

# FC

## Test Report

Product Name	Mindwave
Model No.	MW003
FCC ID.	XG9MW3

Applicant	NeuroSky Inc.
Address	125 South Market Street # 900, San Jose, CA 95113 USA

Date of Receipt	Aug. 31, 2011
Issued Date	Sep. 07, 2011
Report No.	119084R-RFUSP29V01
Report Version	V1.0

The Test Results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of Quietek Corporation.

This report must not be used to claim product endorsement by NVLAP any agency of the U.S. Government

# Test Report Certification

Issued Date: Sep. 07, 2011

Report No.: 119084R-RFUSP29V01



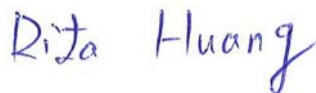
Product Name	Mindwave
Applicant	NeuroSky Inc.
Address	125 South Market Street # 900, San Jose, CA 95113 USA
Manufacturer	DONG GUAN G-COM COMPUTER CO., LTD
Model No.	MW003
FCC ID.	XG9MW3
EUT Rated Voltage	DC 1.5V (Power by battery)
EUT Test Voltage	DC 1.5V(Power by battery)
Trade Name	MindWave, NeuroSky
Applicable Standard	FCC CFR Title 47 Part 15 Subpart C: 2010 ANSI C63.4: 2009
Test Result	Complied

The Test Results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of QuietTek Corporation.

This report must not be used to claim product endorsement by NVLAP any agency of the U.S. Government

Documented By :



( Senior Adm. Specialist / Rita Huang )



Tested By :



( Engineer / Vincent Chu )



Approved By :



(Manager / Vincent Lin )

# TABLE OF CONTENTS

Description	Page
<b>1. GENERAL INFORMATION .....</b>	<b>5</b>
1.1. EUT Description.....	5
1.2. Operational Description.....	7
1.3. Tested System Details.....	8
1.4. Configuration of Tested System .....	8
1.5. EUT Exercise Software .....	8
1.6. Test Facility .....	9
<b>2. CONDUCTED EMISSION .....</b>	<b>10</b>
2.1. Test Equipment.....	10
2.2. Test Setup .....	10
2.3. Limits.....	11
2.4. Test Procedure .....	11
2.5. Uncertainty .....	11
2.6. Test Result of Conducted Emission.....	12
<b>3. PEAK POWER OUTPUT .....</b>	<b>13</b>
3.1. Test Equipment.....	13
3.2. Test Setup .....	13
3.3. Limit .....	13
3.4. Test Procedure .....	13
3.5. Uncertainty .....	13
3.6. Test Result of Peak Power Output.....	14
<b>4. RADIATED EMISSION .....</b>	<b>16</b>
4.1. Test Equipment.....	16
4.2. Test Setup .....	16
4.3. Limits.....	17
4.4. Test Procedure .....	18
4.5. Uncertainty .....	18
4.6. Test Result of Radiated Emission.....	19
<b>5. RF ANTENNA CONDUCTED TEST .....</b>	<b>27</b>
5.1. Test Equipment.....	27
5.2. Test Setup .....	27
5.3. Limits.....	27
5.4. Test Procedure .....	27
5.5. Uncertainty .....	27
5.6. Test Result of RF Antenna Conducted Test.....	28
<b>6. BAND EDGE .....</b>	<b>40</b>
6.1. Test Equipment.....	40
6.2. Test Setup .....	41
6.3. Limit .....	42
6.4. Test Procedure .....	42
6.5. Uncertainty .....	42

6.6.	Test Result of Band Edge .....	43
<b>7.</b>	<b>CHANNEL NUMBER.....</b>	<b>51</b>
7.1.	Test Equipment .....	51
7.2.	Test Setup .....	51
7.3.	Limit .....	51
7.4.	Test Procedure .....	51
7.5.	Uncertainty .....	51
7.6.	Test Result of Channel Number.....	52
<b>8.</b>	<b>CHANNEL SEPARATION.....</b>	<b>54</b>
8.1.	Test Equipment .....	54
8.2.	Test Setup .....	54
8.3.	Limit .....	54
8.4.	Test Procedure .....	54
8.5.	Uncertainty .....	54
8.6.	Test Result of Channel Separation.....	55
<b>9.</b>	<b>DWELL TIME .....</b>	<b>59</b>
9.1.	Test Equipment .....	59
9.2.	Test Setup .....	59
9.3.	Limit .....	59
9.4.	Test Procedure .....	59
9.5.	Uncertainty .....	59
9.6.	Test Result of Dwell Time .....	60
<b>10.</b>	<b>OCCUPIED BANDWIDTH .....</b>	<b>64</b>
10.1.	Test Equipment .....	64
10.2.	Test Setup .....	64
10.3.	Limits.....	64
10.4.	Test Procedure .....	64
10.5.	Uncertainty .....	64
10.6.	Test Result of Occupied Bandwidth .....	65
<b>11.</b>	<b>EMI REDUCTION METHOD DURING COMPLIANCE TESTING .....</b>	<b>71</b>
Attachment 1: EUT Test Photographs		
Attachment 2: EUT Detailed Photographs		

## 1. GENERAL INFORMATION

### 1.1. EUT Description

Product Name	Mindwave
Trade Name	MindWave, NeuroSky
Model No.	MW003
FCC ID.	XG9MW3
Frequency Range	2402 – 2480MHz
Channel Number	79
Type of Modulation	FHSS: GFSK(1Mbps) / $\pi$ / 4DQPSK(2Mbps) / 8DPSK(3Mbps)
Antenna Type	PIFA Antenna
Channel Control	Auto
Antenna Gain	Refer to the table “Antenna List”

#### Antenna List

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Soarcomm Technology Company	3010000158S7	PIFA	2 dBi for 2.4 GHz

Note:

1. The antenna of EUT is conform to FCC 15.203.

#### Frequency of Each Channel:

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
Channel 00:	2402 MHz	Channel 20:	2422 MHz	Channel 40:	2442 MHz	Channel 60:	2462 MHz
Channel 01:	2403 MHz	Channel 21:	2423 MHz	Channel 41:	2443 MHz	Channel 61:	2463 MHz
Channel 02:	2404 MHz	Channel 22:	2424 MHz	Channel 42:	2444 MHz	Channel 62:	2464 MHz
Channel 03:	2405 MHz	Channel 23:	2425 MHz	Channel 43:	2445 MHz	Channel 63:	2465 MHz
Channel 04:	2406 MHz	Channel 24:	2426 MHz	Channel 44:	2446 MHz	Channel 64:	2466 MHz
Channel 05:	2407 MHz	Channel 25:	2427 MHz	Channel 45:	2447 MHz	Channel 65:	2467 MHz
Channel 06:	2408 MHz	Channel 26:	2428 MHz	Channel 46:	2448 MHz	Channel 66:	2468 MHz
Channel 07:	2409 MHz	Channel 27:	2429 MHz	Channel 47:	2449 MHz	Channel 67:	2469 MHz
Channel 08:	2410 MHz	Channel 28:	2430 MHz	Channel 48:	2450 MHz	Channel 68:	2470 MHz
Channel 09:	2411 MHz	Channel 29:	2431 MHz	Channel 49:	2451 MHz	Channel 69:	2471 MHz
Channel 10:	2412 MHz	Channel 30:	2432 MHz	Channel 50:	2452 MHz	Channel 70:	2472 MHz
Channel 11:	2413 MHz	Channel 31:	2433 MHz	Channel 51:	2453 MHz	Channel 71:	2473 MHz
Channel 12:	2414 MHz	Channel 32:	2434 MHz	Channel 52:	2454 MHz	Channel 72:	2474 MHz
Channel 13:	2415 MHz	Channel 33:	2435 MHz	Channel 53:	2455 MHz	Channel 73:	2475 MHz
Channel 14:	2416 MHz	Channel 34:	2436 MHz	Channel 54:	2456 MHz	Channel 74:	2476 MHz
Channel 15:	2417 MHz	Channel 35:	2437 MHz	Channel 55:	2457 MHz	Channel 75:	2477 MHz
Channel 16:	2418 MHz	Channel 36:	2438 MHz	Channel 56:	2458 MHz	Channel 76:	2478 MHz
Channel 17:	2419 MHz	Channel 37:	2439 MHz	Channel 57:	2459 MHz	Channel 77:	2479 MHz
Channel 18:	2420 MHz	Channel 38:	2440 MHz	Channel 58:	2460 MHz	Channel 78:	2480 MHz
Channel 19:	2421 MHz	Channel 39:	2441 MHz	Channel 59:	2461 MHz		

#### Note:

1. This device is a Mindwave with a built-in 2.4GHz Bluetooth V2.0+EDR transceiver.
2. These tests were conducted on a sample for the purpose of demonstrating compliance of Bluetooth transmitter with Part 15 Subpart C Paragraph 15.247 for spread spectrum devices.
3. Regarding to the operation frequency, the lowest, middle and highest frequency are selected to perform the test.
4. The radiation measurements are performed in X, Y, Z-axis positioning. Only the worst case is shown in the report.

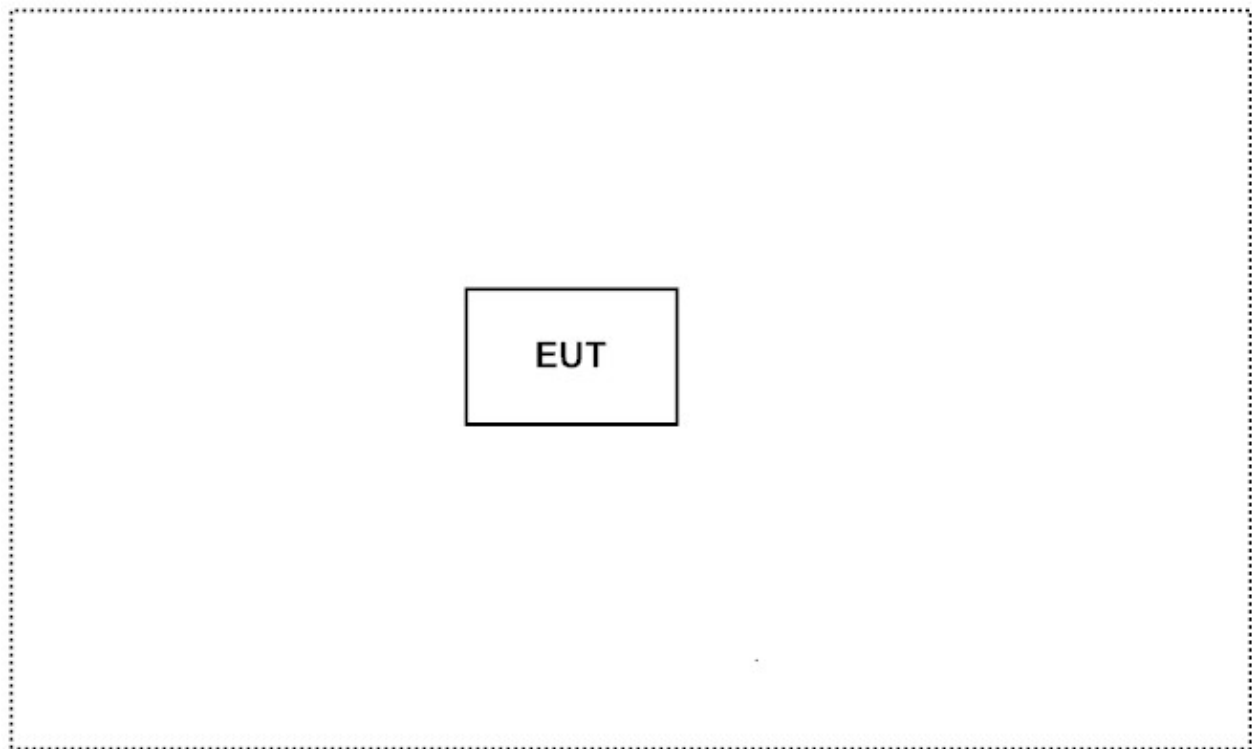
### 1.3. Tested System Details

The types for all equipment, plus descriptions of all cables used in the tested system (including inserted cards) are:

	Product	Manufacturer	Model No.	Serial No.	Power Cord
1	N/A	N/A	N/A	N/A	N/A

Signal Cable Type	Signal cable Description
N/A	N/A

### 1.4. Configuration of Tested System



### 1.5. EUT Exercise Software

- (1) Setup the EUT as shown in Section 1.4.
- (2) Execute software on the EUT.
- (3) Configure the test mode, the test channel, and the data rate.
- (4) Press “OK” to start the continuous Transmit.
- (5) Verify that the EUT works properly.

## 1.6. Test Facility

Ambient conditions in the laboratory:

Items	Required (IEC 68-1)	Actual
Temperature (°C)	15-35	20-35
Humidity (%RH)	25-75	30-65
Barometric pressure (mbar)	860-1060	950-1000

The related certificate for our laboratories about the test site and management system can be downloaded from Quietek Corporation's Web Site: <http://www.quietek.com/tw/ctg/cts/accreditations.htm>  
The address and introduction of Quietek Corporation's laboratories can be founded in our Web site: <http://www.quietek.com/>

Site Description: File on  
Federal Communications Commission  
FCC Engineering Laboratory  
7435 Oakland Mills Road  
Columbia, MD 21046  
Registration Number: 92195



Accreditation on NVLAP  
NVLAP Lab Code: 200533-0



Site Name: Quietek Corporation  
Site Address: No.5-22, Ruishukeng,  
Linkou Dist. New Taipei City 24451,  
Taiwan, R.O.C.  
TEL: 886-2-8601-3788 / FAX : 886-2-8601-3789  
E-Mail : [service@quietek.com](mailto:service@quietek.com)

FCC Accreditation Number: TW1014





## 2. Conducted Emission

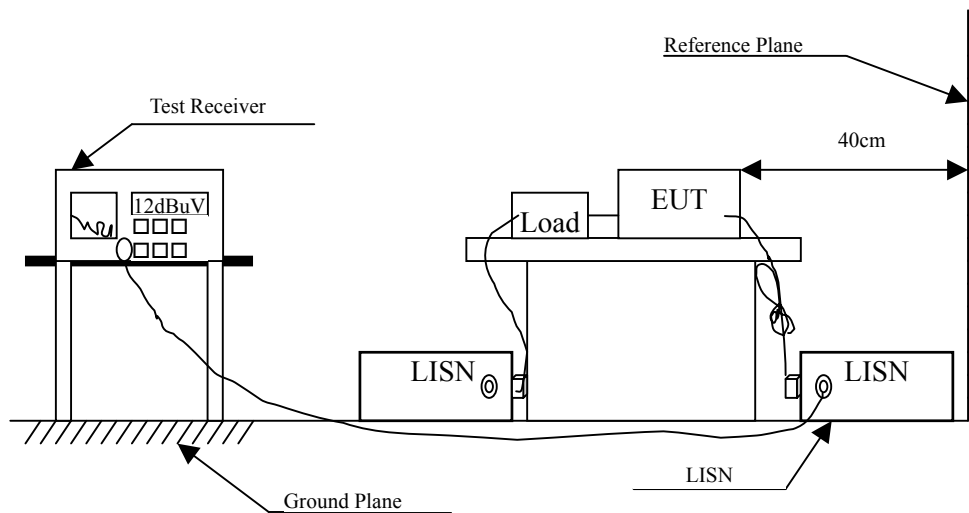
### 2.1. Test Equipment

The following test equipment are used during the conducted emission test:

Item	Instrument	Manufacturer	Type No./Serial No	Last Cal.	Remark
1	Test Receiver	R & S	ESCS 30/825442/014	Feb., 2011	
2	L.I.S.N.	R & S	ESH3-Z5/825562/002	Feb., 2011	EUT
3	L.I.S.N.	R & S	ENV4200/848411/010	Feb., 2011	Peripherals
4	Pulse Limiter	R & S	ESH3-Z2/100410	July, 2011	
5	No.1 Shielded Room			N/A	

Note: All instruments are calibrated every one year.

### 2.2. Test Setup



### 2.3. Limits

FCC Part 15 Subpart C Paragraph 15.207 (dBuV) Limit		
Frequency MHz	Limits	
	QP	AV
0.15 - 0.50	66-56	56-46
0.50-5.0	56	46
5.0 - 30	60	50

Remarks: In the above table, the tighter limit applies at the band edges.

### 2.4. Test Procedure

The EUT and Peripherals are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /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 refer 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 the interface cables must be changed according to ANSI C63.4: 2009 on conducted measurement.

Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

The EUT was setup to ANSI C63.4, 2009; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

### 2.5. Uncertainty

± 2.26 dB

## **2.6. Test Result of Conducted Emission**

Owing to the DC operation of EUT, this test item is not performed.

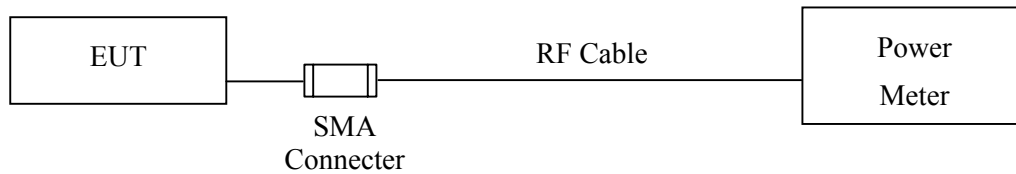
### 3. Peak Power Output

#### 3.1. Test Equipment

	Equipment	Manufacturer	Model No./Serial No.	Last Cal.
X	Power Meter	Anritsu	ML2495A/6K00003357	May, 2011
X	Power Sensor	Anritsu	MA2411B/0738448	Jun, 2011

Note: 1. All equipments are calibrated every one year.  
2. The test instruments marked by “X” are used to measure the final test results.

#### 3.2. Test Setup



#### 3.3. Limit

The maximum peak power shall be less 1Watt.

#### 3.4. Test Procedure

The EUT was setup to ANSI C63.4, 2009; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

#### 3.5. Uncertainty

$\pm 1.27$  dB

### 3.6. Test Result of Peak Power Output

Product : Mindwave  
Test Item : Peak Power Output  
Test Site : No.3 OATS  
Test Mode : Mode 1: Transmit - 1Mbps (GFSK)

Channel No.	Frequency (MHz)	Measurement (dBm)	Required Limit	Result
Channel 00	2402.00	6.77	1 Watt= 30 dBm	Pass
Channel 39	2441.00	6.64	1 Watt= 30 dBm	Pass
Channel 78	2480.00	6.07	1 Watt= 30 dBm	Pass

Product : Mindwave  
Test Item : Peak Power Output  
Test Site : No.3 OATS  
Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

Channel No.	Frequency (MHz)	Measurement (dBm)	Required Limit	Result
Channel 00	2402.00	5.62	1 Watt= 30 dBm	Pass
Channel 39	2441.00	5.24	1 Watt= 30 dBm	Pass
Channel 78	2480.00	4.66	1 Watt= 30 dBm	Pass

## 4. Radiated Emission

### 4.1. Test Equipment

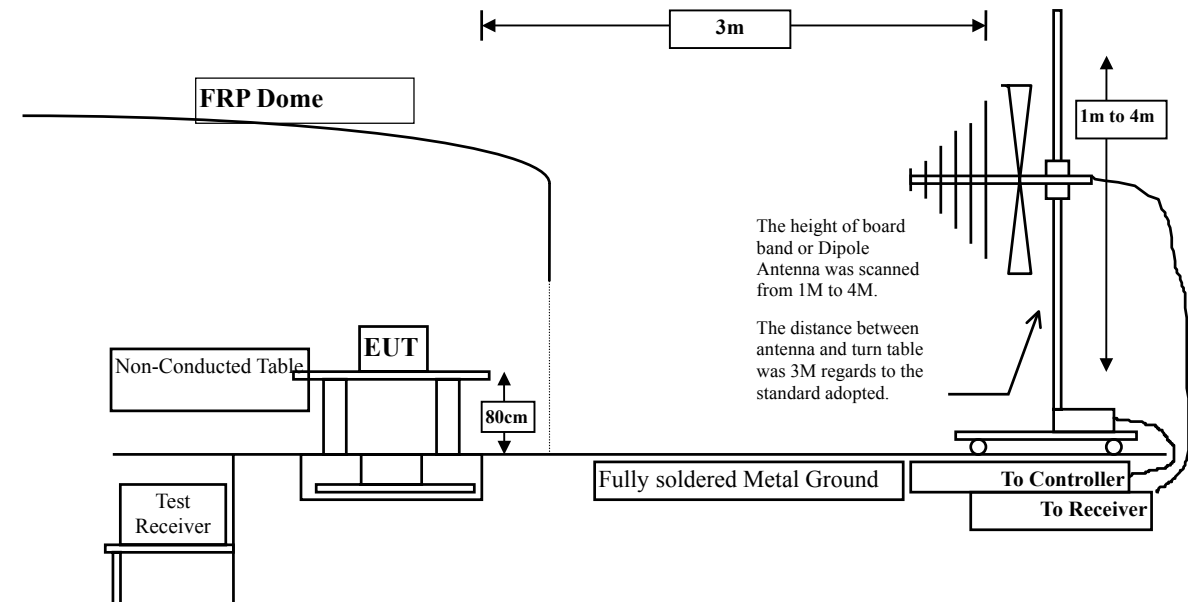
The following test equipments are used during the radiated emission test:

Test Site		Equipment	Manufacturer	Model No./Serial No.	Last Cal.
☒ Site # 3	X	Bilog Antenna	Schaffner Chase	CBL6112B/2673	Sep., 2011
	X	Horn Antenna	Schwarzbeck	BBHA9120D/D305	Sep., 2011
	X	Horn Antenna	Schwarzbeck	BBHA9170/208	Jul., 2011
	X	Pre-Amplifier	Agilent	8447D/2944A09549	Sep., 2011
	X	Spectrum Analyzer	Agilent	E4407B / US39440758	May, 2011
	X	Test Receiver	R & S	ESCS 30/ 825442/018	Sep., 2011
	X	Coaxial Cable	QuieTek	QTK-CABLE/ CAB5	Feb., 2011
	X	Controller	QuieTek	QTK-CONTROLLER/ CTRL3	N/A
	X	Coaxial Switch	Anritsu	MP59B/6200265729	N/A

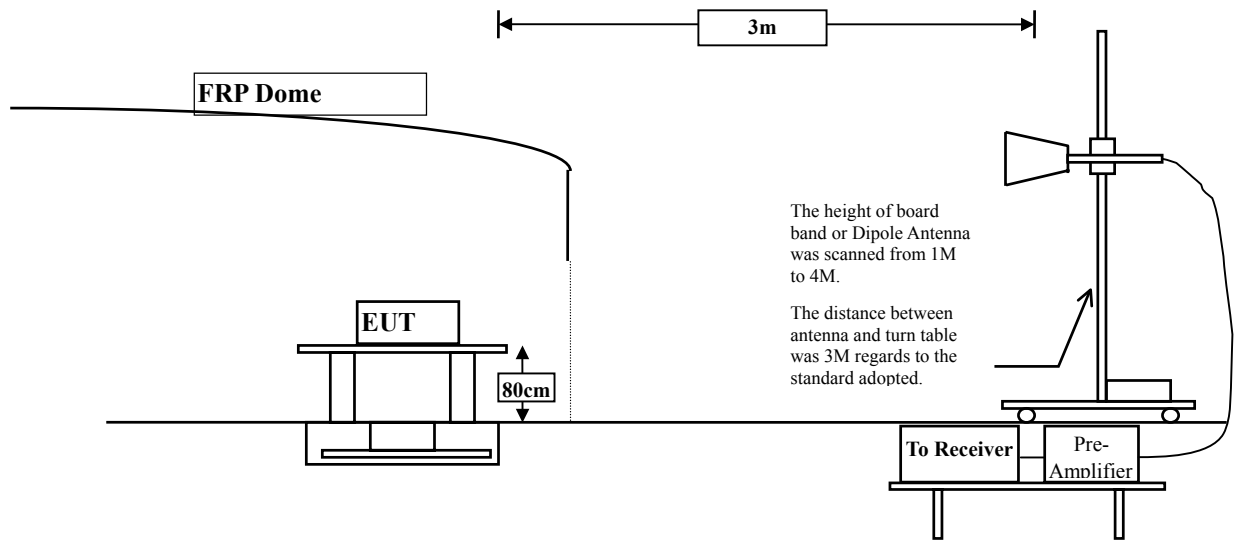
- Note: 1. All equipments are calibrated every one year.  
2. The test instruments marked by "X" are used to measure the final test results.

### 4.2. Test Setup

Below 1GHz



Above 1GHz



#### 4.3. Limits

##### ➤ General Radiated Emission Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

FCC Part 15 Subpart C Paragraph 15.209 Limits		
Frequency MHz	uV/m @3m	dBuV/m@3m
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

- Remarks:
1. RF Voltage (dBuV) = 20 log RF Voltage (uV)
  2. In the Above Table, the tighter limit applies at the band edges.
  3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.



#### 4.4. Test Procedure

The EUT was setup according to ANSI C63.4, 2009 and tested according to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

The EUT is placed on a turn table which is 0.8 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.4:2009 on radiated measurement.

The resolution bandwidth below 1GHz setting on the field strength meter is 120 kHz and above 1GHz is 1MHz.

Radiated emission measurements below 1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

The worst radiated emission is measured on the Final Measurement.

The measurement frequency range from 30MHz - 10th Harmonic of fundamental was investigated.

#### 4.5. Uncertainty

± 3.9 dB above 1GHz

± 3.8 dB below 1GHz

#### 4.6. Test Result of Radiated Emission

Product : Mindwave  
Test Item : Harmonic Radiated Emission  
Test Site : No.3 OATS  
Test Mode : Mode 1: Transmit - 1Mbps (GFSK)(2402MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
	Factor	Level	Level		
MHz	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4804.000	3.327	46.290	49.617	-24.383	74.000
7206.000	10.136	38.520	48.656	-25.344	74.000
9608.000	13.706	36.520	50.226	-23.774	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4804.000	6.638	43.020	49.657	-24.343	74.000
7206.000	11.005	37.260	48.265	-25.735	74.000
9608.000	14.103	35.890	49.993	-24.007	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
 Test Item : Harmonic Radiated Emission  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK)(2441MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4882.000	3.001	46.570	49.571	-24.429	74.000
7323.000	11.846	35.960	47.807	-26.193	74.000
9764.000	12.563	36.640	49.203	-24.797	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4882.000	5.713	42.930	48.644	-25.356	74.000
7323.000	12.727	35.520	48.248	-25.752	74.000
9764.000	13.028	36.610	49.638	-24.362	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
Test Item : Harmonic Radiated Emission  
Test Site : No.3 OATS  
Test Mode : Mode 1: Transmit - 1Mbps (GFSK)(2480MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4960.000	2.760	41.950	44.710	-29.290	74.000
7440.000	12.567	34.920	47.486	-26.514	74.000
9920.000	13.456	36.180	49.636	-24.364	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4960.000	5.557	41.070	46.627	-27.373	74.000
7440.000	13.426	35.070	48.495	-25.505	74.000
9920.000	13.958	35.690	49.648	-24.352	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss –Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
Test Item : Harmonic Radiated Emission  
Test Site : No.3 OATS  
Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)(2402MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4804.000	3.327	42.980	46.307	-27.693	74.000
7206.000	10.136	36.730	46.866	-27.134	74.000
9608.000	13.706	35.780	49.486	-24.514	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4804.000	6.638	40.400	47.037	-26.963	74.000
7206.000	11.005	36.950	47.955	-26.045	74.000
9608.000	14.103	36.180	50.283	-23.717	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss –Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
 Test Item : Harmonic Radiated Emission  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK) (2441MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4882.000	3.001	41.550	44.551	-29.449	74.000
7323.000	11.846	35.150	46.997	-27.003	74.000
9764.000	12.563	36.880	49.443	-24.557	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4882.000	5.713	38.970	44.684	-29.316	74.000
7323.000	12.727	35.220	47.948	-26.052	74.000
9764.000	13.028	36.430	49.458	-24.542	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss –Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
Test Item : Harmonic Radiated Emission  
Test Site : No.3 OATS  
Test Mode : Mode 2: Transmit - 3Mbps (8DPSK) (2480MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
<b>Peak Detector:</b>					
4960.000	2.760	38.060	40.820	-33.180	74.000
7440.000	12.567	35.370	47.936	-26.064	74.000
9920.000	13.456	36.880	50.336	-23.664	74.000
<b>Average</b>					
<b>Detector:</b>					
--					
<b>Vertical</b>					
<b>Peak Detector:</b>					
4960.000	5.557	40.090	45.647	-28.353	74.000
7440.000	13.426	35.620	49.045	-24.955	74.000
9920.000	13.958	36.030	49.988	-24.012	74.000
<b>Average</b>					
<b>Detector:</b>					
--					

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss –Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : Mindwave  
 Test Item : General Radiated Emission  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK) (2441MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
95.960	-7.820	46.146	38.326	-5.174	43.500
206.540	-11.155	49.474	38.319	-5.181	43.500
299.660	-3.585	44.241	40.656	-5.344	46.000
631.400	1.605	29.650	31.255	-14.745	46.000
858.380	5.972	29.216	35.188	-10.812	46.000
1000.000	9.119	38.114	47.233	-6.767	54.000
<b>Vertical</b>					
35.820	-2.159	35.368	33.209	-6.791	40.000
142.520	-6.267	43.742	37.475	-6.025	43.500
288.020	-8.189	47.663	39.474	-6.526	46.000
542.160	-0.269	34.890	34.621	-11.379	46.000
747.800	2.166	31.944	34.110	-11.890	46.000
1000.000	4.329	42.187	46.516	-7.484	54.000

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.



Product : Mindwave  
 Test Item : General Radiated Emission  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK) (2441MHz)

Frequency	Correct	Reading	Measurement	Margin	Limit
MHz	Factor	Level	Level		
	dB	dBuV	dBuV/m	dB	dBuV/m
<b>Horizontal</b>					
82.380	-11.535	45.692	34.157	-5.843	40.000
191.020	-10.040	48.137	38.097	-5.403	43.500
474.260	0.024	35.357	35.380	-10.620	46.000
747.800	3.296	30.881	34.177	-11.823	46.000
937.920	6.406	33.525	39.931	-6.069	46.000
1000.000	9.119	38.074	47.193	-6.807	54.000
<b>Vertical</b>					
31.940	-0.487	34.762	34.276	-5.724	40.000
95.960	-2.790	41.070	38.280	-5.220	43.500
350.100	-3.822	42.048	38.226	-7.774	46.000
542.160	-0.269	35.642	35.373	-10.627	46.000
949.560	6.615	34.601	41.216	-4.784	46.000
1000.000	4.329	42.712	47.041	-6.959	54.000

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

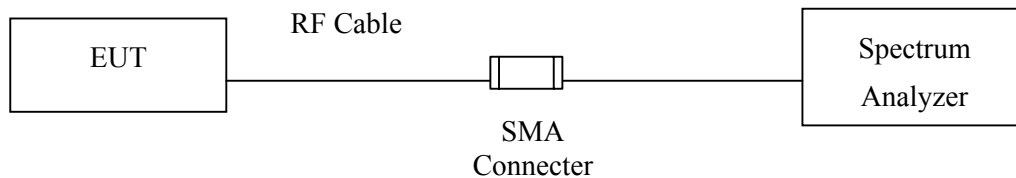
## 5. RF Antenna Conducted Test

### 5.1. Test Equipment

	Equipment	Manufacturer	Model No./Serial No.	Last Cal.
	Spectrum Analyzer	R&S	FSP40 / 100170	Jun, 2011
	Spectrum Analyzer	Agilent	E4407B / US39440758	Jun, 2011
X	Spectrum Analyzer	Agilent	N9010A / MY48030495	Apr., 2011

Note: 1. All equipments are calibrated every one year.  
 2. The test instruments Marked "X" are used to measure the final test results.

### 5.2. Test Setup



### 5.3. Limits

According to FCC Section 15.247(d). In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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 measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

### 5.4. Test Procedure

The EUT was setup to ANSI C63.4, 2009; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

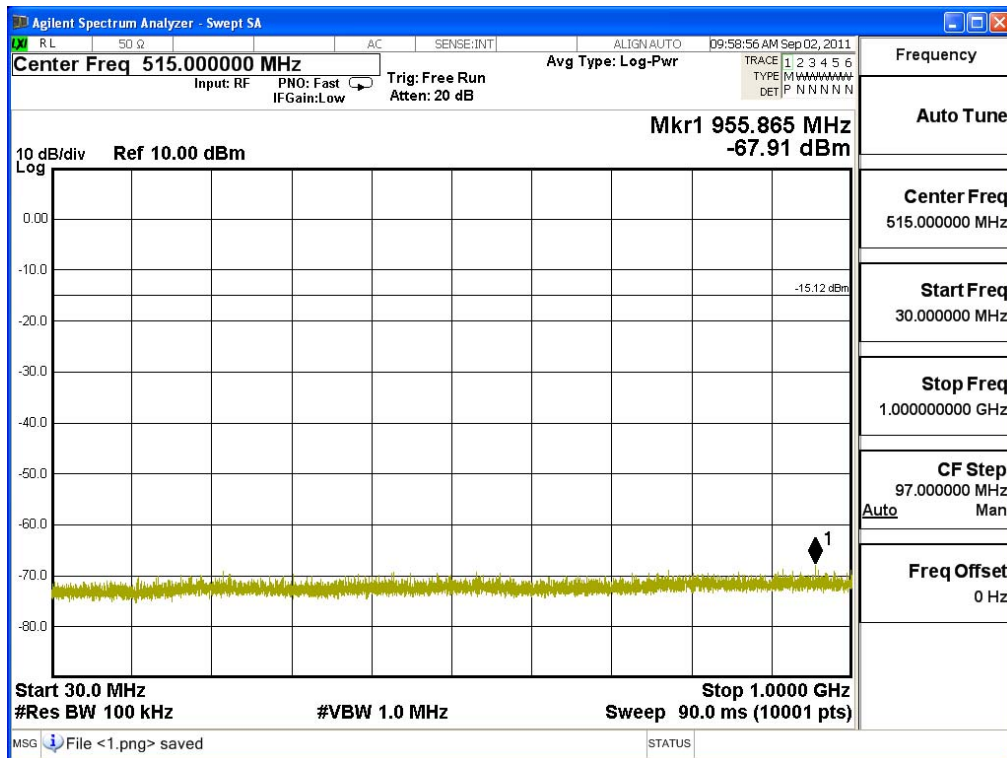
### 5.5. Uncertainty

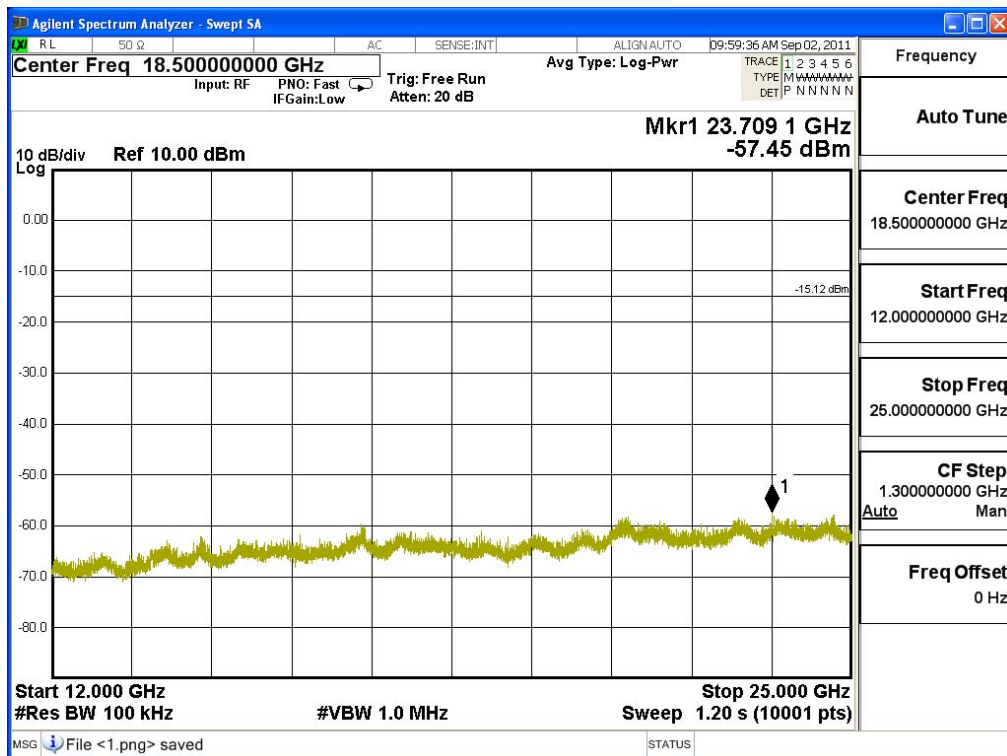
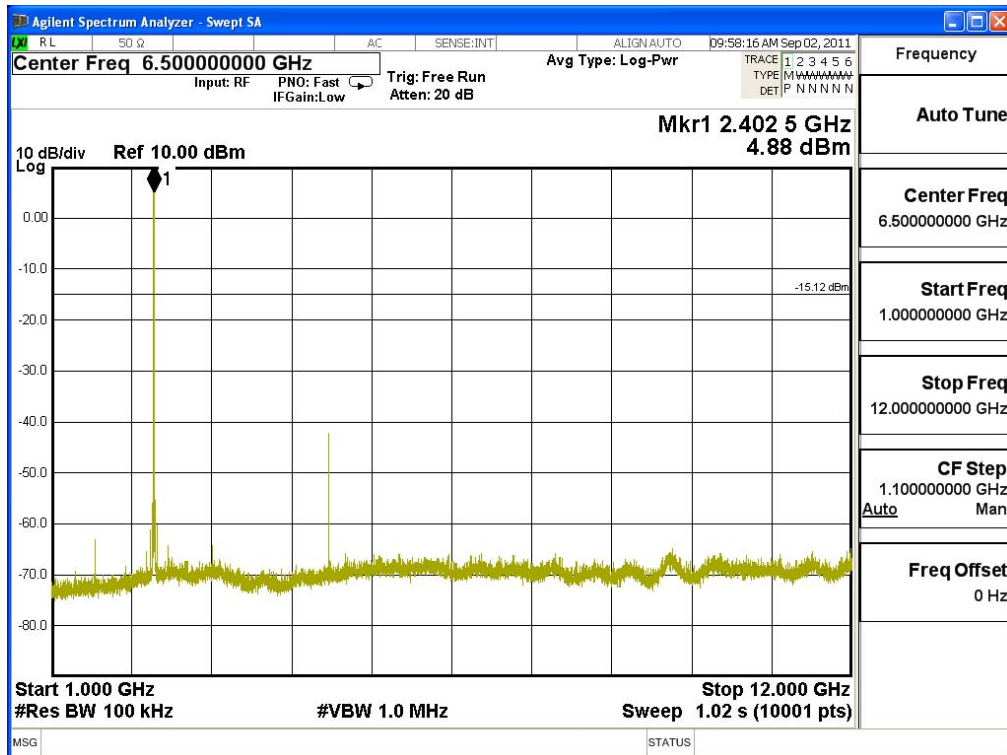
± 150Hz

## 5.6. Test Result of RF Antenna Conducted Test

Product	:	Mindwave
Test Item	:	RF Antenna Conducted Test
Test Site	:	No.3 OATS
Test Mode	:	Mode 1: Transmit - 1Mbps (GFSK)

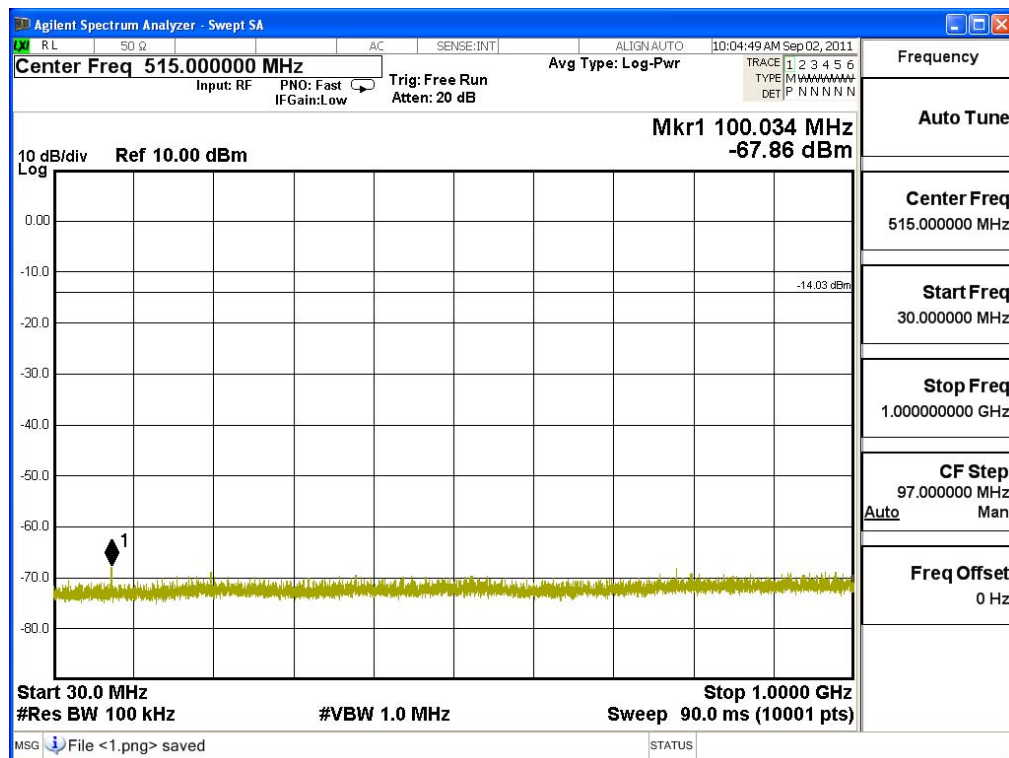
**Figure Channel 00:**

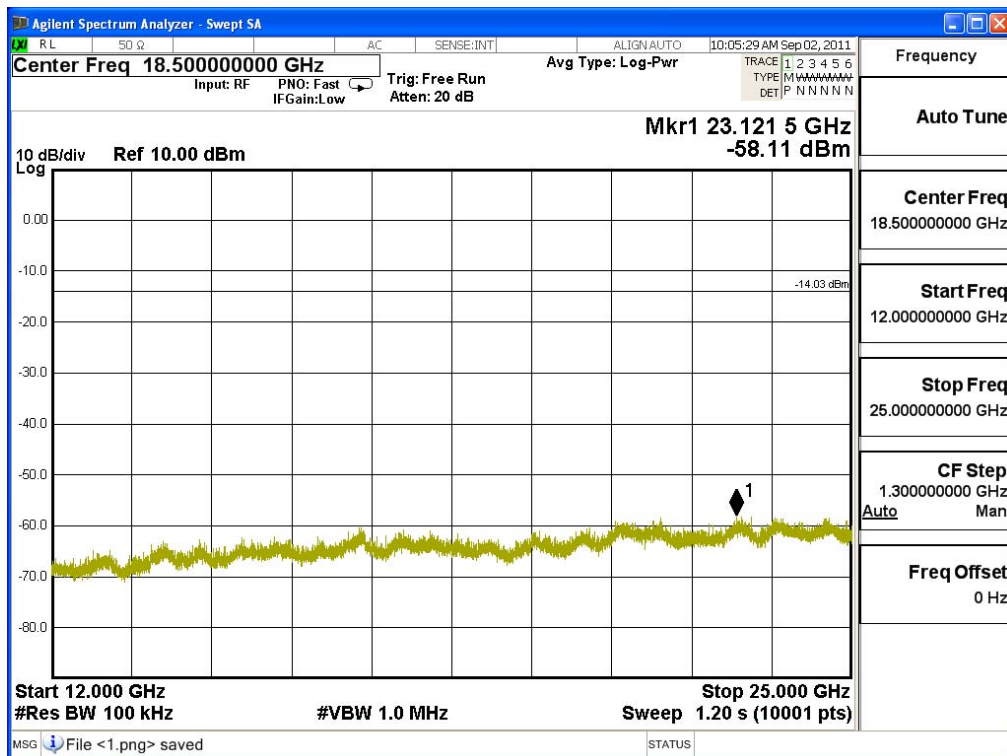
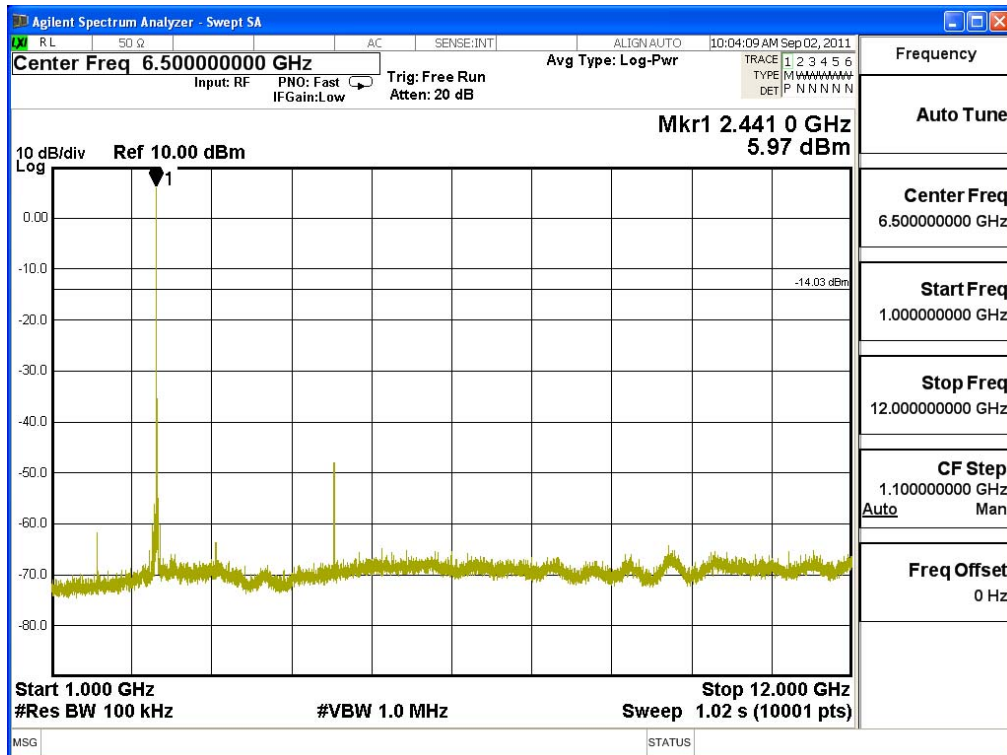




Product : Mindwave  
 Test Item : RF Antenna Conducted Test  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK)

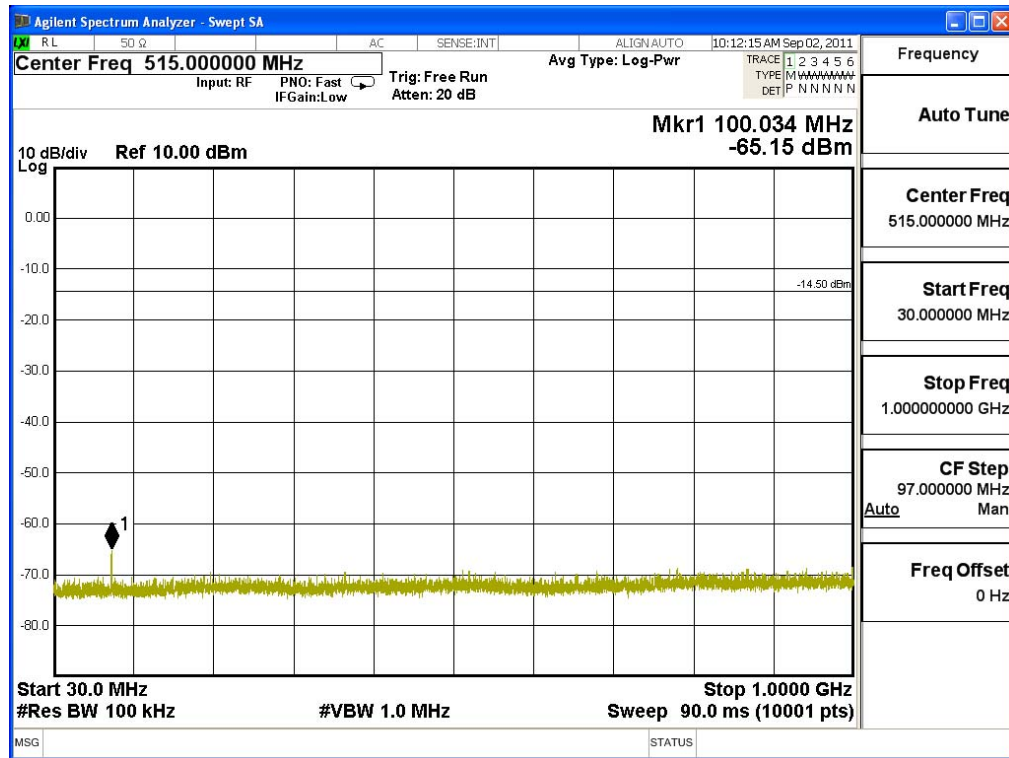
Figure Channel 39:

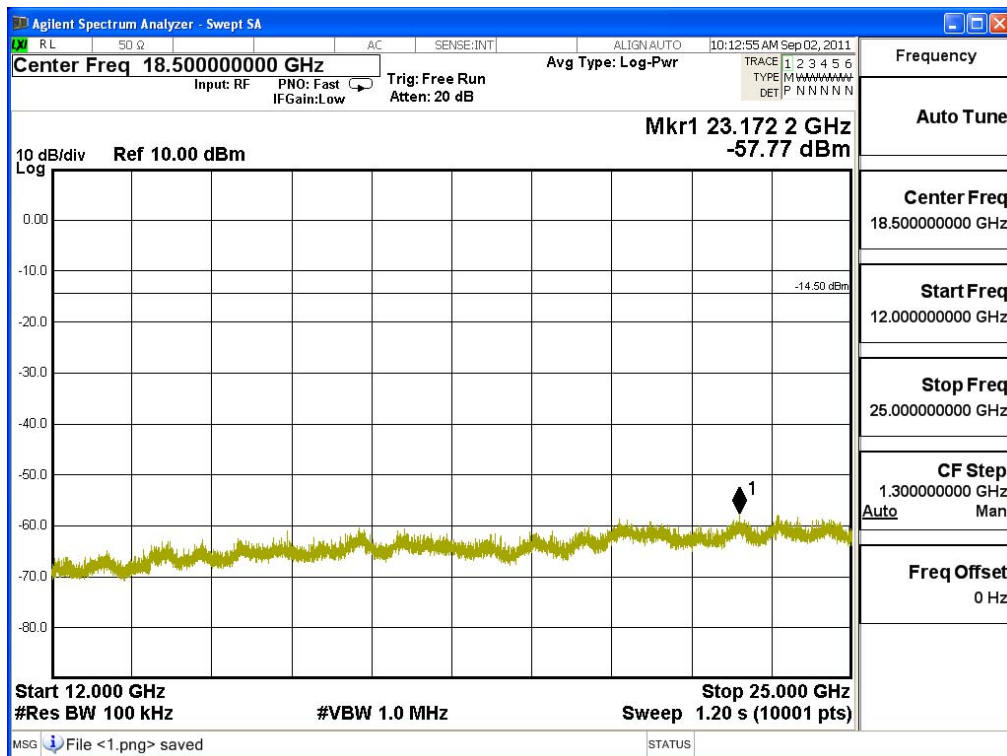
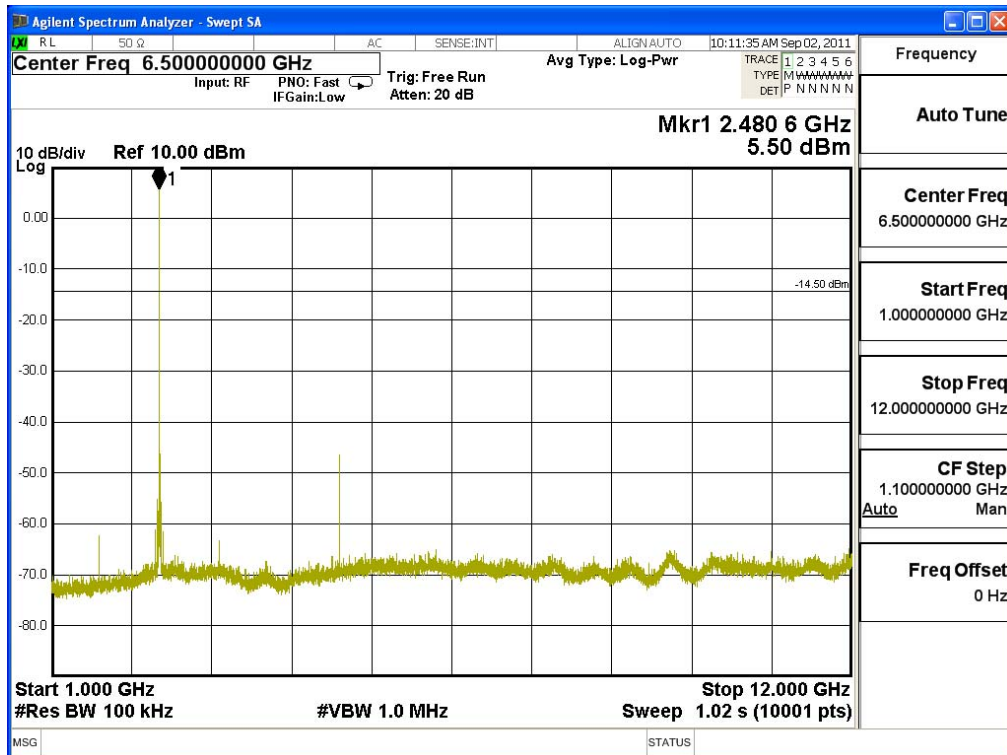




Product : Mindwave  
 Test Item : RF Antenna Conducted Test  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK)

Figure Channel 78:

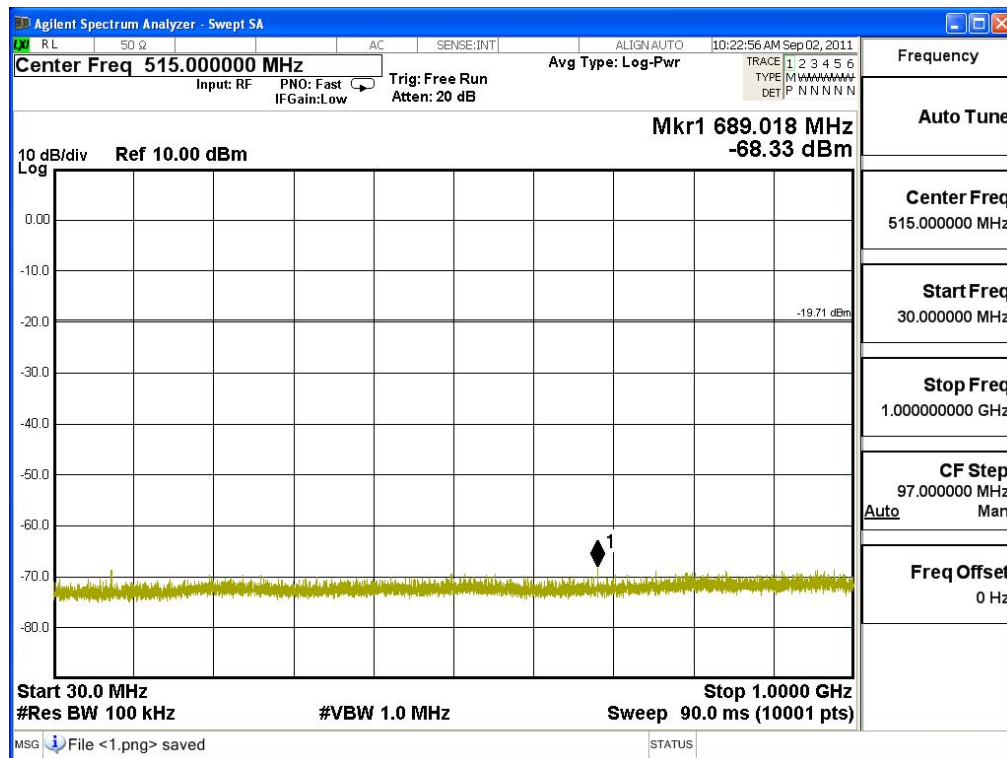


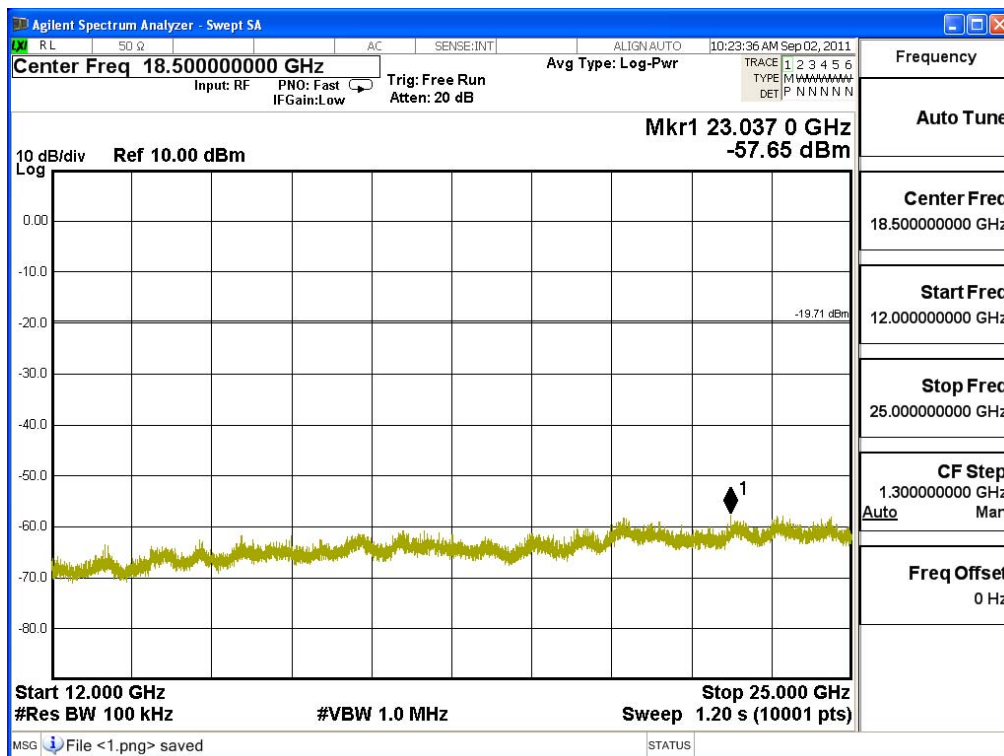
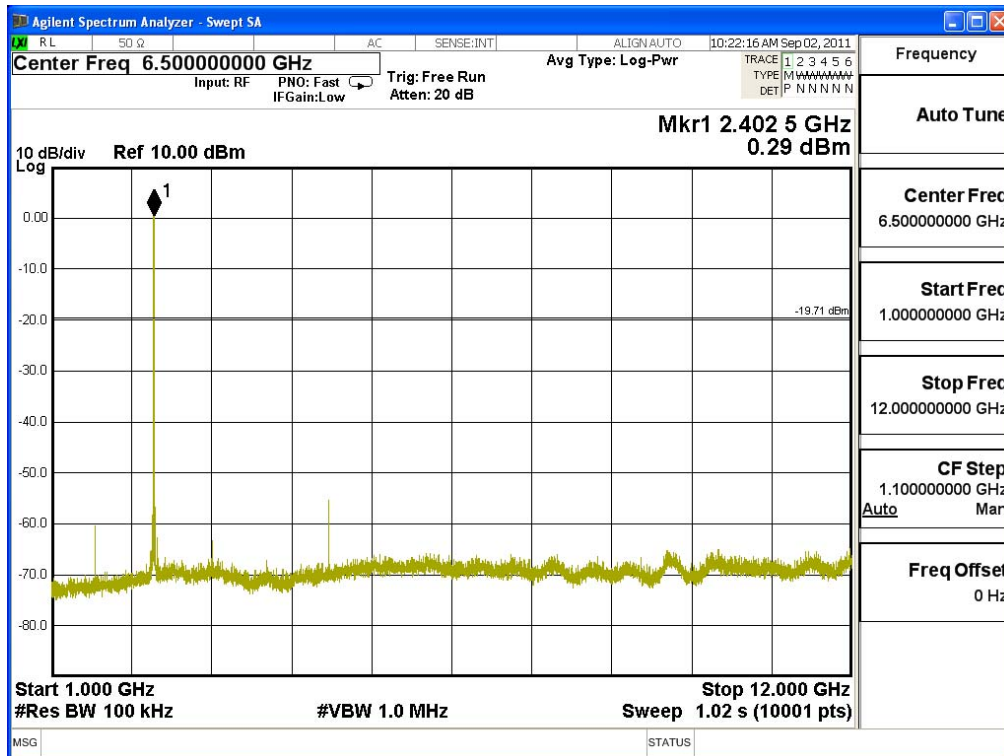




Product : Mindwave  
 Test Item : RF Antenna Conducted Test  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

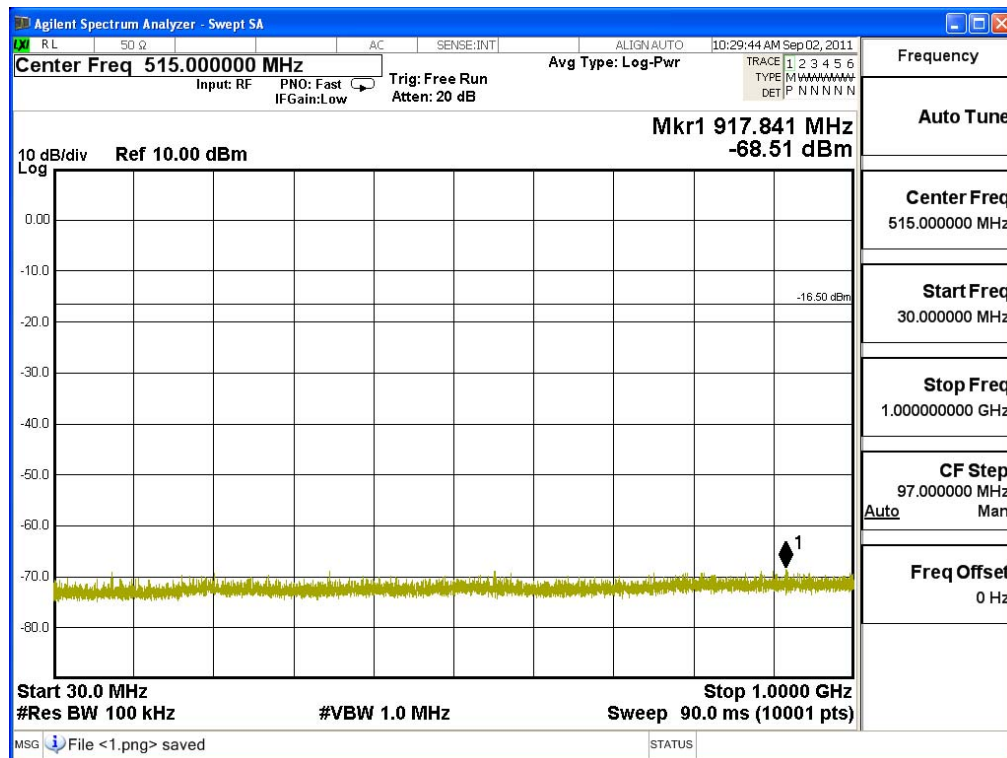
Figure Channel 00:

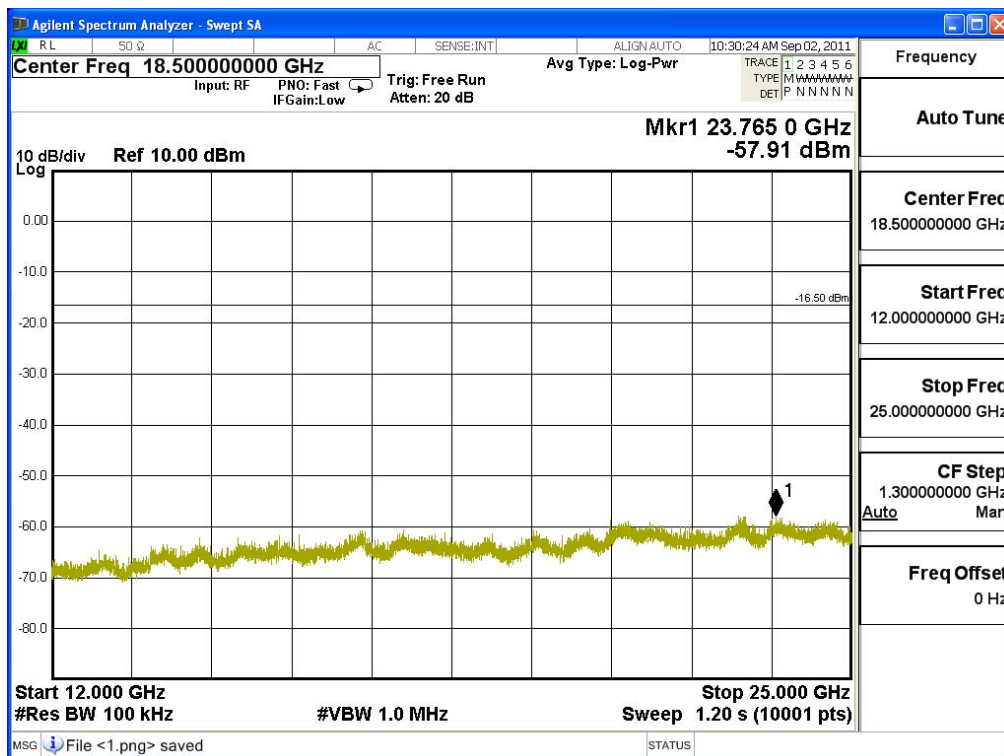
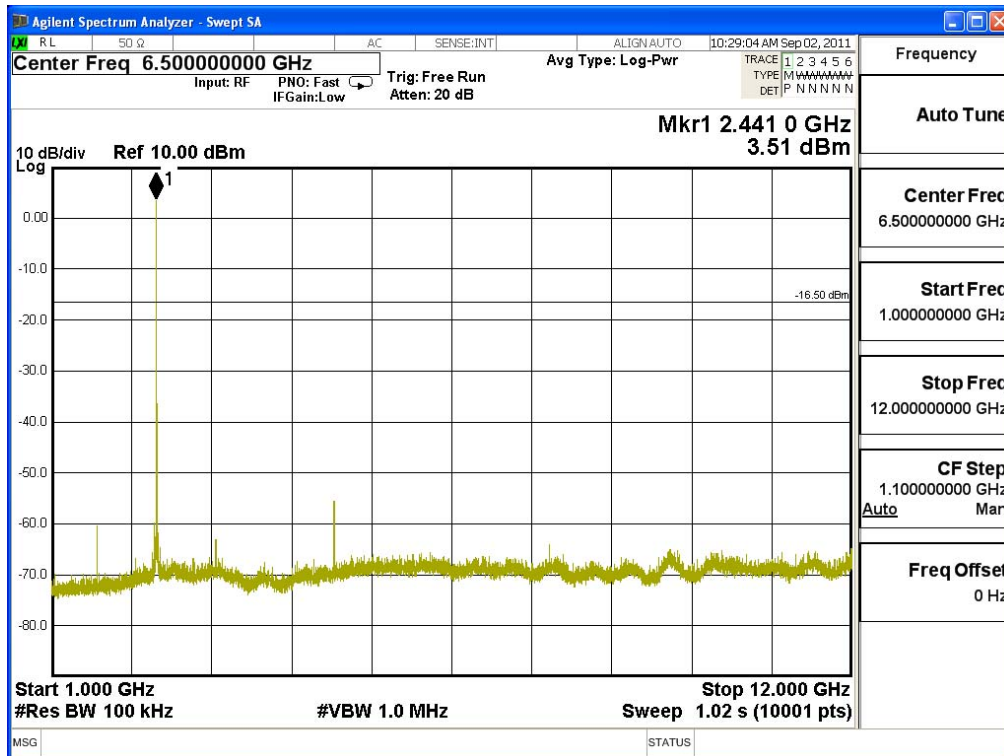




Product : Mindwave  
 Test Item : RF Antenna Conducted Test  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

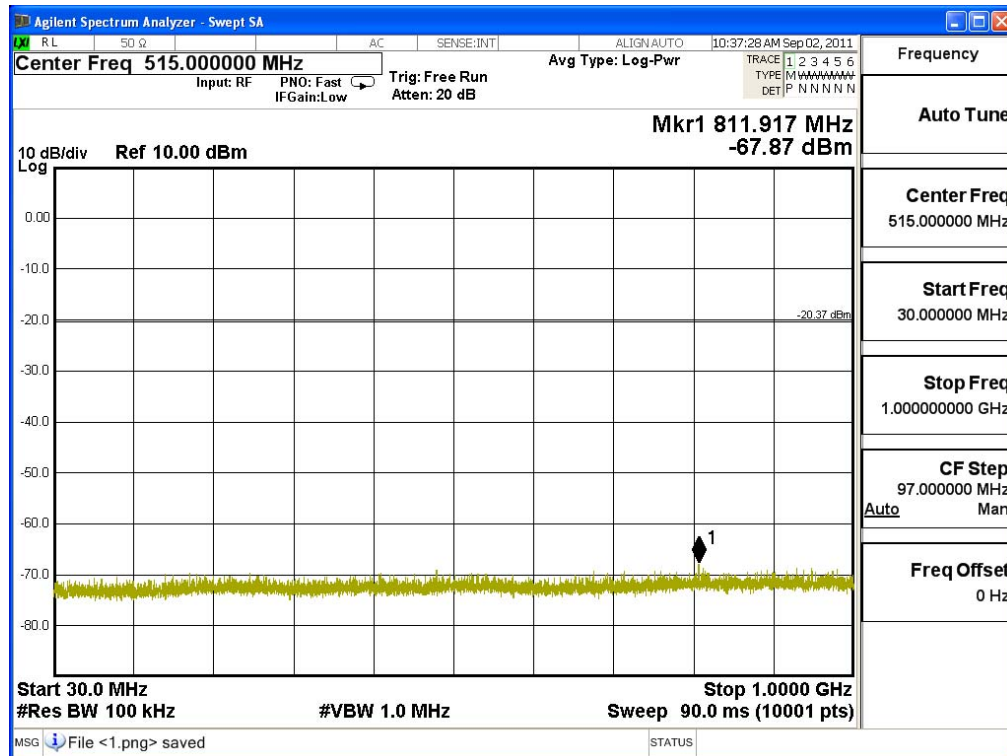
Figure Channel 39:

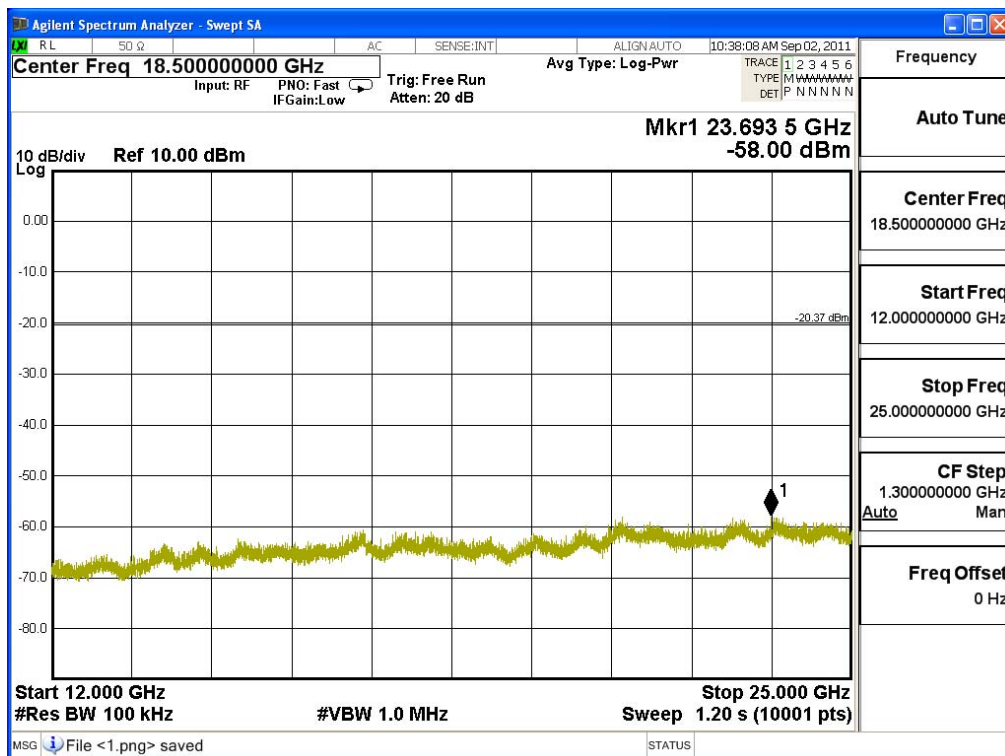
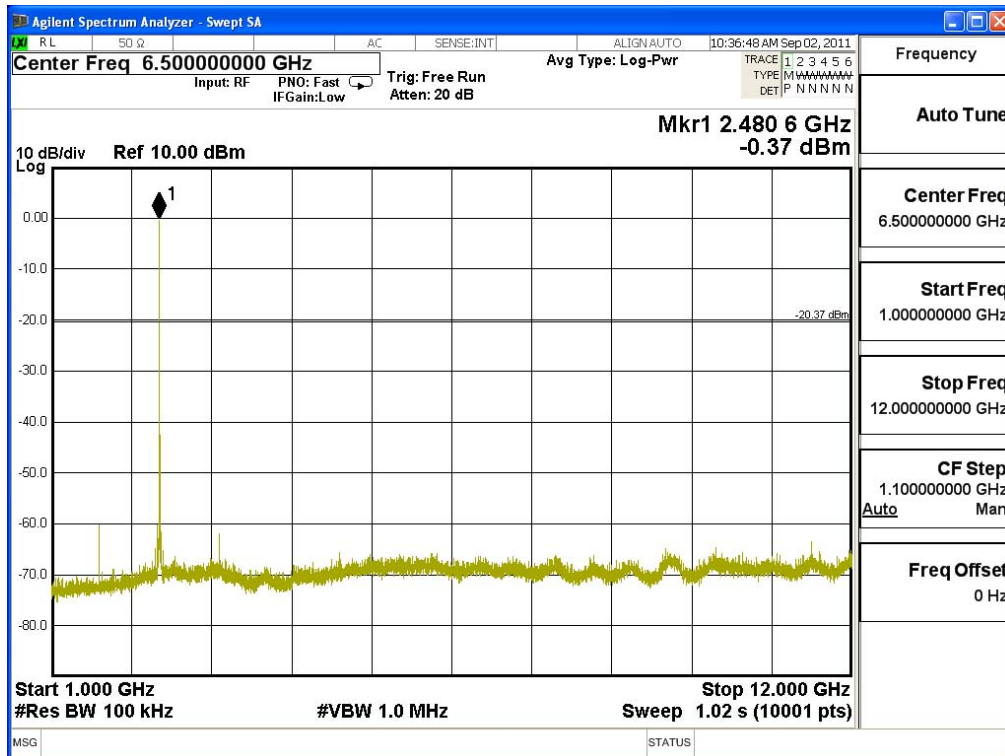




Product : Mindwave  
 Test Item : RF Antenna Conducted Test  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

Figure Channel 78:





## 6. Band Edge

### 6.1. Test Equipment

#### RF Conducted Measurement

The following test equipments are used during the band edge tests:

	Equipment	Manufacturer	Model No./Serial No.	Last Cal.
	Spectrum Analyzer	R&S	FSP40 / 100170	Jun, 2011
	Spectrum Analyzer	Agilent	E4407B / US39440758	Jun, 2011
X	Spectrum Analyzer	Agilent	N9010A / MY48030495	Apr., 2011

#### RF Radiated Measurement:

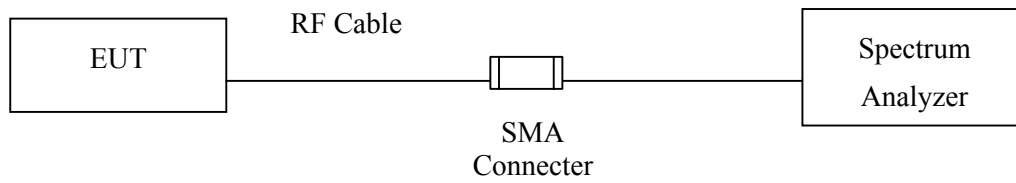
The following test equipments are used during the band edge tests:

Test Site		Equipment	Manufacturer	Model No./Serial No.	Last Cal.
☒ Site # 3		Bilog Antenna	Schaffner Chase	CBL6112B/2673	Sep., 2011
	X	Horn Antenna	Schwarzbeck	BBHA9120D/D305	Sep., 2011
		Horn Antenna	Schwarzbeck	BBHA9170/208	Jul., 2011
	X	Pre-Amplifier	Agilent	8447D/2944A09549	Sep., 2011
	X	Spectrum Analyzer	Agilent	E4407B / US39440758	May, 2011
		Test Receiver	R & S	ESCS 30/ 825442/018	Sep., 2011
	X	Coaxial Cable	QuietTek	QTK-CABLE/ CAB5	Feb., 2011
	X	Controller	QuietTek	QTK-CONTROLLER/ CTRL3	N/A
	X	Coaxial Switch	Anritsu	MP59B/6200265729	N/A

- Note:
1. All equipments are calibrated every one year.
  2. The test instruments marked by "X" are used to measure the final test results.

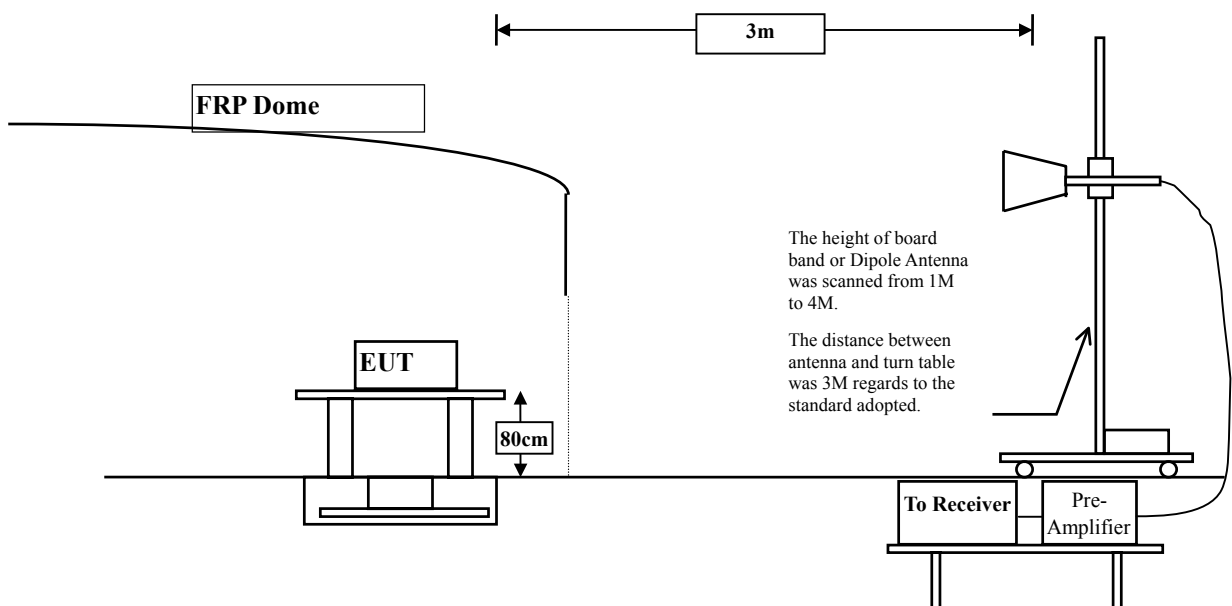
## 6.2. Test Setup

### RF Conducted Measurement



### RF Radiated Measurement:

Above 1GHz





### **6.3. 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

### **6.4. Test Procedure**

The EUT and its simulators are placed on a turn table which is 0.8 meter above ground. The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna can move up and down between 1 meter and 4 meters to find out the maximum emission level.

Both horizontal and vertical polarization of the antenna are set on measurement. In order to find the maximum emission, all of the interface cables must be manipulated according to ANSI C63.4:2009 on radiated measurement.

The bandwidth below 1GHz setting on the field strength meter is 120 kHz, above 1GHz are 1 MHz. The EUT was setup to ANSI C63.4, 2009; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

### **6.5. Uncertainty**

± 3.9 dB above 1GHz

± 3.8 dB below 1GHz

## 6.6. Test Result of Band Edge

Product : Mindwave  
 Test Item : Band Edge  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK)

### Fundamental Filed Strength

Antenna Pole	Frequency [MHz]	Correction Factor [dB/m]	Reading Level [dBuV]	Emission Level [dBuV/m]	Detector
Horizontal	2402	31.573	71.5	103.074	Peak
Horizontal	2402	31.573	58.17	89.744	Average
Vertical	2402	30.917	68.78	99.697	Peak
Vertical	2402	30.917	56.07	86.987	Average

Note: 1:Spectrum Analyzer setting:

Peak detector: RBW=1MHz, VBW=1MHz

Average detector: RBW=1MHz, VBW=10Hz

### Band Edge Test Data

Antenna Pole	Test Frequency (MHz)	Fundamental (dBuV/m)	$\Delta$ (dB)	Band Edge Field Strength (dBuV/m)	Detector
Horizontal	2375.8	103.074	53.836	49.238	Peak
Horizontal	2375.8	89.744	50.124	39.62	Average
Vertical	2375.8	99.697	53.836	45.861	Peak
Vertical	2375.8	86.987	50.124	36.863	Average

Note:

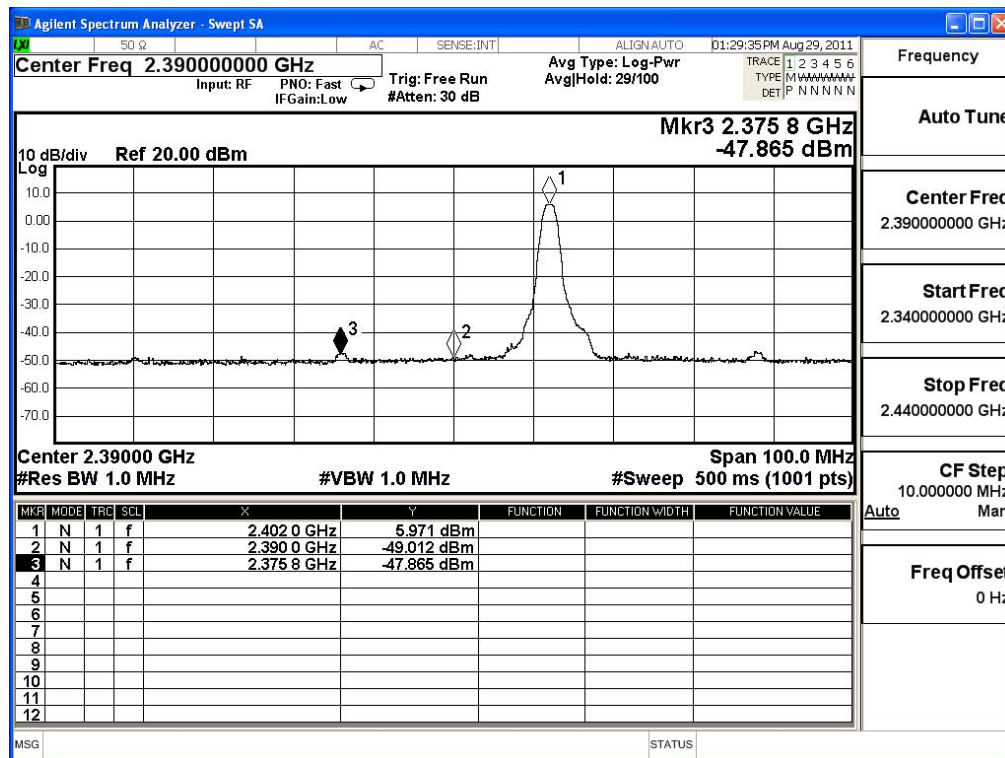
The Band Edge Field Strength was calculated using the Fundamental and Conducted Band Edge measurements per the Marker-Delta Method with the following formula:

Band Edge field Strength = F -  $\Delta$

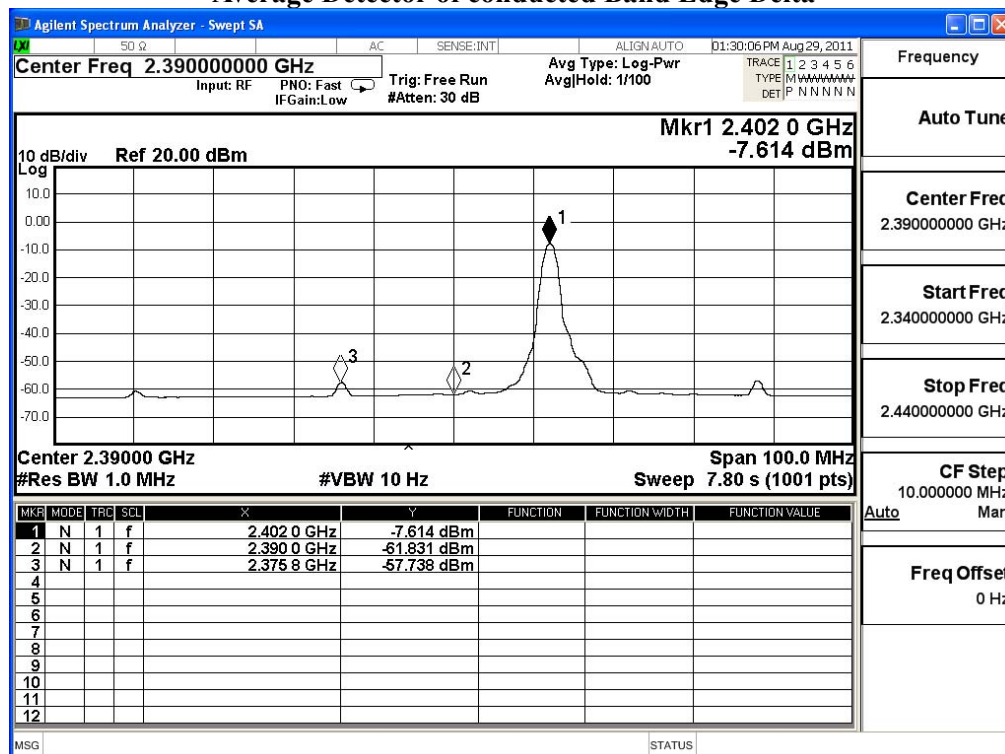
F = Fundamental field Strength (Peak or Average)

$\Delta$  = Conducted Band Edge Delta (Peak or Average)

### Peak Detector of conducted Band Edge Delta



### Average Detector of conducted Band Edge Delta



Product : Mindwave  
 Test Item : Band Edge  
 Test Site : No.3 OATS  
 Test Mode : Mode 1: Transmit - 1Mbps (GFSK)

### Fundamental Filed Strength

Antenna Pole	Frequency [MHz]	Correction Factor [dB/m]	Reading Level [dBuV]	Emission Level [dB(uV/m)]	Detector
Horizontal	2480	32.155	70.59	102.746	Peak
Horizontal	2480	32.155	57.64	89.796	Average
Vertical	2480	31.412	70.96	102.372	Peak
Vertical	2480	31.412	58.16	89.572	Average

Note: 1:Spectrum Analyzer setting:

Peak detector: RBW=1MHz, VBW=1MHz

Average detector: RBW=1MHz, VBW=10Hz

### Band Edge Test Data

Antenna Pole	Test Frequency (MHz)	Fundamental (dBuV/m)	$\Delta$ (dB)	Band Edge Field Strength (dBuV/m)	Detector
Horizontal	2483.5	102.746	49.417	53.329	Peak
Horizontal	2483.5	89.796	49.022	40.774	Average
Vertical	2483.5	102.372	49.417	52.955	Peak
Vertical	2483.5	89.572	49.022	40.55	Average

Note:

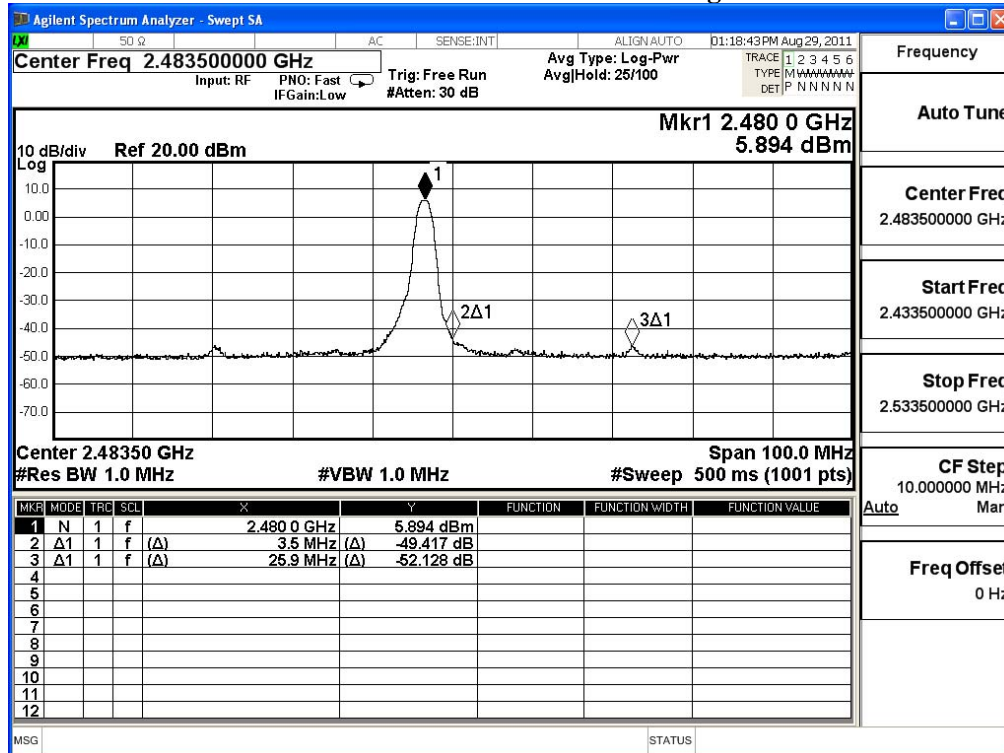
The Band Edge Field Strength was calculated using the Fundamental and Conducted Band Edge measurements per the Marker-Delta Method with the following formula:

Band Edge field Strength = F -  $\Delta$

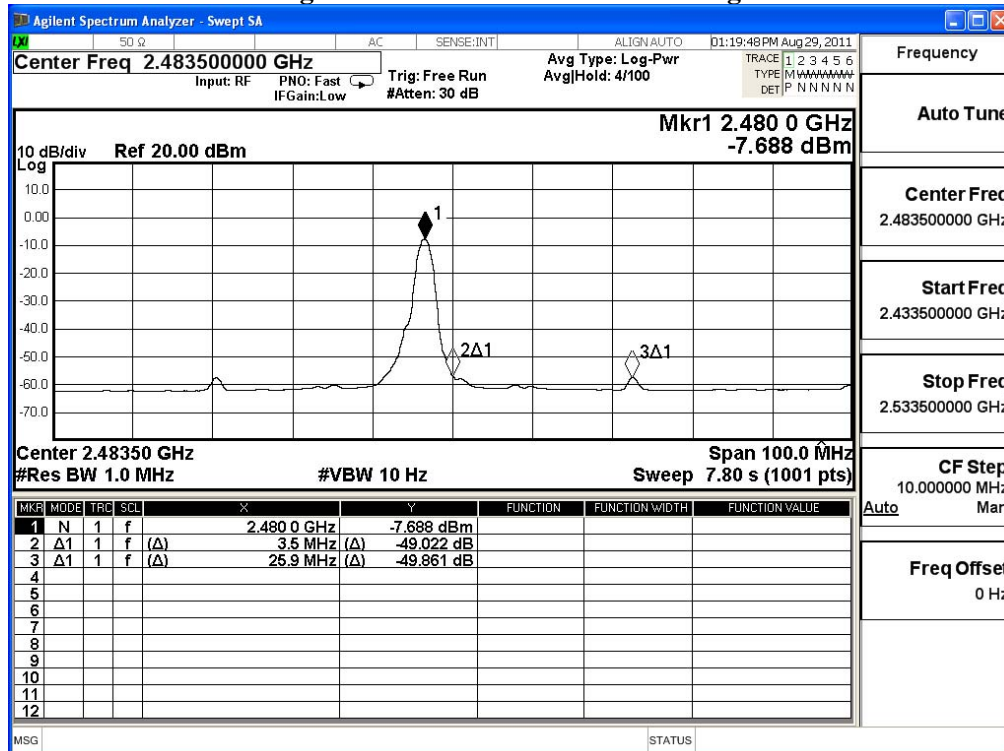
F = Fundamental field Strength (Peak or Average)

$\Delta$  = Conducted Band Edge Delta (Peak or Average)

### Peak Detector of conducted Band Edge Delta



### Average Detector of conducted Band Edge Delta



Product : Mindwave  
 Test Item : Band Edge  
 Test Site : No.3 OATS  
 Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

### Fundamental Filed Strength

Antenna Pole	Frequency [MHz]	Correction Factor [dB/m]	Reading Level [dBuV]	Emission Level [dBuV/m]	Detector
Horizontal	2402	31.573	69.87	101.444	Peak
Horizontal	2402	31.573	54.91	86.484	Average
Vertical	2402	30.917	69.78	100.697	Peak
Vertical	2402	30.917	54.75	85.667	Average

Note: 1:Spectrum Analyzer setting:

Peak detector: RBW=1MHz, VBW=1MHz

Average detector: RBW=1MHz, VBW=10Hz

### Band Edge Test Data

Antenna Pole	Test Frequency (MHz)	Fundamental (dBuV/m)	$\Delta$ (dB)	Band Edge Field Strength (dBuV/m)	Detector
Horizontal	2390	101.444	54.135	47.309	Peak
Horizontal	2375.8	86.484	48.635	37.849	Average
Vertical	2390	100.697	54.135	46.562	Peak
Vertical	2375.8	85.667	48.635	37.032	Average

Note:

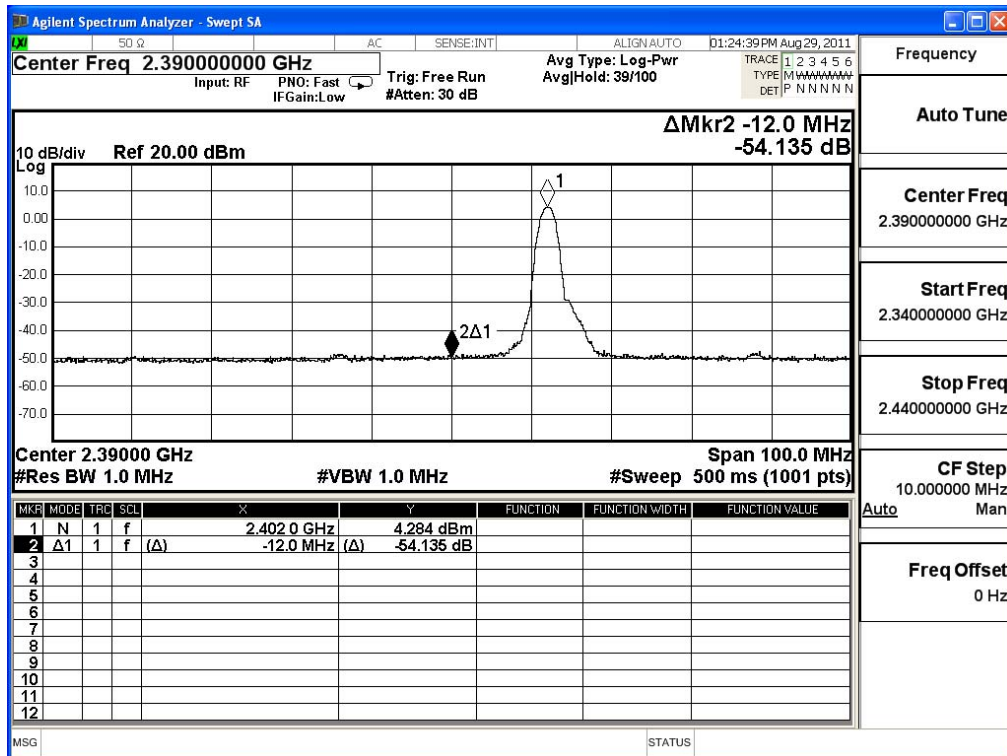
The Band Edge Field Strength was calculated using the Fundamental and Conducted Band Edge measurements per the Marker-Delta Method with the following formula:

Band Edge field Strength = F -  $\Delta$

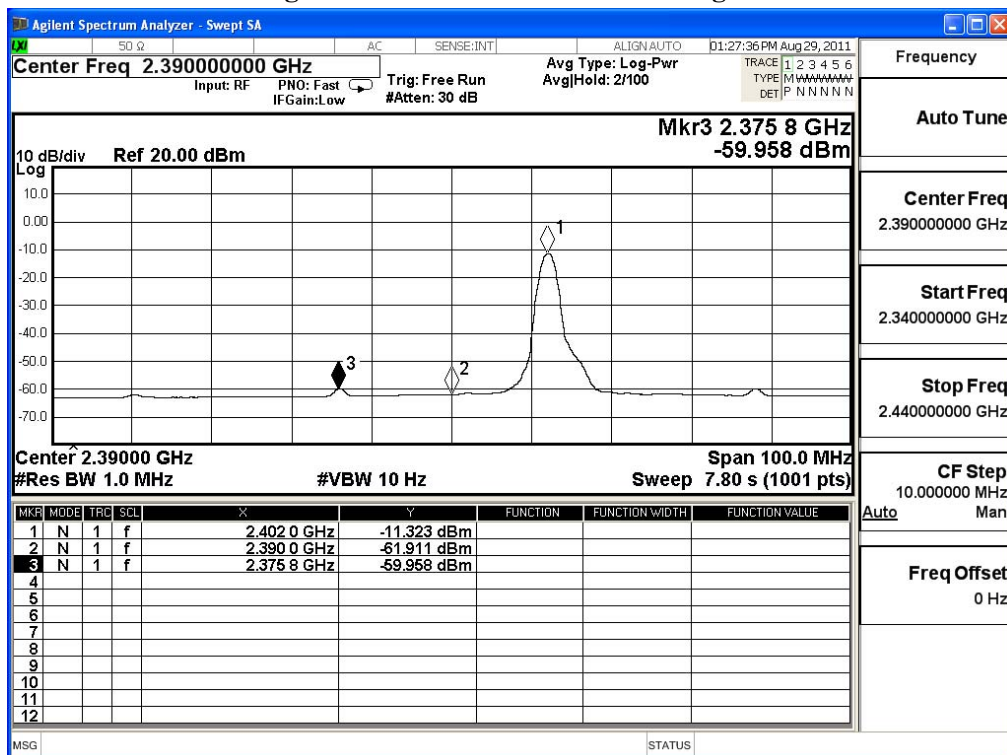
F = Fundamental field Strength (Peak or Average)

$\Delta$  = Conducted Band Edge Delta (Peak or Average)

### Peak Detector of conducted Band Edge Delta



### Average Detector of conducted Band Edge Delta



Product : Mindwave  
Test Item : Band Edge  
Test Site : No.3 OATS  
Test Mode : Mode 2: Transmit - 3Mbps (8DPSK)

### Fundamental Filed Strength

Antenna Pole	Frequency [MHz]	Correction Factor [dB/m]	Reading Level [dBuV]	Emission Level [dB(uV/m)]	Detector
Horizontal	2480	32.155	68.32	100.476	Peak
Horizontal	2480	32.155	53.28	85.436	Average
Vertical	2480	31.412	67.16	98.572	Peak
Vertical	2480	31.412	52.49	83.902	Average

Note: 1:Spectrum Analyzer setting:

Peak detector: RBW=1MHz, VBW=1MHz

Average detector: RBW=1MHz, VBW=10Hz

### Band Edge Test Data

Antenna Pole	Test Frequency (MHz)	Fundamental (dBuV/m)	$\Delta$ (dB)	Band Edge Field Strength (dBuV/m)	Detector
Horizontal	2483.5	100.476	37.93	62.546	Peak
Horizontal	2483.5	85.436	36.908	48.528	Average
Vertical	2483.5	98.572	37.93	60.642	Peak
Vertical	2483.5	83.902	36.908	46.994	Average

Note:

The Band Edge Field Strength was calculated using the Fundamental and Conducted Band Edge measurements per the Marker-Delta Method with the following formula:

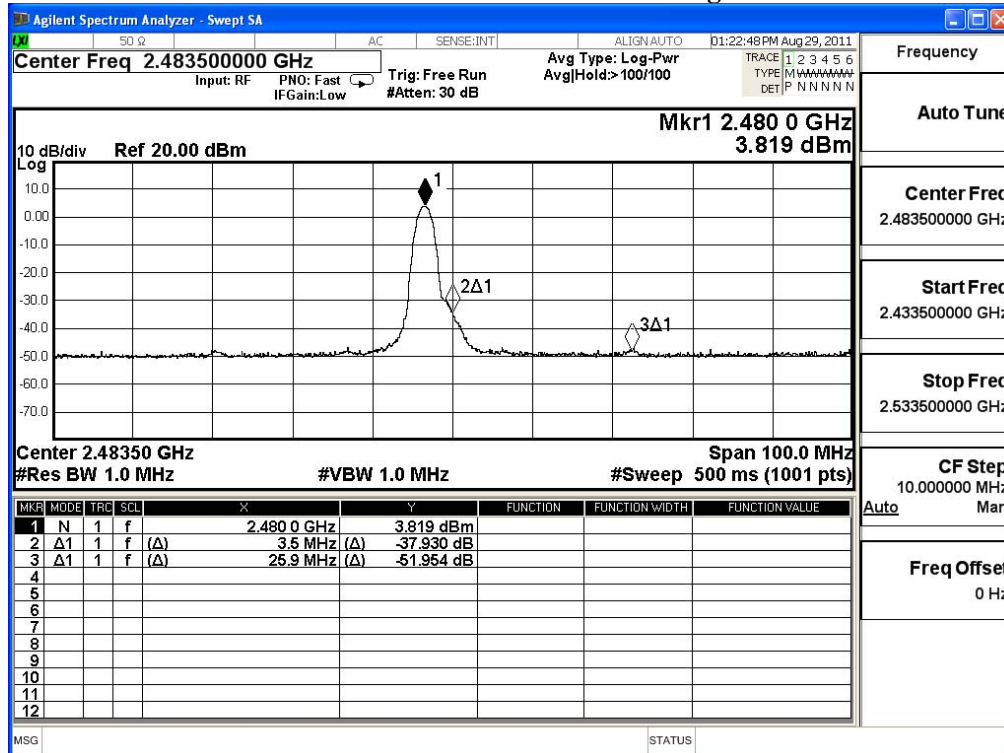
Band Edge field Strength = F -  $\Delta$

F = Fundamental field Strength (Peak or Average)

$\Delta$  = Conducted Band Edge Delta (Peak or Average)



### Peak Detector of conducted Band Edge Delta



### Average Detector of conducted Band Edge Delta

