment A: pi/4-QPSK ch39 2441 DH1  
 Date: 26.MAR.2012 11:16:04

**20 dB Bandwidth @  $\pi/4$ DPSK mode channel 78**



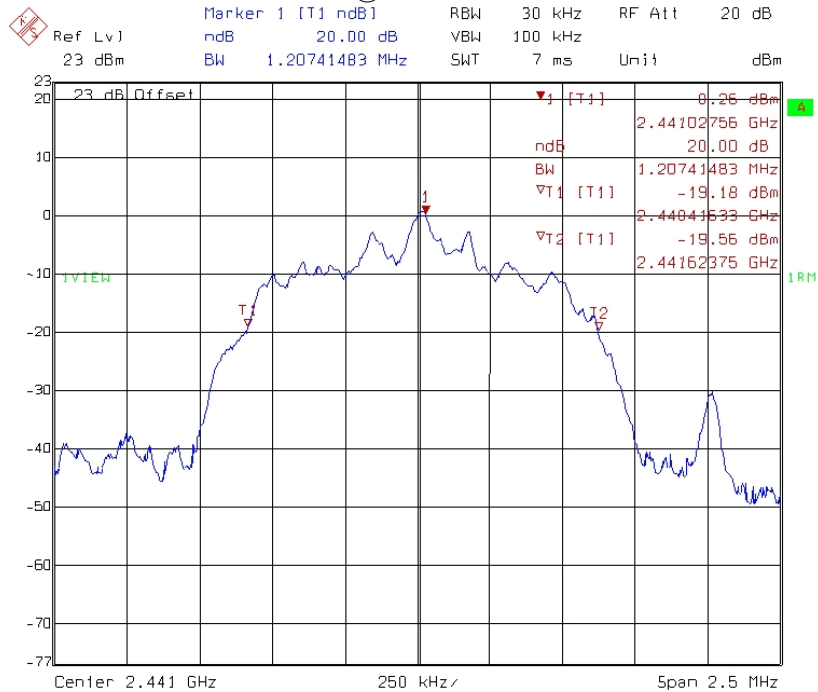
Title: 20dB Bandwidth  
 Comment A: pi/4-QPSK ch78 2480 DH1  
 Date: 26.MAR.2012 11:23:56

**20 dB Bandwidth @ 8DPSK mode channel 0**



Title: 20dB Bandwidth  
 Comment A: 8DPSK ch0 2402 DH1  
 Date: 26.MAR.2012 11:36:23

**20 dB Bandwidth @ 8DPSK mode channel 39**



Title: 20dB Bandwidth  
 Comment A: 8DPSK ch39 2441 DH1  
 Date: 26.MAR.2012 11:47:54

**20 dB Bandwidth @ 8DPSK mode channel 78**



Title: 20dB Bandwidth  
 Comment A: 8DPSK ch78 2480 DH1  
 Date: 26.MAR.2012 11:53:37



#### 4. Carrier Frequency Separation test

##### 4.1 Operating environment

Temperature: 23 °C  
Relative Humidity: 55 %  
Atmospheric Pressure: 1008 hPa

##### 4.2 Test setup & procedure

**The test procedure was according to FCC measurement guidelines DA 00-705.**

The carrier frequency separation per FCC §15.247(a)(1) was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at  $\geq 1\%$  of the span, the video bandwidth  $\geq$  RBW, and the SPAN was wide enough to capture the peaks of two adjacent channels. The carrier frequency separation result is in the following Table.

##### 4.3 Measured data of Carrier Frequency Separation test result

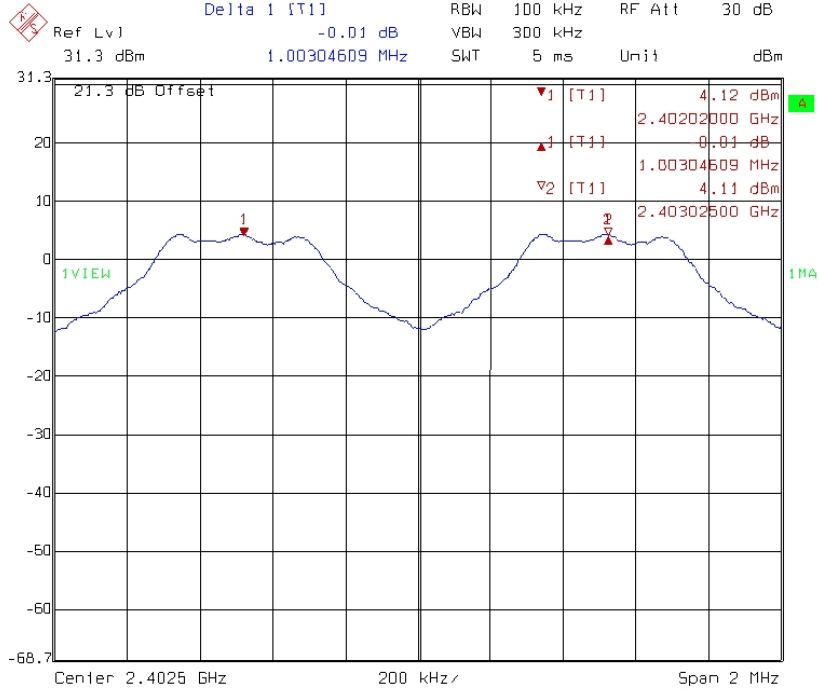
EUT : RB4000HM-a & RB4000HM-c

Mode	Channel	Frequency (MHz)	Carrier freq. Separation (MHz)	Limit 20dB BW*2/3(kHz)
GFSK	0	2402	1.003	544.67
	1	2403		
$\pi/4$ DPSK	0	2402	1.006	818.30
	1	2403		
8DPSK	0	2402	1.004	848.36
	1	2403		

Please see the plot below.

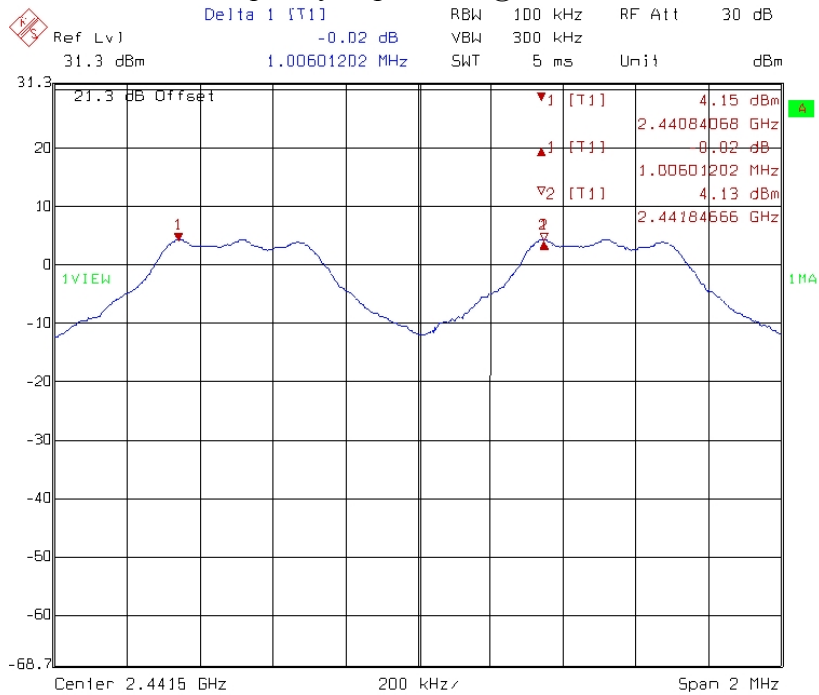
**For RB4000HM-a & RB4000HM-c**

**Carrier Frequency Separation @ GFSK mode**



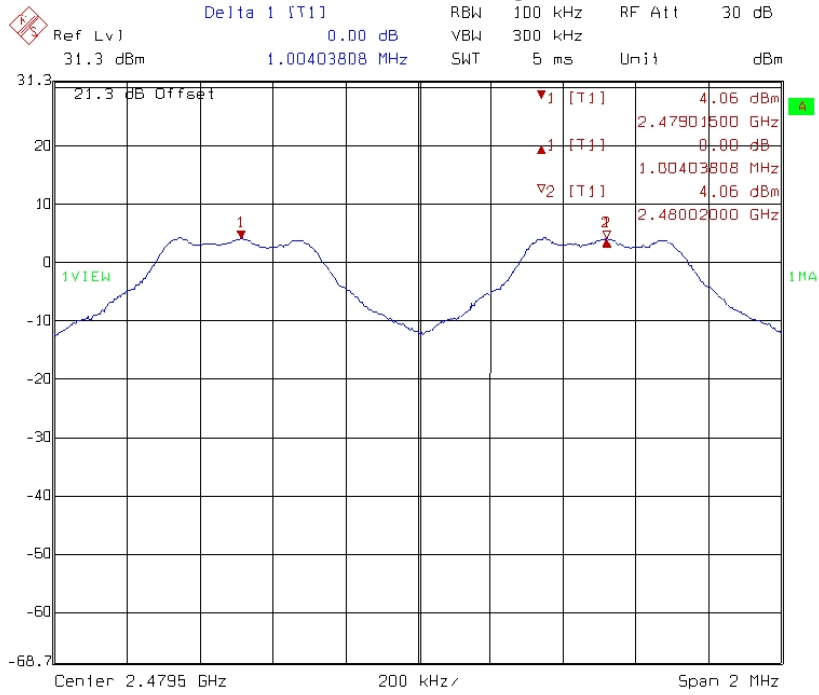
Title: Carrier freq. separation  
 Comment A: GFSK ch0 2402 DH1  
 Date: 22.FEB.2012 10:42:26

**Carrier Frequency Separation @  $\pi/4$ DPSK mode**



Title: Carrier freq. separation  
 Comment A: GFSK ch39 2441 DH1  
 Date: 22.FEB.2012 10:48:41

**Carrier Frequency Separation @ 8DPSK mode**



Title: Carrier freq. separation  
 Comment A: GFSK ch77 2479 DH1  
 Date: 22.FEB.2012 10:56:52





## 5. Number of hopping frequencies test

### 5.1 Operating environment

Temperature: 25 °C  
Relative Humidity: 55 %  
Atmospheric Pressure: 1008 hPa

### 5.2 Test setup & procedure

**The test procedure was according to FCC measurement guidelines DA 00-705.**

The number of hopping frequencies per FCC §15.247(a)(1) was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at  $\geq 1\%$  of the span, the video bandwidth  $\geq$  RBW, and the SPAN was the frequency band of operation. The carrier frequency separation result is in the following Table.

### 5.3 Measured data of number of hopping frequencies test result

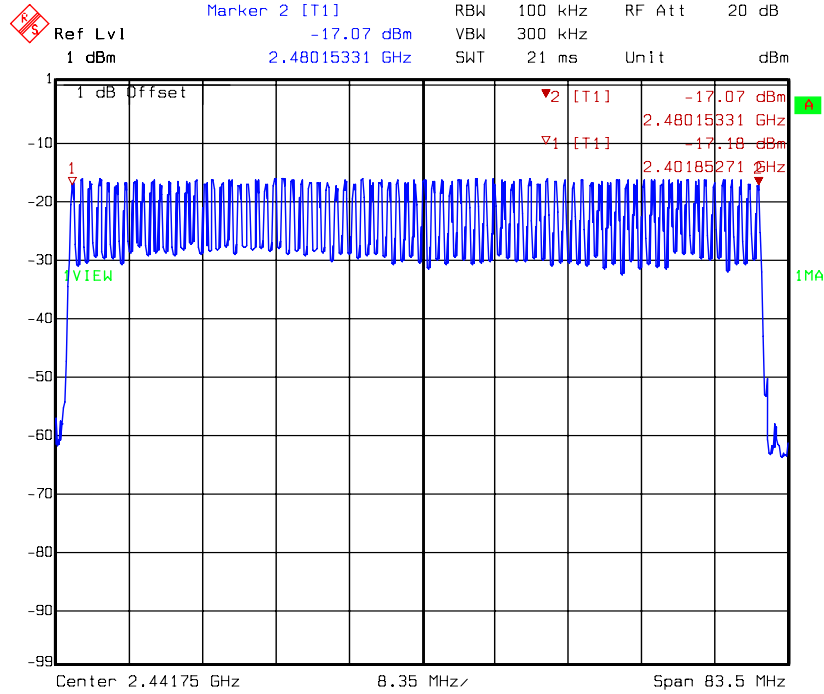
EUT : RB4000HM-a & RB4000HM-c

Frequency Range (MHz)	Total hopping channels
2400 ~ 2483.5	79

Please see the plot below.

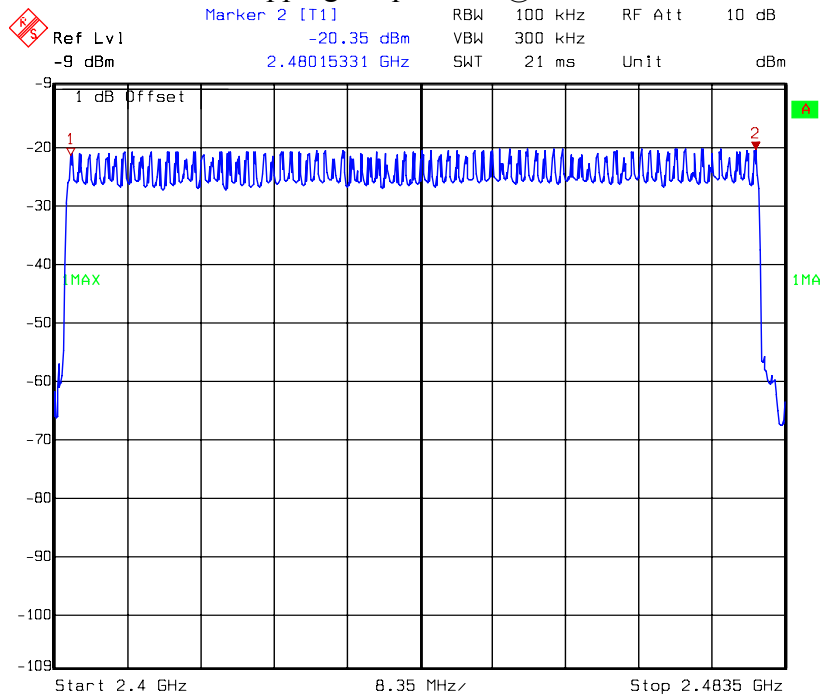
**For RB4000HM-a & RB4000HM-c**

**Number of hopping frequencies @ GFSK mode**



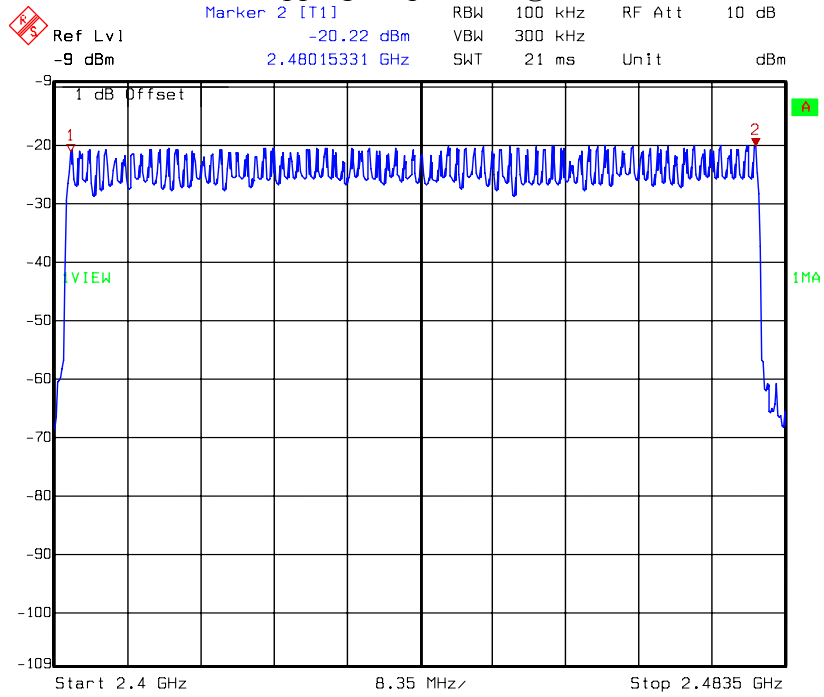
Title: Number of hopping freq  
 Comment A: GFSK ch0 2402 DH1  
 Date: 22.FEB.2012 10:37:36

**Number of hopping frequencies @  $\pi/4$ DPSK mode**



Title: Number of hopping freq  
 Comment A: pi/4-QPSK ch0 2402 DH1  
 Date: 26.MAR.2012 11:13:20

### Number of hopping frequencies @ 8DPSK mode



Title: Number of hopping freq  
Comment A: 8DPSK ch0 2402 DH1  
Date: 26.MAR.2012 11:45:51



## 6. Time of Occupancy (dwell time) & Duty Cycle Correction Factor test

### 6.1 Operating environment

Temperature: 23 °C  
Relative Humidity: 55 %  
Atmospheric Pressure: 1008 hPa

### 6.2 Test setup & procedure

**The test procedure was according to FCC measurement guidelines DA 00-705.**

The time of occupancy (dwell time) per FCC §15.247(a)(1) was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 1MHz, the video bandwidth  $\geq$  RBW, and the zero span function of spectrum analyzer was enable. The EUT has its hopping function enable.

The system makes worst case 1600 hops per second or 1 time slot has a length of 625 $\mu$ s with 79 channels.

The total sweep time is  $0.4(79) = 31.6$  seconds

Due to the number of hops in the 31.6s sweep we determined to reduce the sweep time to 3.16s, count the number of hops and multiply by 10. The total number of hops will be multiplied by the measured time of one pulse.

Time of occupancy (dwell time) for DH1

Number of Hops in 3.16s=32, Total Number of Hops in 31.6s =  $32(10) = 320$

Single Pulse Width = 0.000380762 sec

Dwell time = Pulse Width \* 320 = 122.6 ms

Time of occupancy (dwell time) for DH3

Number of Hops in 3.16s=16, Total Number of Hops in 31.6s =  $16(10) = 160$

Single Pulse Width = 0.001643287 sec

Dwell time = Pulse Width \* 160 = 262.6 ms

Time of occupancy (dwell time) for DH5

Number of Hops in 3.16s=11, Total Number of Hops in 31.6s =  $11(10) = 110$

Single Pulse Width = 0.002895792 sec

Dwell time = Pulse Width \* 110 = 318.5 ms

EUT : RB4000HM-a & RB4000HM-c

Mode	Mode	Pulse Width (ms)	Time of Occupancy (ms)	Limit (sec)
GFSK	DH1	0.380762	125.7	0.4
	DH3	1.643287	262.6	
	DH5	2.895792	318.5	
$\pi/4$ DPSK	DH1	0.380762	125.7	0.4
	DH3	1.643287	262.9	
	DH5	2.895792	318.5	
8DPSK	DH1	0.380762	125.7	0.4
	DH3	1.643287	262.9	
	DH5	2.895792	318.5	

EUT : RB4000HM-a & RB4000HM-c

**Duty Cycle Correction Factor**

Mode	Mode	Time of Occupancy (ms)	Duty Cycle %	Duty Cycle Correction Factor (dB)
GFSK	DH1	125.7	0.3960	-47.95
	DH3	262.6	1.6620	-35.59
	DH5	318.5	2.9100	-30.72
$\pi/4$ DPSK	DH1	125.7	0.4060	-47.74
	DH3	262.6	1.6680	-35.56
	DH5	318.5	2.9180	-30.70
8DPSK	DH1	125.7	0.4120	-47.61
	DH3	262.6	1.6680	-35.56
	DH5	318.5	2.9100	-30.72

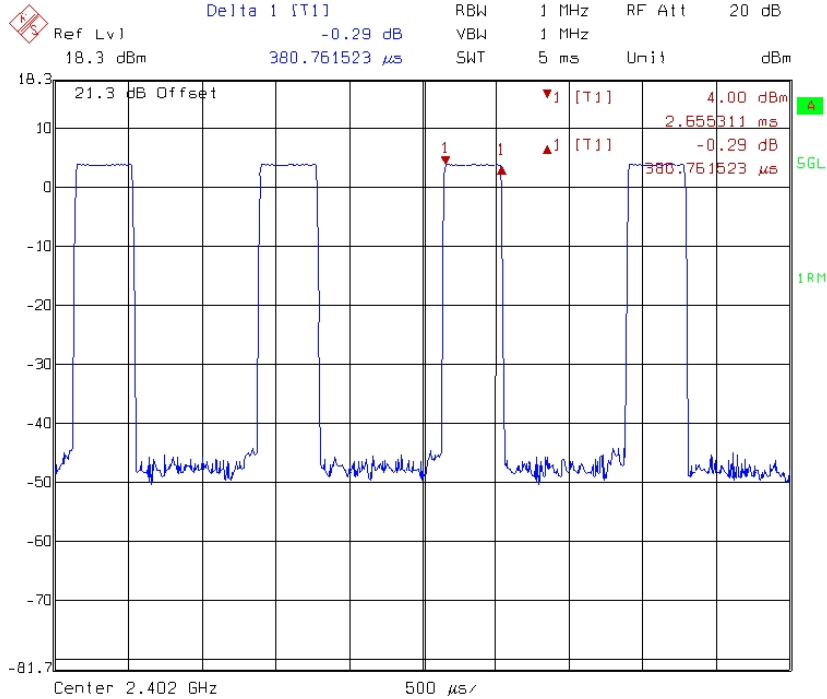
Remark:

1. Duty Cycle = (time of occupancy)/(31.6\*1000)\*100%
2. Duty Cycle Correction Factor = 20 log (duty cycle/100%)
3. The worst case of GFSK mode is -30.72  
 The worse case of  $\pi/4$  DPSK mode is -30.70  
 The worse case of 8DPSK mode is -30.72

Please see the plot below.

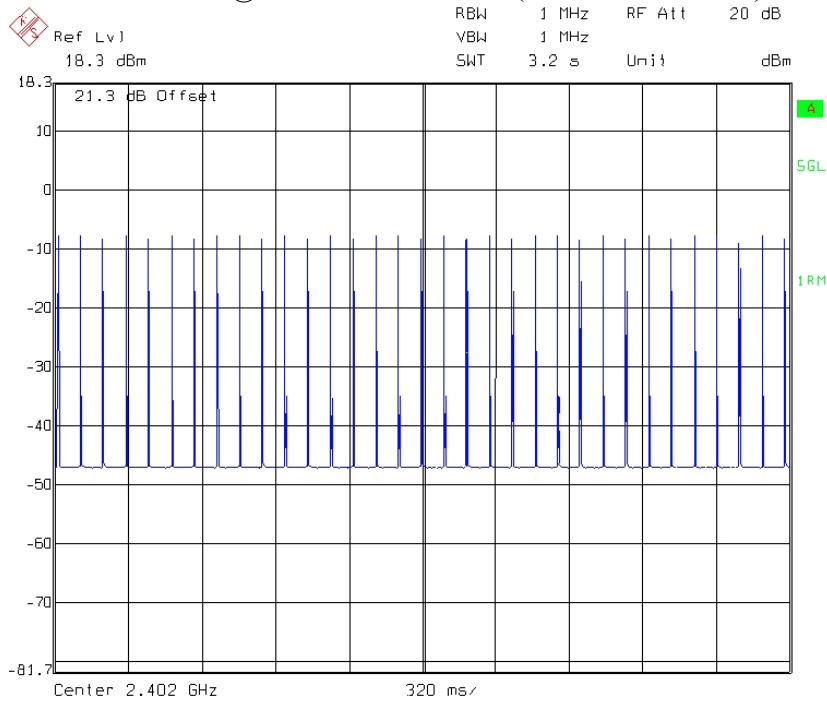
**For RB4000HM-a & RB4000HM-c**

**Dwell time @ GFSK mode DH 1 (Single pulse)**



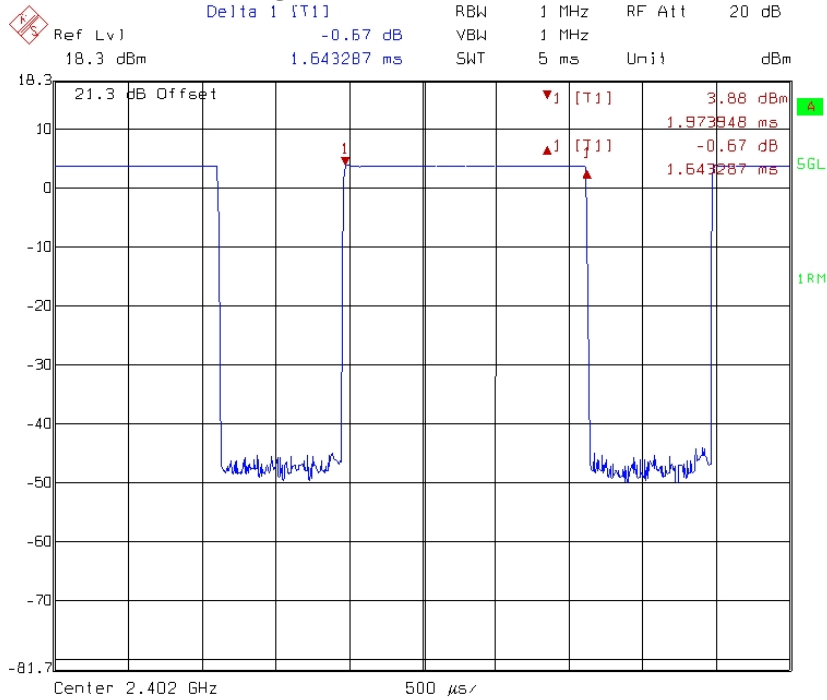
Title: Frequency Range, & (\*Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:00:31

**Dwell time @ GFSK mode DH 1 (Number of Pulses)**



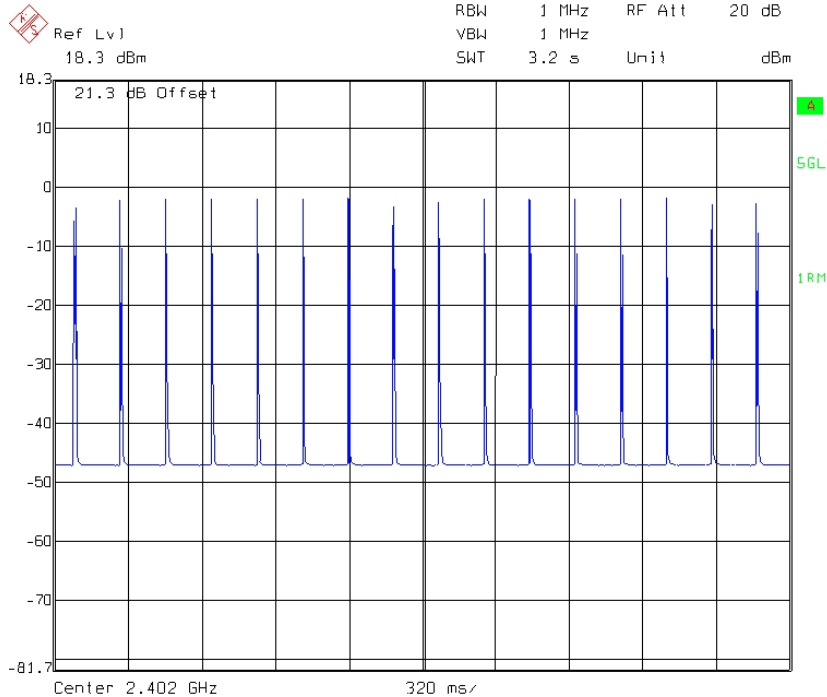
Title: Frequency Range, & (\*Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:34:28

### Dwell time @ GFSK mode DH 3 (Single pulse)



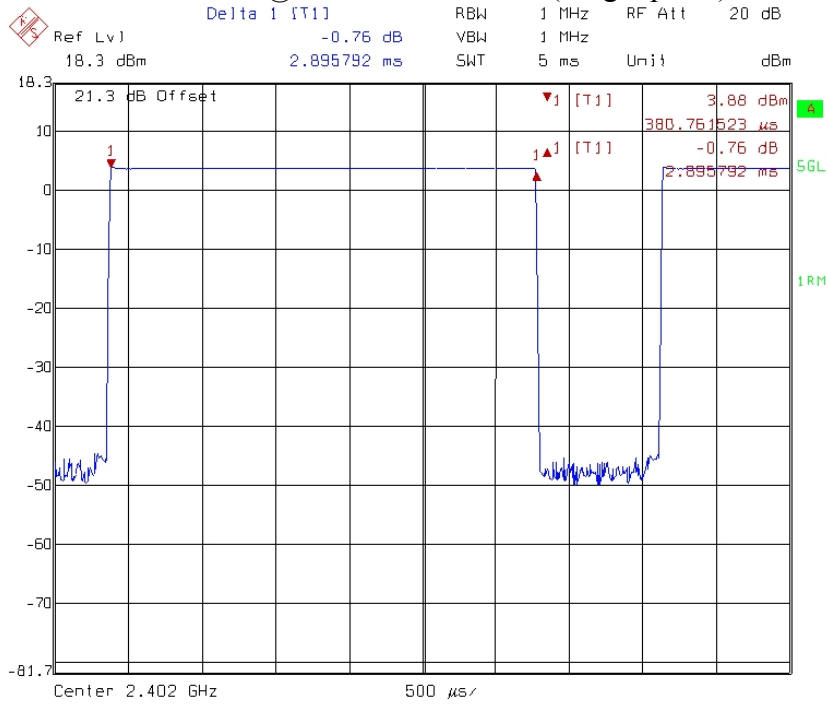
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:47:08

### Dwell time @ GFSK mode DH 3 (Number of Pulses)



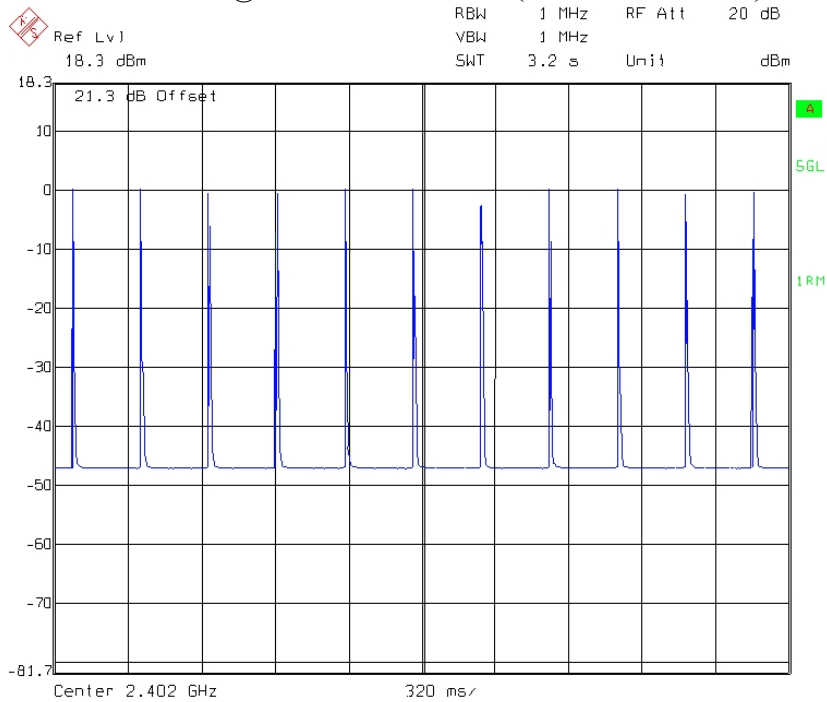
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:26:42

### Dwell time @ GFSK mode DH 5 (Single pulse)



Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:49:23

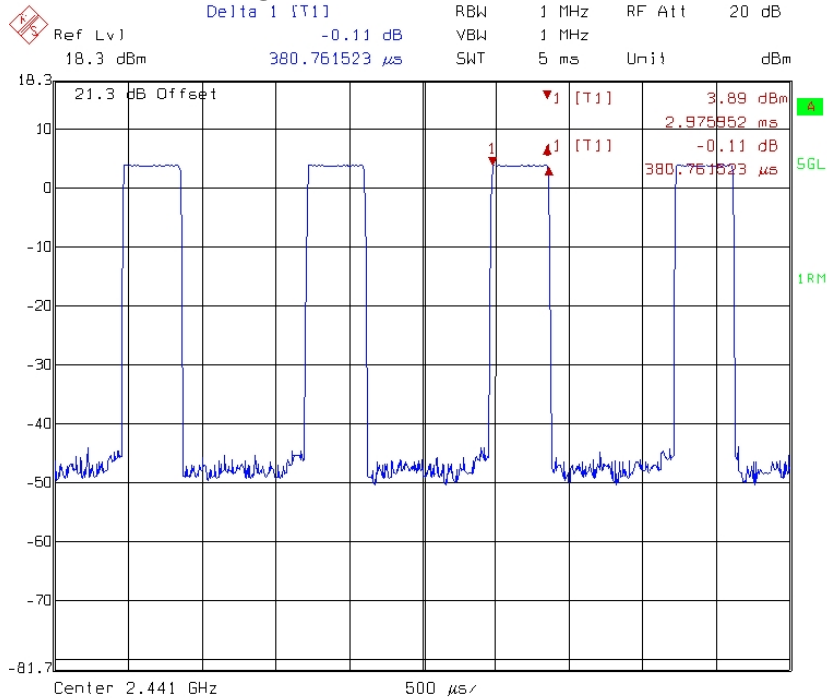
### Dwell time @ GFSK mode DH 5 (Number of Pulses)



Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:27:42

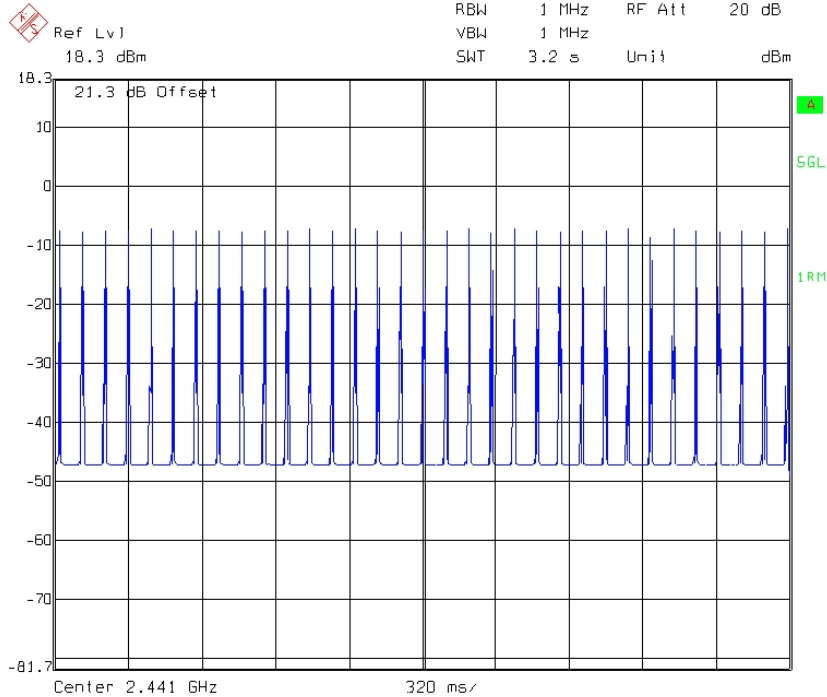


**Dwell time @ $\pi/4$ DPSK mode DH 1 (Single pulse)**



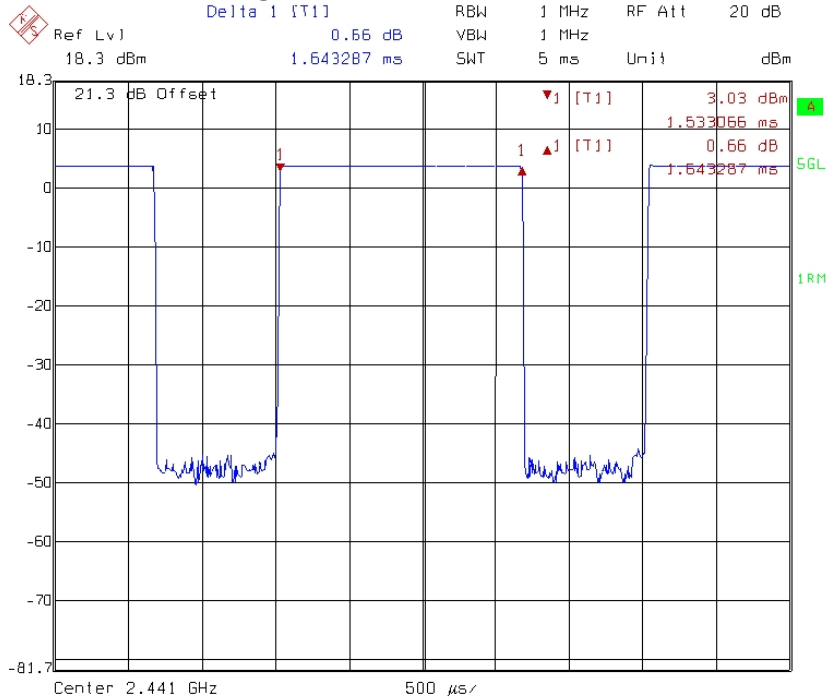
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:15:50

**Dwell time @ $\pi/4$ DPSK mode DH 1 (Number of Pulses)**



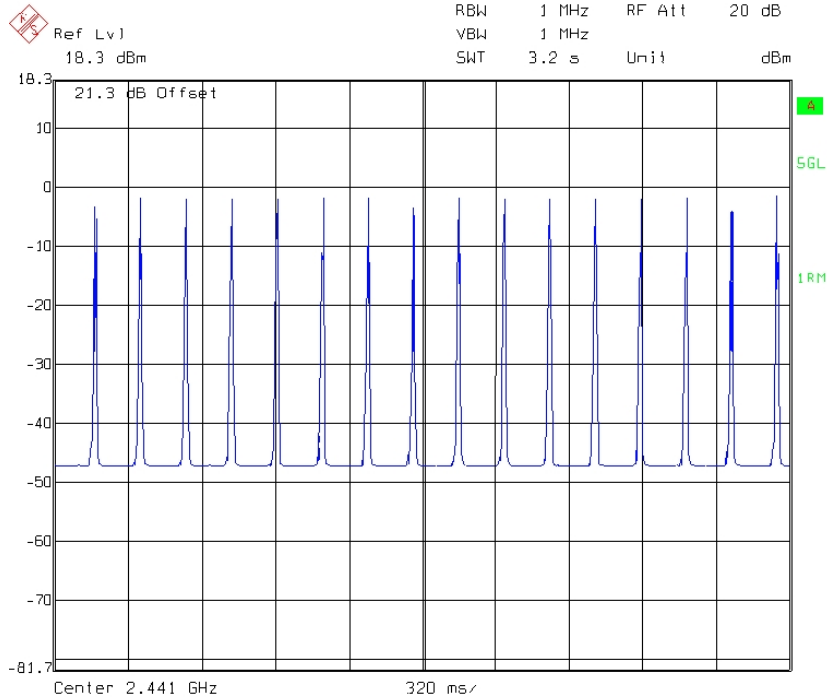
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:23:25

**Dwell time @ $\pi/4$ DPSK mode DH 3 (Single pulse)**



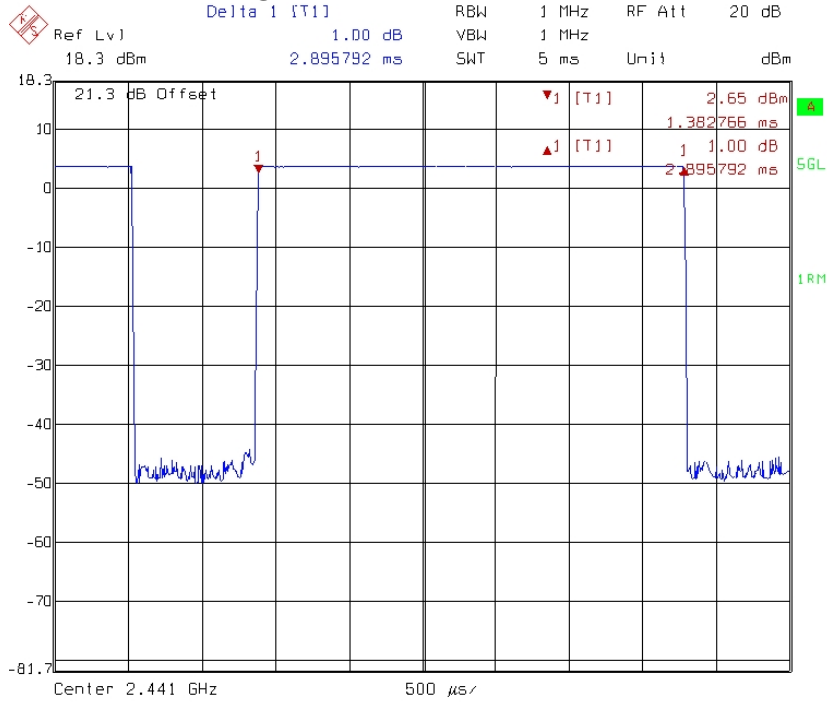
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:42:33

**Dwell time @ $\pi/4$ DPSK mode DH 3 (Number of Pulses)**



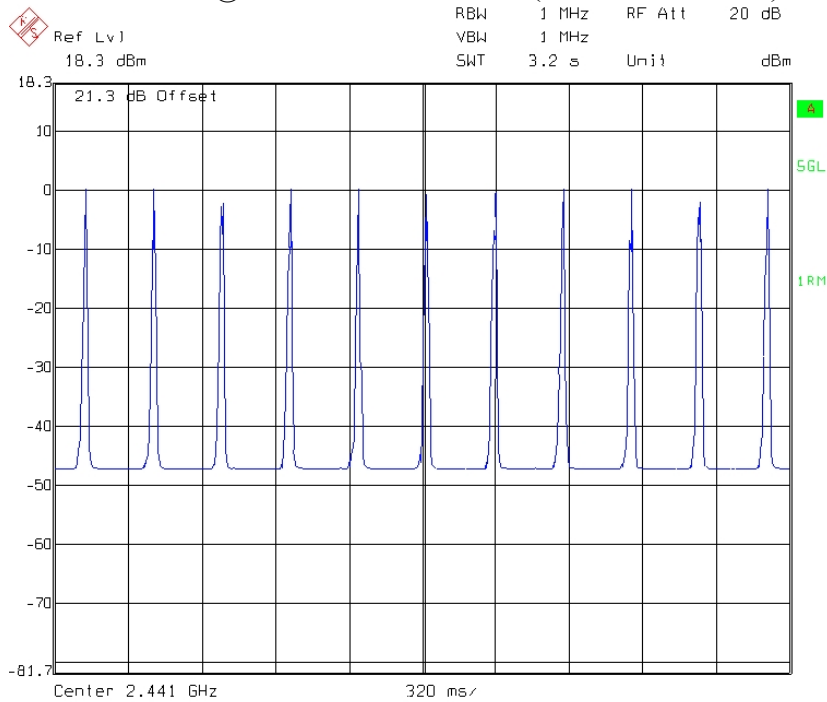
Title: Frequency Range, &(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:26:03

**Dwell time @ $\pi/4$ DPSK mode DH 5 (Single pulse)**



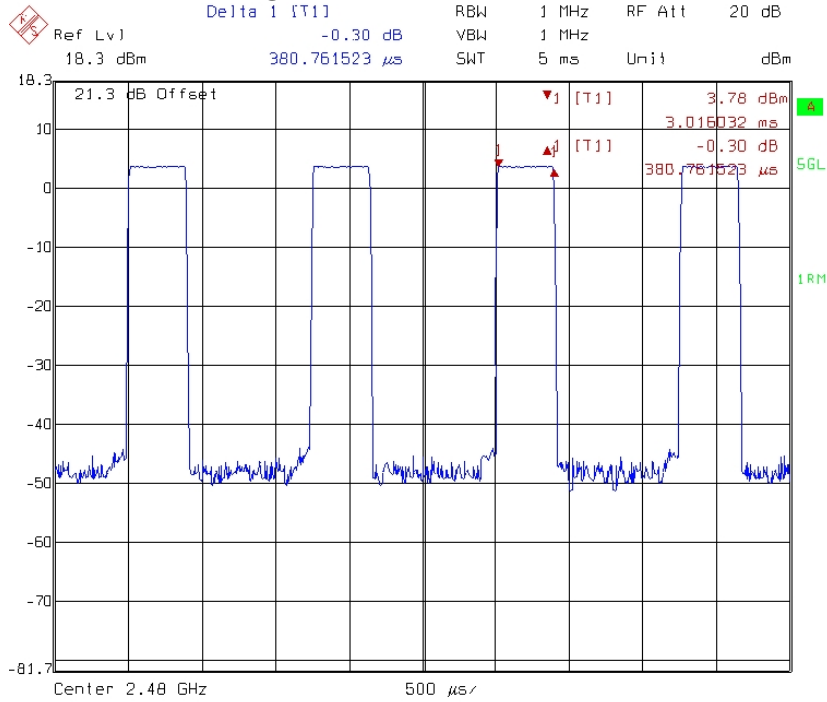
Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:53:29

**Dwell time @ $\pi/4$ DPSK mode DH 5 (Number of Pulses)**



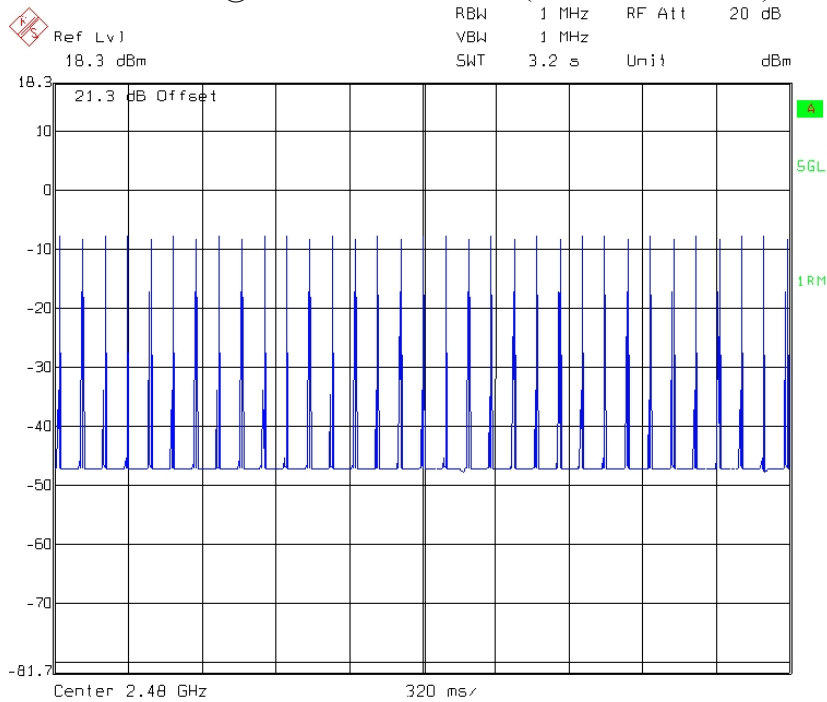
Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:28:16

**Dwell time @ 8DPSK mode DH 1 (Single pulse)**



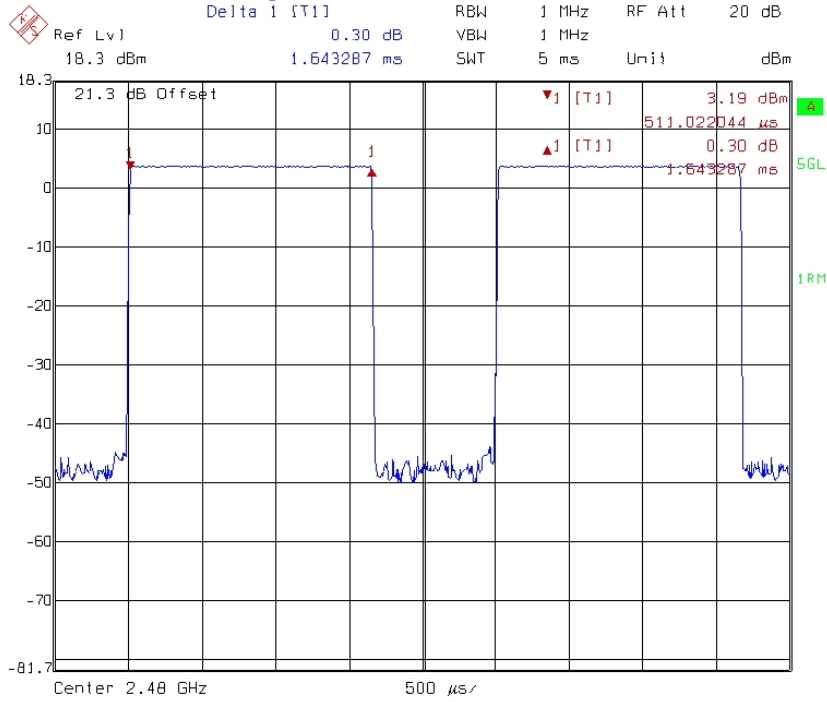
Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:16:58

**Dwell time @ 8DPSK mode DH 1 (Number of Pulses)**



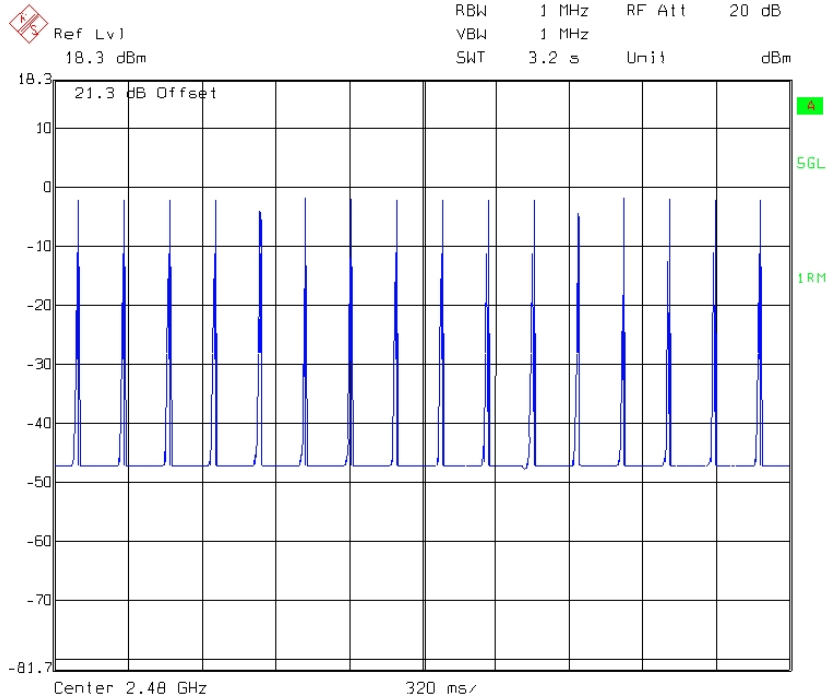
Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:24:28

**Dwell time @ 8DPSK mode DH 3 (Single pulse)**



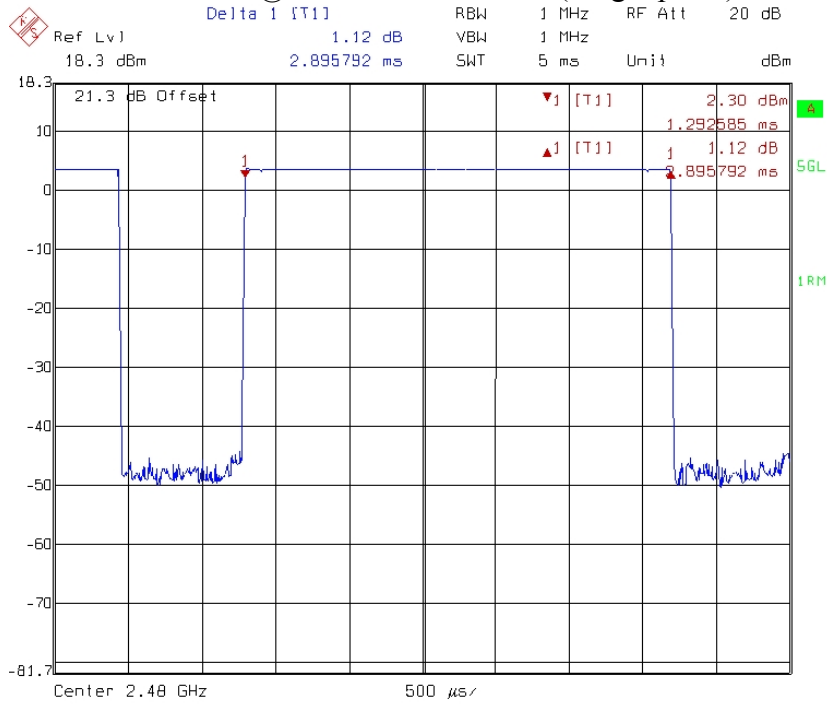
Title: Frequency Range, & (+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:41:19

**Dwell time @ 8DPSK mode DH 3 (Number of Pulses)**



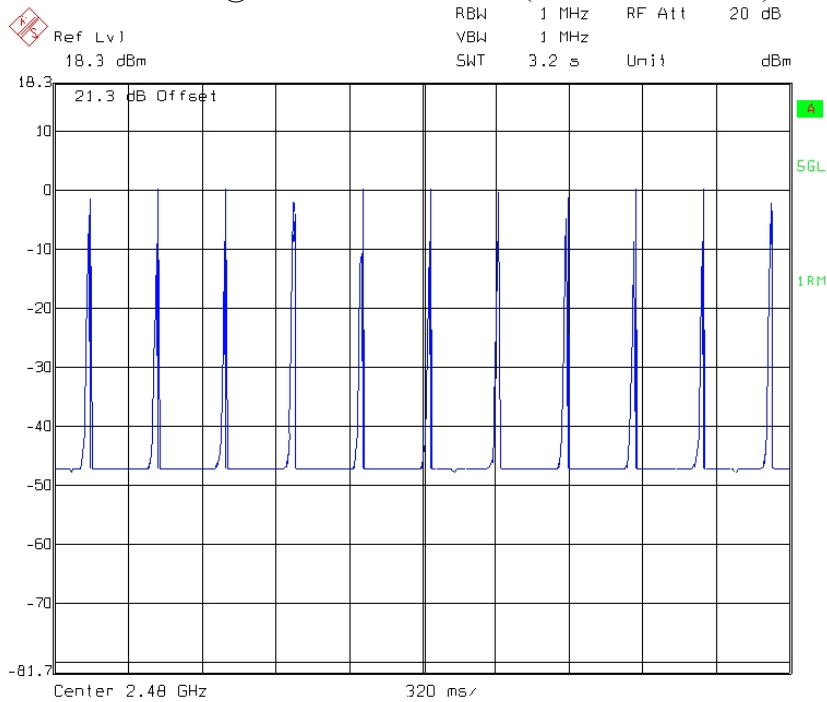
Title: Frequency Range, & (+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:25:29

**Dwell time @ 8DPSK mode DH 5 (Single pulse)**



Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 15:55:03

**Dwell time @ 8DPSK mode DH 5 (Number of Pulses)**



Title: Frequency Range,&(+Y\_RB4000  
 Comment A: 11b 2402 ch-1 Chain0 55c 253v  
 Date: 21.FEB.2012 17:28:52



## 7. Maximum Output Power test

### 7.1 Operating environment

Temperature: 23 °C  
Relative Humidity: 50 %  
Atmospheric Pressure: 1022 hPa

### 7.2 Test setup & procedure

**The test procedure was according to FCC measurement guidelines DA 00-705.**

The power output per FCC §15.247(b) was measured on the EUT using a 50 ohm SMA cable connected to peak power meter via power sensor. Power was read directly and cable loss correction (2 dB) was added to the reading to obtain power at the EUT antenna terminals. The test was performed at 3 channels (lowest, middle and highest channel).

### 7.3 Measured data of Maximum Output Power test results

EUT : RB4000HM-a & RB4000HM-c

Mode	Channel	Frequency (MHz)	Output Power (PK) (dBm)	Total Power (PK) (mw)	Limit (dBm)
GFSK	0	2402	4.67	2.93	30
	39	2441	4.90	3.09	30
	78	2480	4.79	3.01	30
$\pi/4$ DPSK	0	2402	3.07	2.03	30
	39	2441	3.22	2.10	30
	78	2480	3.33	2.15	30
8DPSK	0	2402	3.10	2.04	30
	39	2441	3.25	2.11	30
	78	2480	3.47	2.22	30