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“Wireless that Works”SM

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EMC Test Report

Report No.: 0208009_80211_1

Product Name: 802.11 Combo MiniPCI WLAN Card

Issued Date: October 17, 2002

Applicant:

Philips Components
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Signature Page

The below listed Hyper Corporation Personnel takes responsibility for the contents of this Test Report.

Signatures

Test Engineer(s):

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Reviewed by
Technical
Manager:

Original signed	10.17.02
_____	_____
Kevin Marquess	Date

1. List of Revisions

Version	Date	Author(s)	Description
001	October 17, 2002	William Elliott	Initial Version

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2. Disclaimer Notice

This test report applies only to the EUT (Equipment Under Test) and the results of the specifications called out in this report.

The test results contained herein relate only to the model(s) identified. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics.

This Report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government.

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4. General Information

4.1 Identification of the EUT

Manufacturer: Philips Components

Model No.: PH11107-E

Hardware Version: Rev. 1.0

Software Version: ART Ver. 2.2 Build 7

FCC ID: PUBWCM1008

Frequency Range: 2402 MHz ~ 2472 MHz; 5725 ~ 5850GHz

Channel Number: 1-13 (2402 ~ 2472 GHz);

149 – 165 (5725 ~ 5850 GHz)

Frequency of Each Channel: $2412 + k*5$ (MHz), $k=0\sim11$

$5745 + k*20$ (MHz), $k=0\sim4$

Sample Received Date: September 24, 2002

Test Dates: September 30, 2002 – October 18, 2002

Test Facility: Hyper Corporation

1279 Quarry Lane, Suite B

Pleasanton, CA 94566, USA

4.2 Antenna Description

Antenna Gain: Peak Gain (2402 ~ 2483.5): .46 dBi
 Ave. Gain (2402 ~ 2483.5): -2.8 dBi
 Peak Gain (5725 ~ 5850) : -.49 dBi
 Ave. Gain (5725 ~ 5850) : -2.73 dBi

5. Test Summary

This test report is prepared for the project of 802.11 Combo MiniPCI WLAN Card

5.1 Summary of Test Results

Test	Reference	Results
6 dB Bandwidth	FCC 15.247(a)(2)	Compliant
Peak Power	FCC 15.247(b)(1) IC RSS210 6.2.2(o)(b)	Compliant
Band-edge Compliance of RF Emissions	FCC 15.247(c) IC RSS210 6.2.2(o)(e1)	Compliant
Out of Band Emissions (Conducted)	FCC 15.247(c) IC RSS210 6.2.2(o)(e1)	Compliant
Peak Power Spectral Density	FCC 15.247(d) IC RSS210 6.2.2(o)(b)	Compliant

5.2 Test Specifications

The EUT testing was performed according to the procedures in FCC Part 15 Subpart C section 15.247 and ANSI C63.4/1992, and also compliance with Industry Canada RSS-210 6.2.2 (O).

5.3 Operation Mode

The EUT was tested in a laptop computer for this testing. The EUT was placed into the necessary test modes using "ART" software supplied by the product manufacturer.

5.4 Documentation of test device

Documentation of the tested device has been reviewed by Hyper Corporation Engineers and found to be in compliance with applicable test specifications. All documentation is kept at Hyper Corporation's Quality Department in the Philips EMC Test Folder for this project number.

5.5 General and Special Conditions

The device inside a host laptop and received power from the mini-pci bus of the host controller. All testing was done in an indoor controlled environment with an average temperature of 25.8° C and relative humidity of 45%.

5.6 Equipment and Cable Configurations

The EUT was connected to the spectrum analyzer via a cable connected to the antenna connector of the EUT. There were no other cabling considerations for the tests.

Manufacturer	Description	Model Number	Serial Number	CAL Date
Agilent Technology	PSA Series Spec. Analyzer	E4440A	US40420768	04/23/02
Compaq	Laptop	N400C	N/A	N/A
IBM	ThinkPad Laptop	2366-21U	78-CRC14	N/A

6.1 6 dB Bandwidth

6.1.1 Operation Environment

Temperature: 25.8°C

Relative Humidity: 45%

6.1.2 Test Setup



6.1.3 Test procedure

The EUT transmitter output is connected to the Spectrum Analyzer.

RBW= 1 MHz, VBW = 3 MHz, Detector Peak. Sweep = Auto(Accuracy).

6 dB bandwidth is the width of the emission that is 6 dB down from the peak of the emission, FCC 15.247(a)(2).

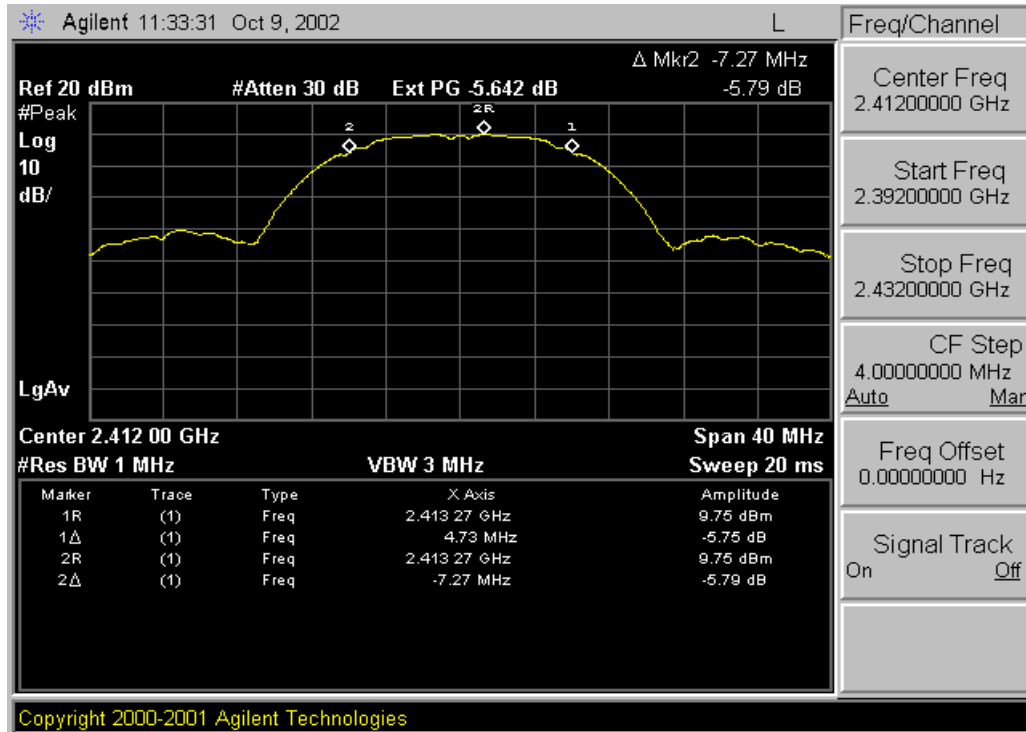
6.1.4 Test Condition

“ The minimum 6dB bandwidth shall be at least 500 kHz”

6.1.5 Results

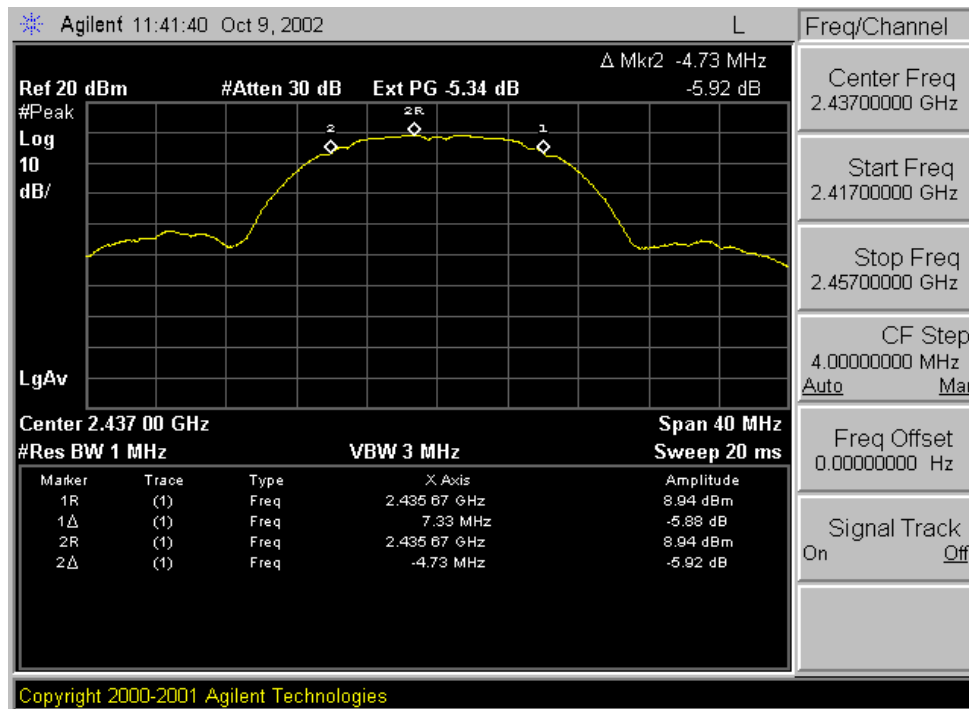
802.11b 2.4 GHz Band

Figure 6.1-1: 6dB Bandwidth 802.11b Low Channel



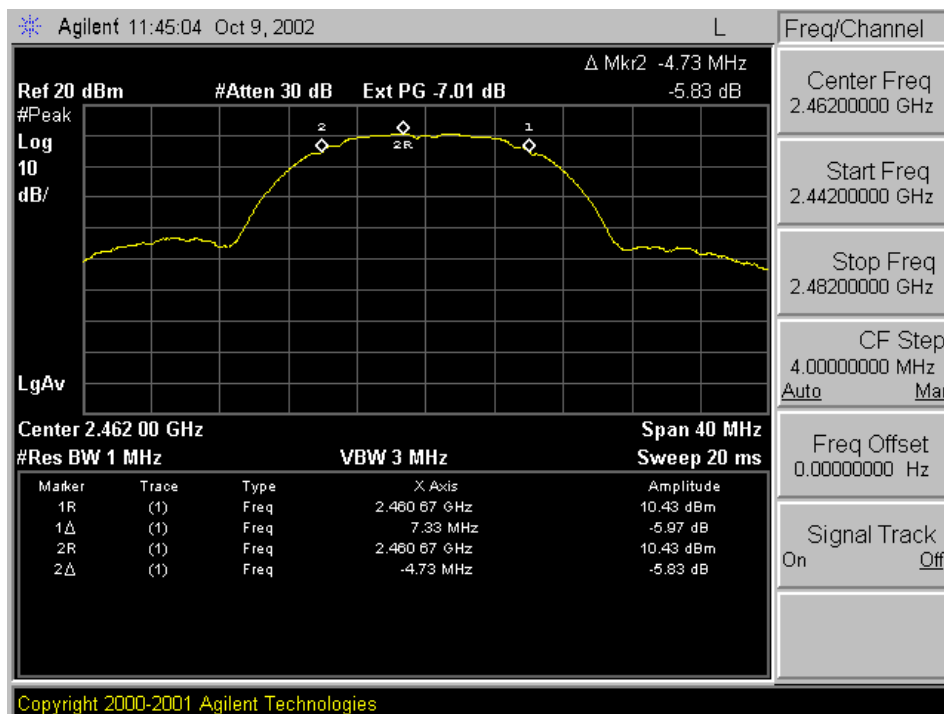
Result = 13.02 MHz – Compliant

Figure 6.1-2: 6dB Bandwidth 802.11b Mid Channel



Result = 12.06 MHz – Compliant

Figure 6.1-3: 6dB Bandwidth 802.11b Hi Channel



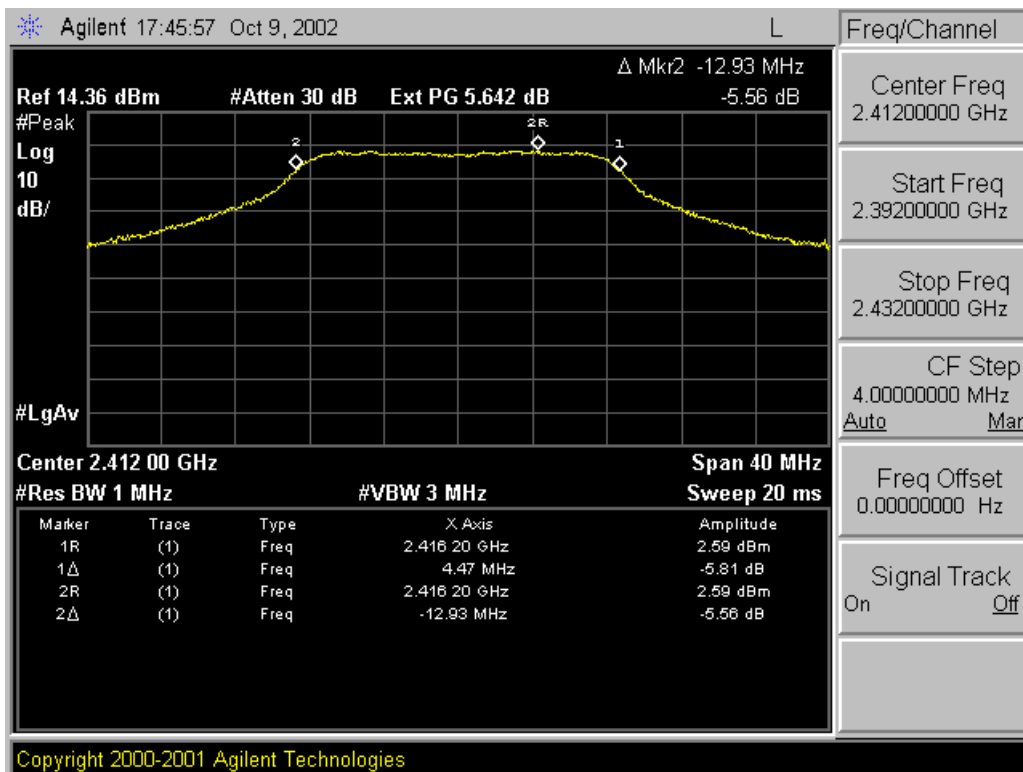
Result = 12.06 MHz – Compliant

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
Lo	2412	13020	500	12520
Mid	2437	12060	500	11560
Hi	2462	12060	500	11560

Table 6.1a – 2.4 GHz Band 802.11b 6dB Bandwidth Results

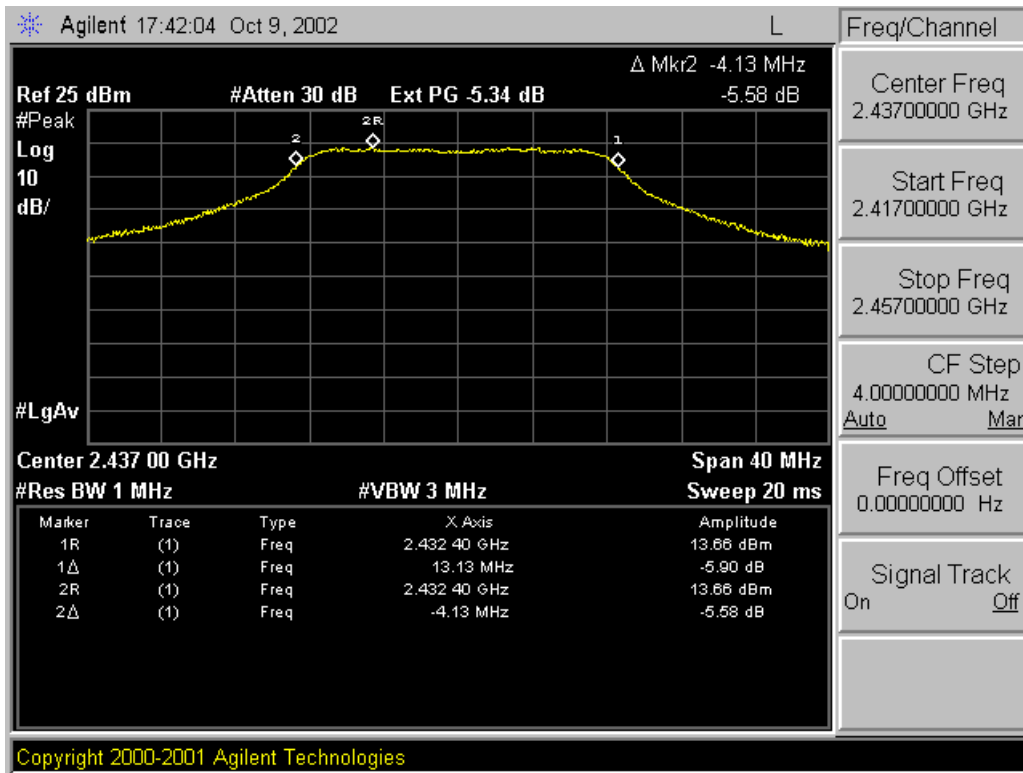
802.11g 2.4 GHz Band

Figure 6.1-4: 6dB Bandwidth 802.11g Lo Channel

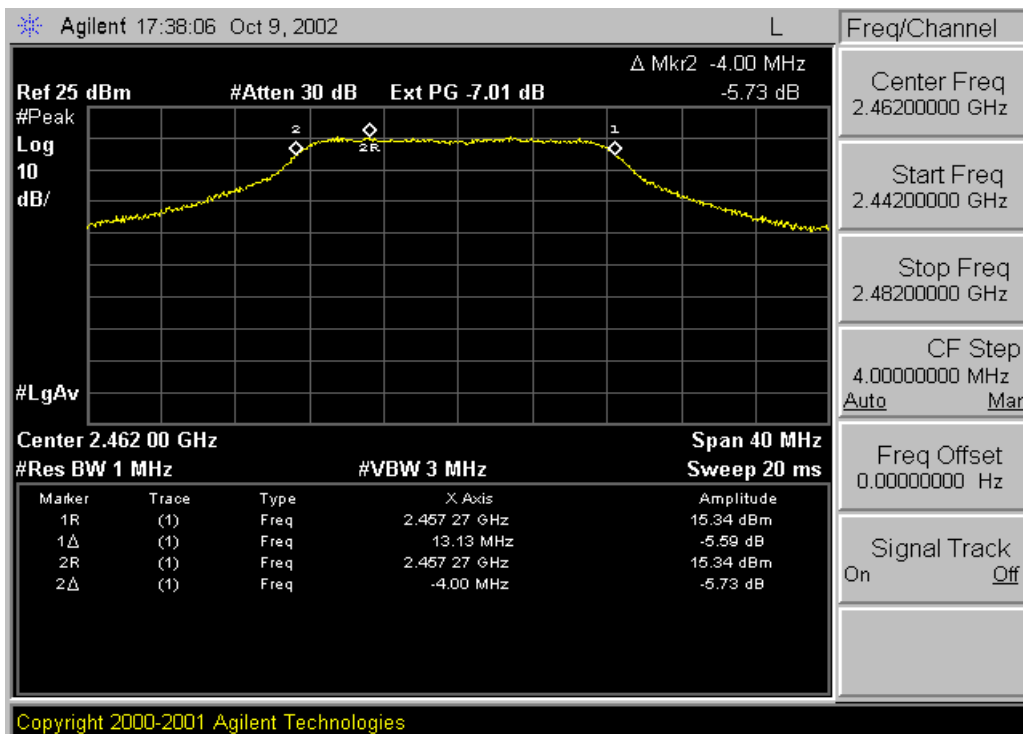


Result = 17.4 MHz – Compliant

Figure 6.1-5: 6dB Bandwidth 802.11g Mid Channel



Result = 17.26 MHz – Compliant
 Figure 6.1-6: 6dB Bandwidth 802.11g Hi Channel



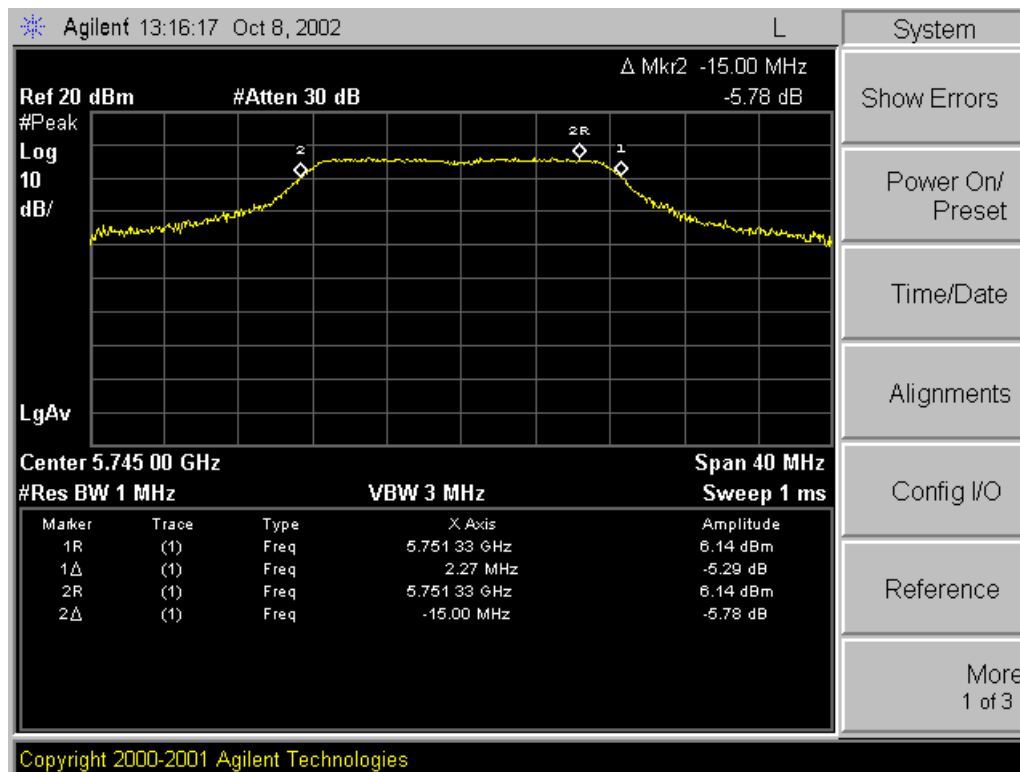
Result = 17.13 MHz – Compliant

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
Lo	2412	17400	500	16900
Mid	2437	17260	500	16760
Hi	2462	17130	500	16630

Table 6.1b – 2.4 GHz Band 802.11g 6dB Bandwidth Results

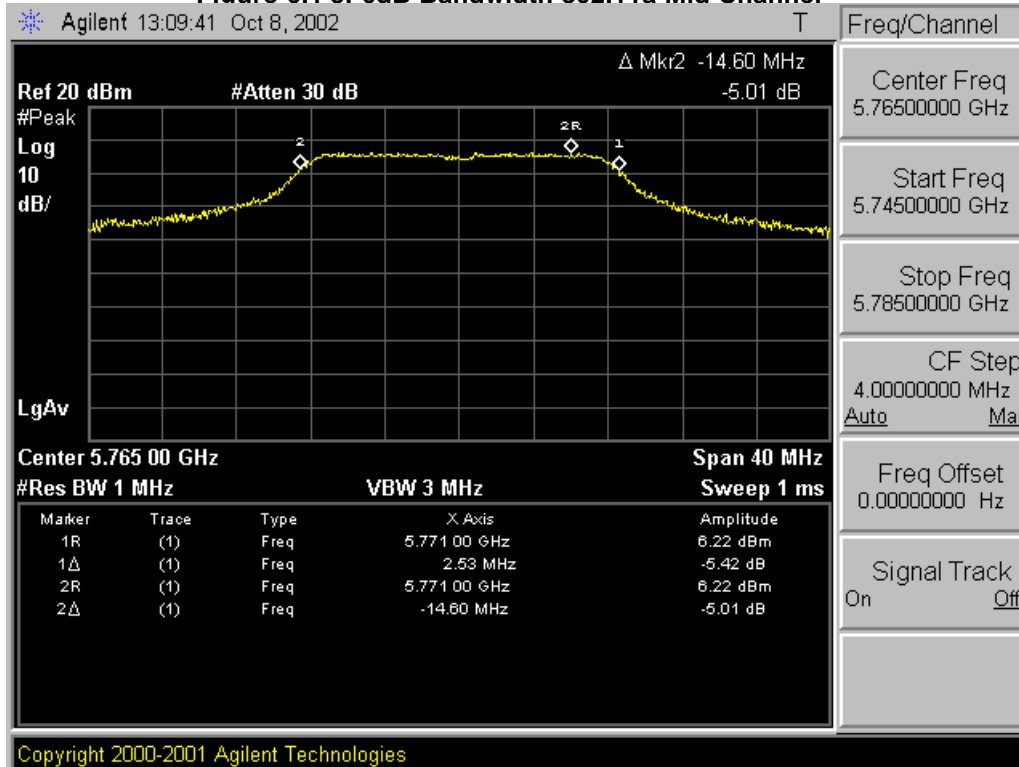
802.11a - 5 GHz Band

Figure 6.1-7: 6dB Bandwidth 802.11a Lo Channel



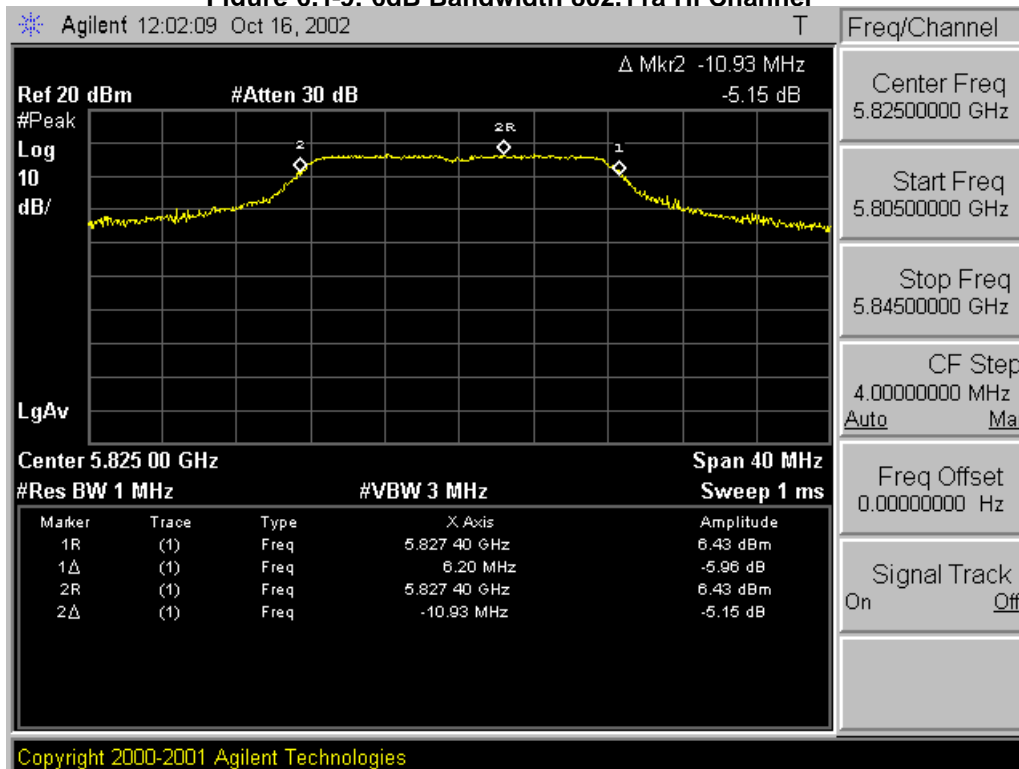
Result = 17.27 MHz – Compliant

Figure 6.1-8: 6dB Bandwidth 802.11a Mid Channel



Result = 16.53 MHz – Compliant

Figure 6.1-9: 6dB Bandwidth 802.11a Hi Channel



Result = 17.13 MHz – Compliant

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
Lo	5745	17270	500	16770
Mid	5785	16530	500	16030
Hi	5825	17130	500	16630

Table 6.1c – 5 GHz Band 802.11a 6dB Bandwidth Results

6.2 Band-edge Measurements

6.2.1 Operation Environment

Temperature: 25.8°C

Relative Humidity: 45%

6.2.2 Test Setup



6.2.3 Test Procedure

The EUT transmitter output is connected to the Spectrum Analyzer. RBW = 100kHz, VBW = 100kHz/300kHz. Sweep = Auto(Accuracy). Three highest points outside the frequency band of operation are indicated, 15.247(c)

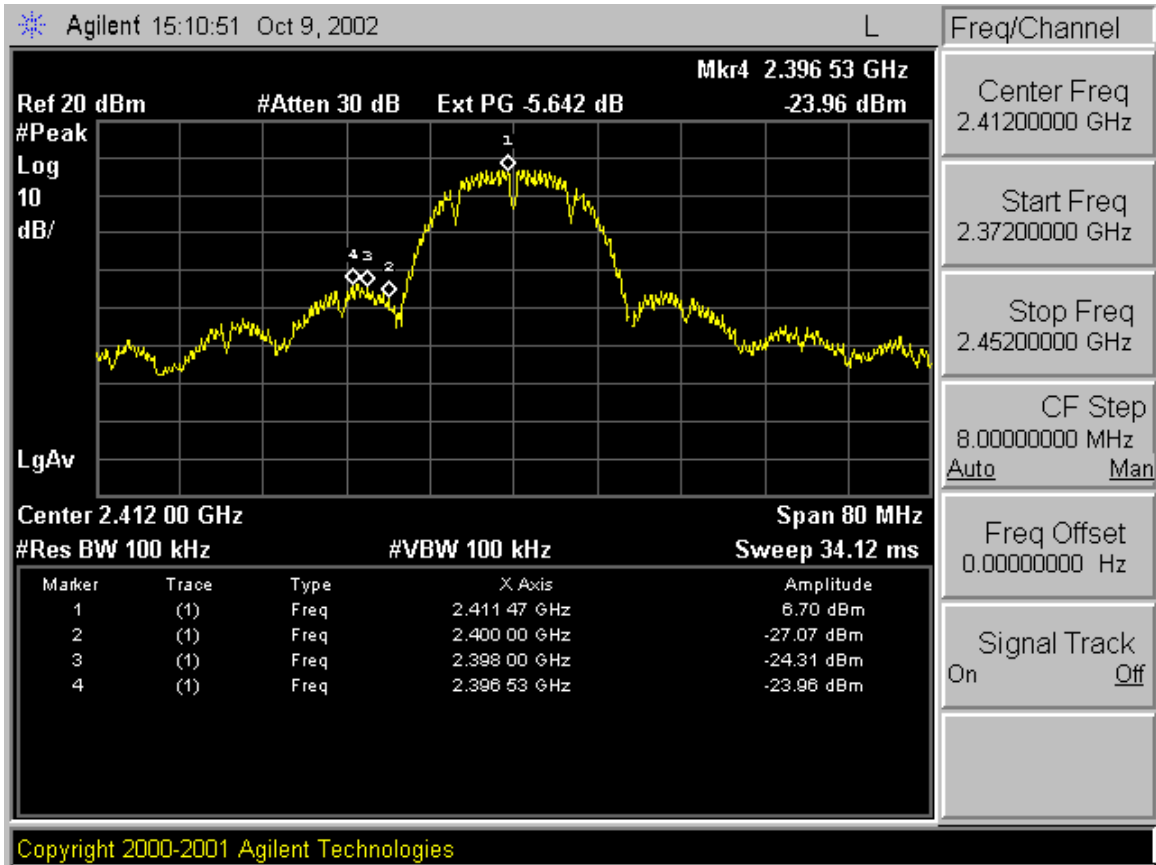
6.2.4 Test Condition

“ In any 100 kHz bandwidth outside the frequency band of operation, the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains highest level of the desired power “

6.2.5 Results

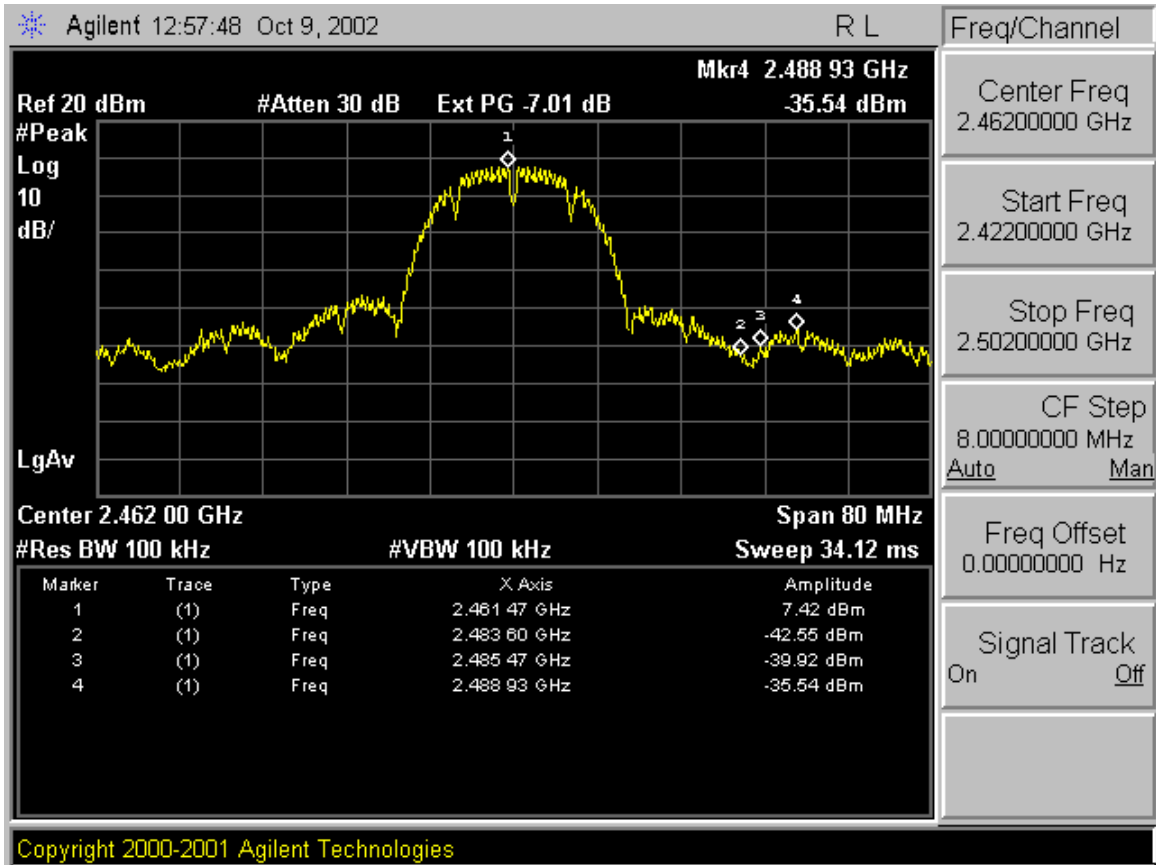
802.11b 2.4 GHz Band

Figure 6.2-1: Lo Band-Edge Measurement 802.11b Lo Channel



Ref = 6.7 dBm at lowest channel (2412 MHz)
 Highest Spur outside Freq. Band = -23.96 dBm
 Emission is 6.7 - (-23.96) = **30.66 dB down**
 Limit = 20 dB below highest level – Compliant

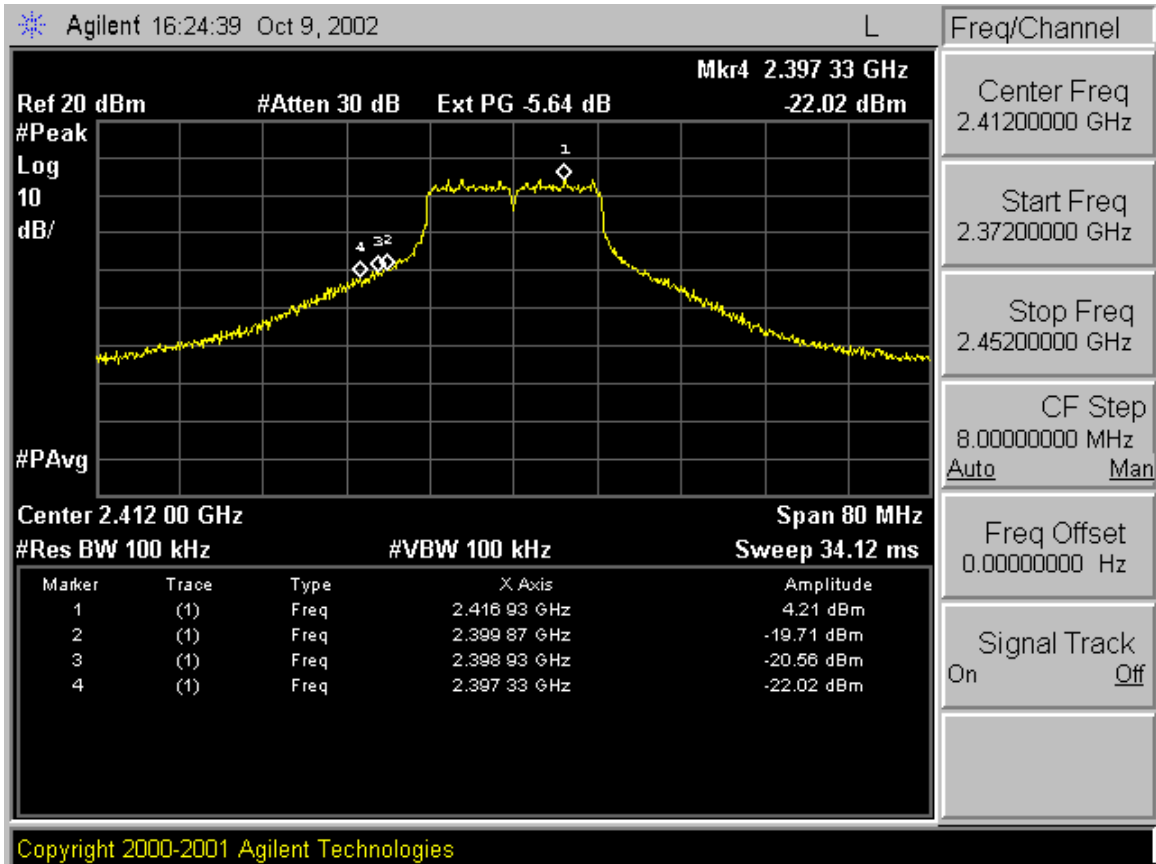
Figure 6.2-2: Hi Band-Edge Measurement 802.11b Hi Channel



Ref = 7.42 dBm at highest channel (2462 MHz)
 Highest Spur outside Freq. Band = -35.54 dBm (2488.93 MHz)
 Emission is $7.42 - (-35.54) = 42.96$ dB down
 Limit = 20 dB below highest level – Compliant

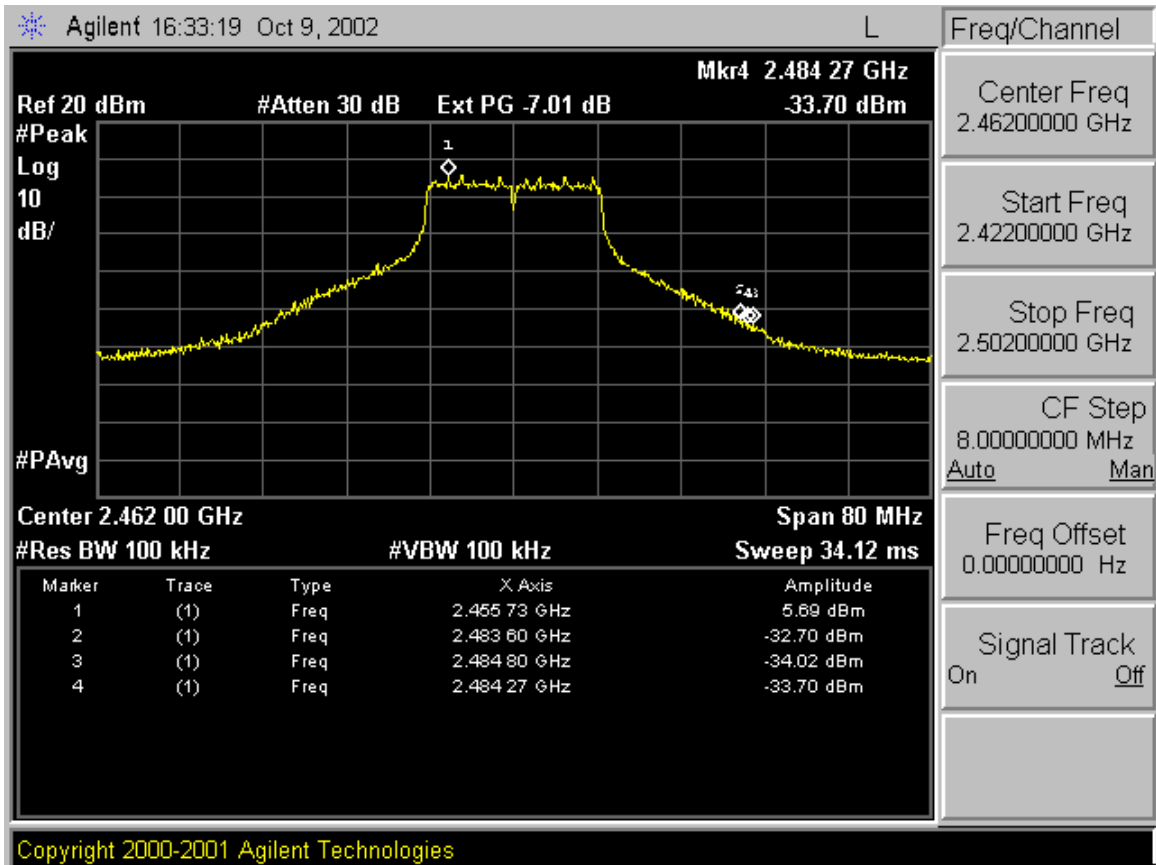
802.11g 2.4 GHz Band

Figure 6.2-3: Lo Band-Edge Measurement 802.11g Lo Channel



Ref = 4.21 dBm at lowest channel (2412 MHz)
 Highest Spur outside Freq. Band = -19.71 dBm (2399.87 MHz)
 Emission is 4.21-(-19.71) = **23.92 dB down**
 Limit = 20 dB below highest level – Compliant

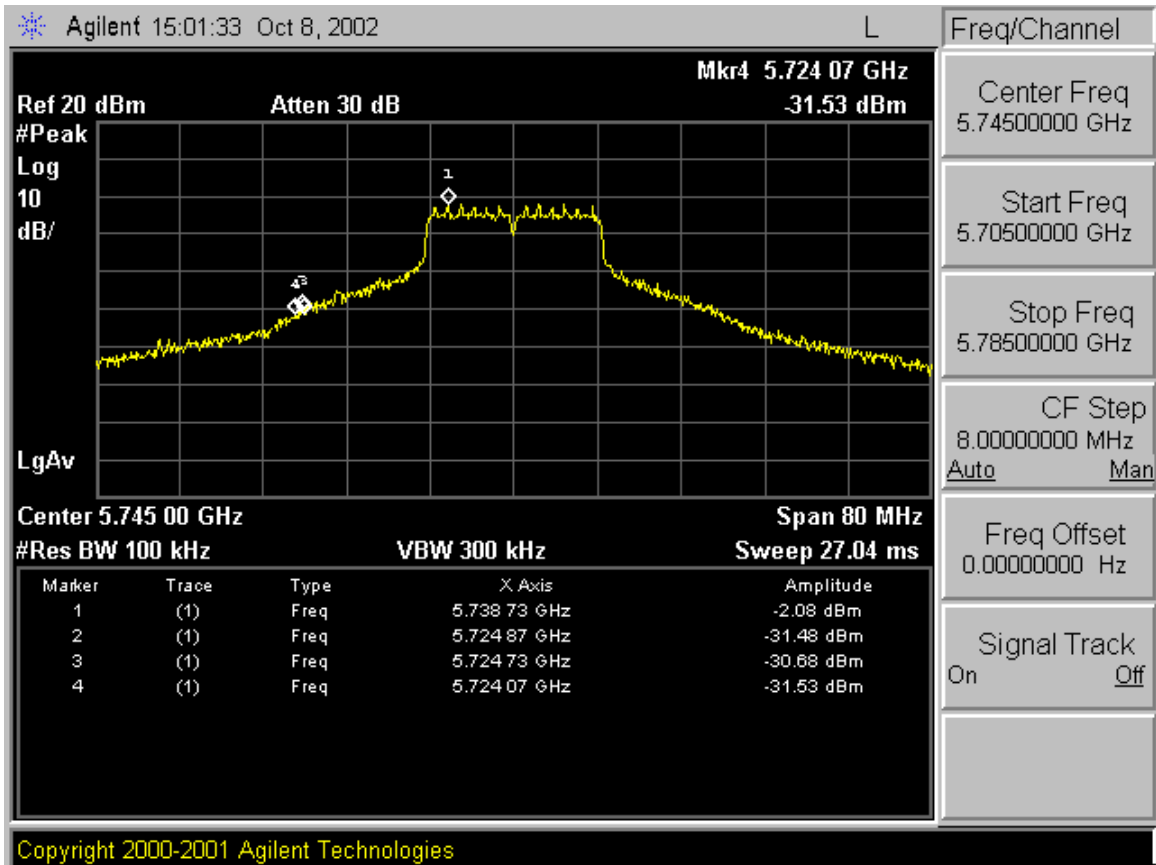
Figure 6.2-4: Hi Band-Edge Measurement 802.11g Hi Channel



Ref = 5.89 dBm at highest channel (2462 MHz)
 Highest Spur outside Freq. Band = -32.70 dBm (2483.60 MHz)
 Emission is 5.89-(-32.70) = **38.59 dB down**
 Limit = 20 dB below highest level – Compliant

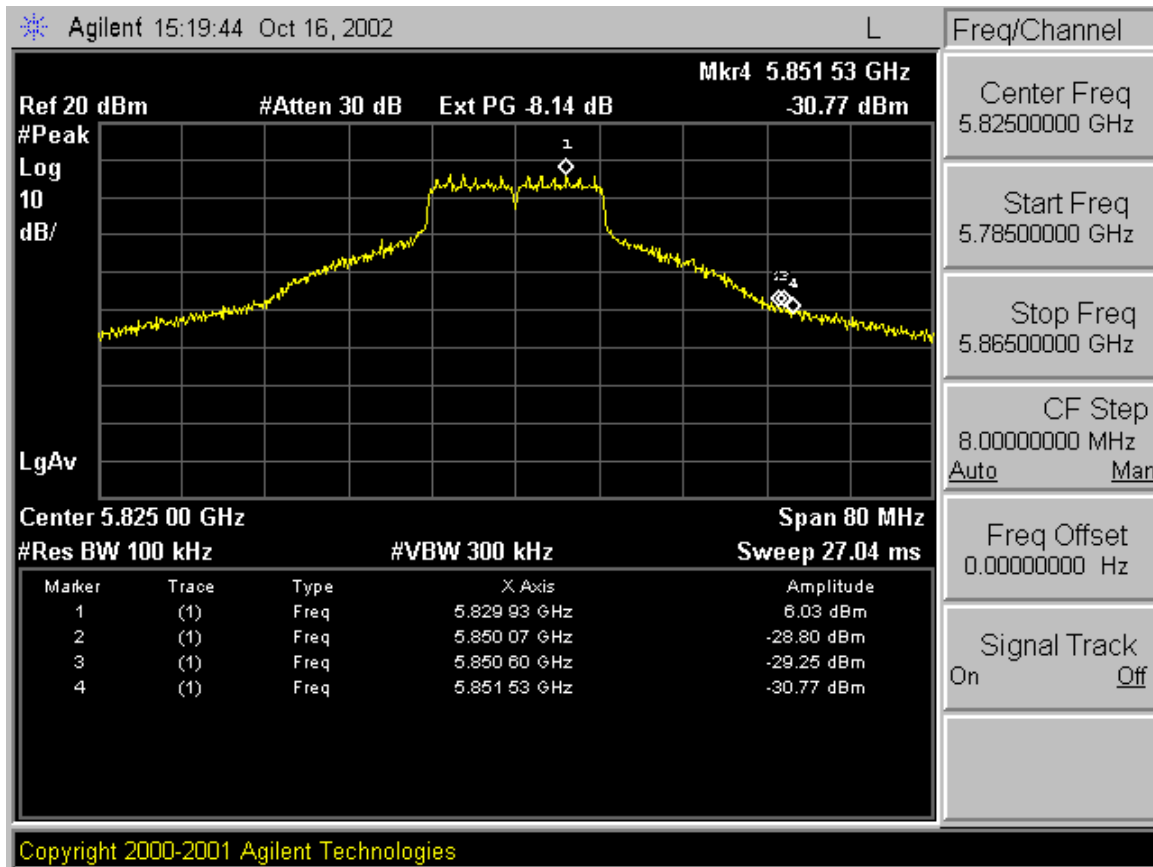
802.11a 5 GHz Band

Figure 6.2-5: Lo Band-Edge Measurement 802.11a Lo Channel



Ref = -2.06 dBm at highest channel (5739.73 MHz)
 Highest Spur outside Freq. Band = -30.68 dBm (5724.73 MHz)
 Emission is $-2.06 - (-30.68) = 32.74$ dB down
 Limit = 20 dB below highest level – Compliant

Figure 6.2-6: Hi Band-Edge Measurement 802.11a Hi Channel



Ref = 6.03 dBm at highest channel (5829.93 MHz)
 Highest Spur outside Freq. Band = -28.80dBm (5850.07 MHz)
 Emission is - 6.03-(-28.80) = **34.83 dB down**
 Limit = 20 dB below highest level – Compliant

6.3 26 dB Emission Bandwidth

6.3.1 Operation Environment

Temperature: 25.8°C

Relative Humidity: 46%

6.3.2 Test Setup



6.3.3 Test procedure

This measurement is used to determine the channel bandwidth for the peak power measurement.

The transmitter output is connected to the spectrum analyzer. The RBW is set to approximately 1% of the emission bandwidth and peak detection is used. VBW = 3RBW. View button is used to capture the emission. The emission bandwidth is determined by determining the points where the spectrum is 26 dB down from the peak power. Repeated measurement by readjusting RBW until RBW/EBW ratio is approximately 1%.

6.3.4 Results

2.4 GHz Band – 802.11b

Channel	Frequency (MHz)	Bandwidth (MHz)
Low	2412	19.27
Middle	2437	19.27
High	2462	19.33

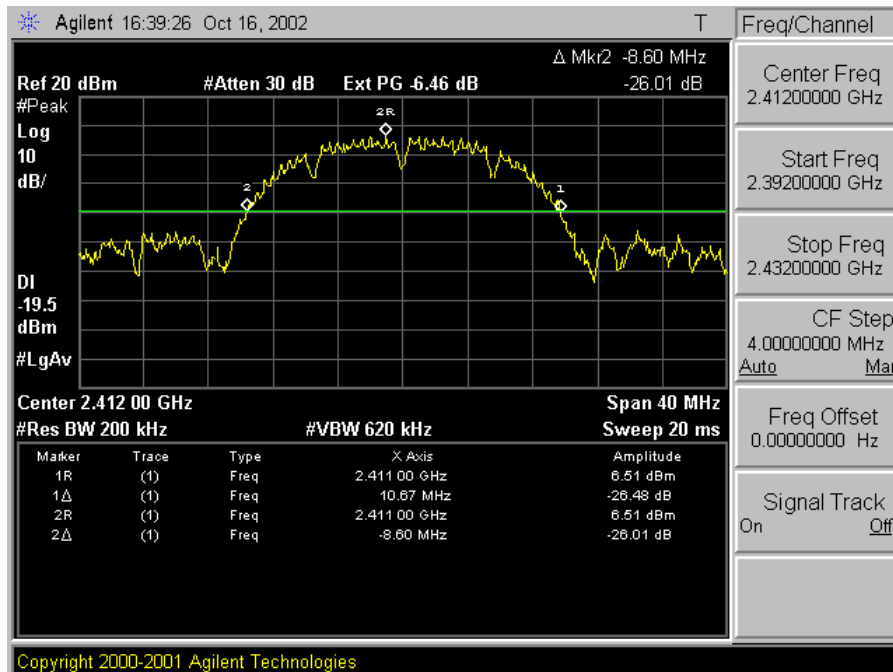
2.4 GHz Band – 802.11g

Channel	Frequency (MHz)	Bandwidth (MHz)
Low	2412	20.4
Middle	2437	19.67
High	2462	19.46

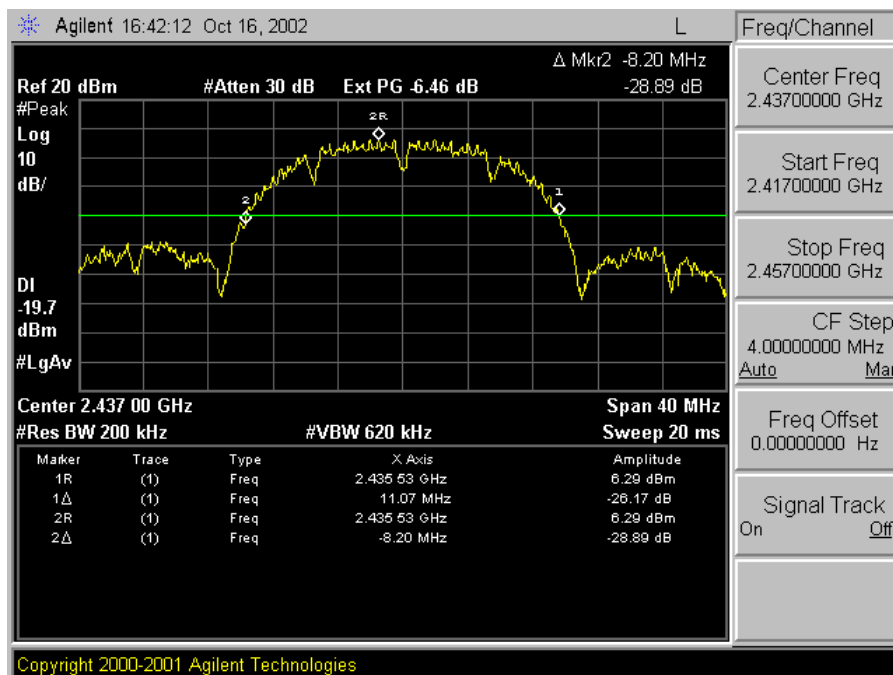
5 GHz Band – 802.11a

Channel	Frequency (MHz)	Bandwidth (MHz)
Low	5745	21.0
Middle	5785	21.07
High	5825	25.2

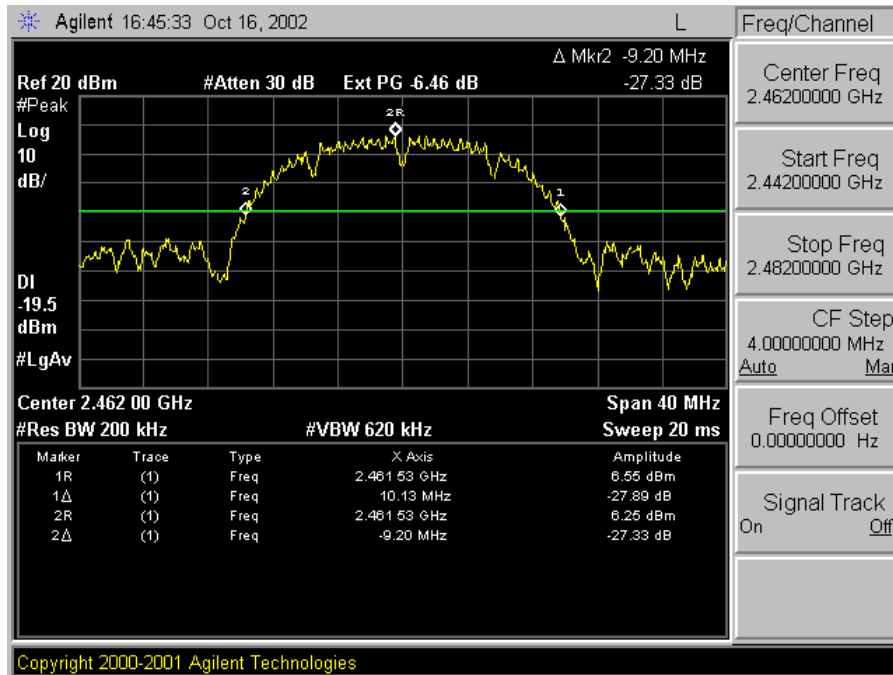
2.4 GHz Band – 802.11b - 26 dB Bandwidth Emission Plots



Lo Channel – 802.11b 26 dB Bandwidth

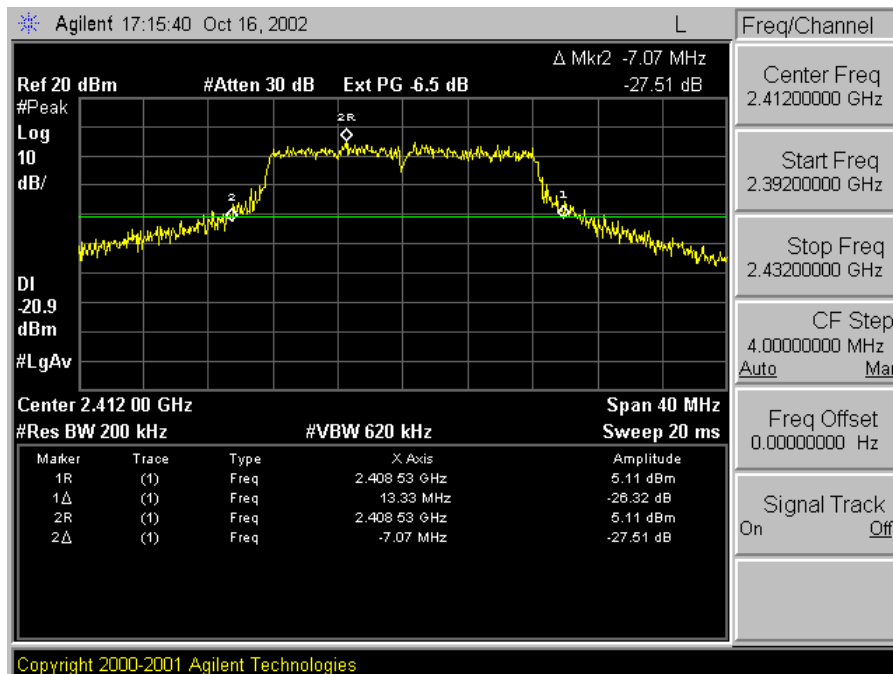


Mid Channel – 802.11b 26 dB Bandwidth

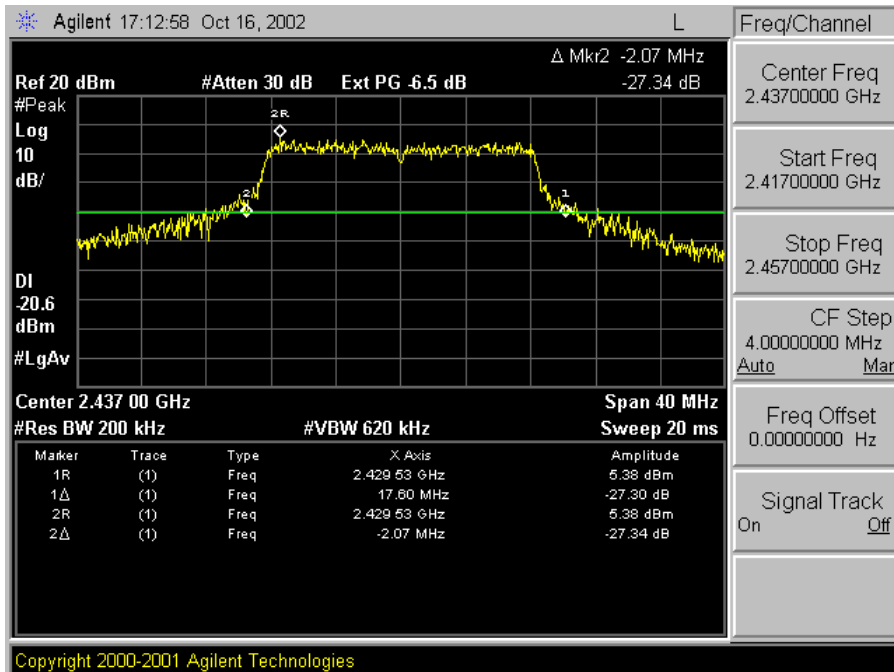


Hi Channel – 802.11b 26 dB Bandwidth

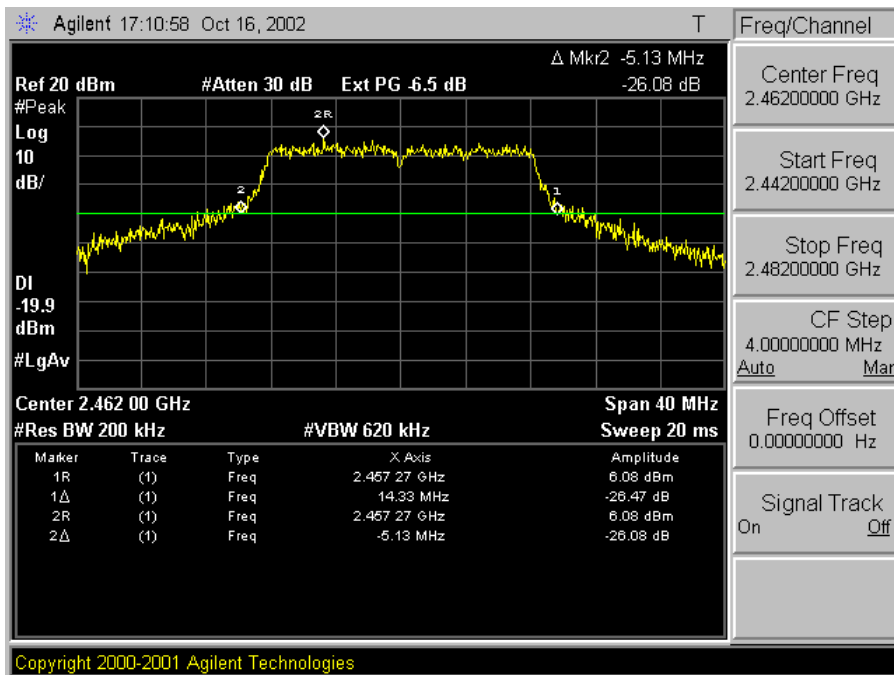
2.4 GHz Band – 802.11g - 26 dB Bandwidth Emission Plots



Lo Channel – 802.11g 26 dB Bandwidth

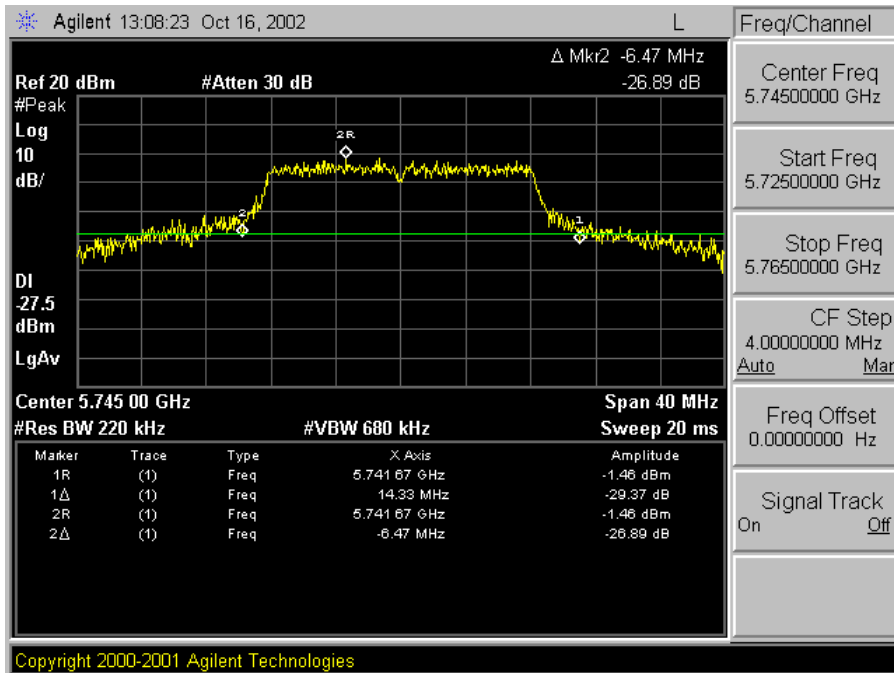


Mid Channel – 802.11g 26 dB Bandwidth

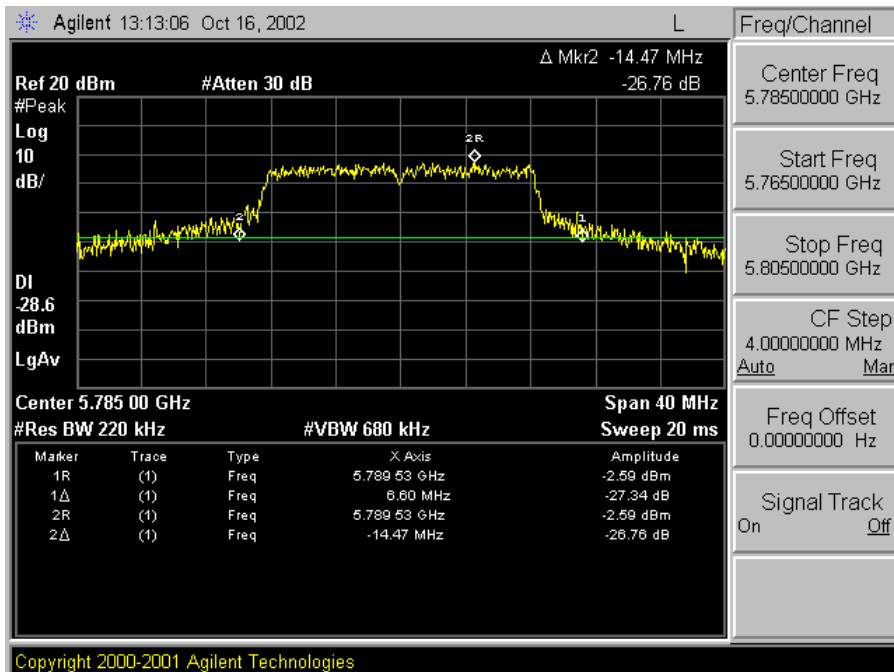


Hi Channel – 802.11g 26 dB Bandwidth

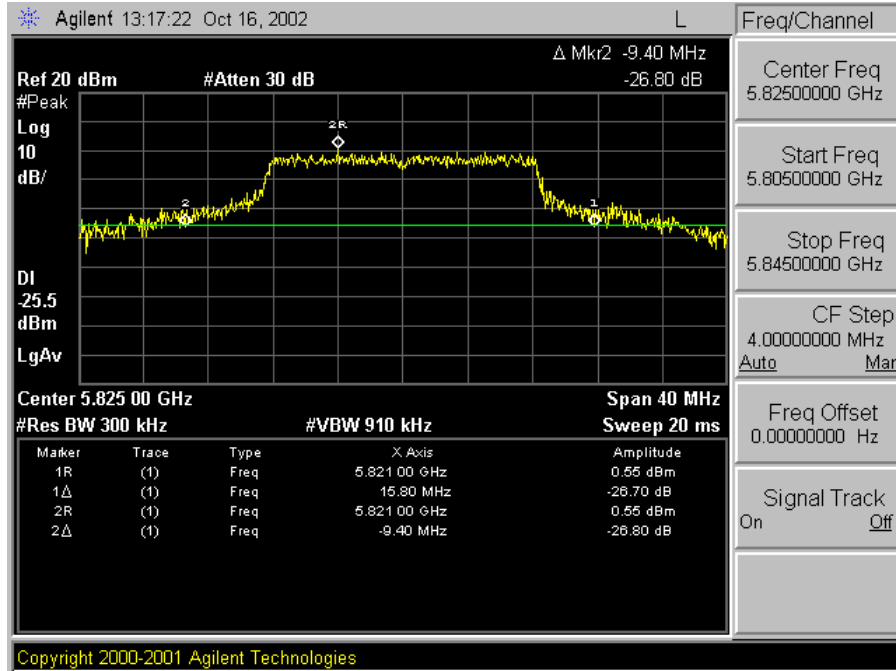
5 GHz Band – 802.11a - 26 dB Bandwidth Emission Plots



Lo Channel – 802.11a 26 dB Bandwidth



Mid Channel – 802.11a 26 dB Bandwidth



Hi Channel – 802.11a 26 dB Bandwidth

6.4 Peak Power

6.4.1 Operation Environment

Temperature: 26°C

Relative Humidity: 40%

6.4.2 Test Setup



6.4.3 Test procedure

The EUT transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 1 MHz and the video bandwidth is set to 3 MHz. Use Sample detector mode. Set max hold. Sweep = Auto(Accuracy). Allow max hold to run for 60 seconds. Computed power by integrating the spectrum across the 26 dB Emission Bandwidth. The integration was performed using the spectrum analyzer's band power measurement function with band limits set to the Emission Bandwidth band edges, 15.247(2)(b)(1).

6.4.4 Test Condition

“Power measured should be less than 1 watt(30 dBm)”

6.4.5 Results

2.4 GHz Band – 802.11b

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	16.27	30	13.73
Middle	2437	16.23	30	13.77
High	2462	16.19	30	13.81

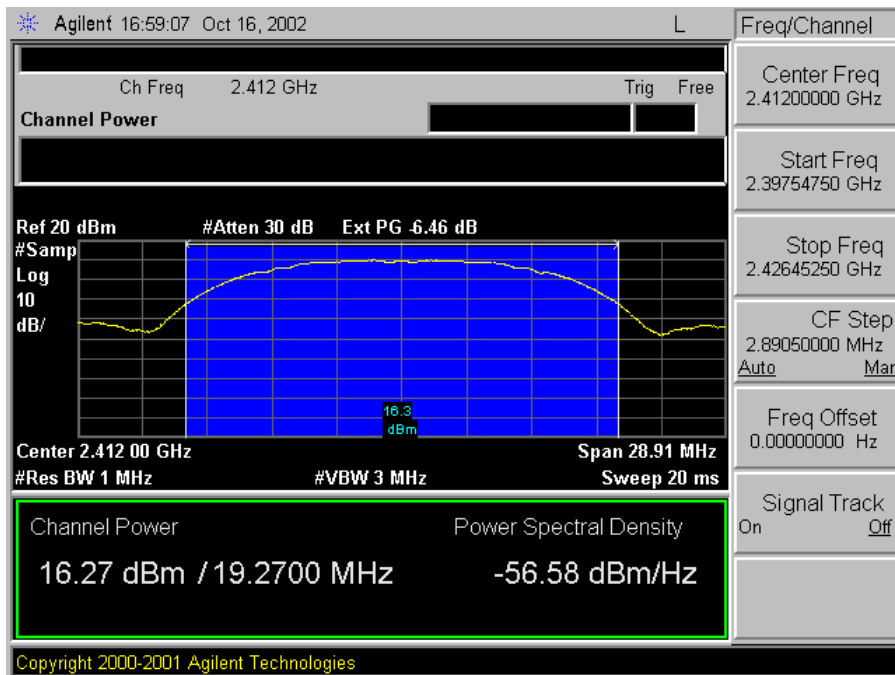
2.4 GHz Band – 802.11g

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	2412	16.35	30	13.65
Middle	2437	16.03	30	13.97
High	2462	16.37	30	13.63

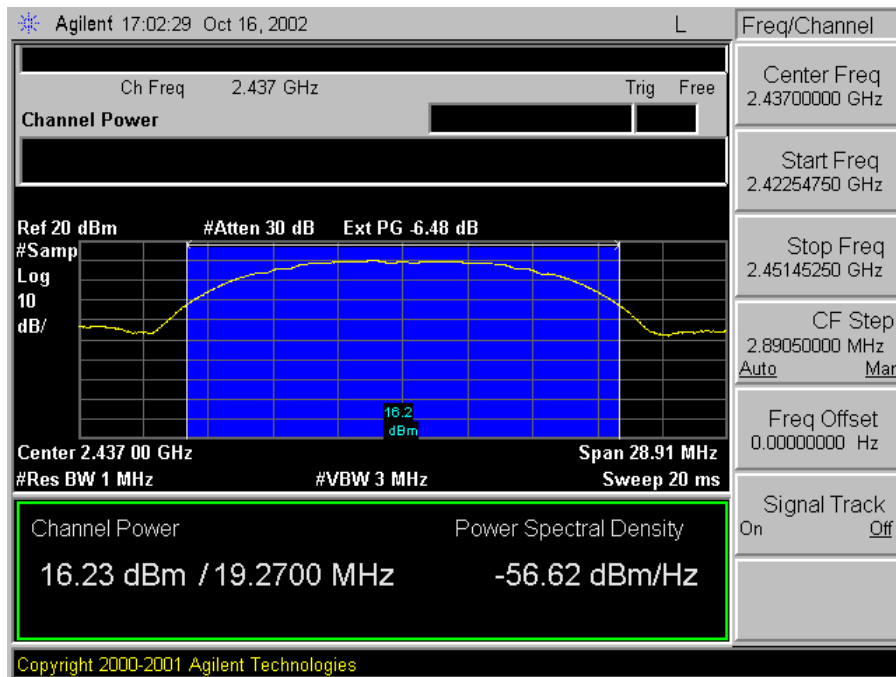
5 GHz Band – 802.11a

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
Low	5745	15.83	30	14.17
Middle	5785	15.86	30	14.14
High	5825	15.95	30	14.05

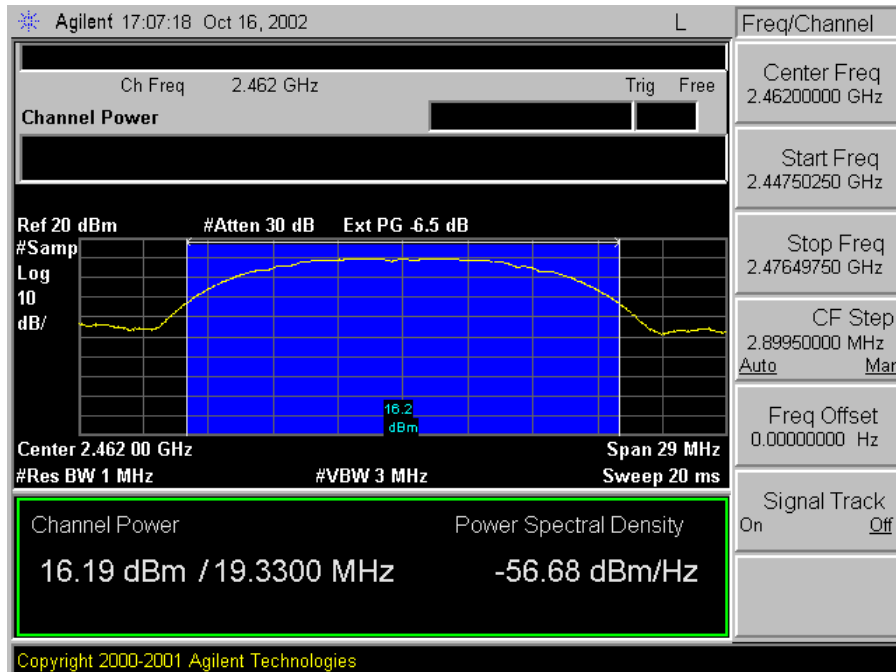
2.4 GHz Band – 802.11b - Peak Power Measurements / Plots



Lo Channel – 802.11b Peak Power

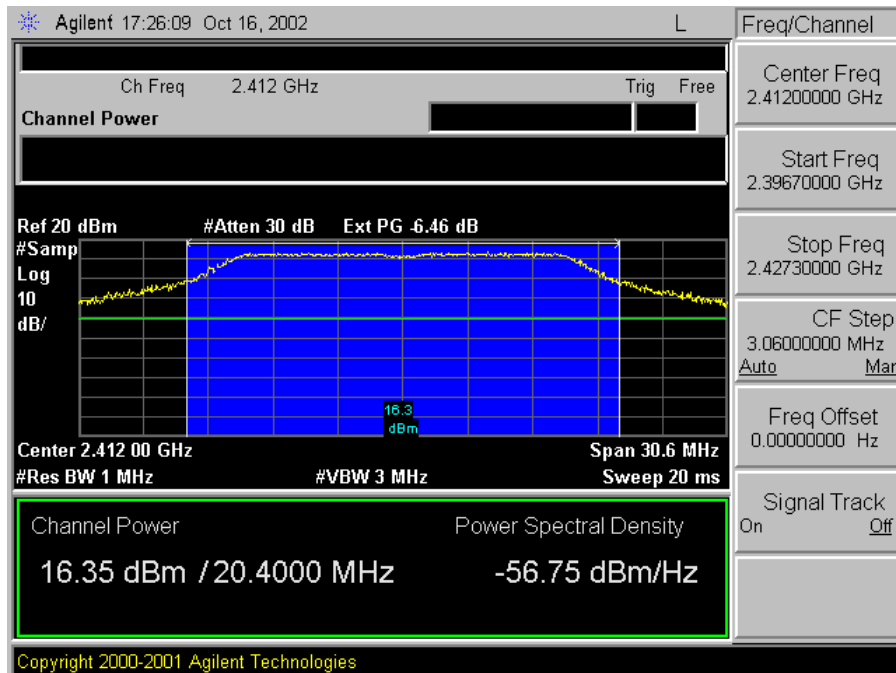


Mid Channel – 802.11b Peak Power

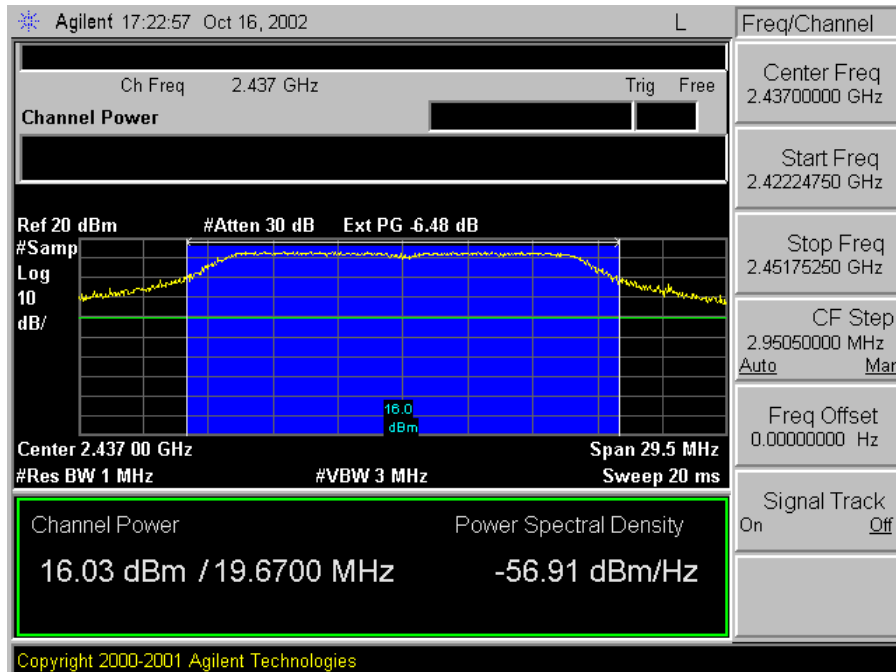


Hi Channel – 802.11b Peak Power

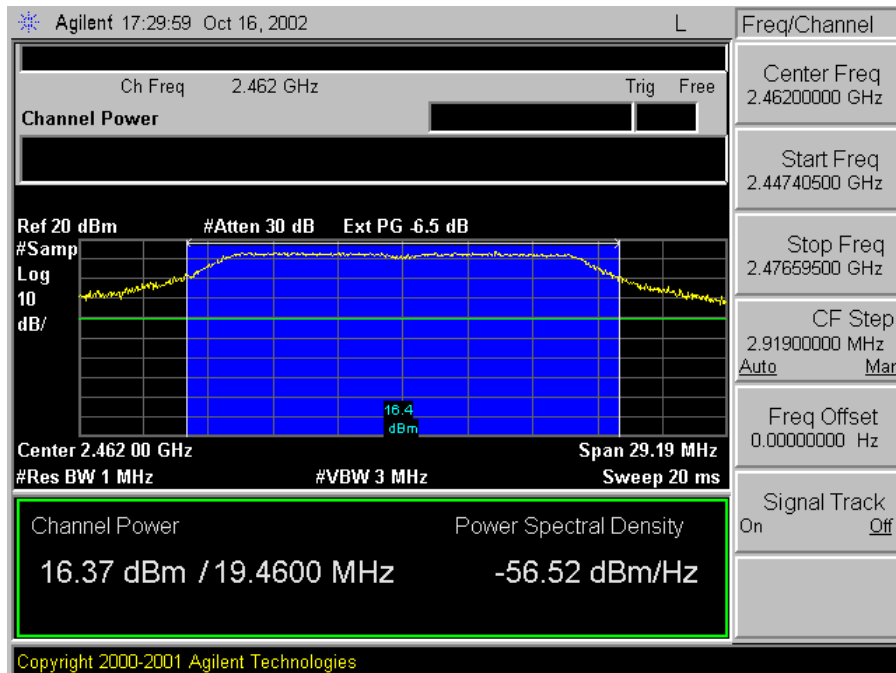
2.4 GHz Band – 802.11g - Peak Power Measurements / Plots



Lo Channel – 802.11g Peak Power

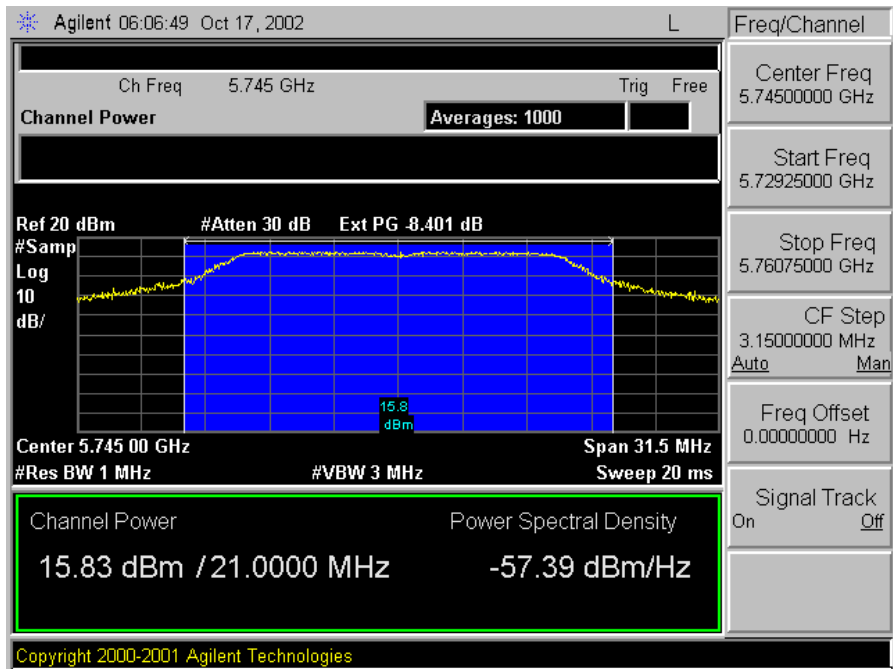


Mid Channel – 802.11g Peak Power

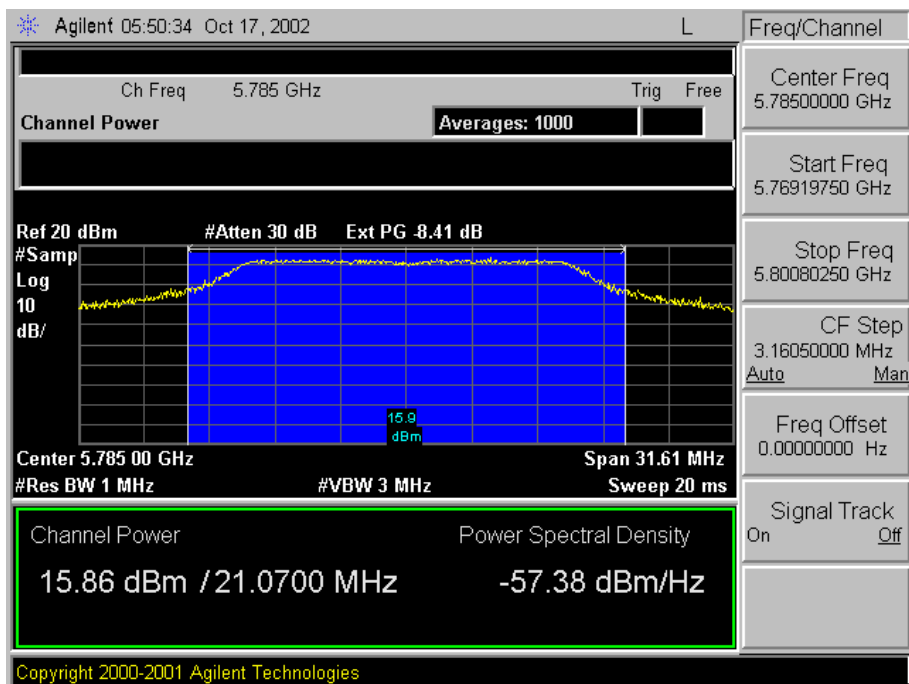


Hi Channel – 802.11g Peak Power

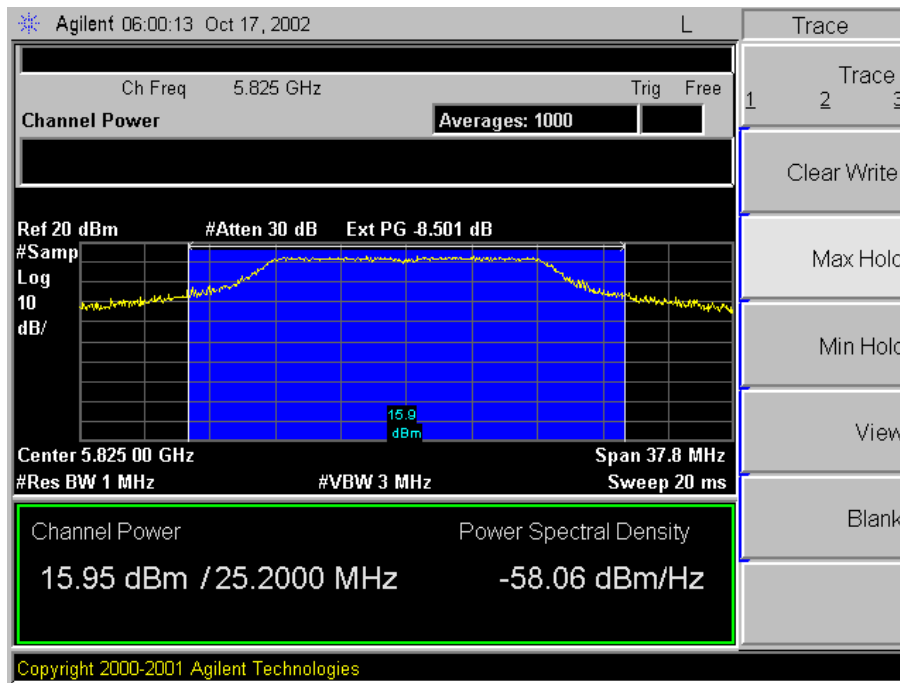
5 GHz Band – 802.11a - Peak Power Measurements / Plots



Lo Channel – 802.11a Peak Power



Mid Channel – 802.11a Peak Power



Hi Channel – 802.11a Peak Power

6.5 Peak Power Spectral Density

6.5.1 Operation Environment

Temperature: 26°C

Relative Humidity: 46%

6.5.2 Test Set-up



6.5.3 Test procedure

The EUT Transmitter output is connected to the spectrum analyzer. RBW=VBW=3kHz, Span=300 kHz. Peak Power spectral density is the highest level found across the emission in any 3 kHz band, 15.247(d)

6.5.4 Test Condition

“The Peak Power spectral density is less then 8 dBm in 3kHz band during any time interval of continuous transmission“

6.5.5 Results

2.4 GHz Band – 802.11b

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-16.62	8	24.62
Middle	2437	-7.14	8	15.14
High	2462	-15.86	8	23.86

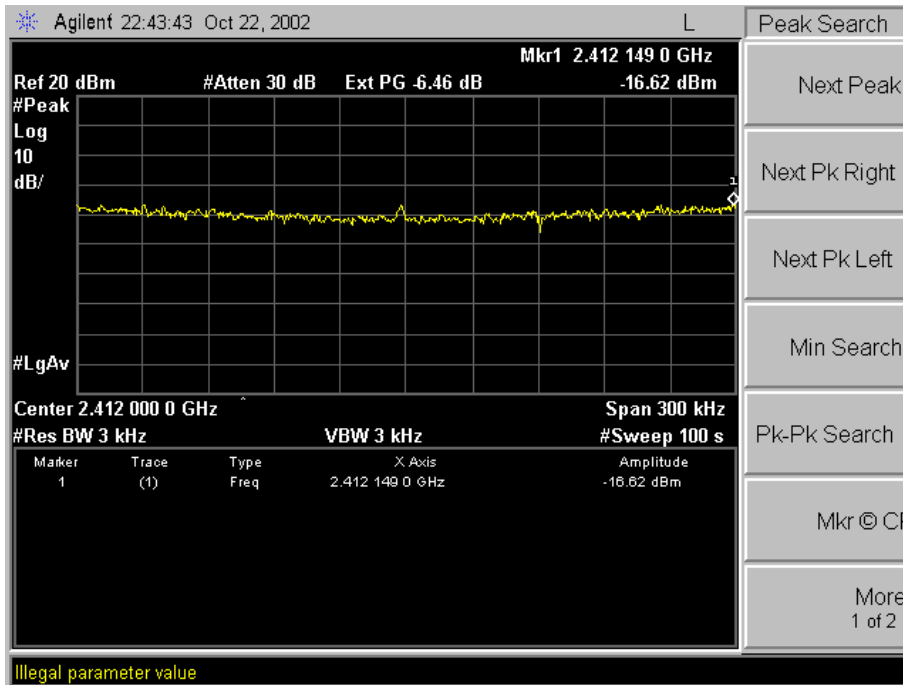
2.4 GHz Band – 802.11g

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-16.62	8	24.62
Middle	2437	-13.58	8	21.58
High	2462	-12.02	8	20.02

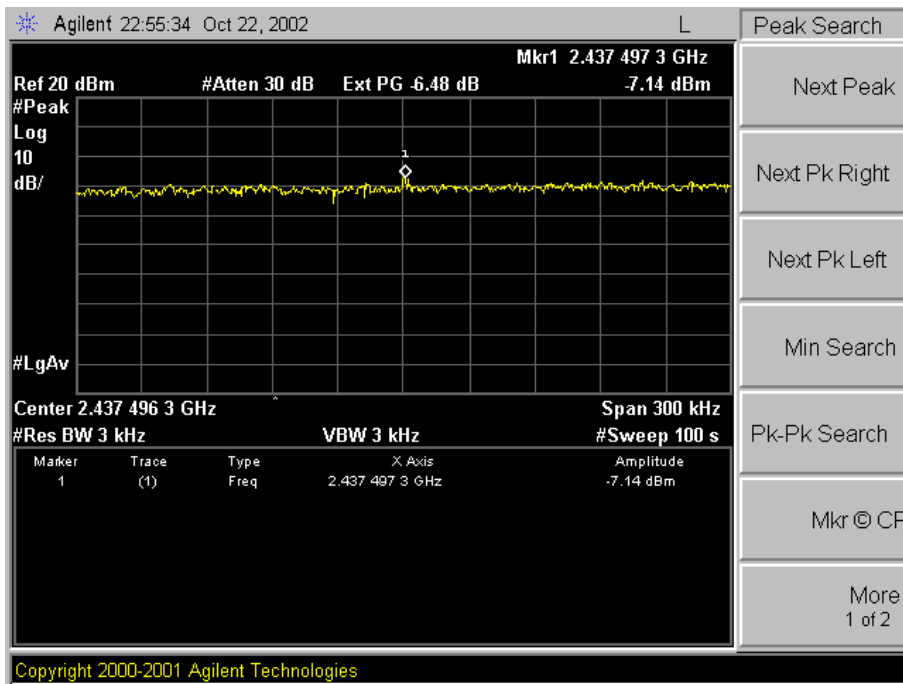
5 GHz Band – 802.11a

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	5745	-13.81	8	20.81
Middle	5785	-14.10	8	22.10
High	5825	-11.65	8	19.65

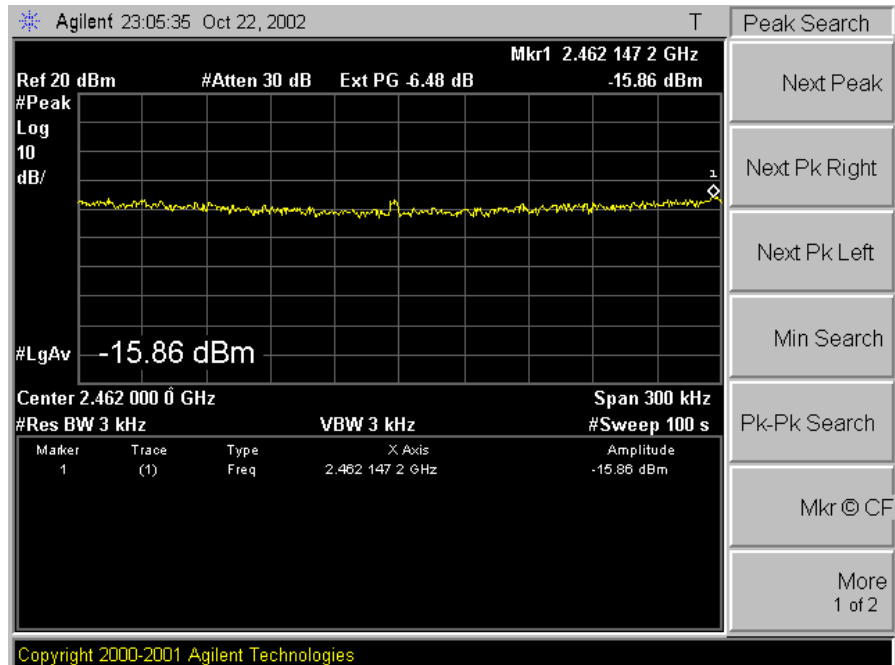
802.11b Peak Power Spectral Density



Low Channel

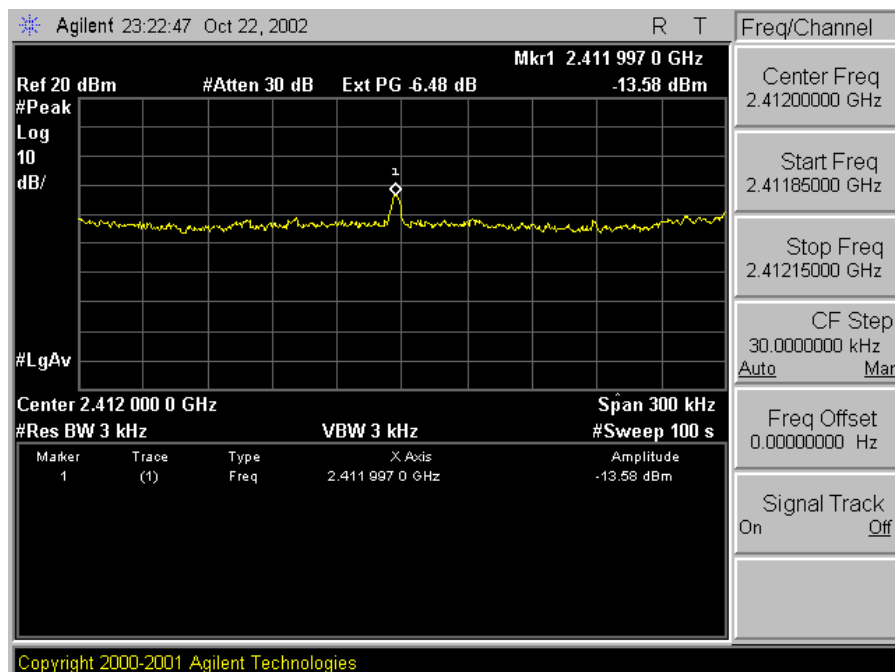


Mid Channel

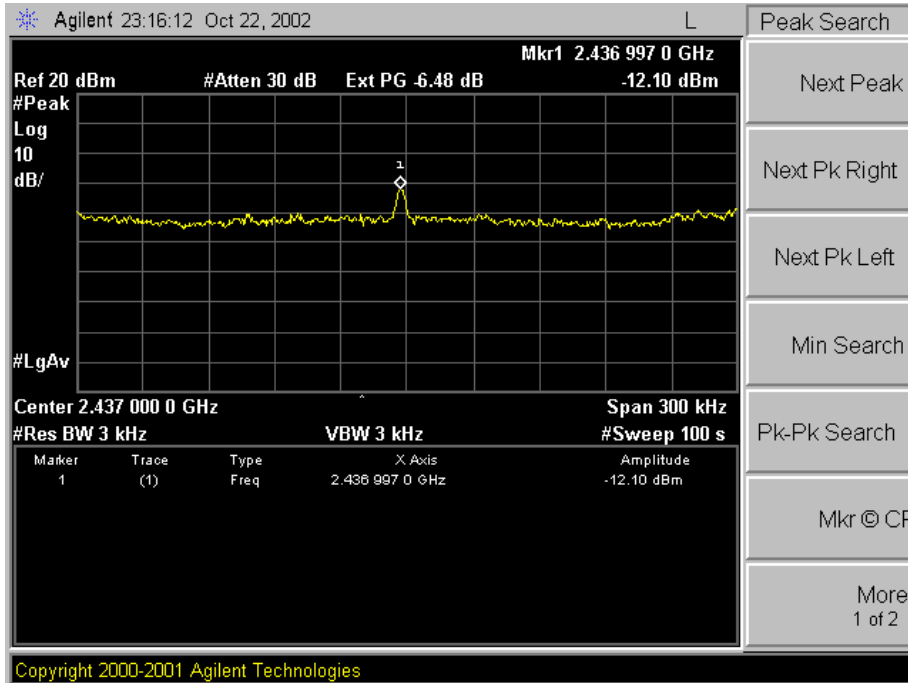


High Channel

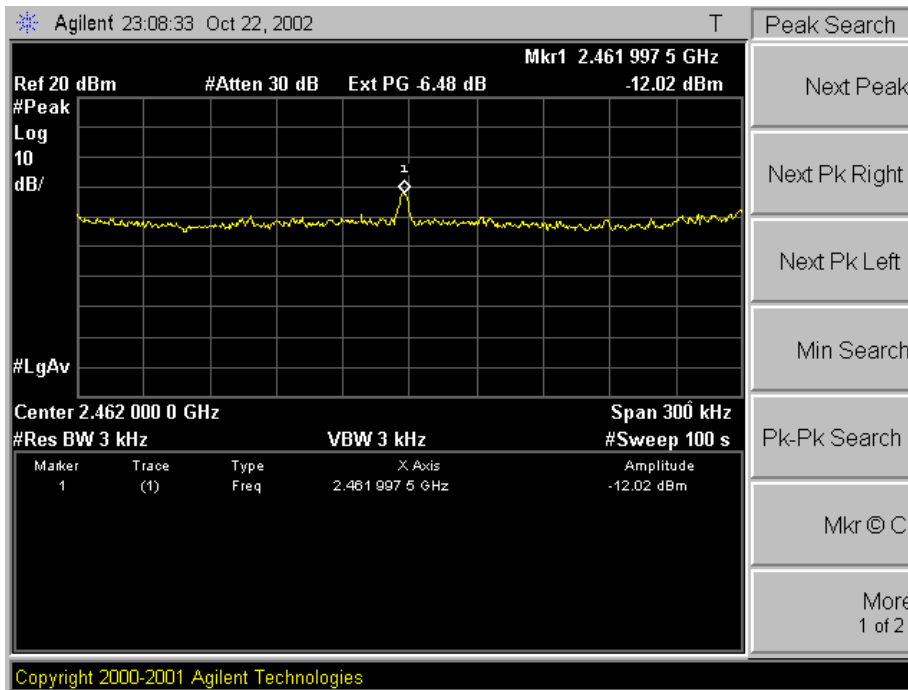
802.11g Peak Power Spectral Density



Low Channel

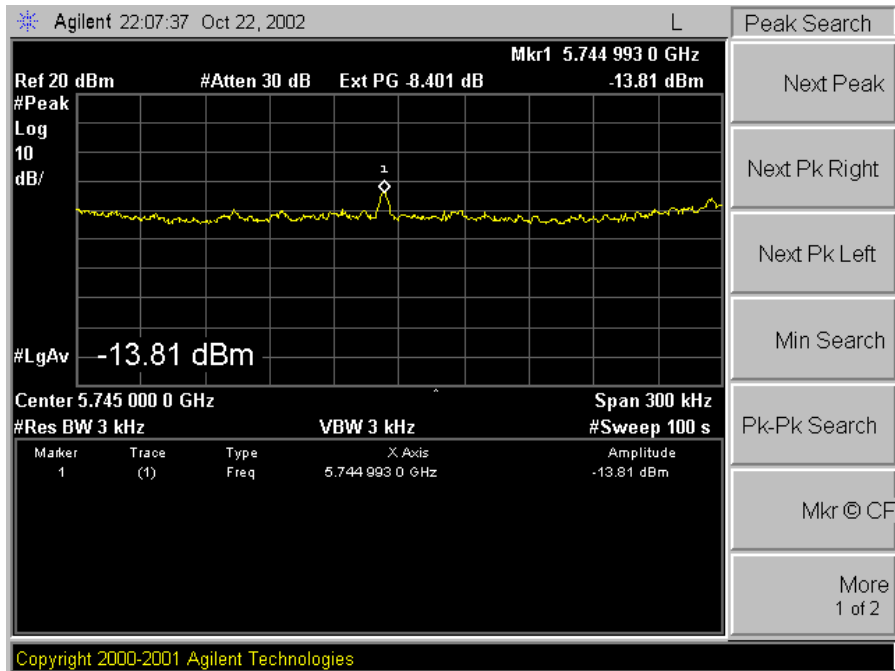


Mid Channel

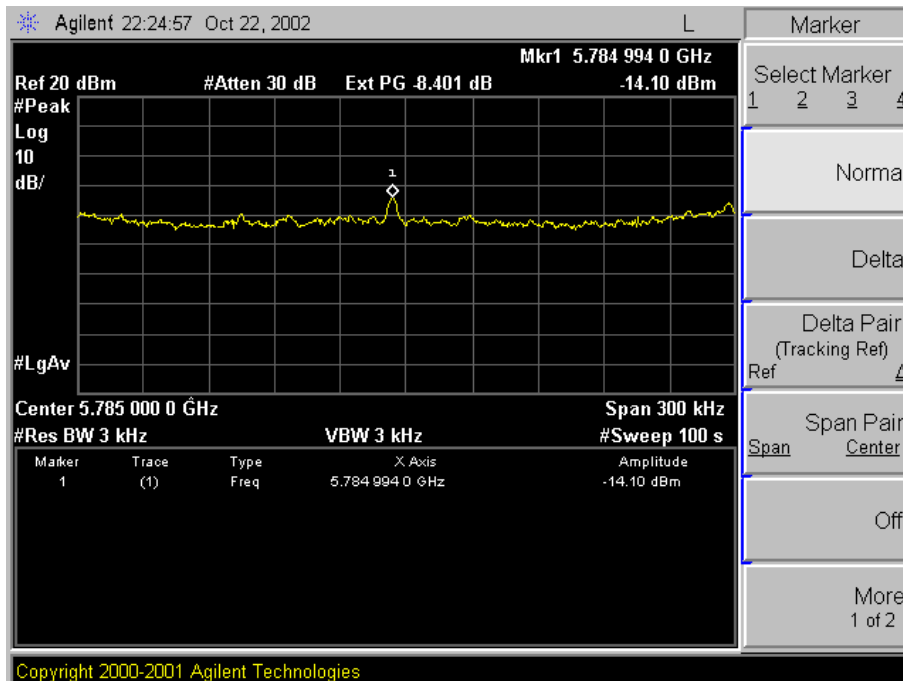


High Channel

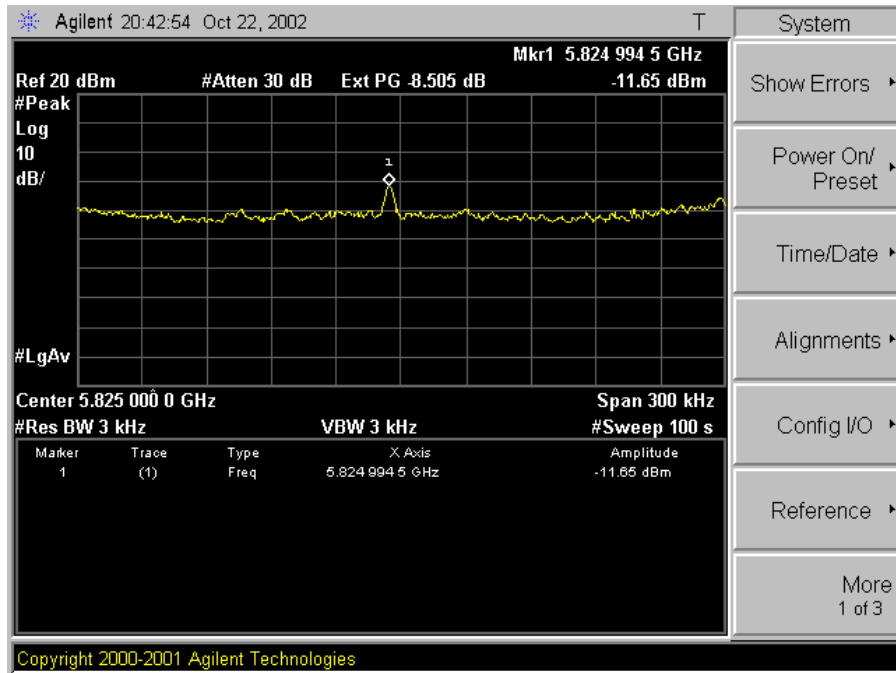
802.11a Peak Power Spectral Density



Low Channel



Mid Channel



High Channel

6.6 Spurious RF Conducted Emissions

6.6.1 Operation Environment

Temperature: 25.8°C

Relative Humidity: 46%

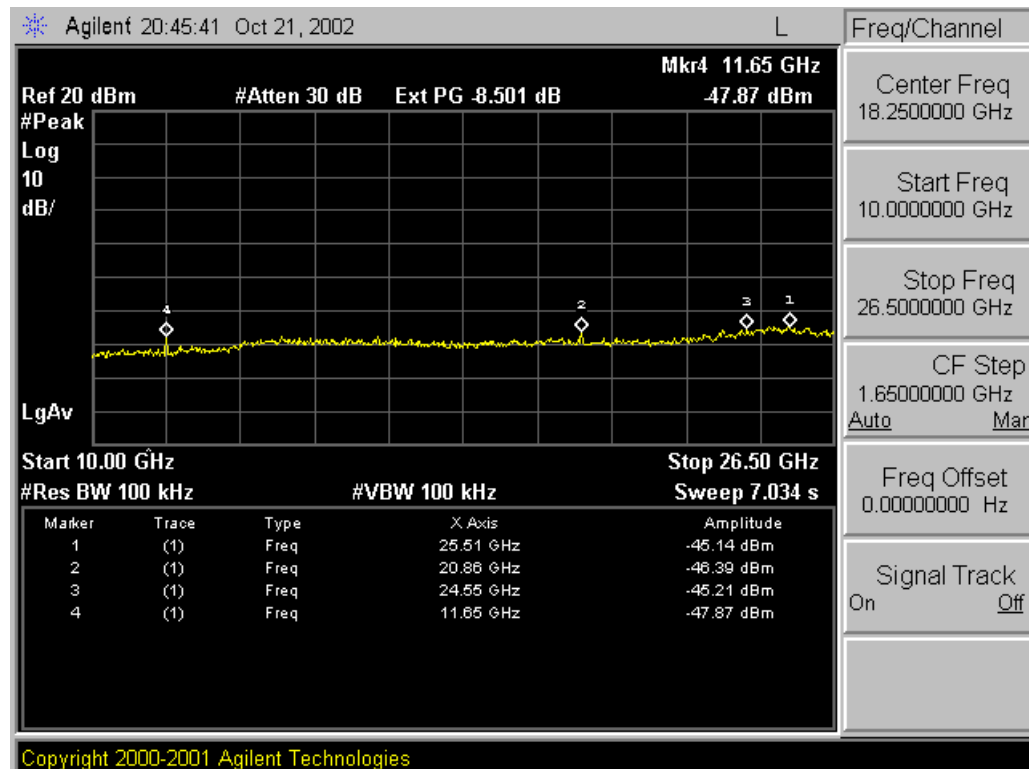
6.6.2 Test Setup

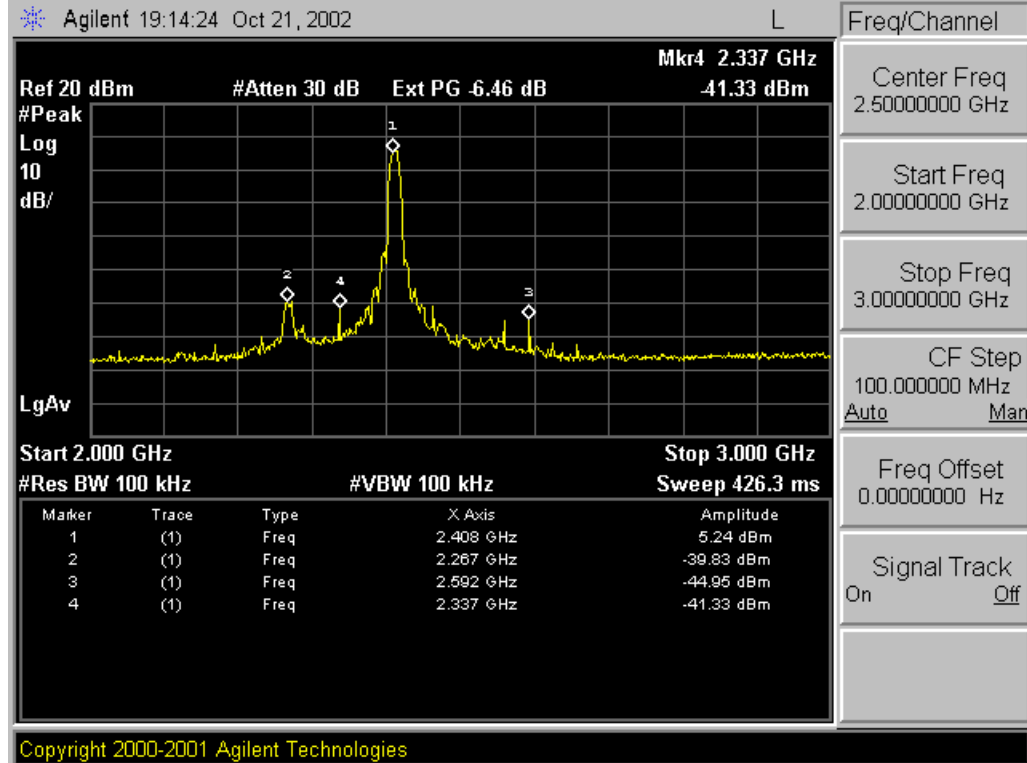
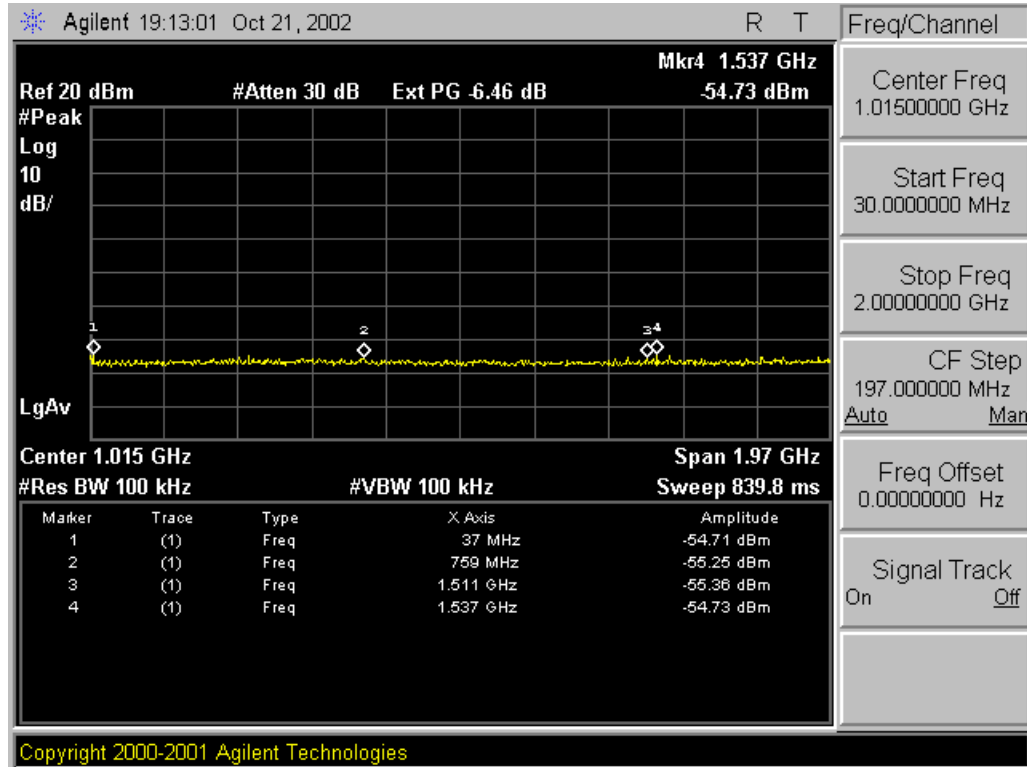


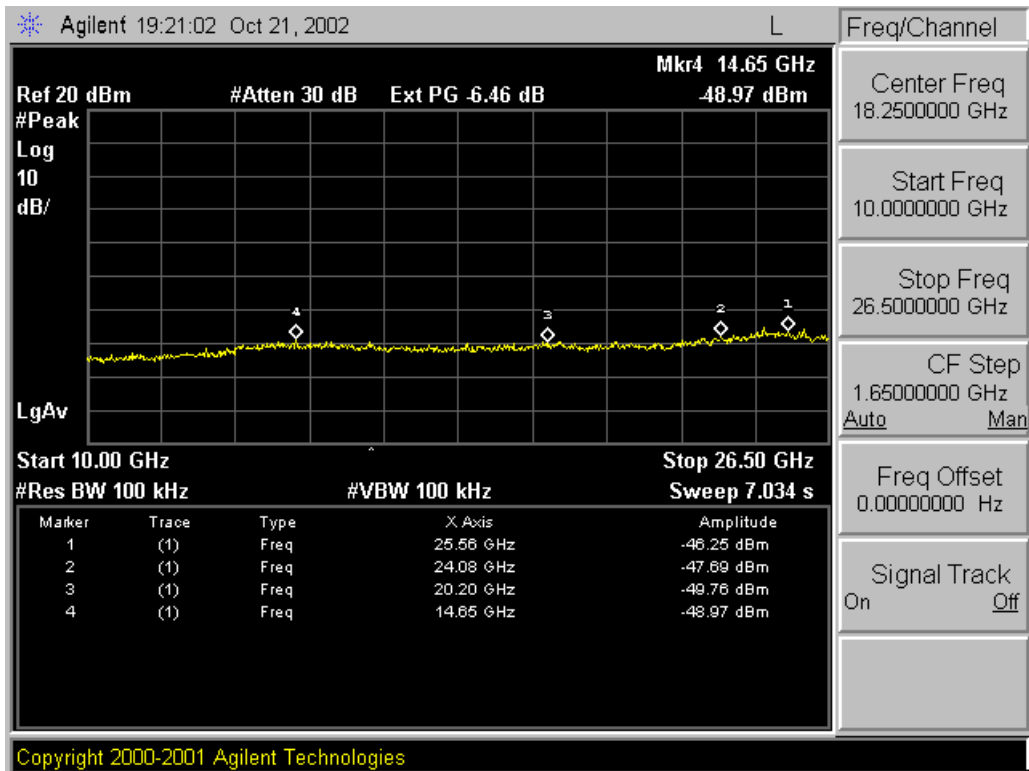
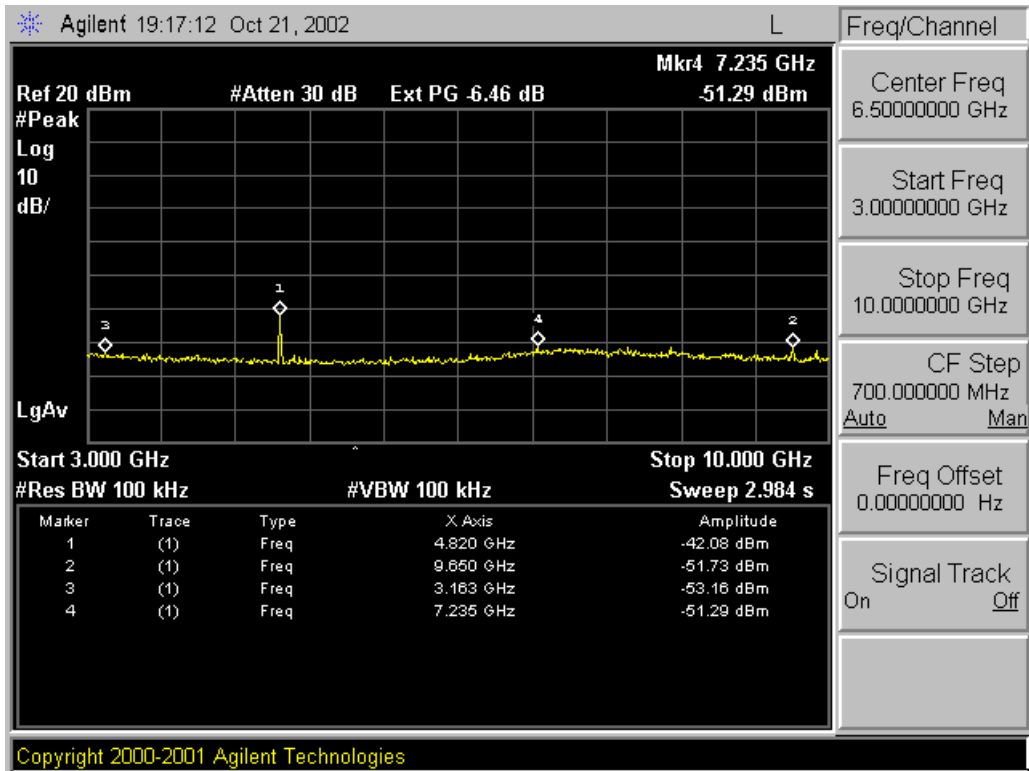
6.6.3 Test procedure

The spurious RF conducted emissions were measured with the EUT set to low, middle and high channel. At each channel the measurement was done by scanning the channel from 30 MHz to 26.5 GHz with four plots for each channel, 30 MHz - 2 GHz, 2 GHz - 3 GHz, 3 GHz - 10 GHz, 10 GHz – 26.5 GHz. RBW=VBW=100KHz.

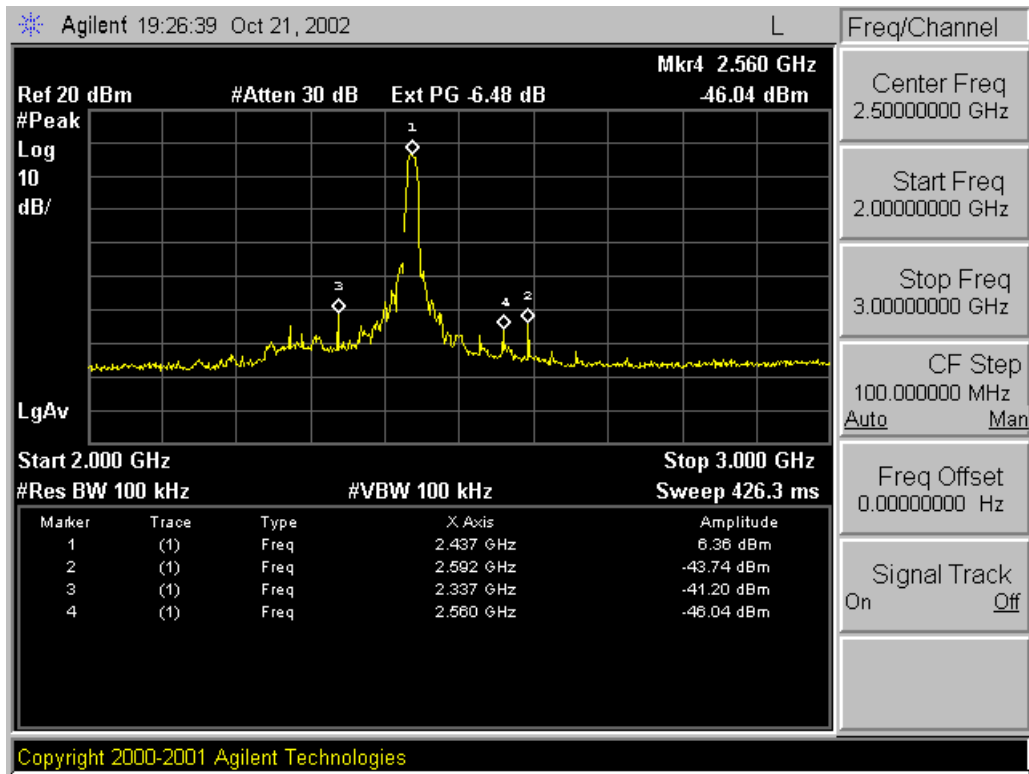
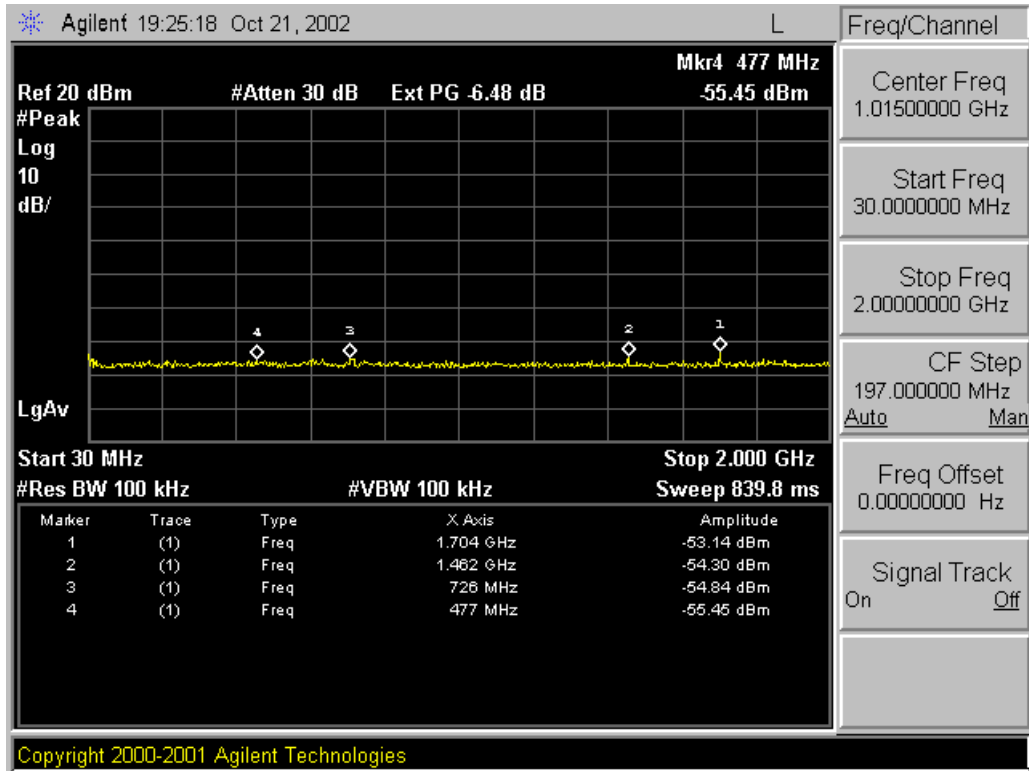
802.11b Conducted Spurious Emissions – Lo Channel

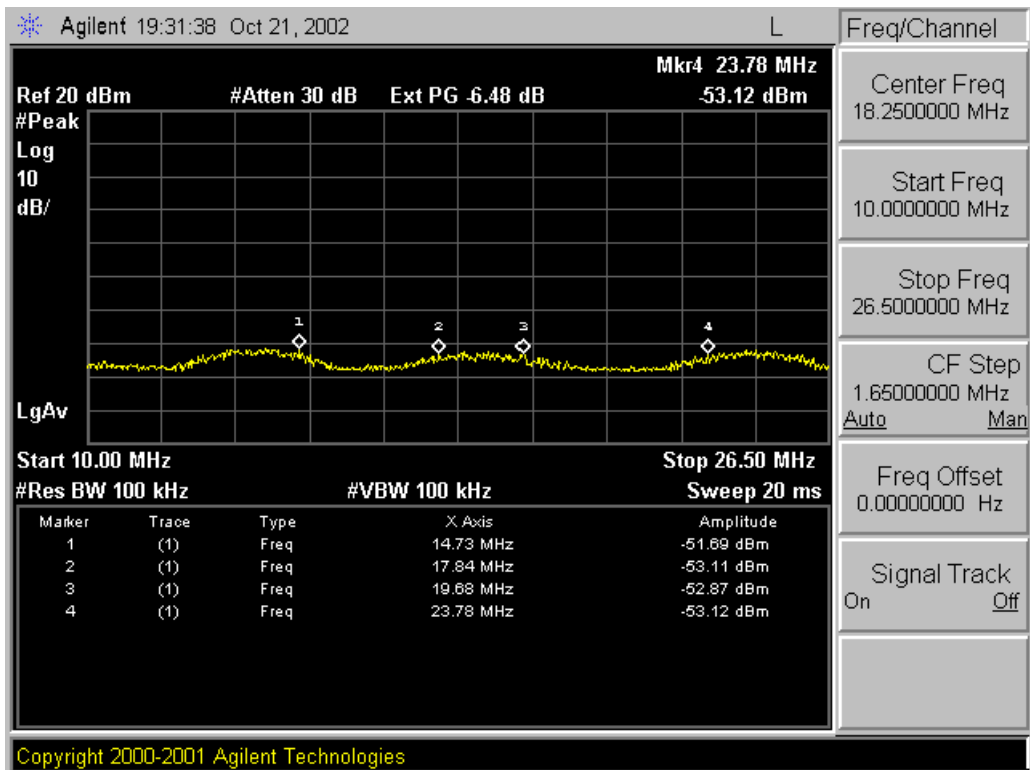
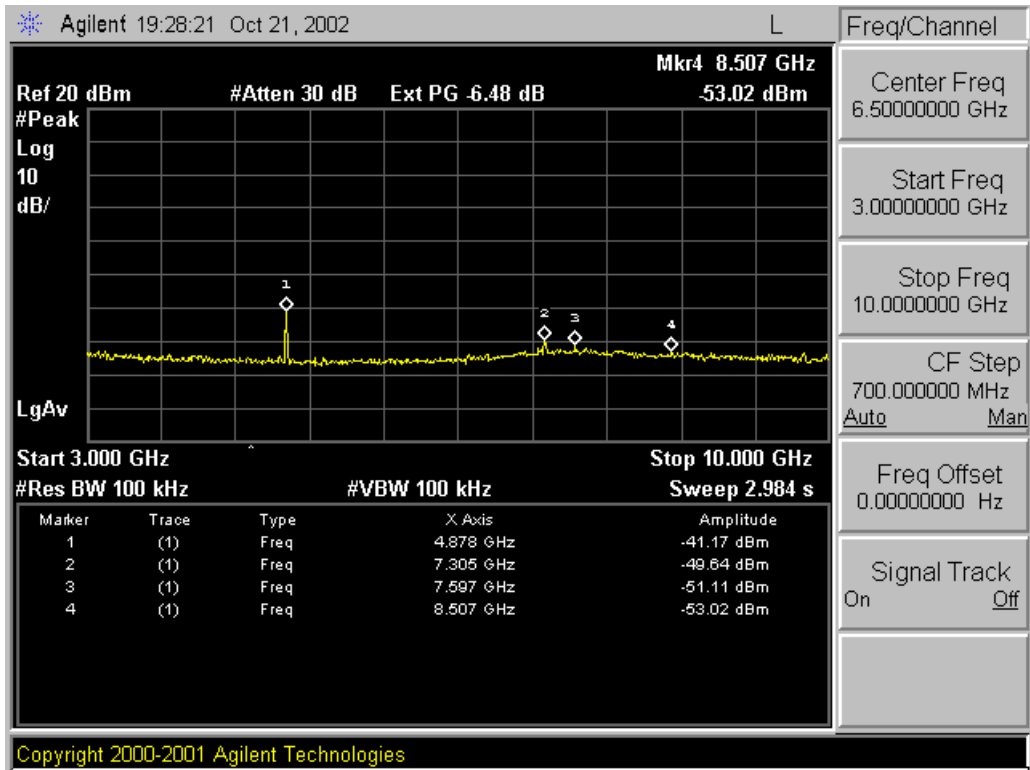




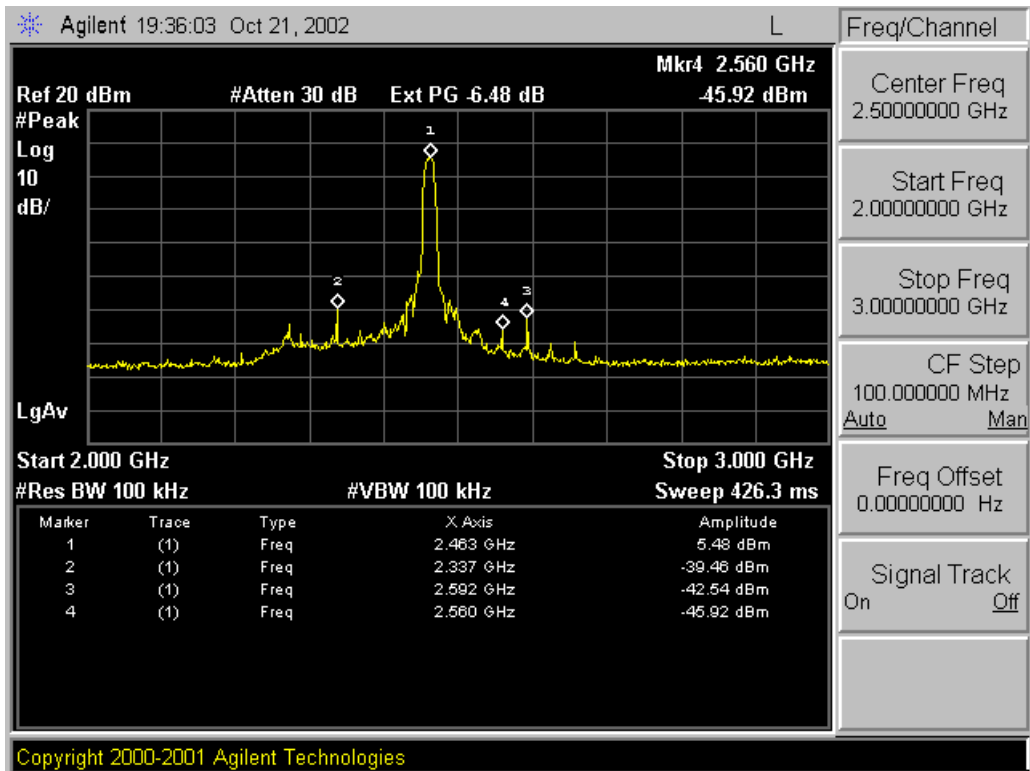
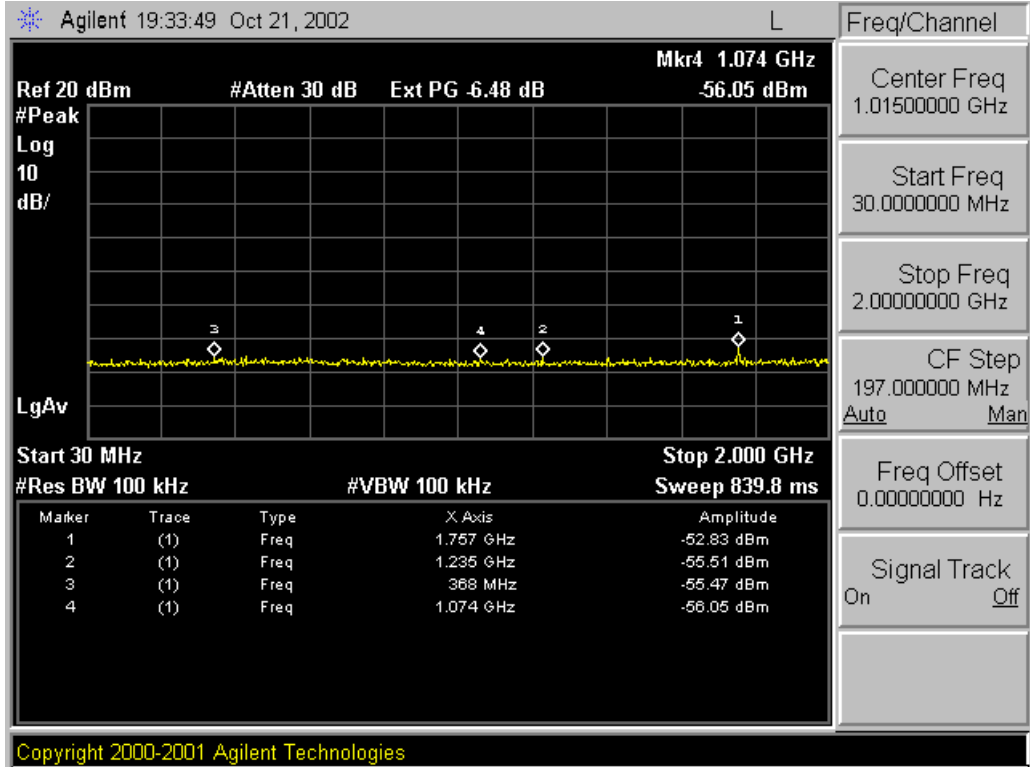


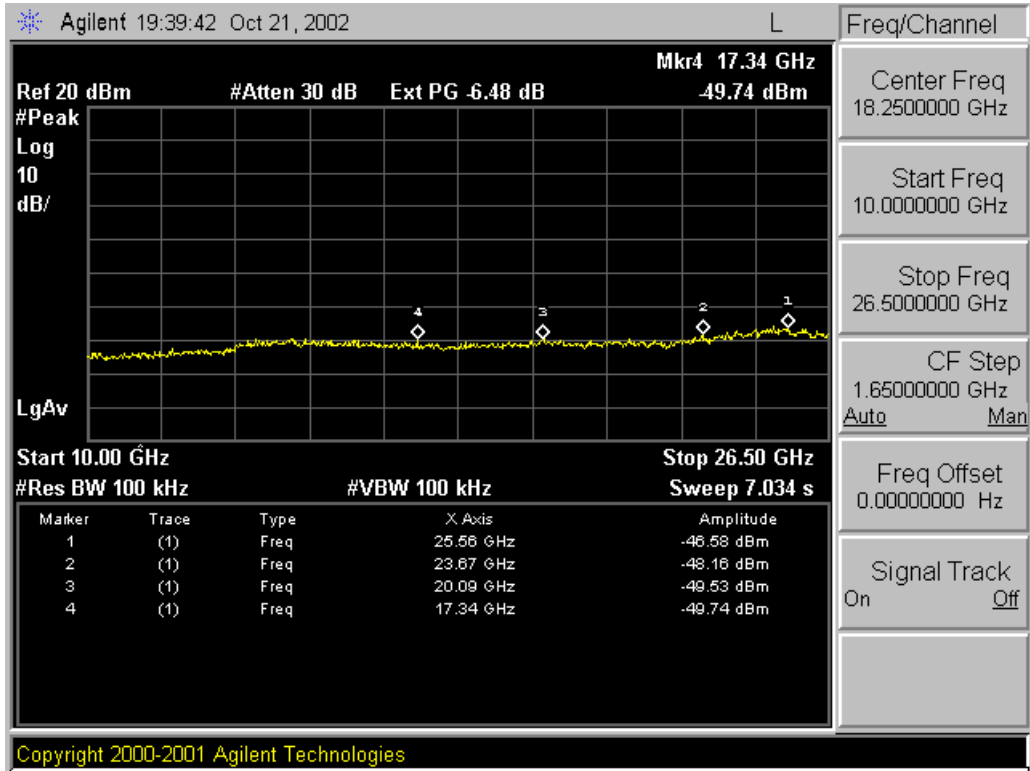
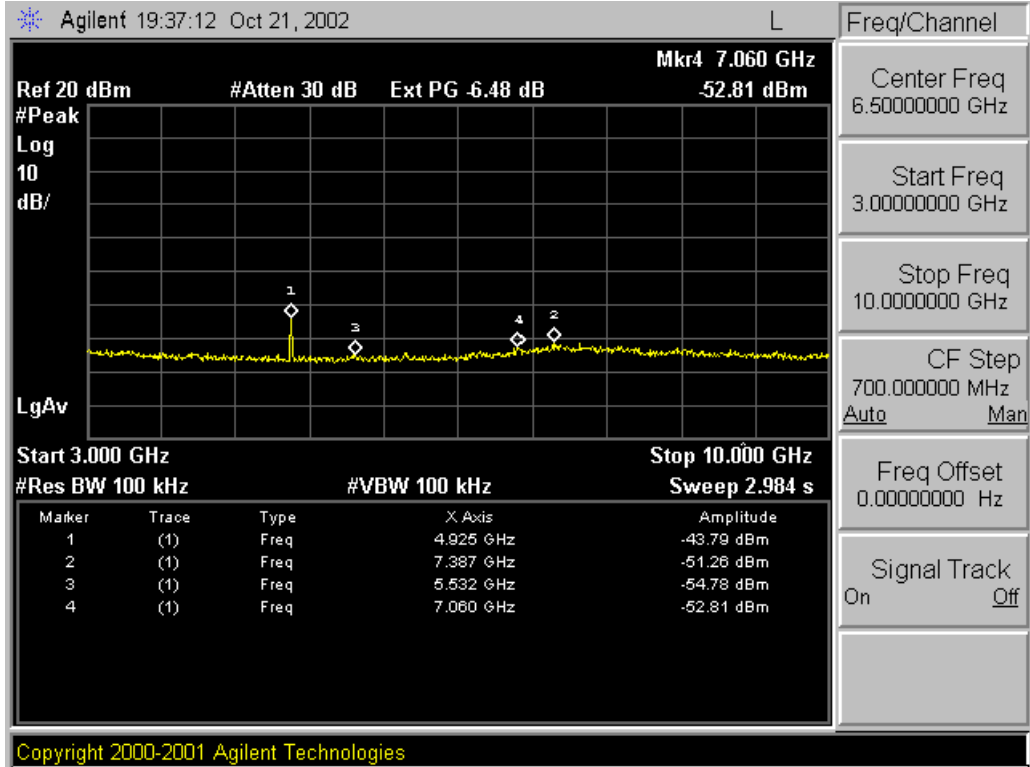
802.11b Conducted Spurious Emissions – Mid Channel



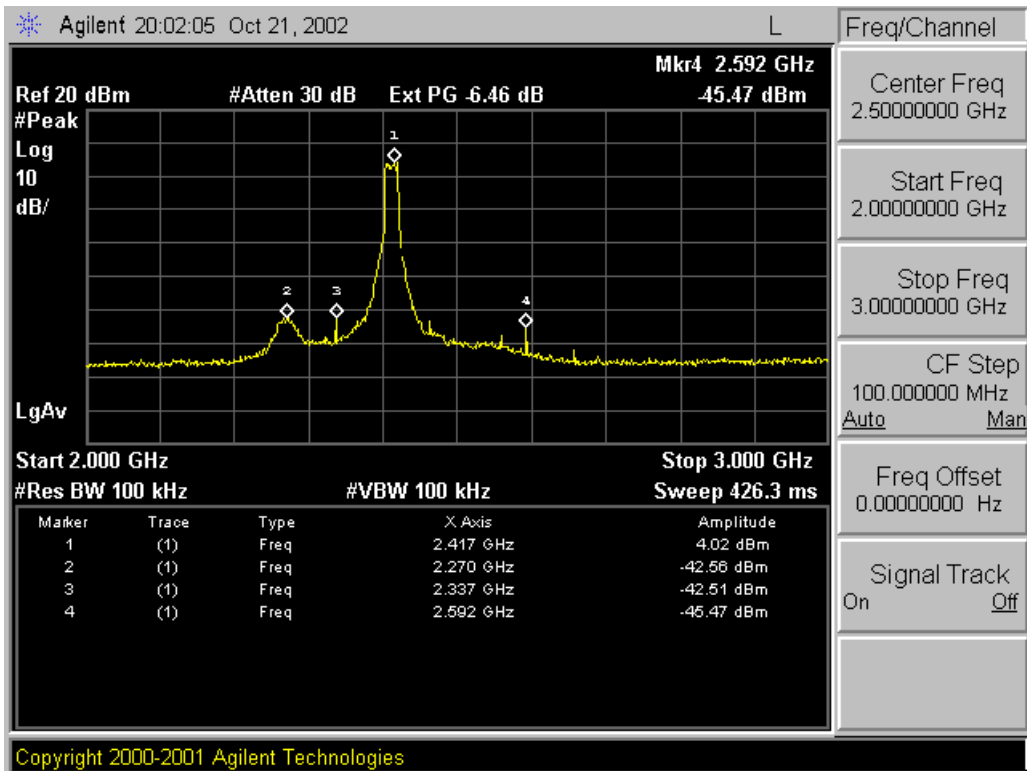
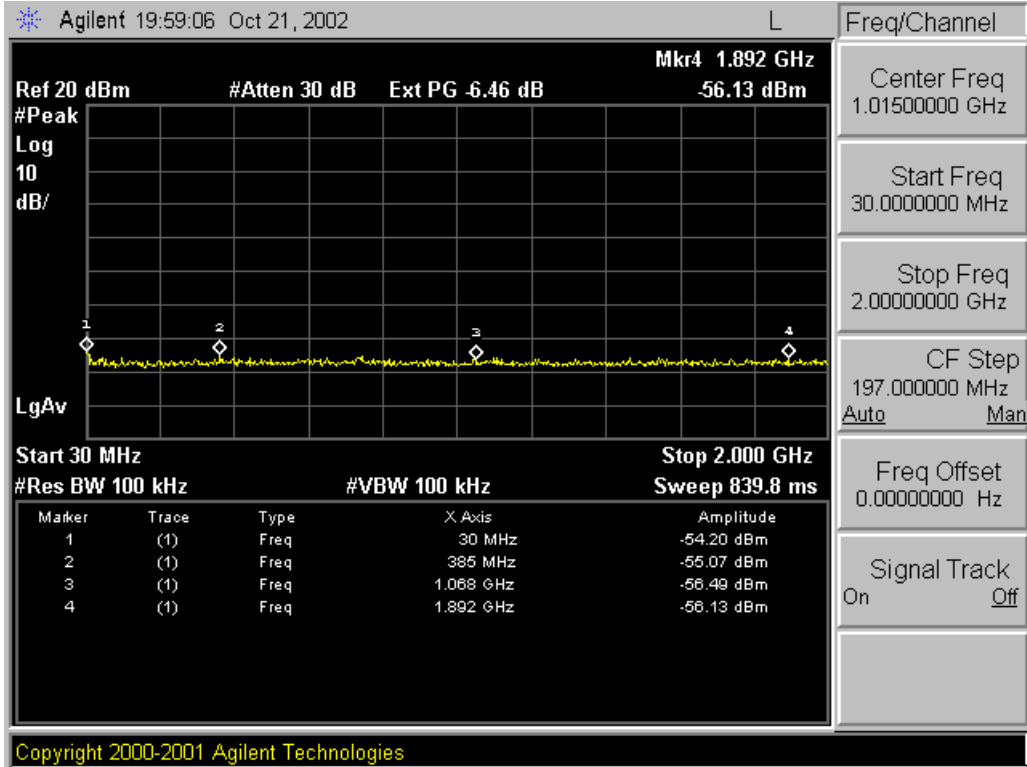


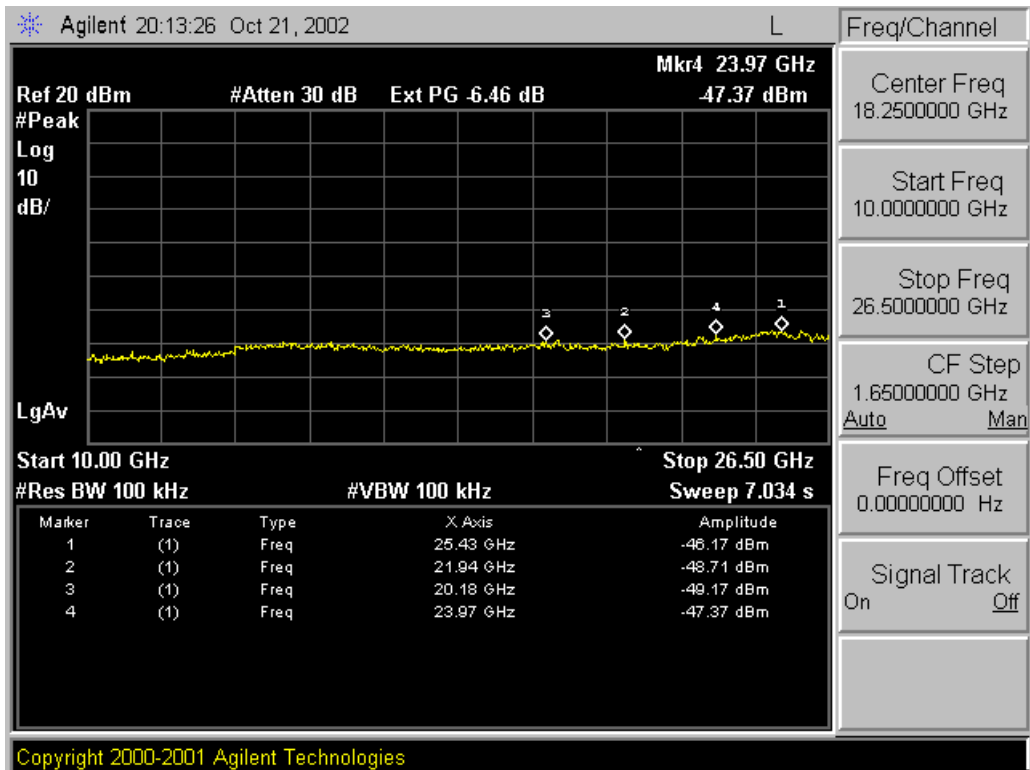
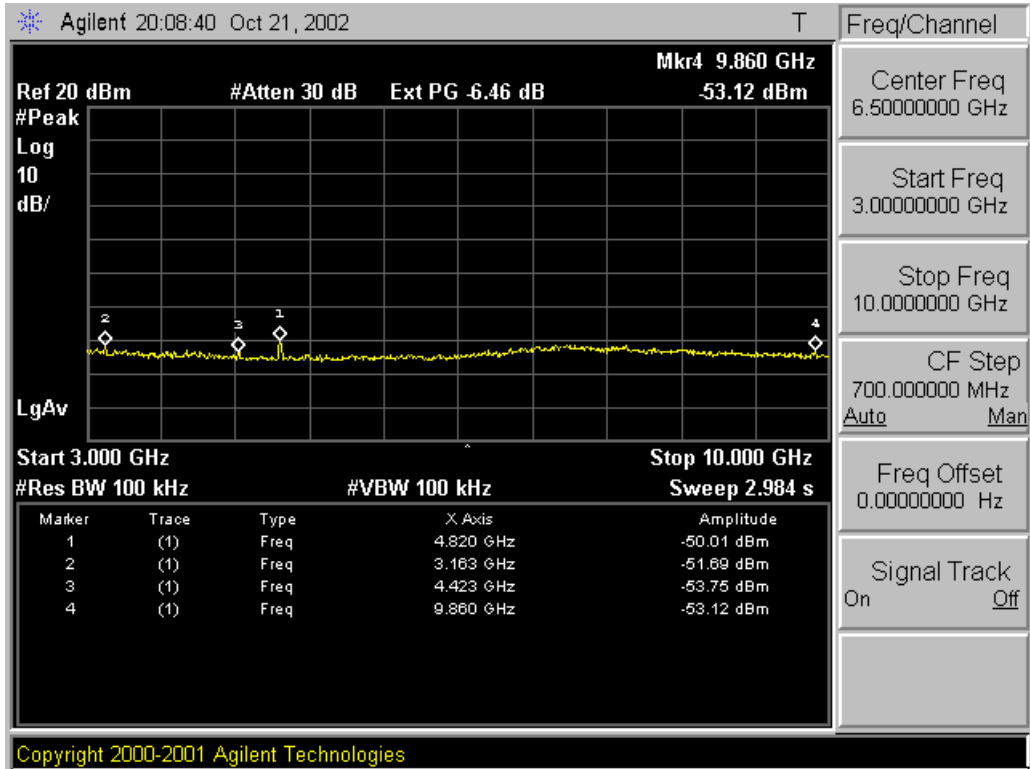
802.11b Conducted Spurious Emissions – Hi Channel



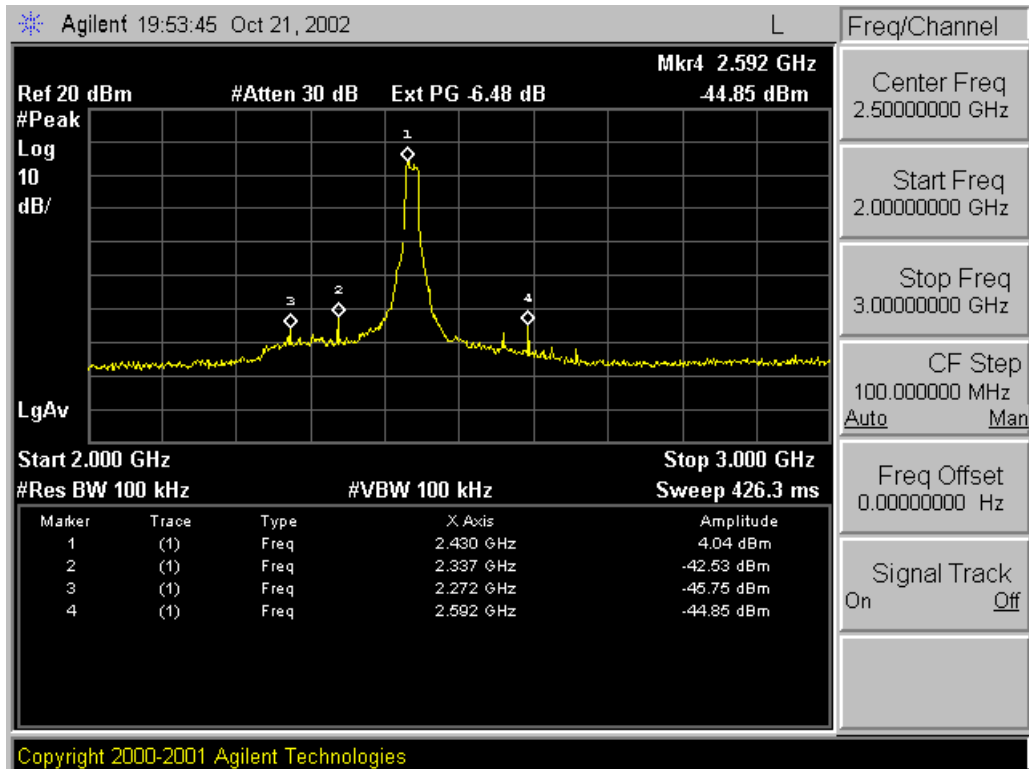
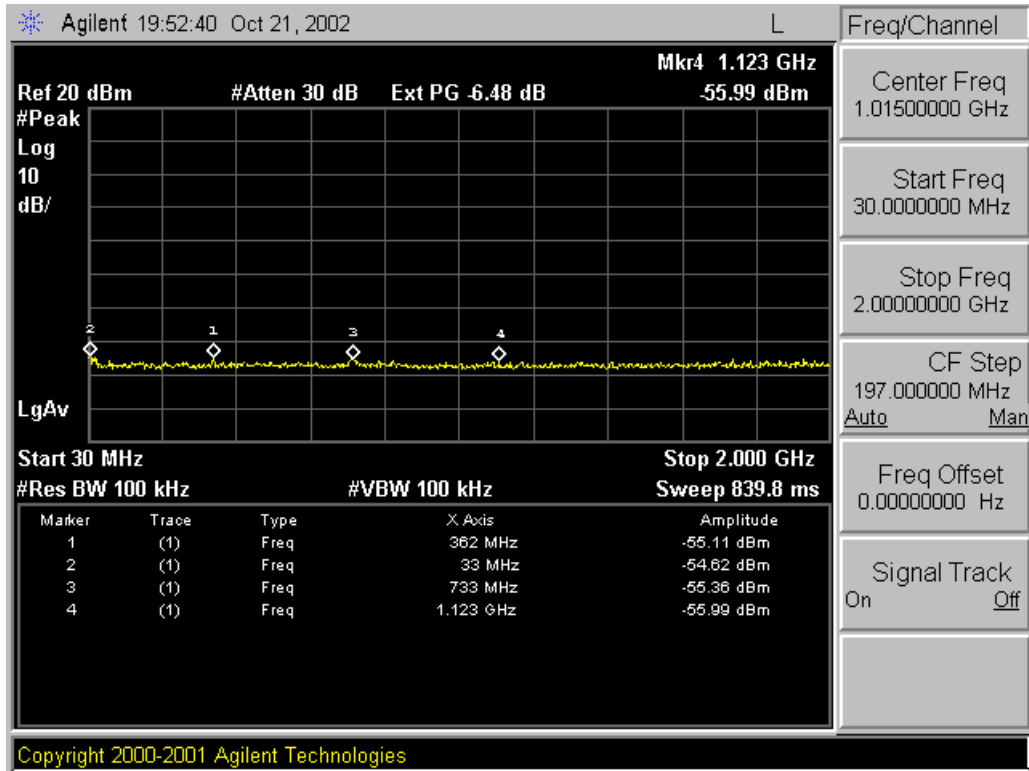


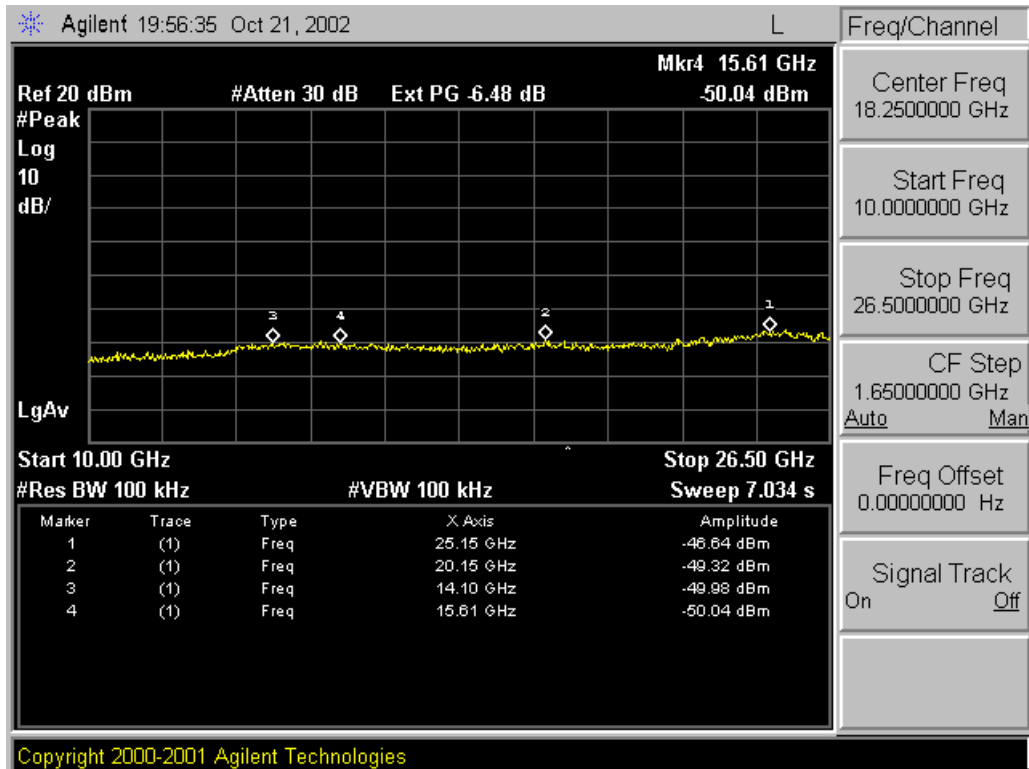
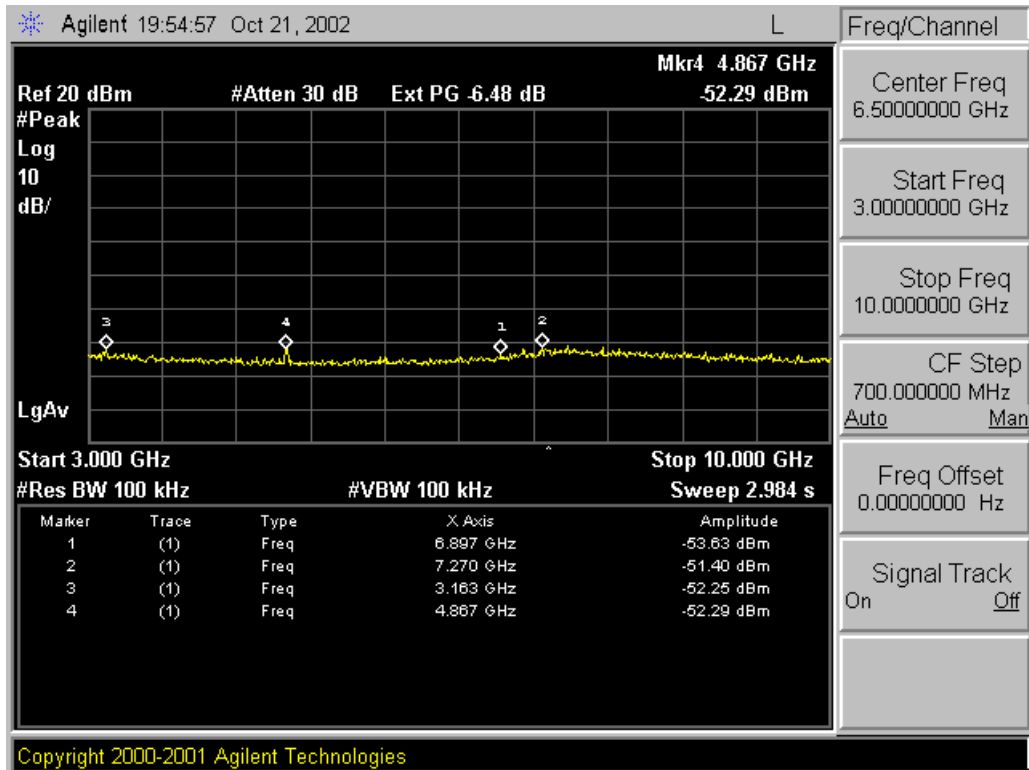
802.11g Conducted Spurious Emissions – Lo Channel



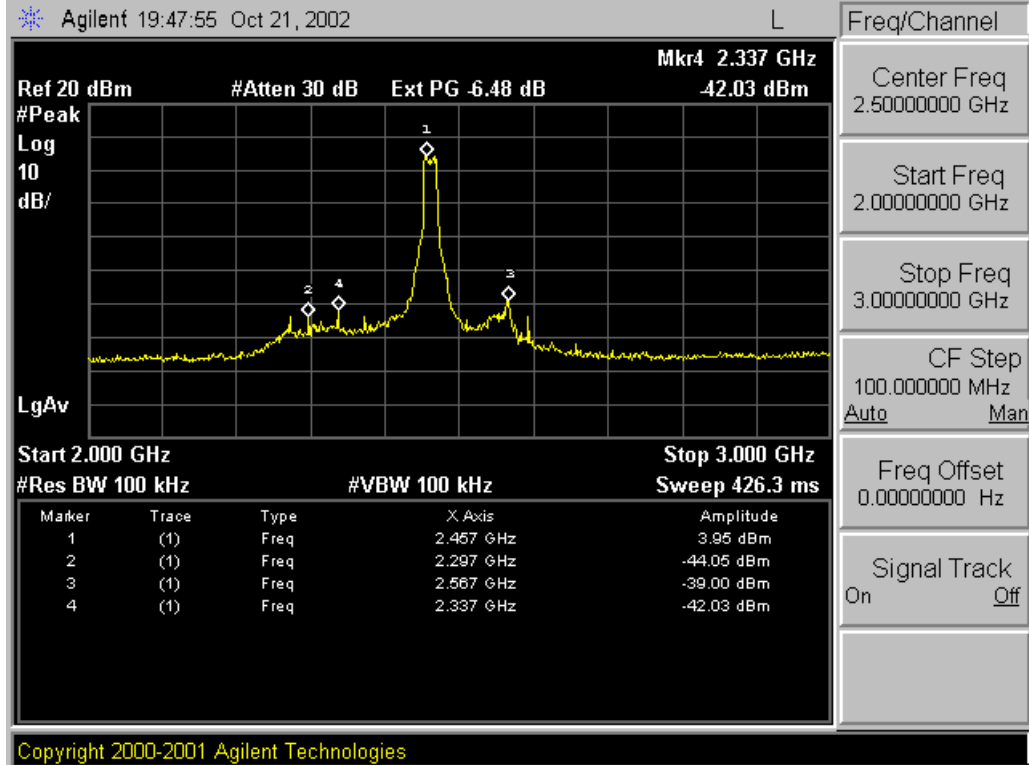
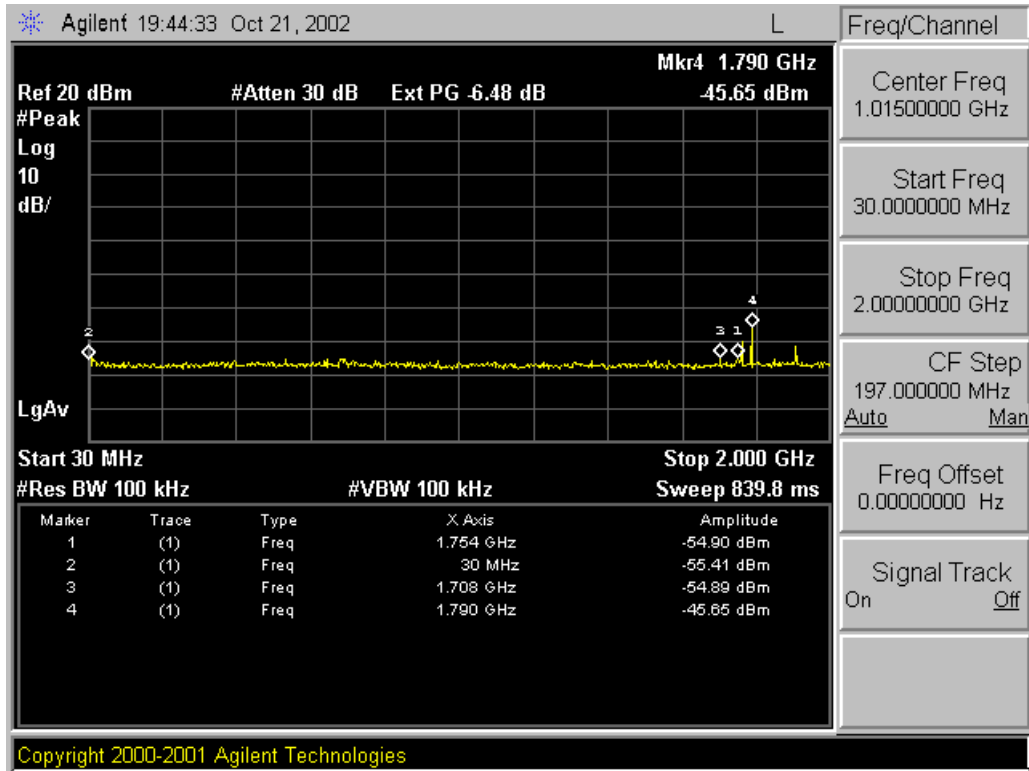


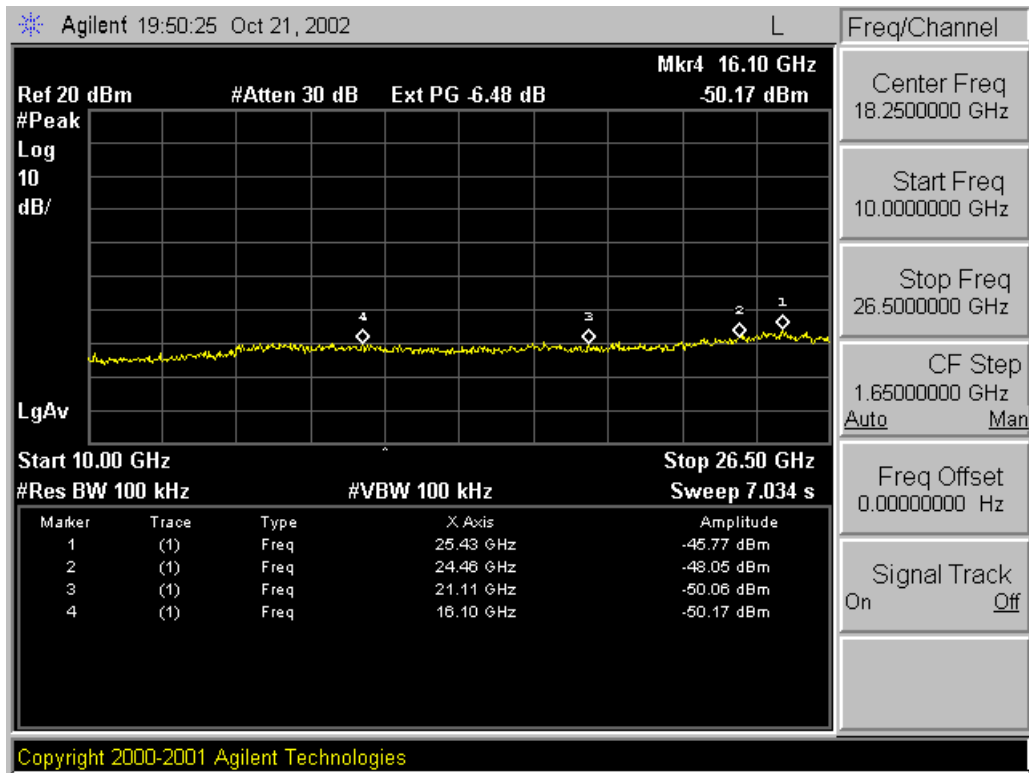
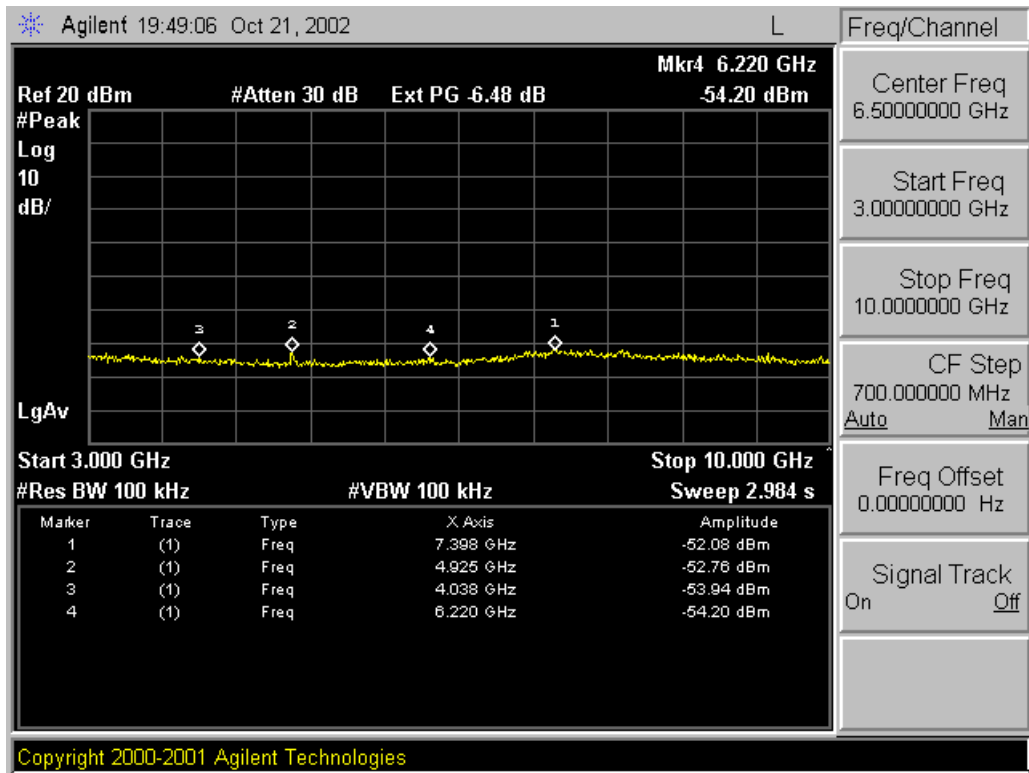
802.11g Conducted Spurious Emissions – Mid Channel



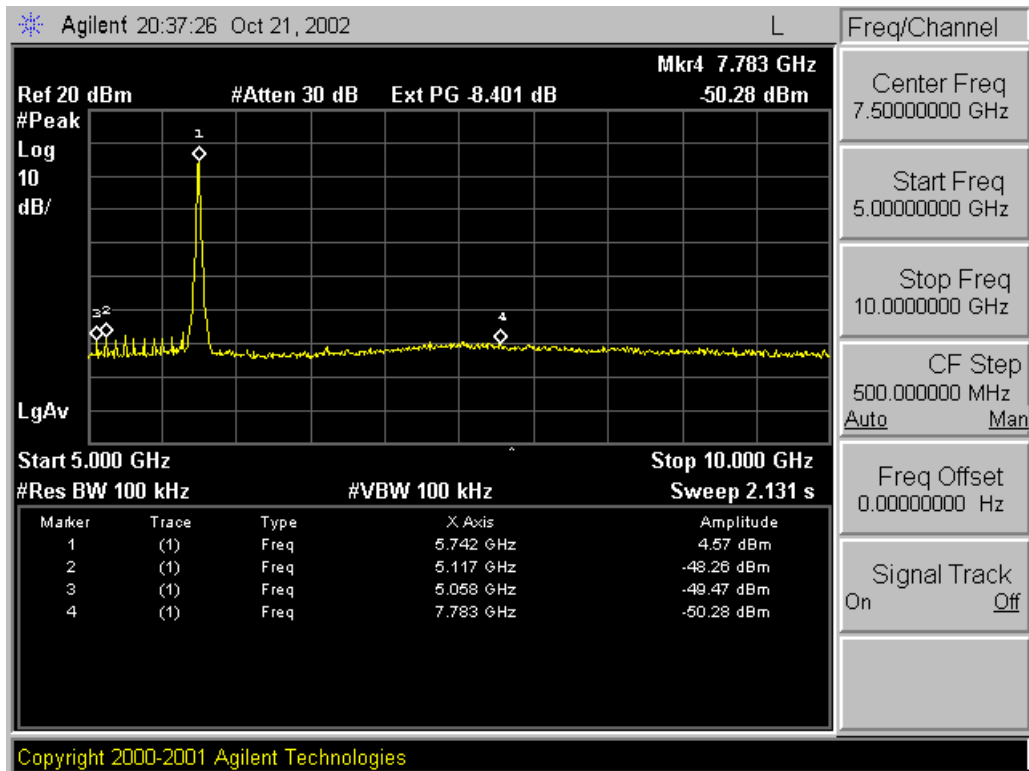
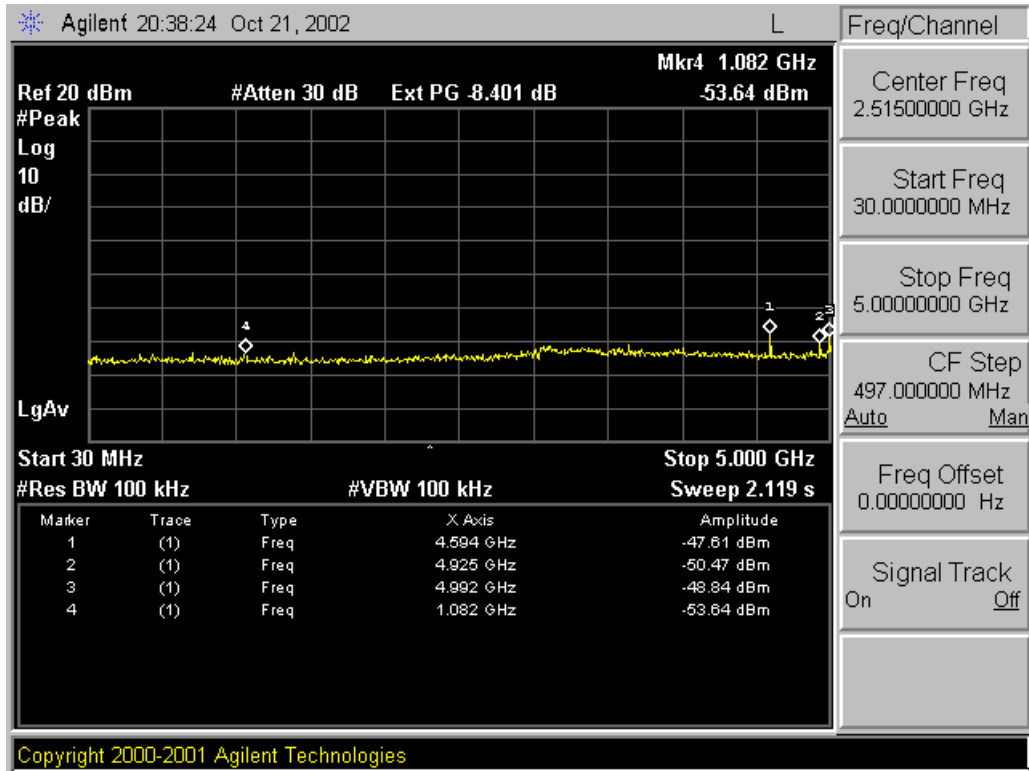


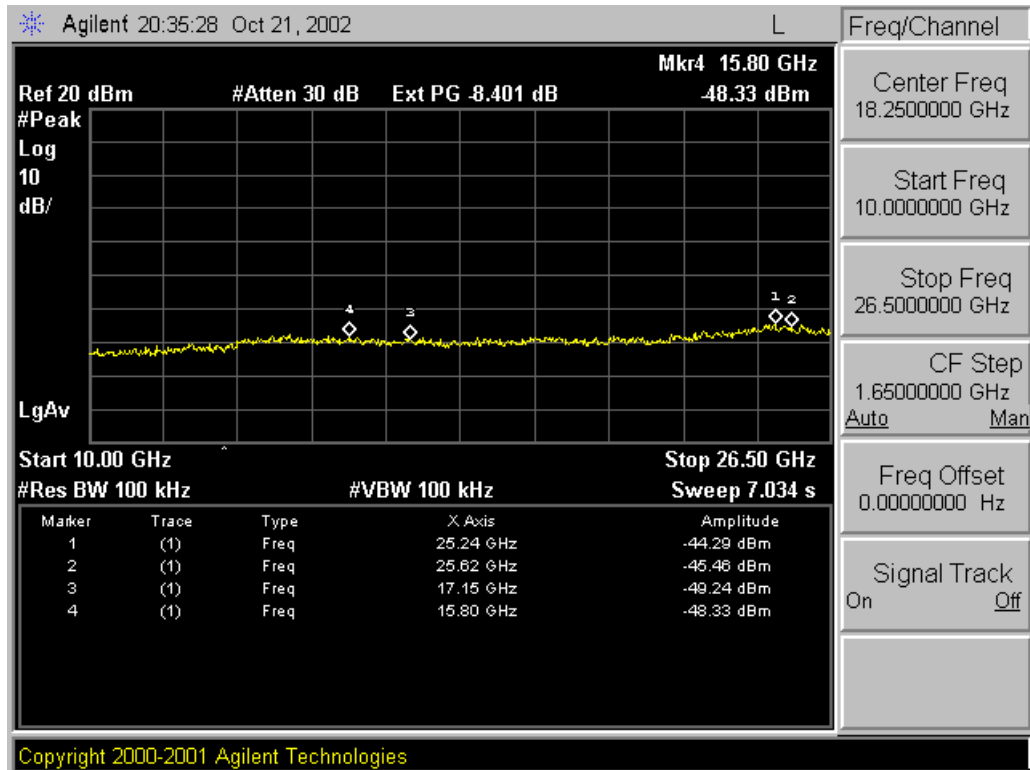
802.11g Conducted Spurious Emissions – Hi Channel



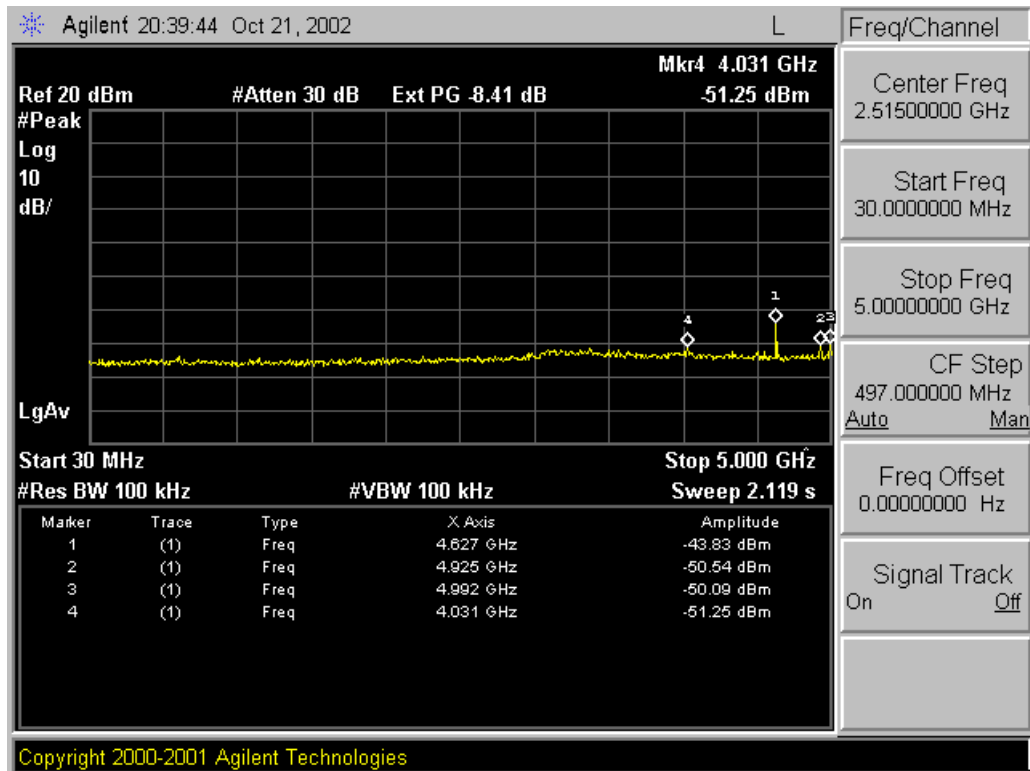


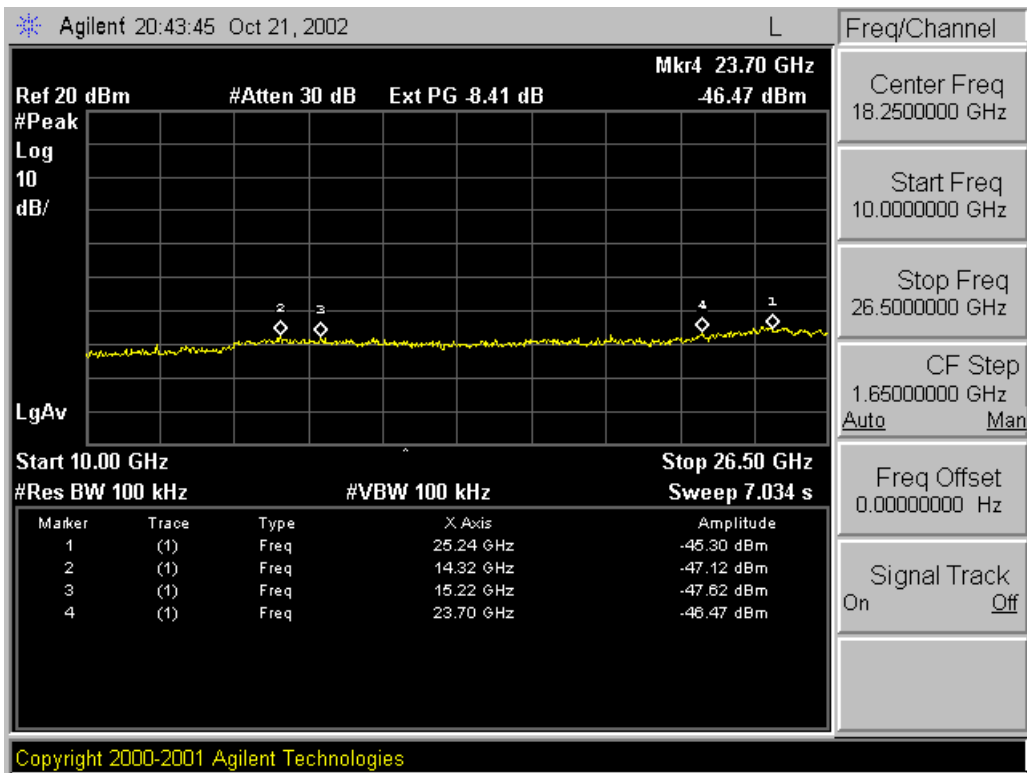
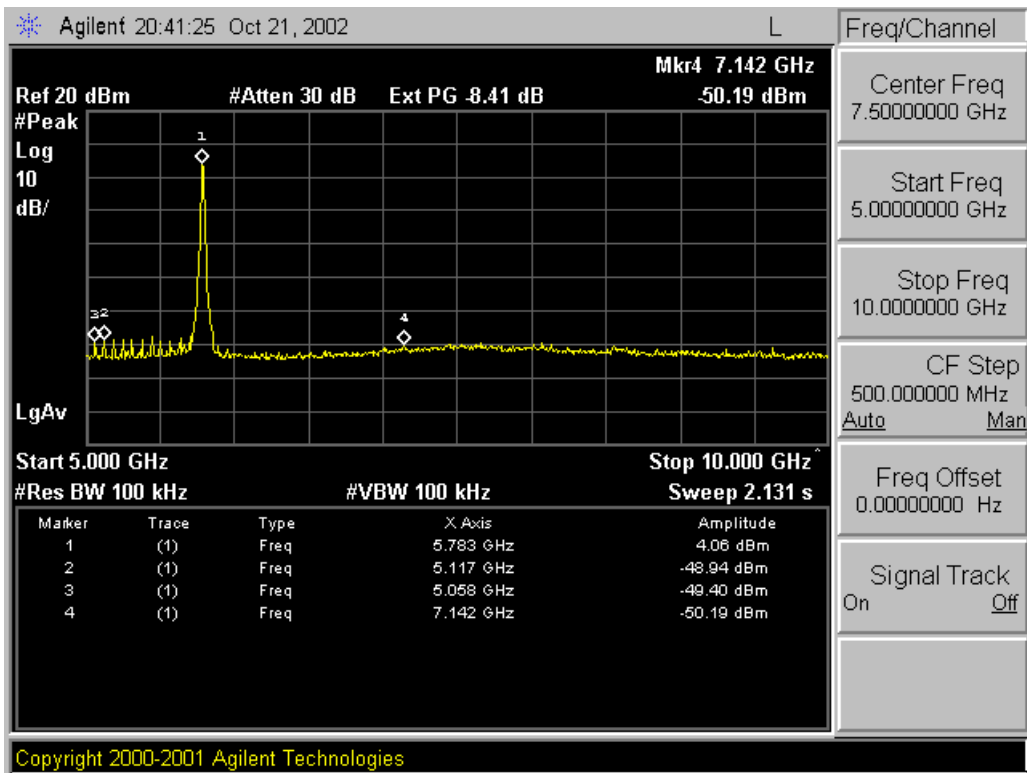
802.11a Conducted Spurious Emissions – Lo Channel



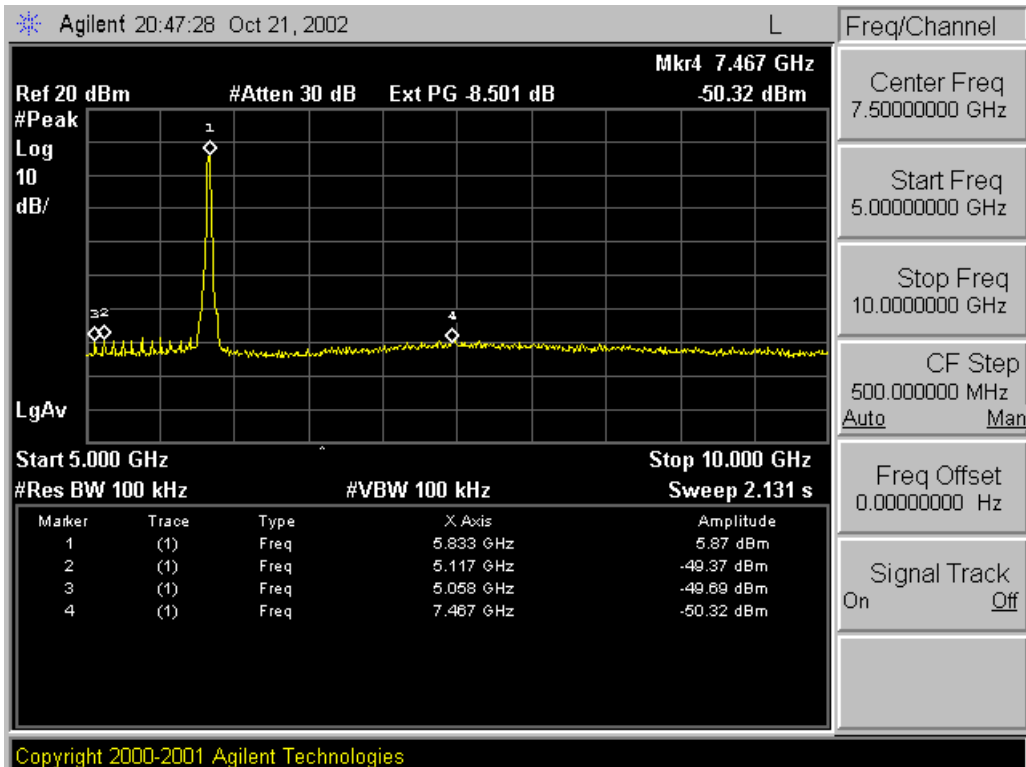
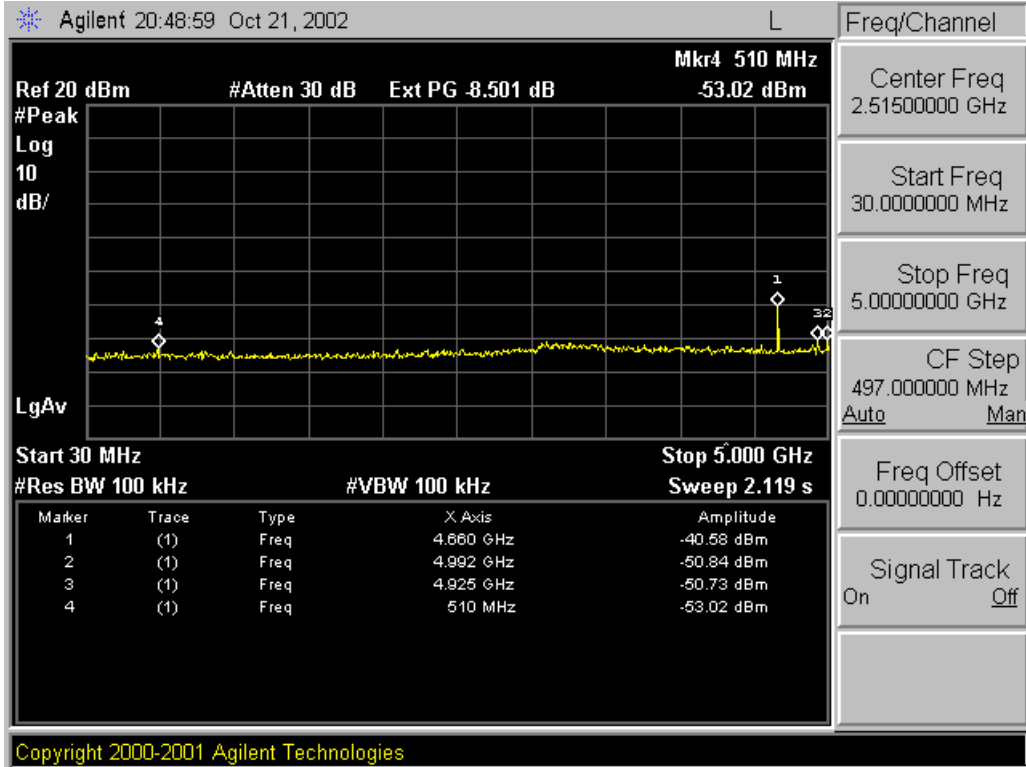


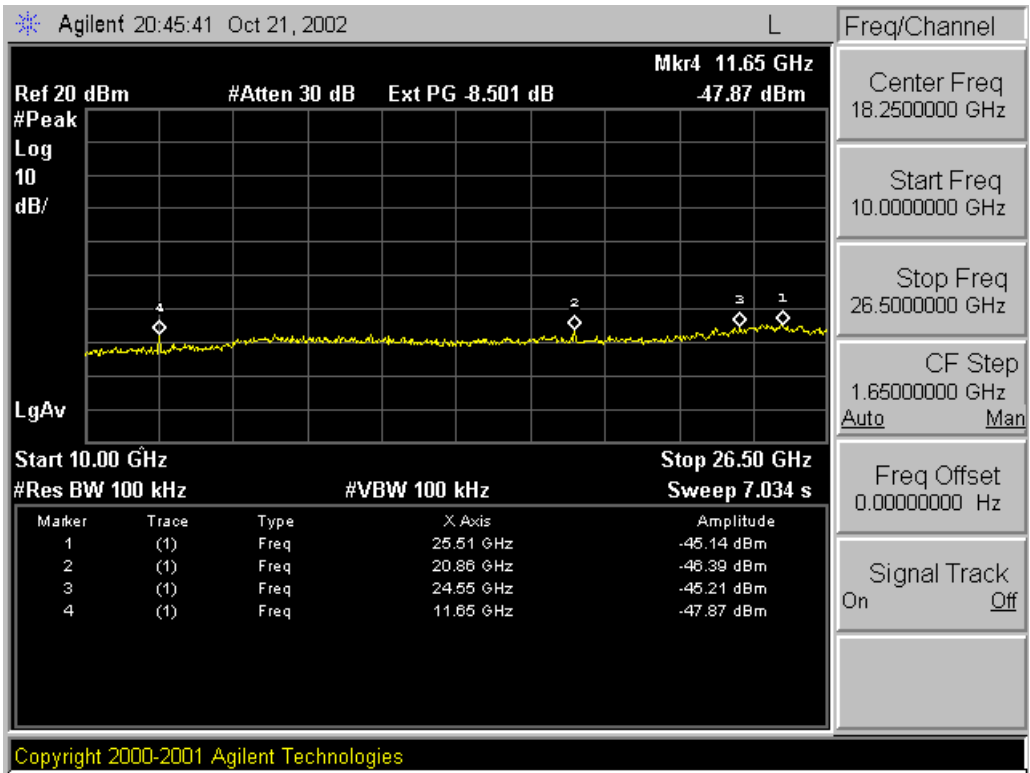
802.11a Conducted Spurious Emissions – Mid Channel





802.11a Conducted Spurious Emissions – Hi Channel





6.7 Maximum Permissible Exposure

6.7.1 Calculations

$$E = \text{SQR ROOT } (30 * P * G) / d$$

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 mW / square cm

Combining equations and rearranging the terms to express d as a function of the other variables yields:

$$d = \text{SQR ROOT } (30 * P * G) / (3770 * S)$$

Changing to units of mW and cm::

$$P(\text{mW}) = P(\text{W}) / 1000$$

And

$$d(\text{cm}) = 100 * d(\text{m})$$

Yields

$$d = 100 * \text{SQR ROOT } ((30 * P * G) / (3770 * S))$$

Therefore

$$d = 0.282 * \text{SQR ROOT } (P * G / S)$$

Where

- d = Distance in Meters
- P = Power In mW
- G = Numeric Antenna Gain
- S = Power Density in mW / cm²

Substituting the log form of gain and power:

$$P (\text{mW}) = 10^{(P(\text{dBm})/10)}$$

And

$$G \text{ (numeric)} = 10^{(G(\text{dBi}) / 10)}$$

Yields

$$\underline{d = .282 * 10^{((P+G) / 20)} / (\text{SQR ROOT } (S))}$$

Where

d = MPE Safe Distance in cm

P= Power In dBm

G = Antenna Gain in dBi

S= Power Density Limit in mW / cm²

6.7.2 Results

2.4 GHz 802.11b

$$\begin{aligned} \text{EUT Output Power} &= \underline{16.27 \text{ dBm}} \quad (\text{Section 6.4.5}) \\ \text{Antenna Gain} &= \underline{.46 \text{ dBi}} \quad (\text{Section 4.2}) \\ \text{S} &= \underline{1.0 \text{ mW} / \text{cm}^2} \quad (\text{CFR 47 Part 1.1310}) \end{aligned}$$

Minimum MPE safe distance (using equation above) = **1.94 cm**

2.4 GHz 802.11g

$$\begin{aligned} \text{EUT Output Power} &= \underline{16.37 \text{ dBm}} \quad (\text{Section 6.4.5}) \\ \text{Antenna Gain} &= \underline{.46 \text{ dBi}} \quad (\text{Section 4.2}) \\ \text{S} &= \underline{1.0 \text{ mW} / \text{cm}^2} \quad (\text{CFR 47 Part 1.1310}) \end{aligned}$$

Minimum MPE safe distance (using equation above) = **1.96 cm**

5 GHz 802.11a

$$\begin{aligned} \text{EUT Output Power} &= \underline{17.48 \text{ dBm}} \quad (\text{Section 6.4.5}) \\ \text{Antenna Gain} &= \underline{-.49 \text{ dBi}} \quad (\text{Section 4.2}) \\ \text{S} &= \underline{1.0 \text{ mW} / \text{cm}^2} \quad (\text{CFR 47 Part 1.1310}) \end{aligned}$$

Minimum MPE safe distance (using equation above) = **1.99 cm**

Safe distance compliant with 20 cm separation distance mandatory for mobile transmitters.

Unit is compliant