Nemko-CCL, Inc.

1940 West Alexander Street
Salt Lake City, UT 84119
801-972-6146

Test Report

Certification

Test Of: CC-RLINT

FCC ID: PII-CCRL

Test Specification: FCC PART 15, Subpart C

Test Report Serial No: 207109-4.3

Applicant:
Vantage Controls Inc.
1061 South 800 East
Orem, UT 84097

Date of Test: April 30, 2012

Report Issue Date: August 27, 2012

Accredited Testing Laboratory By:

NVLAP Lab Code 100272-0

CERTIFICATION OF ENGINEERING REPORT

This report has been prepared by Nemko-CCL, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C. This report may be reproduced in full, partial reproduction may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

- Applicant: Vantage Controls Inc.
- Manufacturer: Vantage Controls Inc.
- Brand Name: Vantage
- Model Number: CC-RLINT
- FCC ID Number: PII-CCRL

On this 27th day of August 2012, I, individually and for Nemko-CCL, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has recognized that the Nemko-CCL, Inc. EMC testing facilities are in good standing, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Nemko-CCL, Inc.

Tested by: Norman P. Hansen
EMC Technician

Reviewed by: Thomas C. Jackson
General Manager

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SECTION 1.0 CLIENT INFORMATION

1.1 Applicant:

Company Name:	Vantage Controls Inc. 1061 South 800 East Orem, UT 84097
Contact Name:	Jim Beagley
Title:	Electrical Engineer

1.2 Manufacturer:

Company Name:	Vantage Controls Inc. 1061 South 800 East Orem, UT 84097
Contact Name:	Jim Beagley
Title:	Electrical Engineer

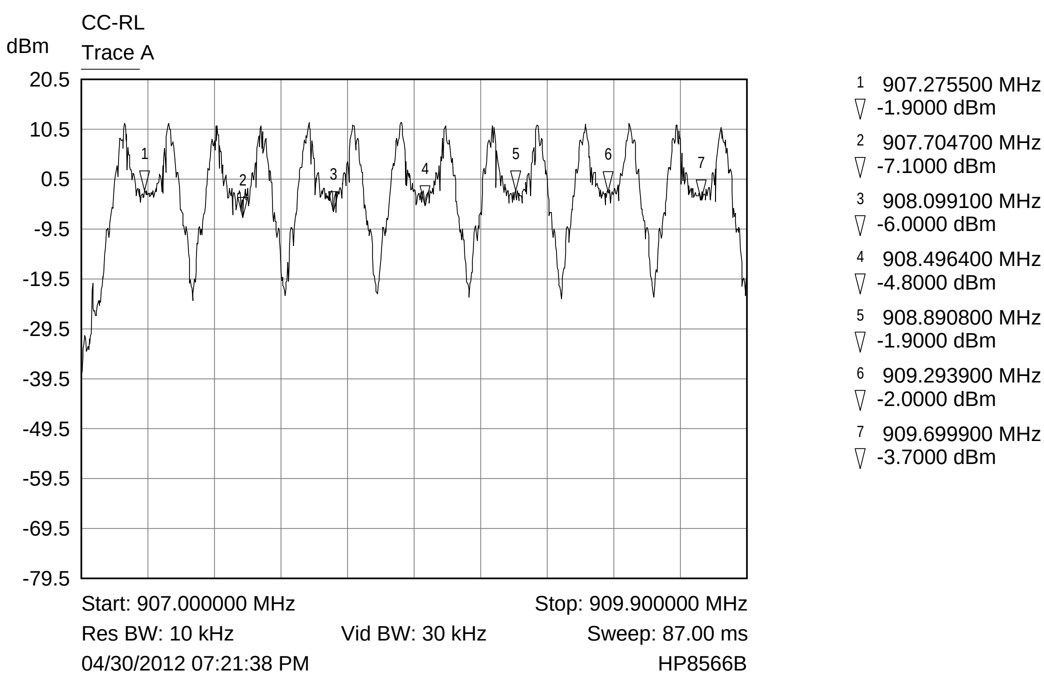
SECTION 2.0 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of EUT:

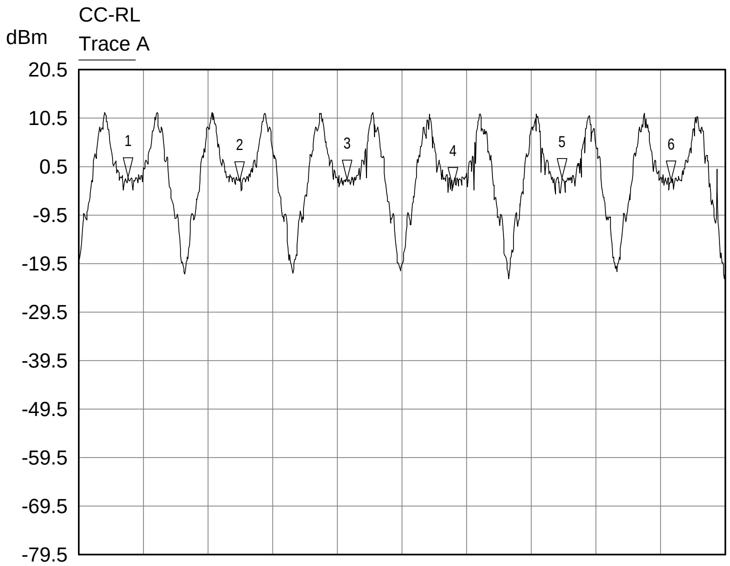
Brand Name:	Vantage
Model Number:	CC-RLINT
Serial Number:	Engineering Unit
Country of Manufacture:	U.S.A.

2.2 Description of EUT:

The CC-RLINT is a device to interface a thermostat into the Vantage home automation system. The CC-RLINT receives power and connects to the thermostat over wiring and communicates with a Vantage controller using a 902- 928 MHz FHSS transceiver. The CC-RLINT uses a heatshrink covering as a housing. The EUT operates from 24 VAC supplied by an external power source used in the HVAC system. The EUT uses a trace on the PCB as an antenna. The CC-RLINT is a FHSS device using 25 channels in the 902 – 928 MHz frequency range. See the plots of the channels below:



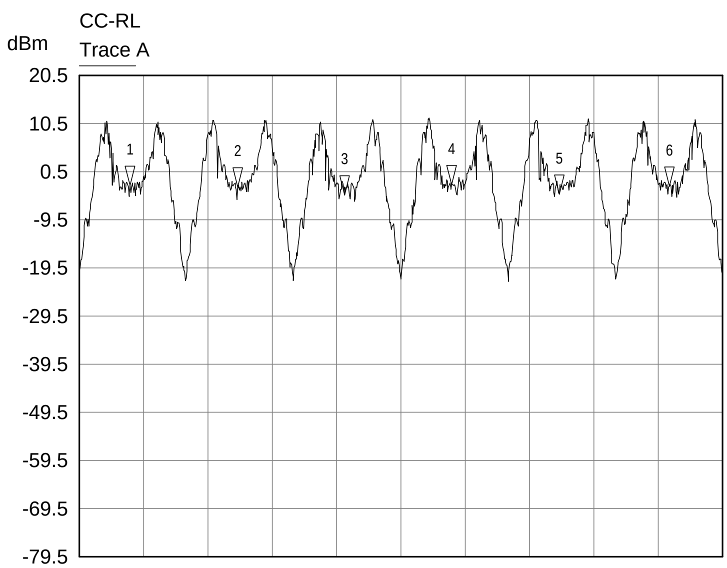
Trace A lower 7 channels



Start: 909.900000 MHz Stop: 912.300000 MHz
Res BW: 10 kHz Vid BW: 30 kHz Sweep: 72.00 ms
04/30/2012 07:26:30 PM HP8566B

Mkr	X-Axis	Value
1 ▽	910.082400 MHz	-1.7000 dBm
2 ▽	910.497600 MHz	-2.5000 dBm
3 ▽	910.896000 MHz	-2.1000 dBm
4 ▽	911.289600 MHz	-3.7000 dBm
5 ▽	911.695200 MHz	-1.9000 dBm
6 ▽	912.098400 MHz	-2.4000 dBm

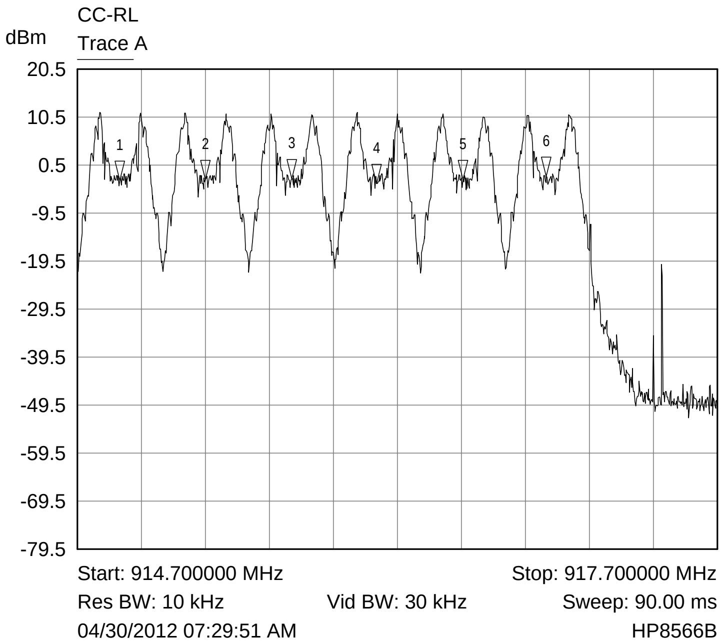
Trace A lower middle 6 channels



Start: 912.300000 MHz Stop: 914.700000 MHz
Res BW: 10 kHz Vid BW: 30 kHz Sweep: 72.00 ms
04/30/2012 07:28:35 PM HP8566B

Mkr	X-Axis	Value
1 ▽	912.489600 MHz	-2.4000 dBm
2 ▽	912.890400 MHz	-2.7000 dBm
3 ▽	913.291200 MHz	-4.3000 dBm
4 ▽	913.689600 MHz	-2.2000 dBm
5 ▽	914.090400 MHz	-4.1000 dBm
6 ▽	914.500800 MHz	-2.5000 dBm

Trace A upper middle 6 channels



Mkr	X-Axis	Value
1 ▽	914.898000 MHz	-2.6000 dBm
2 ▽	915.300000 MHz	-2.5000 dBm
3 ▽	915.705000 MHz	-2.3000 dBm
4 ▽	916.104000 MHz	-3.4000 dBm
5 ▽	916.506000 MHz	-2.5000 dBm
6 ▽	916.899000 MHz	-1.8000 dBm

Trace A upper 6 channels

This report covers the circuitry of the devices subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Part 15, Subpart B has been tested to FCC Subpart B and found to comply. Compliance is shown Nemko-CCL report #207109-3.

2.3 EUT and Support Equipment:

The FCC ID numbers for the EUT and support equipment used during the test are listed below:

Brand Name Model Number Serial No.	FCC ID Number	Description	Name of Interface Ports / Interface Cables
BN: Vantage MN: CC-RLINT (Note 1) SN: Engineering PCB	PII-CCRL	Thermostat to home control interface device	See Section 2.4
BN: Vantage MN: Thermostat SN: None	None	Thermostat	Interface/6 conductors (Note 2)
BN: Amesco MN: XT-2420 SN:None	None	Power supply	Power/2 conductors

Note: (1) EUT
(2) Interface port connected to EUT (See Section 2.4)

The support equipment listed above was not modified in order to achieve compliance with this standard.

2.4 Interface Ports on EUT:

Name of Ports	No. of Ports Fitted to EUT	Cable Descriptions/Length
Thermostat Interface	1	6 unshielded conductors/5 meters

2.5 Modification Incorporated/Special Accessories on EUT:

There were no modifications or special accessories required to comply with the specification.

SECTION 3.0 TEST SPECIFICATION, METHODS & PROCEDURES

3.1 Test Specification:

Title:	FCC PART 15, Subpart C (47 CFR 15) 15.203, 15.207, and 15.247 Limits and methods of measurement of radio interference characteristics of radio frequency devices
Purpose of Test:	The tests were performed to demonstrate initial compliance

3.2 Methods & Procedures:

3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

3.2.2 §15.207 Conducted Limits

(a) Except for Class A digital devices, for equipment 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 band edges.

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	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.

3.2.3 §15.247 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

(2) Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

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

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725 – 5850 MHz bands: 1 watt. As an alternative to a peak power measurement, compliance with the Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna /antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

(e) For digitally modulated systems, the 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

(i) 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.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of Part 18 of this Chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.3 Test Procedure

The conducted disturbance at mains ports and radiated disturbance testing was performed according to the procedures in ANSI C63.4: 2003 and using the guidance, DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, dated March 30, 2000. Testing was performed at Nemko-CCL, Inc. Wanship open area test site #2, located at 29145 Old Lincoln Highway, Wanship, UT. This site has been fully described in a report submitted to the FCC, and was accepted in a letter dated February 15, 2012 (90504).

Nemko-CCL, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2012.

SECTION 4.0 OPERATION OF EUT DURING TESTING

4.1 Operating Environment:

Power Supply: 24 VAC from external power supply connected to 120 VAC/60 Hz

4.2 Operating Modes:

The transmitter was tested while in a constant transmit mode at the maximum power setting at the desired frequency, using either the upper or lower channel. Tests, when required, were made with the EUT hopping between channels. The AC mains voltage was varied as required by §15.31(e) with no change seen in the transmitter characteristics. The EUT was tested on 3 orthogonal axes. The worst-case emissions were seen with the EUT placed horizontally on the EUT table.

4.3 EUT Exercise Software:

Vantage Controls Inc. test firmware was used to exercise the transmitter.

SECTION 5.0 SUMMARY OF TEST RESULTS

5.1 FCC Part 15, Subpart C

5.1.1 Summary of Tests:

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.203	Antenna Requirements	Structural requirement	Complied
15.207	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.247(a)	Channel Separation	902 – 928	Complied
15.247(a)	20 dB Bandwidth	902 – 928	Complied
15.247(a)	Time of Occupancy	902 – 928	Complied
15.247(b)	Peak Output Power	902 – 928	Complied
15.247(c)	Operation with Antennas with Directional Gains >6 dBi	902 – 928	Not Applicable
15.247(d)	Spurious Emissions	30 – 9280	Complied
15.247(e)	Peak Power Spectral Density	902 – 928	Not Applicable
15.247(f)	Hybrid System Requirements	902 – 928	Not Applicable
15.247(g)	Channel Usage	902 – 928	Complied (Note 1)
15.247(h)	Channel Intelligence/Avoidance	902 – 928	Complied (Note 1)
15.247(i)	RF Safety	902 – 928	Complied (Note 1)
Note 1: Compliance with these requirements is shown in documents filed with the FCC at the time of Certification.			

5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

SECTION 6.0 MEASUREMENTS, EXAMINATIONS AND DERIVED RESULTS

6.1 General Comments:

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Appendix 1 of this report.

6.2 Test Results:

6.2.1 §15.203 Antenna Requirements

The EUT uses a trace on the PCB for an antenna and is not user replaceable.

6.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

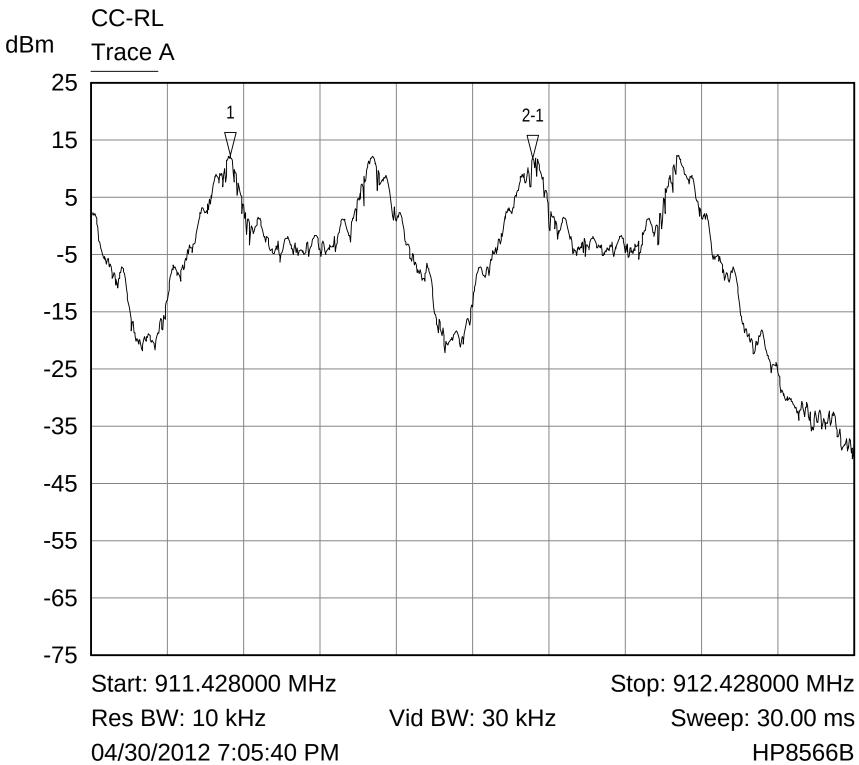
Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.16	Hot Lead	Peak (Note 1)	45.2	55.7	-10.5
0.17	Hot Lead	Peak (Note 1)	42.7	55.2	-12.5
0.18	Hot Lead	Peak (Note 1)	37.6	54.5	-16.9
0.25	Hot Lead	Peak (Note 1)	33.5	51.7	-18.2
0.35	Hot Lead	Peak (Note 1)	26.8	48.9	-22.1
0.92	Hot Lead	Peak (Note 1)	26.2	46.0	-19.8
0.15	Neutral Lead	Peak (Note 1)	40.6	56.0	-15.4
0.23	Neutral Lead	Peak (Note 1)	40.2	52.5	-12.3
0.26	Neutral Lead	Peak (Note 1)	37.1	51.4	-14.3
0.55	Neutral Lead	Peak (Note 1)	26.4	46.0	-19.6
0.65	Neutral Lead	Peak (Note 1)	29.2	46.0	-16.8
0.92	Neutral Lead	Peak (Note 1)	26.6	46.0	-19.4
Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.					

RESULT

The EUT complied with the specification by 10.5 dB.

6.2.3 §15.247(a)(1) Channel Separation

The EUT must have the hopping channel carrier frequencies separated by 25 kHz or the 20 dB bandwidth, whichever is greater. A plot of the channel separation is shown below. The 20 dB bandwidth is 316 kHz and is shown in section 6.2.4.



Mkr	X-Axis	Value	Notes
1 ▽	911.610000 MHz	12.3000 dBm	
2-1 ▽	397.000000 kHz	-0.4000 dB	Channel separation

RESULT

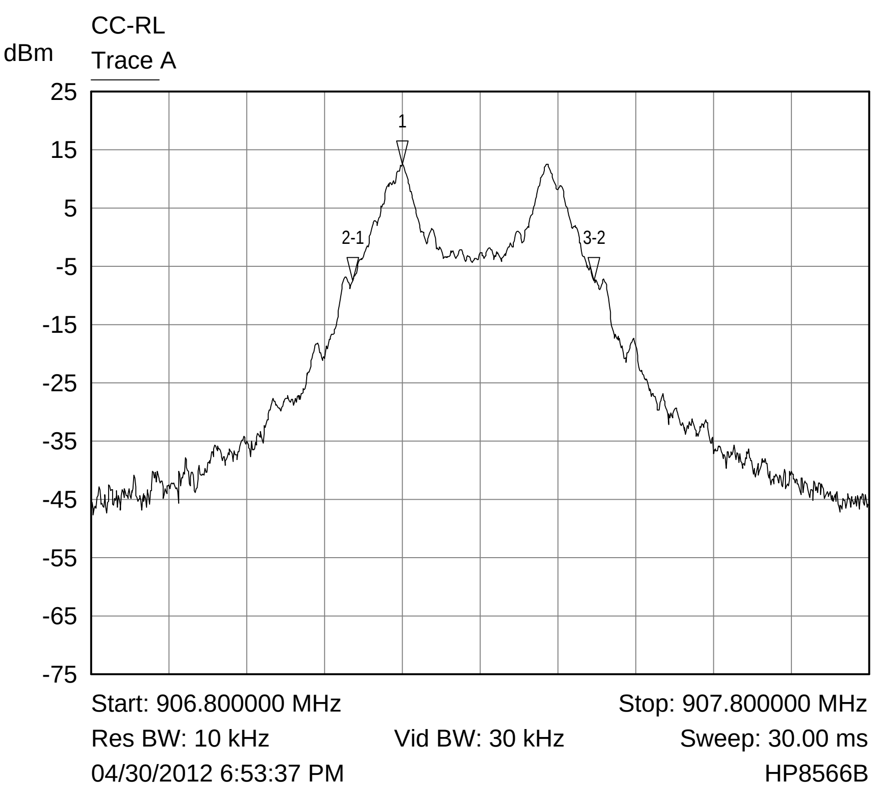
The channel carrier frequency separation is 397 kHz, which is greater than the 20 dB bandwidth of 316 kHz; therefore, the EUT complies with the specification.

6.2.4 §15.247(a)(1)(i) Channel Bandwidth

The 20 dB bandwidth must be less than 500 kHz. See the table and plots below.

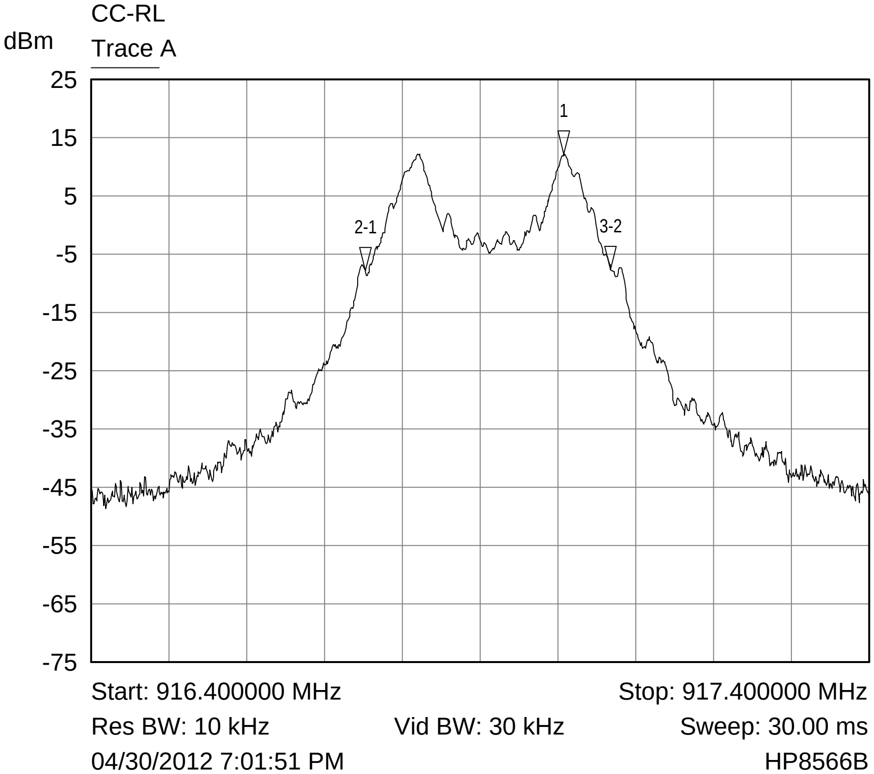
Frequency (MHz)	Emission 6 dB bandwidth (kHz)
907.3	310
916.9	316

Lowest Channel Bandwidth



Mkr	X-Axis	Value	Notes
1 ▽	907.200000 MHz	12.5000 dBm	
2-1 ▽	-64.000000 kHz	-20.0000 dB	
3-2 ▽	310.000000 kHz	0 dB	20 dB Bandwidth

Upper Channel Bandwidth



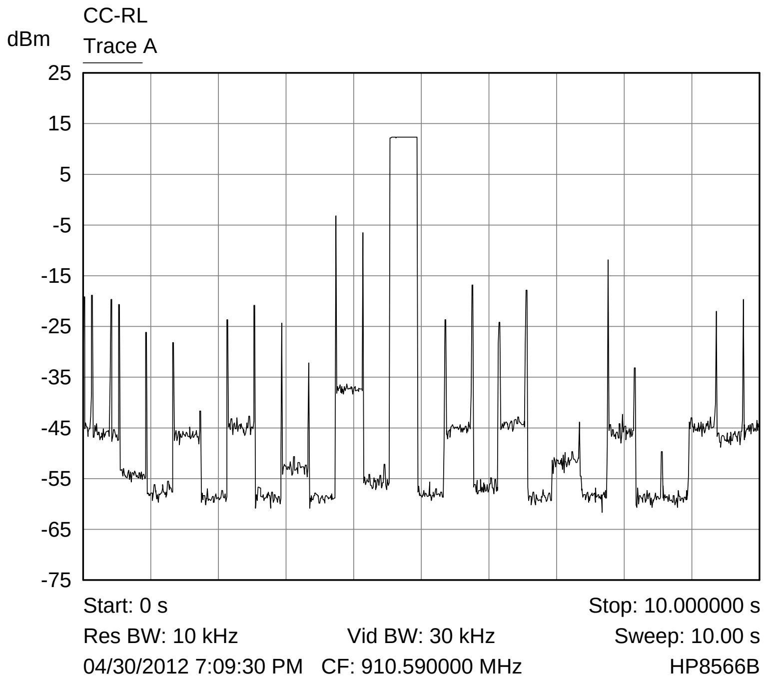
Mkr	X-Axis	Value	Notes
1 ▽	917.007000 MHz	12.2000 dBm	
2-1 ▽	-255.000000 kHz	-20.0000 dB	
3-2 ▽	316.000000 kHz	0.2000 dB	20 dB Bandwidth

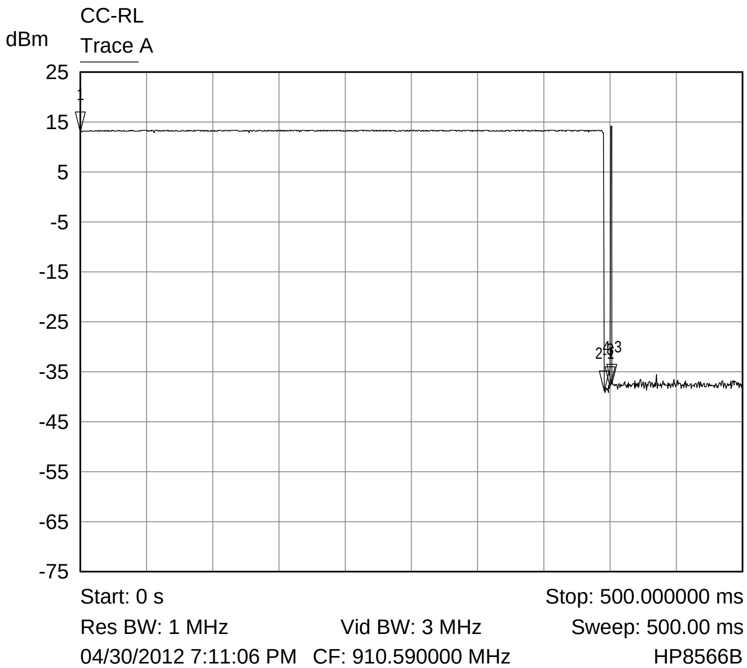
RESULT

In the configuration tested, the 20 dB bandwidth was less than 500 kHz; therefore, the EUT complied with the requirements of the specification.

6.2.5 §15.247(a)(1)(i) Channel Occupancy

The EUT uses 25 channels that have a bandwidth greater than 250 kHz; therefore, the EUT must have an average time of occupancy on any frequency that is not greater than 0.4 seconds in a 10 second period. See the plots below:





Mkr	X-Axis	Value	Notes
1 ▽	0 s	13.0000 dBm	
2-1▽	395.500000 ms	-51.9000 dB	on time
3 ▽	400.000000 ms	-38.0000 dBm	
4-3▽	1.500000 ms	0.5000 dB	on time

Trace A   395.5 ms + 1.5 ms = 397 ms on time/10seconds

RESULT

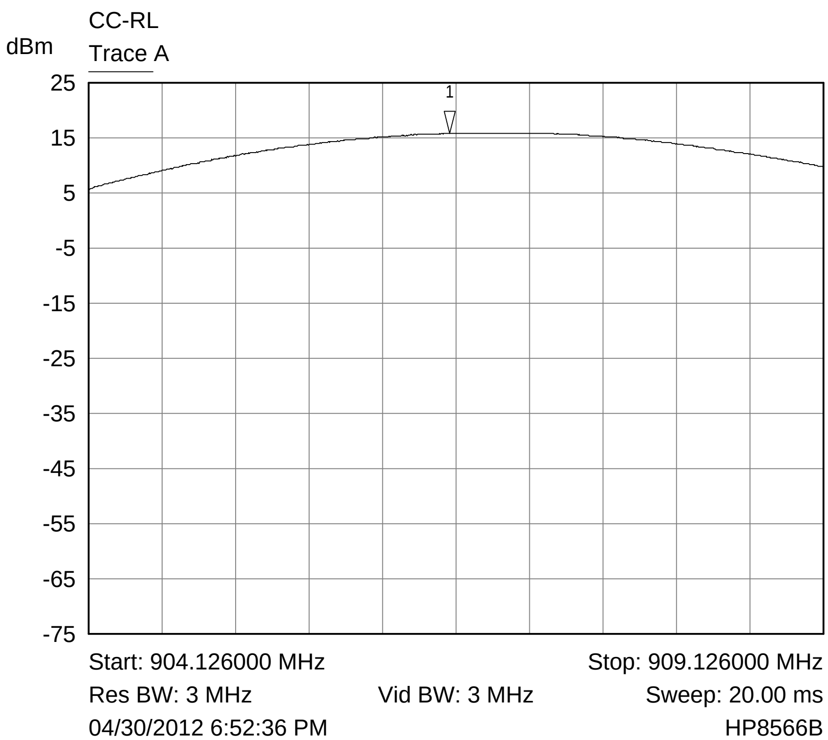
The EUT complies with the specification as the EUT transmits for 397 ms in every 10 seconds, less than the 0.4 seconds allowed by the specification.

6.2.6 §15.247(b)(2) Peak Output Power

The EUT uses 25 hopping channels. The limit for this device is 30 dBm or 1 Watt. Plots are shown below and the results of this testing are summarized in the table.

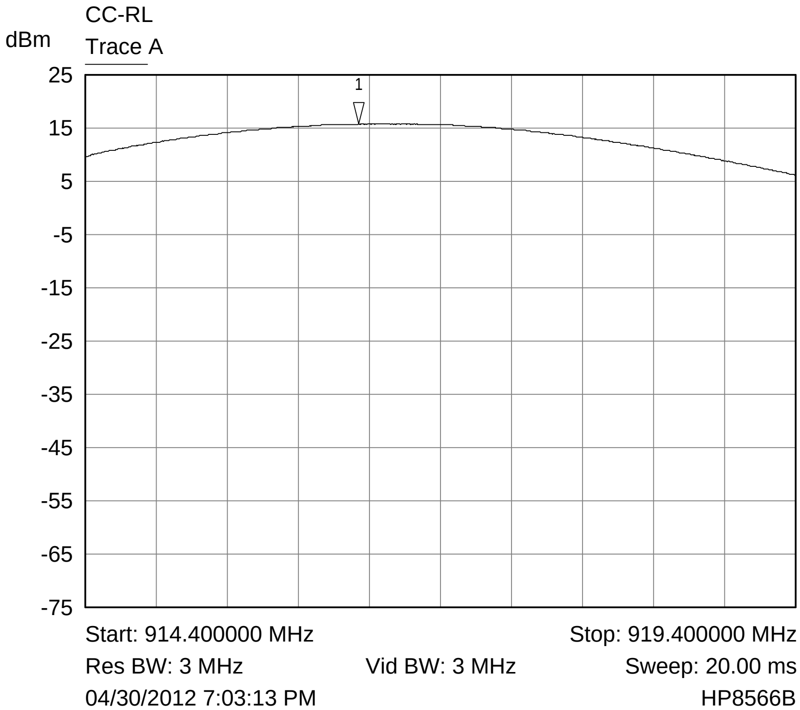
Frequency (MHz)	Measurement (dBm)	Output Power (mW)
907.3	15.9	38.90
916.9	15.8	38.02

Lowest Channel



Mkr	X-Axis	Value	Notes
1 ∇	906.581000 MHz	15.9000 dBm	

Upper Channel



Mkr	X-Axis	Value	Notes
1 ▽	916.325000 MHz	15.8000 dBm	

RESULT

In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification.

6.2.7 §15.247(d) Spurious Emissions

6.2.7.1 Conducted Spurious Emissions

The frequency range from 30 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. The tables show the measurement data from spurious emissions across the frequency range when transmitting at the lowest frequency and highest frequency.

The emissions must be attenuated 20 dB below the highest power level measured within the authorized band as measured with a 100 kHz RBW; the highest level measured was 15.4 dBm; therefore, the criteria is 15.4 – 20.0 = -4.6 dBm.

Transmitting on the Lowest Channel (907.3MHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
1814.6	-14.3	-4.6
2721.9	-40.3	-4.6
3629.2	-45.3	-4.6
4536.5	-44.8	-4.6
5443.8	-44.0	-4.6
6351.1	-40.6	-4.6
7258.4	-39.3	-4.6
8165.7	-40.1	-4.6
9073.0	-40.4	-4.6

Transmitting on the Highest Channel (916.9 MHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
1833.8	-15.2	-4.6
2750.7	-42.2	-4.6
3667.6	-45.3	-4.6
4584.5	-45.1	-4.6
5501.4	-45.7	-4.6
6418.3	-40.7	-4.6
7335.2	-41.0	-4.6
8252.1	-40.9	-4.6
9169.0	-41.0	-4.6

RESULT

The spurious conducted emissions were attenuated by at least 20; therefore, the EUT complies with the specification.

6.2.5.2 Radiated Spurious Emissions

The frequency range from 30 MHz to 9280 MHz was investigated to measure any radiated spurious emissions in the restricted bands. Any spurious emission in the restricted bands must meet the limits specified in **§**15.209.

The tables show the emissions in the restricted bands. Plots are shown with the upper and lower channels with the hopping stopped. A plot also shows the operating range/band edges with hopping enabled.

Transmitting at 907.3 MHz

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2721.9	Peak	Vertical	18.3	32.6	50.9	74.0	-23.1
2721.9	Average	Vertical	15.6	32.6	48.2	54.0	-5.8
2721.9	Peak	Horizontal	20.9	32.6	53.5	74.0	-20.5
2721.9	Average	Horizontal	18.3	32.6	50.9	54.0	-3.1
3629.2	Peak	Vertical	9.7	35.7	45.4	74.0	-28.6
3629.2	Average	Vertical	4.5	35.7	40.2	54.0	-13.8
3629.2	Peak	Horizontal	11.1	35.7	46.8	74.0	-27.2
3629.2	Average	Horizontal	1.1	35.7	36.8	54.0	-17.2
4536.5	Peak	Vertical	5.3	37.1	42.4	74.0	-31.6
4536.5	Average	Vertical	2.2	37.1	39.3	54.0	-14.7
4536.5	Peak	Horizontal	4.6	37.1	41.7	74.0	-32.3
4536.5	Average	Horizontal	0.8	37.1	37.9	54.0	-16.1
5443.8	Peak	Vertical	3.3	39.3	42.6	74.0	-31.4
5443.8	Average	Vertical	-2.4	39.3	36.9	54.0	-17.1
5443.8	Peak	Horizontal	2.6	39.3	41.9	74.0	-32.1
5443.8	Average	Horizontal	-3.6	39.3	35.7	54.0	-18.3
7258.4	Peak	Vertical	0.8	42.2	43.0	74.0	-31.0
7258.4	Average	Vertical	-7.6	42.2	34.6	54.0	-19.4
7258.4	Peak	Horizontal	2.5	42.2	44.7	74.0	-29.3

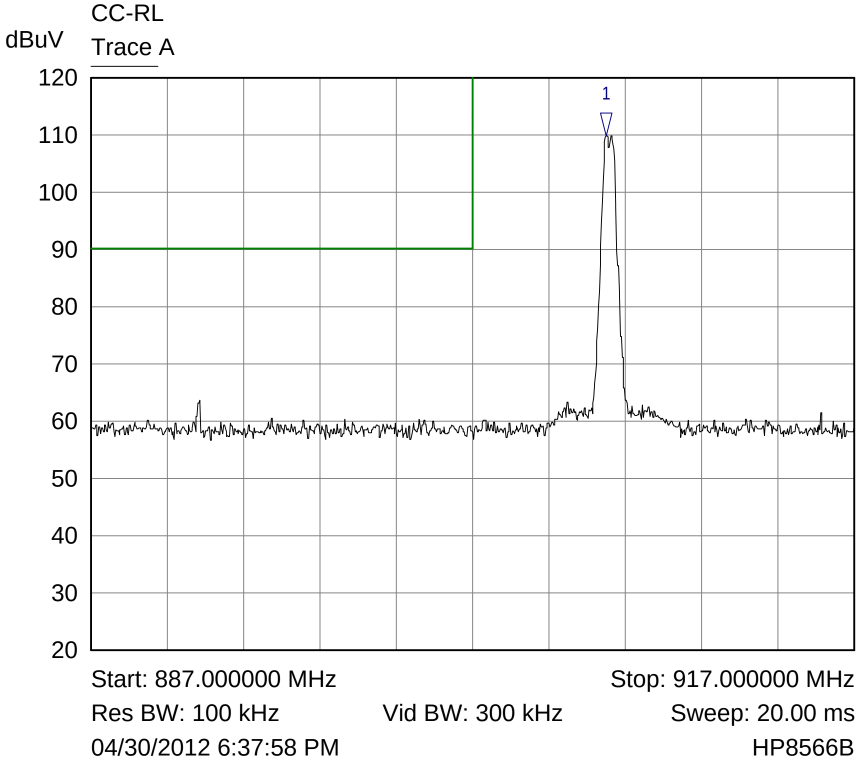
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7258.4	Average	Horizontal	-7.0	42.2	35.2	54.0	-18.8
8165.7	Peak	Vertical	-2.3	43.5	41.2	74.0	-32.8
8165.7	Average	Vertical	-10.0	43.5	33.5	54.0	-20.5
8165.7	Peak	Horizontal	-1.3	43.5	42.2	74.0	-31.8
8165.7	Average	Horizontal	-9.7	43.5	33.8	54.0	-20.2
9073.0	Peak	Vertical	0.4	44.5	44.9	74.0	-29.1
9073.0	Average	Vertical	-9.9	44.5	34.6	54.0	-19.4
9073.0	Peak	Horizontal	-1.4	44.5	43.1	74.0	-30.9
9073.0	Average	Horizontal	-10.4	44.5	34.1	54.0	-19.9

Transmitting at 916.9 MHz

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2750.7	Peak	Vertical	15.7	32.8	48.5	74.0	-25.5
2750.7	Average	Vertical	12.4	32.8	45.2	54.0	-8.8
2750.7	Peak	Horizontal	18.7	32.8	51.5	74.0	-22.5
2750.7	Average	Horizontal	16.4	32.8	49.2	54.0	-4.8
3667.6	Peak	Vertical	9.1	35.9	45.0	74.0	-29.0
3667.6	Average	Vertical	3.2	35.9	39.1	54.0	-14.9
3667.6	Peak	Horizontal	10.9	35.9	46.8	74.0	-27.2
3667.6	Average	Horizontal	5.6	35.9	41.5	54.0	-12.5
4584.5	Peak	Vertical	5.4	37.2	42.6	74.0	-31.4
4584.5	Average	Vertical	0.5	37.2	37.7	54.0	-16.3
4584.5	Peak	Horizontal	5.4	37.2	42.6	74.0	-31.4
4584.5	Average	Horizontal	0.9	37.2	38.1	54.0	-15.9
5501.4	Peak	Vertical	2.5	39.5	42.0	74.0	-32.0
5501.4	Average	Vertical	-4.8	39.5	34.7	54.0	-19.3
5501.4	Peak	Horizontal	2.3	39.5	41.8	74.0	-32.2
5501.4	Average	Horizontal	-2.9	39.5	36.6	54.0	-17.4
7335.2	Peak	Vertical	2.5	42.3	44.8	74.0	-29.2
7335.2	Average	Vertical	-8.4	42.3	33.9	54.0	-20.1
7335.2	Peak	Horizontal	0.5	42.3	42.8	74.0	-31.2

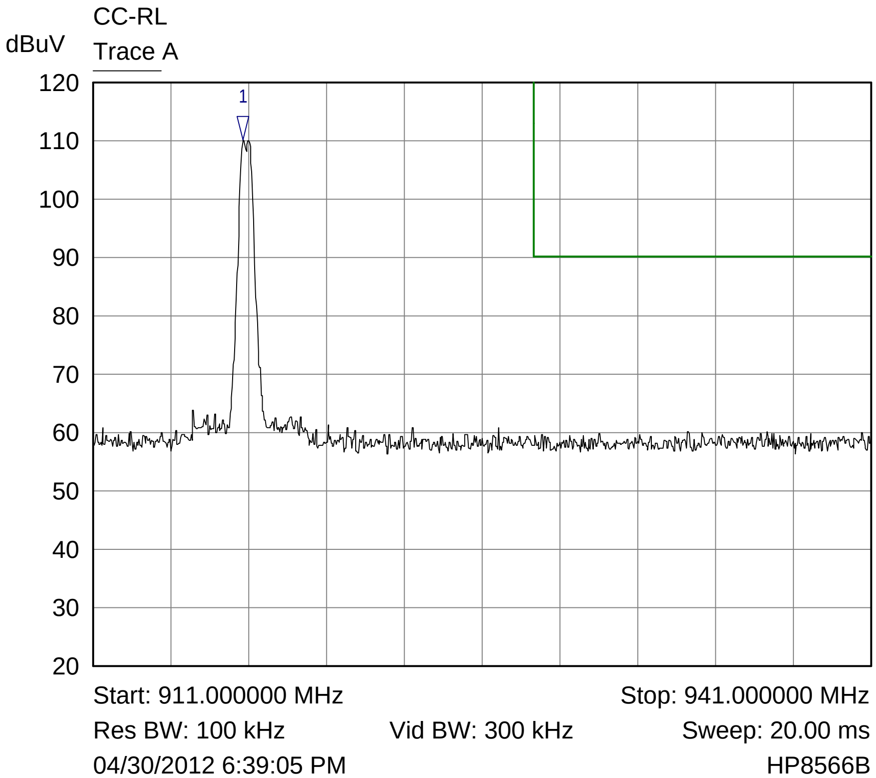
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7335.2	Average	Horizontal	-8.9	42.3	33.4	54.0	-20.6
8252.1	Peak	Vertical	-2.0	43.6	41.6	74.0	-32.4
8252.1	Average	Vertical	-9.3	43.6	34.3	54.0	-19.7
8252.1	Peak	Horizontal	0.9	43.6	44.5	74.0	-29.5
8252.1	Average	Horizontal	-9.5	43.6	34.1	54.0	-19.9
9169.0	Peak	Vertical	1.3	44.6	45.9	74.0	-28.1
9169.0	Average	Vertical	-8.6	44.6	36.0	54.0	-18.0
9169.0	Peak	Horizontal	1.4	44.6	46.0	74.0	-28.0
9169.0	Average	Horizontal	-8.8	44.6	35.8	54.0	-18.2

Transmitting at the Lowest Frequency (907.3 MHz)



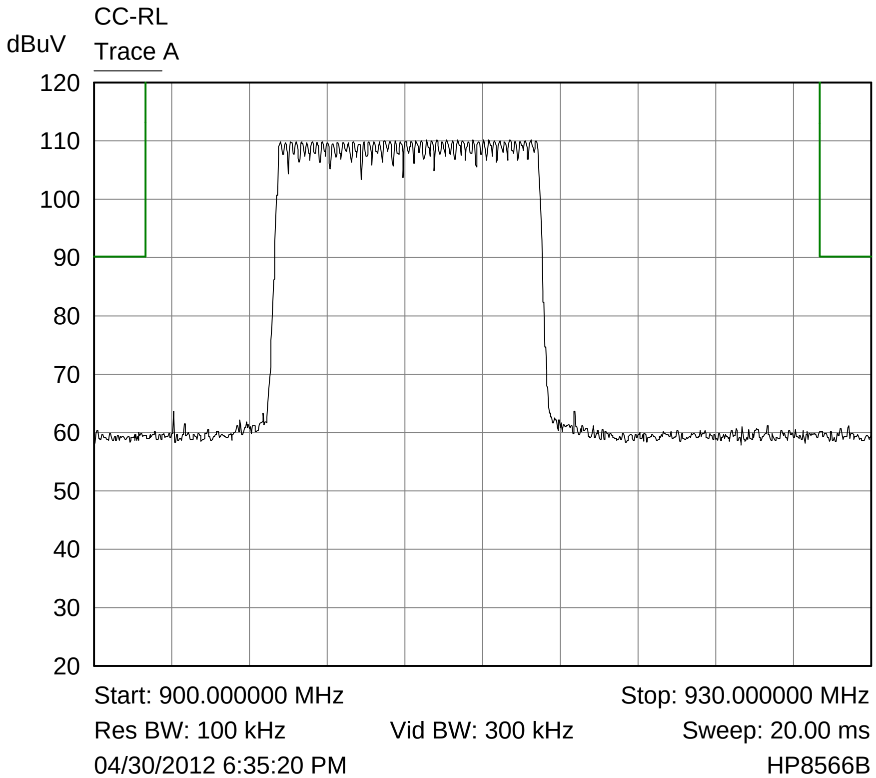
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	907.250000 MHz	109.9000 dBuV	

Transmitting at the Highest Frequency (916.9 MHz)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	916.790000 MHz	110.2000 dBuV	

Band Edges while Hopping



RESULT

All of the emissions, even those not in the restricted bands that are required to meet a more relaxed limit, met the general limits specified in **§**15.209; therefore, the EUT complies with the specification.

APPENDIX 1 TEST PROCEDURES AND TEST EQUIPMENT

A1.1 §15.207 Conducted Disturbance at the AC Mains

The conducted disturbance at mains ports from the EUT was measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted disturbance at mains ports measurements are performed in a screen room using a (50 Ω/50 µH) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of devices with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

(a) Each power cord, which is terminated in a mains supply plug, shall be tested separately.
(b) Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
(c) Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
(d) Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
(e) When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

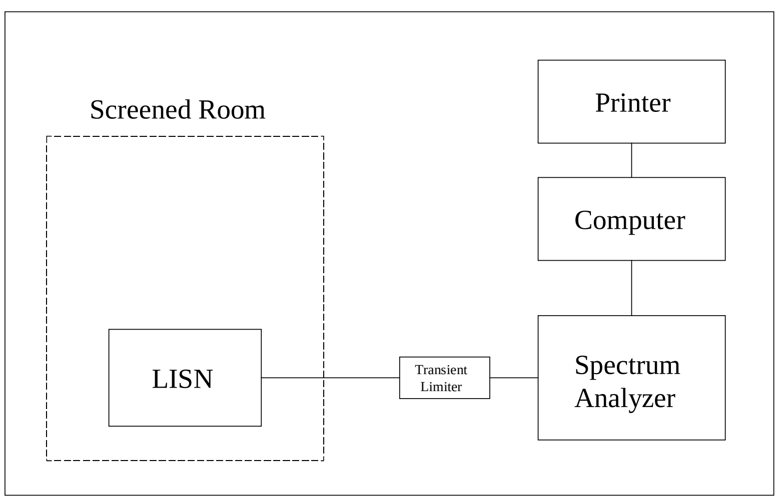
For AC mains port testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Conducted Emissions	Revision 1.2	N/A

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012
LISN	EMCO	3825/2	9305-2099	03/12/2012
Conductance Cable Wanship Site #2	Nemko-CCL, Inc.	Cable J	N/A	12/14/2011
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/14/2011

An independent calibration laboratory or Nemko-CCL Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Conducted Emissions Test Setup



A1.2 §15.247 Radiated Measurements

The radiated disturbance from the EUT was measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings. A preamplifier with a fixed gain of 26 dB was used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges.

A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz, at a distance of 3 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors. A double-ridged guide antenna was used to measure the emissions at frequencies above 1000 MHz at a distance of 3 or 1 meter from the EUT.

The configuration of the EUT was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.3 via the interconnecting cables listed in Section 2.4. A technician manually manipulated these interconnecting cables to obtain worst-case radiated disturbance. The EUT was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

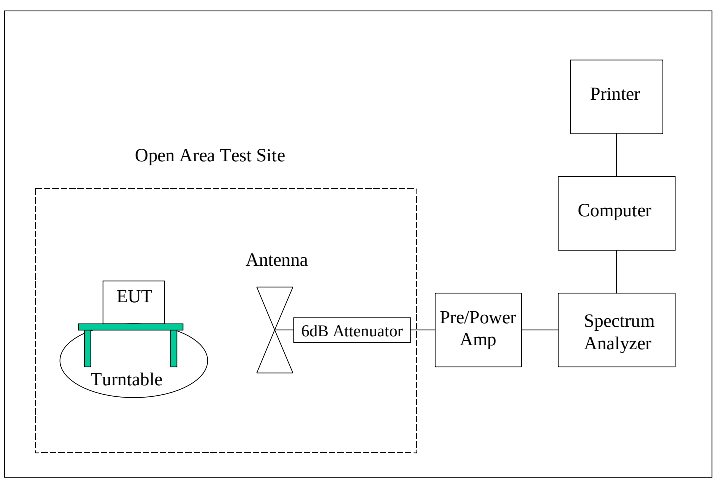
Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Radiated Emissions	Revision 1.3	N/A
Spectrum Analyzer/Receiver	Rhode & Schwarz	1302.6005.40	100064	07/28/2011
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012
Biconilog Antenna	EMCO	3142	9601-1009	04/121/2011
Double Ridged Guide Antenna	EMCO	3115	9604-4779	03/10/2011

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
High Frequency Amplifier	Miteq	AFS4-01001800-43-10P-4	1096455	06/22/2011
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	1296	05/14/2012
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	1297	05/14/2012
3 Meter Radiated Emissions Cable Wanship Site #2	Microcoax	UFB205A-0-4700-000000	1295	05/10/2011
Pre/Power-Amplifier	Hewlett Packard	8447F	3113A05161	08/25/2011
6 dB Attenuator	Hewlett Packard	8491A	32835	12/14/2011

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Radiated Emissions Test Setup

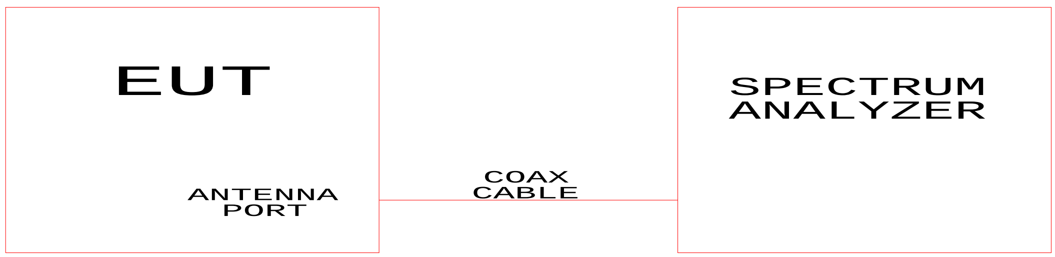


A1.2 §15.247 Conducted Measurements at the Antenna

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

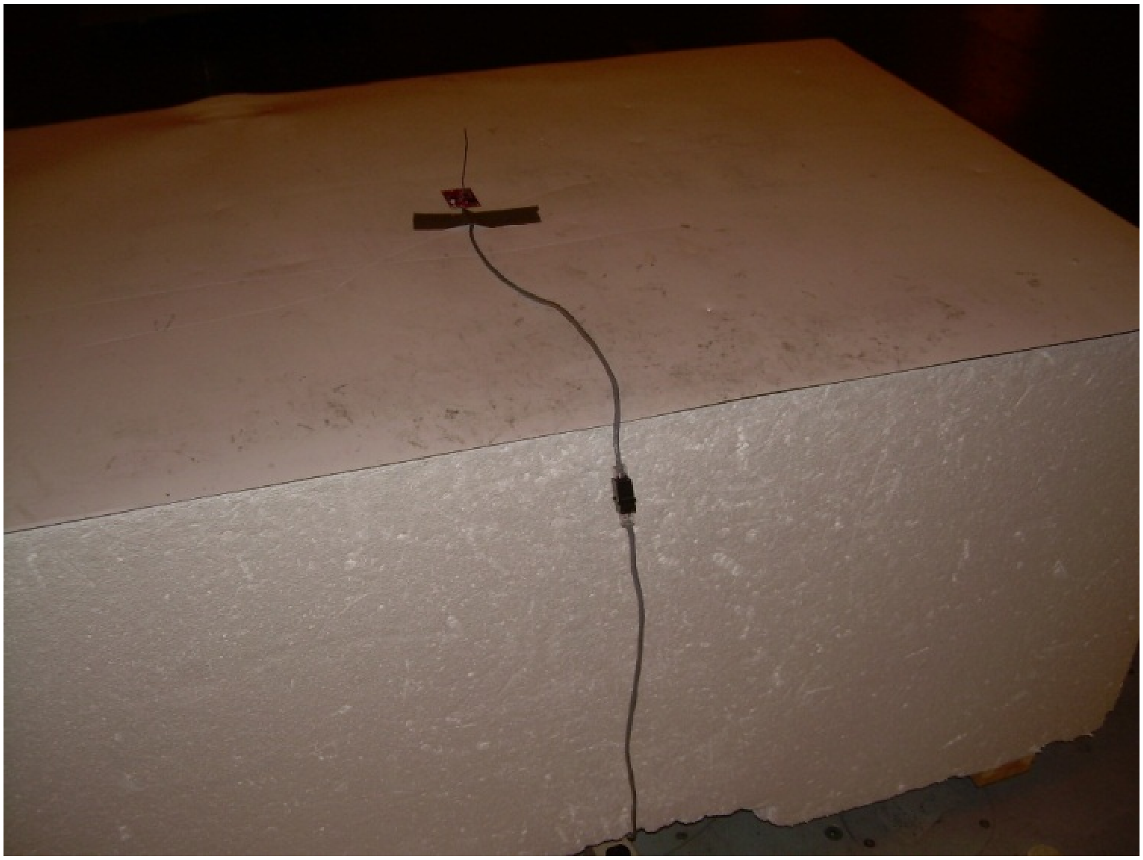
Test Configuration Block Diagram



APPENDIX 2 PHOTOGRAPHS

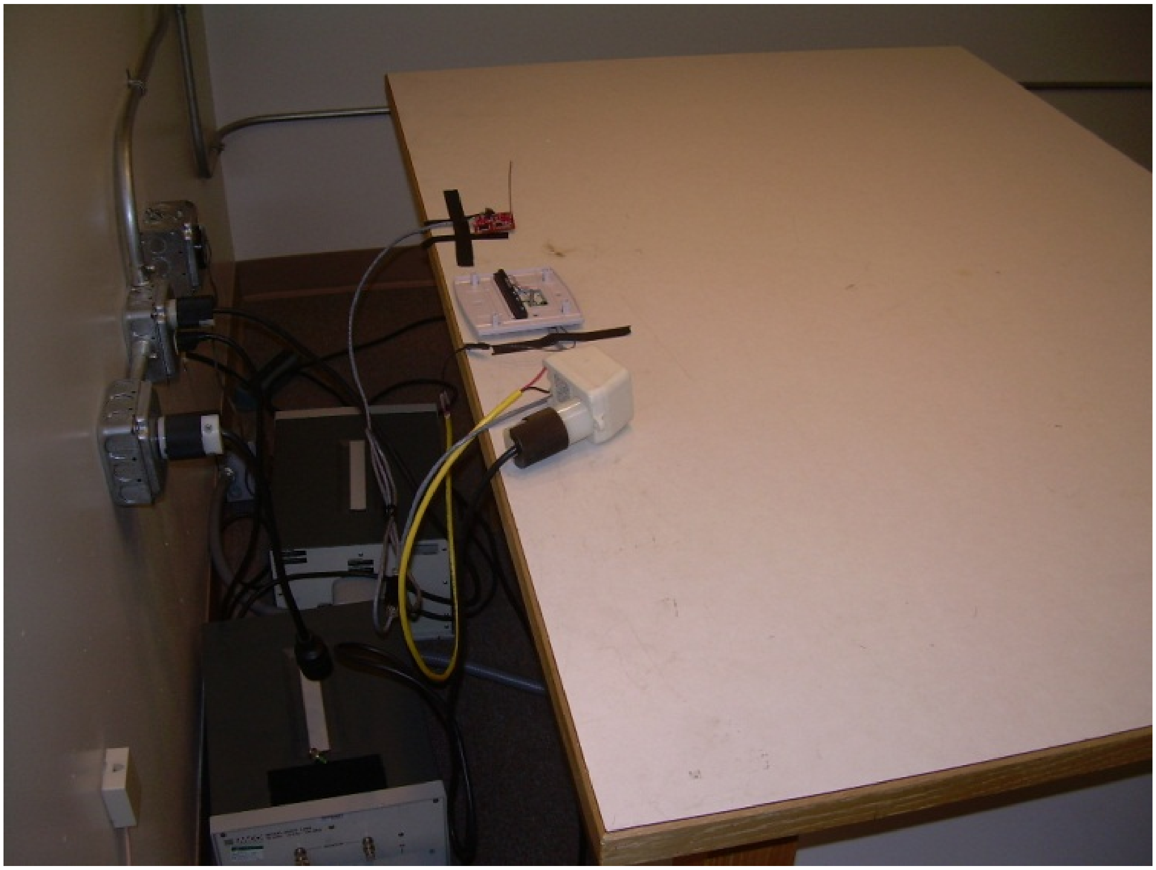
Photograph 1 – Front View Radiated Setup Worst Case Configuration

Photograph 2 – Back View Radiated Setup Worst Case Configuration

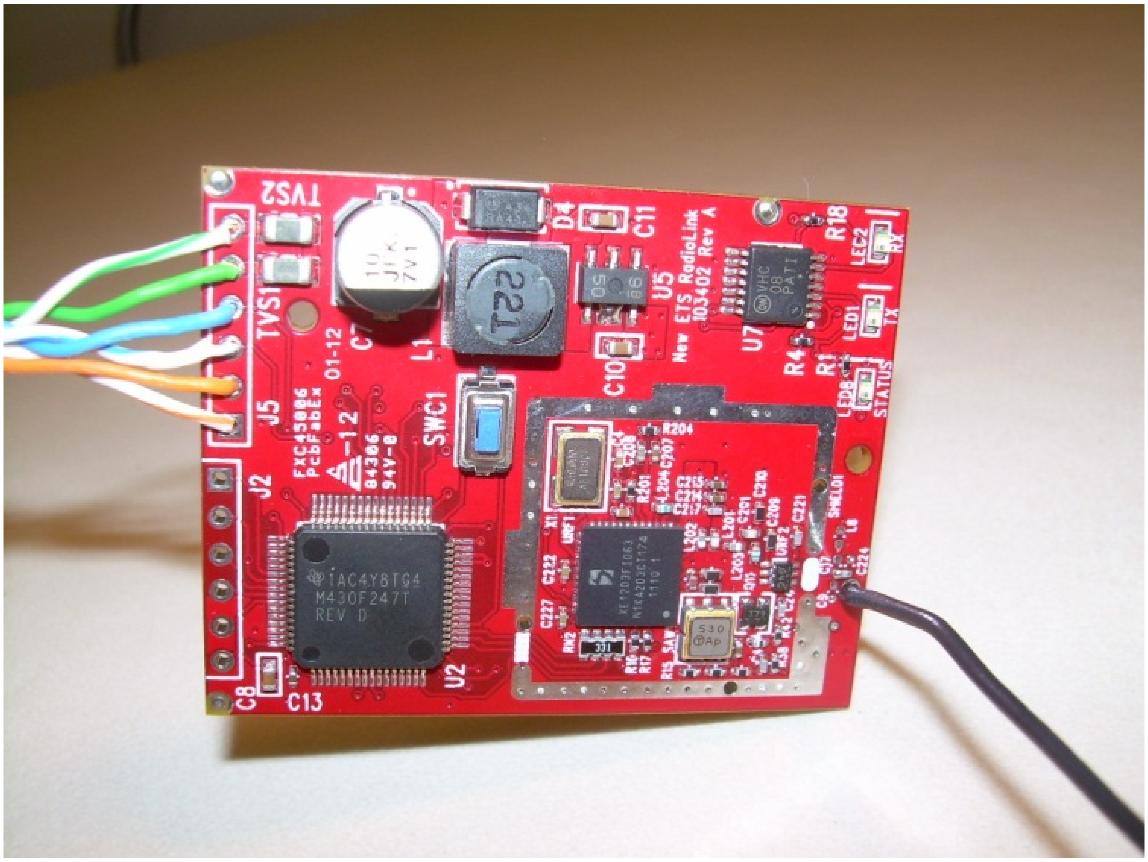


Photograph 3 – Front View Conducted Emissions Worst Case Configuration

Photograph 4 – Back View Conducted Emissions Worst Case Configuration



Photograph 5 – Front View of the EUT



Photograph 6 – Back View of the EUT