HaveTest Report: EDCS - 467665

For

AIR-LAP1510AG-A-K9

Cisco Aironet 1500 Series Outdoor Mesh Access Points

Against the following Specifications :

CFR47 Part 90.210

Cisco Systems

EMC Laboratory

170 West Tasman Drive

San Jose, CA 95134

ACCREDITED

Certificate Number : 1178-01

Author: James Nicholson
Approved By:
Title:

This test report has been electronically authorized and archived using the CISCO Engineering Document Control system.

APPENDIX E: TEST EQUIPMENT USED TO PERFORM THE TEST **28**

Section 1: Overview

Test Summary

The samples were assessed against the tests detailed in section 3 under the requirements of the following standards:

Emissions:
CFR47 Part 90.210

Notes:

1) Where a specification listed on the front cover of this report has deviations from the basic standards listed above, the additional technical requirements of the specification were also assessed.
2) Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
3) Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.
4) For Radiated and Conducted emissions results refer to section 2.9 for measurement uncertainty considerations
5) Where applicable, details of the precise distance used when performing radiated immunity measurements can be found in Cisco document EDCS-221012.
6) Where testing has been performed to EN61000-4-3, additional measurements were conducted to establish the field strength at a 40cm height in both the horizontal and vertical antenna polarities (applies to floor standing EUT's only). This field strength data can be found in Cisco document ENG-72588.

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on the samples submitted.

This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the federal Government.

This report may contain data that are not covered by the A2LA accreditation (Certificate number 1178-01). Please refer to Appendix F for further details.

With regard to this assessment, the following points should be noted:

a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).

d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.

e) All AC testing was performed at one or more of the following supply voltages:
110V (+/-10%) 60Hz
220V (+/-10%) 50 or 60Hz

f) Cisco Systems Inc., are accredited by the American Association for Laboratory Accreditation (A2LA). For the specific scope of accreditation under certificate number 1178-01.see appendix F for further details.

2.2 Date of start of testing

10-July-2005

2.3 Report Issue Date

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

2.4 Testing facilities

This assessment was performed by:

Testing Laboratory

Cisco Systems, Inc.,
170 West Tasman Drive
San Jose, CA 95134,
USA

Test Engineers

James Nicholson

2.5 Equipment Assessed (EUT)

AIR-LAP1510AG-x-K9 Cisco Aironet 1500 Series Outdoor Mesh Access Point

2.6 EUT Description

The AIR-LAP1510AG-A-K9 access point operates simultaneously in both the 2.4 and either 4.9 or 5 GHz spectrum, to provide data rates up to 54 Mbps in each band in accordance with IEEE 802.11a and 802.11g standards, including backwards compatibility to 802.11b. AIR-LAP1510AG-x-K9 supports both inline power and local power. The AIR-LAP1510AG-A-K9 utilized standard “N” type antenna connectors, and requires professional installation. The 4.9GHz Channel Bandwidth is 20MHz.

2.7 Scope of Assessment

Tests have been performed in accordance with the relevant Test and Assessment Plan (TAP), a copy of which is contained in Appendix H of this report, and the relevant Cisco EMC compliance test procedures (ENG-23438). This test report may not cover all of the tests highlighted in the test plan.

2.8 Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, these are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in dBuV and current in dBuA.

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB]

The components of factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss, Current Probe Factors.

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

2.9 Measurement Uncertainty

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

10kHz - 30 MHz	+/- 2.8 dB (E Field)
10kHz - 30 MHz	+/- 2.8 dB (H Field)
30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

4 kHz - 30 MHz	+/- 2.2 dB (using Current Probe)
9 kHz - 150 kHz	+/- 4.1 dB (using LISN)

10 kHz - 30 MHz	+/- 2.6 dB (using Current Probe)
150 kHz - 30 MHz	+/- 3.7 dB (using LISN)
150 kHz - 30 MHz	+/- 3.1 dB (using CDN)
150 kHz - 30 MHz	Under Consideration (Using CVP-1)

A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line. For further explanation refer to Cisco Systems Inc Measurement Uncertainty Document: ENG-4001 8

Section 3: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the “Justification for worst Case test Configuration” section of this report for further details on the selection of EUT samples.

3.1 Sample Details

Equipment Details
AIR-LAP1510AG-A-K9
AIR-ANT5175V-N 4.9GHz, 6.5dBi Omni-Directional

The following antennas are included in this filing:

AIR-ANT5175V-N 4.9GHz, 6.5dBi Omni-Directional

Appendix A: Formal Emission Test Results

Average Output Power

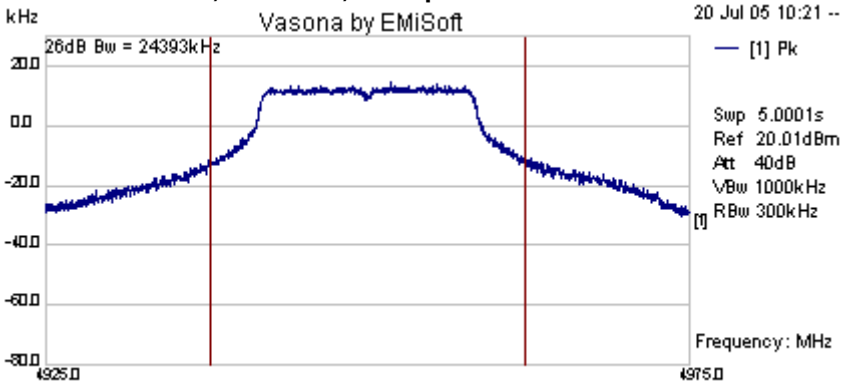
4.9GHz GHz Average Power with 6.5dBi Antenna

Frequency (MHz)	Data Rate (Mbps)	Target Power (dBm)	Measured Power (dBm)
4950	36	20	19.8
4980	36	20	19.6

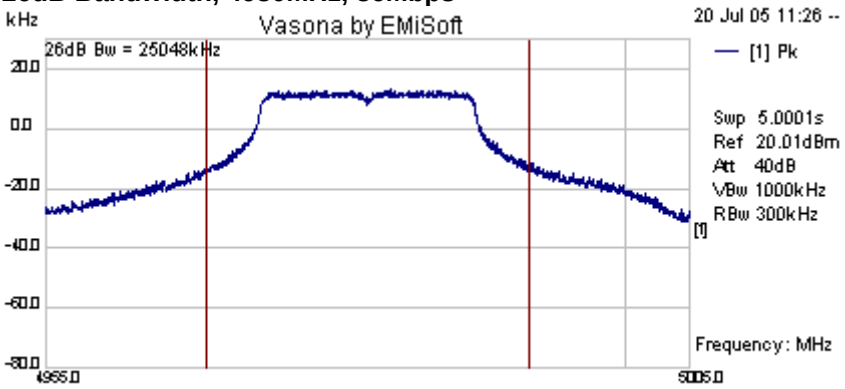
26dB Bandwidth

Frequency (MHz)	Data Rate (Mbps)	26dB Bandwidth (kHz)
4950	36	24,393
4980	36	25,048

26dB Bandwidth, 4950MHz,36 Mbps



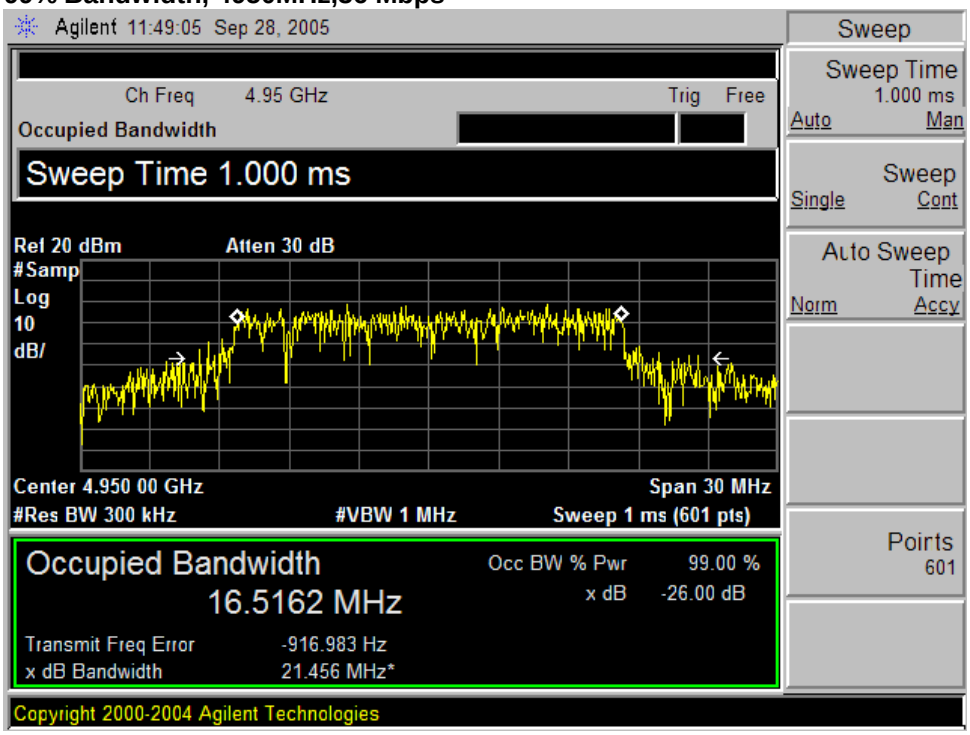
26dB Bandwidth, 4980MHz, 36Mbps



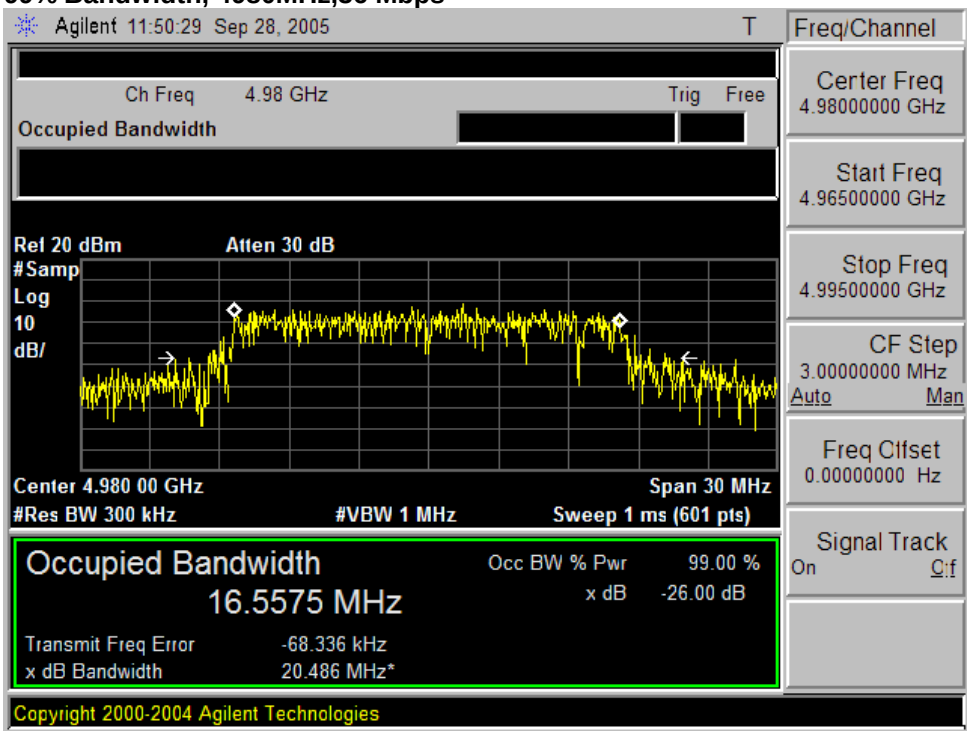
99% Bandwidth

Frequency (MHz)	Data Rate (Mbps)	99% Bandwidth (MHz)
4950	36	16.56
4980	36	16.52

99% Bandwidth, 4950MHz,36 Mbps



99% Bandwidth, 4980MHz,36 Mbps

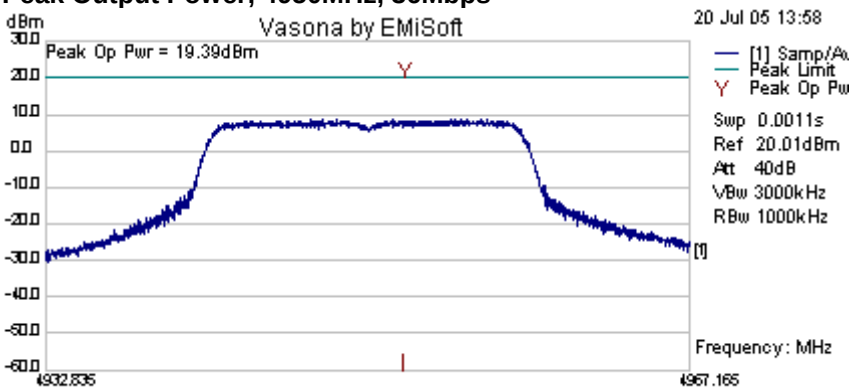


Peak Output Power

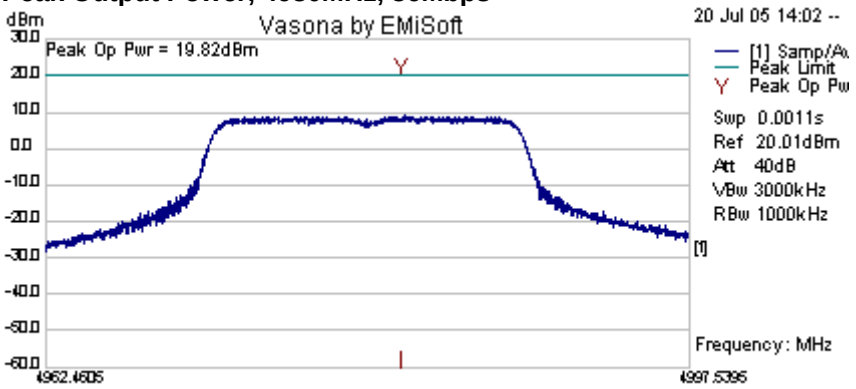
The transmitting power of stations operating in the 4940–4990 MHz band must not exceed 20dBm for a 20MHz low power device using antennas up to 9dBi gain.

Frequency (MHz)	Data Rate (Mbps)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
4950	36	19.39	20	0.61
4980	36	19.82	20	0.18

Peak Output Power, 4950MHz, 36Mbps



Peak Output Power, 4980MHz, 36Mbps

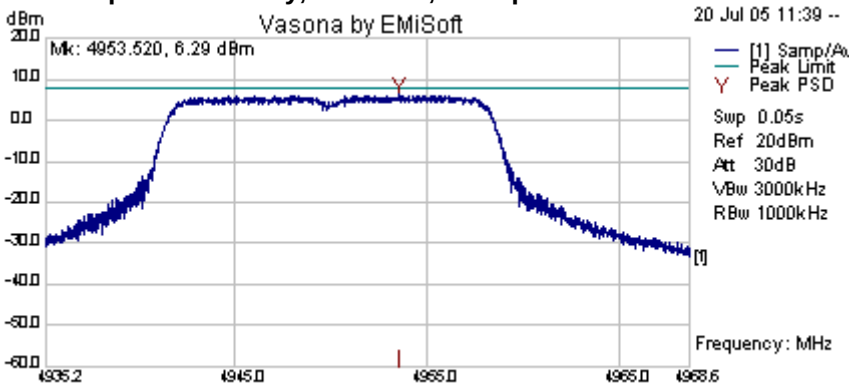


Power Spectral Density

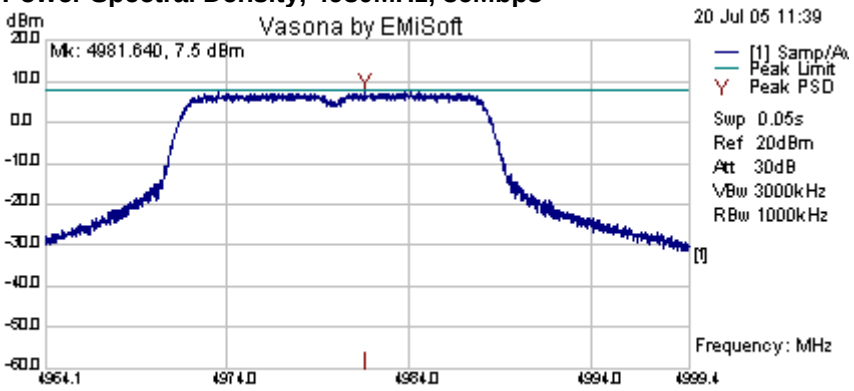
Low power devices operating in the 4940–4990 MHz band are limited to a peak power spectral density of 8 dBm per one MHz.

Frequency (MHz)	Data Rate (Mbps)	Power Spectral Density (dBm/MHz)	Limit (dBm)	Margin (dB)
4950	36	6.29	8	1.71
4980	36	7.50	8	0.50

Power Spectral Density, 4950MHz, 36Mbps



Power Spectral Density, 4980MHz, 36Mbps



Frequency Stability

Frequency Stability over Temperature
The frequency stability shall be measured with variation of ambient temperature from -30[deg] to +50[deg] centigrade. (Frequency variation listed in parts per million)

Frequency (MHz)	-35°C	-25°C	-15°C	-5°C	5°C	15°C	25°C	35°C	45°C	55°C
4950	-0.1	0.69	1.47	2.26	2.07	1.87	1.68	3.99	6.30	8.61
4980	-0.1	0.69	1.47	2.26	2.07	1.87	1.68	3.99	6.30	8.61

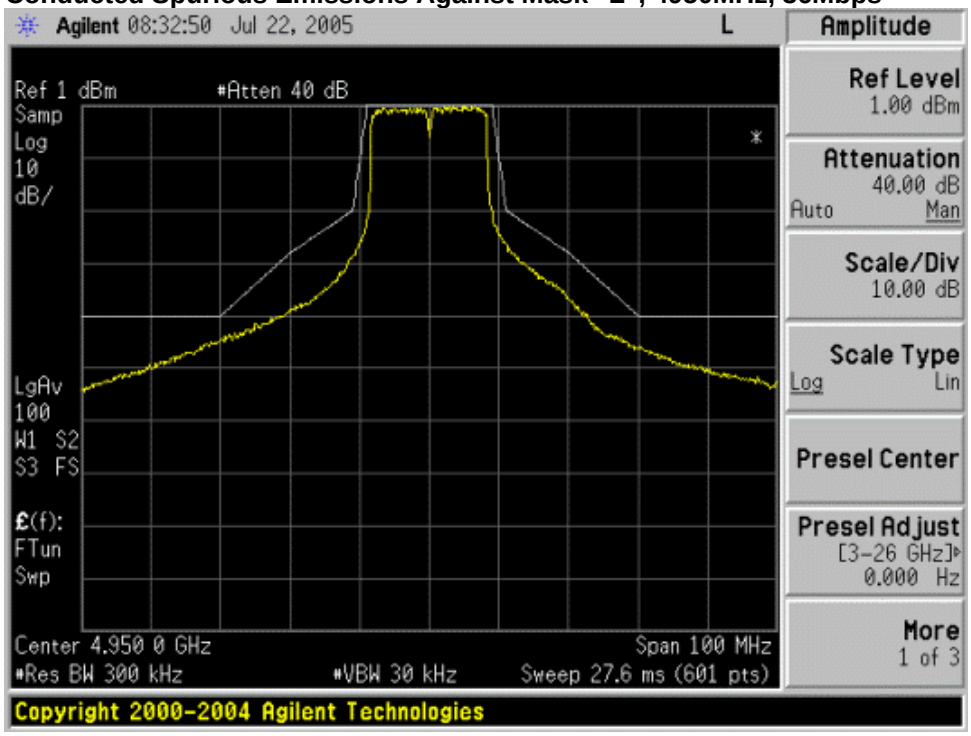
Frequency Stability over Primary Supply Voltage (100-240 Vac)
The frequency stability shall be measured with variation of primary supply voltage from 85 to 115 percent of the nominal value. (Frequency variation listed in parts per million)

Frequency (MHz)	85Vac	276Vac
4950	2.19	2.68
4980	2.19	2.68

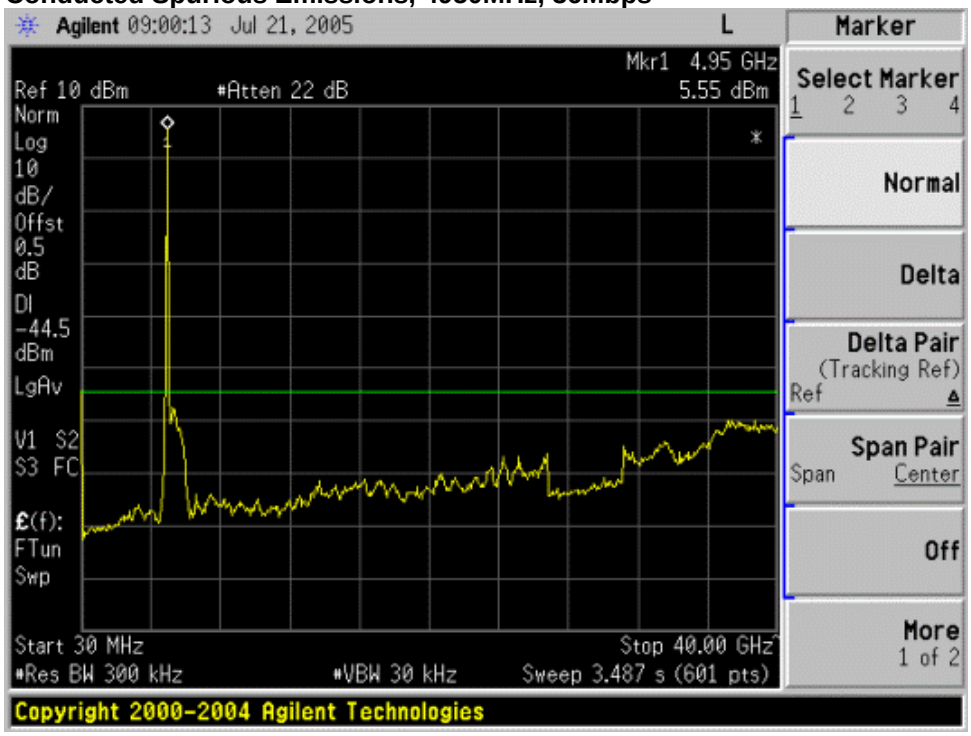
(1) Conducted Spurious Emissions

For low power transmitters (20 dBm or less) operating in the 4940–4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:
(1) On any frequency removed from the assigned frequency between 0–45% of the authorized bandwidth (BW): 0 dB.
(2) On any frequency removed from the assigned frequency between 45–50% of the authorized bandwidth: 219 log (%of (BW)/45) dB.
(3) On any frequency removed from the assigned frequency between 50–55% of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.
(4) On any frequency removed from the assigned frequency between 55–100% of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.
(5) On any frequency removed from the assigned frequency between 100–150% of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 40 dB.

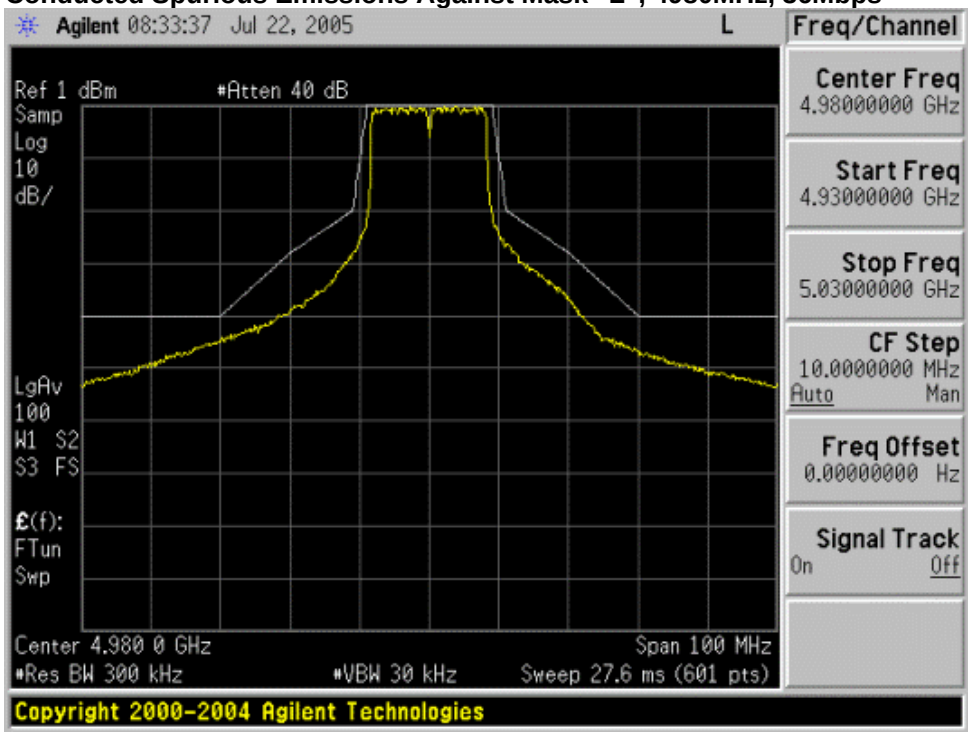
Conducted Spurious Emissions Against Mask "L", 4950MHz, 36Mbps



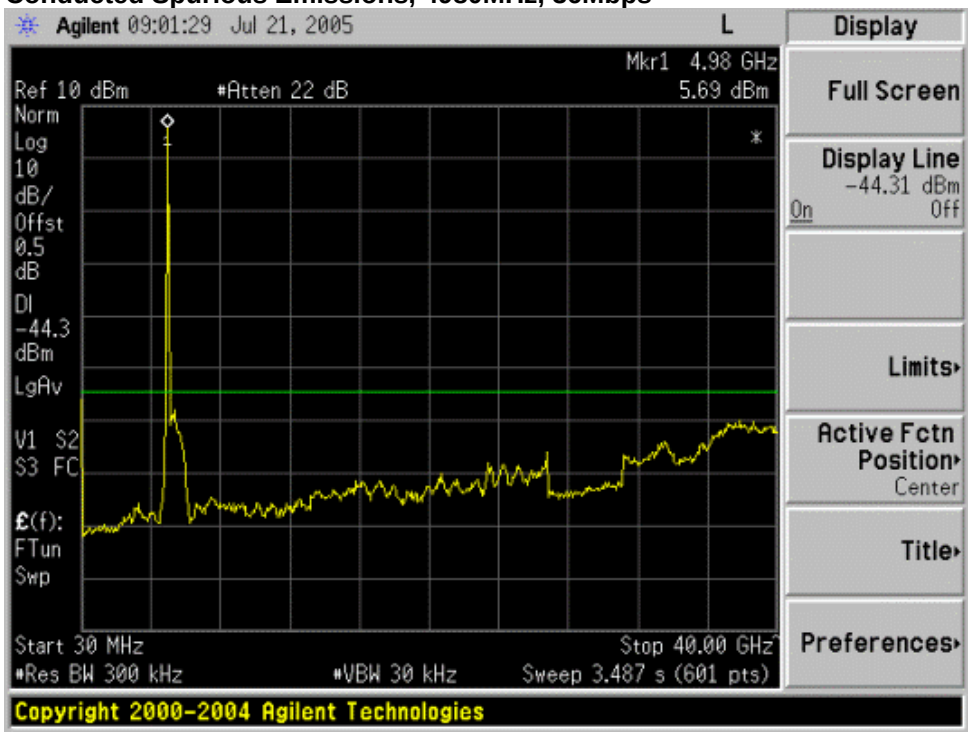
Conducted Spurious Emissions, 4950MHz, 36Mbps



Conducted Spurious Emissions Against Mask "L", 4980MHz, 36Mbps



Conducted Spurious Emissions, 4980MHz, 36Mbps



Radiated Transmitter Spurious Emissions

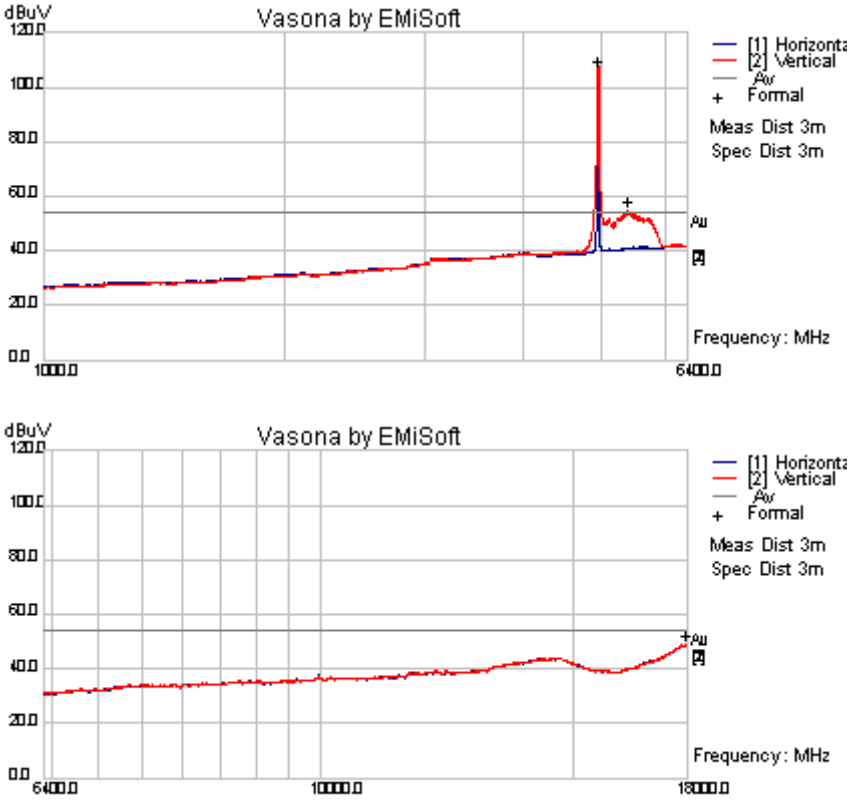
The data in the table below reflects measurements using the substitution method as defined in accordance with FCC 2.1053 and TIA/EIA-603B and in the Cisco Substitution Method Test Procedure EDCS-479519. The graphical representations below display all recorded spurs in terms of field strength.

EIRP (dBm) = SG Reading (dBm)+Cable Loss (dB)+Antenna Gain (dBi)
Spur Limit (dBm) = Fundamental EIRP (dBm)-40dB

f (MHz)	SA Reading (dBuV/m)	Antenna Polarity	SG Reading (dBm)	Cable Loss (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Notes
4950	119	V	-13.4	1.1	8.2	-4.1			Fundamental
5400	66.4	V	-65.8	1.2	8.5	-56.1	-44.1	12	Spur
4980	118.3	V	-13.7	1.1	8.3	-4.3			Fundamental
5400	66.6	V	-65.6	1.2	8.5	-55.9	-44.3	11.6	Spur

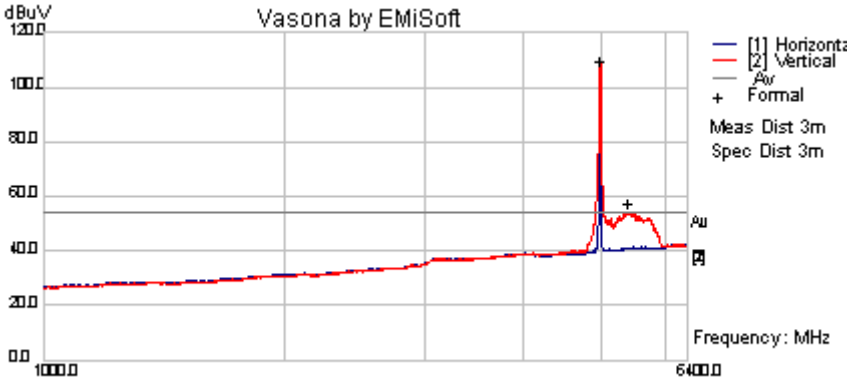
4950MHz, 36Mbps, 6.5dBi Omni-Directional Antenna

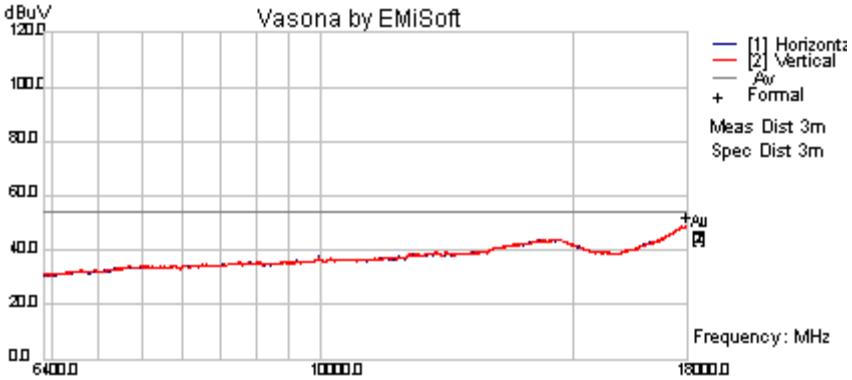
1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW



4950MHz, 36Mbps, 6.5dBi Omni-Directional Antenna

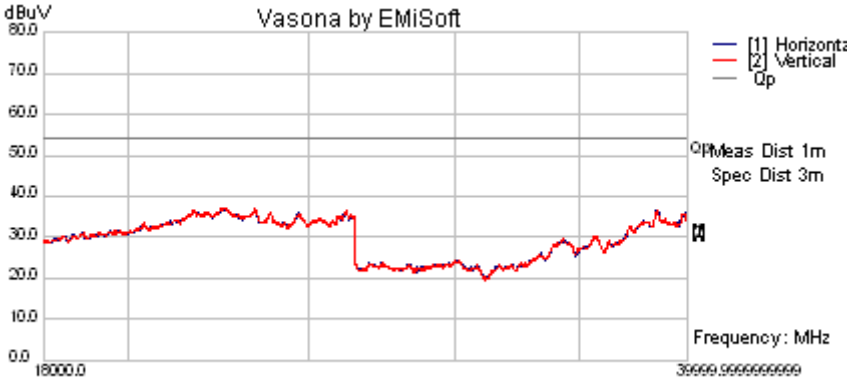
1-18GHz Average Spurs, 1MHz RBW, 10Hz VBW





All Transmit Frequencies, 36Mbps, 6.5dBi Omni-Directional Antenna

18-40GHz Average Spurs, 1MHz RBW, 10Hz VBW



Maximum Permissible Exposure (MPE) Calculations

Given

E=√(30*P*G)/d and S=E^2/3770

where

E=Field Strength in Volts/meter
P=Power in Watts
G=Numeric Antenna Gain
d=Distance in meters
S=Power Density in mW/cm^2

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:

d=√((30*P*G)/(3770*S))

Changing to units of power in mW and distance in cm, using:

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

yields

d=100*√((30*(P/1000)*G)/(3770*S))
d=0.282*√(P*G/S)

where

d=Distance in cm
P=Power in mW
G=Numerica Antenna Gain
S=Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

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

yields

d=0.282*10^((P+G)/20)/√S Equation (1)

where

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

Equation (1) and the measured peak power is used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 20 cm even if the calculations indicate that the MPE distance may be less.

S=1mW/cm^2 maximum. The highest 4.9GHz antenna gain supported is 6.5 dBi. Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

Frequency (MHz)	Bit Rate (Mbps)	Power Density (mW/cm^2)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)	Limit (cm)	Margin (cm)
4950	36	1	20	6.5	5.96	20	14.04
4980	36	1	20	6.5	5.96	20	14.04

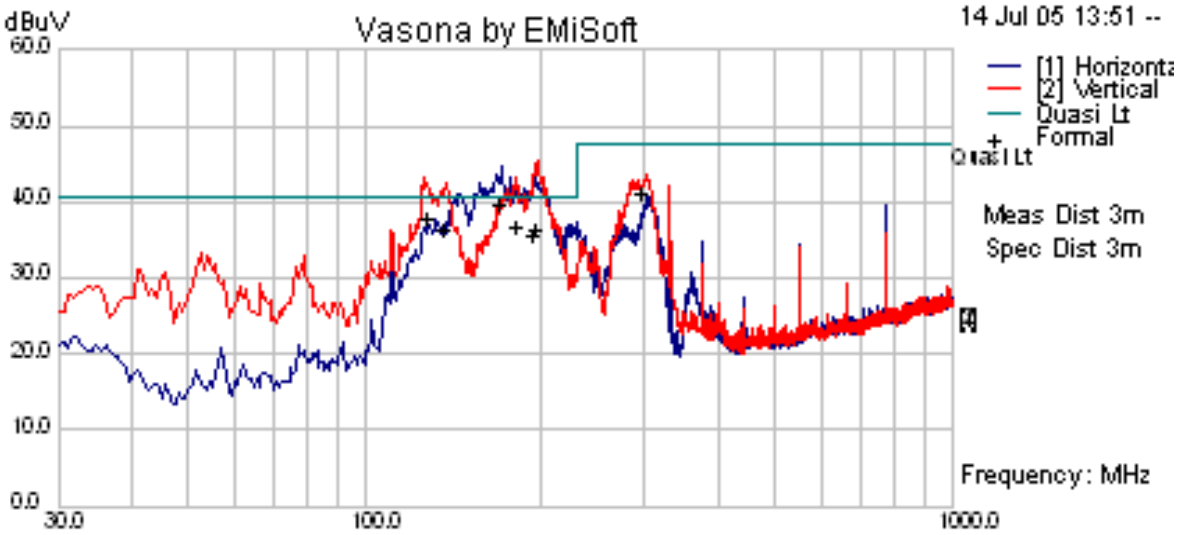
MPE Calculations

To maintain compliance, installations will assure a separation distance of at least 2 meters.

30MHz-1GHz Radiated Spurious Emissions

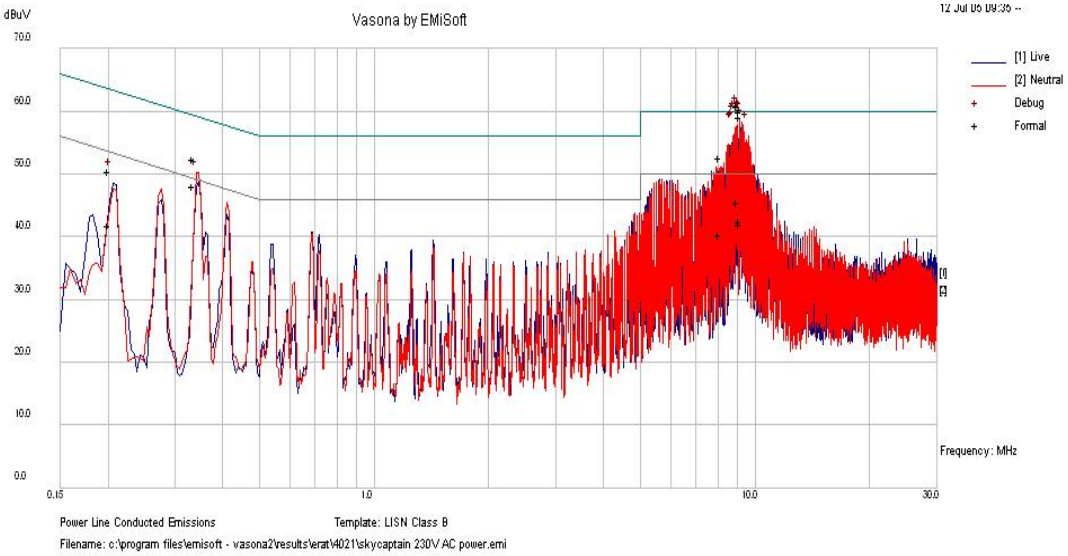
Radiated emissions which fall in the restricted bands, as defined in Sec. 15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

Spur Frequency (MHz)	Spur Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
128.52	36.20	40.5	4.30
136.66	34.75	40.5	5.75
170.71	38.07	40.5	2.43
182.95	35.08	40.5	5.42
194.83	33.93	40.5	6.57
196.18	34.70	40.5	5.80
296.86	39.29	47.5	8.21



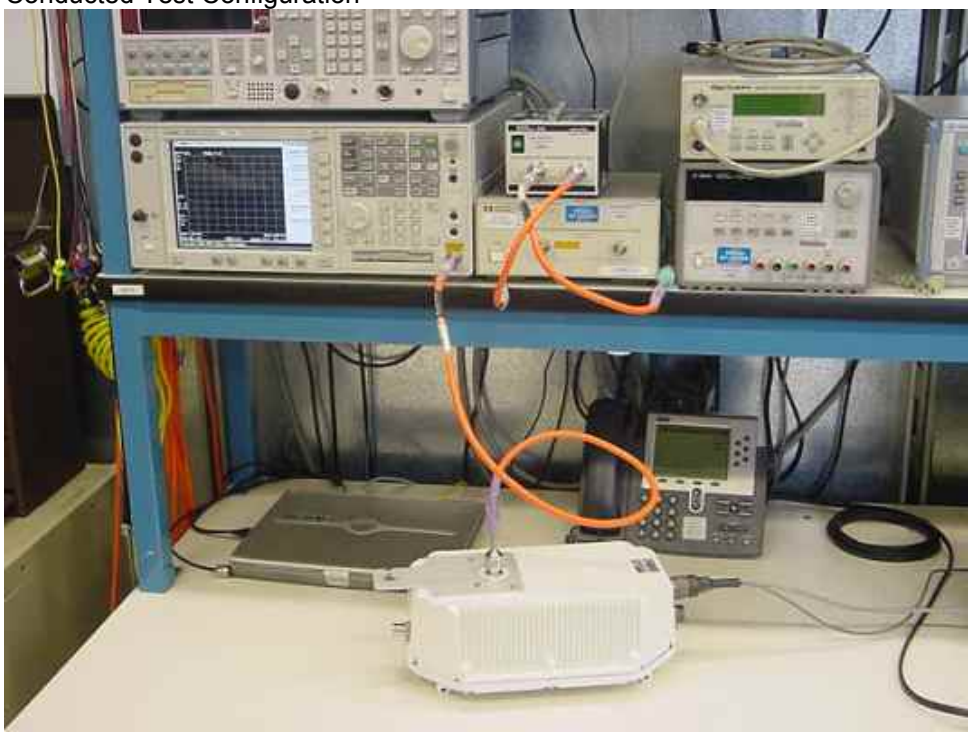
AC Mains .150-30MHz Conducted Emissions

Frequency (MHz)	Level (dBuV)	Type	Line	Limit dBuV	Margin dB
9.168	57.2	Qp	N	60	2.8
9.302	56.4	Qp	N	60	3.6
9.305	55.6	Qp	L	60	4.4
0.341	44.6	Av	N	49.2	4.6
9.168	41.8	Av	N	50	8.2
0.341	48.8	Qp	N	59.2	10.4
8.217	49	Qp	N	60	11
9.302	38.8	Av	N	50	11.2
9.305	38.4	Av	L	50	11.6
8.217	36.6	Av	N	50	13.4
0.204	38.2	Av	L	53.4	15.2
0.204	46.8	Qp	L	63.4	16.6



Appendix B: Test Setup Photos

Conducted Test Configuration



8dBi 2.4GHz Omni-Directional Antenna with 7.5dBi 5GHz/6dBi 4.9GHz Omni-Directional Antenna

Appendix C: Test Procedures

Test procedures are summarized below

6dB Bandwidth	EDCS # - 422115
26dB Bandwidth	EDCS # - 422115
Average Output Power	EDCS # - 422117
Co-Located Transmitter	EDCS # - 422118
Conducted Spurious Test	EDCS # - 422119
Peak Transmit Power Measurement	EDCS # - 422123
Power Spectral Density	EDCS # - 422113
Peak Excursion Test	EDCS # - 422121
Radiated Band Edge	EDCS # - 422124
Radiated Spurious Test	EDCS # - 422125
Extreme Test Condition	EDCS # - 450056
Equivalent Isotropic Radiated Power	EDCS # - 450047
Frequency Tolerance	EDCS # - 462996
Power per MHz	EDCS # - 463000

Appendix D: Scope of Accreditation: A2LA certificate number 1178-01

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

http://www.a2la2.net/scopepdf/1178-01.pdf

Summary of accredited radio testing capabilities:

San Jose, CA, Building P:	LP0002: 2004 RRL no.2005-25
San Jose, CA, Building N:	LP0002: 2004 RRL no.2005-25
San Jose, CA, Building I:	LP0002: 2004 RRL no. 2005-25
San Jose, CA, Building B:	LP0002: 2004 (conducted measurements only) RRL no.2005-25 (conducted measurement only)

Appendix E: Test Equipment Used to perform the test

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due
000513	Gigatronics/ 8542C	Universal Power Meter	21-JAN-2005	21-JAN-2006
000514	Gigatronics/ 80420A	Power Sensor, 0.01-18GHz	11-JAN-2005	11-JAN-2006
000579	Megaphase/ SF26 S1S1 36	RF Coaxial Cable, to 26GHz, 36in	15-FEB-2005	15-FEB-2006
000590	Agilent/ E4448A	Spectrum Analyzer	02-FEB-2005	02-FEB-2006
000599	Weinschel Corp./ 69-20-12	20dB Attenuator	20-DEC-2004	20-DEC-2005
001229	HP/ 85460A	RF Filter Section	06-DEC-2004	06-DEC-2005
001230	HP/ 85462A	EMI Receiver RF Section	06-DEC-2004	06-DEC-2005
003003	HP/ 83731B	Synthesized Signal Generator	21-JAN-2005	21-JAN-2006
004882	EMC Test Systems/ 3115	Double Ridged Guide Horn Antenna	29-APR-2005	29-APR-2006
005691	Miteq/ NSP1800-25-S1	Broadband Preamplifier (1-18GHz)	07-OCT-2004	07-OCT-2005
007036	HP/ E7401A	Spectrum Analyzer	23-JUL-2004	23-JUL-2005
007221	EMC Test Systems/ 3115	Double Ridged Guide Horn Antenna	Cal Not Required	N/A
008097	Huber + Suhner/ RG-223	RG-233 Cable 9m	29-JUL-2004	29-JUL-2005
008123	Huber + Suhner/ SF106A	1m Sucoflex Cable	03-SEP-2004	03-SEP-2005
008166	HP/ 8491B Opt 010	10dB Attenuator	19-JAN-2005	19-JAN-2006
008002	Fischer Custom Communications/ FCC-450B-2.4-N	Instrumentation Limiter	21-JAN-2005	21-JAN-2006
008197	TTE/ H613-150K-50-21378	Hi Pass Filter - 150KHz cutoff	29-MAR-2005	29-MAR-2006
008448	Cisco/ NSA 5m Chamber	NSA 5m Chamber	03-JAN-2005	03-JAN-2006
018719	Rohde & Schwarz/ ESCS 30	EMI Test Receiver, 9kHz-2.75GHz	13-SEP-2004	13-SEP-2005
019630	Rohde & Schwarz/ ESI 40	EMI Test Receiver, 20Hz - 40GHz	21-OCT-2004	21-OCT-2005
020666	EMC Test Systems/ 3160-10	Standard Gain Horn Antenna, 26.5-40GHz	Cal Not Required	N/A
020821	Micro-Coax/ UFB142A-1-1572-200200	RF Coaxial Cable, to 40GHz, 157.2 in	23-SEP-2004	23-SEP-2005
020975	Micro-Coax/ UFB311A-0-1344-520520	RF Coaxial Cable, to 18GHz, 134.4 in	28-MAR-2005	28-MAR-2006
021117	Micro-Coax/ UFB311A-0-2484-520520	RF Coaxial Cable, to 18GHz, 248.4 in	19-AUG-2004	19-AUG-2005

021382	Solar Electronics Company/ 9252-50-24-BNC	LISN	26-APR-2005	26-APR-2006
025654	Micro-Coax/ UFB311A-1-0840-504504	RF Coaxial Cable, to 18GHz, 84 in	28-MAR-2005	28-MAR-2006
025657	Micro-Coax/ UFB311A-1-0840-504504	RF Coaxial Cable, to 18GHz, 84 in	19-AUG-2004	19-AUG-2005
025666	Micro-Coax/ UFB142A-1-0720-200504	RF Coaxial Cable, to 40GHz, 72 in	23-SEP-2004	23-SEP-2005
026860	Cisco/ 1840	18-40GHz EMI Test Head/Verification Fixture	23-SEP-2004	23-SEP-2005
030265	Agilent/ 11713A	Attenuator/Switch Driver	Cal Not Required	N/A
030495	Agilent/ 8761B	SPDT RF Switch, to 18GHz	28-MAR-2005	28-MAR-2006
030560	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
030562	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	19-AUG-2004	19-AUG-2005
030563	Micro-Coax/ UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
030569	Micro-Coax/ UFB311A-1-3510-504504	RF Coaxial Cable, to 18GHz	28-MAR-2005	28-MAR-2006
031700	Micro-Tronics/ BRC50705	Notch Filter, SB:5.725-5.875GHz, to 12 GHz	06-OCT-2004	06-OCT-2005
033599	Midwest Microwave/ CSY-NMNM-80-273001	RF Coaxial Cable, 27ft. to 18GHz	09-MAY-2005	09-AUG-2005
033599	Midwest Microwave/ CSY-NMNM-80-273001	RF Coaxial Cable, 27ft. to 18GHz	10-FEB-2005	09-AUG-2005
034064	Micro-Coax/ UFB293C-2-0840-300504	RF Coaxial Cable, 7ft to 18GHz	28-OCT-2004	28-OCT-2005
034075	Schaffner/ RSG 2000	Reference Spectrum Generator, 1-18GHz	12-AUG-2004	12-AUG-2005
034188	Micro-Tronics/ BRC50703-02	Notch Filter, SB:5.150-5.350GHz, to 11GHz	26-APR-2005	26-APR-2006
034189	Micro-Tronics/ BRC50704-02	Notch Filter, SB:5.470-5.725GHz, to 12GHz	26-APR-2005	26-APR-2006
034304	Micro-Tronics/ BRM50702-02	Band Reject Filter	26-APR-2005	26-APR-2006
035040	Micro-Tronics/ HPM50112-02	Hi Pass Filter	26-APR-2005	26-APR-2006
035268	Agilent/ E4440A	Precision Spectrum Analyzer	12-APR-2005	12-APR-2006
6717	EMCO 3115	1-18GHz Horn Antenna	22-APR-2005	22-APR-2006
29301	ETS 3117	1-18GHz Horn Antenna	22-APR-2005	22-APR-2006

MY40001647	Agilent 8753ES	30kHz-6GHz Network Analyzer	19-NOV-2005	19-NOV-2006
US42070220	Agilent E4446A	3Hz-44GHz Spectrum Analyzer	01-JAN-2005	01-JAN-2006