Nemko-CCL, Inc.

1940 West Alexander Street
Salt Lake City, UT 84119
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Test Report

Certification

Test Of: CowAlert

FCC ID: WWP-COWALERT

Test Specification:

FCC PART 15, Subpart C

Test Report Serial No: 234765-3.1

Applicant:

IceRobotics Ltd
Bankhead Steading
Bankhead Road
South Queensferry
Edinburgh EH30 9TF
United Kingdom

Date of Test: April 4 & 8-11, 2013

Report Issue Date: April 30, 2013

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: IceRobotics Ltd
- Manufacturer: IceRobotics Ltd
- Brand Name: IceRobotics
- Model Number: CowAlert
- FCC ID Number: WWP-COWALERT

On this 30th day of April 2013, 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.

Mark M. Feil

Tested by: Mark M. Feil
EMC Engineer

Reviewed by: Thomas C. Jackson
General Manager

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SECTION 1.0 CLIENT INFORMATION

1.1 Applicant:

Company Name:	IceRobotics Ltd Bankhead Steading Bankhead Road South Queensferry Edinburgh EH30 9TF United Kingdom
Contact Name:	Fraser Arnot
Title:	Operations Manager

1.2 Manufacturer:

Company Name:	IceRobotics Ltd Bankhead Steading Bankhead Road South Queensferry Edinburgh EH30 9TF United Kingdom
Contact Name:	Fraser Arnot
Title:	Operations Manager

SECTION 2.0 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of EUT:

Brand Name:	IceRobotics
Model Number:	CowAlert
Dimensions:	EtherReader: 24.1 cm x 15.9 cm x 8.9 Trigger Box: 17.8 cm x 7.6 cm x 13.1 128 kHz Antenna: 75 cm x 75 cm x 0.6
Country of Manufacture:	United Kingdom

2.2 Description of EUT:

The CowAlert system—together with the IceQube—acquires data logs of animal movements, enabling analysis of such data. For testing, the system was powered by a Sanyo AD-173 or Celetron GP14-2001 power supply. The CowAlert System comprises a 128 kHz antenna, an antenna trigger box and the EtherReader which interfaces with a computer via Ethernet and wirelessly with an IceQube. The IceQube sensor is strapped to the leg of an animal for a period of a few weeks up to many years, during which time it gathers data of the movement of the animal. The IceQube does not transmit constantly. Transmission is activated via its 128 kHz inductor when the animal passes through the 128 Khz field produced by the antenna of the CowAlert System. Alternatively, or in addition, the IceQube can be programmed to transmit automatically at pre-defined time intervals.

There are three activation modes which result in three sets of transceiving frequencies within the 2400 MHz to 2483.5 MHz frequency band. “Double pulse” mode activates channels 8 (2402.6 MHz), 64 (2420.9 MHz), and 128 (2441.7 MHz). “Triple pulse” mode activates channels 50 (2416.3 MHz), 100 (2432.6 MHz), 150 (2448.9 MHz). “Timed download” mode activates channels 30 (2409.8 MHz), 200 (2465.2 MHz), 230 (2475.0 MHz). After activation the CowAlert system and the Ice Qube communicate with each other (transmit and receive) at 2.402-2.475 GHz for a few seconds while the data is downloaded, then the IceQube transmitter is turned off.

The CowAlert both transmits and receives in the 2400 MHz to 2483.5 MHz frequency band, and transmits at 128 kHz. Testing was performed at the upper channel (2475 MHz), the middle channel (2441.7 MHz), and the lower channel (2402.6 MHz). Test results for 128 kHz are covered in Nemko-CCL report #234765-8.1. Plots of the tested channels are shown in section 6.2.4.

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 and found to comply. See Nemko-CCL report #234767-2.

2.3 EUT and Support Equipment:

The EUT and support equipment used during the test are listed below:

Brand Name Model Number	FCC ID Number	Description	Name of Interface Ports / Interface Cables
BN: IceRobotics MN: CowAlert (Note 1)	WWP-COWALERT	Transmitter activator and data downloader	See Section 2.4
BN: IceRobotics MN: IceQube	WWP-ICEQUBE	Data logger and transmitter	Wireless interface
BN: Samsung MN: N310 (Note 2)	N/A	Laptop computer	Ethernet / Cat5E

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

2.4 Interface Ports on EUT:

Name of Port	No. of Ports Fitted to EUT	Cable Descriptions/Length
Ethernet	1	Ethernet / Cat5E

2.5 Modification Incorporated/Special Accessories on EUT:

The following modifications were made to the EUT during testing to comply with the specification. This report is not complete without an accompanying signed attestation, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

1. A 10,000 pf capacitor was placed from TA1 to TA2 on the EtherReader’s output to the trigger box.

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 15.249 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 §15.249 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(2) The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5 degrees. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5 degrees, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

(e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

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. 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 Code: 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 the desired frequency, using either the upper, middle, or lower channel. The voltage to the transmitter was varied as required by §15.31(e) with no change seen in the transmitter characteristics.

4.3 EUT Exercise Software:

Internal IceRobotics 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
15.249(a)	Field Strength of the Fundamental Frequency	2400 – 2483.5	Complied
15.249(a)	Field Strength of the Harmonics	2400 – 2483.5	Complied
15.249(d)	Field Strength of Spurious Emissions	0.009 – 24750.0	Complied

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 is professionally installed; additionally, it uses a reverse polarity SMA connector for the 2.4 GHz antenna, and thus meets the requirements of §15.203. The EUT was tested with 2 dBi mini helical antenna ANT-24G-WHJ-SMA. Photos of the antenna and its connections are shown in Appendix 2.

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)	51.6	55.5	-3.9
0.21	Hot Lead	Peak (Note 1)	44.2	53.3	-9.1
4.01	Hot Lead	Quasi-Peak (Note 1)	35.1	46.0	-10.9
4.35	Hot Lead	Peak (Note 1)	42.4	46.0	-3.6
4.44	Hot Lead	Peak (Note 1)	38.9	46.0	-7.1
4.63	Hot Lead	Peak (Note 1)	41.1	46.0	-4.9
4.69	Hot Lead	Peak (Note 1)	41.5	46.0	-4.5
6.05	Hot Lead	Peak (Note 1)	39.4	50	-10.6
6.45	Hot Lead	Peak (Note 1)	39.4	50	-10.6
24.9	Hot Lead	Peak (Note 1)	39.1	50	-10.9
3.12	Neutral Lead	Peak (Note 1)	40.0	46.0	-6.0
3.68	Neutral Lead	Peak (Note 1)	40.6	46.0	-5.4
3.85	Neutral Lead	Peak (Note 1)	41.1	46.0	-4.9
4.00	Neutral Lead	Peak (Note 1)	42.6	46.0	-3.4
4.15	Neutral Lead	Peak (Note 1)	42.2	46.0	-3.8

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
4.49	Neutral Lead	Quasi-Peak (Note 2)	44.8	56.0	-11.2
4.49	Neutral Lead	Average (Note 2)	19.4	46.0	-26.6
5.00	Neutral Lead	Peak (Note 1)	43.3	46.0	-2.7
5.90	Neutral Lead	Peak (Note 1)	40.4	50.0	-9.6
6.55	Neutral Lead	Peak (Note 1)	40.8	50.0	-9.2

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 2.7 dB.

6.2.3 §15.249(a) Fundamental Field Strength

The table below shows the low, middle and high fundamental emissions, measured at 3 meters using peak detection.

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB/m)	Peak Field Strength (dBμV/m)	Average Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Limit (dBμV/m)	Average Margin (dB)
2402.6	Peak	V	63.7	31.8	95.5	85.1	114	-18.5	94	-8.9
2402.6	Peak	H	66.6	31.8	98.4	88.0	114	-15.6	94	-6
2441.7	Peak	V	63.4	31.9	95.3	84.9	114	-18.7	94	-9.1
2441.7	Peak	H	67.4	31.9	99.3	88.9	114	-14.7	94	-5.1
2475.0	Peak	V	62.3	32.0	94.3	83.9	114	-19.7	94	-10.1
2475.0	Peak	H	67.8	32.0	99.8	89.4	114	-14.2	94	-4.6

RESULT

The EUT complied with the specification by 4.6 dB.

6.2.3 §15.249(a) and §15.249(d) Field Strength of Harmonics and Spurious Emissions

The spurious emissions and harmonic emissions were measured from 0.009 MHz to 24750.0 MHz on the low, middle, and high channels. The tables below show the emissions from the transmitter. Emissions from the digital circuitry and receivers of the EUT are shown in Nemko-CCL report 234767-2.1. The average measurement was obtained using an average factor of 10.4 dB. For details on the average factor calculation see Appendix 3. Measurements above 18 GHz were made at a 1 meter measurement distance, with the noise floor was at least 6 dB below the limit. For harmonics and spurious emissions, measurements are shown to the degree beyond which only noise floor was seen.

6.2.3.1 Lowest Channel Harmonics and Spurious Emissions

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Peak Field Strength (dBμV/m)	Average Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Limit (dBμV/m)	Average Margin (dB)
4805.2	Peak	V	52.6	37.6	58.6	48.2	74.0	-15.4	54.0	-5.8
4805.2	Peak	H	51.7	37.6	57.7	47.3	74.0	-16.3	54.0	-6.7
7207.8	Peak	V	40.3	41.7	51.6	41.2	74.0	-22.4	54.0	-12.8
7207.8	Peak	H	37.3	41.7	48.6	38.2	74.0	-25.4	54.0	-15.8

RESULT

The EUT complied with the specification on this channel by 5.8 dB.

6.2.3.2 Middle Channel Harmonics and Spurious Emissions

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Peak Field Strength (dBμV/m)	Average Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Limit (dBμV/m)	Average Margin (dB)
4883.4	Peak	V	51.8	37.8	57.9	47.5	74.0	-16.1	54.0	-6.5
4883.4	Peak	H	49.1	37.8	55.2	43.8	74.0	-18.8	54.0	-9.2
7325.1	Peak	V	36.8	42.1	48.4	38.0	74.0	-25.6	54.0	-16.0
7325.1	Peak	H	34.6	42.1	46.2	35.8	74.0	-27.8	54.0	-18.2

RESULT

The EUT complied with the specification on this channel by 6.5 dB.

6.2.3.3 Highest Channel Harmonics and Spurious Emissions

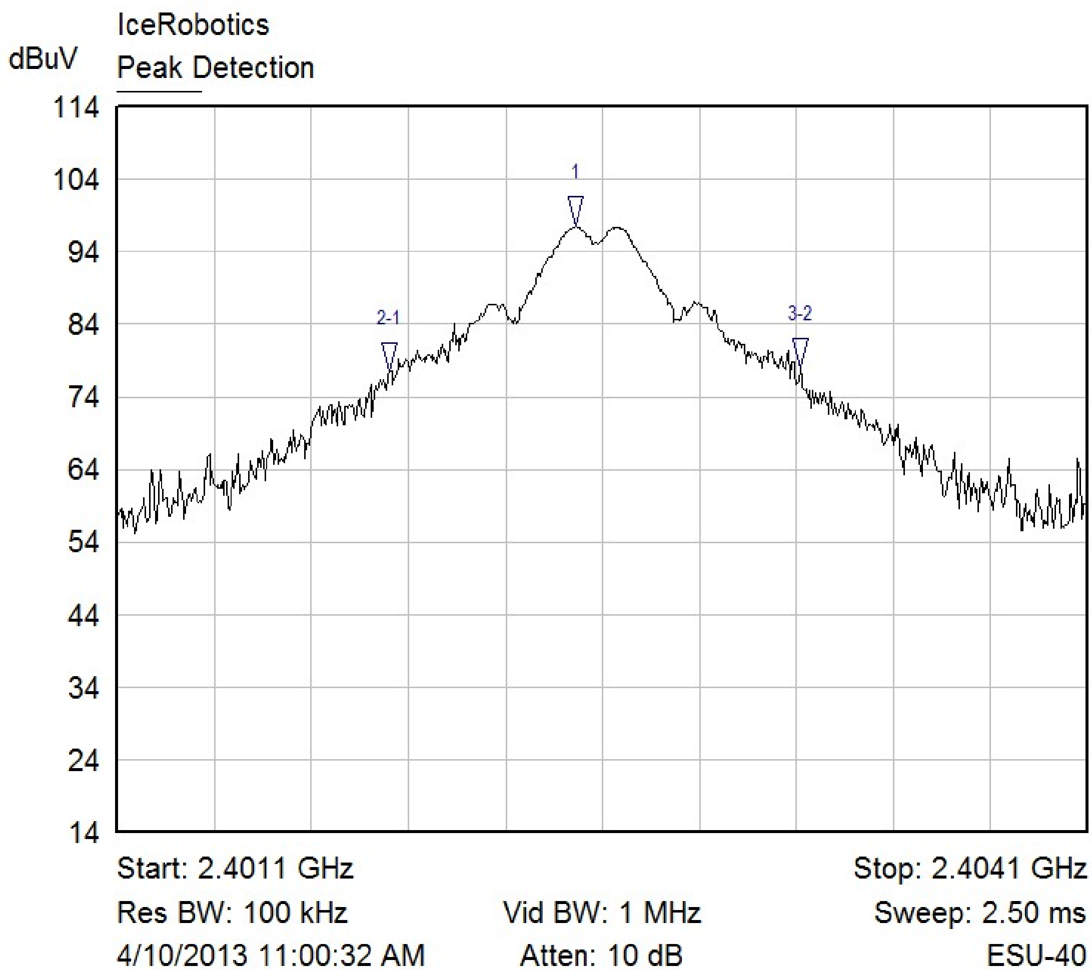
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Peak Field Strength (dBμV/m)	Average Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Limit (dBμV/m)	Average Margin (dB)
4950	Peak	V	52.2	37.9	58.4	48.0	74.0	-15.6	54.0	-6.0
4950	Peak	H	49.6	37.9	55.8	45.4	74.0	-18.2	54.0	-8.6
7425	Peak	V	37.0	42.4	48.9	38.5	74.0	-25.1	54.0	-15.5
7425	Peak	H	35.8	42.4	47.7	37.3	74.0	-26.3	54.0	-16.7

RESULT

The EUT complied with the specification on this channel by 6.0 dB.

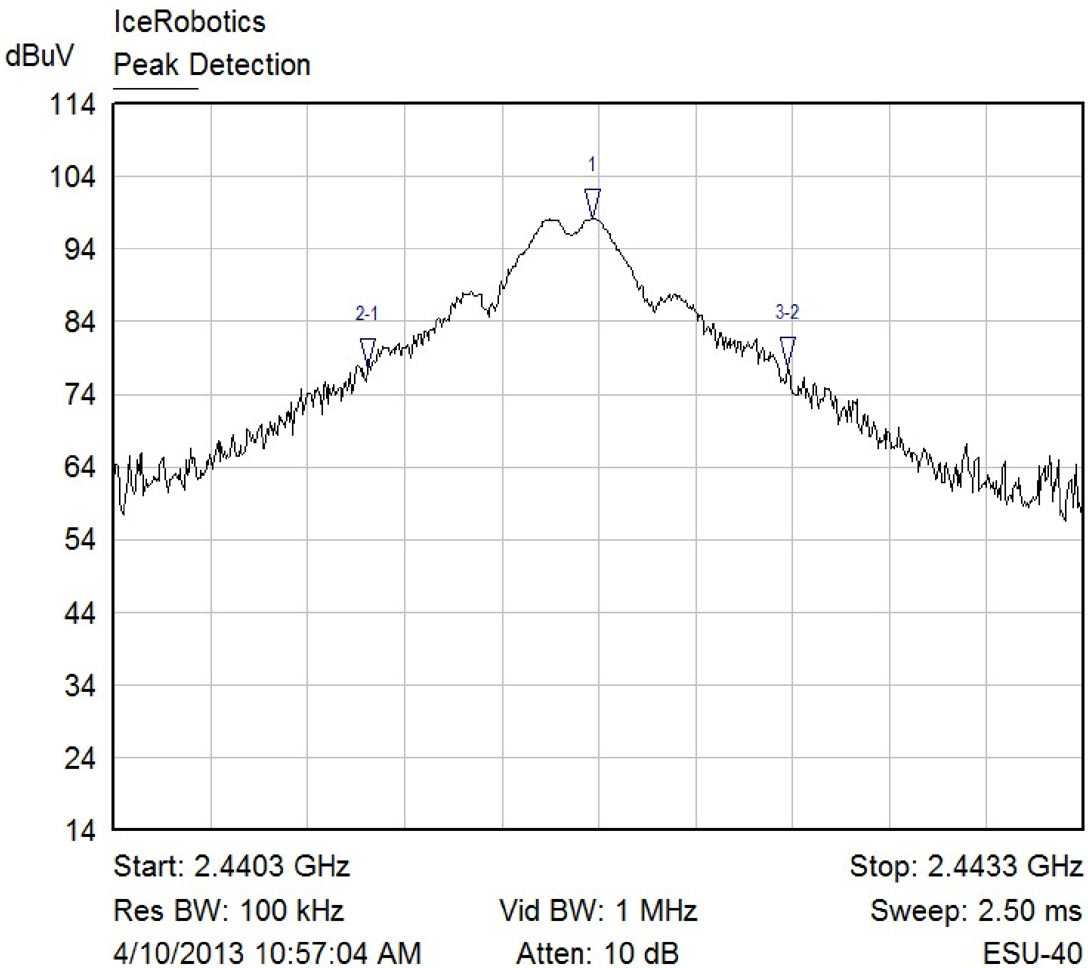
6.2.4 Channel Bandwidth and Band Edge

The 20 dB bandwidths of the lower, middle, and upper channels are shown in the plots below. These plots show that the fundamental emissions have a 20 dB band width of ~1.3 MHz and are contained completely within the 2400 – 2483.5 MHz frequency band.



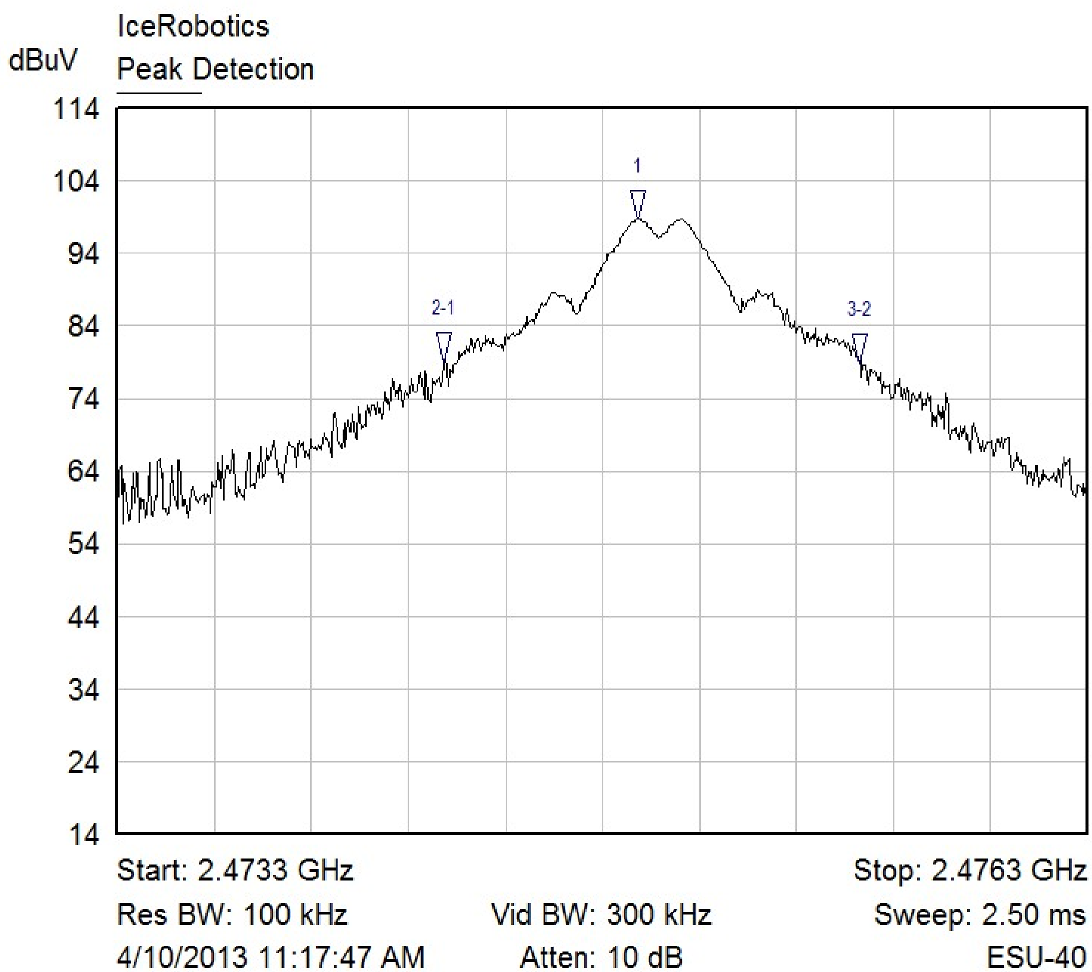
Mkr	X-Axis	Value	Notes
1 ▽	2.4025 GHz	97.46 dBuV	
2-1 ▽	-576.9231 kHz	-20.02 dB	
3-2 ▽	1.2692 MHz	0.57 dB	

Peak Detection Lower Channel BW



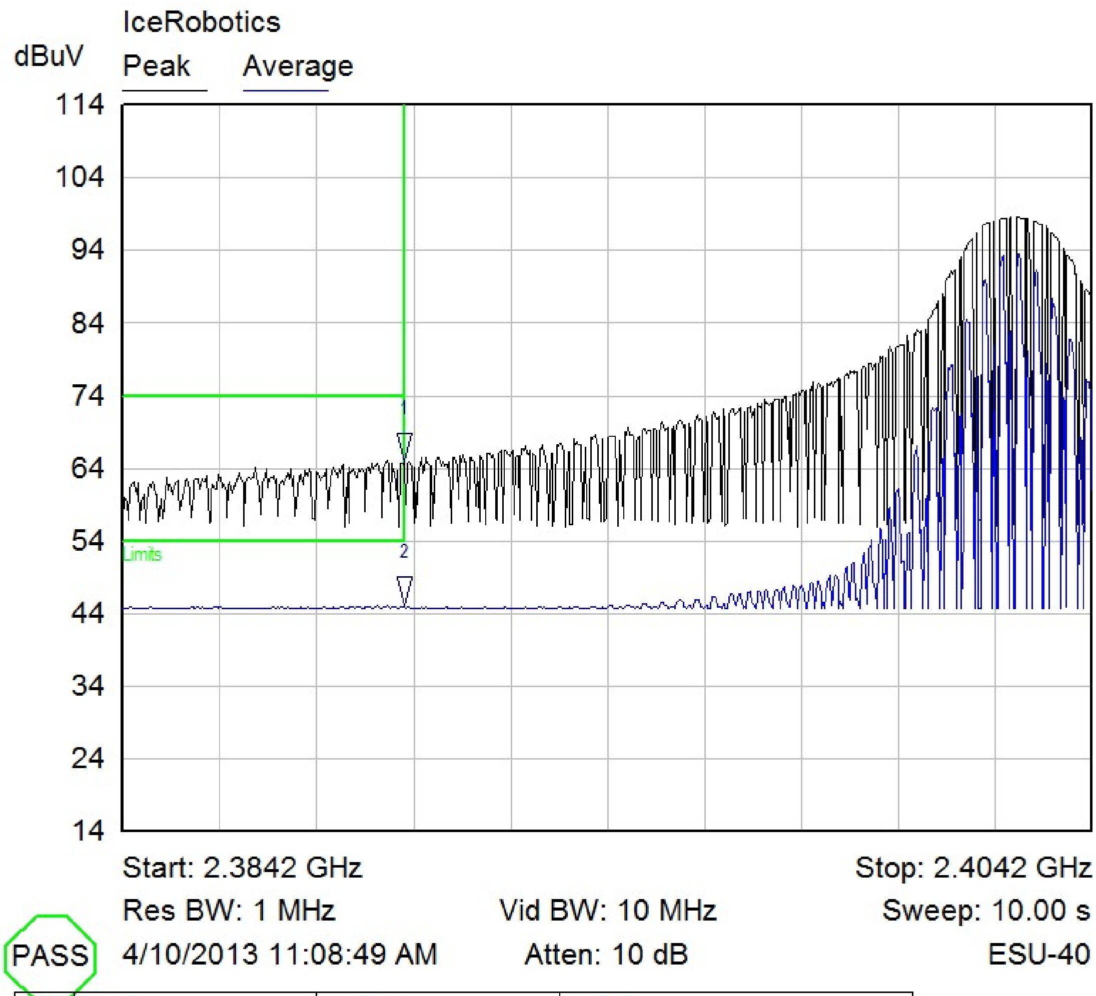
Mkr	X-Axis	Value	Notes
1 ∇	2.4418 GHz	98.20 dBuV	
2-1 ∇	-697.1154 kHz	-20.46 dB	
3-2 ∇	1.3029 MHz	0.14 dB	

Peak Detection   Middle Channel BW



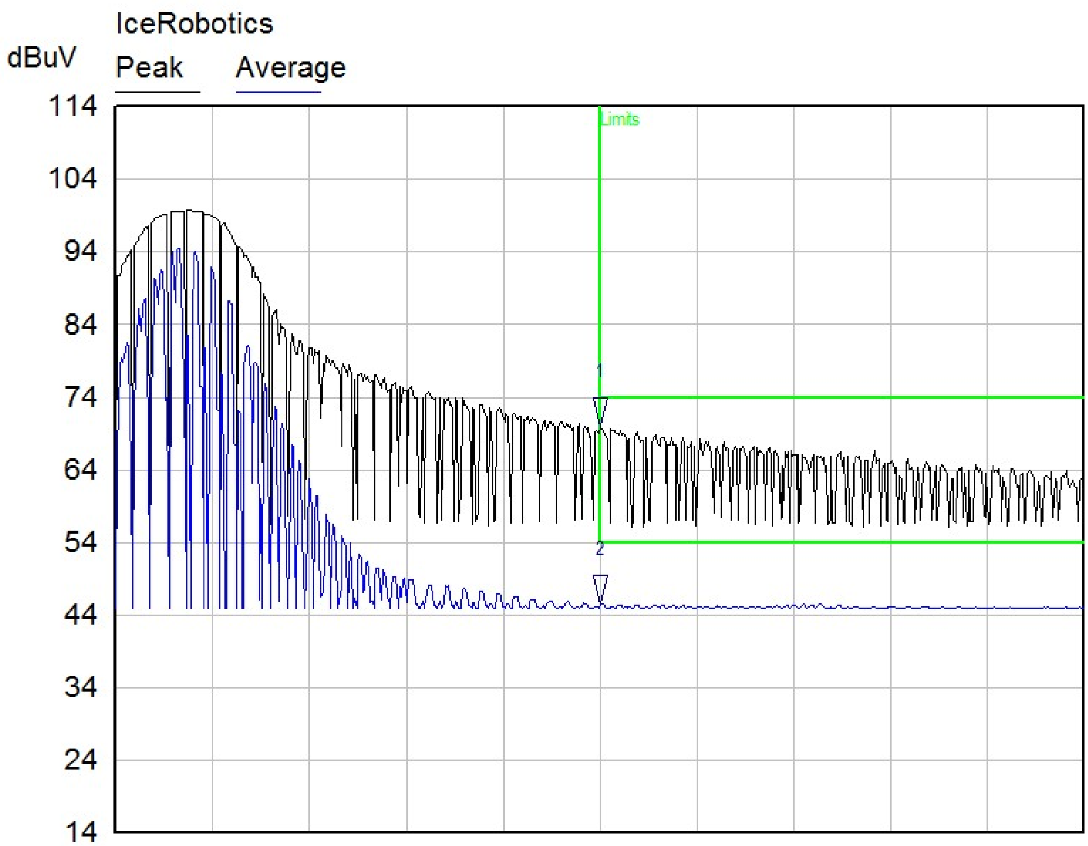
Mkr	X-Axis	Value	Notes
1 ∇	2.4749 GHz	98.61 dBuV	
2-1 ∇	-600.9615 kHz	-19.61 dB	
3-2 ∇	1.2837 MHz	-0.19 dB	

Peak Detection   Upper Channel BW



Mkr	X-Axis	Value	Notes
1 ▽	2.3900 GHz	64.81 dBuV	Compliant
2 ▽	2.3900 GHz	44.99 dBuV	Compliant

Peak Lower Channel BE



Start: 2.4735 GHz Stop: 2.4935 GHz
Res BW: 1 MHz Vid BW: 10 MHz Sweep: 10.00 s
PASS 4/10/2013 11:14:58 AM Atten: 10 dB ESU-40

Mkr	X-Axis	Value	Notes
1 ∇	2.4835 GHz	69.93 dBuV	Compliant
2 ∇	2.4835 GHz	45.45 dBuV	Compliant

Peak Upper Channel BE

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.

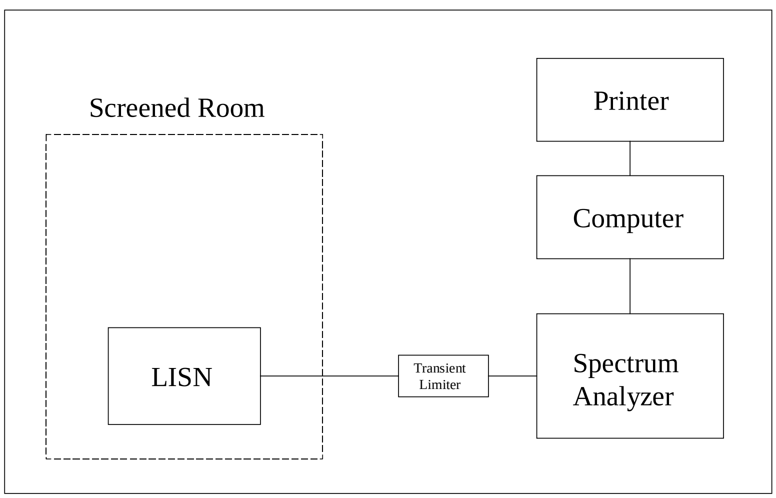
For AC mains port testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

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	12/07/2012	12/07/2013
Test Software	Nemko-CCL, Inc.	Conducted Emissions	Revision 1.2	N/A	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	02/06/2013	02/06/2014

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration	Due Date of Calibration
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	02/06/2013	02/06/2014
LISN	EMCO	3825/2	9305-2099	03/12/2013	03/12/2014
Conductance Cable Wanship Site #2	Nemko-CCL, Inc.	Cable J	N/A	12/21/2012	12/21/2013
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/21/2012	12/21/2013

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 §15.249 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 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.

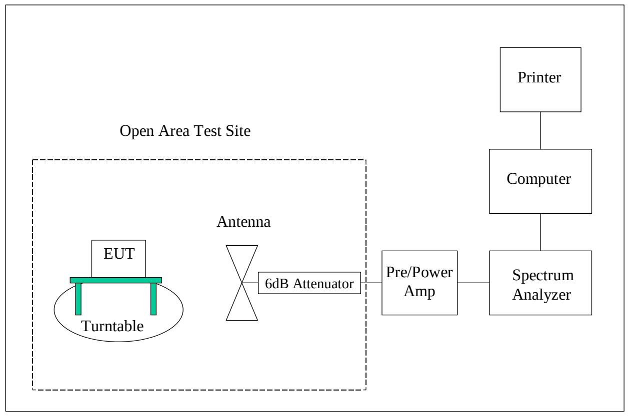
Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

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	12/07/2012	12/07/2013
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	02/06/2013	02/06/2014
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	02/06/2013	02/06/2014
Loop Antenna	EMCO	6502	9111-2675	03/04/2013	03/04/2015
Biconilog Antenna	EMCO	3142	9601-1008	10/10/2012	10/10/2014
Double Ridged Guide Antenna	EMCO	3115	9409-4355	06/06/2012	06/06/2014
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	12/21/2012	12/21/2013
2.4 GHz Filter	Microtronics	HPM50111-03	001	06/26/2012	06/26/2013

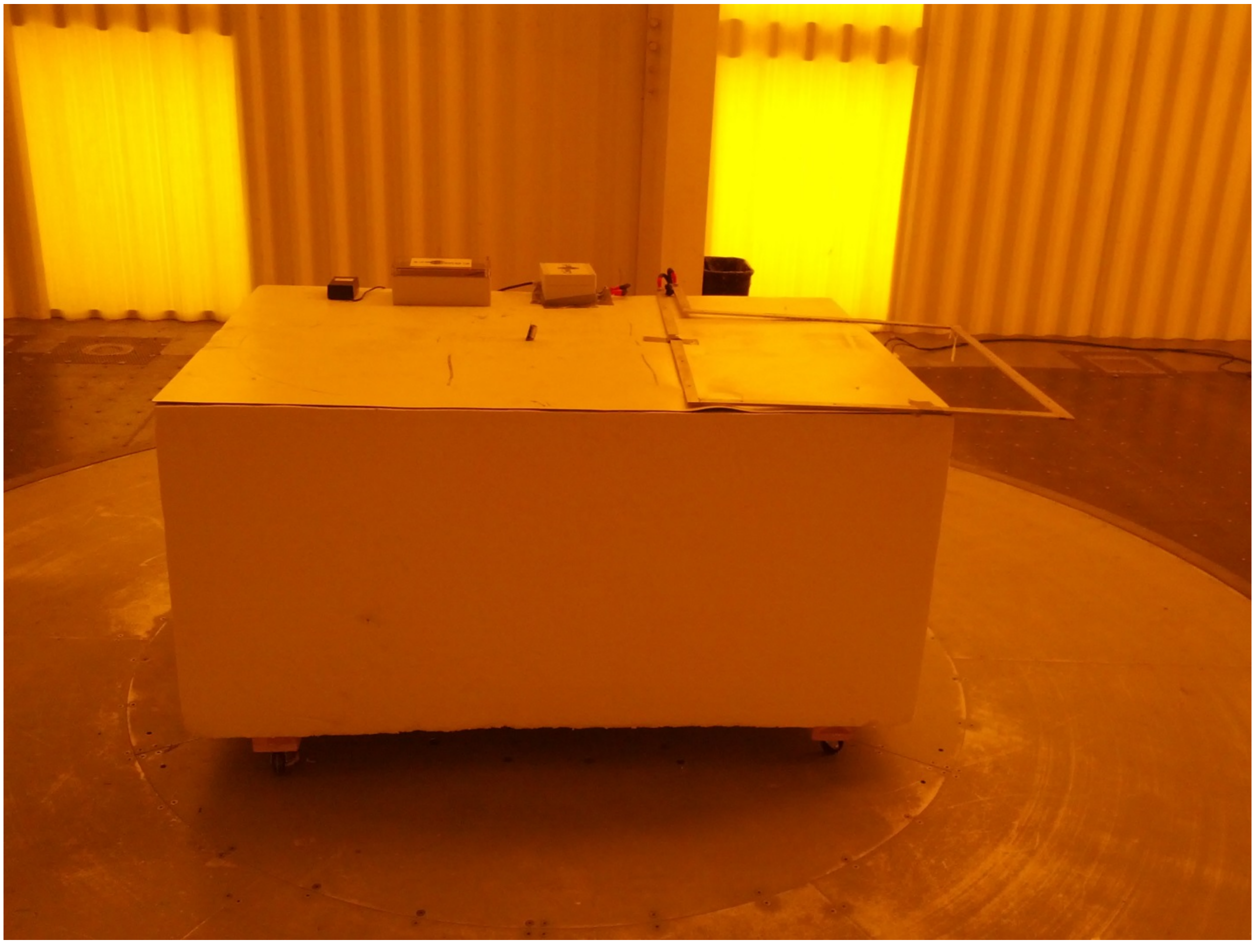
An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology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

Radiated Emissions Test Setup

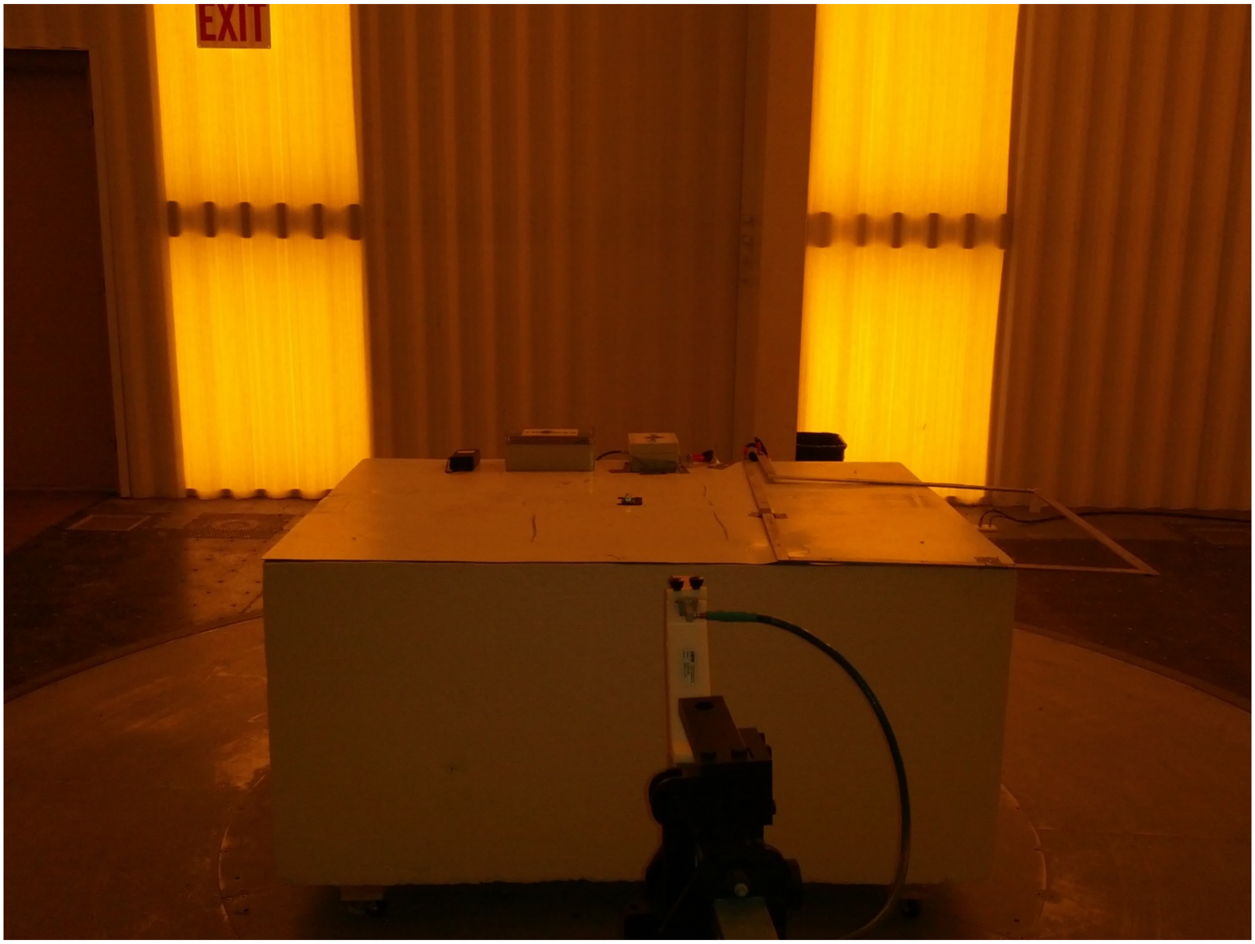


APPENDIX 2 PHOTOGRAPHS

Photograph 1 – Front View Radiated Disturbance Worst Case Configuration

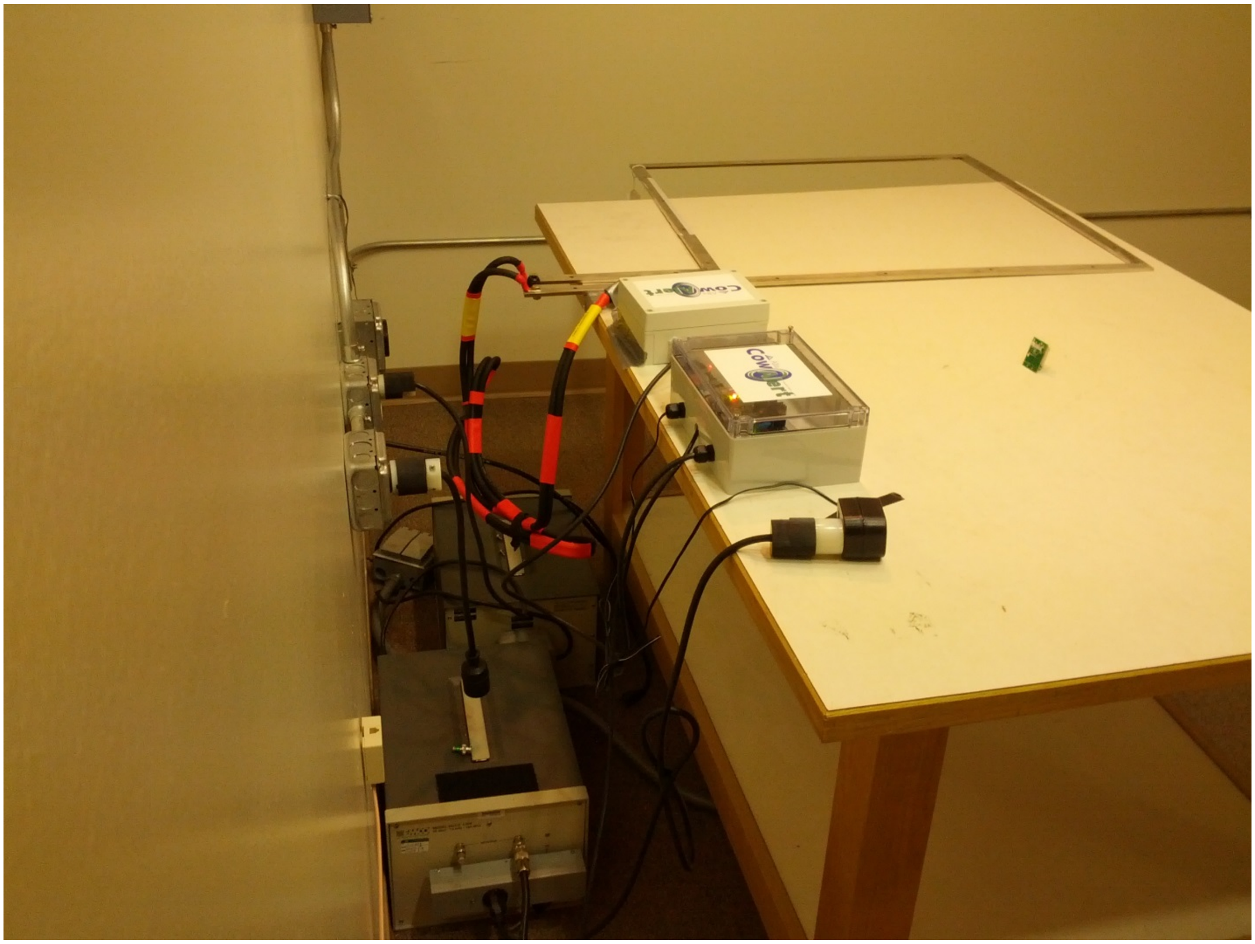


Photograph 2 – Back View Radiated Disturbance Worst Case Configuration

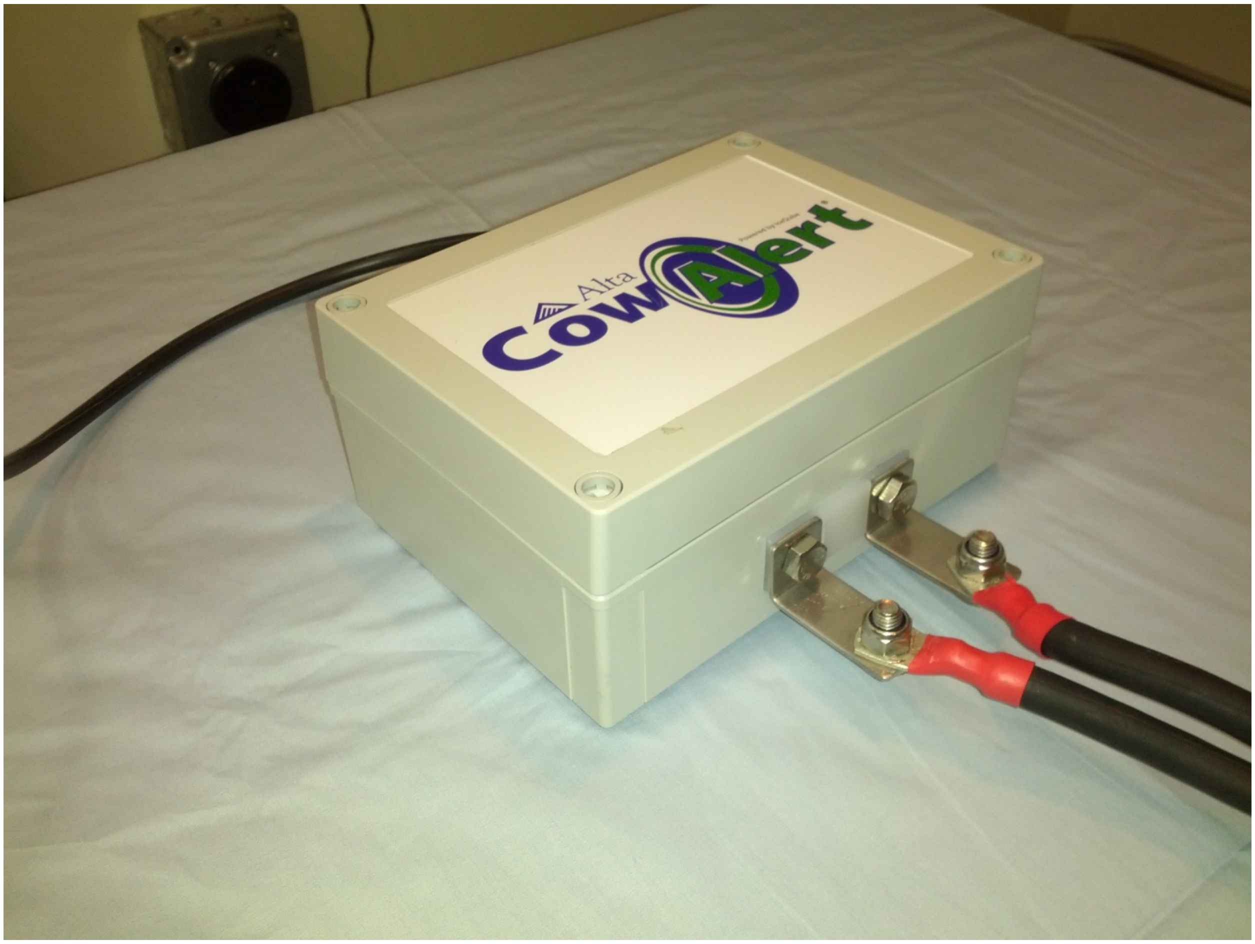


Photograph 3 – Front View Conducted Disturbance Worst Case Configuration

Photograph 4 – Back View Conducted Disturbance Worst Case Configuration

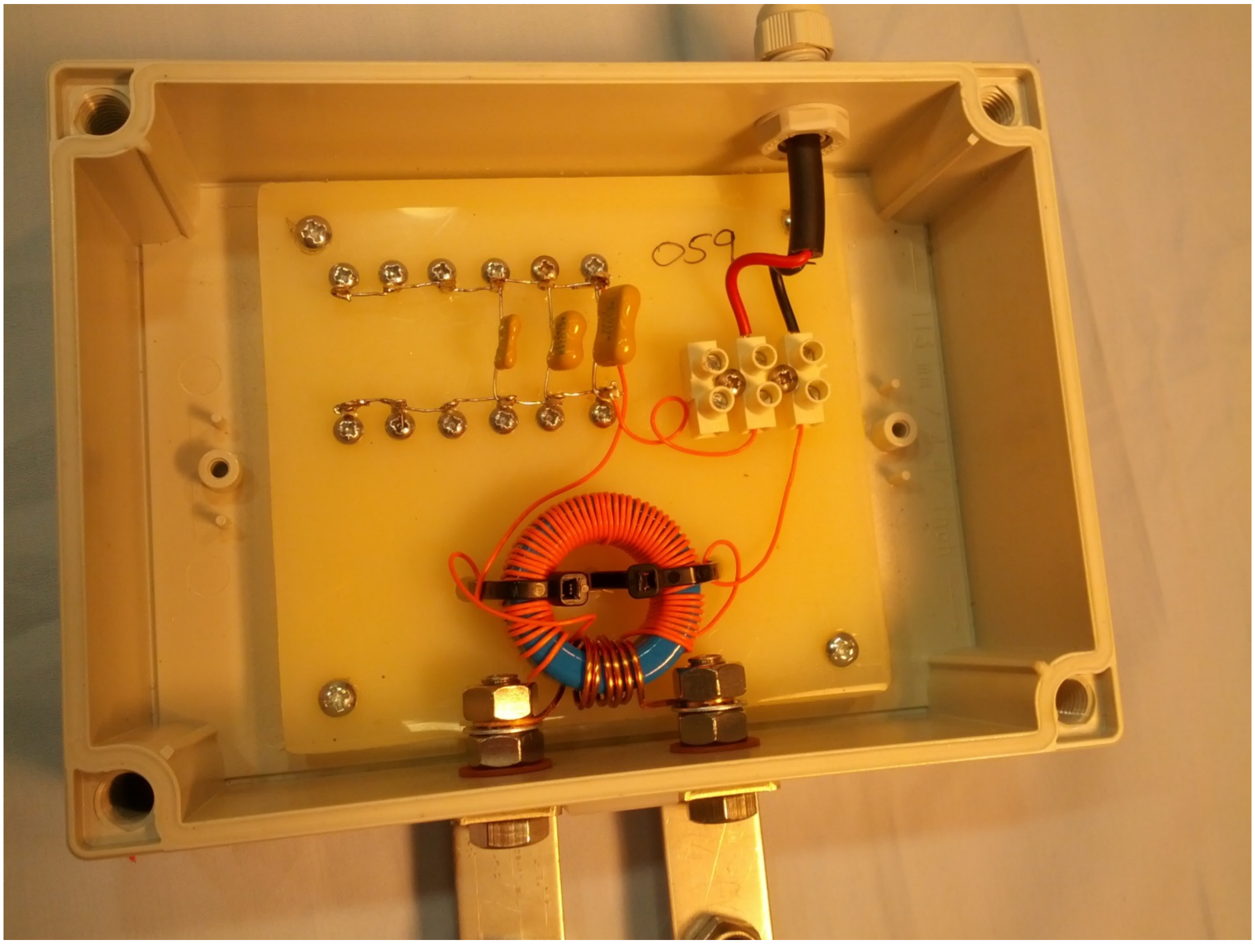


Photograph 5 – Front View of Trigger Box

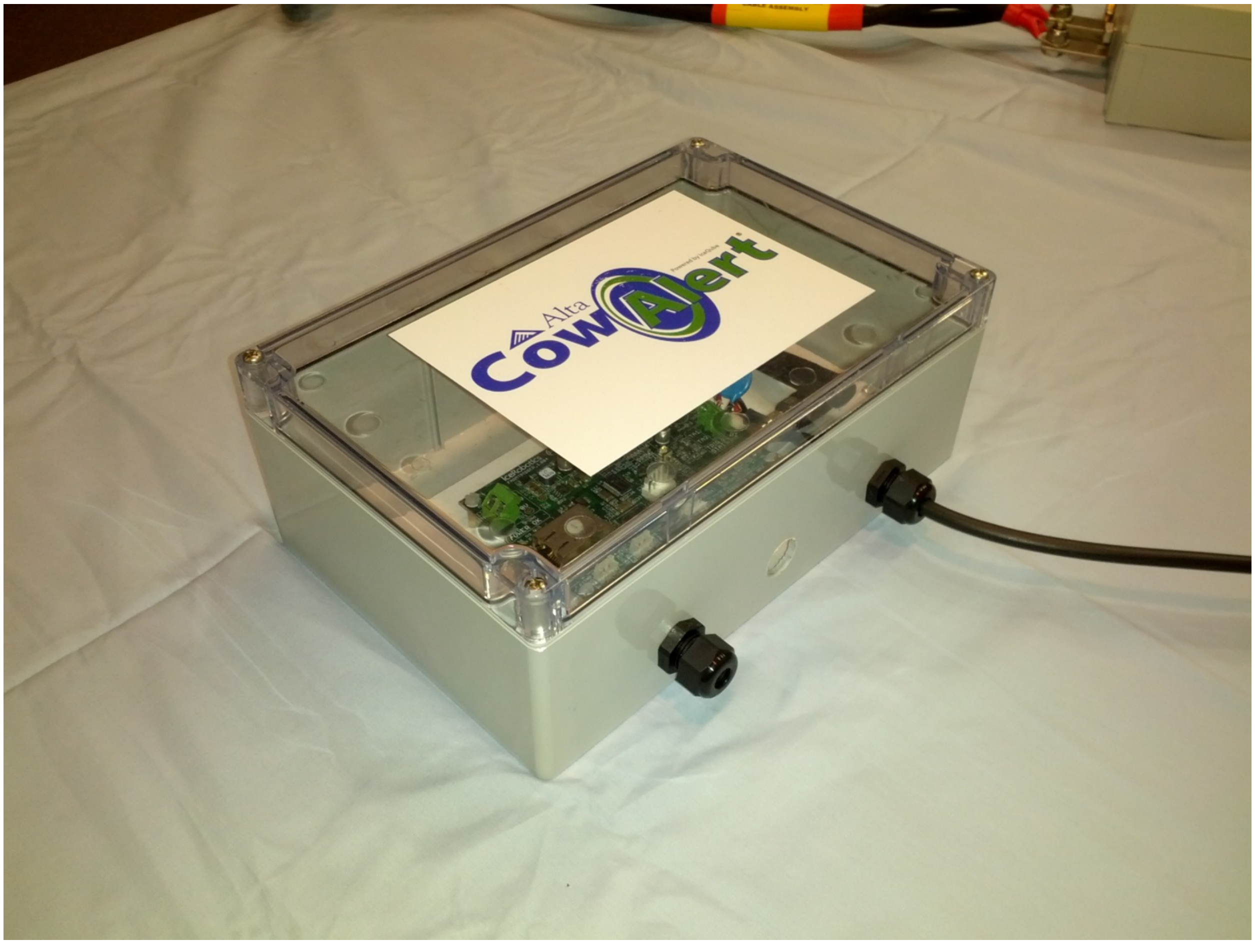


Photograph 6 – Rear View of Trigger Box

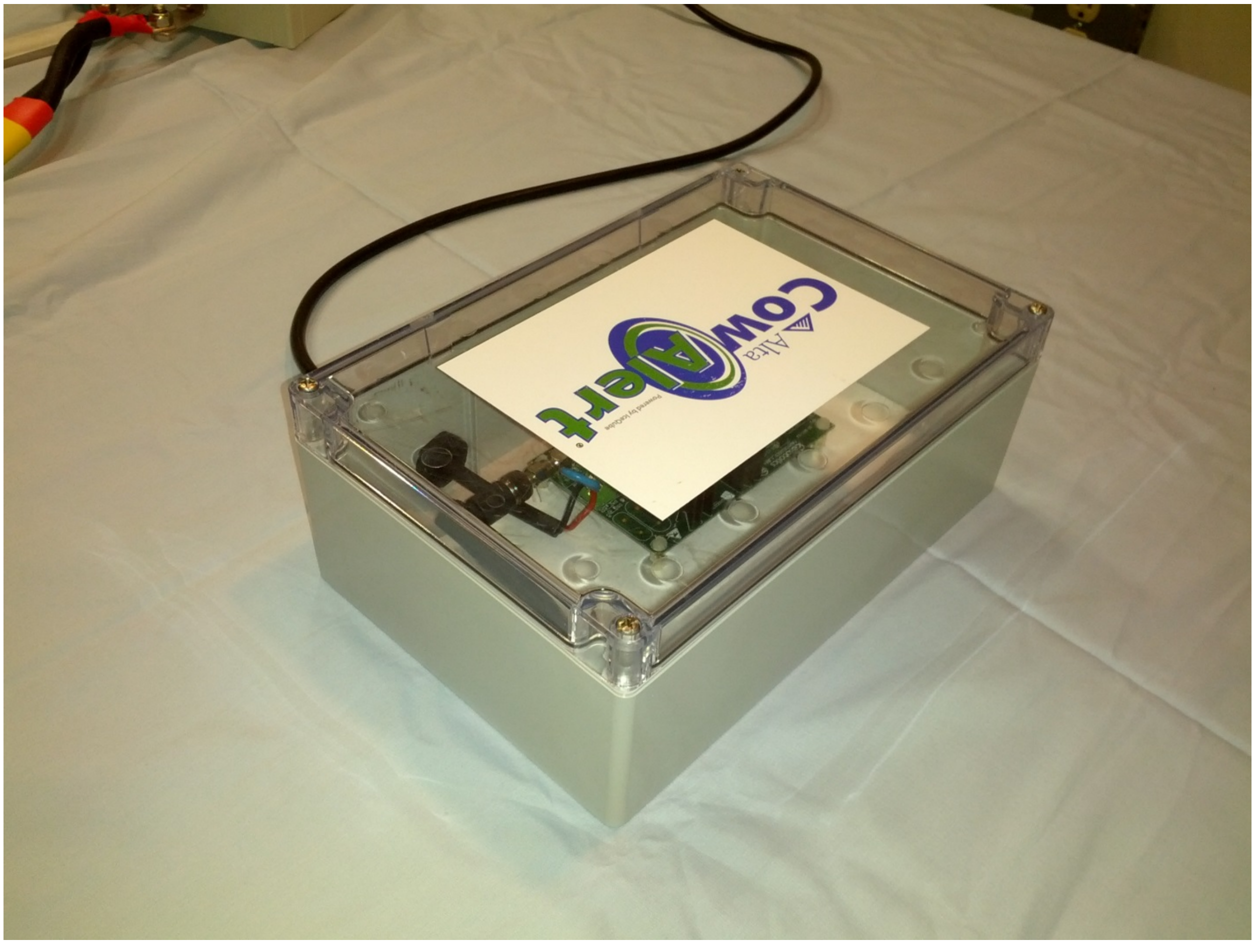
Photograph 7 – Internal View of Trigger Box (all components shown)



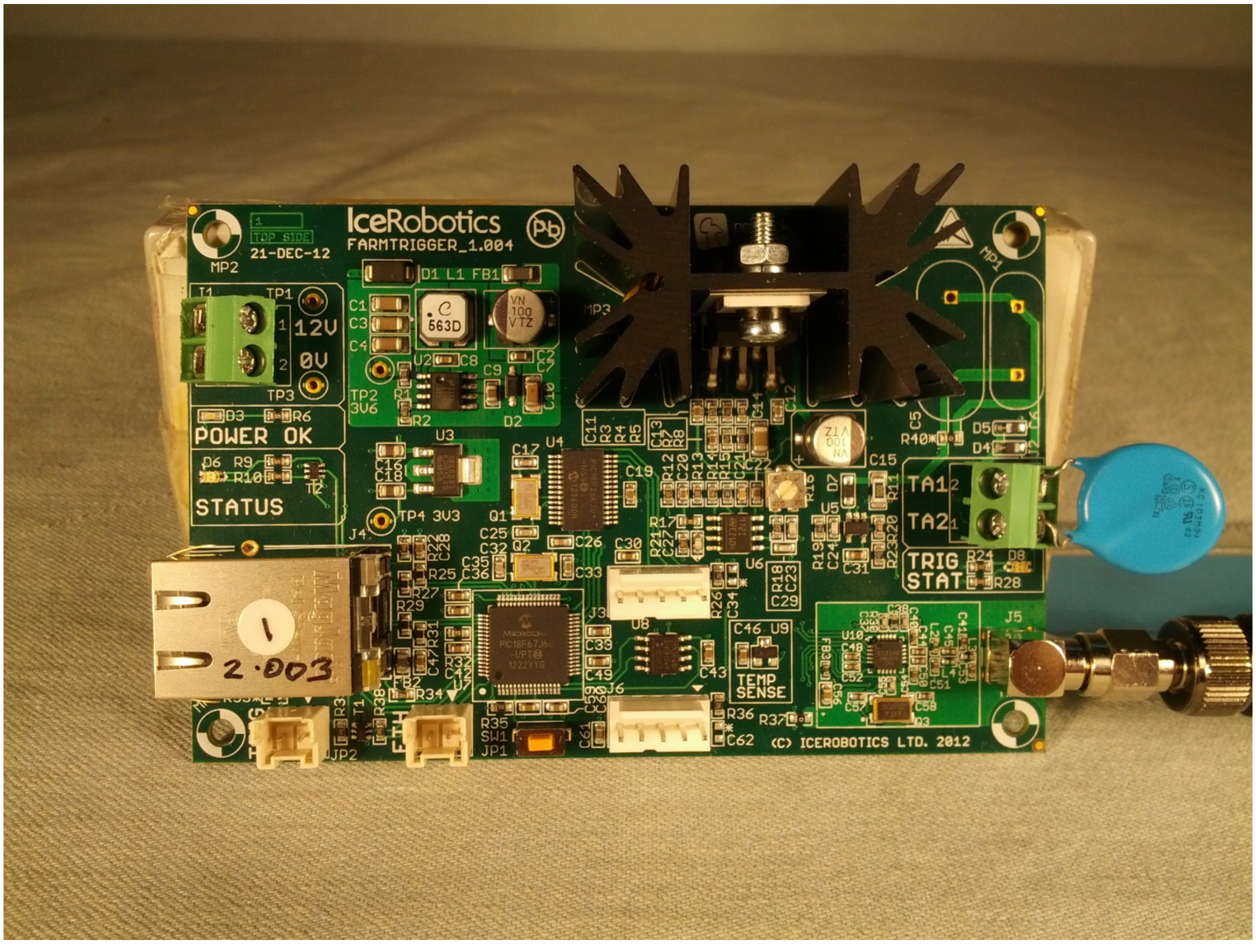
Photograph 8 – Front View of EtherReader



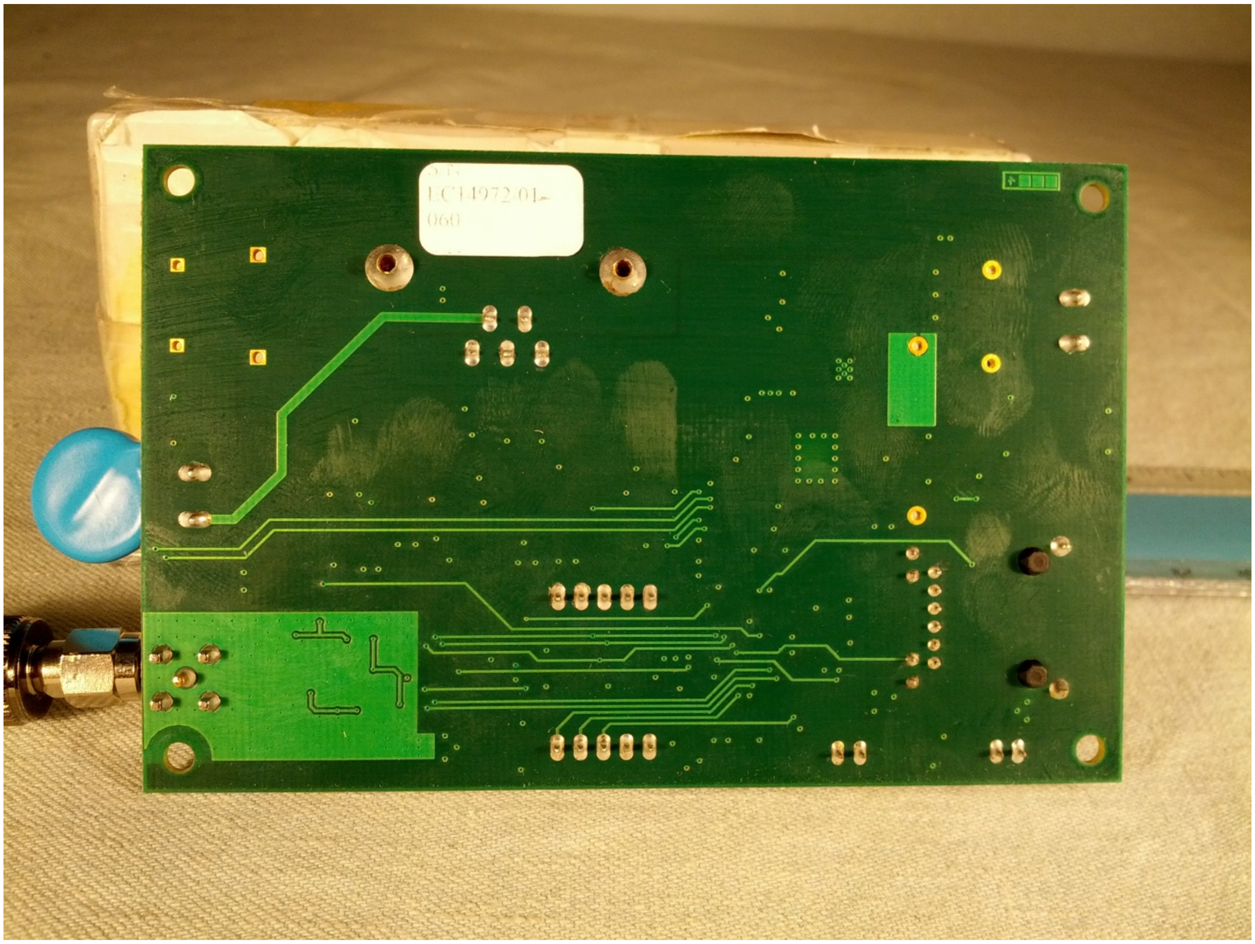
Photograph 9 – Rear View of EtherReader



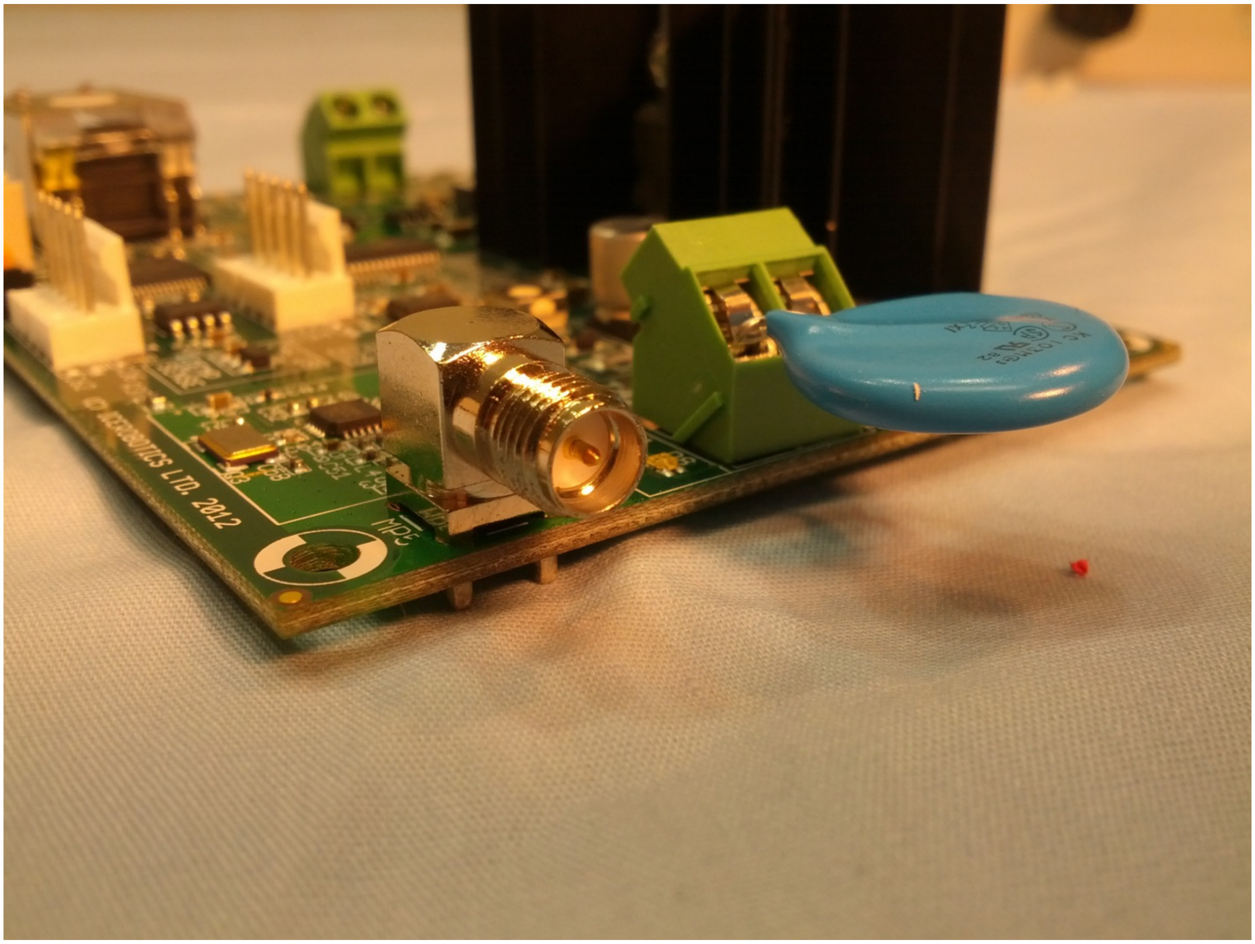
Photograph 10 – Front View of EtherReader PCB



Photograph 11 – Rear View of EtherReader PCB



Photograph 12 – View of the Antenna Connector



Photograph 13 – View of the 2.4 GHz Antenna

Photograph 14 – View of the 128 kHz Antenna

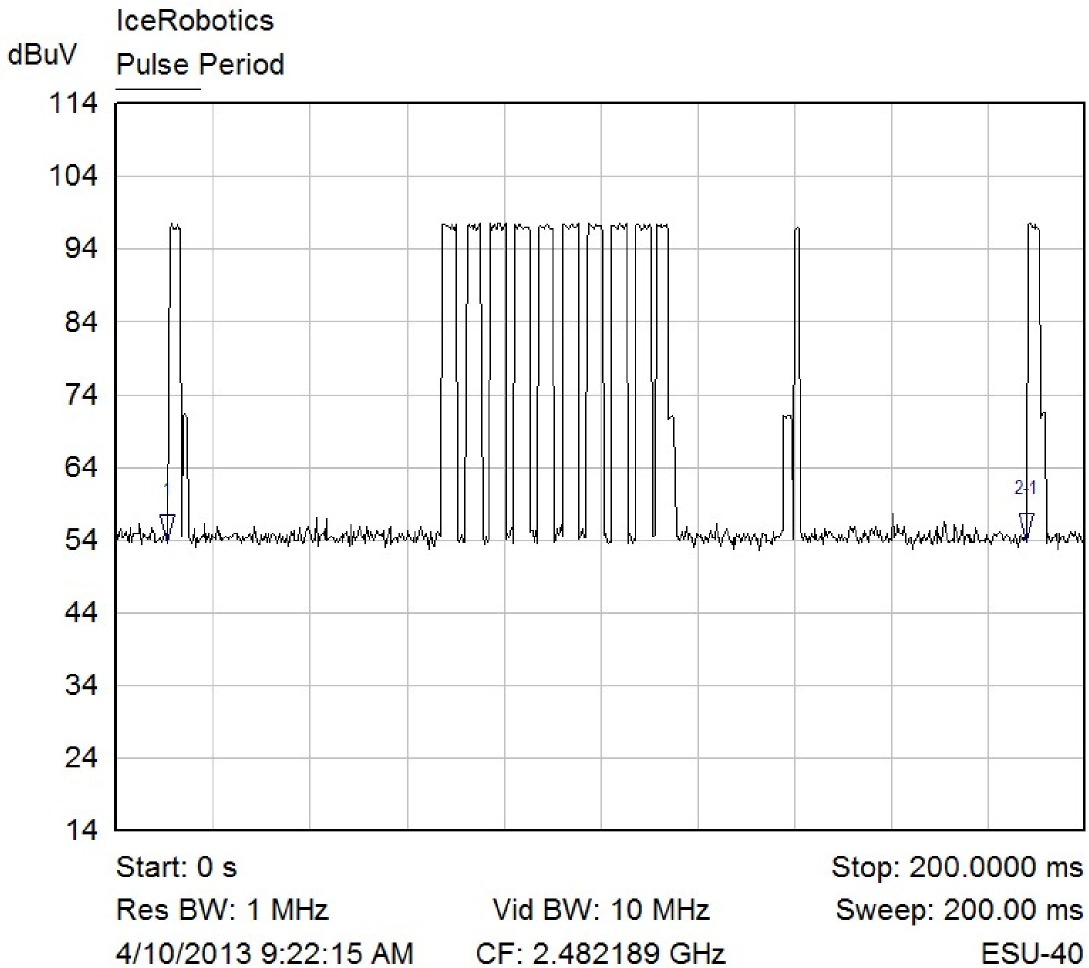
APPENDIX 3 Average Factor Calculation

The average factor is calculated by taking the average over the 100 millisecond period over which the average is greatest, as specified in §15.35(C). The pulse widths and pulse period needed to make the average factor and duty calculations are shown in the graphs below.

Pulse Period: 177.2 ms

Total On Time for Pulse Period:
9 pulses x 2.9808 ms + 2 x 2.2115 ms + 1.1218 ms = 32.37 ms

Duty Cycle (using the full pulse width shown below):
32.37 ms / 177.2 ms =18%

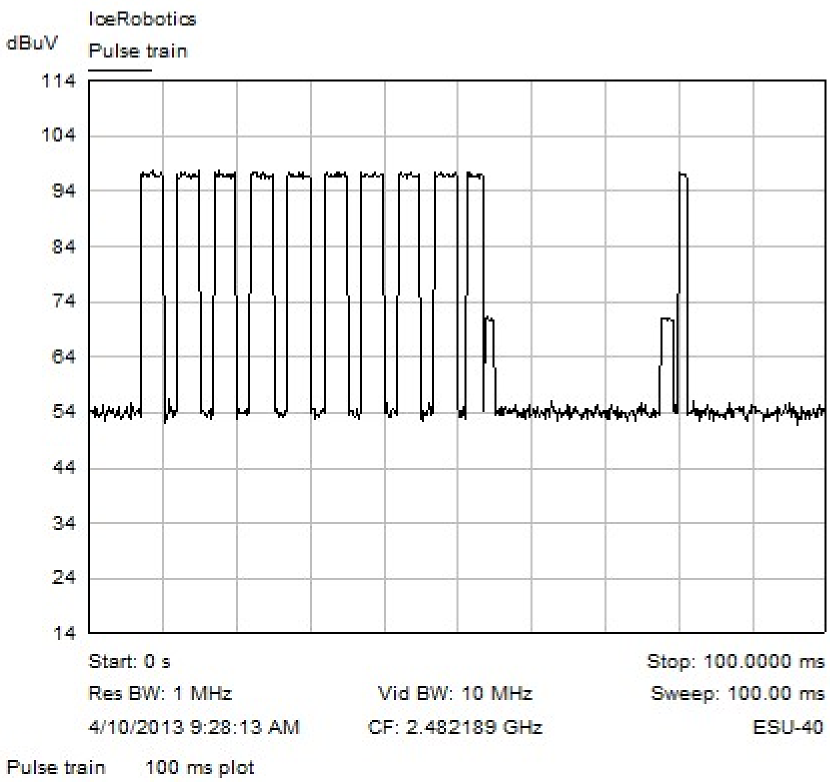


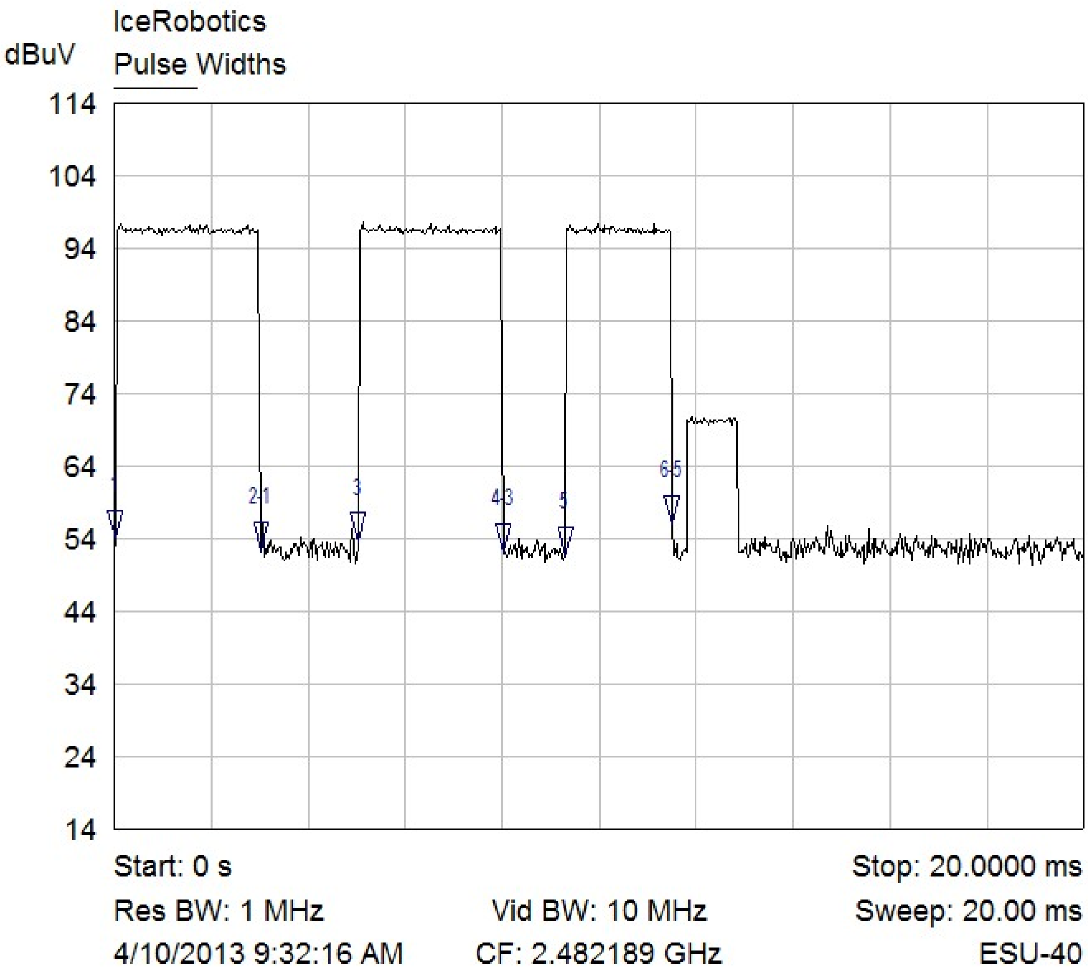
Mkr	X-Axis	Value	Notes
1 ▽	10.5769 ms	53.43 dBuV	
2-1 ▽	177.2436 ms	0.27 dB	

Pulse Period 200 ms plot

Total On Time for Worst 100 ms:
9 pulses x 2.9808 ms + 2.2115 ms + 1.1218 ms = 30.16 ms

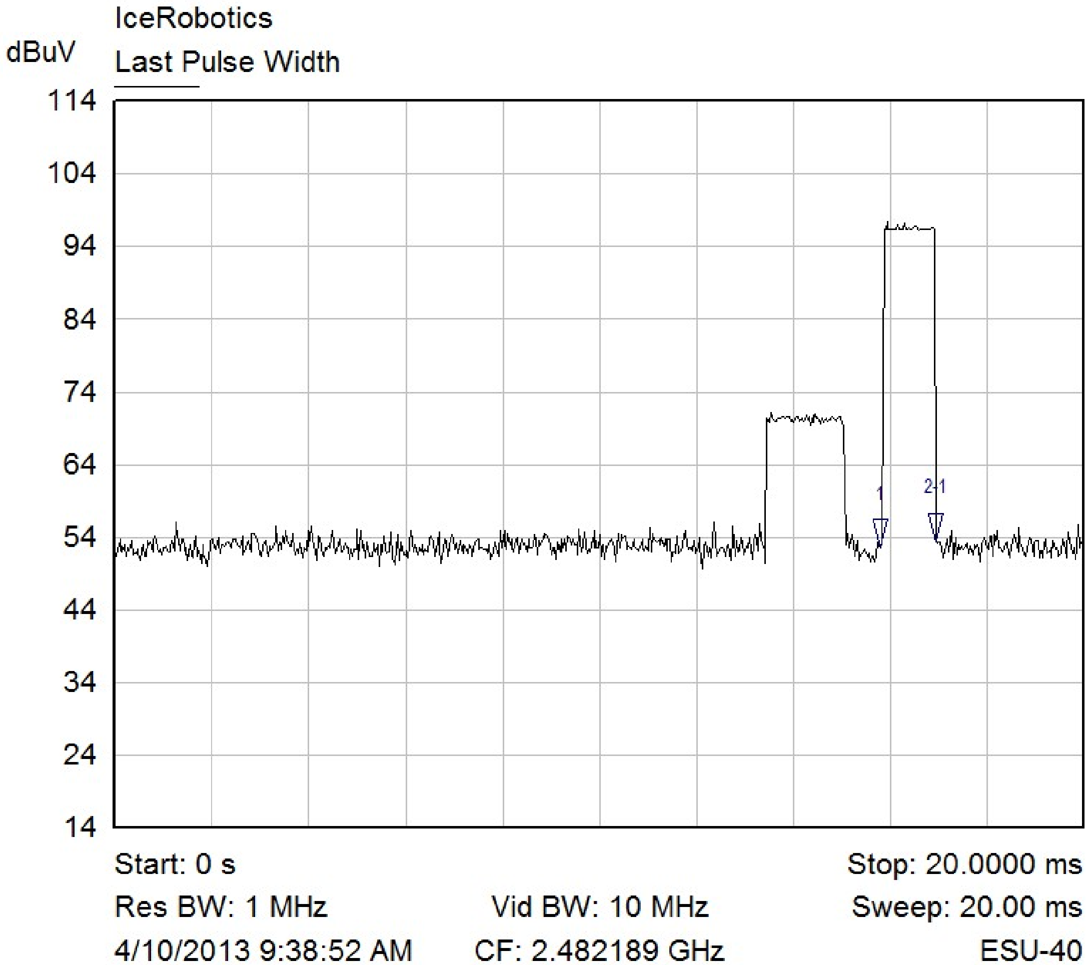
Average Factor (using the worst case 100 ms period shown below):
20 log (30.16 ms / 100 ms) = -10.41 dB





Mkr	X-Axis	Value	Notes
1 ▽	32.0513 us	53.99 dBuV	
2-1 ▽	2.9808 ms	-1.73 dB	
3 ▽	5.0321 ms	53.70 dBuV	
4-3 ▽	2.9808 ms	-1.57 dB	
5 ▽	9.2949 ms	51.73 dBuV	
6-5 ▽	2.2115 ms	4.21 dB	

Pulse Widths 20 ms End of Main



Mkr	X-Axis	Value	Notes
1 ▽	15.8013 ms	52.52 dBuV	
2-1 ▽	1.1218 ms	0.82 dB	

Last Pulse Width 20 ms Single Pulse