FCC CFR47 PART 15 SUBPART C
CERTIFICATION
TEST REPORT

FOR

2.4GHz 802.11n MPCI MODULE

MODEL NUMBER: WLN-1306

FCC ID: NHPWLN1306

REPORT NUMBER: 06U10242-1

ISSUE DATE: APRIL 24, 2006

Prepared for
CAMEO
NO. 42, SEC. 6, MINCYUAN E. RD.
NEIHU DISTRICT, TAIPEI CITY 114
TAIWAN

Prepared by
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Revision History

Rev.	Issue Date	Revisions	Revised By
--	04/24/06	Initial Issue	A. ILARINA

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: CAMEO
NO. 42, SEC. 6, MINCYUAN RD.
NEIHU DISTRICT, TAIPEI CITY 114
TAIWAN

EUT DESCRIPTION: 2.4 GHz 802.11n MPCI MODULE

MODEL: WLN-1306

SERIAL NUMBER: **MB71-010-A08**

DATE TESTED: APRIL 15 – APRIL 18, 2006

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

Approved & Released For CCS By: Tested By:

ALVIN ILARINA
EMC SUPERVISOR
COMPLIANCE CERTIFICATION SERVICES

CHIN PANG
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

2. TEST METHODOLOGY

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

3. 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.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. MEASUREMENT UNCERTAINTY

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

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

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an 802.11n MIMO transceiver in MPCI module form factor. It has two transmitter chains and two receive chains (2x2 configurations). The 2x2 configuration is implemented with two outside chains (Chain 0 and Chain 2).

The radio module is manufactured by Cameo.

The model number may have been changed after testing commenced. All data in this report is applicable to the model number documented in Section 1 above.

5.2. MAXIMUM OUTPUT POWER

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

2400 to 2483.5 MHz Authorized Band

Frequency Range (MHz)	Mode	Total Output Power (dBm)	Total Output Power (mW)
2412 - 2462	802.11b	26.03	400.87
2412 - 2462	802.11g	28.79	756.83
2412 - 2462	802.11n HT20	28.74	748.17
2422 - 2452	802.11n HT40	28.18	657.66

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes two dipole antennas for transmitting & receiving, each with a maximum gain of 2.0 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed in the host support equipment during testing was Atheros AR5002, ANWI Diagnostic Kernel Drive.

The test utility software used during testing was Art Software Revision 0.1 Build #5 ART_11n.

5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case channel is determined as the channel with the highest output power. The highest measured output power was at 2437 MHz.

The worst-case data rates are determined to be the lowest data rates in each mode, based on the investigations by measuring the PSD, peak power and average power across all the data rates, bandwidths, modulations and spatial stream modes.

Thus all emissions tests were made with following data rates:

- b mode, 20 MHz Channel Bandwidth, 2412 MHz-2462 MHz, 1 Mb/s, BPSK Modulation, Spatial Stream 1.
- g mode, 20 MHz Channel Bandwidth, 2412 MHz-2462 MHz, 6 Mb/s, OFDM Modulation, Spatial Stream 1.
- HT20 mode, 20 MHz Channel Bandwidth, 2412 MHz-2462 MHz, 6.5 Mb/s, BPSK Modulation, Spatial Stream 1..
- HT40 mode, 40 MHz Channel Bandwidth, 2422 MHz-2452 MHz, 13.5 Mb/s, BPSK Modulation, Spatial Stream 1.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	IBM Thinkpad	R52	L3-GR106	DoC
AC Adapter	IBM	08K8204	11S08K8204Z1ZAC859223U	DoC

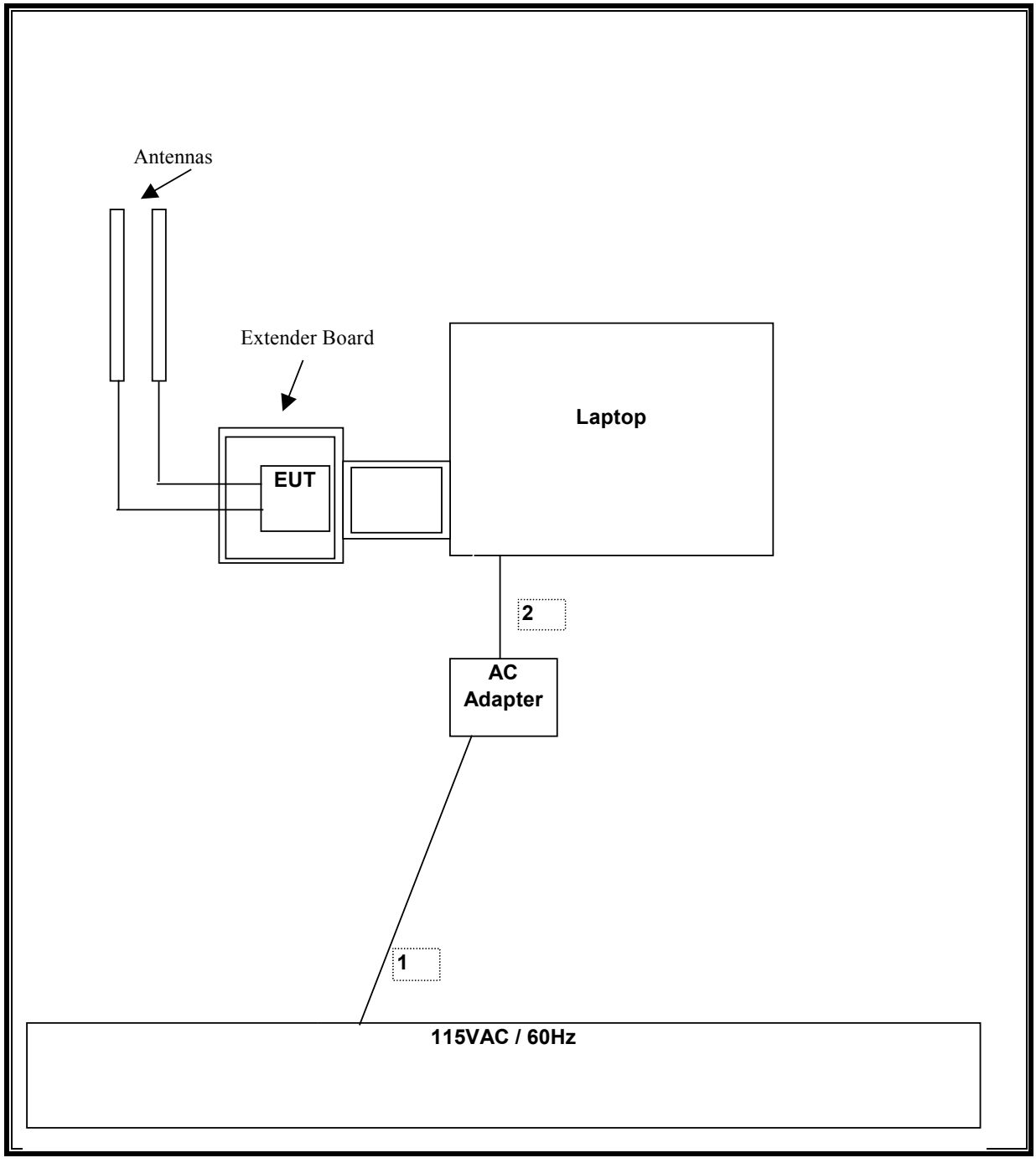
I/O CABLES

I/O CABLE LIST						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	1	US 115V	Un-shielded	2m	NA
2	DC	1	DC	Un-shielded	2m	NA

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



6. 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**
Peak Power Meter	Agilent	E4416A	GB41291160	12/2/2007
Peak / Average Power Sensor	Agilent	E9327A	US40440755	12/2/2007
4.0 High Pass Filter	Micro Tronics	HPM13351	3	N/A
EMI Receiver, 9 kHz ~ 2.9 GHz	Agilent / HP	8542E	3942A00286	2/4/2007
RF Filter Section	Agilent / HP	85420E	3705A00256	2/4/2007
Antenna, Horn 1 ~ 18 GHz	EMCO	3115	6717	4/22/2006
Preamplifier, 1 ~ 26.5 GHz	Agilent / HP	8449B	3008A00561	10/3/2007
Antenna, Bilog 30 MHz ~ 2 Ghz	Sunol Sciences	JB1	A121003	9/3/2006
Spectrum Analyzer 3 Hz ~ 44 GHz	Agilent / HP	E4446A	US42510266	10/19/2006
EMI Test Receiver	R & S	ESHS 20	827129/006	6/3/2006
LISN, 10 kHz ~ 30 MHz	FCC	LISN-50/250-25-2	2023	8/30/2006

7. LIMITS AND RESULTS

7.1. CHANNEL TESTS FOR THE 2400 TO 2483.5 MHz BAND

7.1.1. 6 dB BANDWIDTH

LIMIT

§15.247 (a) (2) 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 300 kHz. The sweep time is coupled.

RESULTS

No non-compliance noted:

TRANSMIT CHAIN 0

802.11b Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	12030	500	11530
Middle	2437	12000	500	11500
High	2462	12000	500	11500

802.11g Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	16330	500	15830
Middle	2437	16370	500	15870
High	2462	16370	500	15870

802.11 HT20 Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	17500	500	17000
Mid	2437	17670	500	17170
High	2462	17530	500	17030

802.11 HT40 Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2422	35080	500	34580
2'nd Low	2427	35250	500	34750
Mid	2437	35250	500	34750
2'nd High	2447	35250	500	34750
High	2452	35330	500	34830

TRANSMIT CHAIN 2

802.11b Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	12000	500	11500
Middle	2437	12000	500	11500
High	2462	12000	500	11500

802.11g Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	16400	500	15900
Middle	2437	16370	500	15870
High	2462	16430	500	15930

802.11 HT20 Mode

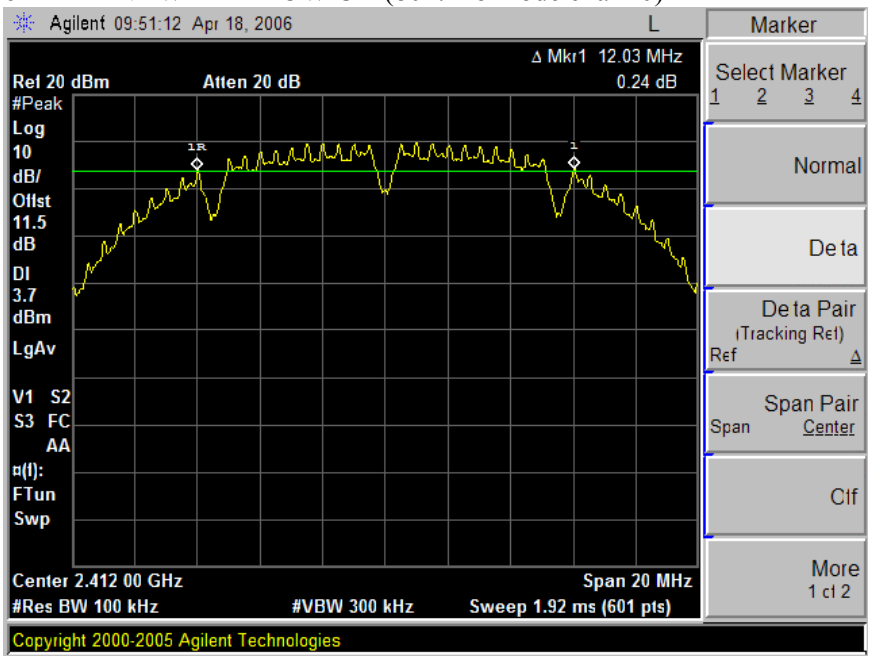
Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2412	17670	500	17170
Mid	2437	17630	500	17130
High	2462	17630	500	17130

802.11 HT40 Mode

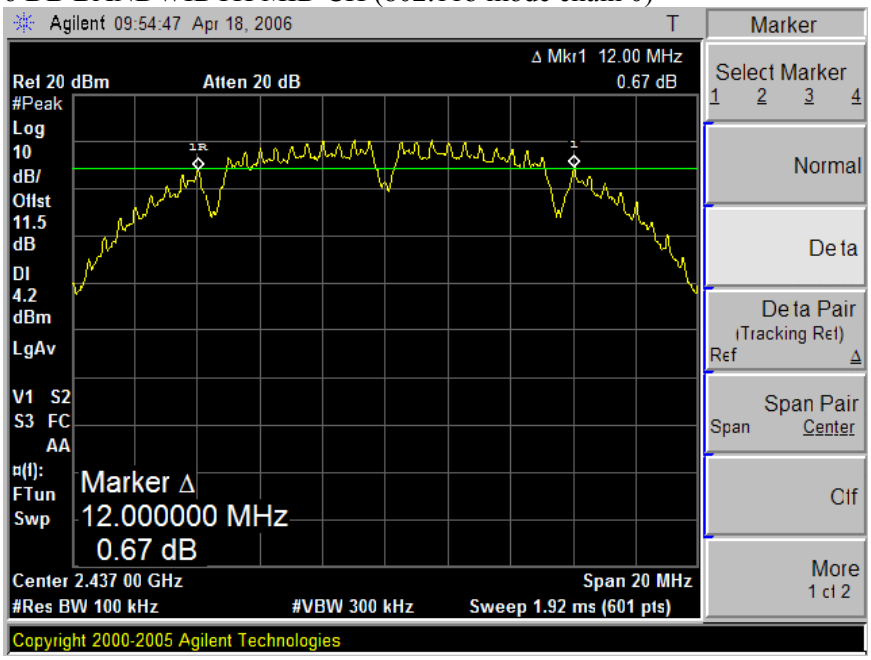
Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	Margin (kHz)
Low	2422	35080	500	34580
2'nd Low	2427	35250	500	34750
Mid	2437	35250	500	34750
2'nd High	2447	35250	500	34750
High	2452	35330	500	34830

6 DB BANDWIDTH (802.11b MODE CHAIN 0)

6 DB BANDWIDTH LOW CH (802.11b mode chain 0)



6 DB BANDWIDTH MID CH (802.11b mode chain 0)



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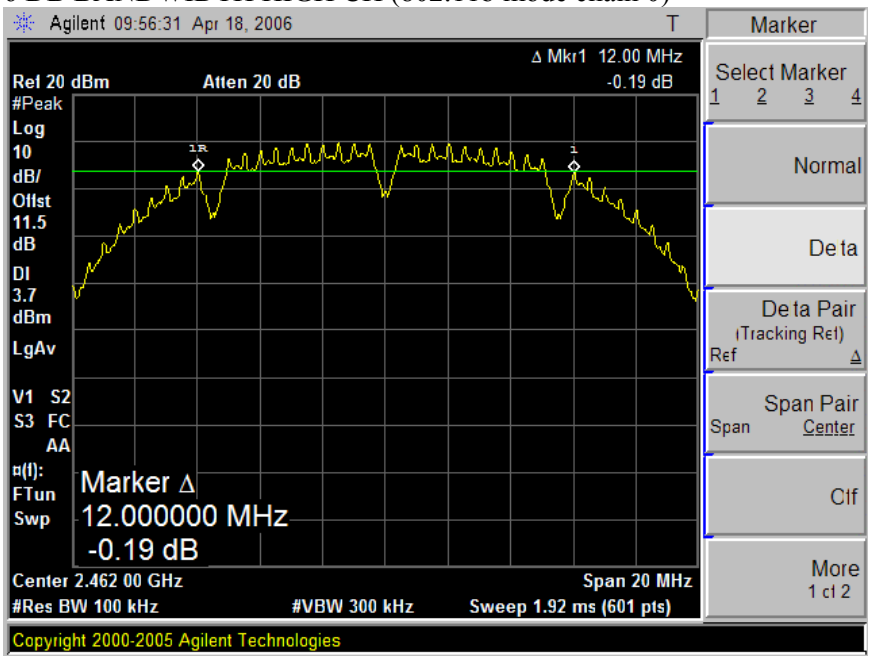
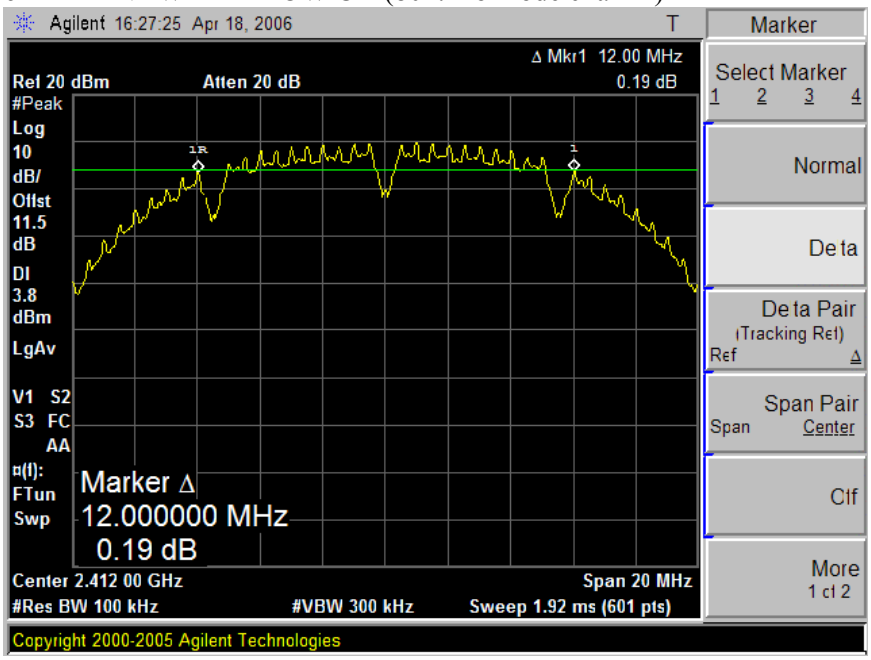
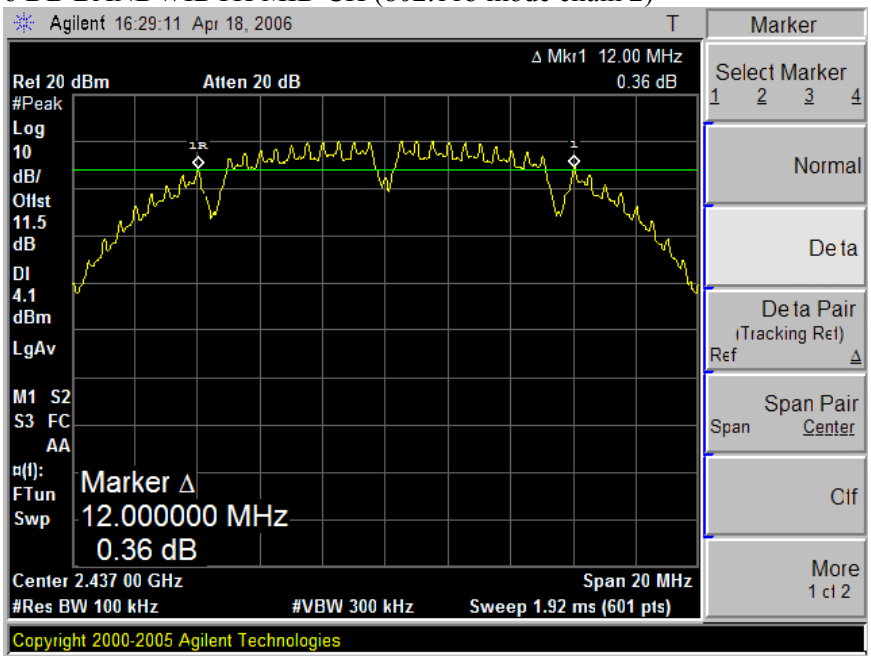


6 DB BANDWIDTH (802.11b MODE CHAIN 2)

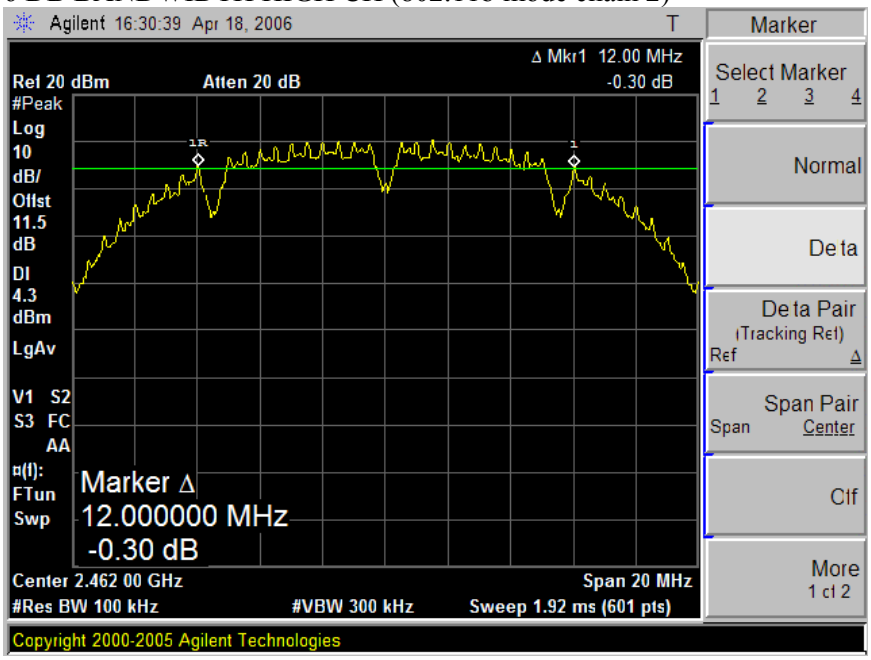
6 DB BANDWIDTH LOW CH (802.11b mode chain 2)



6 DB BANDWIDTH MID CH (802.11b mode chain 2)

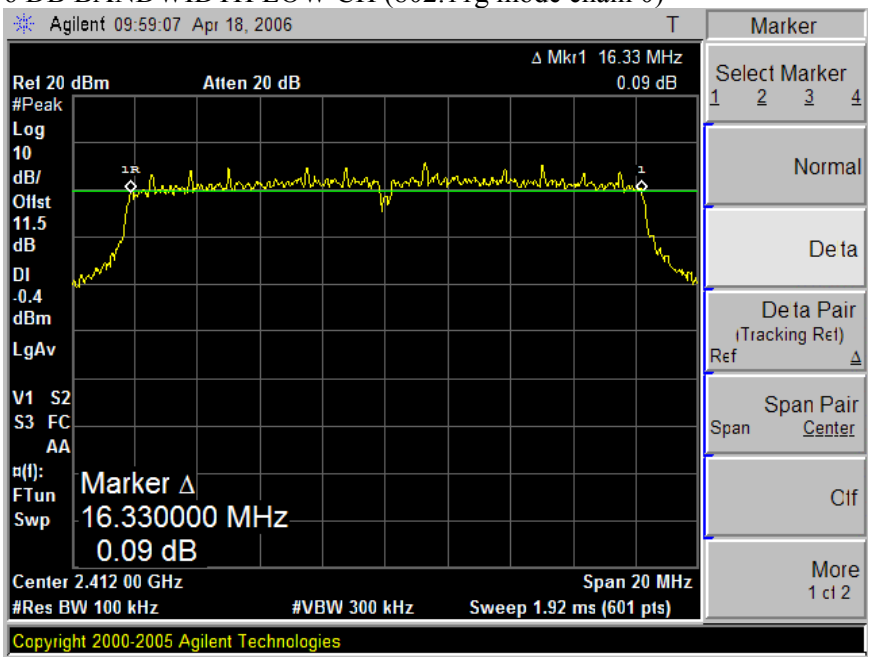


6 DB BANDWIDTH HIGH CH (802.11b mode chain 2)

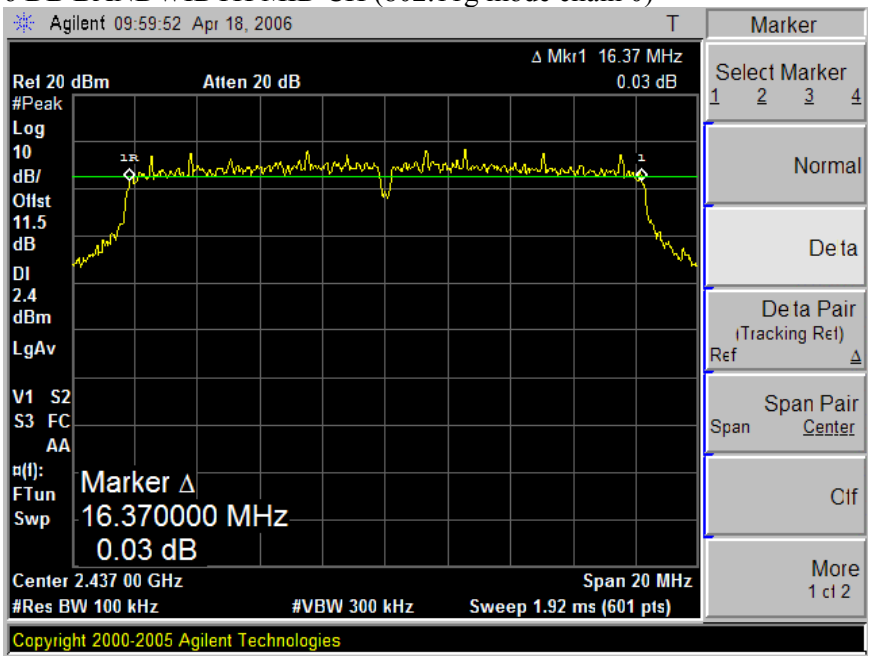


6 DB BANDWIDTH (802.11g MODE CHAIN 0)

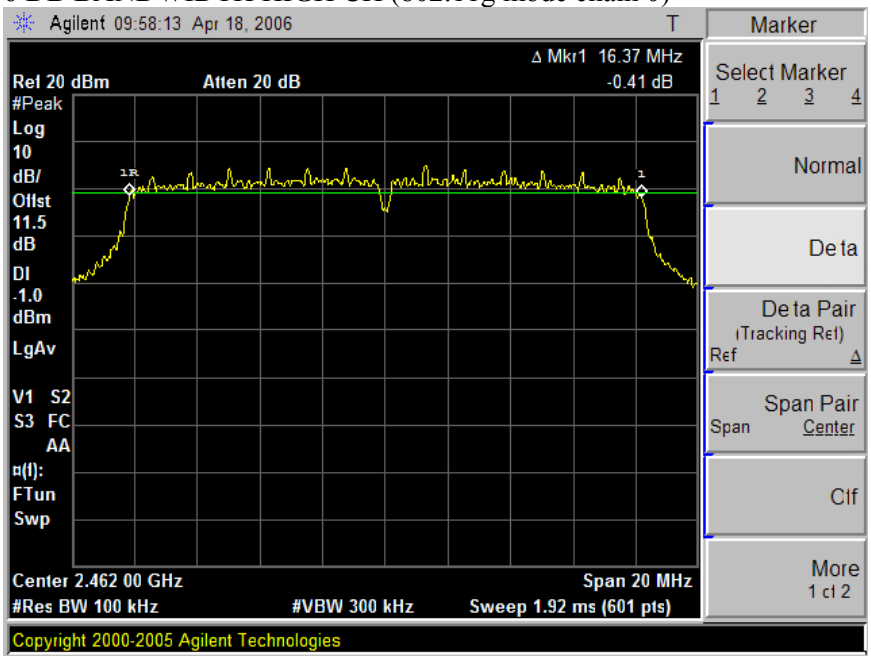
6 DB BANDWIDTH LOW CH (802.11g mode chain 0)



6 DB BANDWIDTH MID CH (802.11g mode chain 0)

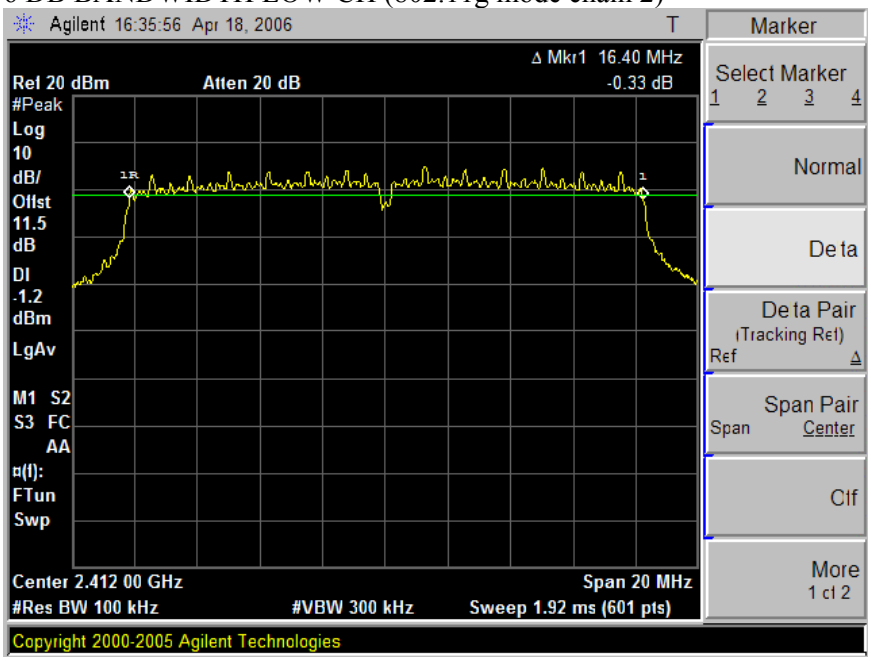


6 DB BANDWIDTH HIGH CH (802.11g mode chain 0)

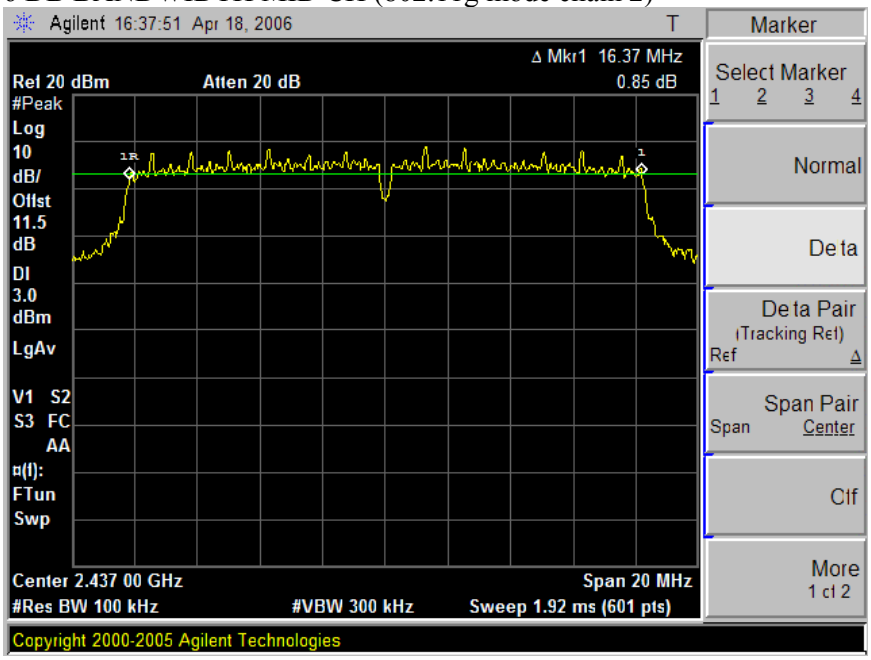


6 DB BANDWIDTH (802.11g MODE CHAIN 2)

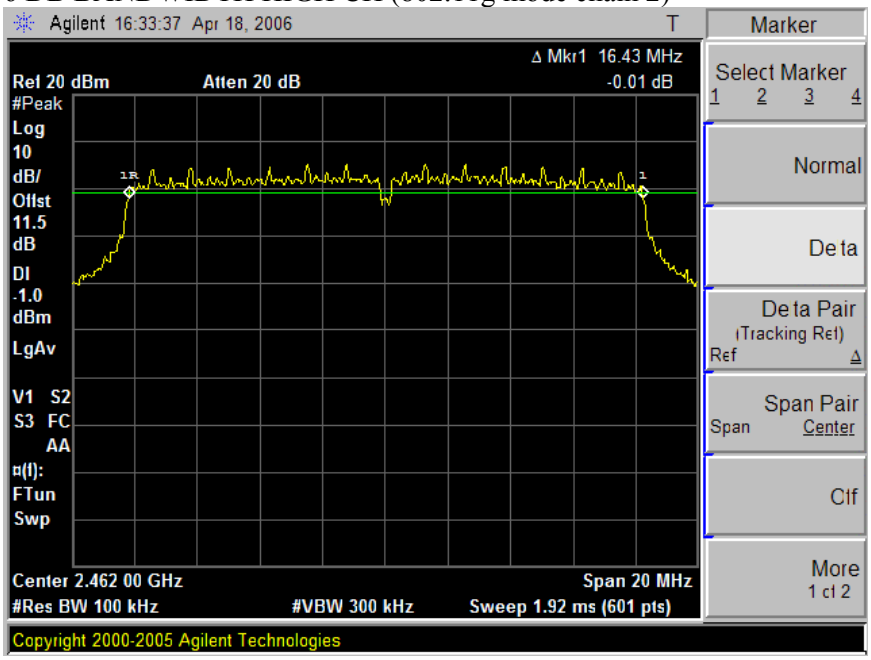
6 DB BANDWIDTH LOW CH (802.11g mode chain 2)



6 DB BANDWIDTH MID CH (802.11g mode chain 2)

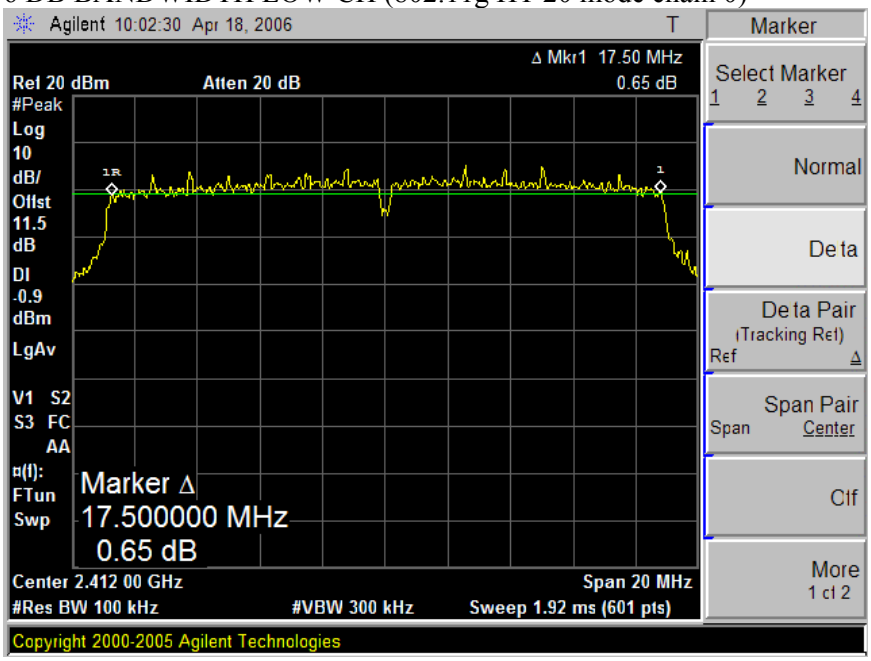


6 DB BANDWIDTH HIGH CH (802.11g mode chain 2)

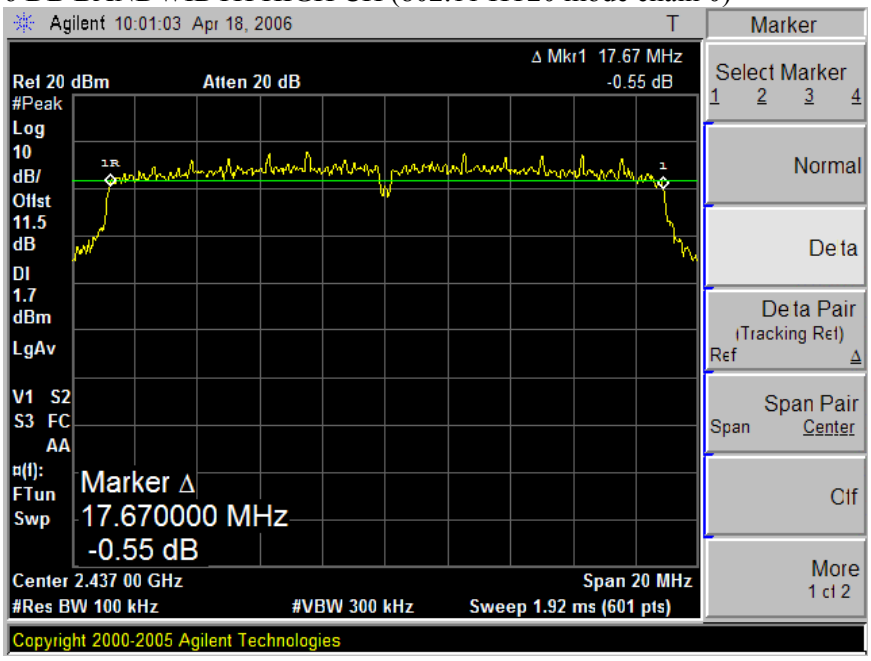


6 DB BANDWIDTH (802.11g HT20 MODE CHAIN 0)

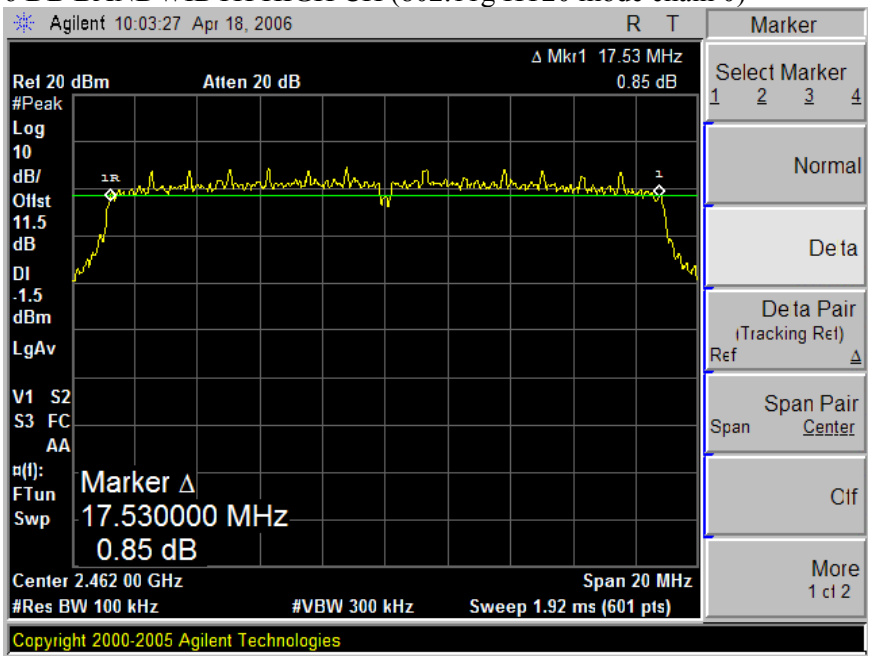
6 DB BANDWIDTH LOW CH (802.11g HT 20 mode chain 0)



6 DB BANDWIDTH HIGH CH (802.11 HT20 mode chain 0)

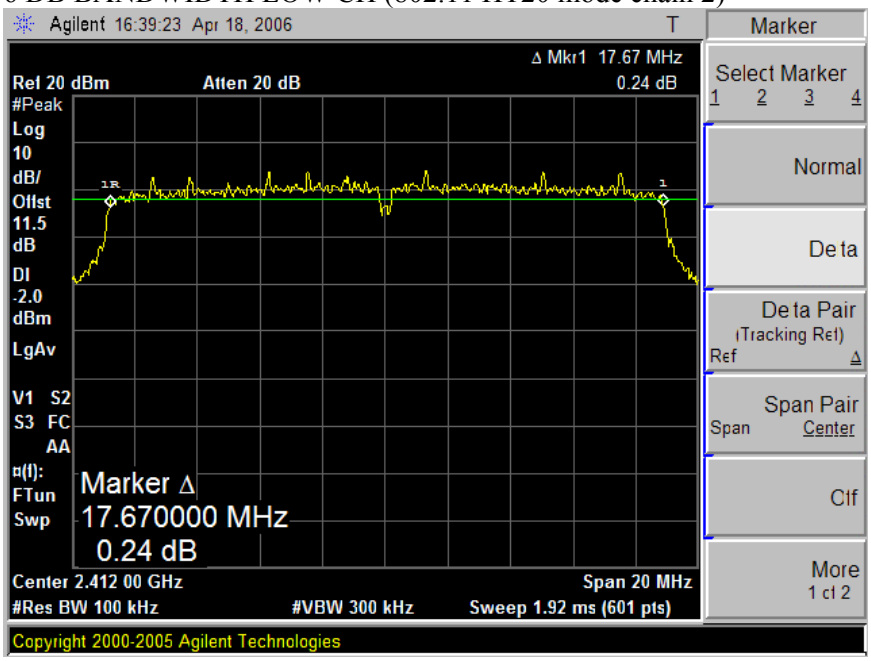


6 DB BANDWIDTH HIGH CH (802.11g HT20 mode chain 0)

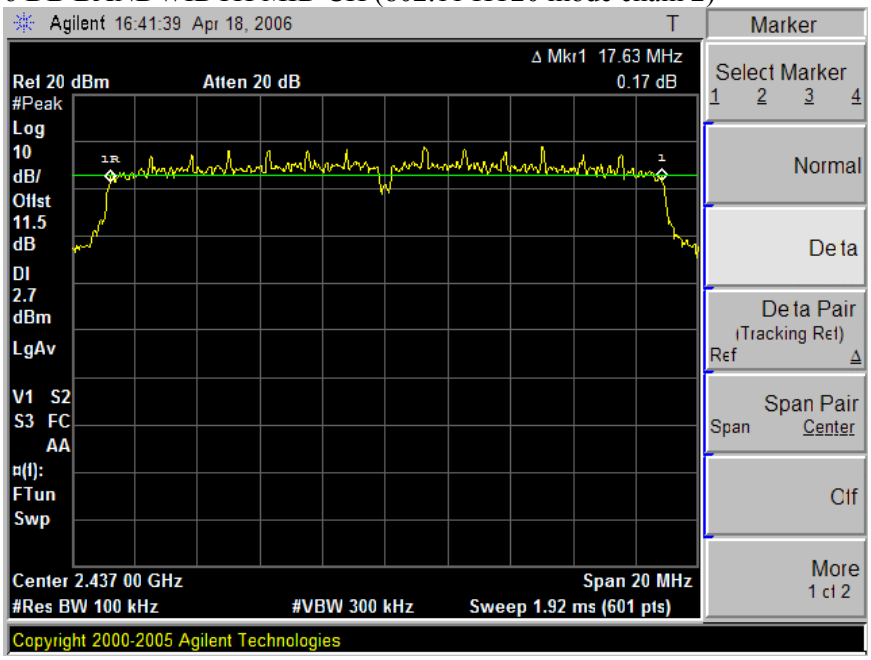


6 DB BANDWIDTH (802.11 HT20 MODE CHAIN 2)

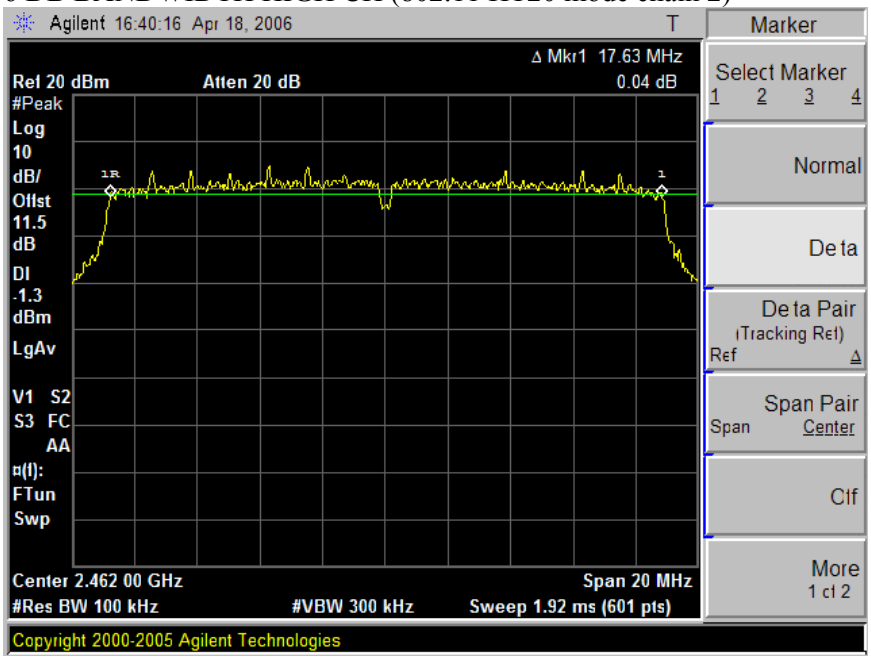
6 DB BANDWIDTH LOW CH (802.11 HT20 mode chain 2)



6 DB BANDWIDTH MID CH (802.11 HT20 mode chain 2)

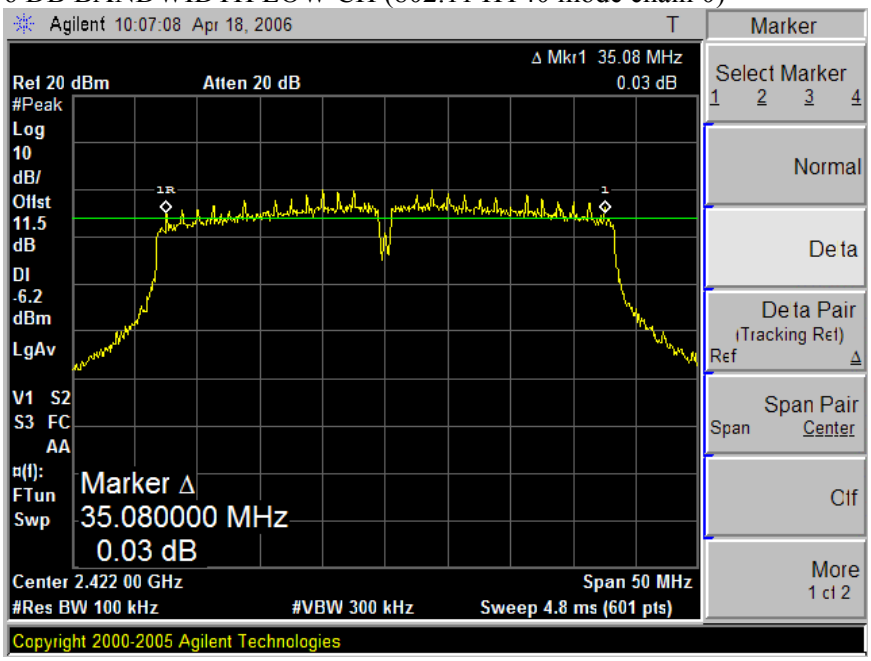


6 DB BANDWIDTH HIGH CH (802.11 HT20 mode chain 2)

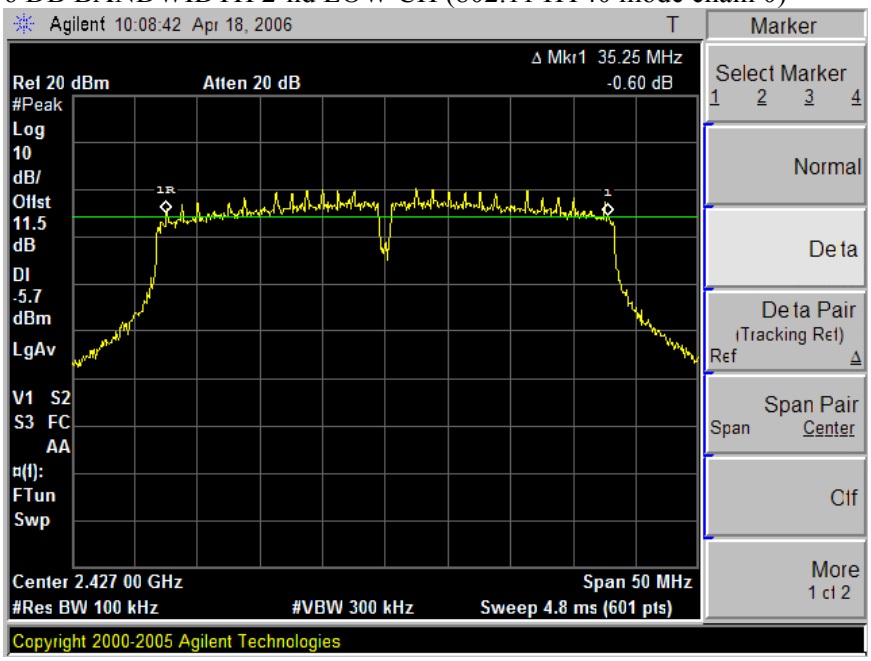


6 DB BANDWIDTH (802.11 HT40 MODE CHAIN 0)

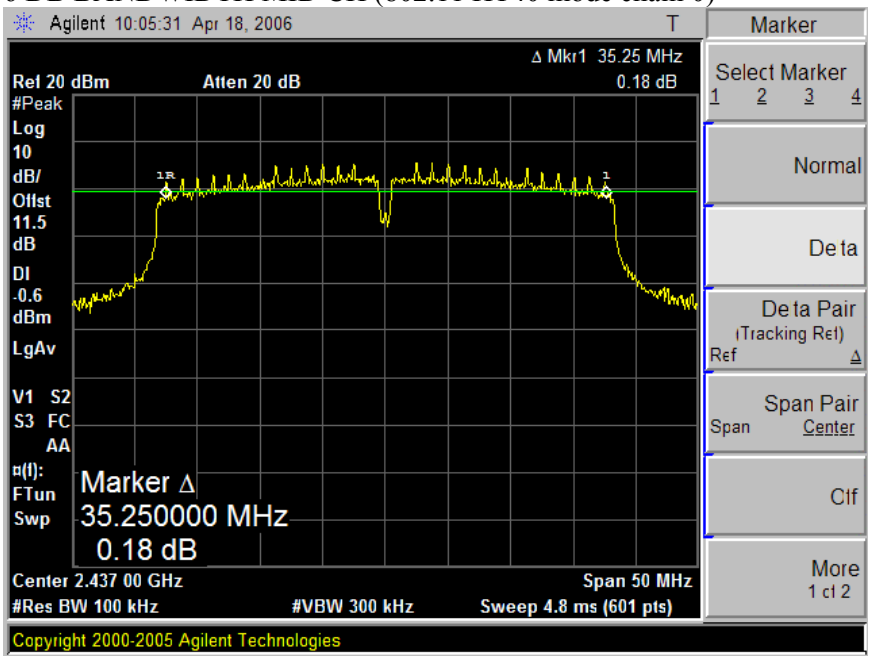
6 DB BANDWIDTH LOW CH (802.11 HT40 mode chain 0)



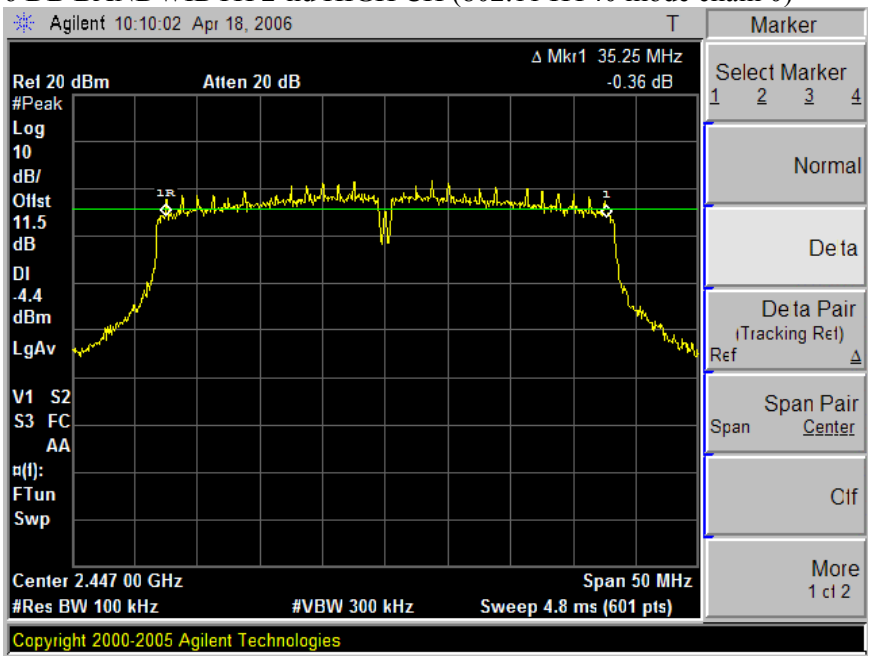
6 DB BANDWIDTH 2'nd LOW CH (802.11 HT40 mode chain 0)



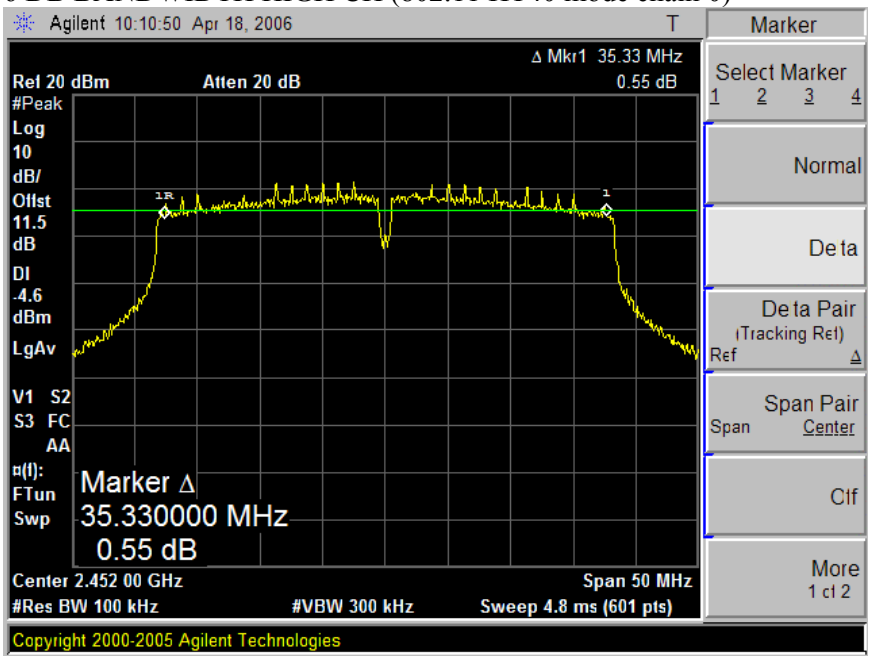
6 DB BANDWIDTH MID CH (802.11 HT40 mode chain 0)



6 DB BANDWIDTH 2'nd HIGH CH (802.11 HT40 mode chain 0)

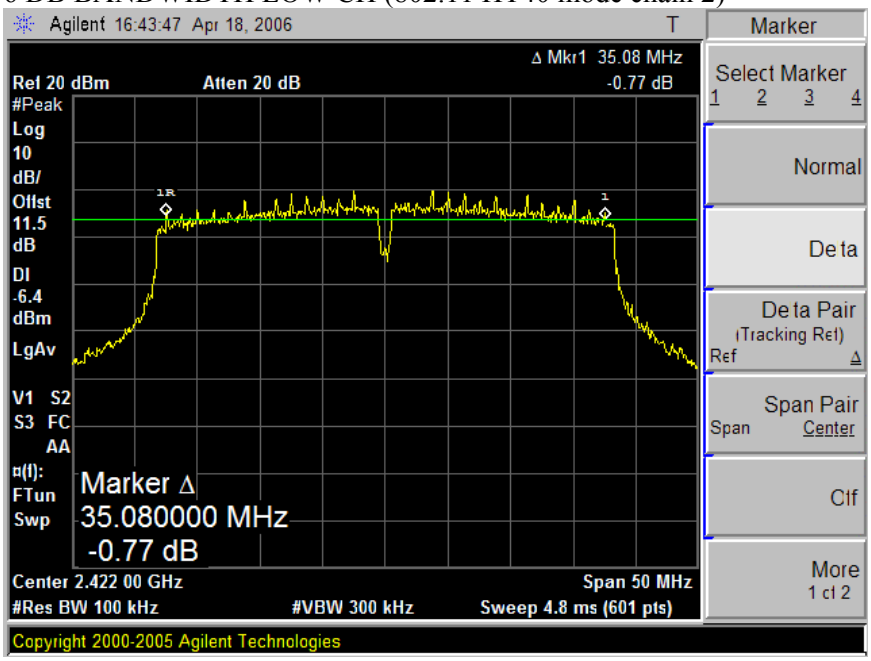


6 DB BANDWIDTH HIGH CH (802.11 HT40 mode chain 0)

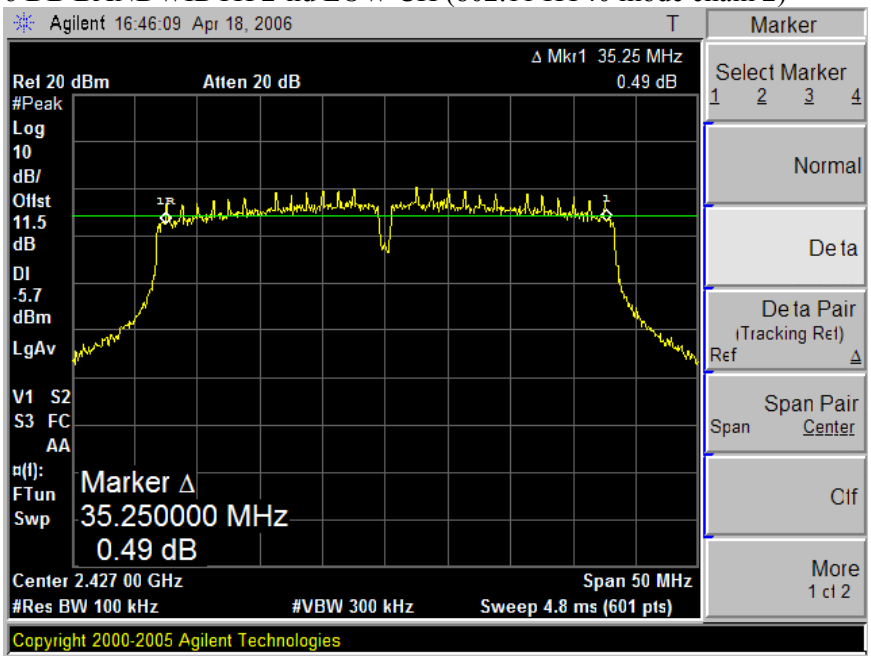


6 DB BANDWIDTH (802.11 HT40 MODE CHAIN 2

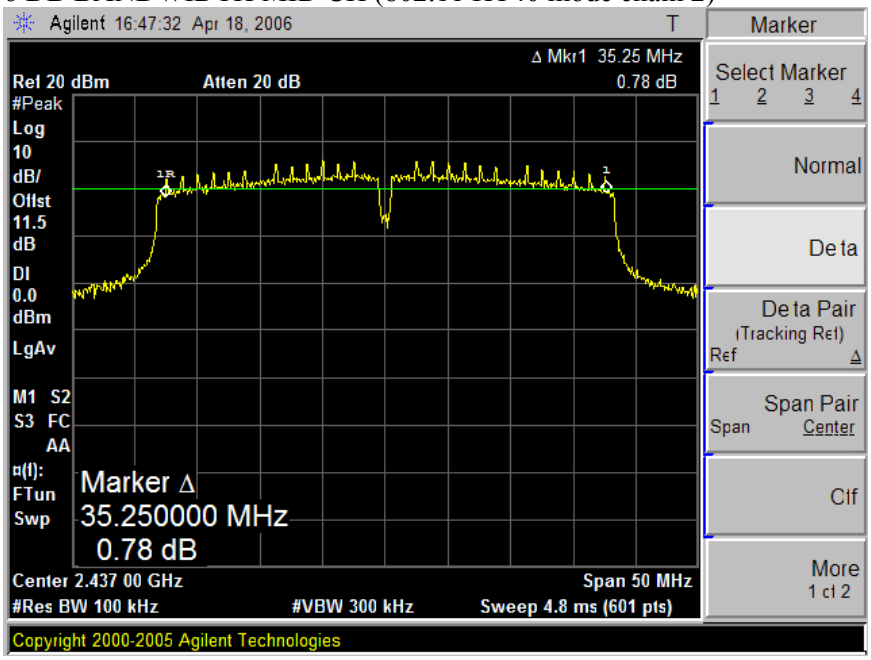
6 DB BANDWIDTH LOW CH (802.11 HT40 mode chain 2)



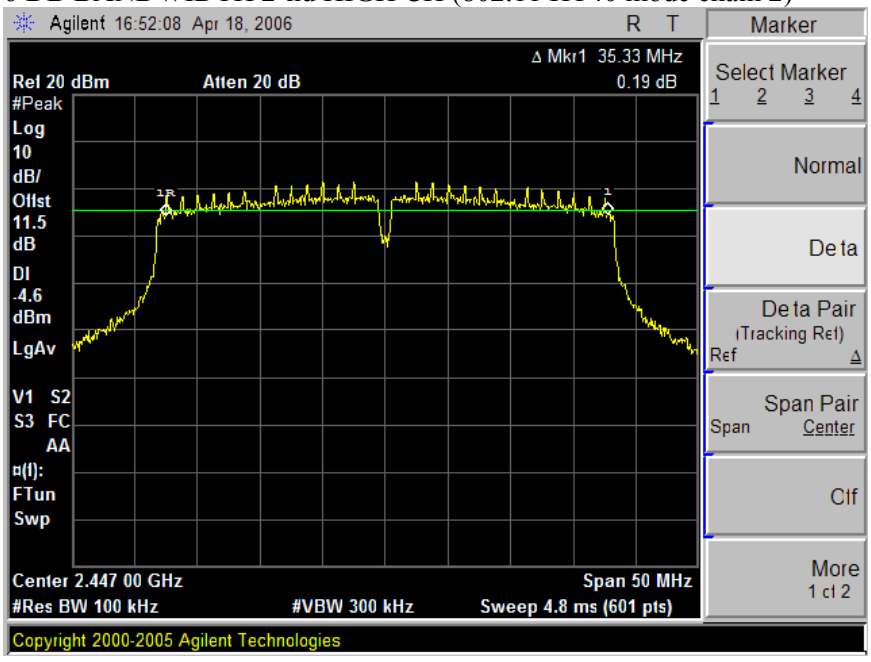
6 DB BANDWIDTH 2'nd LOW CH (802.11 HT40 mode chain 2)



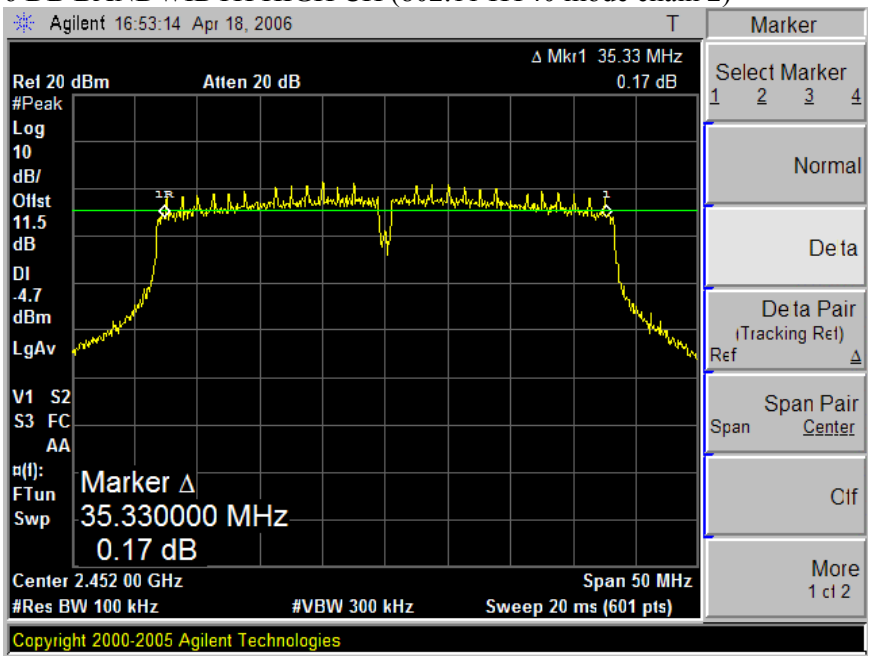
6 DB BANDWIDTH MID CH (802.11 HT40 mode chain 2)



6 DB BANDWIDTH 2'nd HIGH CH (802.11 HT40 mode chain 2)



6 DB BANDWIDTH HIGH CH (802.11 HT40 mode chain 2)



7.1.2. 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

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

RESULTS

No non-compliance noted:

802.11b Mode

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 2 (MHz)
Low	2412	15.4758	15.6062
Middle	2437	15.5276	15.5673
High	2462	15.51	15.5105

802.11g Mode

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 2 (MHz)
Low	2412	16.5415	16.5917
Middle	2437	16.654	16.5829
High	2462	16.5939	16.5832

802.11 HT20 Mode

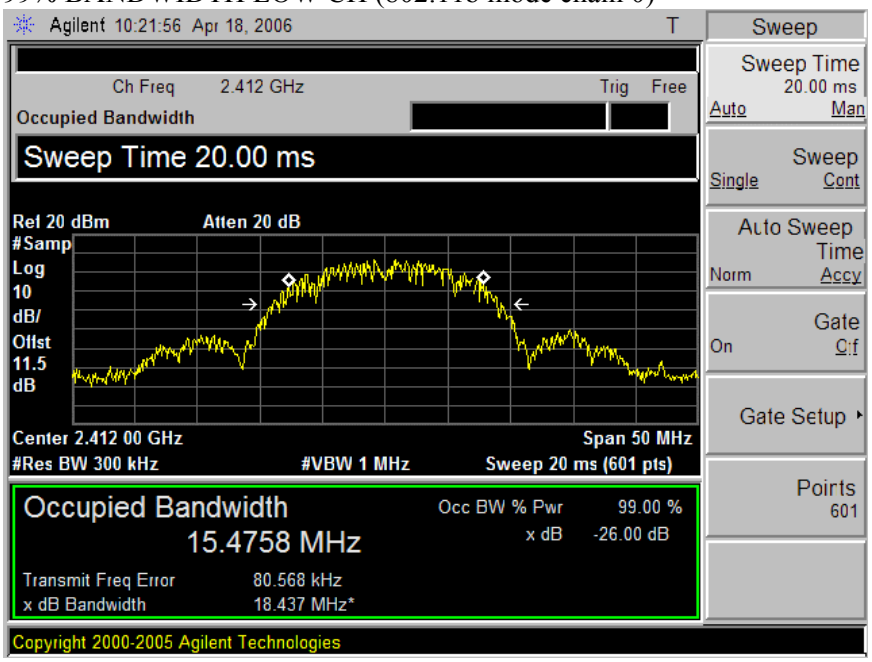
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 2 (MHz)
Low	2412	17.708	17.719
Middle	2437	17.6766	17.7203
High	2462	17.6832	17.7156

802.11 HT40 Mode

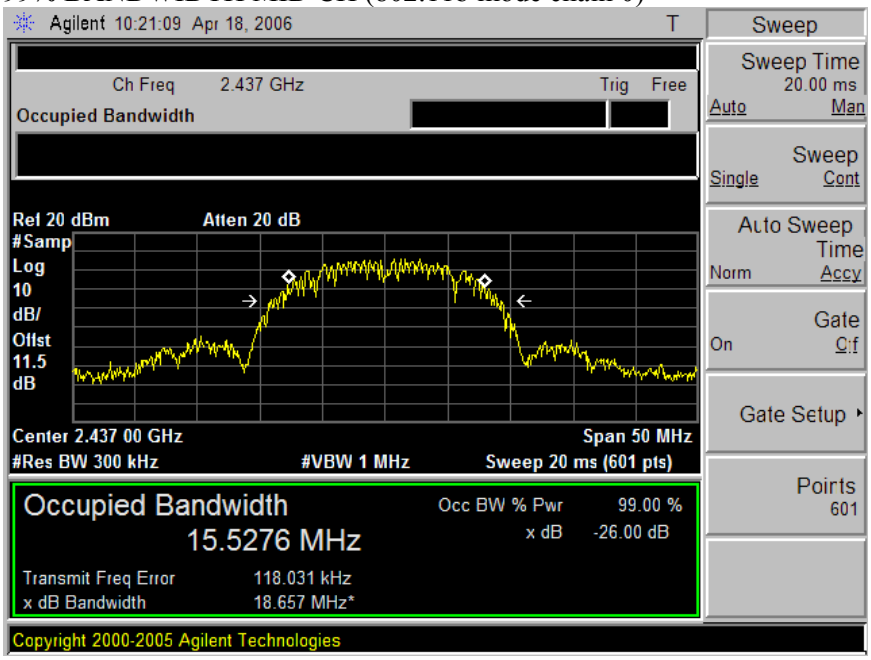
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 2 (MHz)
Low	2422	35.9443	35.9941
2'nd Low	2427	35.8936	35.9398
Middle	2437	35.944	35.9549
2'nd High	2447	35.984	35.9768
High	2452	35.953	35.9603

99% BANDWIDTH (802.11b MODE CHAIN 0)

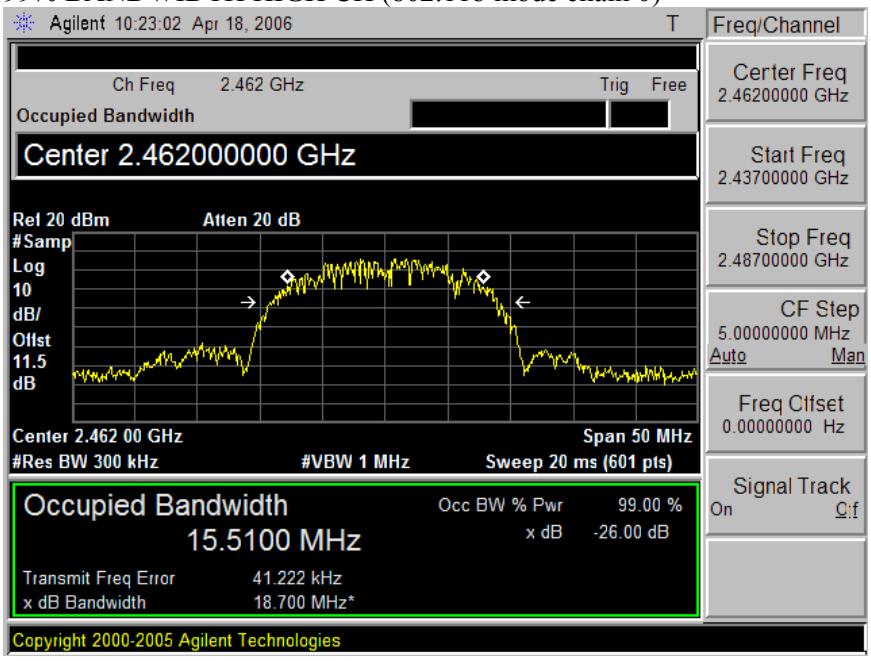
99% BANDWIDTH LOW CH (802.11b mode chain 0)



99% BANDWIDTH MID CH (802.11b mode chain 0)

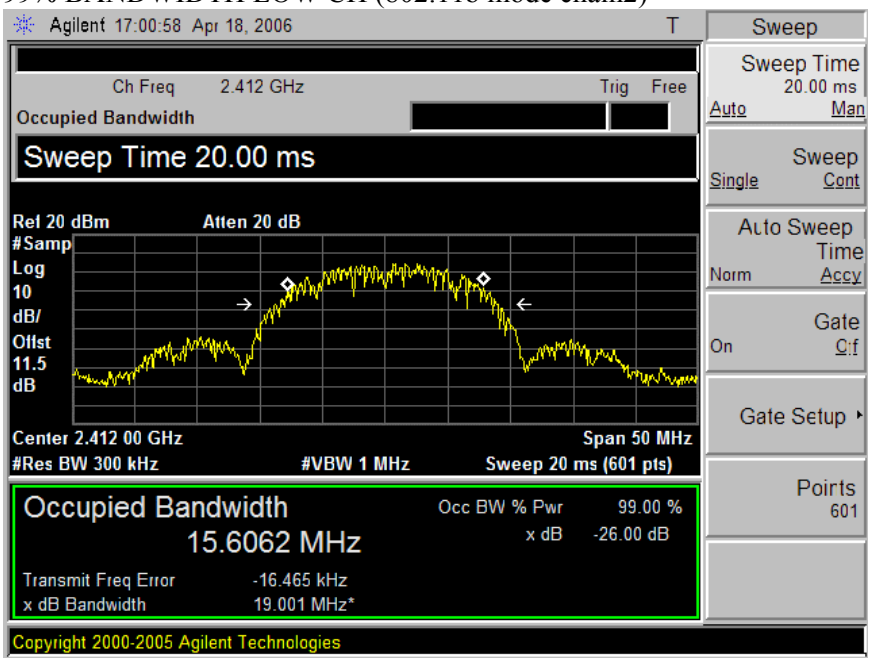


99% BANDWIDTH HIGH CH (802.11b mode chain 0)

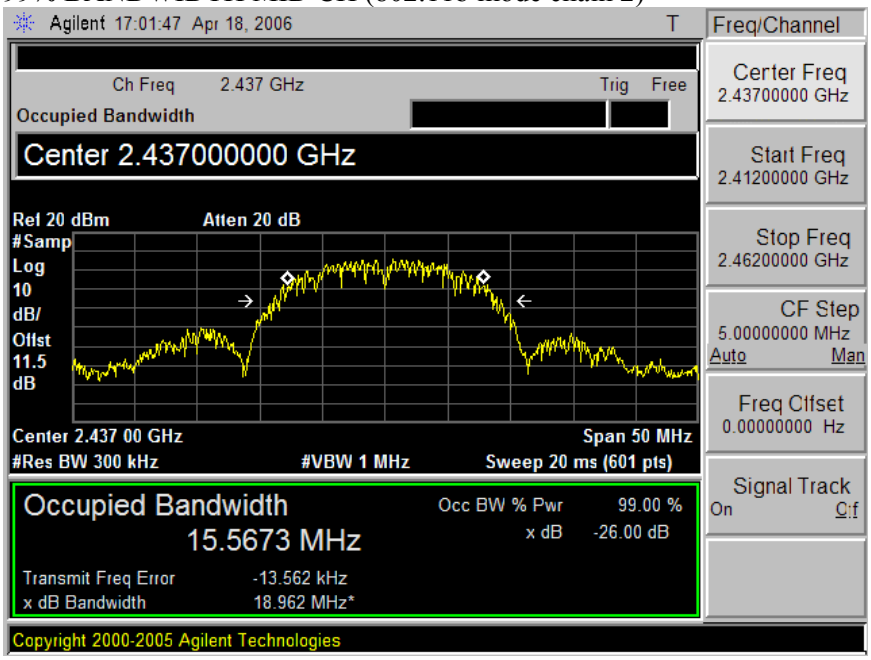


99% BANDWIDTH (802.11b MODE CHAIN 2)

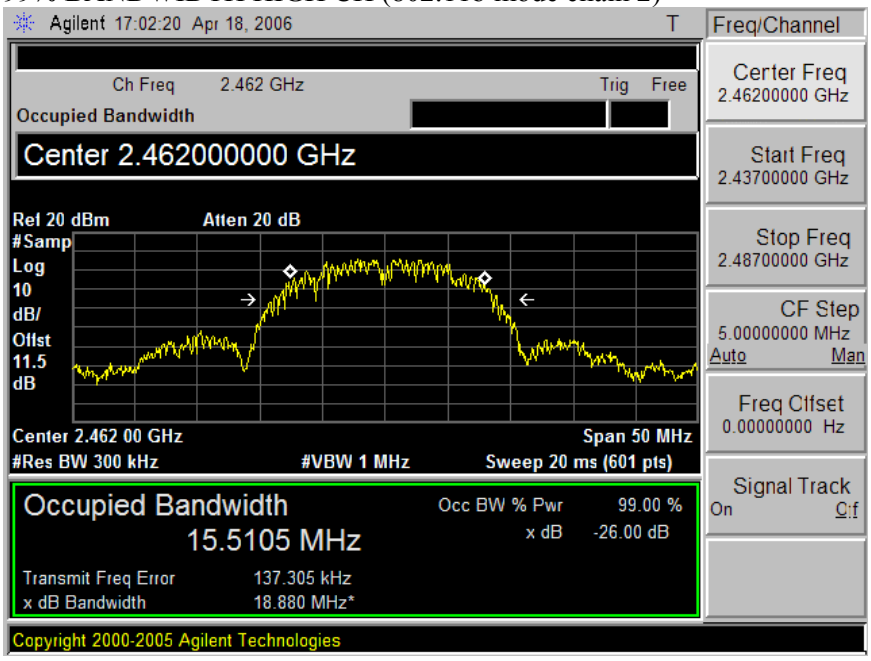
99% BANDWIDTH LOW CH (802.11b mode chain2)



99% BANDWIDTH MID CH (802.11b mode chain 2)

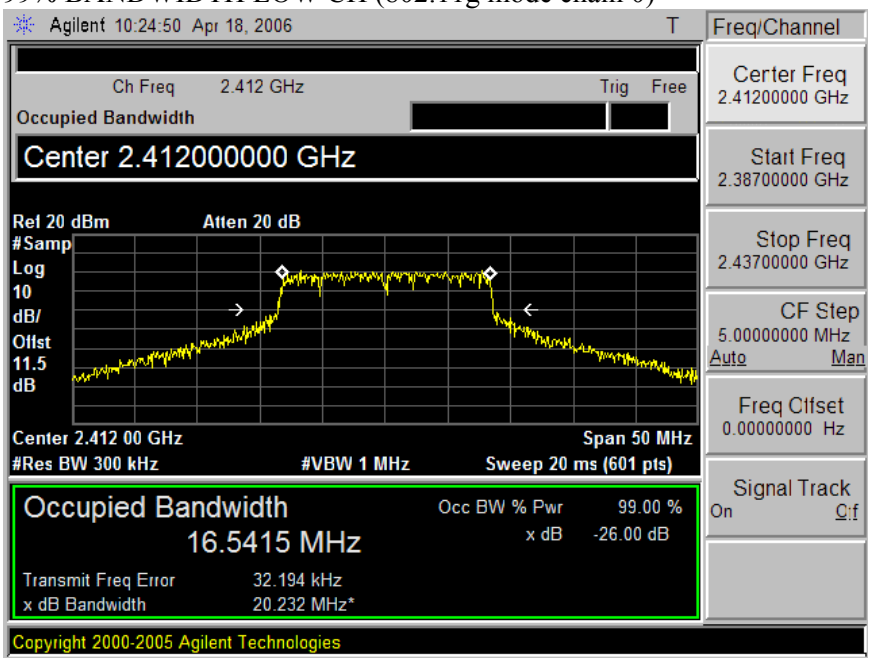


99% BANDWIDTH HIGH CH (802.11b mode chain 2)

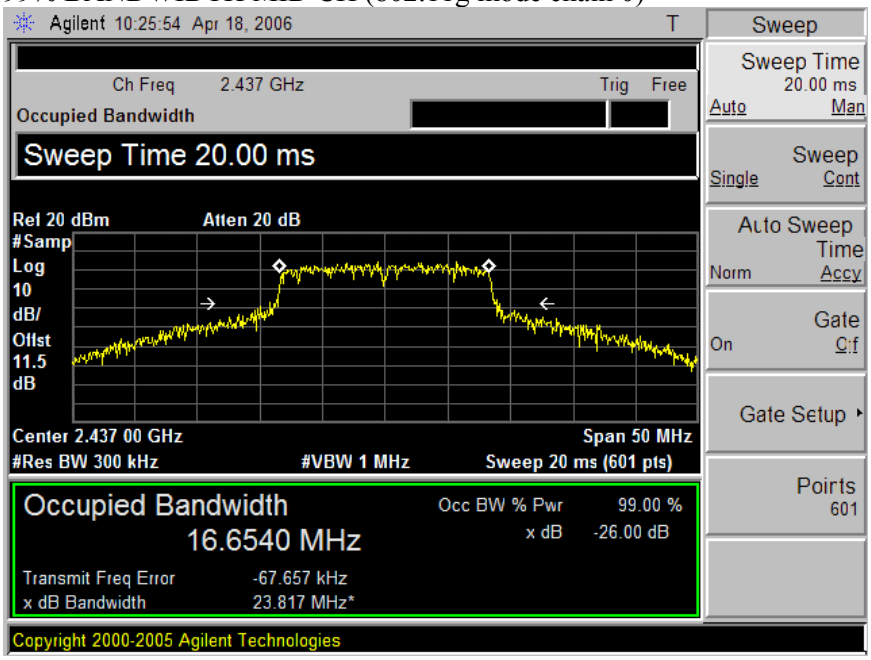


99% BANDWIDTH (802.11g MODE CHAIN 0)

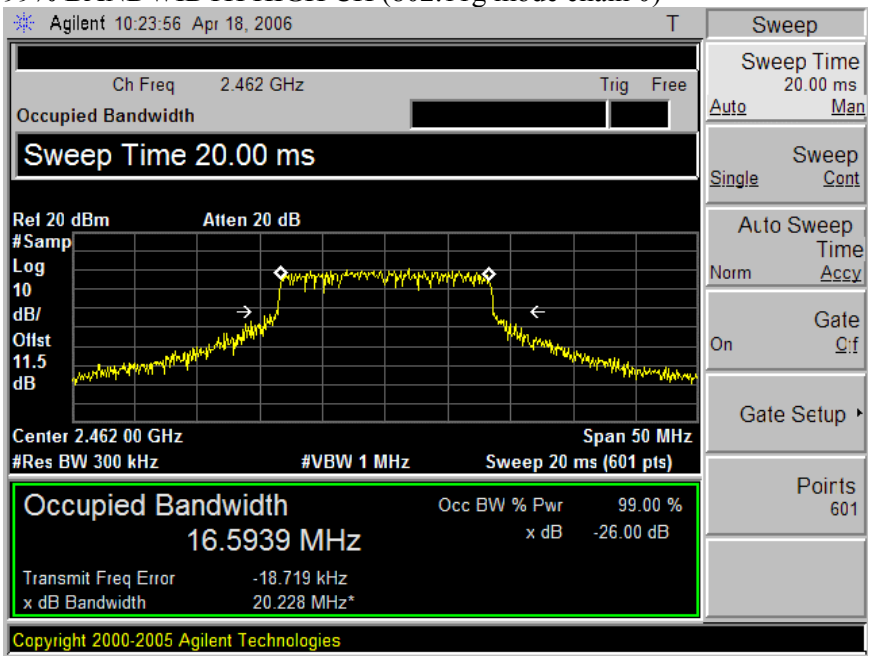
99% BANDWIDTH LOW CH (802.11g mode chain 0)



99% BANDWIDTH MID CH (802.11g mode chain 0)

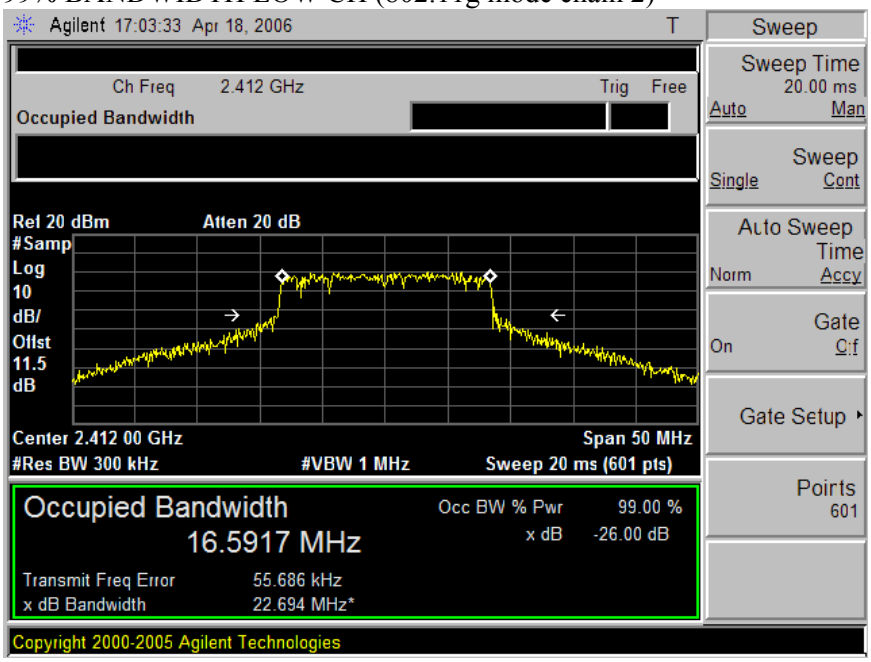


99% BANDWIDTH HIGH CH (802.11g mode chain 0)

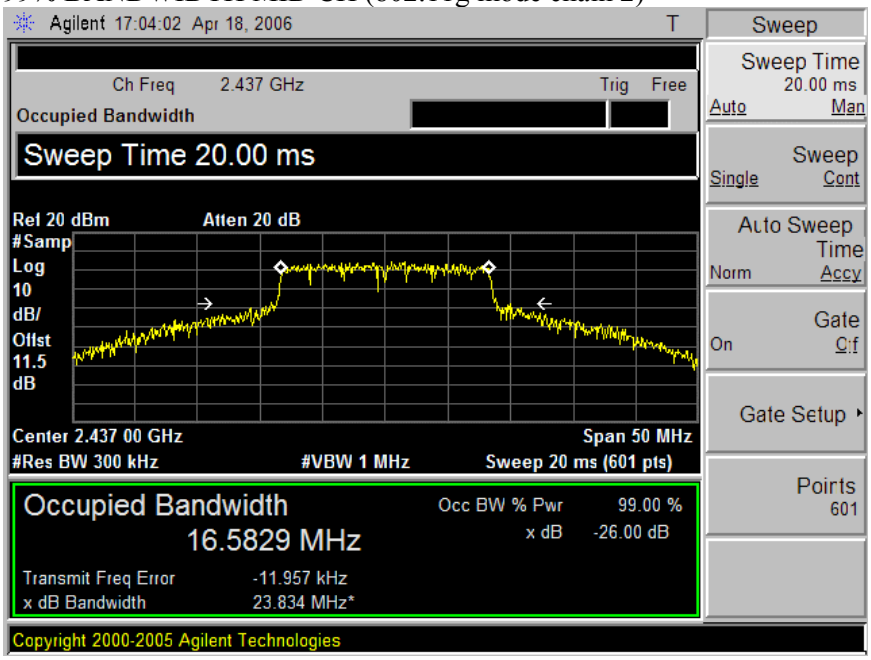


99% BANDWIDTH (802.11g MODE CHAIN 2)

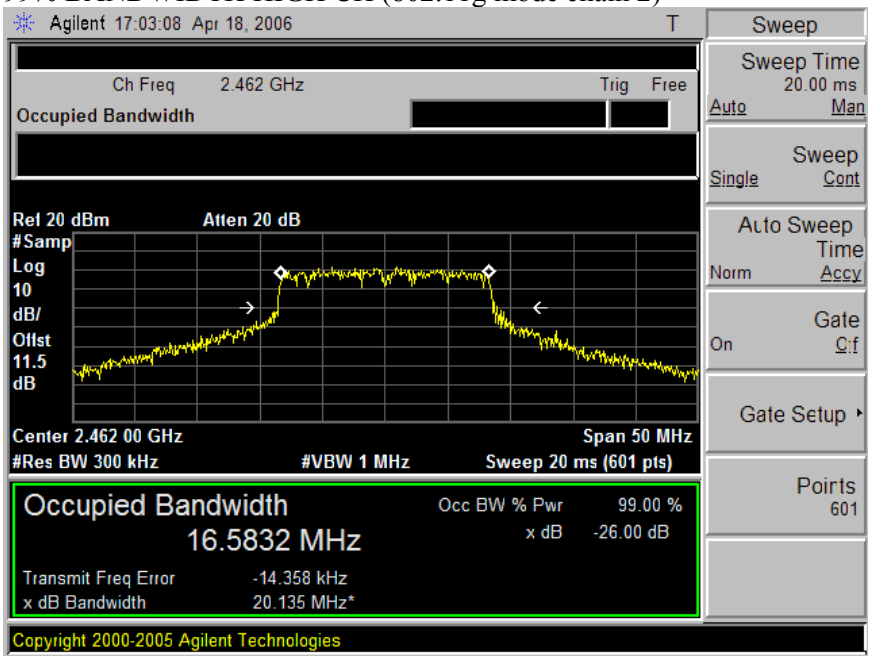
99% BANDWIDTH LOW CH (802.11g mode chain 2)



99% BANDWIDTH MID CH (802.11g mode chain 2)

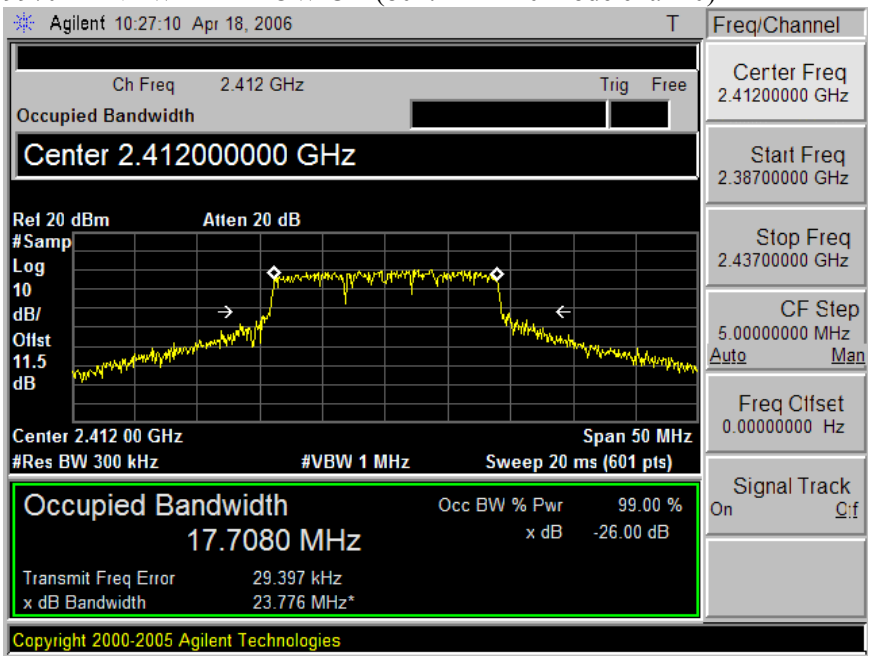


99% BANDWIDTH HIGH CH (802.11g mode chain 2)

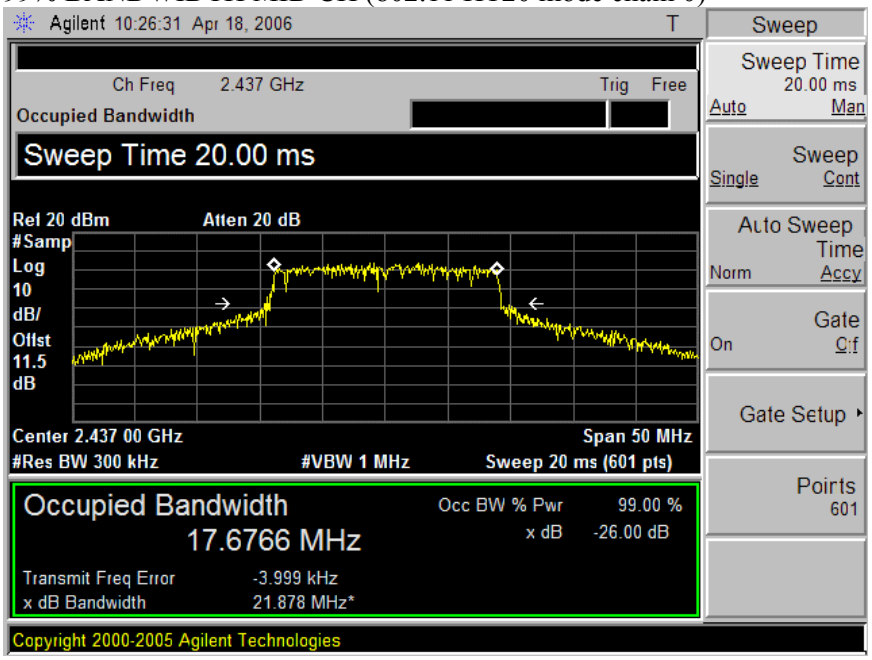


99% BANDWIDTH (802.11 HT20 MODE CHAIN 0)

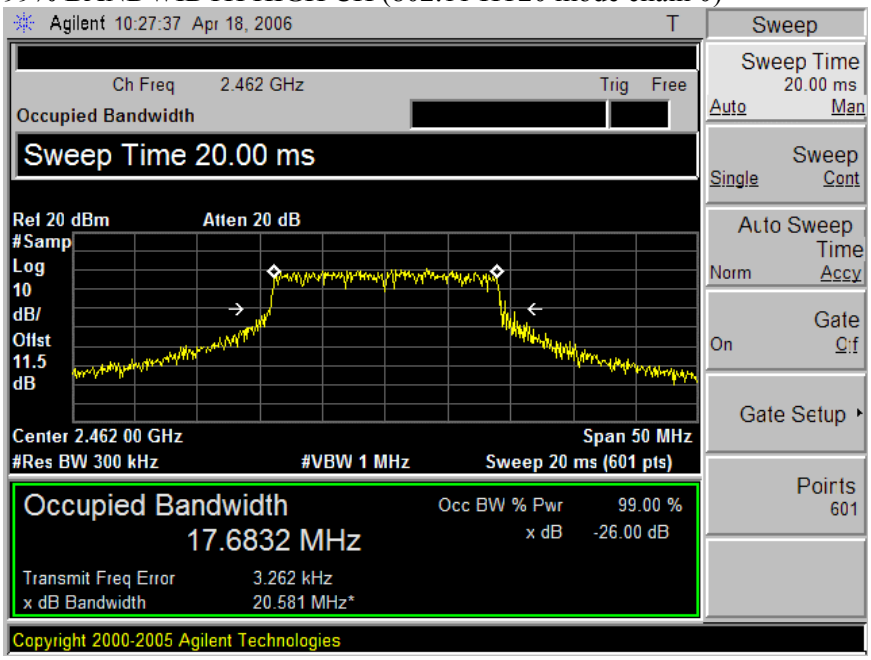
99% BANDWIDTH LOW CH (802.11 HT20 mode chain 0)



99% BANDWIDTH MID CH (802.11 HT20 mode chain 0)

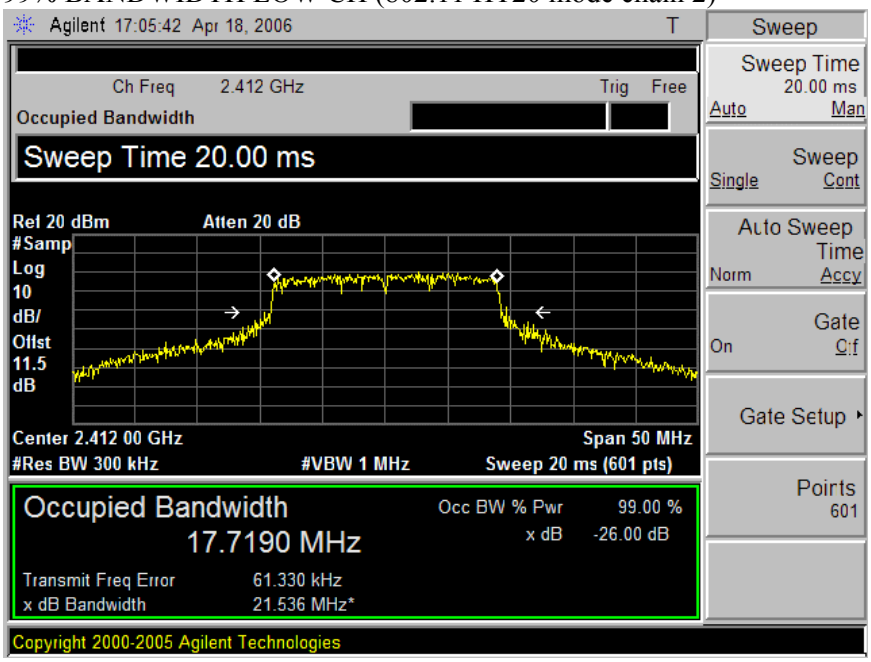


99% BANDWIDTH HIGH CH (802.11 HT20 mode chain 0)

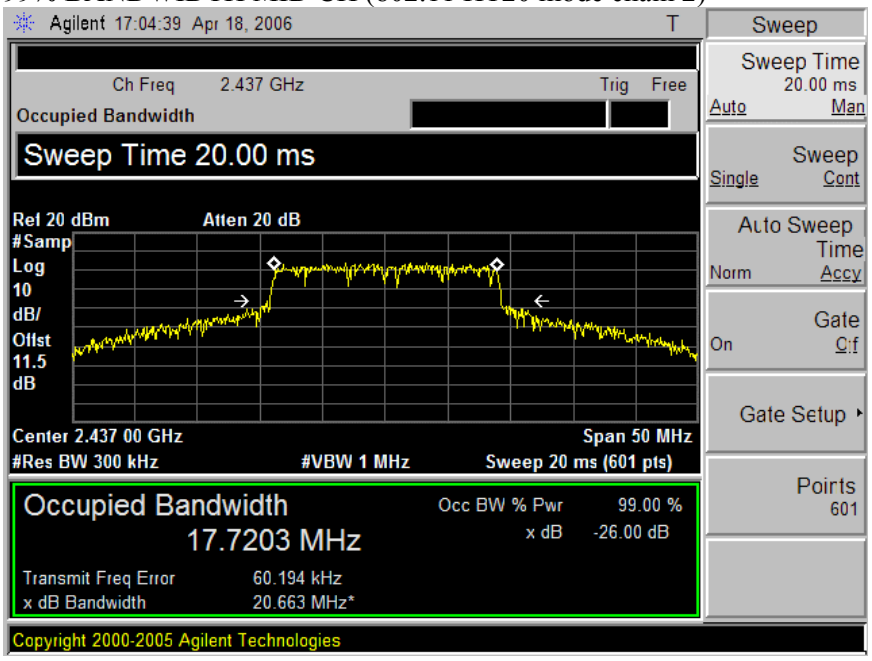


99% BANDWIDTH (802.11 HT20 MODE CHAIN 2)

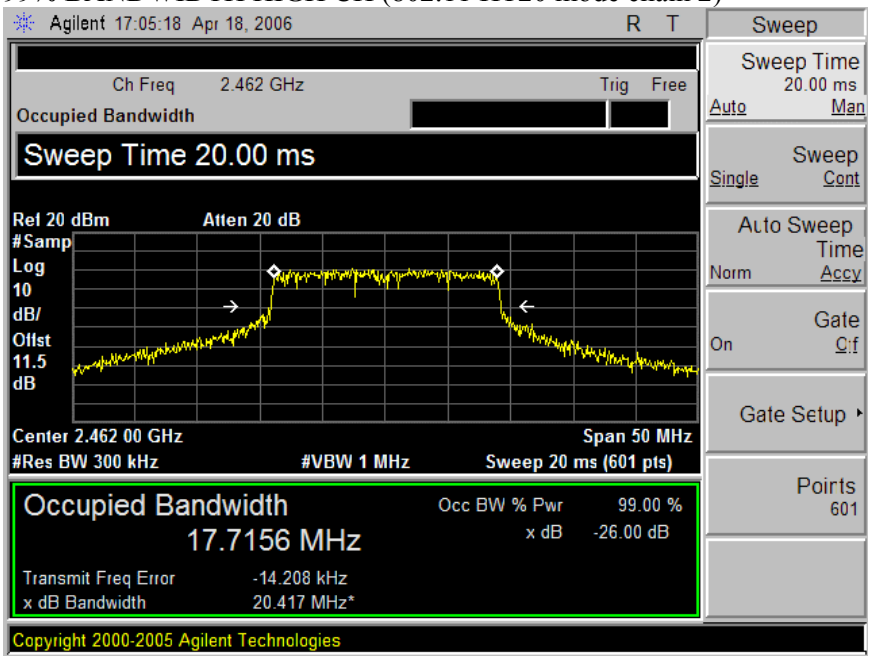
99% BANDWIDTH LOW CH (802.11 HT20 mode chain 2)



99% BANDWIDTH MID CH (802.11 HT20 mode chain 2)

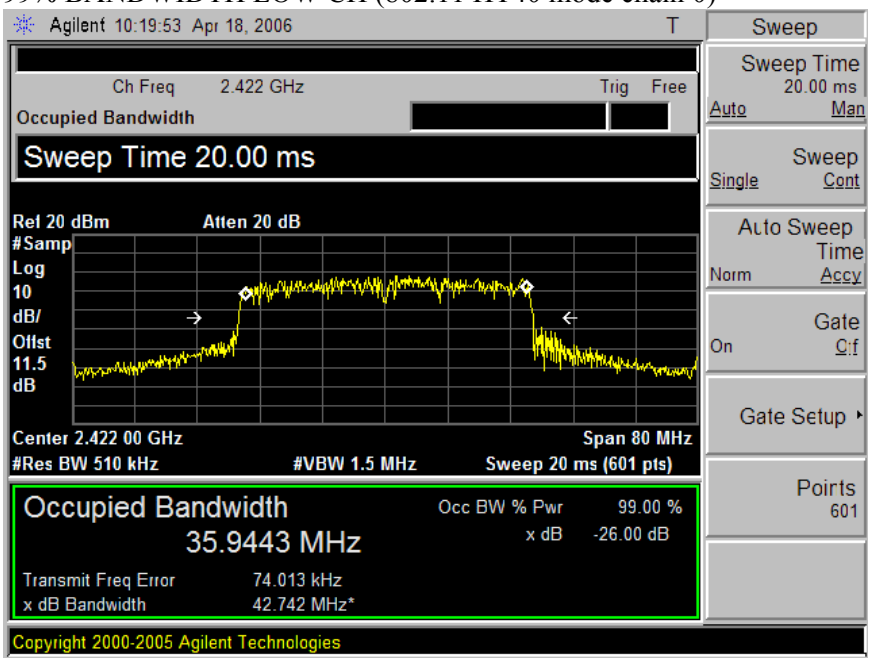


99% BANDWIDTH HIGH CH (802.11 HT20 mode chain 2)

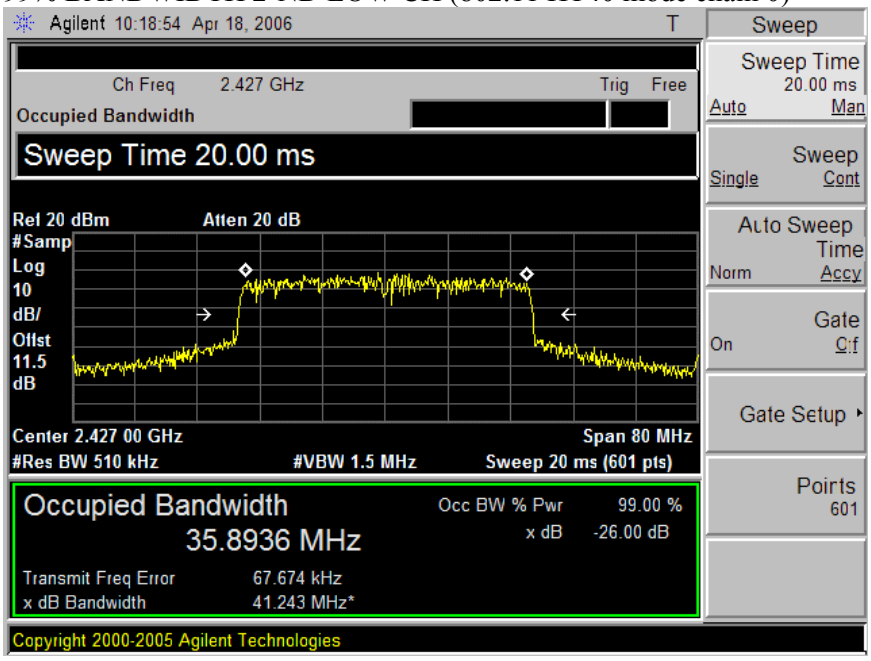


99% BANDWIDTH (802.11 HT40 MODE CHAIN 0)

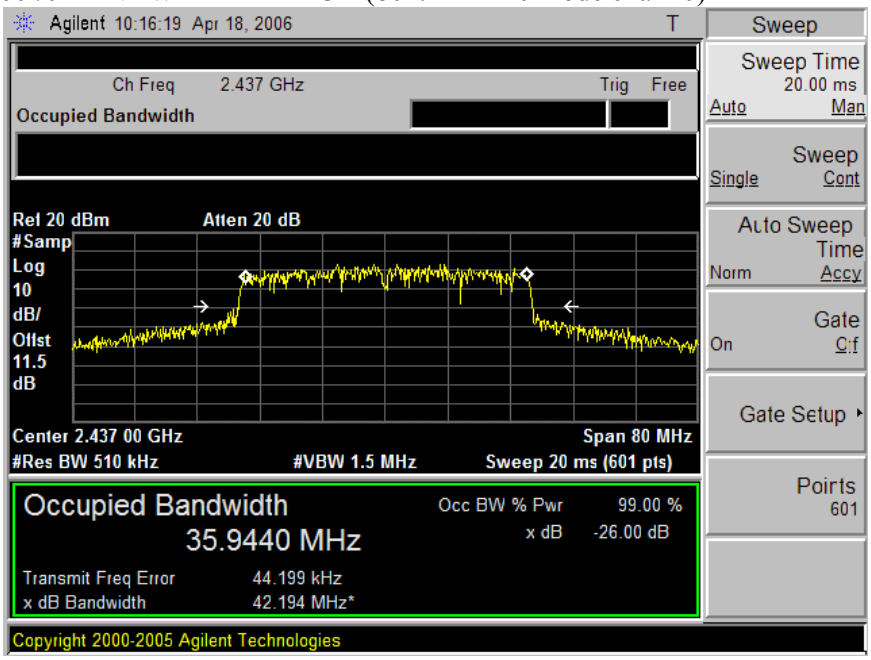
99% BANDWIDTH LOW CH (802.11 HT40 mode chain 0)



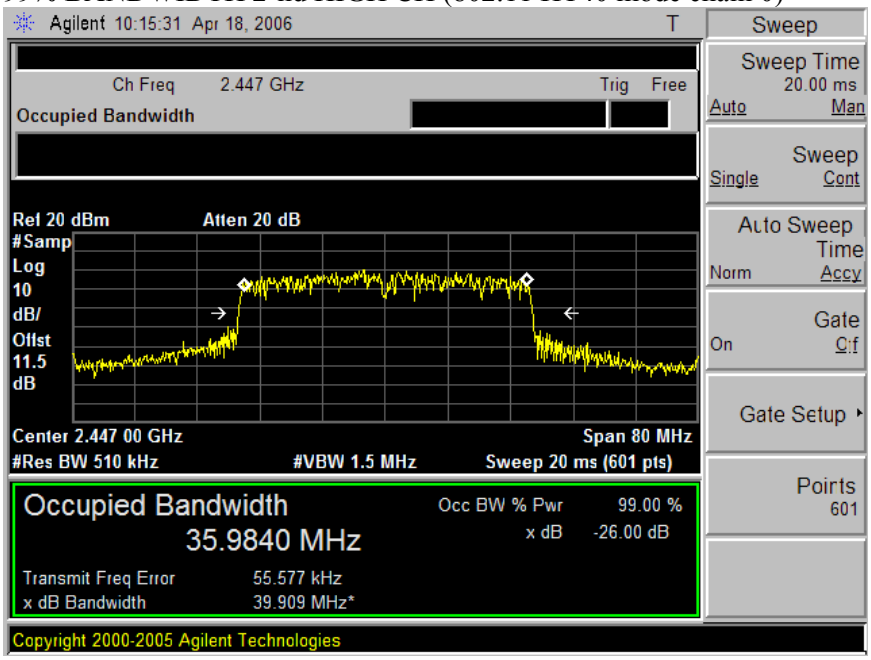
99% BANDWIDTH 2'ND LOW CH (802.11 HT40 mode chain 0)



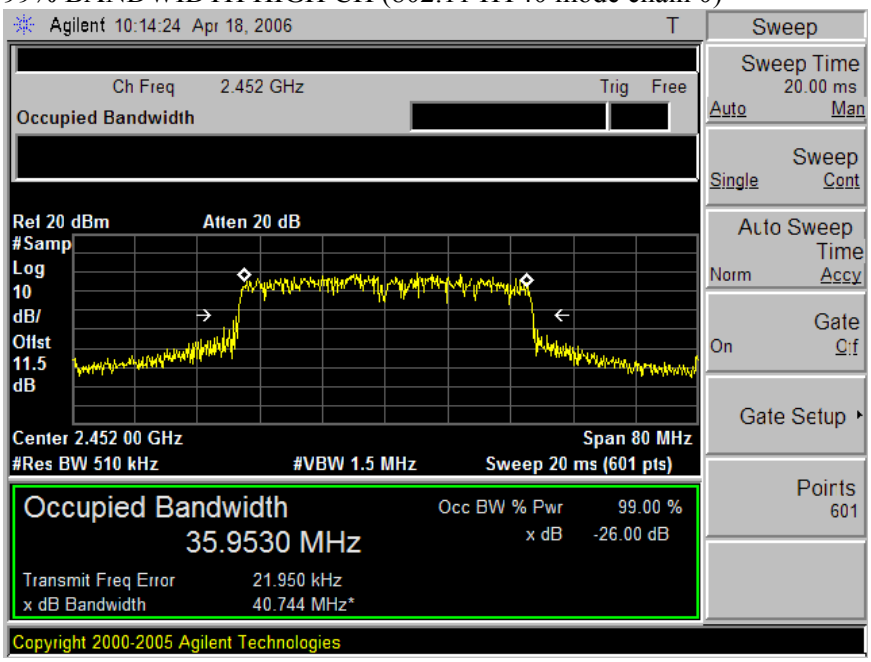
99% BANDWIDTH MID CH (802.11 HT40 mode chain 0)



99% BANDWIDTH 2'nd HIGH CH (802.11 HT40 mode chain 0)

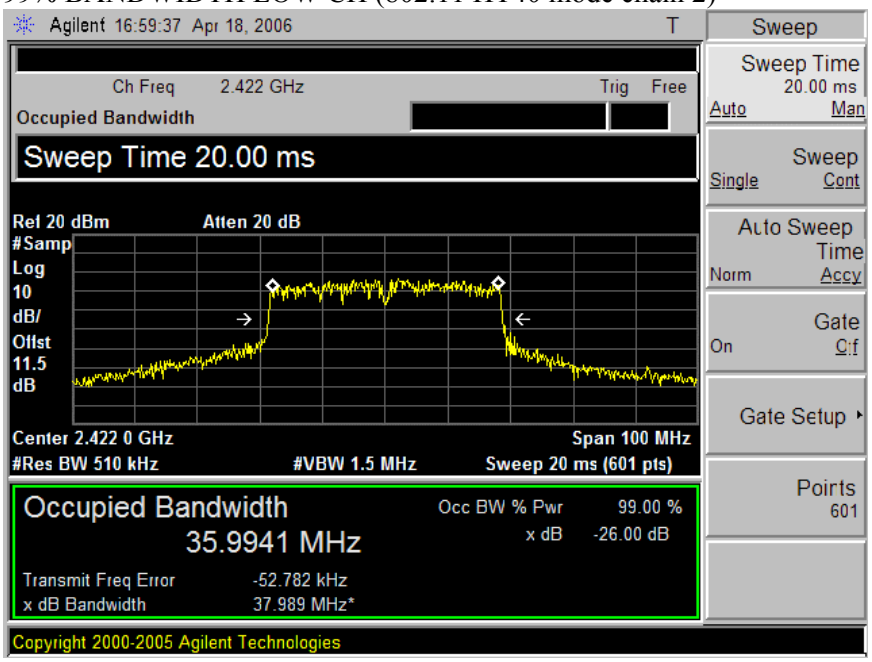


99% BANDWIDTH HIGH CH (802.11 HT40 mode chain 0)

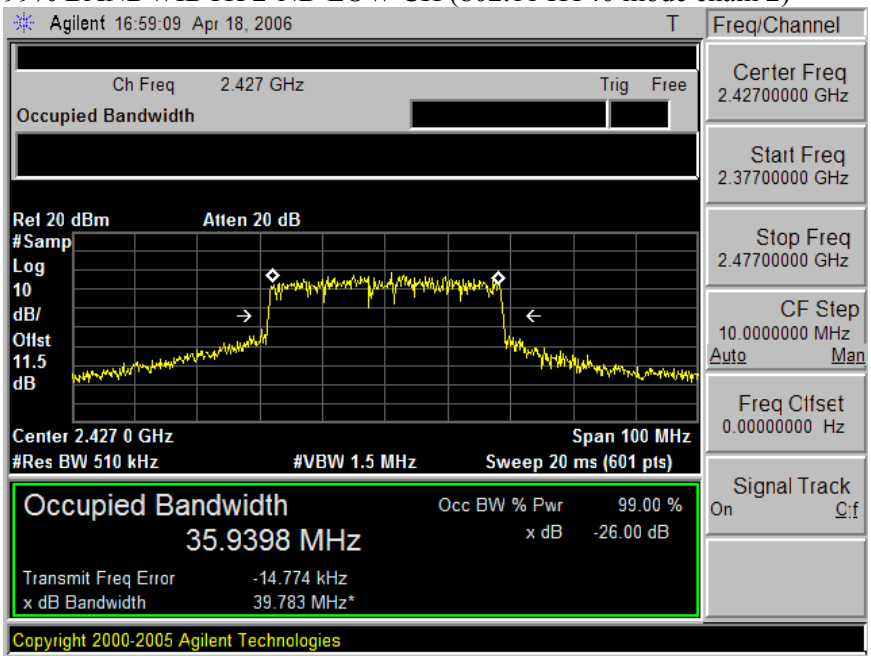


99% BANDWIDTH (802.11 HT40 MODE CHAIN 2)

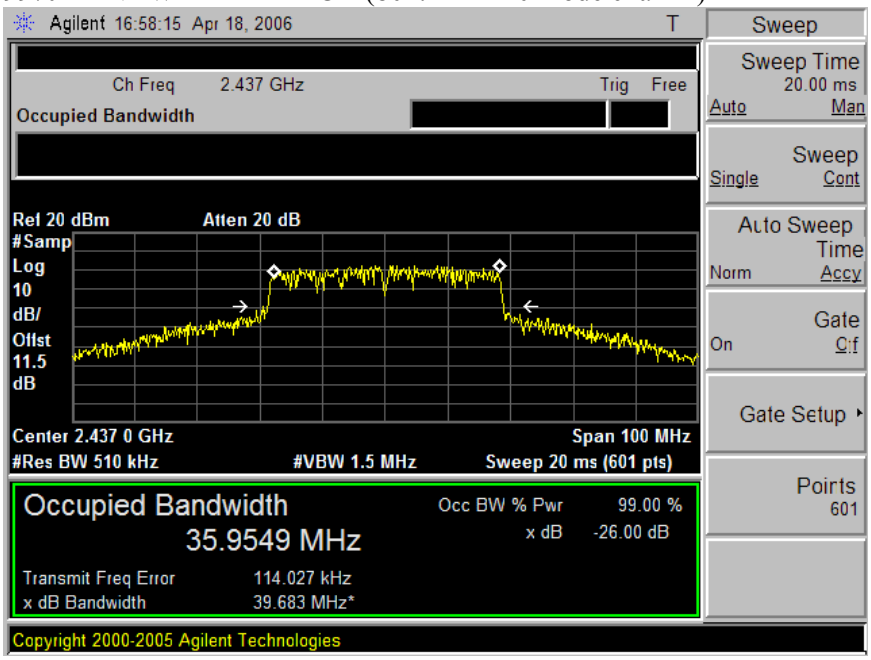
99% BANDWIDTH LOW CH (802.11 HT40 mode chain 2)



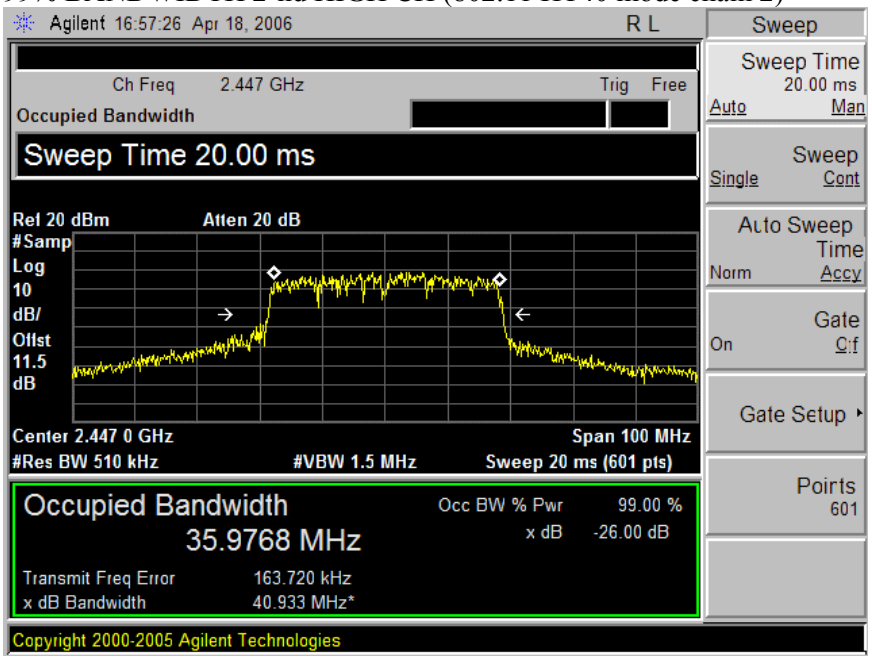
99% BANDWIDTH 2'ND LOW CH (802.11 HT40 mode chain 2)



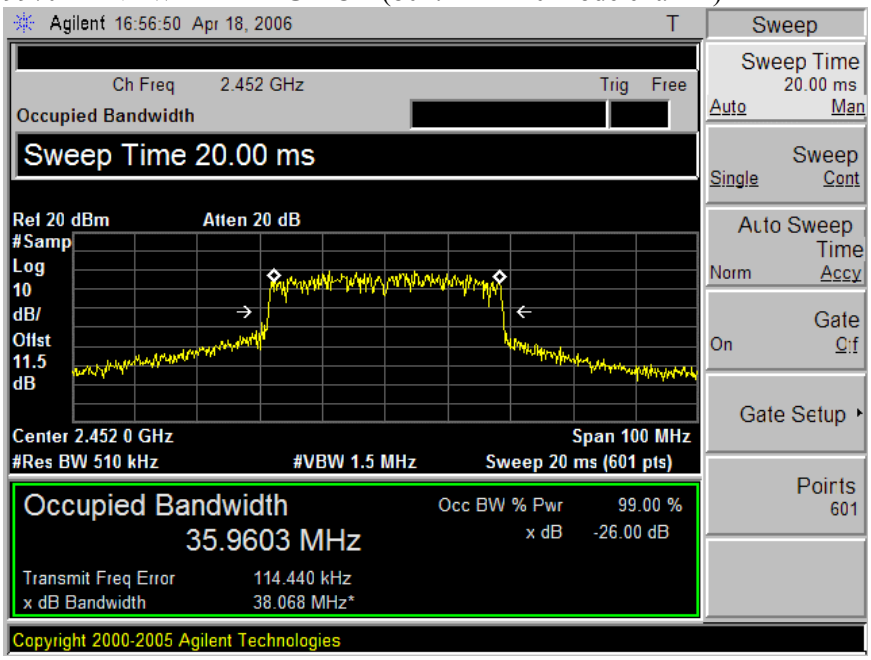
99% BANDWIDTH MID CH (802.11 HT40 mode chain 2)



99% BANDWIDTH 2'nd HIGH CH (802.11 HT40 mode chain 2)



99% BANDWIDTH HIGH CH (802.11 HT40 mode chain 2)



7.1.3. 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) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz , and 5725-5850 MHz bands: 1 watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

§15.247 (b) (4) (i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

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

RESULTS,

The maximum antenna gain is 2.0 dBi for other than fixed, point-to-point operations, therefore the limit is 30 dBm.

Total peak power calculation formula: 10 log (10^ (Pchain0 / 10) + 10^ (Pchain2 / 10))

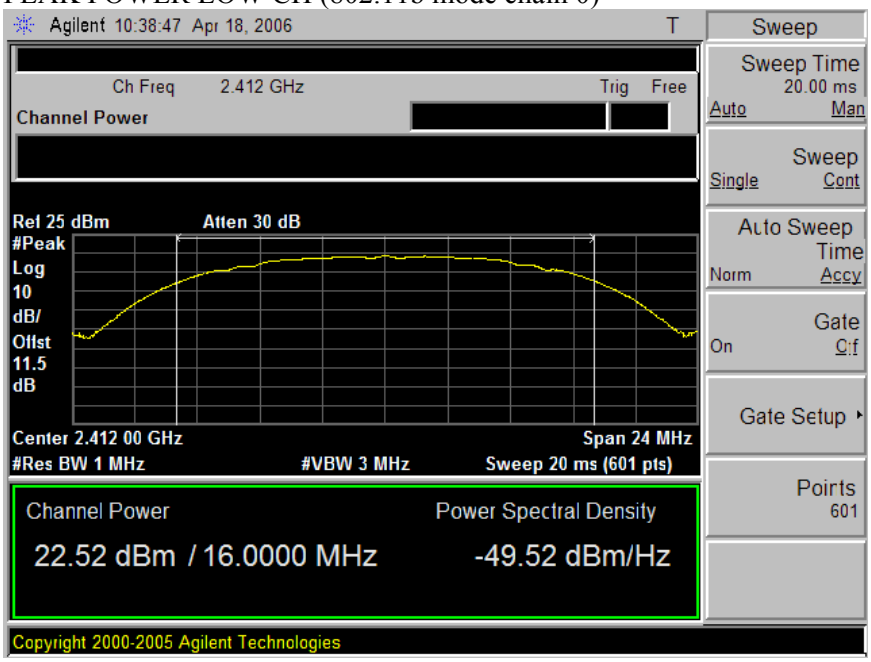
Note: Pchain 0, Pchain1 and Pchain2 are in dBm

No non-compliance noted:

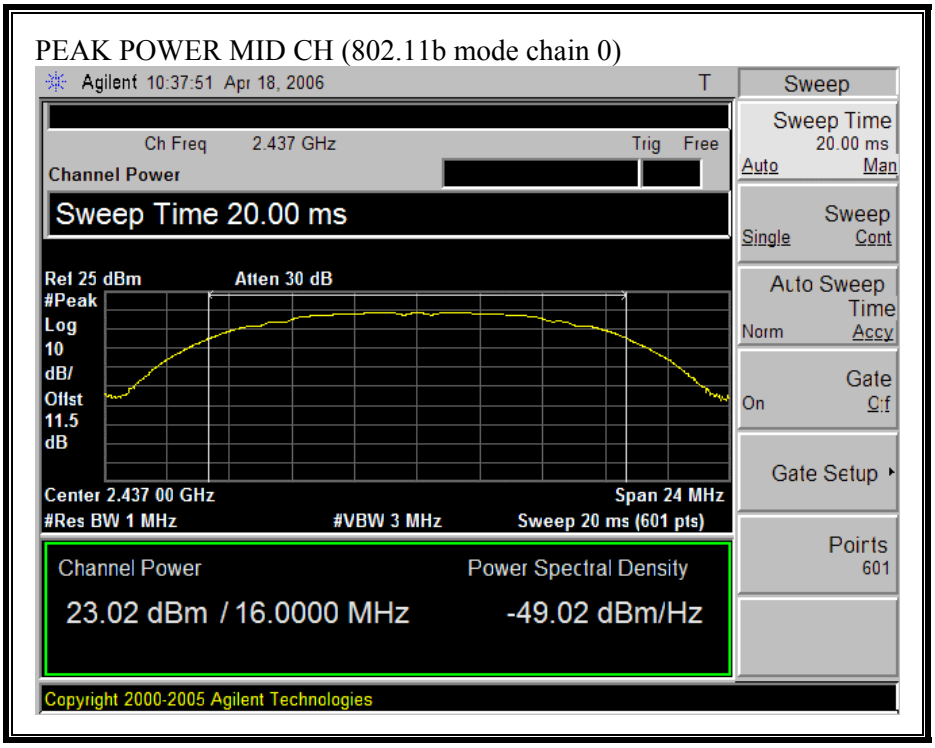
Channel	Frequency (MHz)	Peak Power Chain 0 (dBm)	Peak Power Chain 2 (dBm)	Peak Power Total (dBm)	Limit (dBm)	Margin (dB)
802.11b Mode						
Low	2412	22.52	21.95	25.25	30.0	-4.75
Middle	2437	23.02	23.02	26.03	30.0	-3.97
High	2462	22.03	22.01	25.03	30.0	-4.97
802.11g Mode						
Low	2412	22.71	21.95	25.36	30.0	-4.64
Middle	2437	25.63	25.93	28.79	30.0	-1.21
High	2462	22.63	22.55	25.60	30.0	-4.40
802.11 HT20 Mode						
Low	2412	22.70	21.86	25.31	30.0	-4.69
Middle	2437	25.50	25.94	28.74	30.0	-1.26
High	2462	21.90	22.56	25.25	30.0	-4.75
802.11 HT40 Mode						
Low	2422	19.66	19.29	22.49	30.0	-7.51
Second Low	2427	20.47	20.04	23.27	30.0	-6.73
Middle	2437	24.91	25.42	28.18	30.0	-1.82
Second High	2447	21.48	21.27	24.39	30.0	-5.61
High	2452	21.42	21.39	24.42	30.0	-5.58

OUTPUT POWER (802.11b MODE CHAIN 0)

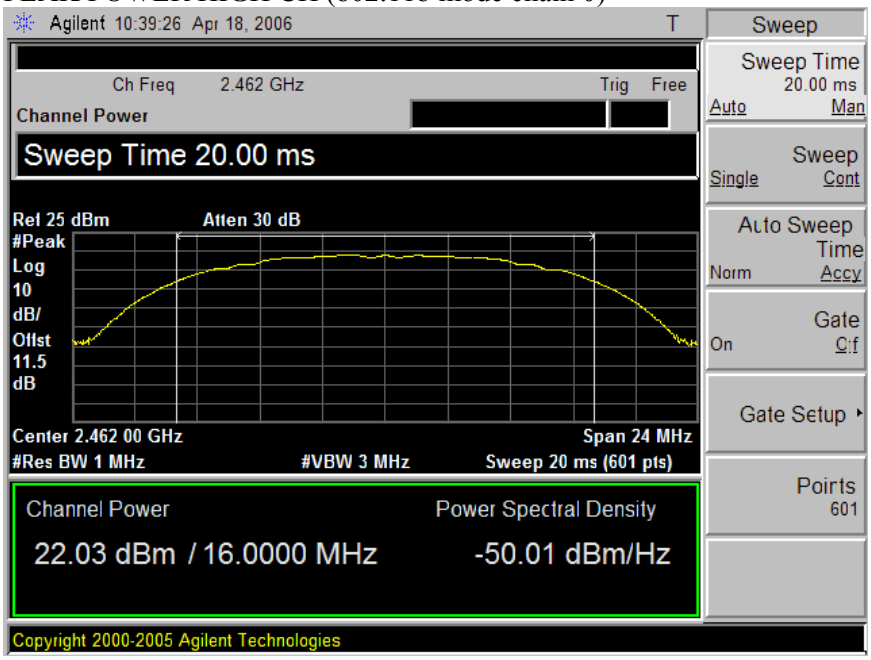
PEAK POWER LOW CH (802.11b mode chain 0)



PEAK POWER MID CH (802.11b mode chain 0)

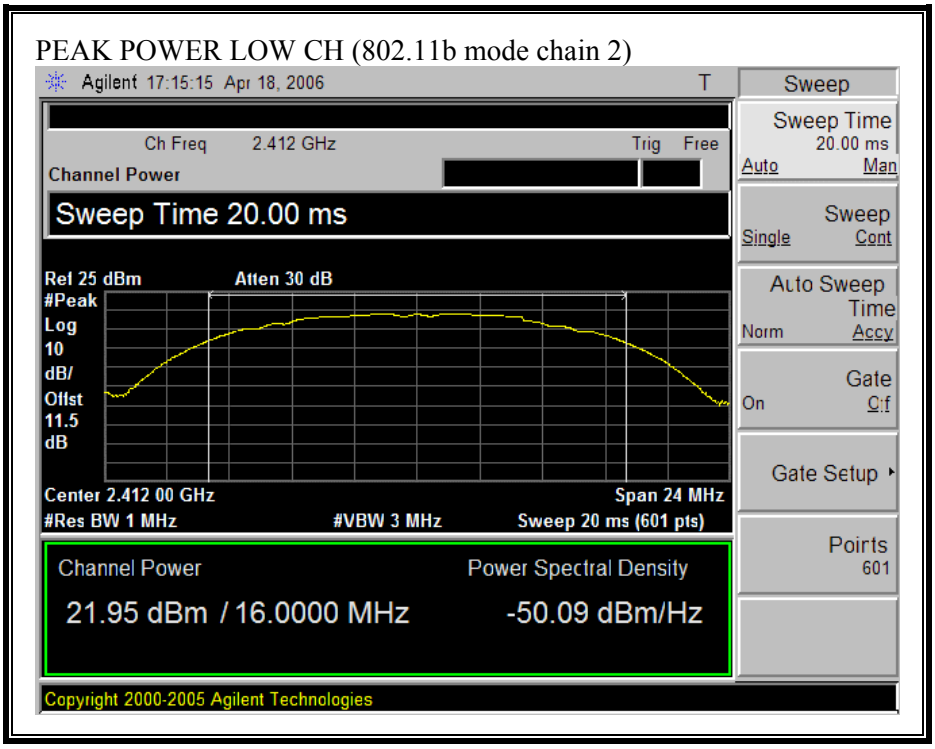


PEAK POWER HIGH CH (802.11b mode chain 0)

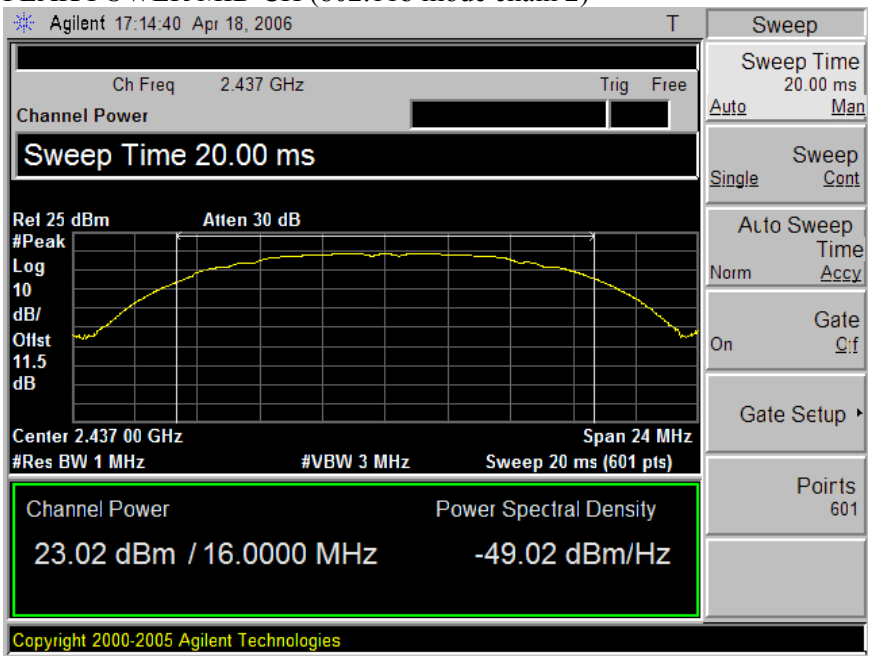


OUTPUT POWER (802.11b MODE CHAIN 2)

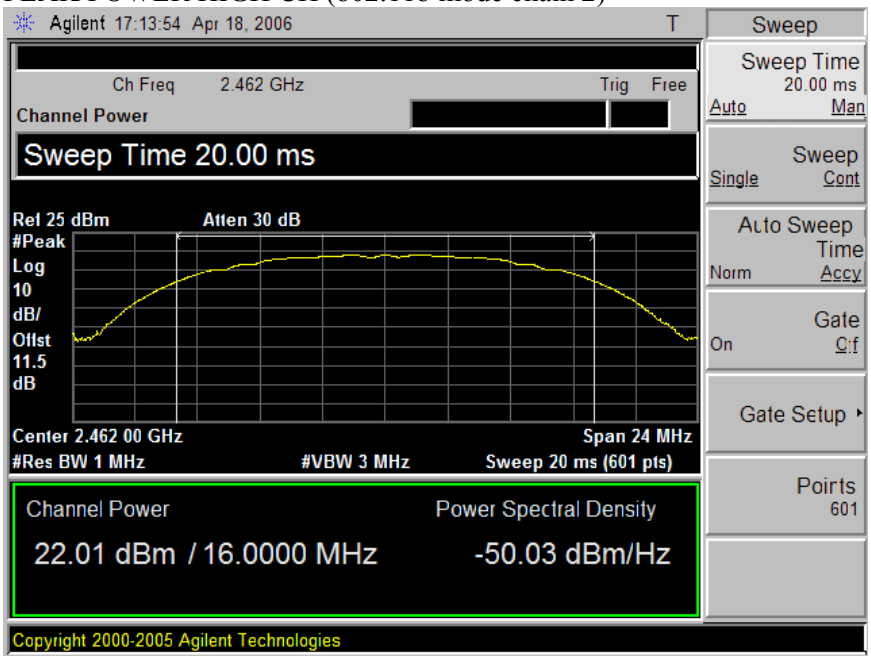
PEAK POWER LOW CH (802.11b mode chain 2)



PEAK POWER MID CH (802.11b mode chain 2)

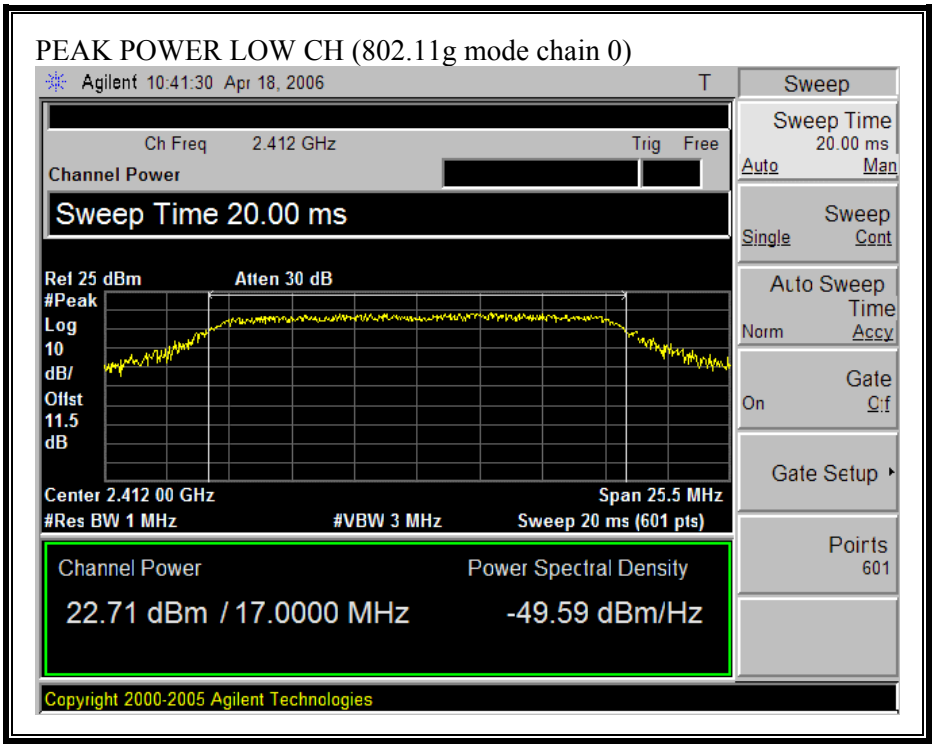


PEAK POWER HIGH CH (802.11b mode chain 2)

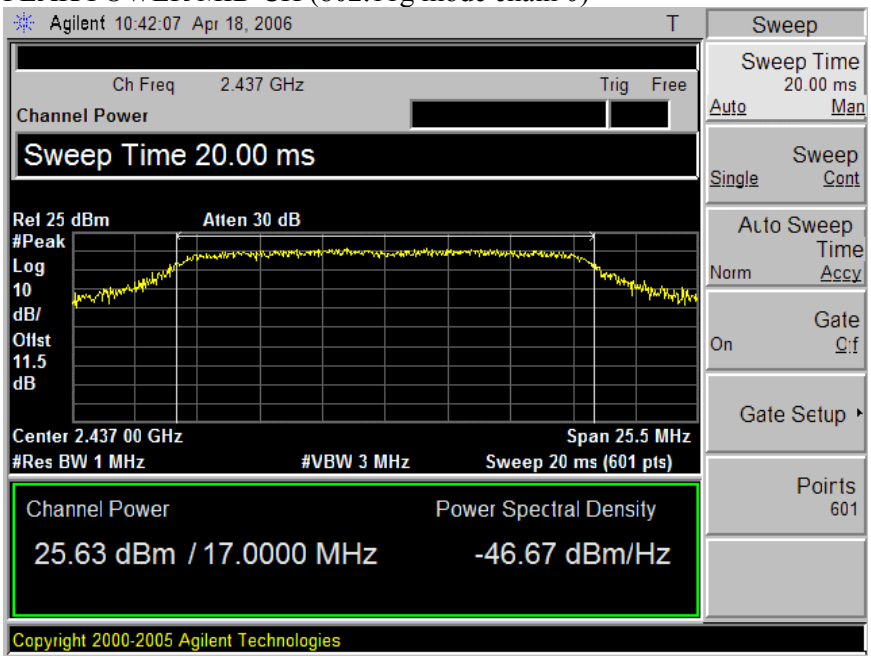


OUTPUT POWER (802.11g MODE CHAIN 0)

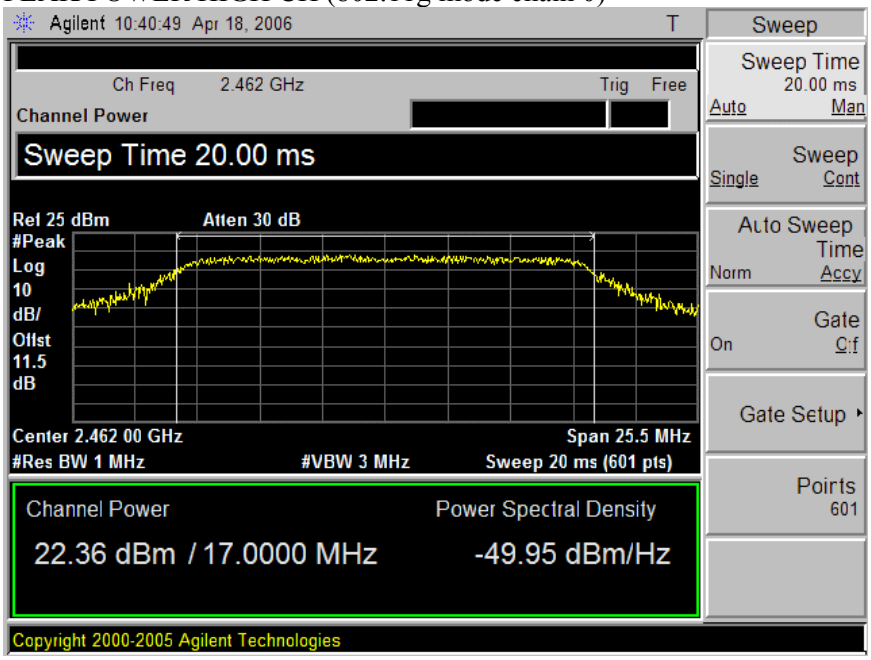
PEAK POWER LOW CH (802.11g mode chain 0)



PEAK POWER MID CH (802.11g mode chain 0)

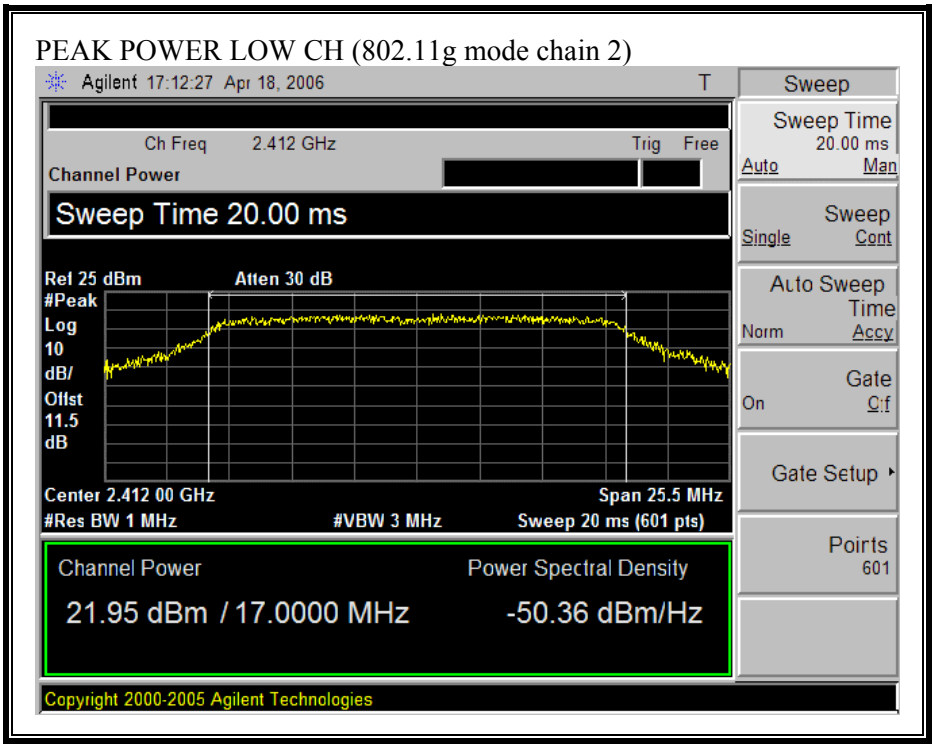


PEAK POWER HIGH CH (802.11g mode chain 0)

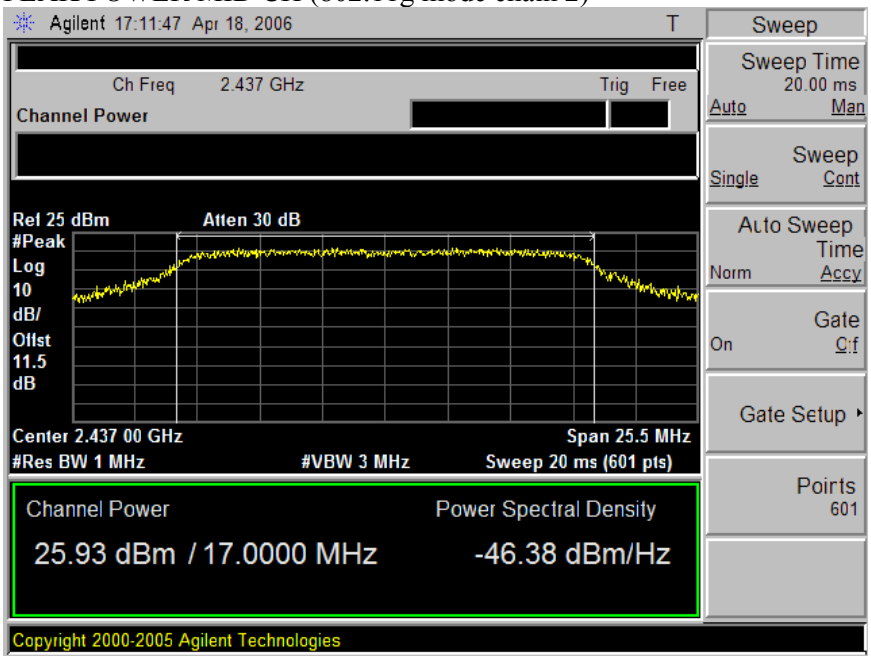


OUTPUT POWER (802.11g MODE CHAIN 2)

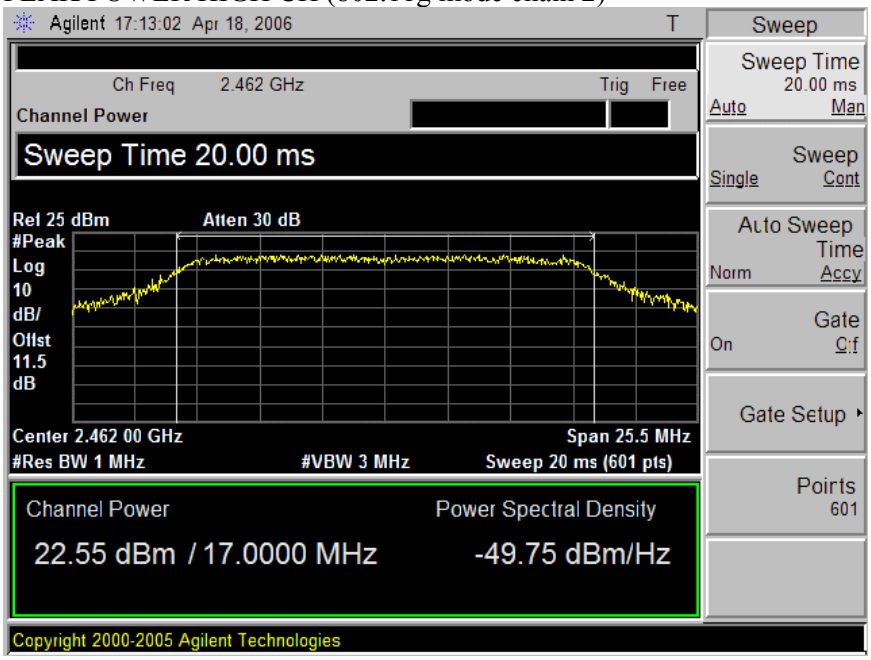
PEAK POWER LOW CH (802.11g mode chain 2)



PEAK POWER MID CH (802.11g mode chain 2)

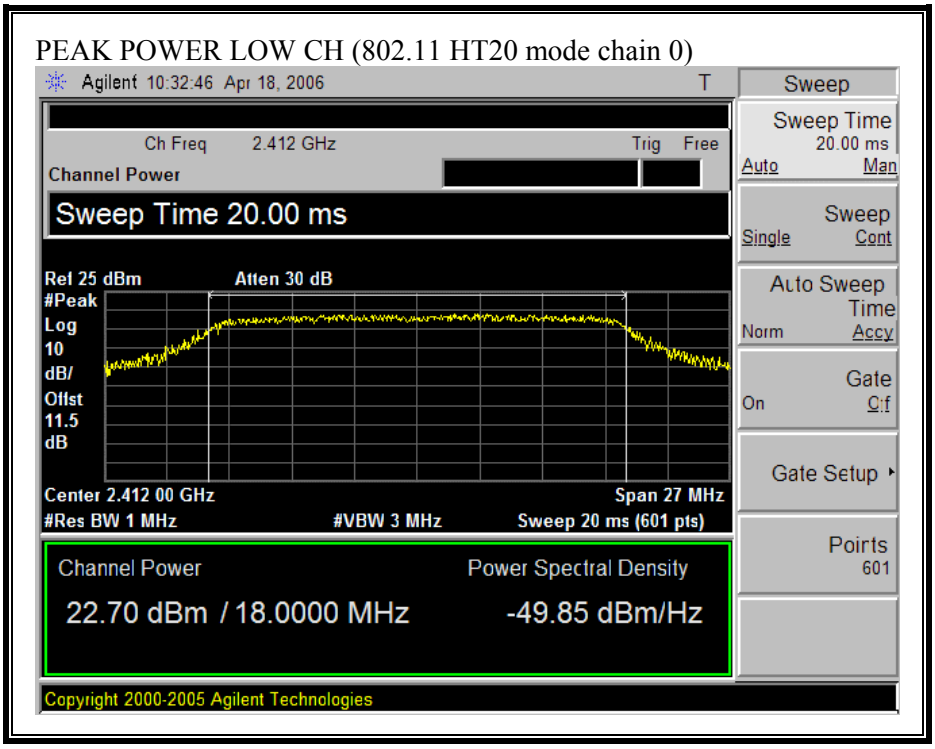


PEAK POWER HIGH CH (802.11g mode chain 2)

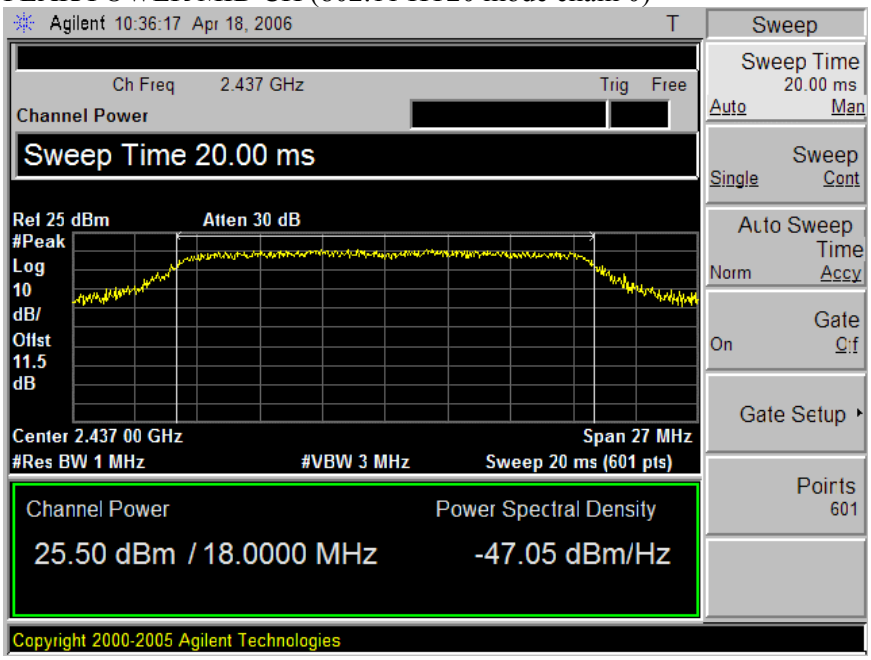


OUTPUT POWER (802.11g HT20 MODE CHAIN 0)

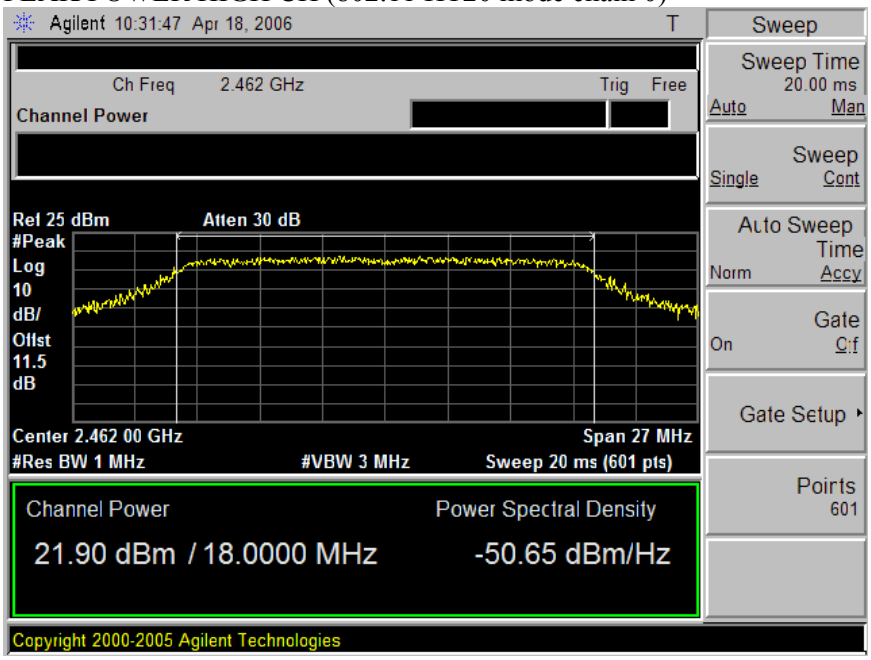
PEAK POWER LOW CH (802.11 HT20 mode chain 0)



PEAK POWER MID CH (802.11 HT20 mode chain 0)

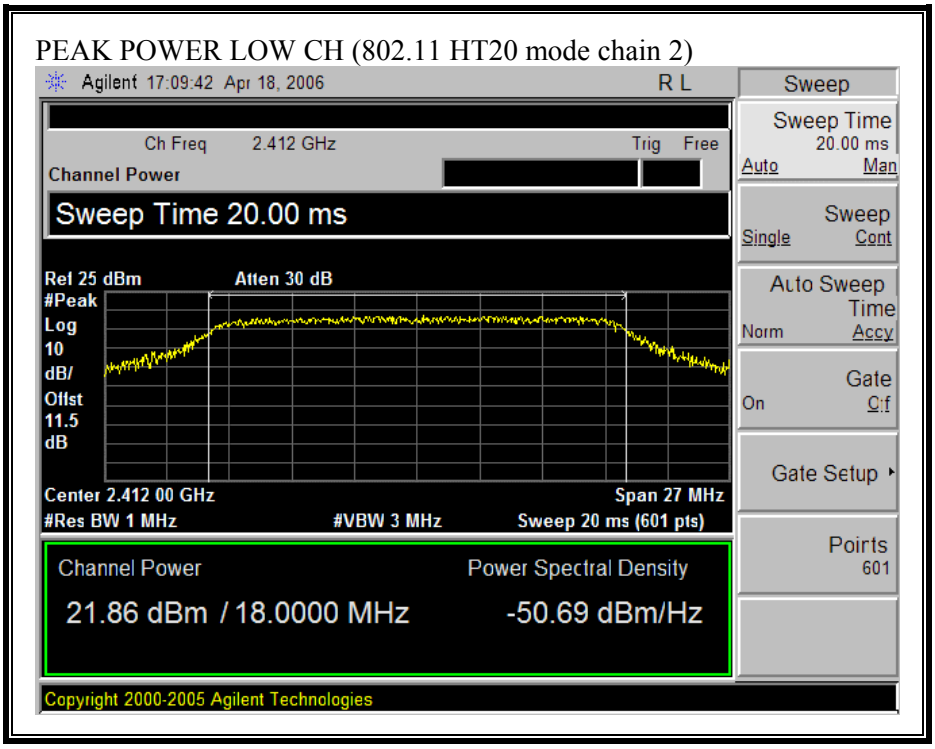


PEAK POWER HIGH CH (802.11 HT20 mode chain 0)

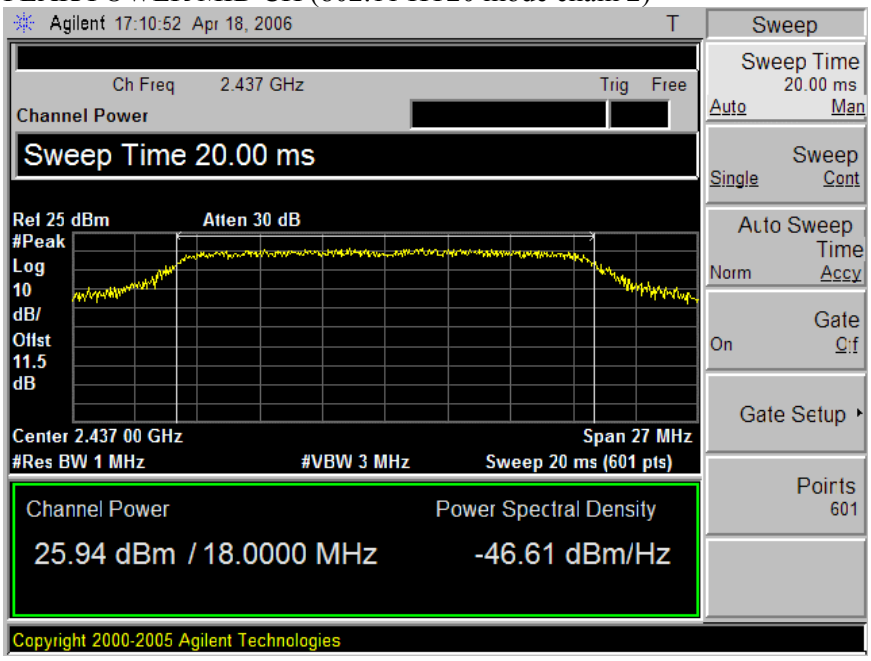


OUTPUT POWER (802.11 HT20 MODE CHAIN 2)

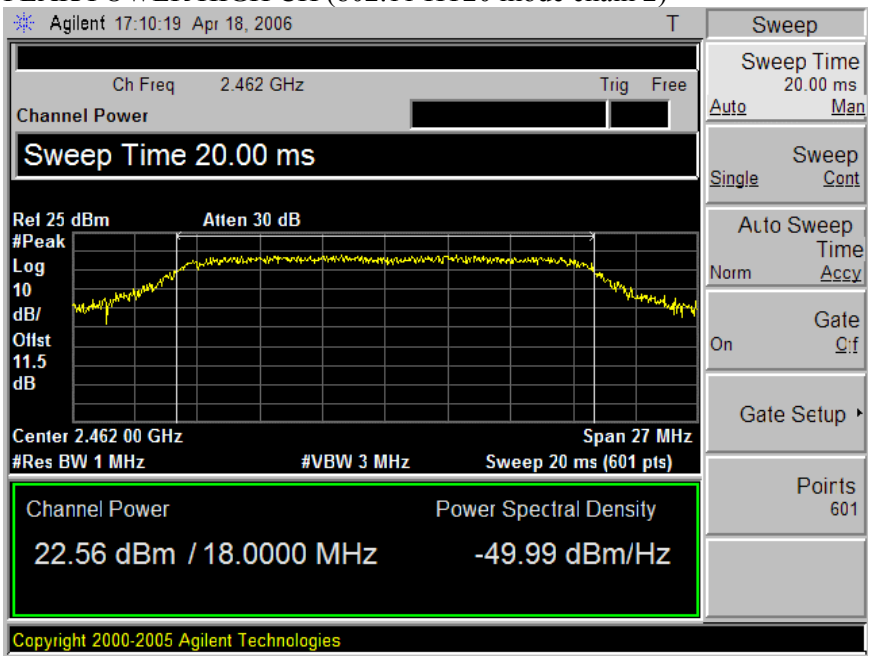
PEAK POWER LOW CH (802.11 HT20 mode chain 2)



PEAK POWER MID CH (802.11 HT20 mode chain 2)

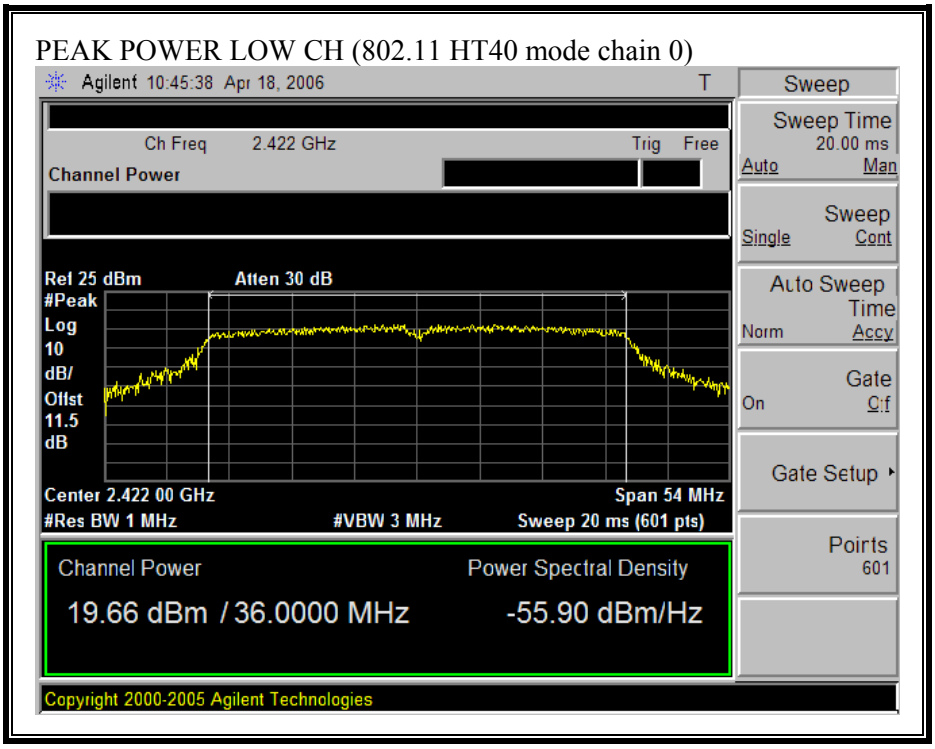


PEAK POWER HIGH CH (802.11 HT20 mode chain 2)

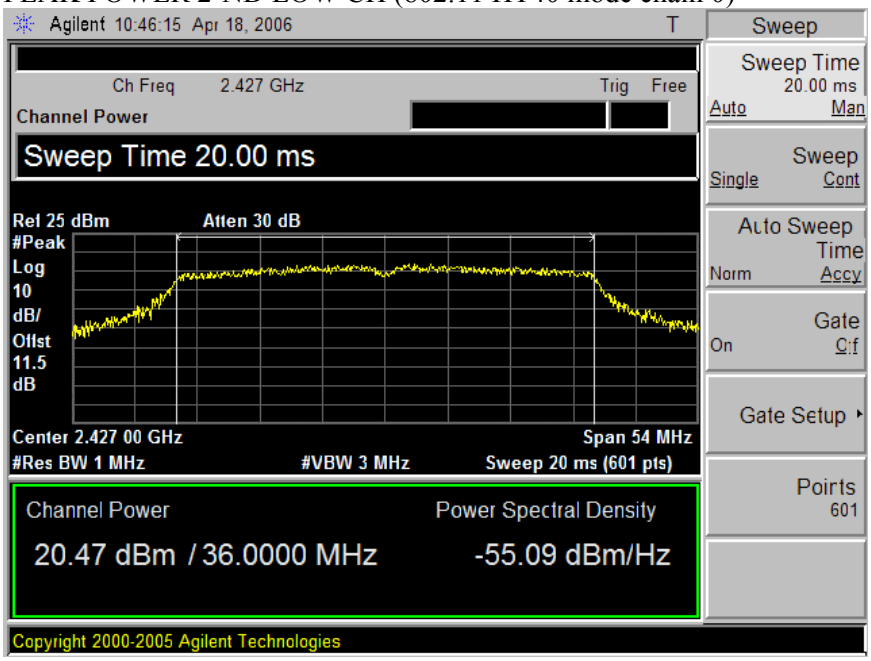


OUTPUT POWER (802.11 HT40 MODE CHAIN 0)

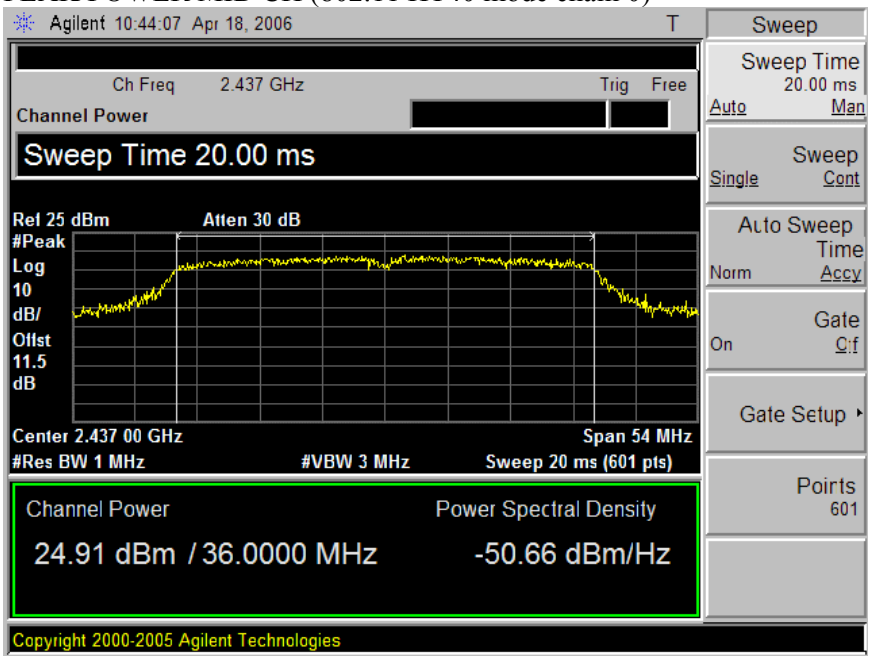
PEAK POWER LOW CH (802.11 HT40 mode chain 0)



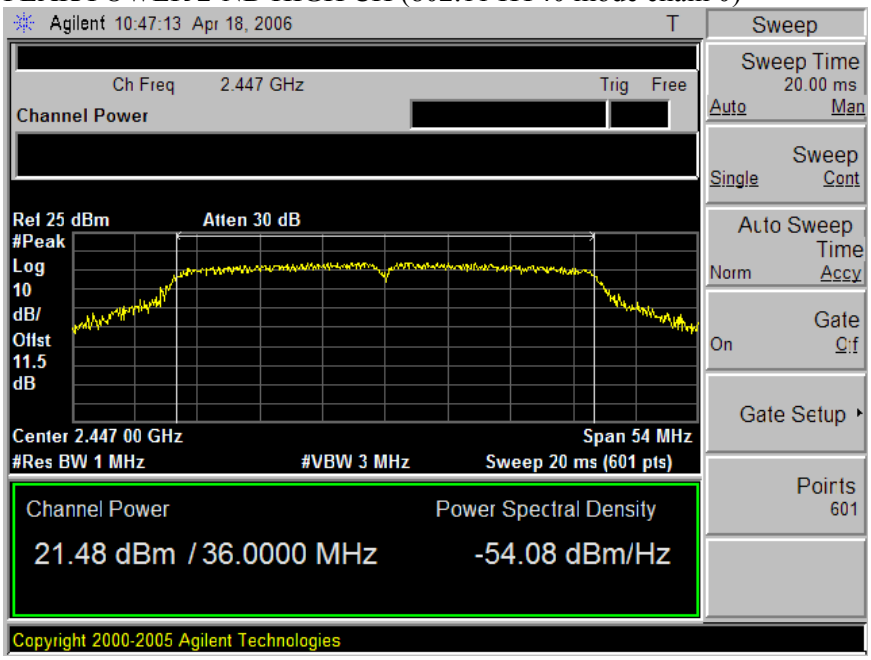
PEAK POWER 2'ND LOW CH (802.11 HT40 mode chain 0)



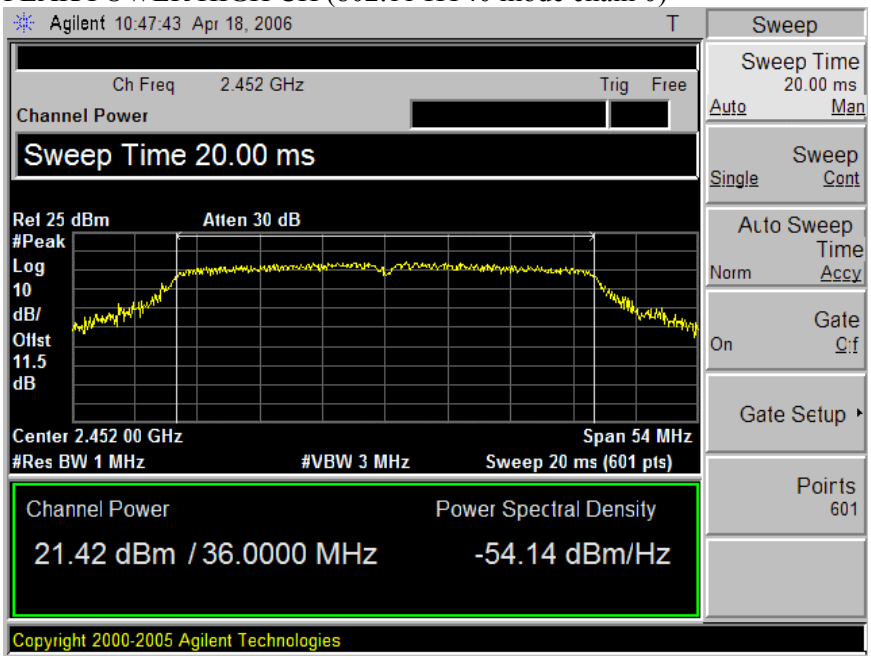
PEAK POWER MID CH (802.11 HT40 mode chain 0)



PEAK POWER 2'ND HIGH CH (802.11 HT40 mode chain 0)

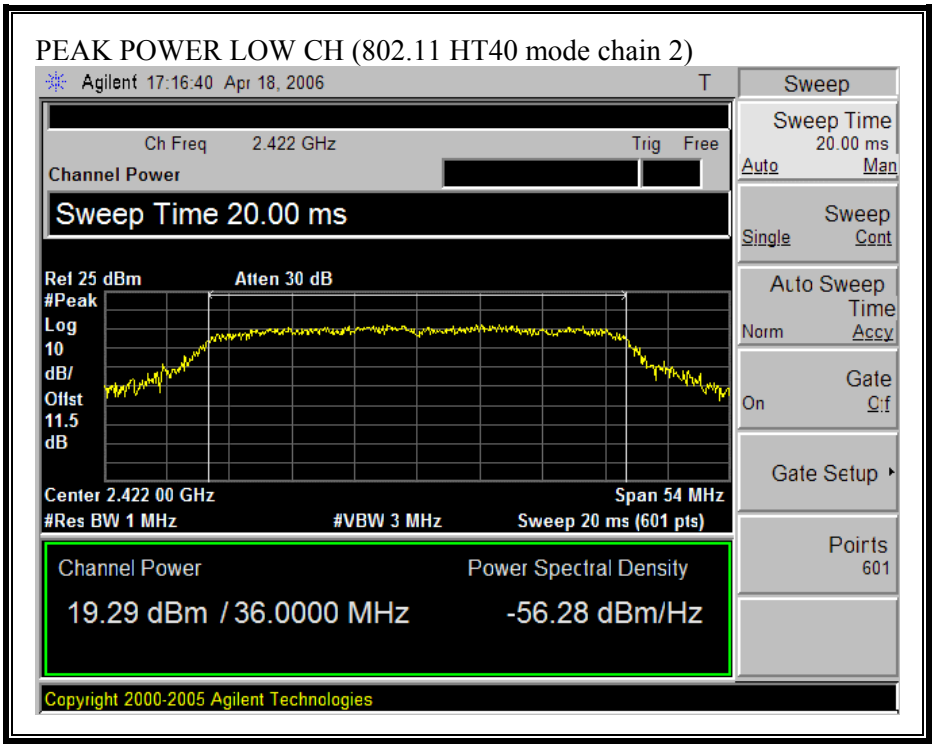


PEAK POWER HIGH CH (802.11 HT40 mode chain 0)

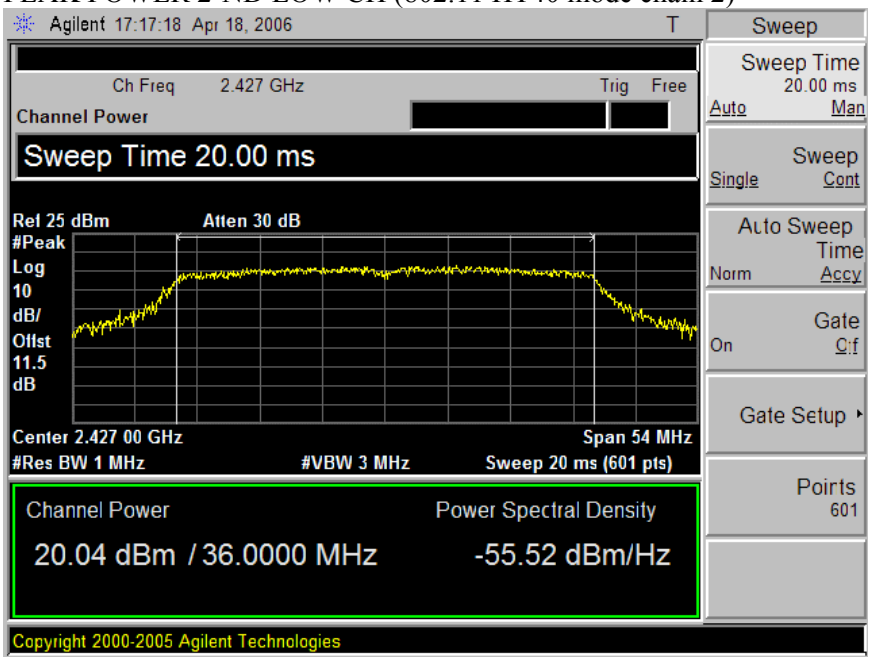


OUTPUT POWER (802.11 HT40 MODE CHAIN 2)

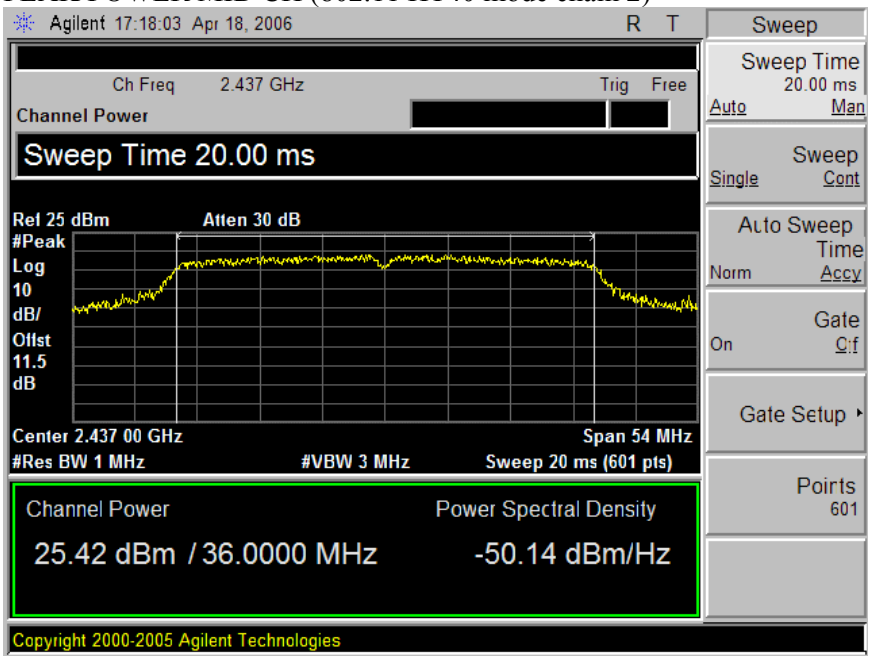
PEAK POWER LOW CH (802.11 HT40 mode chain 2)



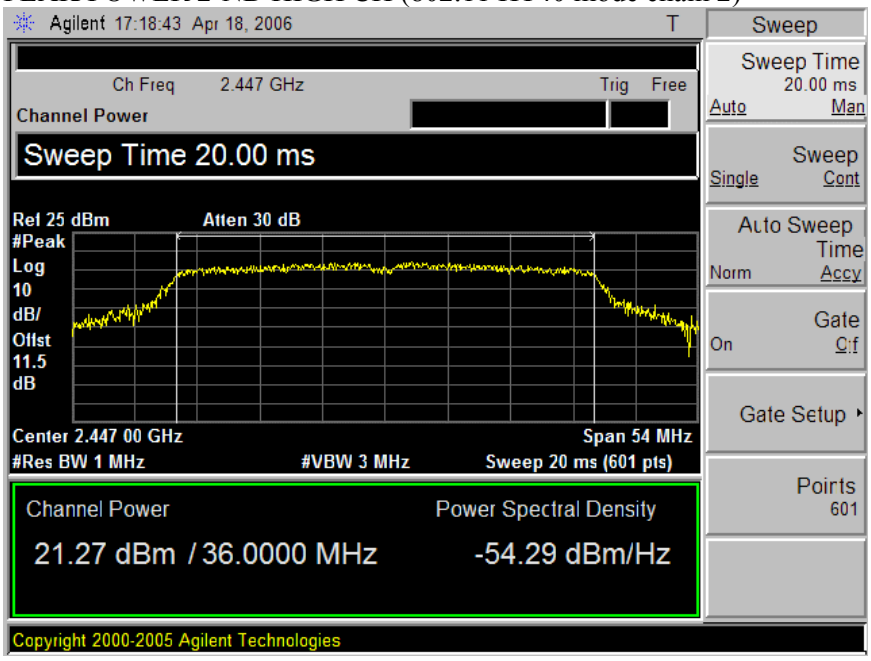
PEAK POWER 2'ND LOW CH (802.11 HT40 mode chain 2)



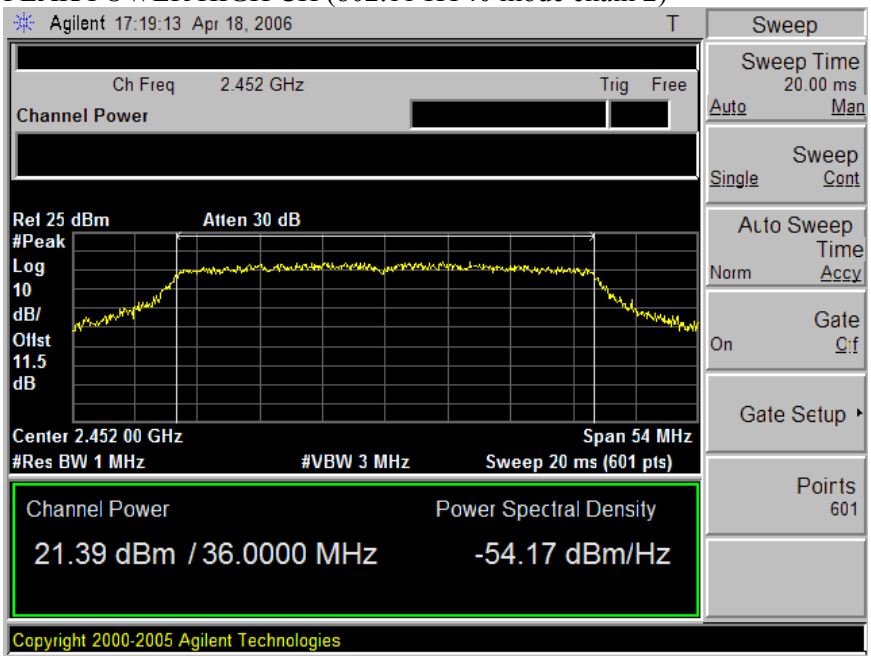
PEAK POWER MID CH (802.11 HT40 mode chain 2)



PEAK POWER 2'ND HIGH CH (802.11 HT40 mode chain 2)



PEAK POWER HIGH CH (802.11 HT40 mode chain 2)



7.1.4. 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

$S = E ^ 2 / 3770$

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

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

where

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

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

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

LIMITS

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

RESULTS

No non-compliance noted: (MPE distance equals 20 cm)

Mode	MPE Distance (cm)	Total Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm^2)
802.11b	20.0	26.03	2.00	0.13
802.11g	20.0	28.79	2.00	0.24
802.11n HT20	20.0	28.74	2.00	0.24
802.11n HT40	20.0	28.18	2.00	0.21

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.

Mode	Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
802.11b	1.0	26.03	2.00	7.11
802.11g	1.0	28.79	2.00	9.77
802.11n HT20	1.0	28.74	2.00	9.71
802.11n HT40	1.0	28.18	2.00	9.10

No non-compliance noted: (MPE distance is greater than 20 cm)

7.1.5. AVERAGE POWER

AVERAGE POWER LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

No non-compliance noted:

The cable assembly insertion loss of 11.5 dB (including 10 dB pad and 1.5 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 Chain 0 (dBm)	Average Power Chain 2 (dBm)	Average Power Total (dBm)
802.11b Mode				
Low	2412	19.30	17.80	21.62
Middle	2437	19.80	19.51	22.67
High	2462	19.22	19.13	22.19
802.11g Mode				
Low	2412	16.38	15.50	18.97
Middle	2437	19.86	19.74	22.81
High	2462	15.80	16.10	18.96
802.11 HT20 Mode				
Low	2412	16.30	15.40	18.88
Middle	2437	19.86	19.80	22.84
High	2462	15.70	16.20	18.97
802.11 HT40 Mode				
Low	2422	12.80	12.36	15.60
Second Low	2427	14.00	13.72	16.87
Middle	2437	19.20	19.40	22.31
Second High	2447	15.00	15.13	18.08
High	2452	15.00	15.20	18.11

7.1.6. 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.

RESULTS

No non-compliance noted:

802.11b Mode

Channel	Frequency (MHz)	PPSD Chain 0 (dBm)	PPSD Chain 2 (dBm)	PPSD Total (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-4.00	-3.96	-0.97	8	-8.97
Middle	2437	-4.25	-3.61	-0.91	8	-8.91
High	2462	-3.67	-4.40	-1.01	8	-9.01

802.11g Mode

Channel	Frequency (MHz)	PPSD Chain 0 (dBm)	PPSD Chain 2 (dBm)	PPSD Total (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-7.53	-9.25	-5.30	8	-13.30
Middle	2437	-3.05	-5.15	-0.96	8	-8.96
High	2462	-9.30	-7.56	-5.33	8	-13.33

802.11 HT20 Mode

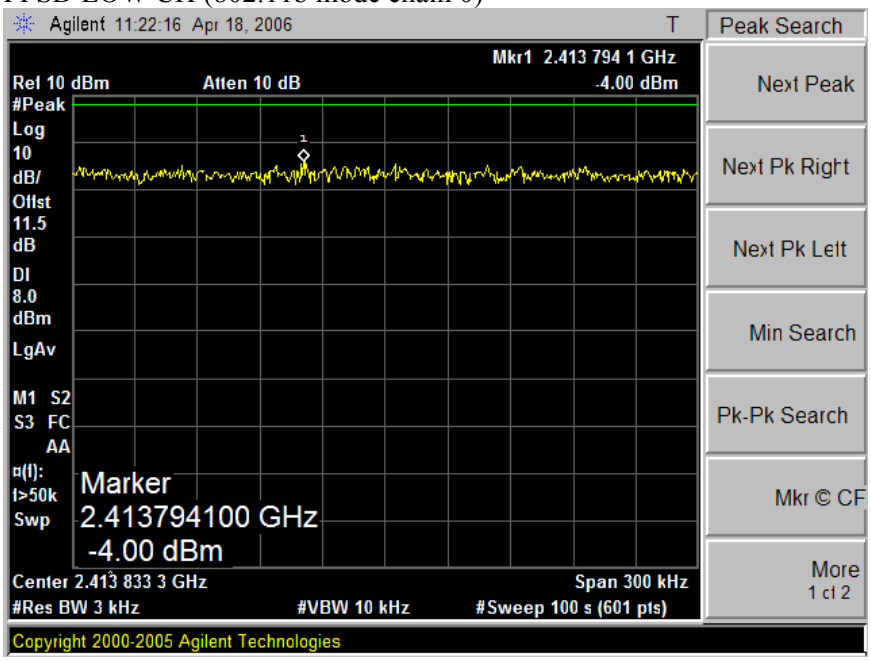
Channel	Frequency (MHz)	PPSD Chain 0 (dBm)	PPSD Chain 2 (dBm)	PPSD Total (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-8.61	-8.21	-5.40	8	-13.40
Middle	2437	-4.38	-5.83	-2.03	8	-10.03
High	2462	-9.58	-9.54	-6.55	8	-14.55

802.11 HT40 Mode

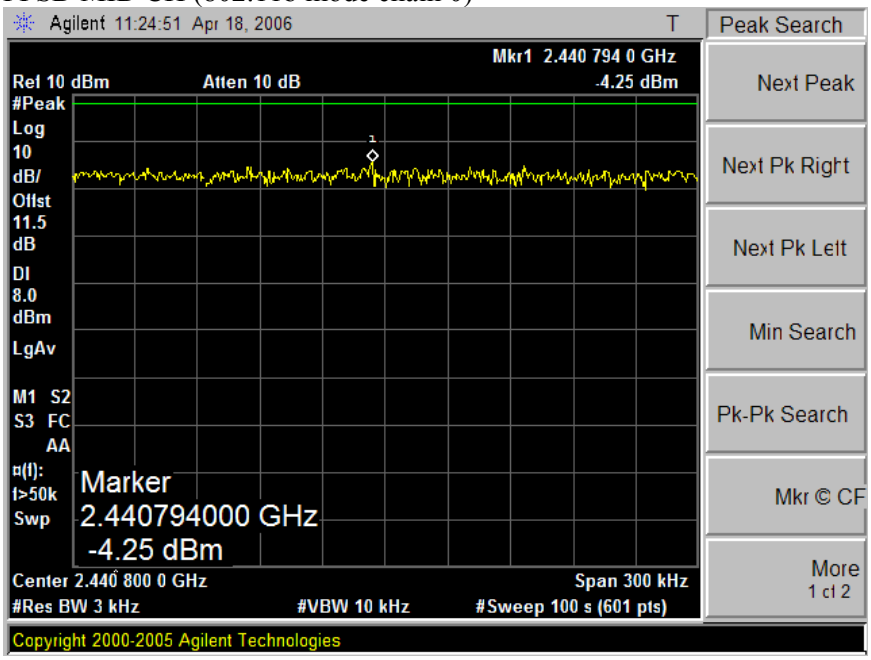
Channel	Frequency (MHz)	PPSD Chain 0 (dBm)	PPSD Chain 2 (dBm)	PPSD Total (dBm)	Limit (dBm)	Margin (dB)
Low	2422	-13.66	-13.97	-10.80	8	-18.80
2'nd Low	2427	-10.67	-13.02	-8.68	8	-16.68
Middle	2437	-6.92	-8.15	-4.48	8	-12.48
2'nd High	2447	-12.44	-12.08	-9.25	8	-17.25
High	2452	-10.21	-12.13	-8.05	8	-16.05

PEAK POWER SPECTRAL DENSITY (802.11b MODE CHAIN 0)

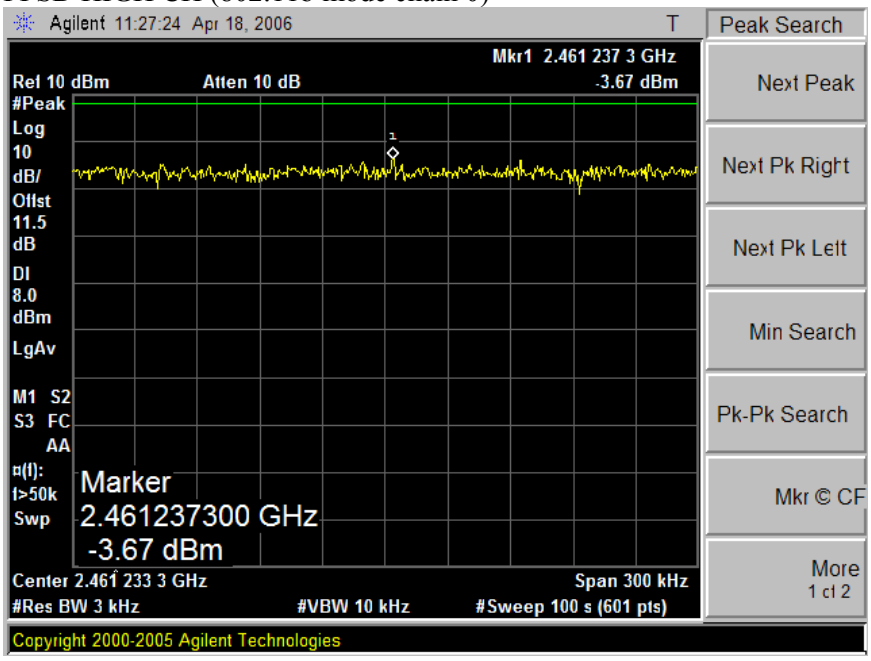
PPSD LOW CH (802.11b mode chain 0)



PPSD MID CH (802.11b mode chain 0)

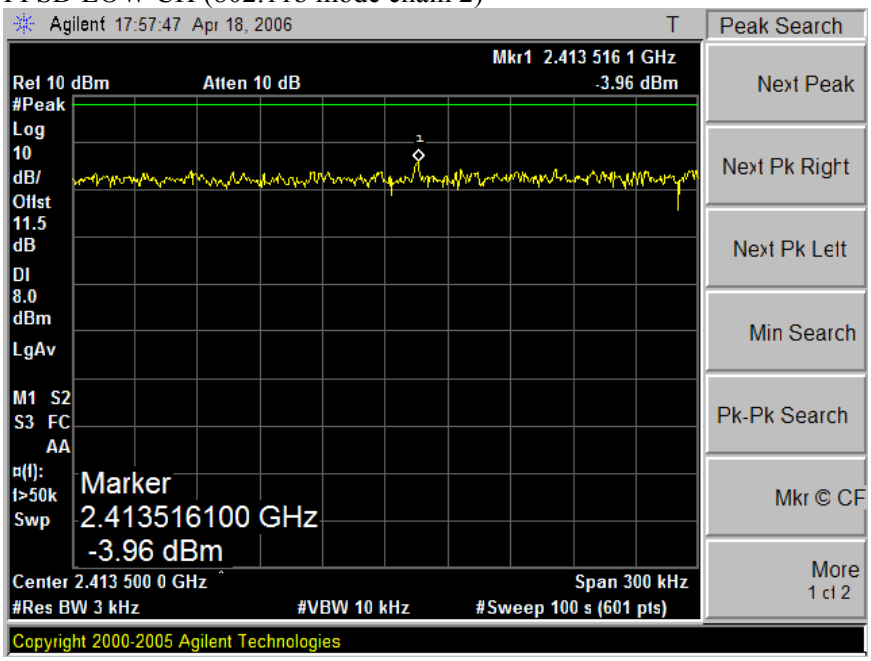


PPSD HIGH CH (802.11b mode chain 0)

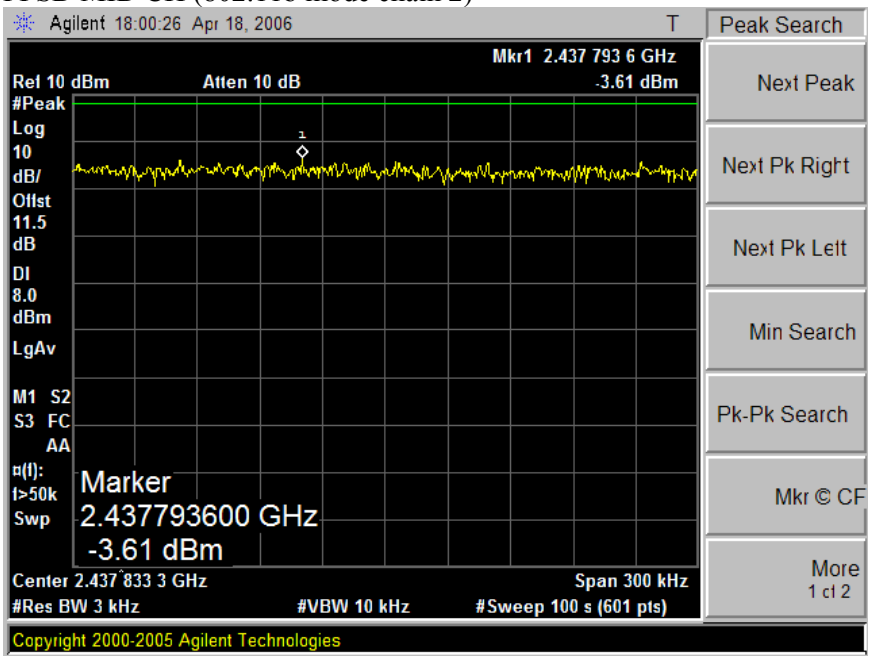


PEAK POWER SPECTRAL DENSITY (802.11b MODE CHAIN 2)

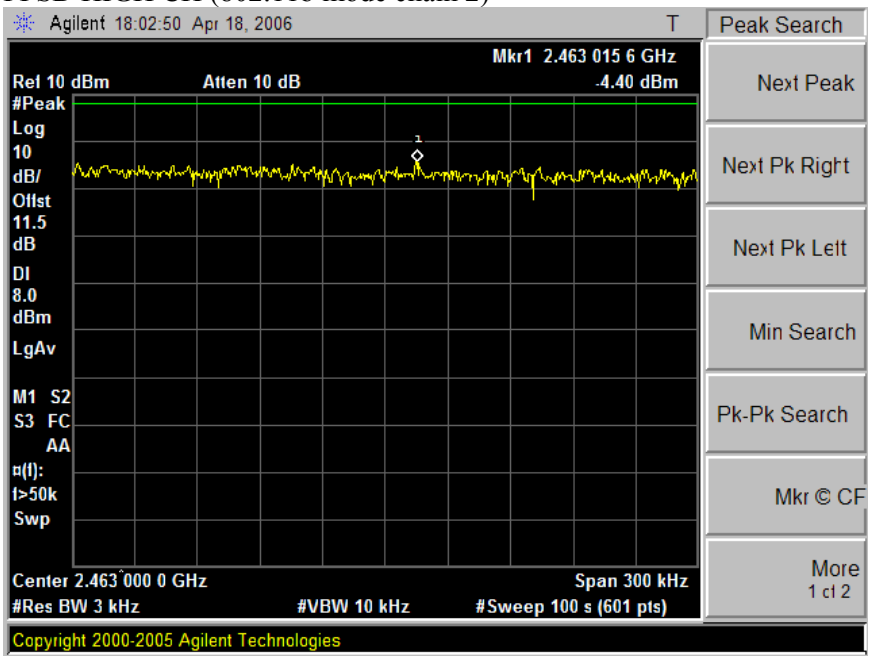
PPSD LOW CH (802.11b mode chain 2)



PPSD MID CH (802.11b mode chain 2)

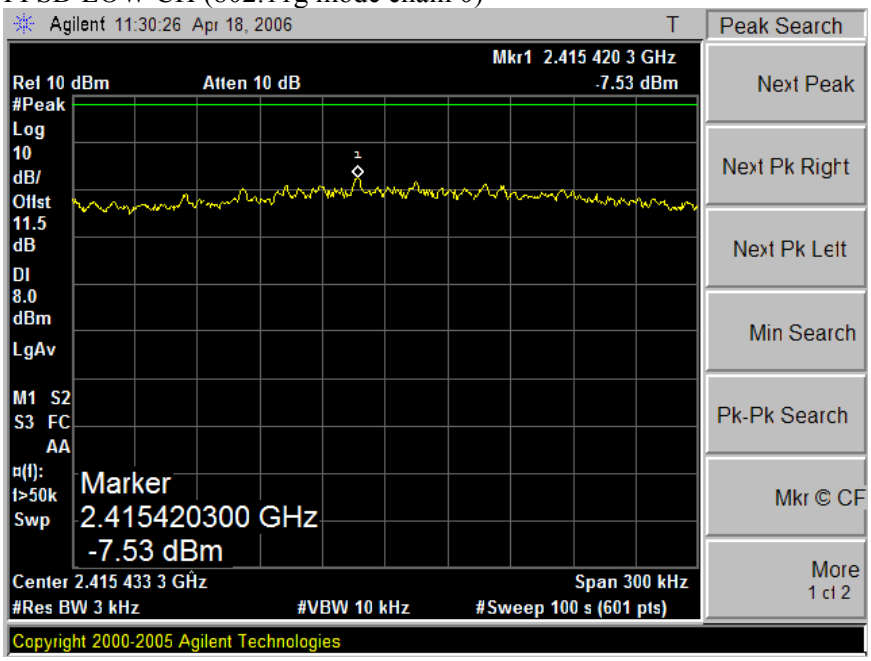


PPSD HIGH CH (802.11b mode chain 2)

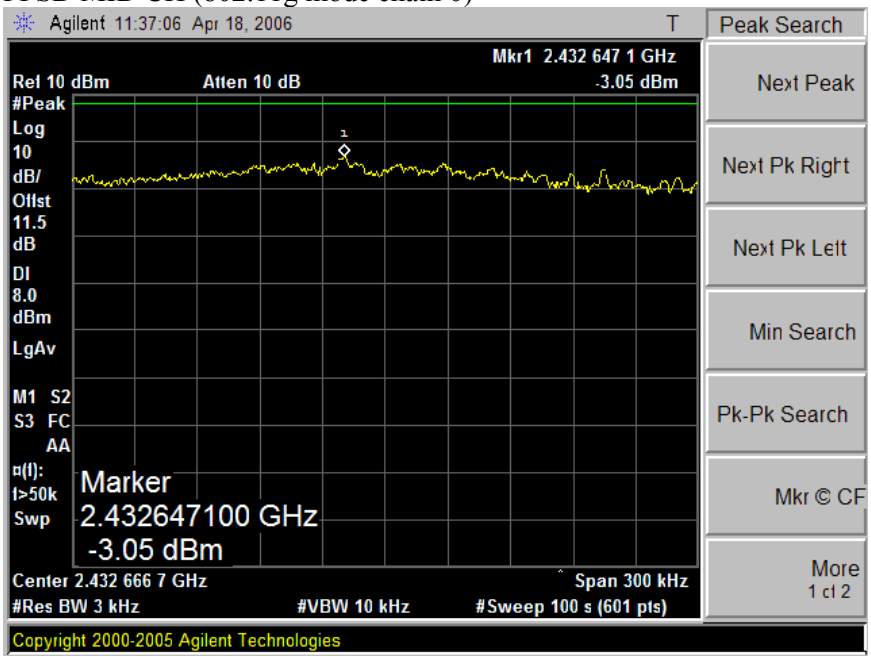


PEAK POWER SPECTRAL DENSITY (802.11g MODE CHAIN 0)

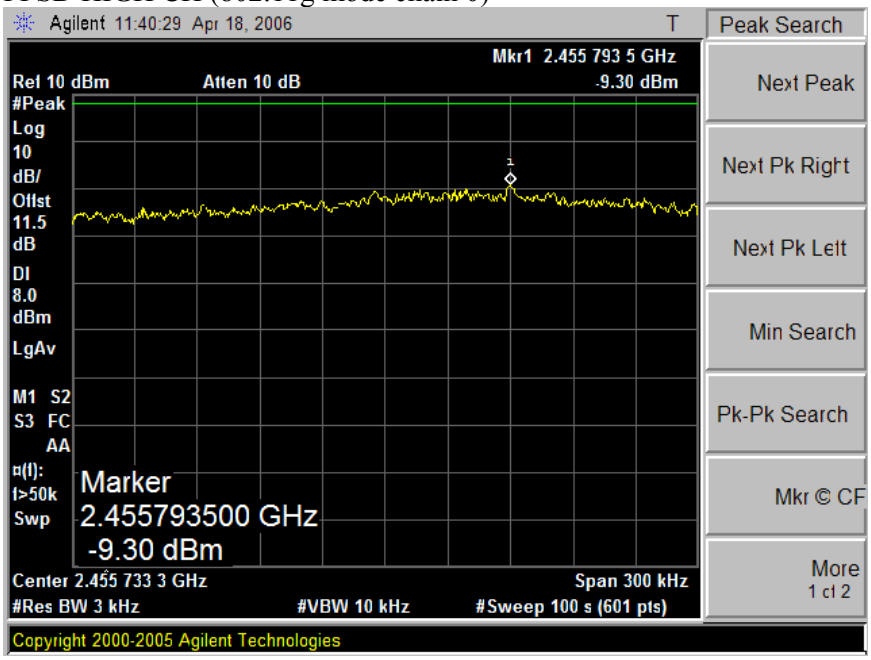
PPSD LOW CH (802.11g mode chain 0)



PPSD MID CH (802.11g mode chain 0)

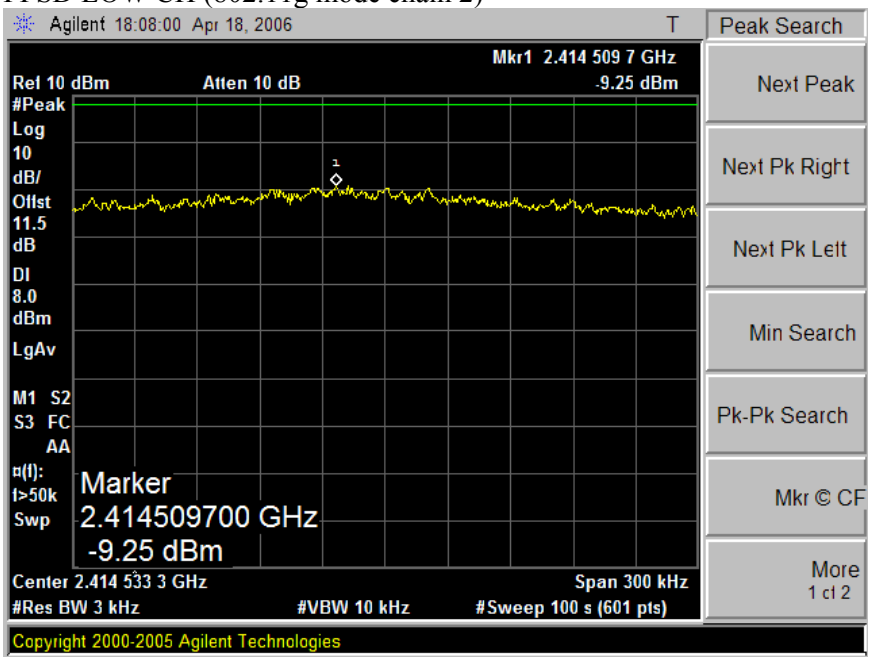


PPSD HIGH CH (802.11g mode chain 0)

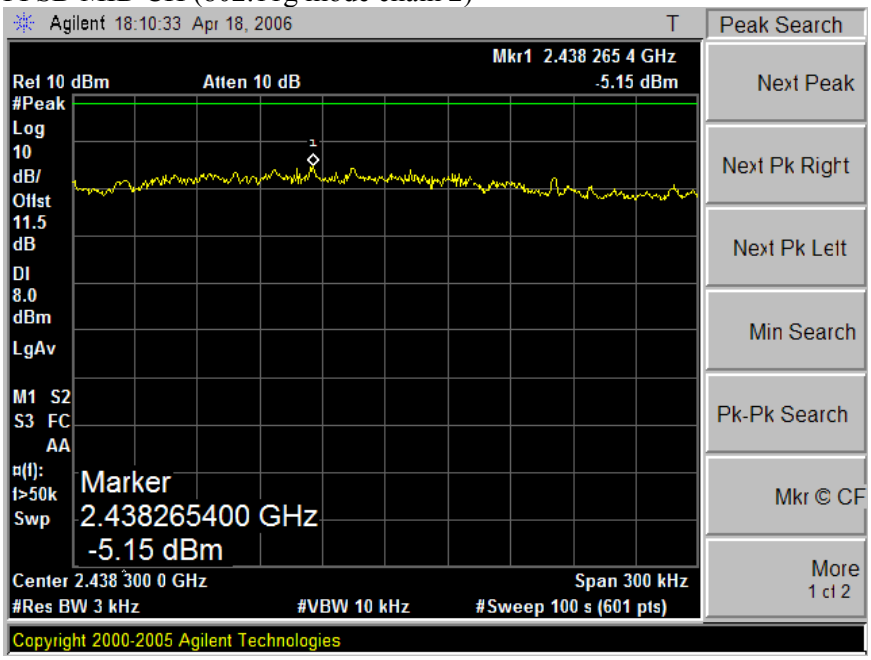


PEAK POWER SPECTRAL DENSITY (802.11g MODE CHAIN 2)

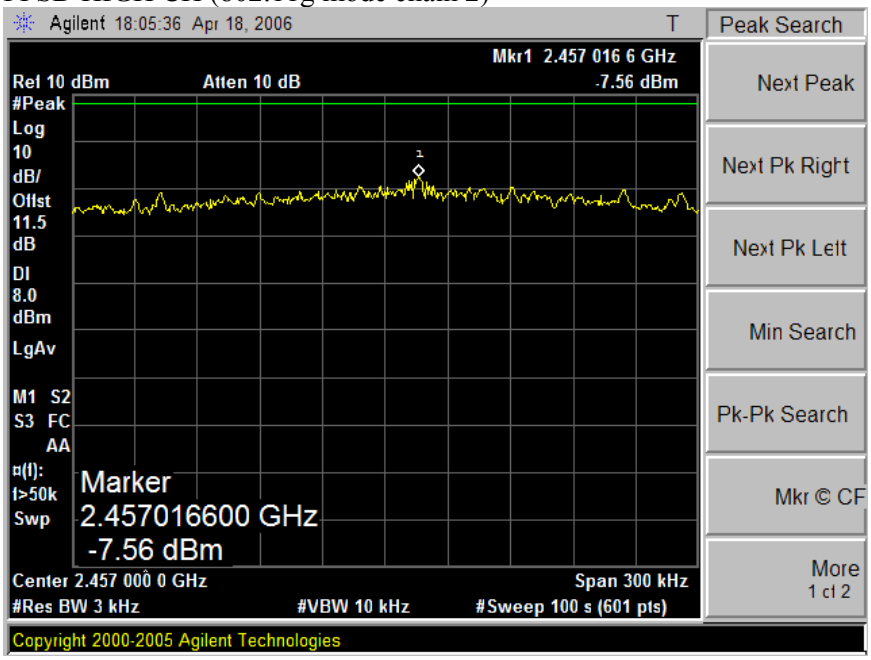
PPSD LOW CH (802.11g mode chain 2)



PPSD MID CH (802.11g mode chain 2)



PPSD HIGH CH (802.11g mode chain 2)



PEAK POWER SPECTRAL DENSITY (802.11 HT20 MODE CHAIN 0)

PPSD LOW CH (802.11 HT20 mode chain 0)