Nemko-CCL, Inc.

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

Test Report

Certification

Test Of:

2GIG-GCX

FCC ID: WDQ-ZW01

Test Specification:

FCC PART 15, Subpart C

Test Report Serial No: 223853-3.2

Applicant:
2GIG Technologies
2961 W. Maple Loop Drive
Lehi, UT 84043

Date of Test: October 30, 2012

Issue Date: December 12, 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: 2GIG Technologies
- Manufacturer: Flextronics and Hourui Linear Electronics Manufactory
- Brand Name: Go!Control
- Model Number: 2GIG-GCX
- FCC ID Number: WDQ-ZW01

On this 12th day of December 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.

Norman P Hansen

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:	2GIG Technologies 2961 W. Maple Loop Drive Lehi, UT 84043
Contact Name:	Greg Hansen
Title:	Regulatory Compliance Manager

1.2 Manufacturer:

Company Name:	Flextronics 89 Yong Fu Road Tong Fu Industrial Park Bao An District Shenzhen, 518103 P.R. China
Contact Name:	Feng Zhou
Title:	QA Engineer

1.3 Manufacturer:

Company Name:	Hourui Linear Electronics Manufactory Hourui Second Industrial Zone Hourui Village Bao An District Shenzhen, P.R. China
Contact Name:	Henry Luk
Title:	Senior Electronic Engineering Supervisor

SECTION 2.0 EQUIPMENT UNDER TEST (EUT)

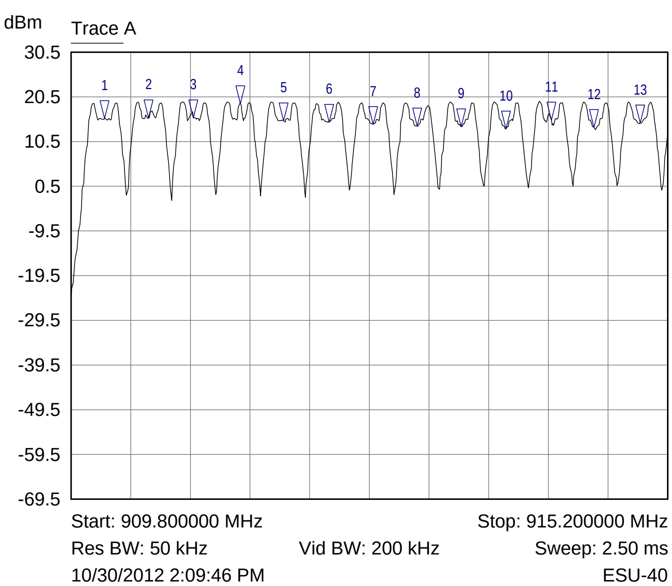
2.1 Identification of EUT:

Brand Name:	2GIG
Model Number:	2GIG-GCX
Serial Number:	Engineering Unit
Dimensions:	8.5” x 6” x 1.25”

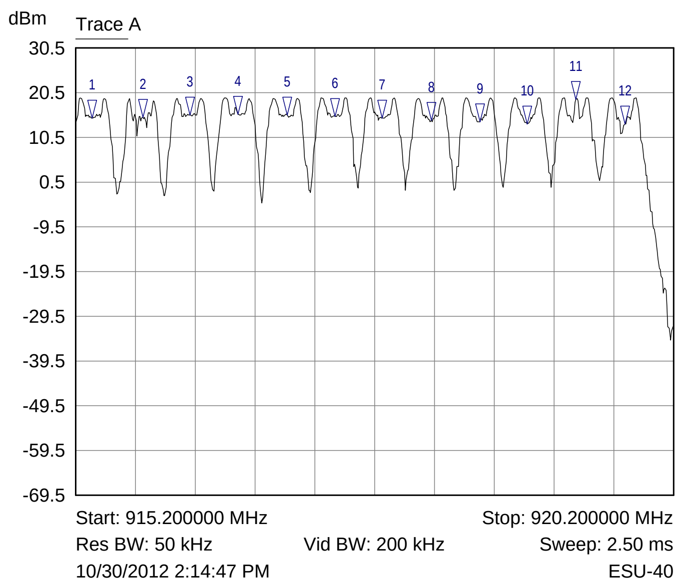
2.2 Description of EUT:

The 2GIG-GCX is a control panel for use in home automation and security systems. The 2GIG-GCX is powered by a ZB Power ZB-A140017 power supply. A Ni-mh 7.2 V, 2000 mA battery power pack provides back up power during power outages. The 2GIG-GCX, fully configured, has a POTS line interface, contact interface ports, a Z-Wave 908.42 MHz transceiver, a 910 – 920 MHz FHSS transceiver, and a Telit HE910 2G/3G cell modem. A 3.75” x 2.25” touchscreen is provided for direct user interface.

This report covers the FHSS transceiver. The 910.1 to 919.8 MHz FHSS transceiver uses 25 channels. Plots of the channels are shown below. The Z-Wave transceiver was tested and is covered in a separate report. The circuitry of the device subject to FCC Part 15, Subpart B, ICES-003, as well as the 345 MHz receiver under RSS-Gen are covered in Nemko-CCL report #223853-2. The Telit HE910 carries modular certification under FCC ID #RI7HE910 and Industry Canada #5131A-HE910.



Mkr	Trace	X-Axis	Value
1 ▽	Trace A	910.102885 MHz	15.6385 dBm
2 ▽	Trace A	910.500962 MHz	15.7779 dBm
3 ▽	Trace A	910.907692 MHz	15.8992 dBm
4 ▽	Trace A	911.331731 MHz	18.9918 dBm
5 ▽	Trace A	911.721154 MHz	15.1545 dBm
6 ▽	Trace A	912.136538 MHz	14.9121 dBm
7 ▽	Trace A	912.534615 MHz	14.4081 dBm
8 ▽	Trace A	912.932692 MHz	14.0705 dBm
9 ▽	Trace A	913.330769 MHz	13.8100 dBm
10 ▽	Trace A	913.737500 MHz	13.3959 dBm
11 ▽	Trace A	914.144231 MHz	15.3561 dBm
12 ▽	Trace A	914.533654 MHz	13.6765 dBm
13 ▽	Trace A	914.949038 MHz	14.6005 dBm



Mkr	Trace	X-Axis	Value
1 ▽	Trace A	915.336218 MHz	14.8045 dBm
2 ▽	Trace A	915.760897 MHz	14.9181 dBm
3 ▽	Trace A	916.153526 MHz	15.5180 dBm
4 ▽	Trace A	916.554167 MHz	15.6950 dBm
5 ▽	Trace A	916.970833 MHz	15.4195 dBm
6 ▽	Trace A	917.371474 MHz	15.1259 dBm
7 ▽	Trace A	917.764103 MHz	14.8654 dBm
8 ▽	Trace A	918.172756 MHz	14.2962 dBm
9 ▽	Trace A	918.581410 MHz	13.9548 dBm
10 ▽	Trace A	918.974038 MHz	13.4818 dBm
11 ▽	Trace A	919.382692 MHz	18.9584 dBm
12 ▽	Trace A	919.791346 MHz	13.5294 dBm

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: 2GIG MN: 2GIG-GCX (Note 1) SN: Engineering Unit	WDQ-ZW01	Control Panel	See Section 2.4
BN: Toshiba MN: 2020 SN: None	None	PBX	Line/Modular cord (Note 2)

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
Telephone	1	Modular cord with RJ45 and RJ10 connectors/10 meters
Power/Contact	1	8 conductors/1 meter

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 registered with the FCC, and was renewed February 15, 2012 (90504). This registration is valid for three years.

Nemko-CCL, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab: 100272-0, which is effective until September 30, 2013.

SECTION 4.0 OPERATION OF EUT DURING TESTING

4.1 Operating Environment:

Power Supply: 120 VAC
AC Mains Frequency: 60 Hz

4.2 Operating Modes:

The transmitter was tested while in a constant transmit mode at full power 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 to the AC adapter was varied as required by §15.31(e) with no change seen in the voltage supplied to the transmitter or in transmitter characteristics.

4.3 EUT Exercise Software:

2GIG Technologies software 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	Structural Requirement	Not Applicable
15.247(d)	Spurious Emissions	0.05 to 9280	Complied
15.247(e)	Peak Power Spectral Density	902 - 928	Not Applicable
15.247(f)	Hybrid System Requirements	N/A	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 helical wire antenna that is soldered to the PCB.

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)
0.15	Hot Lead	Peak (Note 1)	49.3	56.0	-6.7
0.42	Hot Lead	Peak (Note 1)	41.0	47.5	-6.5
0.89	Hot Lead	Peak (Note 1)	42.5	46.0	-3.5
3.64	Hot Lead	Peak (Note 1)	38.9	46.0	-7.1
4.56	Hot Lead	Peak (Note 1)	39.4	46.0	-6.6
24.05	Hot Lead	Peak (Note 1)	43.1	50.0	-6.9
25.40	Hot Lead	Peak (Note 1)	44.4	50.0	-5.6
26.13	Hot Lead	Peak (Note 1)	43.3	50.0	-6.7
27.05	Hot Lead	Peak (Note 1)	44.2	50.0	-5.8
0.18	Neutral Lead	Peak (Note 1)	44.6	54.3	-9.7
0.90	Neutral Lead	Quasi-Peak (Note 2)	43.8	56.0	-12.2
0.90	Neutral Lead	Average (Note 2)	40.3	46.0	-5.7
4.55	Neutral Lead	Peak (Note 1)	36.8	46.0	-9.2
12.40	Neutral Lead	Peak (Note 1)	42.6	50.0	-7.4
26.55	Neutral Lead	Peak (Note 1)	44.8	50.0	-5.2
27.05	Neutral Lead	Peak (Note 1)	44.8	50.0	-5.2
27.48	Neutral Lead	Peak (Note 1)	45.2	50.0	-4.8

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
28.45	Neutral Lead	Peak (Note 1)	43.4	50.0	-6.6
28.90	Neutral Lead	Peak (Note 1)	43.1	50.0	-6.9

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.

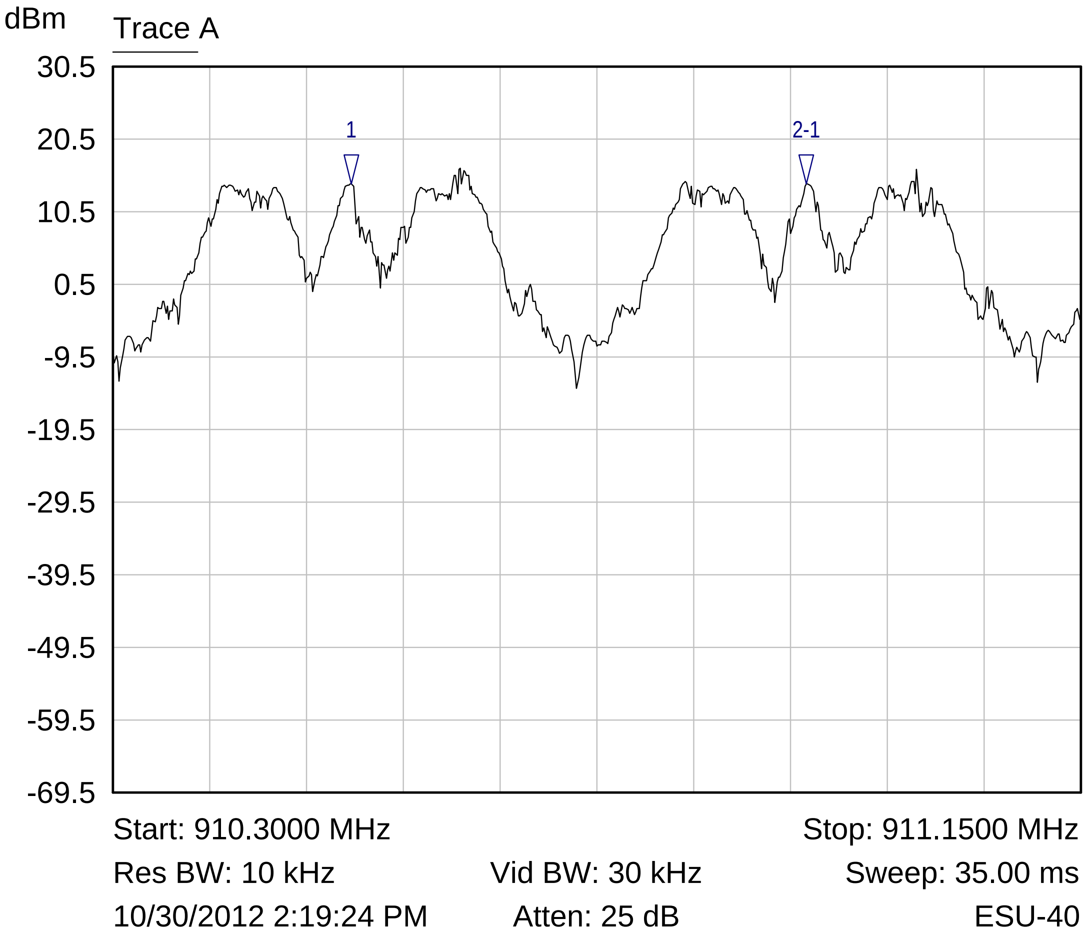
Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

RESULT

The EUT complied with the specification by 3.5 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 showing a 399 kHz channel separation is shown below. The 20 dB bandwidth is 393.75 kHz and is shown in section 6.2.4.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	910.5098 MHz	14.33 dBm	
2-1 ▽	Trace A	399.1186 kHz	-0.02 dB	

RESULT

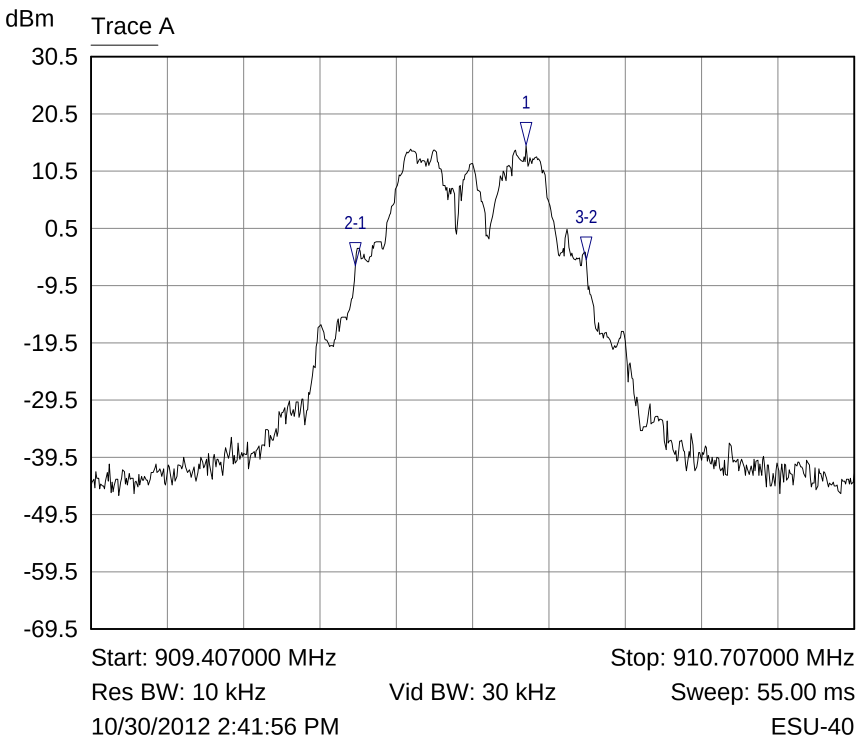
The channel carrier frequency separation is 399 kHz, which is greater than the 20 dB bandwidth of 393.75 kHz; therefore, the EUT complies with the specification.

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

The 20 dB bandwidth of the hopping channels is shown in the table and plots below.

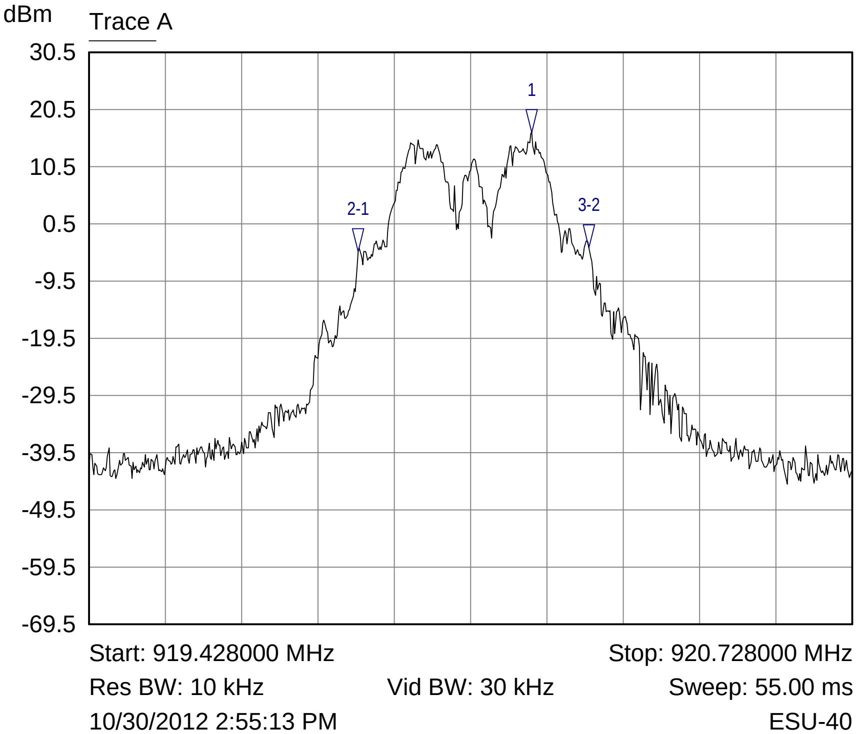
Frequency (MHz)	Emission 20 dB bandwidth (kHz)
910.1	393.75
919.8	393.75

Lowest Channel Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	910.148667 MHz	15.0330 dBm	
2-1 ▽	Trace A	-291.666667 kHz	-20.9547 dB	
3-2 ▽	Trace A	393.750000 kHz	0.9900 dB	

Upper Channel Bandwidth



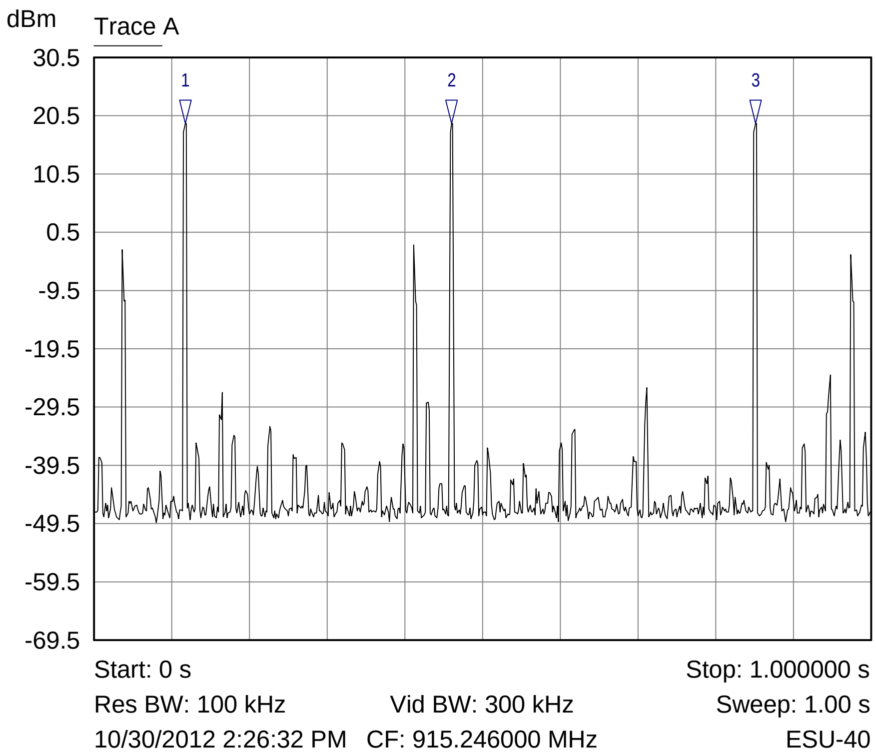
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	920.182167 MHz	16.4331 dBm	
2-1 ▽	Trace A	-295.833334 kHz	-20.7964 dB	
3-2 ▽	Trace A	393.750000 kHz	0.6232 dB	

RESULT

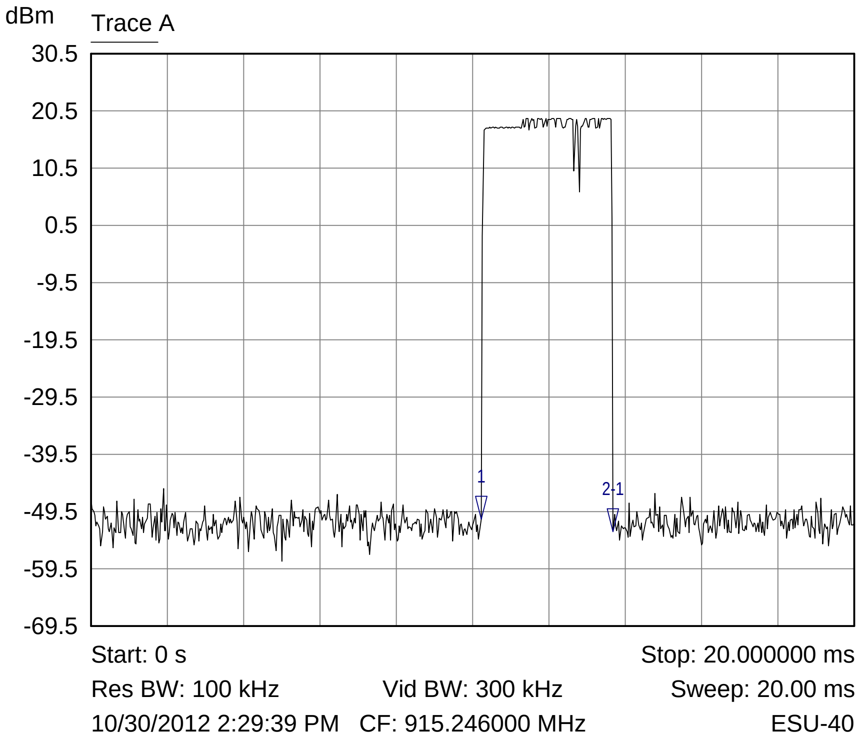
In the configuration tested, the channel separation was greater than the emission bandwidth kHz; therefore, the EUT complied with the requirements of the specification.

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 period of 10 seconds. See the plots and calculations below.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	116.987179 ms	19.2147 dBm	
2 ▽	Trace A	459.935897 ms	19.2101 dBm	
3 ▽	Trace A	850.961538 ms	19.2151 dBm	



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Trace A	10.224359 ms	-50.7774 dBm	
2-1 ∇	Trace A	3.461538 ms	-2.1981 dB	

From the plot, the EUT transmits up to 3 times per second for 3.462 ms at each transmission.

Dwell time = 10 seconds x 3 hops/sec x 0.003462 seconds = 0.104 seconds

RESULT

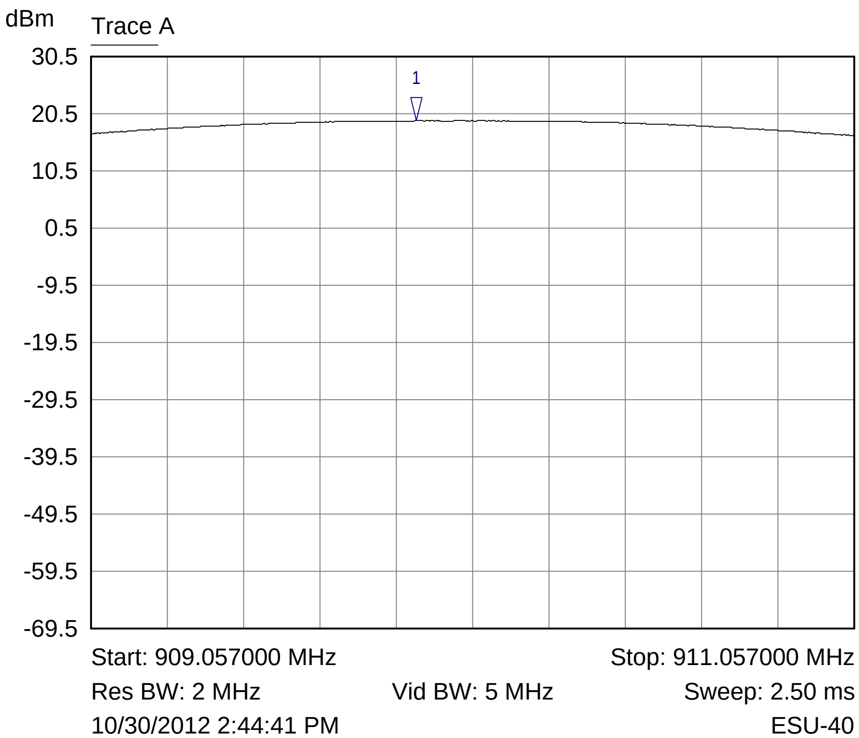
The EUT complies with the specification as the EUT transmits on an individual channel for 104 milliseconds, less than the 0.4 seconds allowed by the specification.

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.

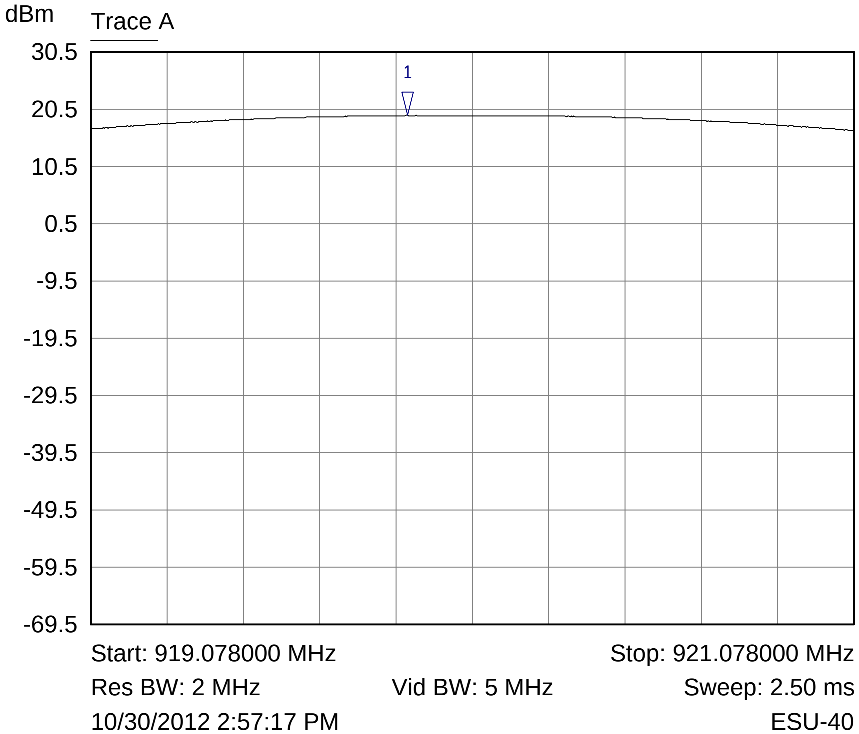
Frequency (MHz)	Measurement (dBm)	Output Power (mW)
910.1	19.44	87.9
919.8	19.32	85.5

Lowest Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	909.909564 MHz	19.3179 dBm	

Upper Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	919.908128 MHz	19.4353 dBm	

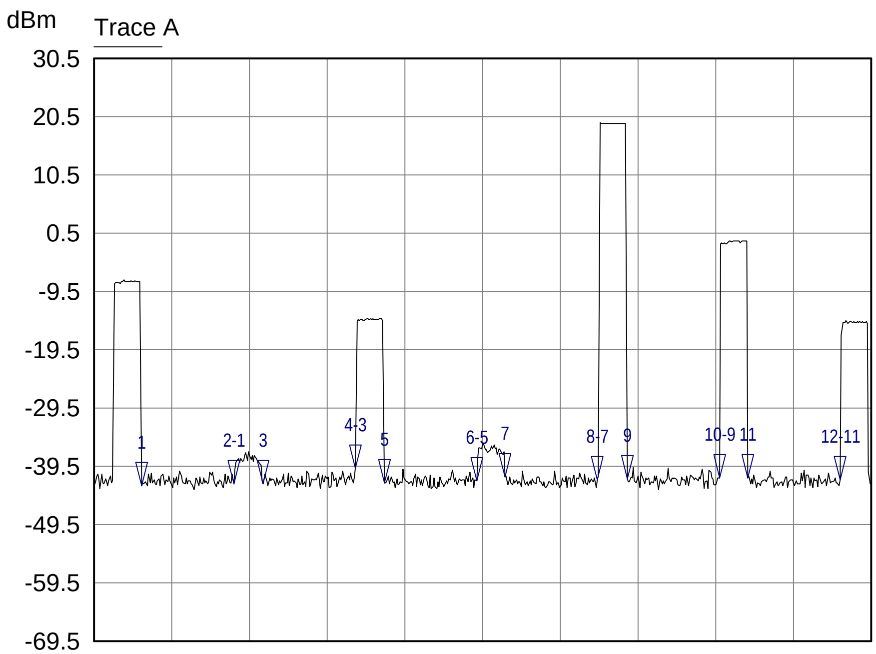
RESULT

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

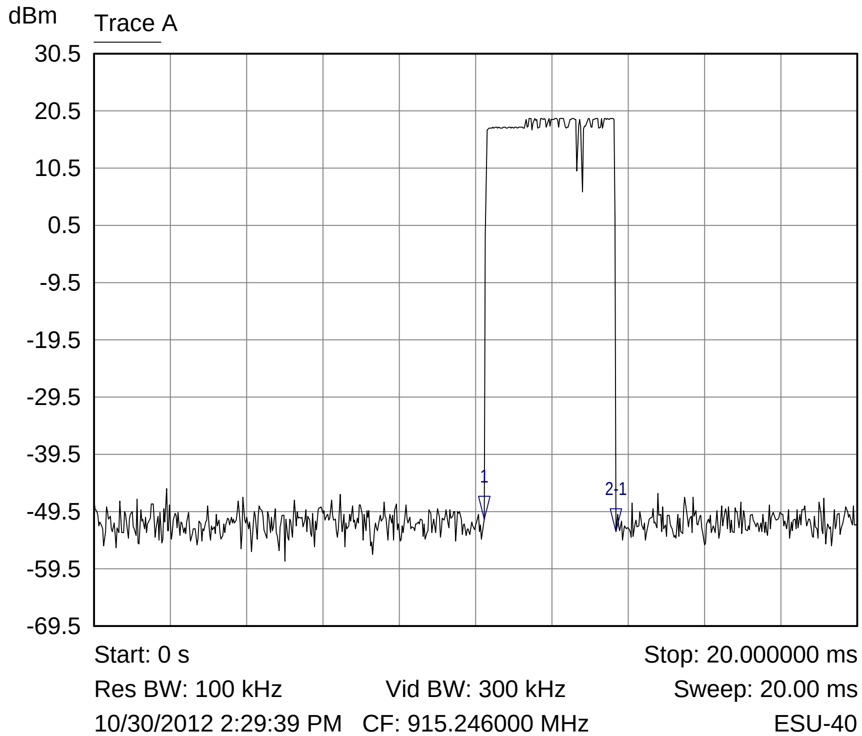
6.2.7.1 Radiated Emissions

The frequency range from 0.05 MHz to the 10^{th} harmonic of the fundamental frequency was investigated to measure any radiated emissions. Any emissions in the restricted bands must meet the limits specified in **§**15.209. Emissions outside restricted bands must be attenuated 20 dB from the fundamental. An averaging factor of 12.9 dB was applied. The plots and calculations for the duty cycle and averaging factor are shown below. The tables below show the emission measurements for any radiated emission and the plots show the band edges of the lower and upper channel fundamental emission.



Start: 0 s | Stop: 100.000000 ms
Res BW: 1 MHz | Vid BW: 3 MHz | Sweep: 100.00 ms
10/30/2012 2:23:25 PM | CF: 915.246000 MHz | ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.089744 ms	-42.7873 dBm	
2-1 ▽	Trace A	11.858974 ms	0.3507 dB	
3 ▽	Trace A	21.794872 ms	-42.5181 dBm	
4-3 ▽	Trace A	11.858974 ms	2.7129 dB	
5 ▽	Trace A	37.339744 ms	-42.3367 dBm	
6-5 ▽	Trace A	11.858974 ms	0.3897 dB	
7 ▽	Trace A	52.884615 ms	-41.3986 dBm	
8-7 ▽	Trace A	11.858974 ms	-0.4527 dB	
9 ▽	Trace A	68.589744 ms	-41.7174 dBm	
10-9 ▽	Trace A	11.858974 ms	0.1905 dB	
11 ▽	Trace A	84.134615 ms	-41.5519 dBm	
12-11 ▽	Trace A	11.858974 ms	-0.2950 dB	



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	10.224359 ms	-50.7774 dBm	
2-1 ▽	Trace A	3.461538 ms	-2.1981 dB	

As seen in the plots above, the EUT transmits for 3.46 seconds per channel per hop. The first plot demonstrates that the EUT only transmits once at a specific channel during a 100 ms time frame. The first plot shows that the EUT has an off period of 11.86 ms between hops.

Duty Cycles were calculated as shown below.

20 log (3.46 ms on time / 100 ms) = -29.2 dB

Or alternately,
20 log (3.46 ms on time / (3.46 ms on time + 11.86 ms off time between hops) = -12.9 dB

-12.9 dB was used as an averaging factor in measuring the radiated emissions that have the same characteristics as the fundamental.

Transmitting at the Lowest Frequency

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1820.2	Peak	Vertical	22.3	29.3	0.0	51.6	74.0	-22.4
1820.2	Average	Vertical	16.1	29.3	-12.9	32.5	54.0	-21.5
1820.2	Peak	Horizontal	30.6	29.3	0.0	59.9	74.0	-14.1
1820.2	Average	Horizontal	25.8	29.3	-12.9	42.2	54.0	-11.8
2730.3	Peak	Vertical	18.3	32.7	0.0	51.0	74.0	-23.0
2730.3	Average	Vertical	13.9	32.7	-12.9	33.7	54.0	-20.3
2730.3	Peak	Horizontal	29.1	32.7	0.0	61.8	74.0	-12.2
2730.3	Average	Horizontal	25.5	32.7	-12.9	45.3	54.0	-8.7
3640.5	Peak	Vertical	15.2	35.8	0.0	51.0	74.0	-23.0
3640.5	Average	Vertical	9.7	35.8	-12.9	32.6	54.0	-21.4
3640.5	Peak	Horizontal	20.9	35.8	0.0	56.7	74.0	-17.3
3640.5	Average	Horizontal	15.8	35.8	-12.9	38.7	54.0	-15.3
4550.7	Peak	Vertical	12.7	37.1	0.0	49.8	74.0	-24.2
4550.7	Average	Vertical	5.7	37.1	-12.9	29.9	54.0	-24.1
4550.7	Peak	Horizontal	9.4	37.1	0.0	46.5	74.0	-27.5
4550.7	Average	Horizontal	1.0	37.1	-12.9	25.2	54.0	-28.8
5460.8	Peak	Vertical	2.0	39.3	0.0	41.3	74.0	-32.7
5460.8	Average	Vertical	-5.7	39.3	-12.9	20.7	54.0	-33.3
5460.8	Peak	Horizontal	1.5	39.3	0.0	40.8	74.0	-33.2
5460.8	Average	Horizontal	-5.7	39.3	-12.9	20.7	54.0	-33.3
6370.9	Peak	Vertical	7.1	39.8	0.0	46.9	74.0	-27.1
6370.9	Average	Vertical	-3.3	39.8	-12.9	23.6	54.0	-30.4
6370.9	Peak	Horizontal	7.6	39.8	0.0	47.4	74.0	-26.6
6370.9	Average	Horizontal	-3.4	39.8	-12.9	23.5	54.0	-30.5
7281.0	Peak	Vertical	5.2	42.2	0.0	47.4	74.0	-26.6
7281.0	Average	Vertical	-5.2	42.2	-12.9	24.1	54.0	-29.9
7281.0	Peak	Horizontal	5.3	42.2	0.0	47.5	74.0	-26.5
7281.0	Average	Horizontal	-4.6	42.2	-12.9	24.7	54.0	-29.3
8191.5	Peak	Vertical	6.8	43.5	0.0	50.3	74.0	-23.7
8191.5	Average	Vertical	-3.0	43.5	-12.9	27.6	54.0	-26.4
8191.5	Peak	Horizontal	6.9	43.5	0.0	50.4	74.0	-23.6

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
8191.5	Average	Horizontal	-3.2	43.5	-12.9	27.4	54.0	-26.6
9101.5	Peak	Vertical	-1.1	44.6	0.0	43.5	74.0	-30.5
9101.5	Average	Vertical	-10.4	44.6	-12.9	21.3	54.0	-32.7
9101.5	Peak	Horizontal	-0.9	44.6	0.0	43.7	74.0	-30.3
9101.5	Average	Horizontal	-10.0	44.6	-12.9	21.7	54.0	-32.3

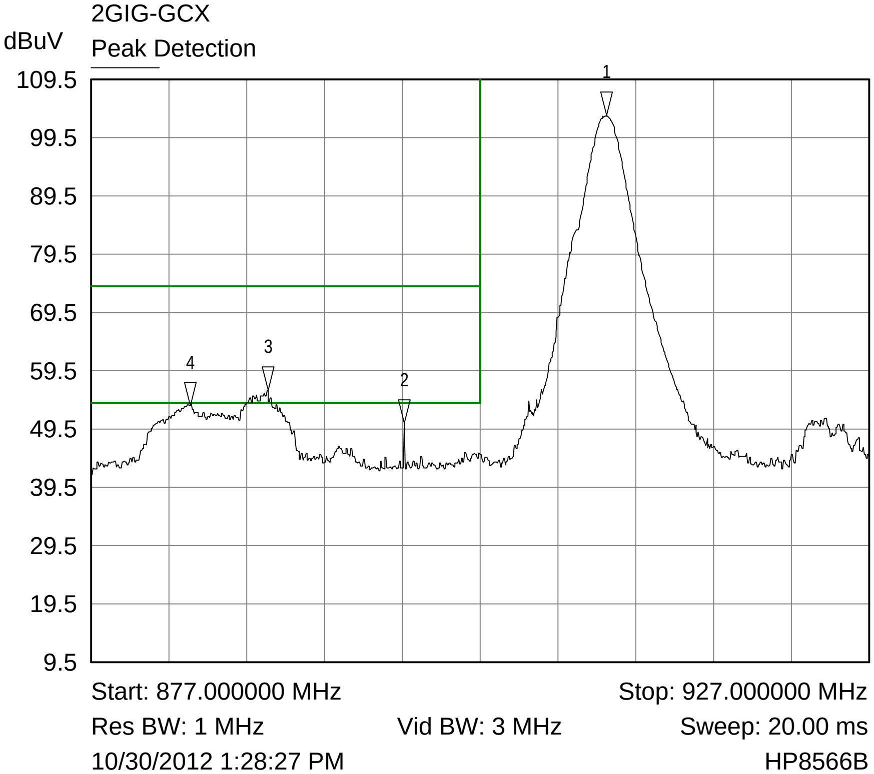
Transmitting at the Highest Frequency

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1839.6	Peak	Vertical	20.6	29.4	0.0	50.0	74.0	-24.0
1839.6	Average	Vertical	15.4	29.4	-12.9	31.9	54.0	-22.1
1839.6	Peak	Horizontal	28.1	29.4	0.0	57.5	74.0	-16.5
1839.6	Average	Horizontal	23.6	29.4	-12.9	40.1	54.0	-13.9
2759.7	Peak	Vertical	15.5	32.9	0.0	48.4	74.0	-25.6
2759.7	Average	Vertical	9.9	32.9	-12.9	29.9	54.0	-24.1
2759.7	Peak	Horizontal	26.1	32.9	0.0	59.0	74.0	-15.0
2759.7	Average	Horizontal	22.5	32.9	-12.9	42.5	54.0	-11.5
3679.6	Peak	Vertical	15.2	35.9	0.0	51.1	74.0	-22.9
3679.6	Average	Vertical	10.1	35.9	-12.9	33.1	54.0	-20.9
3679.6	Peak	Horizontal	16.4	35.9	0.0	52.3	74.0	-21.7
3679.6	Average	Horizontal	12.3	35.9	-12.9	35.3	54.0	-18.7
4599.3	Peak	Vertical	15.3	37.2	0.0	52.5	74.0	-21.5
4599.3	Average	Vertical	7.5	37.2	-12.9	31.8	54.0	-22.2
4599.3	Peak	Horizontal	10.3	37.2	0.0	47.5	74.0	-26.5
4599.3	Average	Horizontal	2.1	37.2	-12.9	26.4	54.0	-27.6
5519.2	Peak	Vertical	2.6	39.5	0.0	42.1	74.0	-31.9
5519.2	Average	Vertical	-6.4	39.5	-12.9	20.2	54.0	-33.8
5519.2	Peak	Horizontal	2.8	39.5	0.0	42.3	74.0	-31.7
5519.2	Average	Horizontal	-6.7	39.5	-12.9	19.9	54.0	-34.1
6439.0	Peak	Vertical	6.4	39.9	0.0	46.3	74.0	-27.7

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
6439.0	Average	Vertical	-2.9	39.9	-12.9	24.1	54.0	-29.9
6439.0	Peak	Horizontal	7.1	39.9	0.0	47.0	74.0	-27.0
6439.0	Average	Horizontal	-3.0	39.9	-12.9	24.0	54.0	-30.0
7358.8	Peak	Vertical	3.1	42.4	0.0	45.5	74.0	-28.5
7358.8	Average	Vertical	-2.3	42.4	-12.9	27.2	54.0	-26.8
7358.8	Peak	Horizontal	4.7	42.4	0.0	47.1	74.0	-26.9
7358.8	Average	Horizontal	1.3	42.4	-12.9	30.8	54.0	-23.2
8278.6	Peak	Vertical	-0.2	43.6	0.0	43.4	74.0	-30.6
8278.6	Average	Vertical	-11.9	43.6	-12.9	18.8	54.0	-35.2
8278.6	Peak	Horizontal	0.7	43.6	0.0	44.3	74.0	-29.7
8278.6	Average	Horizontal	-10.3	43.6	-12.9	20.4	54.0	-33.6
9198.2	Peak	Vertical	-0.6	44.6	0.0	44.0	74.0	-30.0
9198.2	Average	Vertical	-11.3	44.6	-12.9	20.4	54.0	-33.6
9198.2	Peak	Horizontal	-0.8	44.6	0.0	43.8	74.0	-30.2
9198.2	Average	Horizontal	-11.2	44.6	-12.9	20.5	54.0	-33.5

No other emissions were seen. Noise floor was greater than 6 dB below the limit.

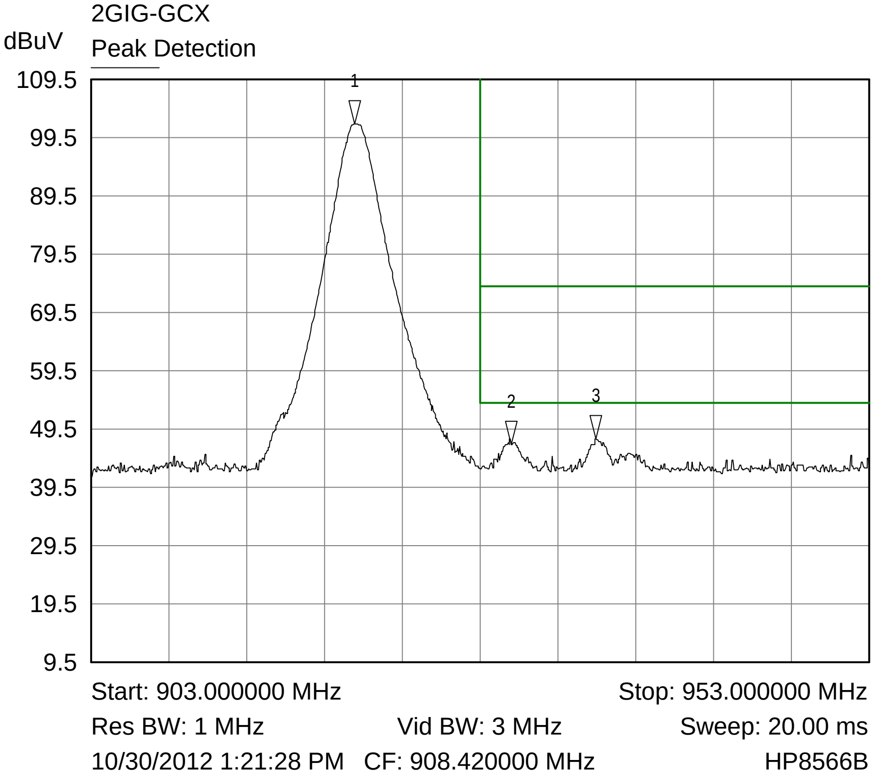
Lower Band Edge



Mkr	X-Axis	Value	Notes
1 ▽	910.100000 MHz	103.3000 dBuV	
2 ▽	897.150000 MHz	50.5000 dBuV	Ambient noise at the OATS
3 ▽	888.350000 MHz	56.1000 dBuV	Ambient noise at the OATS
4 ▽	883.350000 MHz	53.5000 dBuV	Ambient noise at the OATS

Peak Detection Lower band edge

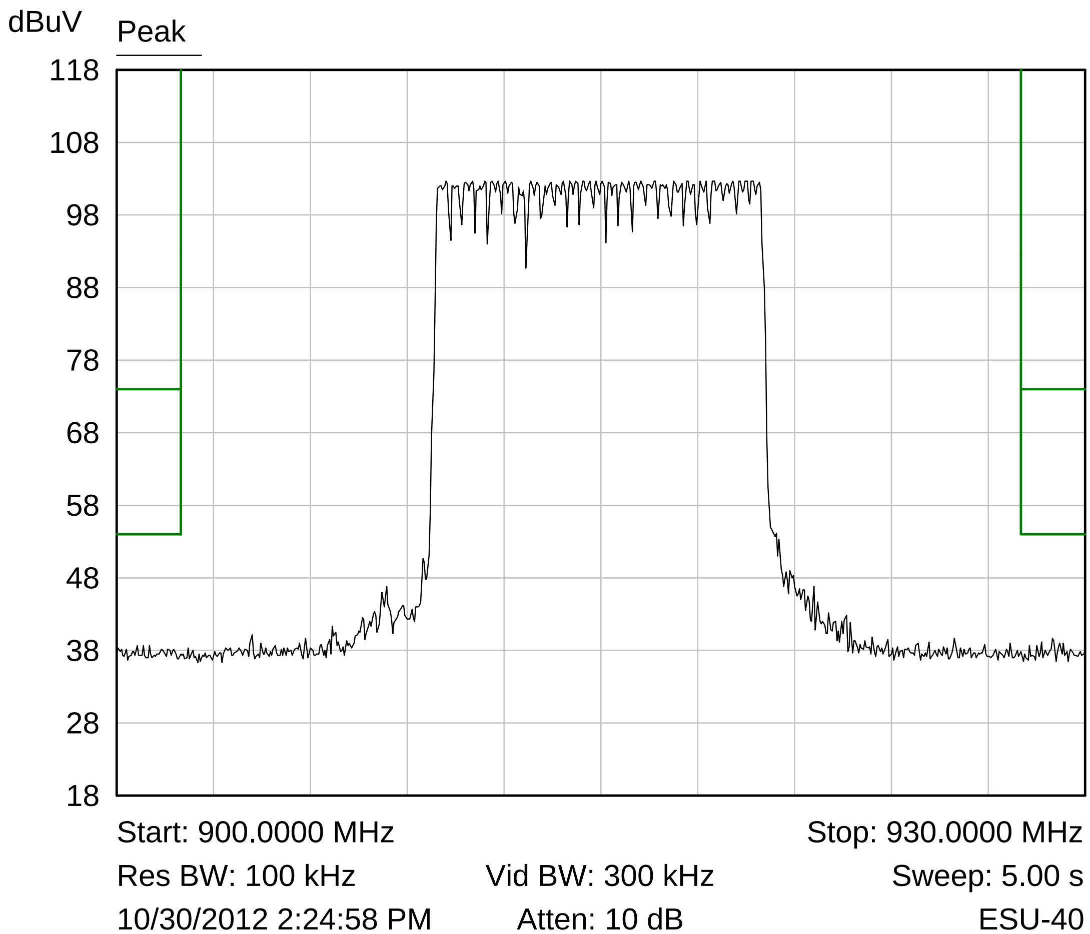
Upper Band Edge



Mkr	X-Axis	Value	Notes
1 ▽	919.950000 MHz	101.9000 dBuV	
2 ▽	930.000000 MHz	46.9000 dBuV	
3 ▽	935.450000 MHz	47.9000 dBuV	

Peak Detection   Upper band edge

EUT Operating Band While Hopping



Peak Operating band

RESULT

All emissions, including those outside the restricted bands, met the 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.

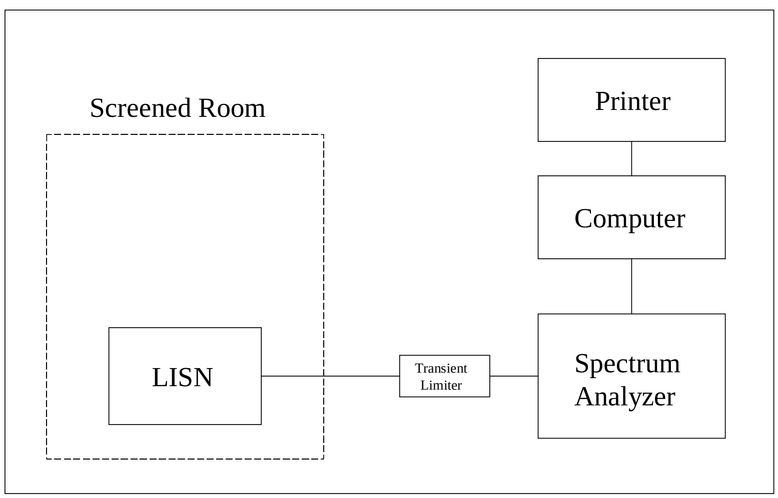
For AC mains port testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration	Due Date of Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011	11/16/2012
Test Software	Nemko-CCL, Inc.	Conducted Emissions	Revision 1.2	N/A	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012	01/17/2013

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration	Due Date of Calibration
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012	01/18/2013
LISN	EMCO	3825/2	9305-2099	03/12/2012	03/12/2013
Conductance Cable Wanship Site #2	Nemko-CCL, Inc.	Cable J	N/A	12/14/2011	12/14/2012
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/14/2011	12/14/2012

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 emissions from the intentional radiator were measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings.

A loop antenna was used to measure emissions below 30 MHz. Emission readings more than 20 dB below the limit at any frequency may not be listed in the reported data. For frequencies between 9 kHz and 30 MHz, or the lowest frequency generated or used in the device greater than 9 kHz, and less than 30 MHz, the spectrum analyzer resolution bandwidth was set to 9 kHz and the video bandwidth was set to 30 kHz. For average measurements, the spectrum analyzer average detector was used.

For frequencies above 30 MHz, an amplifier and preamplifier were 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. For peak emissions above 1000 MHz the spectrum analyzer's resolution bandwidth was set to 1 MHz and the video bandwidth was set to 3 MHz. For average measurements above 1000 MHz the spectrum analyzer's resolution bandwidth was set to 1 MHz and the average detector of the analyzer was used.

A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz and a Double Ridge Guide Horn antenna was used to measure the frequency range of 1 GHz to 18 GHz, and a Pyramidal Horn antenna was used to measure the frequency range of 18 GHz to 25 GHz, at a distance of 3 meters and/or 1 meter from the EUT. The readings obtained by the antenna are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors.

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.

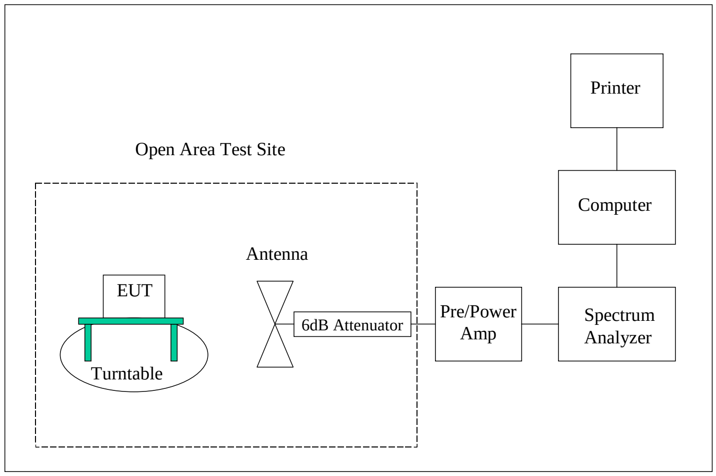
Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

For radiated emission testing at 30 MHz or above that is performed at distances closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration	Due Date of Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011	11/16/2012
Test Software	Nemko-CCL, Inc.	Radiated Emissions	Revision 1.3	N/A	N/A
Spectrum Analyzer/Receiver	Rhode & Schwarz	ESU40	100064	07/28/2012	07/28/2013
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012	01/17/2013
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012	01/18/2013
Loop Antenna	EMCO	6502	2011	03/11/2011	03/11/2013
Biconilog Antenna	EMCO	3142	9601-1009	04/21/2011	04/21/2013
Double Ridged Guide Antenna	EMCO	3115	9604-4779	03/10/2011	03/10/2013
High Frequency Amplifier	Miteq	AFS4-01001800-43-10P-4	1096455	06/26/2012	06/26/2013
6’ High Frequency Cable	Microcoax	UFB197C-0-0720-000000	1296	05/14/2012	05/14/2013
20’ High Frequency Cable	Microcoax	UFB197C-1-3120-000000	1297	05/14/2012	05/14/2013
3 Meter Radiated Emissions Cable Wanship Site #2	Microcoax	UFB205A-0-4700-000000	1295	05/10/2011	05/10/2013
Pre/Power-Amplifier	Hewlett Packard	8447F	3113A05161	08/27/2012	08/27/2013
6 dB Attenuator	Hewlett Packard	8491A	32835	12/14/2011	12/14/2012

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

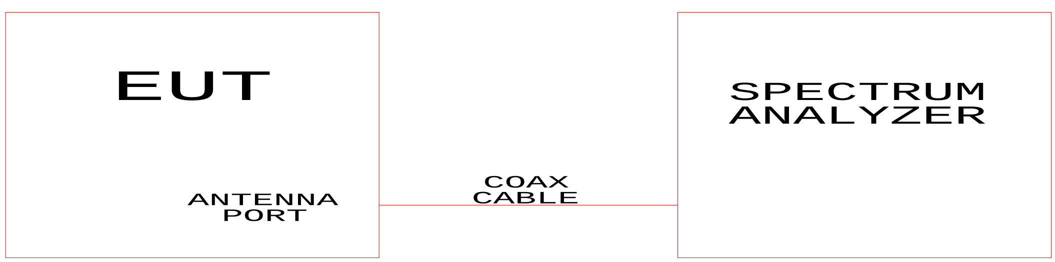


A1.2 §15.247 Conducted Measurements at the Antenna

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	ESU40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

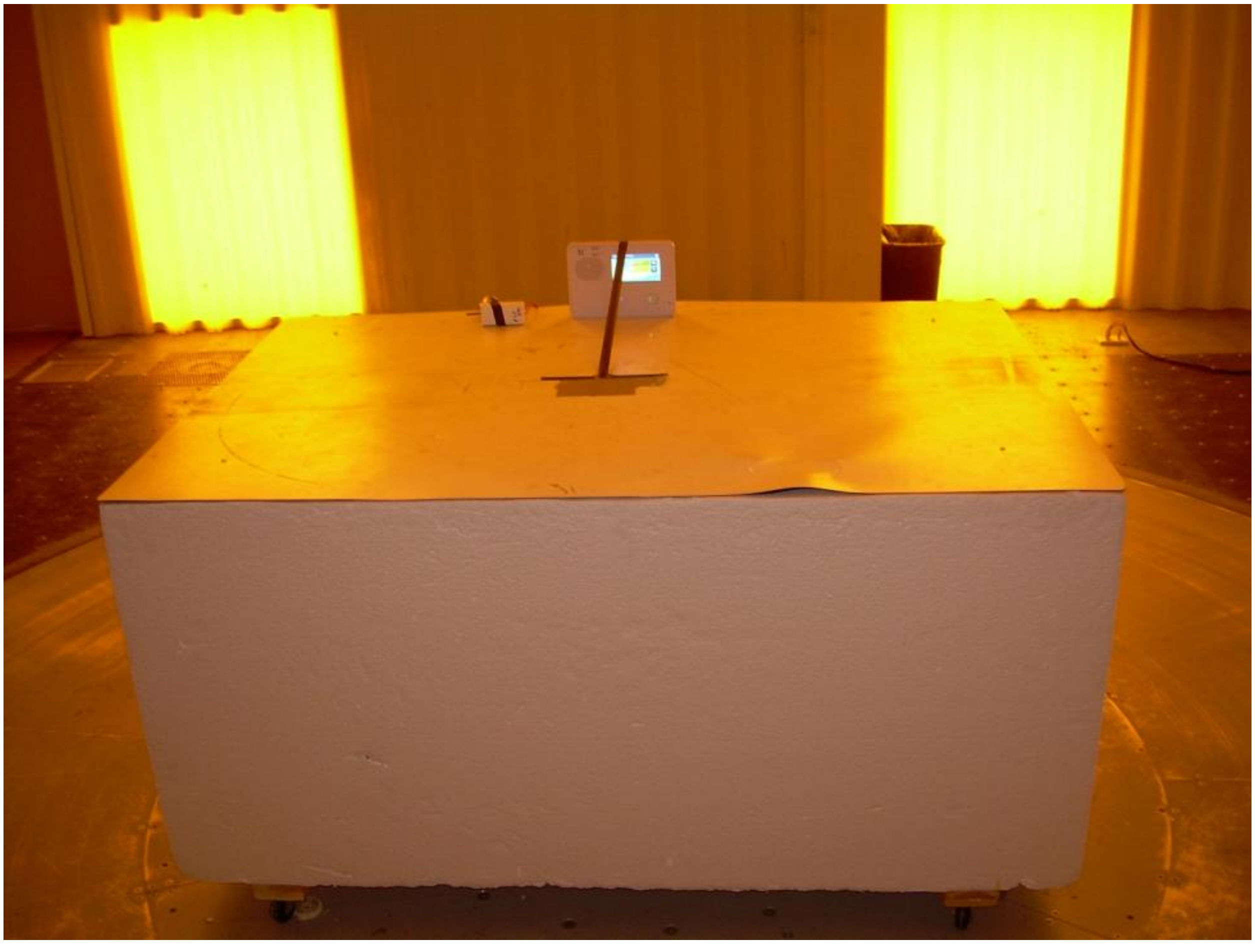
An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology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

Test Configuration Block Diagram

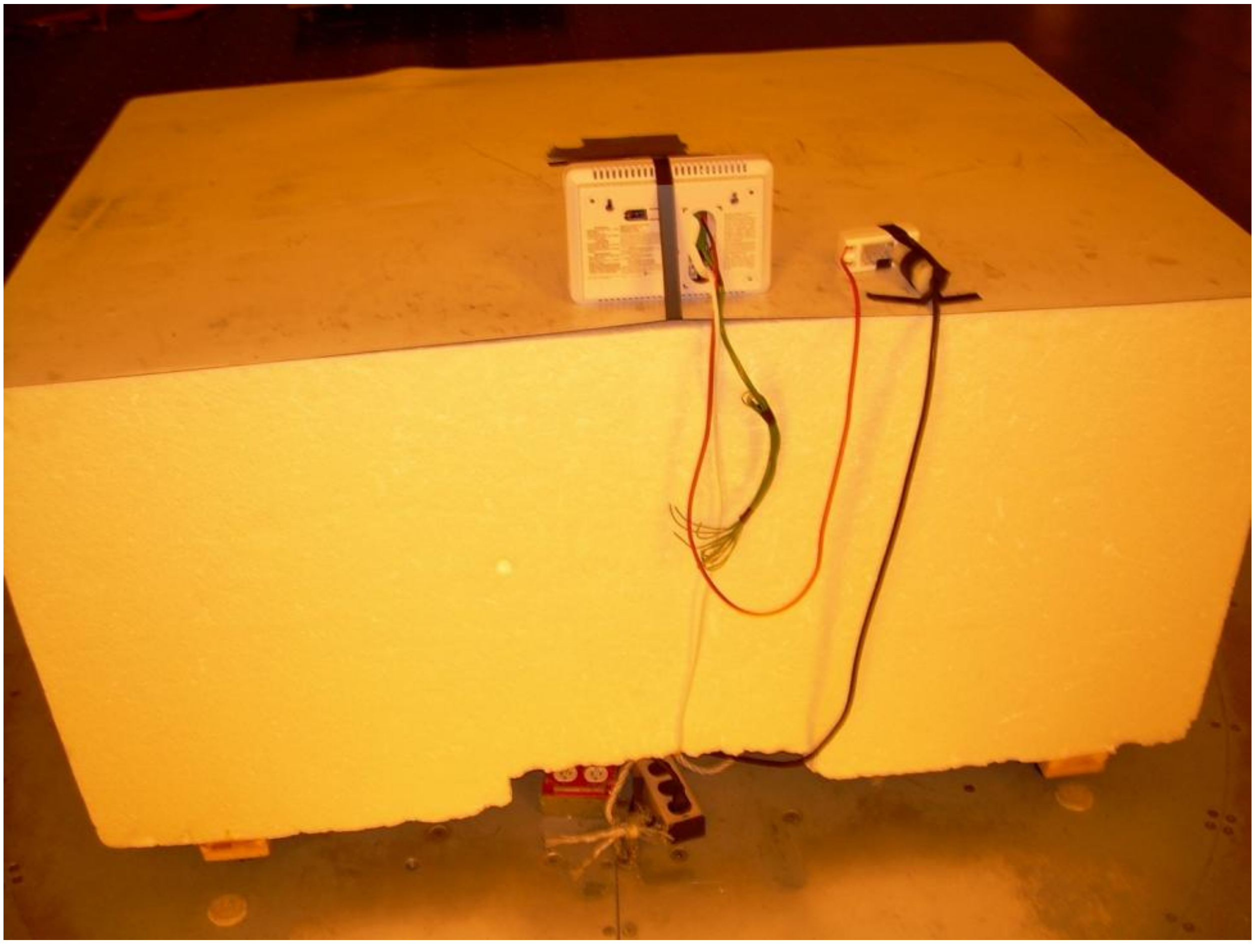


APPENDIX 2 PHOTOGRAPHS

Photograph 1 – Front View Radiated Disturbance Worst Case Configuration



Photograph 2 – Back View Radiated Disturbance Worst Case Configuration



Photograph 3 – Front View Conducted Disturbance Worst Case Configuration

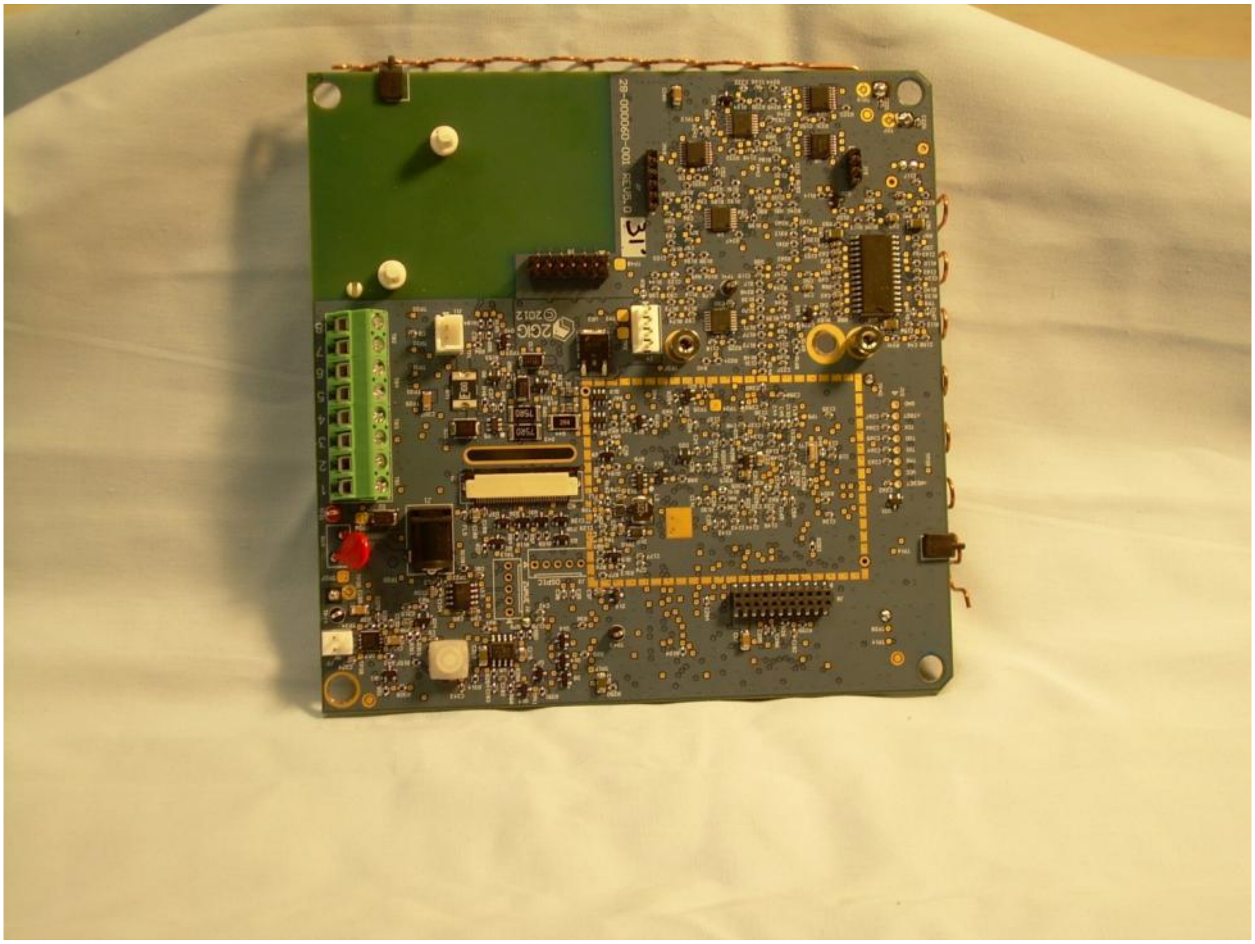
Photograph 4 – Back View Conducted Disturbance Worst Case Configuration

Photograph 5 – Front View of the EUT

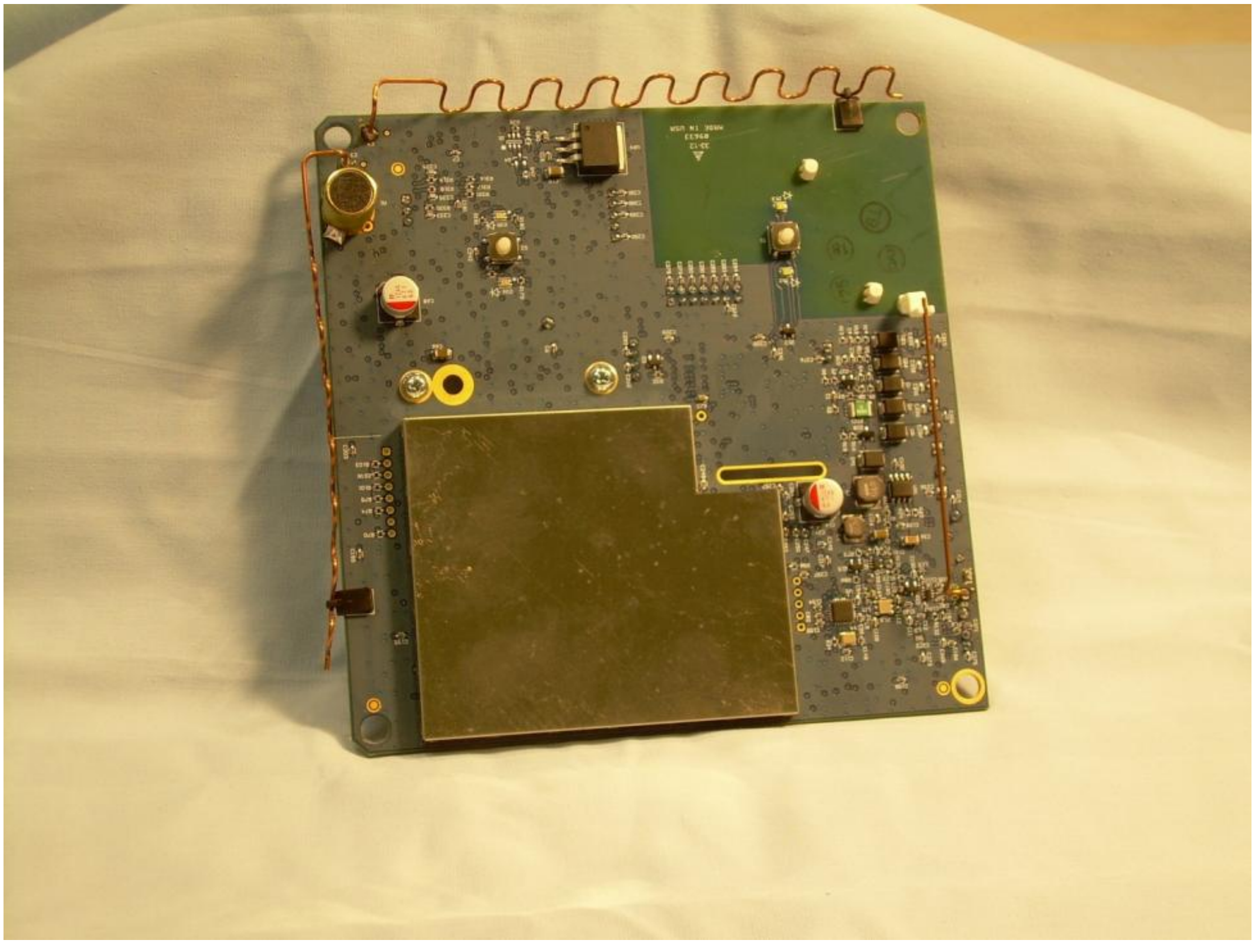
Photograph 6 – Back View of the EUT

Photograph 7 – Internal View of the EUT

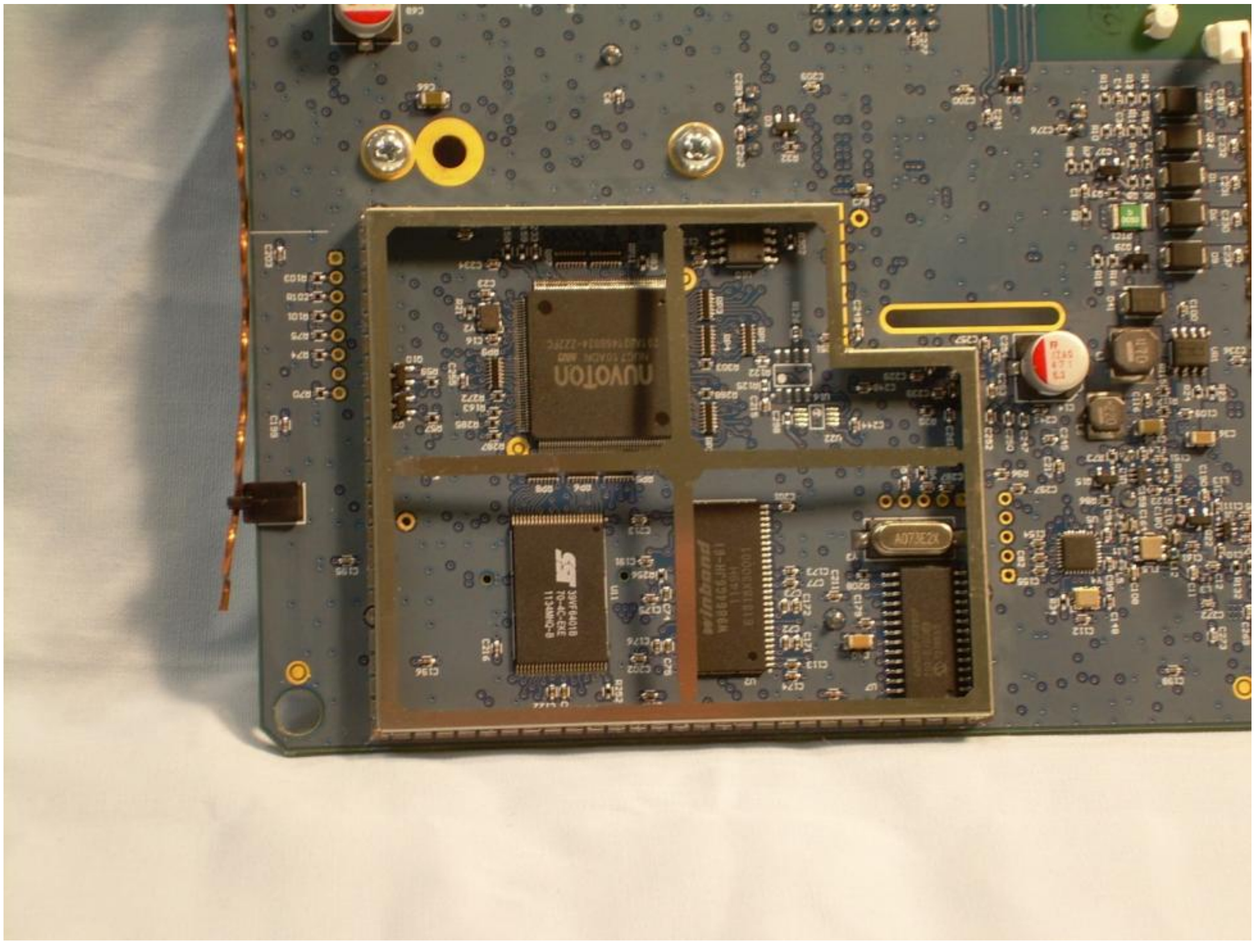
Photograph 8 – View of the Back Side of the Main PCB



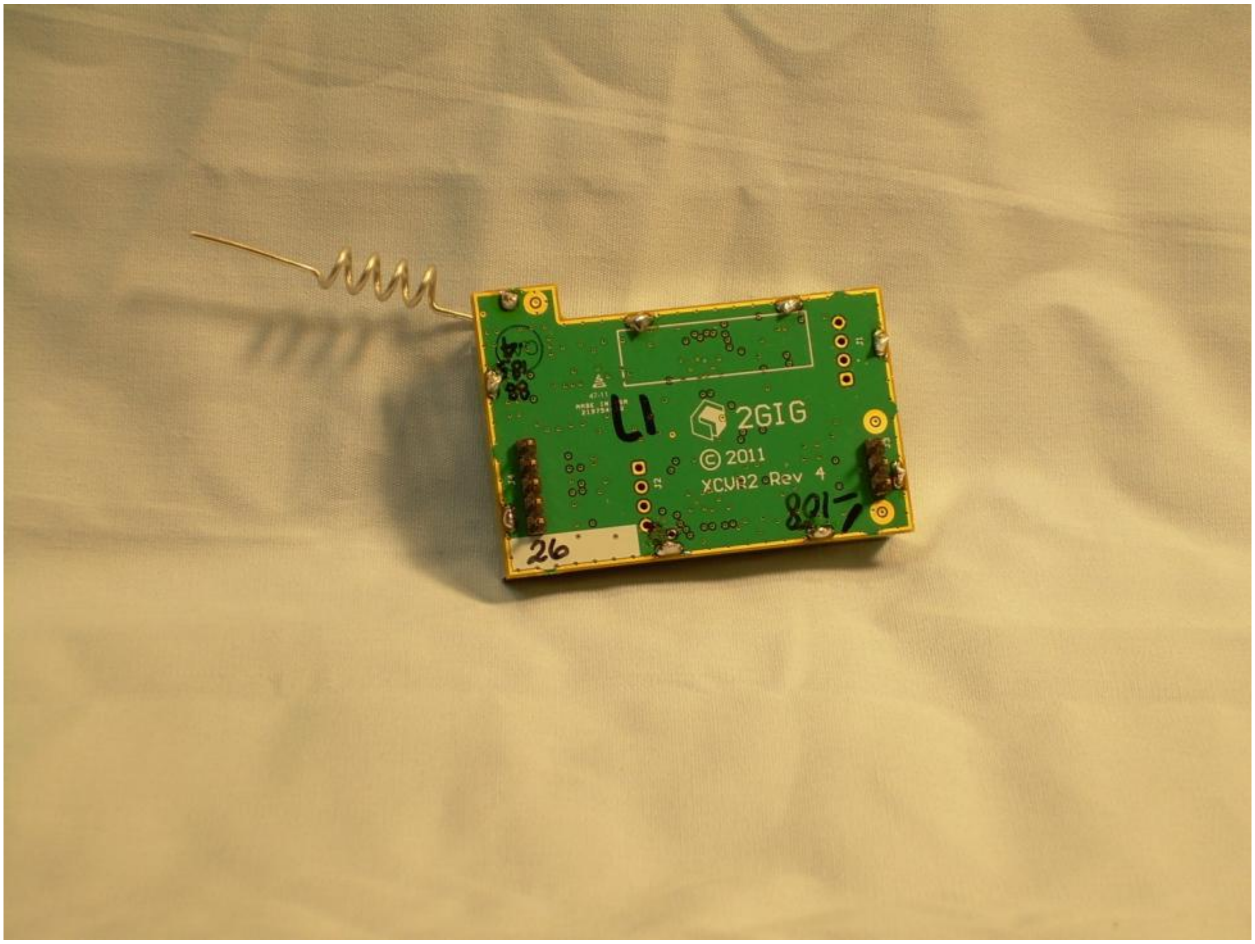
Photograph 9 – Front View of the Main PCB



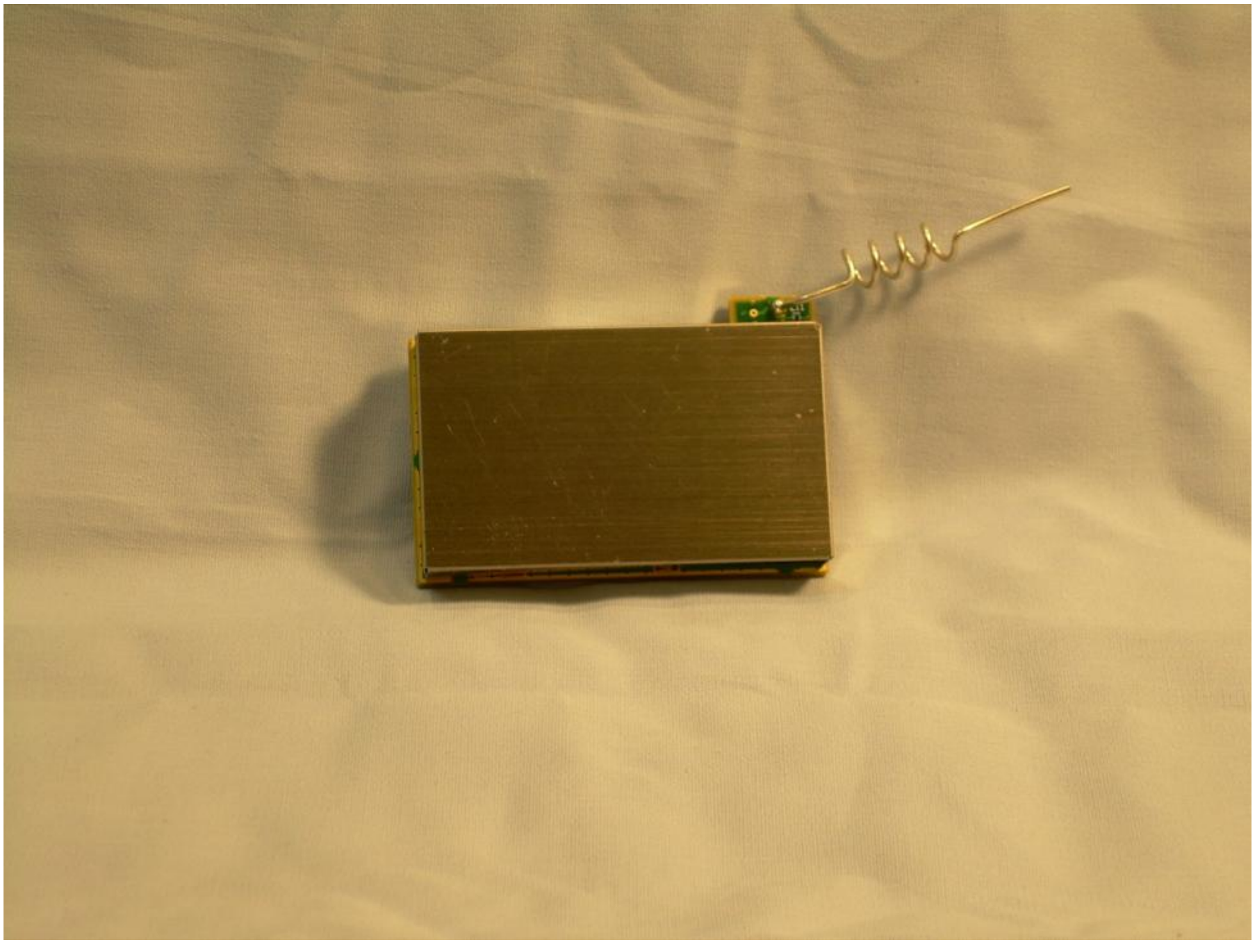
Photograph 10 – View of the Circuitry Under the RF Shield on the Main PCB



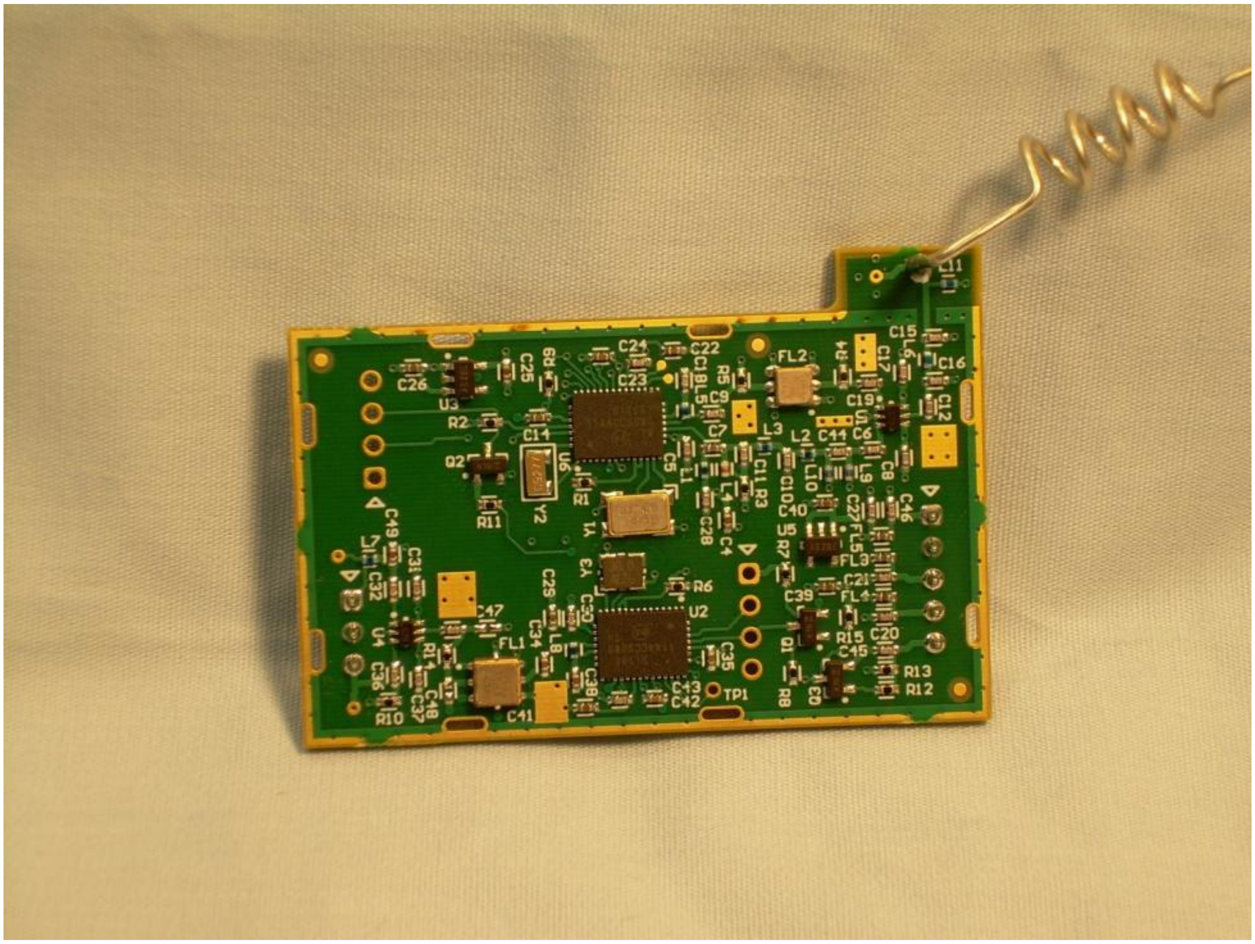
Photograph 11 – Back View of the FHSS Transceiver Module



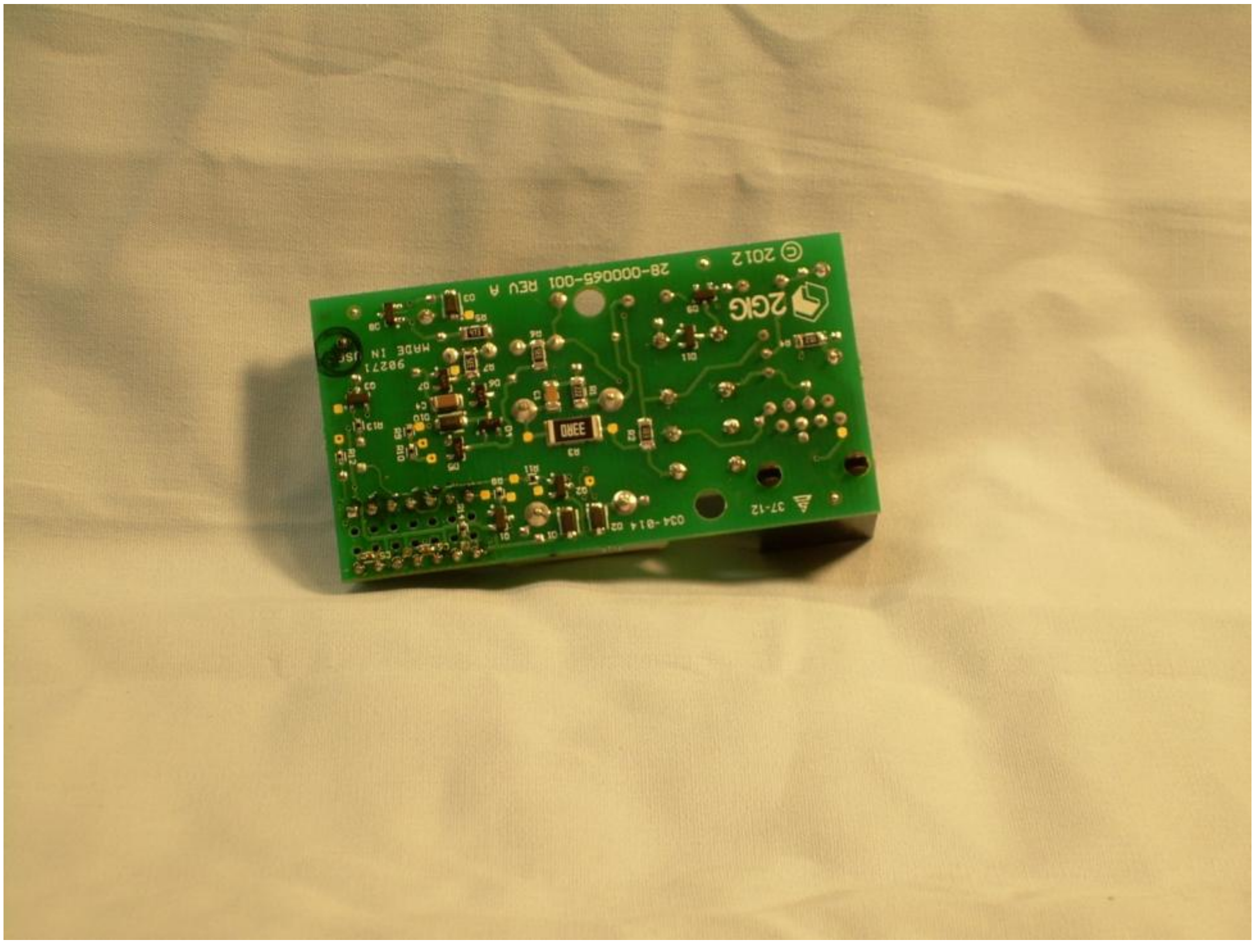
Photograph 12 – Front View of the FHSS Transceiver



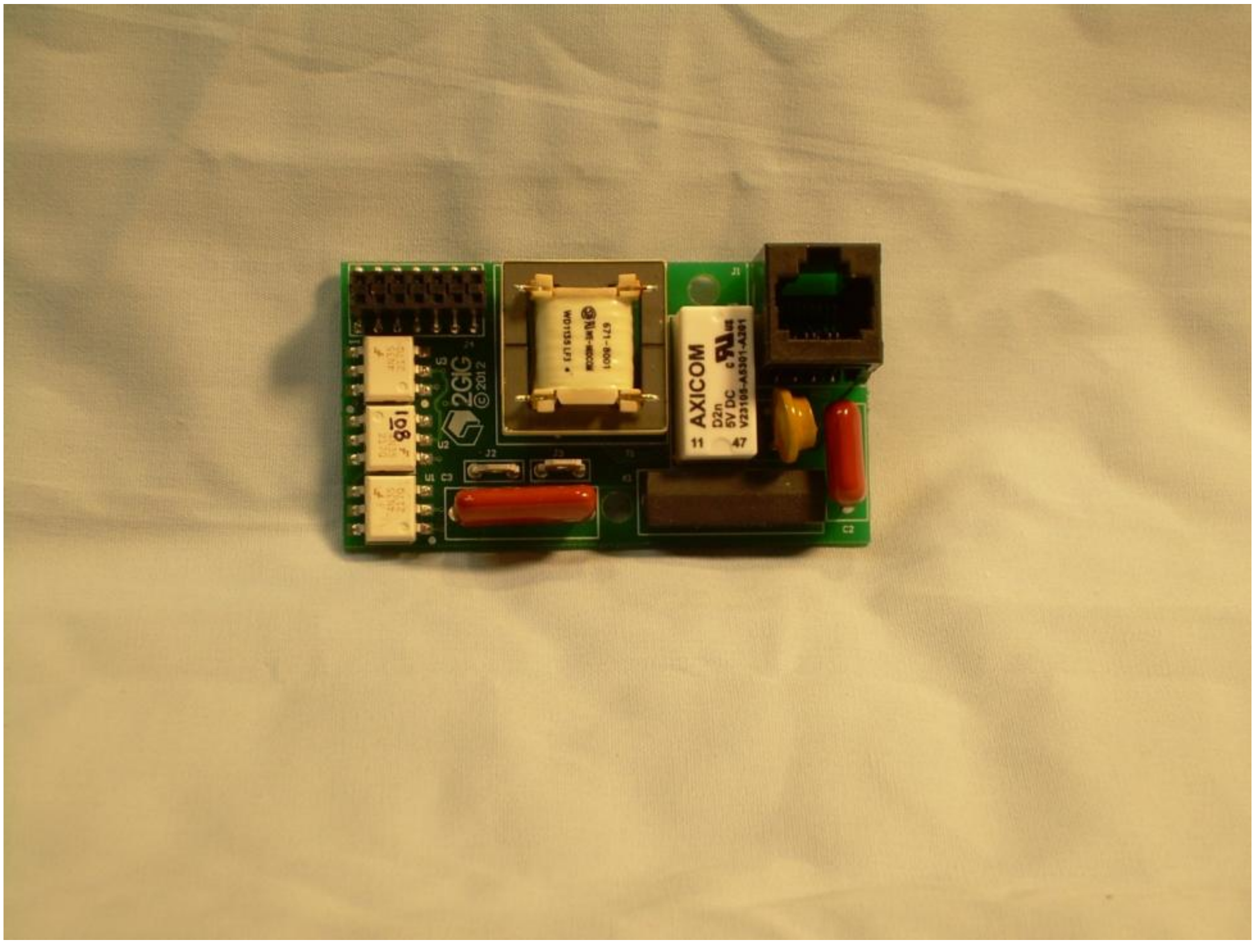
Photograph 13 – View of the Circuitry Under the RF Shield of the FHSS Transceiver



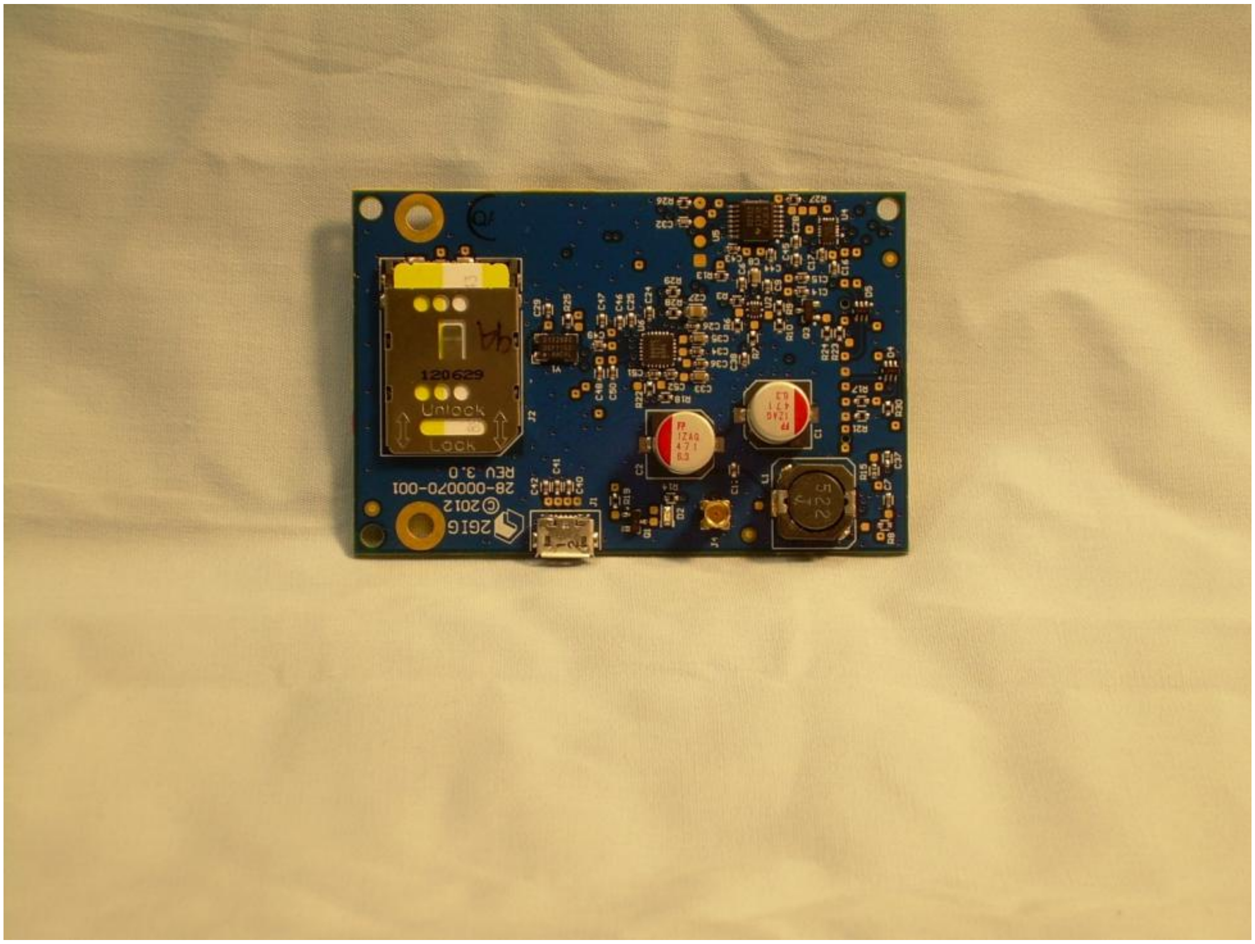
Photograph 14 – Front View of the POTS PCB



Photograph 15 – Back View of the POTS PCB



Photograph 16 – Front View of the 2G/3G Cell Modem



Photograph 17 – Back View of the 2G/3G Cell Modem