



**FCC CFR47 PART 15 SUBPART E  
CLASS II PERMISSIVE CHANGE  
CERTIFICATION TEST REPORT**

**FOR**

**802.11ag /DRAFT 802.11n WIRELESS LAN PCI-E MINI CARD**

**MODEL NUMBER: BCM94321MC**

**FCC ID: QDS-BRCM1022**

**REPORT NUMBER: 07U11296-2**

**ISSUE DATE: OCTOBER 2, 2007**

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**NVLAP**<sup>®</sup>

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue	Date	Revisions	Revised By
--		10/02/07	Initial Issue	Hsin Fu Shih

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** BROADCOM CORPORATION  
190 MATHILDA PLACE  
SUNNYVALE, CA 94086, USA

**EUT DESCRIPTION:** 802.11ag /DRAFT 802.11n WIRELESS LAN PCI-E MINI CARD

**MODEL:** BCM94321MC

**SERIAL NUMBER:** CN-0SE2C2-70166-77L-001M

**DATE TESTED:** SEPTEMBER 24 – 25, 2007

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 15 SUBPART E	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.

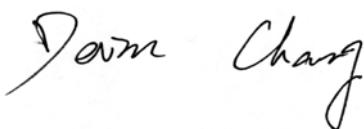
**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions 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:



HSIN FU SHIH  
ENGINEERING SUPERVISOR  
COMPLIANCE CERTIFICATION SERVICES

Tested By:



DEVIN CHANG  
EMC ENGINEER  
COMPLIANCE CERTIFICATION SERVICES

## 2. TEST METHODOLOGY

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

## 3. FACILITIES AND ACCREDITATION

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

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

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

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

### 4.2. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radiated Emission, 30 to 200 MHz	+/- 3.3 dB
Radiated Emission, 200 to 1000 MHz	+4.5 / -2.9 dB
Radiated Emission, 1000 to 2000 MHz	+4.5 / -2.9 dB
Radiated Emission, Above 2000 MHz	+/- 43 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 chipset. The chipset is installed on a Mini PCI-E card, model number BCM94321MC.

The radio module is manufactured by Broadcom Corp.

### 5.2. CLASS II PERMISSIVE CHANGE DESCRIPTION

Add portable platform, Dell PP29L (Spears) and PP28L (Hawke)

The antennas used on Dell PP29L (Spears) and PP28L (Hawke) are the same type as WNC 81.ED415.002 and Hitachi HFT17-DL03, which are already certified in previous filing for FCC ID: QDS-BRCM1022, and have lower gains.

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The EUT has 2 Tx/Rx antennas that are automatically selected for use as per the MCS index and STF mode selections. Preliminary testing was performed on all antennas to determine the worst case final testing was performed on the worst case (Aux antenna - Spear Acon for 2.4 GHz & Spear WNC for 5GHz).

Antenna gain list:

Frequency band	Antenna	Hawke (PP28L)		Spears (PP29L)	
		Max gain (dBi)		Max gain (dBi)	
		ACON	WNC	ACON	WNC
2.4GHz	Main	2.3	2.24	-0.3	0.44
	Aux	0	1.62	<b>3.1</b>	2.92
5.8GHz	Main	-1.4	1.03	0	1.11
	Aux	0.1	-0.1	-0.4	<b>0.87</b>
5.2GHz	Main	-1.8	1.89	-0.5	1.49
	Aux	-0.3	-0.13	-0.7	<b>0.06</b>

### 5.4. SOFTWARE AND FIRMWARE

The EUT was tested in the following manner:

- “epi\_ttcp.exe” was used to transmit UDP packets to a broadcast IP address (192.168.66.255) – i.e. no ACK required. This test mode sends a continuous packetized data stream with duty cycles that vary dependant upon data rate/MCS Index selected.
- “wl ampdu” and “frameburst” were enabled to ensure worst case data packet transfer and duty cycle.
  - Worst case packet length have also been used to ensure max duty cycle.

## 5.5. WORST-CASE CONFIGURATION AND MODE

Operating modes were changed directly in software with no other changes to the set up. Power levels were verified across all the MCS Index at the start of test and as required throughout testing.

Prior to each test a power meter was used to tune the gated average power within a Tx packet. The channel gates on the meter were set to ensure that, at the time of recording, only packet power was captured without including duty cycle off time.

Power was tuned for different modes, channels and antennas based on the power tuning table contained in the Operational Description submitted under the same filing.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

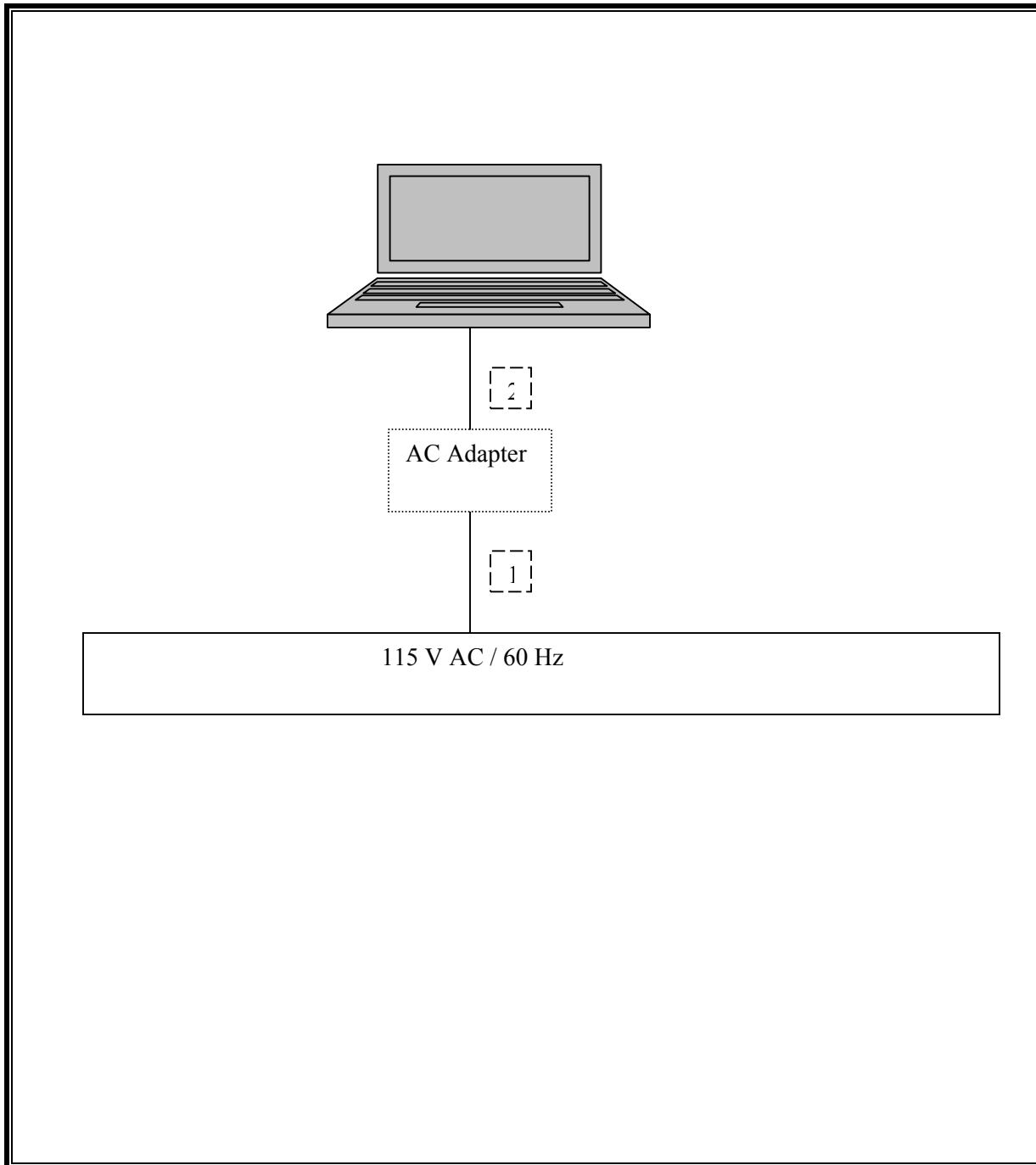
PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop PC	Dell	Inspiron 1526	CN-0SE2C2-70166-77L-001M	DOC
AC Adapter	Dell	DA65NS0-00	CF745	DOC

### I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	AC	Unshielded	0.8 m	N/A
2	DC	1	DC	Unshielded	1.8 m	N/A

### TEST SETUP

The EUT is installed in a host laptop computer. 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	S/N	Cal Due
EMI Test Receiver	R & S	ESHS 20	827129/006	1/27/08
LISN, 10 kHz ~ 30 MHz	FCC	LISN-50/250-25-2	2023	10/15/07
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	8379443	10/15/07
SA RF Section, 1.5 GHz	Agilent / HP	85680B	2814A04227	1/7/08
SA Display Section 2	Agilent / HP	85662A	2816A16696	4/7/08
Quasi-Peak Adaptor	Agilent / HP	85650A	3145A01654	1/21/08
Preamplifier, 1 ~ 26.5 GHz	Agilent / HP	8449B	3008A00931	8/3/08
Antenna, Horn 1 ~ 18 GHz	EMCO	3115	2238	4/15/08
Antenna, Bilog 30 MHz ~ 2 Ghz	Sunol Sciences	JB1	A121003	10/13/07
Preamp 30-1000MHz	Sonoma	310N	185623	1/20/08
Spectrum Analyzer 3 Hz ~ 44 GHz	Agilent / HP	E4446A	MY43360112	8/7/08
Peak Power Meter	Agilent	E4416A	GB41291160	12/2/07
Peak / Average Power Sensor	Agilent	E9327A	US40440755	12/2/07
2.4-2.5 GHz Reject Filter	Micro-Tronics	BRM50702	1	CNR

## 7. LIMITS AND RESULTS

### 7.1. RADIATED EMISSIONS

#### 7.1.1. 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
<sup>1</sup> 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	( <sup>2</sup> )
13.36 - 13.41			

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

<sup>2</sup> 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 in the 2.4 GHz band.

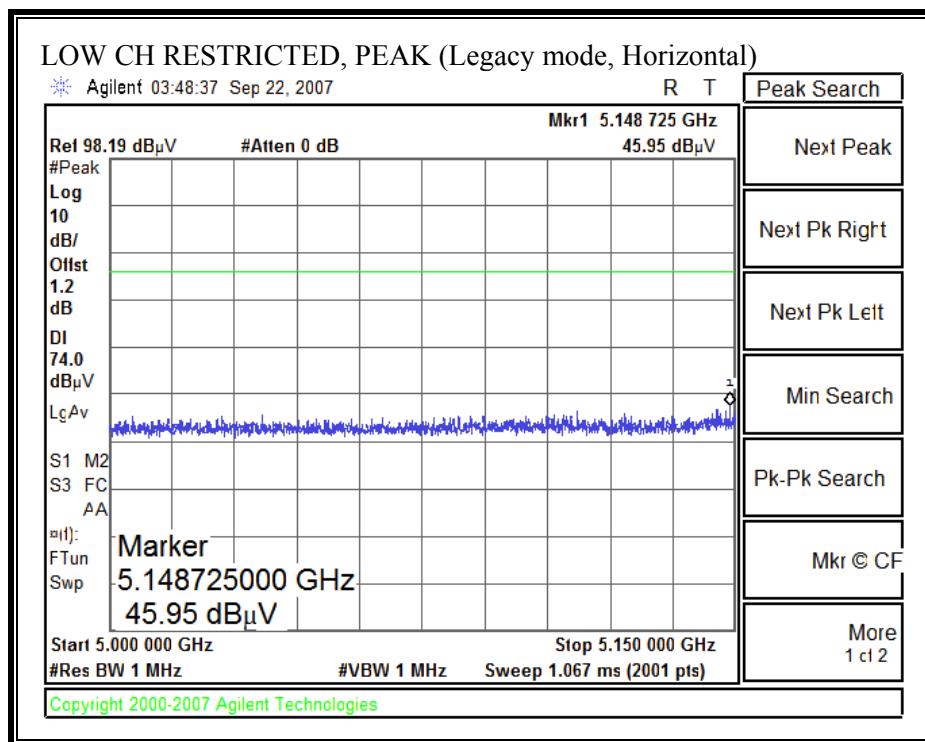
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each 5 GHz band.

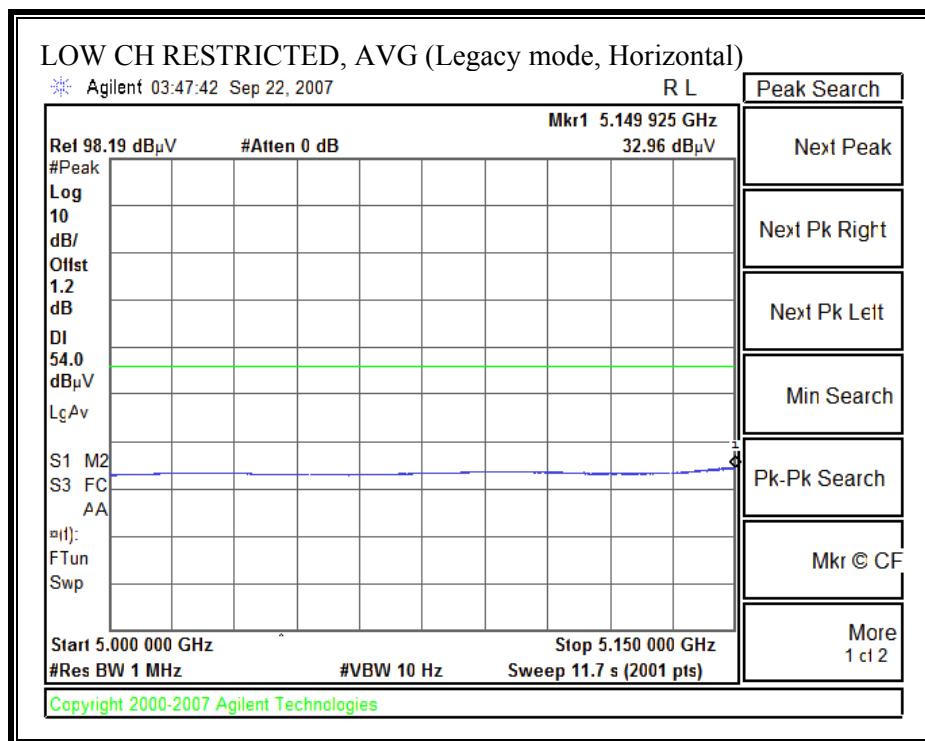
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

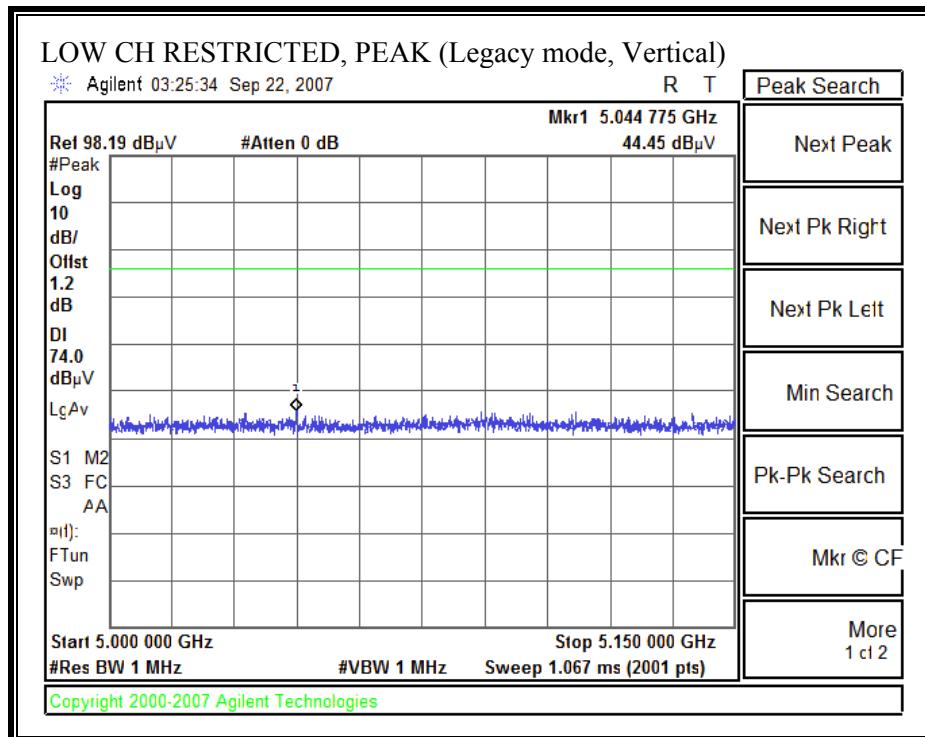
### 7.1.2. TRANSMITTER ABOVE 1 GHZ FOR 5150 TO 5350 MHz BAND

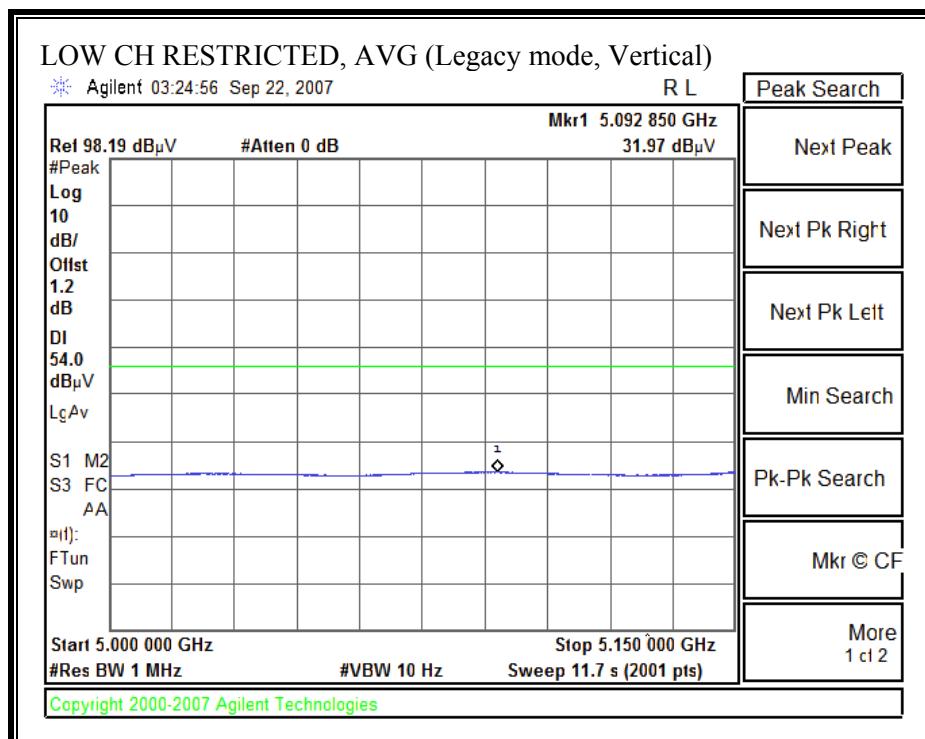
#### RESTRICTED BANDEDGE (Legacy MODE, LOW CHANNEL, 5180MHz, HORIZONTAL)

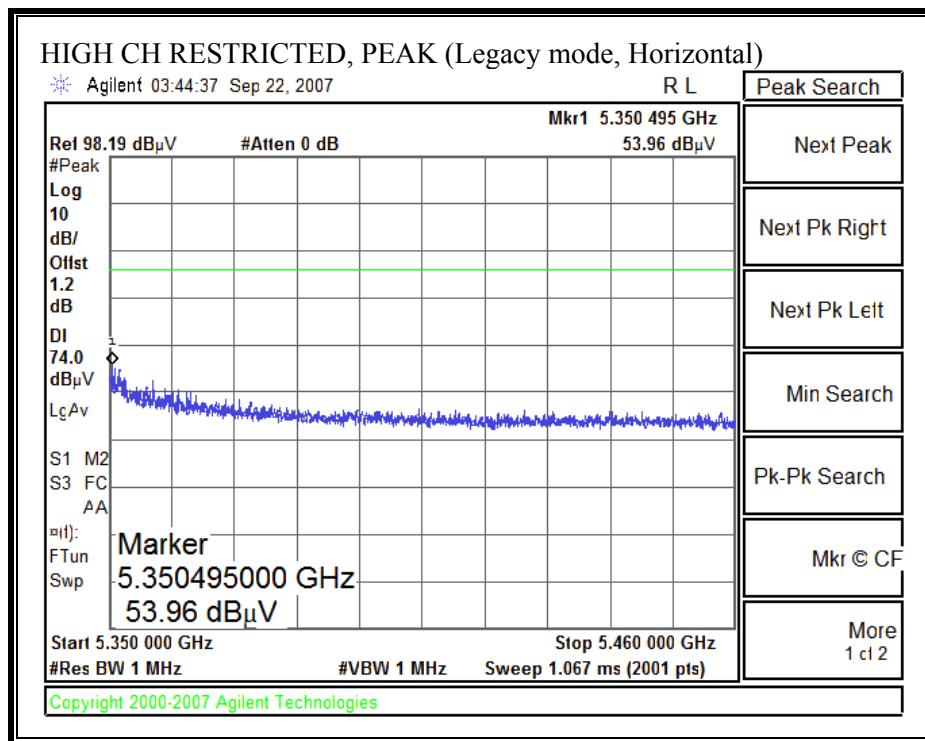
##### Antenna - Spear WNC Aux Antenna

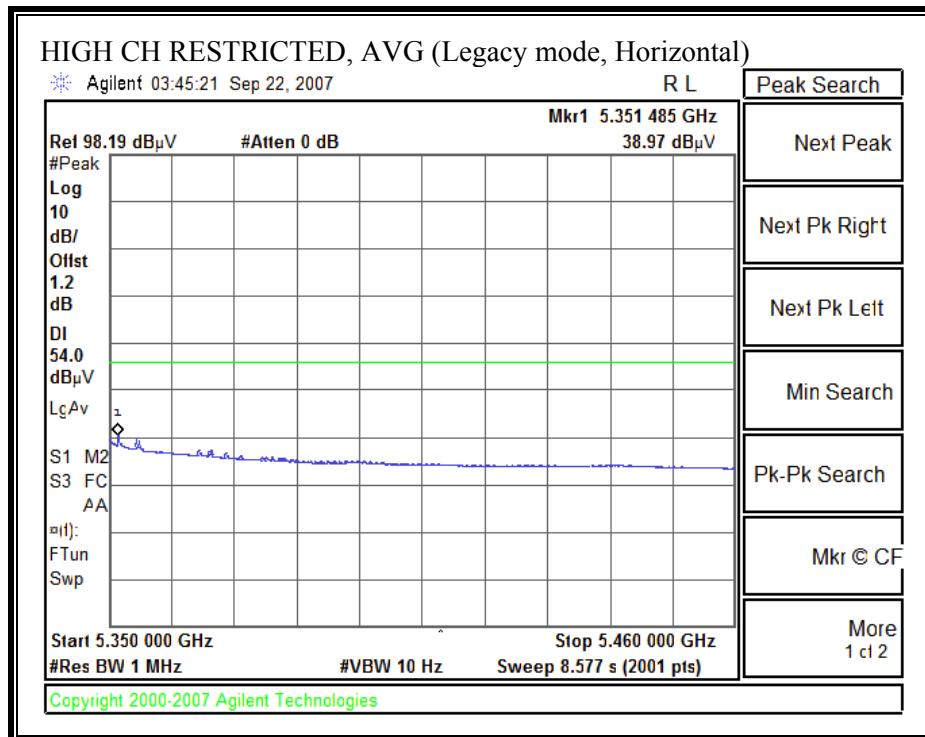


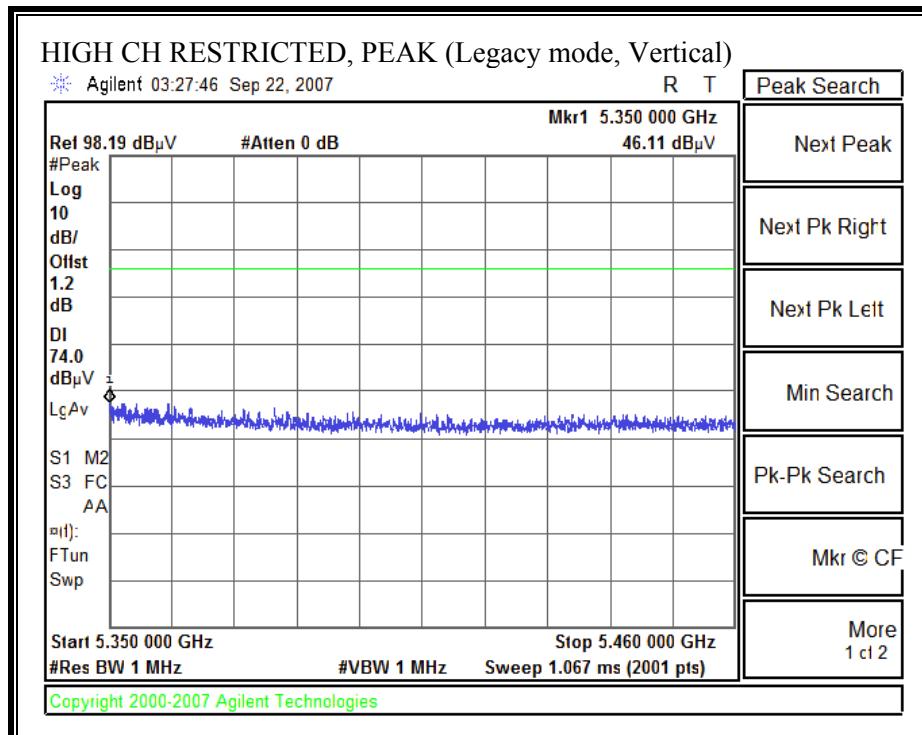
**Antenna - Spear WNC Aux Antenna**

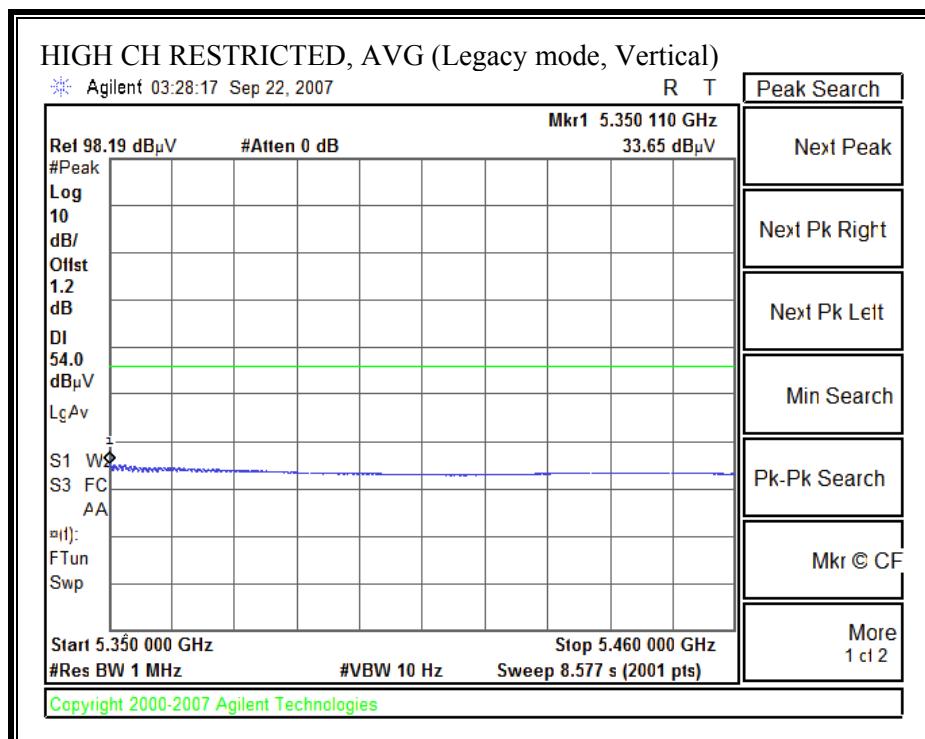
**RESTRICTED BANDEDGE (Legacy MODE, LOW CHANNEL, 5180MHz, VERTICAL)****Antenna - Spear WNC Aux Antenna**

Antenna - Spear WNC Aux Antenna

**RESTRICTED BANDEDGE (Legacy MODE, HIGH CHANNEL, 5320MHz, HORIZONTAL)****Antenna - Spear WNC Aux Antenna**

Antenna - Spear WNC Aux Antenna

**RESTRICTED BANDEDGE (Legacy MODE, HIGH CHANNEL, 5320MHz, VERTICAL)****Antenna - Spear WNC Aux Antenna**

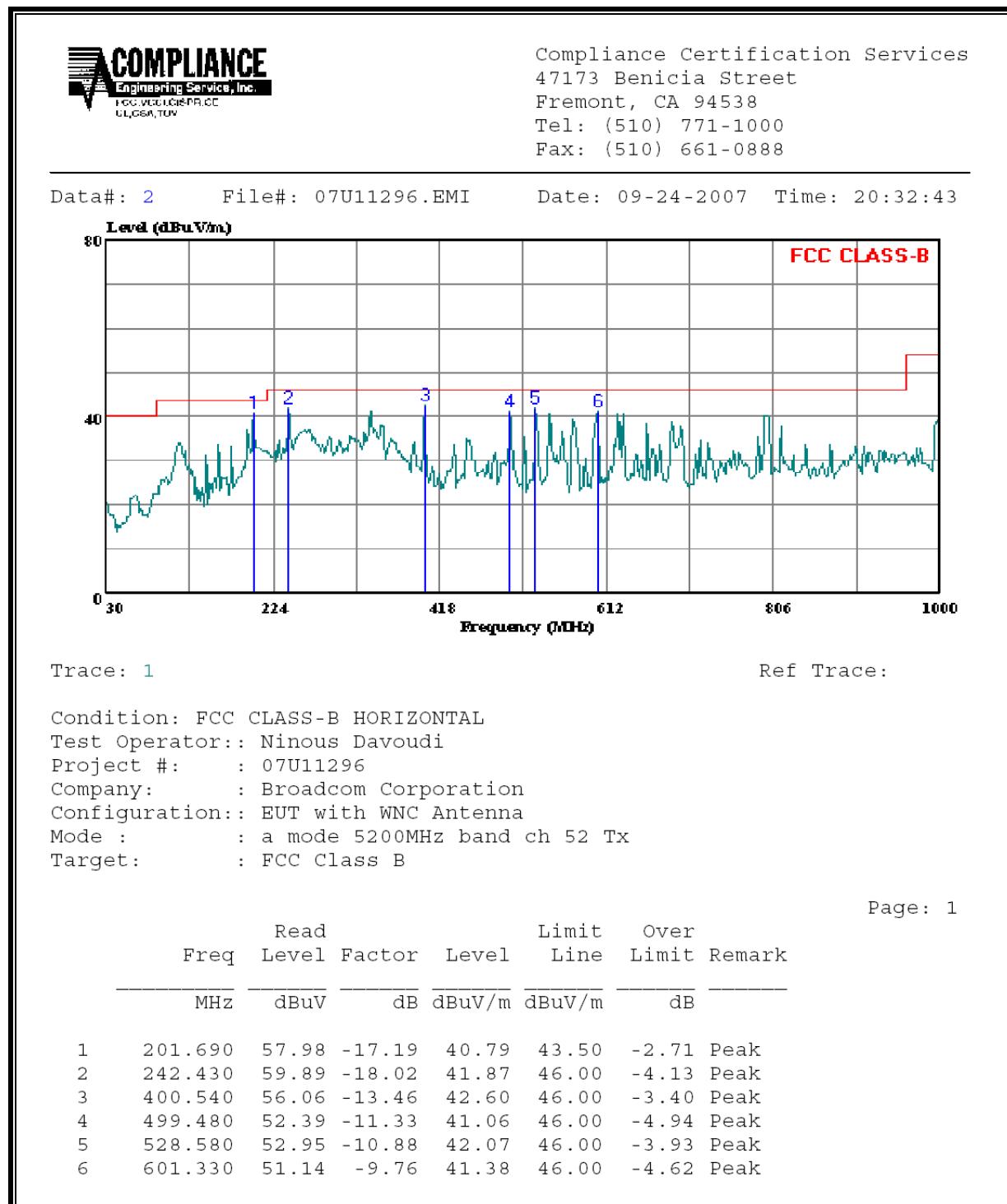
Antenna - Spear WNC Aux Antenna

**HARMONICS AND SPURIOUS EMISSIONS (A MODE, Aux Antenna)**

High Frequency Measurement Compliance Certification Services, Fremont 5m Chamber																
Company: Broadcom Project #: 07U11296 Date: 09/24/07 Test Engineer: Devin Chang Configuration: EUT only Mode: Tx Mid Channel Model: BCM94321MC-C2PC																
<u>Test Equipment:</u>																
Horn 1-18GHz			Pre-amplifier 1-26GHz			Pre-amplifier 26-40GHz			Horn > 18GHz			Limit				
T120; S/N: 29310 @3m			T145 Agilent 3008A005									FCC 15.209				
Hi Frequency Cables																
2 foot cable			3 foot cable			12 foot cable			HPF			Reject Filter			<b>Peak Measurements</b> RBW=VBW=1MHz <b>Average Measurements</b> RBW=1MHz ; VBW=10Hz	
Frank 177079007			Gordon 177080004													
<b>f</b> <b>GHz</b>	<b>Dist</b> <b>(m)</b>	<b>Read Pk</b> <b>dBuV</b>	<b>Read Avg.</b> <b>dBuV</b>	<b>AF</b> <b>dB/m</b>	<b>CL</b> <b>dB</b>	<b>Amp</b> <b>dB</b>	<b>D Corr</b> <b>dB</b>	<b>Fltr</b> <b>dB</b>	<b>Peak</b> <b>dBuV/m</b>	<b>Avg</b> <b>dBuV/m</b>	<b>Pk Lim</b> <b>dBuV/m</b>	<b>Avg Lim</b> <b>dBuV/m</b>	<b>Pk Mar</b> <b>dB</b>	<b>Avg Mar</b> <b>dB</b>	<b>Notes</b> <b>(V/H)</b>	
<b>MID CH (5260MHz)</b>																
10.520	3.0	47.9	32.1	37.5	2.4	-34.4	0.0	0.0	53.3	37.6	74	54	-20.7	-16.4	V	
10.520	3.0	53.0	30.3	37.5	2.4	-34.4	0.0	0.0	58.4	35.7	74	54	-15.6	-18.3	H	
Rev. 4.12.7																
f Measurement Frequency Dist Distance to Antenna Read Analyzer Reading AF Antenna Factor CL Cable Loss					Amp Preamp Gain D Corr Distance Correct to 3 meters Avg Average Field Strength @ 3 m Peak Calculated Peak Field Strength HPF High Pass Filter					Avg Lim Average Field Strength Limit Pk Lim Peak Field Strength Limit Avg Mar Margin vs. Average Limit Pk Mar Margin vs. Peak Limit						

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

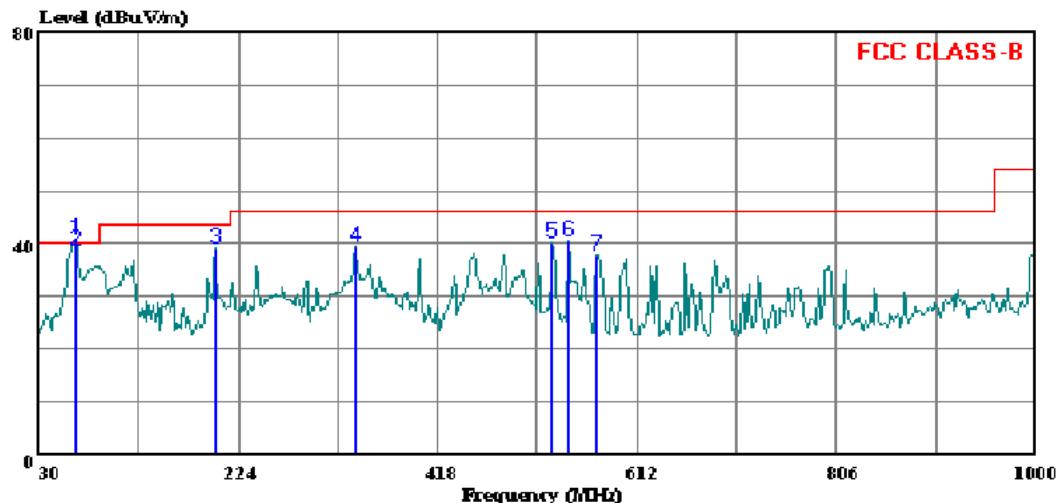
#### SPURIOUS EMISSIONS 30 TO 1000 MHz (5GHz Band, WORST-CASE CONFIGURATION, HORIZONTAL)



**SPURIOUS EMISSIONS 30 TO 1000 MHz (5GHz Band, WORST-CASE CONFIGURATION, VERTICAL)****VERTICAL PLOT**

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

Data#: 5 File#: 07U11296.EMI Date: 09-24-2007 Time: 20:49:20



Trace: 3

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator:: Ninous Davoudi  
Project #: 07U11296  
Company: Broadcom Corporation  
Configuration:: EUT with WNC Antenna  
Mode : a mode 5200MHz band ch 52 Tx  
Target: FCC Class B

Page: 1

Freq	Read		Limit	Over	Remark
	Level	Factor			
MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1 *	65.890	63.59	-22.66	40.93	40.00 0.93 Peak
2	65.890	61.44	-22.66	38.78	40.00 -1.22 QP
3	201.690	56.24	-17.19	39.05	43.50 -4.45 Peak
4	337.490	54.32	-14.80	39.52	46.00 -6.48 Peak
5	528.580	51.14	-10.88	40.26	46.00 -5.74 Peak
6	546.040	51.03	-10.48	40.55	46.00 -5.45 Peak
7	572.230	48.10	-10.20	37.90	46.00 -8.10 Peak

## 7.2. POWERLINE CONDUCTED EMISSIONS

### LIMIT

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

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

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

<sup>\*</sup> 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.

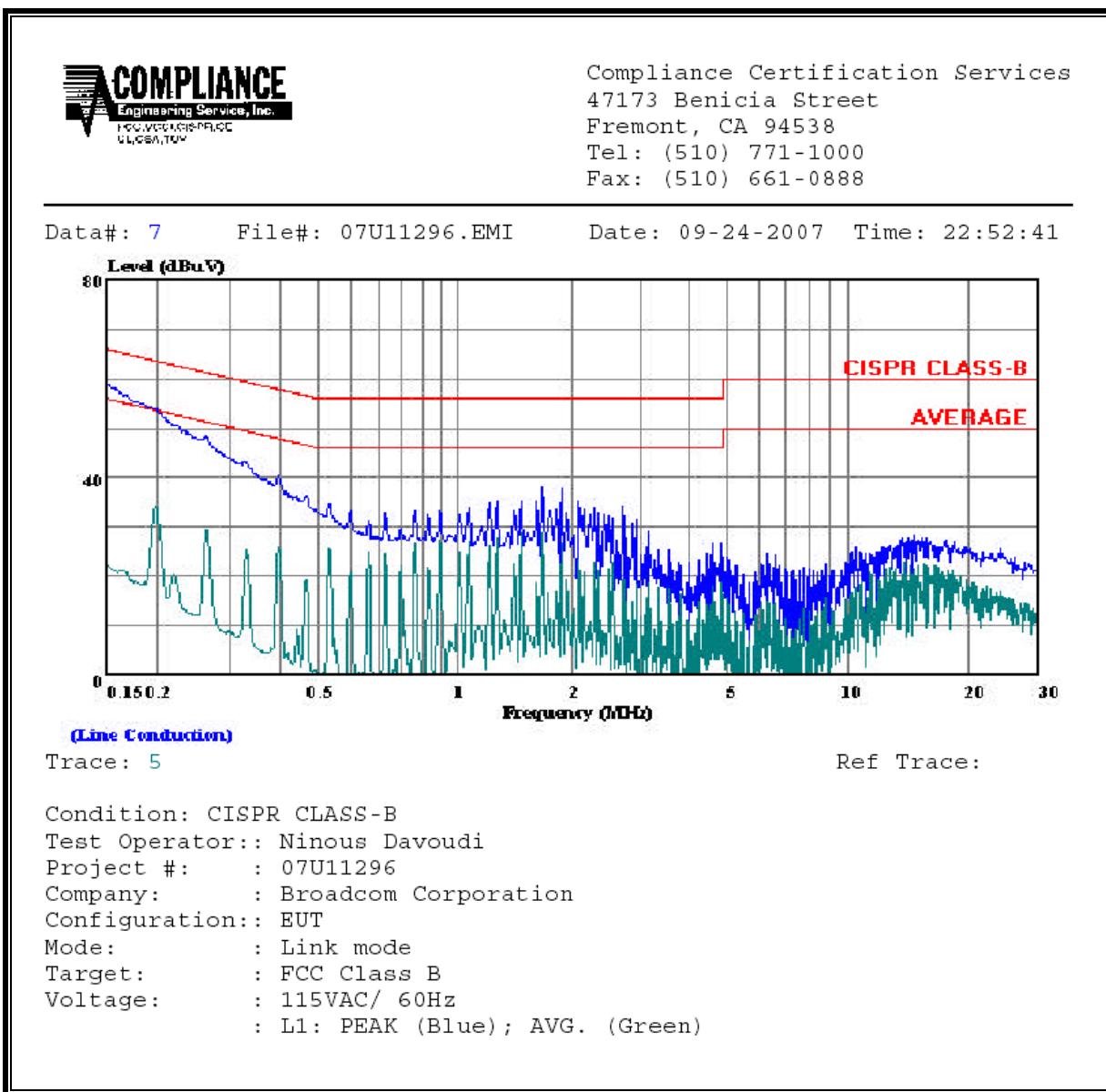
Line conducted data is recorded for both NEUTRAL and HOT lines.

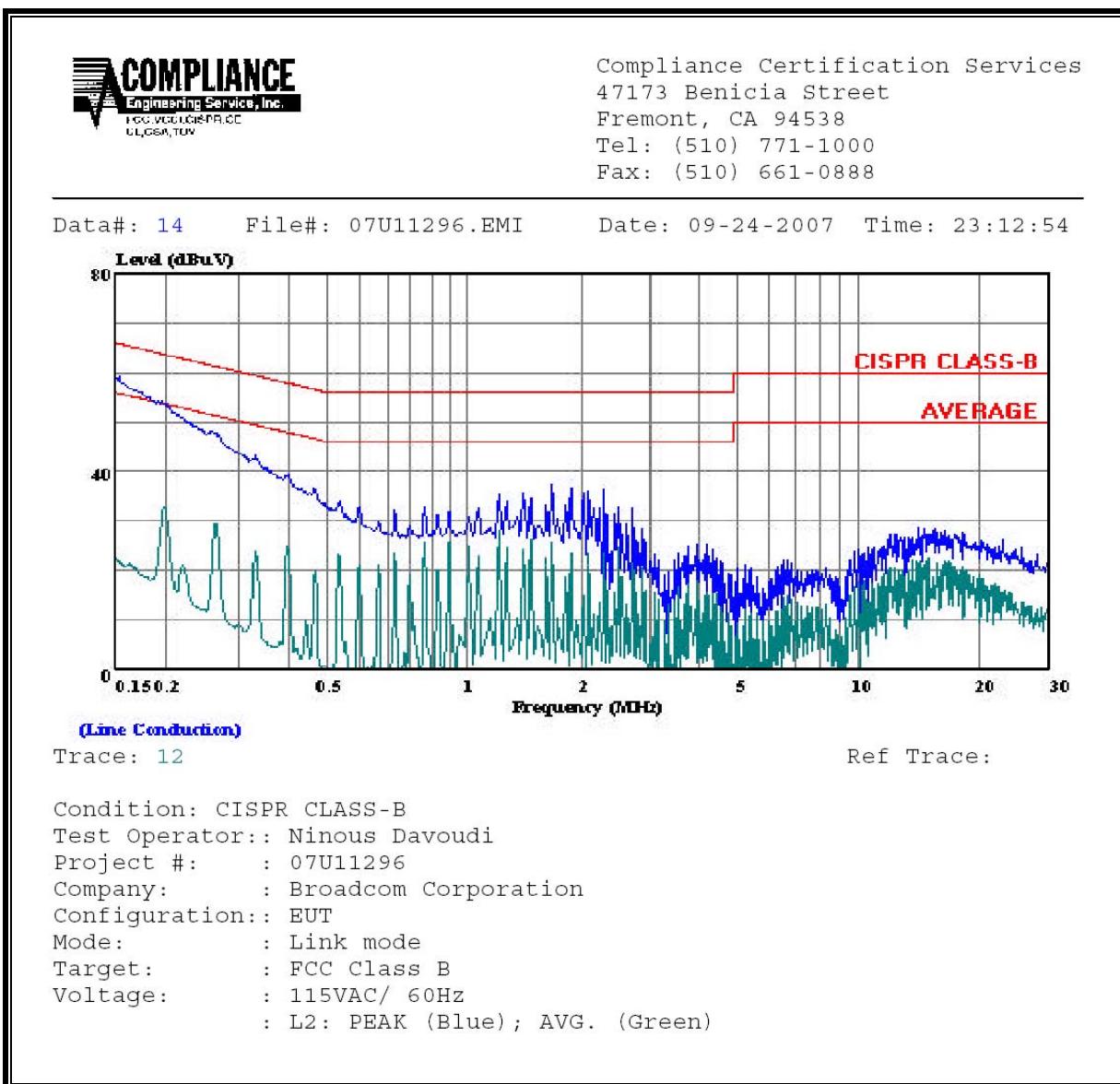
### RESULTS

No non-compliance noted:

**6 WORST EMISSIONS (5GHz Band)**

CONDUCTED EMISSIONS DATA (115VAC 60Hz)									
Freq. (MHz)	Reading			Closs (dB)	Limit QP	EN_B AV	Margin		Remark
	PK (dBuV)	QP (dBuV)	AV (dBuV)				QP (dB)	AV (dB)	
0.15	59.04	--	21.72	0.00	65.89	55.89	-6.85	-34.17	L1
1.78	38.02	--	28.59	0.00	56.00	46.00	-17.98	-17.41	L1
1.99	37.80	--	26.67	0.00	56.00	46.00	-18.20	-19.33	L1
0.15	59.06	--	21.98	0.00	65.84	55.84	-6.78	-33.86	L2
1.78	37.48	--	25.52	0.00	56.00	46.00	-18.52	-20.48	L2
2.40	36.36	--	24.09	0.00	56.00	46.00	-19.64	-21.91	L2
6 Worst Data									

**LINE 1 RESULTS**

**LINE 2 RESULTS**

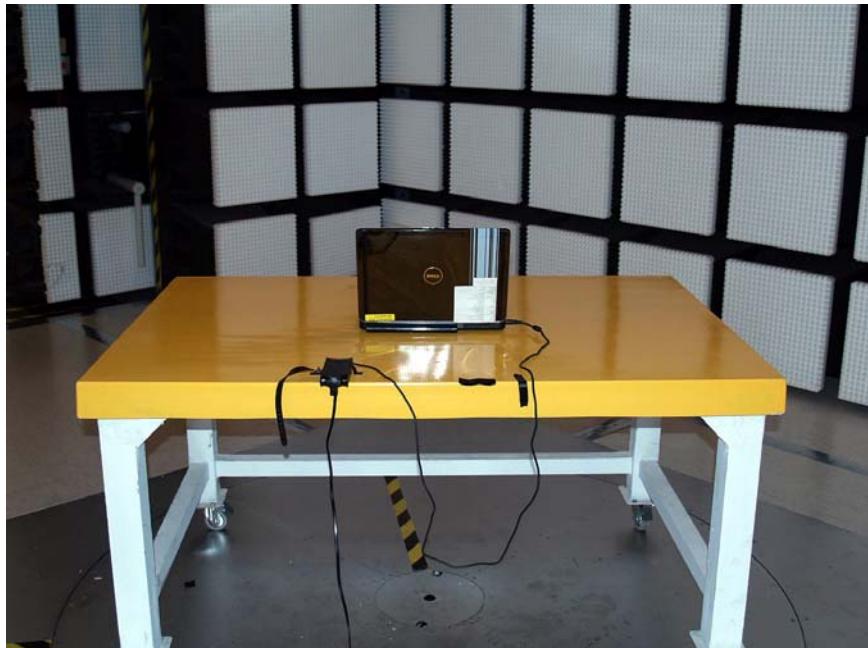
## 8. SETUP PHOTOS

### 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**