FCC CFR47 PART 15 CERTIFICATION
CLASS II PERMISSIVE CHANGE
TEST REPORT

FOR

802.11b WLAN RF PORT

MODEL NUMBER: CCRF-5020

BRAND NAME: SYMBOL MOBIUS™ ACCESS PORT

FCC ID: H9PCCRF5020

REPORT NUMBER: 03U1881-1

ISSUE DATE: APRIL 25, 2003

Prepared for
SYMBOL TECHNOLOGIES, INC.
6480 VIA DEL ORO DRIVE
SAN JOSE, CA 95119
USA

Prepared by
COMPLIANCE CERTIFICATION SERVICES
561 F 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: SYMBOL TECHNOLOGIES, INC.
6480 VIA DEL ORO DRIVE
SAN JOSE, CA 95119 USA

EUT DESCRIPTION: 802.11B WLAN WITH ADDITIONAL ANTENNA TYPES

MODEL NUMBER: CCRF-5020

DATE TESTED: MARCH 24 TO MARCH 28, 2003

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.

Approved & Released For CCS By:

MIKE HECKROTTE
CHIEF EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

Tested By:

CHIN PANG
ASSOCIATE EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

2. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

The EUT is a WLAN operating over the 2400 to 2483.5 MHz band with an output power of 17.2 dBm (52.5 mW). The highest antenna gain, including coaxial feed cable, is 17.8 dBi.

Below is a summary of the schematic changes made to the device.

(1) Optimized Power over Ethernet
(2) Optimized RF section for RX sensitivity – component value changes, etc.
(3) Changed from Molex to Tyco RJ-45 connector

Additional antennas and antenna types are added, as follows:

RF Exposure Antenna Summary

Network Systems Organization
Source Based

FCC ID: **H9PCCRF5020** WLAN RF Port AP DC Factor: 1.000
Output Power: 57.5 mW Class II Permissive Change Remote DC Factor: 1.000

Mobile Antennas (R>2m)

Ant No	Antenna Desc.	Symbol P/N	Type	Gain (dBi)	Cable Loss (dB)	Net Gain	Pout (dBm)	MPE (cm)	TR Status	Device Use
01.	Panel 8.5, 120° Sector	ML-2499-11PNA2-01	Panel	11.2	2.68	8.5	14.92	5.7	See # 11	Fixed Pt - MutiPt
02.	Panel 9.5, 65°	ML-2499-12PNA2-01	Panel	12.2	2.68	9.5	14.92	6.4	See # 11	Fixed Pt - MutiPt
03.	Panel 6.3, 80°, Diverse	ML-2499-7PNA2-01	Panel	7.6	1.34	6.3	16.26	4.4	See # 11	Fixed Pt - MutiPt
04.	Rubber Duck, Cushcraft	ML-2499-APA2-01	Dipole	2.0	0.00	2.0	17.60	2.7	See # 9	Fixed Pt - MutiPt
05.	Pipe Bomb 11" x 48"	ML-2499-HPA3-01	Dipole	6.2	1.34	4.9	16.26	3.7	See # 9	Fixed Pt - MutiPt
06.	Panel HD 6.3, 65°	ML-2499-PNAHD-01	Panel	7.6	1.34	6.3	16.26	4.4	See # 11	Fixed Pt - MutiPt
07.	Patch, 2.3, 48°	ML-2499-SD3-01	Patch	3.6	1.34	2.3	16.26	2.8	Tested	Fixed Pt - MutiPt
08.	Patch, Diversity	ML-2499-SDD1-01	Patch	3.6	1.34	2.3	16.26	2.8	See # 7	Fixed Pt - MutiPt
09.	Dipole 25" x 7"	ML-2499-BMMA1-01	Dipole	7.0	0.20	6.8	17.40	4.7	Tested	Fixed Pt - MutiPt
10.	Dish, 18, 10°	ML-2499-BPDA1-01	Dish	24.0	6.17	17.8	11.43	16.7	Tested	Fixed Pt - Pt
11.	Panel 14.5, 31°	ML-2499-BPNA3-01	Panel	14.5	0.33	14.2	17.26	10.9	Tested	Fixed Pt - Pt
12.	Yagi, 13.6, 34°	ML-2499-BYGA2-01	Yagi	13.9	0.33	13.6	17.26	10.2	Tested	Fixed Pt - Pt

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

4.1. FACILITIES AND EQUIPMENT

The open area test sites and conducted measurement facilities used to collect the radiated data are located at 561F Monterey Road, Morgan Hill, California, USA. The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

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

4.2. TABLE OF ACCREDITATIONS AND LISTINGS

Country	Agency	Scope of Accreditation	Logo
USA	FCC	3/10 meter Open Area Test Sites to perform FCC Part 15/18 measurements	1300
Japan	VCCI	CISPR 22 Two OATS and one conducted Site	R-1014, R-619, C-640
Norway	NEMKO	EN50081-1, EN50081-2, EN50082-1, EN50082-2, IEC61000-6-1, IEC61000-6-2, EN50083-2, EN50091-2, EN50130-4, EN55011, EN55013, EN55014-1, EN55104, EN55015, EN61547, EN55022, EN55024, EN61000-3-2, EN61000-3-3, EN60945, EN61326-1	ELA 117
Norway	NEMKO	EN60601-1-2 and IEC 60601-1-2, the Collateral Standards for Electro-Medical Products. MDD, 93/42/EEC, AIMD 90/385/EEC	ELA-171
Taiwan	BSMI	CNS 13438	SL2-IN-E-1012
Canada	Industry Canada	RSS210 Low Power Transmitter and Receiver	IC2324 A,B,C, and F

5. CALIBRATION AND UNCERTAINTY

5.1. MEASURING INSTRUMENT CALIBRATION

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

5.2. MEASUREMENT UNCERTAINTY

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

Radiated Emission	
30MHz – 200 MHz	+/- 3.3dB
200MHz – 1000MHz	+4.5/-2.9dB
1000MHz – 2000MHz	+4.6/-2.2dB
Power Line Conducted Emission	
150kHz – 30MHz	+/-2.9

5.3. TEST AND MEASUREMENT EQUIPMENT

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

TEST AND MEASUREMENT EQUIPMENT LIST				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due Date
Quasi-Peak Adapter	HP	85650B	3014A06685	6/28/03
SA Display Section 3	HP	85662A	3026A19146	6/28/03
SA RF Section 1.5GHZ	MITEQ	NSP2600-44	646456	4/26/03
Preamplifier	HP	8447D	2944A06550	8/22/03
Horn Antenna (1 - 18GHz)	EMCO	3115	6739	2/4/04
Antenna, Biconical	Eaton	94455-1	1214	3/06/04
Antenna, Log Periodic 200-1000MHz	EMCO	3146	9107-3163	3/06/04
Preamplifier	Miteq	NSP10023988	646456	4/26/03
Spectrum Analyzer	HP	8593EM	3710A00205	6/11/03
High Pass Filter (4.57GHz)	FSY Microwave	FM-4570-9SS	003	N.C.R.

6. SUPPORT EQUIPMENT / EUT SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Device Type	Manufacturer	Model	Serial Number	FCC ID
Laptop	Dell	PPL	NA	DoC
Ethernet Hub	Accton	EN2040	NA	DoC
LAN Hub	PowerD Sine	4001	A02126015000044	DoC
AC Adapter	Netgear	48121003CT	PWR-002-004	NA
AC Adapter	Dell	DA-2	85391	NA
Disk Antenna	Cushcraft	ML-2499-BP0A1-01	S24024PDSNF	NA

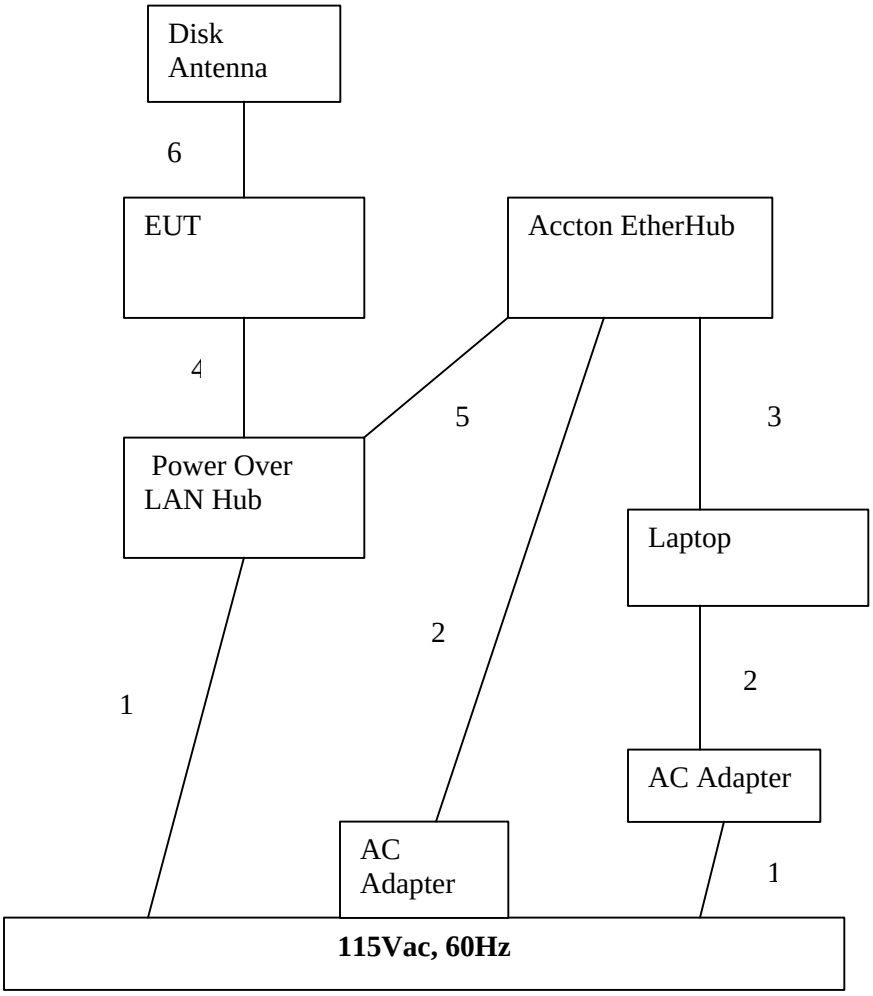
I/O CABLES

Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	US115V	Un-Shielded	2m	NA
2	DC	2	DC	Un-Shielded	2m	NA
3,4	Hub	1	RJ45	Un-Shielded	2m	NA
5	Hub	1	RJ45	Un-Shielded	5m	NA
6	RF	1	Coax	Shielded	5m	NA

TEST SETUP

The EUT was operated as a standalone device, using an Ethernet connection to make setup adjustments. Each antenna is external.

SETUP DIAGRAM



7. APPLICABLE RULES AND RESULT

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.

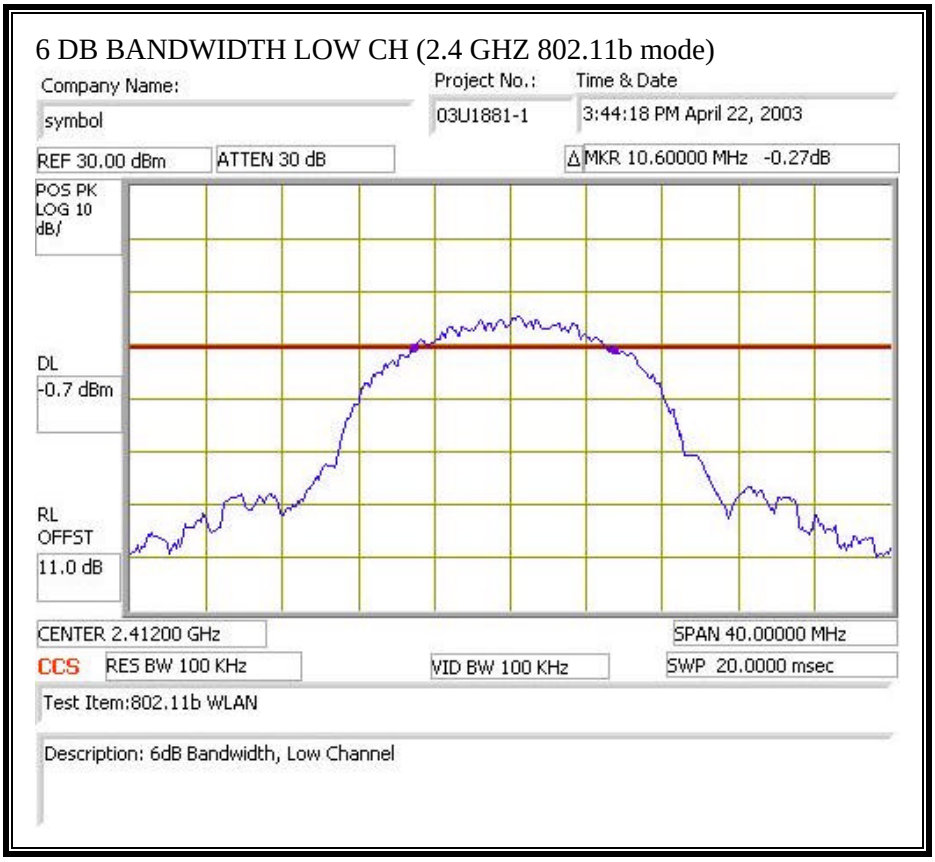
RESULTS

No non-compliance noted:

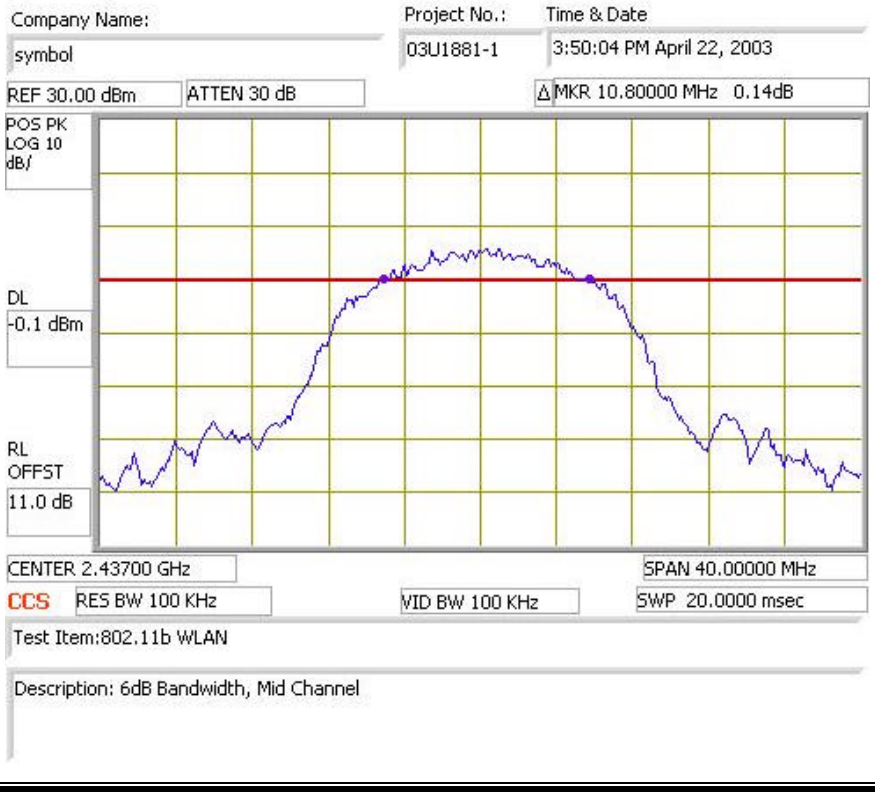
802.11b Mode

Channel	Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)
Low	2412	10600	500
Middle	2437	10800	500
High	2462	10100	500

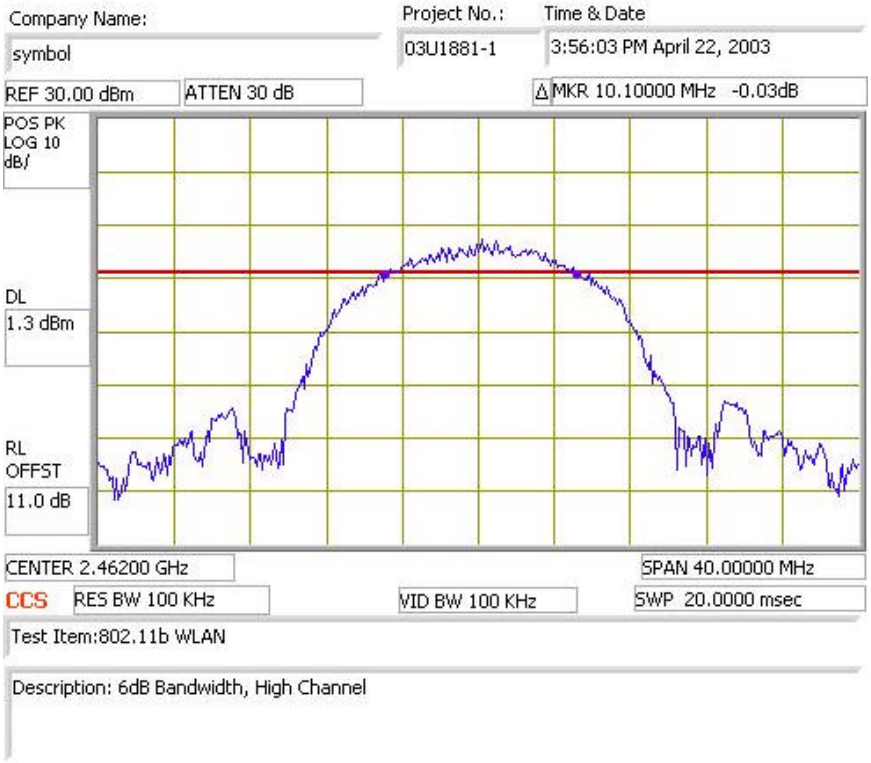
6 DB BANDWIDTH (802.11b MODE)



6 DB BANDWIDTH MID CH (2.4 GHZ 802.11b mode)



6 DB BANDWIDTH HIGH CH (2.4 GHZ 802.11b mode)



7.2. 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 17.8 dBi, including coaxial feed cable, therefore the limit is 18.2 dBm.

AVERAGE POWER LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter. The power meter is set to simultaneously read peak power and average power.

RESULTS

No non-compliance noted:

2.4 GHz BAND RESULTS

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

2.4 GHz Band, 802.11b Mode

Channel	Frequency (MHz)	Average (dBm)	Peak (dBm)	Limit (dBm)	Margin (dB)
Low	2412	12.91	16.71	18.2	-1.49
Middle	2437	13.4	17.2	18.2	-1
High	2462	12.8	16.7	18.2	-1.5

7.3. MAXIMUM PERMISSIBLE EXPOSURE

LIMITS

§15.247 (b) (5) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of this chapter.

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 mW and 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

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

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

S = 1.0 mW / cm^2 from 1.1310 Table 1

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.

RESULTS

No non-compliance noted:

MPE DISTANCE (2.4 GHZ 802.11b MODE)

MPE Distance = 15.85 cm

7.4. 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 >= 3KHz, 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.

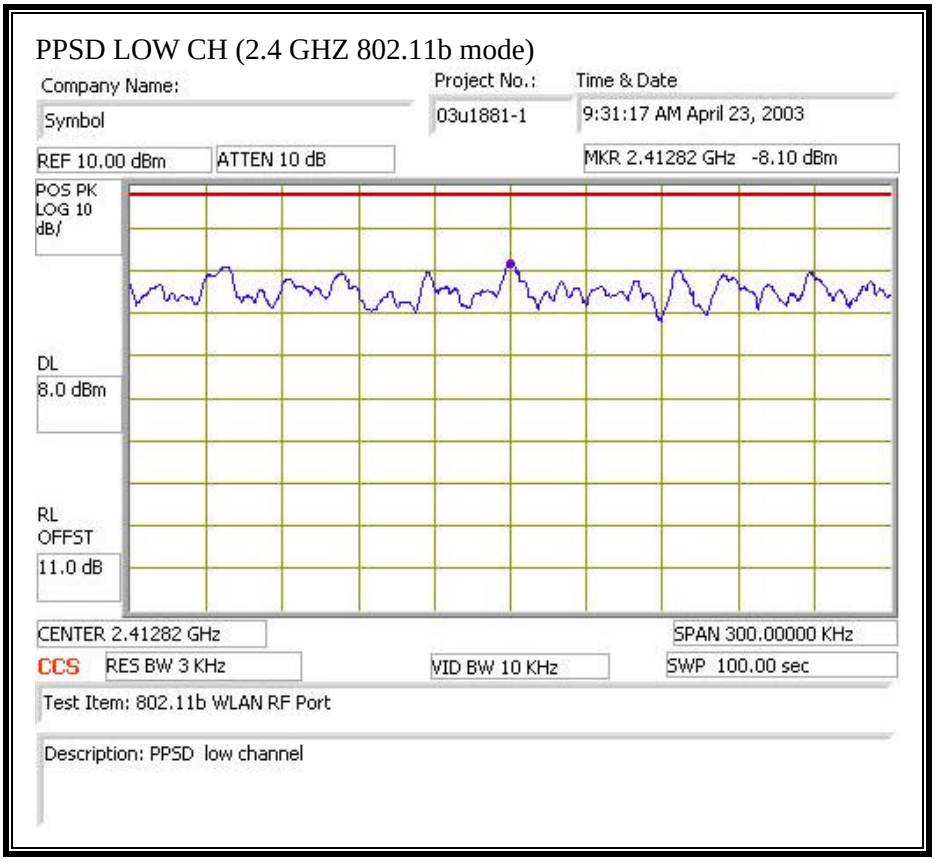
RESULTS

No non-compliance noted:

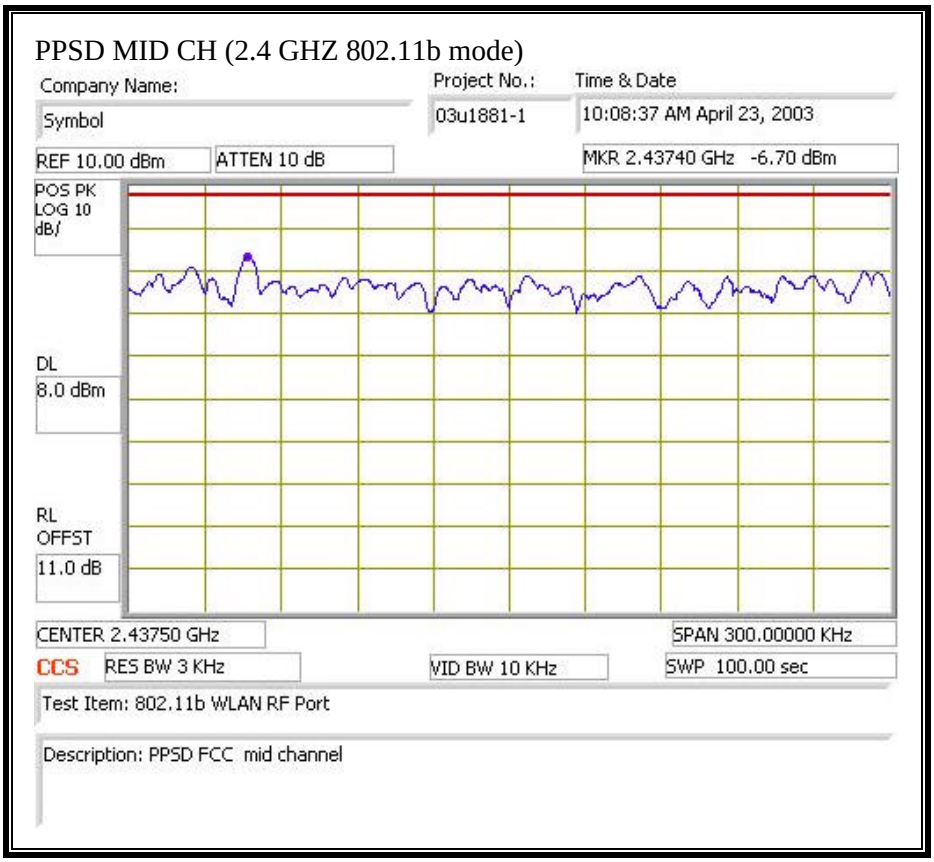
2.4 GHz Band, 802.11b Mode

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-8.1	8	-16.1
Middle	2437	-6.7	8	-14.7
High	2462	-8.1	8	-16.1

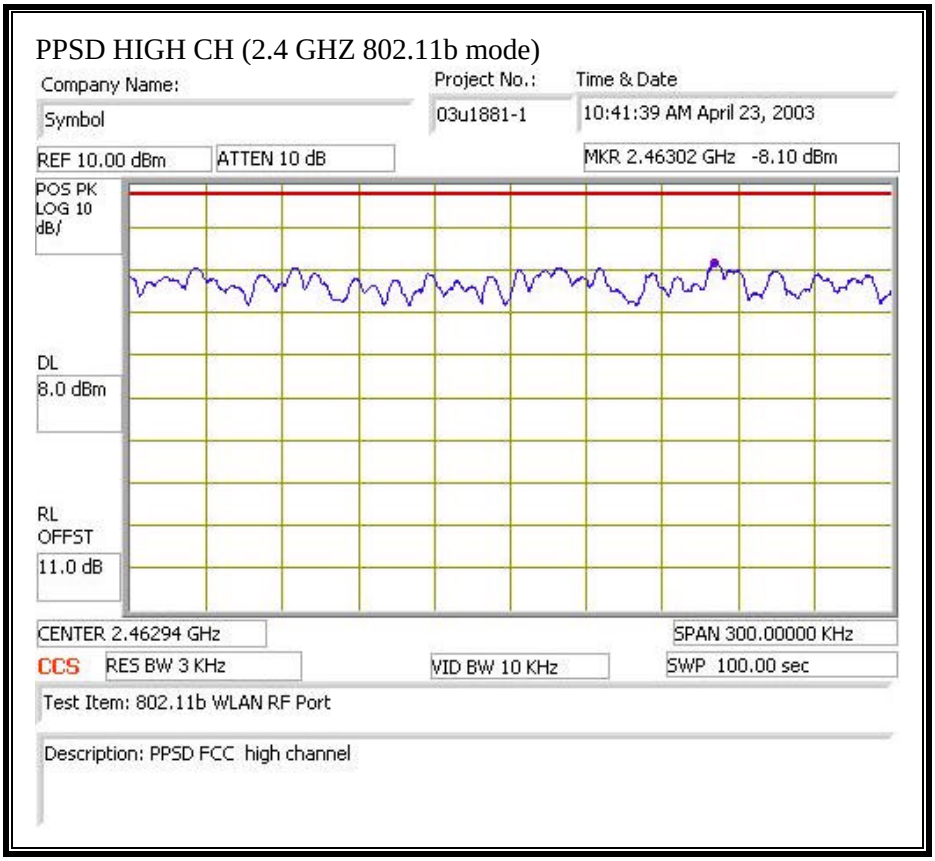
PEAK POWER SPECTRAL DENSITY (802.11b MODE)



PPSD MID CH (2.4 GHZ 802.11b mode)



PPSD HIGH CH (2.4 GHZ 802.11b mode)



7.5. 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 100 kHz.

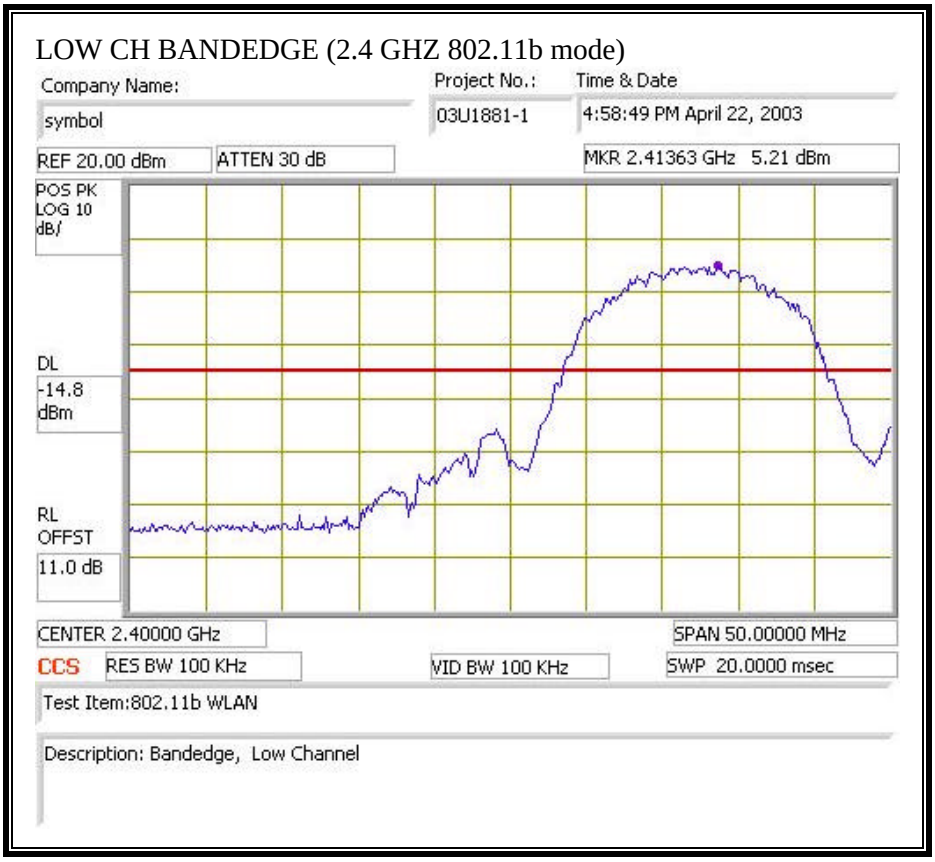
Measurements are made over the 30 MHz to 26.5 GHz range with the transmitter set to the lowest, middle, and highest channels within the 2.4 GHz band.

Measurements are made over the 30 MHz to 40 GHz range with the transmitter set to the lowest, middle, and highest channels within the 5.8 GHz band.

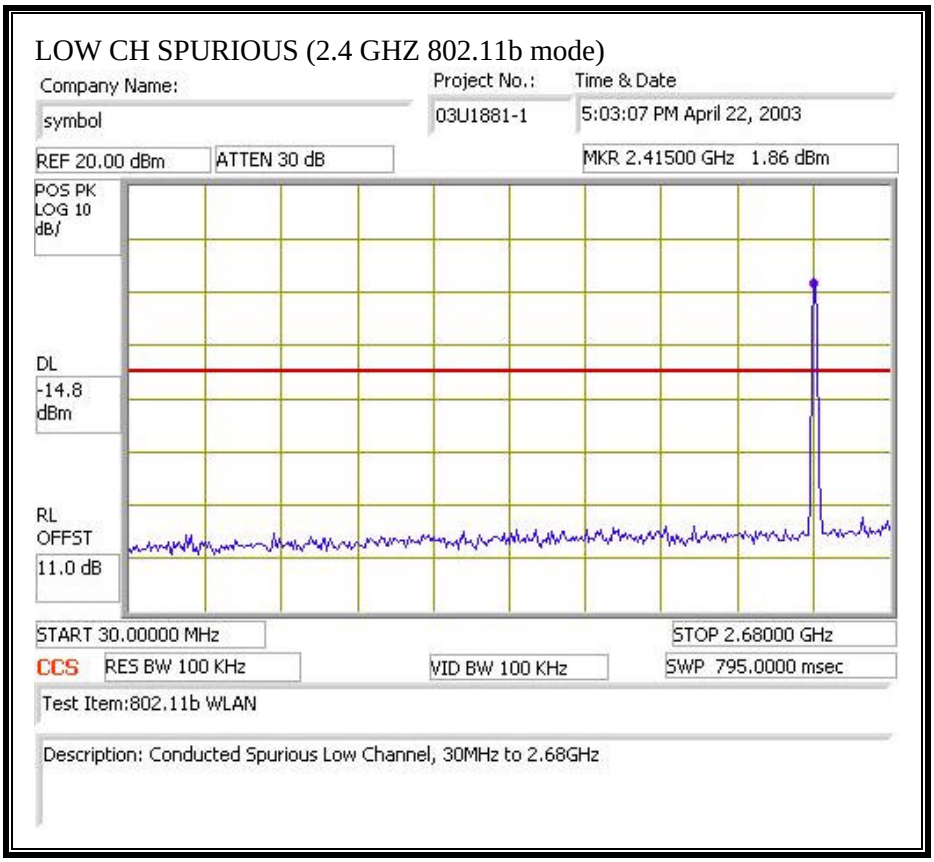
RESULTS

No non-compliance noted:

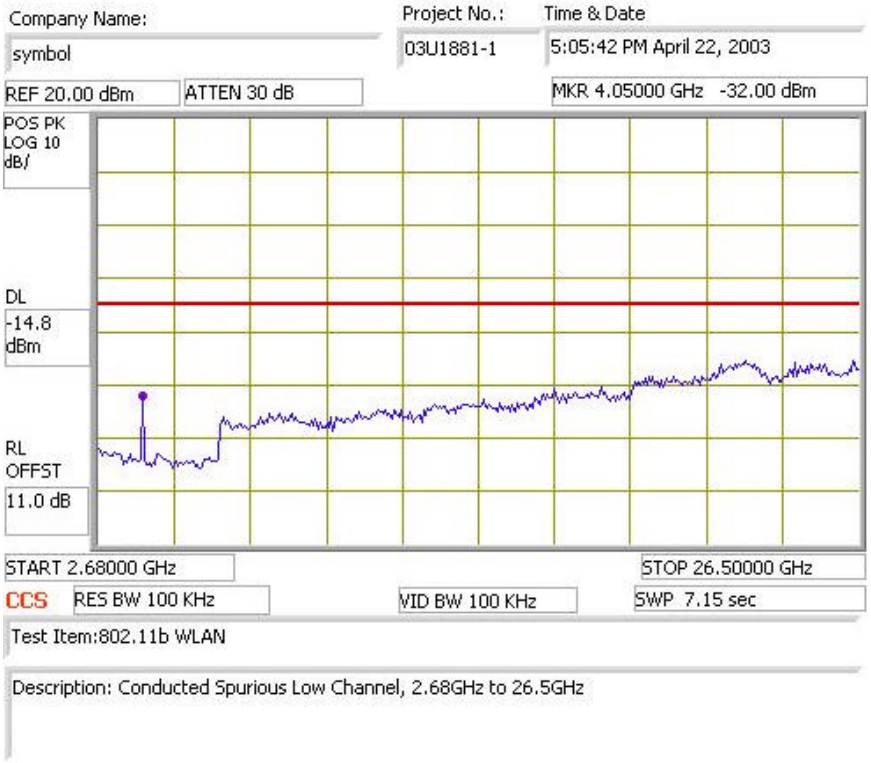
CONDUCTED SPURIOUS EMISSIONS, LOW CHANNEL (802.11b MODE)



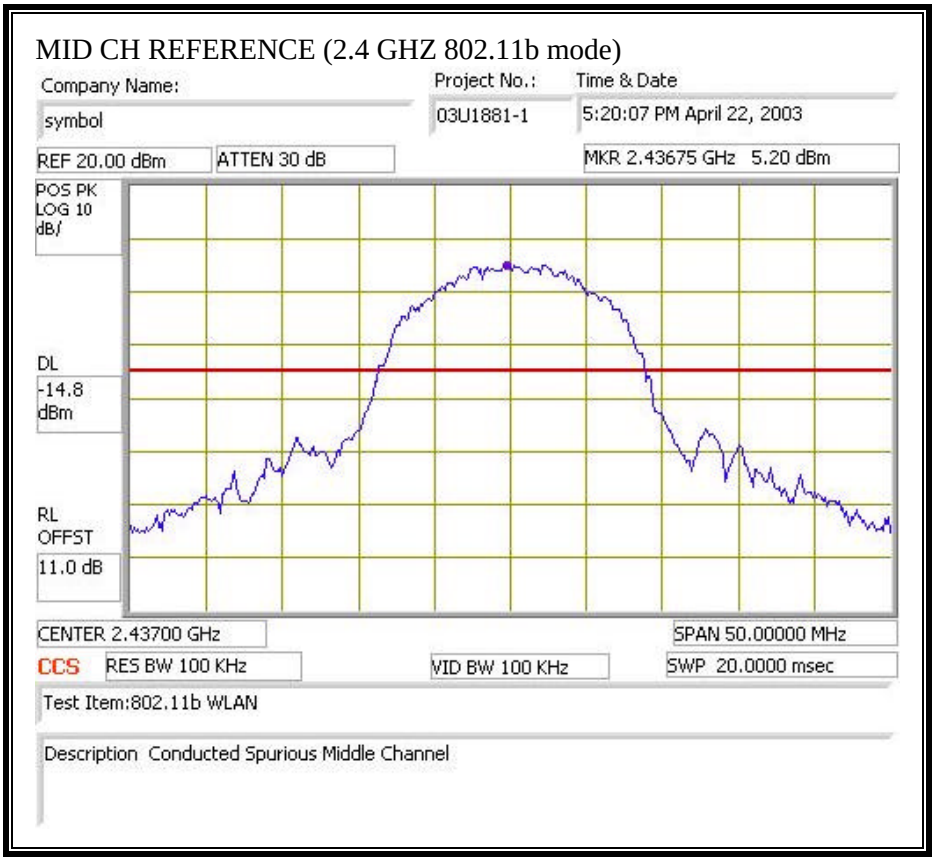
LOW CH SPURIOUS (2.4 GHZ 802.11b mode)



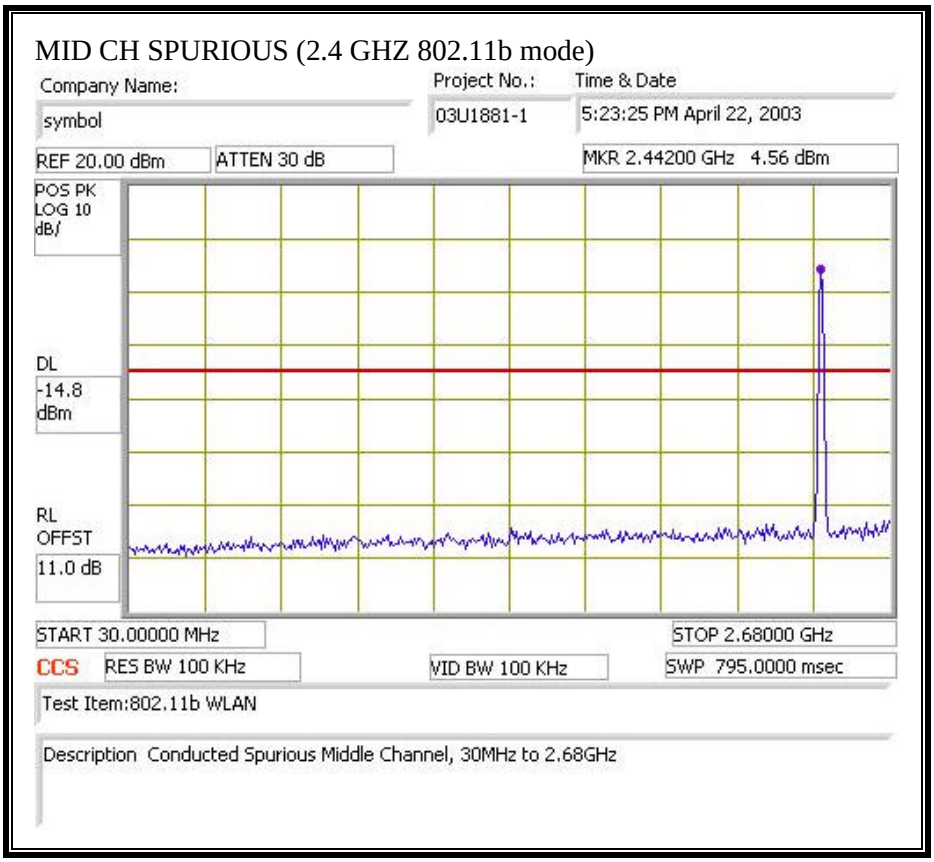
LOW CHANNEL SPURIOUS 2 (2.4 GHZ 802.11b mode)



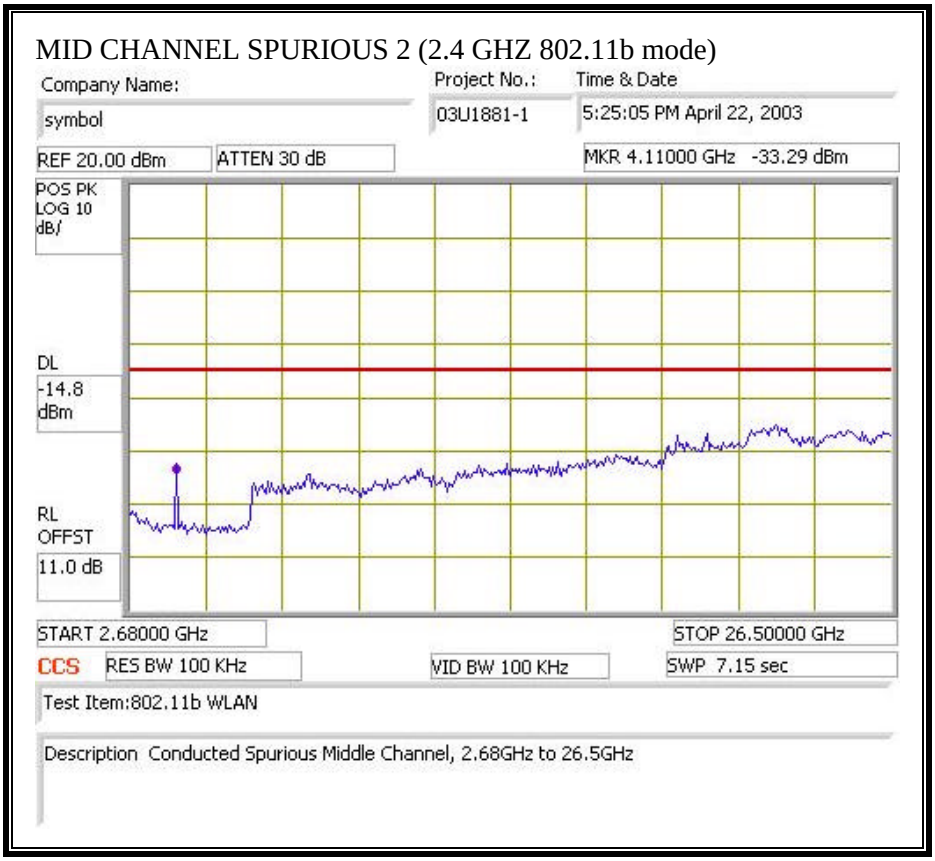
CONDUCTED SPURIOUS EMISSIONS, MID CHANNEL (802.11b MODE)



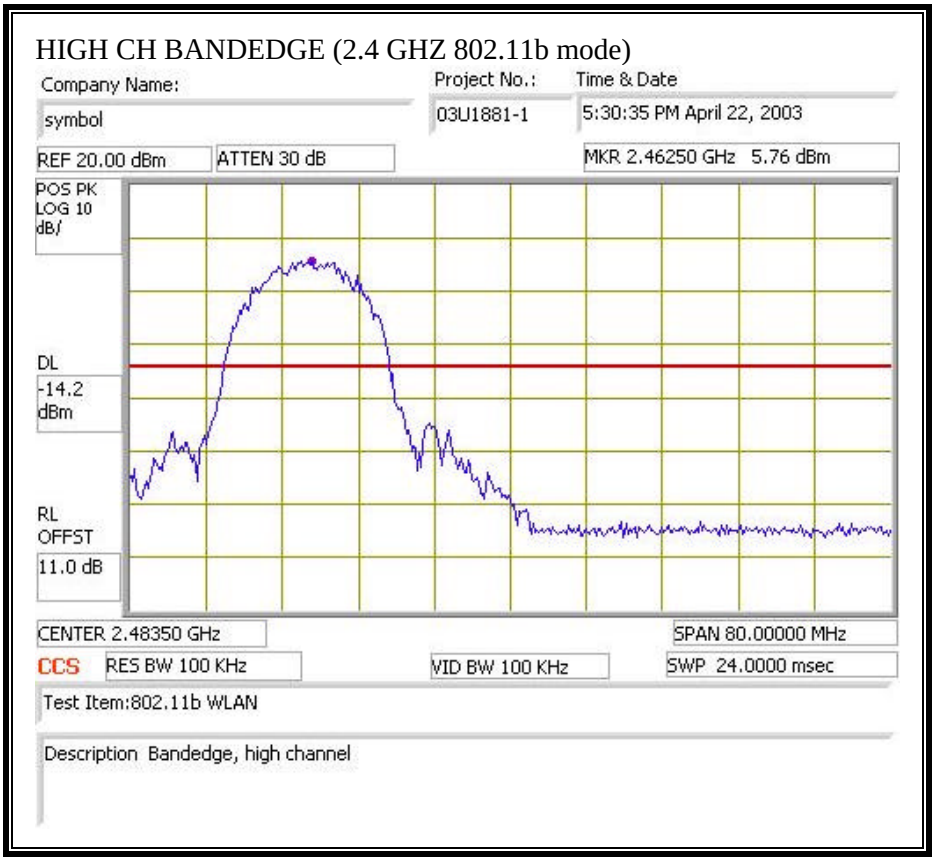
MID CH SPURIOUS (2.4 GHZ 802.11b mode)



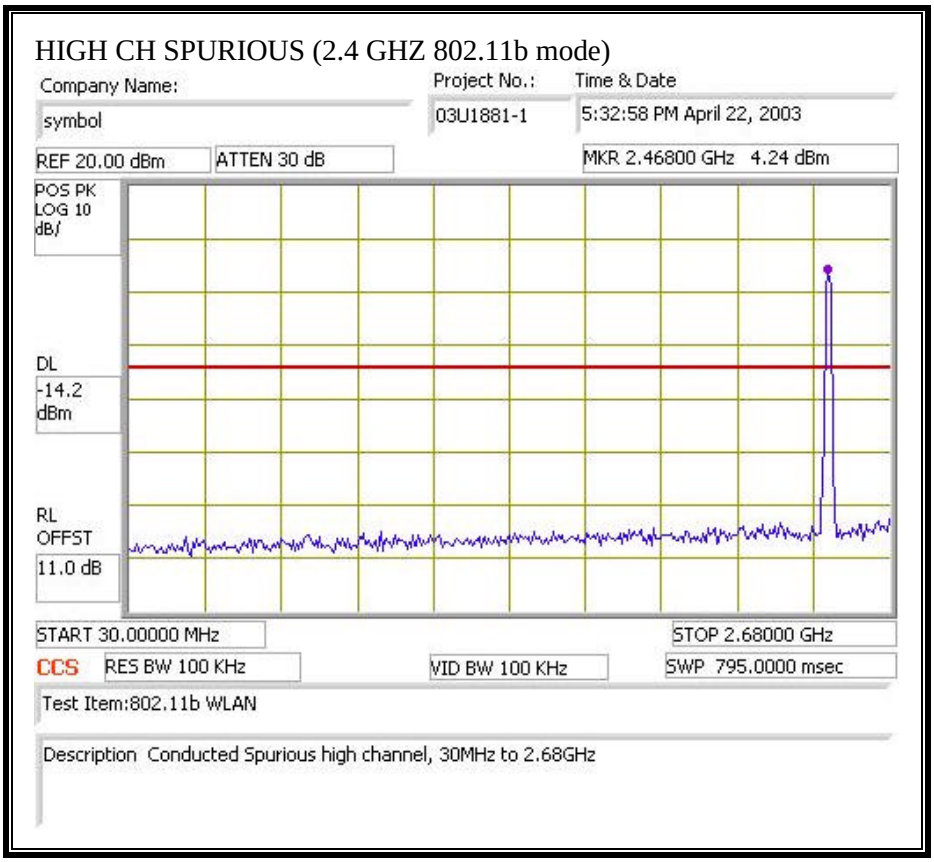
MID CHANNEL SPURIOUS 2 (2.4 GHZ 802.11b mode)



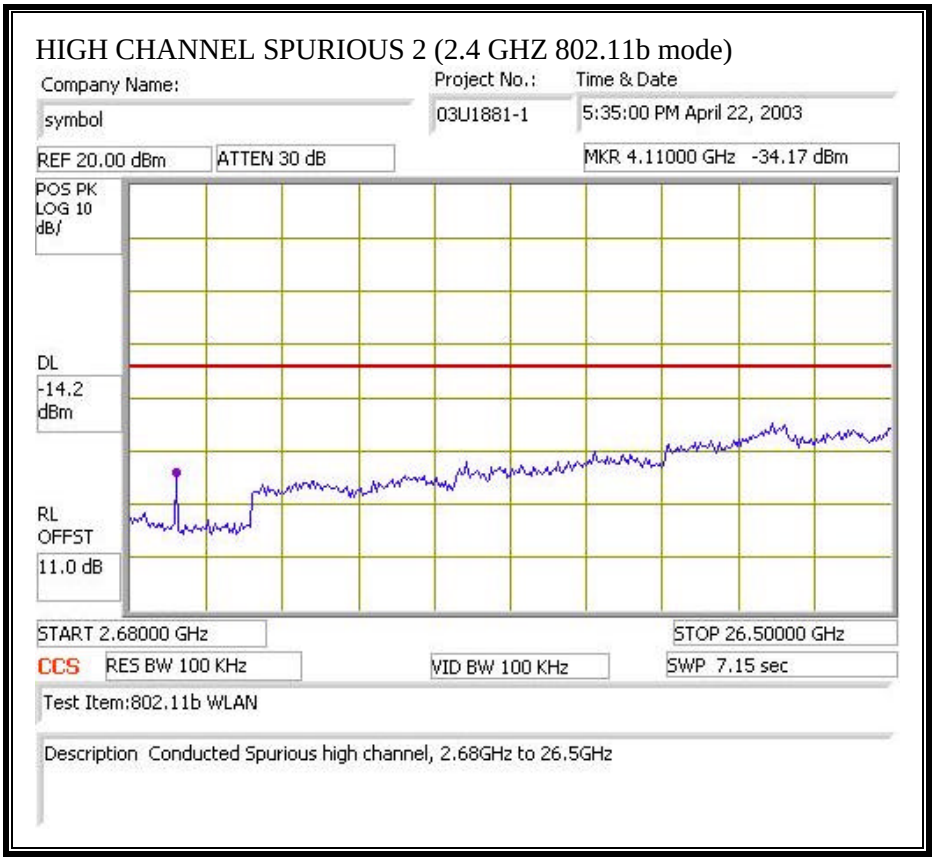
CONDUCTED SPURIOUS EMISSIONS, HIGH CHANNEL (802.11b MODE)



HIGH CH SPURIOUS (2.4 GHZ 802.11b mode)



HIGH CHANNEL SPURIOUS 2 (2.4 GHZ 802.11b mode)



7.6. 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.

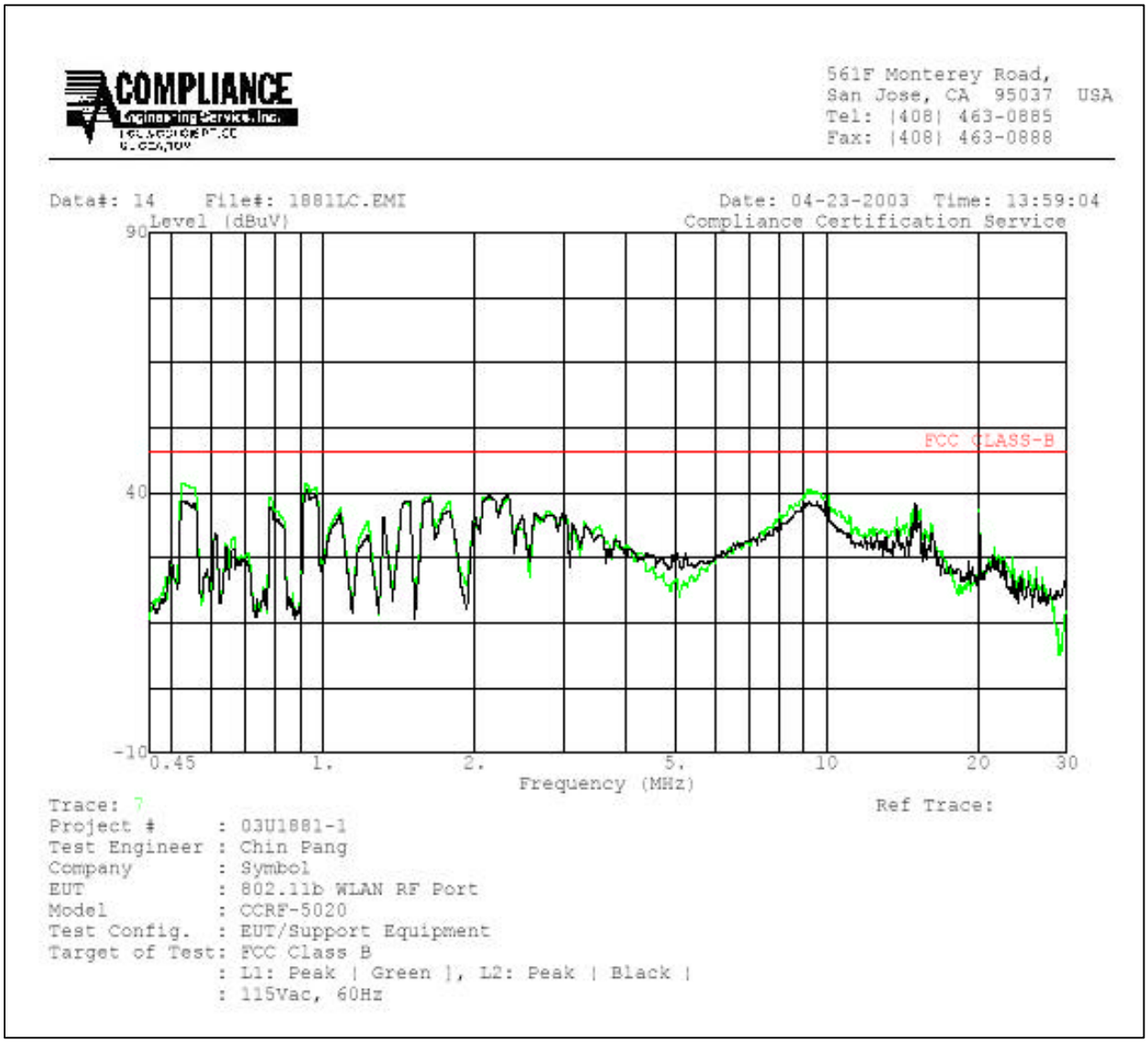
The EUT is configured in accordance with ANSI C63.4/2001.

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

CONDUCTED EMISSIONS DATA (115VAC 60Hz)									
Freq.	Reading			Closs	Limit	FCC_B	Margin		Remark
(MHz)	PK (dBuV)	QP (dBuV)	AV (dBuV)	(dB)	QP	AV	QP (dB)	AV (dB)	L1 / L2
0.53	41.72	--	--	0.00	48.00	--	-6.28	--	L1
0.93	42.24	--	--	0.00	48.00	--	-5.76	--	L1
9.25	41.05	--	--	0.00	48.00	--	-6.95	--	L1
0.93	40.22	--	--	0.00	48.00	--	-7.78	--	L2
2.16	40.12	--	--	0.00	48.00	--	-7.88	--	L2
10.02	41.02	--	--	0.00	48.00	--	-6.98	--	L2
6 Worst Data									



7.7. RADIATED EMISSIONS

§15.205- RESTRICTED BANDS OF OPERATIONS

(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

(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- RADIATED EMISSION LIMITS

(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.

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

TEST SETUP

The EUT is placed on the wooden table. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4/1992.

The EUT is set to transmit in a continuous mode. For each antenna type, the highest gain version is tested.

TEST PROCEDURE

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.

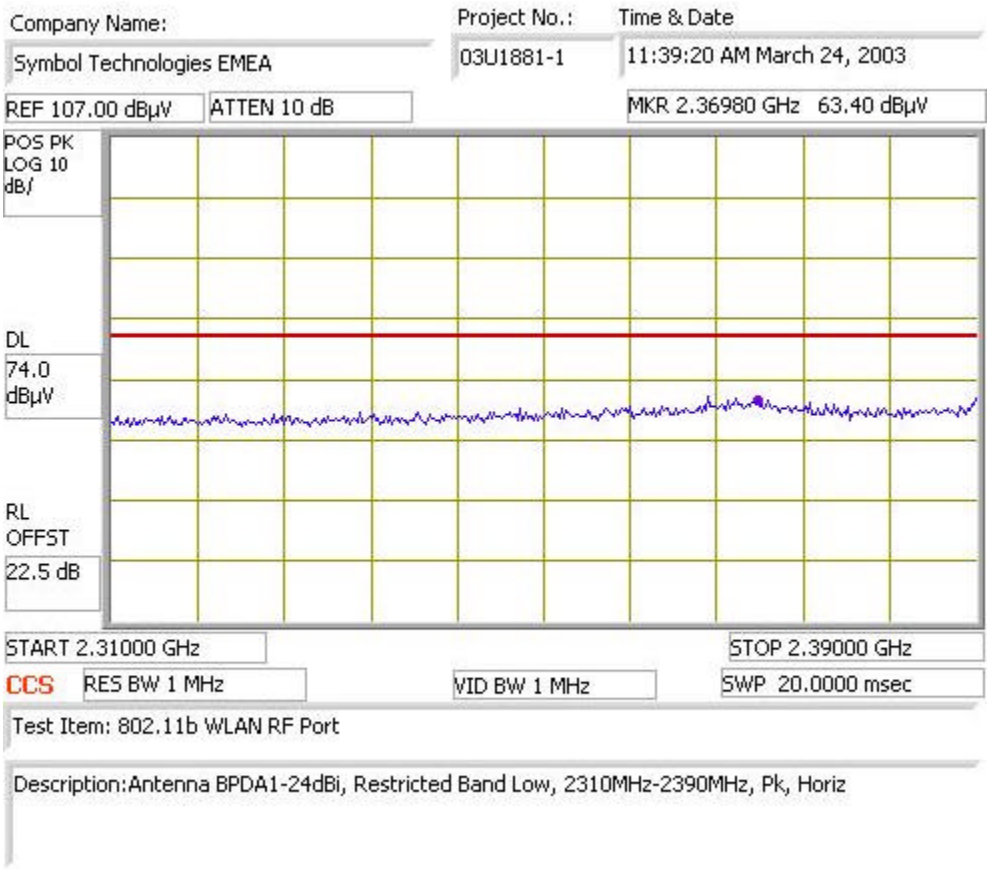
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

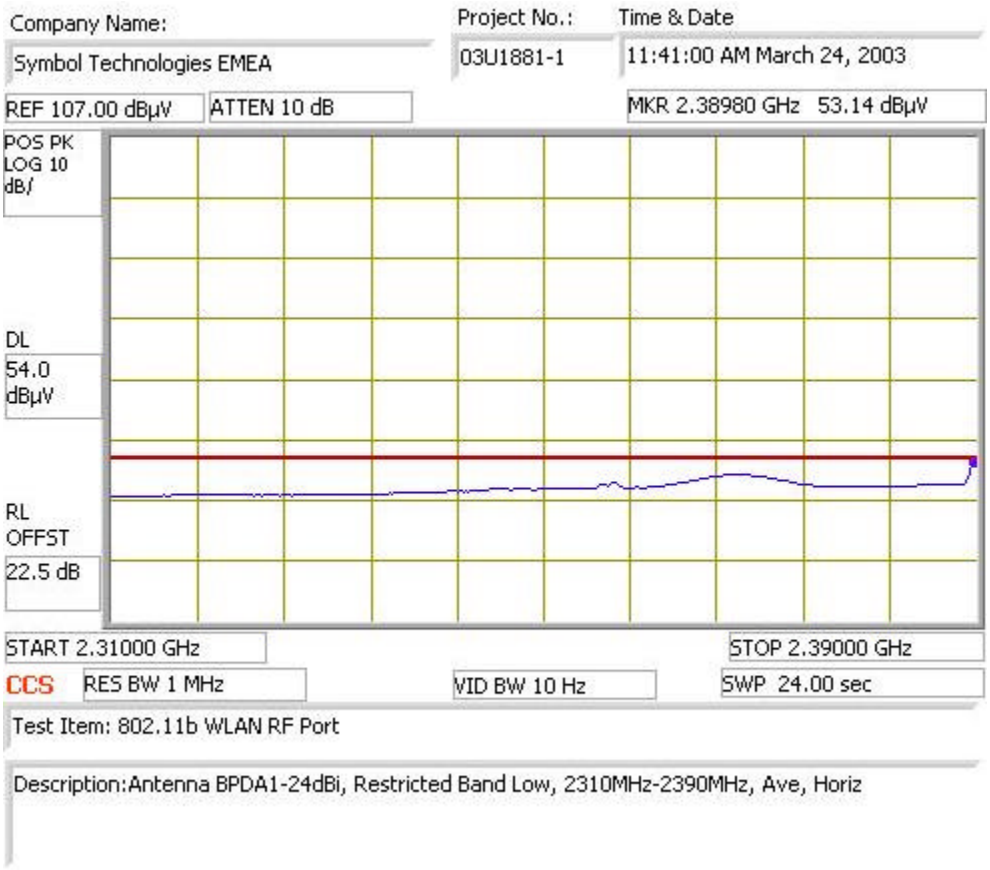
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The frequency span is set small enough to easily differentiate between broadcast stations, intermittent ambient signals and EUT emissions. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the suspected signal. Measurements were made with the antenna polarized in both the vertical and the horizontal positions.

7.7.1. DISH ANTENNA RESULTS

SETUP PHOTO

ADJACENT RESTRICTED BAND (LOW CHANNEL, HORIZONTAL)





ADJACENT RESTRICTED BAND (LOW CHANNEL, VERTICAL)