

# TEST REPORT

for the  
**Airport Express**

**Model # A1084**

**Apple Computer, Inc.**

**May 28, 2004**

Engineering contact:

Mike Kriege  
Apple Computers, Inc.  
1 Infinite Loop M/S 26A  
Cupertino, California 95014  
(408) 974-0560 Voice, (408) 862-5061 Fax  
E-Mail: kriege@apple.com

EMC NVLAP Technical Manager:

  
Robert Steinfeld

Date: MAY 28, 2004

EMC Test Engineer:

  
Mike Kriege

Date: 5-28-2004

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1 Test Report Summary

Specification	Test or Requirement	Result	Comment
CFR 15.247(a)(2)	6 dB Bandwidth greater than 500 kHz	Pass	Section 7.1
CFR 15.247(b)(3)	Maximum Peak Output Power Requirement: Less than 1 Watt	Pass	Section 7.3
CFR 15.247(d)	Peak Power Spectral Density Requirement: Less than +8 dBm in any 3 kHz bandwidth	Pass	Section 7.5
CFR 15.247(c)	-20 dBc Spurious Emissions	Pass	Section 7.6
CFR 15.209(a)	Radiated Emissions 30 MHz to 25 GHz	Pass	Section 7.7
CFR 15.207(a)	AC Power Line	Pass	Section 7.8

## **2 EUT Description**

The Apple Wireless LAN access point, code named Q61, operates in the 2.4 GHz unlicensed Industrial , Scientific and Medical band and uses Direct Sequence Spread Spectrum and OFDM communication techniques. This device uses the Broadcom BCM2050 radio and the Broadcom BCM4712 Integrated Network Processor and is compliant with IEEE Std 802.11 g/b. The BCM2050 provides wireless data communications at rates up to 54 Mbps, depending on the coding techniques employed and the range of the system. Technical Information on the Apple Airport Express is provided in the table below.

<b>Apple Airport Express Information</b>	
<b>Product</b>	Wireless LAN Access Point
<b>Trade Name</b>	Apple Airport Express
<b>Model Number</b>	A1084
<b>Power Supply</b>	Integrated 100-240V AC Power Supply
<b>Frequency Range</b>	IEEE 802.11b, g 2412 - 2462 MHz
<b>Transmit Power</b>	15 dBm
<b>Modulation Technique</b>	IEEE 802.11b: DSSS, DQPSK, DBPSK IEEE 802.11g: OFDM
<b>Antenna Gain</b>	+0.94 dBi
<b>Antenna Description</b>	Diversity, Integrated PCB PIFA (Planar Inverted-F Antenna)
<b>Emission Designator</b>	22MOF7D

### **3 Test Methodology**

The tests documented in this report were performed in accordance with ANSI C63.4 and FCC CFR 47 Part 2 and Part 15.

## **4 Facilities and Accreditation**

### **4.1 Facilities and Equipment**

The ac power line and RF conducted emissions measurements were performed at the Apple Computer, Inc. facility located at 20650 Valley Green Drive, Cupertino, California 95014. The radiated emissions measurements were performed at the Apple Computer, Inc. Evelyn 1, 10 meter semi-anechoic chamber located at 123 East Evelyn Ave., Mountain View, California 94041. Both of these facilities are constructed in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

All Receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

### **4.2 Laboratory Accreditation**

The test facilities at Apple Computer, Inc. used to perform radiated and conducted emissions measurements are accredited by National Voluntary Laboratory Accreditation Program to perform Electromagnetic Interference tests according to FCC Part 15 and CISPR 22. Apple Computer, Inc. NVLAP Lab Code is 20071-0 and is effective through September 30, 2004-05-28. No part of this report may be used to claim or endorsement by NVLAP or any agency of the US Government.

The Apple Computer, Inc Evelyn 1 10 meter Semi-anechoic chamber is currently listed with the FCC. The FCC Registration Number is 90450 and is effective through Jan 5, 2007.

## 5 Calibration and Uncertainty

### 5.1 Measurement Instrument Calibration

The measurement instruments utilized to perform the tests documented in this report have been calibrated in accordance with the manufacturer's recommendations and are traceable to national standards.

### 5.2 Measurement Uncertainty

The Apple measurement uncertainty policy, available upon request under Apple File Number EMC20, ensures uncertainty has been calculated using the proper procedure. Apple will use this measurement uncertainty knowledge in determining the pass / fail criteria from the test data. The measurement uncertainty has been determined to be the following:

Conducted Emissions = +/- 2.3 dB  
Radiated Emissions = +/- 4.1 dB

### 5.3 Test Equipment

The following test equipment was used

Description	Manufacturer	Model No.	Identification No.	Last Cal	Next Cal
Spectrum Analyzer	R&S	ESIB 40	100105	Aug, 2003	Aug, 2004
Spectrum Analyzer	R&S	ESIB 26	1088.7490	Oct, 2003	Oct, 2004
Spectrum Analyzer	HP	4404B	US41441488	Aug 2003	Aug, 2004
Receiver	R & S	ESCS 30	1102.4500.30	Jan 2004	Jan 2005
Antenna	Sunol	JB1	A122302-1	Dec 2003	Dec 2004
Antenna	Sunol	JB1	A122302-2	Dec 2003	Dec 2004
Amplifier	Amplifier Research	AR	Amp 16	Nov 2003	Nov 2004
Amplifier	Amplifier Research	AR	Amp 17	Nov 2003	Nov 2004
Amplifier	HP	8449	3008A00713	March, 2004	March 2005
Horn Antenna	EMCO	3117	34197	March 2004	March 2009
Horn Antenna	EMCO	3160-09	011269-0041264	Sept 2001	Sept 2005
Power Meter	Boonton	4532	165201	May 2004	May 2005
Power Meter Sensor	Boonton	57318	3890	May 2004	May 2005

**6 Setup of Equipment Under Test**

**EUT Support Equipment**

<b>Peripheral Support Equipment</b>				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	M8407	PT318199	DoC
Wireless G Adapter	Linksys	WPC54G	BDH03839693	PKW-WPC54G-2
USB Printer	Epson	Stylus 41UX	EFFY005769	DoC
Amplified Speakers	Cyber Acoustics	CA2014	E124946	DoC

<b>I/O Cable List</b>				
Port	Manufacturer	Shielded?	Ferrite?	Length
AC Power	Apple	No	No	1.8 meters
USB	Copartner	Yes	No	1.5 meters
Ethernet	CMG	Yes	No	2.2 meters
Audio	Cyber Acoustics	No	No	1 Meter

### **EUT Operating Conditions**

All of the equipment and cables were placed in the worst-case configuration to maximize the emissions during the tests. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

For scans below 1 GHz, the EUT transceiver and all the EUT I/O ports were activated. A large file from a remote server was transferred via the EUT's Ethernet port to a wireless client from the EUT's transmitter. The EUT's USB port was activated by connecting a USB printer. The EUT's audio port was activated by using an application called "AirPlay" launched from a wireless client and playing music through the EUT from a shared itunes library.

For measurements above 1 GHz, a special program called iperf was used to setup a continuous transmit mode. The iperf software was used with EUT firmware called "Q61\_6.0a11\_FullROM\_DEBUG.bin" which allows telnet access to the EUT. The channel was set using an OS X terminal window from a wired (Ethernet) client. For example, setting the channel to be channel 1, the following commands were used with an EUT SSID of "Apple". An application called "MacStumbler" was used to identify the EUT SSID and confirm the channel.

```
telnet base-station.local 24
#> wl antdiv 0
#> wl txant 0
#> wl disassoc
#> wl channel 1
#> wl join Apple
```

The data rates of 1, 6, and 54 Mbps were set using the same terminal window and the following commands:

```
#> wl rate 1
#> wl rate 6
#> wl rate 5
```

In order to establish a routing path, ping from a new terminal window in both the wired and wireless clients by typing the following:

```
ping -c 5 <ip address of basestation>
```

In order to put the transmitter into a continuous transmit mode, both a wired (Ethernet) and wireless client are needed. From a new OS X terminal window, the wireless client which has been associated to the EUT and which has the ip address of <wireless client ip address>, the following commands were entered into a terminal window

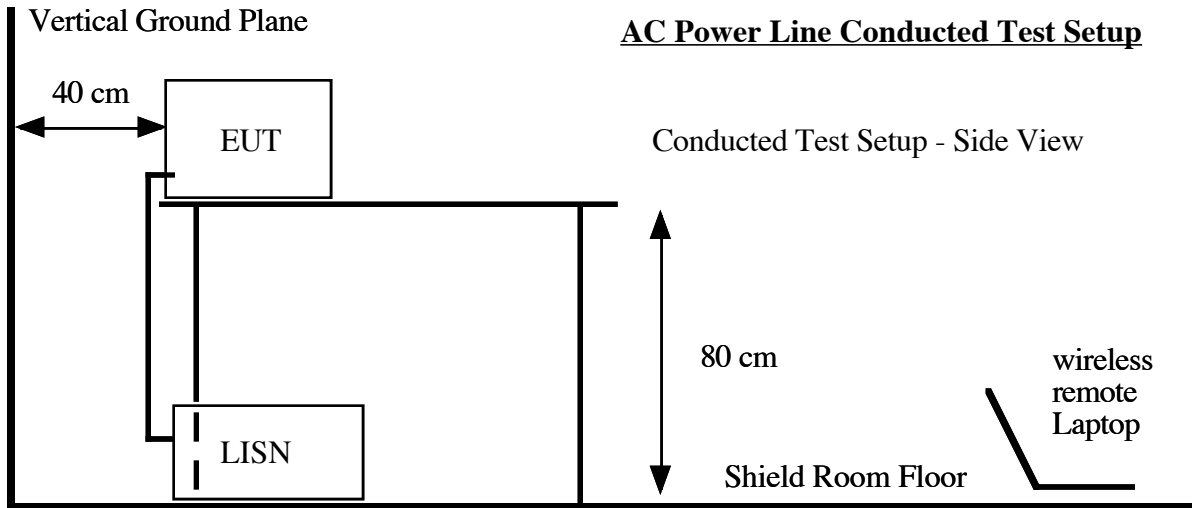
From the wireless client:  
cd iperf folder  
./iperf -s

From a wired client:  
cd iperf folder  
./iperf -t 100000 -i 2 -c <wireless client ip address>

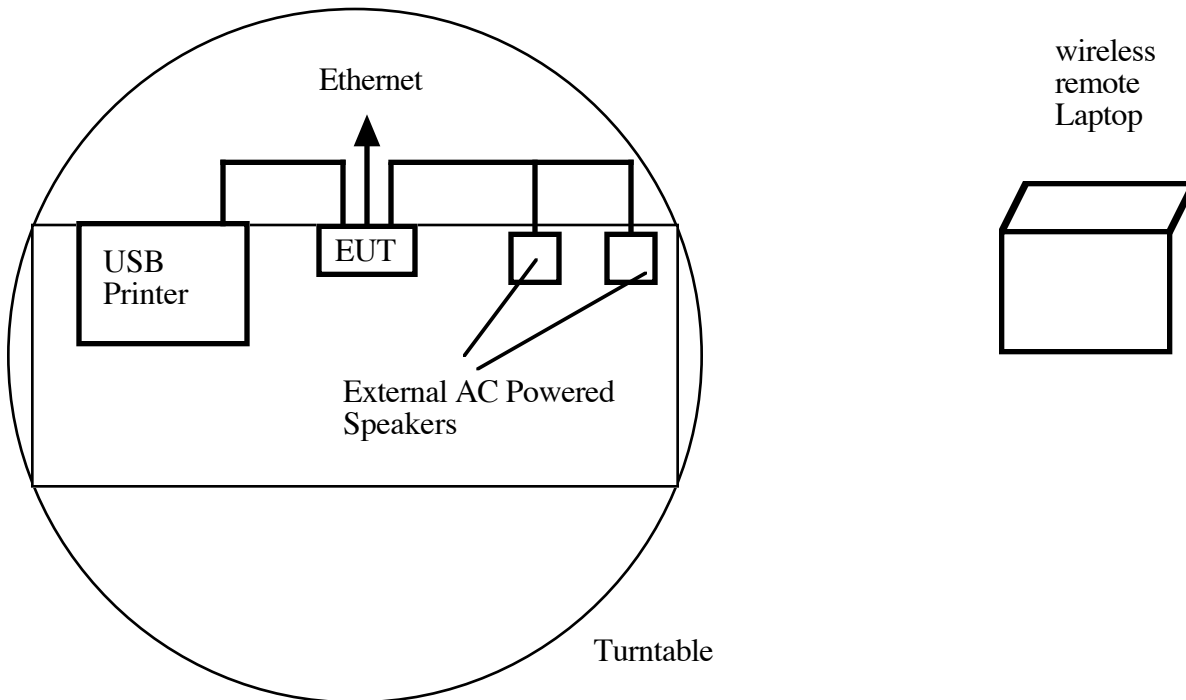


**Test Setup Block Diagrams**

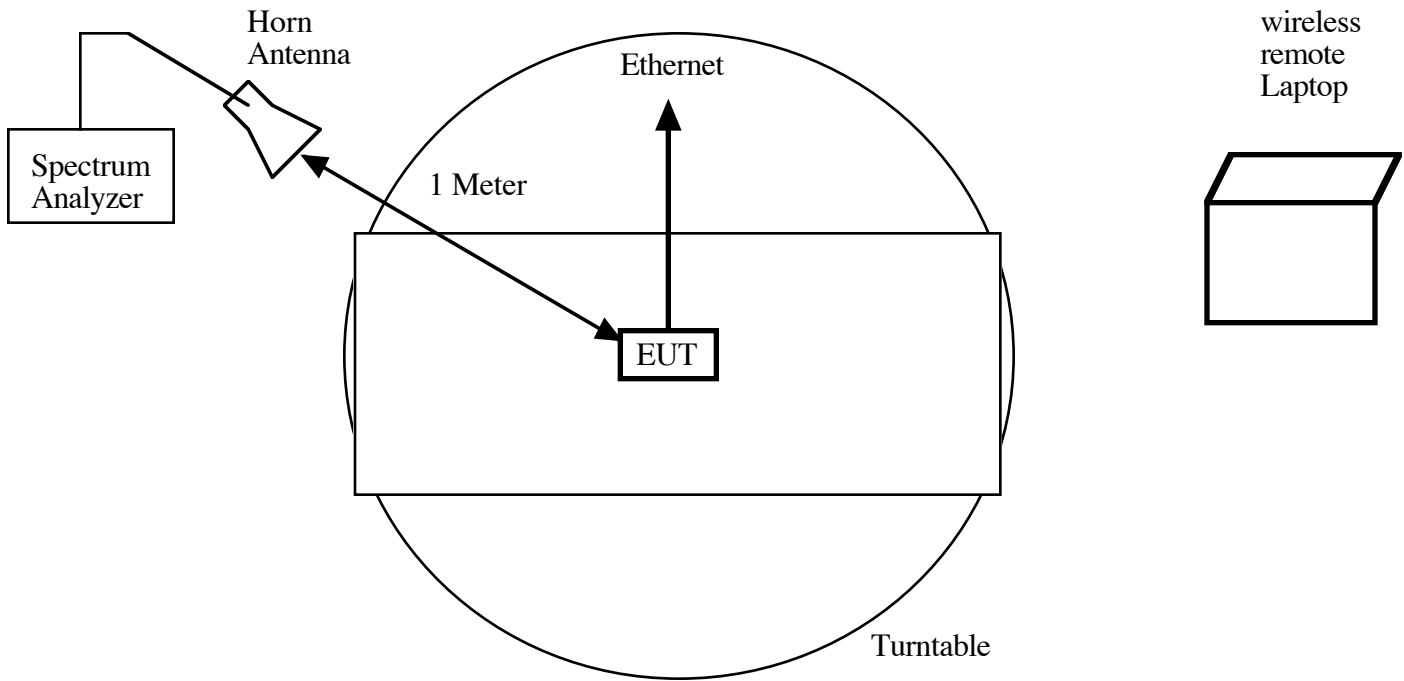
For AC Power Line conducted and RF Radiated Emissions, the EUT was placed on a nonmetallic table, 80 cm above the metallic ground-plane. The EUT and peripherals were powered from a filtered ac mains supply.



**RF Radiated Emissions Test Setup Below 1 GHz**



RF Radiated Emissions Test Setup Above 1 GHz



## 7 Applicable Limits and Test Results

### 7.1 6 dB Bandwidth

#### Limit

The Minimum 6 dB bandwidth shall be greater than 500 kHz.

#### Test Procedure

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

#### 6 dB Bandwidth Results

No non-compliance was found.

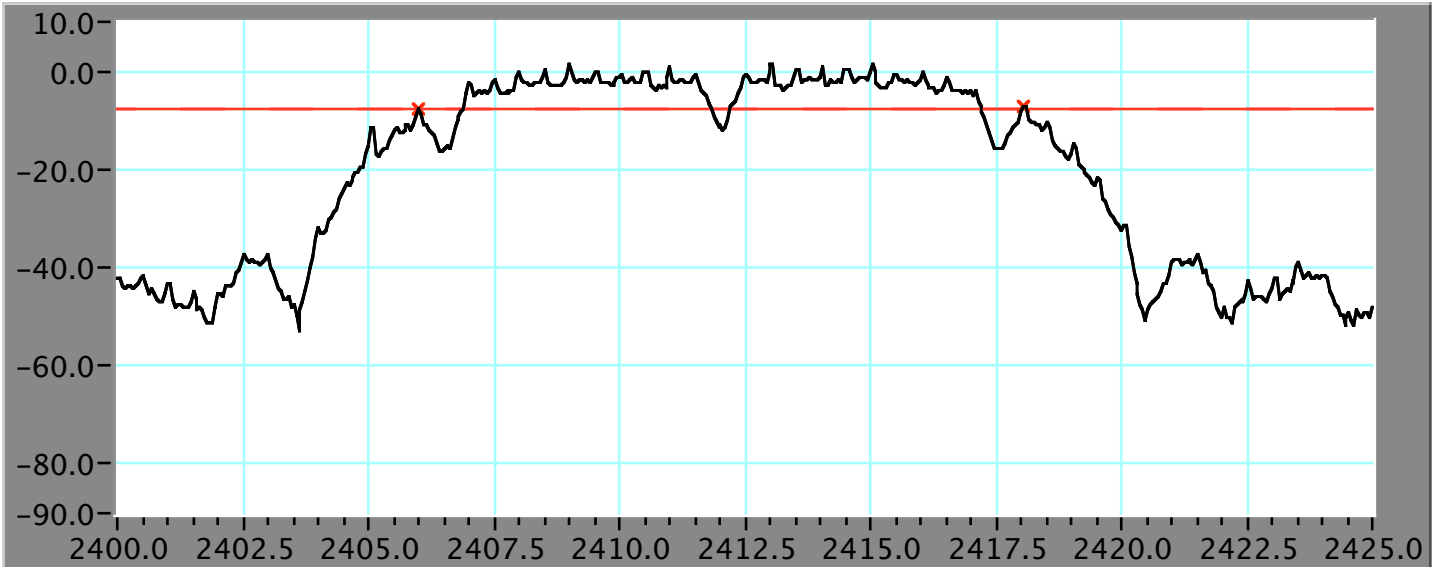
##### 802.11b Mode

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>6 dB Bandwidth (kHz)</b>	<b>Minimum Limit (kHz)</b>	<b>Margin (kHz)</b>
Low	2412	12,000	500	11,500
Mid	2437	12,030	500	11,530
High	2462	12,000	500	15,500

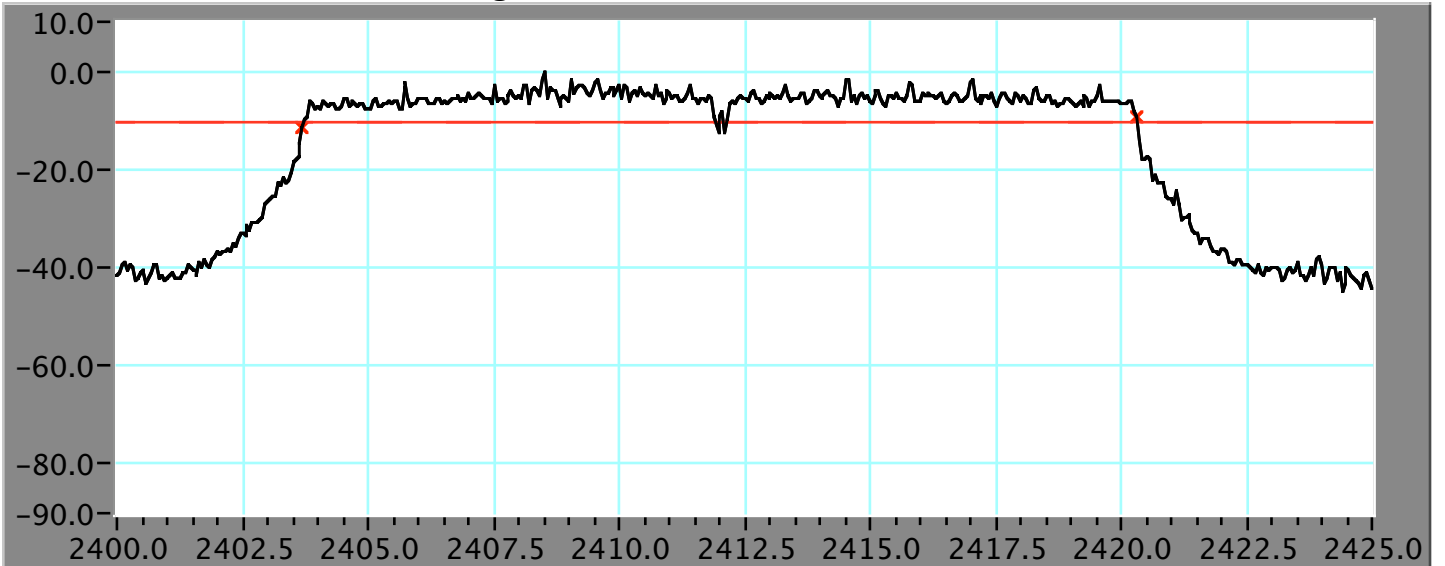
##### 802.11g Mode

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>6 dB Bandwidth (kHz)</b>	<b>Minimum Limit (kHz)</b>	<b>Margin (kHz)</b>
Low	2412	16,600	500	16,100
Mid	2437	16,480	500	15,980
High	2462	16,430	500	15,930

6 dB Bandwidth Channel 1 (802.11b mode)

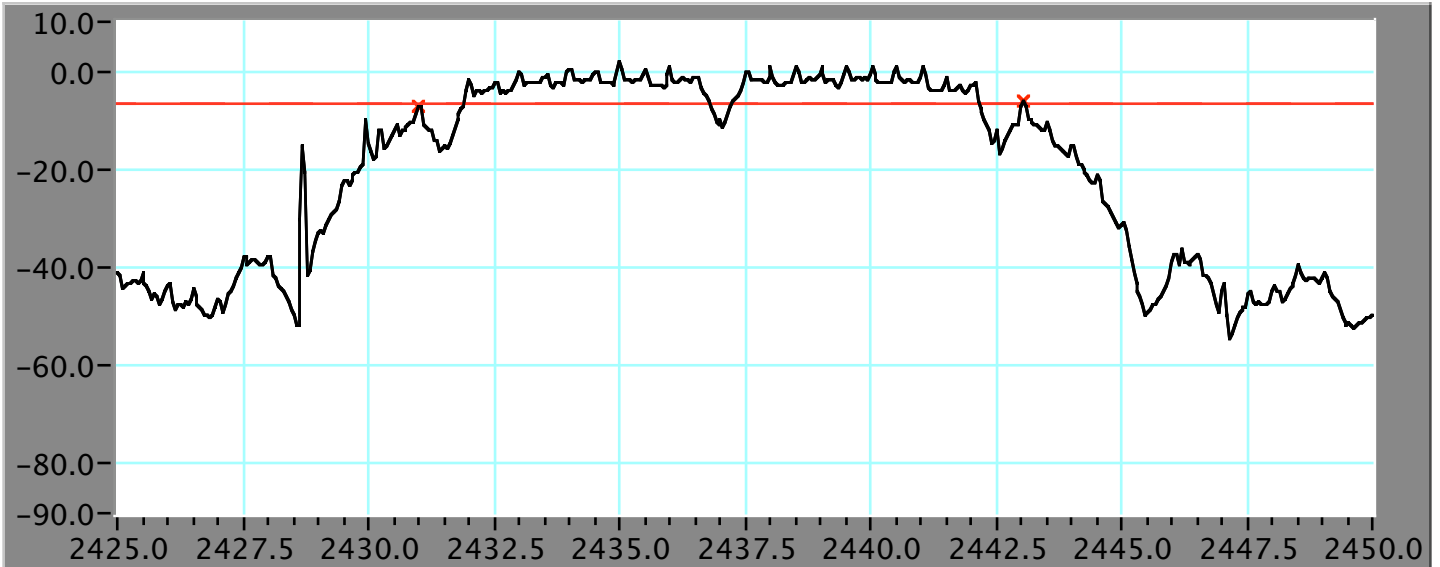


6 dB Bandwidth Channel 1 (802.11g mode)

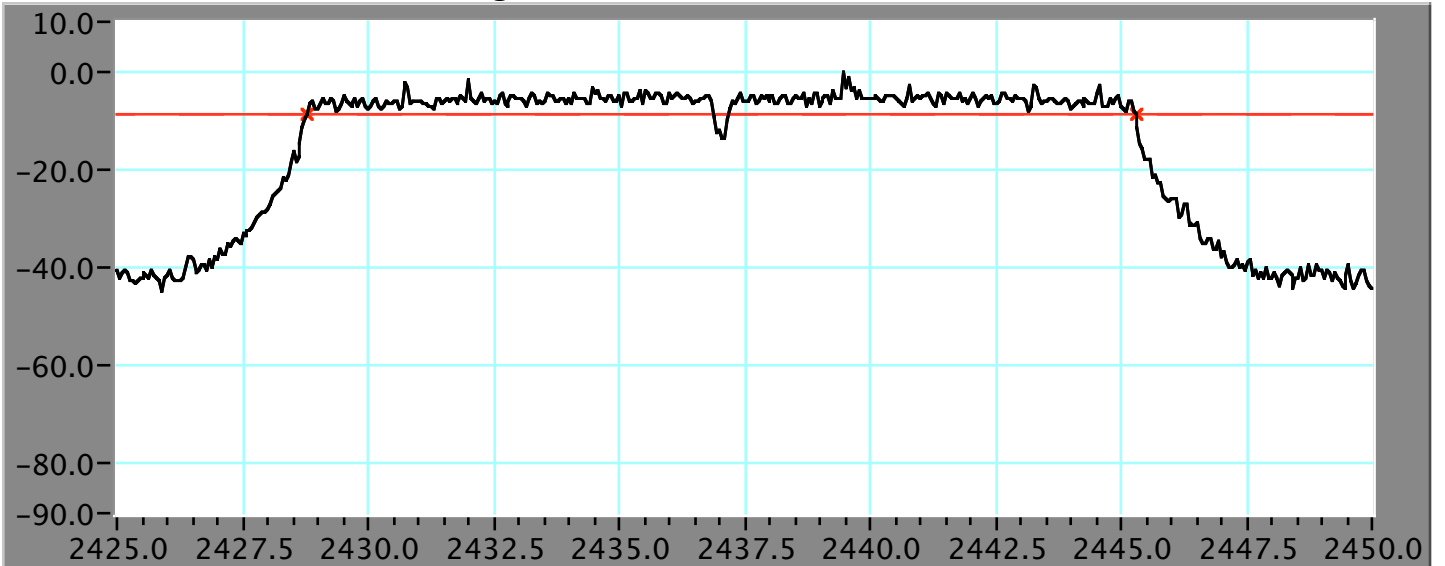


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6 dB Bandwidth Channel 6 (802.11b mode)

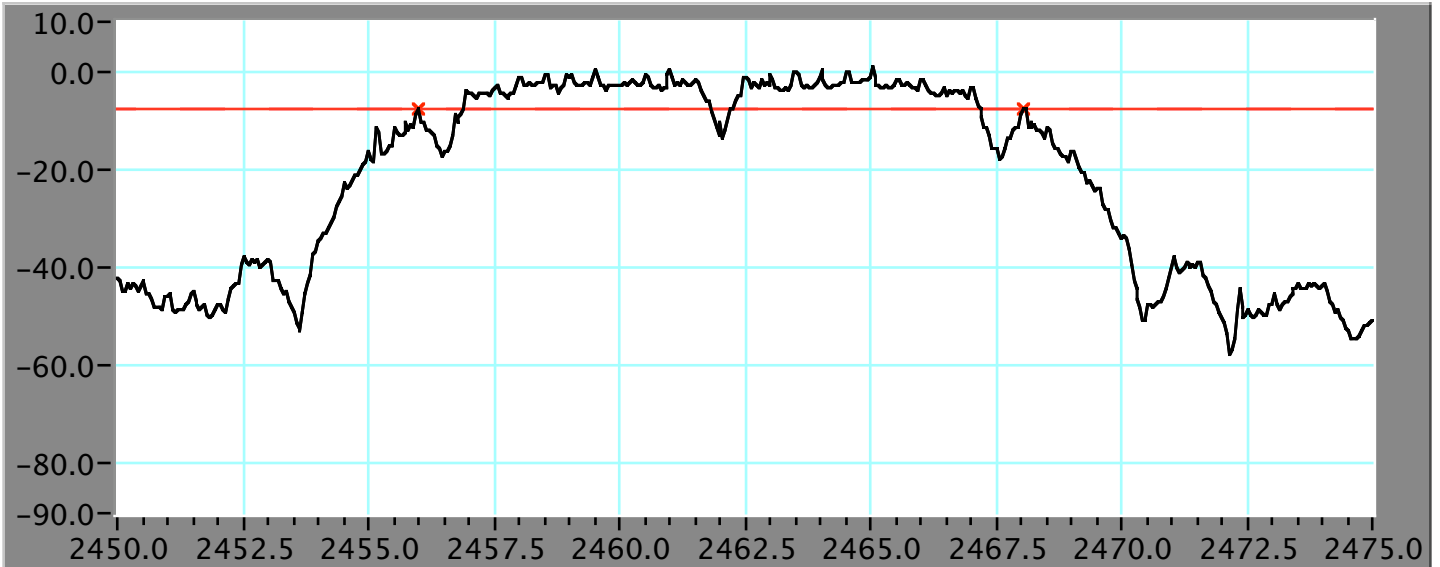


6 dB Bandwidth Channel 6 (802.11g mode)

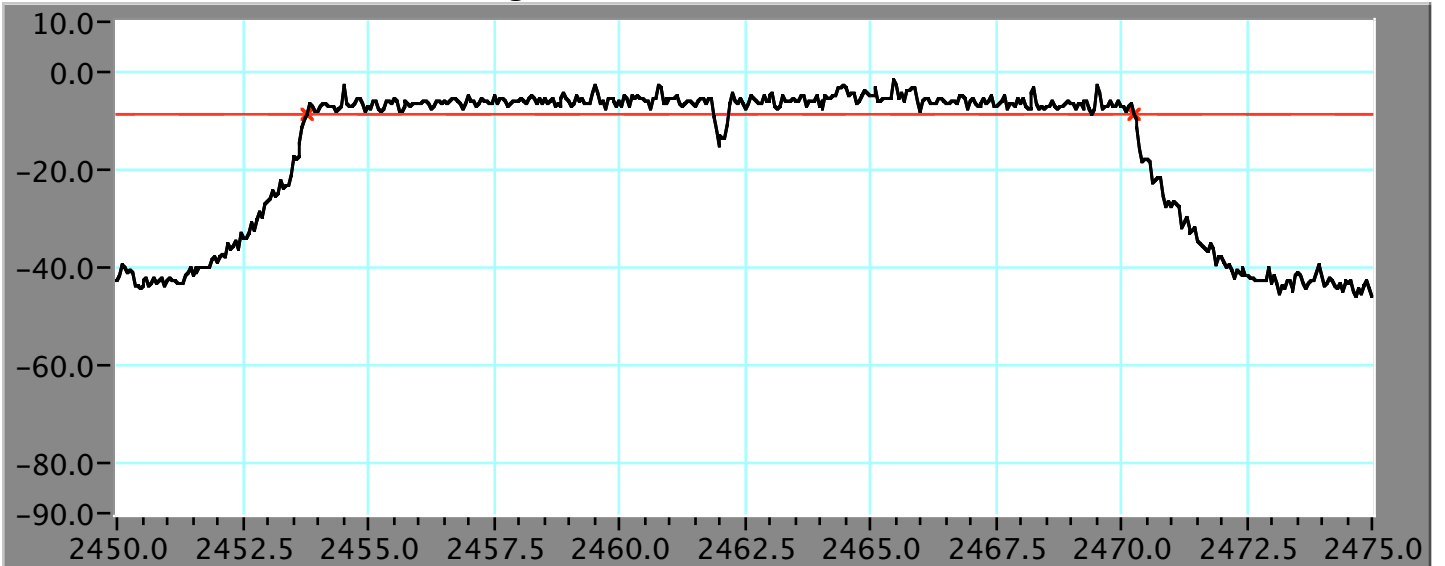


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6 dB Bandwidth Channel 11 (802.11b mode)



6 dB Bandwidth Channel 11 (802.11g mode)



Date of Test: May 25, 2004

## 7.2 99% dB Bandwidth

### Limit

None; for reporting purposes only.

### Test Procedure

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmitter output is connected to a spectrum analyzer. The RBW is set to 1 to 3% of the 99% BW and the VBW is set to at least 3 times the RBW. RBW = 300 kHz, VBW = 1000 kHz. The Spectrum Analyzer 99% Bandwidth built-in function is enabled. This is done by selecting the marker function NORMAL, then selecting the OCCUPIED PWR BANDW softkey. In the spectrum display mode, the % POWER BW is set to 99% from the POWER MEAS SETTINGS sub-menu.

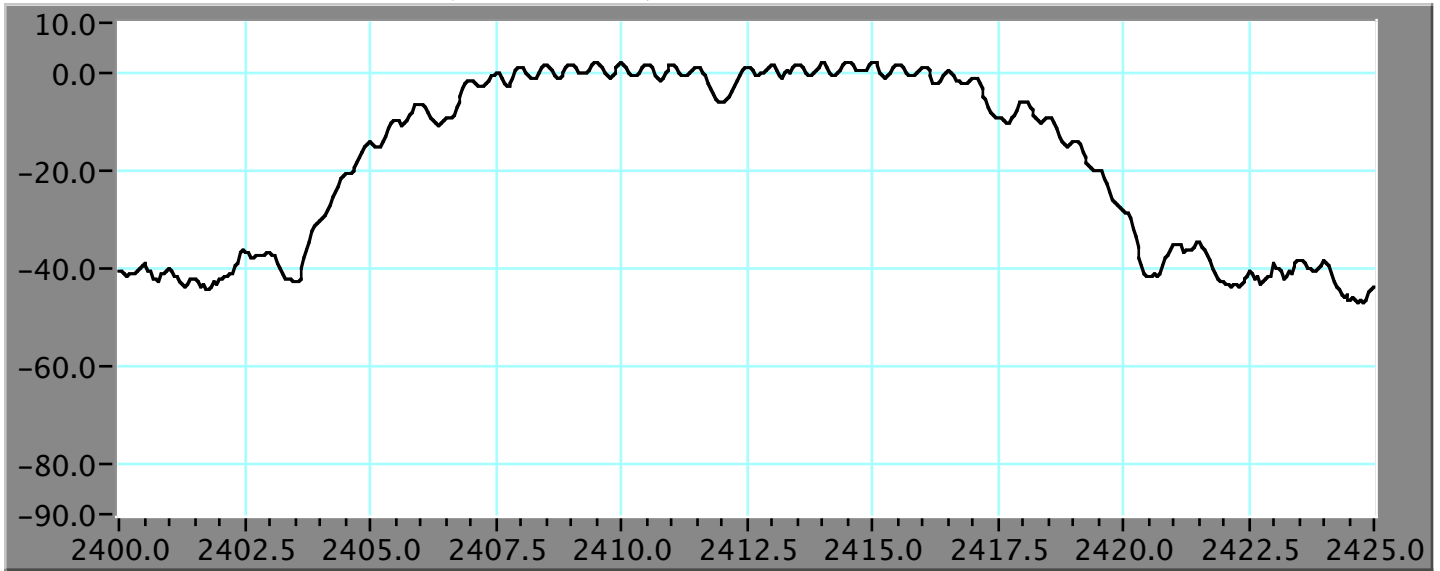
### 99% dB Bandwidth Results (802.11b mode)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	12.775
Mid	2437	12.725
High	2462	12.775

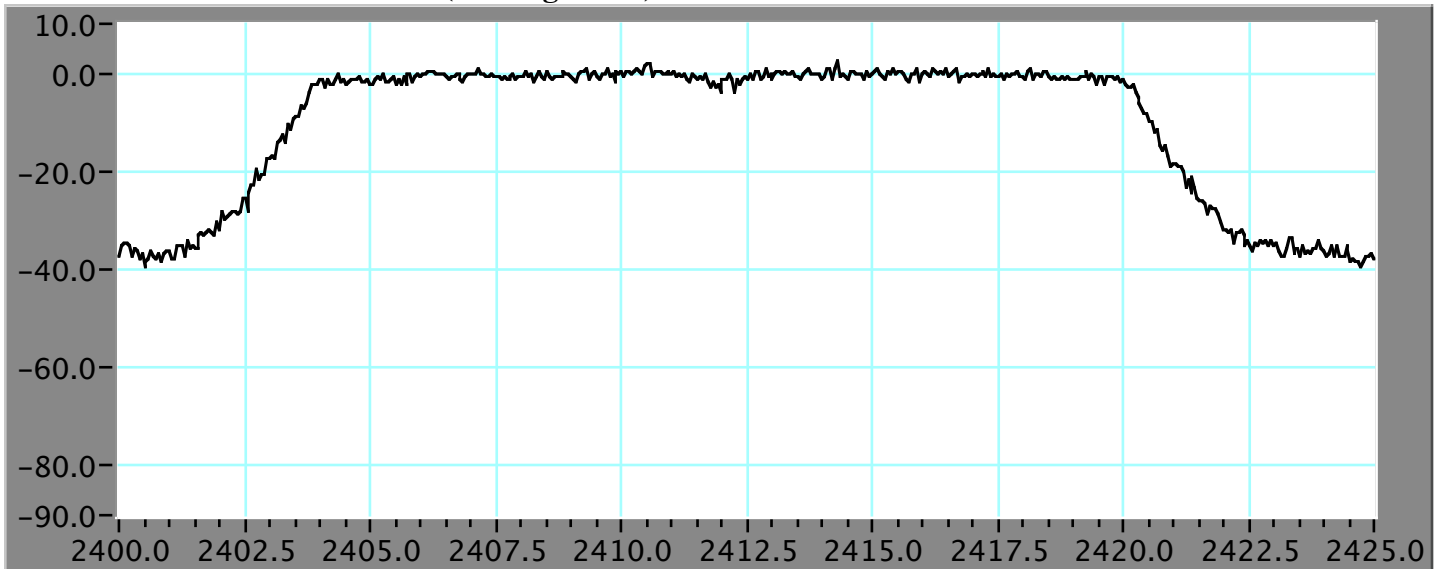
### 99% dB Bandwidth Results (802.11g mode)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	16.583
Mid	2437	16.583
High	2462	16.585

99% dB Bandwidth Channel 1 (802.11b mode)



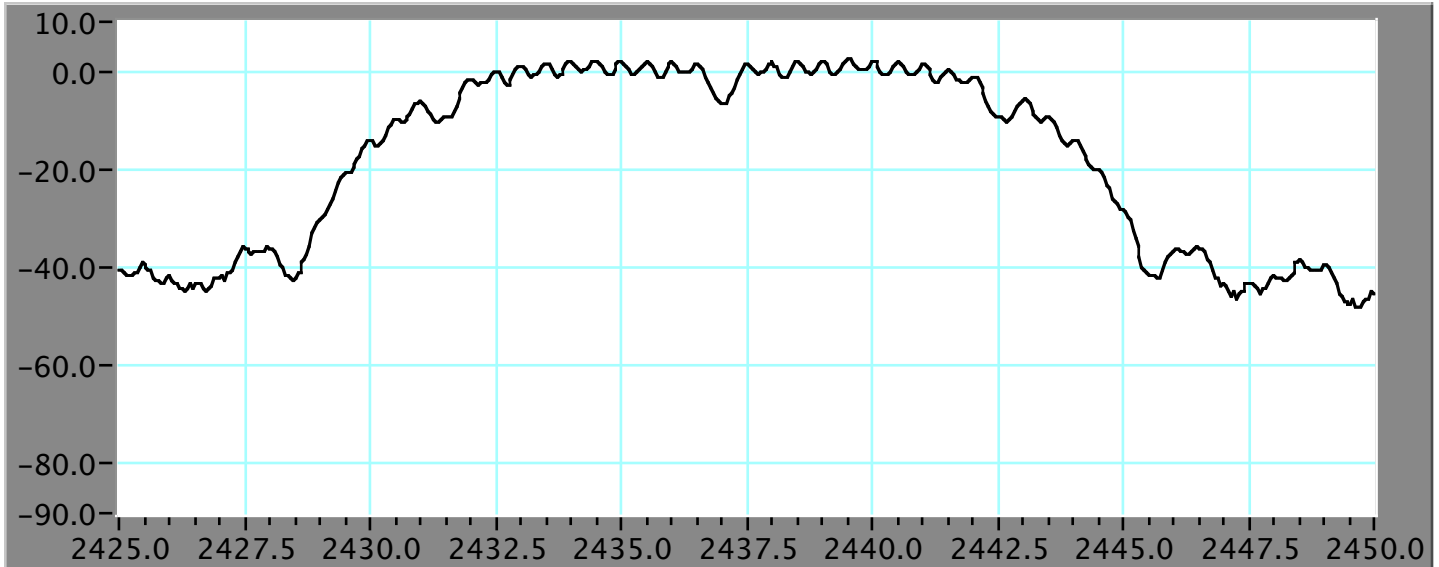
99% dB Bandwidth Channel 1 (802.11g mode)



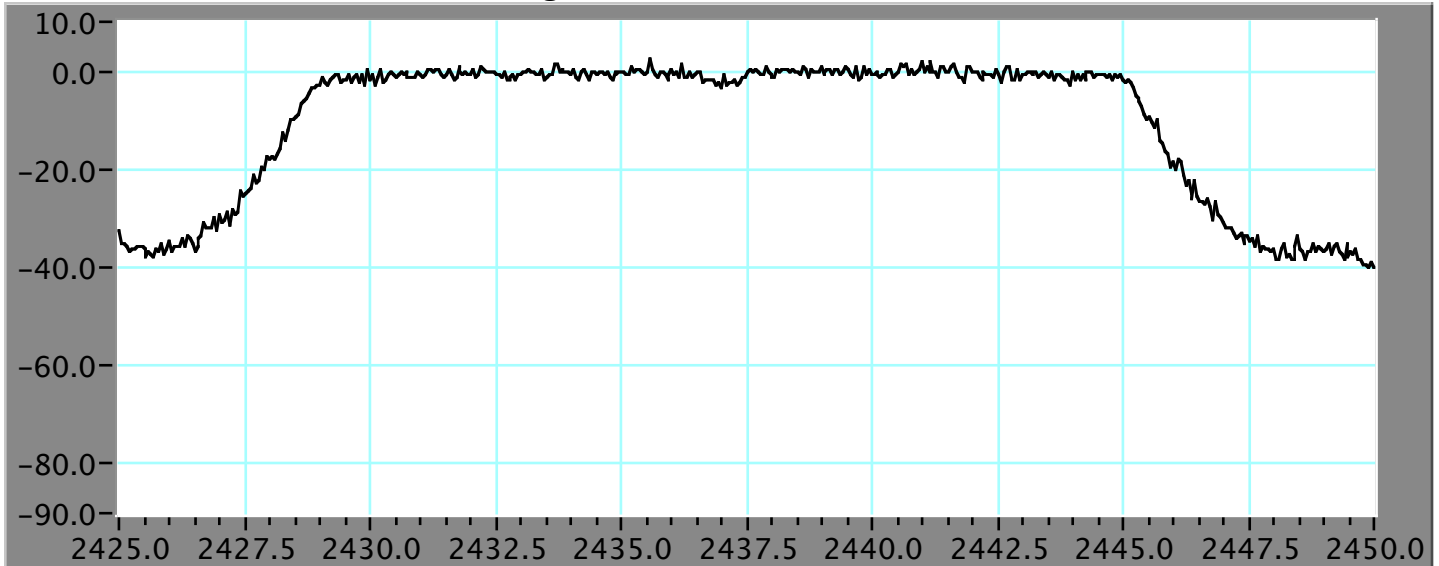
Date of Test: May 25, 2004



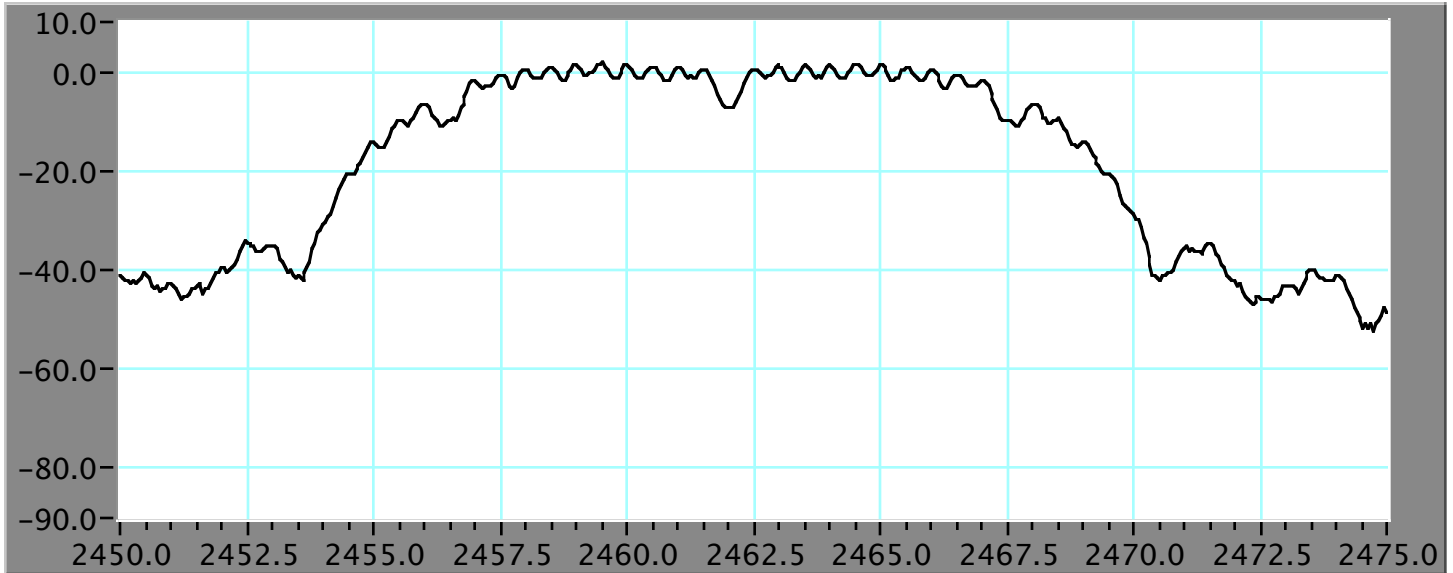
99% dB Bandwidth Channel 6 (802.11b mode)



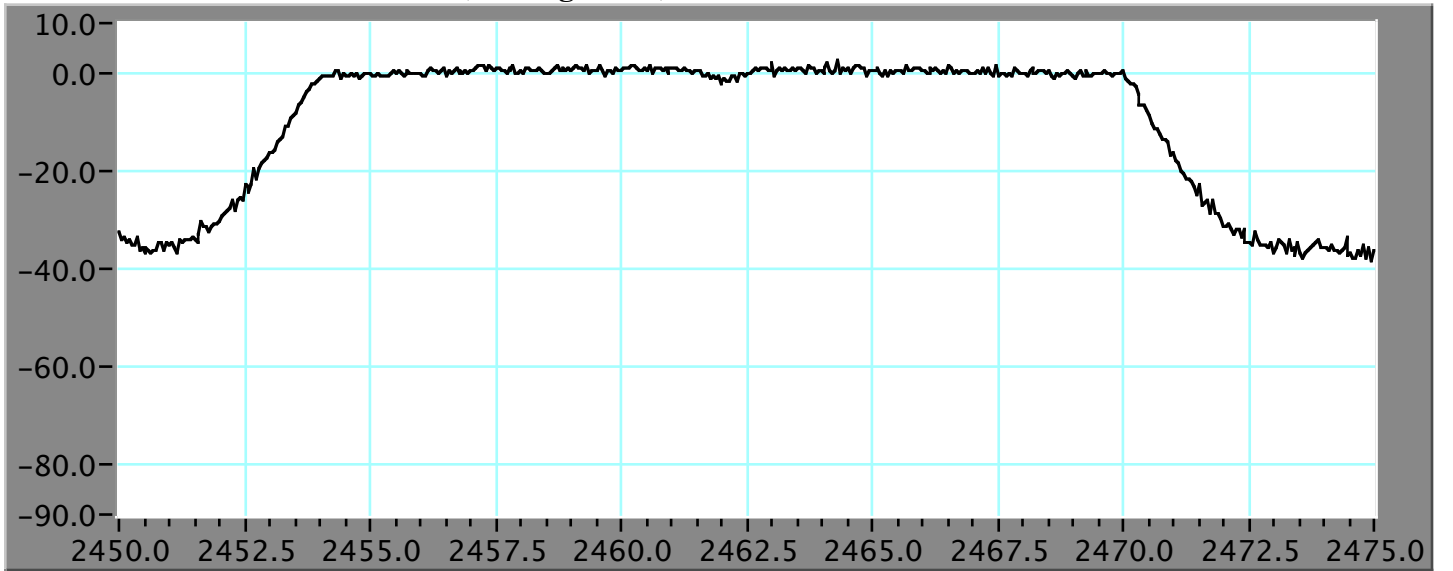
99% dB Bandwidth Channel 6 (802.11g mode)



99% dB Bandwidth Channel 11 (802.11b mode)



99% dB Bandwidth Channel 11 (802.11g mode)



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### 7.3 Maximum Peak Power Output

#### Limit

The maximum Peak Output Power for systems using digital modulation and employing an antenna with a gain not greater than 6 dBi shall not exceed 1 Watt (30 dBm).

#### Test Setup

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmitter output is connected to a spectrum analyzer. The maximum peak power output was found using the Spectrum Analyzer's built-in channel power integration function which integrates the power over a bandwidth greater than or equal to the 99% bandwidth. This is done by selecting the Spectrum Analyzer's Marker NORMAL button. The channel bandwidth was set to a bandwidth greater than or equal to the 99% bandwidth. Then the CHANNEL POWER button was selected and the reading were recorded. The RBW = 1 MHz and the VBW = 3 MHz.

#### Maximum Peak Output Power Test Results

No non-compliance were found.

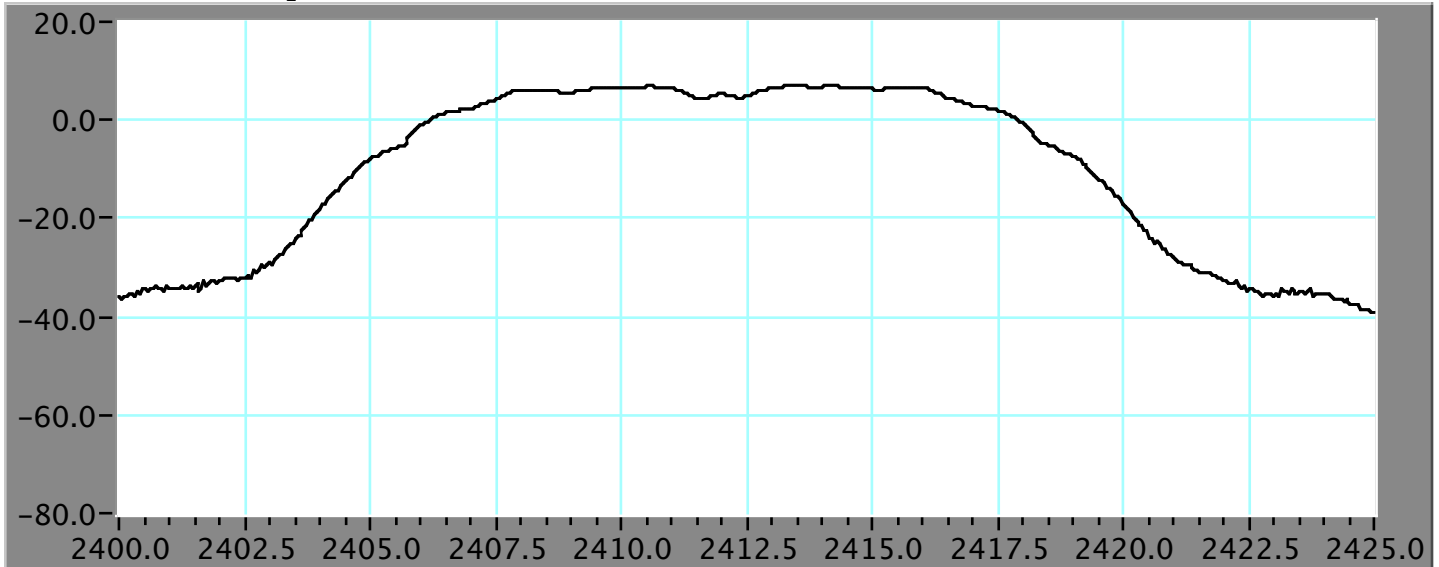
802.11b mode

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	14.6	30	-15.4
Mid	2437	14.35	30	-15.65
High	2462	14.26	30	-15.74

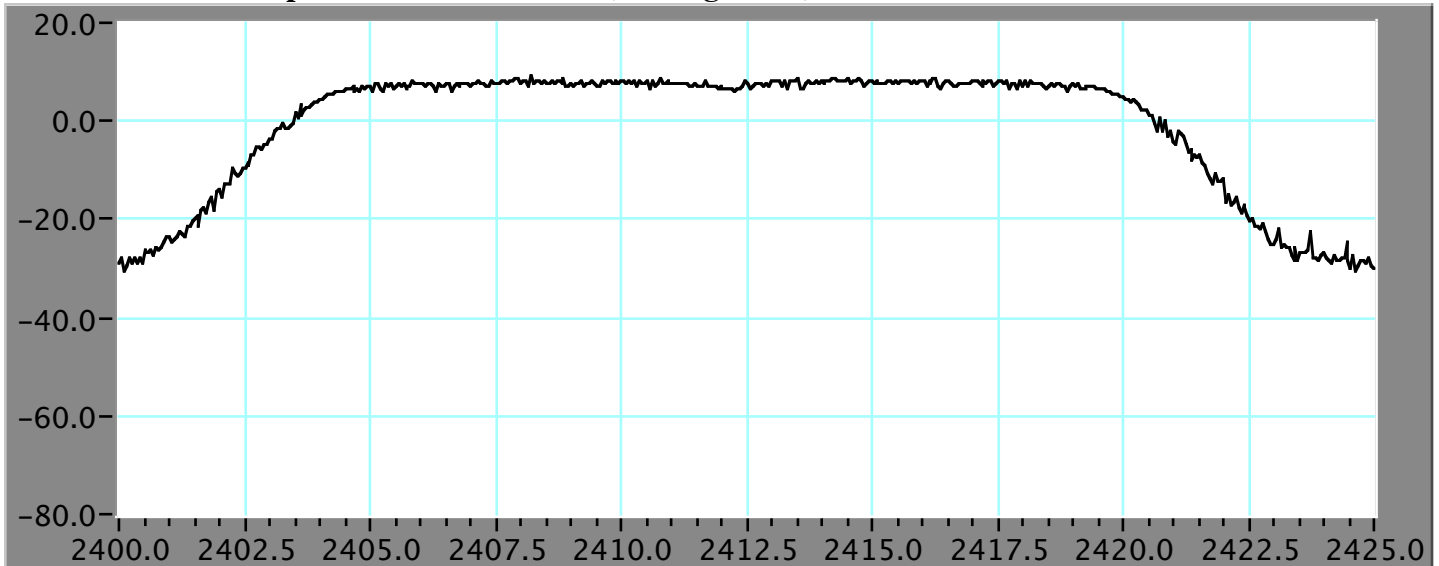
802.11g mode

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	17.9	30	-12.1
Mid	2437	18.04	30	-11.96
High	2462	18.08	30	-11.92

Maximum Peak Output Power Channel 1 (802.11b mode)

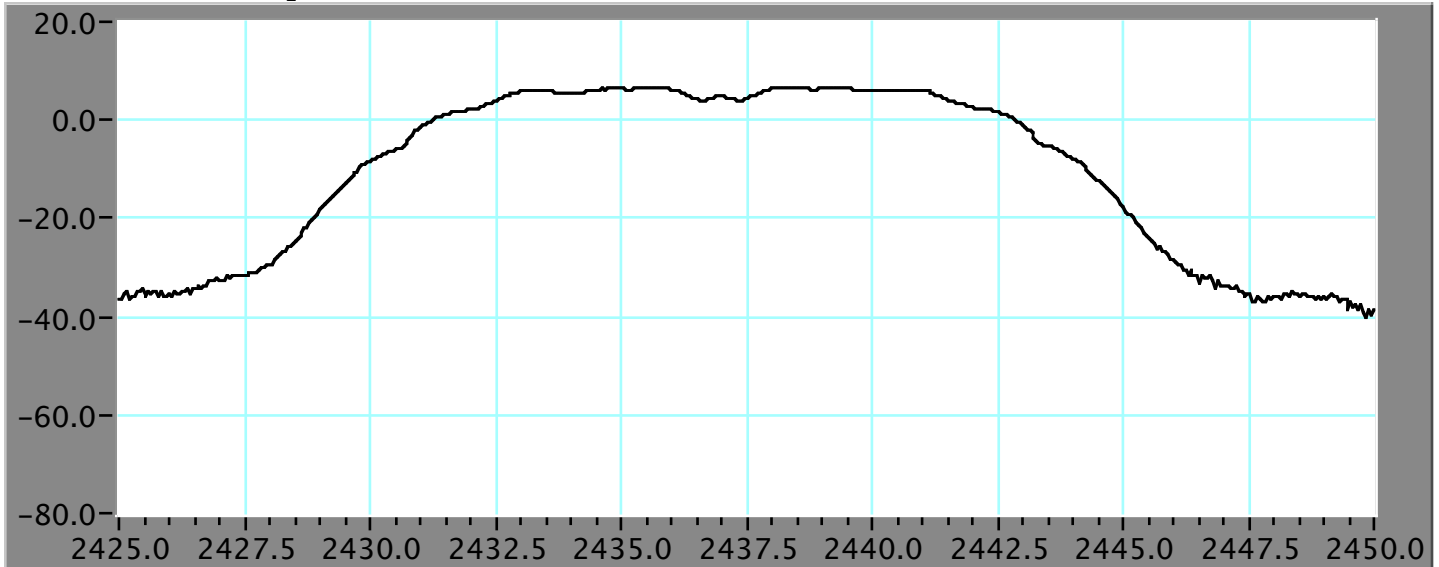


Maximum Peak Output Power Channel 11 (802.11g mode)

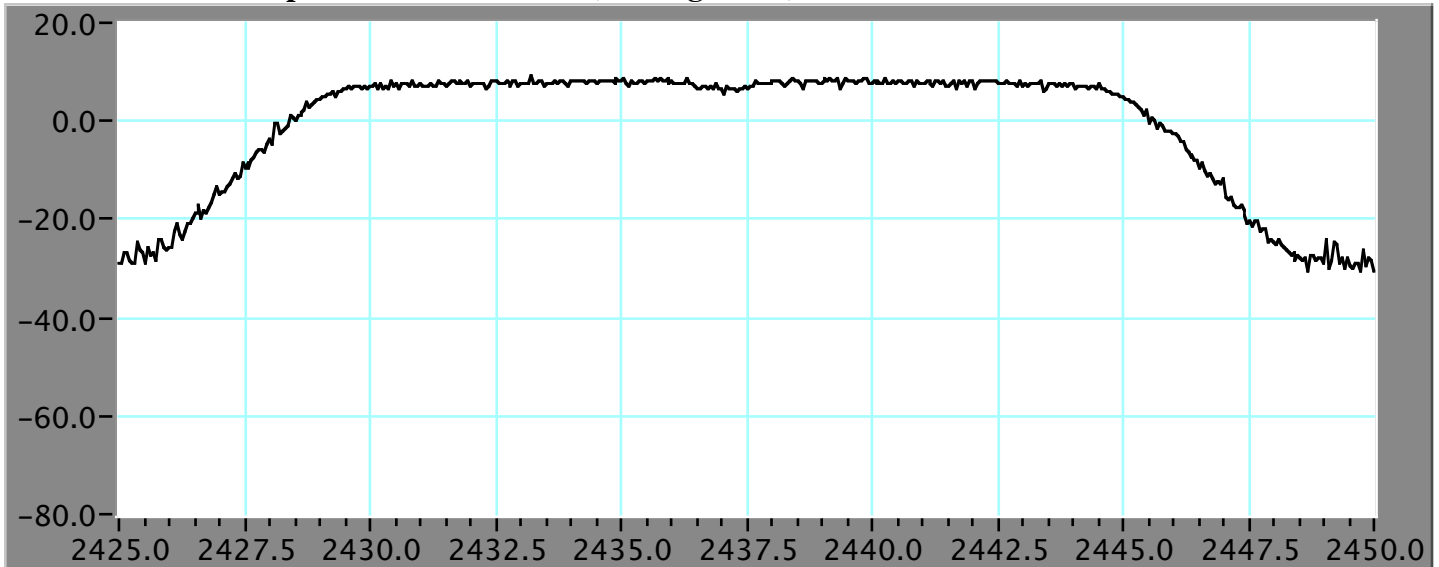


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Maximum Peak Output Power Channel 6 (802.11b mode)

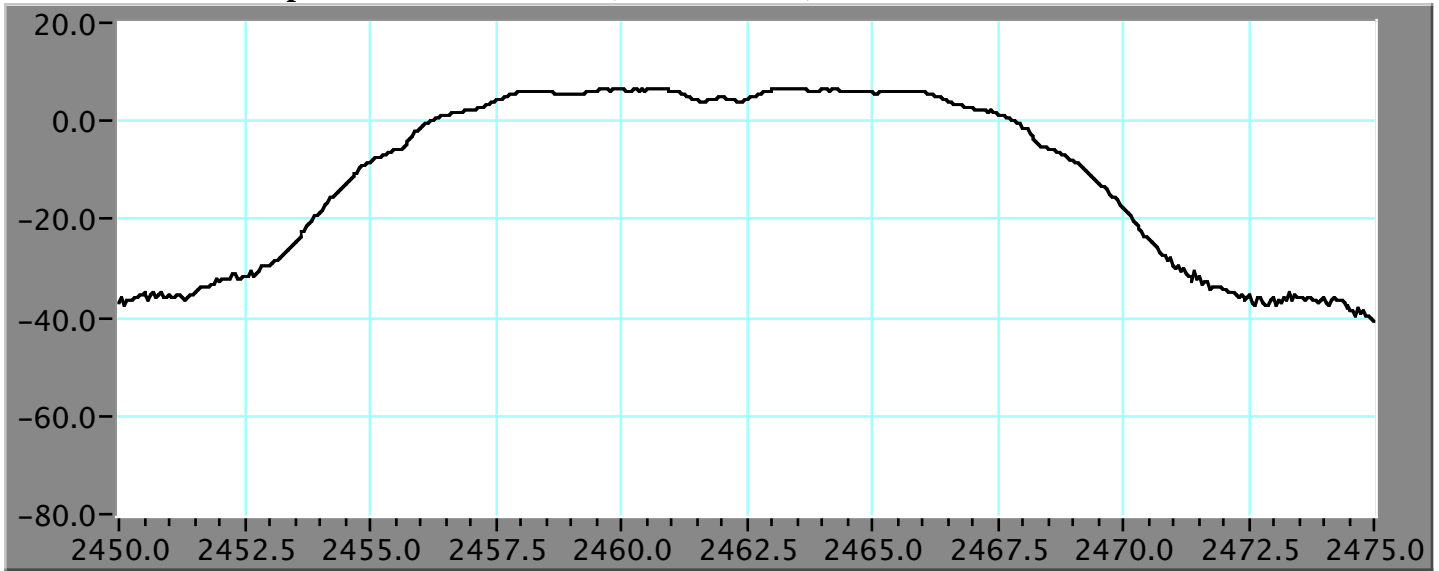


Maximum Peak Output Power Channel 6 (802.11g mode)

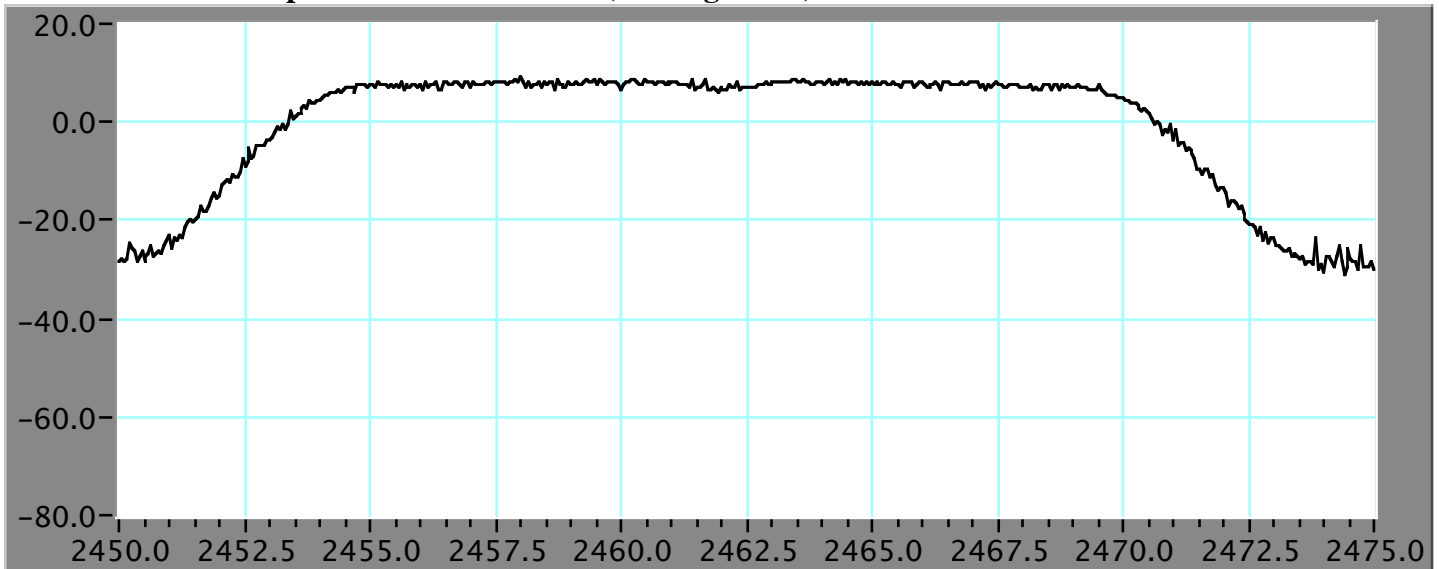


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Maximum Peak Output Power Channel 11 (802.11b mode)



Maximum Peak Output Power Channel 11 (802.11g mode)



Date of Test: May 25, 2004

## 7.4 Average Power

### Average Power Limit

None; for reporting purposes only

### Test Procedure

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmitter is connected directly to a power meter.

### Average Power Test Results

The cable assembly insertion loss (including 12 dB pad and 0.7 dB cable) was entered directly into the power meter as an offset. The readings were read directly from the power meter.

#### 802.11b Mode

Channel	Frequency (MHz)	Average Power (dBm)
Low	2412	13.4
Mid	2437	13.1
High	2462	13.3

#### 802.11g Mode

Channel	Frequency (MHz)	Average Power (dBm)
Low	2412	12.5
Mid	2437	12.2
High	2462	12.3

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## 7.5 Peak Power Spectral Density

### Limit

For Direct Sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### Test Procedure

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmit output is connected to a spectrum analyzer. The maximum level in a 3 kHz bandwidth is measured with the spectrum analyzer using RBW = 3 kHz and VBW = 10 kHz, sweep time = span / 3 kHz. A span of 6 MHz was used and the sweep time was 1000 Seconds.

### Peak Power Spectral Density Test Results

No non-compliance was found.

#### 802.11b Mode

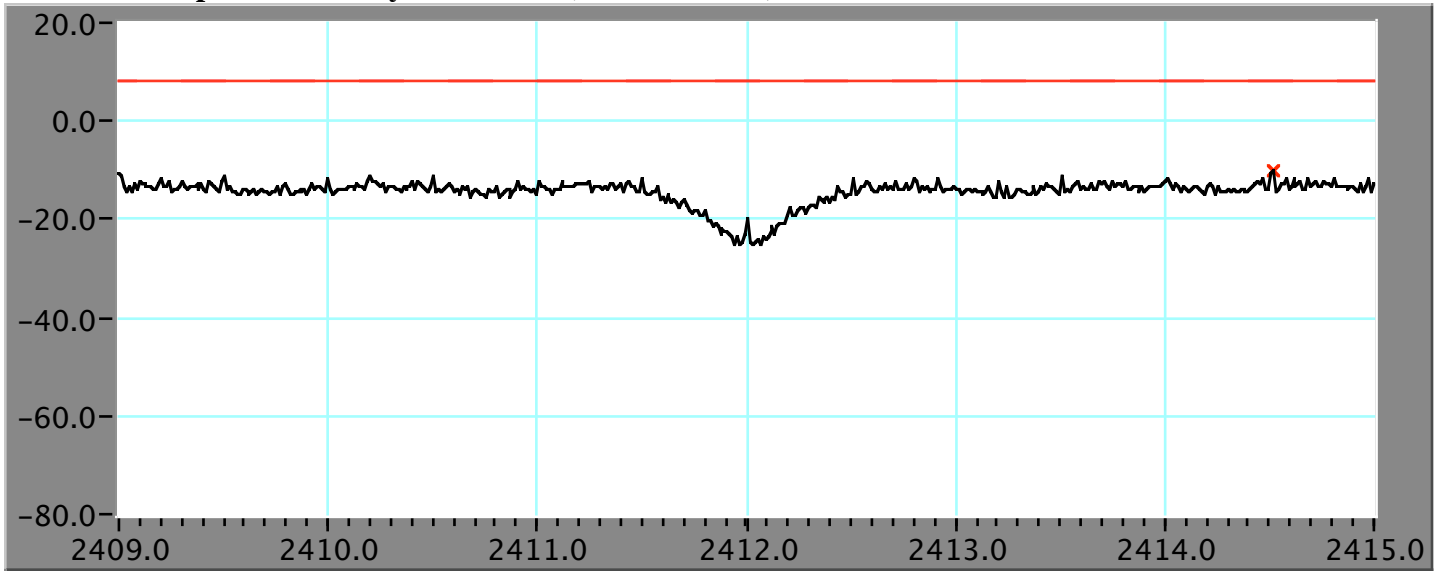
Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-9.9	8	-17.9
Mid	2437	-9.1	8	-17.1
High	2462	-10.1	8	-18.1

#### 802.11g Mode

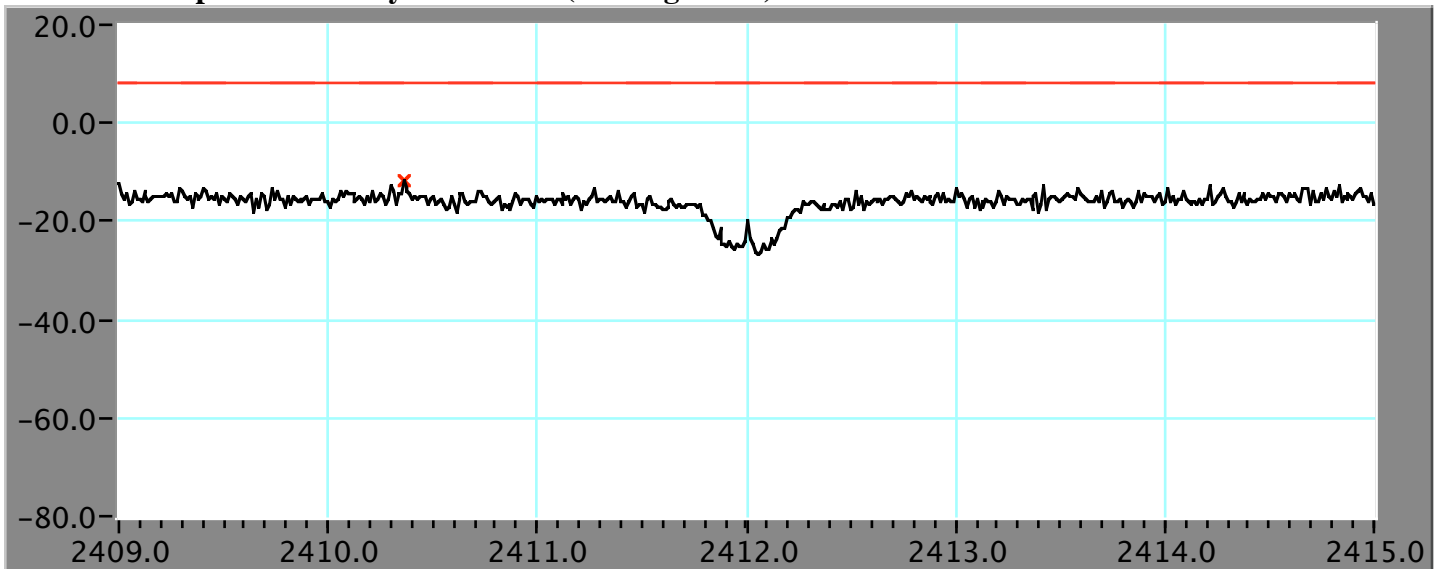
Channel	Frequency (MHz)	Peak Power Spectral Density (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-11.5	8	-19.5
Mid	2437	-11.5	8	-19.5
High	2462	-11.9	8	-19.9



Peak Power Spectral Density Channel 1 (802.11b mode)

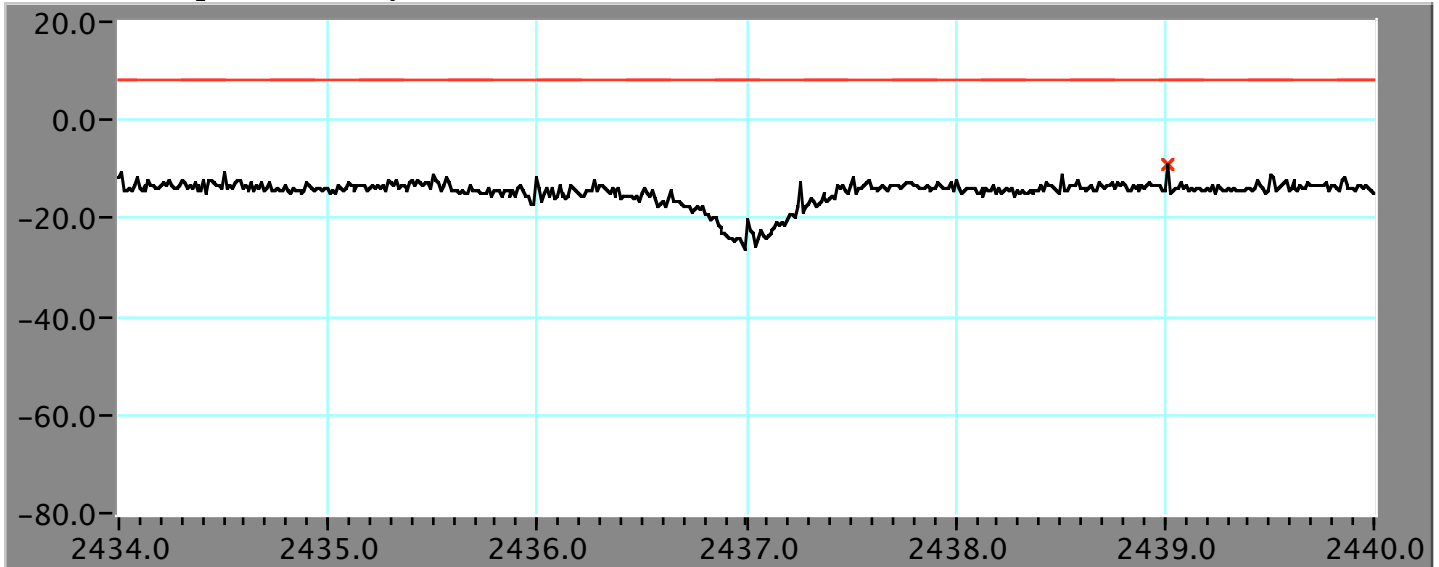


Peak Power Spectral Density Channel 1 (802.11g mode)

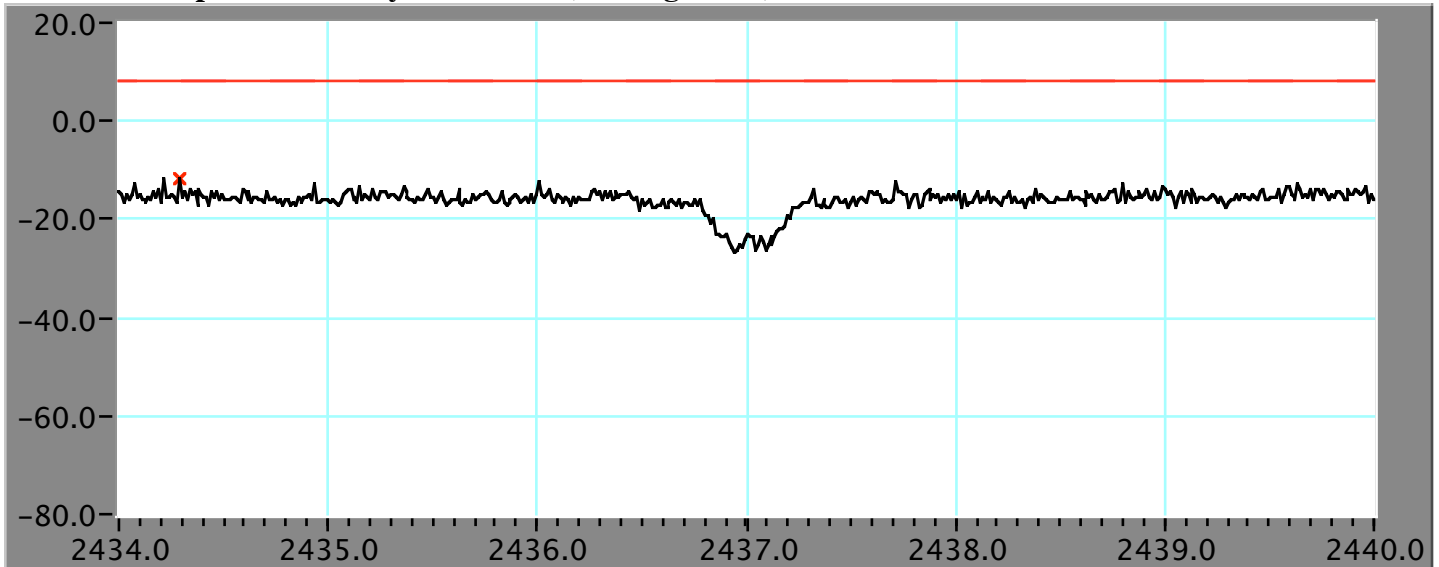


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Peak Power Spectral Density Channel 6 (802.11b mode)

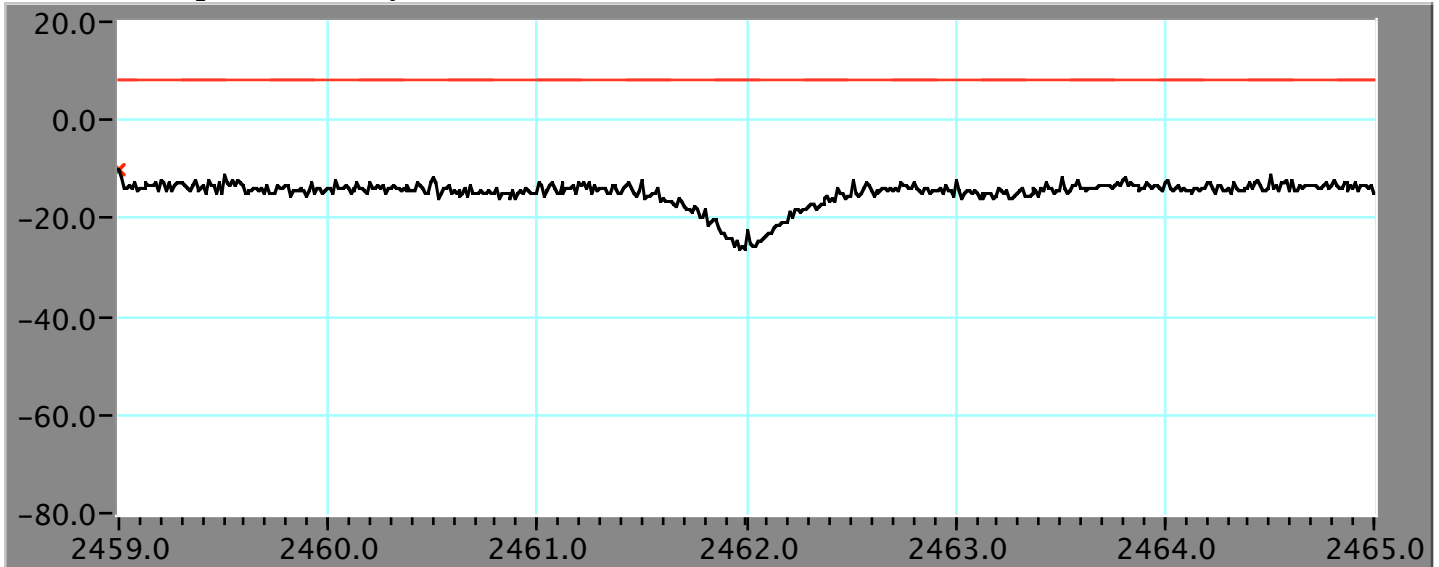


Peak Power Spectral Density Channel 6 (802.11g mode)

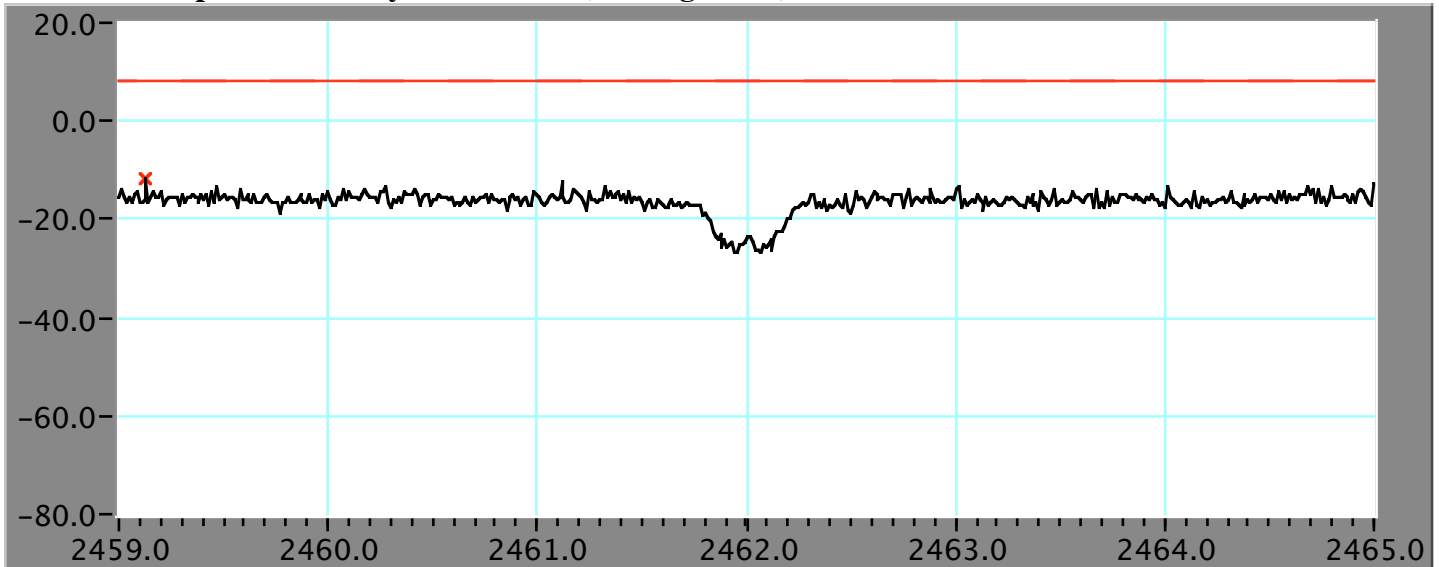


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Peak Power Spectral Density Channel 11 (802.11b mode)



Peak Power Spectral Density Channel 11 (802.11g mode)



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## **7.6 -20 dBc Conducted Spurious Emissions**

### **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 desired power, based on either an RF conducted or a radiated measurement.

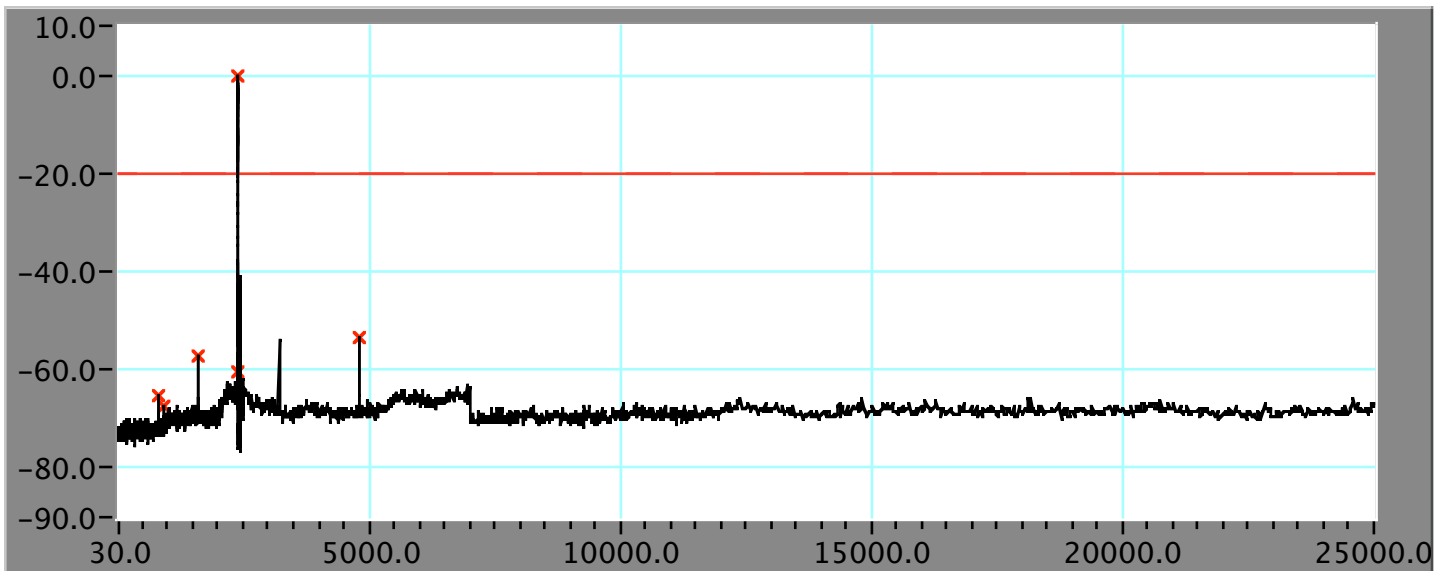
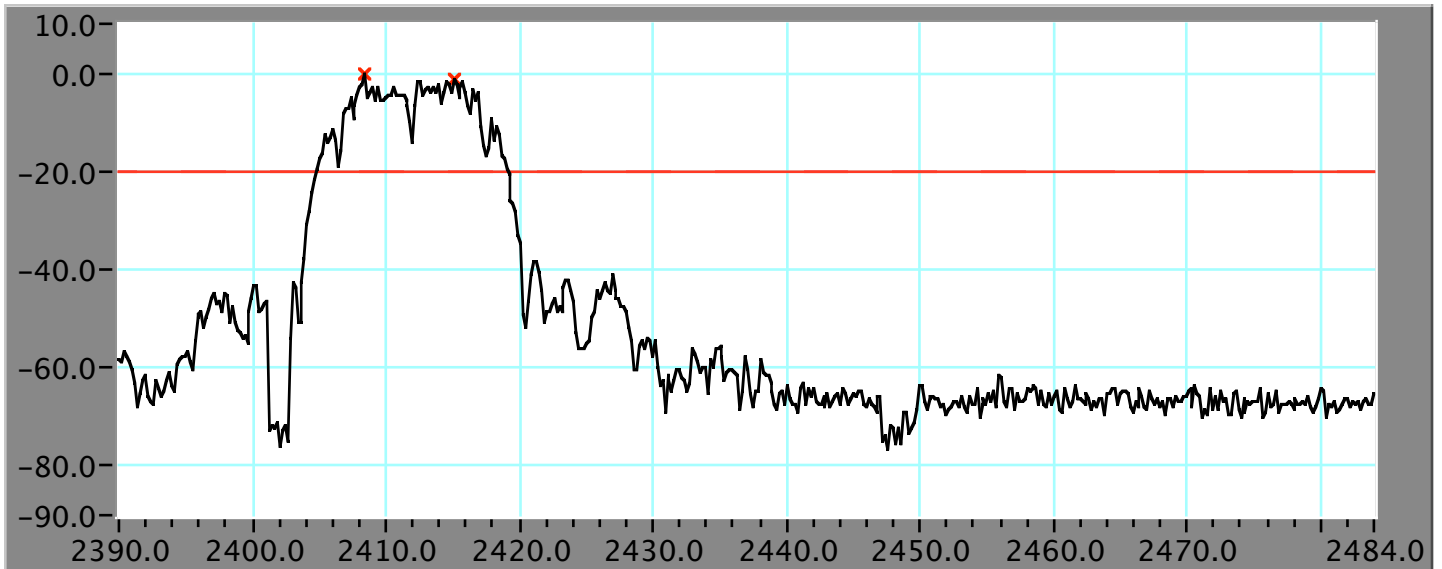
### **Test Procedure**

The transmitter is set to continuously transmit using iperf as described in Section 6 and the transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The spectrum from 30 MHz to 25 GHz is investigated when transmitting on the low, mid and high channels for 802.11b and 802.11g mode.

### **Test Results**

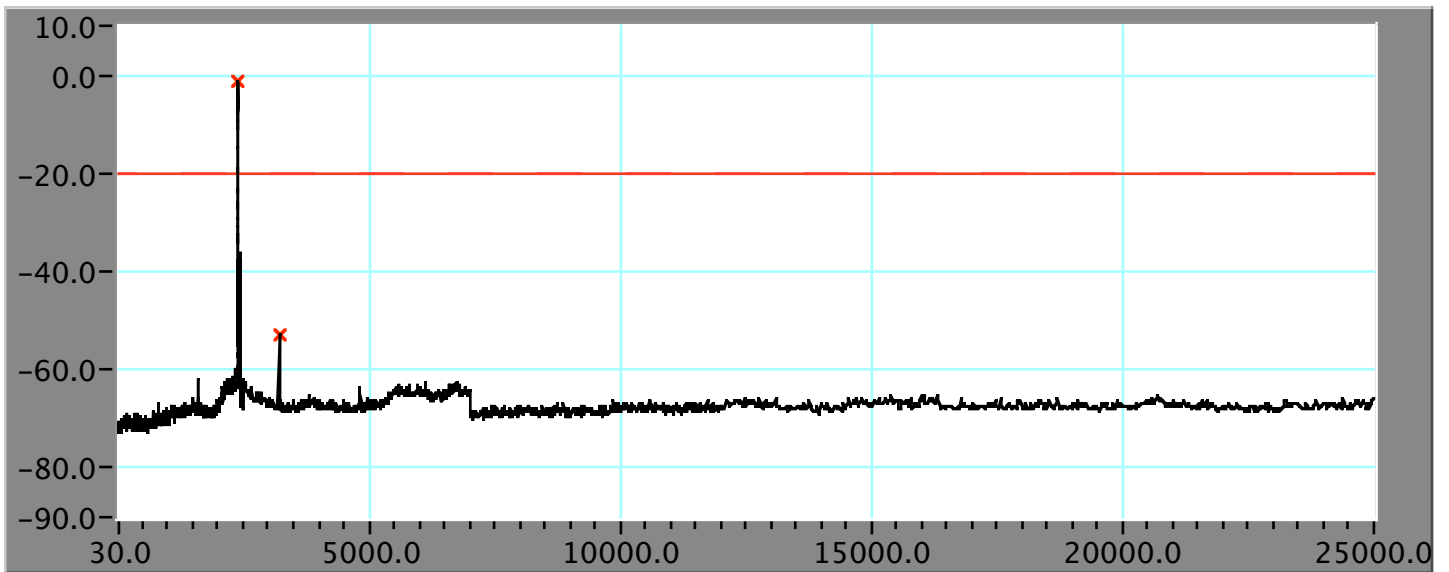
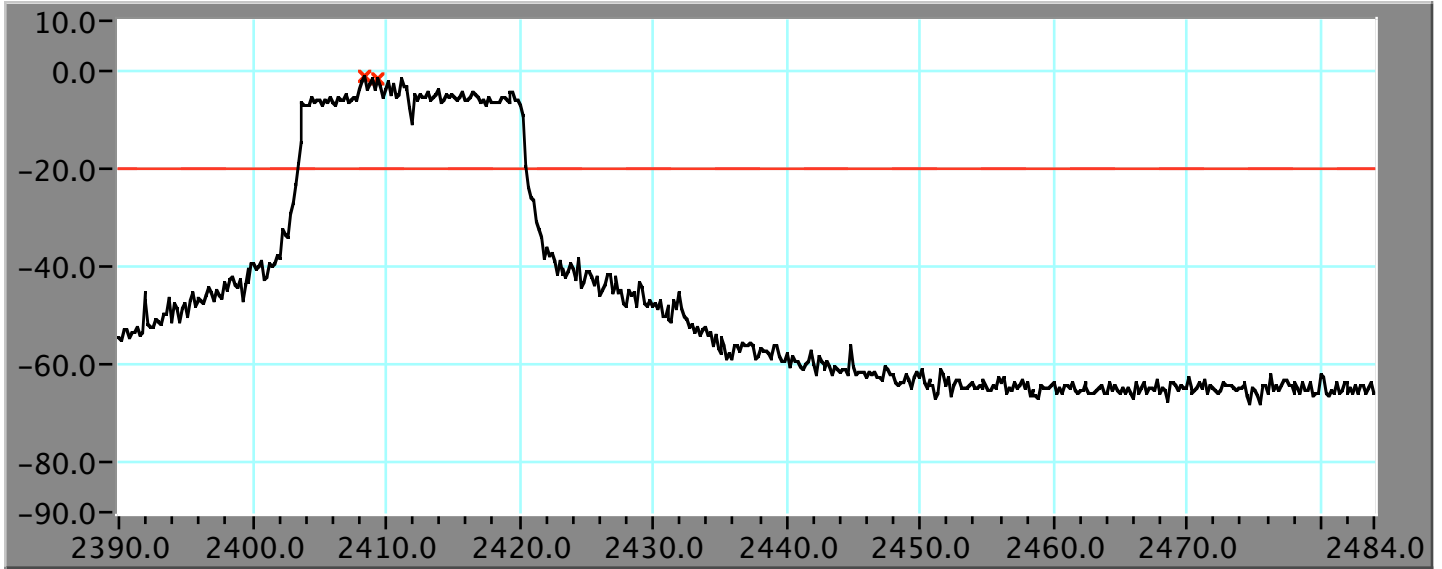
No non-compliance was found.

-20 dBc Conducted Spurious Emissions Channel 1 (802.11b mode)



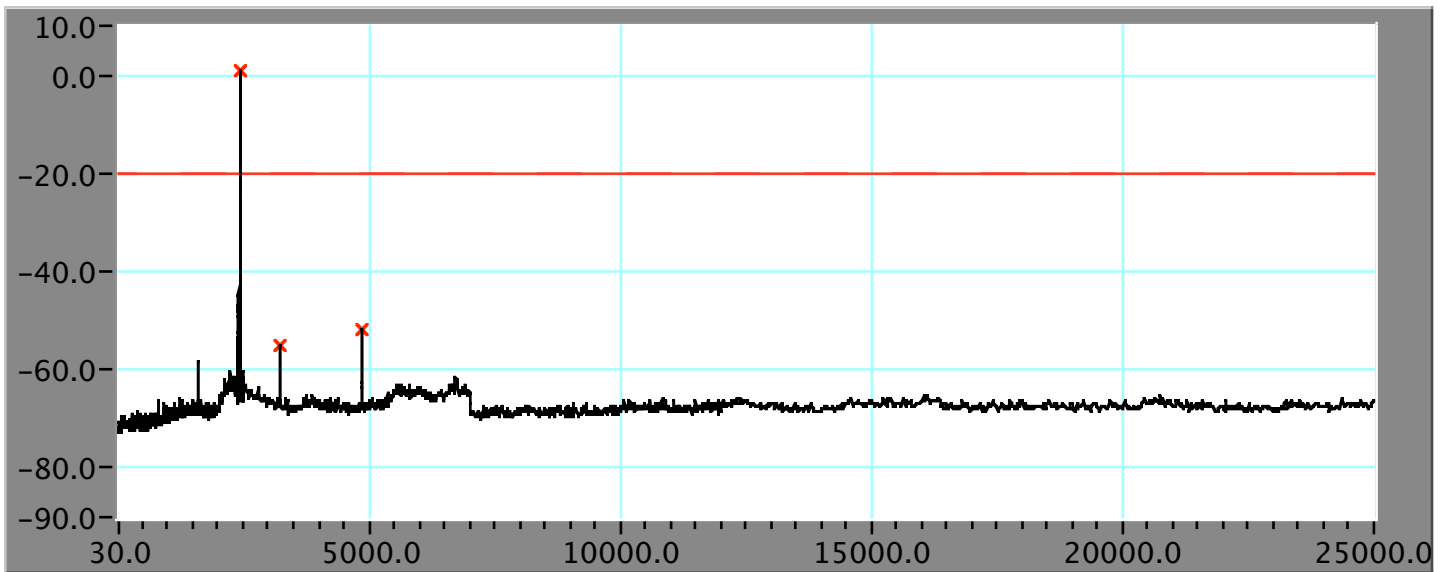
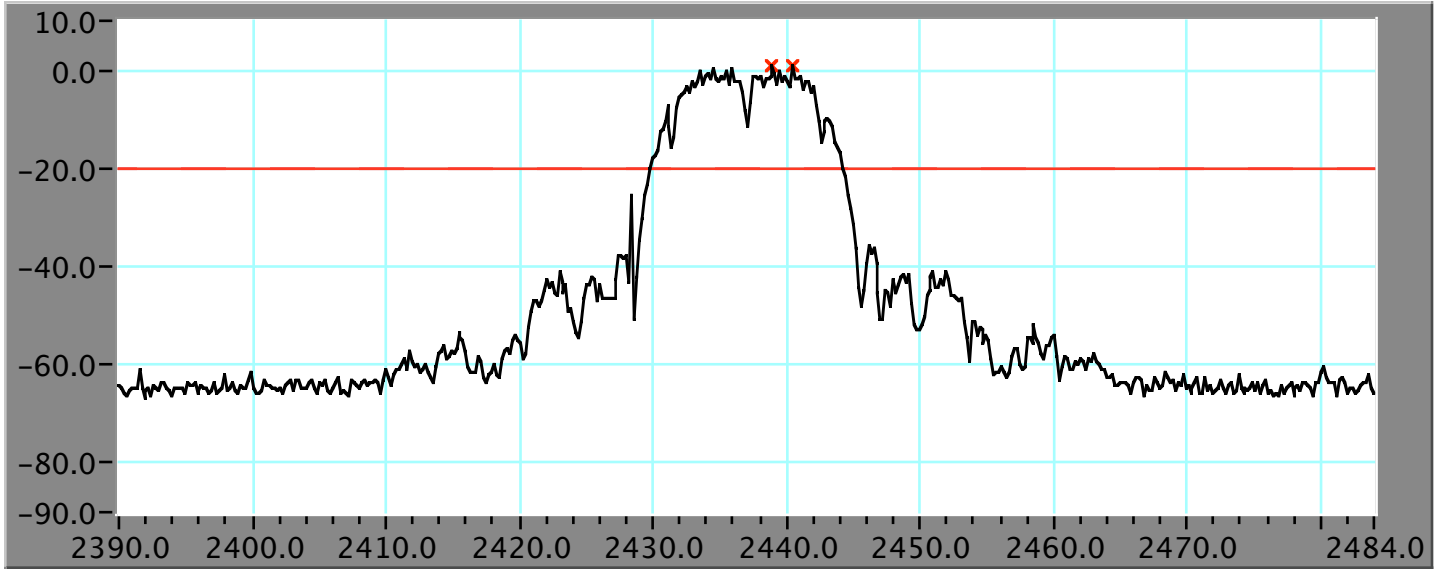
Date of Test: May 26, 2004

-20 dBc Conducted Spurious Emissions Channel 1 (802.11g mode)



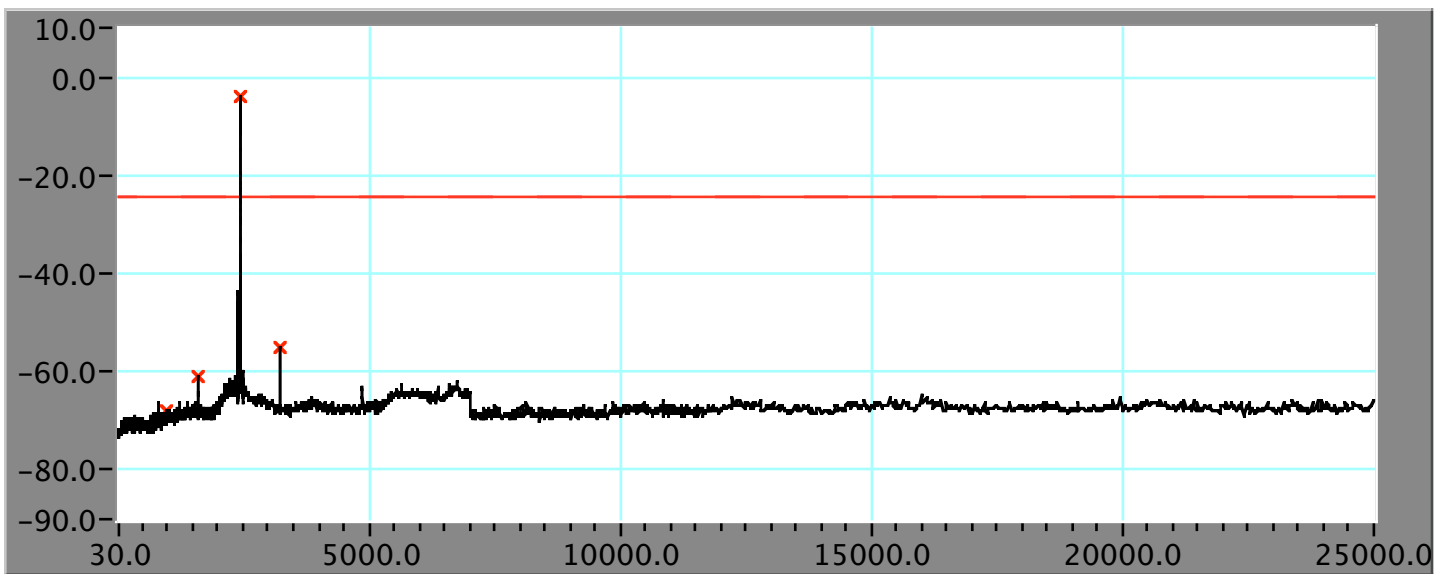
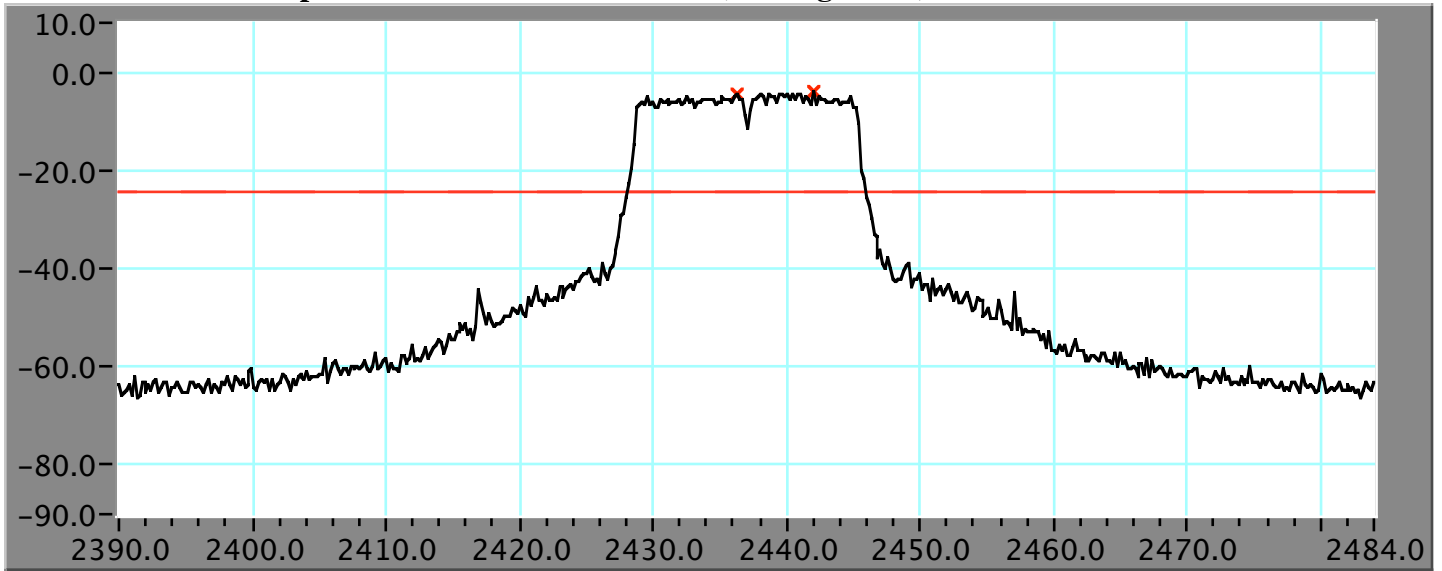
Date of Test: May 26, 2004

-20 dBc Conducted Spurious Emissions Channel 6 (802.11b mode)



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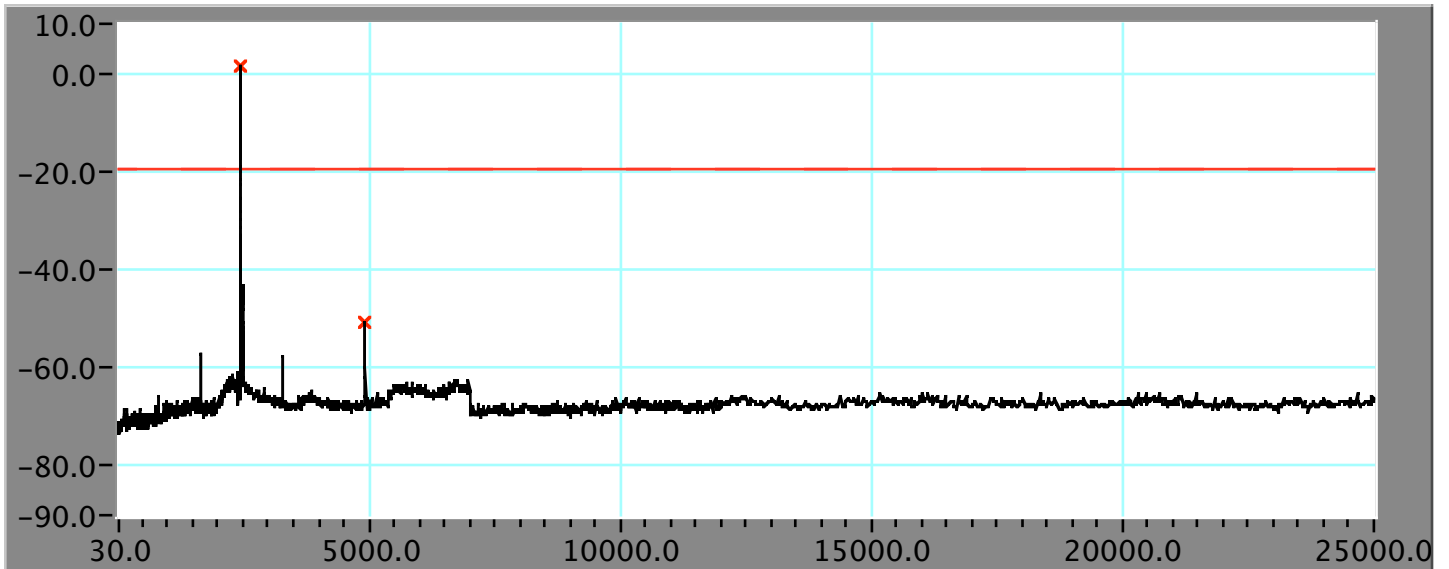
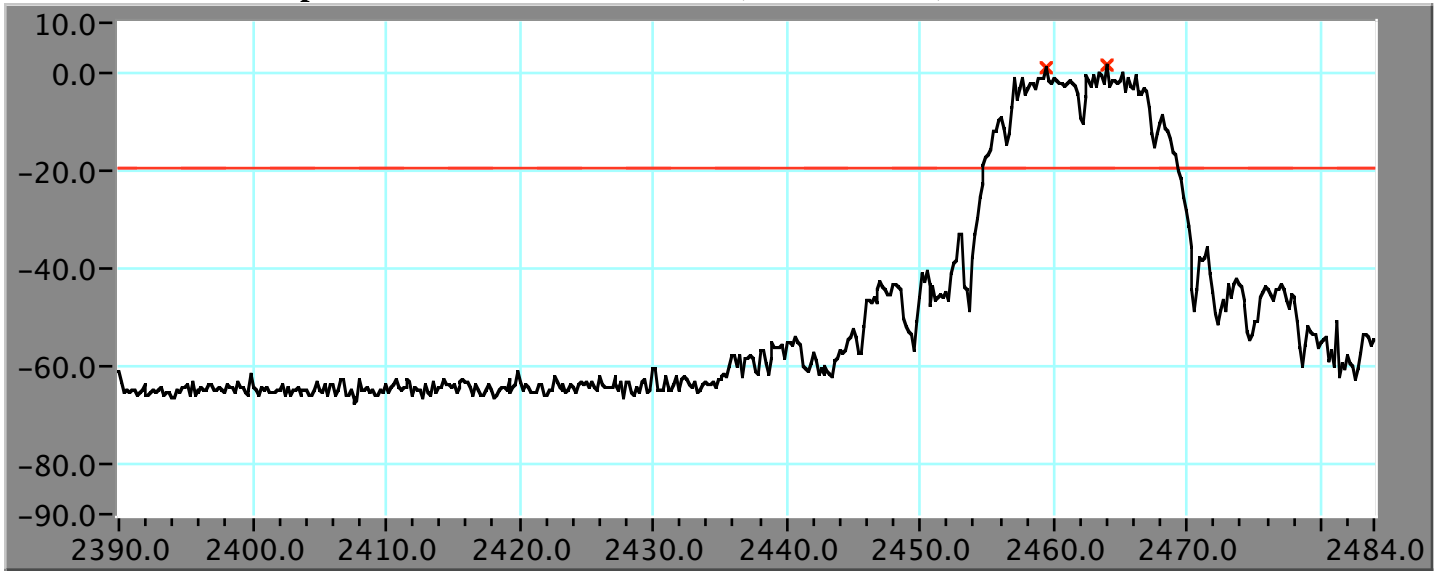
-20 dBc Conducted Spurious Emissions Channel 6 (802.11g mode)



Date of Test: May 26, 2004

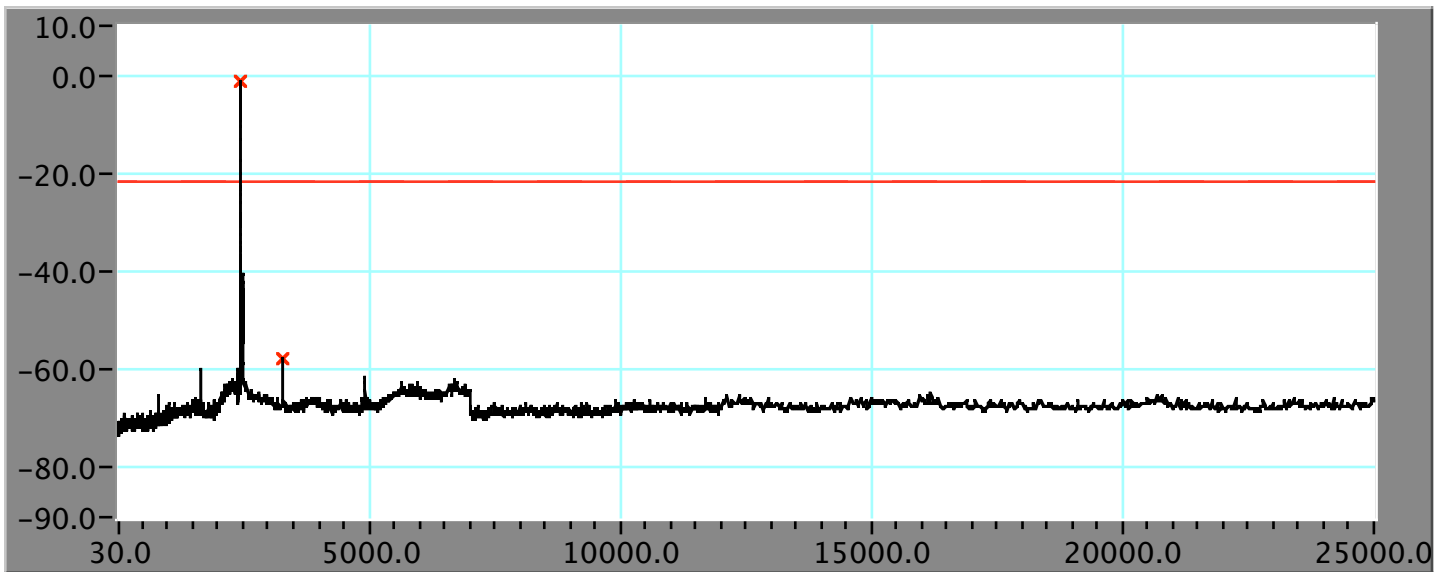
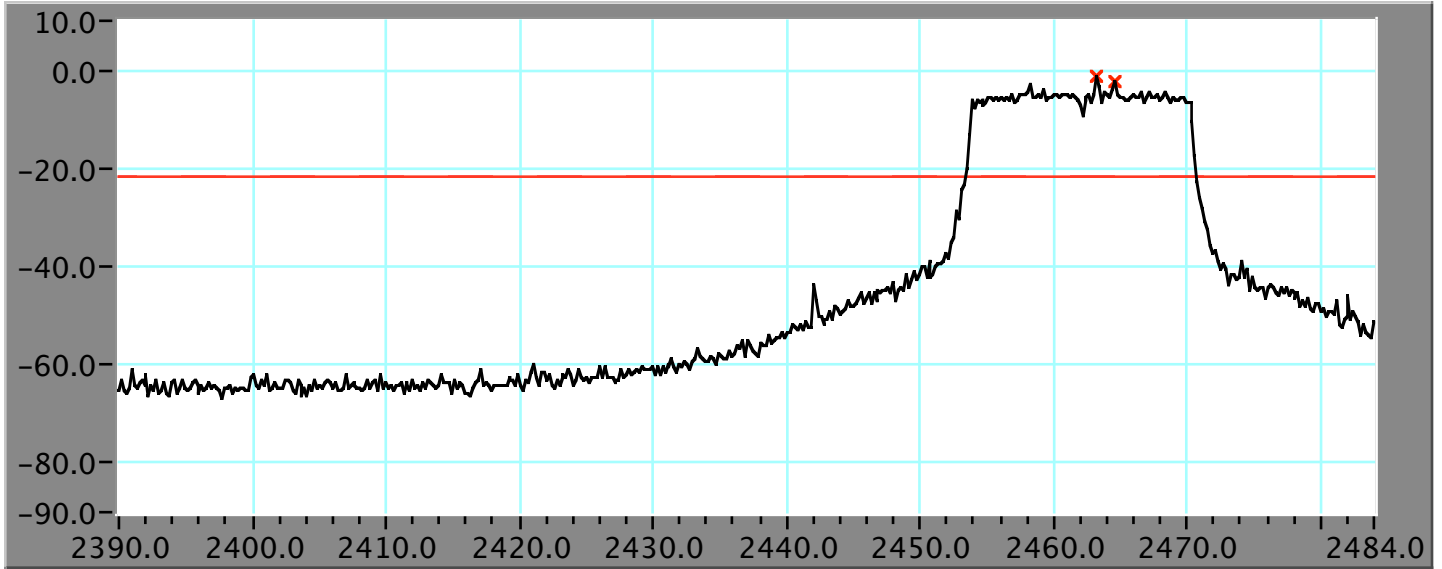


-20 dBc Conducted Spurious Emissions Channel 11 (802.11b mode)



Date of Test: May 26, 2004

-20 dBc Conducted Spurious Emissions Channel 11 (802.11g mode)



Date of Test: May 26, 2004

## 7.7 Radiated Emissions

### Limits

Per CFR 47 Section 15.209(a), Radiated Emissions shall be investigated up to the 10 harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. The emissions from an intentional radiator shall not exceed the specified field-strength levels.

Frequency (MHz)	Field Strength (mV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

### Test Procedures

Radiated Emission measurements were performed at the Apple Computer Evelyn 1, 10 meter semi-anechoic chamber located at 123 East Evelyn Avenue, Mountain View, California. The EUT was placed on a nonmetallic table, 80 cm above the metallic ground-plane. The EUT and peripherals were powered from a filtered main supply.

The frequency spectrum from 30 MHz to 25 GHz was scanned and the emission levels maximized at each frequency. The antenna was varied in height and the system was rotated 360 degrees while scanning for maximum emission amplitudes. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

For measurements above 1 GHz, the transmitter is set to continuously transmit using iperf as described in Section 6 and scans were performed with the transmitter frequency set to the low, mid and high channels. For scans below 1 GHz, all the EUT I/O ports were activated. A large file from a remote server was transferred via the EUT's Ethernet port to a wireless client from the EUT's transmitter. The EUT' USB port was activated by connecting a USB printer. The EUT's audio port was activated by using an Application called "AirPlay" and playing music.

- low (channel 1) - 2.412 GHz
- mid (channel 6) - 2.437 GHz
- high (channel 11) - 2.462 GHz

For measurements below 1 GHz, the RBW is set to 100 kHz and the VBW is set to 100 kHz. Peak detection was used unless otherwise noted as Quasi-Peak. For peak measurements above 1 GHz, the RBW is set to 1 MHz and the VBW is set to 1 MHz. For Average measurements the RBW is set to 1 MHz and the VBW is set to 10 Hz. Radiated Emission measurements below 1 GHz were performed at an EUT to antenna distance of 3 meters and measurements above 1 GHz were performed at an EUT to antenna distance of 1 meter. Pre scans of the Airport Express transmitter above 1 GHz were performed using several data rates including 1 Mbps (802.11b mode), 6 Mbps and 54 Mbps (802.11g mode). During these pre-scans, it was determined that the worst case mode was with 1 Mbps and so this data rate was activated throughout the testing.

### Test Results

No non-compliance was found.

### **Restricted Bands**

The restricted bands at the lower and upper edges of the ISM band were scanned for the maximum emissions with the transmitter set to continuously transmit at corresponding low and highest channels. During pre-scans, it was found that using a 1 Mbps data rate represented the worst case and so this data rate was used.

The actual frequency range of the adjacent restricted bands is from 2310 MHz to 2390 MHz and from 2483.5 MHz to 2500 MHz. However, for testing purposes, the range was extended to allow maximizing on the intentional transmitter emissions.

### **Restricted Bands Instrument Settings**

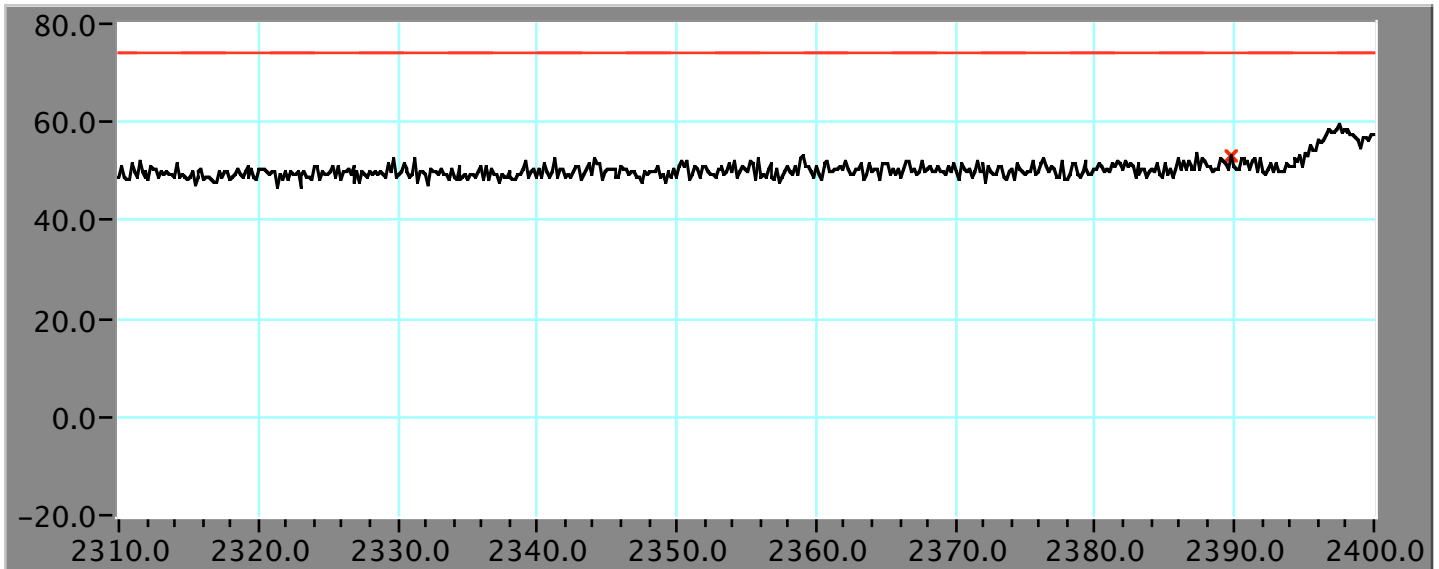
#### *Peak Measurements*

Frequency Range	Reference Level	Attenuation	Resolution BW	Video BW	Sweep Rate
2310-2400 MHz	80 dBuV/m	10 dB	1 MHz	1 MHz	5 mS
2475-2500 MHz	80 dBuV/m	10 dB	1 MHz	1 MHz	5 mS

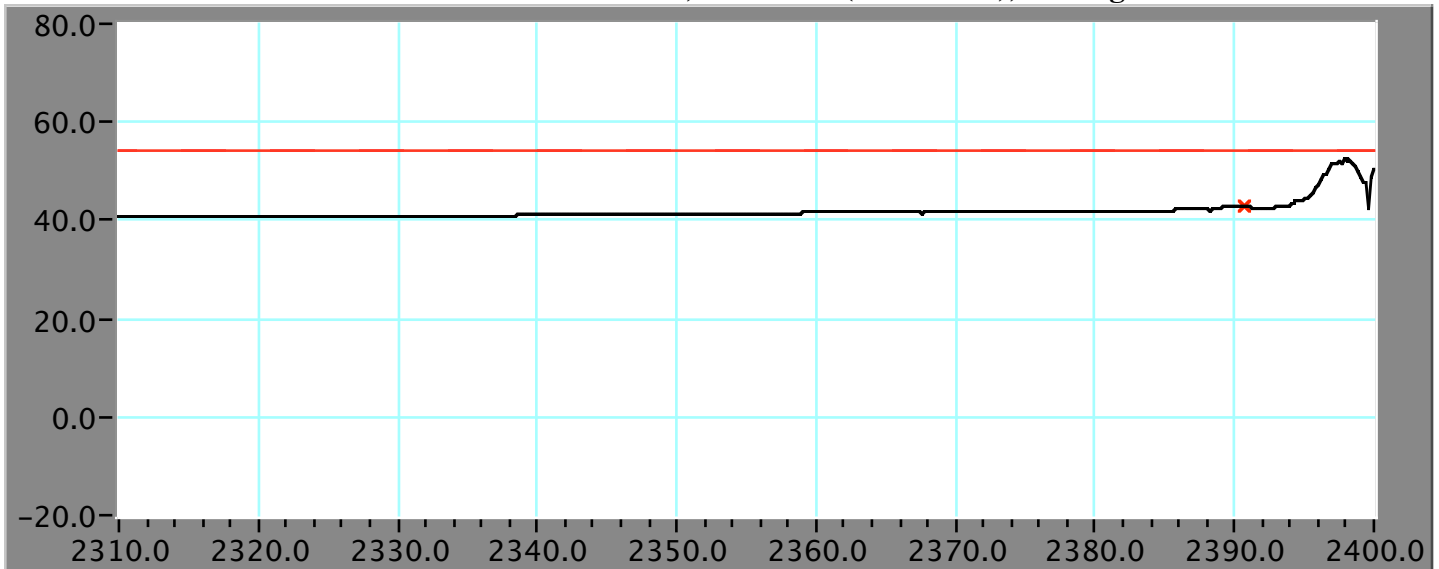
#### *Average Measurements*

Frequency Range	Reference Level	Attenuation	Resolution BW	Video BW	Sweep Rate
2310-2400 MHz	80 dBuV/m	10 dB	1 MHz	10 Hz	22.5 Seconds
2475-2500 MHz	80 dBuV/m	10 dB	1 MHz	10 Hz	6.4 Seconds

2310 MHz - 2390 MHz Restricted Band - Vertical, channel 1 (2.412 GHz), Peak Detection



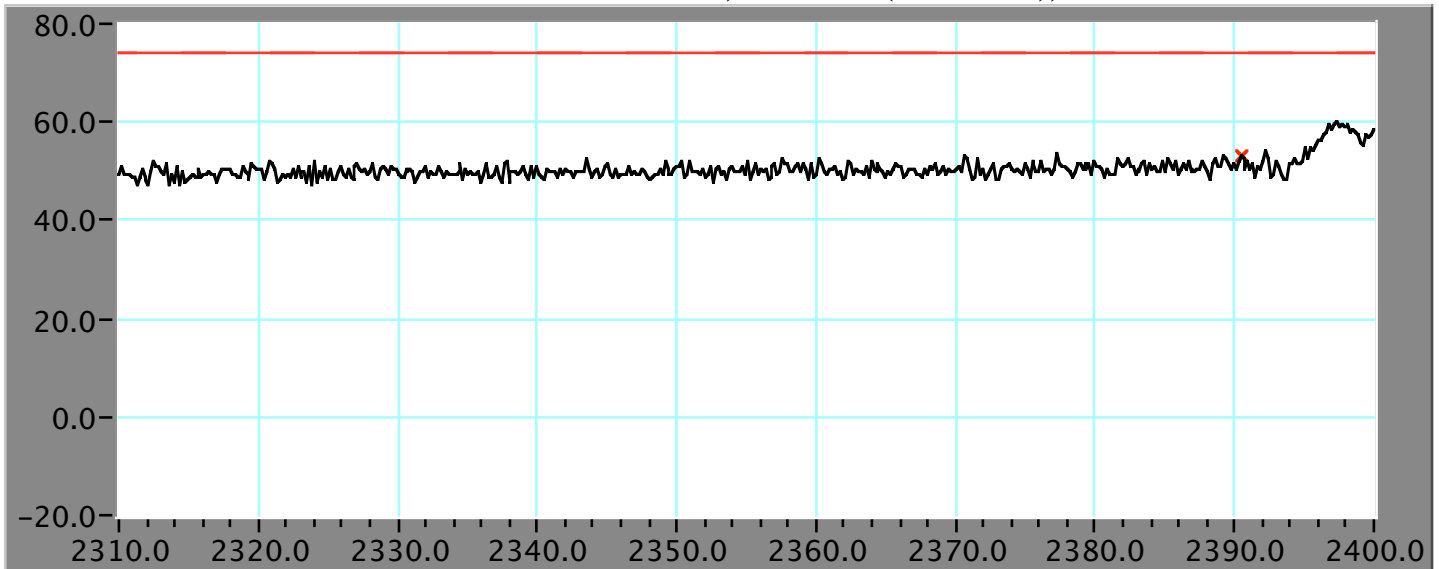
2310 MHz - 2390 MHz Restricted Band - Vertical, channel 1 (2.412 GHz), Average Detection



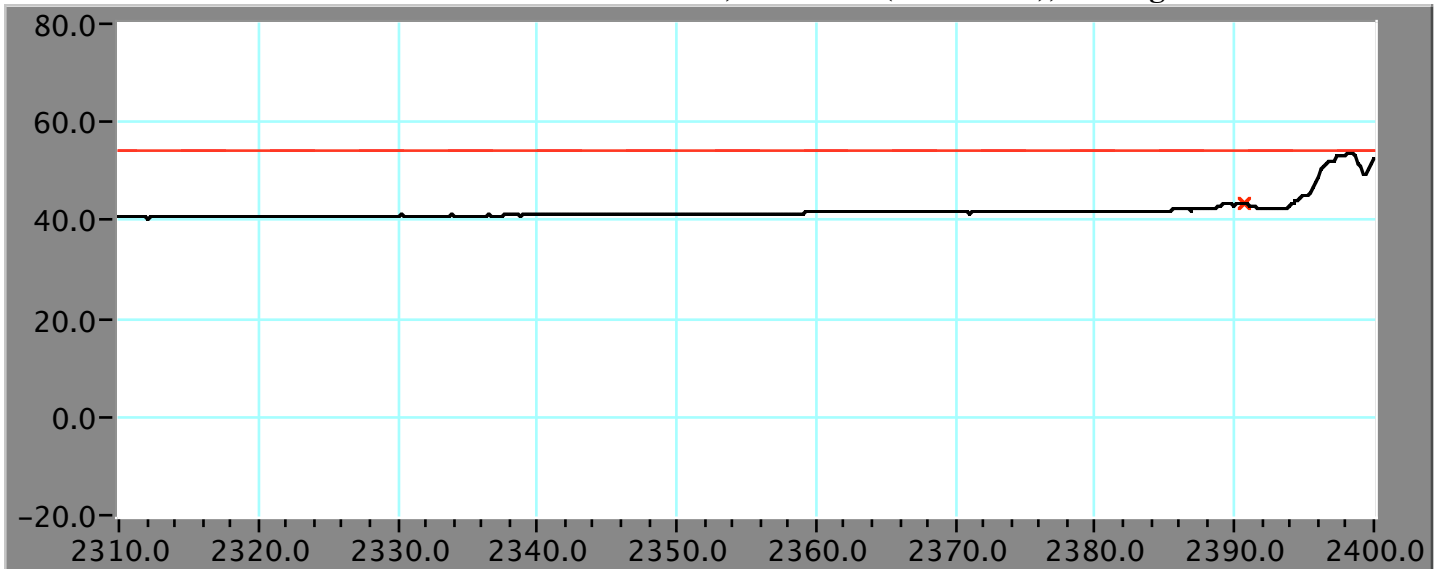
Frequency	Level	Limit	Delta	Raw Data	Antenna	Cable	Amp
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB
2389.72	53.1	74	-20.9	26.52	32.9	3.82	9.5
2390.8	43.1	54	-10.9	16.48	32.9	3.82	9.5

Date of Test: May 14, 2004

2310 MHz - 2390 MHz Restricted Band - Horizontal, channel 1 (2.412 GHz), Peak Detection



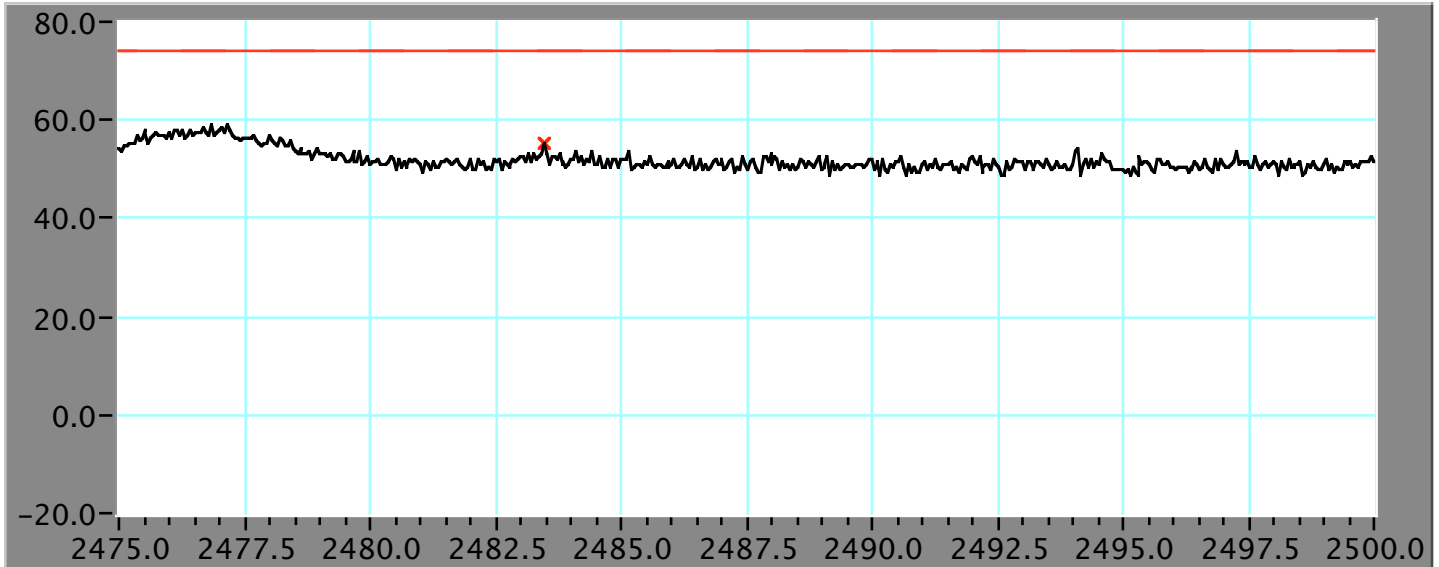
2310 MHz - 2390 MHz Restricted Band - Horizontal, channel 1 (2.412 GHz), Average Detection



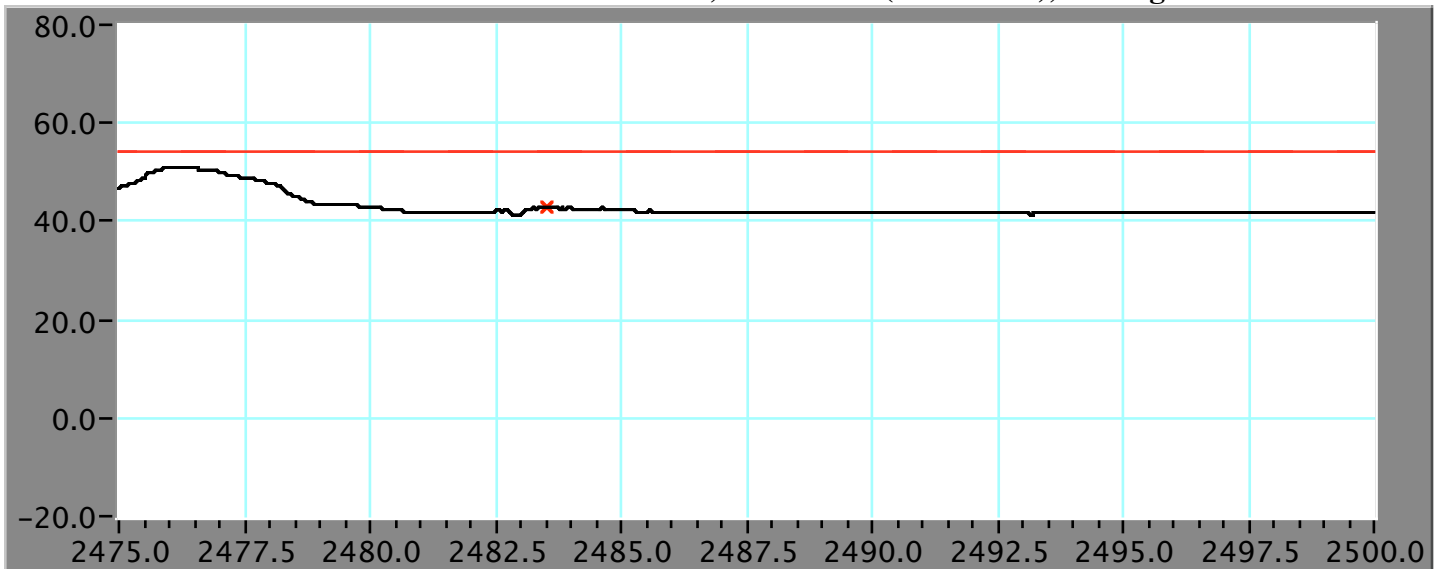
Frequency	Level	Limit	Delta	Raw Data	Antenna	Cable	Amp
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB
2390.44	53.3	74	-20.7	26.66	32.9	3.82	9.5
2390.8	43.7	54	-10.3	17.08	32.9	3.82	9.5

Date of Test: May 14, 2004

2483.5 MHz - 2500 MHz Restricted Band - Vertical, channel 11 (2.462 GHz), Peak Detection



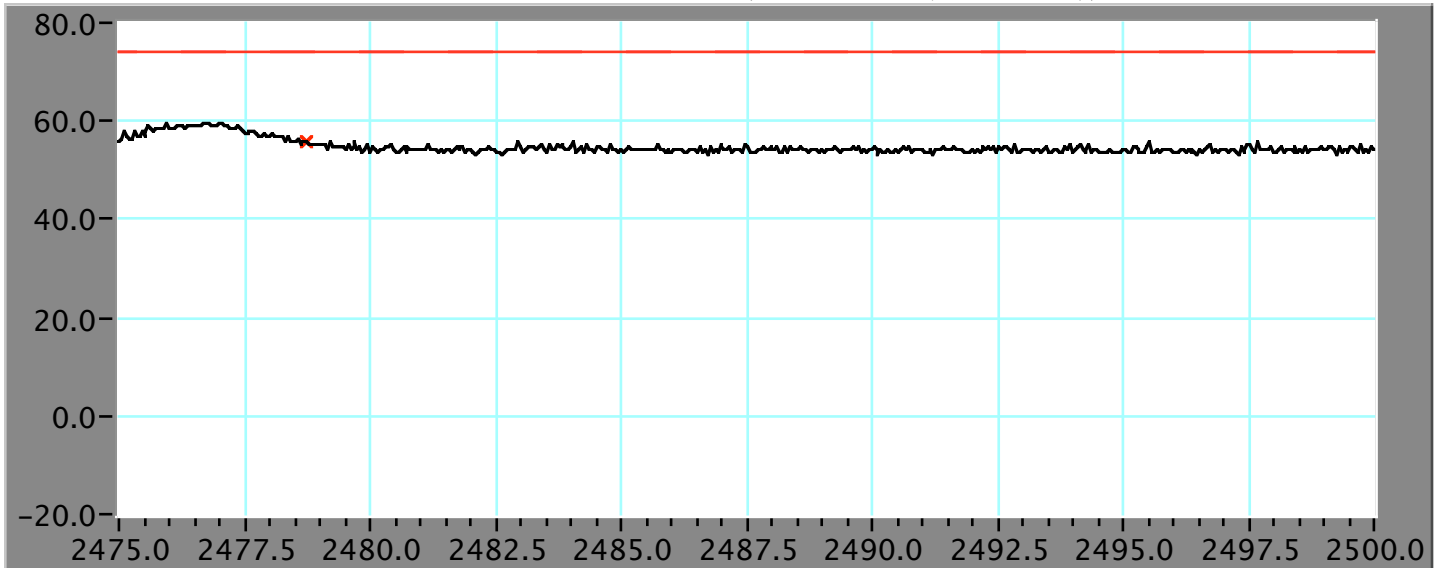
2483.5 MHz - 2500 MHz Restricted Band - Vertical, channel 11 (2.462 GHz), Average Detection



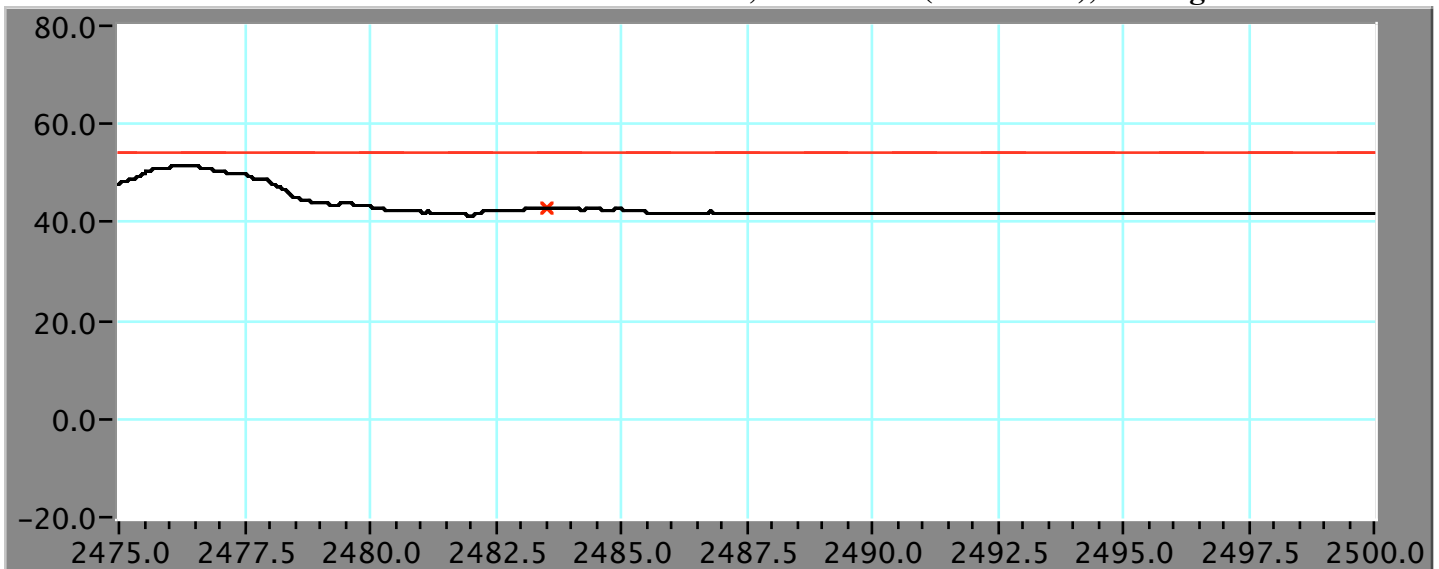
Frequency	Level	Limit	Delta	Raw Data	Antenna	Cable	Amp
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB
2483.47	53.3	74	-18.7	28.5	32.38	3.96	9.5
2483.52	43	54	-11	16.11	32.38	3.82	9.5

Date of Test: May 14, 2004

2483.5 MHz - 2500 MHz Restricted Band - Horizontal, channel 11 (2.462 GHz), Peak Detection



2483.5 MHz - 2500 MHz Restricted Band - Horizontal, channel 11 (2.462 GHz), Average Detection



Frequency	Level	Limit	Delta	Raw Data	Antenna	Cable	Amp
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB
2478.76	56	74	-18	29.17	32.38	3.96	9.5
2483.52	42.9	54	-11.1	16.04	32.38	3.82	9.5

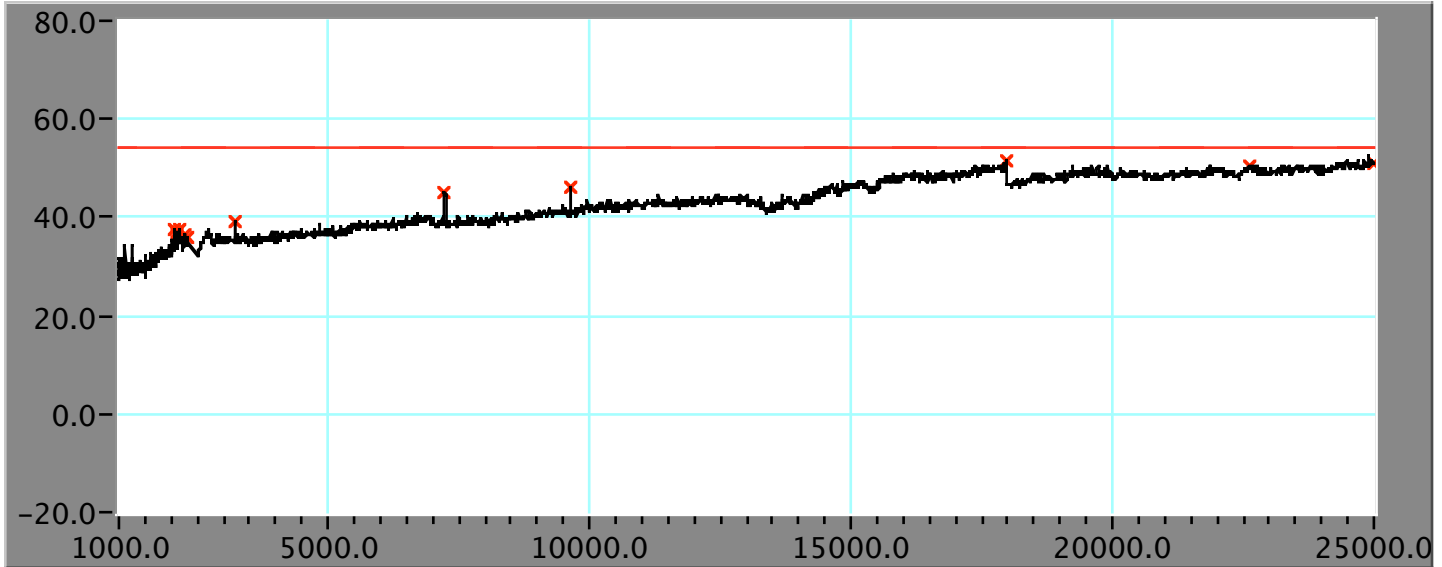
Date of Test: May 14, 2004



**Spurious Radiated Emissions above 1 GHz**

Radiated Emissions scans from 1 to 25 GHz for the low, mid and high channels were performed to demonstrate compliance with the restricted bands in CFR 47 Section 205(a). During pre-scans, it was found that using a 1 Mbps data rate represented the worst case and so this data rate was used throughout the spurious emissions scans above 1 GHz. The data from the Radiated Emissions scans are presented in the following pages.

**Vertical, channel 1 (2.412 GHz)**

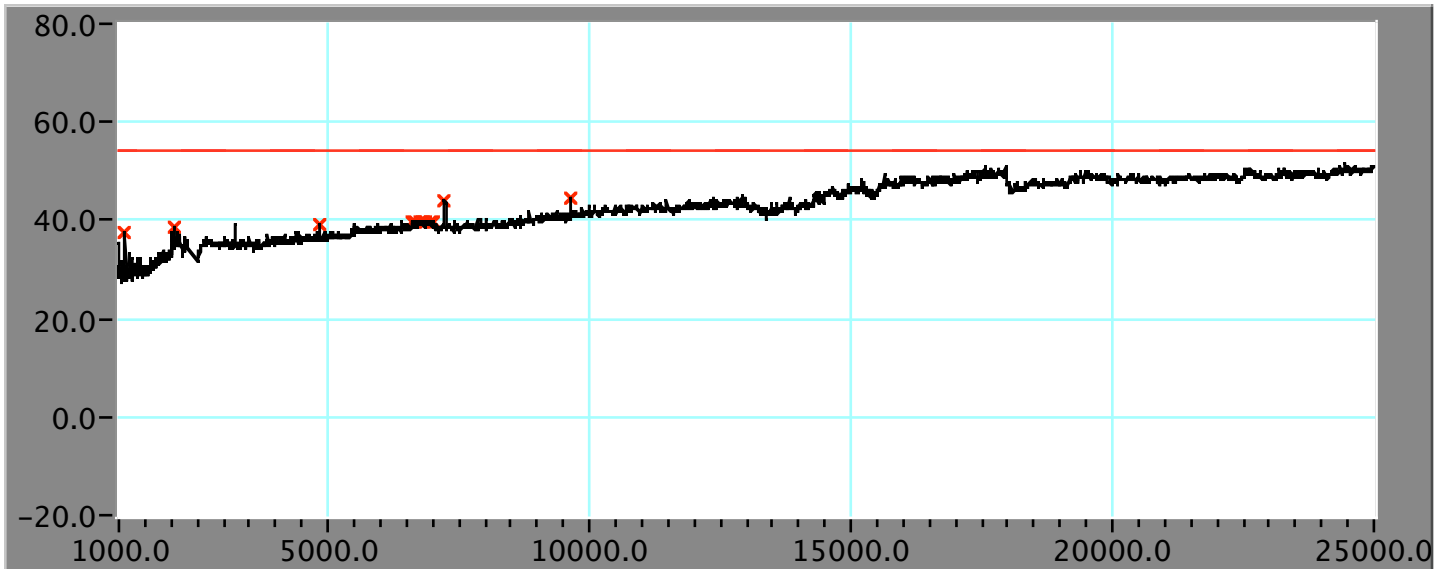


Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
2057.98	37.3	54.0	-16.7	47.22	31.96	1.66	43.54	9.92
2102.61	36.8	54.0	-17.2	46.72	32.00	1.70	43.62	9.92
2136.73	36.3	54.0	-17.7	46.22	32.04	1.71	43.70	9.95
2181.36	37.7	54.0	-16.3	47.45	32.08	1.71	43.54	9.74
2278.50	36.5	54.0	-17.5	46.23	32.18	1.79	43.67	9.70
2296.87	36.0	54.0	-18.0	45.66	32.20	1.78	43.66	9.69
3212.42	39.1	54.0	-14.9	47.74	33.36	2.15	44.12	8.61
7228.46	45.2	54.0	-8.8	49.87	36.11	3.60	44.42	4.71
9645.29	46.1	54.0	-7.9	49.67	37.59	3.99	45.18	3.60
18000.00	51.4	54.0	-2.6	46.36	41.90	7.66	44.55	-5.01
22615.23	50.6	54.0	-3.4	47.66	40.37	7.20	44.68	-2.89
25000.00	50.9	54.0	-3.1	47.50	40.46	7.48	44.56	-3.38

All levels are with a peak detector unless otherwise indicated.

Date of Test: May 14, 2004

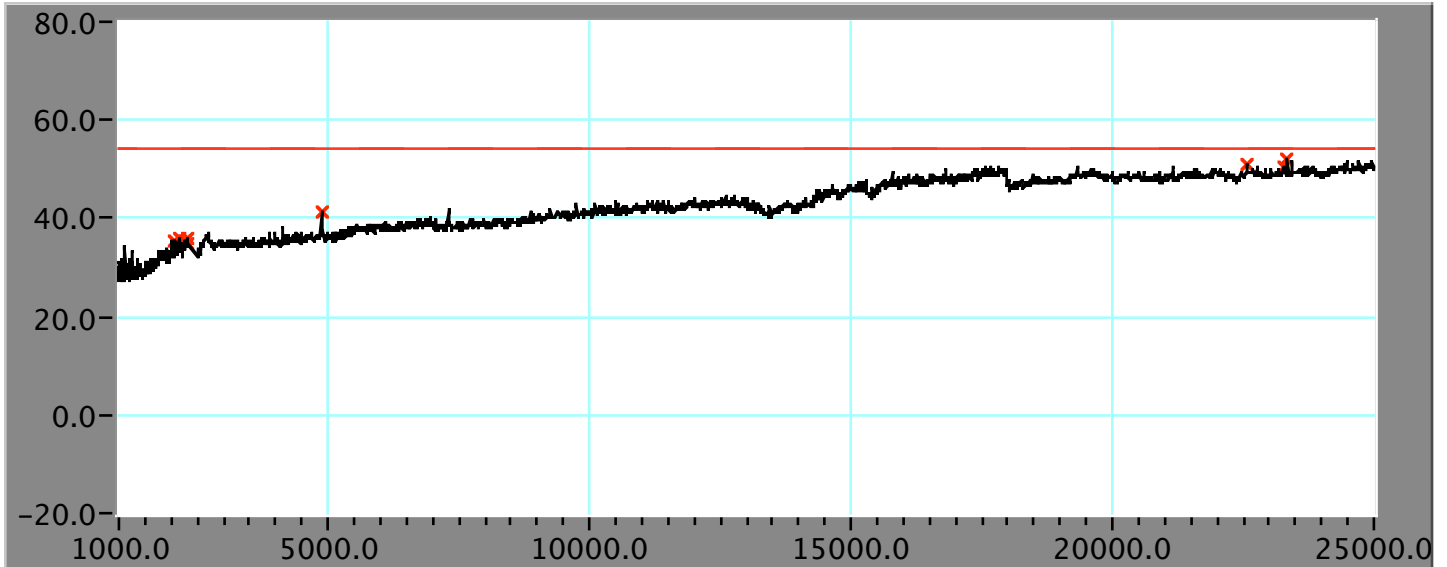
Horizontal, channel 1 (2.412 GHz)



Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
1126.01	37.6	54.0	-16.4	53.16	27.58	1.19	44.33	15.56
2050.10	38.4	54.0	-15.6	48.34	31.95	1.66	43.55	9.94
4826.65	39.3	54.0	-14.7	46.01	34.80	2.69	44.16	6.67
6603.21	39.5	54.0	-14.5	44.49	36.04	3.20	44.21	4.97
6657.31	39.7	54.0	-14.3	44.62	36.06	3.21	44.21	4.94
6738.48	39.8	54.0	-14.2	44.69	36.10	3.25	44.20	4.86
6792.58	39.7	54.0	-14.3	44.44	36.12	3.31	44.16	4.73
6873.75	39.5	54.0	-14.5	44.12	36.15	3.38	44.12	4.59
6936.87	39.6	54.0	-14.4	44.28	36.17	3.35	44.17	4.65
7000.00	39.5	54.0	-14.5	44.20	36.20	3.33	44.24	4.71
7228.46	44.1	54.0	-9.9	48.77	36.11	3.60	44.42	4.71
9645.29	44.6	54.0	-9.4	48.23	37.59	3.99	45.18	3.60

All levels are with a peak detector unless otherwise indicated.

Vertical Channel 6 (2.437 GHz)

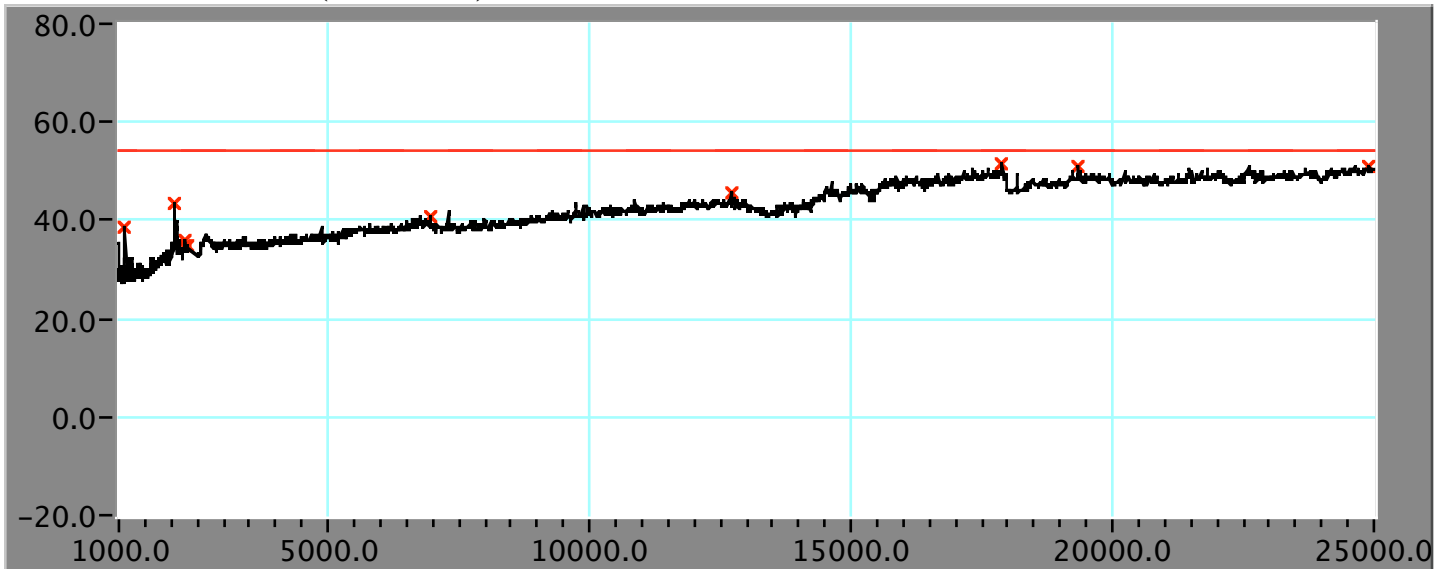


Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
2057.98	35.4	54.0	-18.6	45.34	31.96	1.66	43.54	9.92
2084.23	35.1	54.0	-18.9	45.01	31.98	1.68	43.56	9.90
2147.23	35.7	54.0	-18.3	45.56	32.05	1.71	43.65	9.90
2168.24	35.7	54.0	-18.3	45.48	32.07	1.71	43.54	9.76
2260.12	35.2	54.0	-18.8	45.01	32.16	1.77	43.72	9.79
2278.50	35.5	54.0	-18.5	45.19	32.18	1.79	43.67	9.70
2294.25	35.9	54.0	-18.1	45.56	32.19	1.78	43.66	9.69
2310.00	35.0	54.0	-19.0	44.68	32.21	1.77	43.67	9.68
4871.74	41.1	54.0	-12.9	47.68	34.82	2.69	44.13	6.61
22573.15	50.7	54.0	-3.3	47.92	40.37	7.17	44.72	-2.82
23260.52	50.5	54.0	-3.5	47.48	40.40	7.16	44.59	-2.97
23344.69	52.2	54.0	-1.8	49.06	40.40	7.19	44.45	-3.14

All levels are with a peak detector unless otherwise indicated.

Date of Test: May 14, 2004

Horizontal Channel 6 (2.437 GHz)

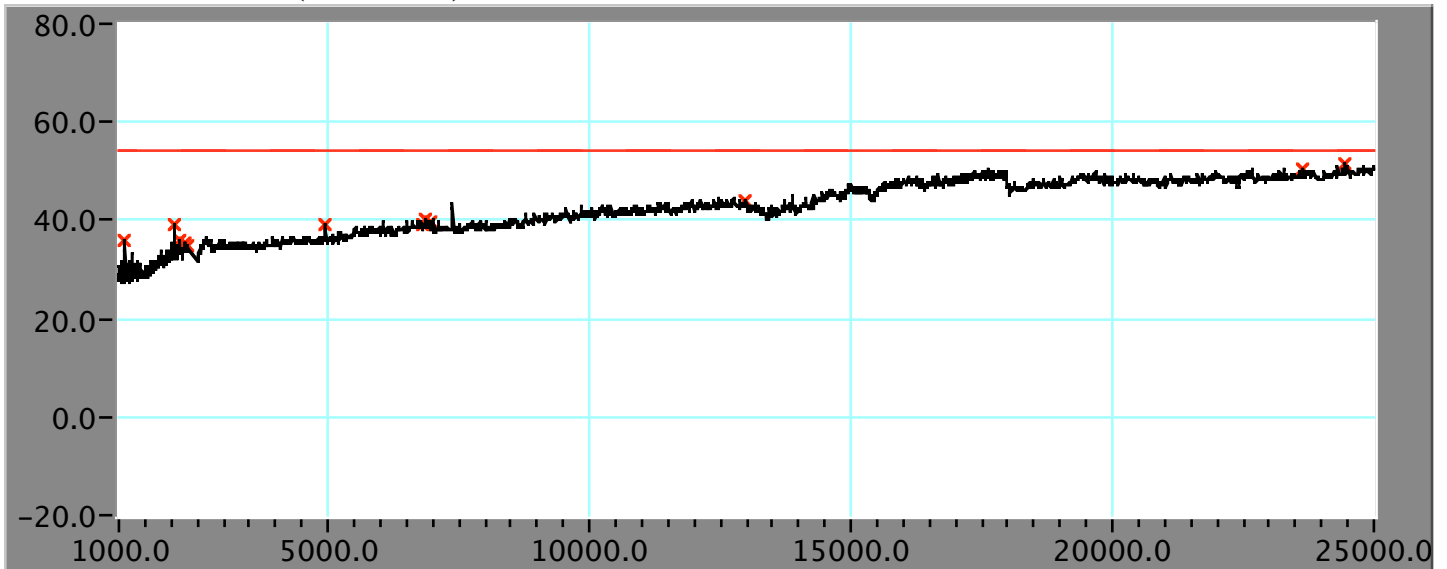


Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
1123.39	38.7	54.0	-15.3	54.29	27.57	1.19	44.34	15.58
2050.10	43.5	54.0	-10.5	53.40	31.95	1.66	43.55	9.94
2246.99	34.7	54.0	-19.3	44.54	32.15	1.76	43.76	9.86
2262.75	35.0	54.0	-19.0	44.76	32.16	1.77	43.72	9.78
2281.12	35.8	54.0	-18.2	45.47	32.18	1.79	43.66	9.69
2304.75	34.8	54.0	-19.2	44.50	32.20	1.78	43.67	9.68
6963.93	40.6	54.0	-13.4	45.25	36.19	3.34	44.20	4.67
12699.40	45.5	54.0	-8.5	45.82	39.22	5.31	44.88	0.35
17899.80	51.3	54.0	-2.7	46.28	42.00	7.52	44.53	-4.99
19346.69	50.7	54.0	-3.3	46.84	40.25	8.39	44.73	-3.91
24915.83	51.0	54.0	-3.0	47.73	40.46	7.46	44.66	-3.27

All levels are with a peak detector unless otherwise indicated.

Date of Test: May 14, 2004

Vertical Channel 11 (2.462 GHz)

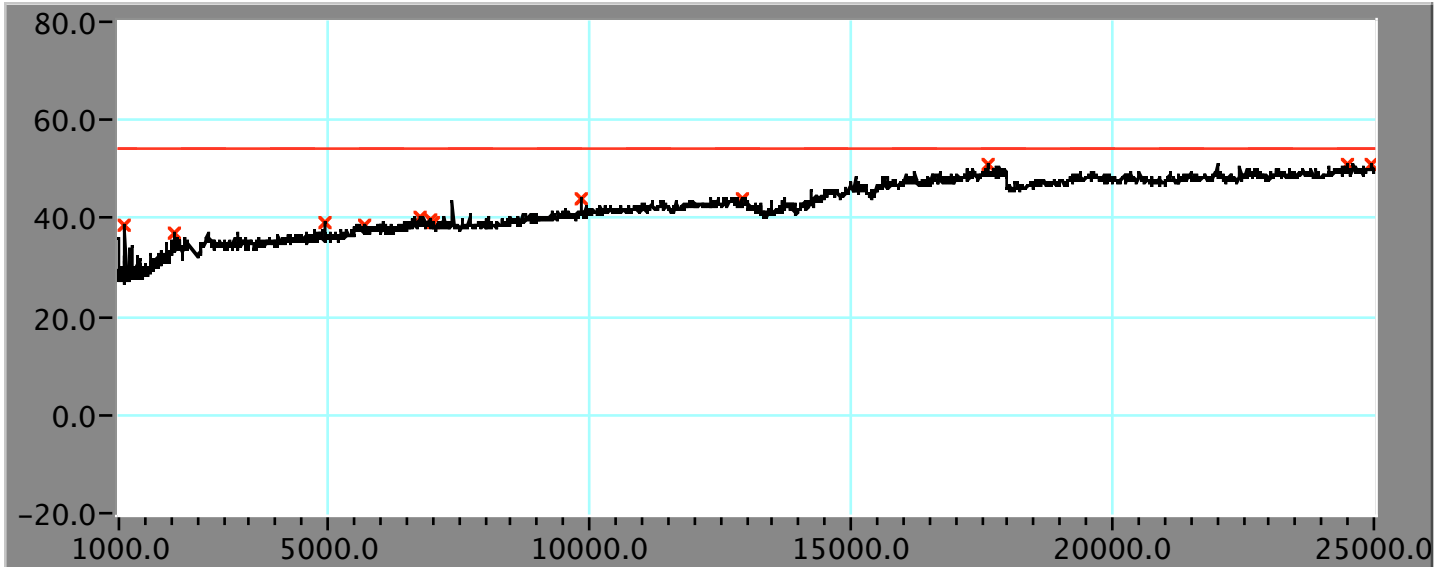


Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
1126.01	35.7	54.0	-18.3	51.28	27.58	1.19	44.33	15.56
2076.35	39.1	54.0	-14.9	49.01	31.98	1.67	43.54	9.90
2162.99	35.8	54.0	-18.2	45.64	32.06	1.71	43.57	9.80
2270.62	35.1	54.0	-18.9	44.88	32.17	1.78	43.69	9.74
2307.37	34.9	54.0	-19.1	44.54	32.21	1.78	43.67	9.68
4925.85	39.1	54.0	-14.9	45.63	34.86	2.71	44.06	6.49
6819.64	39.4	54.0	-14.6	44.03	36.13	3.35	44.13	4.66
6882.77	40.0	54.0	-14.0	44.58	36.15	3.38	44.13	4.60
6963.93	39.6	54.0	-14.4	44.28	36.19	3.34	44.20	4.67
12987.98	43.9	54.0	-10.1	43.86	39.39	5.34	44.75	0.01
23653.31	50.6	54.0	-3.4	47.43	40.41	7.23	44.47	-3.18
24438.88	51.3	54.0	-2.7	48.42	40.44	7.35	44.87	-2.91

All levels are with a peak detector unless otherwise indicated.

Date of Test: May 14, 2004

Horizontal Channel 11 (2.462 GHz)



Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
1126.01	38.4	54.0	-15.6	53.99	27.58	1.19	44.33	15.56
2055.35	37.0	54.0	-17.0	46.94	31.96	1.66	43.54	9.93
4925.85	39.1	54.0	-14.9	45.60	34.86	2.71	44.06	6.49
5719.44	38.6	54.0	-15.4	44.26	35.38	2.96	43.99	5.65
6765.53	40.0	54.0	-14.0	44.84	36.11	3.28	44.18	4.80
6936.87	39.7	54.0	-14.3	44.39	36.17	3.35	44.17	4.65
6990.98	38.9	54.0	-15.1	43.63	36.20	3.33	44.23	4.70
9849.70	43.7	54.0	-10.3	46.89	37.71	4.38	45.23	3.15
12903.81	43.8	54.0	-10.2	43.89	39.34	5.36	44.79	0.08
17619.24	50.8	54.0	-3.2	45.89	42.28	7.23	44.65	-4.87
24494.99	50.8	54.0	-3.2	47.96	40.44	7.37	44.93	-2.88
24957.92	51.1	54.0	-2.9	47.81	40.46	7.47	44.61	-3.32

All levels are with a peak detector unless otherwise indicated.

Date of Test: May 14, 2004

### Radiated Emissions less than 1 GHz Test Procedure

The frequency spectrum from 30 MHz to 1 GHz was scanned and the emission levels maximized at each frequency recorded. The antenna was varied in height between 1.0 and 4.0 meters and the system was rotated 360 degrees while scanning for maximum emission amplitudes. This procedure was performed for both horizontal and vertical polarization of the receiving antenna. During maximization the position of the cables was varied and the scanning repeated until the worst case emission was found. The data recorded in this report are the maximum emission levels measured. Pre scans were performed using the low, mid and high channel. No difference in the emissions was found. The data presented is with channel 1.

Radiated Emission measurements at or below 1 GHz were performed at an EUT to antenna distance of 3 meters.

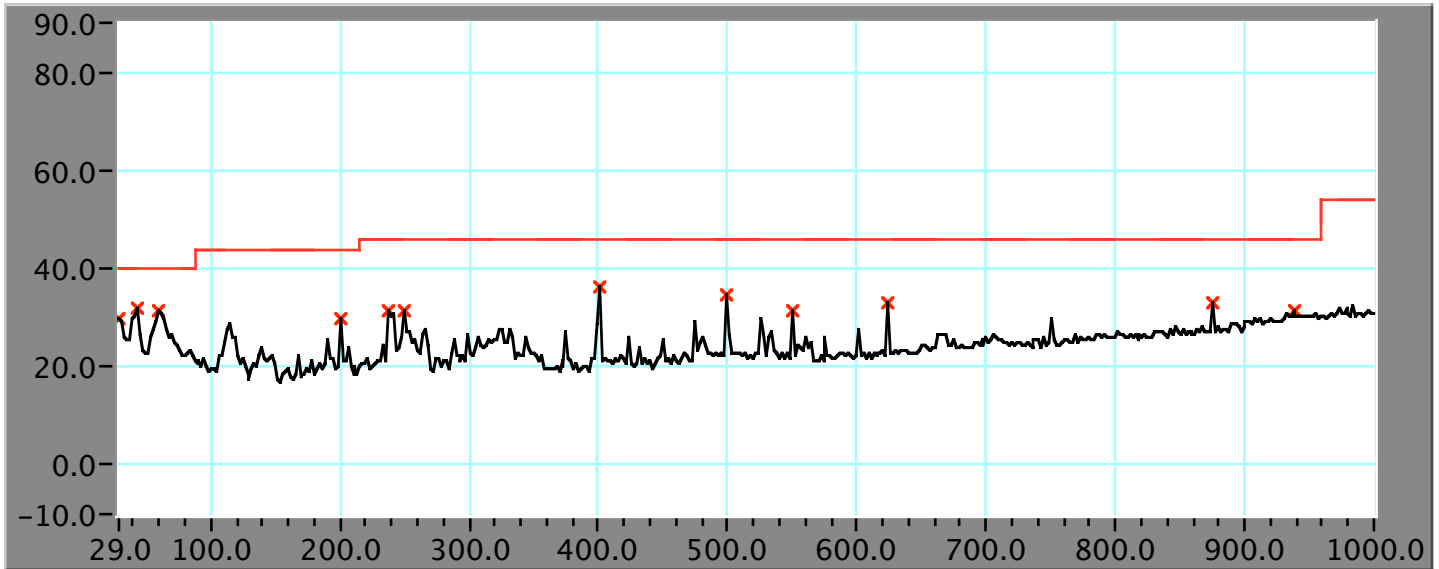
### Radiated Emissions less than 1 GHz Instrument Settings:

Instrument Settings				
Frequency Range	Reference Level	Attenuation	Resolution BW	Video BW
30 MHz - 1 GHz	90 dBuV	10	100 kHz	100 kHz

**Radiated Emissions less than 1 GHz**

The data below was collected with a transmitter frequency of 2.412 GHz which is the lowest channel.

**Radiated Emissions Data less than 1 GHz. Vertical 802.11b mode Channel 1**

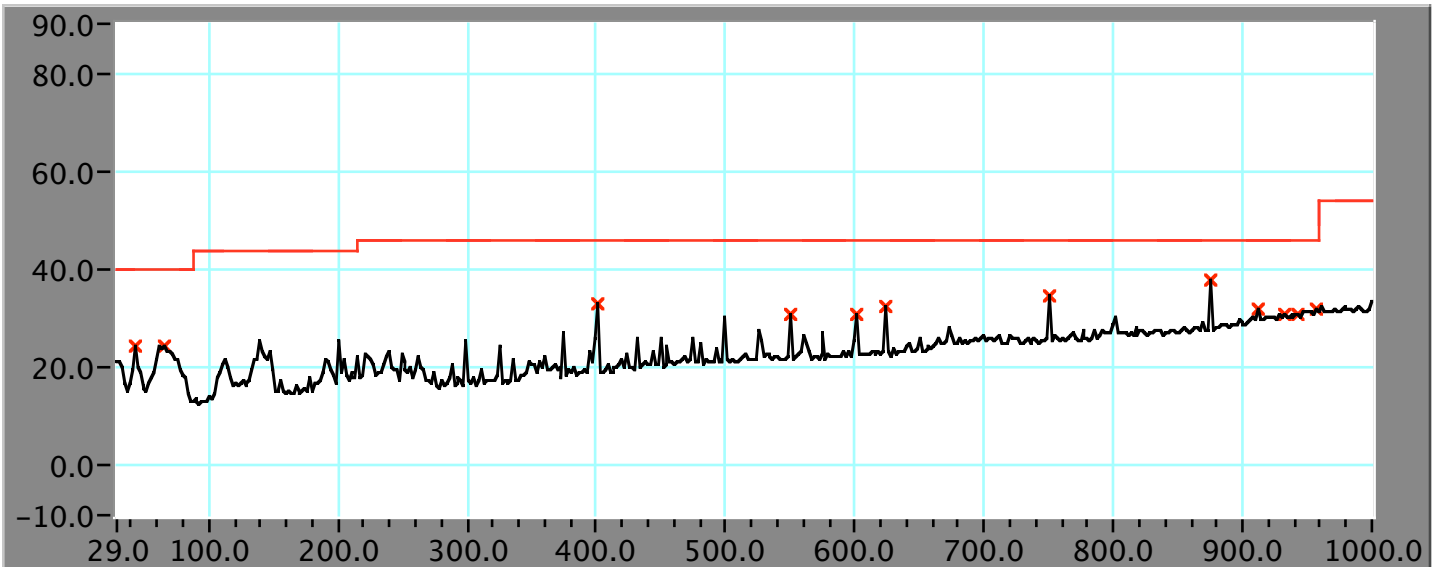


Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
29.00	29.6	40.0	-10.4	40.25	21.55	1.17	33.42	10.70
42.62	32.0	40.0	-8.0	52.43	11.55	1.37	33.32	20.41
60.13	31.2	40.0	-8.8	56.08	6.70	1.60	33.19	24.89
200.24	30.0	43.5	-13.5	47.88	12.07	2.88	32.84	17.89
237.21	31.4	46.0	-14.6	48.91	12.20	3.15	32.88	17.53
248.89	31.4	46.0	-14.6	48.72	12.31	3.23	32.89	17.35
400.67	36.3	46.0	-9.7	49.22	15.73	4.23	32.90	12.93
499.91	34.4	46.0	-11.6	44.84	18.00	4.84	33.25	10.41
550.50	31.2	46.0	-14.8	41.41	18.00	5.14	33.34	10.21
624.44	33.1	46.0	-12.9	41.92	19.34	5.54	33.71	8.83
875.46	33.0	46.0	-13.0	37.87	21.70	7.09	33.65	4.86
937.73	31.2	46.0	-14.8	33.91	22.80	7.50	32.99	2.69

Date of Test: May 26, 2004



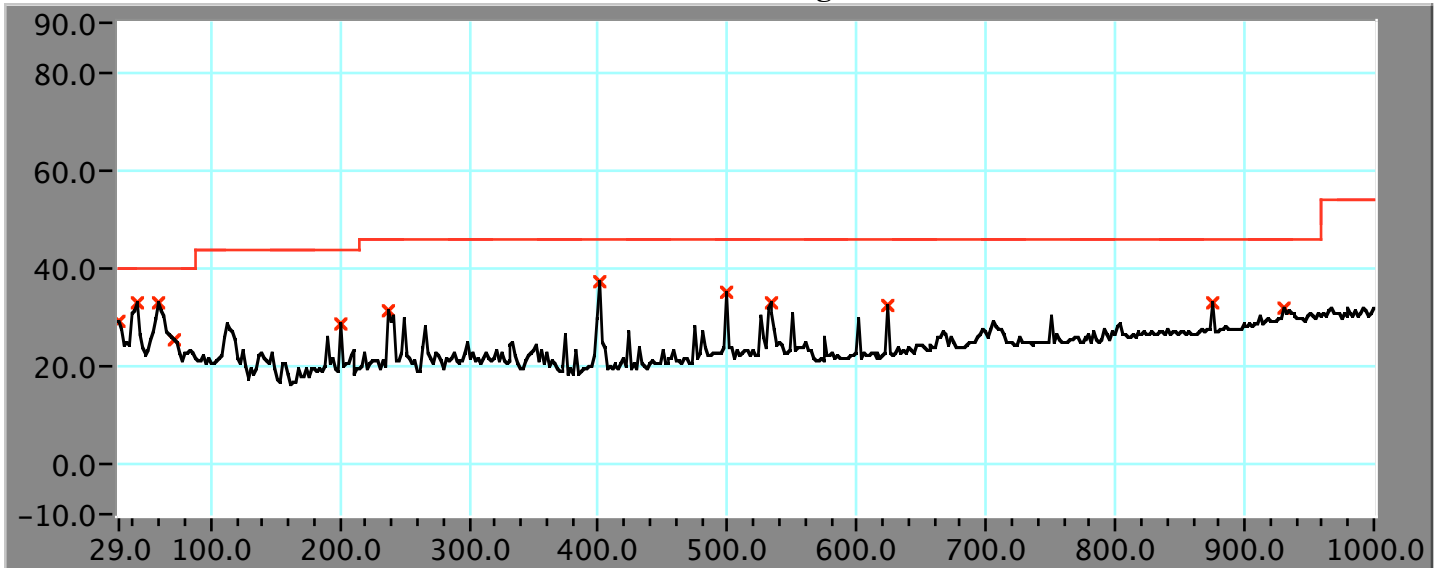
Radiated Emissions Data less than 1 GHz. Horizontal 802.11b mode. Channel 1



Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
42.62	24.7	40.0	-15.3	43.83	12.80	1.37	33.32	19.16
65.97	24.6	40.0	-15.4	47.79	8.37	1.67	33.18	23.14
400.67	33.1	46.0	-12.9	45.59	16.21	4.23	32.90	12.45
550.50	30.7	46.0	-15.3	40.18	18.76	5.14	33.34	9.45
601.09	30.7	46.0	-15.3	39.27	19.50	5.41	33.47	8.56
624.44	32.7	46.0	-13.3	41.28	19.60	5.54	33.71	8.57
750.93	34.5	46.0	-11.5	40.39	21.68	6.28	33.81	5.85
875.46	38.1	46.0	-7.9	42.15	22.50	7.09	33.65	4.06
912.43	31.7	46.0	-14.3	34.46	23.20	7.34	33.31	2.77
931.89	31.1	46.0	-14.9	33.42	23.26	7.46	33.06	2.34
943.57	30.9	46.0	-15.1	33.05	23.20	7.54	32.93	2.19
957.19	32.0	46.0	-14.0	33.39	23.73	7.63	32.78	1.42

Date of Test: May 26, 2004

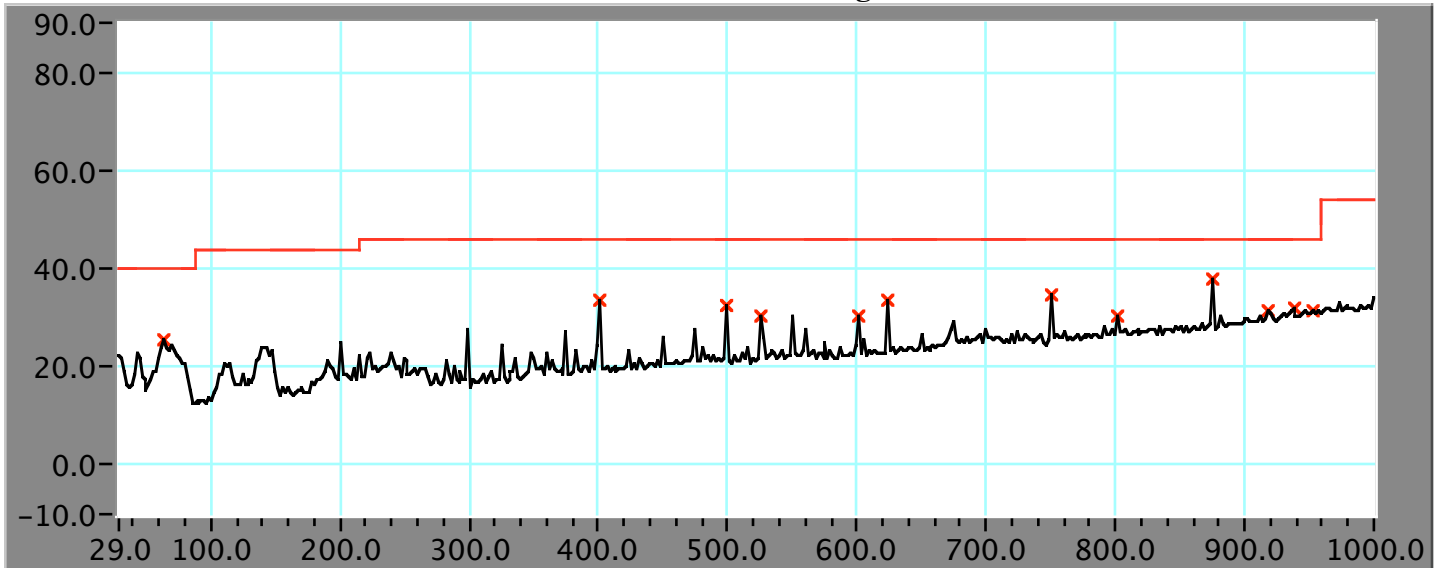
Radiated Emissions Data less than 1 GHz. Vertical 802.11g mode Channel 1



Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
29.00	29.0	40.0	-11.0	39.68	21.55	1.17	33.42	10.70
42.62	32.9	40.0	-7.1	53.35	11.55	1.37	33.32	20.41
60.13	32.9	40.0	-7.1	57.77	6.70	1.60	33.19	24.89
71.81	25.6	40.0	-14.4	49.82	7.18	1.72	33.15	24.25
200.24	28.8	43.5	-14.7	46.73	12.07	2.88	32.84	17.89
237.21	31.6	46.0	-14.4	49.14	12.20	3.15	32.88	17.53
400.67	37.6	46.0	-8.4	50.49	15.73	4.23	32.90	12.93
499.91	34.9	46.0	-11.1	45.31	18.00	4.84	33.25	10.41
532.99	32.9	46.0	-13.1	43.33	17.87	5.03	33.33	10.43
624.44	32.5	46.0	-13.5	41.32	19.34	5.54	33.71	8.83
875.46	32.8	46.0	-13.2	37.71	21.70	7.09	33.65	4.86
929.95	32.0	46.0	-14.0	35.03	22.60	7.45	33.09	3.04

Date of Test: May 26, 2004

Radiated Emissions Data less than 1 GHz. Horizontal 802.11g mode Channel 1



Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	Amp dB	All Factor dB
64.03	25.3	40.0	-14.7	48.62	8.20	1.64	33.19	23.35
400.67	33.4	46.0	-12.6	45.87	16.21	4.23	32.90	12.45
499.91	32.3	46.0	-13.7	42.49	18.22	4.84	33.25	10.19
525.20	30.4	46.0	-15.6	40.15	18.60	4.99	33.30	9.71
601.09	30.4	46.0	-15.6	38.93	19.50	5.41	33.47	8.56
624.44	33.4	46.0	-12.6	41.93	19.60	5.54	33.71	8.57
750.93	34.8	46.0	-11.2	40.64	21.68	6.28	33.81	5.85
801.52	30.4	46.0	-15.6	35.91	21.80	6.60	33.88	5.49
875.46	38.0	46.0	-8.0	42.07	22.50	7.09	33.65	4.06
918.27	31.3	46.0	-14.7	33.82	23.30	7.37	33.23	2.56
937.73	31.9	46.0	-14.1	34.15	23.20	7.50	32.99	2.29
953.30	31.6	46.0	-14.4	33.36	23.48	7.61	32.82	1.74

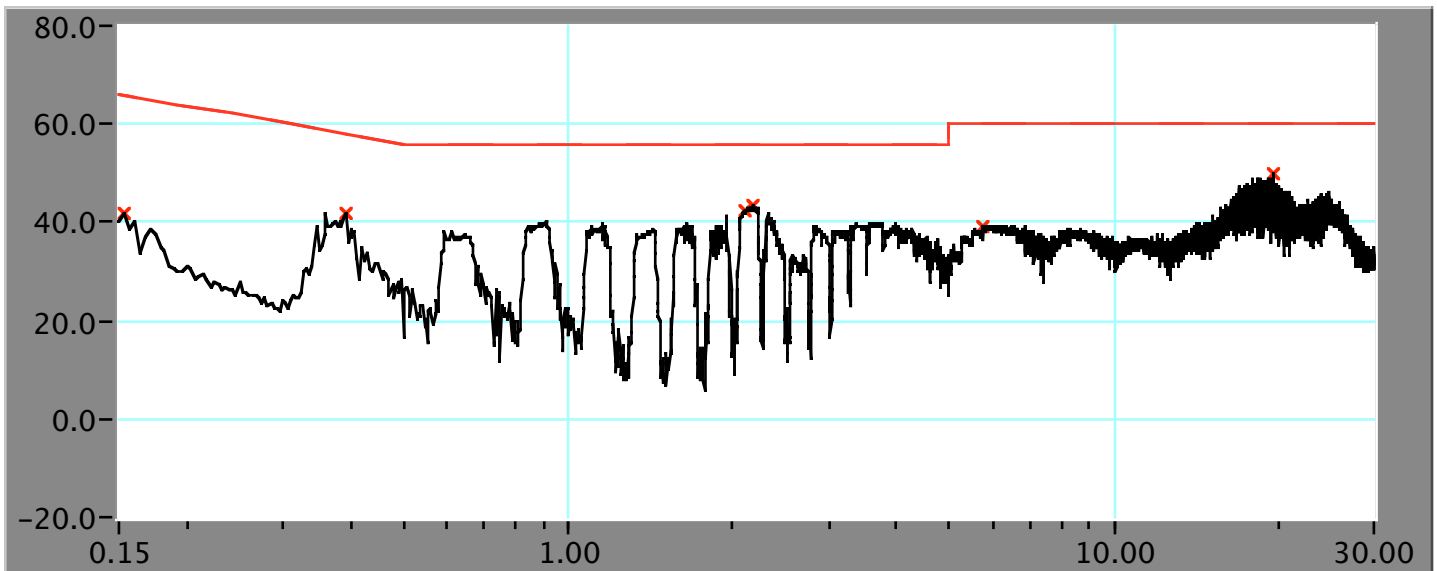
Date of Test: May 26, 2004

## 7.8 AC Power Line Conducted Emissions

### AC Power Line Emissions Test Procedure

The frequency spectrum from 150 kHz to 30 Hz was scanned on the ac power mains on both line 1 and line 2. Both peak and average detectors were employed. Because none of the peak emissions exceeded the Quasi-Peak emissions were not recorded. The data presented is with channel 1.

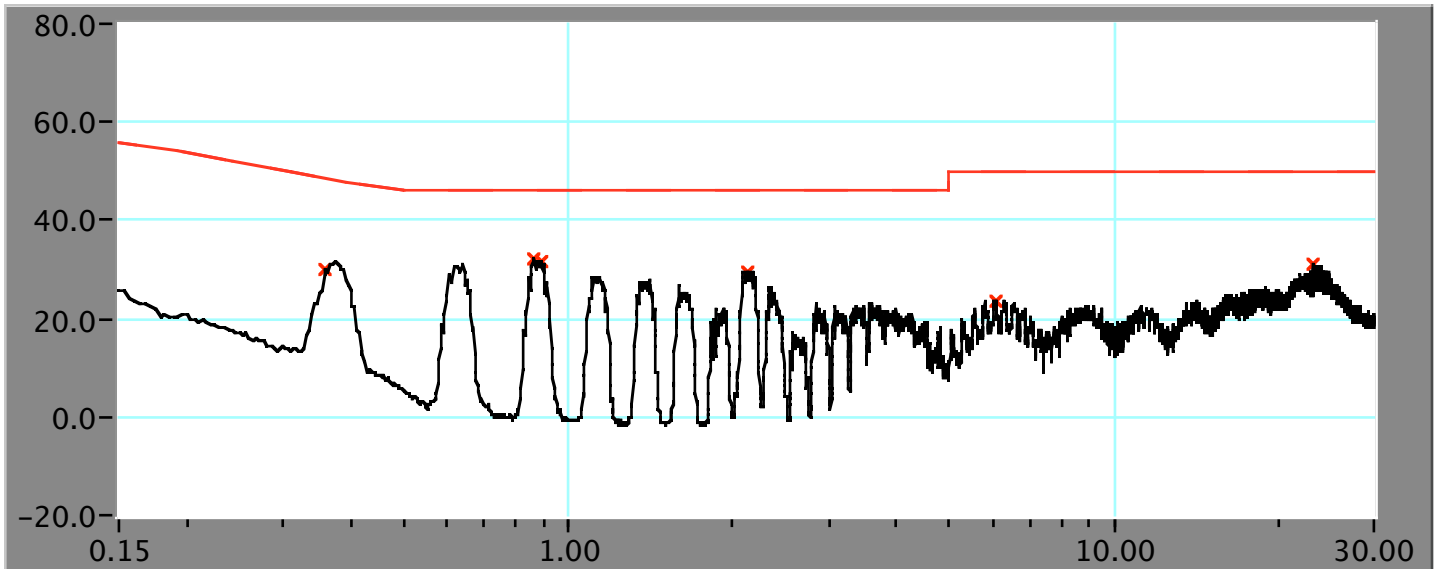
### AC Power Line Emissions Line 1 Peak Detector



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	Xducer dB	All Factor dB
0.154	42.0	65.8	-23.8	39.42	2.48	0.06	0.00	-2.54
0.392	41.7	58.0	-16.3	40.69	0.92	0.07	0.00	-0.99
2.119	42.3	56.0	-13.7	41.83	0.34	0.14	0.00	-0.48
2.179	43.2	56.0	-12.8	42.74	0.34	0.15	0.00	-0.48
5.765	39.3	60.0	-20.7	38.76	0.33	0.24	0.00	-0.57
19.587	49.9	60.0	-10.1	48.78	0.66	0.45	0.00	-1.11

Date of Test: May 19, 2004

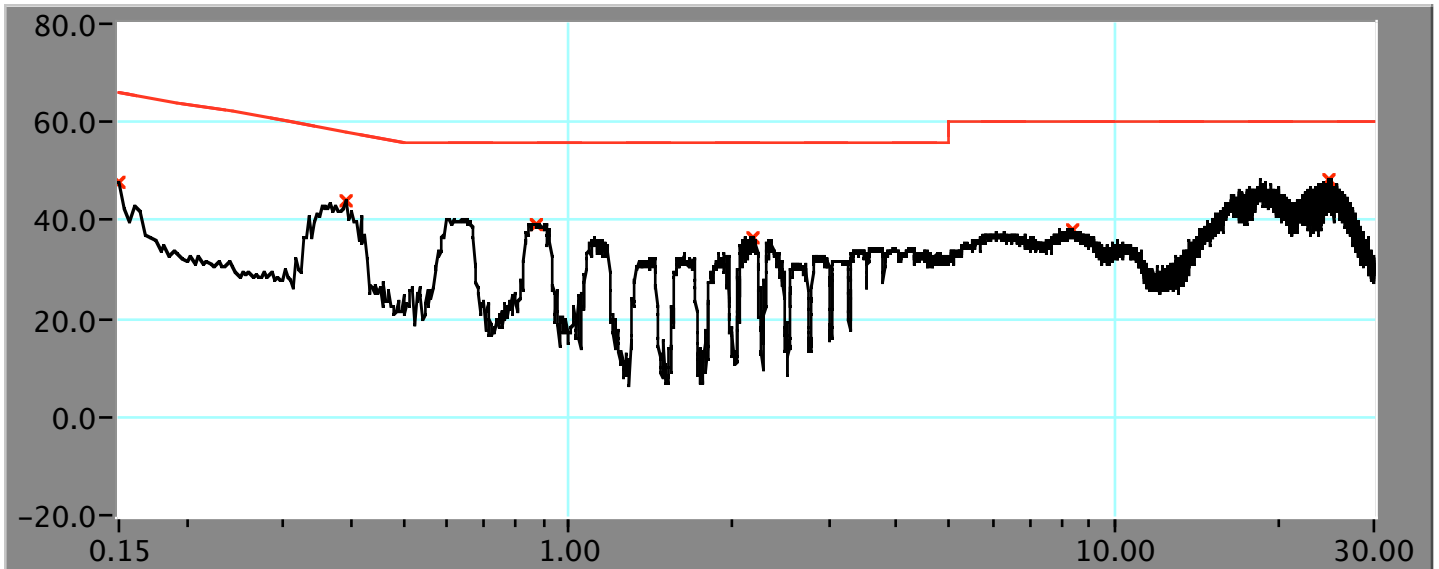
AC Power Line Emissions Line 1 Average Detector



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	Xducer dB	All Factor dB
0.360	29.8 Av	48.7	-18.9	28.75	1.02	0.07	0.00	-1.09
0.868	32.2 Av	46.0	-13.8	31.66	0.46	0.09	0.00	-0.55
0.893	31.6 Av	46.0	-14.4	31.11	0.45	0.09	0.00	-0.54
2.130	29.7 Av	46.0	-16.3	29.23	0.34	0.14	0.00	-0.48
6.082	23.7 Av	50.0	-26.3	23.06	0.35	0.25	0.00	-0.60
23.233	30.8 Av	50.0	-19.2	29.51	0.83	0.49	0.00	-1.33

Date of Test: May 19, 2004

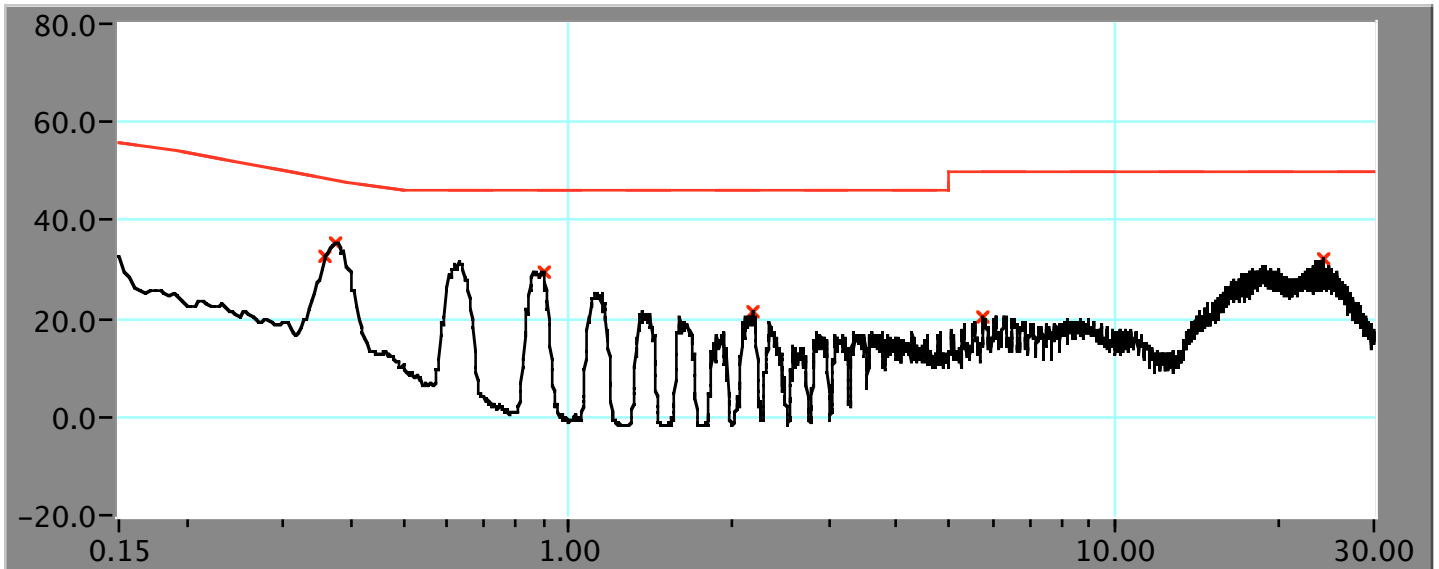
AC Power Line Emissions Line 2 Peak Detector



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	Xducer dB	All Factor dB
0.150	47.9	66.0	-18.1	45.34	2.45	0.06	0.00	-2.51
0.392	43.9	58.0	-14.1	42.95	0.90	0.07	0.00	-0.97
0.879	39.3	56.0	-16.7	38.77	0.43	0.09	0.00	-0.52
2.176	36.4	56.0	-19.6	35.96	0.30	0.15	0.00	-0.45
8.438	38.0	60.0	-22.0	37.32	0.42	0.28	0.00	-0.71
24.797	48.4	60.0	-11.6	46.84	1.07	0.51	0.00	-1.58

Date of Test: May 19, 2004

AC Power Line Emissions Line 2 Average Detector



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	Xducer dB	All Factor dB
0.360	32.8 Av	48.7	-15.9	31.72	1.01	0.07	0.00	-1.08
0.374	35.2 Av	48.4	-13.2	34.19	0.96	0.07	0.00	-1.03
0.900	29.5 Av	46.0	-16.5	29.00	0.41	0.09	0.00	-0.50
2.176	21.4 Av	46.0	-24.6	20.92	0.30	0.15	0.00	-0.45
5.776	20.3 Av	50.0	-29.7	19.76	0.33	0.24	0.00	-0.57
24.267	32.1 Av	50.0	-17.9	30.62	0.96	0.50	0.00	-1.46

Date of Test: May 19, 2004