FCC CFR47 PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CLASS II PERMISSIVE CHANGE

CERTIFICATION TEST REPORT

FOR

2.4GHz ZIGBEE RADIO MODULE

MODEL NUMBER: AIR-CAP1552Sx-A-K9

FCC ID: LDK102078P
IC: 2461B-102078P

REPORT NUMBER: 11U14083-1, Revision A

ISSUE DATE: NOVEMBER 15, 2011

Prepared for
CISCO SYSTEMS, INC.
4125 HIGHLANDER PKWY
RICHFIELD, OH 44286, U.S.A.

Prepared by
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	11/02/11	Initial Issue	F. Ibrahim
A	11/15/11	Revised Maximum Output Power section	F. Ibrahim

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: CISCO SYSTEMS, INC.
4125 HIGHLANDER PARKWAY
RICHFIELD, OH 44286, U.S.A.

EUT DESCRIPTION: 2.4 GHz ZigBee Radio Module

MODEL: AIR-CAP1552Sx-A-K9

SERIAL NUMBER: 47-24455-01 (#26)
NSN (#19) – used for Radiated Emissions 30M-1GHz

DATE TESTED: OCTOBER 11 - OCTOBER 17, 2011

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

Compliance Certification Services (UL CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. 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 UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL CCS By:

FRANK IBRAHIM
EMC SUPERVISOR
UL CCS

Tested By:

DAVID GARCIA
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL 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. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.52 dB
Radiated Disturbance, 30 to 1000 MHz	4.94 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an 802.15.4 ZigBee Radio Module.

The radio module is manufactured by Honeywell.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2405 – 2480	802.15.4	17.7	58.88

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a sector antenna, with a maximum peak gain of 14 dBi.

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was BRR_SimpleIR, rev. 5.5.2.

5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case channel is determined as the channel with the highest output power. Radiated Emissions 30-1000 MHz and Power Line Conducted Emissions were performed with the EUT set to transmit continuously at the channel with highest output power.

There is only one modulation for this device, which is OQPSK-DSSS, and one data rate, which is 250 kbps.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	Dell	D620	28071776413	DoC
AC Adapter	Dell	LA65NS0-00	CN-ODF263-71615-720-2D21	N/A
Jig Board	Honeywell	Rev. AT2	N/A	N/A
Vertically Polarized Sector Antenna	Cisco	AIR-ANT2414S-R	N/A	N/A

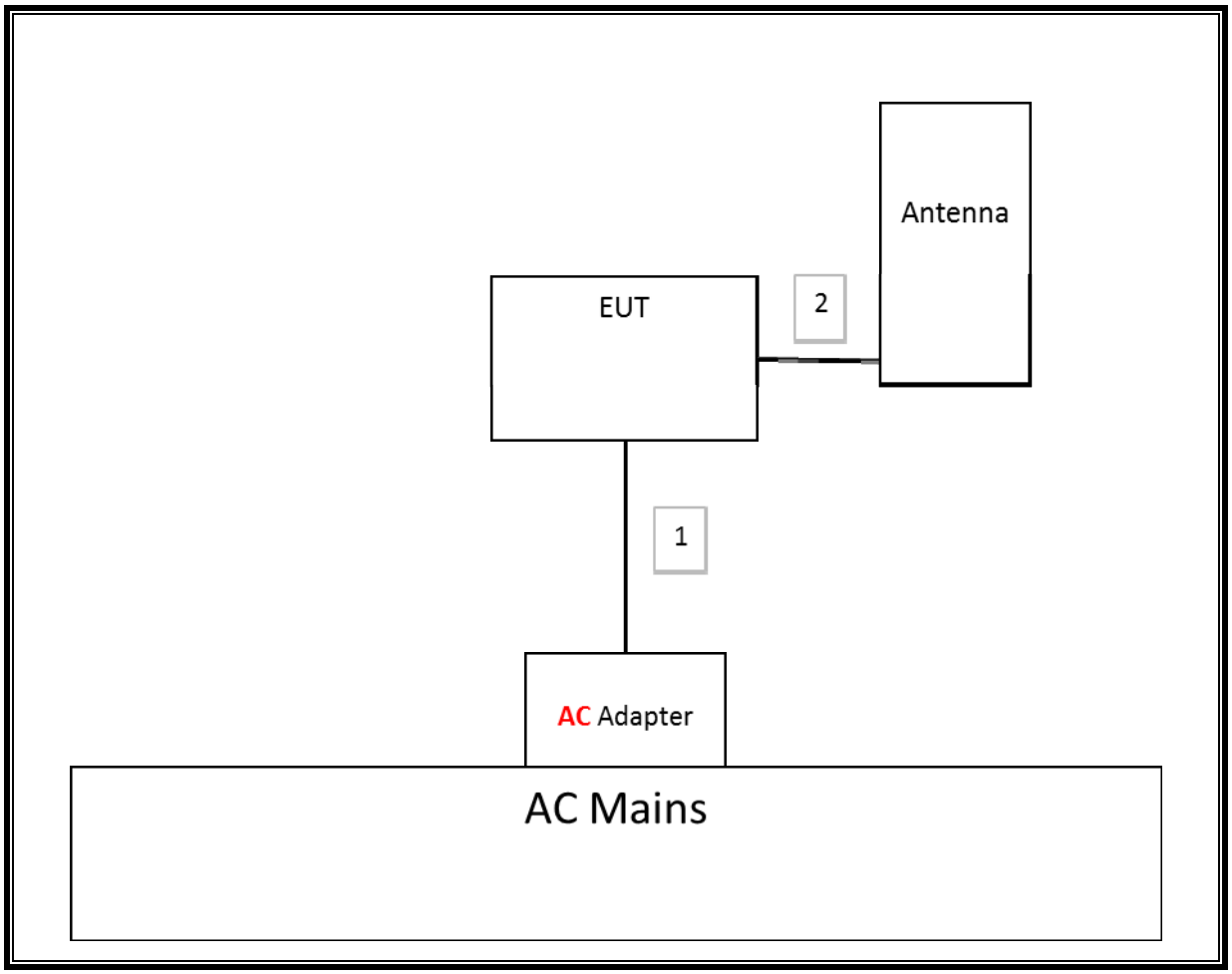
I/O CABLES

I/O CABLE LIST						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	1	AC	Unshielded	1.5m	Permanently affixed AC cord.
2	Antenna	2	N	Shielded	1.5m	

TEST SETUP

The EUT is installed in a host enclosure 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**	**Asset**	**Cal Date**	**Cal Due**
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01176	8/4/2011	8/4/2012
Antenna, Horn, 18 GHz	EMCO	3115	C00872	6/29/2011	6/29/2012
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	7/18/2011	7/18/2012
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01171	7/16/2011	7/16/2012
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	1/27/2011	1/27/2012
Peak Power Meter	Agilent / HP	E4416A	C00963	3/22/2011	3/22/2013
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	4/13/2011	4/13/2012
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	7/28/2011	7/28/2012

7. ANTENNA PORT TEST RESULTS

Note: For all antenna port testing, except output power, refer to report "11u13912-2B FCC IC DTS WLAN Report", the conducted output power was higher under report "11u13912-2B FCC IC DTS WLAN Report", therefore, it is worst-case.

7.1. OUTPUT POWER

LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain is 14 dBi for other than fixed, point-to-point operations, therefore the limit is 22 dBm.

TEST PROCEDURE

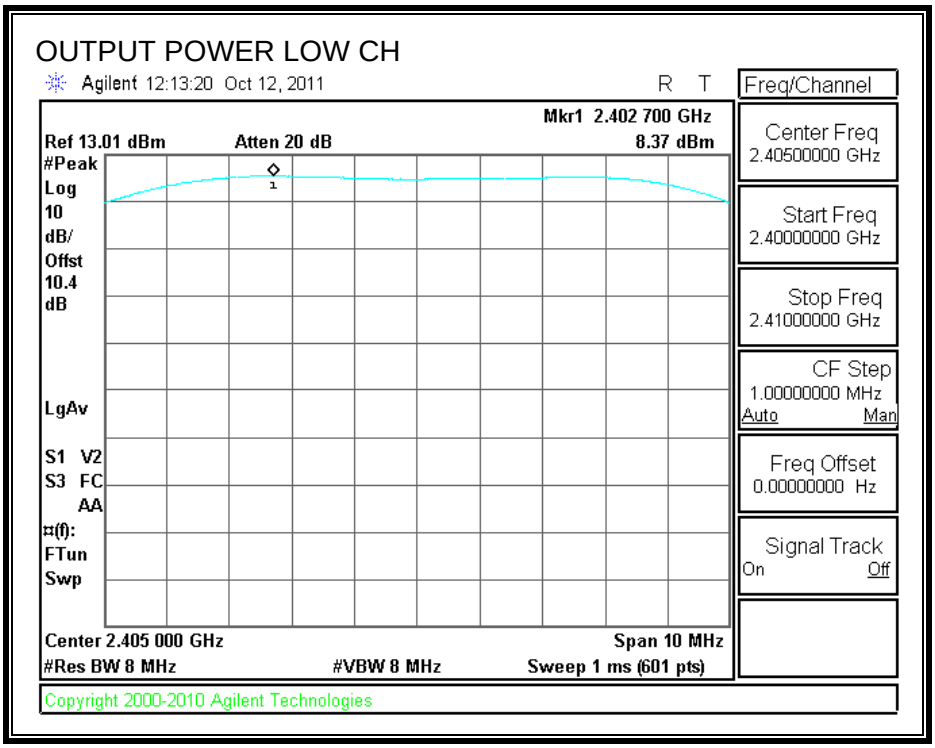
Peak power is measured using the Channel bandwidth Alternative peak output power procedure specified in "TCB Training for Devices covered under Scopes A1 - A4" by Joe Dichoso, May 2003.

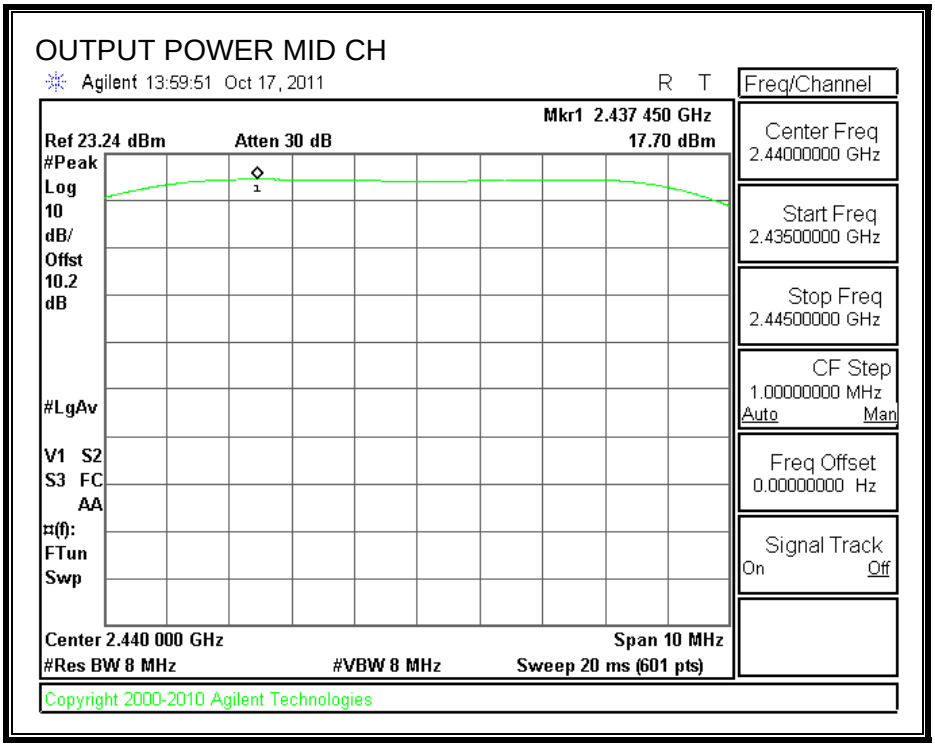
RESULTS

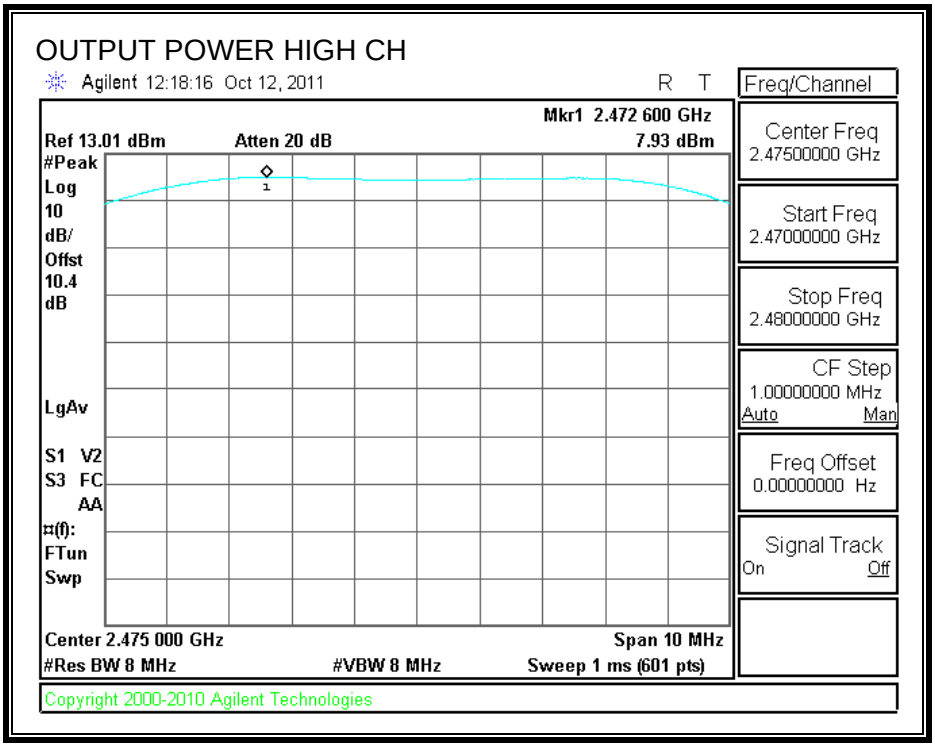
Channel	Frequency (MHz)	Peak Power Reading (dBm)	Attenuator and Cable Offset (dB)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2405	8.37	0	8.37	22	-13.63
Middle	2440	17.7	0	17.70	22	-4.30
High	2475	7.93	0	7.93	22	-14.07

Note: Attenuator/cable offset was included in the spectrum analyzer measurement.

OUTPUT POWER







7.2. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.54 dB (including 10 dB pad and 0.54 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Power (dBm)
Low	2405	6.91
Middle	2440	16.46
High	2475	6.93

8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

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.

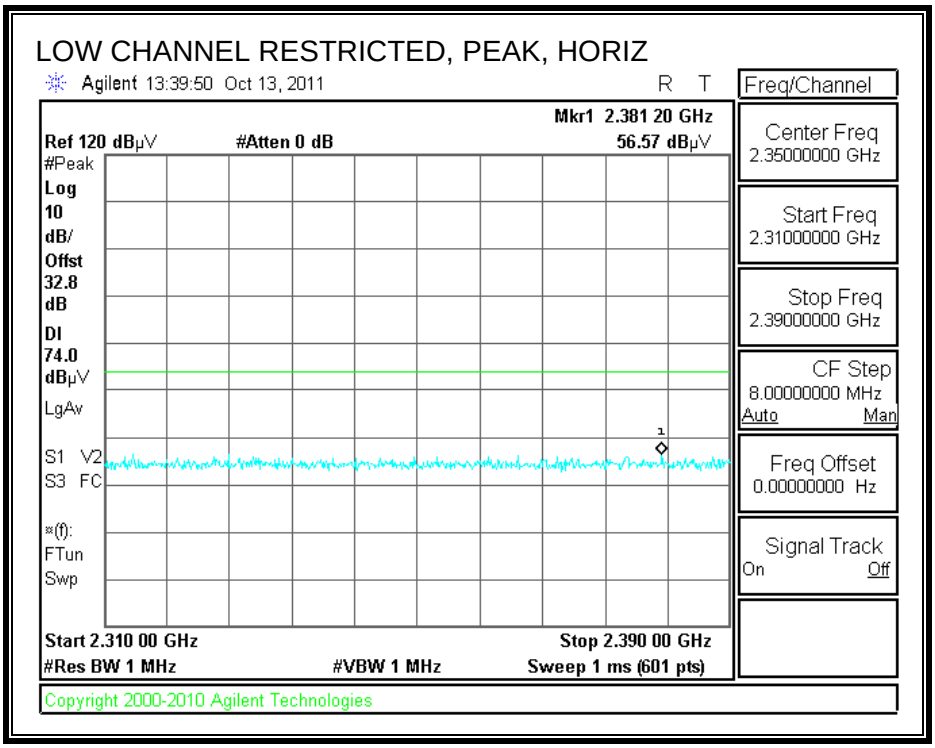
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

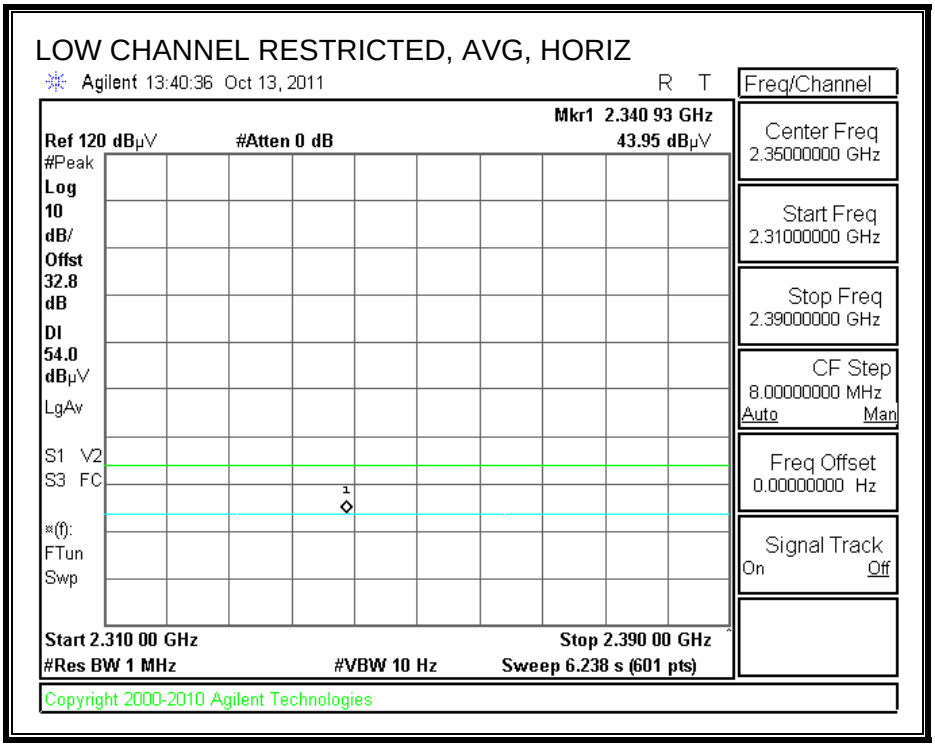
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.2. TRANSMITTER ABOVE 1 GHz

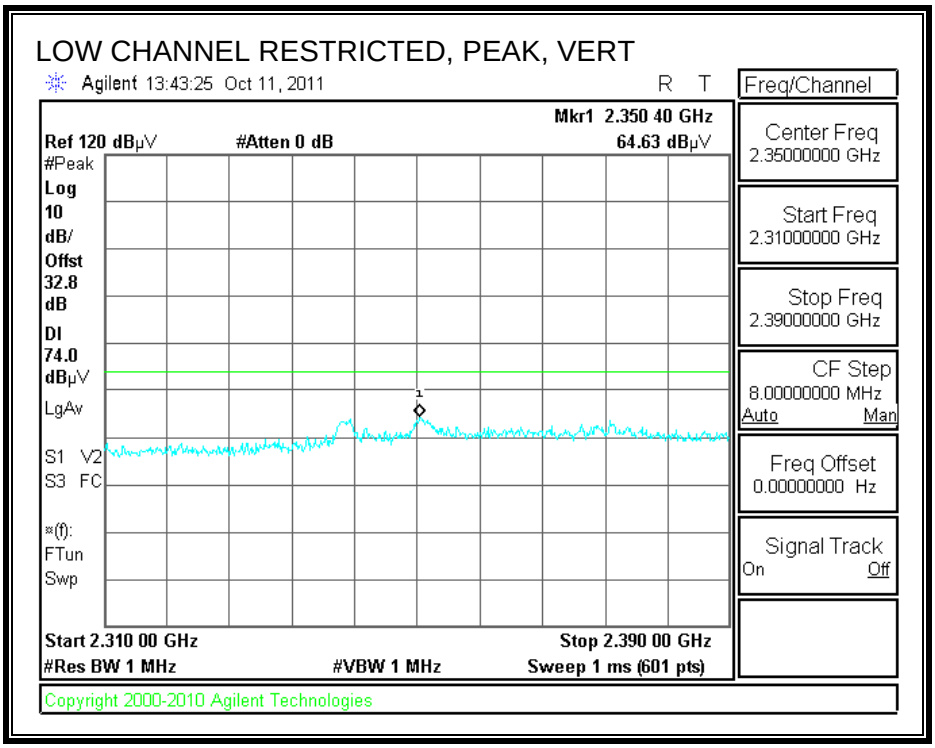
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



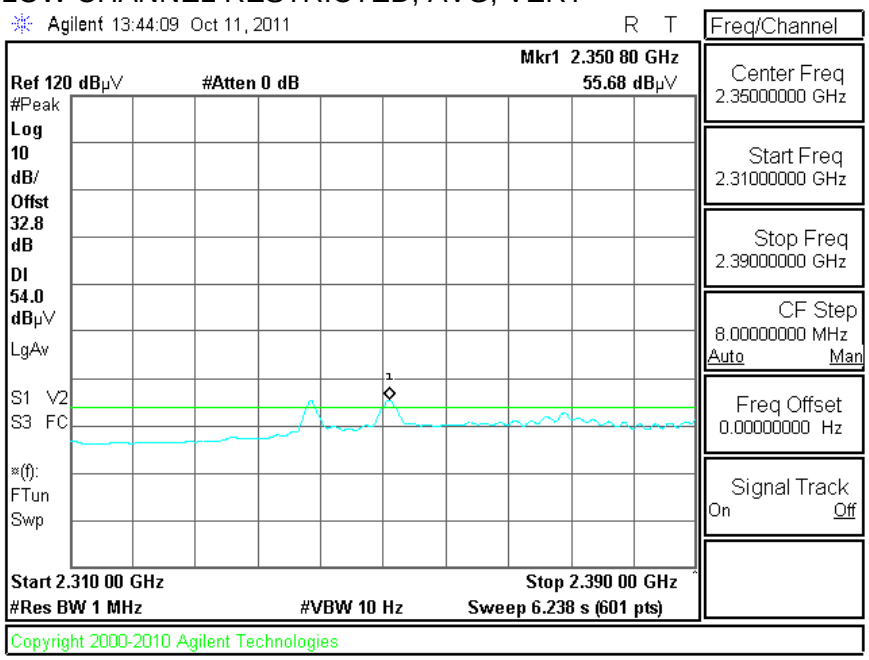
LOW CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



LOW CHANNEL RESTRICTED, AVG, VERT



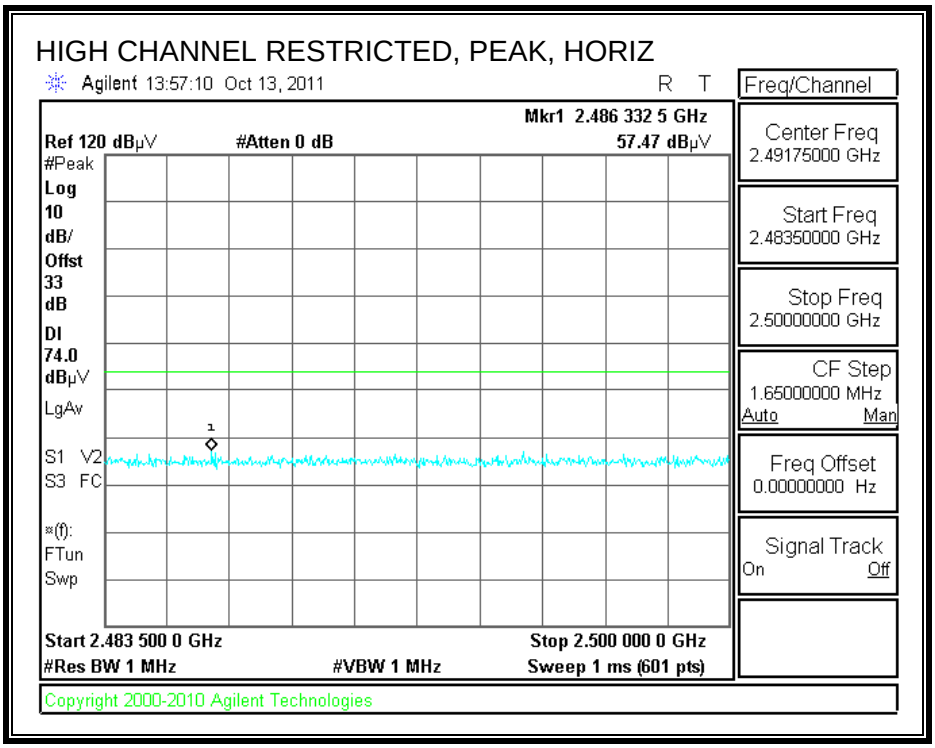
Note: Duty Cycle = 41.21%

Duty Cycle Correction Factor = 7.7 dB

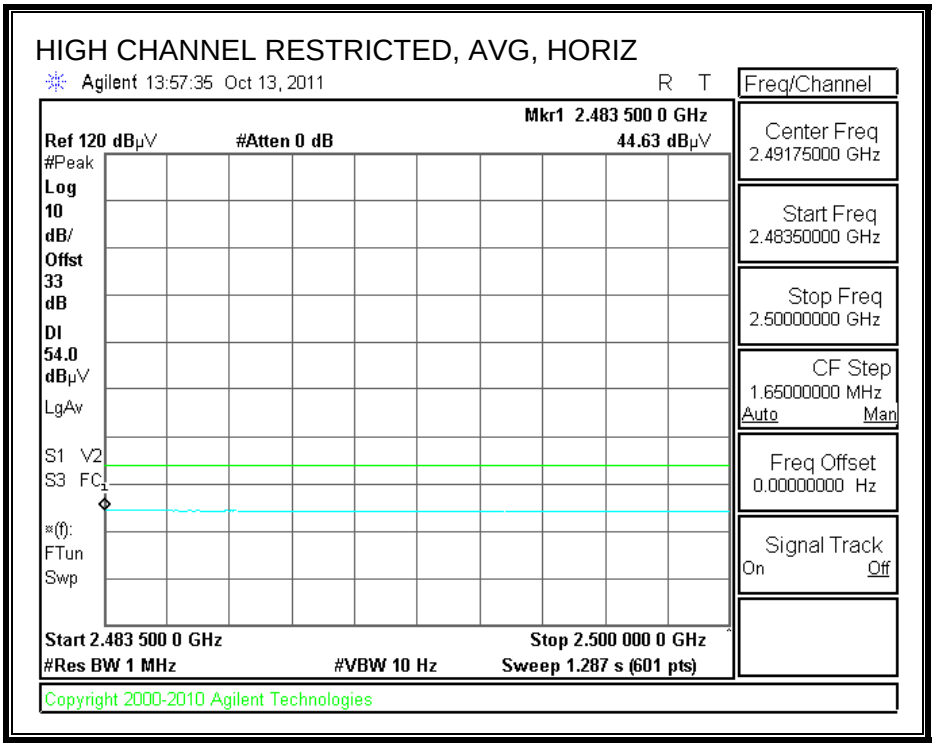
Corrected Reading = 55.68 – 7.7 = 47.98 dBuV/m

Passing Margin = 47.98 – 54 = -6.02 dB

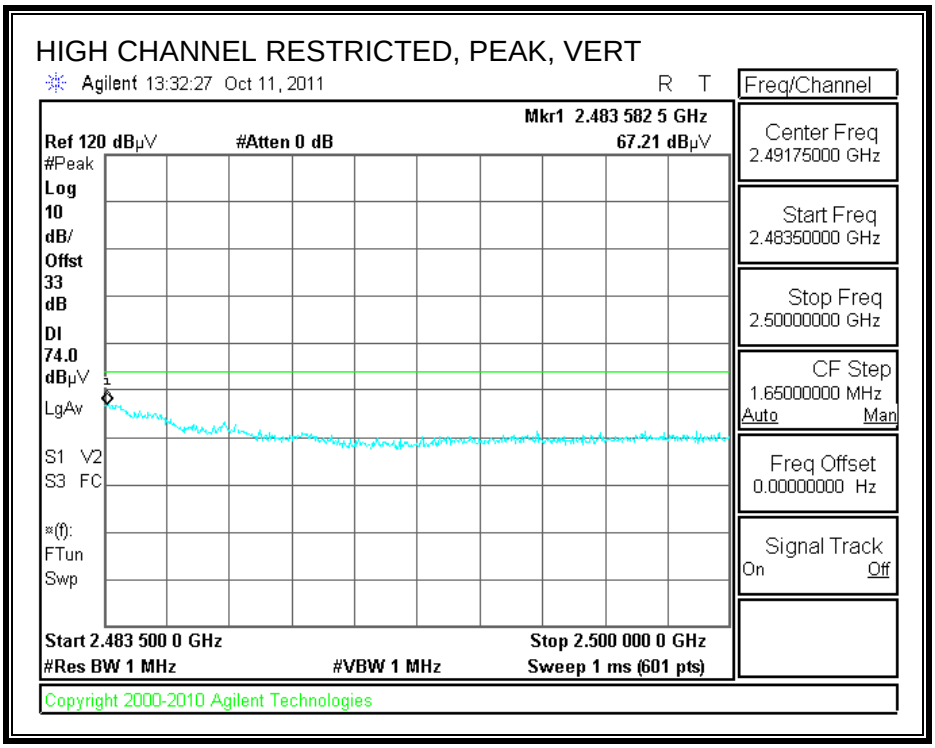
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



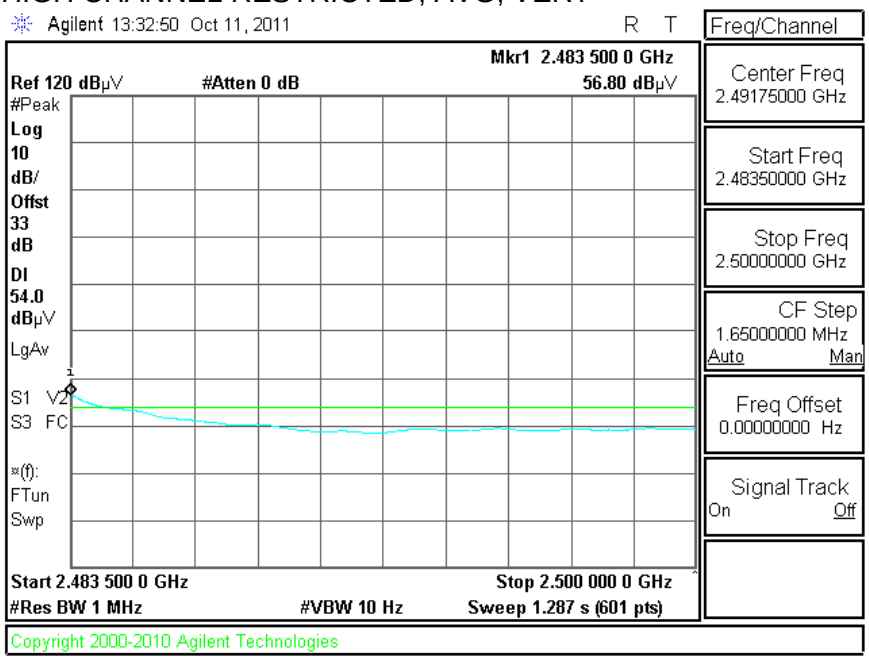
HIGH CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HIGH CHANNEL RESTRICTED, AVG, VERT



Note: Duty Cycle = 41.21%

Duty Cycle Correction Factor = 7.7 dB

Corrected Reading = 56.80 – 7.7 = 49.10 dBuV/m

Passing Margin = 49.10 – 54 = -4.90 dB

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company: Cisco
Project #: 11U14083
Date: 10/11/2911
Test Engineer: Mark Nolting (with David G.)
Configuration: EUT with new antenna
Mode: ZigBee: Transmitting

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B			FCC 15.205

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		R_001

Peak Measurements
RBW=VBW=1MHz
Average Measurements
RBW=1MHz ; VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Channel: 2405MHz (Power setting = 18dBm)															
4.810	3.0	42.3	32.6	33.9	6.8	-34.1	0.0	0.0	48.8	39.2	74	54	-25.2	-14.8	H
12.025	3.0	36.2	23.7	39.8	11.9	-32.3	0.0	0.0	55.6	43.1	74	54	-18.4	-10.9	H
4.810	3.0	47.3	38.6	33.9	6.8	-34.1	0.0	0.0	53.9	45.2	74	54	-20.1	-8.8	V
12.025	3.0	35.4	24.6	39.8	11.9	-32.3	0.0	0.0	54.7	44.0	74	54	-19.3	-10.0	V
Mid Channel: 2440MHz (Power setting = 18dBm)															
4.880	3.0	42.3	32.2	33.9	6.8	-34.0	0.0	0.0	49.0	38.9	74	54	-25.0	-15.1	H
7.320	3.0	46.8	38.0	36.6	9.1	-33.1	0.0	0.0	59.4	50.6	74	54	-14.6	-3.4	H
12.200	3.0	34.9	23.4	39.6	12.0	-32.3	0.0	0.0	54.2	42.7	74	54	-19.8	-11.3	H
4.880	3.0	46.8	38.4	33.9	6.8	-34.0	0.0	0.0	53.5	45.1	74	54	-20.5	-8.9	V
7.320	3.0	48.9	40.4	36.6	9.1	-33.1	0.0	0.0	61.5	53.0	74	54	-12.5	-1.0	V
12.200	3.0	35.8	24.0	39.6	12.0	-32.3	0.0	0.0	55.1	43.3	74	54	-18.9	-10.7	V
High Channel: 2475MHz (Power setting = 18dBm)															
4.950	3.0	37.9	28.2	34.0	6.9	-34.0	0.0	0.0	44.7	35.0	74	54	-29.3	-19.0	H
7.425	3.0	47.5	38.4	36.7	9.1	-33.1	0.0	0.0	60.3	51.1	74	54	-13.7	-2.9	H
12.375	3.0	35.0	23.6	39.5	12.0	-32.3	0.0	0.0	54.2	42.8	74	54	-19.8	-11.2	H
4.950	3.0	41.7	31.8	34.0	6.9	-34.0	0.0	0.0	48.5	38.6	74	54	-25.5	-15.4	V
7.425	3.0	46.7	37.5	36.7	9.1	-33.1	0.0	0.0	59.4	50.2	74	54	-14.6	-3.8	V
12.375	3.0	34.4	23.7	39.5	12.0	-32.3	0.0	0.0	53.7	42.9	74	54	-20.3	-11.1	V

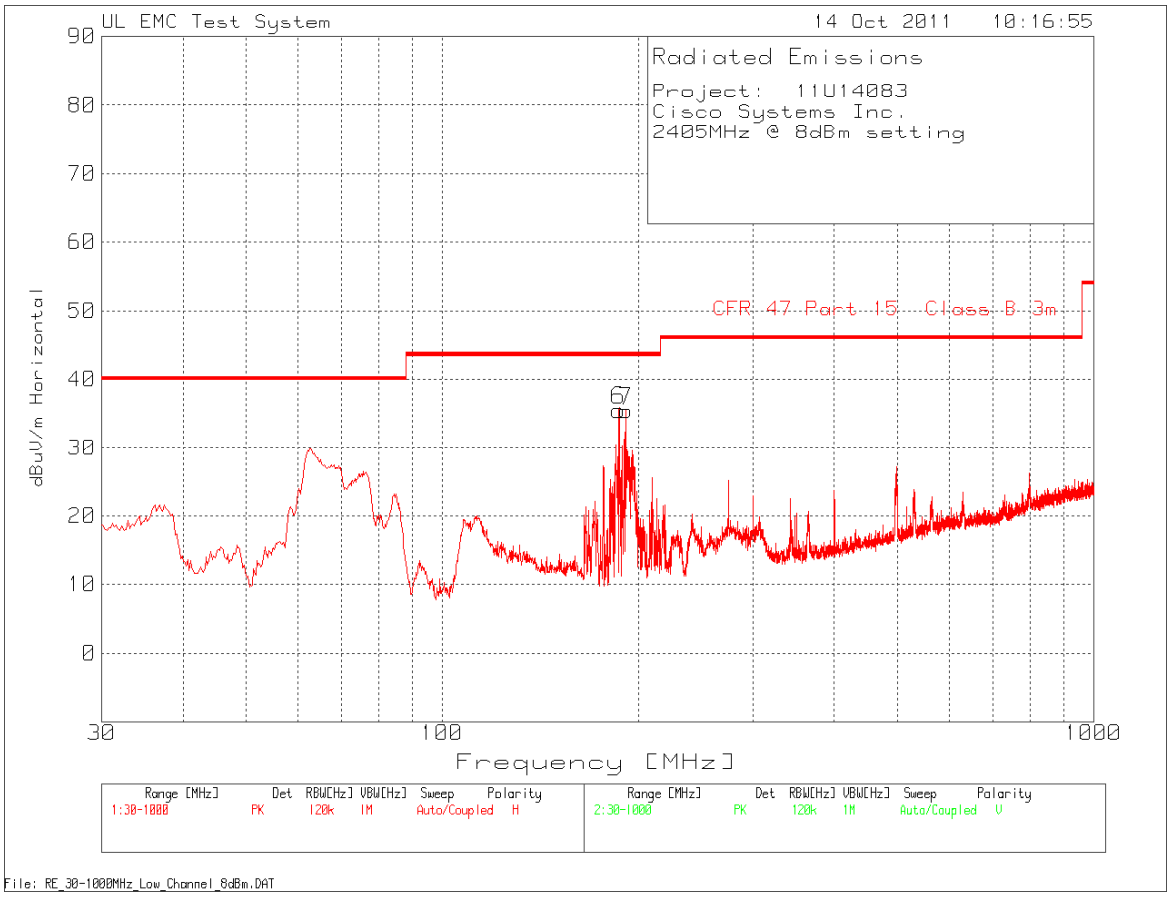
Rev. 07.08.11

f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

8.3. WORST-CASE BELOW 1 GHz

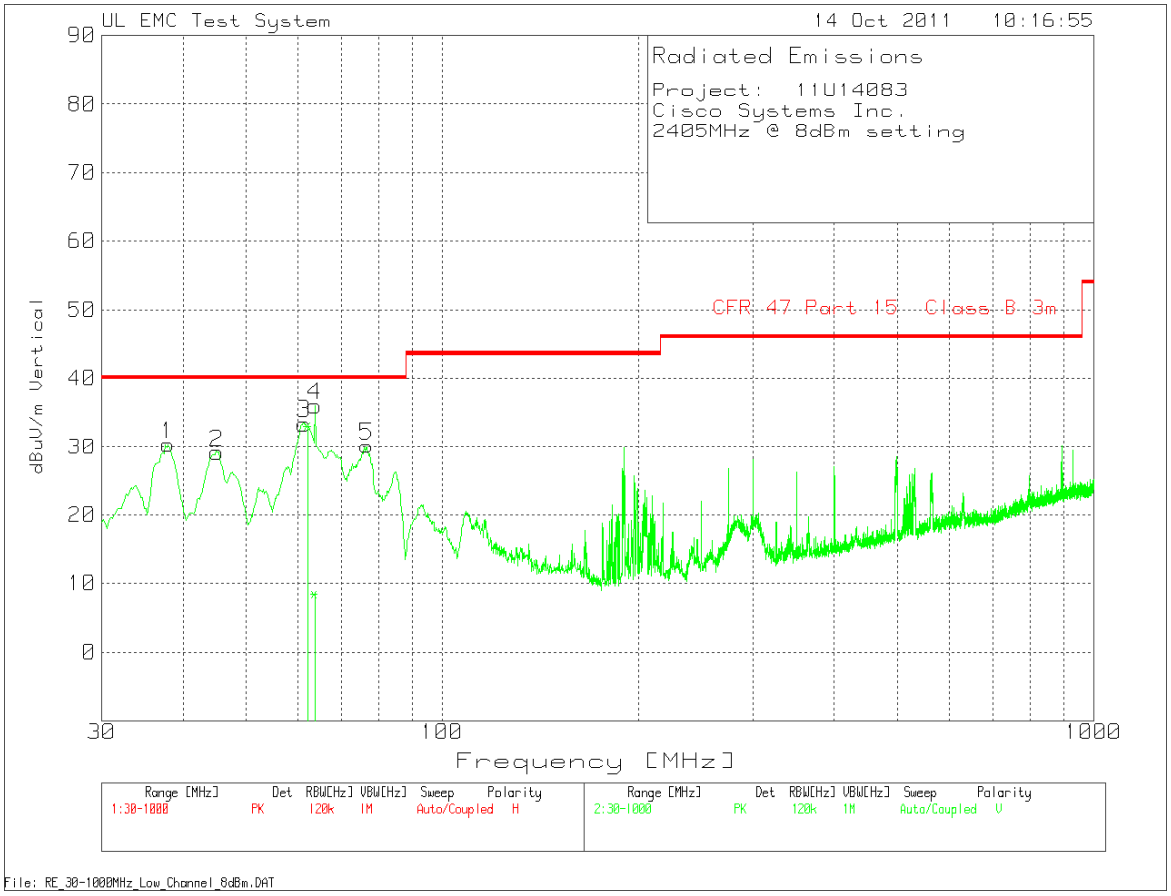
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT



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

VERTICAL PLOT



DATA

Project: 11U14083
Cisco Systems Inc.
2405MHz @ 8dBm setting

Test Frequency	Meter Reading	Detector	3m below 1GHz Cable.TXT [dB]	3m T15 PreAmp below 1GHz.TXT [dB]	3m Bilog T185 below 1GHz.TXT [dB]	dBuV/m	CFR 47 Part 15 Class B 3m	Margin	Height [cm]	Polarity
186.6267	50.83	PK	1.3	-27.7	11.1	35.53	43.5	-7.97	176	Horz
191.6667	50.33	PK	1.4	-27.7	11.4	35.43	43.5	-8.07	251	Horz
37.9476	42.7	PK	0.7	-28.2	15.1	30.3	40	-9.7	99	Vert
45.1199	44.89	PK	0.7	-28.2	11.7	29.09	40	-10.91	99	Vert
61.4029	52.81	PK	0.9	-28.2	7.9	33.41	40	-6.59	99	Vert
63.729	55.32	PK	0.9	-28.2	8	36.02	40	-3.98	176	Vert
76.5228	49.21	PK	1	-28.1	8	30.11	40	-9.89	99	Vert

9. MAXIMUM PERMISSIBLE EXPOSURE

FCC RULES

§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.

IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m^2)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\,000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, f, is in MHz.
2. A power density of 10 W/m^2 is equivalent to 1 mW/cm^2.
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

EQUATIONS

Power density is given by:

S = EIRP / (4 * Pi * D^2)

where

S = Power density in W/m^2
EIRP = Equivalent Isotropic Radiated Power in W
D = Separation distance in m

Power density in units of W/m^2 is converted to units of mWc/m^2 by dividing by 10.

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

where

D = Separation distance in m
EIRP = Equivalent Isotropic Radiated Power in W
S = Power density in W/m^2

For multiple colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the Power * Gain product (in linear units) of each transmitter.

Total EIRP = (P1 * G1) + (P2 * G2) + ... + (Pn * Pn)

where

Px = Power of transmitter x
Gx = Numeric gain of antenna x

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

LIMITS

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

From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m^2

RESULTS

2.4 GHz Band

Multiple chain or colocated transmitters									
Band	**Mode**	**Chain for MIMO**	**Separation Distance (m)**	**Output AV Power (dBm)**	**Antenna Gain (dBi)**	**EIRP (dBm)**	**EIRP (W)**	**IC Power Density (W/m^2)**	**FCC Power Density (mW/cm^2)**
2.4 GHz	Zigbee	N/A		16.46	14.00	30.46	1.11		
2.4 GHz	WLAN	1		25.00	4.00	29.00	0.79		
2.4 GHz	WLAN	2		25.00	4.00	29.00	0.79		
Combined			0.20				2.70	5.37	0.537

5.8 GHz Band

Multiple chain or colocated transmitters									
Band	**Mode**	**Chain for MIMO**	**Separation Distance (m)**	**Output AV Power (dBm)**	**Antenna Gain (dBi)**	**EIRP (dBm)**	**EIRP (W)**	**IC Power Density (W/m^2)**	**FCC Power Density (mW/cm^2)**
2.4 GHz	Zigbee	N/A		16.46	14.00	30.46	1.11		
5.8 GHz	WLAN	1		25.00	7.00	32.00	1.58		
5.8 GHz	WLAN	2		25.00	7.00	32.00	1.58		
Combined			0.20				4.28	8.52	0.852

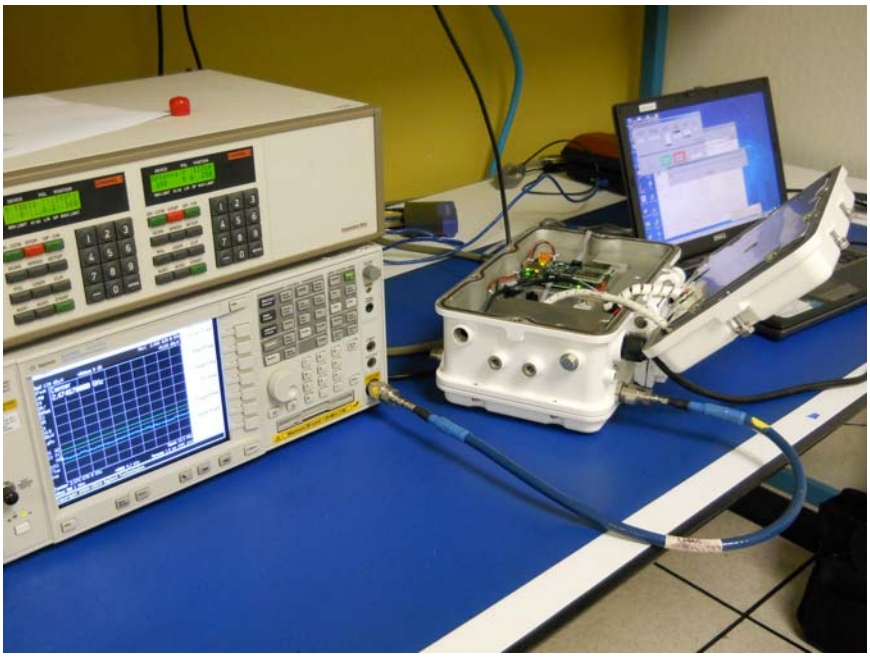
Note:
The AV output power for WLAN and the antenna gains for WLAN for both 2.4 GHz and 5.8 GHz bands are taken from the reports with the following numbers:

1552_Series_2400_2483.5_Test_Report.pdf
1552_Series_5725_5850_Test_Report.pdf

10. SETUP PHOTOS

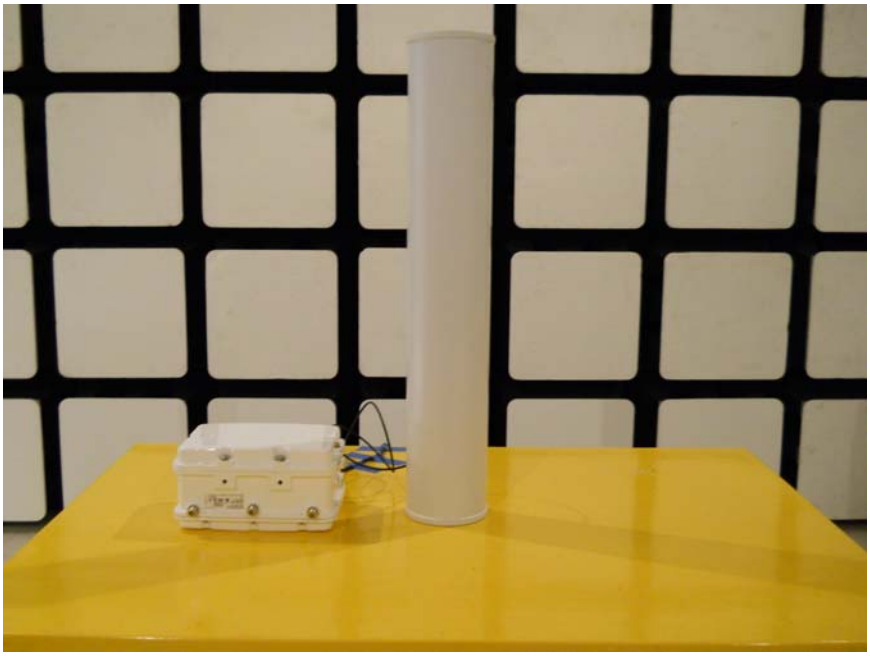
ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP

ANTENNA PORT CONDUCTED PHOTO

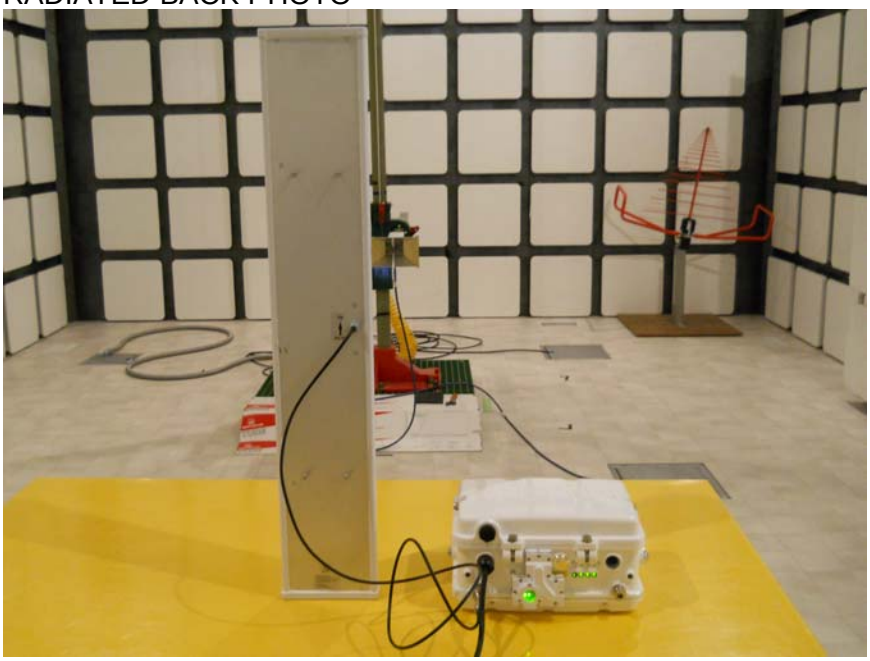


RADIATED RF MEASUREMENT SETUP

RADIATED FRONT PHOTO



RADIATED BACK PHOTO



END OF REPORT