EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement:	FCC
Test Requirements:	FCC Part 15
Applicant:	Silver Spring Networks 575 Broadway Street Redwood City, CA 94063
FCC ID:	**OWS-NIC511**
IC:	**5975A-NIC511**
Model No.:	NIC311x
Add External Antennas:	WP Wireless "Flex" Antenna (900MHz/2.4 GHz dual band)

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Silver Spring Networks (SSN) NIC514 is a radio module for electric power meter communications use. The board incorporates a 900 MHz frequency hopping i210 Mesh radio.

The product has been certified with an internal custom sheet metal antenna. The board has been modified to make provision for connecting an optional external antenna. The modification consists of the addition of a diplexer and an antenna switch.

III. TEST DATES AND TEST LOCATION

Testing was performed on various dates between 22 October – 23 November 2009.
900 MHz radiated emissions tests were performed at:

Compliance Certification Services
47173 Benicia Street
Fremont, CA 94538

Antenna port conducted tests were performed at Silver Spring Networks.

T.N. Cokenias 28 January 2010
EMC Consultant/Agent for Silver Spring Networks

15.203 Antenna connector requirement

The EUT has an internal antenna and an external antenna port.

Antenna description	Mfr.	Model No.	Gain
Internal antenna (original antenna)	SSN	n/a	4 dBi at 915 MHz
Flex Antenna (new antenna)	WP Wireless	WPIANTUGMLR120006A1	3 dBi at 915 MHz

TEST PROCEDURES

All tests were performed in accordance with the applicable procedures called out in the following documents, unless otherwise noted:

FCC 47CFR15

RSS-210 Issue 7: Low power license exempt radio frequency devices (July 2007)
RSS-212: Test Facilities and Test Methods for Radio Equipment

ANSI C63.4 – 2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

Test were performed at three frequencies:

900 MHz FHSS

Channel 0 (LOW) – 902.3 MHz
Channel 43 (MID) -915.2 MHz
Channel 82 (HIFH) – 926.9 MHz

Test Equipment

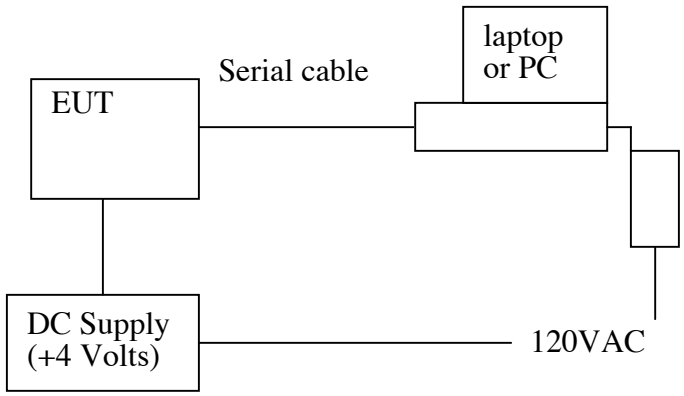
Compliance Certification Services:

TEST EQUIPMENT LIST					
Description	**Manufacturer**	**Model**	**Asset**	**Cal Date**	**Cal Due**
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01179	08/24/09	08/24/10
Antenna, Horn, 18 GHz	EMCO	3115	C00945	01/29/09	01/29/10
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	02/04/09	02/04/10
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR	CNR

Silver Spring Networks:

Equipment	Mfr	Model	Serial No.	Cal Date
Spectrum analyzer	Agilent	E44053	MY45113391	07/23/10
Spectrum analyzer	Agilent	EXA	MY48030147	07/23/10
Spectrum Analyzer	HP	8562B	2712A00113	09/25/10

Test Set-up Diagram



Support Equipment

Equipment	Mfr	Model	Asset No.
DC Power Supply	Agilent	E3610A	2844
Laptop PC	Dell	PP01L	TW-0791UH1280-OC9-6558
AC/DC adapter	CUI Inc.	DSA-60W-20	2607HB

FREQUENCY HOPPING SPREAD SPECTRUM RADIO EMISSIONS

TEST RESULTS

Radiated Test Set-up, 30 MHz - 9.3 GHz

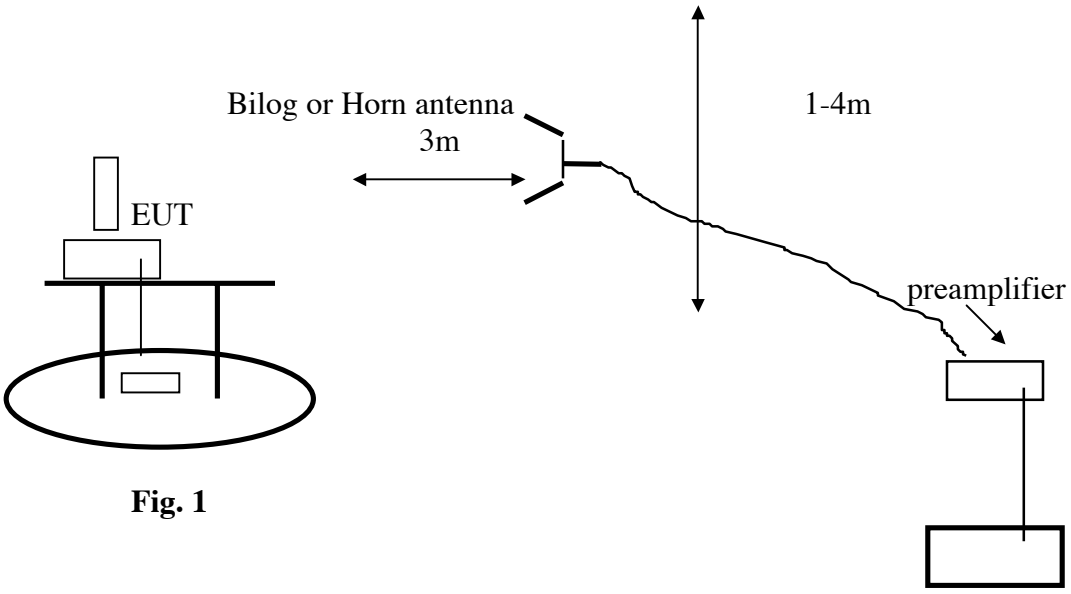


Fig. 1

Test Procedures

Radiated emissions generated by the transmitter portion of the EUT were measured.

1. The EUT was placed on a wooden table resting on a turntable on the test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted in the with the EUT TX antenna pointed directly to the search antenna.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Emissions were investigated to the 10^{th} harmonic of the fundamental.

4. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst-case results are presented. Refer to data sheets below. Restricted band emissions meet 54 dBuV/m. Other undesired emissions from the transmitter meet the -20 dBc requirement in 15.247(d).

15.205 Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505 (1)	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 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	
13.36 - 13.41	322 - 335.4		

15.209 General Field Strength Limits

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

Radiated Emissions

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Company: Silver Springs Networks
Project #: 09U12834
Date: 11/23/09
Test Engineer: Doug Anderson
Configuration: EUT / Support PC / DC Supply
Continuous 900 MHz Band Tx

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz
T73; S/N: 6717 @3m	T144 Miteq 3008A00931		

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: Ch. 0 (902.3 MHz)															
2.707	3.0	53.3	50.9	29.1	4.1	-37.4	0.0	0.0	49.1	46.7	74	54	-24.9	-7.3	H, ATS112 = 60
3.609	3.0	42.6	29.6	31.4	4.8	-36.9	0.0	0.0	41.9	29.0	74	54	-32.1	-25.0	H, ATS112 = 60
8.121	3.0	41.9	30.5	36.4	7.7	-36.2	0.0	0.0	49.8	38.4	74	54	-24.2	-15.6	H, ATS112 = 60
2.707	3.0	54.3	51.9	29.1	4.1	-37.4	0.0	0.0	50.1	47.7	74	54	-23.9	-6.3	V, ATS112 = 60
3.609	3.0	42.4	28.7	31.4	4.8	-36.9	0.0	0.0	41.7	28.0	74	54	-32.3	-26.0	V, ATS112 = 60
4.511	3.0	43.6	31.3	32.7	5.6	-36.5	0.0	0.0	45.4	33.1	74	54	-28.6	-20.9	V, ATS112 = 60
8.120	3.0	44.8	36.3	36.4	7.7	-36.2	0.0	0.0	52.7	44.2	74	54	-21.3	-9.8	V, ATS112 = 60
Mid Channel: Ch. 43 (915.2 MHz)															
2.746	3.0	53.1	50.2	29.2	4.1	-37.4	0.0	0.0	49.0	46.2	74	54	-25.0	-7.8	H, ATS112 = 60
3.661	3.0	41.8	28.8	31.5	4.9	-36.9	0.0	0.0	41.3	28.3	74	54	-32.7	-25.7	H, ATS112 = 60
4.576	3.0	41.6	29.0	32.8	5.6	-36.5	0.0	0.0	43.5	30.9	74	54	-30.5	-23.1	H, ATS112 = 60
8.237	3.0	43.2	34.3	36.5	7.8	-36.3	0.0	0.0	51.2	42.3	74	54	-22.8	-11.7	H, ATS112 = 60
2.746	3.0	52.0	49.1	29.2	4.1	-37.4	0.0	0.0	47.9	45.0	74	54	-26.1	-9.0	V, ATS112 = 60
3.661	3.0	43.9	31.1	31.5	4.9	-36.9	0.0	0.0	43.4	30.6	74	54	-30.6	-23.4	V, ATS112 = 60
4.576	3.0	42.3	32.4	32.8	5.6	-36.5	0.0	0.0	44.2	34.3	74	54	-29.8	-19.7	V, ATS112 = 60
8.236	3.0	43.2	34.4	36.5	7.8	-36.3	0.0	0.0	51.2	42.4	74	54	-22.8	-11.6	V, ATS112 = 60
High Channel: Ch. 82 (926.9 MHz)															
2.781	3.0	51.6	48.5	29.3	4.2	-37.4	0.0	0.0	47.7	44.6	74	54	-26.3	-9.4	H, ATS112 = 60
3.708	3.0	41.7	28.7	31.6	4.9	-36.8	0.0	0.0	41.4	28.4	74	54	-32.6	-25.6	H, ATS112 = 60
4.635	3.0	41.3	30.8	32.9	5.7	-36.5	0.0	0.0	43.4	32.9	74	54	-30.6	-21.1	H, ATS112 = 60
8.342	3.0	40.9	29.8	36.6	7.8	-36.3	0.0	0.0	49.0	37.9	74	54	-25.0	-16.1	H, ATS112 = 60
2.781	3.0	51.9	48.8	29.3	4.2	-37.4	0.0	0.0	48.0	44.9	74	54	-26.0	-9.1	V, ATS112 = 60
3.707	3.0	42.7	31.7	31.6	4.9	-36.8	0.0	0.0	42.4	31.4	74	54	-31.6	-22.6	V, ATS112 = 60
4.635	3.0	42.8	35.1	32.9	5.7	-36.5	0.0	0.0	44.8	37.2	74	54	-29.2	-16.8	V, ATS112 = 60
8.342	3.0	40.8	29.3	36.6	7.8	-36.3	0.0	0.0	48.9	37.4	74	54	-25.1	-16.6	V, ATS112 = 60

Rev. 11.10.08

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		

Radiated Emissions below 1 GHz

All emissions were more than 20 dB below the limits.

PEAK OUTPUT POWER

PEAK POWER LIMIT

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (2) For frequency hopping systems operating in the 902-928 MHz band, employing at least 50 hopping channels: 1 watt; and employing less than 50 hopping channels, but at least 25 hopping channels: 0.25 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 below 6 dBi, therefore the power limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer and the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

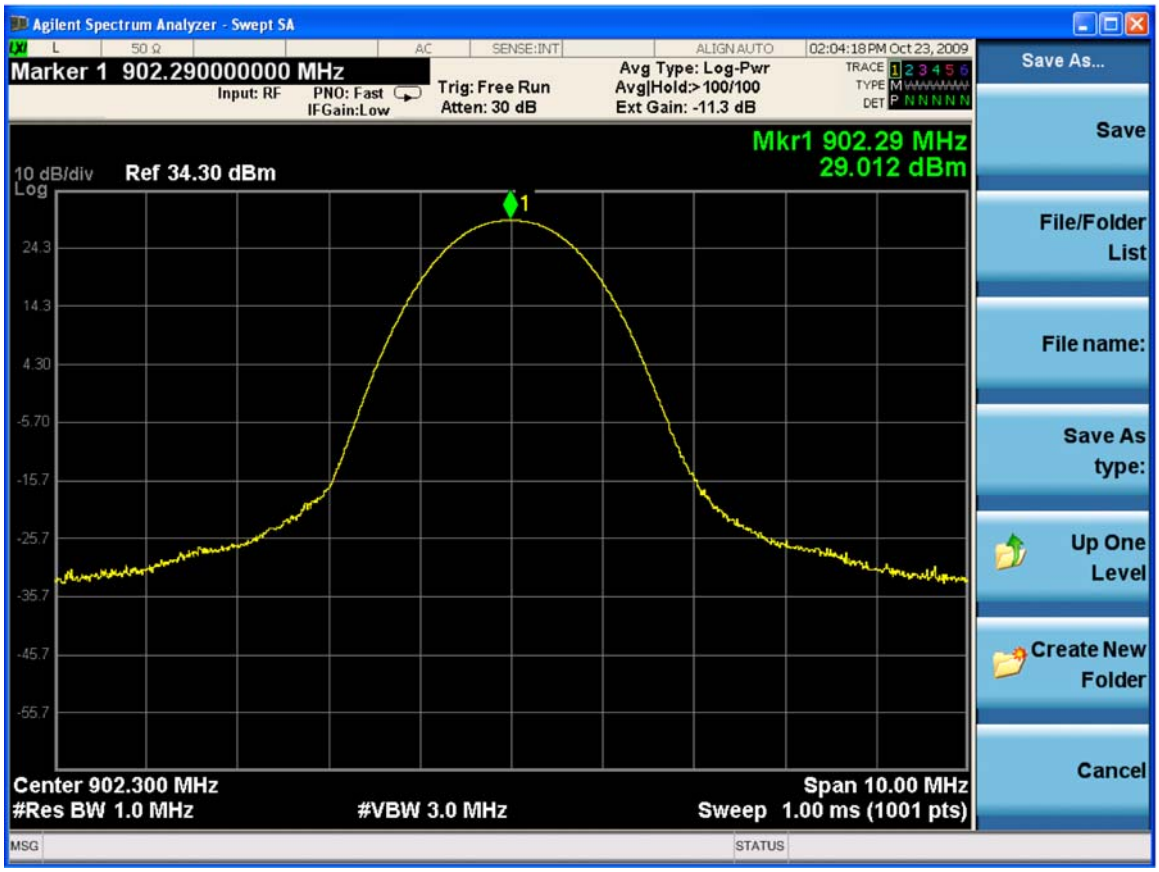
Note: Power measurements were at external antenna connector port on the radio board.

RESULTS

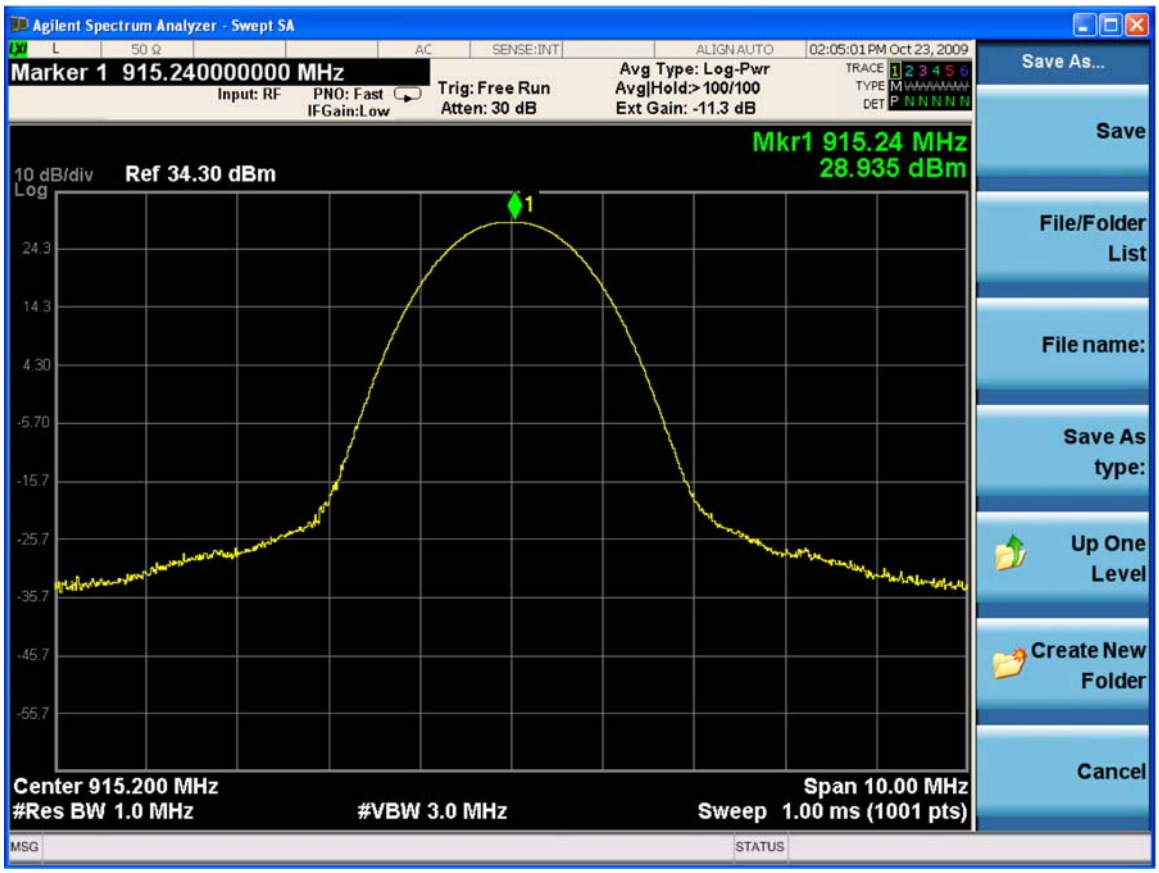
No non-compliance noted:

Channel	Frequency	P out
Low	902.3	29.01
Mid	914.9	28.94
High	926.9	28.76

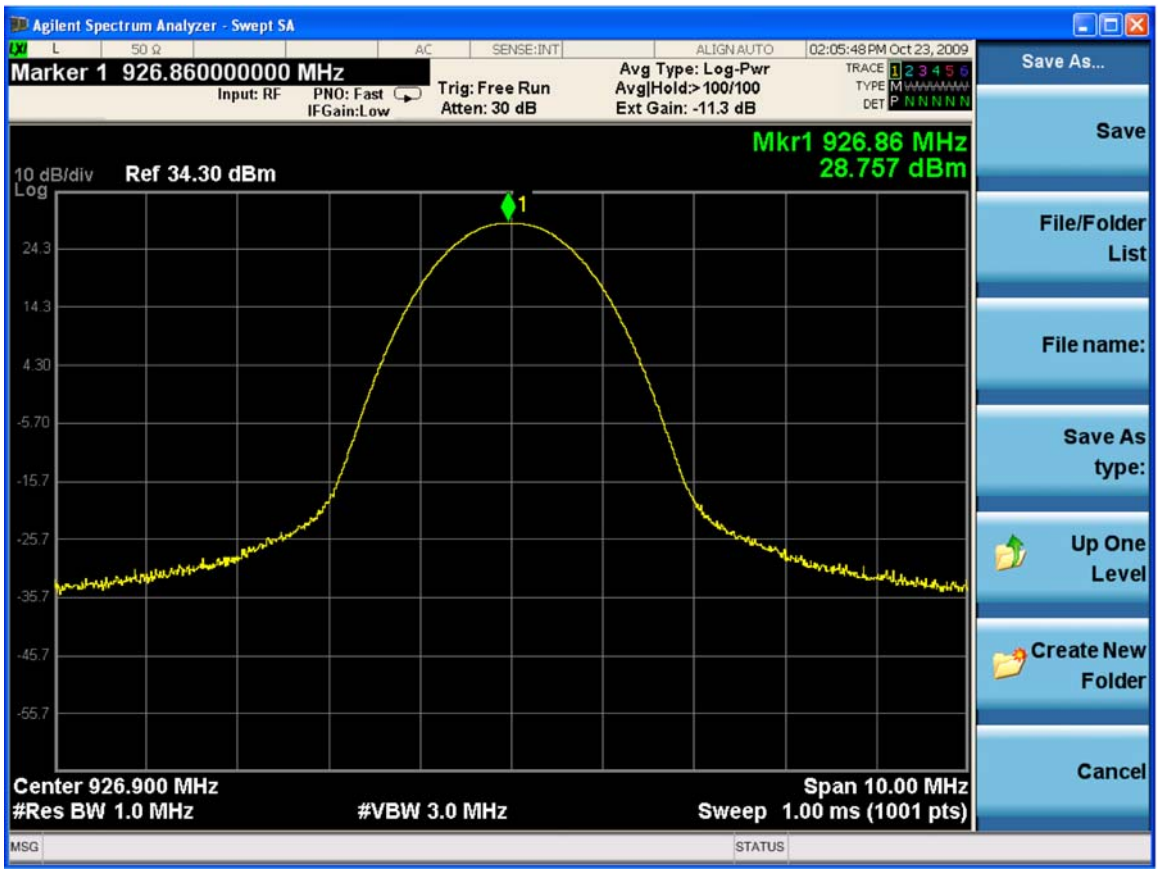
OUTPUT POWER LOW CHANNEL



OUTPUT POWER MID CHANNEL



OUTPUT POWER HIGH CHANNEL



MAXIMUM PERMISSIBLE EXPOSURE

LIMITS

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

$E = \sqrt{(30 * P * G) / d}$

and

$S = E \wedge 2 / 3770$

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 Power to mW and Distance to cm, using:

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

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

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

yields

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

From §1.1310 Table 1 (B), S = 0.6 mW/cm^2

RESULTS

No non-compliance noted:

Silver Spring Networks									
FCC ID: OWS-NIC514									
IC: 5975A- NIC514									
Utility Meter WLAN Transceiver			2.4 GHz			**Calculate mW/cm2 here. Enter frequency in MHz:**			
RF Hazard Distance Calculation						Calculation of Limits from 1.1310 Table 1			
								Controlled	Uncontrolled
								Ave 6 min	Ave 30 min
mW/cm2 from Table1:		0.60	(E: 61 V/m)			F(MHz)	**Actual F, MHz**	Occ, mW/c2	Gen, mW/cm2
						0.3-3	0.5	100.0	100.0
Max RF Power	TX Antenna	MPE distance	S, mW/cm@	Comment		*3.0 - 30.0*	*5*	*180.0*	*36.0*
P, dBm	G, dBi	cm	at 20 cm			**30.0-300**	**55**	**1.0**	**0.2**
						300-1500	*902*	*3.0*	*0.60*
29.0	**3.0**	**14.5**	**0.32**			1500-100000	5555	5.0	1.0
						Enter P(mW)	Equivalent dBm	**Enter dBm**	Equivalent Watts
Basis of Calculations:						***64***	**18.1**	***18.1***	64.6
E^2/3770 = S, mW/cm2									
E, V/m = (Pwatts*Ggain*30)^.5/d, meters									
d = ((Pwatts*G*30)/3770*S))^0.5			Pwatts*Ggain = 10^(PdBm-30+GdBi)/10)						
S@20cm = 20 log (MPE dist/20cm)									
NOTE: For mobile or fixed location transmitters, minimum separation distance is for FCC compliance is 20 cm,									
even if calculations indicate MPE distance is less									

MPE Distance: 14.5 cm

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.

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

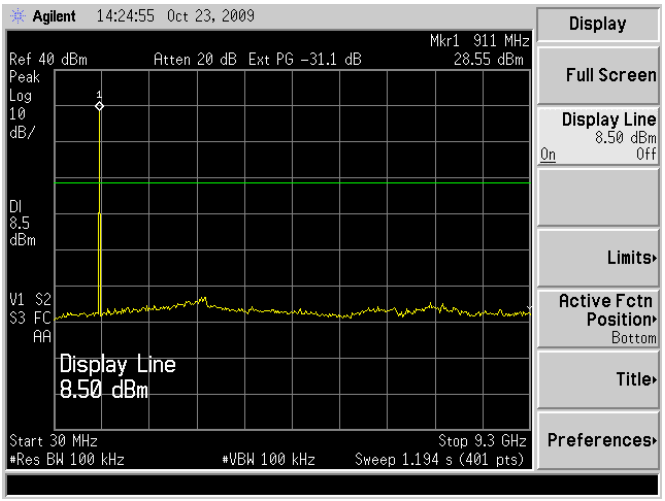
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

The spectrum from 30 MHz to 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

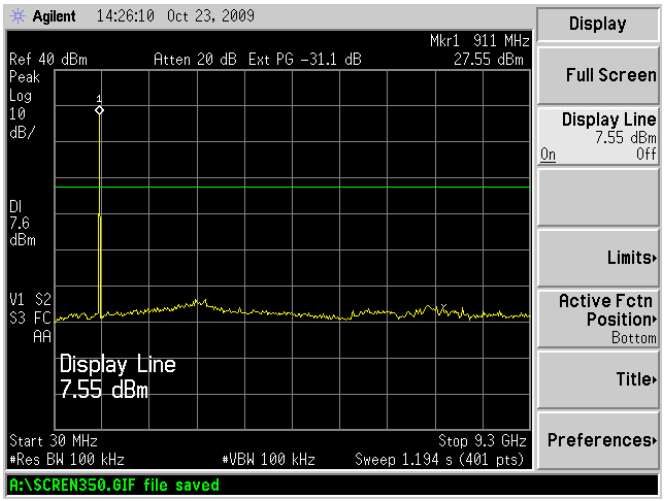
RESULTS

No non-compliance noted:

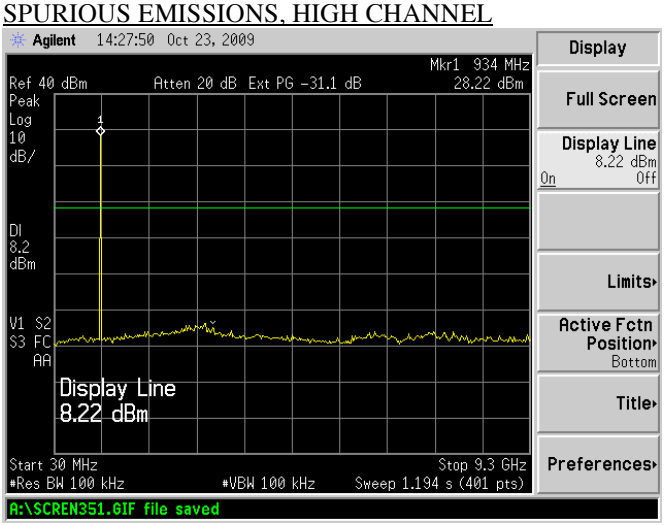
SPURIOUS EMISSIONS, LOW CHANNEL



SPURIOUS EMISSIONS, MID CHANNEL

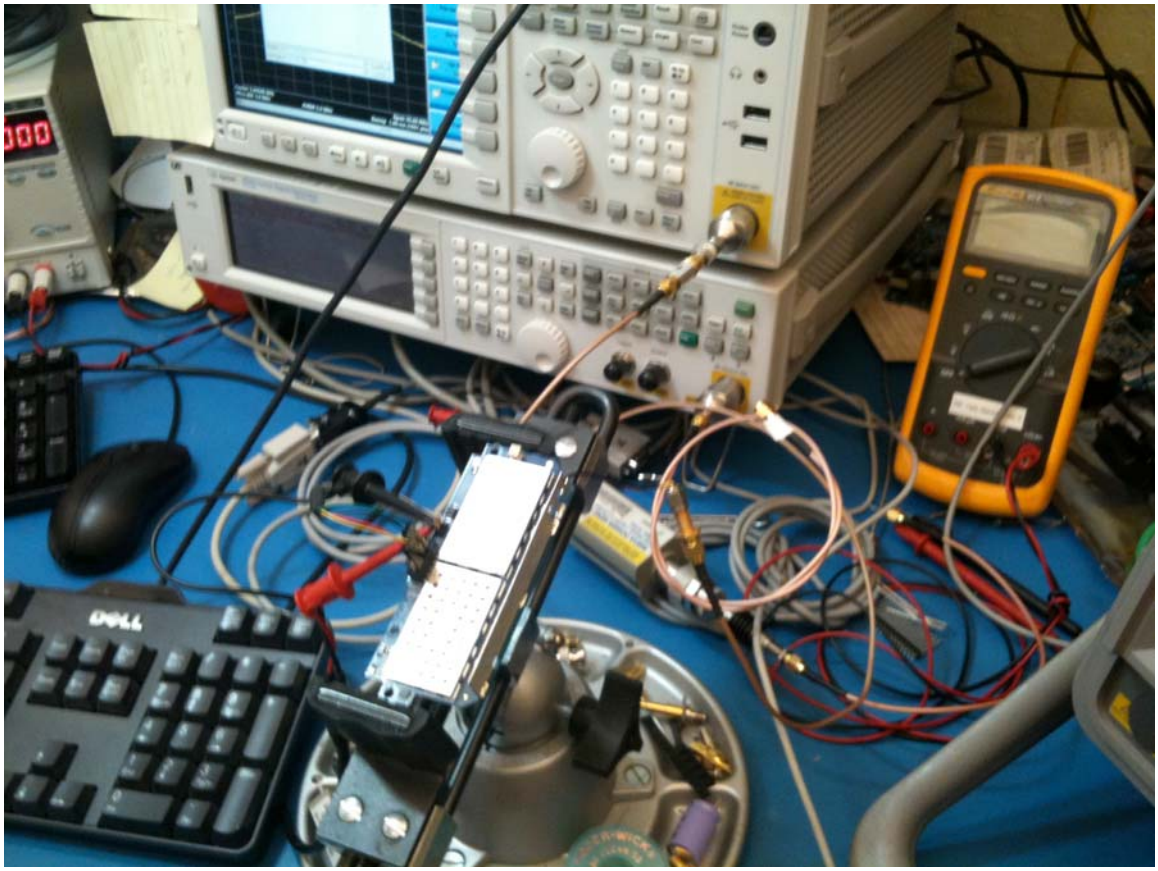


SPURIOUS EMISSIONS, HIGH CHANNEL

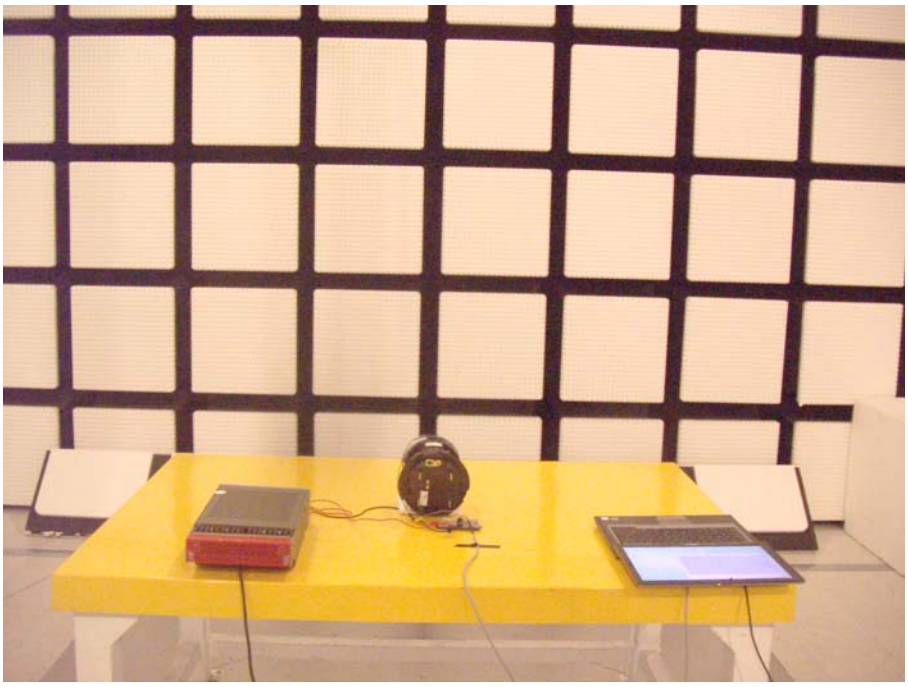


SETUP PHOTOS

ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP, SILVER SPRING NETWORKS



RADIATED RF MEASUREMENT SETUP, CCS



END OF REPORT

Report Revision History

Revision No.	Revision Description	Pages Revised	Revised by	Date
-	Original Issue		T. Cokenias	01/28/2010