



**FCC CFR47 PART 15 SUBPART C  
INDUSTRY CANADA RSS-210 ISSUE 7**

**CERTIFICATION TEST REPORT**

**FOR**

**Wi-Fi 802.11 b/g**

**MODEL NUMBER: A1213**

**FCC ID: BCGA1213**

**IC: 579C-A1213**

**REPORT NUMBER: 07U11180-1**

**ISSUE DATE: AUGUST 24, 2007**

*Prepared for*

**APPLE INC.**

**1 INFINITE LOOP**

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**NVLAP LAB CODE 200065-0**

Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
--	08/24/07	Initial Issue	Frank Ibrahim

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE INC.  
1 INFINITE LOOP  
CUPERTINO, CA 95014, USA

**EUT DESCRIPTION:** Wi-Fi 802.11 b/g

**MODEL:** A1213

**SERIAL NUMBER:** 9C72609DDV1

**DATE TESTED:** July 18 - 22, 2007

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 15 SUBPART C	NO NON-COMPLIANCE NOTED
IC RSS-210 ISSUE 7 ANNEX 8	NO NON-COMPLIANCE NOTED

Compliance Certification Services, Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By:

Tested By:



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FRANK IBRAHIM  
EMC SUPERVISOR  
COMPLIANCE CERTIFICATION SERVICES

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TOM CHEN  
EMC ENGINEER  
COMPLIANCE CERTIFICATION SERVICES

## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 2 and RSS-210 Issue 7.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://www.ccsemc.com>.

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Radiated Emission, 30 to 200 MHz	+/- 3.3 dB
Radiated Emission, 200 to 1000 MHz	+4.5 / -2.9 dB
Radiated Emission, 1000 to 2000 MHz	+4.5 / -2.9 dB
Power Line Conducted Emission	+/- 2.9 dB

Uncertainty figures are valid to a confidence level of 95%.

## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

The EUT is an 802.11 b/g wireless LAN PCI-E mini card that utilizes an integral antenna for diversity, with a maximum gain of 1.9 dBi.

### 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

2400 to 2483.5 MHz Authorized Band

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2412 - 2462	802.11b	18.80	75.86
2412 - 2462	802.11g	18.99	79.25

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a monopole antenna with a maximum gain of 1.9 dBi.

### 5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 8.108.3.p61, Snowbird3A53.

The test utility software used during testing was Marvell Labtool UART8686 Labtool GUI, rev. 1.03.

### 5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case channel is determined as the channel with the highest output power. The highest measured output power was on the mid channel in the 802.11g mode.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	Manufacturer	Model	Serial Number
Laptop PC	Apple	Mac book	AOU268504
AC/DC Adapter	Apple	A1205	RR609002LUDM1
EXT. Board	Apple	N45 JTAP	V47190033YY2

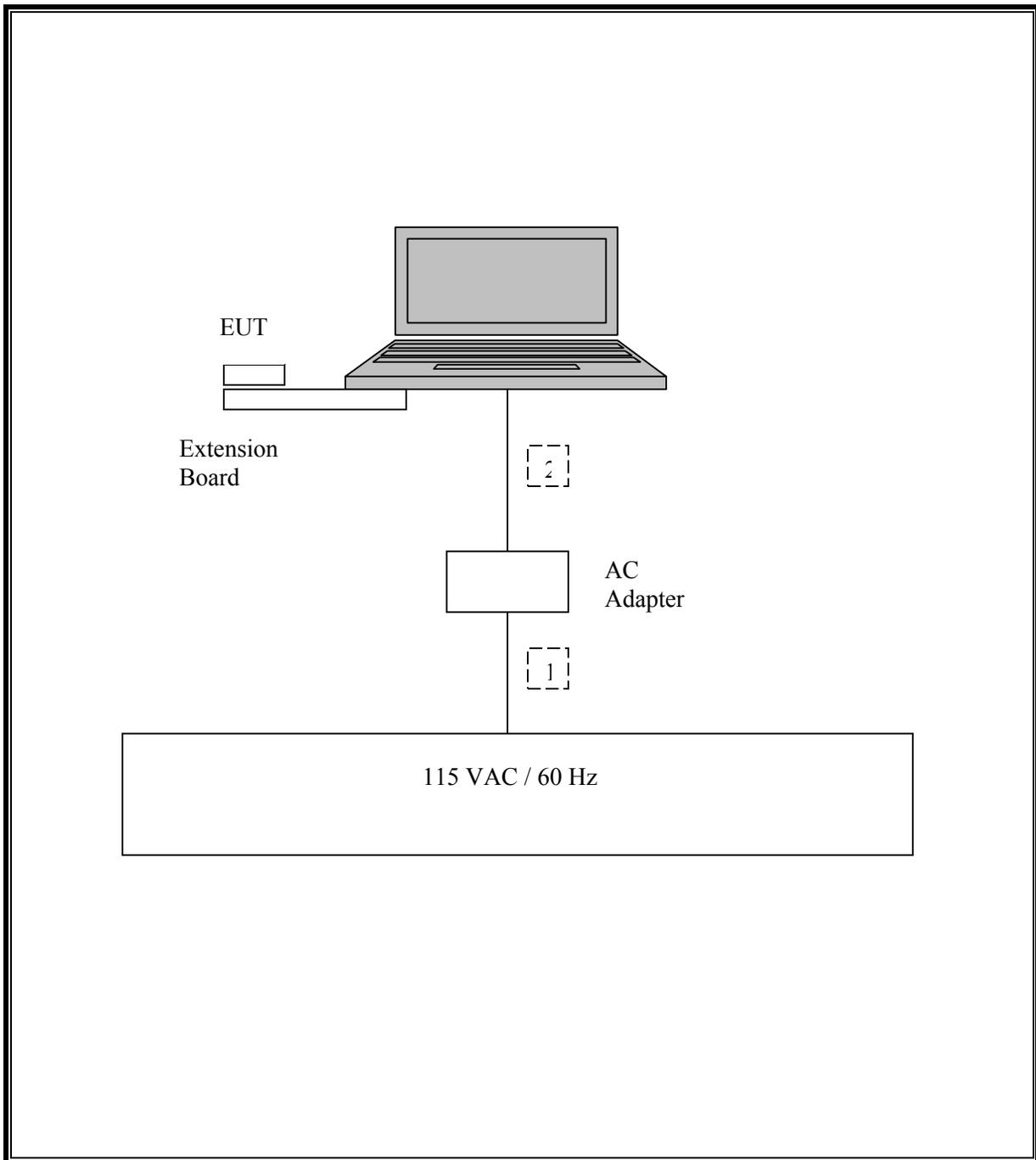
### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	AC	Unshielded	1.5 m	N/A
2	DC	1	DC	Unshielded	2.0 m	N/A

### TEST SETUP

The EUT is connected in a host laptop computer via an interface board adapter / extension board during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR TESTS**



## 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment were utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	S/N	Cal Due
EMI Test Receiver	R & S	ESHS 20	827129/006	01/27/08
Site A Line Stabilizer / Conditioner	Tripplite	LC-1800a	A0051681	CNR
LISN, 10 kHz ~ 30 MHz	FCC	LISN-50/250-25-2	2023	09/15/07
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	8379443	09/15/07
Spectrum Analyzer	HP	E4446A	US42510266	10/18/07
Antenna, Horn 1 ~ 18 GHz	EMCO	3117	29310	04/15/08
Antenna, Horn 8 ~ 26 GHz	ARA	MWH-1826/B	1049	10/06/07
Preamplifier, 1 ~ 26.5 GHz	HP	8449B	3008A00369	08/03/08
Temperature / Humidity Chamber	Thermotron	SE 600-10-10	29800	04/16/08
Peak Power Meter	Agilent	E4416A	GB41291160	12/02/07
Peak / Average Power Sensor	Agilent	E9327A	US40440755	12/02/07
RF Filter Section	HP	85420E	3705A00256	06/12/08
EMI Receiver, 9 kHz ~ 2.9 GHz	HP	8542E	3942A00286	06/12/08
Bilog Antenna, 30MHz---- 2GHz	Sunol Sciences	JB1 Antenna	A121003	10/13/07
4.0 High Pass Filter	Micro Tronics	HPM13351	3	N/A

## 7. LIMITS AND RESULTS

### 7.1. CHANNEL TESTS FOR THE 2400 TO 2483.5 MHz BAND

#### 7.1.1. 6 dB BANDWIDTH

##### LIMIT

§15.247 (a) (2)  
RSS-210 Clause A8.2 (1)

##### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

##### RESULTS

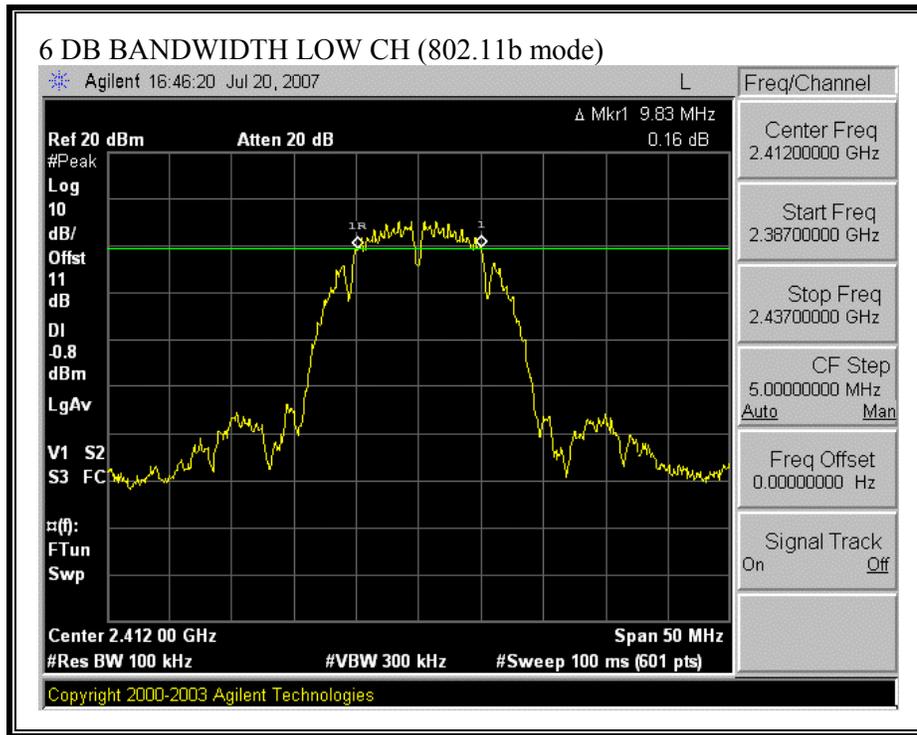
No non-compliance noted:

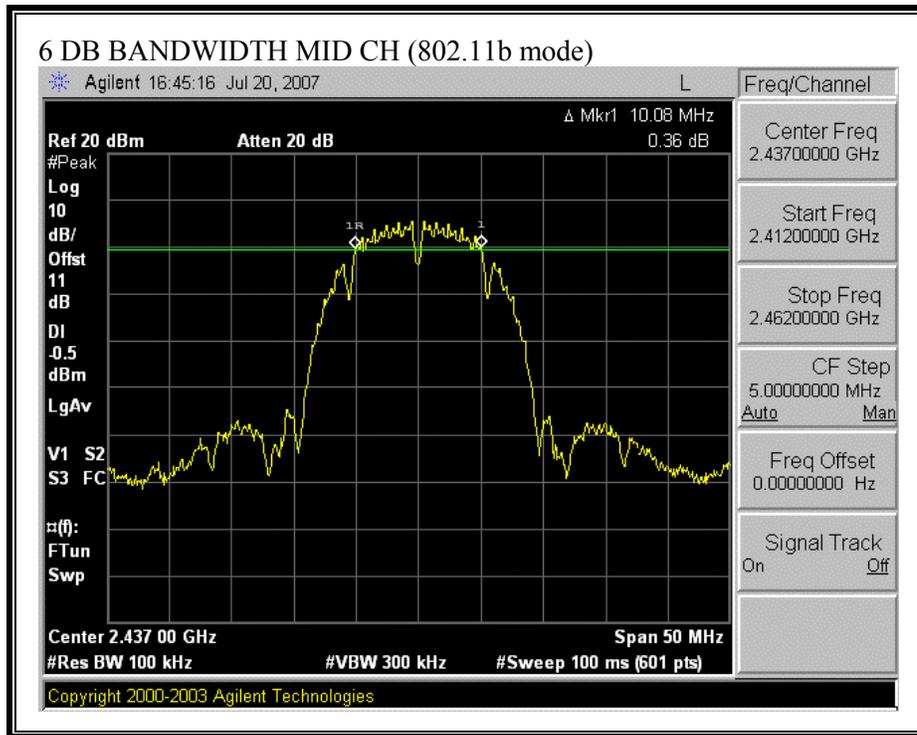
Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)
Low	2412	9830	500
Middle	2437	10080	500
High	2462	10170	500

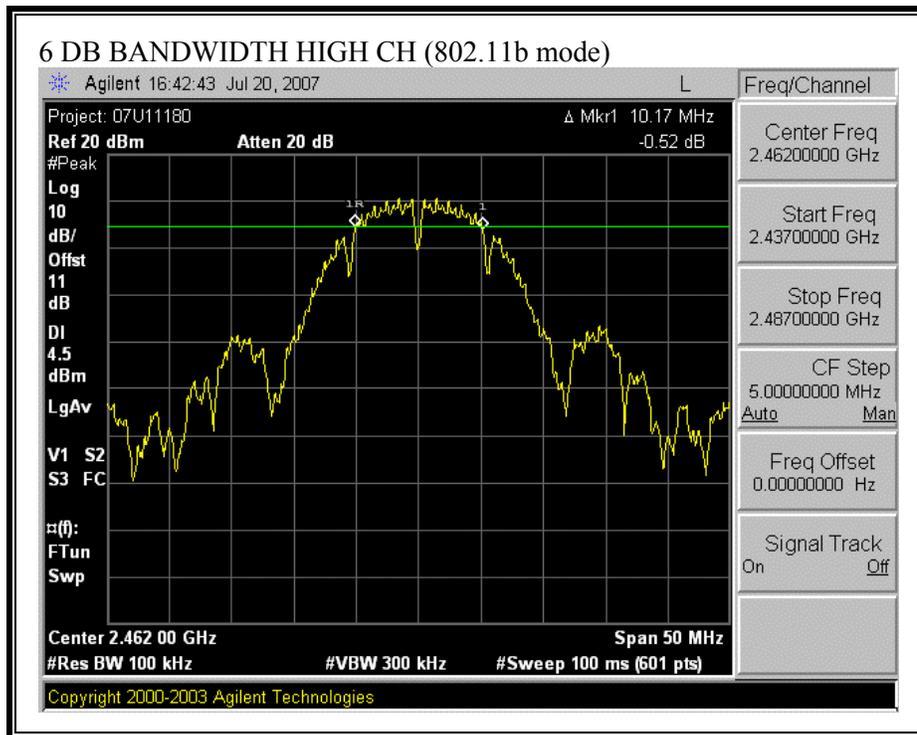
802.11g Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)
Low	2412	16580	500
Middle	2437	16580	500
High	2462	16580	500

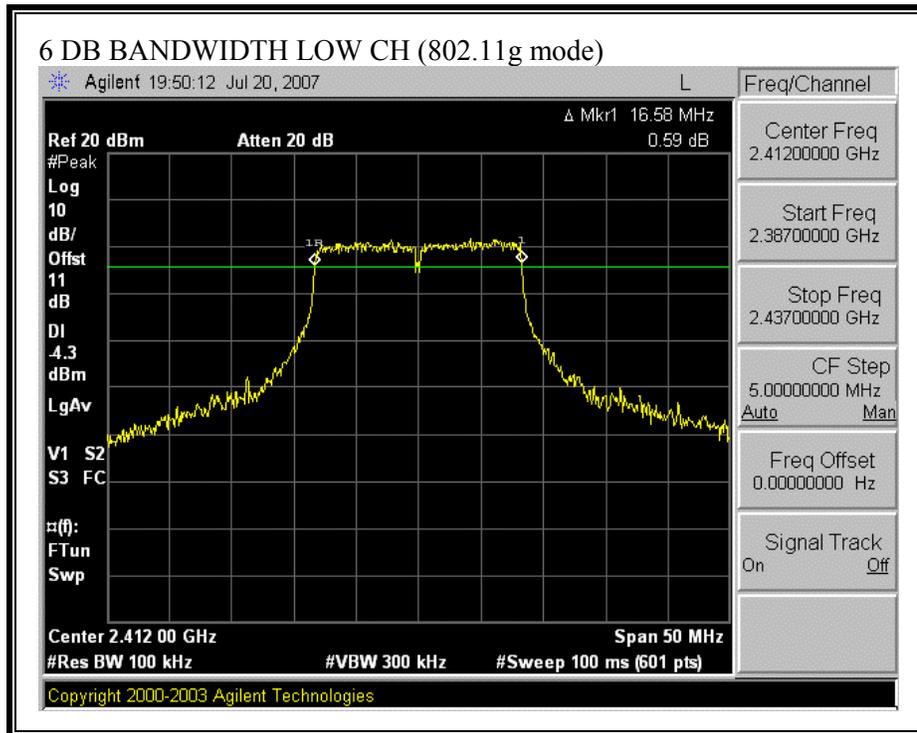
**6 DB BANDWIDTH (802.11b MODE)**

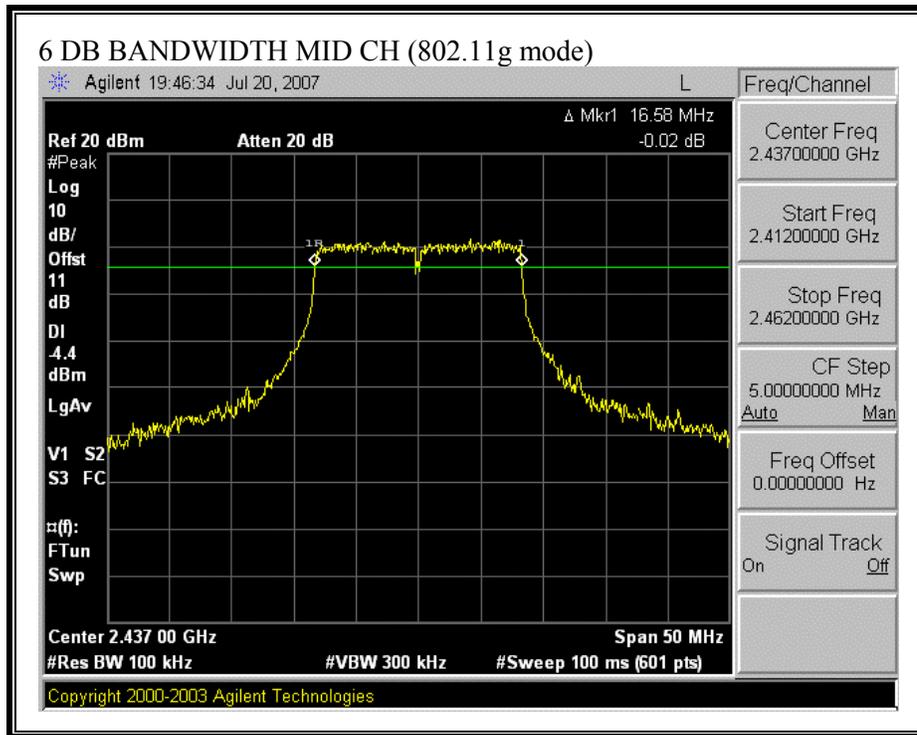


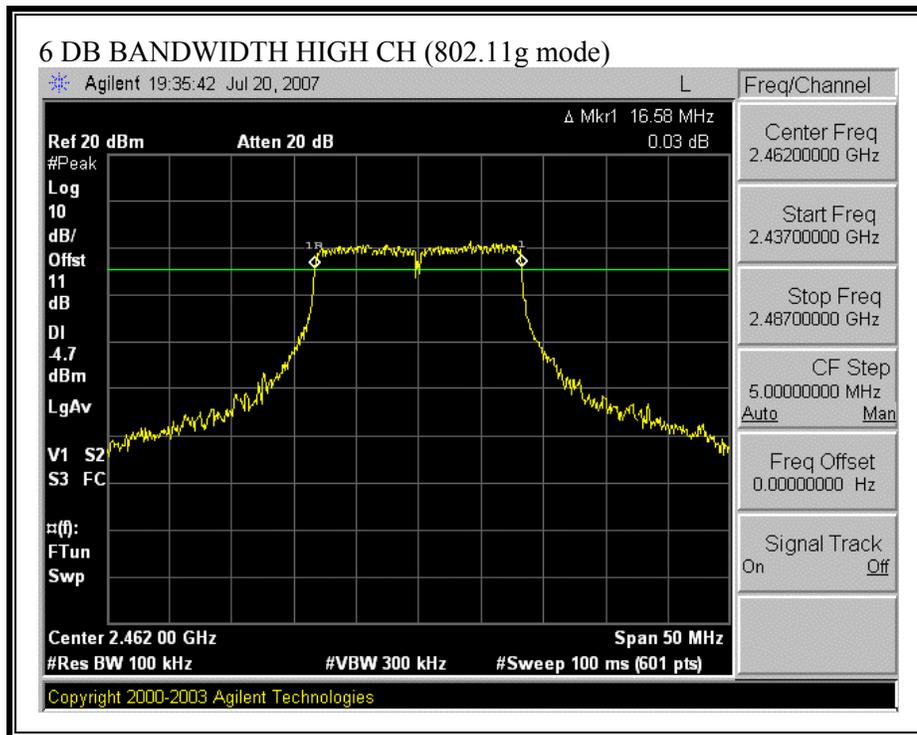




**6 DB BANDWIDTH (802.11g MODE)**







### 7.1.2. 99% BANDWIDTH

#### LIMIT

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

#### RESULTS

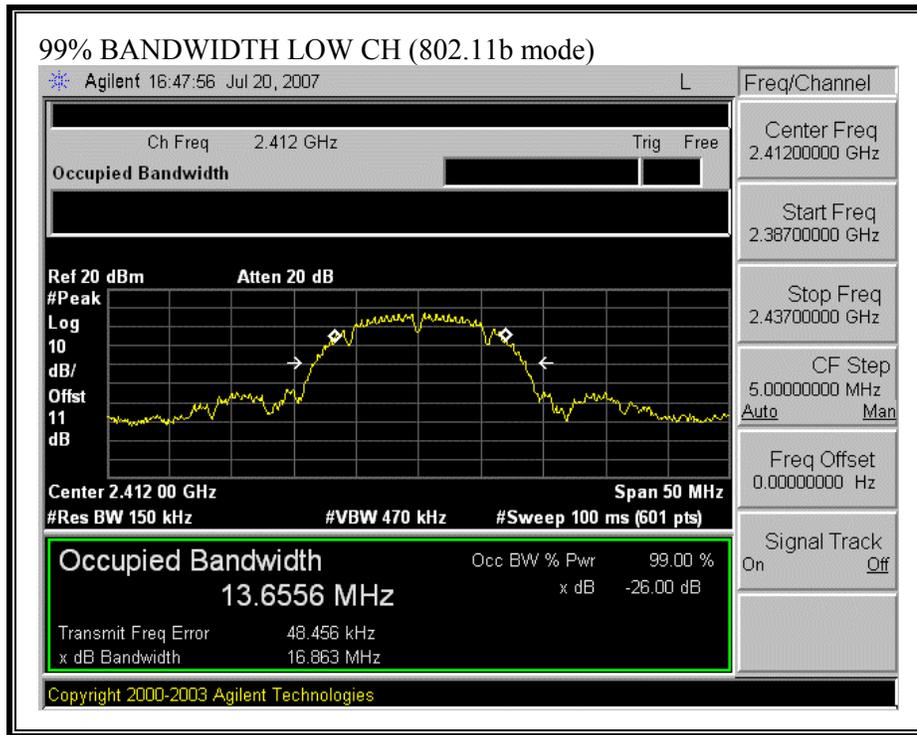
802.11b Mode

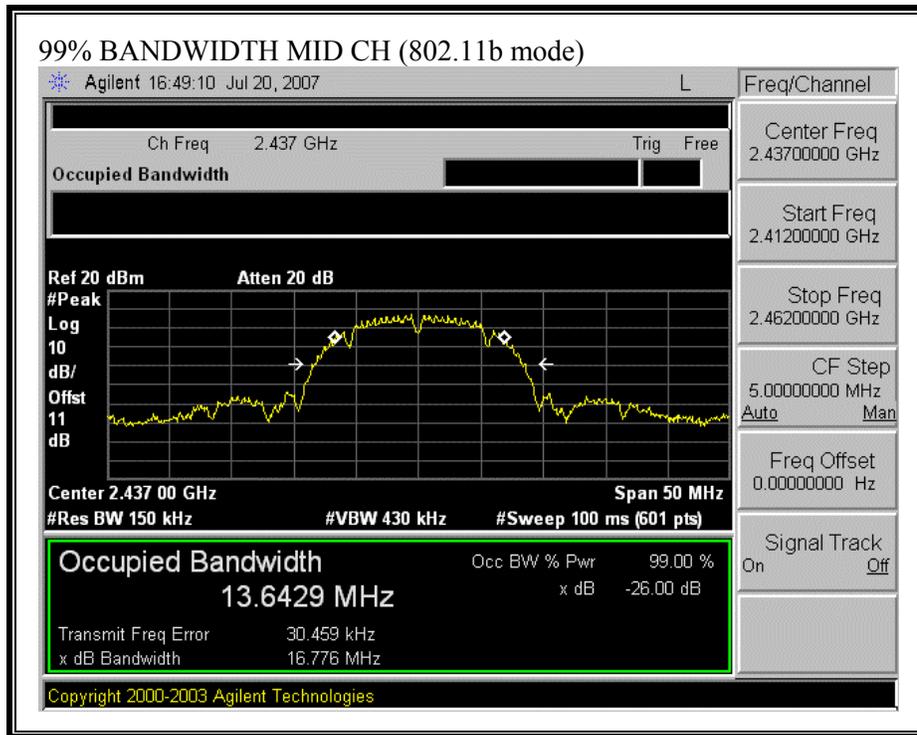
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	13.6556
Middle	2437	13.6429
High	2462	13.6555

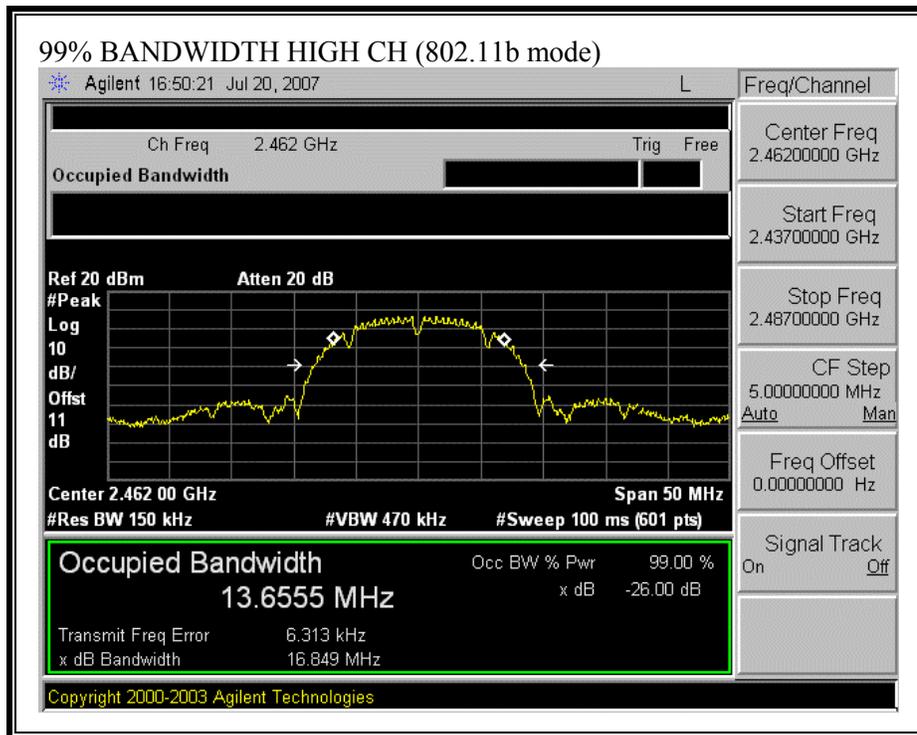
802.11g Mode

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	16.629
Middle	2437	16.5823
High	2462	16.6153

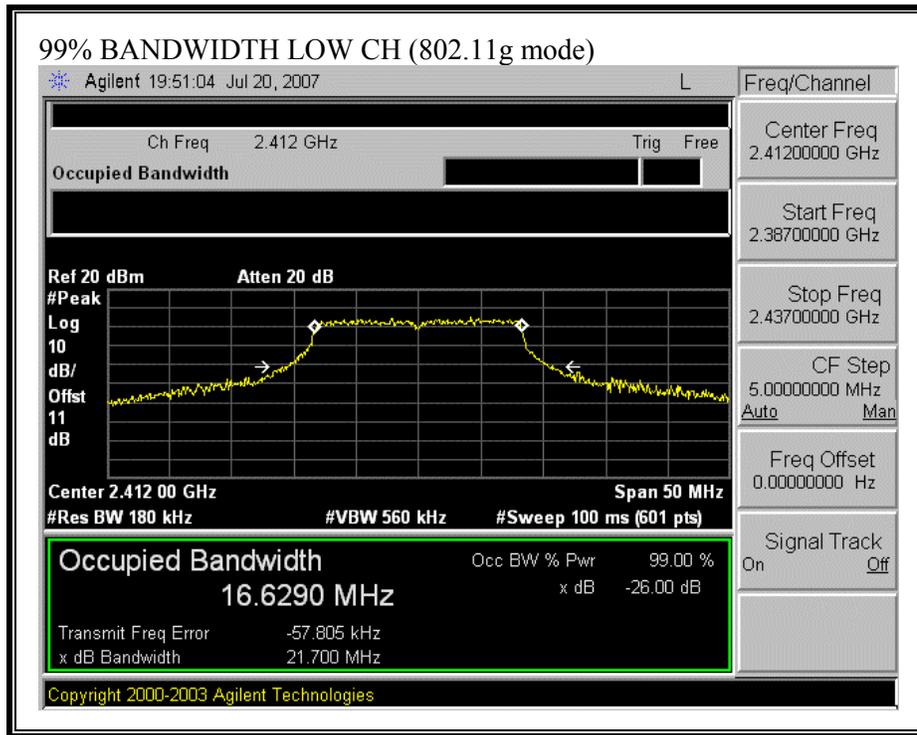
**99% BANDWIDTH (802.11b MODE)**

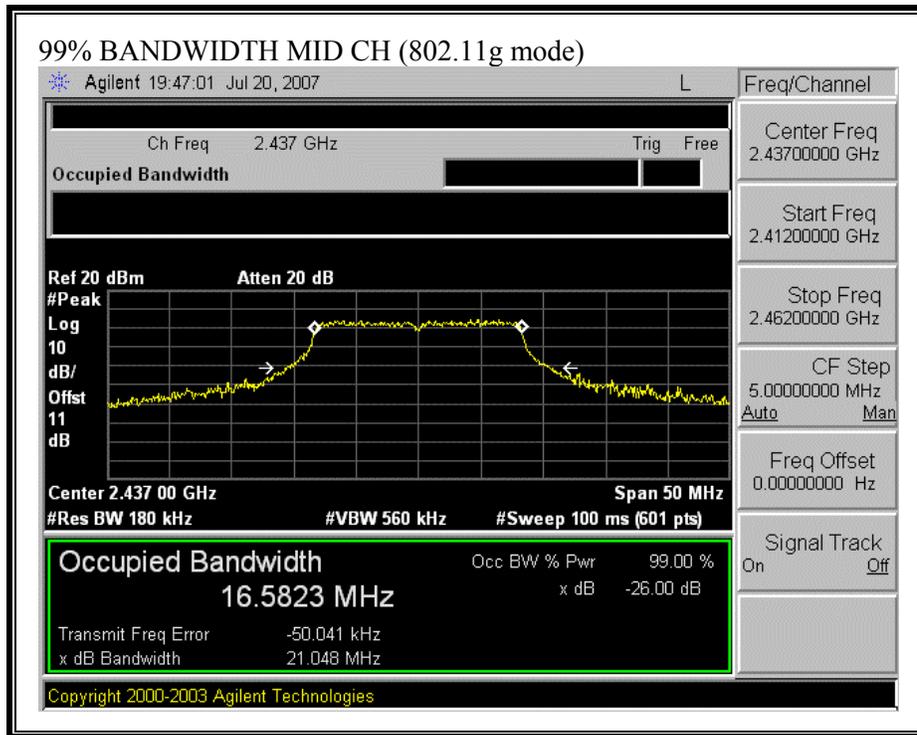


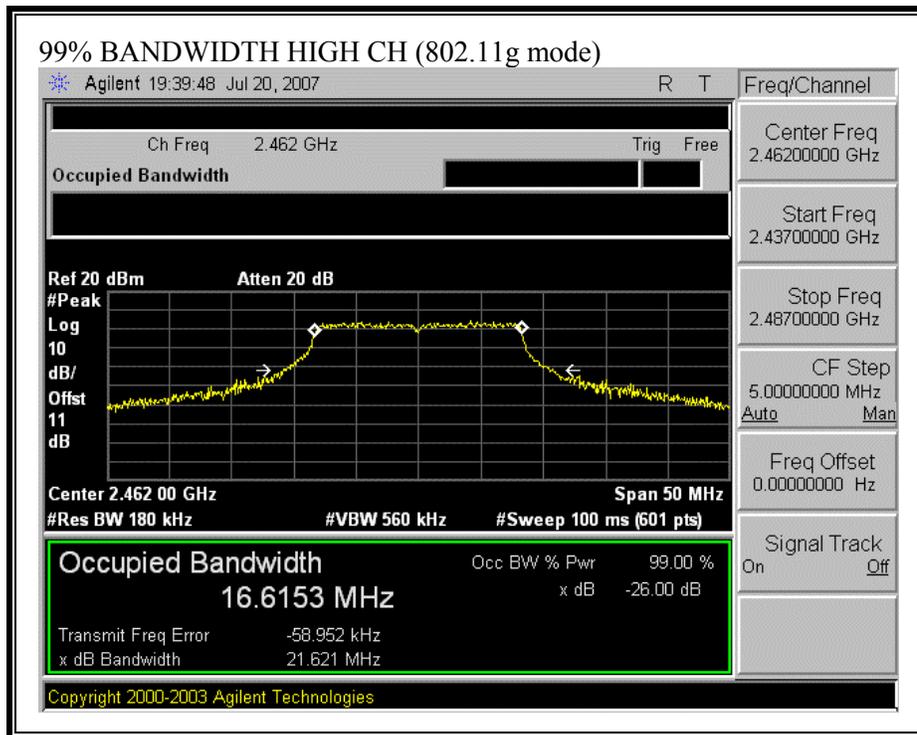




**99% BANDWIDTH (802.11g MODE)**







### 7.1.3. PEAK OUTPUT POWER

#### **PEAK POWER LIMIT**

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

#### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer and the analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth.

#### **RESULTS**

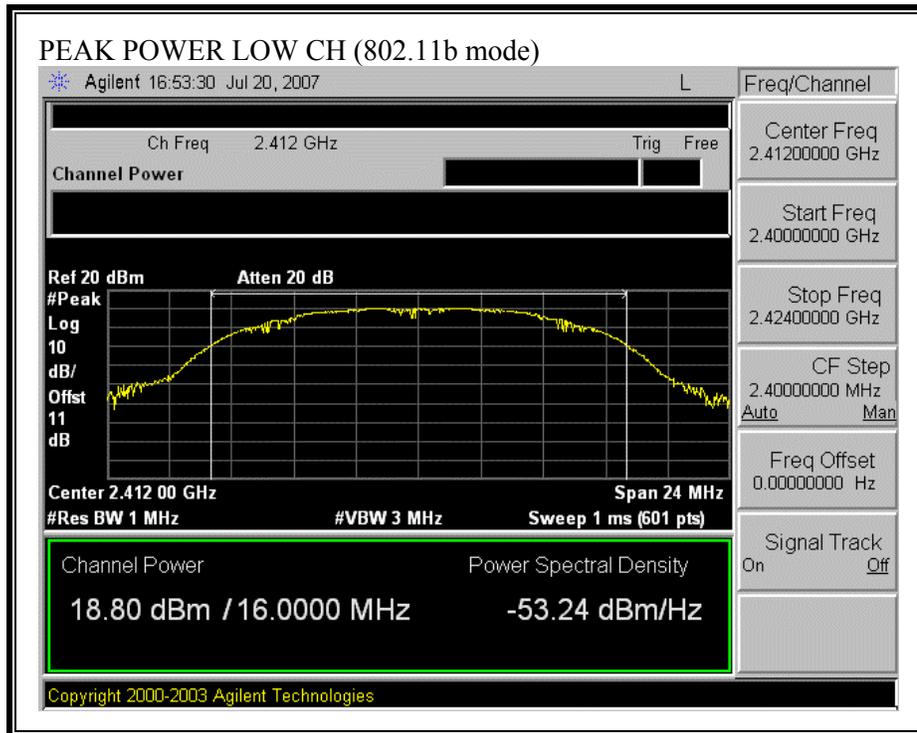
802.11b Mode

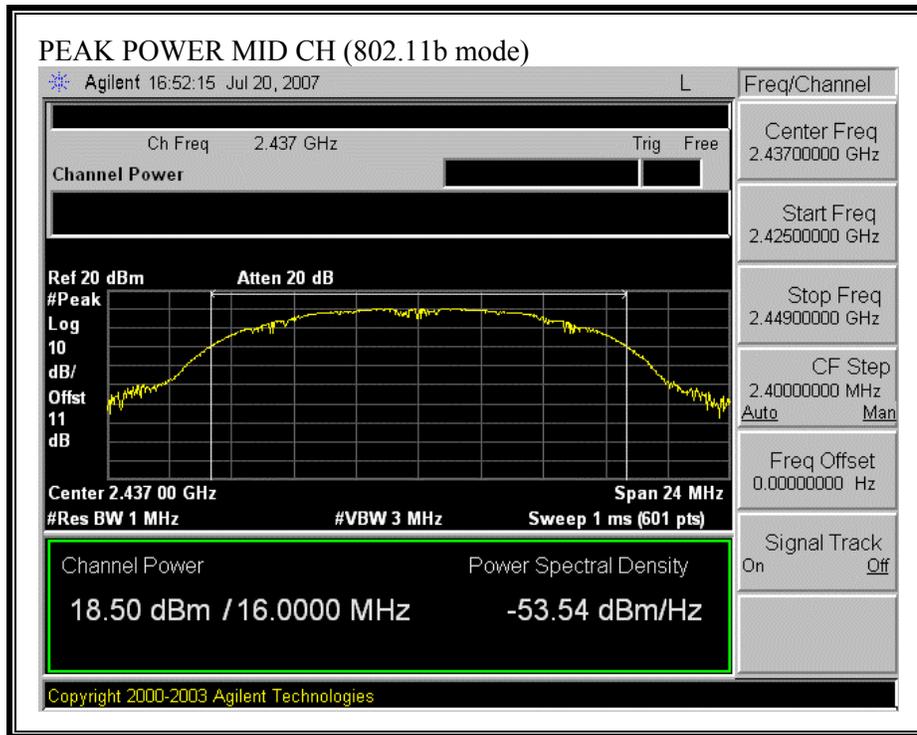
Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	18.80	30	-11.20
Middle	2437	18.50	30	-11.50
High	2462	18.61	30	-11.39

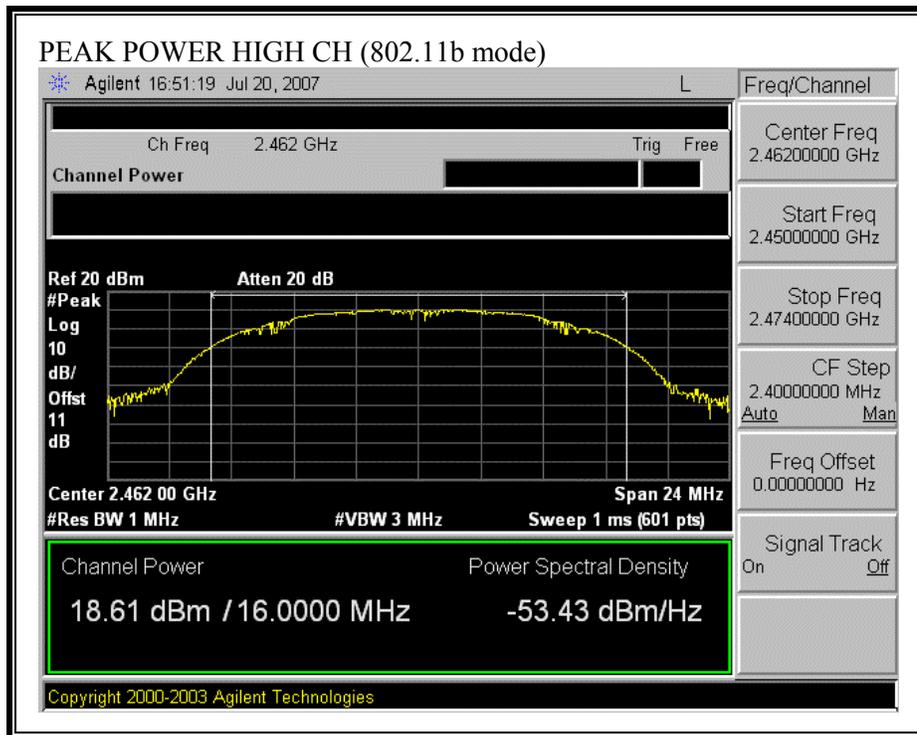
802.11g Mode

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	18.98	30	-11.02
Middle	2437	18.99	30	-11.01
High	2462	18.72	30	-11.28

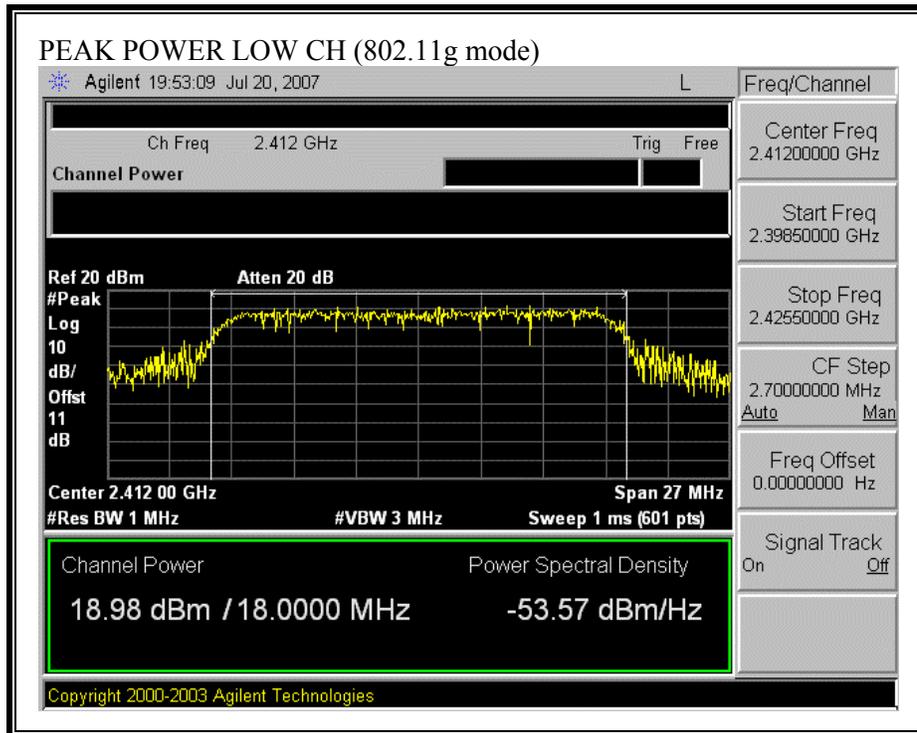
**OUTPUT POWER (802.11b MODE)**

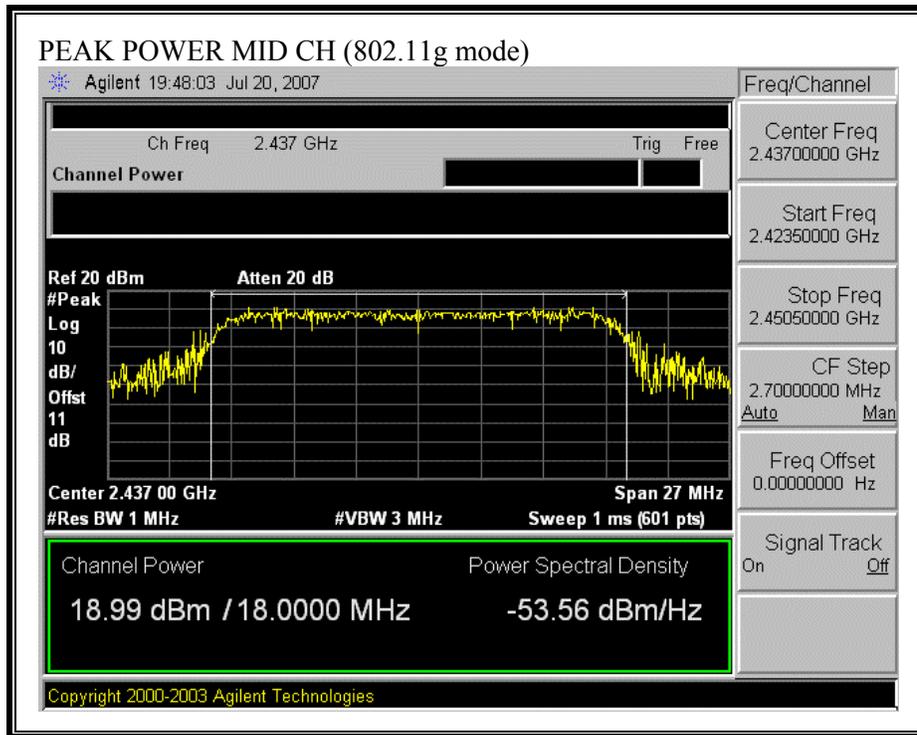


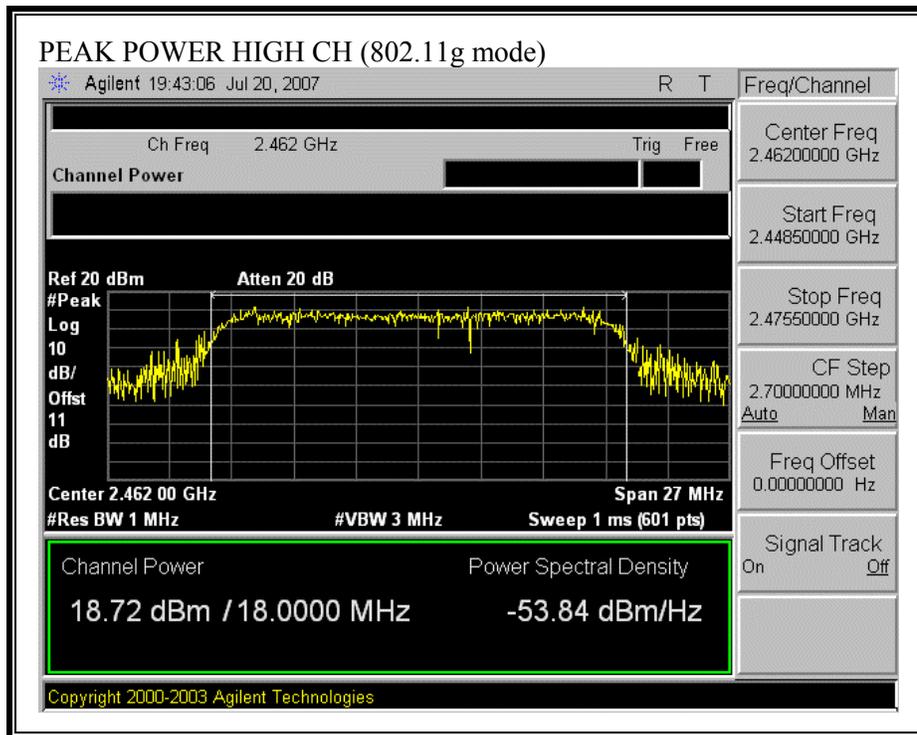




**OUTPUT POWER (802.11g MODE)**







### 7.1.4. AVERAGE POWER

#### AVERAGE POWER LIMIT

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

##### 802.11b Mode

Channel	Frequency (MHz)	Power (dBm)
Low	2412	15.73
Middle	2437	15.54
High	2462	16.14

##### 802.11g Mode

Channel	Frequency (MHz)	Power (dBm)
Low	2412	15.56
Middle	2437	15.13
High	2462	15.74

### 7.1.5. PEAK POWER SPECTRAL DENSITY (FCC)

#### LIMIT

§15.247 (d) 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 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 > 3 kHz, sweep time = span / 3 kHz, and video averaging is turned off. The PPSD is the highest level found across the emission in any 3 kHz band.

#### RESULTS

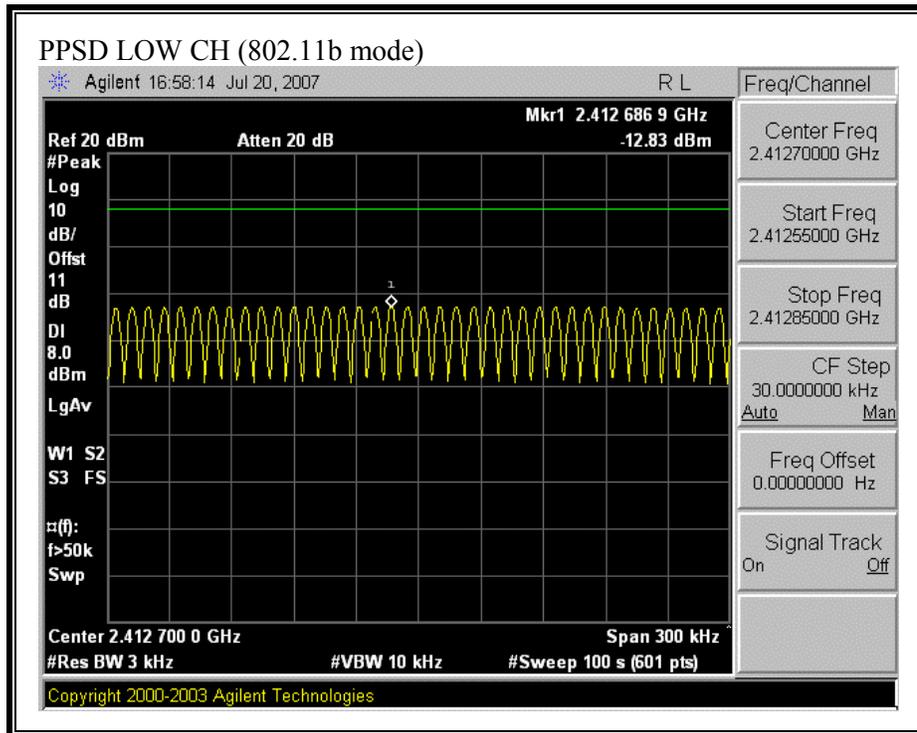
##### 802.11b Mode

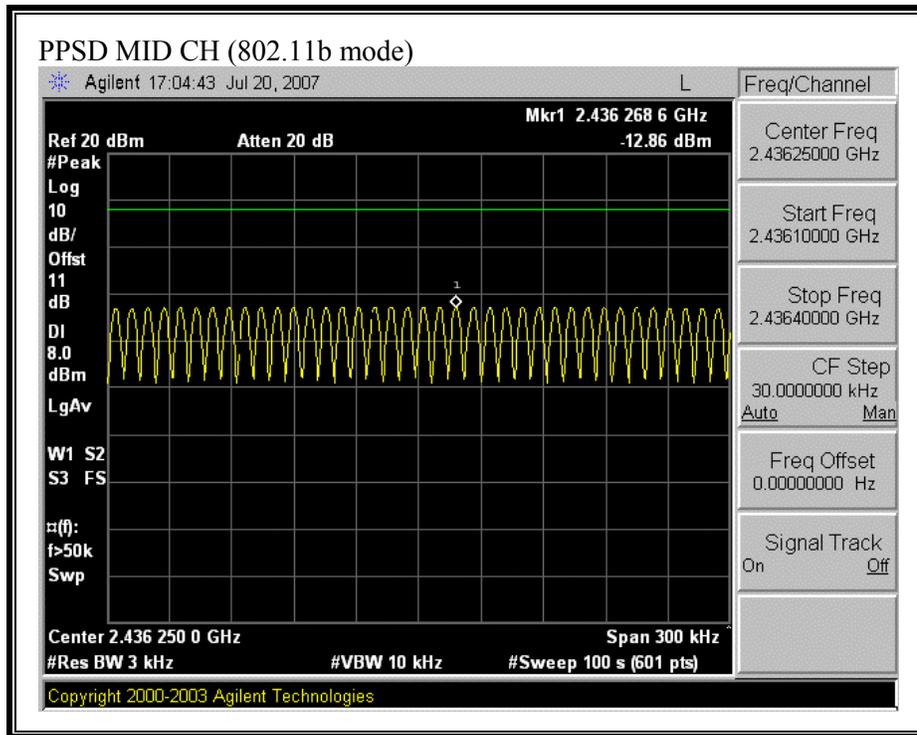
Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-12.83	8	-20.83
Middle	2437	-12.86	8	-20.86
High	2462	-13.00	8	-21.00

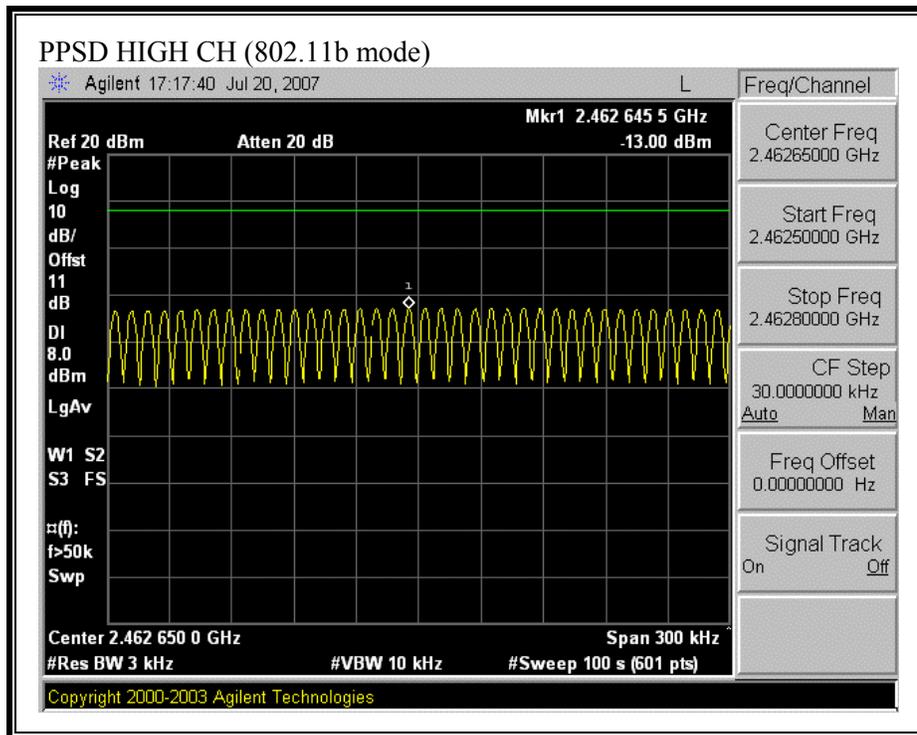
##### 802.11g Mode

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-9.81	8	-17.81
Middle	2437	-8.66	8	-16.66
High	2462	-7.86	8	-15.86

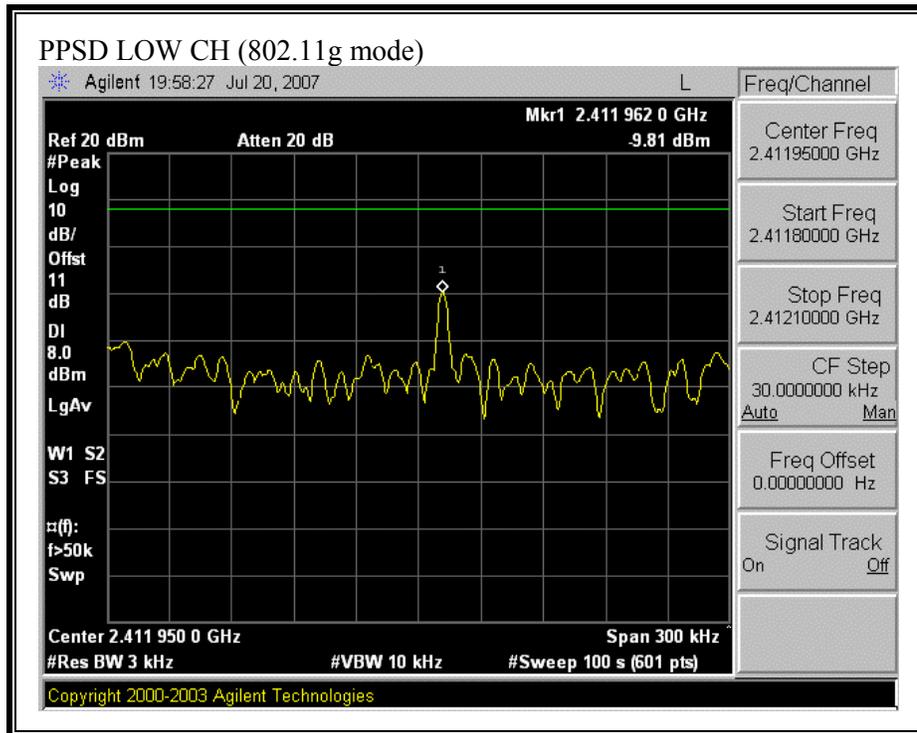
**PEAK POWER SPECTRAL DENSITY (802.11b MODE)**

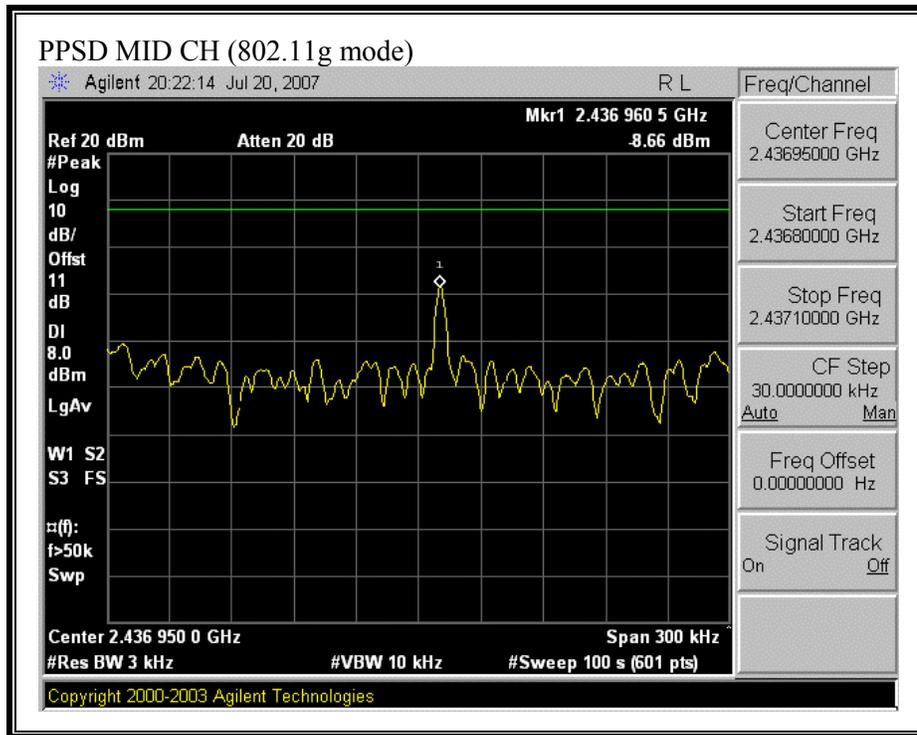


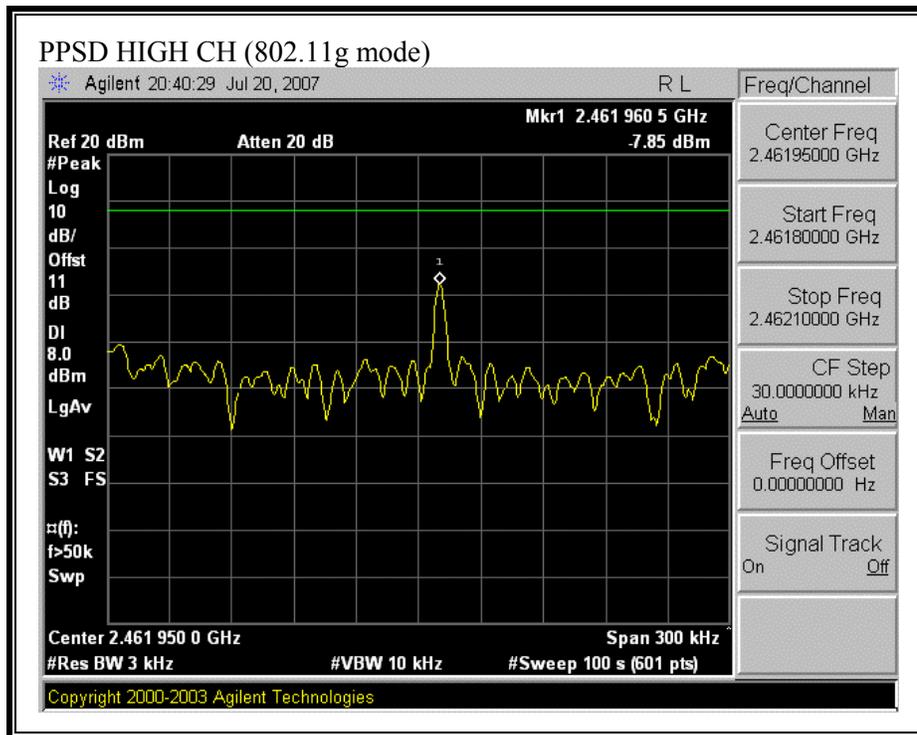




**PEAK POWER SPECTRAL DENSITY (802.11g MODE)**







### **7.1.6. PEAK POWER SPECTRAL DENSITY (IC)**

#### **LIMIT**

RSS-210 A8.2 (2) The transmitter power spectral density (into the antenna) shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0 second duration. This power spectral density shall be determined in accordance with the provisions of Section A8.4 below. The same method of determining the conducted output power shall be used to determine the power spectral density.

#### **TEST PROCEDURE**

The transmitter output is connected to the spectrum analyzer. The RBW is set to 3 kHz. The VBW is set to 10 kHz. An initial scan is made by measuring the emission envelope over the 99 % bandwidth. The frequency at which this envelope is maximum is used as the center frequency for the final scan. For the final scan, the span is set to 3 kHz times the number of spectrum analyzer bins. The sweep time is 1 s times the number of spectrum analyzer bins. The RMS value of the trace is calculated.

**RESULTS**

No non-compliance noted:

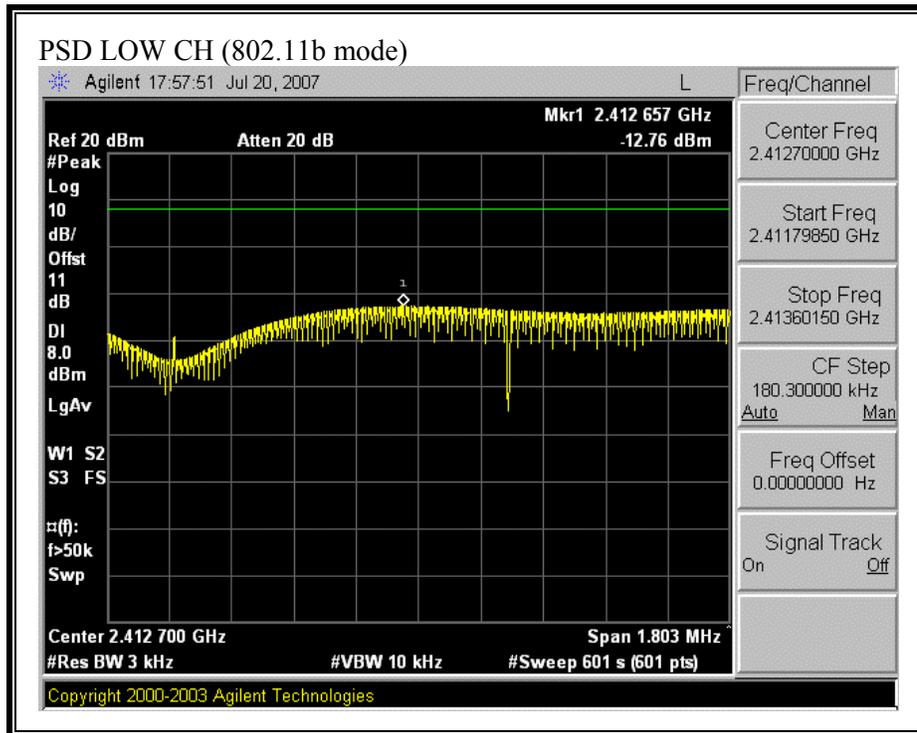
802.11b Mode

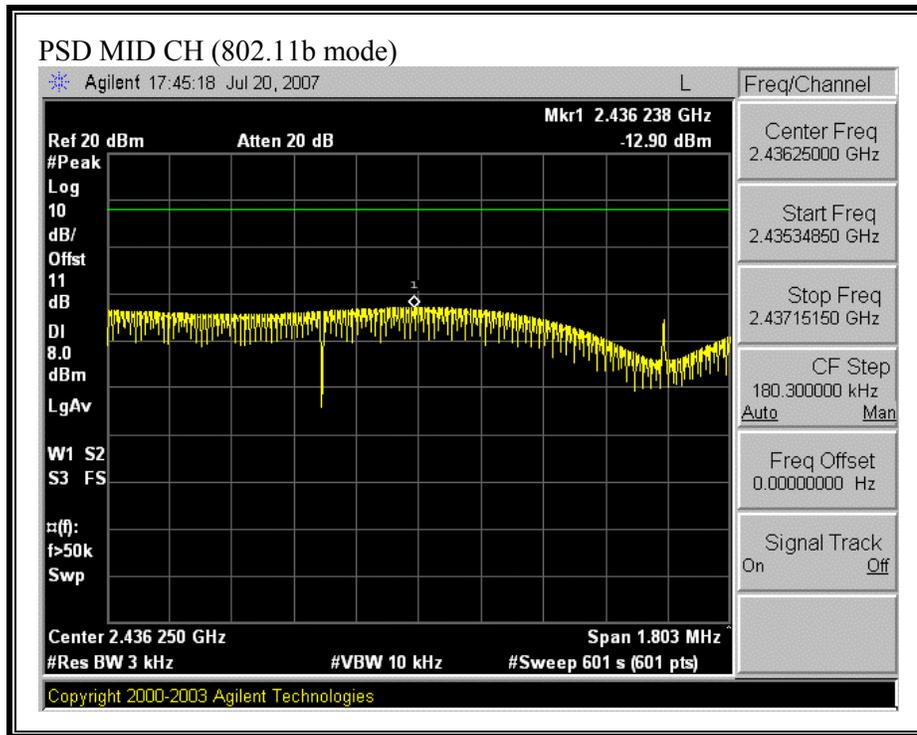
<b>Channel</b>	<b>Frequency (MHz)</b>	<b>PSD (dBm)</b>	<b>Limit (dBm)</b>	<b>Margin (dB)</b>
Low	2412	-12.76	8	-20.76
Middle	2437	-12.90	8	-20.90
High	2462	-13.02	8	-21.02

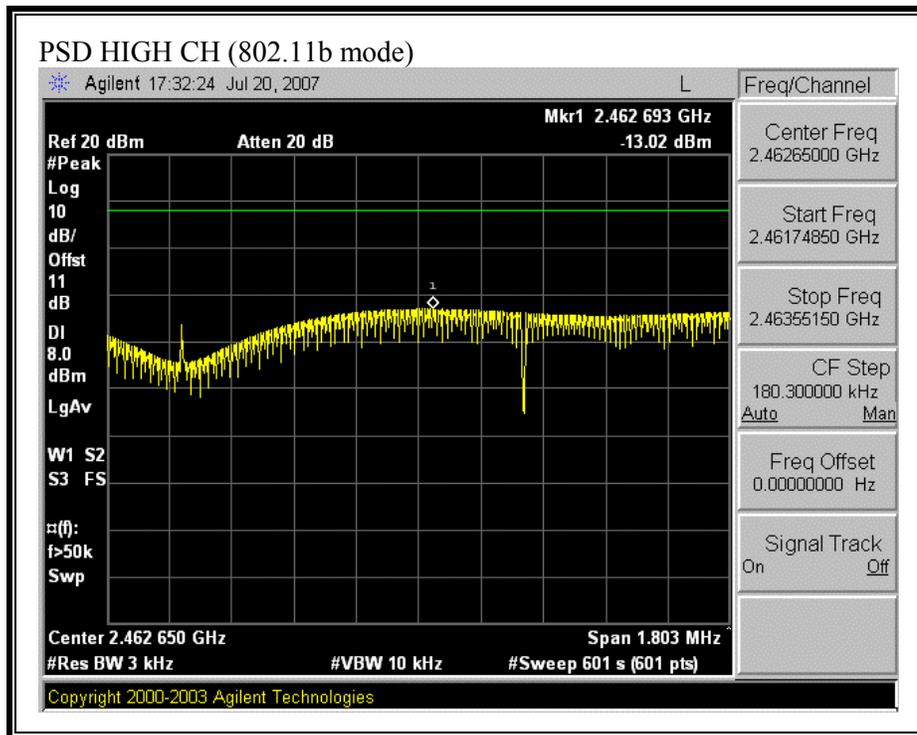
802.11g Mode

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>PSD (dBm)</b>	<b>Limit (dBm)</b>	<b>Margin (dB)</b>
Low	2412	-10.08	8	-18.08
Middle	2437	-8.62	8	-16.62
High	2462	-8.16	8	-16.16

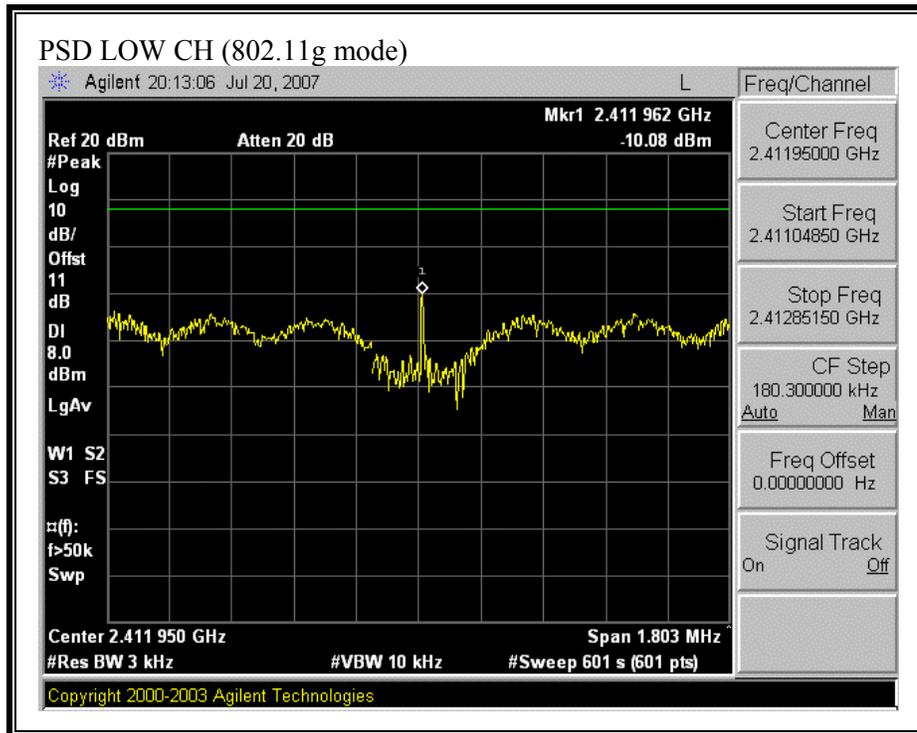
**POWER SPECTRAL DENSITY (802.11b MODE)**

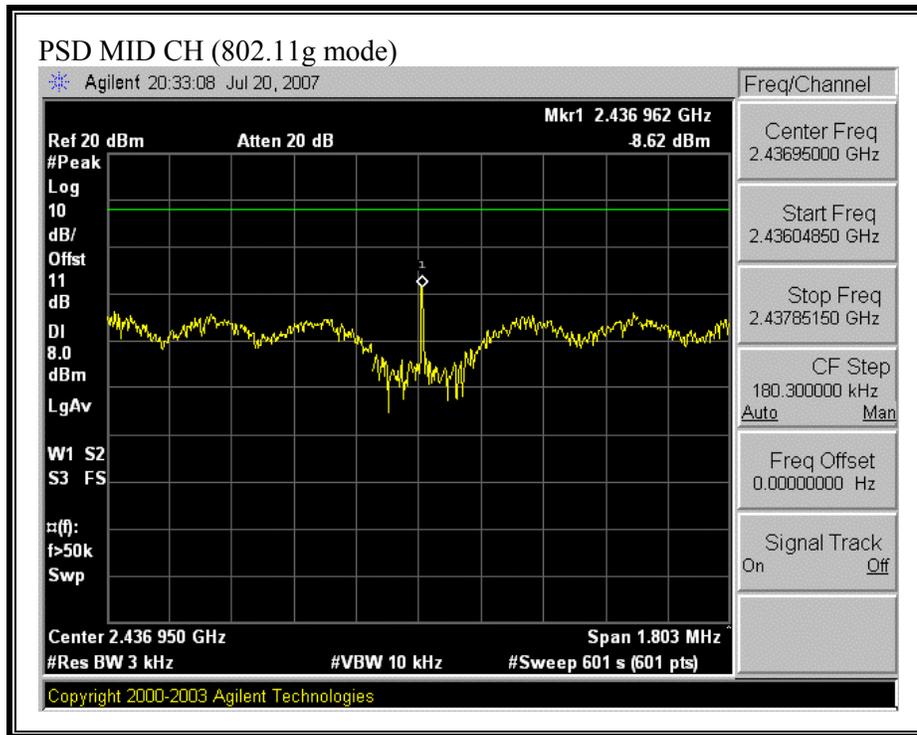


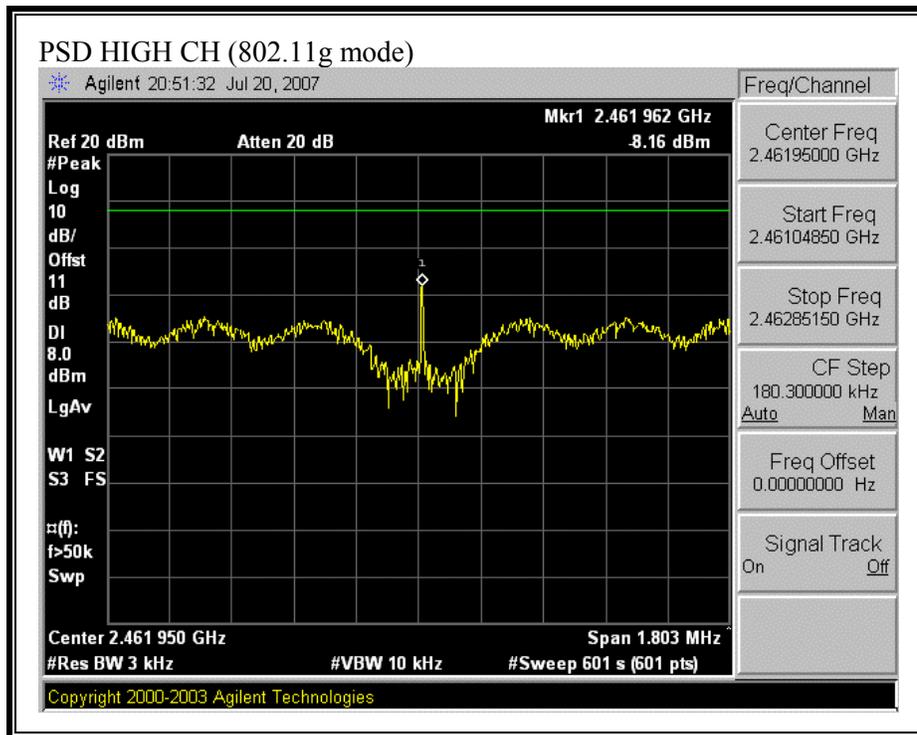




**POWER SPECTRAL DENSITY (802.11g MODE)**







## 7.1.7. CONDUCTED SPURIOUS EMISSIONS

### **LIMITS**

§15.247 (c) 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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### **TEST PROCEDURE**

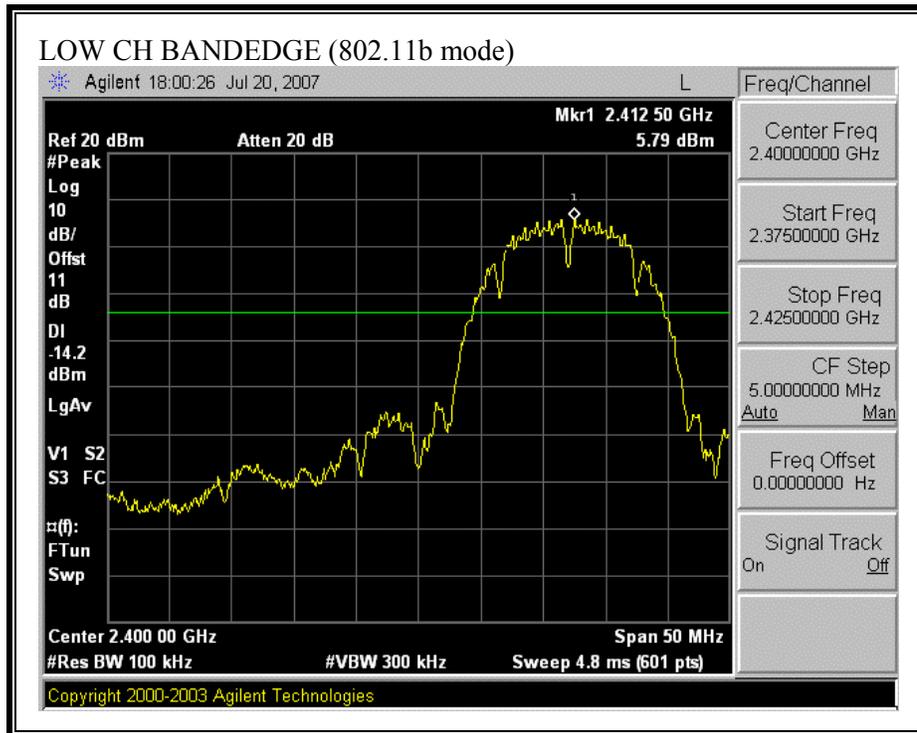
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

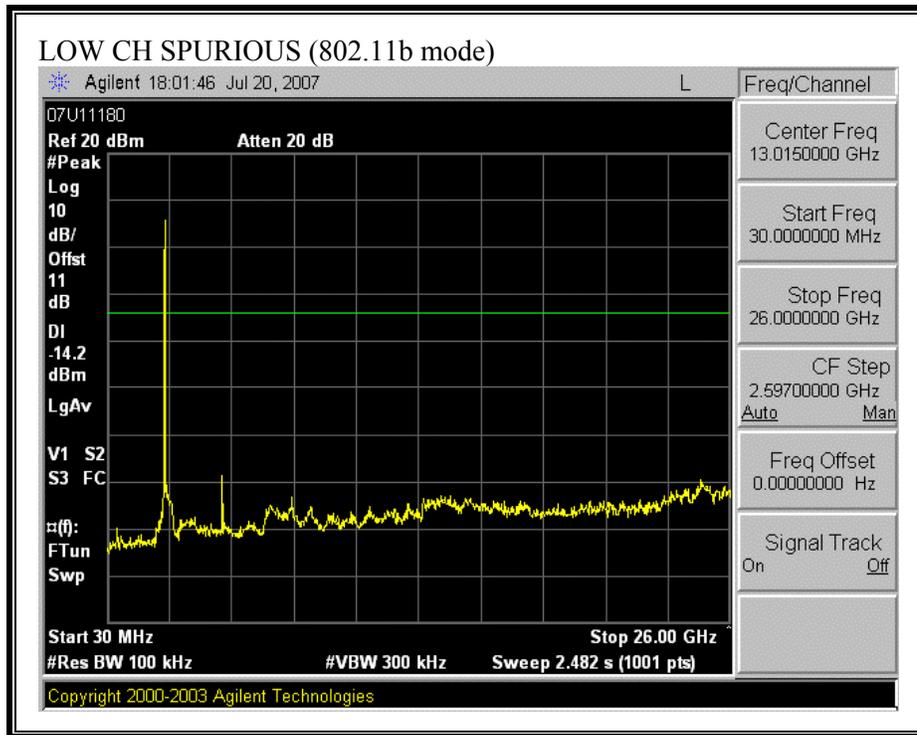
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

### **RESULTS**

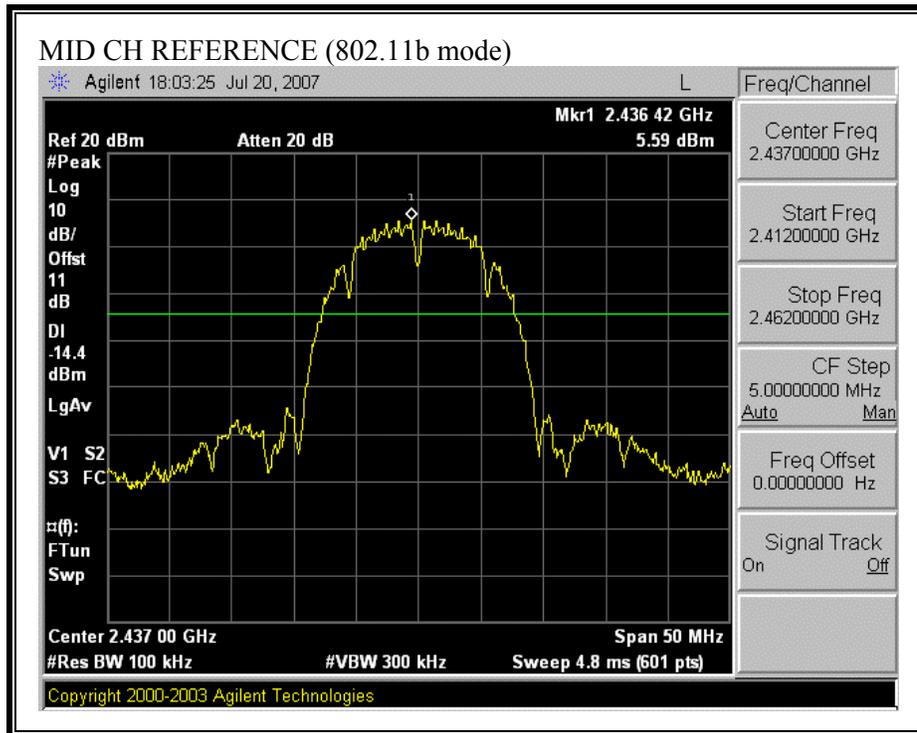
No non-compliance noted:

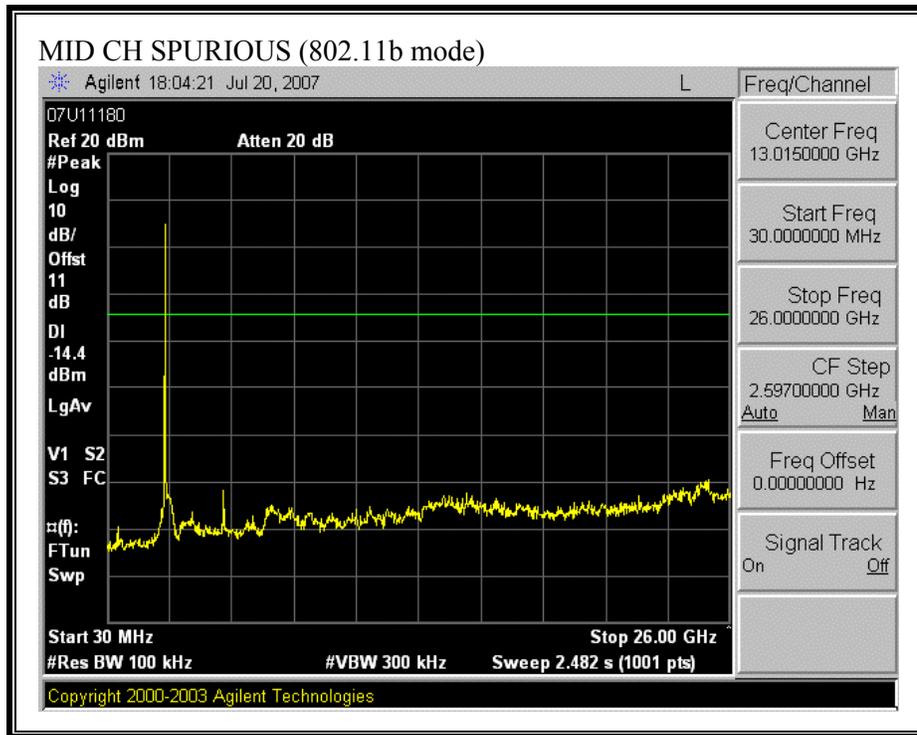
**SPURIOUS EMISSIONS, LOW CHANNEL (802.11b MODE)**



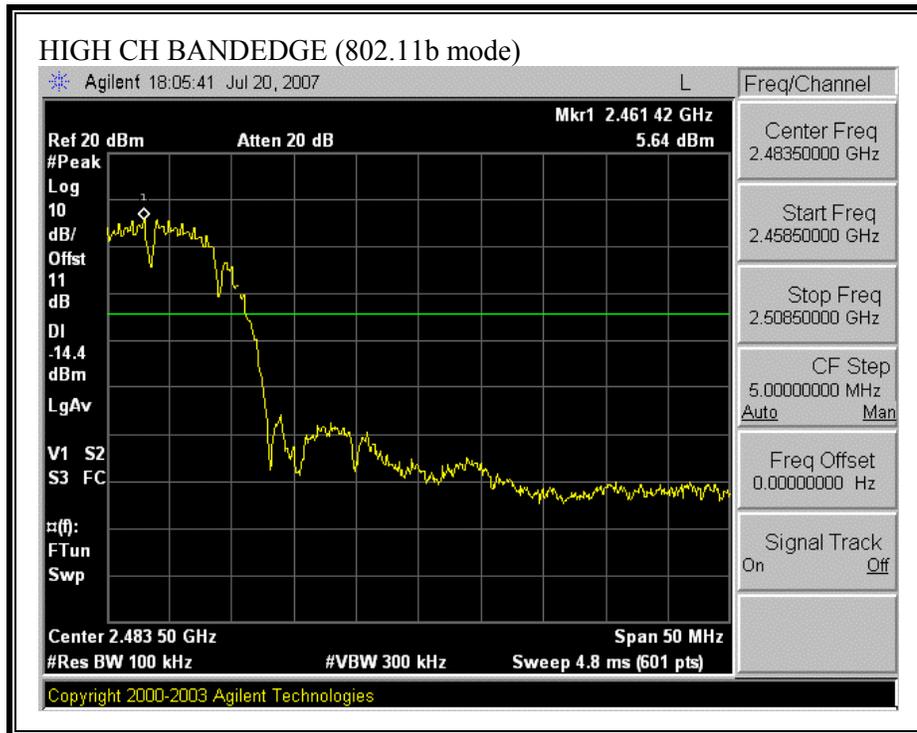


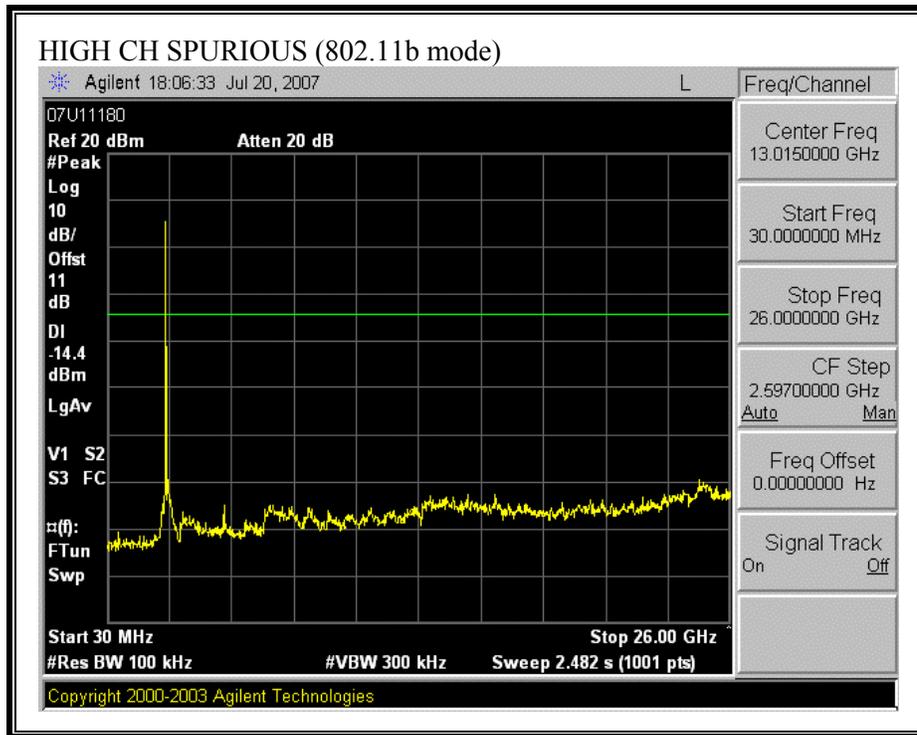
**SPURIOUS EMISSIONS, MID CHANNEL (802.11b MODE)**



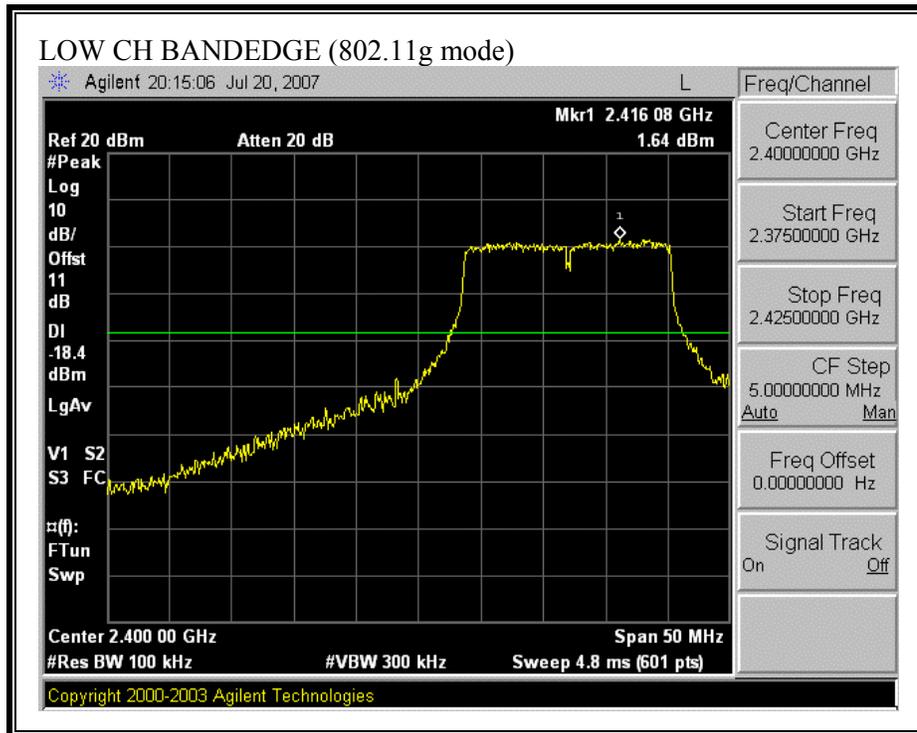


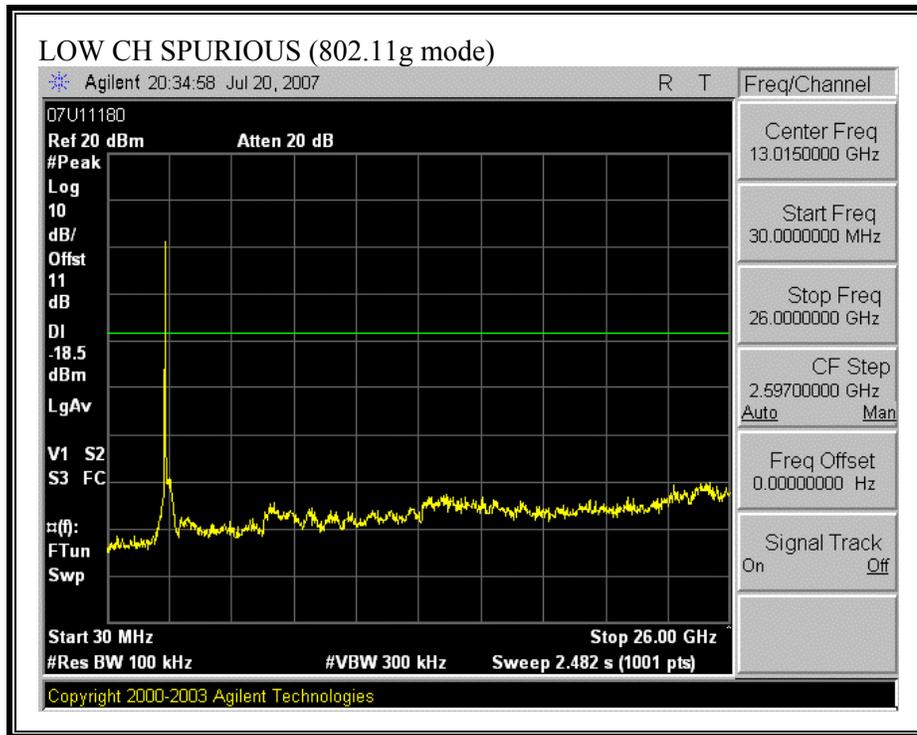
**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11b MODE)**



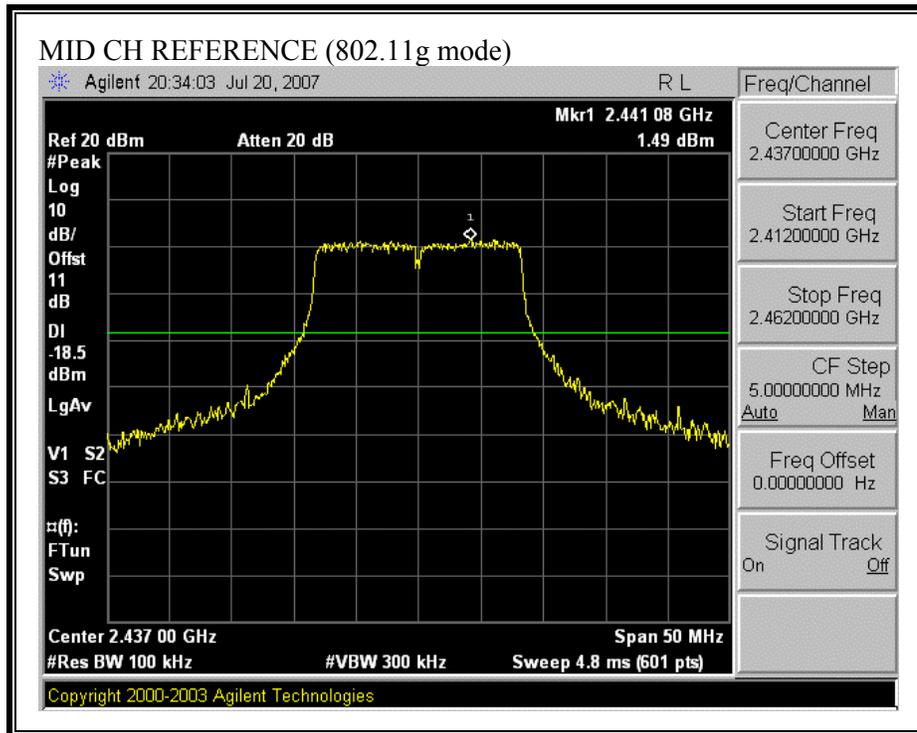


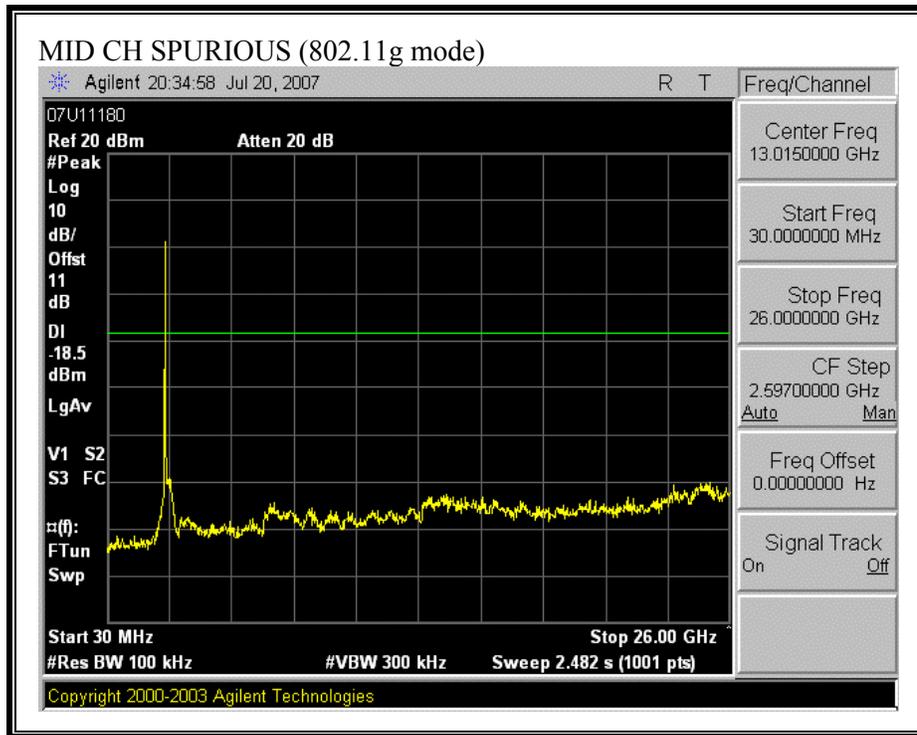
**SPURIOUS EMISSIONS, LOW CHANNEL (802.11g MODE)**



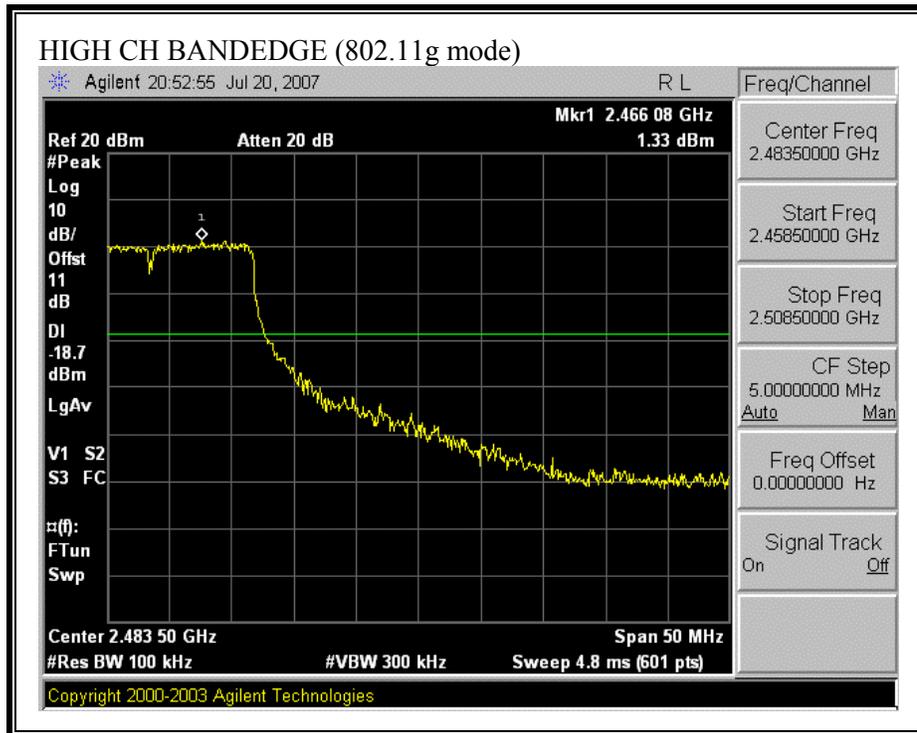


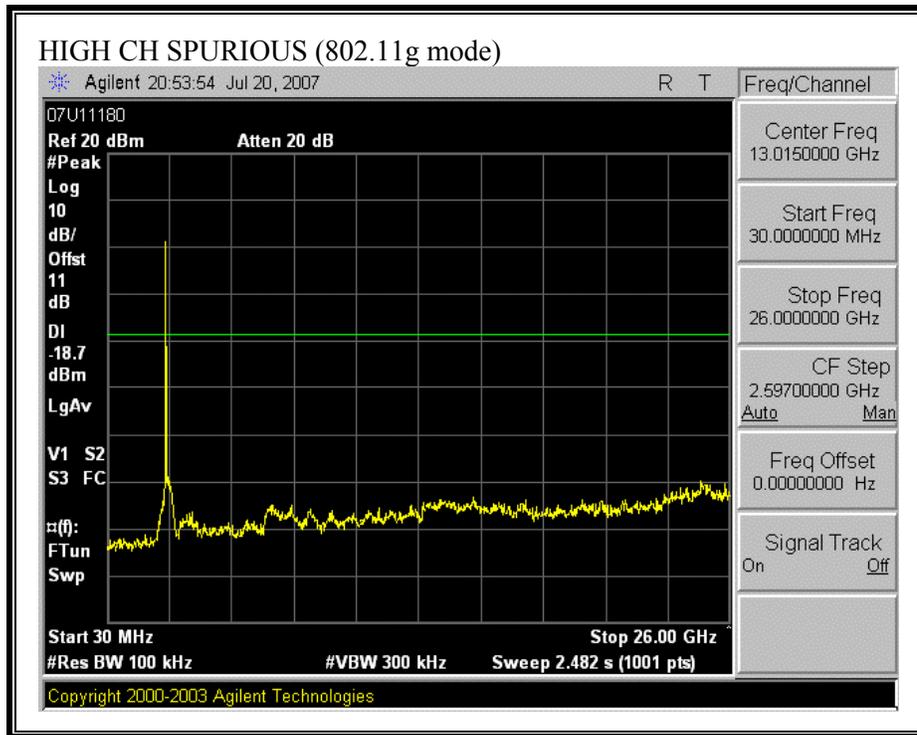
**SPURIOUS EMISSIONS, MID CHANNEL (802.11g MODE)**





**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11g MODE)**





## 7.2. RADIATED EMISSIONS

### LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

### TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

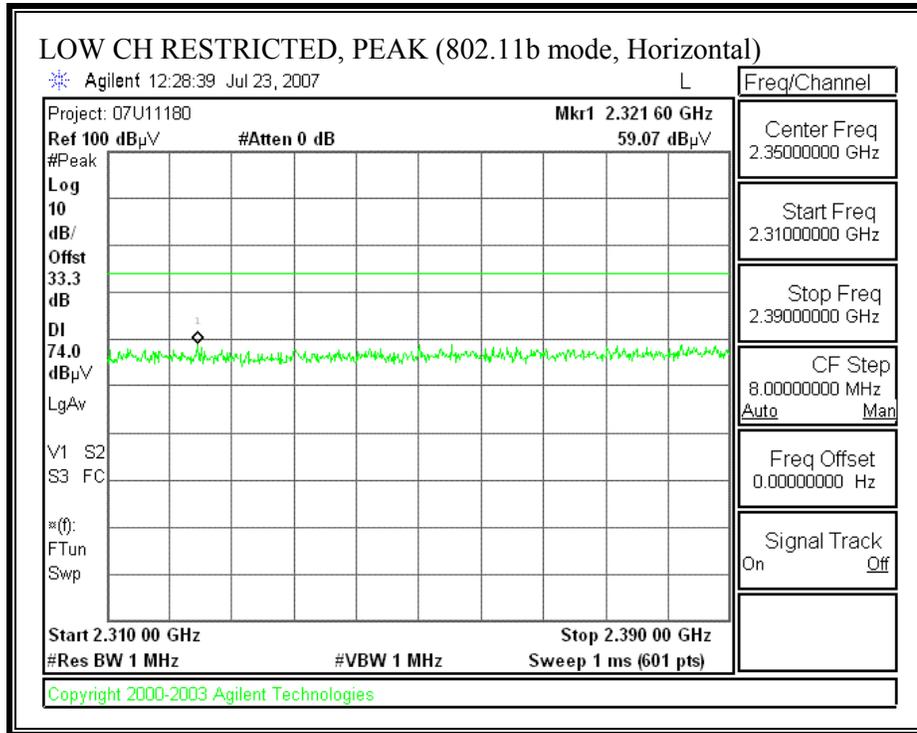
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

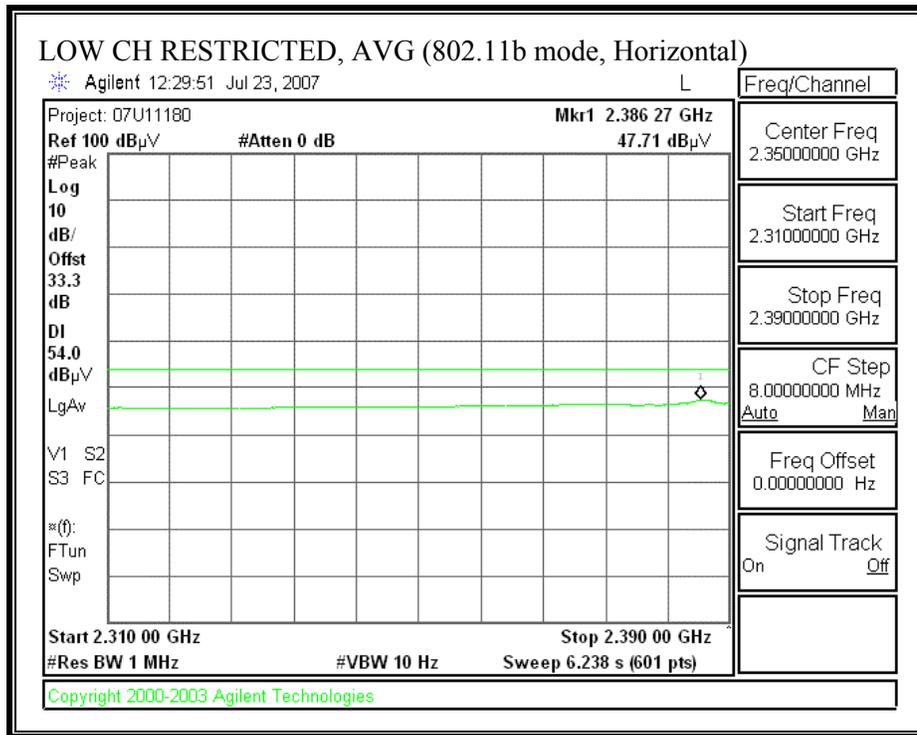
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

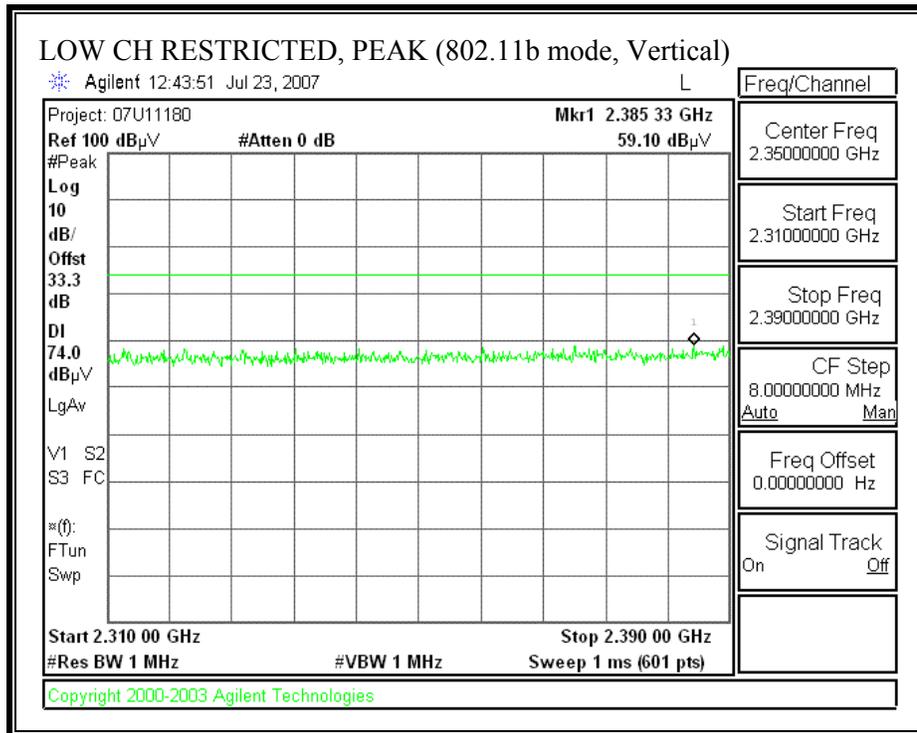
### 7.2.1. RADIATED EMISSION ABOVE 1 GHz

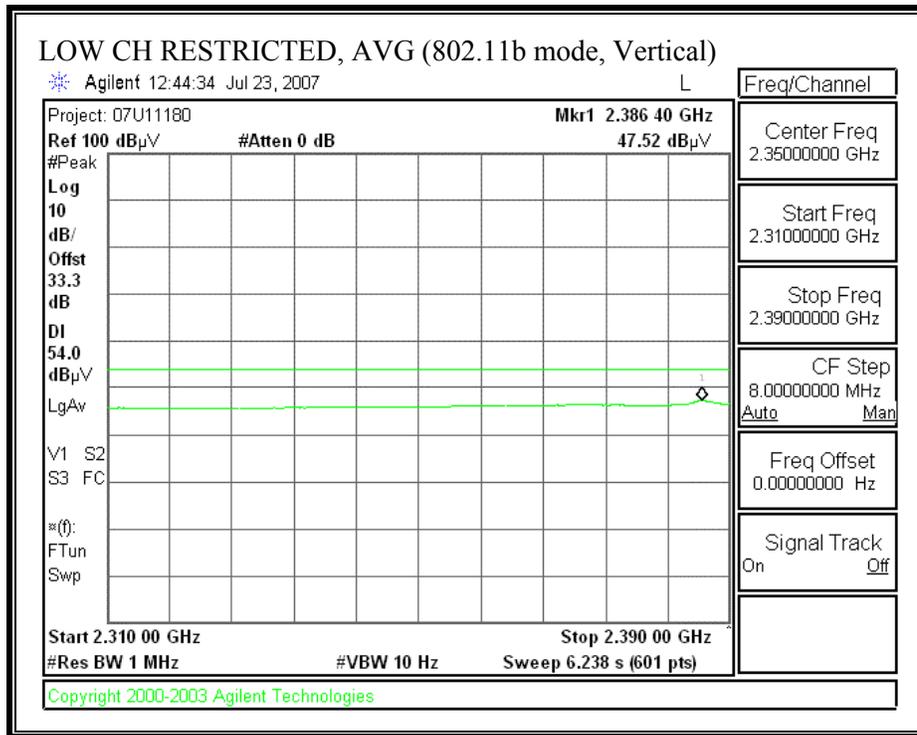
#### RESTRICTED BANDEDGE (b MODE, LOW CHANNEL, HORIZONTAL)



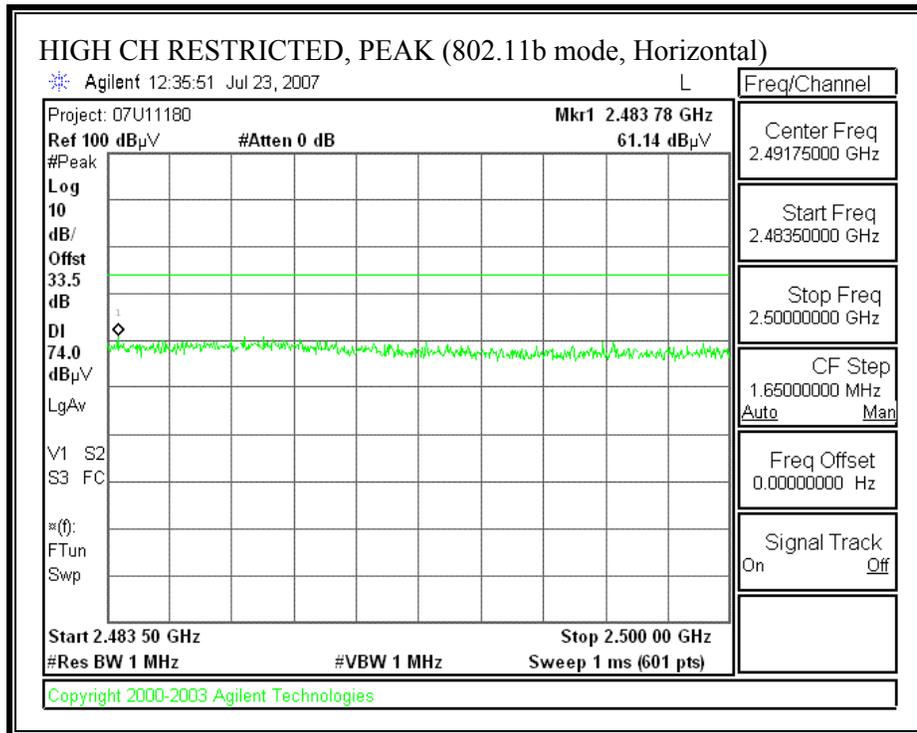


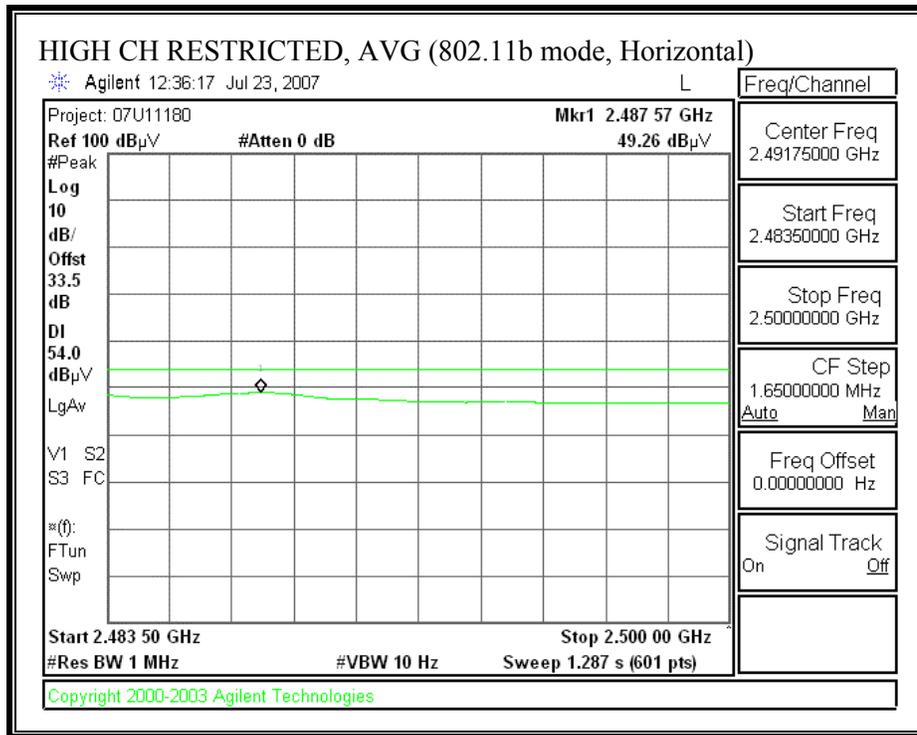
**RESTRICTED BANDEDGE (b MODE, LOW CHANNEL, VERTICAL)**



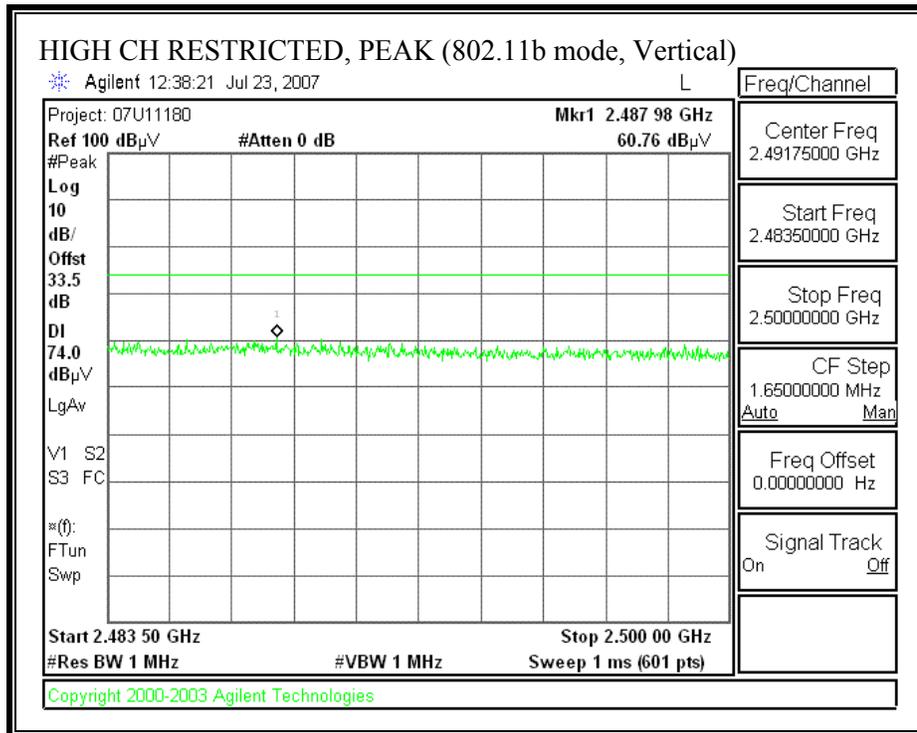


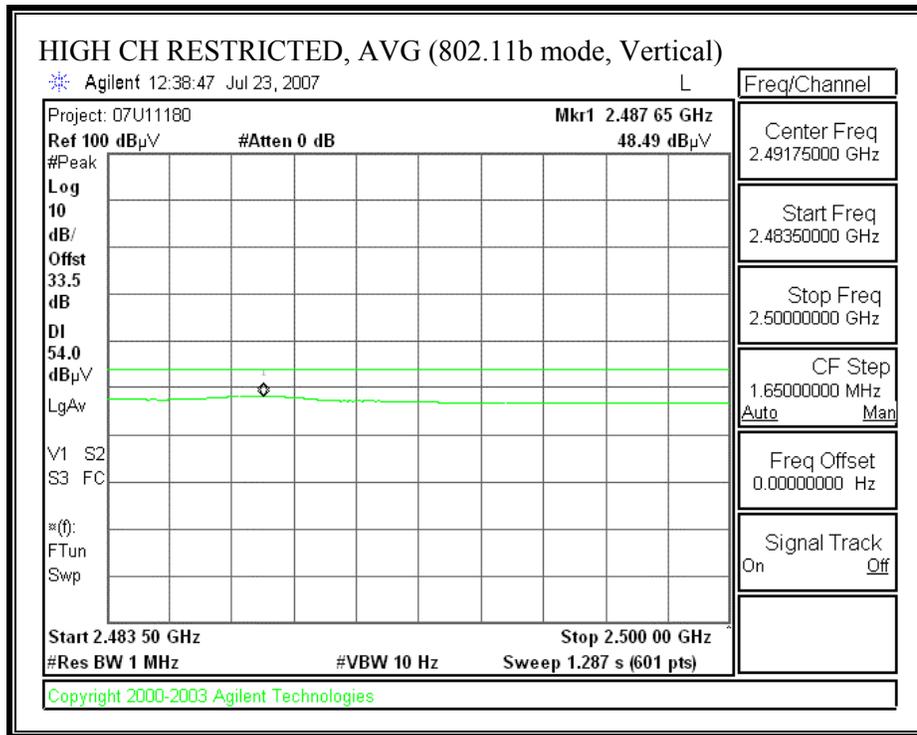
**RESTRICTED BANDEDGE (b MODE, HIGH CHANNEL, HORIZONTAL)**





**RESTRICTED BANDEDGE (b MODE, HIGH CHANNEL, VERTICAL)**





**HARMONICS AND SPURIOUS EMISSIONS (b MODE)**

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Apple Computer  
 Project #: 07U11180  
 Date: 07/23/2007  
 Test Engineer: Ninous Davoudi  
 Configuration: Stand-alone EUT  
 Mode: b mode

**Test Equipment:**

Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz	Limit
T59; S/N: 3245 @3m	T145 Agilent 3008A0056			FCC 15.209

Hi Frequency Cables

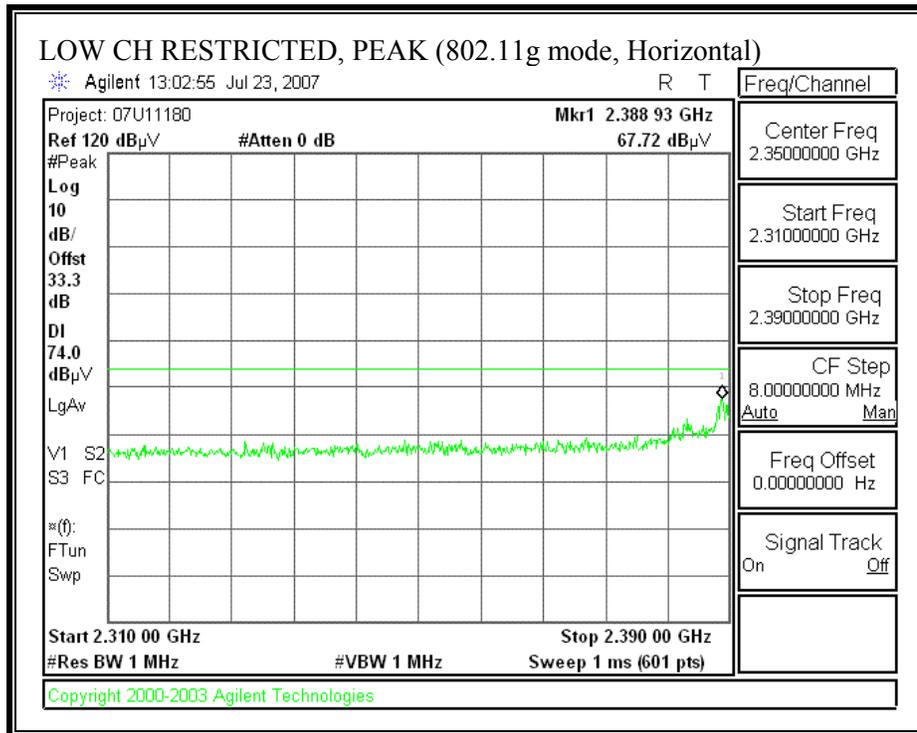
2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz
		A-5m Chamber	HPF_4.0GHz		Average Measurements RBW=1MHz; VBW=10Hz

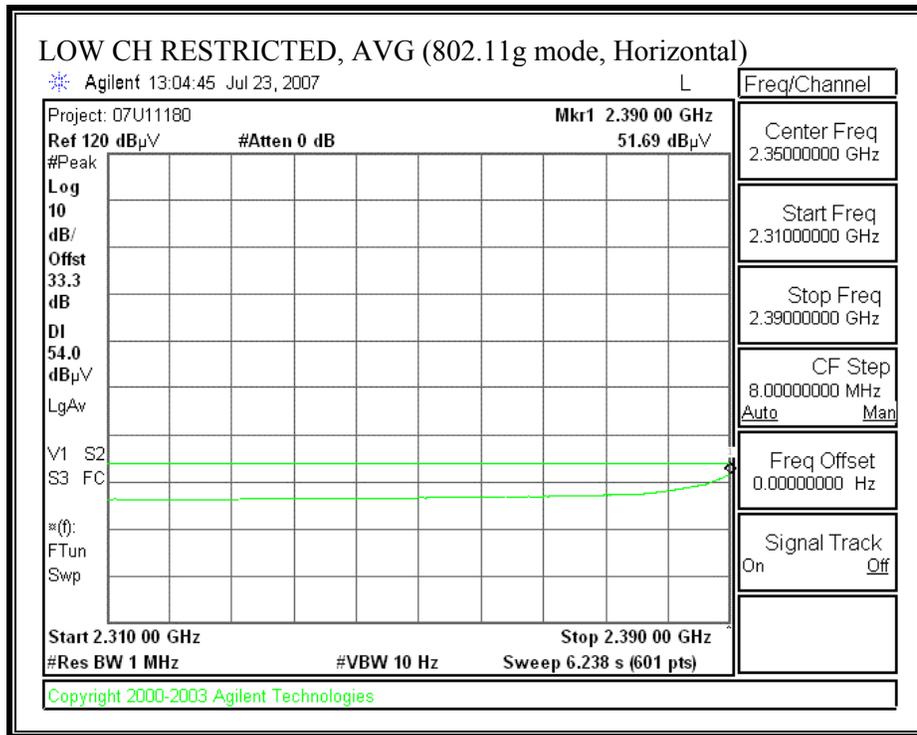
f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>L ch</b>															
4.8	3.0	40.1	31.2	33.2	6.9	-34.8	0.0	0.6	45.9	37.0	74	54	-28.1	-17.0	H
7.236	3.0	37.9	25.4	35.2	8.4	-34.7	0.0	0.6	47.4	34.9	74	54	-26.6	-19.1	H
9.648	3.0	38.1	30.5	36.7	9.7	-35.0	0.0	0.8	50.2	42.7	74	54	-23.8	-11.3	H
4.800	3.0	38.8	28.3	33.1	6.9	-34.8	0.0	0.6	44.5	34.0	74	54	-29.5	-20.0	V
7.236	3.0	38.7	25.6	35.2	8.4	-34.7	0.0	0.6	48.2	35.1	74	54	-25.8	-18.9	V
9.648	3.0	40.1	33.7	36.7	9.7	-35.0	0.0	0.8	52.2	45.8	74	54	-21.8	-8.2	V
<b>M ch</b>															
4.874	3.0	39.2	27.0	33.2	6.9	-34.9	0.0	0.6	45.0	32.9	74	54	-29.0	-21.1	V
7.308	3.0	37.8	25.0	35.2	8.4	-34.7	0.0	0.6	47.4	34.6	74	54	-26.6	-19.4	V
9.748	3.0	40.9	35.2	36.7	9.8	-35.0	0.0	0.8	53.2	47.5	74	54	-20.8	-6.5	V
4.874	3.0	40.9	30.6	33.2	6.9	-34.9	0.0	0.6	46.8	36.5	74	54	-27.2	-17.5	H
7.308	3.0	36.5	24.7	35.2	8.4	-34.7	0.0	0.6	46.1	34.3	74	54	-27.9	-19.7	H
9.748	3.0	39.4	31.8	36.7	9.8	-35.0	0.0	0.8	51.7	44.0	74	54	-22.3	-10.0	H
<b>H ch</b>															
4.924	3.0	38.7	26.8	33.2	7.0	-34.9	0.0	0.6	44.6	32.7	74	54	-29.4	-21.3	H
7.386	3.0	38.1	25.0	35.3	8.4	-34.6	0.0	0.6	47.8	34.8	74	54	-26.2	-19.2	H
9.848	3.0	38.8	32.2	36.7	9.9	-35.1	0.0	0.8	51.2	44.6	74	54	-22.8	-9.4	H
4.924	3.0	38.7	26.0	33.2	7.0	-34.9	0.0	0.6	44.7	32.0	74	54	-29.3	-22.0	V
7.386	3.0	39.7	25.9	35.3	8.4	-34.6	0.0	0.6	49.5	35.6	74	54	-24.5	-18.4	V
9.848	3.0	42.5	37.0	36.7	9.9	-35.1	0.0	0.8	54.9	49.4	74	54	-19.1	-4.6	V

**Note:** EUT was scanned from 1 GHz to 25 GHz, no other emissions were detected above the system noise floor

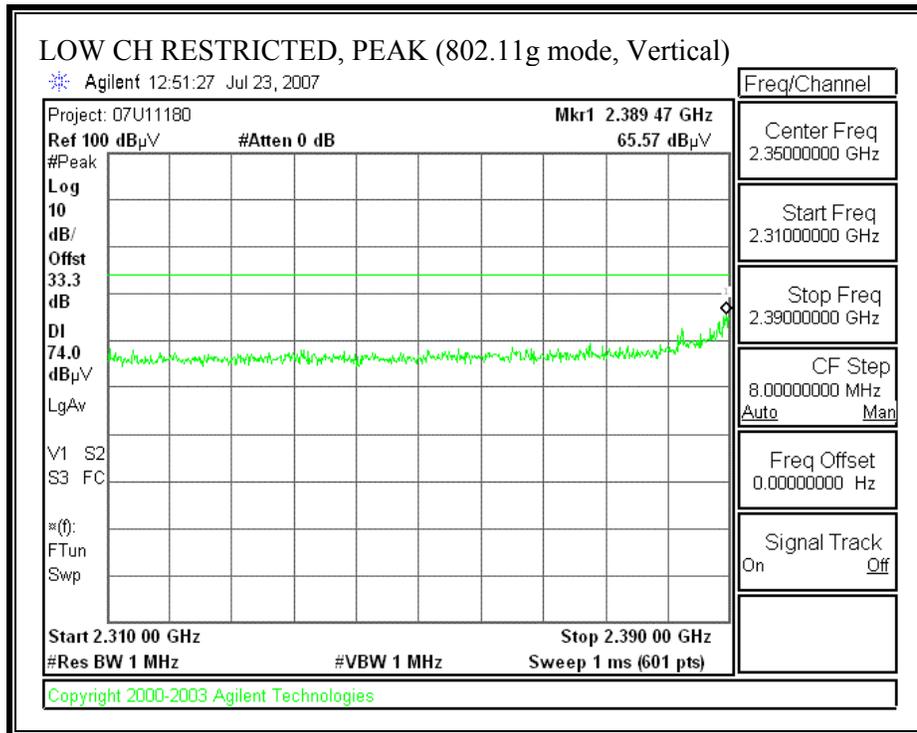
f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

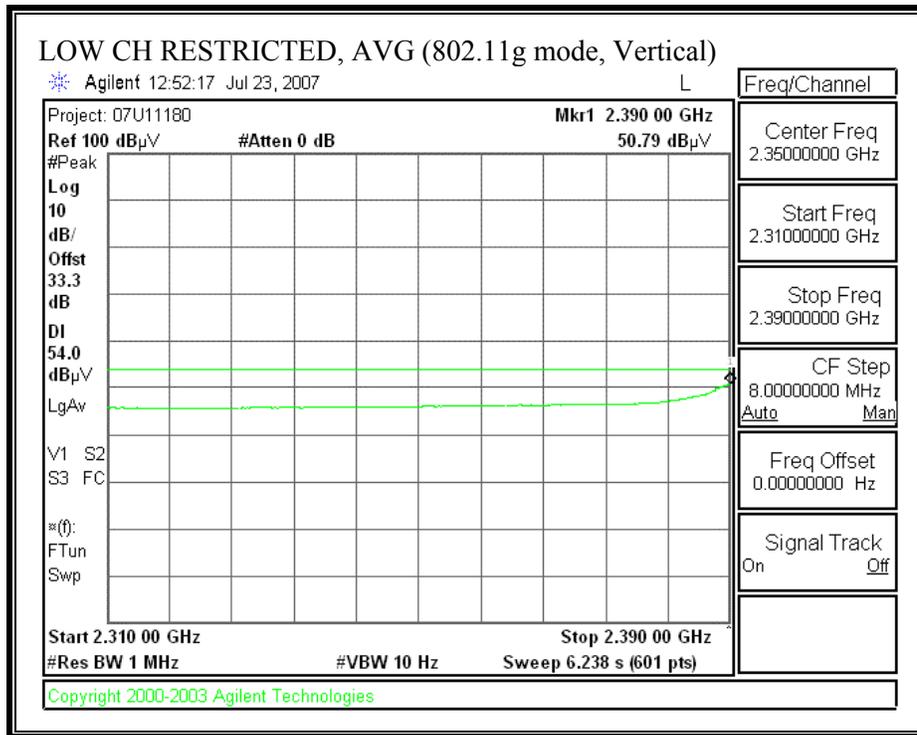
**RESTRICTED BANDEDGE (g MODE, LOW CHANNEL, HORIZONTAL)**



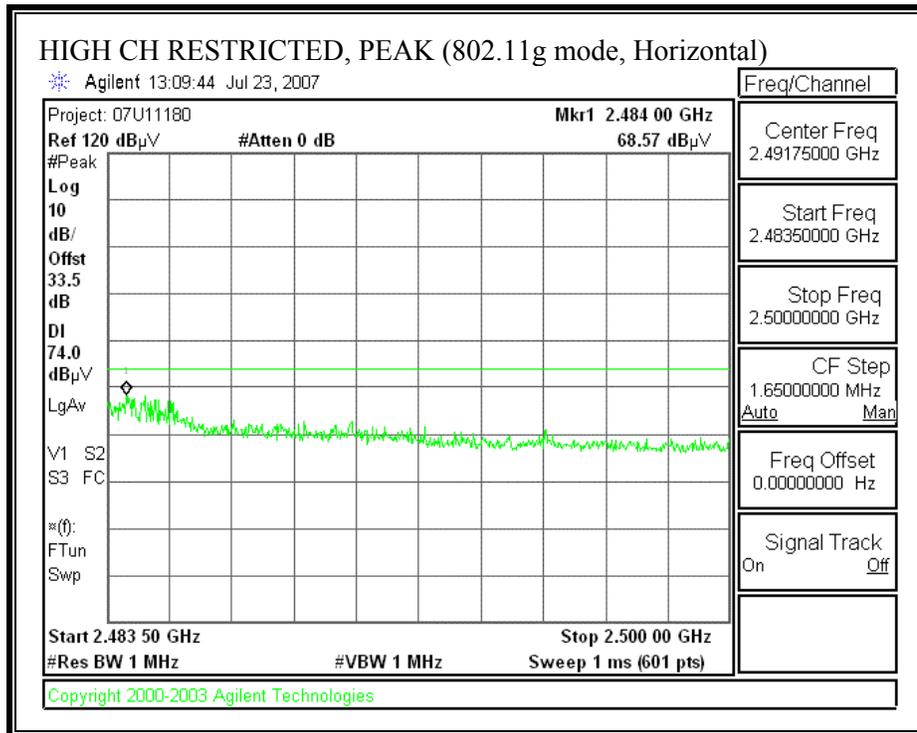


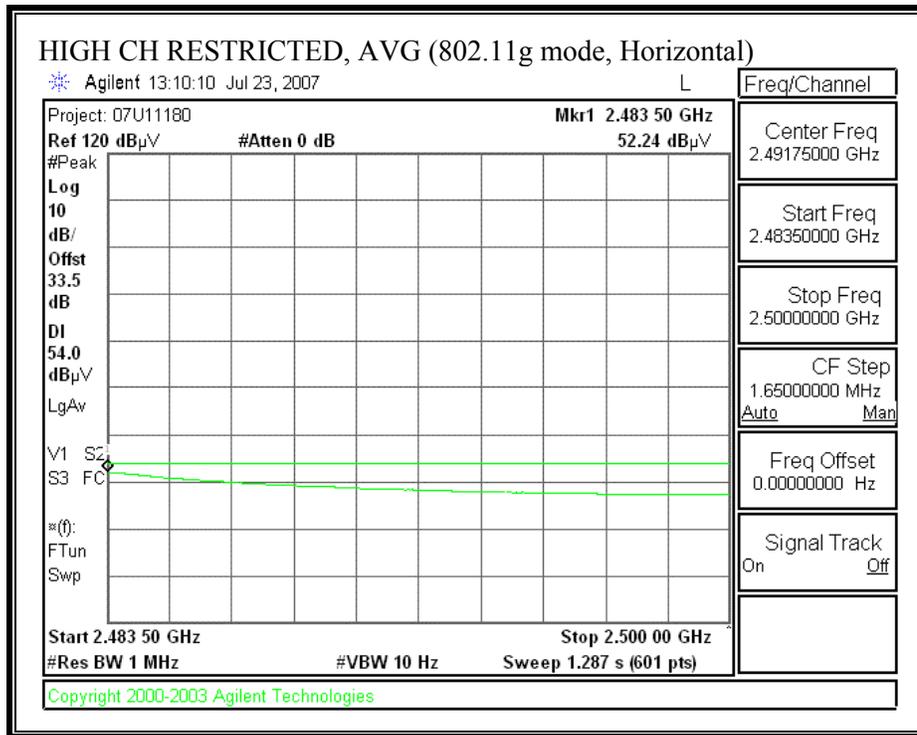
**RESTRICTED BANDEDGE (g MODE, LOW CHANNEL, VERTICAL)**



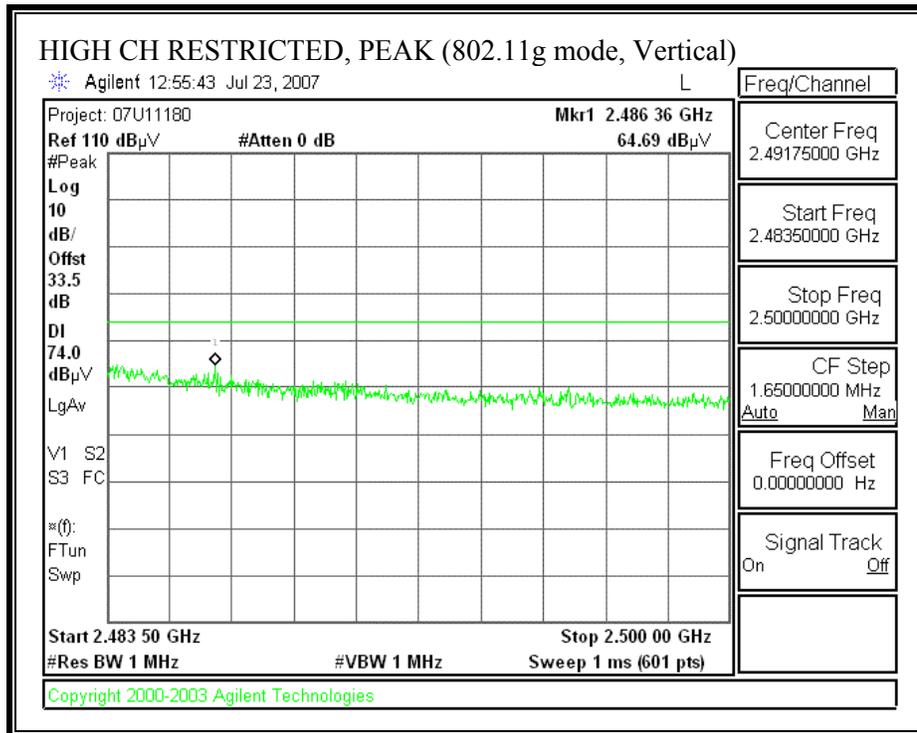


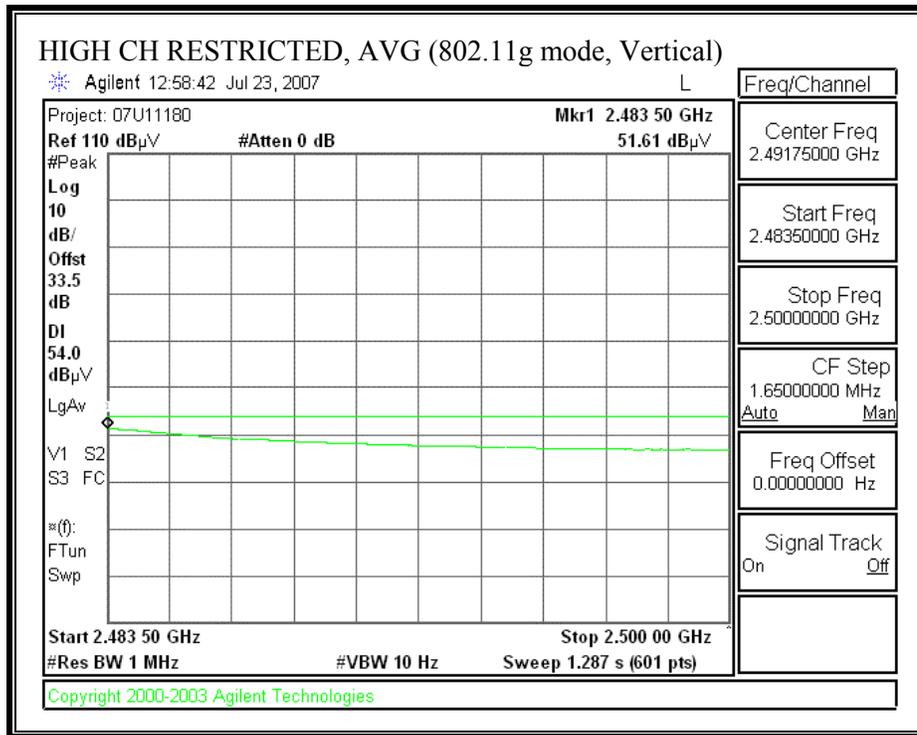
**RESTRICTED BANDEDGE (g MODE, HIGH CHANNEL, HORIZONTAL)**





**RESTRICTED BANDEDGE (g MODE, HIGH CHANNEL, VERTICAL)**





**HARMONICS AND SPURIOUS EMISSIONS (g MODE)**

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Apple Computer  
 Project #: 07U11180  
 Date: 07/23/07  
 Test Engineer: Ninous Davoudi  
 Configuration: Stand-alone EUT  
 Mode: g mode

**Test Equipment:**

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T59; S/N: 3245 @3m	T145 Agilent 3008A0056			FCC 15.209

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz
		A-5m Chamber	HPF_4.0GHz		Average Measurements RBW=1MHz ; VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>L ch</b>															
4.824	3.0	38.1	26.1	33.2	6.9	-34.8	0.0	0.6	43.9	31.9	74	54	-30.1	-22.1	H
7.236	3.0	37.8	25.6	35.2	8.4	-34.7	0.0	0.6	47.3	35.1	74	54	-26.7	-18.9	H
4.800	3.0	38.6	26.1	33.1	6.9	-34.8	0.0	0.6	44.4	31.9	74	54	-29.6	-22.1	V
7.236	3.0	37.5	25.4	35.2	8.4	-34.7	0.0	0.6	47.0	34.9	74	54	-27.0	-19.1	V
<b>M ch</b>															
4.874	3.0	38.9	26.2	33.2	6.9	-34.9	0.0	0.6	44.8	32.1	74	54	-29.2	-21.9	V
7.308	3.0	37.2	24.8	35.2	8.4	-34.7	0.0	0.6	46.8	34.4	74	54	-27.2	-19.6	V
4.874	3.0	39.1	26.3	33.2	6.9	-34.9	0.0	0.6	45.0	32.2	74	54	-29.0	-21.8	H
7.308	3.0	38.6	25.4	35.2	8.4	-34.7	0.0	0.6	48.2	35.0	74	54	-25.8	-19.0	H
<b>H ch</b>															
4.924	3.0	39.2	25.3	33.2	7.0	-34.9	0.0	0.6	45.2	31.3	74	54	-28.8	-22.7	H
7.386	3.0	38.7	24.9	35.3	8.4	-34.6	0.0	0.6	48.4	34.6	74	54	-25.6	-19.4	H
4.924	3.0	39.1	24.8	33.2	7.0	-34.9	0.0	0.6	45.1	30.8	74	54	-28.9	-23.2	V
7.386	3.0	39.5	25.3	35.3	8.4	-34.6	0.0	0.6	49.2	35.0	74	54	-24.8	-19.0	V

**Note:** EUT was scanned from 1 GHz to 25 GHz, no other emissions were detected above the system noise floor

f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

**HARMONICS AND SPURIOUS EMISSIONS (RX MODE)**

**High Frequency Measurement**  
 Compliance Certification Services, Fremont 5m Chamber

Company: Apple Computer  
 Project #: 07U11180  
 Date: 07/23/07  
 Test Engineer: Ninous Davoudi  
 Configuration: Stand-alone EUT  
 Mode: RX mode

**Test Equipment:**

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T59; S/N: 3245 @3m	T145 Agilent 3008A0056		T89; ARA 18-26GHz; S/N:1049	RX RSS 210

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz
		A-5m Chamber	HPF_4.0GHz		Average Measurements RBW=1MHz ; VBW=10Hz

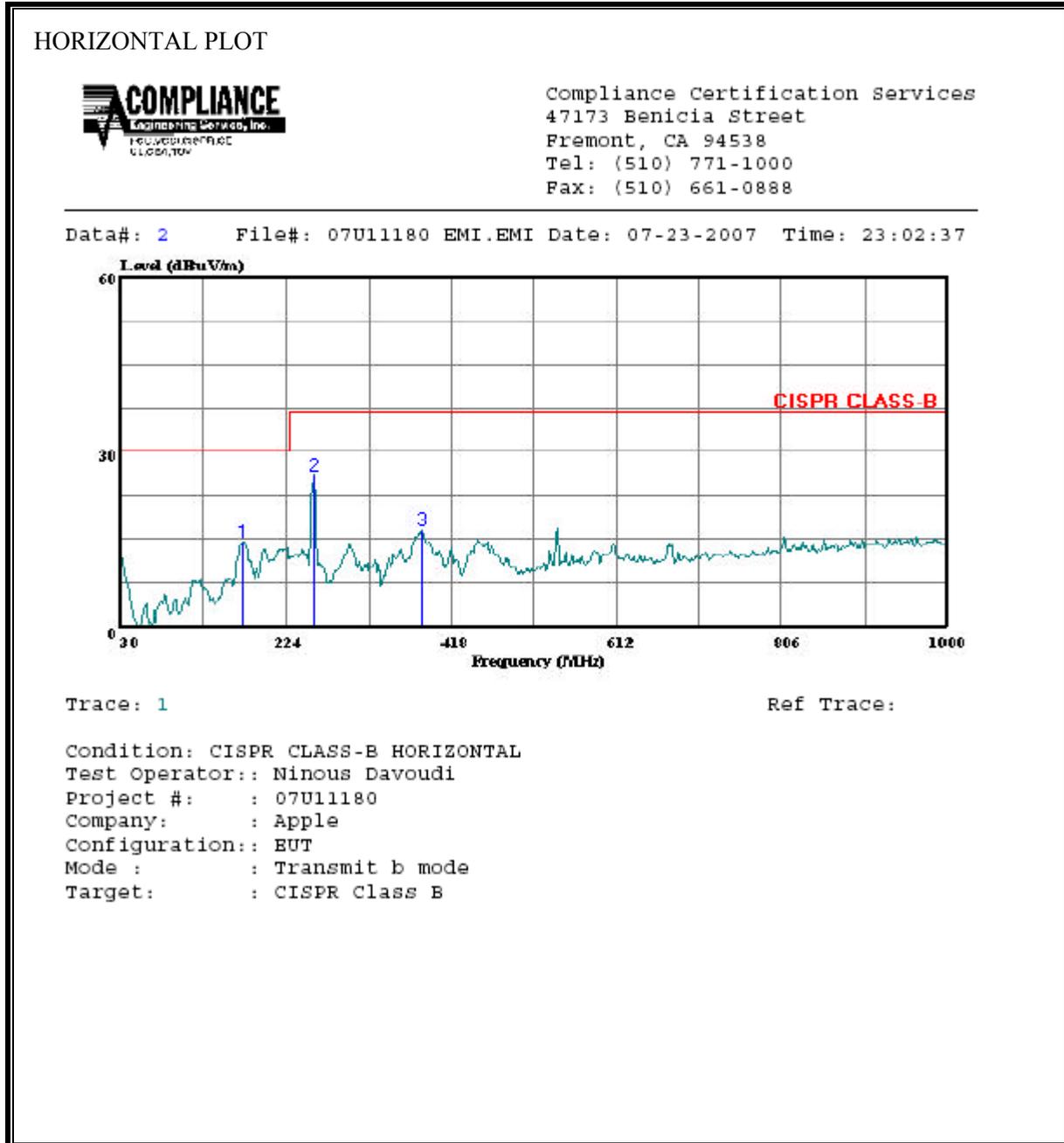
f GHz	Dist (m)	Read Pk dBuV	Read Avg dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filtr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
<b>L ch</b>															
4.8	3.0	40.1	31.2	33.2	6.9	-34.8	0.0	0.6	45.9	37.0	74	54	-28.1	-17.0	H
7.236	3.0	37.9	25.4	35.2	8.4	-34.7	0.0	0.6	47.4	34.9	74	54	-26.6	-19.1	H
9.648	3.0	38.1	30.5	36.7	9.7	-35.0	0.0	0.8	50.2	42.7	74	54	-23.8	-11.3	H
4.800	3.0	38.8	28.3	33.1	6.9	-34.8	0.0	0.6	44.5	34.0	74	54	-29.5	-20.0	V
7.236	3.0	38.7	25.6	35.2	8.4	-34.7	0.0	0.6	48.2	35.1	74	54	-25.8	-18.9	V
9.648	3.0	40.1	33.7	36.7	9.7	-35.0	0.0	0.8	52.2	45.8	74	54	-21.8	-8.2	V
<b>M ch</b>															
4.874	3.0	39.2	27.0	33.2	6.9	-34.9	0.0	0.6	45.0	32.9	74	54	-29.0	-21.1	V
7.308	3.0	37.8	25.0	35.2	8.4	-34.7	0.0	0.6	47.4	34.6	74	54	-26.6	-19.4	V
9.748	3.0	40.9	35.2	36.7	9.8	-35.0	0.0	0.8	53.2	47.5	74	54	-20.8	-6.5	V
4.874	3.0	40.9	30.6	33.2	6.9	-34.9	0.0	0.6	46.8	36.5	74	54	-27.2	-17.5	H
7.308	3.0	36.5	24.7	35.2	8.4	-34.7	0.0	0.6	46.1	34.3	74	54	-27.9	-19.7	H
9.748	3.0	39.4	31.8	36.7	9.8	-35.0	0.0	0.8	51.7	44.0	74	54	-22.3	-10.0	H
<b>H ch</b>															
4.924	3.0	38.7	26.8	33.2	7.0	-34.9	0.0	0.6	44.6	32.7	74	54	-29.4	-21.3	H
7.386	3.0	38.1	25.0	35.3	8.4	-34.6	0.0	0.6	47.8	34.8	74	54	-26.2	-19.2	H
9.848	3.0	38.8	32.2	36.7	9.9	-35.1	0.0	0.8	51.2	44.6	74	54	-22.8	-9.4	H
4.924	3.0	38.7	26.0	33.2	7.0	-34.9	0.0	0.6	44.7	32.0	74	54	-29.3	-22.0	V
7.386	3.0	39.7	25.9	35.3	8.4	-34.6	0.0	0.6	49.5	35.6	74	54	-24.5	-18.4	V
9.848	3.0	42.5	37.0	36.7	9.9	-35.1	0.0	0.8	54.9	49.4	74	54	-19.1	-4.6	V

**Note:** EUT was scanned from 1 GHz to 25 GHz, no other emissions were detected above the system noise floor.

f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

### 7.2.2. RADIATED EMISSIONS BELOW 1 GHz

#### SPURIOUS EMISSIONS 30 TO 1000 MHz (11b MODE, HORIZONTAL)



HORIZONTAL DATA

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	172.590	29.22	-14.72	14.50	30.00	-15.50	Peak
2	256.980	39.73	-13.86	25.87	37.00	-11.13	Peak
3	383.080	26.87	-10.25	16.62	37.00	-20.38	Peak

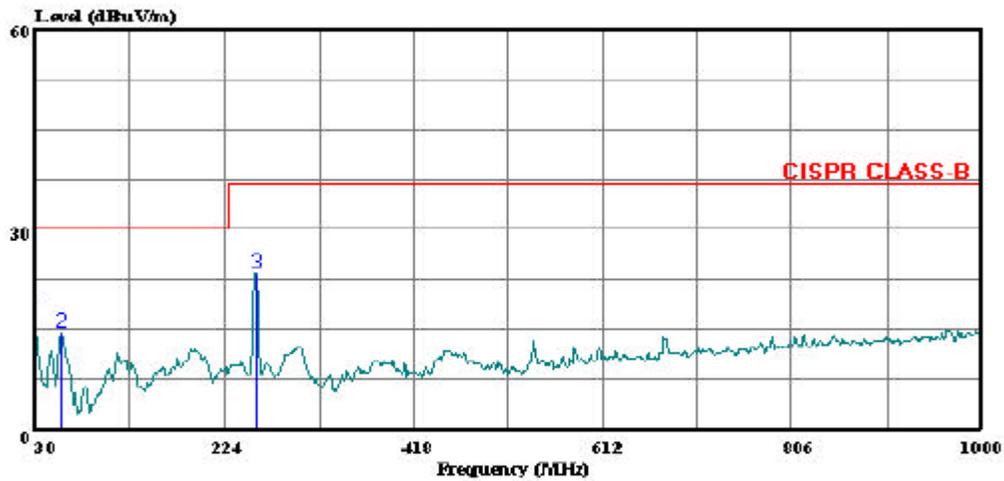
**SPURIOUS EMISSIONS 30 TO 1000 MHz (11b MODE, VERTICAL)**

VERTICAL PLOT



Compliance Certification Services  
47173 Benicia Street  
Fremont, CA 94538  
Tel: (510) 771-1000  
Fax: (510) 661-0888

Data#: 4 File#: 07U11180 EMI.EMI Date: 07-23-2007 Time: 23:20:55



Trace: 3

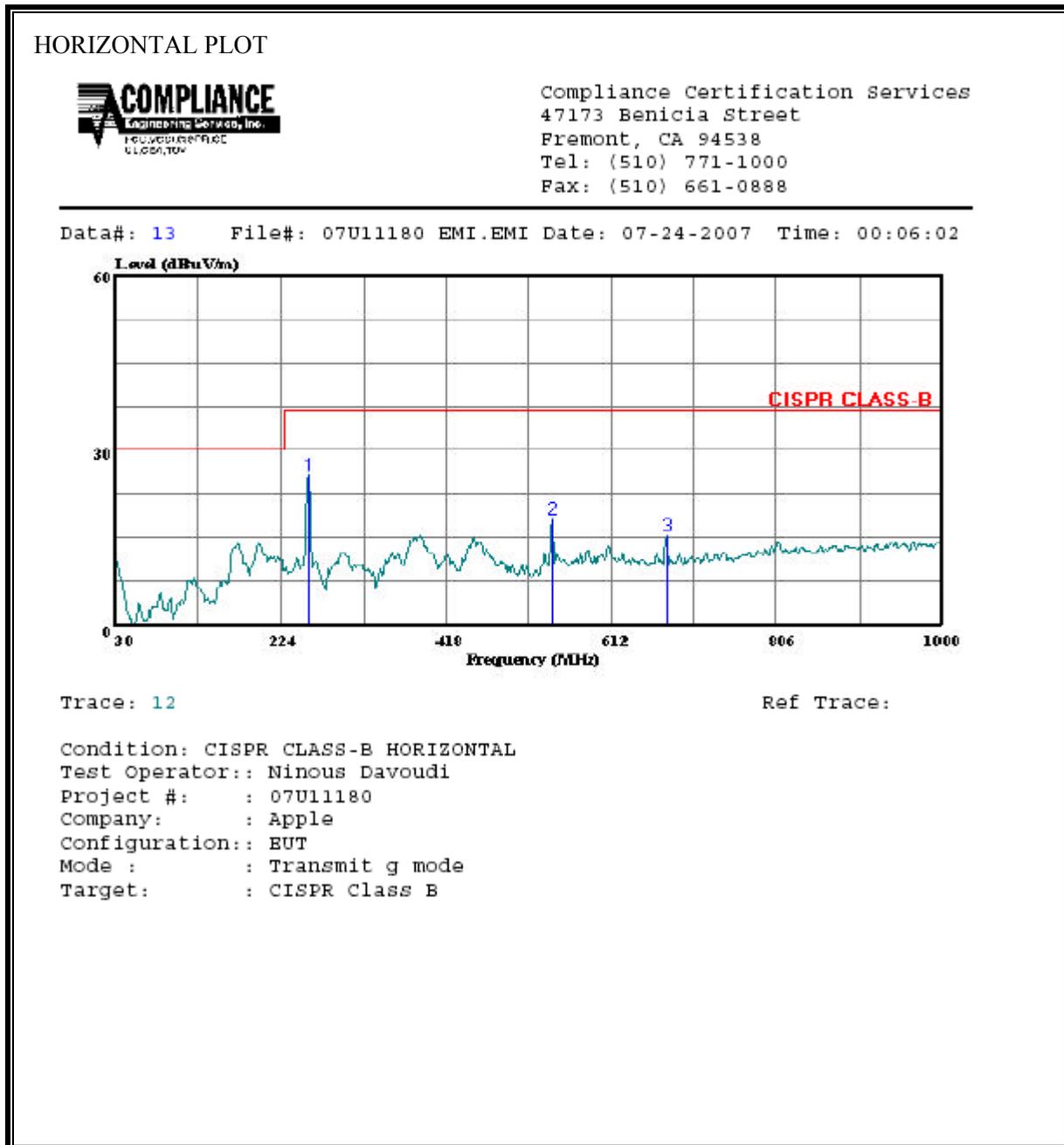
Ref Trace:

Condition: CISPR CLASS-B VERTICAL  
Test Operator:: Ninous Davoudi  
Project #: : 07U11180  
Company: : Apple  
Configuration: : EUT  
Mode : : Transmit b mode  
Target: : CISPR Class B

VERTICAL DATA

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	30.000	21.85	-5.76	16.09	30.00	-13.91	Peak
2	56.190	33.94	-19.49	14.45	30.00	-15.55	Peak
3	256.980	37.30	-13.86	23.44	37.00	-13.56	Peak

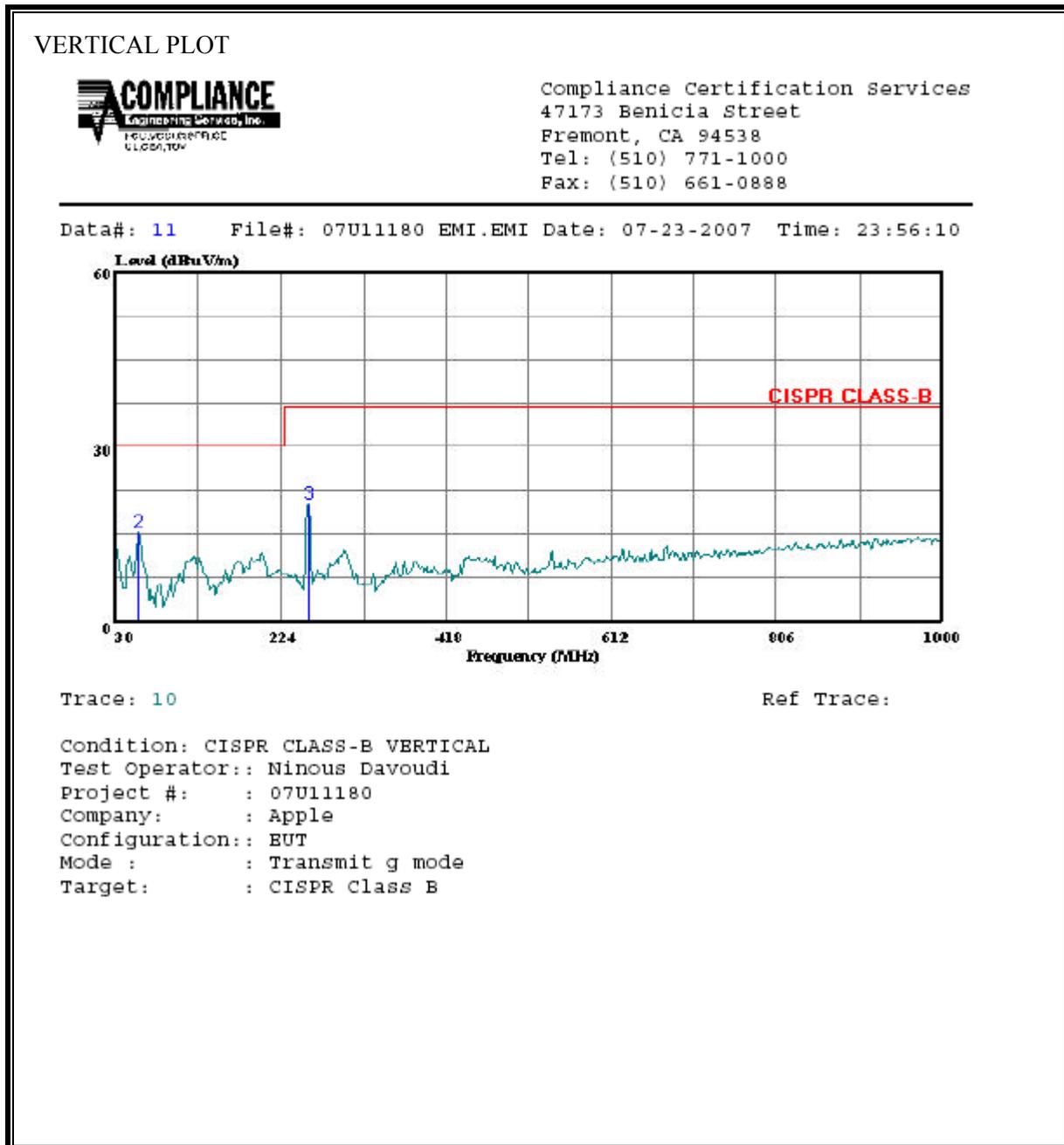
**SPURIOUS EMISSIONS 30 TO 1000 MHz (11g MODE, HORIZONTAL)**



HORIZONTAL DATA

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	256.980	39.47	-13.86	25.61	37.00	-11.39	Peak
2	543.130	24.69	-6.45	18.24	37.00	-18.76	Peak
3	676.990	19.15	-3.90	15.25	37.00	-21.75	Peak

**SPURIOUS EMISSIONS 30 TO 1000 MHz (11g MODE, VERTICAL)**



VERTICAL DATA

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	30.000	21.45	-5.76	15.69	30.00	-14.31	Peak
2	58.130	34.85	-19.59	15.26	30.00	-14.74	Peak
3	256.980	34.14	-13.86	20.28	37.00	-16.72	Peak

### 7.3. POWERLINE CONDUCTED EMISSIONS

#### LIMIT

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\* Decreases with the logarithm of the frequency.

#### TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The resolution bandwidth is set to 9 kHz for both peak detection and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

Line conducted data is recorded for both NEUTRAL and HOT lines.

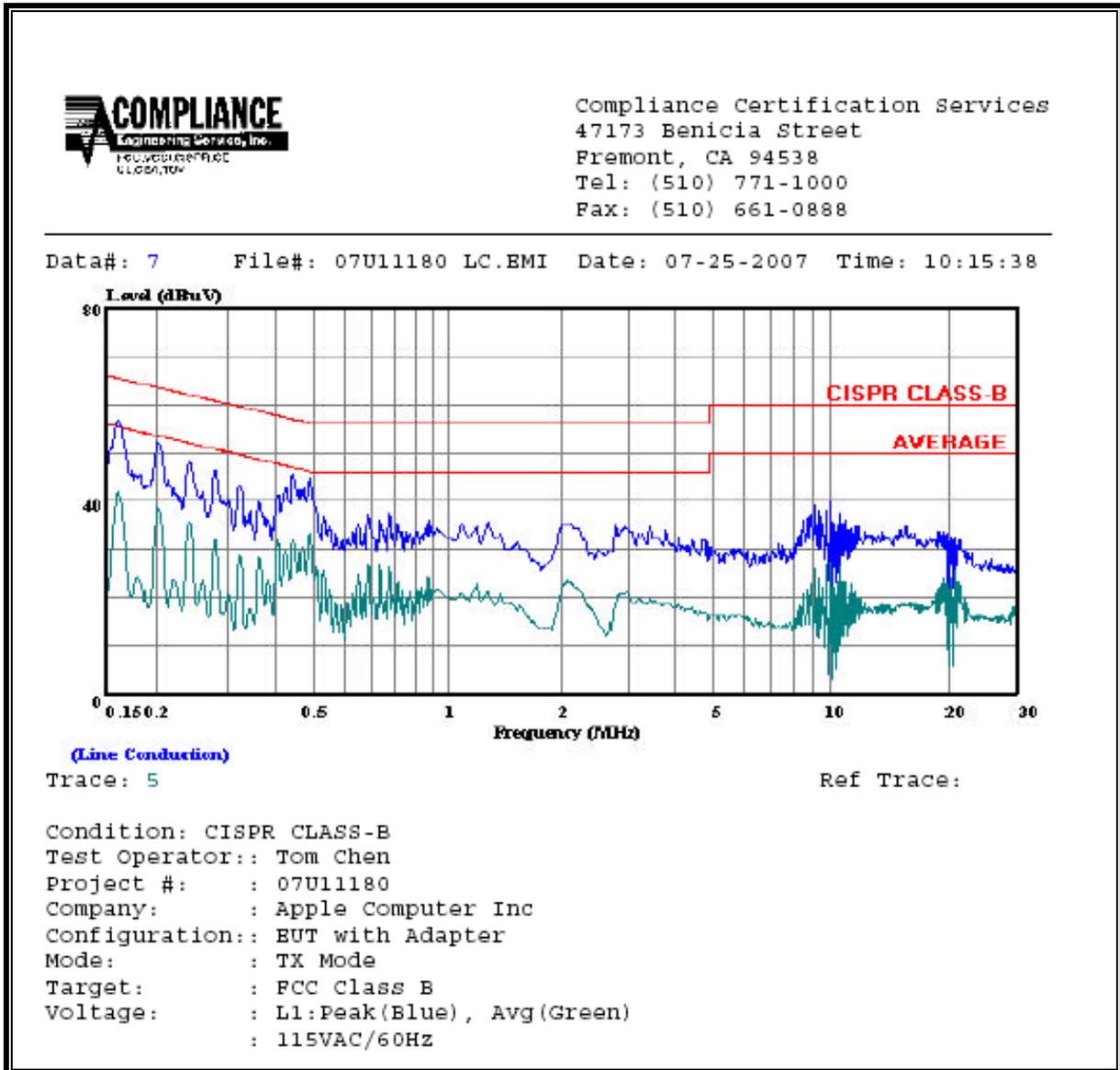
#### RESULTS

No non-compliance noted.

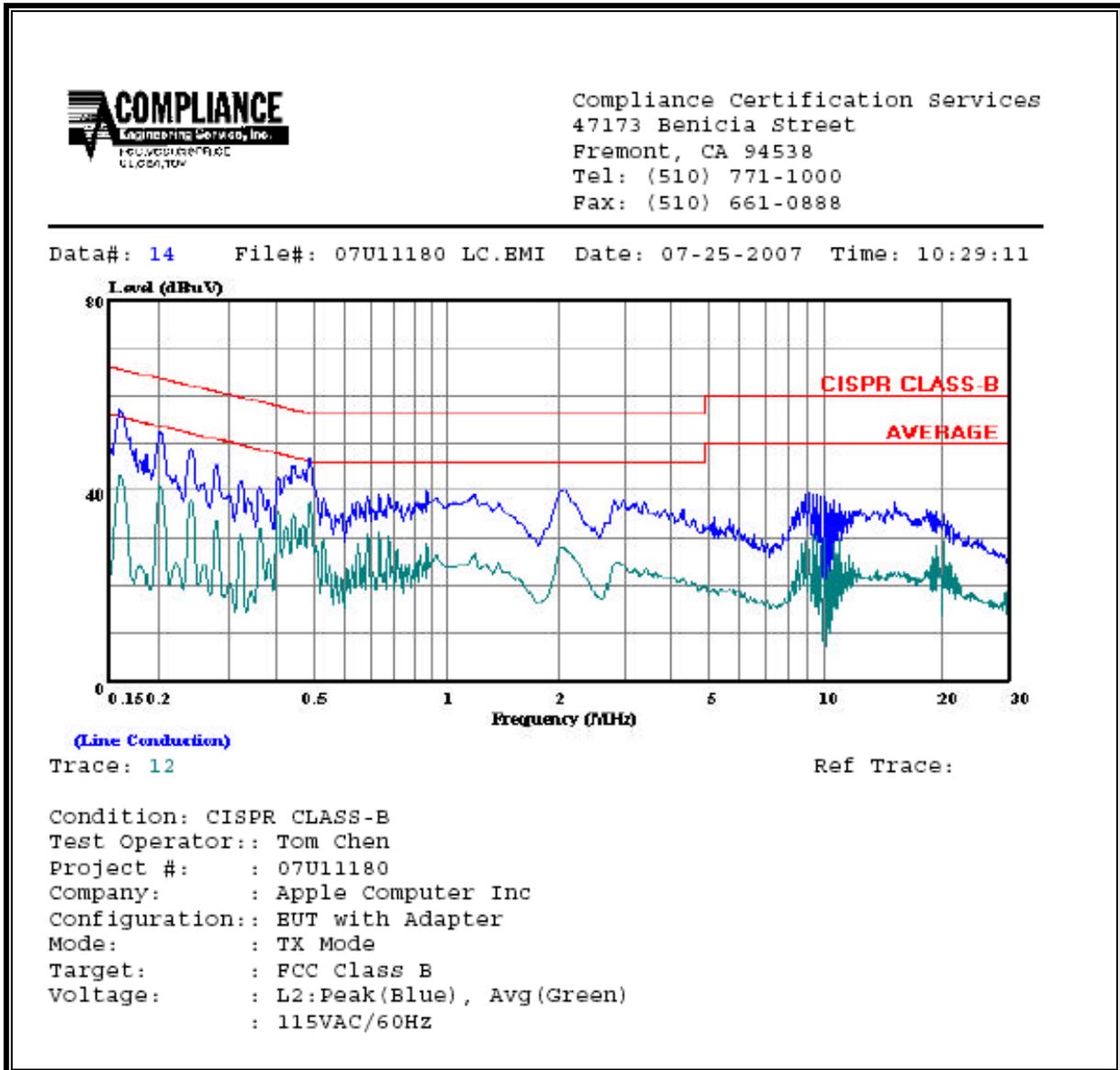
**6 WORST EMISSIONS**

CONDUCTED EMISSIONS DATA (115VAC 60Hz)										
Freq. (MHz)	Reading			Class (dB)	Limit QP	FCC B		Margin		Remark L1 / L2
	PK (dBuV)	QP (dBuV)	AV (dBuV)			AV	QP (dB)	AV (dB)		
0.16	56.66	--	41.76	0.00	65.41	55.41	-8.75	-13.65	L1	
0.20	52.22	--	38.96	0.00	63.57	53.57	-11.35	-14.61	L1	
0.44	45.66	--	31.88	0.00	56.99	46.99	-11.33	-15.11	L1	
0.16	57.00	--	43.23	0.00	65.52	55.52	-8.52	-12.29	L2	
0.20	52.34	--	41.07	0.00	63.57	53.57	-11.23	-12.50	L2	
0.48	46.84	--	37.22	0.00	56.27	46.27	-9.43	-9.05	L2	
6 Worst Data										

**LINE 1 RESULTS**



**LINE 2 RESULTS**



## 7.4. MAXIMUM PERMISSIBLE EXPOSURE

### FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0 .....	614	1.63	*(100)	6
3.0–30 .....	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30–300 .....	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34 .....	614	1.63	*(100)	30
1.34–30 .....	824/f	2.19/f	*(180/f <sup>2</sup> )	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
30–300 .....	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

\* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

**IC RULES**

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

**Table 5  
 Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)**

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m <sup>2</sup> )	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	280/ <i>f</i>	2.19/ <i>f</i>		6
10–30	28	2.19/ <i>f</i>		6
30–300	28	0.073	2*	6
300–1 500	1.585 <i>f</i> <sup>0.5</sup>	0.0042 <i>f</i> <sup>0.5</sup>	<i>f</i> /150	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	616 000 / <i>f</i> <sup>1.2</sup>
150 000–300 000	0.158 <i>f</i> <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> <i>f</i>	616 000 / <i>f</i> <sup>1.2</sup>

\* Power density limit is applicable at frequencies greater than 100 MHz.

- Notes:**
1. Frequency, *f*, is in MHz.
  2. A power density of 10 W/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.
  3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

## **CALCULATIONS**

Given

$$E = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power Density in milliwatts/square centimeter

Combining equations, rearranging the terms to express the distance as a function of the remaining variables, changing to units of Power to mW and Distance to cm, and substituting the logarithmic form of power and gain yields:

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S}$$

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm<sup>2</sup>

Rearranging terms to calculate the power density at a specific distance yields

$$S = 0.0795 * 10^{((P + G) / 10)} / (d^2)$$

The power density in units of mW/cm<sup>2</sup> is converted to units of W/m<sup>2</sup> by multiplying by a factor of 10.

**LIMITS**

From FCC §1.1310 Table 1 (B), the maximum value of  $S = 1.0 \text{ mW/cm}^2$

From IC Safety Code 6, Section 2.2 Table 5 Column 4,  $S = 10 \text{ W/m}^2$

**RESULTS**

Mode	Band	MPE Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	FCC Power Density ( $\text{mW/cm}^2$ )	IC Power Density ( $\text{W/m}^2$ )
802.11b	2.4 GHz	20.0	18.80	3.00	0.03	0.30
802.11g	5 GHz	20.0	18.99	3.00	0.03	0.31

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.