# FCC CFR47 PART 15 SUBPART C CERTIFICATION

# TEST REPORT

**FOR**

**802.11 a/b/g Mini PCI MODULE**

**MODEL NUMBER: AR5BMB-44**

**FCC ID: PPD-AR5BMB-00044**

**REPORT NUMBER: 04U2552-1**

**ISSUE DATE: APRIL 30, 2004**

*Prepared for*
**ATHEROS COMMUNICATIONS, INC.**
**529 ALMANOR AVENUE**
**SUNNYVALE**
**CA 94085, USA**

*Prepared by*
**COMPLIANCE CERTIFICATION SERVICES**
**561F MONTEREY ROAD,**
**MORGAN HILL, CA 95037, USA**
**TEL: (408) 463-0885**
**FAX: (408) 463-0888**

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# 1. TEST RESULT CERTIFICATION

**COMPANY NAME:** ATHEROS COMMUNICATIONS, INC.
529 ALMANOR AVENUE
SUNNYVALE, CA 94085, USA

**EUT DESCRIPTION:** 802.11a/b/g Mini PCI module

**MODEL:** AR5BMB-44

**DATE TESTED:** FEBRUARY 24 – MARCH 19, 2004

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| FCC PART 15 SUBPART C | 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**: This document reports conditions under which testing was conducted and results of tests performed. 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.

**Note:** The 2.4 and 5.8 GHz bands are applicable to this report; another band of operation (5.2 GHz) is documented in a separate report.

Approved & Released For CCS By:

MIKE HECKROTTE
ENGINEERING MANAGER
COMPLIANCE CERTIFICATION SERVICES

Tested By:

YAN ZHENG
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

# 2. EUT DESCRIPTION

The EUT is an 802.11a/b/g transceiver Mini PCI card module.

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

| Frequency Band (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|---|---|---|---|
| 2412 - 2462 | 802.11b | 20.85 | 121.62 |
| 2412 - 2462 | 802.11g | 24.45 | 278.61 |
| 2437 | 802.11g Turbo | 24.34 | 271.64 |
| 5785 - 5825 | 802.11a | 25.74 | 374.97 |
| 5760 - 5800 | 802.11a Turbo | 24.38 | 274.16 |

The radio utilizes two film antennas for diversity (main and auxiliary), Hitachi model HTL017. Each antenna has a maximum gain of 4.24 dBi, without cable loss, in the 2.4 GHz band and 4.12 dBi, without cable loss, in the 5.8 GHz band.

The module alternately utilizes two other film antennas: Hitachi model HTL008 and Tyco model TIAN01 antennas. These have lower gains in the 2.4 and 5.8 GHz bands compared to the HTL017.

Two HTL017 antennas were utilized during final compliance tests.

# 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4/2001, FCC CFR 47 Part 2 and FCC CFR 47 Part 15.

# 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 561F Monterey Road, Morgan Hill, 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.

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**LAB CODE:200065-0**

No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.

# 5. CALIBRATION AND UNCERTAINTY

## 5.1. 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.

## 5.2. 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%.

## 5.3. TEST AND MEASUREMENT EQUIPMENT

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

| TEST EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **Cal Due** |
| Spectrum Analyzer | Agilent | E4446A | MY43360112 | 1/13/2005 |
| Peak Power Meter | Agilent | E4416A | GB41291160 | 11/7/2004 |
| Peak / Average Power Sensor | Agilent | E9327A | US40440755 | 11/7/2004 |
| Antenna, Horn 1 ~ 18 GHz | EMCO | 3115 | 2238 | 2/4/2005 |
| Antenna, Horn 18 ~ 26 GHz | ARA | SWH-28 | 1007 | 2/24/2005 |
| Antenna, Horn 26 ~ 40 GHz | ARA | MWH-2640/B | 1029 | 12/3/2004 |
| PreAmplifier 1-26GHz | MITEQ | NSP2600-SP | 924341 | 4/25/2004 |
| PreAmplifier 26-40 GHz | MITEQ | NSP4000-SP2 | 924343 | 6/1/2004 |
| 7.6GHz High Pass Filter | Micro-tronics | HPM13195 | SN-002 | N/A |
| 4.0GHz High Pass Filter | Micro-tronics | HPM13351 | SN-001 | N/A |
| EMI Receiver, 9 kHz ~ 2.9 GHz | HP | 8542E | 3942A00286 | 11/20/2004 |
| RF Filter Section | HP | 85420E | 3705A00256 | 11/20/2004 |
| Antenna, Bicon/Log, 30 ~ 2000 MHz | Sunol Sciences | JB1 | A121003 | 12/22/2004 |
| LISN, 10 kHz ~ 30 MHz | FCC | 50/250-25-2 | 114 | 10/13/2004 |
| Line Filter | Lindgren | LMF-3489 | 497 | CNR |
| LISN, 10 kHz ~ 30 MHz | Solar | 8012-50-R-24-BNC | 8379443 | 10/13/2004 |

# 6. SETUP OF EQUIPMENT UNDER TEST

## SUPPORT EQUIPMENT

| PERIPHERAL SUPPORT EQUIPMENT LIST | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID** |
| LAPTOP | DEL | PP01L | DS/N CN-04P240-48643-2BK-4144 | DOC |
| AC ADAPTER | DELL | AA20031 | DS/N CN-09364U-16291-2A9-01LG | DOC |
| CARDBUS ADAPTER | STELLCOM | STCBMP13 | SN-022 | DOC |

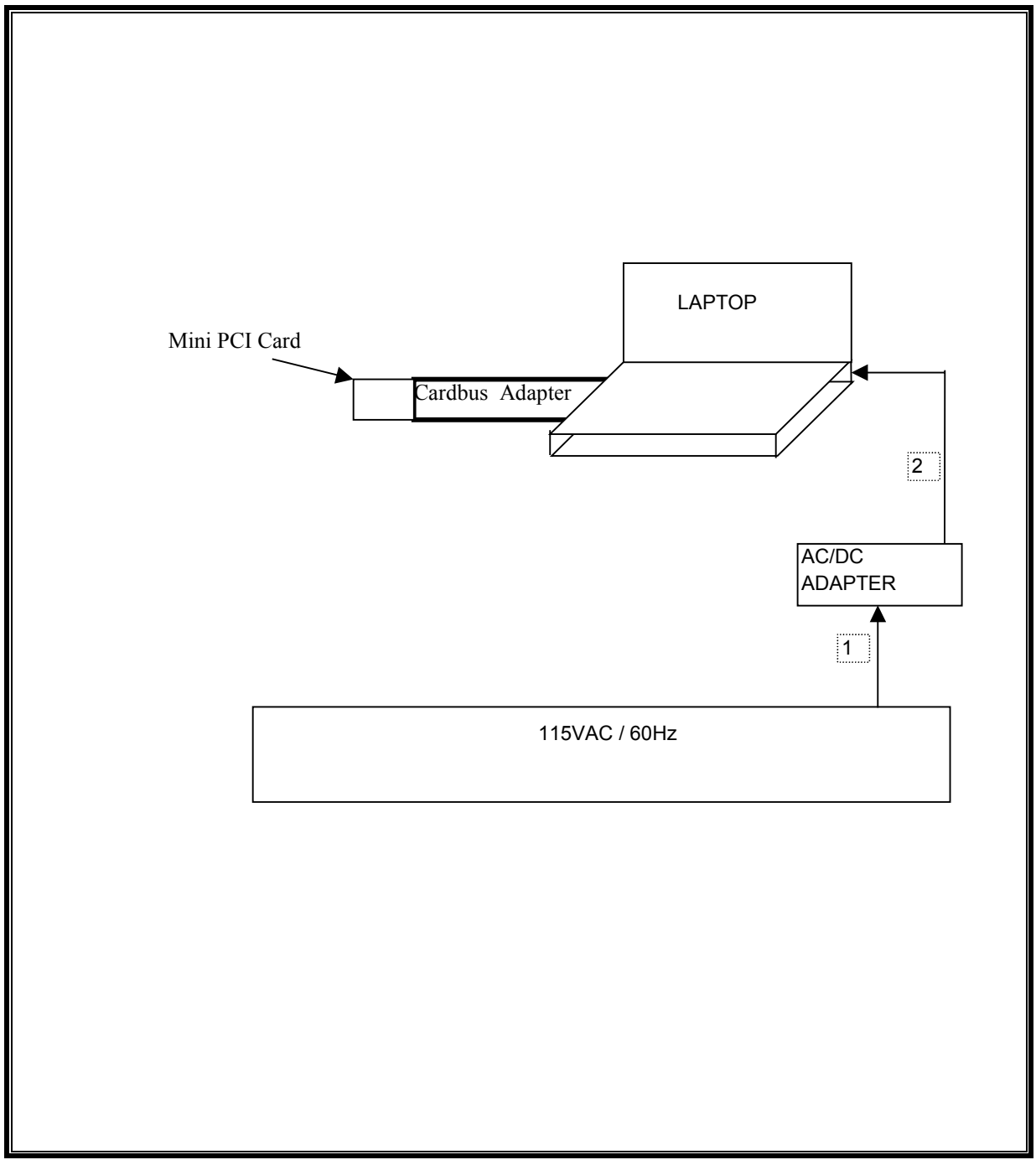
## I/O CABLES

| I/O CABLE LIST | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length** | **Remarks** |
| 1 | AC | 2 | US115 | UNSHIELDED | 2m | NO |
| 2 | DC | 1 | DC | UNSHIELDED | 2m | NO |

## TEST SETUP

The EUT is installed in a host laptop computer via a cardbus-to-miniPCI adapter / extension board during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR TESTS**



# 7. APPLICABLE LIMITS AND TEST RESULTS

## 7.1. 6 dB BANDWIDTH

**LIMIT**

§15.247 (a) (2) For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

**TEST PROCEDURE**

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.

**2.4 GHz BAND RESULTS**

No non-compliance noted:

802.11b Mode

| Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Minimum Limit (kHz) | Margin (kHz) |
|---|---|---|---|---|
| Low | 2412 | 12070 | 500 | 11570 |
| Middle | 2437 | 12070 | 500 | 11570 |
| High | 2462 | 11970 | 500 | 11470 |

802.11g Mode

| Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Minimum Limit (kHz) | Margin (kHz) |
|---|---|---|---|---|
| Low | 2412 | 16400 | 500 | 15900 |
| Middle | 2437 | 16330 | 500 | 15830 |
| High | 2462 | 16400 | 500 | 15900 |

802.11g Turbo Mode

| Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Minimum Limit (kHz) | Margin (kHz) |
|---|---|---|---|---|
| Middle | 2437 | 32530 | 500 | 32030 |

## 5.8 GHz BAND RESULTS

No non-compliance noted:

802.11a Mode

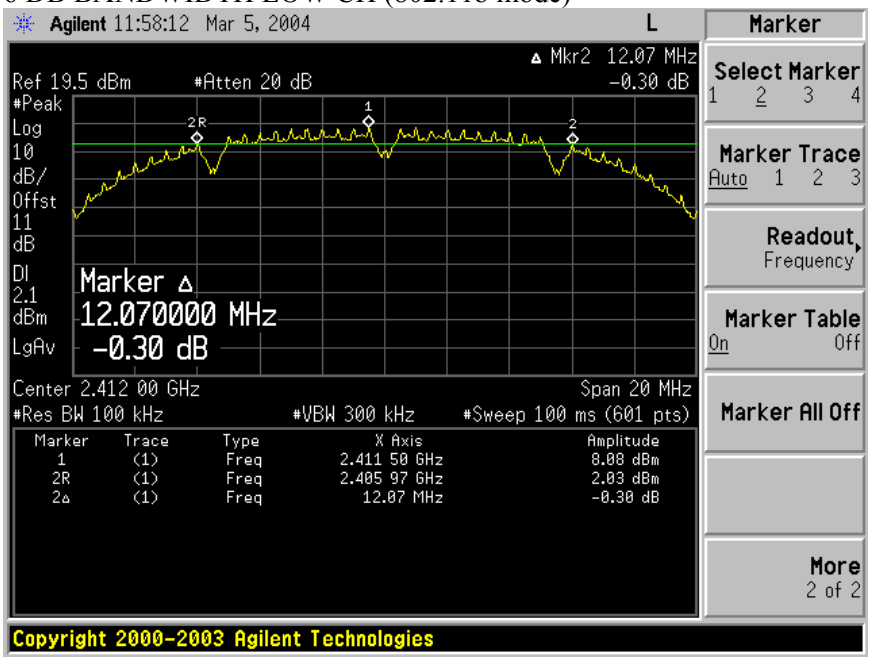
| Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Minimum Limit (kHz) | Margin (kHz) |
|---|---|---|---|---|
| Low | 5745 | 16500 | 500 | 16000 |
| Middle | 5785 | 16500 | 500 | 16000 |
| High | 5825 | 16500 | 500 | 16000 |

802.11a Turbo Mode

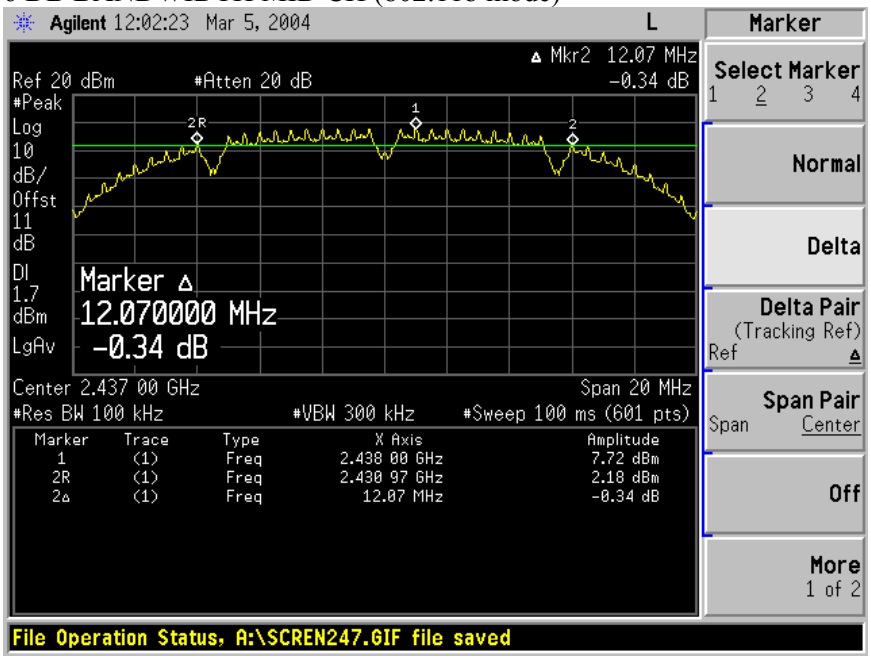
| Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Minimum Limit (kHz) | Margin (kHz) |
|---|---|---|---|---|
| Low | 5760 | 31417 | 500 | 30917 |
| High | 5800 | 31417 | 500 | 30917 |

## 6 DB BANDWIDTH (802.11b MODE)

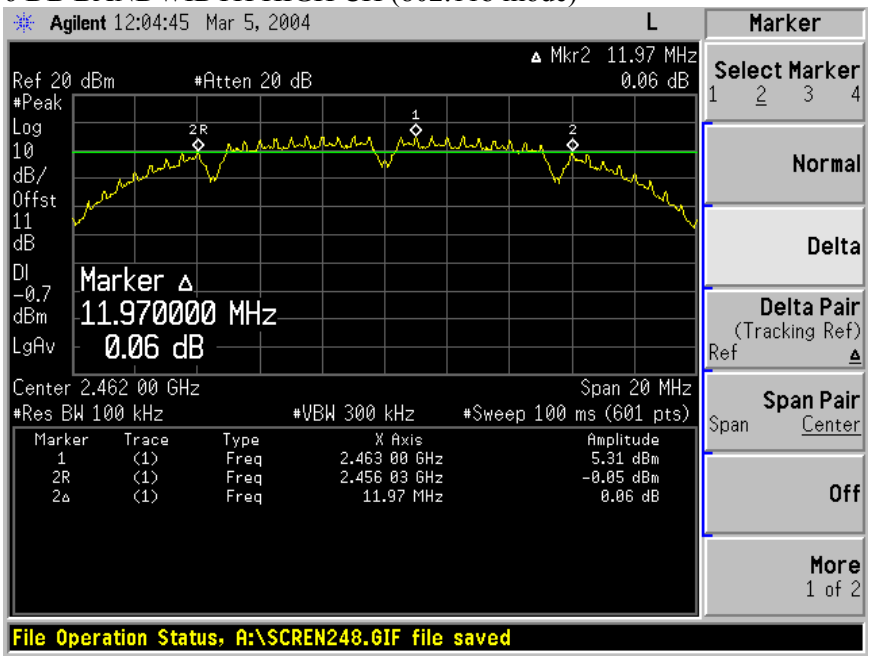
6 DB BANDWIDTH LOW CH (802.11b mode)



6 DB BANDWIDTH MID CH (802.11b mode)

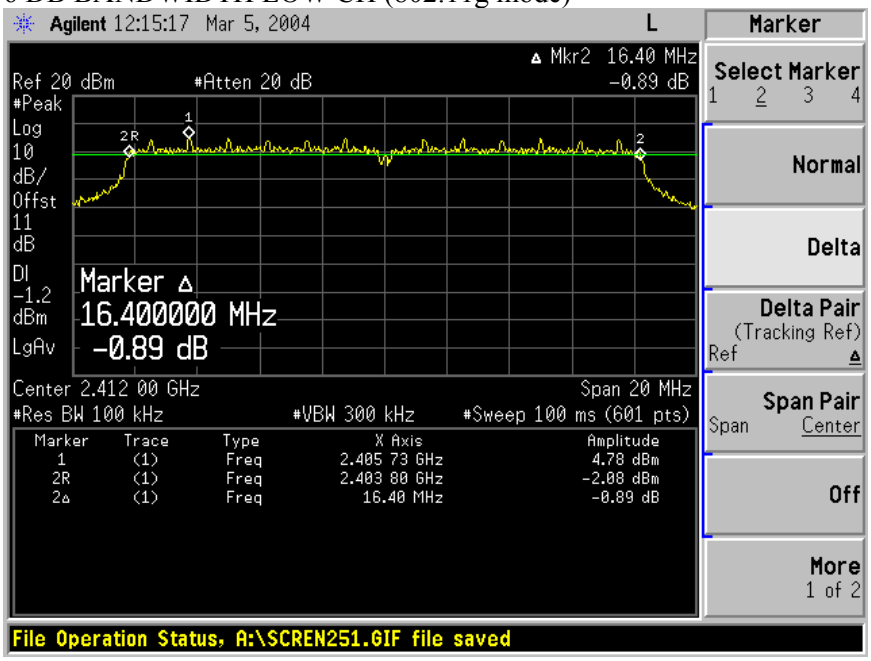


6 DB BANDWIDTH HIGH CH (802.11b mode)

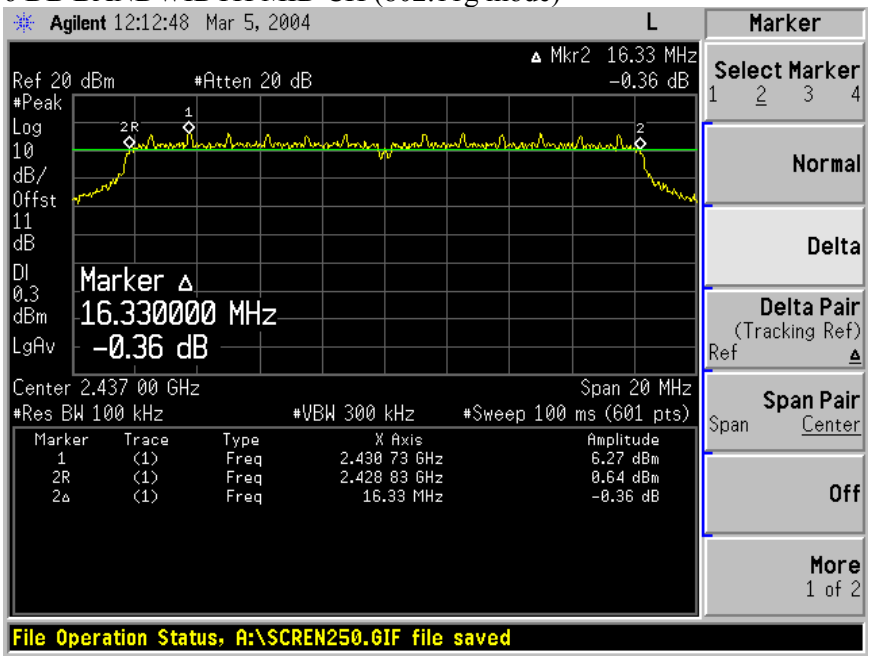


## 6 DB BANDWIDTH (802.11g MODE)

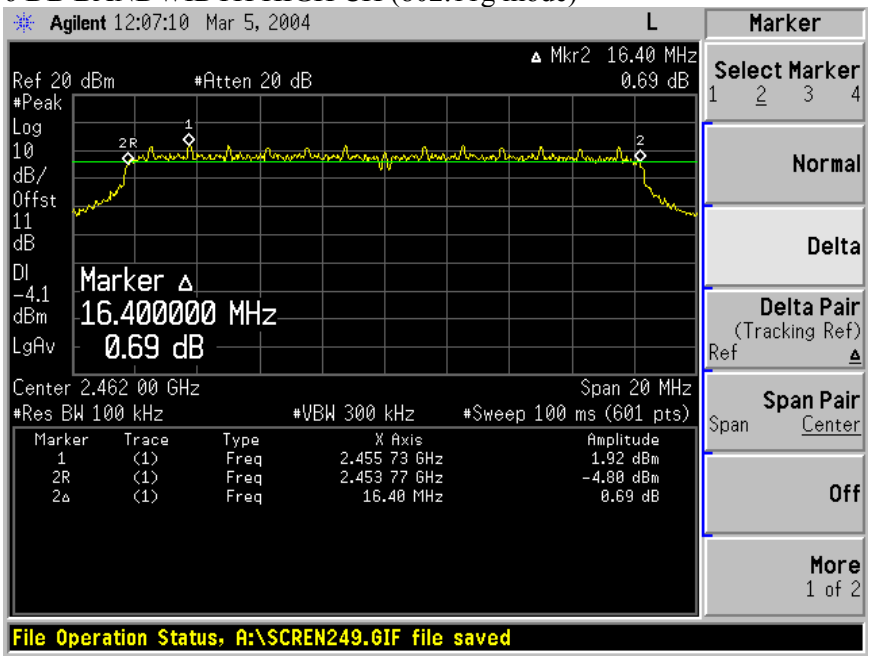
6 DB BANDWIDTH LOW CH (802.11g mode)



6 DB BANDWIDTH MID CH (802.11g mode)

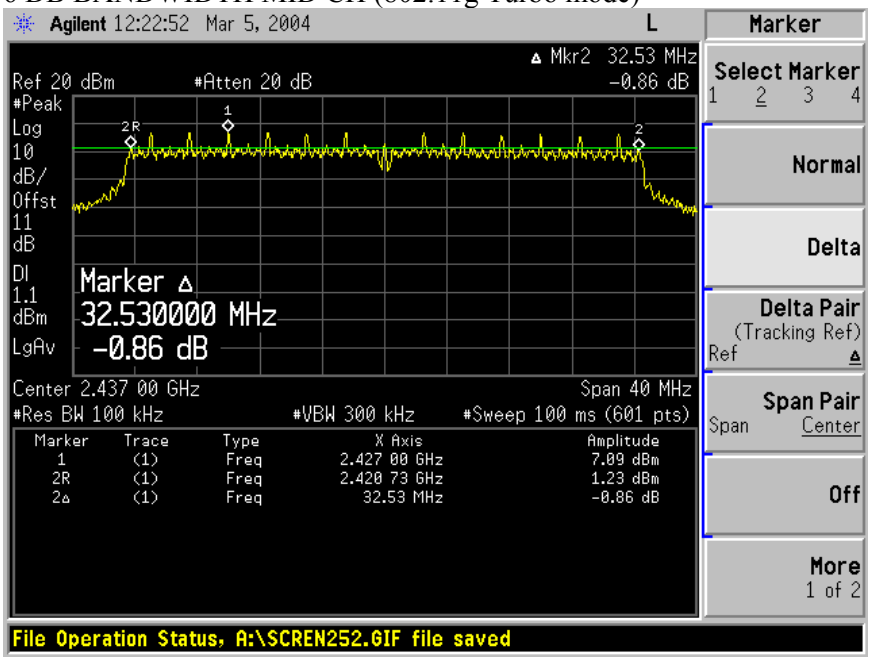


6 DB BANDWIDTH HIGH CH (802.11g mode)



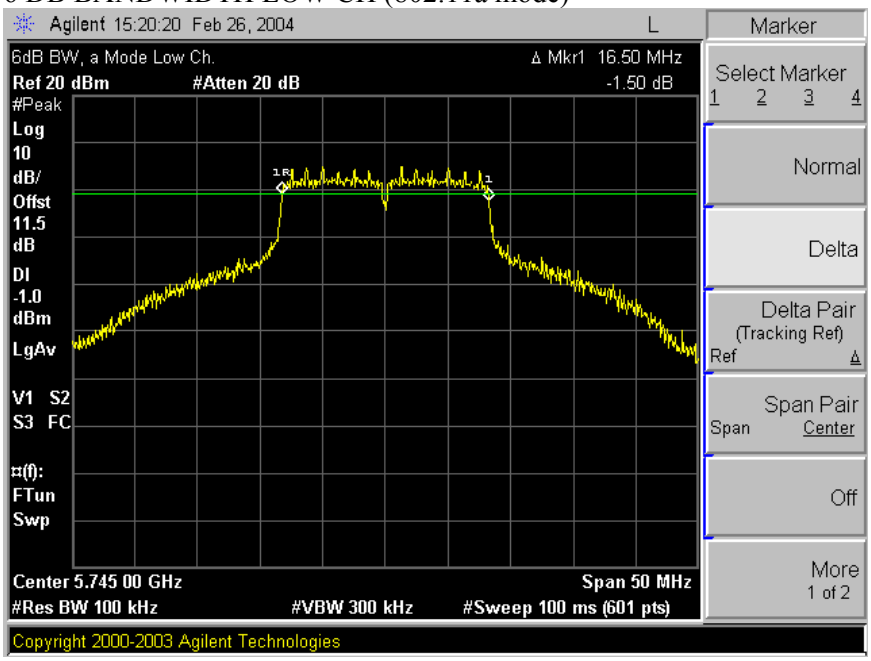
## 6 DB BANDWIDTH (802.11g TURBO MODE)

6 DB BANDWIDTH MID CH (802.11g Turbo mode)

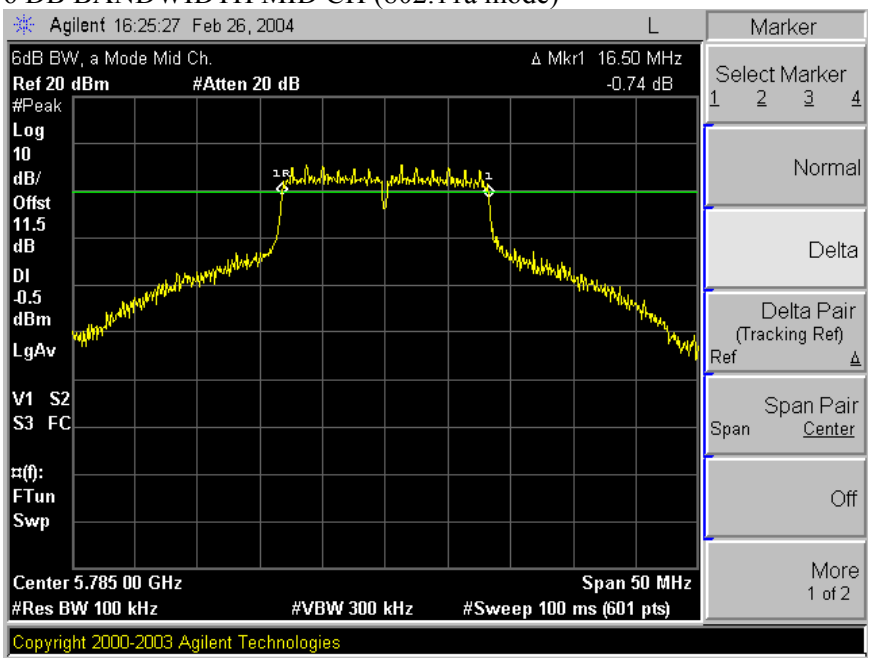


## 6 DB BANDWIDTH (802.11a MODE)

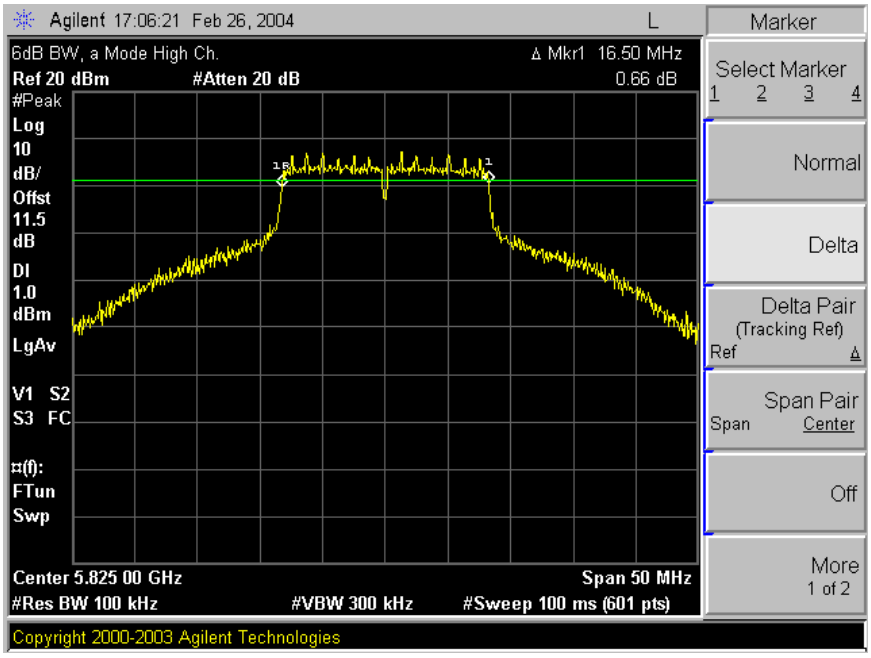
6 DB BANDWIDTH LOW CH (802.11a mode)



6 DB BANDWIDTH MID CH (802.11a mode)

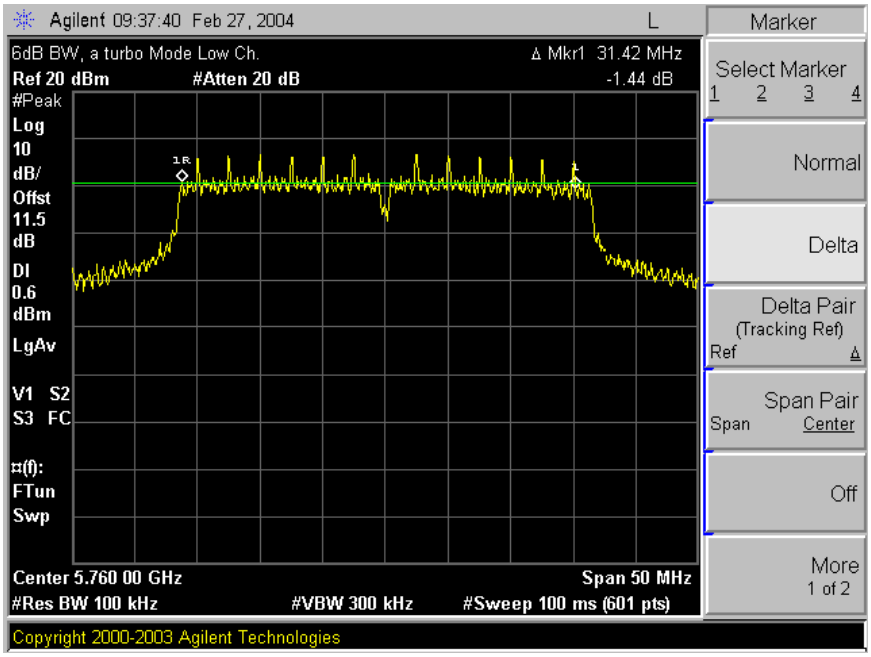


6 DB BANDWIDTH HIGH CH (802.11a mode)

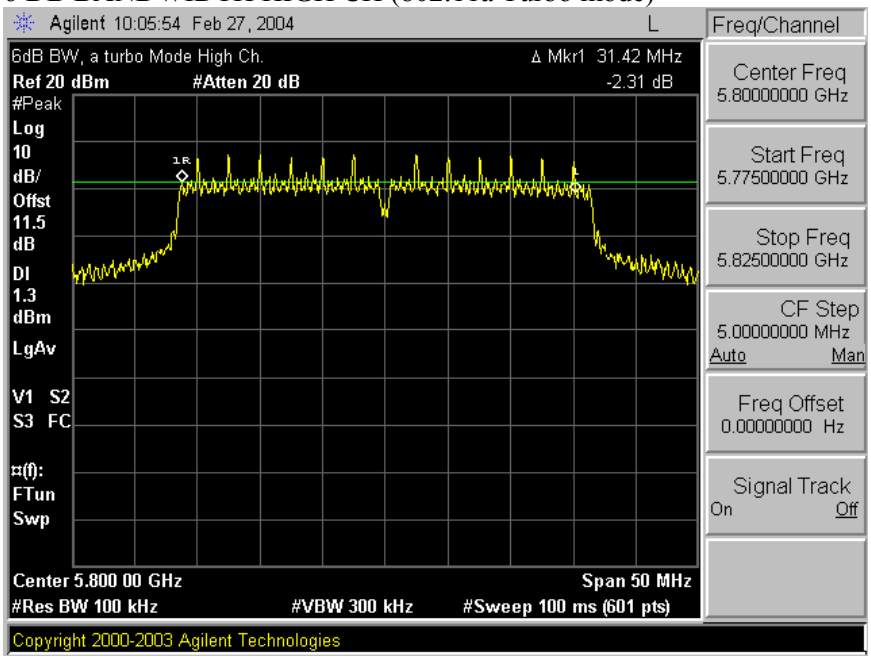


## 6 DB BANDWIDTH (802.11a TURBO MODE)

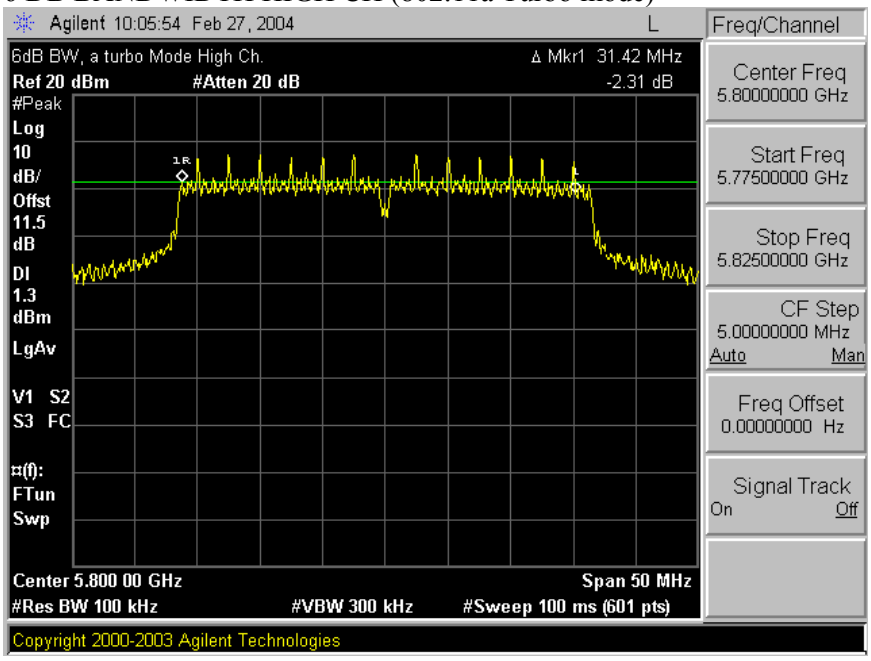
6 DB BANDWIDTH LOW CH (802.11a Turbo mode)



6 DB BANDWIDTH HIGH CH (802.11a Turbo mode)



6 DB BANDWIDTH HIGH CH (802.11a Turbo mode)



## 7.2. 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.

**2.4 GHz BAND RESULTS**

No non-compliance noted:

802.11b Mode

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2412 | 15.5621 |
| Middle | 2437 | 15.6073 |
| High | 2462 | 15.4983 |

802.11g Mode

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2412 | 16.4833 |
| Middle | 2437 | 16.5017 |
| High | 2462 | 16.4644 |

802.11g Turbo Mode

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Middle | 2437 | 32.8648 |

## 5.8 GHz BAND RESULTS

No non-compliance noted:

802.11a Mode

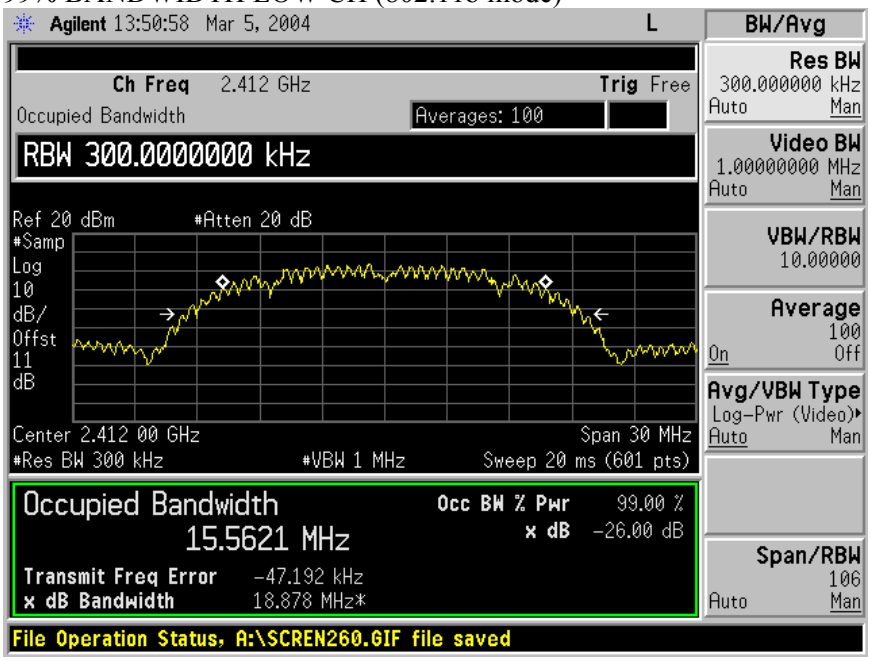
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 5745 | 16.693 |
| Middle | 5785 | 16.918 |
| High | 5825 | 17.633 |

802.11a Turbo Mode

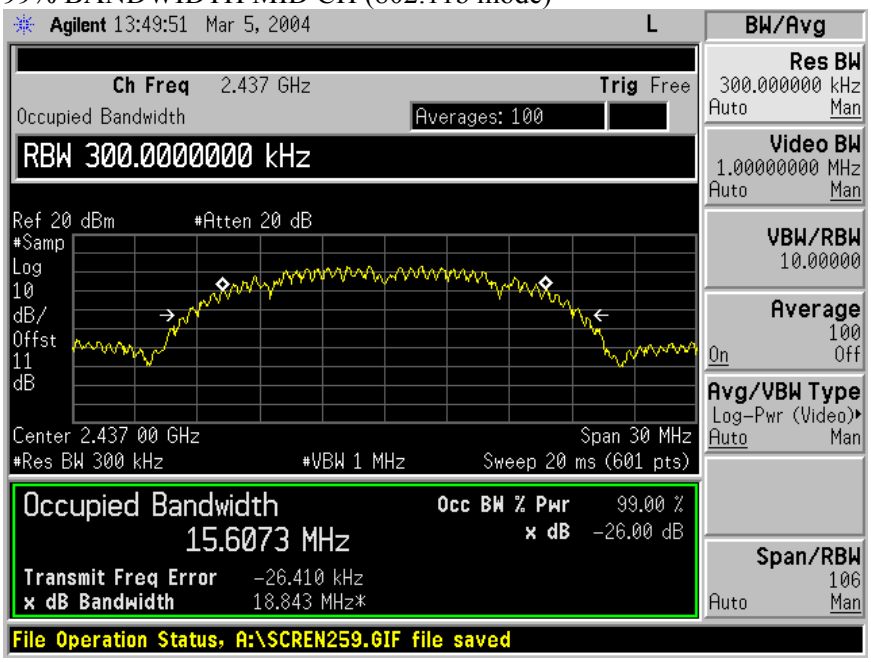
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 5760 | 32.919 |
| High | 5800 | 33.179 |

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

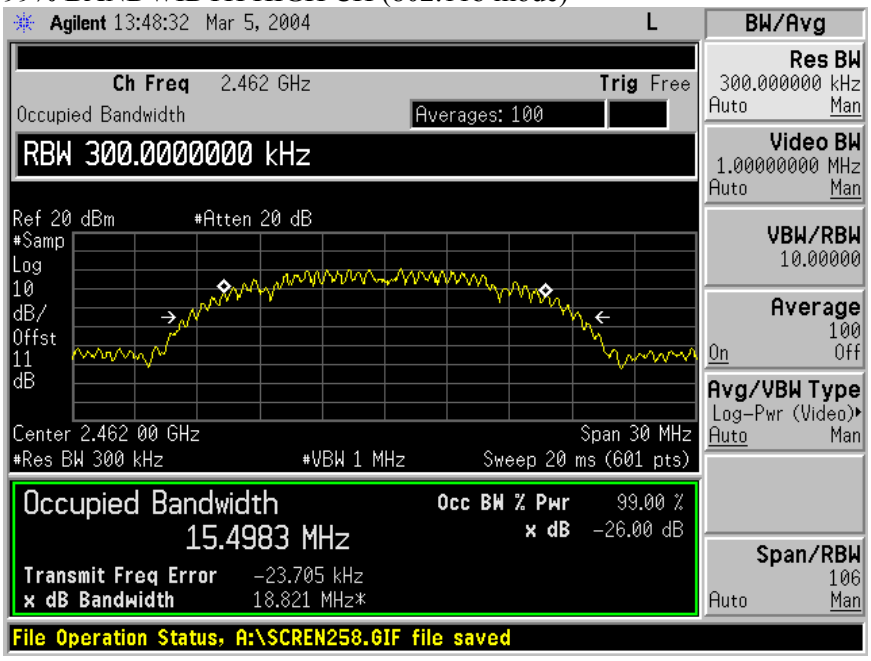
99% BANDWIDTH LOW CH (802.11b mode)



99% BANDWIDTH MID CH (802.11b mode)

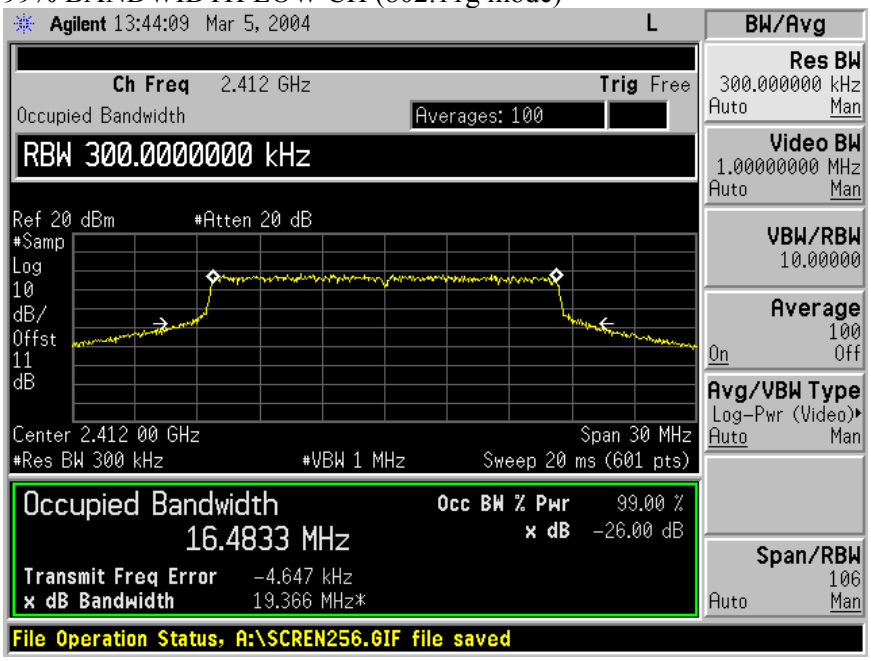


99% BANDWIDTH HIGH CH (802.11b mode)

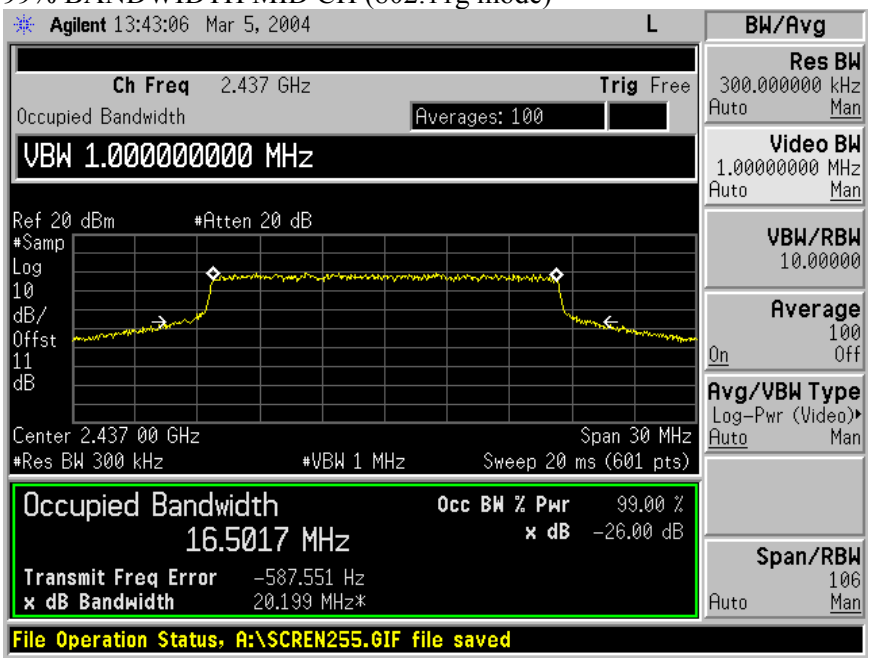


**99% BANDWIDTH (802.11g MODE)**

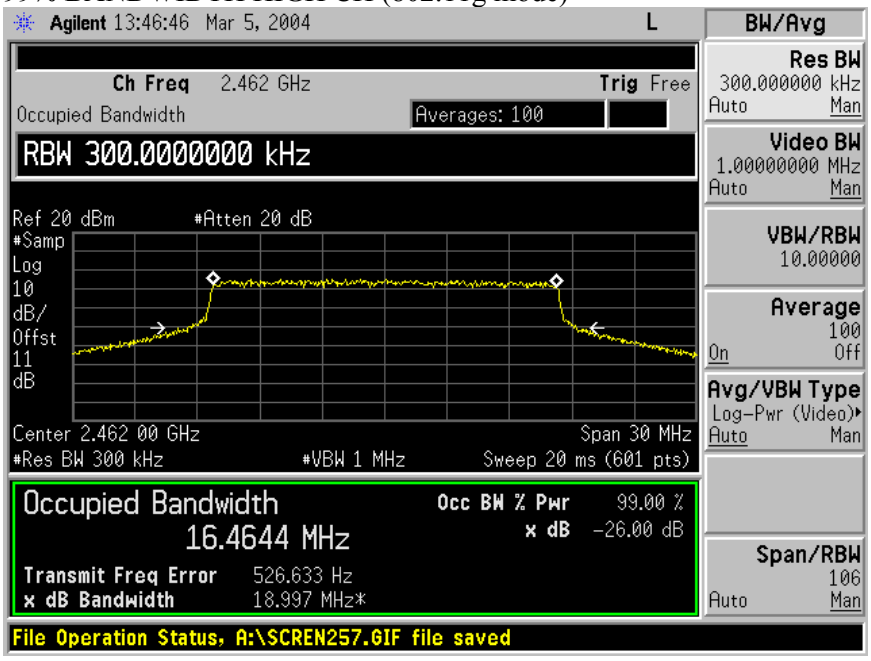
99% BANDWIDTH LOW CH (802.11g mode)



99% BANDWIDTH MID CH (802.11g mode)

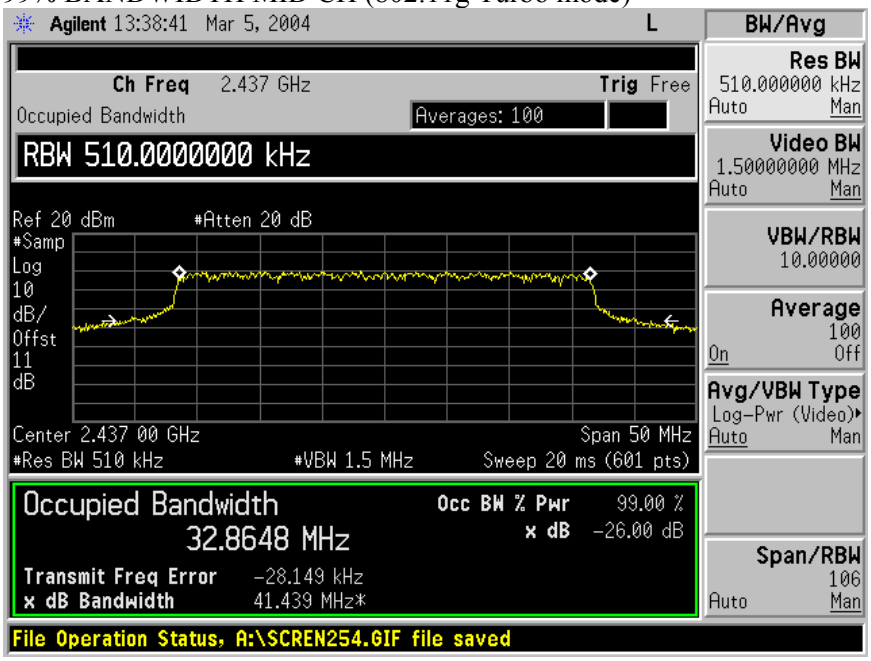


99% BANDWIDTH HIGH CH (802.11g mode)



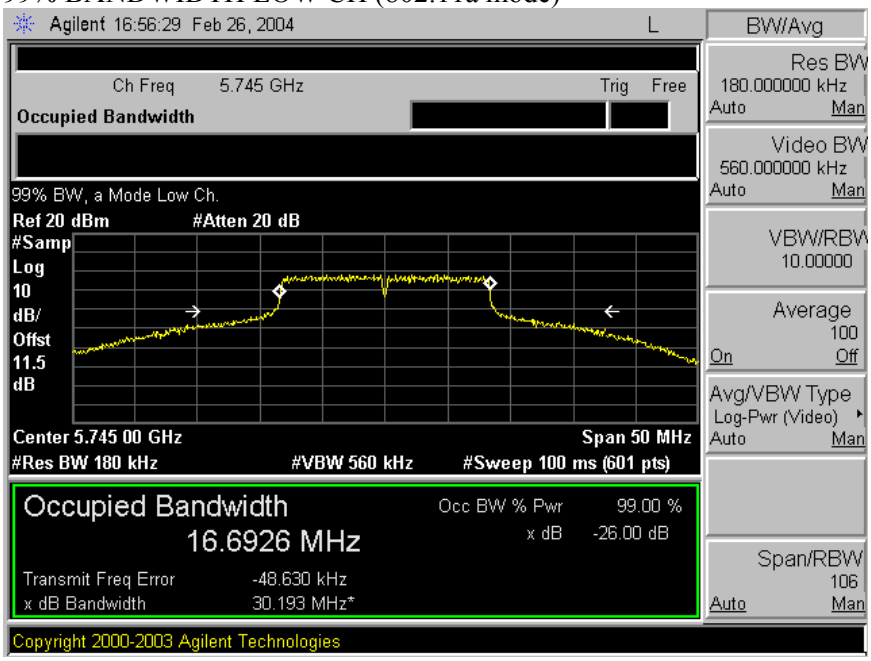
**99% BANDWIDTH (802.11g TURBO MODE)**

99% BANDWIDTH MID CH (802.11g Turbo mode)

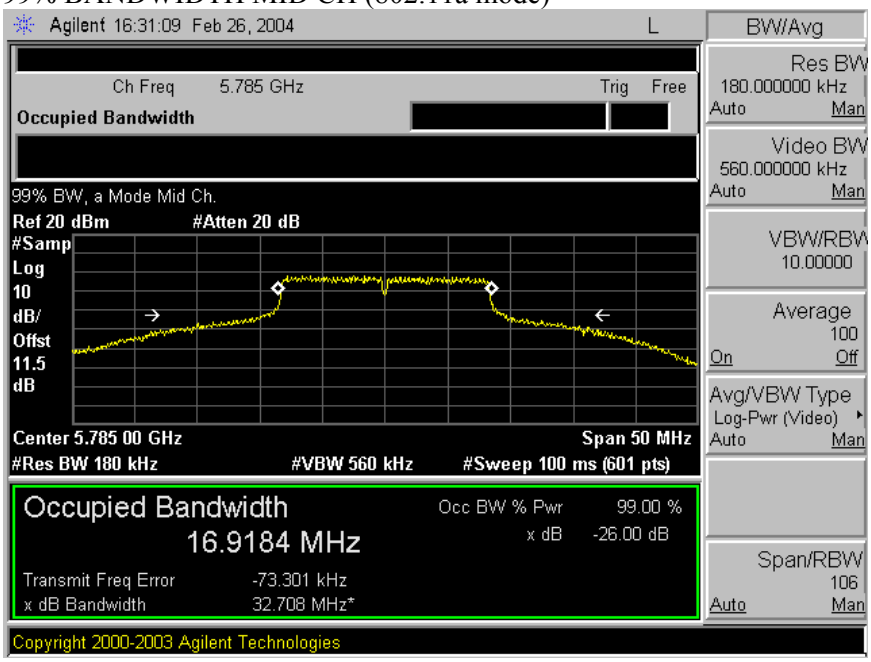


**99% BANDWIDTH (802.11a MODE)**

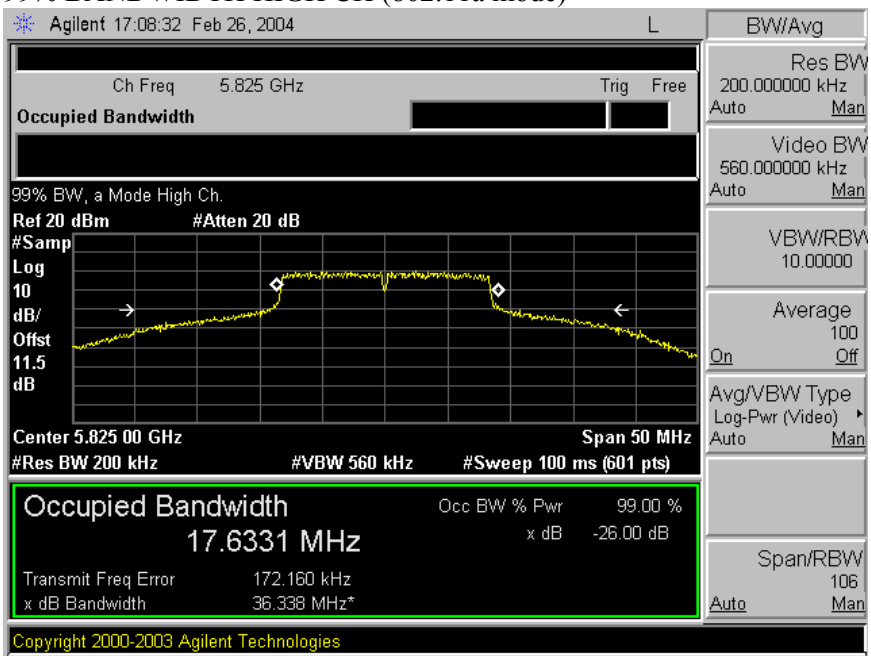
99% BANDWIDTH LOW CH (802.11a mode)



99% BANDWIDTH MID CH (802.11a mode)

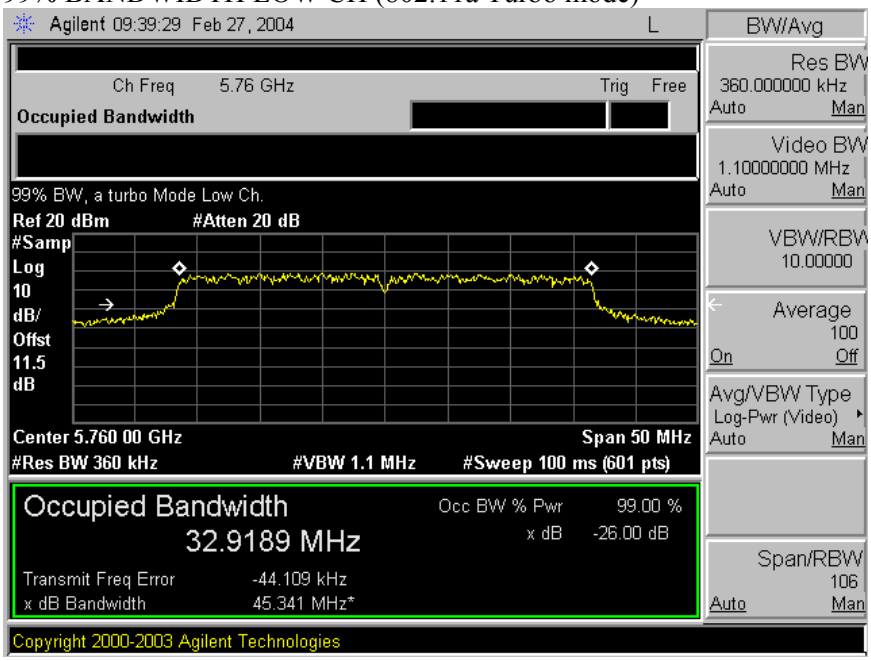


99% BANDWIDTH HIGH CH (802.11a mode)

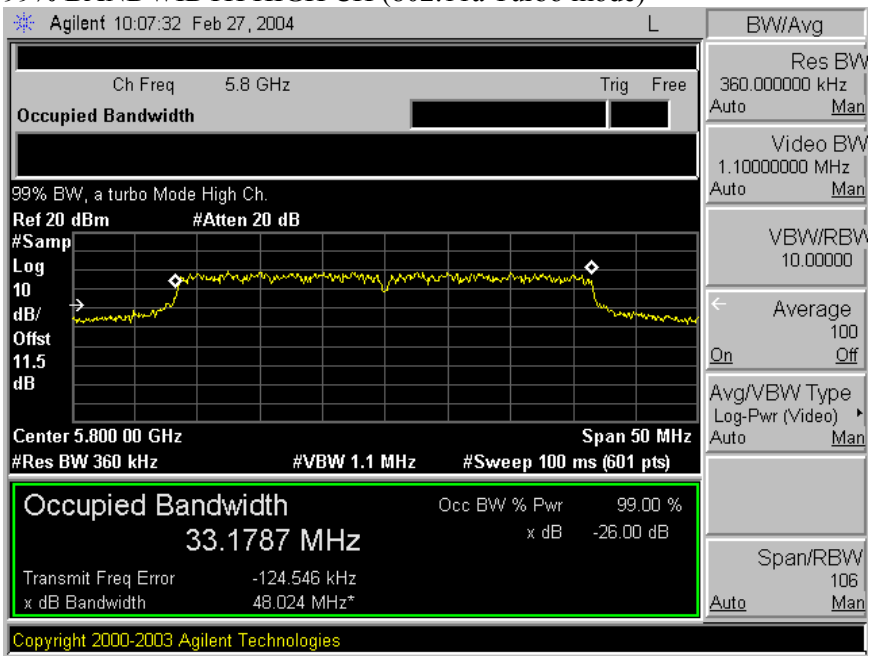


**99% BANDWIDTH (802.11a TURBO MODE)**

99% BANDWIDTH LOW CH (802.11a Turbo mode)



99% BANDWIDTH HIGH CH (802.11a Turbo mode)



## 7.3. PEAK OUTPUT POWER

**PEAK POWER LIMIT**

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz , and 5725-5850 MHz bands: 1 watt.

§15.247 (b) (4) Except as shown in paragraphs (b)(3) (i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum antenna gain is 4.24 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.

## 2.4 GHZ BAND RESULTS

No non-compliance noted:

802.11b Mode

| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2412 | 19.96 | 30 | -10.04 |
| Middle | 2437 | 20.85 | 30 | -9.15 |
| High | 2462 | 17.96 | 30 | -12.04 |

802.11g Mode

| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2412 | 23.15 | 30 | -6.85 |
| Middle | 2437 | 24.45 | 30 | -5.55 |
| High | 2462 | 20.20 | 30 | -9.80 |

802.11g Turbo Mode

| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Middle | 2437 | 24.34 | 30 | -5.66 |

## 5.8 GHZ BAND RESULTS

No non-compliance noted:

802.11a Mode

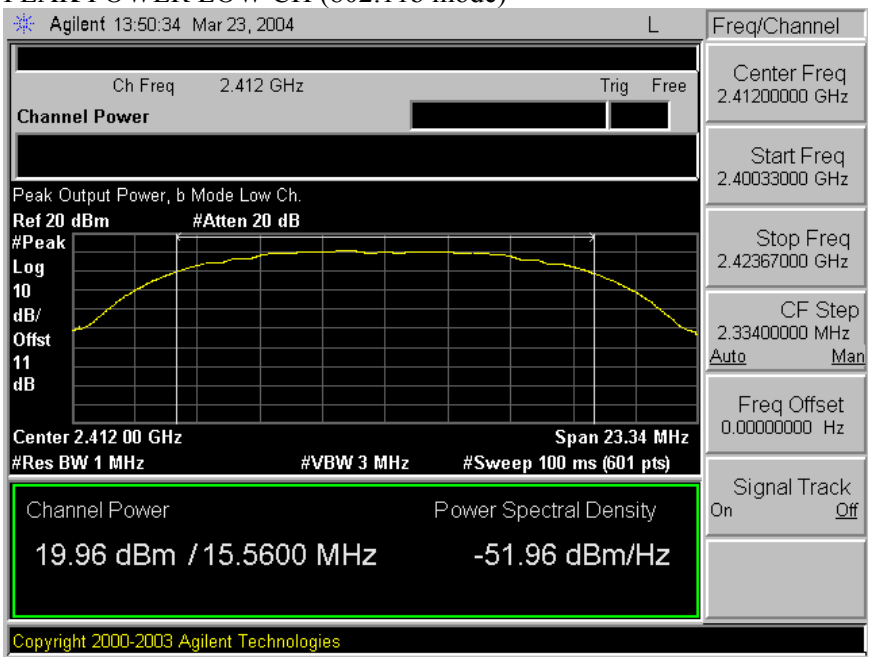
| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 5745 | 24.35 | 30 | -5.65 |
| Middle | 5785 | 24.38 | 30 | -5.62 |
| High | 5825 | 25.74 | 30 | -4.26 |

802.11a Turbo Mode

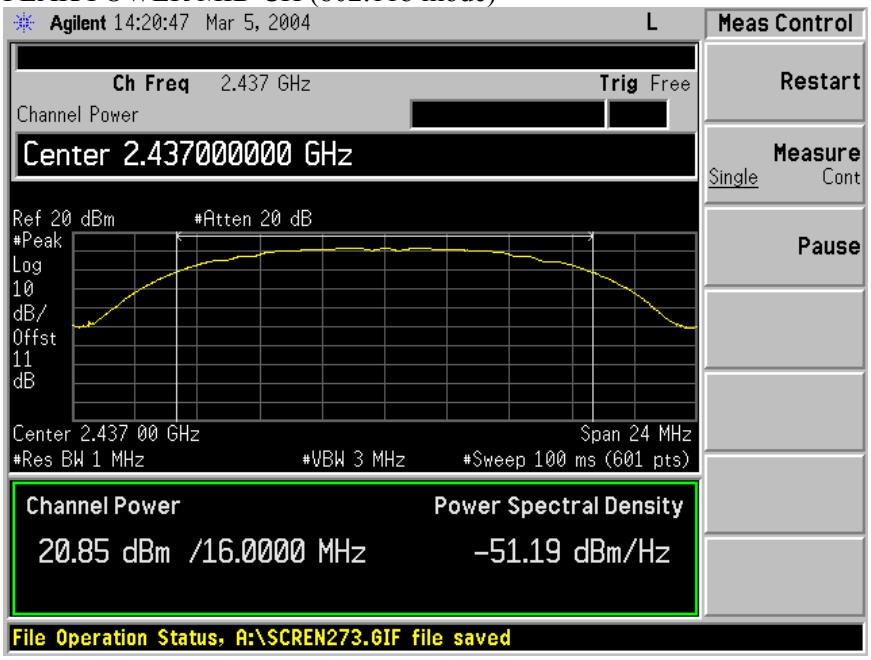
| Channel | Frequency (MHz) | Peak Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 5760 | 24.32 | 30 | -5.68 |
| High | 5800 | 24.38 | 30 | -5.62 |

**OUTPUT POWER (802.11b MODE)**

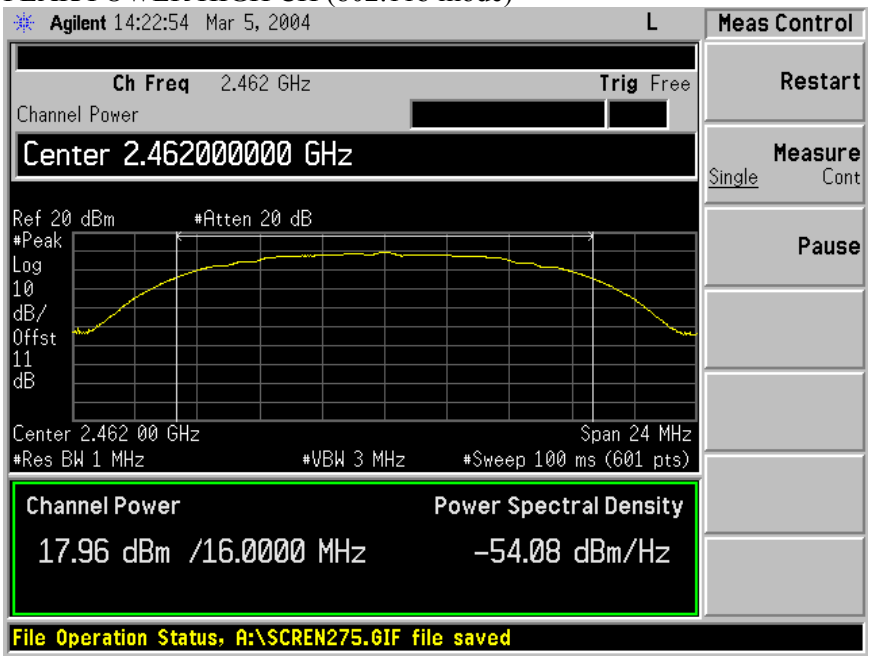
PEAK POWER LOW CH (802.11b mode)



PEAK POWER MID CH (802.11b mode)

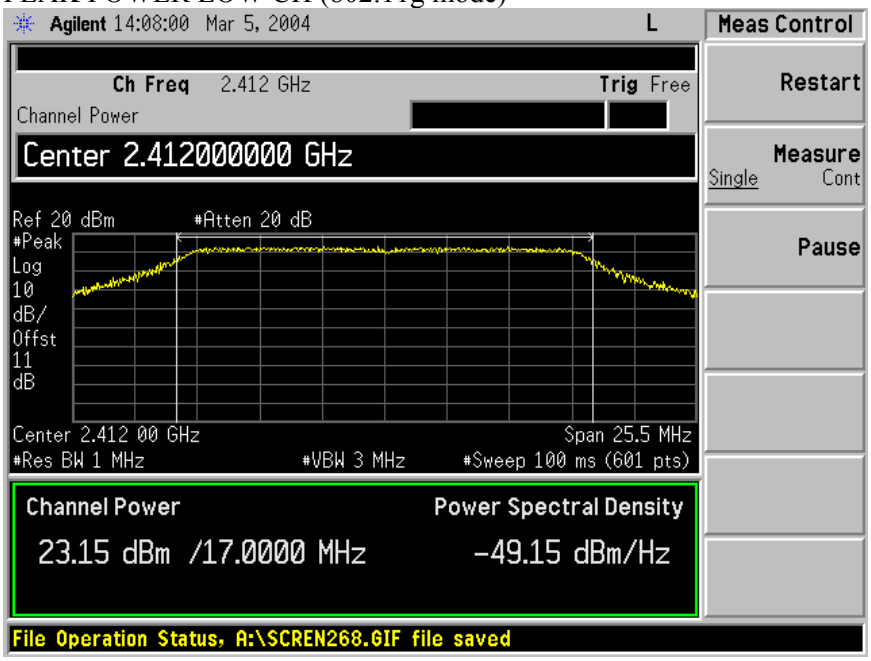


PEAK POWER HIGH CH (802.11b mode)

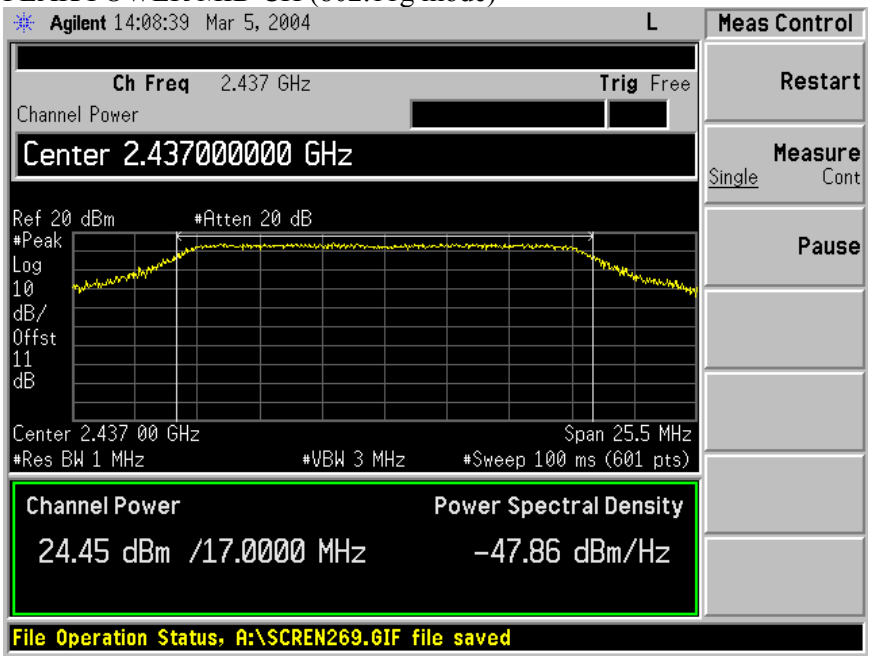


**OUTPUT POWER (802.11g MODE)**

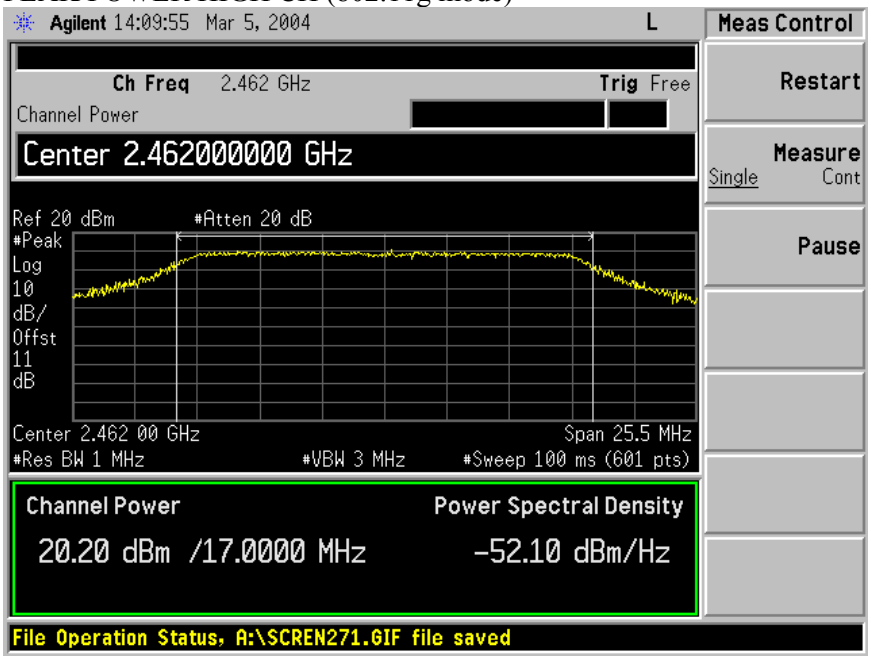
PEAK POWER LOW CH (802.11g mode)



PEAK POWER MID CH (802.11g mode)

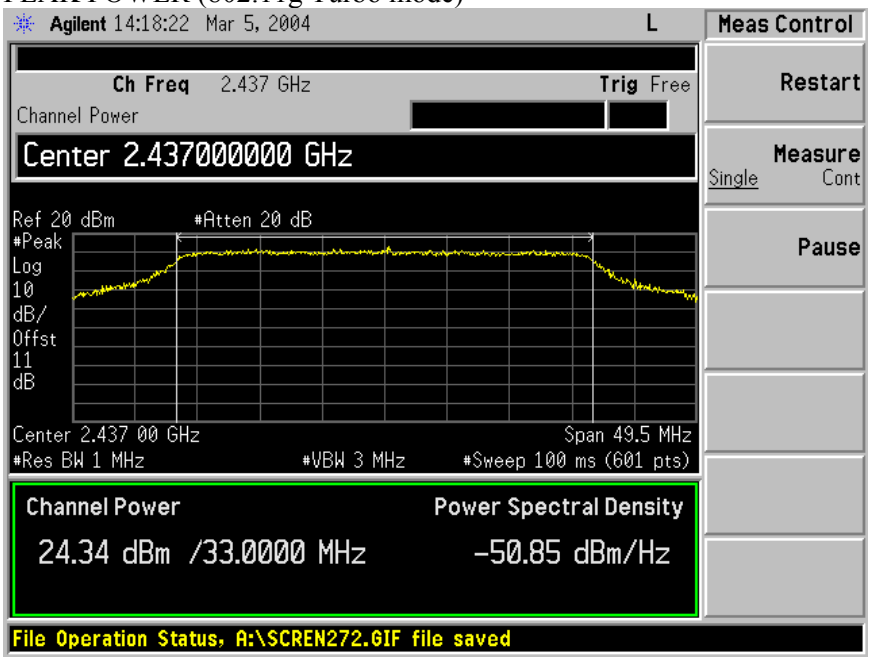


PEAK POWER HIGH CH (802.11g mode)



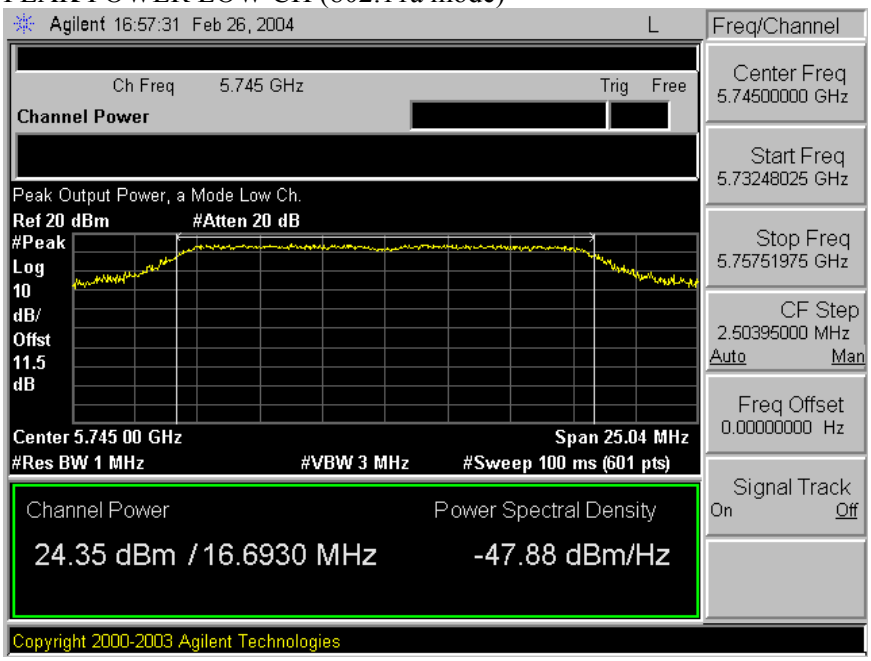
**OUTPUT POWER (802.11g TURBO MODE)**

PEAK POWER (802.11g Turbo mode)

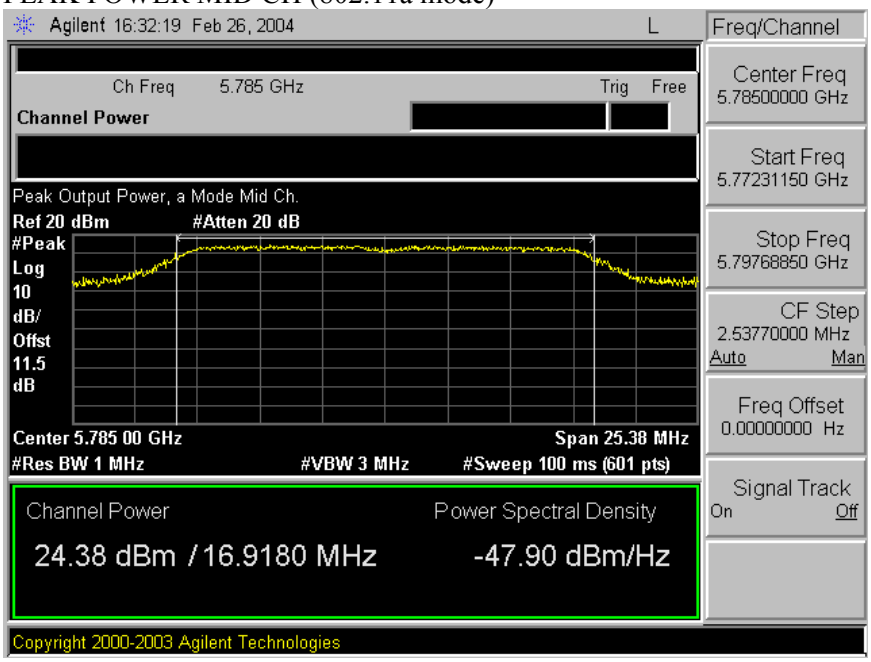


**OUTPUT POWER (802.11a MODE)**

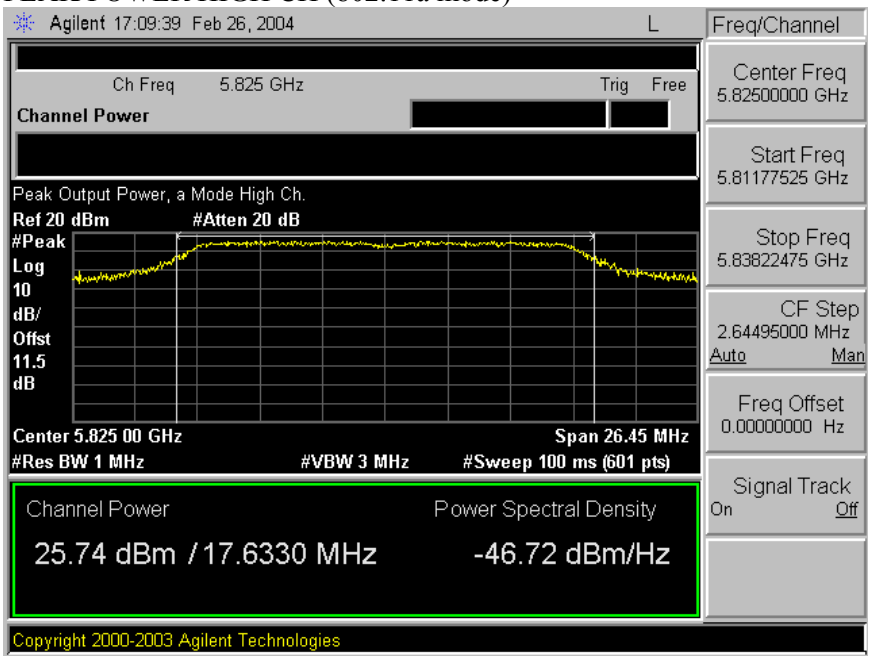
PEAK POWER LOW CH (802.11a mode)



PEAK POWER MID CH (802.11a mode)

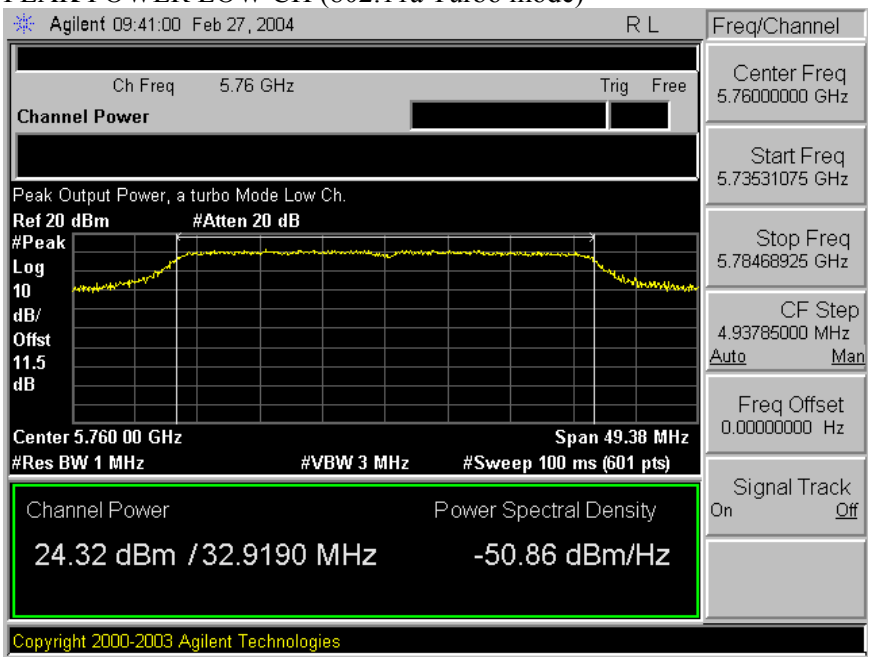


PEAK POWER HIGH CH (802.11a mode)

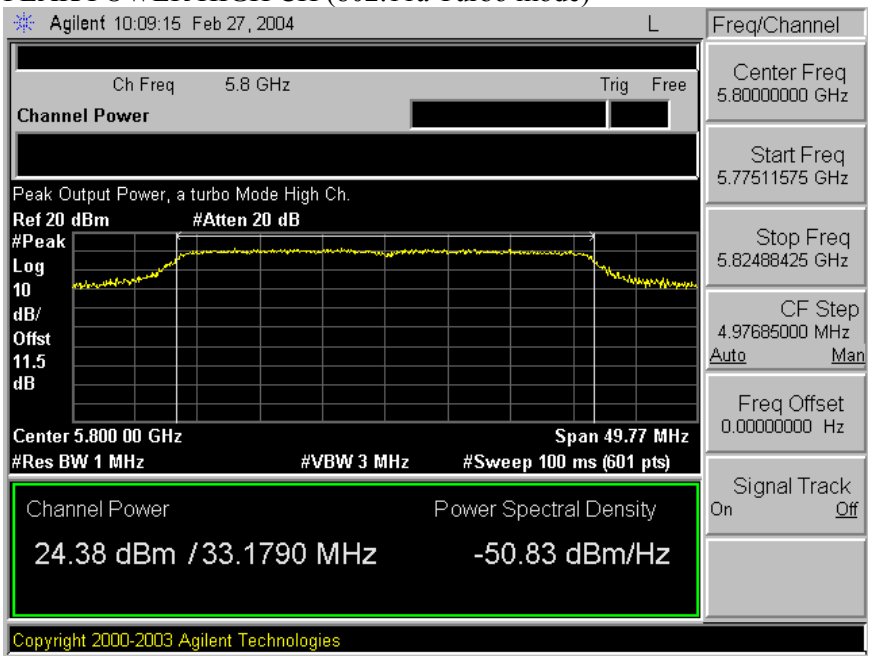


**OUTPUT POWER (802.11a TURBO MODE)**

PEAK POWER LOW CH (802.11a Turbo mode)



PEAK POWER HIGH CH (802.11a Turbo mode)



## 7.4. MAXIMUM PERMISSIBLE EXPOSURE

**LIMITS**

§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 ($mW/cm^2$) | 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/$f^2$) | 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/$f^2$) | 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 ($mW/cm^2$) | 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.

**CALCULATIONS**

Given

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

and

$S = E \wedge 2 / 3770$

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 and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 \wedge ((P + G) / 20) / \sqrt{S}$ Equation (1)

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Equation (1) and the measured peak power is used to calculate the MPE distance.

**LIMITS**

From §1.1310 Table 1 (B), S = 1.0 mW/cm^2

**2.4 GHz BAND RESULTS**

No non-compliance noted:

| Mode | Power Density Limit (mW/cm^2) | Output Power (dBm) | Antenna Gain (dBi) | MPE Distance (cm) |
|---|---|---|---|---|
| 802.11b | 1.0 | 20.85 | 4.24 | 5.07 |
| 802.11g | 1.0 | 24.45 | 4.24 | 7.67 |
| 802.11g Turbo | 1.0 | 24.34 | 4.24 | 7.57 |

**5.8 GHz BAND RESULTS**

No non-compliance noted:

| Mode | Power Density Limit (mW/cm^2) | Output Power (dBm) | Antenna Gain (dBi) | MPE Distance (cm) |
|---|---|---|---|---|
| 802.11a | 1.0 | 25.74 | 4.12 | 8.78 |
| 802.11a Turbo | 1.0 | 24.38 | 4.12 | 7.50 |

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.

## 7.5. AVERAGE POWER

### AVERAGE POWER LIMIT

None; for reporting purposes only.

### TEST PROCEDURE

The transmitter output is connected to a power meter.

### 2.4 GHZ BAND RESULTS

No non-compliance noted:

The cable assembly insertion loss of 11.03 dB (including 10 dB pad and 1.03 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

802.11b Mode

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 2412 | 16.50 |
| Middle | 2437 | 19.80 |
| High | 2462 | 16.90 |

802.11g Mode

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 2412 | 16.80 |
| Middle | 2437 | 19.50 |
| High | 2462 | 14.90 |

802.11g Turbo Mode

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Middle | 2437 | 19.00 |

## 5.8 GHZ BAND RESULTS

No non-compliance noted:

The cable assembly insertion loss of 11.6 dB (including 10 dB pad and 1.6 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

802.11a Mode

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 5745 | 17.60 |
| Middle | 5785 | 17.10 |
| High | 5825 | 17.20 |

802.11a Turbo Mode

| Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|
| Low | 5760 | 17.30 |
| High | 5800 | 17.00 |

## 7.6. PEAK POWER SPECTRAL DENSITY

**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.

**2.4 GHz BAND RESULTS**

No non-compliance noted:

802.11b Mode

| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2412 | -7.06 | 8 | -15.06 |
| Middle | 2437 | -8.02 | 8 | -16.02 |
| High | 2462 | -4.94 | 8 | -12.94 |

802.11g Mode

| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2412 | -6.04 | 8 | -14.04 |
| Middle | 2437 | -0.50 | 8 | -8.50 |
| High | 2462 | -4.38 | 8 | -12.38 |

802.11g Turbo Mode

| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Middle | 2437 | -0.51 | 8 | -8.51 |

**5.8 GHz BAND RESULTS**

No non-compliance noted:

802.11a Mode

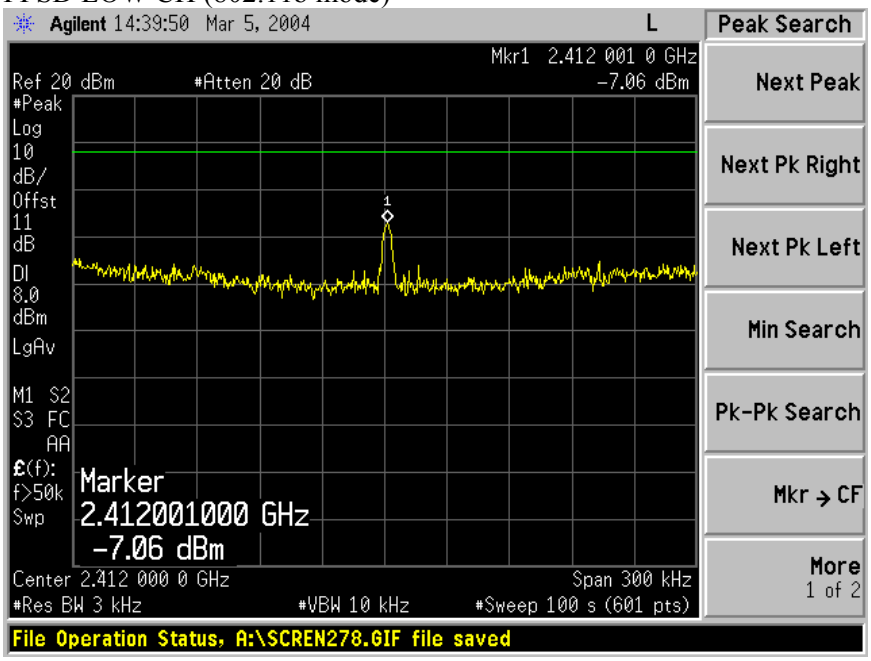
| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 5745 | -8.34 | 8 | -16.34 |
| Middle | 5785 | -8.18 | 8 | -16.18 |
| High | 5825 | -5.29 | 8 | -13.29 |

802.11a Turbo Mode

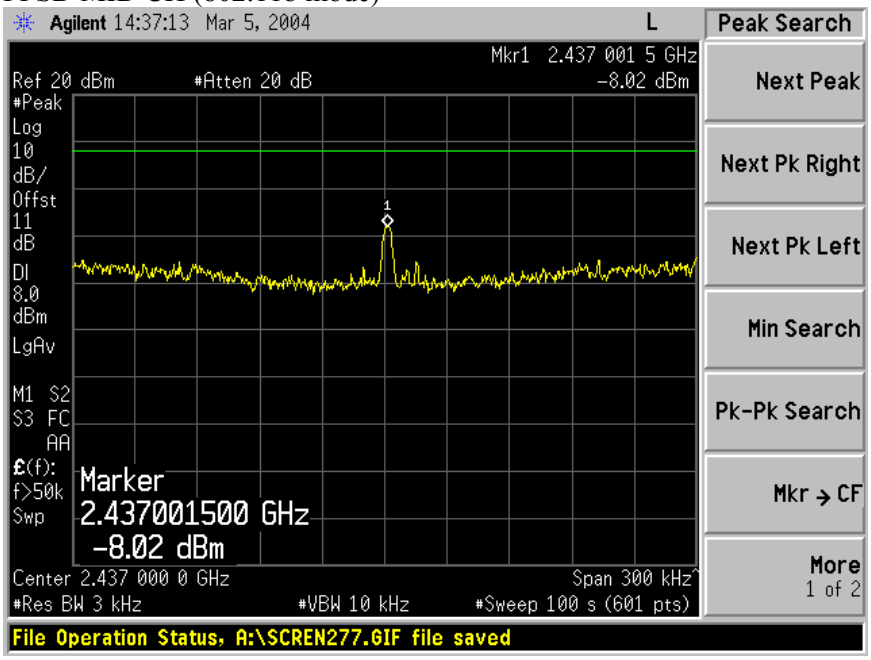
| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 5760 | -8.04 | 8 | -16.04 |
| High | 5800 | -9.28 | 8 | -17.28 |

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

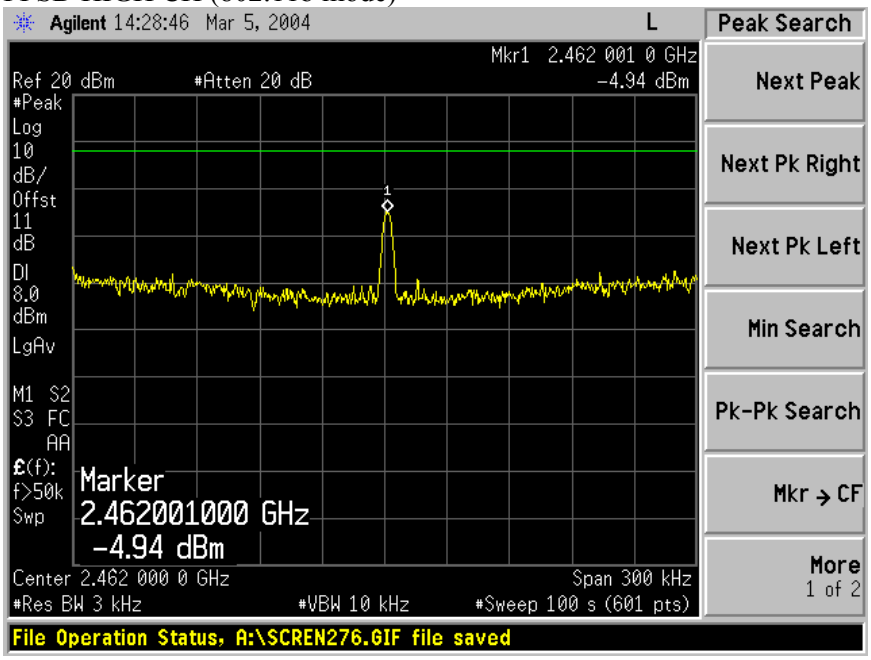
PPSD LOW CH (802.11b mode)



PPSD MID CH (802.11b mode)

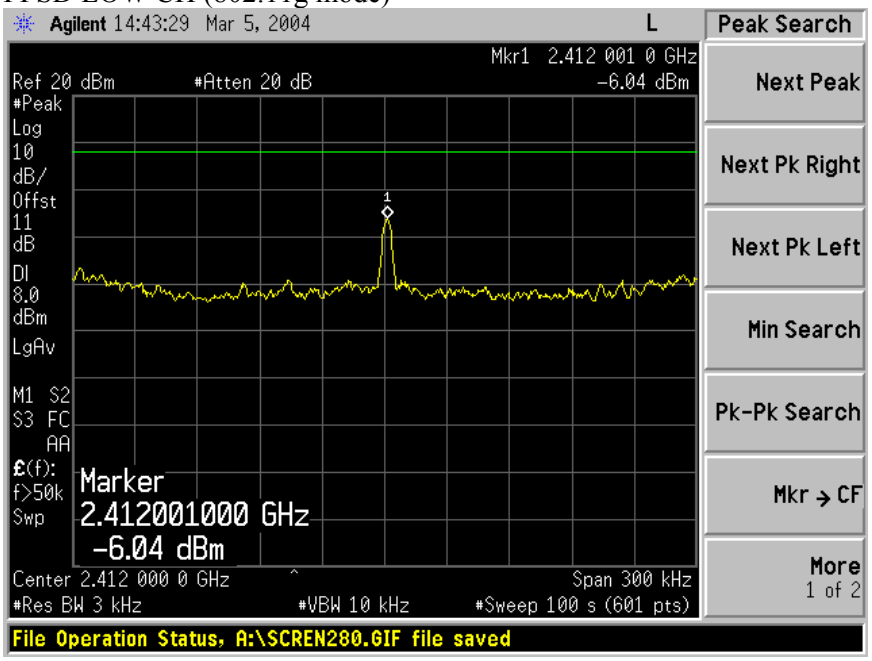


PPSD HIGH CH (802.11b mode)

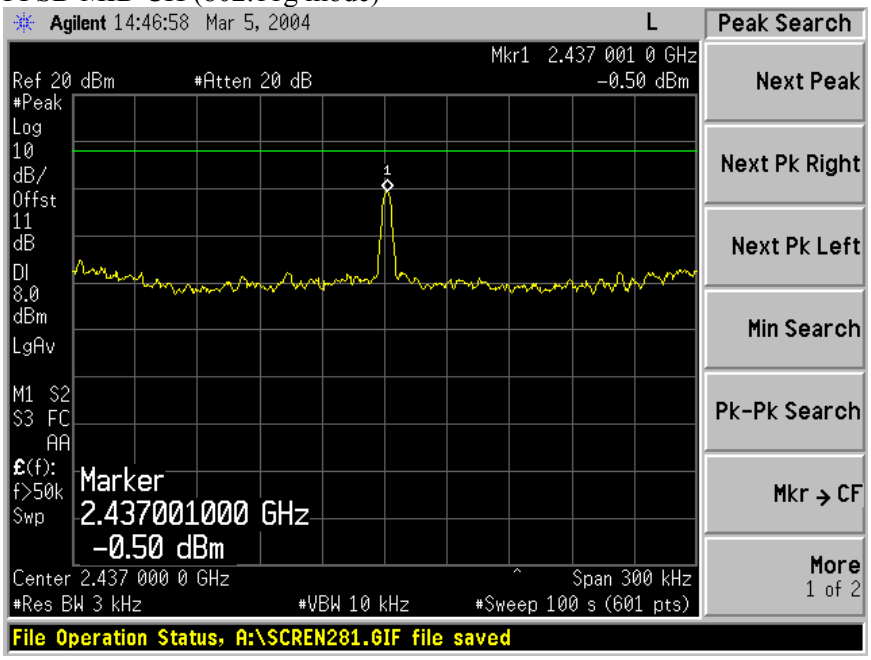


**PEAK POWER SPECTRAL DENSITY (802.11g MODE)**

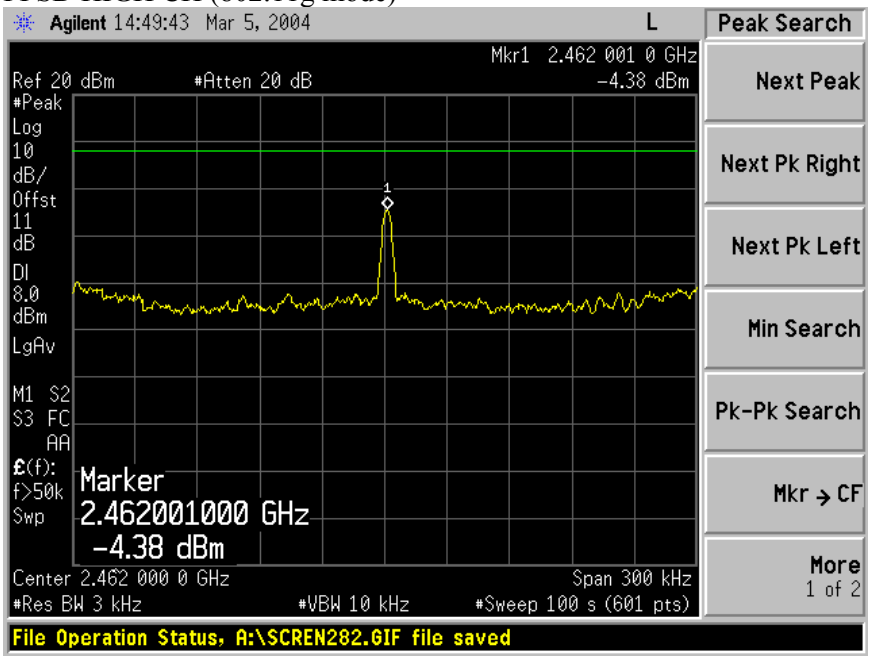
PPSD LOW CH (802.11g mode)



PPSD MID CH (802.11g mode)

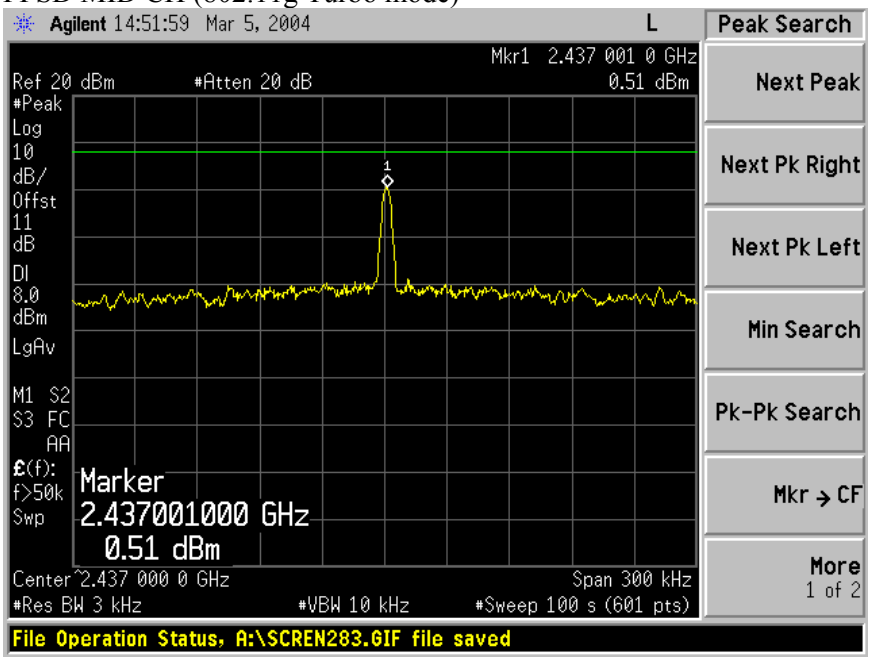


PPSD HIGH CH (802.11g mode)



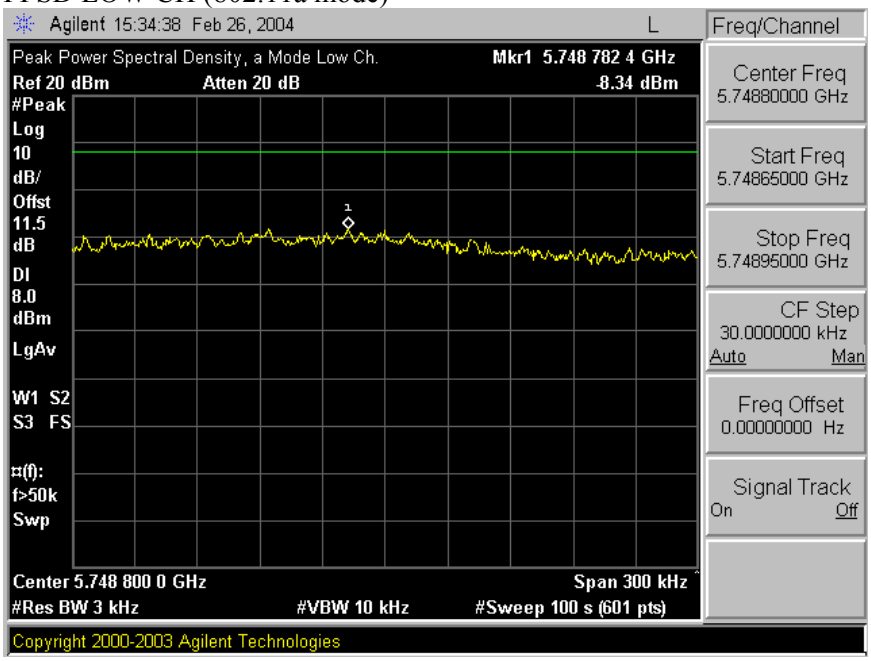
## PEAK POWER SPECTRAL DENSITY (802.11g TURBO MODE)

PPSD MID CH (802.11g Turbo mode)

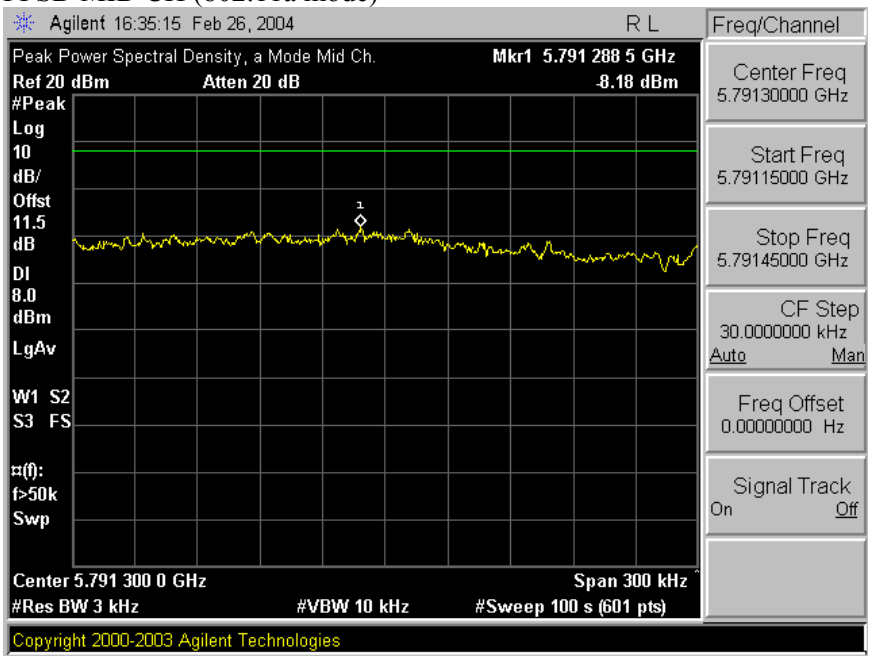


## PEAK POWER SPECTRAL DENSITY (802.11a MODE)

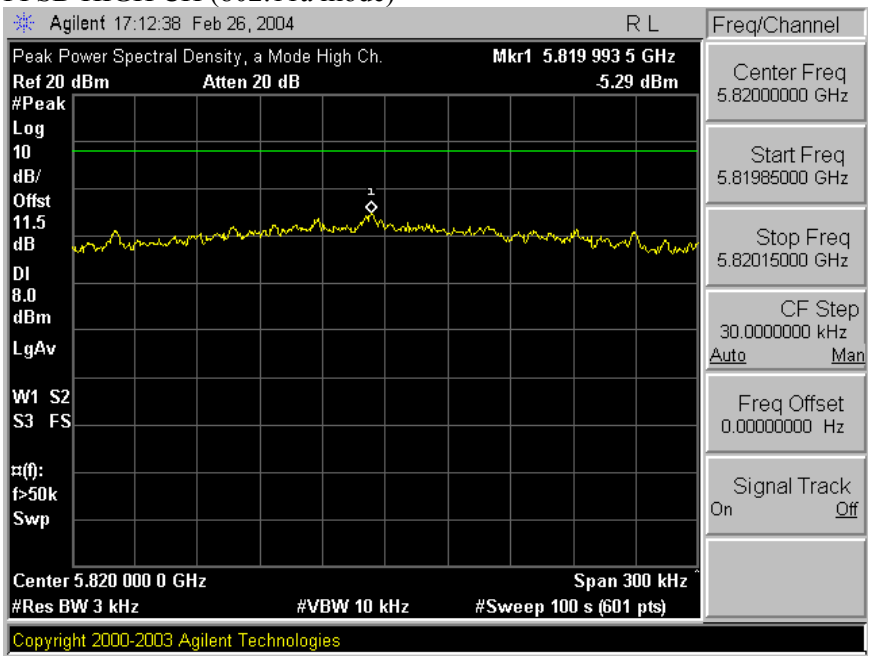
PPSD LOW CH (802.11a mode)



PPSD MID CH (802.11a mode)

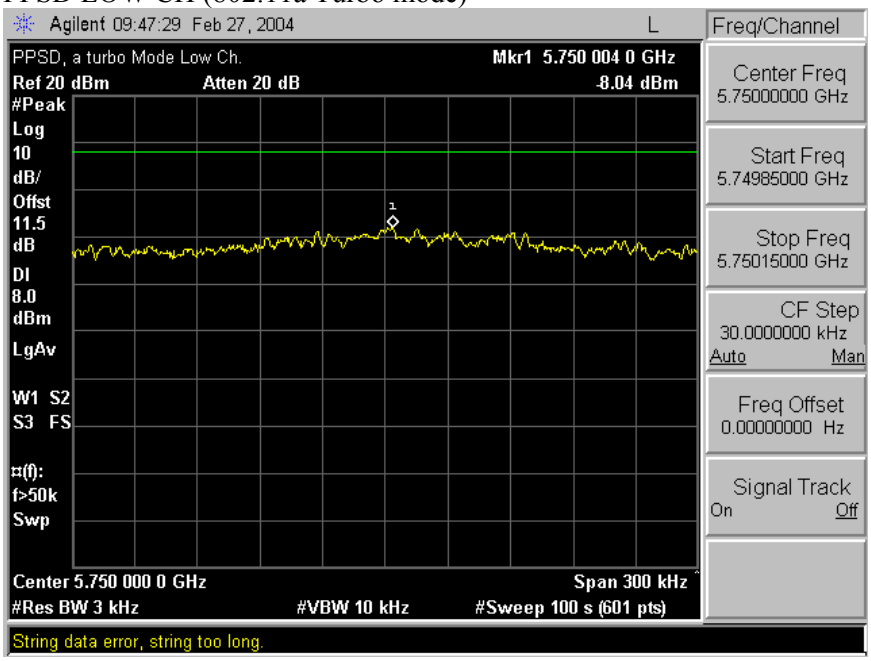


PPSD HIGH CH (802.11a mode)

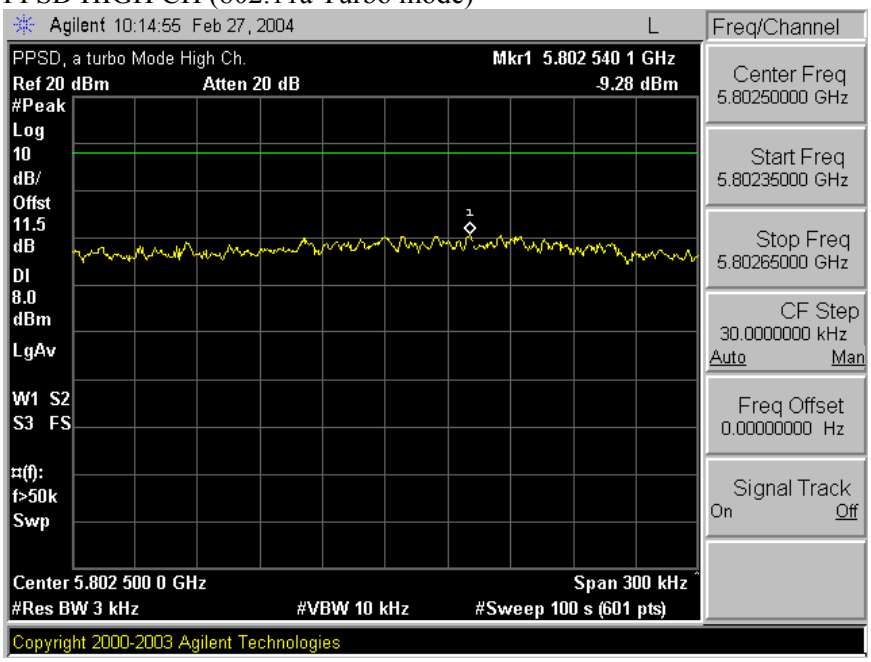


## PEAK POWER SPECTRAL DENSITY (802.11a TURBO MODE)

PPSD LOW CH (802.11a Turbo mode)



PPSD HIGH CH (802.11a Turbo mode)



## 7.7. 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 in the 2.4 GHz band.

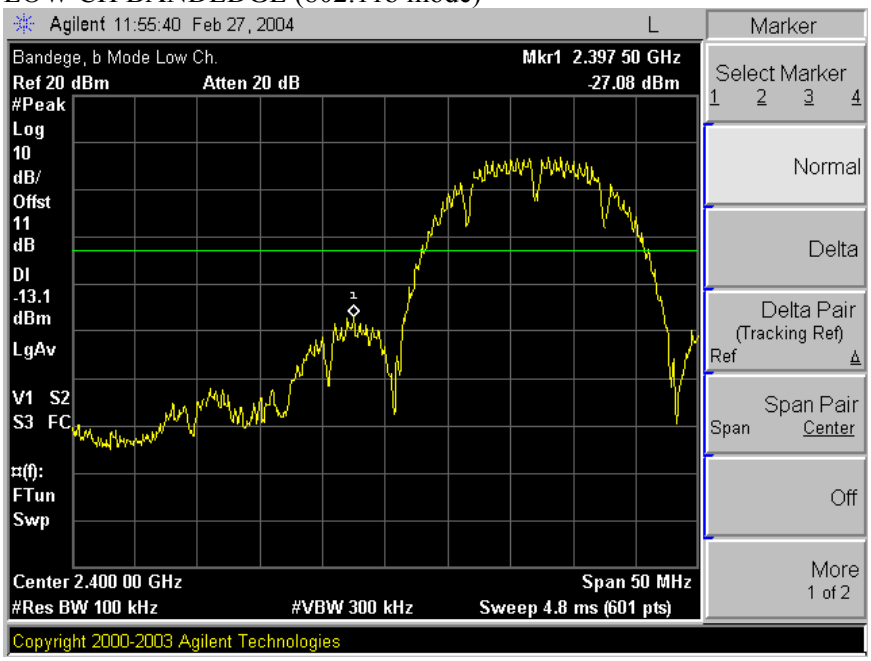
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 5.8 GHz band.

**RESULTS**

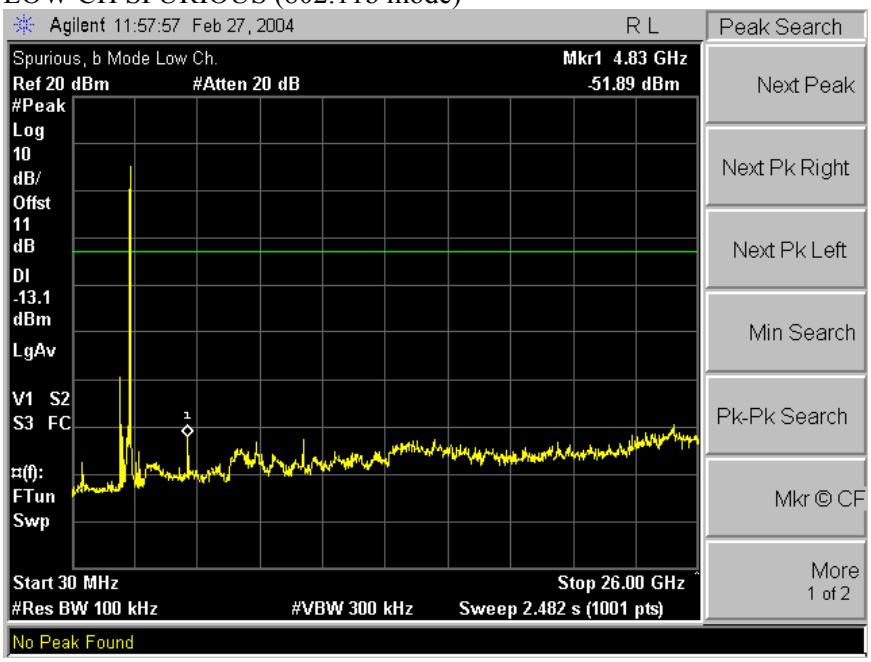
No non-compliance noted:

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

LOW CH BANDEDGE (802.11b mode)

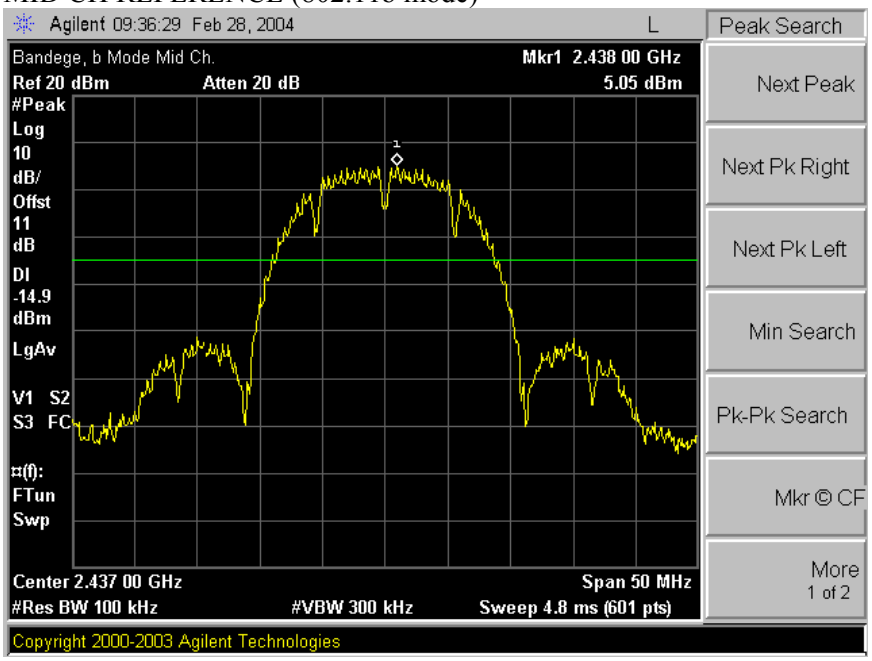


LOW CH SPURIOUS (802.11b mode)

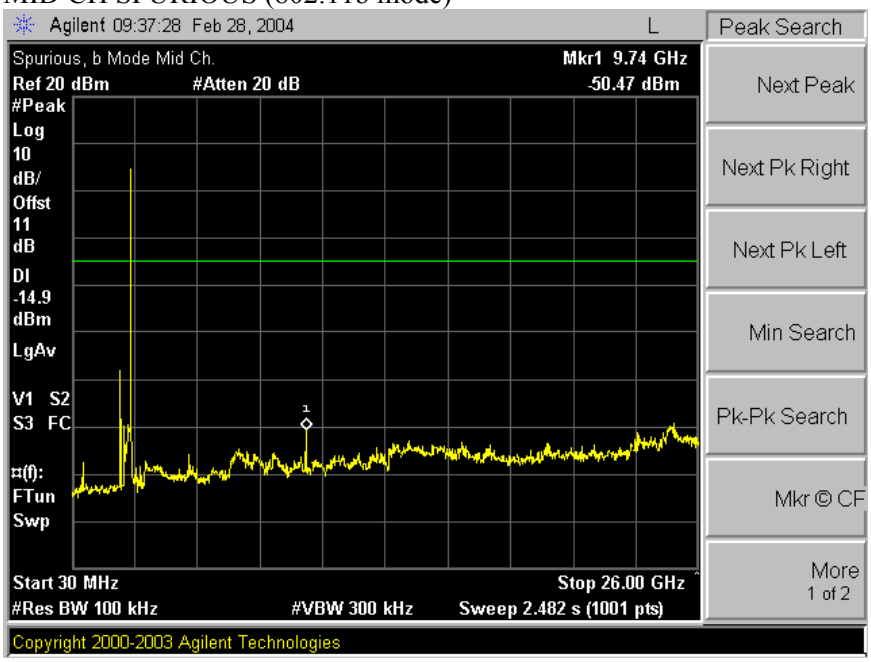


**SPURIOUS EMISSIONS, MID CHANNEL (802.11b MODE)**

MID CH REFERENCE (802.11b mode)

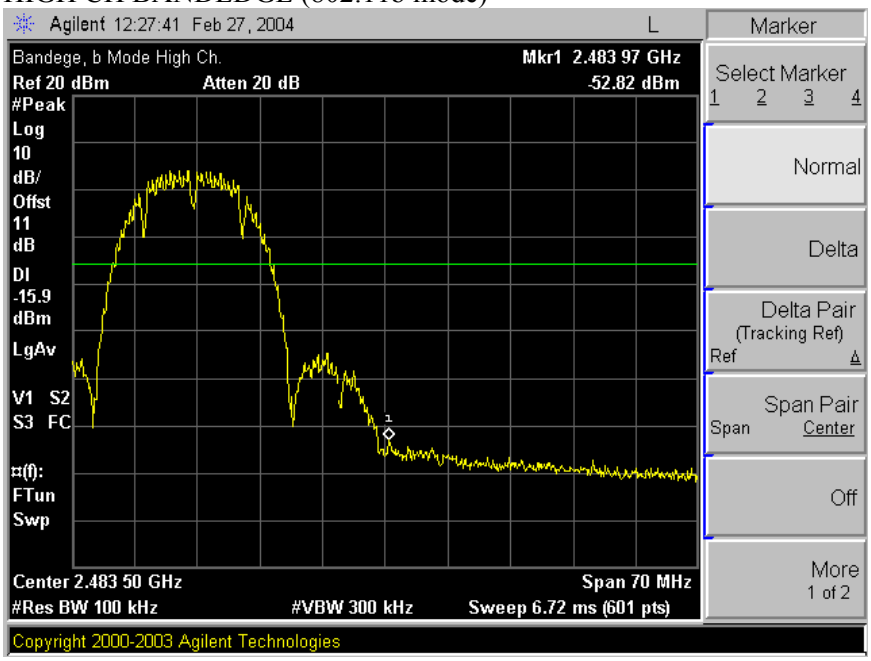


MID CH SPURIOUS (802.11b mode)

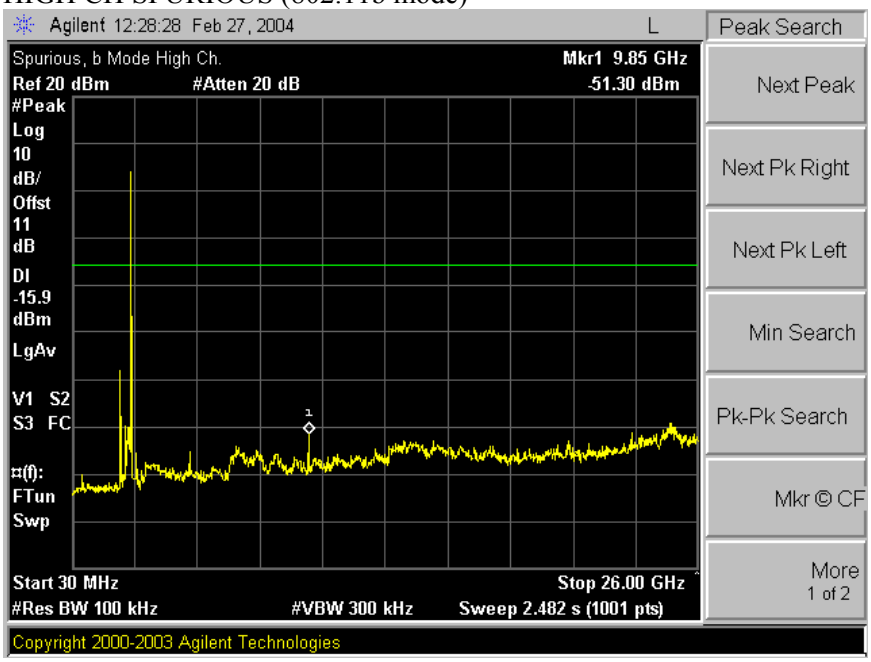


**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11b MODE)**

HIGH CH BANDEDGE (802.11b mode)

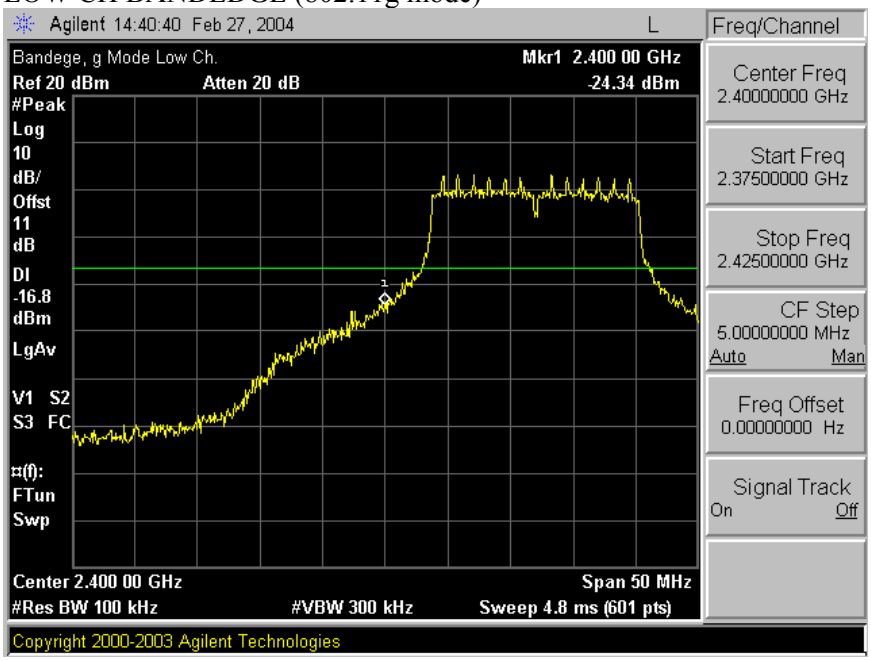


HIGH CH SPURIOUS (802.11b mode)

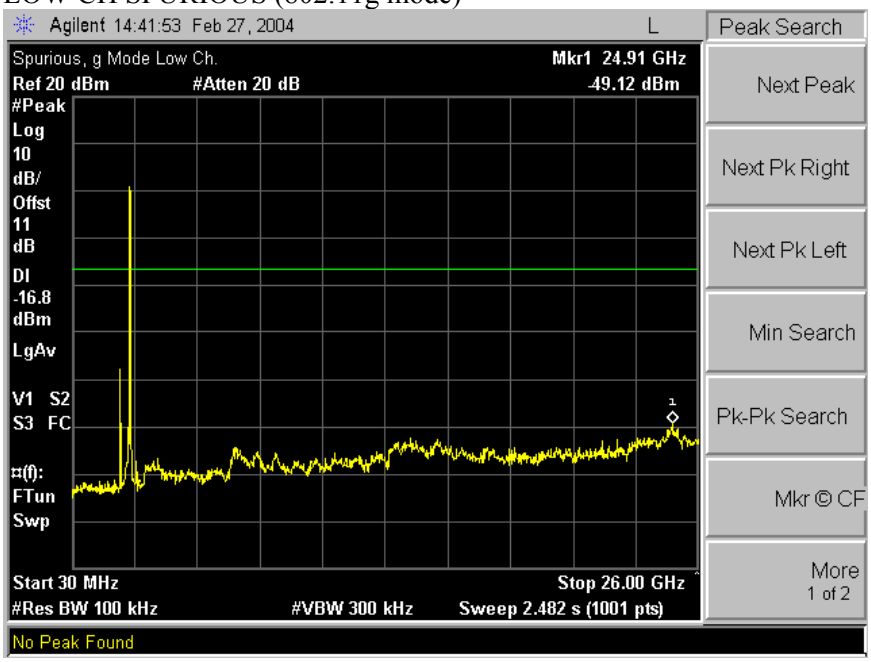


**SPURIOUS EMISSIONS, LOW CHANNEL (802.11g MODE)**

LOW CH BANDEDGE (802.11g mode)

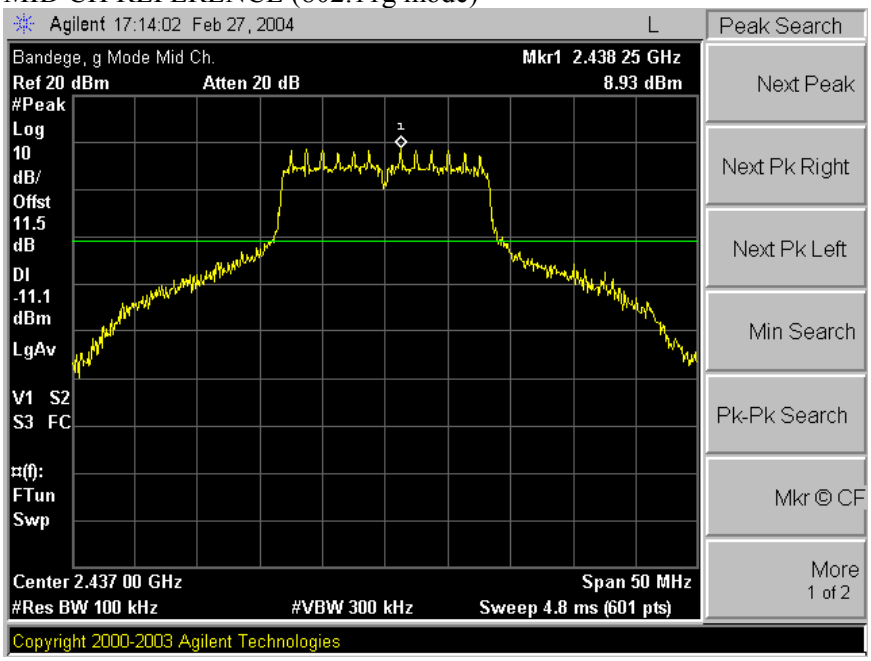


LOW CH SPURIOUS (802.11g mode)

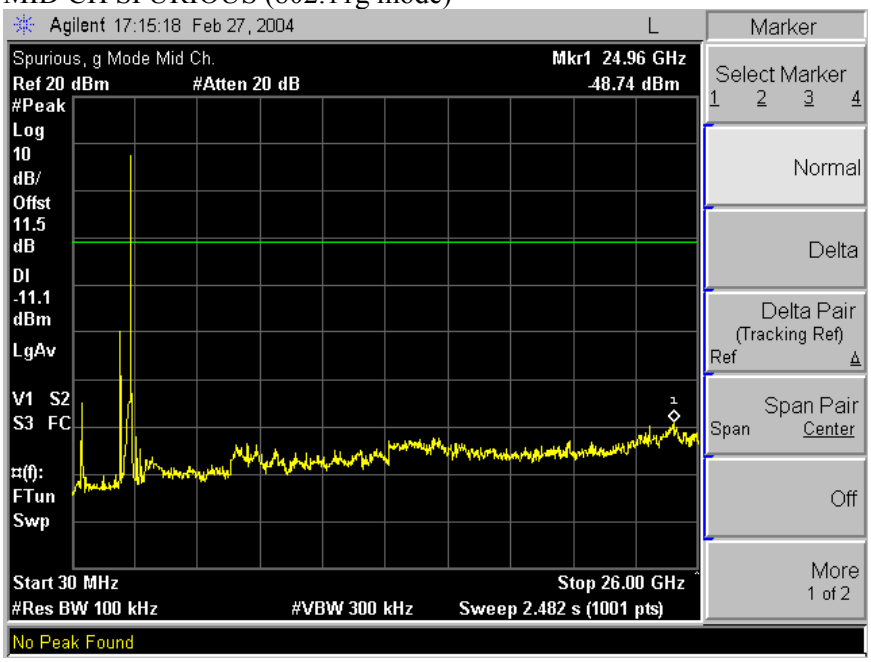


**SPURIOUS EMISSIONS, MID CHANNEL (802.11g MODE)**

MID CH REFERENCE (802.11g mode)

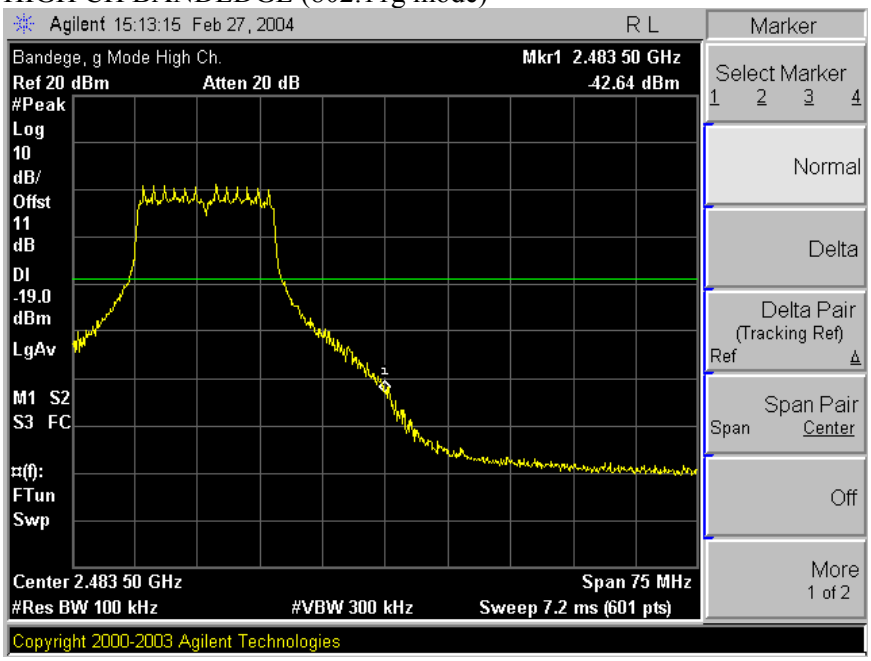


MID CH SPURIOUS (802.11g mode)

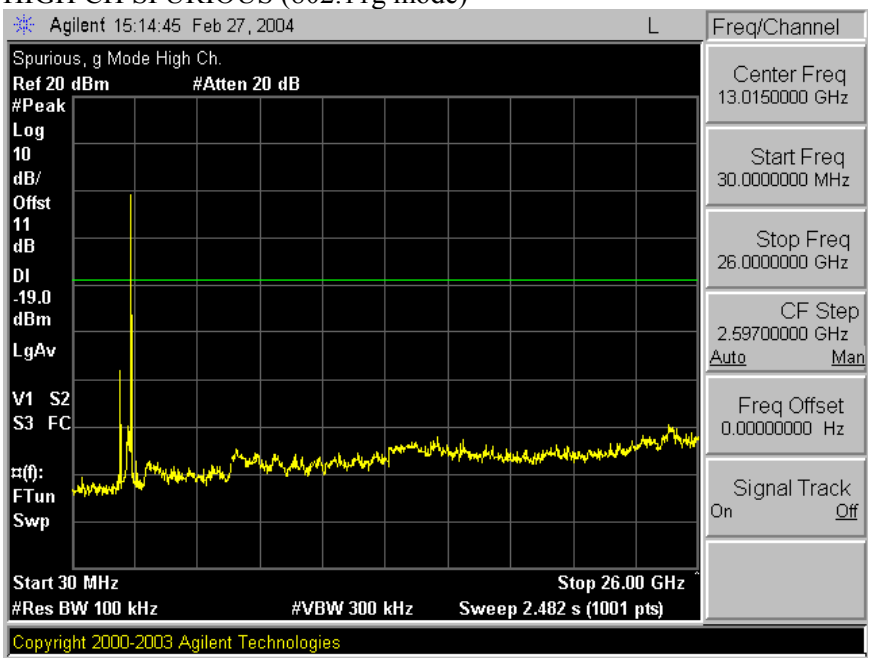


**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11g MODE)**

HIGH CH BANDEDGE (802.11g mode)

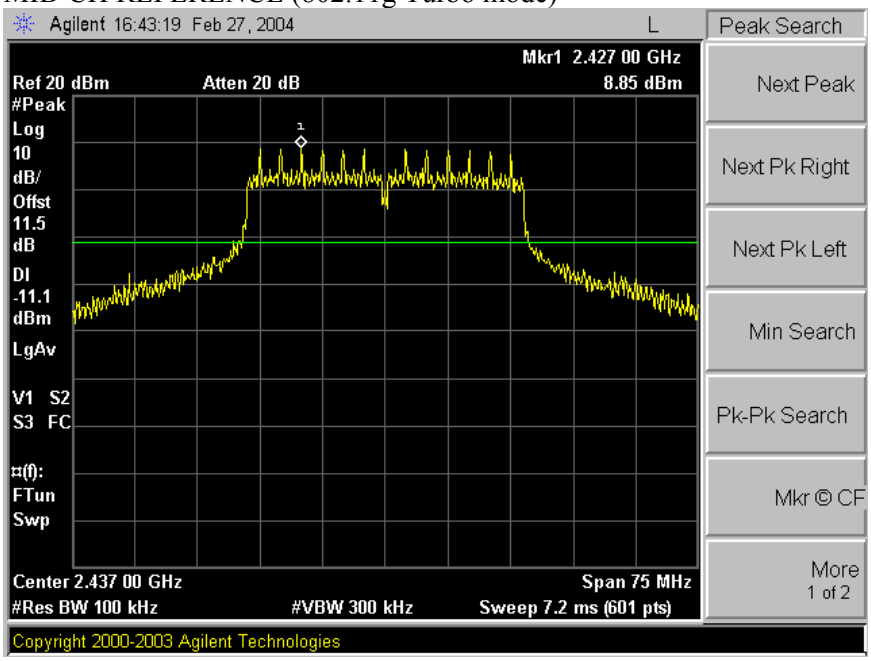


HIGH CH SPURIOUS (802.11g mode)

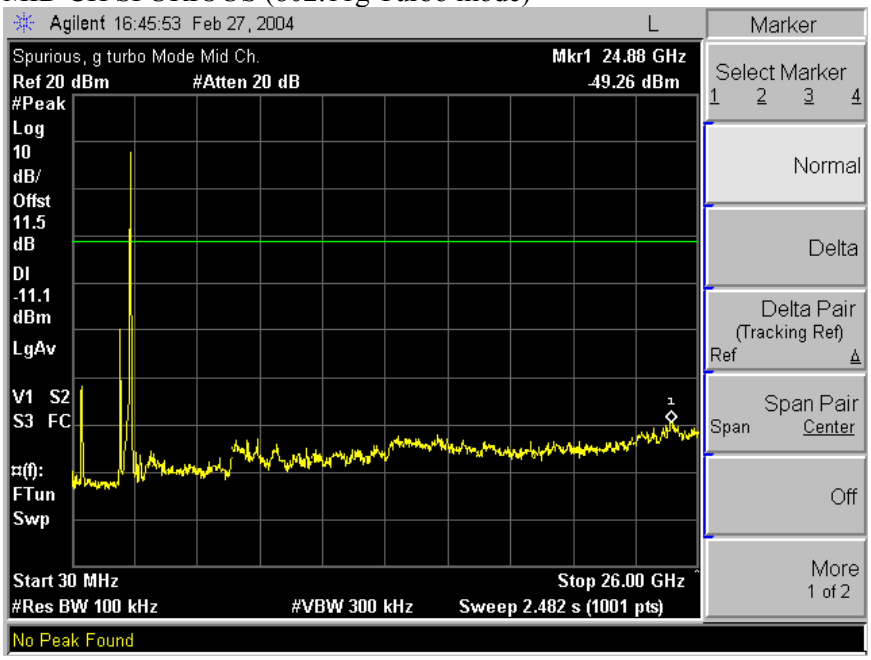


**SPURIOUS EMISSIONS, MID CHANNEL (802.11g TURBO MODE)**

MID CH REFERENCE (802.11g Turbo mode)

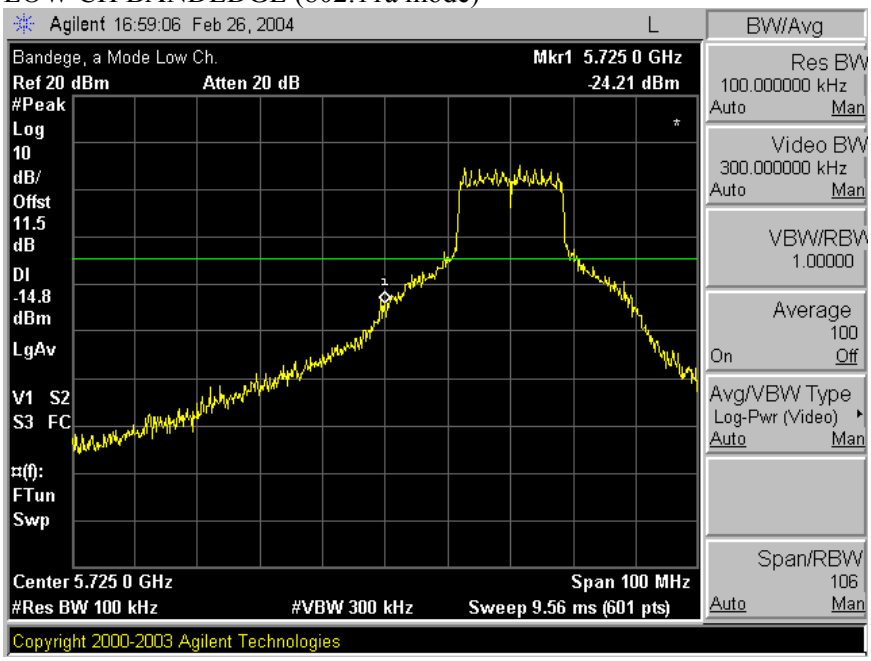


MID CH SPURIOUS (802.11g Turbo mode)

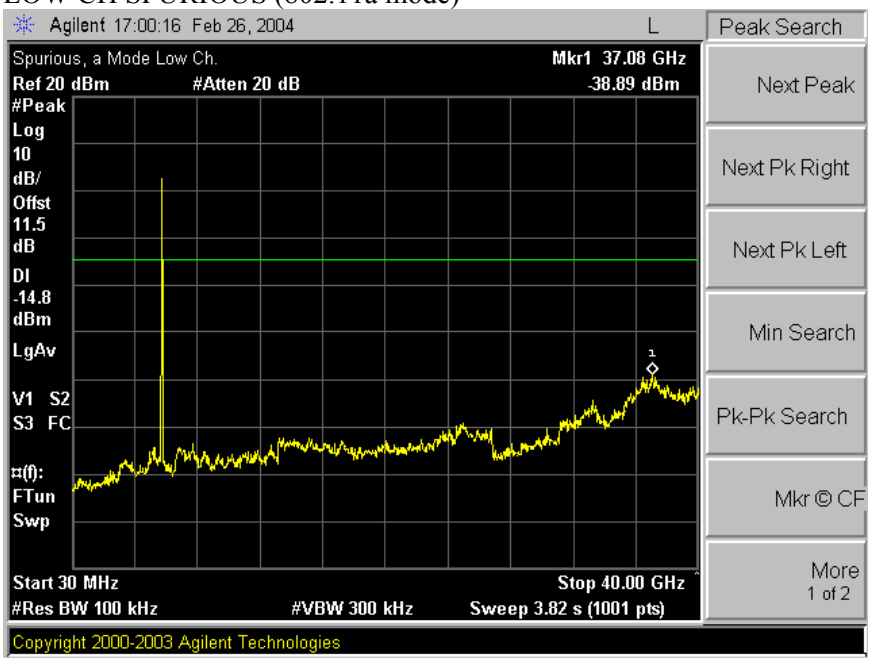


**SPURIOUS EMISSIONS, LOW CHANNEL (802.11a MODE)**

LOW CH BANDEDGE (802.11a mode)

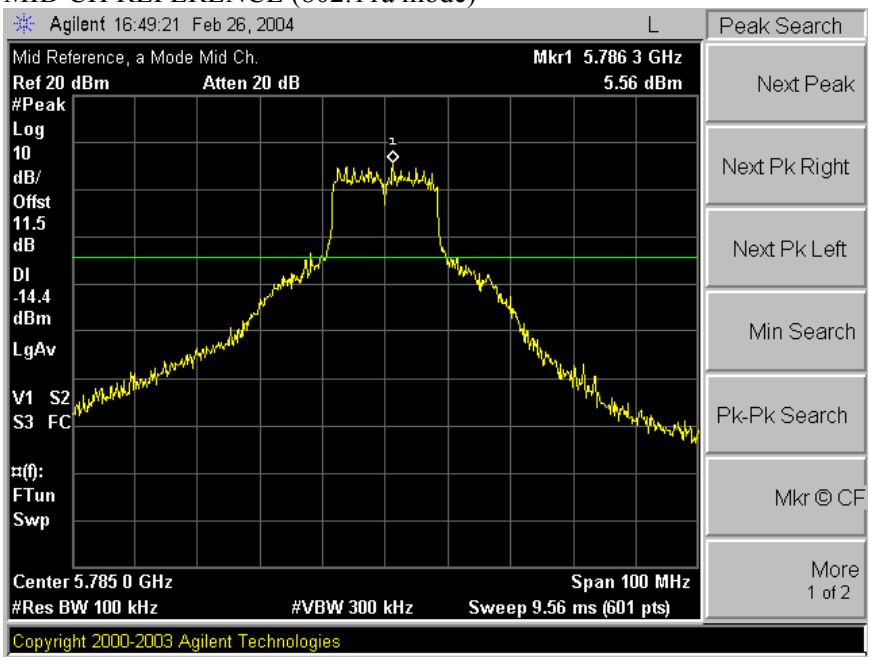


LOW CH SPURIOUS (802.11a mode)

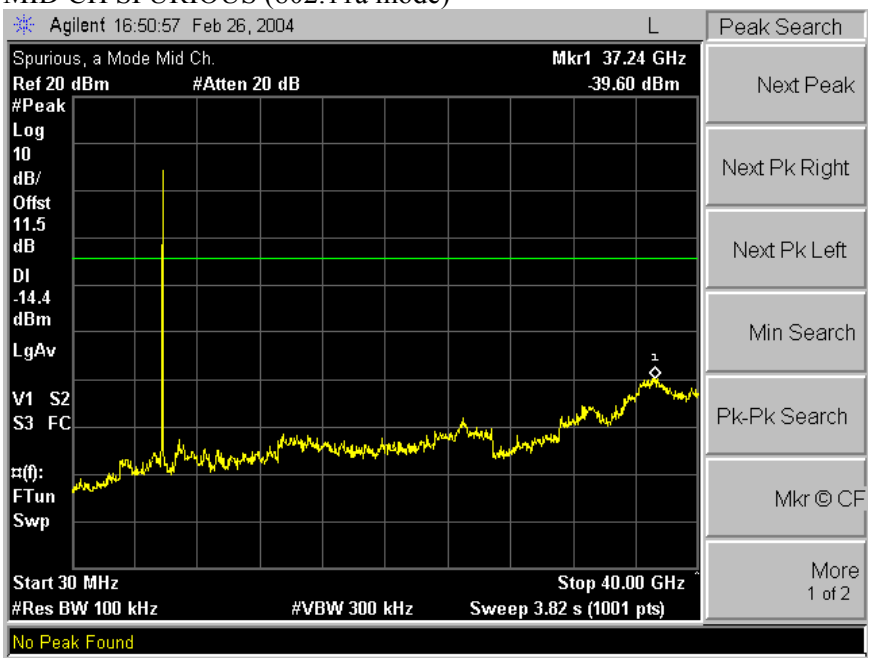


**SPURIOUS EMISSIONS, MID CHANNEL (802.11a MODE)**

MID CH REFERENCE (802.11a mode)

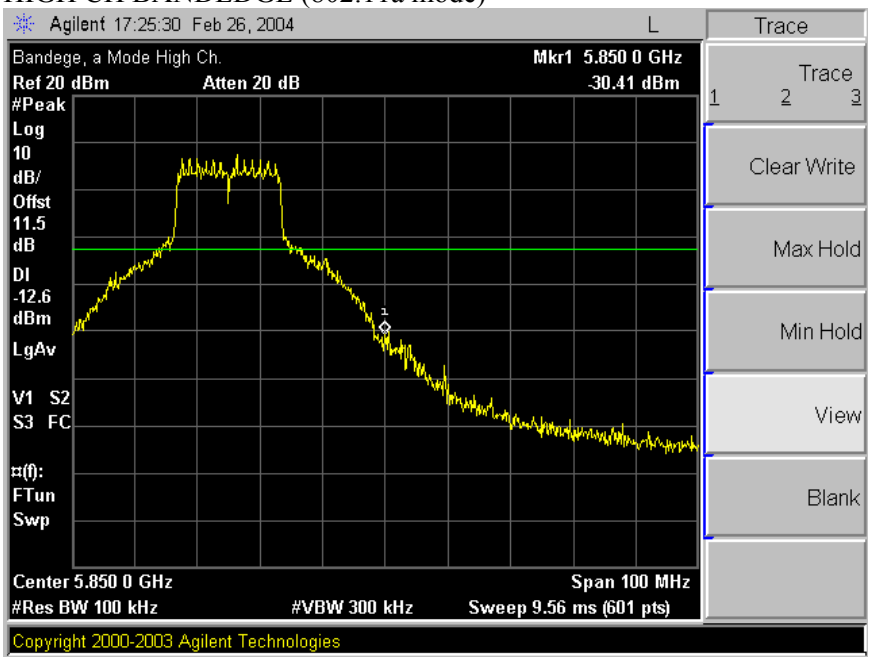


MID CH SPURIOUS (802.11a mode)

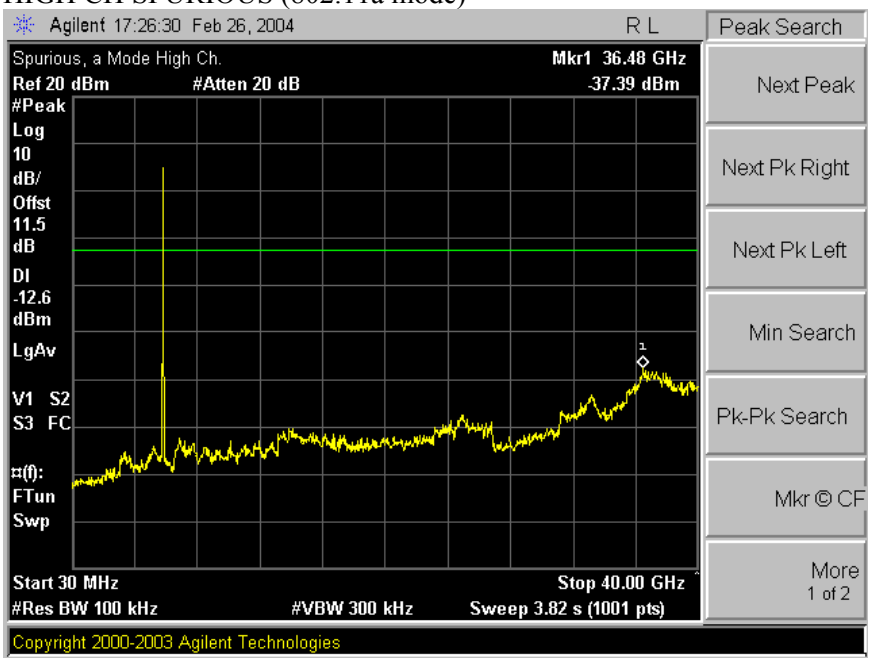


**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11a MODE)**

HIGH CH BANDEDGE (802.11a mode)

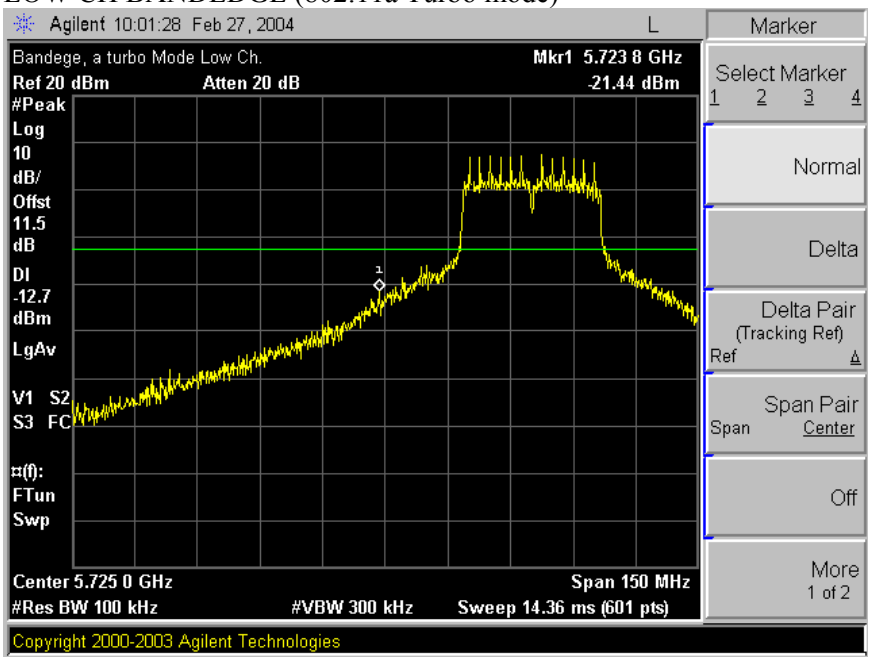


HIGH CH SPURIOUS (802.11a mode)

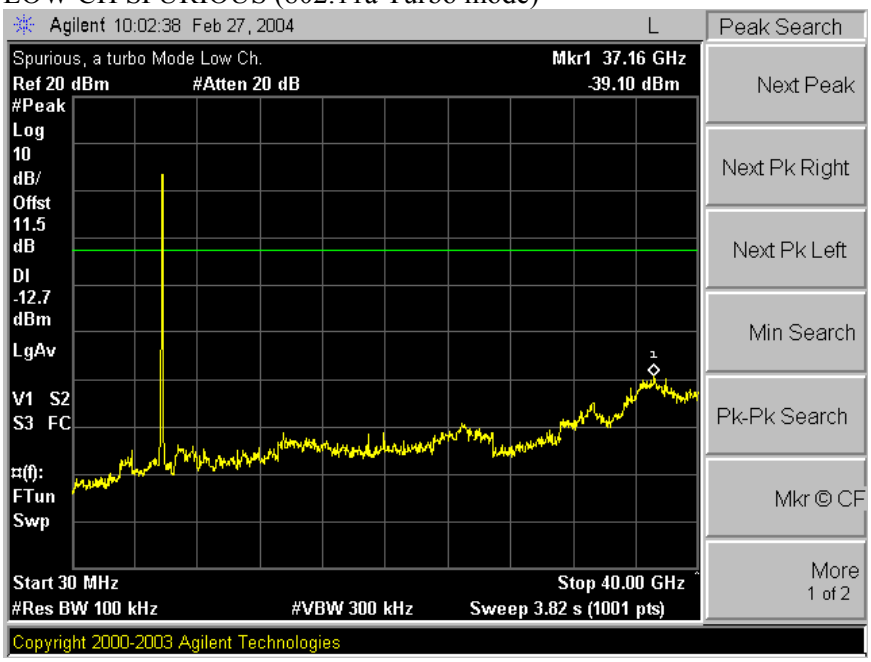


**SPURIOUS EMISSIONS, LOW CHANNEL (802.11a TURBO MODE)**

LOW CH BANDEDGE (802.11a Turbo mode)

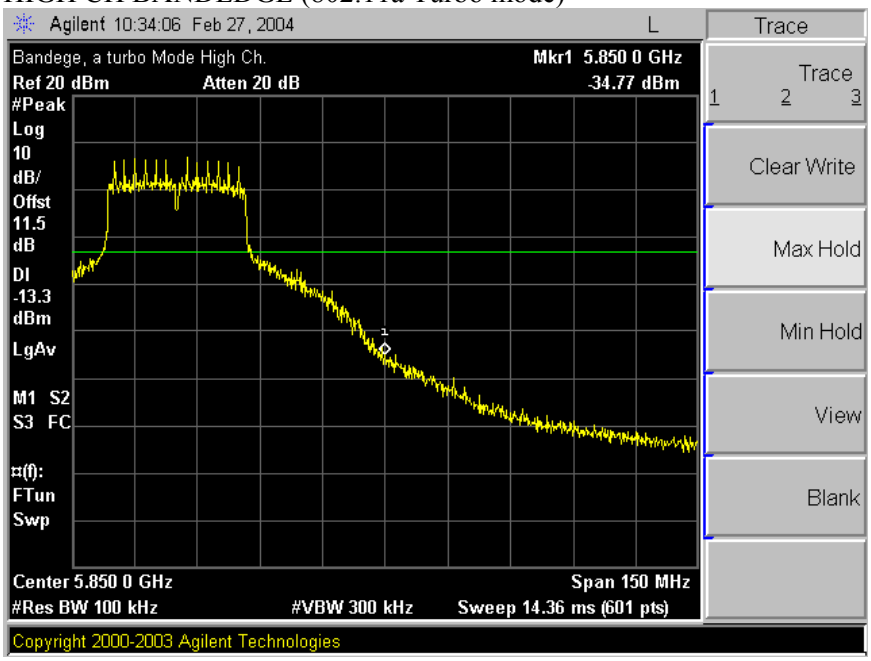


LOW CH SPURIOUS (802.11a Turbo mode)

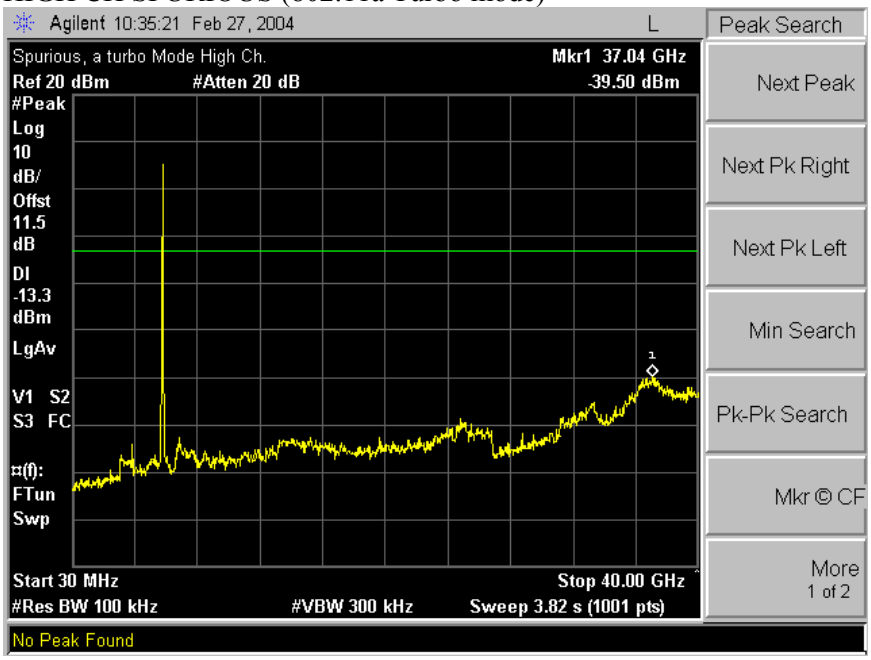


**SPURIOUS EMISSIONS, HIGH CHANNEL (802.11a TURBO MODE)**

HIGH CH BANDEDGE (802.11a Turbo mode)



HIGH CH SPURIOUS (802.11a Turbo mode)



# 7.8. RADIATED EMISSIONS

## 7.8.1. TRANSMITTER RADIATED SPURIOUS EMISSIONS

**LIMITS**

§15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| [1]0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614 | 5.35 - 5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960 - 1240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1300 - 1427 | 8.025 - 8.5 |
| 4.17725 - 4.17775 | 37.5 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.6 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2655 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | ([2]) |
| 13.36 - 13.41 | | | |

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

§15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 30 - 88 | 100 ** | 3 |
| 88 - 216 | 150 ** | 3 |
| 216 - 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

## 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 of the 2.4 GHz band.

The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels of the 5.8 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.

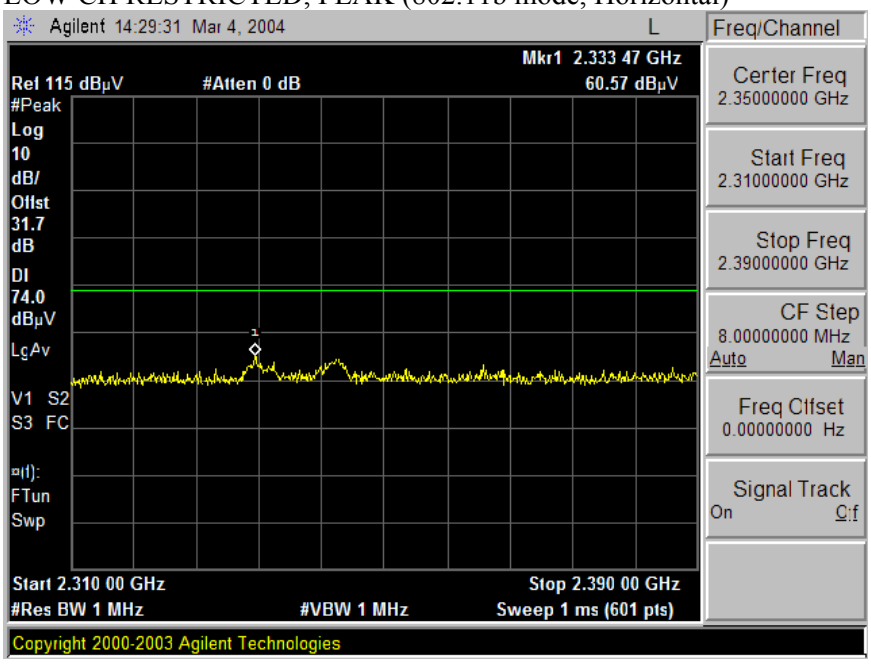
## RESULTS

No non-compliance noted:

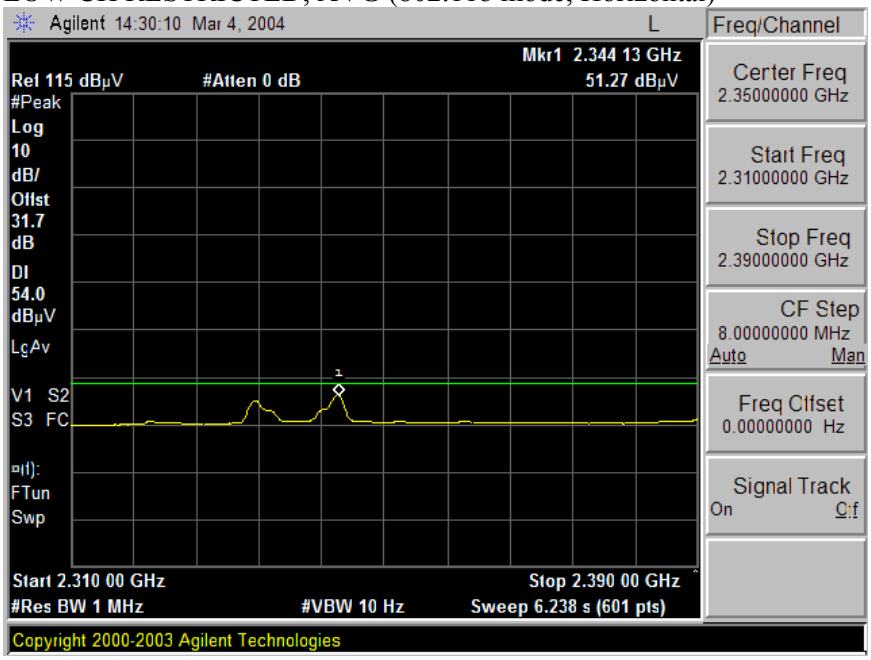
## 7.8.2. TRANSMITTER RADIATED EMISSIONS ABOVE 1 GHZ

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

LOW CH RESTRICTED, PEAK (802.11b mode, Horizontal)

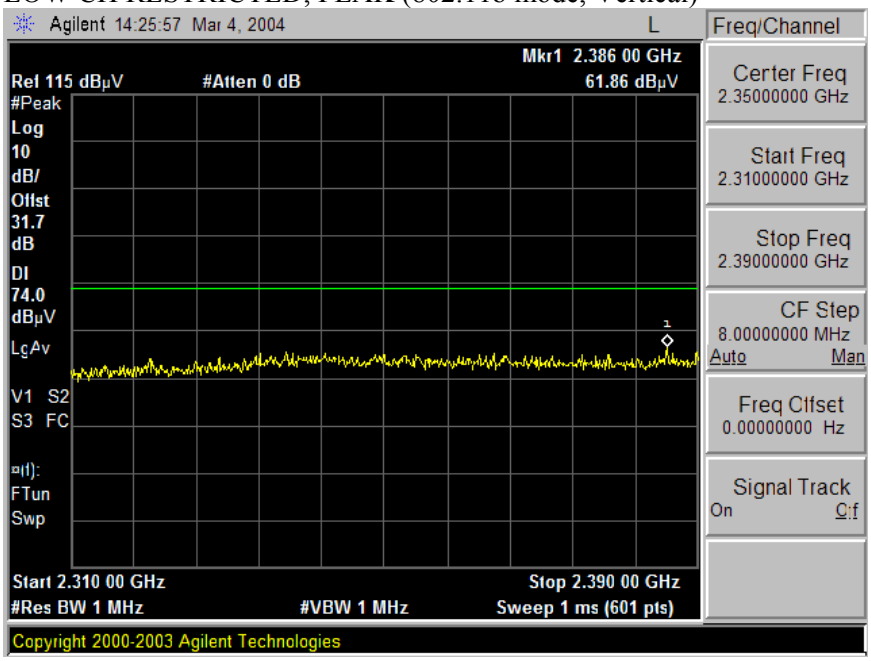


LOW CH RESTRICTED, AVG (802.11b mode, Horizontal)

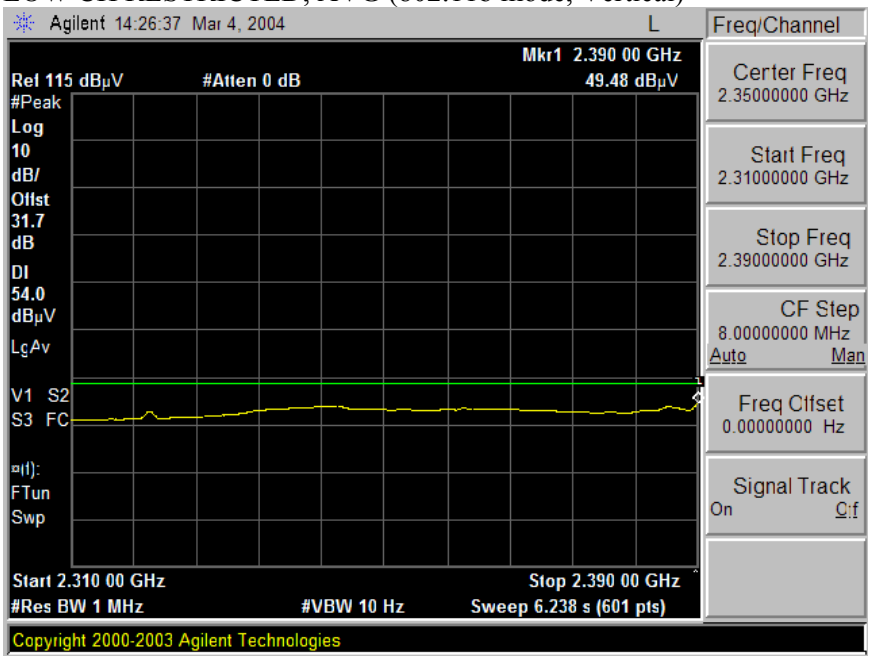


**RESTRICTED BANDEDGE (b MODE, LOW CHANNEL, VERTICAL)**

LOW CH RESTRICTED, PEAK (802.11b mode, Vertical)

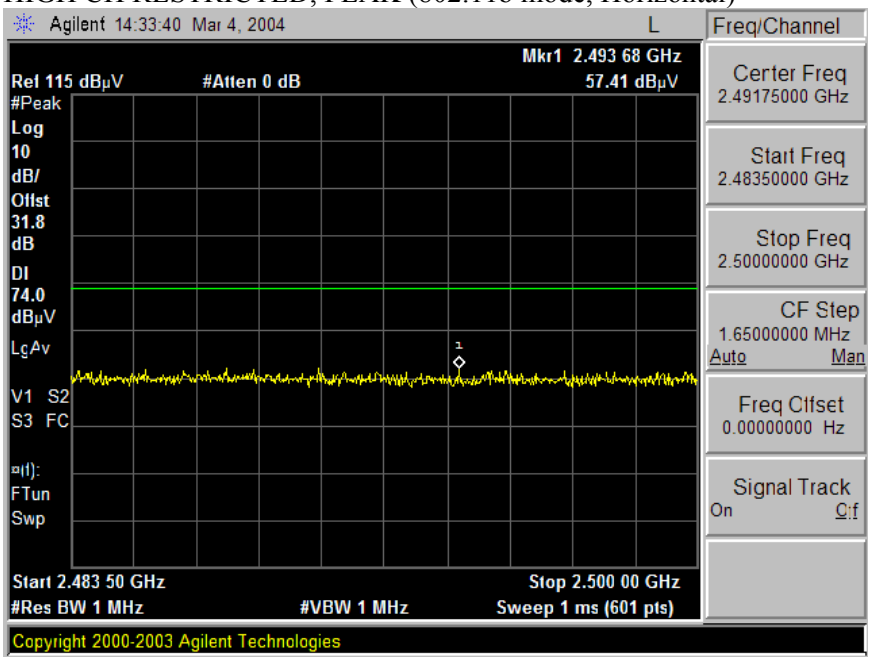


LOW CH RESTRICTED, AVG (802.11b mode, Vertical)

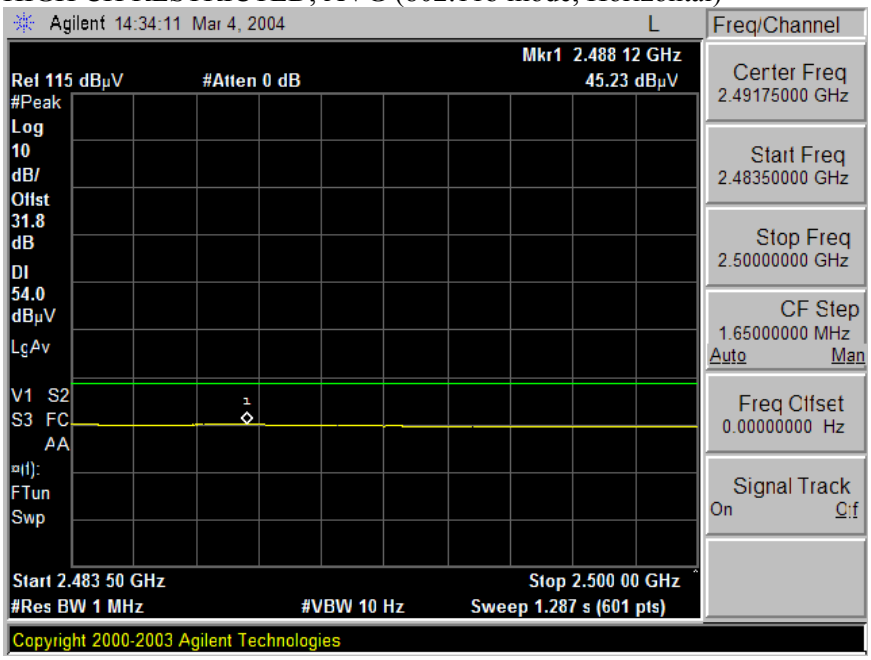


**RESTRICTED BANDEDGE (b MODE, HIGH CHANNEL, HORIZONTAL)**

HIGH CH RESTRICTED, PEAK (802.11b mode, Horizontal)

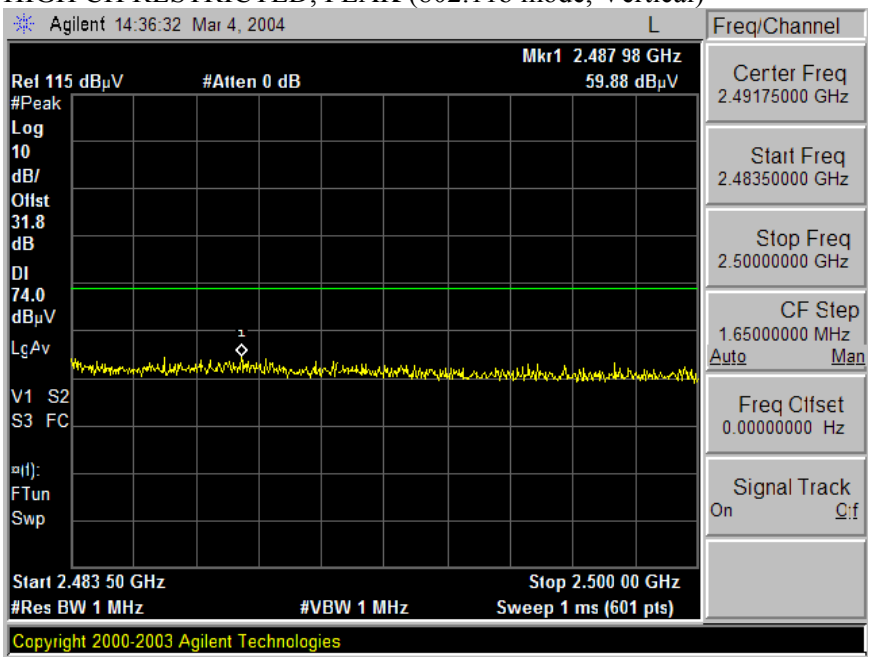


HIGH CH RESTRICTED, AVG (802.11b mode, Horizontal)

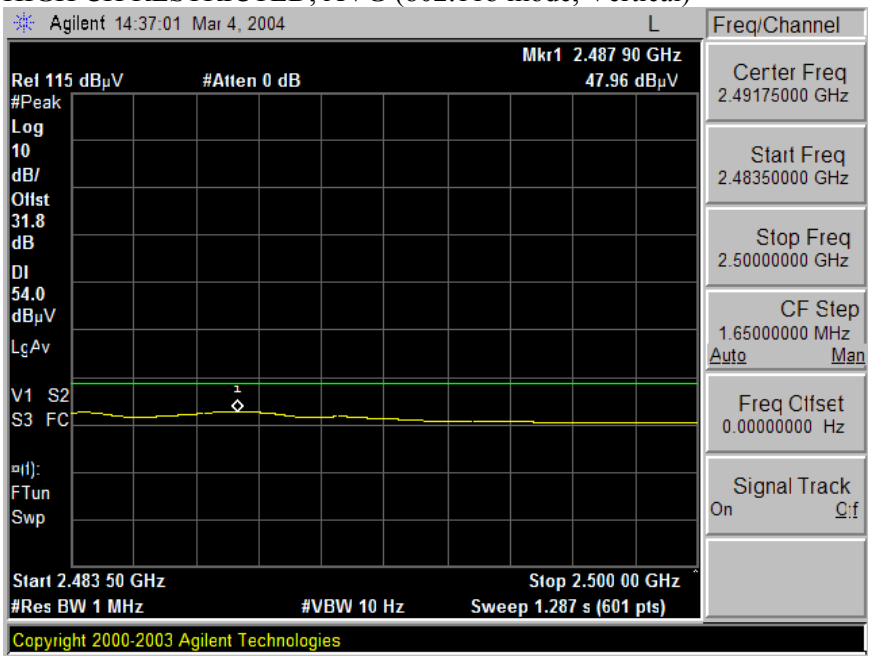


**RESTRICTED BANDEDGE (b MODE, HIGH CHANNEL, VERTICAL)**

HIGH CH RESTRICTED, PEAK (802.11b mode, Vertical)



HIGH CH RESTRICTED, AVG (802.11b mode, Vertical)



## HARMONICS AND SPURIOUS EMISSIONS (b MODE)

02/29/04 **High Frequency Measurement**

**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr:** David Garcia
**Project #:** 04U2552
**Company:** Atheros Communications, Inc.
**EUT Descrip.:** 802.11 a/b/g Mini PCI Module
**EUT M/N:** MB44
**Test Target:** 2.4Ghz Harmonics
**Mode Oper:** ART, L,M,H channels, b mode

**Test Equipment:**

| EMCO Horn 1-18GHz | Spectrum Analyzer | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz |
|---|---|---|---|---|
| T73; S/N: 6717 @3m | Agilent E4446A Analyzer | T63 Miteq 646456 | | |

Hi Frequency Cables: ☑ (2 ft) ☐ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Limit: FCC 15.209

**Peak Measurements:** 1 MHz Resolution Bandwidth, 1MHz Video Bandwidth

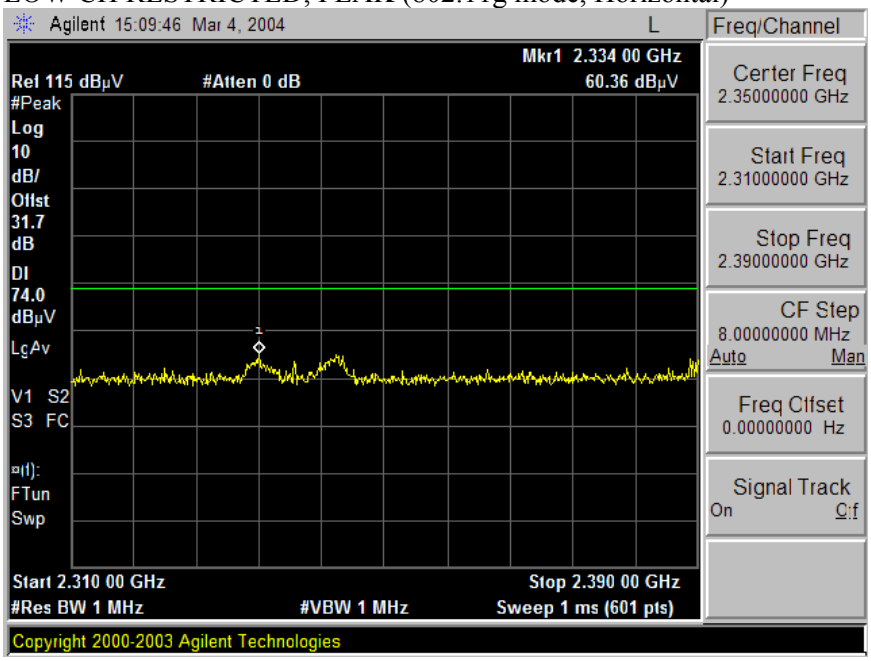
**Average Measurements:** 1 MHz Resolution Bandwidth, 10Hz Video Bandwidth

| f GHz | Dist feet | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | HPF | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11b low | | | | | | | | | | | | | | | |
| 4.824 | 9.8 | 53.5 | 50.6 | 33.4 | 2.9 | -35.3 | 0.0 | 1.0 | 55.4 | 52.4 | 74.0 | 54.0 | -18.6 | -1.6 | V |
| 9.648 | 9.8 | 44.0 | 33.9 | 38.6 | 4.0 | -33.3 | 0.0 | 1.0 | 54.2 | 44.1 | 74.0 | 54.0 | -19.8 | -9.9 | V |
| 11b mid | 9.8 | | | | | | | | | | | | | | |
| 4.874 | 9.8 | 54.5 | 50.3 | 33.4 | 2.9 | -35.3 | 0.0 | 1.0 | 56.5 | 52.3 | 74.0 | 54.0 | -17.5 | -1.7 | V |
| 9.748 | 9.8 | 43.1 | 33.2 | 38.5 | 4.1 | -33.4 | 0.0 | 1.0 | 53.2 | 43.3 | 74.0 | 54.0 | -20.8 | -10.7 | V |
| 11b high | 9.8 | | | | | | | | | | | | | | |
| 4.924 | 9.8 | 52.3 | 48.0 | 33.5 | 2.9 | -35.3 | 0.0 | 1.0 | 54.3 | 50.0 | 74.0 | 54.0 | -19.7 | -4.0 | V |
| 9.848 | 9.8 | 43.8 | 32.5 | 38.4 | 4.1 | -33.4 | 0.0 | 1.0 | 53.9 | 42.6 | 74.0 | 54.0 | -20.1 | -11.4 | V |
| 11b low | 9.8 | | | | | | | | | | | | | | |
| 4.824 | 9.8 | 51.5 | 46.8 | 33.4 | 2.9 | -35.3 | 0.0 | 1.0 | 53.4 | 48.7 | 74.0 | 54.0 | -20.6 | -5.3 | H |
| 11b mid | 9.8 | | | | | | | | | | | | | | |
| 4.874 | 9.8 | 55.8 | 47.5 | 33.4 | 2.9 | -35.3 | 0.0 | 1.0 | 57.8 | 49.5 | 74.0 | 54.0 | -16.2 | -4.5 | H |
| 11b high | 9.8 | | | | | | | | | | | | | | |
| 4.924 | 9.8 | 47.6 | 41.3 | 33.5 | 2.9 | -35.3 | 0.0 | 1.0 | 49.6 | 43.3 | 74.0 | 54.0 | -24.4 | -10.7 | H |
| 9.848 | 9.8 | 43.7 | 32.3 | 38.4 | 4.1 | -33.4 | 0.0 | 1.0 | 53.8 | 42.4 | 74.0 | 54.0 | -20.2 | -11.6 | H |

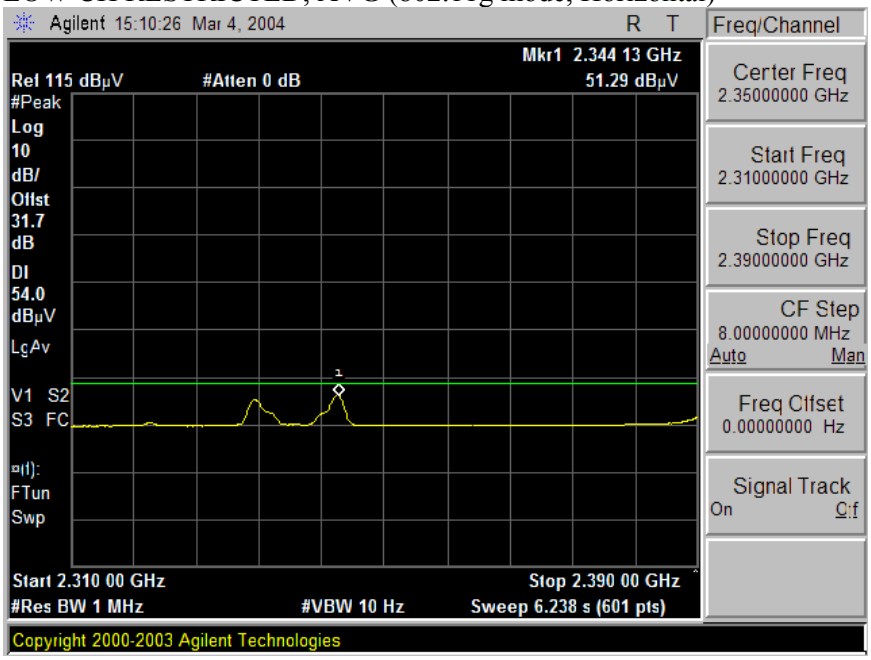
| | | | | | |
|---|---|---|---|---|---|
| f | Measurement Frequency | Amp | Preamp Gain | Avg Lim | Average Field Strength Limit |
| Dist | Distance to Antenna | D Corr | Distance Correct to 3 meters | Pk Lim | Peak Field Strength Limit |
| Read | Analyzer Reading | Avg | Average Field Strength @ 3 m | 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)**

LOW CH RESTRICTED, PEAK (802.11g mode, Horizontal)

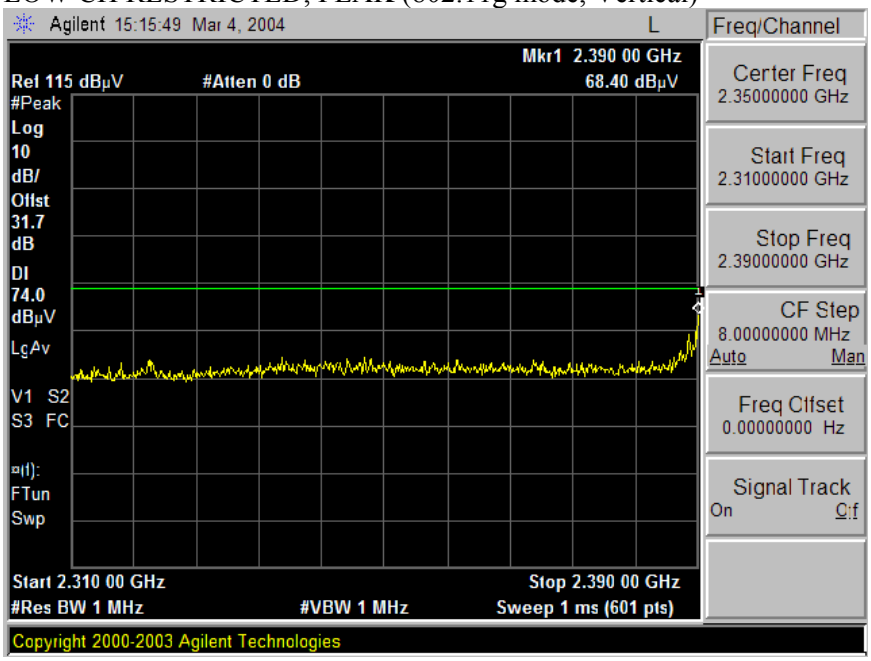


LOW CH RESTRICTED, AVG (802.11g mode, Horizontal)

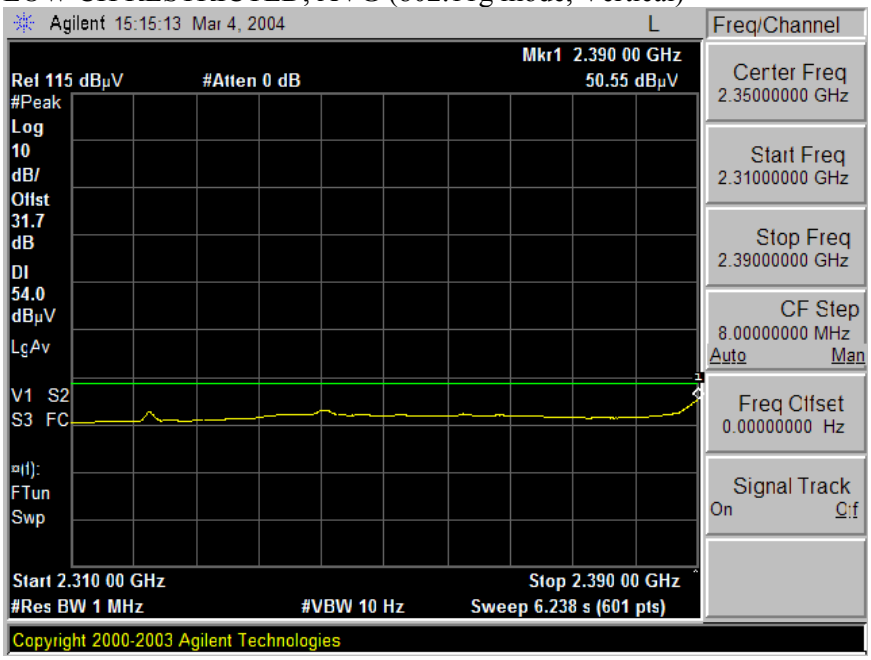


**RESTRICTED BANDEDGE (g MODE, LOW CHANNEL, VERTICAL)**

LOW CH RESTRICTED, PEAK (802.11g mode, Vertical)

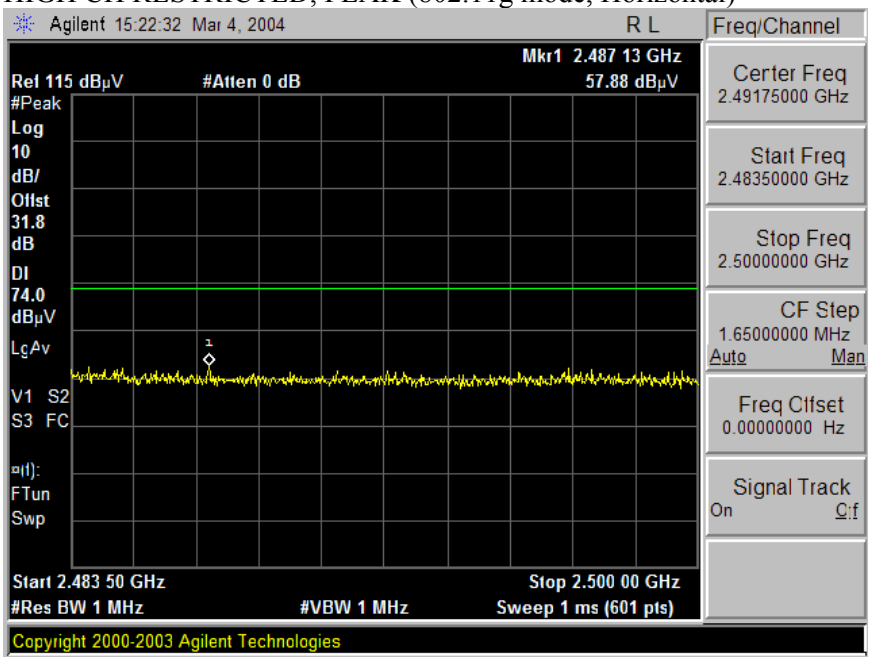


LOW CH RESTRICTED, AVG (802.11g mode, Vertical)

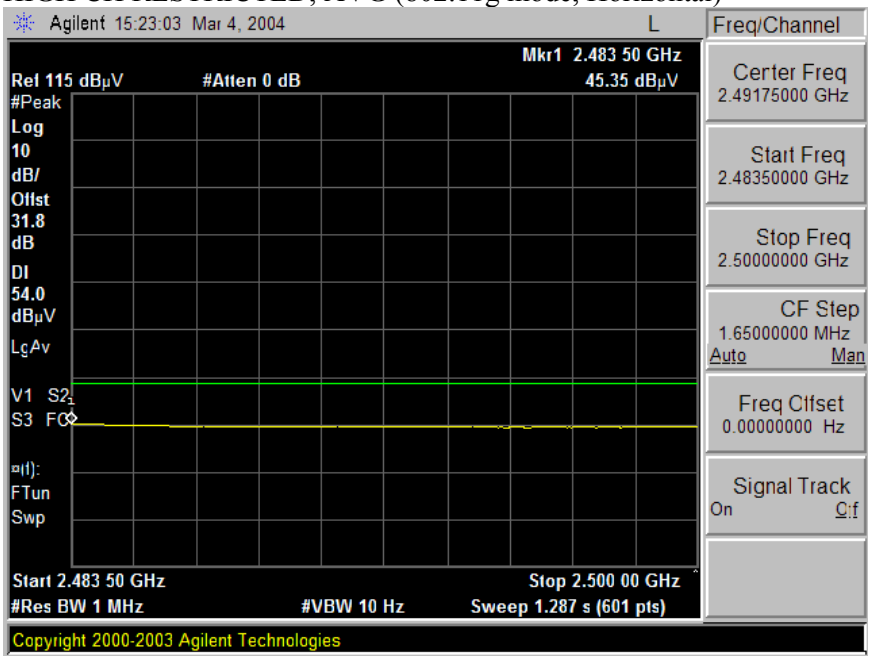


**RESTRICTED BANDEDGE (g MODE, HIGH CHANNEL, HORIZONTAL)**

HIGH CH RESTRICTED, PEAK (802.11g mode, Horizontal)

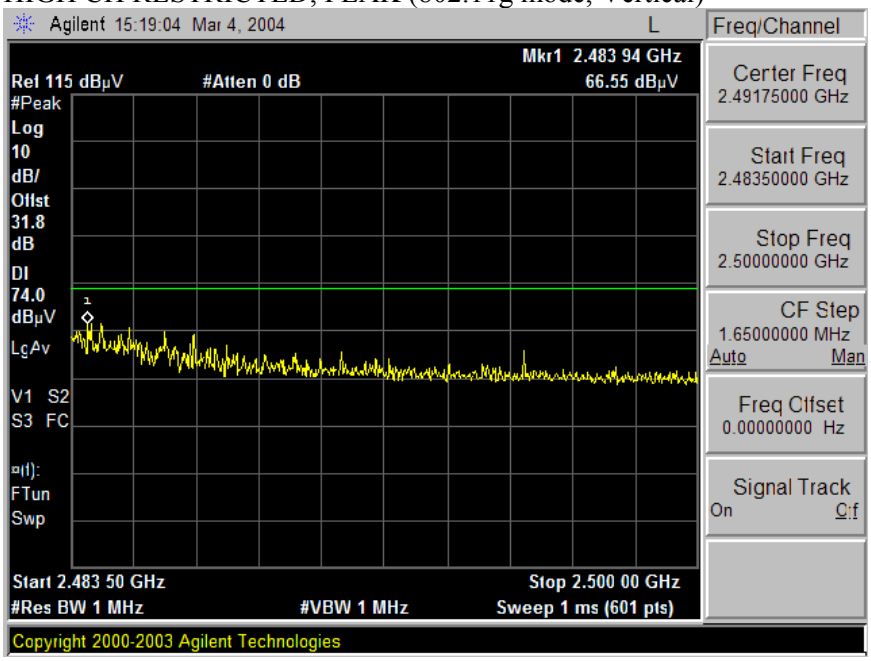


HIGH CH RESTRICTED, AVG (802.11g mode, Horizontal)

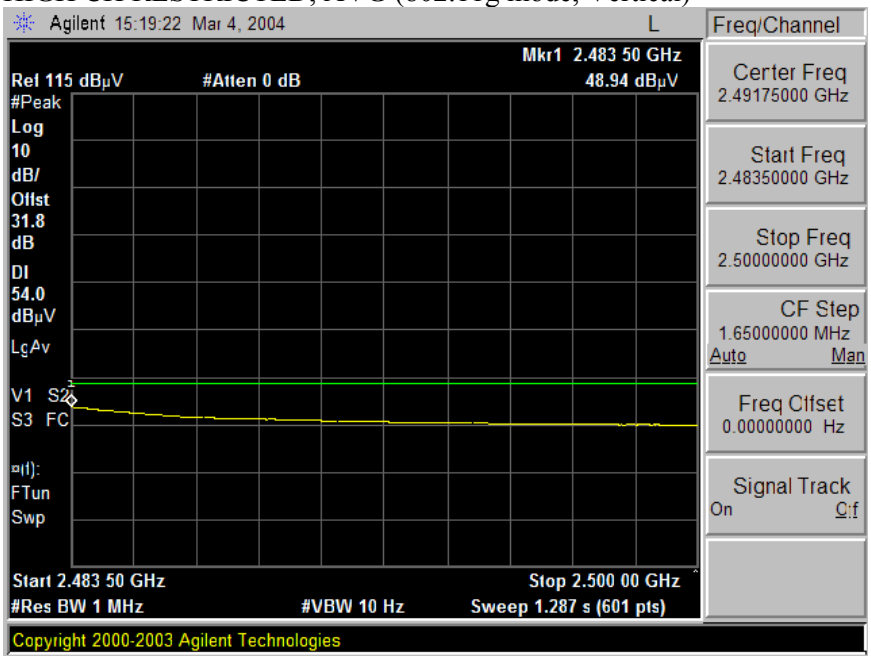


**RESTRICTED BANDEDGE (g MODE, HIGH CHANNEL, VERTICAL)**

HIGH CH RESTRICTED, PEAK (802.11g mode, Vertical)



HIGH CH RESTRICTED, AVG (802.11g mode, Vertical)



## HARMONICS AND SPURIOUS EMISSIONS (g MODE)

03/04/04 **High Frequency Measurement**
**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr: VIEN TRAN**
**Project #: 04U2470-1**
**Company: TOSHIBA**
**EUT Descrip.: MB44 ON EXTENDED CARD**
**EUT M/N: MB44 _ ACE9**
**Test Target: 15.247**
**Mode Oper: Tx_11g & TURBO MODE 2.4GHz BAND**

**Test Equipment:**

| EMCO Horn 1-18GHz | Spectrum Analyzer | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz |
|---|---|---|---|---|
| T60; S/N: 2238 @3m | Agilent E4446A Analyzer | T63 Miteq 646456 | | |

Hi Frequency Cables: ☑ (2 ft) ☐ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Limit: FCC 15.209

**Peak Measurements:** 1 MHz Resolution Bandwidth, 1MHz Video Bandwidth

**Average Measurements:** 1 MHz Resolution Bandwidth, 10Hz Video Bandwidth

| f GHz | Dist feet | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | HPF | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOW CH 2412MHz | | | | | | | | | | | | | | | |
| 4.824 | 9.8 | 47.7 | 35.4 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 49.3 | 37.0 | 74.0 | 54.0 | -24.7 | -17.0 | V |
| 7.326 | 9.8 | 45.0 | 33.5 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 51.5 | 40.0 | 74.0 | 54.0 | -22.5 | -14.0 | V |
| 4.824 | 9.8 | 45.9 | 33.4 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 47.5 | 35.0 | 74.0 | 54.0 | -26.5 | -19.0 | H |
| 7.326 | 9.8 | 43.6 | 32.8 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 50.1 | 39.3 | 74.0 | 54.0 | -23.9 | -14.7 | H |
| MID CH 2437MHz | | | | | | | | | | | | | | | |
| 4.874 | 9.8 | 53.7 | 41.3 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 55.4 | 43.0 | 74.0 | 54.0 | -18.6 | -11.0 | V |
| 7.311 | 9.8 | 49.0 | 35.1 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 55.4 | 41.5 | 74.0 | 54.0 | -18.6 | -12.5 | V |
| 4.874 | 9.8 | 50.0 | 37.5 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 51.7 | 39.2 | 74.0 | 54.0 | -22.3 | -14.8 | H |
| 7.311 | 9.8 | 45.4 | 33.4 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 51.8 | 39.8 | 74.0 | 54.0 | -22.2 | -14.2 | H |
| HI CH 2462MHZ | | | | | | | | | | | | | | | |
| 4.924 | 9.8 | 48.9 | 36.5 | 33.2 | 2.9 | -35.3 | 0.0 | 1.0 | 50.6 | 38.2 | 74.0 | 54.0 | -23.4 | -15.8 | V |
| 7.386 | 9.8 | 44.5 | 32.6 | 36.3 | 3.9 | -34.5 | 0.0 | 1.0 | 51.1 | 39.2 | 74.0 | 54.0 | -22.9 | -14.8 | V |
| 4.924 | 9.8 | 46.7 | 34.7 | 33.2 | 2.9 | -35.3 | 0.0 | 1.0 | 48.4 | 36.4 | 74.0 | 54.0 | -25.6 | -17.6 | H |
| 7.386 | 9.8 | 43.8 | 32.1 | 36.3 | 3.9 | -34.5 | 0.0 | 1.0 | 50.4 | 38.7 | 74.0 | 54.0 | -23.6 | -15.3 | H |

| | | | | | |
|---|---|---|---|---|---|
| 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 (g TURBO MODE)

03/04/04 **High Frequency Measurement**
**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr: VIEN TRAN**
**Project #: 04U2470-1**
**Company: TOSHIBA**
**EUT Descrip.: MB44 ON EXTENDED CARD**
**EUT M/N: MB44 _ ACE9**
**Test Target: 15.247**
**Mode Oper: Tx_11g & TURBO MODE 2.4GHz BAND**

**Test Equipment:**

| EMCO Horn 1-18GHz | Spectrum Analyzer | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz |
|---|---|---|---|---|
| T60; S/N: 2238 @3m | Agilent E4446A Analyzer | T63 Miteq 646456 | | |

Hi Frequency Cables: ☑ (2 ft) ☐ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Limit: FCC 15.209

**Peak Measurements:** 1 MHz Resolution Bandwidth, 1MHz Video Bandwidth

**Average Measurements:** 1 MHz Resolution Bandwidth, 10Hz Video Bandwidth

| f GHz | Dist feet | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | HPF | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MID CH 2437MHz_TURBO | | | | | | | | | | | | | | | |
| 4.874 | 9.8 | 56.2 | 42.9 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 57.9 | 44.6 | 74.0 | 54.0 | -16.1 | -9.4 | V |
| 7.311 | 9.8 | 45.7 | 34.0 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 52.1 | 40.4 | 74.0 | 54.0 | -21.9 | -13.6 | V |
| 4.874 | 9.8 | 47.2 | 35.6 | 33.1 | 2.9 | -35.3 | 0.0 | 1.0 | 48.9 | 37.3 | 74.0 | 54.0 | -25.1 | -16.7 | H |
| 7.311 | 9.8 | 44.0 | 32.8 | 36.2 | 3.8 | -34.6 | 0.0 | 1.0 | 50.4 | 39.2 | 74.0 | 54.0 | -23.6 | -14.8 | H |

| | | | | | |
|---|---|---|---|---|---|
| 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 (a MODE)

02/29/04 **High Frequency Measurement**

**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr:** David Garcia
**Project #:** 04U2552
**Company:** Atheros Communications Inc.
**EUT Descrip.:** LAN Module
**EUT M/N:** MB44, # ACF7
**Test Target:** Harmonics
**Mode Oper:** ART w/HTL antenna, 5.8 band, a mode

**Test Equipment:**

| EMCO Horn 1-18GHz | Spectrum Analyzer | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz |
|---|---|---|---|---|
| T59; S/N: 3245 @3m | Agilent E4446A Analyzer | T63 Miteq 646456 | | |

Hi Frequency Cables: ☑ (2 ft) ☐ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Limit: FCC 15.209

**Peak Measurements:** 1 MHz Resolution Bandwidth, 1MHz Video Bandwidth

**Average Measurements:** 1 MHz Resolution Bandwidth, 10Hz Video Bandwidth

| f GHz | Dist feet | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | HPF | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11.490 | 9.8 | 48.1 | 36.9 | 38.7 | 4.6 | -34.2 | 0.0 | 1.0 | 58.2 | 47.0 | 74.0 | 54.0 | -15.8 | -7.0 | V |
| 17.235 | 9.8 | 48.4 | 37.2 | 42.6 | 5.9 | -39.8 | 0.0 | 1.0 | 58.1 | 46.9 | 74.0 | 54.0 | -15.9 | -7.1 | V |
| 11.570 | 9.8 | 50.2 | 38.6 | 38.8 | 4.6 | -34.3 | 0.0 | 1.0 | 60.3 | 48.7 | 74.0 | 54.0 | -13.7 | -5.3 | V |
| 17.355 | 9.8 | 48.6 | 36.1 | 43.2 | 6.0 | -39.8 | 0.0 | 1.0 | 58.9 | 46.4 | 74.0 | 54.0 | -15.1 | -7.6 | V |
| 11.650 | 9.8 | 51.5 | 40.6 | 38.9 | 4.6 | -34.4 | 0.0 | 1.0 | 61.6 | 50.7 | 74.0 | 54.0 | -12.4 | -3.3 | V |
| 11.490 | 9.8 | 49.6 | 38.5 | 38.7 | 4.6 | -34.2 | 0.0 | 1.0 | 59.7 | 48.6 | 74.0 | 54.0 | -14.3 | -5.4 | H |
| 17.235 | 9.8 | 49.0 | 37.9 | 42.6 | 5.9 | -39.8 | 0.0 | 1.0 | 58.7 | 47.6 | 74.0 | 54.0 | -15.3 | -6.4 | H |
| 11.570 | 9.8 | 49.2 | 39.2 | 38.8 | 4.6 | -34.3 | 0.0 | 1.0 | 59.3 | 49.3 | 74.0 | 54.0 | -14.7 | -4.7 | H |
| 11.650 | 9.8 | 52.8 | 41.8 | 38.9 | 4.6 | -34.4 | 0.0 | 1.0 | 62.9 | 51.9 | 74.0 | 54.0 | -11.1 | -2.1 | H |

| | | | | | |
|---|---|---|---|---|---|
| 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 (a TURBO MODE)

02/27/04 **High Frequency Measurement**
**Compliance Certification Services, Morgan Hill Open Field Site**

**Test Engr:** Yan Zheng
**Project #:** 04U2552
**Company:** Atheros
**EUT Descrip.:** 802.11 a/b/g Mini PCI card
**EUT M/N:** MB44
**Test Target:** FCC Class B
**Mode Oper:** Transmit, 5.8GHz, turbo mode,

**Test Equipment:**

| EMCO Horn 1-18GHz | Spectrum Analyzer | Pre-amplifer 1-26GHz | Pre-amplifer 26-40GHz | Horn > 18GHz |
|---|---|---|---|---|
| T60; S/N: 2238 @3m | Agilent E4446A Analyzer | T86 Miteq 924341 | | T87; ARA 18-26GHz; S/N:1049 |

Hi Frequency Cables: ☐ (2 ft) ☐ (2 ~ 3 ft) ☑ (4 ~ 6 ft) ☑ (12 ft)

Limit: FCC 15.205

**Peak Measurements:**
1 MHz Resolution Bandwidth
1MHz Video Bandwidth

**Average Measurements:**
1 MHz Resolution Bandwidth
10Hz Video Bandwidth

| f GHz | Dist feet | Read Pk dBuV | Read Avg. dBuV | AF dB/m | CL dB | Amp dB | D Corr dB | HPF | Peak dBuV/m | Avg dBuV/m | Pk Lim dBuV/m | Avg Lim dBuV/m | Pk Mar dB | Avg Mar dB | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbo mode | | | | | | | | | | | | | | | |
| channel 5760MHz | | | | | | | | | | | | | | | |
| 11.520 | 9.8 | 59.9 | 47.6 | 38.7 | 8.1 | -44.6 | 0.0 | 1.0 | 63.1 | 50.8 | 74.0 | 54.0 | -10.9 | -3.2 | V |
| 17.280 | 9.8 | 56.3 | 43.8 | 42.4 | 9.4 | -48.4 | 0.0 | 1.0 | 60.6 | 48.1 | 74.0 | 54.0 | -13.4 | -5.9 | V |
| 11.520 | 9.8 | 55.2 | 44.2 | 38.7 | 8.1 | -44.6 | 0.0 | 1.0 | 58.4 | 47.4 | 74.0 | 54.0 | -15.6 | -6.6 | H |
| 17.280 | 9.8 | 53.6 | 42.7 | 42.4 | 9.4 | -48.4 | 0.0 | 1.0 | 57.9 | 47.0 | 74.0 | 54.0 | -16.1 | -7.0 | H |
| channel 5800MHz | | | | | | | | | | | | | | | |
| 11.600 | 9.8 | 58.8 | 46.0 | 38.8 | 8.2 | -44.7 | 0.0 | 1.0 | 62.0 | 49.2 | 74.0 | 54.0 | -12.0 | -4.8 | V |
| 16.860 | 9.8 | 56.6 | 43.3 | 40.9 | 9.3 | -48.6 | 0.0 | 1.0 | 59.1 | 45.8 | 74.0 | 54.0 | -14.9 | -8.2 | V |
| 11.600 | 9.8 | 56.8 | 44.0 | 38.8 | 8.2 | -44.7 | 0.0 | 1.0 | 60.0 | 47.2 | 74.0 | 54.0 | -14.0 | -6.8 | H |
| 16.860 | 9.8 | 53.3 | 41.9 | 40.9 | 9.3 | -48.6 | 0.0 | 1.0 | 55.8 | 44.4 | 74.0 | 54.0 | -18.2 | -9.6 | H |
| No spurious emisisons above the system noise floor were detected above 17 GHz. | | | | | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 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 | | |

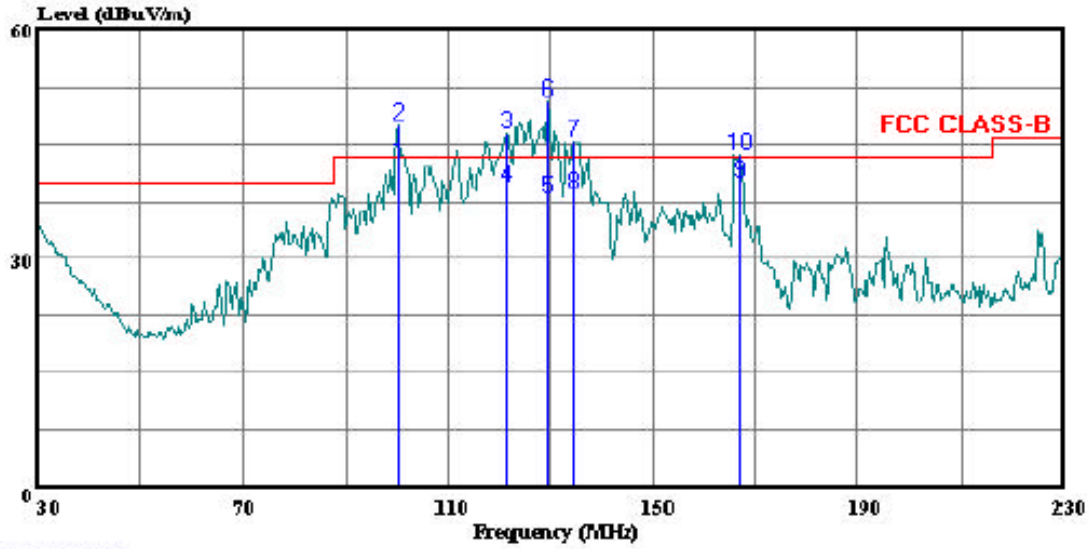
## 7.8.3. WORST-CASE RADIATED EMISSIONS BELOW 1 GHz

**SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)**

HORIZONTAL PLOT 30_230MHz

COMPLIANCE Engineering Services, Inc.
561F Monterey Road
San Jose, CA 95131
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 12 File#: BELOW 1GHz.EMI Date: 02-28-2004 Time: 12:37:34




(Audix ATC)
Trace: 1 Ref Trace:

Condition: FCC CLASS-B HORIZONTAL
Test Eng: : VIEN TRAN
Project #: : 04U2552
Company: : ATHEROS
EUT: : 802.11A,B,G MINI PCI CARD
Model No: : MB44
Configuration: : EUT/LAPTOP
Target of Test: : FCC-B
Mode of Operation: TX(WORST CASE)
30-230MHz

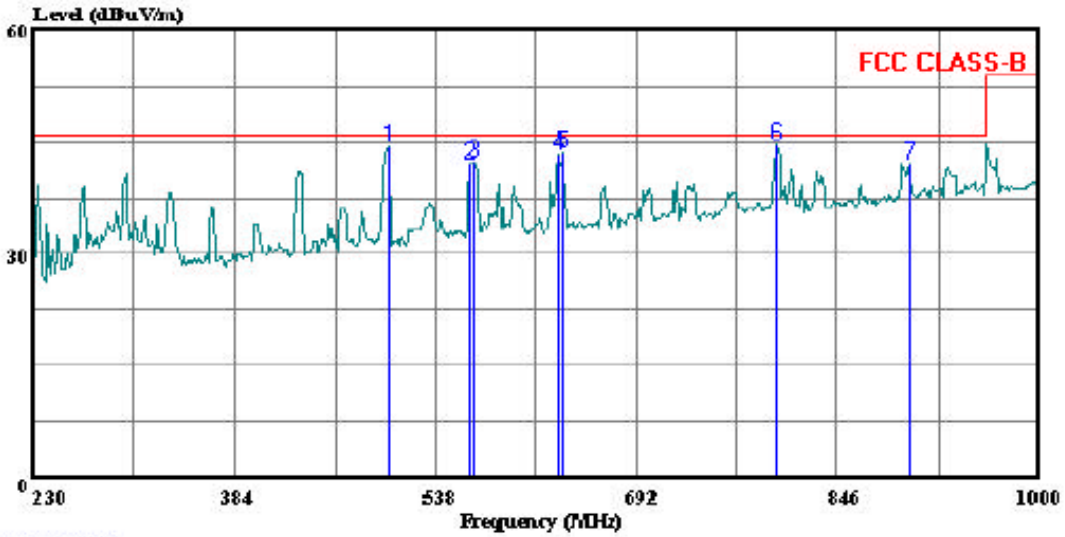
HORIZONTAL DATA 30_230MHz

| | | Freq | Remark | Read Level | Factor | Level | Limit Line | Over Limit |
|---|---|---|---|---|---|---|---|---|
| | | MHz | | dBuV | dB | dBuV/m | dBuV/m | dB |
| 1 | | 100.400 | QP | 31.80 | 10.59 | 42.39 | 43.50 | -1.11 |
| 2 | * | 100.400 | Peak | 37.04 | 10.59 | 47.63 | 43.50 | 4.13 |
| 3 | * | 121.400 | Peak | 31.30 | 15.09 | 46.39 | 43.50 | 2.89 |
| 4 | | 121.400 | QP | 24.50 | 15.09 | 39.59 | 43.50 | -3.92 |
| 5 | | 129.400 | QP | 22.40 | 15.55 | 37.95 | 43.50 | -5.55 |
| 6 | * | 129.400 | Peak | 35.01 | 15.54 | 50.55 | 43.50 | 7.05 |
| 7 | * | 134.400 | Peak | 29.94 | 15.43 | 45.37 | 43.50 | 1.87 |
| 8 | | 134.400 | QP | 23.00 | 15.43 | 38.43 | 43.50 | -5.07 |
| 9 | | 166.800 | QP | 26.40 | 13.62 | 40.02 | 43.50 | -3.48 |
| 10 | * | 166.800 | Peak | 29.95 | 13.61 | 43.56 | 43.50 | 0.06 |

HORIZONTAL PLOT 230_1000MHz

561F Monterey Road
San Jose, CA 95131
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 5 File#: BELOW 1GHz.EMI Date: 02-28-2004 Time: 11:03:59




(Audix ATC)
Trace: 4 Ref Trace:

Condition: FCC CLASS-B HORIZONTAL
Test Eng: : VIEN TRAN
Project #: : 04U2552
Company: : ATHEROS
EUT: : 802.11A,B,G MINI PCI CARD
Model No: : MB44
Configuration: : EUT/LAPTOP
Target of Test: : FCC-B
Mode of Operation: TX(WORST CASE)_230-1000MHz

HORIZONTAL DATA 230_1000MHz

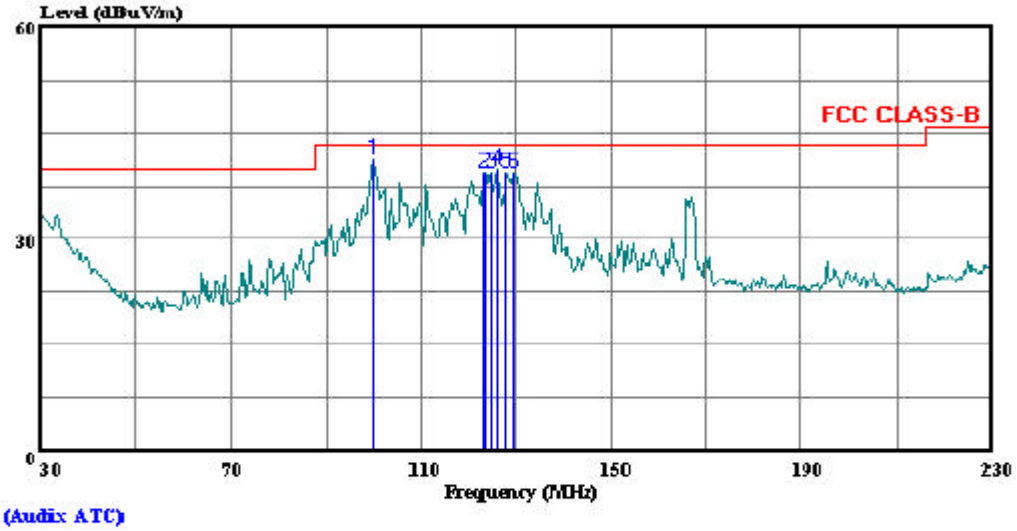
| | Freq | Remark | Read Level | Factor | Level | Limit Line | Over Limit |
|---|---|---|---|---|---|---|---|
| | MHz | | dBuV | dB | dBuV/m | dBuV/m | dB |
| 1 | 502.580 | Peak | 23.67 | 20.63 | 44.30 | 46.00 | -1.70 |
| 2 | 564.180 | Peak | 20.76 | 21.44 | 42.20 | 46.00 | -3.80 |
| 3 | 568.030 | Peak | 20.78 | 21.59 | 42.37 | 46.00 | -3.63 |
| 4 | 631.940 | Peak | 20.87 | 22.41 | 43.28 | 46.00 | -2.72 |
| 5 | 635.790 | Peak | 21.00 | 22.53 | 43.53 | 46.00 | -2.47 |
| 6 | 799.030 | Peak | 19.70 | 25.01 | 44.71 | 46.00 | -1.29 |
| 7 | 901.440 | Peak | 15.98 | 26.20 | 42.18 | 46.00 | -3.83 |

**SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)**

VERTICAL PLOT 30_230MHZ

561F Monterey Road
San Jose, CA 95131
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 7 File#: BELOW 1GHz.EMI Date: 02-28-2004 Time: 11:11:07




(Audix ATC)
Trace: 6 Ref Trace:

Condition: FCC CLASS-B VERTICAL
Test Eng: : VIEN TRAN
Project #: : 04U2552
Company: : ATHEROS
EUT: : 802.11A,B,G MINI PCI CARD
Model No: : MB44
Configuration: : EUT/LAPTOP
Target of Test: : FCC-B
Mode of Operation: TX(WORST CASE)
: 30-230MHz

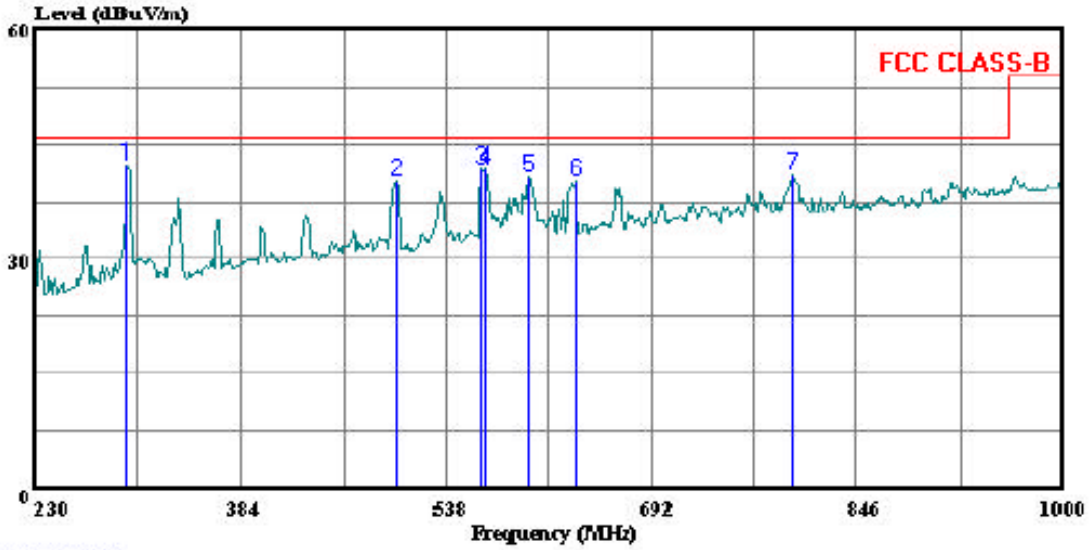
VERTICAL DATA 30_230MHZ

| | Freq | Remark | Read Level | Factor | Level | Limit Line | Over Limit |
|---|---|---|---|---|---|---|---|
| | MHz | | dBuV | dB | dBuV/m | dBuV/m | dB |
| 1 | 99.800 | Peak | 30.76 | 10.41 | 41.17 | 43.50 | -2.33 |
| 2 | 123.400 | Peak | 24.24 | 15.31 | 39.55 | 43.50 | -3.95 |
| 3 | 124.400 | Peak | 24.01 | 15.41 | 39.42 | 43.50 | -4.08 |
| 4 | 125.800 | Peak | 24.63 | 15.48 | 40.11 | 43.50 | -3.39 |
| 5 | 127.800 | Peak | 24.07 | 15.51 | 39.58 | 43.50 | -3.92 |
| 6 | 129.400 | Peak | 23.92 | 15.54 | 39.46 | 43.50 | -4.04 |

VERTICAL PLOT 230_1000MHZ

561F Monterey Road
San Jose, CA 95131
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 9 File#: BELOW 1GHz.EMI Date: 02-28-2004 Time: 11:30:26




(Audix ATC)

Trace: 8 Ref Trace:

Condition: FCC CLASS-B VERTICAL
Test Eng: : VIEN TRAN
Project #: : 04U2552
Company: : ATHEROS
EUT: : 802.11A,B,G MINI PCI CARD
Model No: : MB44
Configuration: : EUT/LAPTOP
Target of Test: : FCC-B
Mode of Operation: TX(WORST CASE)
: 230-1000MHz

VERTICAL DATA 230_1000MHZ

| | Freq | Remark | Read Level | Factor | Level | Limit Line | Over Limit |
|---|---|---|---|---|---|---|---|
| | MHz | | dBuV | dB | dBuV/m | dBuV/m | dB |
| 1 | 298.530 | Peak | 26.42 | 15.91 | 42.33 | 46.00 | -3.68 |
| 2 | 501.040 | Peak | 19.72 | 20.61 | 40.32 | 46.00 | -5.68 |
| 3 | 564.180 | Peak | 20.41 | 21.44 | 41.85 | 46.00 | -4.15 |
| 4 | 568.030 | Peak | 20.22 | 21.59 | 41.81 | 46.00 | -4.19 |
| 5 | 598.830 | Peak | 18.84 | 21.93 | 40.77 | 46.00 | -5.24 |
| 6 | 635.790 | Peak | 17.84 | 22.53 | 40.37 | 46.00 | -5.63 |
| 7 | 797.490 | Peak | 15.96 | 24.99 | 40.95 | 46.00 | -5.05 |

## 7.9. 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 µH/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.

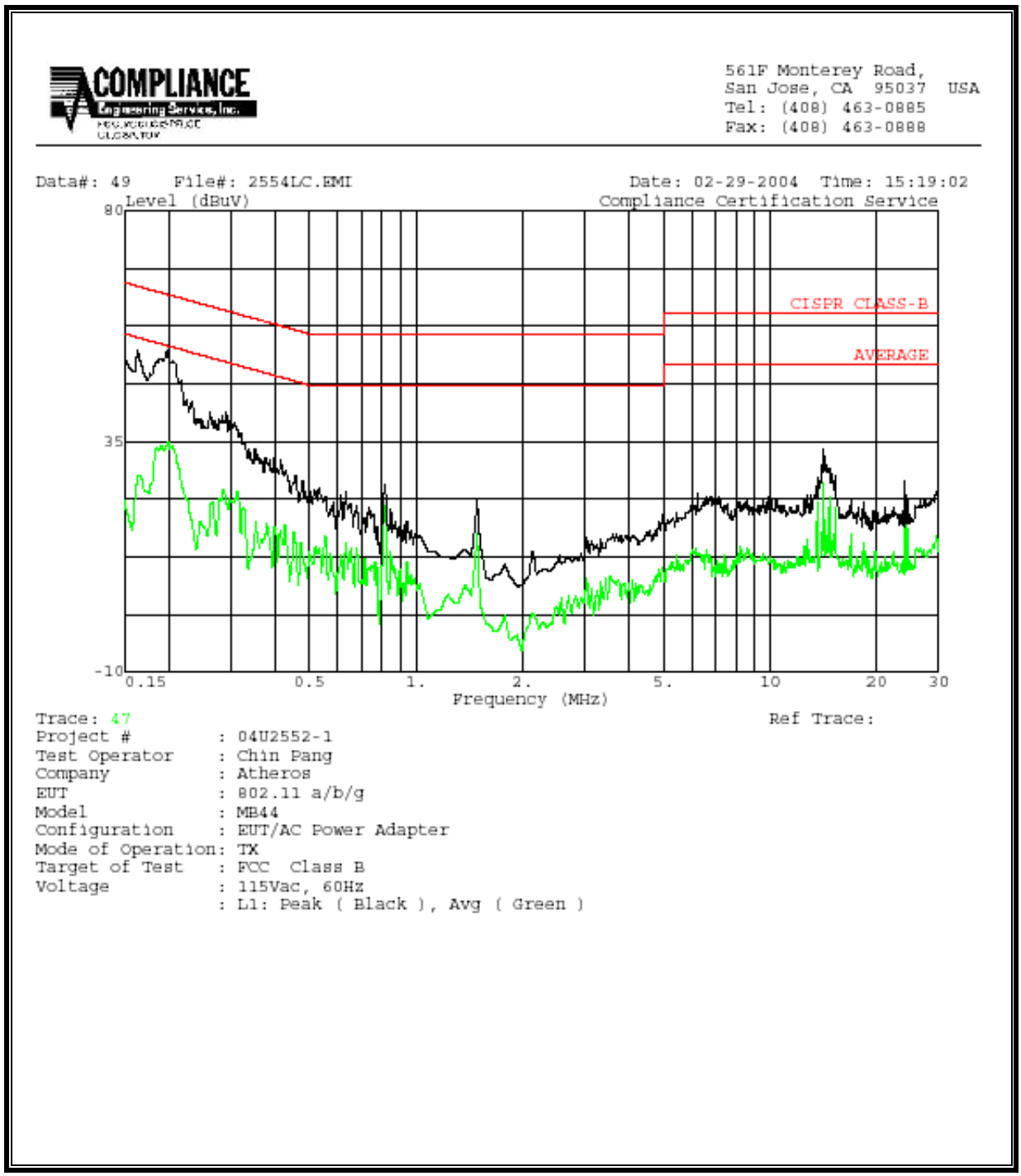
**RESULTS**

No non-compliance noted:

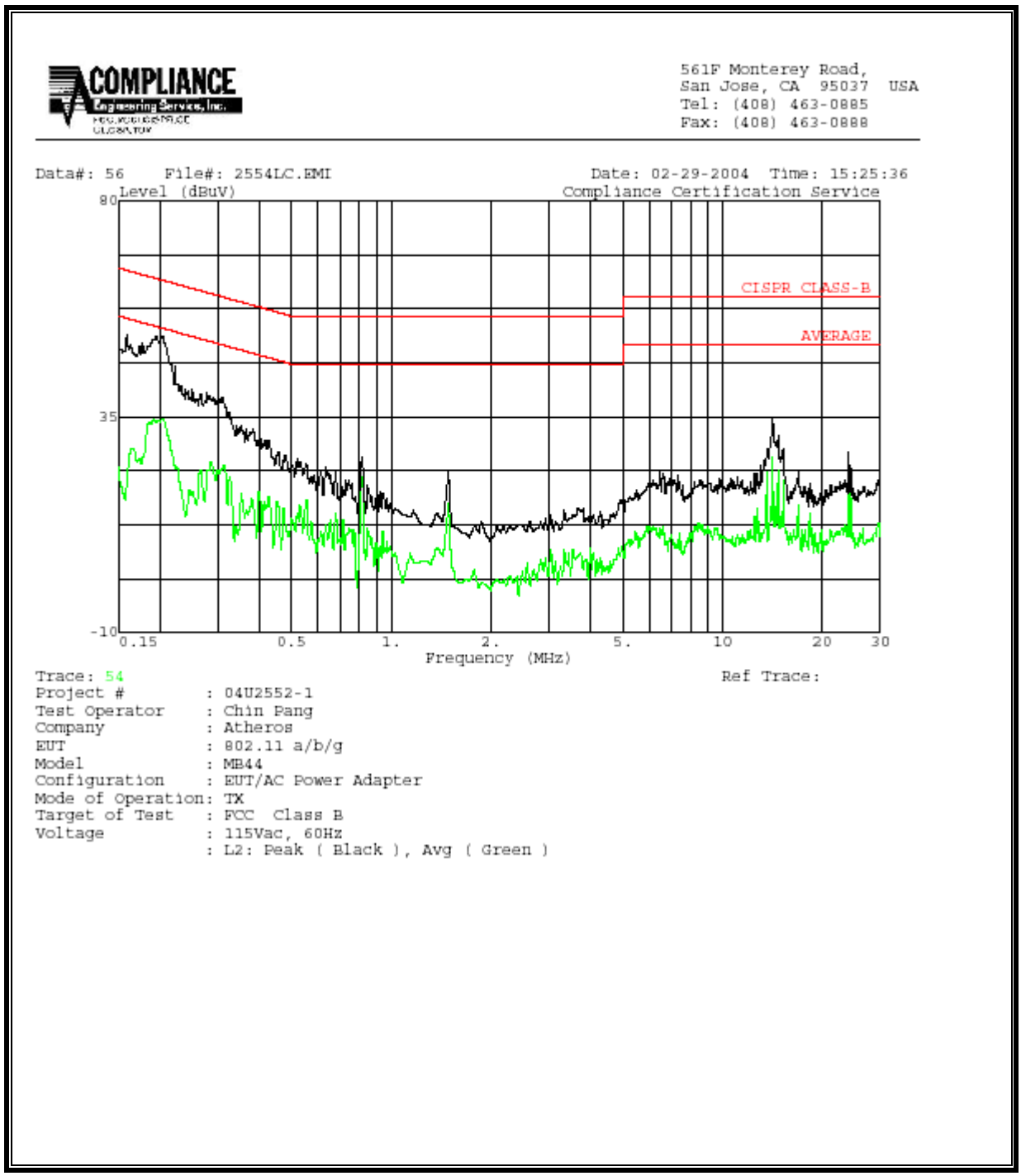
## 6 WORST EMISSIONS

| CONDUCTED EMISSIONS DATA (115VAC 60Hz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Freq.** | **Reading** | | | **Closs** | **Limit** | **EN_B** | **Margin** | | **Remark** |
| **(MHz)** | **PK (dBuV)** | **QP (dBuV)** | **AV (dBuV)** | **(dB)** | **QP** | **AV** | **QP (dB)** | **AV (dB)** | **L1 / L2** |
| 0.16 | 53.05 | -- | 28.17 | 0.00 | 65.60 | 55.60 | -12.55 | -27.43 | L1 |
| 0.20 | 52.83 | -- | 34.79 | 0.00 | 64.63 | 54.63 | -11.80 | -19.84 | L1 |
| 14.36 | 34.61 | -- | 27.21 | 0.00 | 60.00 | 50.00 | -25.39 | -22.79 | L1 |
| 0.16 | 52.13 | -- | 28.51 | 0.00 | 65.71 | 55.71 | -13.58 | -27.20 | L2 |
| 0.20 | 52.50 | -- | 35.02 | 0.00 | 64.51 | 54.51 | -12.01 | -19.49 | L2 |
| 14.21 | 35.40 | -- | 27.36 | 0.00 | 60.00 | 50.00 | -24.60 | -22.64 | L2 |
| 6 Worst Data | | | | | | | | | |

**LINE 1 RESULTS**



**LINE 2 RESULTS**



# 8. SETUP PHOTOS

**ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP**

ANTENNA PORT CONDUCTED PHOTO

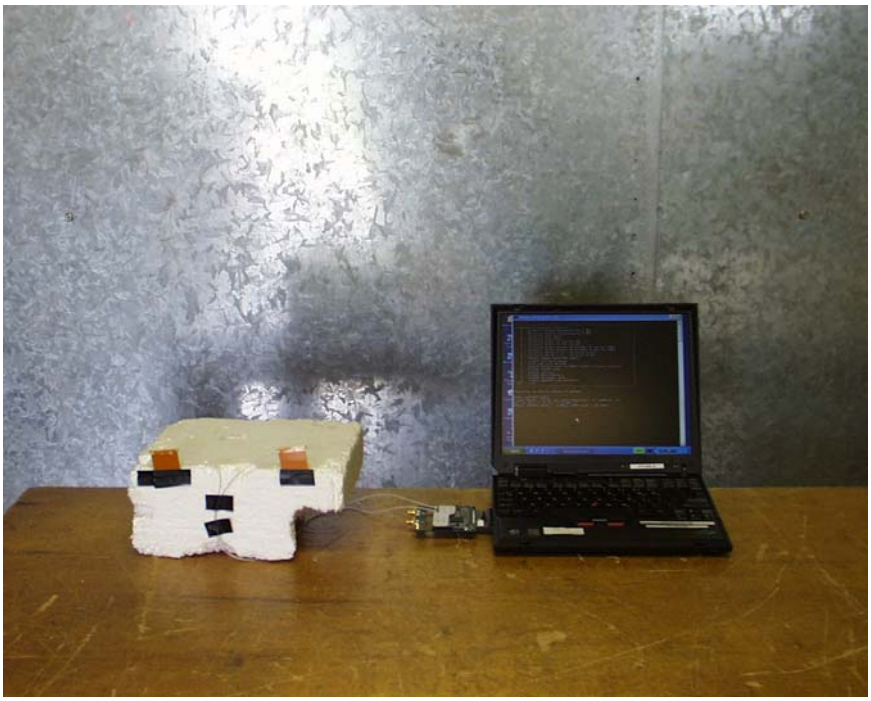
**RADIATED RF MEASUREMENT SETUP**

RADIATED FRONT PHOTO

RADIATED BACK PHOTO

## POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP

LINE CONDUCTED FRONT PHOTO



LINE CONDUCTED BACK PHOTO


# END OF REPORT