For The Scope of Accreditation Under Lab Code 200612-0

Excellence in Compliance Testing

# EMC Technical Report

## Prepared For: Johnson Outdoors Marine Electronics

## Model Covered: HELIX 10 SI GPS
## Model Variants: See Product Description

**In Accordance with the:**
**Electromagnetic Compatibility Directive – 2004/108/EC**

**Immunity Product Standard: EN 60945:2002**
**Emissions Product Standard(s):**
**EN 60945:2002**

**ACS Report: 15-0212.C08.1B**
**Report Revision: B**
**Report Issue Date: August 24, 2015**


**Project Manager:**

**Arthur Sumner**
**EMC Technician**
**Advanced Compliance Solutions, Inc.**

**Reviewed by:**

**Forrest Duncan**
**EMC Department Manager**
**Advanced Compliance Solutions, Inc.**


***This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.***



**This report contains 45 pages**

| REVISION HISTORY<br>Report Number: 15-0212.C08.1B<br>Manufacturer: Johnson Outdoors Marine Electronics<br>Model: HELIX 10 SI GPS | | | | | |
|---|---|---|---|---|---|
| DATE | OLD REVISION | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY |
| August 20, 2015 | --- | A | Initial Release | All | Forrest Duncan |
| August 24, 2015 | A | B | Revised Cables D and E descriptions; Corrected RFI and CI modulation | 10, 32, 40 | Forrest Duncan |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# Project Information Sheet

**ACS Project: 15-0212.C08.1B**

## Applicant Details

**Manufacturer:** Johnson Outdoors Marine Electronics
**Street Address:** 678 Humminbird Lane
**City, State/Province and Postal Code:** Eufaula, AL 36027
**Country:** USA
**Contact:** David Vernon

**Phone:** 334-687-6612
**Fax:**
**Email:** dvernon@johnsonoutdoors.com

## Sample Information

**Model:** HELIX 10 SI GPS
**Model Variant(s):** See Product Description
**Environment of Use:** Commercial
**Sample Receive Date:** June 29, 2015
**Sample Receive Condition:** Good
**Test Mode Description:** Normal operation; monitoring depth, speed, and GPS
**Failure Mode (Provided by Mfg.):** Depth reading should be within +/- 1ft of reading from depth simulator - EXCEPT in exclusion band of 190kHz to 210kHz. Sonar is designed to operate at 200kHz so loss of depth in this range is acceptable. LossExclusion band around the GPS frequency during RFI testing
**Highest Data Rate:** 800MHz
**Source:** Microcontroller

## Product Description

The Humminbird HELIX 10 SI GPS unit is a fishfinder/GPS product with Side Imaging sonar capability that uses a 10" Color Display along with sonar/GPS. It is used in the marine environment and is shipped with a transducer and power cable (6'). For purposes of testing the following accessories are added: Speed/Temp, External GPS, and Ethernet connector to ancillary display unit. The model variants are declared as follows:

HELIX 10 DI GPS and HELIX 10 SONAR GPS: These use same hardware with changes to sonar circuitry to allow different sonar frequencies to be used
HELIX 9 SI GPS, HELIX 9 DI GPS, and HELIX 9 SONAR GPS: These use the same main board as the HELIX10 units but a smaller 9" Display.

## Test Information

**Test Start Date:** June 30, 2015
**Test End Date:** July 6, 2015
**Emissions Pre-scan Site:** SAC
**Final Emissions Site:** SAC
**EMI Freq. Band:** 10kHz to 2GHz
**RFI Site:** FAC
**Radiated Emissions Equipment Class:** Class B
**Harmonic Current EMI Class:** N/A

## Test Methods Applied

(Check all that apply)

- ☒ CISPR 16-2-1 Ed. 1.1 2005
- ☒ CISPR 16-2-3 1st Ed. 2003
- ☒ IEC 61000-4-2 Ed. 2.0
- ☒ IEC 61000-4-3 Ed. 3.2
- ☒ IEC 61000-4-4 Ed. 3.0
- ☐ IEC 61000-4-5 2nd Ed.
- ☒ IEC 61000-4-6 3rd Ed.
- ☐ IEC 61000-4-8 2nd Ed.
- ☐ IEC 61000-4-11 2nd Ed.

# Table of Contents

# SECTION A: GENERAL INFORMATION

## 1.0 Introduction

### 1.1 Scope

This report documents conformance with the requirements set forth in EN 60945:2002 and details the results of testing performed on June 30, 2015 through July 6, 2015 on the model HELIX 10 SI GPS manufactured by Johnson Outdoors Marine Electronics.

### 1.2 Purpose

Testing was performed to evaluate the EUT with regard to EMC regulatory requirements in accordance with the European Unions CE Marking arrangements.

### 1.3 Results Summary

| Product Standard or Test Method Applied | Description | Result |
|---|---|---|
| **Product Standards** | | |
| EN 60945:2002 | Maritime navigation and radio communication equipment and systems General Requirements Methods of testing and required test results | Pass |
| EN 61000-3-2:2006 w/A1:2009 and A2:2009 | Electromagnetic compatibility (EMC) -- Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase) | N/A |
| EN 61000-3-3:2008 | Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current <= 16 A per phase and not subject to conditional connection | N/A |
| **Basic Immunity Standards per EN 60945:2002** | | |
| IEC 61000-4-2 Ed. 2.0 | Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test | Pass |
| IEC 61000-4-3 Ed. 3.2 | Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test | Pass |
| IEC 61000-4-4 Ed. 3.0 | Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test | Pass |
| IEC 61000-4-5 2nd Ed. | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test | N/A |
| IEC 61000-4-6 3rd Ed. | Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields | Pass |
| IEC 61000-4-8 2nd Ed. | Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test | N/A |
| IEC 61000-4-11 2nd Ed. | Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests | N/A |

N/A = Not Applicable

## 1.4 Performance Criteria

### 1.4.1 Emissions Performance Criteria

For model HELIX 10 SI GPS the limits which apply are EN 60945:2002 Class B. These limits are found in Table 1.4.1-1 below:

**Table 1.4.1-1 Emissions Limits EN 60945:2002 Class B**

| | Portable | Protected | Exposed | Submerged |
|---|---|---|---|---|
| Conducted emissions (9.2) | | 10 kHz – 150 kHz<br>150 kHz – 350 kHz<br>350 kHz – 30 MHz | 63 mV – 0,3 mV (96 dBµV – 50 dBµV)<br>1 mV – 0,3 mV (60 dBµV – 50 dBµV)<br>0,3 mV (50 dBµV) | |
| Radiated emissions (9.3) | 150 kHz – 300 kHz<br>300 kHz – 30 MHz<br>30 MHz – 2 GHz<br>156 MHz – 165 MHz | 10 mV/m – 316 µV/m (80 dBµV/m – 52 dBµV/m)<br>316 µV/m – 50µV/m (52 dBµV/m – 34 dBµV/m)<br>500 µV/m (54 dBµV/m) except for<br>16 µV/m (24 dBµV/m) quasi-peak<br>or 32 µV/m (30 dBµV/m) peak | | |

### 1.4.2 Immunity Performance Criteria

Each immunity test requires 1 of 3 performance criteria to be met. Below are descriptions of each.

***Performance Criterion A:*** The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

***Performance Criterion B:*** The EUT shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self-recoverable is however, allowed, but no change of actual operating state or stored data is allowed.

***Performance Criterion C:*** Temporary degradation or loss of function or performance is allowed during the test, provided the function is self-recoverable, or can be restored at the end of the test by the operation of the controls, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

# 2.0 Test Facilities & Environment

### 2.1 Test Facilities
All testing was performed at the following address:

Advanced Compliance Solutions, Inc.
5015 B.U. Bowman Drive
Buford GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598
www.acstestlab.com

The laboratory is fully equipped to carry out the tests outlined in section 1.0

### 2.2 Laboratory Accreditations/Recognitions/Certifications
ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP). Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

### 2.3 Test Environment
Unless otherwise specified by the generic or product standard, the EUT was evaluated within the climate conditions of the EUT as specified by the manufacturer.

Where the manufacturer does not specify climate parameters for the EUT, all test are performed within the climate parameters given below:

- Ambient temperature 15° to 35° C
- Relative Humidity 30% to 60%
- Atmospheric Pressure 860mbar to 1060mbar

### 2.4 Test Equipment Calibration Statement
Test equipment used for each test is specified in the relevant sections of this test report. Unless expressly given, all test equipment is calibrated on an annual basis, where applicable. All test equipment is operated within the climate specifications as defined by the manufacturer.

# 3.0 Equipment Under Test (EUT)

### 3.1 Manufacturer
Johnson Outdoors Marine Electronics
678 Humminbird Lane
Eufaula, AL 36027
David Vernon
dvernon@johnsonoutdoors.com

### 3.2 Modifications

Table 3.2-1 below describes any modification required to bring the EUT into compliance with the test standard. Photographs of the modifications, if any, are contained in appendix a.

**Table 3.2-1: EUT Modifications**

| |
|---|
| ☒ **Modifications were not required to bring the EUT into compliance with the requirements.**<br>☐ **Modifications were required to bring the EUT into compliance with the requirements.** |

### 3.3 System Block Diagram and Support Equipment

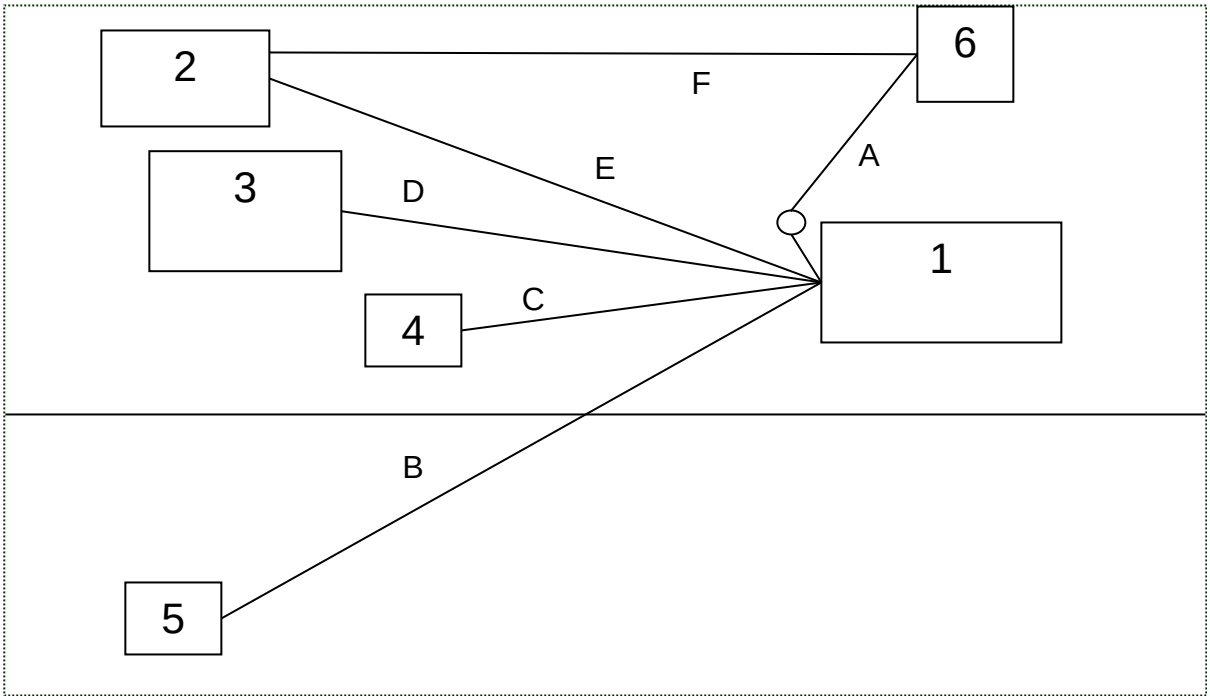



Figure 3.3-1: System Block Diagram

**Table 3.3-1: EUT and Support Equipment Description**

| Item # | Type Device | Manufacturer | Model/Part # | Serial # |
|---|---|---|---|---|
| 1 | EUT | Johnson Outdoors | HELIX 10 SI GPS | ES#1 |
| 2 | Aux Display | Johnson Outdoors | Matrix 899 | 13111503-0341 |
| 3 | Depth Guage | N/A | N/A | N/A |
| 4 | Speedometer blade spinner | N/A | N/A | N/A |
| 5 | GPS Puck-style antenna | N/A | N/A | 13091842-0045 |
| 6 | 12V Marine battery | Autocraft | 24DC-1 | 6216457823 |

**Table 3.3-2: Cable Description**

| Cable # | Cable Type | Length | Shield | Termination |
|---|---|---|---|---|
| A | DC leads | 10’ | No | 1 – 6 |
| B | GPS cable | 20’ | No | 1 – 5 |
| C | Speedometer cable | 20’ | No | 1 – 4 |
| D | I/O Cable | 16’ | Yes | 1 – 3 |
| E | Ethernet cable | 500cm | Yes | 1 - 2 |
| F | DC leads | 185cm | No | 2 - 6 |

### 3.4 Observations

Any general observations regarding any part of the evaluation are given in table 3.4-1.

**Table 3.4-1: Observations**

| Observation No. | Description |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

# SECTION B: EMISSIONS – TEST INFORMATION AND RESULTS

## 4.0 Radiated and Conducted Emissions

## 4.1 Radiated Emissions

### 4.1.1 Test Site Description

#### 4.1.1.1 Open Area Test Site

The open area test site consists of a 40’ x 66’ concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8” holes that are staggered every 3/16”. The individual sheets are placed to overlap each other by 1/4” and are riveted together to provide a continuous seam. Rivets are spaced every 3” in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12’ beyond the turntable edge and 16’ beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8’ copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10’ flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40’ from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7’ x 7’ square and 4’ deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4” PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 4.1.1.1-1 below:

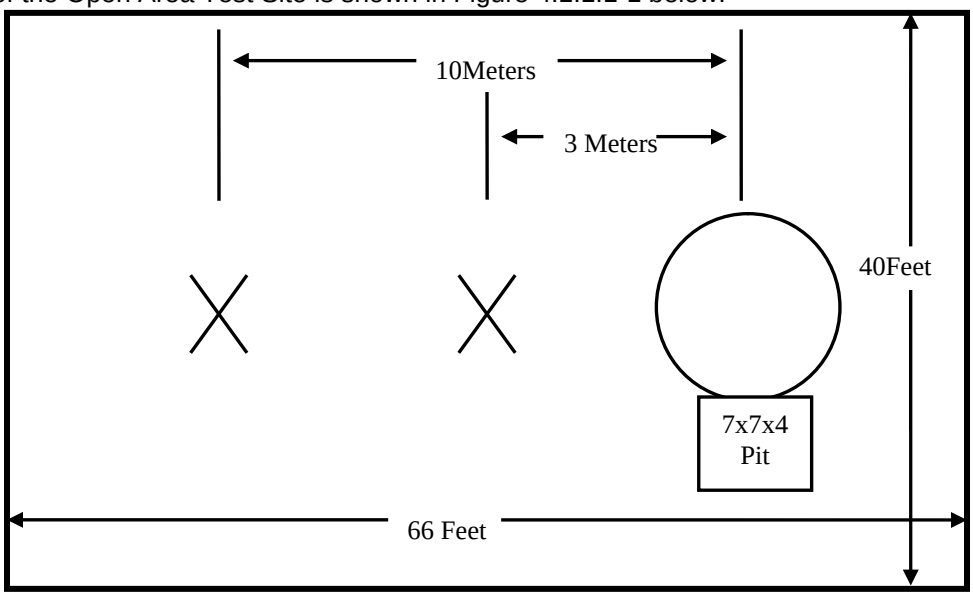



**Figure 4.1.1.1-1: Open Area Test Site**

#### 4.1.1.2 Semi-Anechoic Chamber

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 4" x 4" x ¾" thick and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable. The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the turntable. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chase from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

To comply with the requirements of the test methods given on page 3, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, an 8 ft. patch of 12" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009. Next, three vertical structures (Fences) were created and covered with 8" pyramidal RF absorbing foam, two 4 ft. x 4 ft. and one 6 ft. x 4 ft. These fences were placed at locations to prevent high energy signals from reaching the back chamber wall and reflecting back to the receive antenna.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 4.1.1.2-1 below:

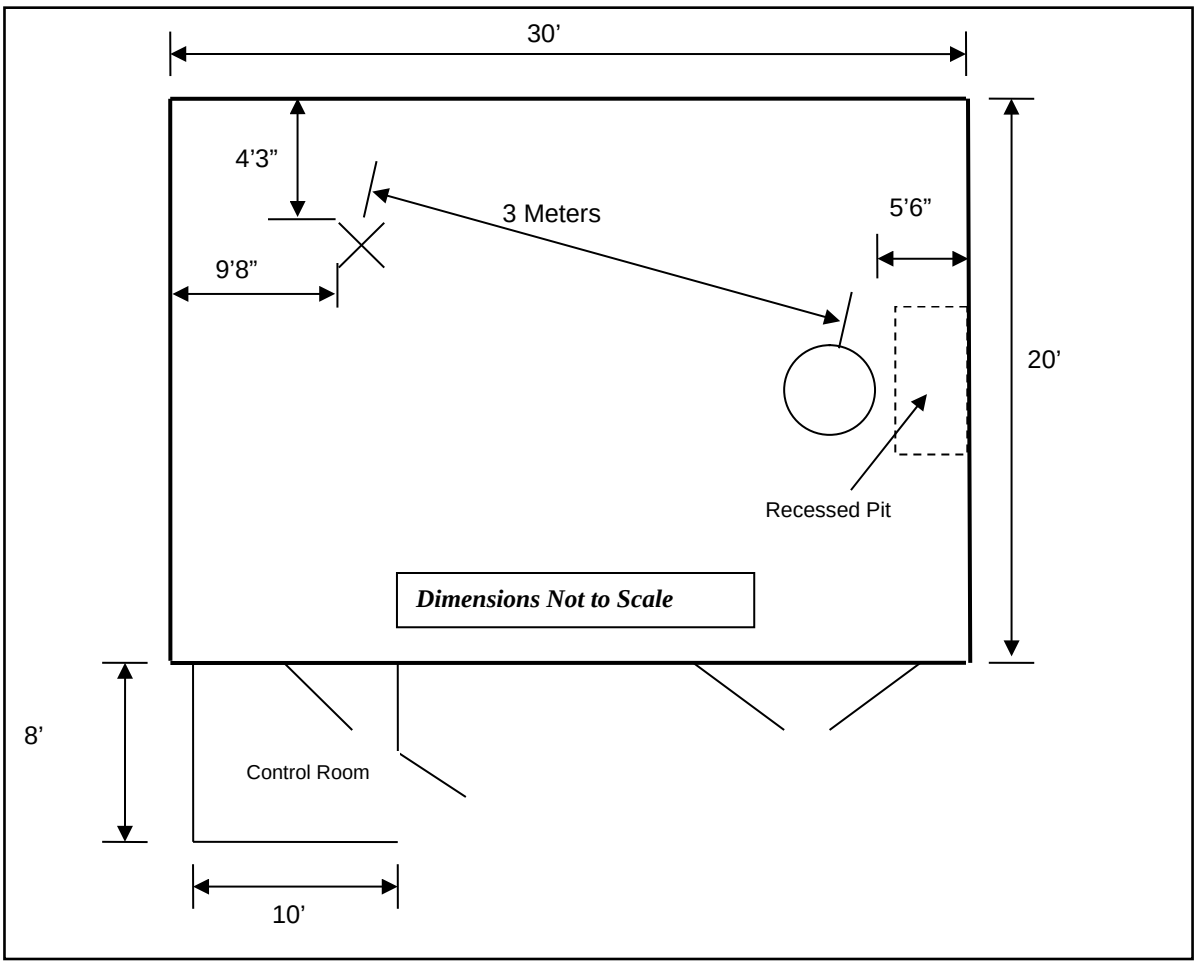



**Figure 4.1.1.2-1: Semi-Anechoic Chamber Test Site**

### 4.1.1.3 Fully Anechoic Chamber

The 3m fully anechoic chamber is used for pre-screening the EUT for emissions only. Final screening is performed on the OATS or in case of Class B EUT's, in the 3m semi-anechoic chamber. The Fully Anechoic Chamber has been characterized for field uniformity in accordance with IEC 61000-4-3 and can be used for final radiated fields immunity testing.

The Fully-Anechoic Chamber Test Site consists of a 24'L x 16'W x 12'H shielded enclosure. The chamber is fully lined with RF absorbing foam. The foam ranges in type from 8-24" conventional pyramidal cones, 8-12" conventional wedges and 6" and 16" Hybrid Foam over ferrite tile. The Hybrid material is placed in the 6 specular regions of the chamber for better low-frequency performance. The specular regions are 1) directly behind the receiving antenna, 2) on the floor between the receiving antenna and the EUT table, 3) the wall directly behind the EUT, 4&5) the side walls between the receiving antenna and the EUT table and 6) the ceiling between the receiving antenna and the EUT. The specular regions are 6' x 4' in size.

The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using 3/4" stainless steel braided cable.

The turntable is a remotely controlled EMCO Model 1060 and is 150cm in diameter and is located 1m from the absorber on the back wall of the chamber.

A diagram of the Fully Anechoic Chamber Test Site is shown in Figure 4.1.1.3-1 below:

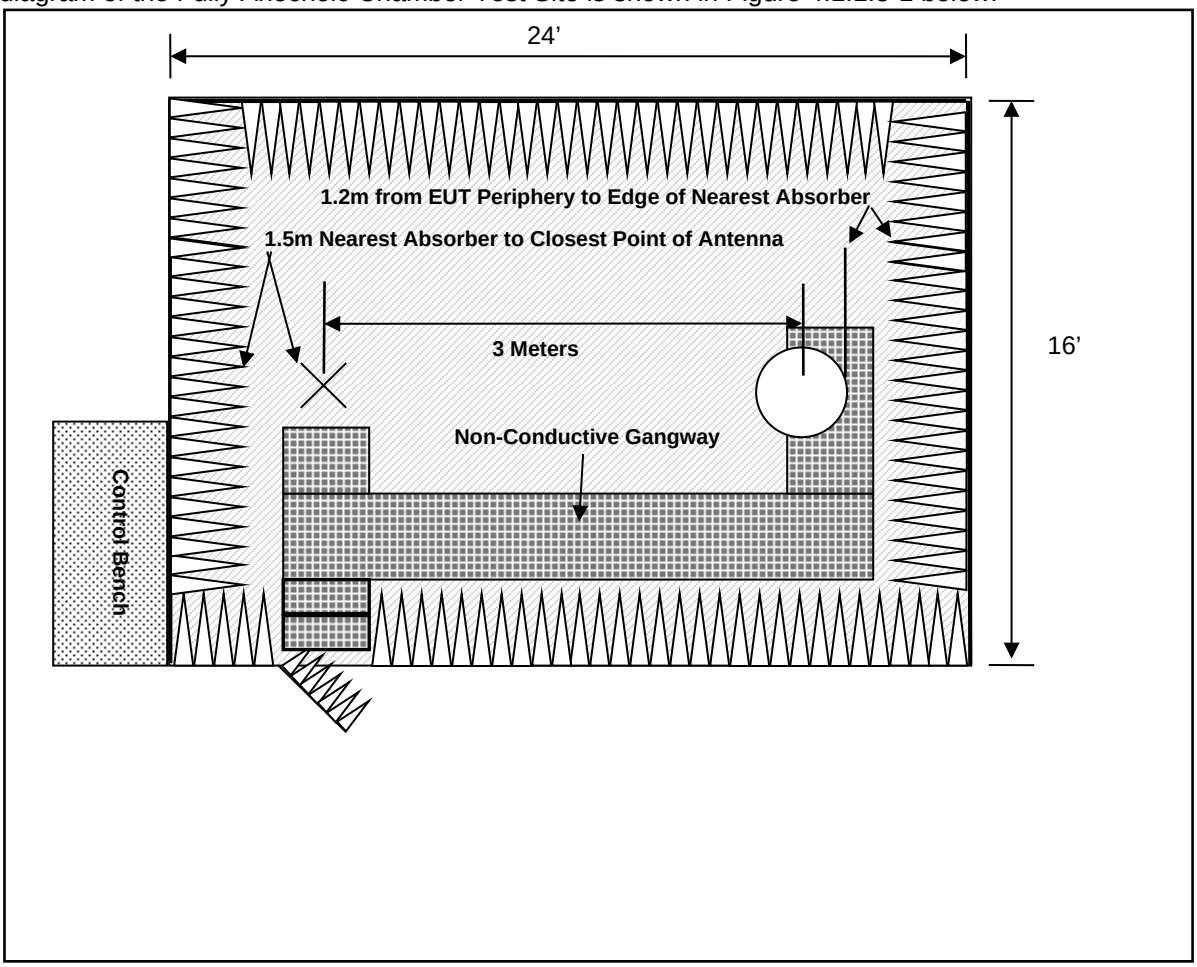



**Figure 4.1.1.3-1: Fully Anechoic Chamber Test Site**

### 4.1.2 Test Equipment

Table 4.1.2-1 identifies all equipment used for radiated emissions respectively.

**Table 4.1.2-1 Test Equipment – Radiated Emissions**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 1 | Rohde & Schwarz | ESMI - Display | Spectrum Analyzers | 833771/007 | 7/11/2014 | 7/11/2015 |
| 2 | Rohde & Schwarz | ESMI-Receiver | Spectrum Analyzers | 839587/003 | 7/11/2014 | 7/11/2015 |
| 73 | Agilent | 8447D | Amplifiers | 2727A05624 | 7/15/2014 | 7/15/2015 |
| 338 | Hewlett Packard | 8449B | Amplifiers | 3008A01111 | 7/30/2013 | 7/30/2015 |
| 167 | ACS | Chamber EMI Cable Set | Cable Set | 167 | 10/28/2014 | 10/28/2015 |
| 422 | Florida RF | SMS-200AW-72.0-SMR | Cables | 805 | 11/5/2014 | 11/5/2015 |
| 628 | EMCO | 6502 | Antennas | 9407-2877 | 2/7/2014 | 2/7/2016 |
| 30 | Spectrum Technologies | DRH-0118 | Antennas | 970102 | 4/30/2015 | 4/30/2017 |
| 40 | EMCO | 3104 | Antennas | 3211 | 2/10/2015 | 2/10/2017 |
| 412 | Electro Metrics | LPA-25 | Antennas | 1241 | 7/24/2014 | 7/24/2016 |

**NCR = No Calibration Required**

### 4.1.3 Test Methodology

#### 4.1.3.1 Pre-Scans

Radiated pre-scans are performed on all EUT's in either the 3m Semi-Anechoic or the 3m Fully-Anechoic Chamber. Final emission testing for Class A equipment is performed on the 3/10m Open Area Test Site (OATS) as described in section 4.1.1.1. Final emission testing on Class B equipment can be performed either in the 3m Semi-Anechoic chamber described in section 4.1.1.2 or on the OATS.

Pre-scans are a method by which the 10 highest emissions can be identified for final evaluation. This is achieved by taking automated emission snapshots of the EUT at various azimuths and antenna heights. The software is programmed to perform a peak sweep of the band using the maxhold function. This sweep is performed every 90º in both horizontal and vertical polarities and at antenna heights of 100cm and 300cm. Although not a fully maximized scan, the pre-scan gives a good indication of pass or fail.

#### 4.1.3.2 Final Scans

Radiated emissions measurements were made over the frequency range of 150kHz to 2GHz. Quasi-Peak measurements are taken with the Spectrum Analyzer's resolution bandwidth was set to 120KHz and video bandwidth set to 300 kHz for measurements below 1000MHz. Average measurements above 1000MHz are taken using measurement instruments average detector. The calculation for the radiated emissions field strength is as follows:

**Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor**
**Margin(dB) = Applicable Limit - Corrected Reading**

#### 4.1.3.3 Test Criteria

The EUT must meet the Class B Limits as given in section 1.4.1.

#### 4.1.3.4 Test Justification

☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

### 4.1.4 Test Setup Photographs

**Figure 4.1.4-1: Radiated Emissions - Front View**

**Figure 4.1.4-2: Radiated Emissions - Rear View**

### 4.1.5 Test Data

Final tabulated radiated emissions data are reported in the Test Data Table below:

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **June 30, 2015** | **Temperature (ºC)** | **23** |
| **Technician:** | **Ryan McGann** | **Humidity (%)** | **39** |
| **Equipment Class:** | **Class B** | **Barometric Pressure (mBar)** | **1016** |
| **Tested Modes:** | **EUT & Transducer on table - Ancillary unit & Speed Temp Sensor under floor - GPS Antenna outside chamber with fix** | | |
| **AC Input Power:** | **N/A** | | |
| **DC Input Power:** | **12Vdc** | | |

**Test Data Table:**

**Measurement Distance:**

☐ 1 Meter ☒ 3 Meter ☐ 10 Meter

| Frequency (MHz) | Measured Level (dBuV) | | Antenna Polarity (H/V) | Antenna Height (cm) | Turntable Position (o) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pk | Qpk/Av | | | | | Pk | Qpk/Av | Pk | Qpk/Av | Pk | Qpk/Av |
| **34.64** | | 42.90 | V | 100 | 347 | -13.71 | --------- | 29.19 | -------- | 54.0 | --------- | 24.8 |
| **310.22** | | 41.15 | H | 100 | 180 | -9.21 | --------- | 31.94 | -------- | 54.0 | --------- | 22.1 |
| **329.19** | | 52.22 | H | 100 | 228 | -9.98 | --------- | 42.24 | -------- | 54.0 | --------- | 11.8 |
| **375.69** | | 43.21 | H | 100 | 224 | -9.06 | --------- | 34.15 | -------- | 54.0 | --------- | 19.8 |
| **422.72** | | 40.80 | H | 100 | 229 | -7.59 | --------- | 33.21 | -------- | 54.0 | --------- | 20.8 |
| **469.68** | | 46.56 | V | 117 | 167 | -6.23 | --------- | 40.33 | -------- | 54.0 | --------- | 13.7 |
| **157.6** | 27.31 | 25.01 | V | 100 | 210 | -11.02 | 16.29 | 13.99 | 30.0 | 24.0 | 13.7 | 10.0 |
| **159.61** | 26.24 | 22.78 | V | 100 | 225 | -10.33 | 15.91 | 12.45 | 30.0 | 24.0 | 14.1 | 11.6 |
| **164.21** | 28.56 | 24.23 | V | 100 | 125 | -9.69 | 18.87 | 14.54 | 30.0 | 24.0 | 11.1 | 9.5 |
| **1081.46** | | 41.48 | V | 100 | 159 | -13.25 | --------- | 28.23 | --------- | 54.0 | --------- | 25.8 |
| **1201.1** | | 41.48 | V | 100 | 262 | -12.72 | --------- | 28.76 | --------- | 54.0 | --------- | 25.2 |

Qpk = Quasi-Peak Measurement or Limit (< 1GHz)
AV = Average Measurement or Limit (>1GHz)

**Notes:**
**There were no significant emissions found above 1GHz.**

## 4.2 Conducted Emissions

### 4.2.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

A diagram of the room is shown below in figure 4.2.1-1:

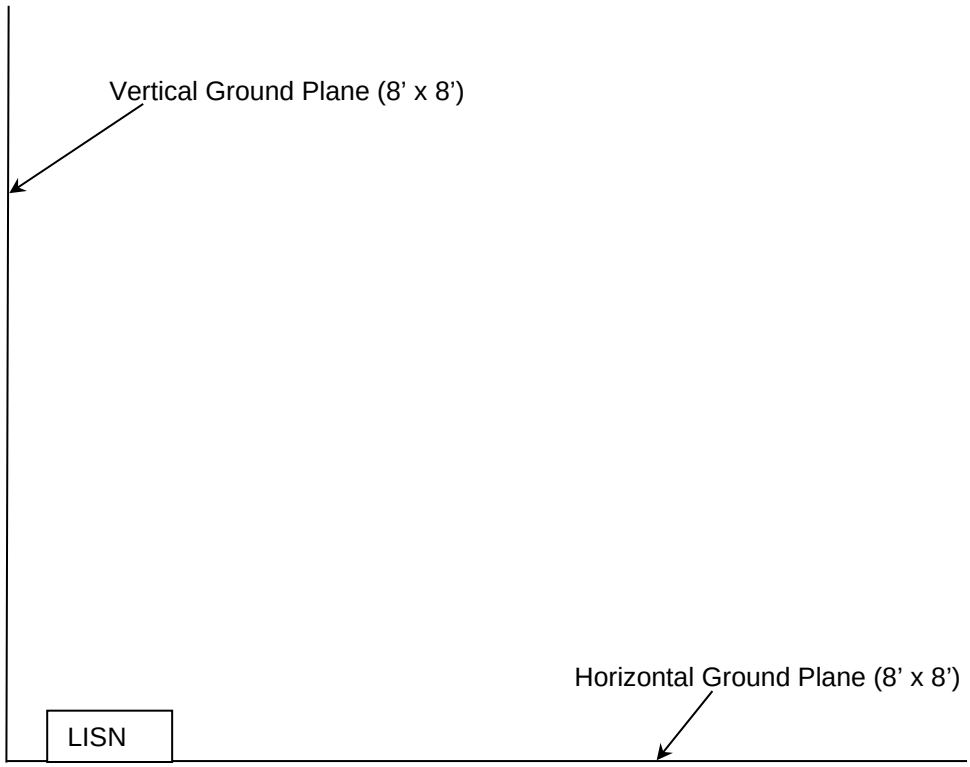



**Figure 4.2.1-1: AC Mains Conducted EMI Site**

### 4.2.2 Test Equipment

**Table 4.2.2-1 Test Equipment – Conducted Emissions**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 324 | ACS | Belden | Cables | 8214 | 5/5/2015 | 5/5/2016 |
| 168 | Hewlett Packard | 11947A | Attenuators | 44829 | 1/19/2015 | 1/19/2016 |
| 316 | Rohde Schwarz | ESH3-Z5 | LISN | 861189-010 | 7/14/2015 | 7/14/2016 |
| RE112 | Rohde Schwarz | ESIB26 | Analyzer | 836119/012 | 10/30/2014 | 10/30/2015 |

**NCR=No Calibration Required**

### 4.2.3 Test Methodology

Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

**Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss**
**Margin = Applicable Limit - Corrected Reading**

#### 4.2.3.1 Test Criteria

The EUT must meet the Class B Limits as given in section 1.4.1.

#### 4.2.3.2 Test Justification

☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

### 4.2.4 Test Setup Photographs

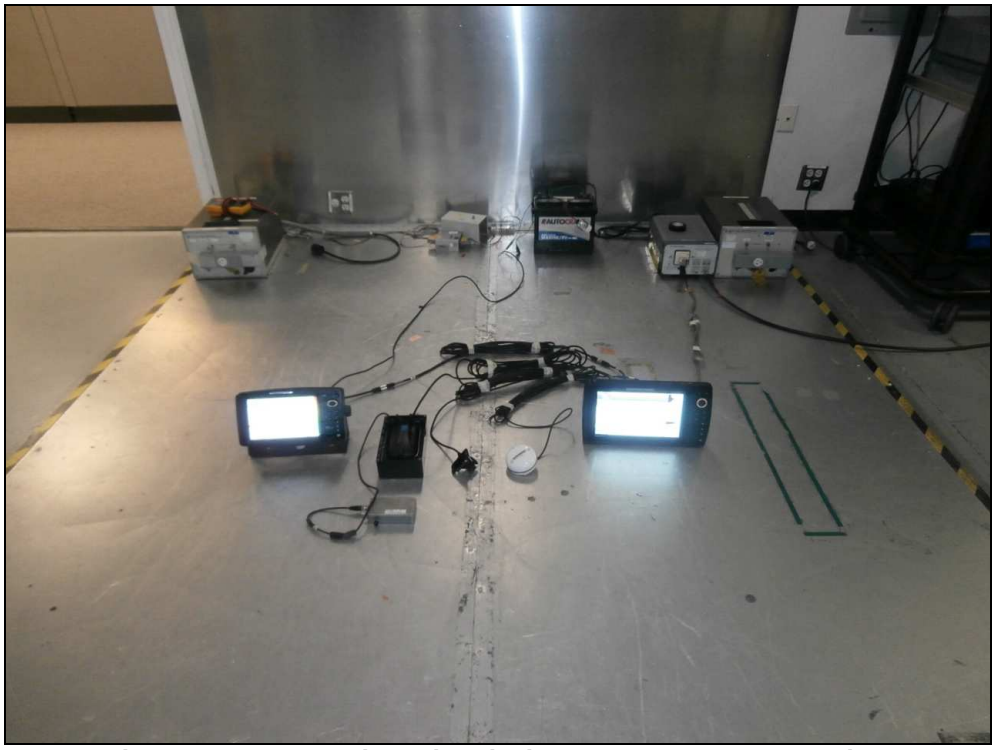


**Figure 4.2.4-1: Conducted Emissions Test Setup – Front View**

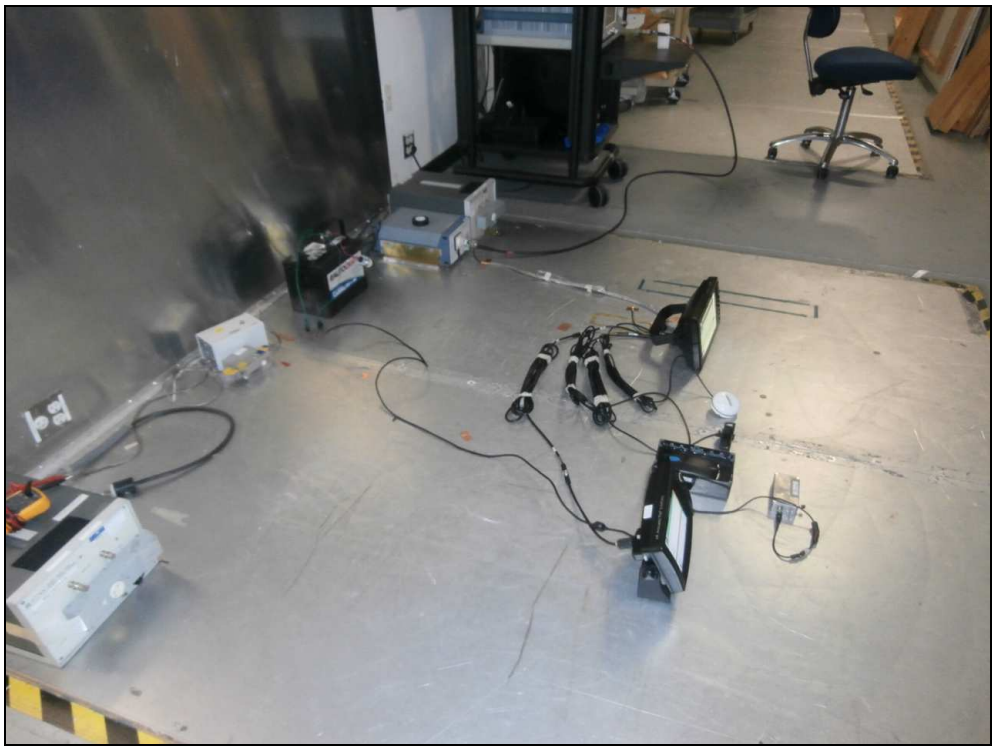


**Figure 4.2.4-2: Conducted Emissions Test Setup – Side View**

### 4.2.5 Test Data

Tabulated data is given in the Test Data Tables below.

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **July 1, 2015** | **Temperature (ºC)** | **25** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **39** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1016** |
| **Tested Modes:** | **2D sonar mode; monitoring depth, temperature, and GPS** | | |
| **AC Input Power:** | **N/A** | | |
| **DC Input Power:** | **12Vdc** | | |

**Tested Leads:**

☐ **AC Mains – Number of Lines:**
☒ **DC Mains – Number of Lines: 2**
☐ **Telecom Port – Quantity:**

**Test Data Tables:**

**Check All That Apply to This Data**
☒ **Line 1** ☐ **Line 2** ☐ **Line 3** ☐ **Line 4**
☒ **To Ground** ☐ **Floating**
☐ **Telecom Port _____**
☒ **dBµV** ☐ **dBµA**

**Power Supply Description: 12Vdc**

| Frequency (MHz) | Corrected Reading | | Limit (dBuV) | Margin (dB) | Line | Correction (dB) |
|---|---|---|---|---|---|---|
| | Quasi-Peak (dBuV) | Average (dBuV) | | | | |
| 18.243587 | --- | 27.18 | 50.00 | 22.82 | L1 | 11.5 |
| 18.243587 | 30.37 | --- | 60.00 | 29.63 | L1 | 11.5 |
| 18.488477 | --- | 22.98 | 50.00 | 27.02 | L1 | 11.5 |
| 18.488477 | 26.60 | --- | 60.00 | 33.40 | L1 | 11.5 |
| 18.914129 | --- | 24.68 | 50.00 | 25.32 | L1 | 11.5 |
| 18.914129 | 28.20 | --- | 60.00 | 31.80 | L1 | 11.5 |
| 19.707515 | --- | 26.65 | 50.00 | 23.35 | L1 | 11.6 |
| 19.707515 | 30.29 | --- | 60.00 | 29.71 | L1 | 11.6 |
| 20.314328 | --- | 17.43 | 50.00 | 32.57 | L1 | 11.6 |
| 20.314328 | 21.38 | --- | 60.00 | 38.62 | L1 | 11.6 |
| 20.869840 | --- | 20.64 | 50.00 | 29.36 | L1 | 11.7 |
| 20.869840 | 24.39 | --- | 60.00 | 35.61 | L1 | 11.7 |

**Notes:**

**Check All That Apply to This Data**
☐ Line 1 ☒ Line 2 ☐ Line 3 ☐ Line 4
☒ To Ground ☐ Floating
☐ Telecom Port _____
☒ dBµV ☐ dBµA

**Power Supply Description: 12Vdc**

| Frequency (MHz) | Corrected Reading | | Limit (dBuV) | Margin (dB) | Line | Correction (dB) |
|---|---|---|---|---|---|---|
| | Quasi-Peak (dBuV) | Average (dBuV) | | | | |
| 18.365031 | --- | 24.33 | 50.00 | 25.67 | N | 11.3 |
| 18.365031 | 27.46 | --- | 60.00 | 32.54 | N | 11.3 |
| 18.915732 | --- | 23.56 | 50.00 | 26.44 | N | 11.3 |
| 18.915732 | 27.16 | --- | 60.00 | 32.84 | N | 11.3 |
| 19.710321 | --- | 25.24 | 50.00 | 24.76 | N | 11.3 |
| 19.710321 | 28.96 | --- | 60.00 | 31.04 | N | 11.3 |
| 20.262224 | --- | 20.08 | 50.00 | 29.92 | N | 11.3 |
| 20.262224 | 24.10 | --- | 60.00 | 35.90 | N | 11.3 |
| 20.311523 | --- | 9.94 | 50.00 | 40.06 | N | 11.3 |
| 20.311523 | 13.39 | --- | 60.00 | 46.61 | N | 11.3 |
| 21.664830 | --- | 21.74 | 50.00 | 28.26 | N | 11.5 |
| 21.664830 | 25.51 | --- | 60.00 | 34.49 | N | 11.5 |

**Notes:**

# 5.0 Harmonic Current Emissions

## 5.1 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

**This test is not applicable, because the EUT is not powered through an AC Mains power supply.**

# 6.0 Voltage Fluctuations & Flicker

## 6.1 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

**This test is not applicable, because the EUT is not powered through an AC Mains power supply.**

# SECTION C: IMMUNITY – TEST INFORMATION AND RESULTS

## 7.0 Electrostatic Discharge Immunity

### 7.1 Test Site Description

The EUT was configured and connected to satisfy its functional requirements.

For a table top configuration, the EUT was placed on an insulating support of 0.5mm in the center of the Horizontal Coupling Plane (HCP). The HCP laid flat on a non-conductive table measuring 1.6 meters x 0.8 meters x 0.8 meters. The non-conductive table was placed on a 16 feet x 8 feet Ground Reference Plane (GRP). The Vertical Coupling Plane was placed 10cm from the EUT and insulated from the HCP.

For a floor standing configuration the EUT was placed on a 10cm insulated support. The non-conductive spacer was placed on a 16 feet x 8 feet Ground Reference Plane (GRP). The Vertical Coupling Plane was placed 10cm from the EUT.

Both the HCP and the VCP were connected to the GRP via cables with 470kΩ resistors located at each end. The ground lead of the ESD generator was also connected to the GRP.

### 7.2 Test Equipment

**Table 7.2-1: Test Equipment List**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 582 | Kikusui | KES4021A | ESD Gun | SA003046 | 4/28/2015 | 4/28/2016 |
| 144 | Omega | RH411 | Climate Monitoring Equipment | H0103373 | 7/24/2014 | 7/24/2016 |

**NCR = No Calibration Required**

### 7.3 Test Methodology

IEC 61000-4-2 - Electromagnetic compatibility (EMC) - Part 4. Testing and measurement techniques - Section 4.2 Electrostatic discharge immunity test - Basic EMC Publication, was the guiding document for this test. The purpose of this test is to verify the immunity of single devices or systems against electrostatic discharges (ESD) generated by an operator or object touching the equipment, or by objects or persons coming into contact in the vicinity of the equipment.

Only areas of the EUT that are accessible to the user are considered for the evaluation.

Direct Contact Discharge

Devices with accessible conductive surfaces are subject to direct contact discharges. Each test point identified was subjected to 10 discharges of both positive and negatives impulses.

Indirect Contact Discharge

The EUT was subjected to indirect contact discharges to a horizontal coupling plane (HCP). At least 10 single discharges in both polarities were applied to the EUT via the HCP on all sides and at a separation distance of 10cm. In addition the EUT was subjected indirect discharges to a vertical coupling plane (VCP). At least 10 single discharges in both polarities were applied to the EUT via the VCP on all sides and at a separation distance of 10cm.

Air Discharge

Insulated surfaces of the EUT that are accessible were subjected to air discharges. Each test point is subjected to 10 discharges of each polarity.

#### 7.3.1 Test Criteria

EN 60945:2002 requires performance criterion B to be met as described in section 1.4.2.

### 7.3.2 Test Justification

☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

## 7.4 Test Setup Photograph

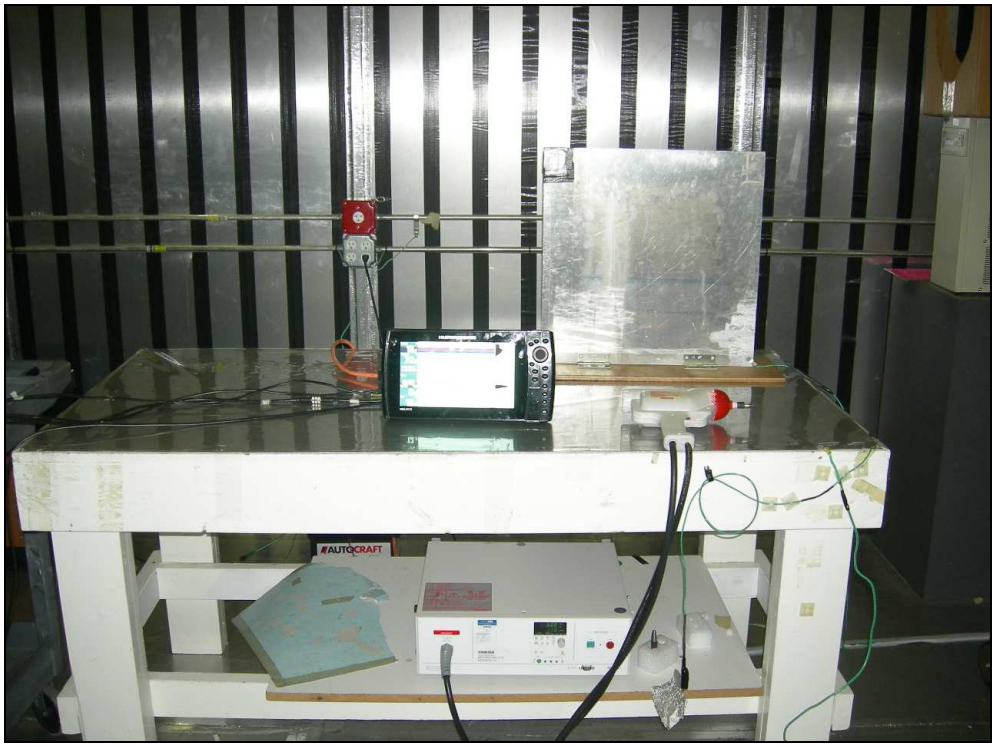
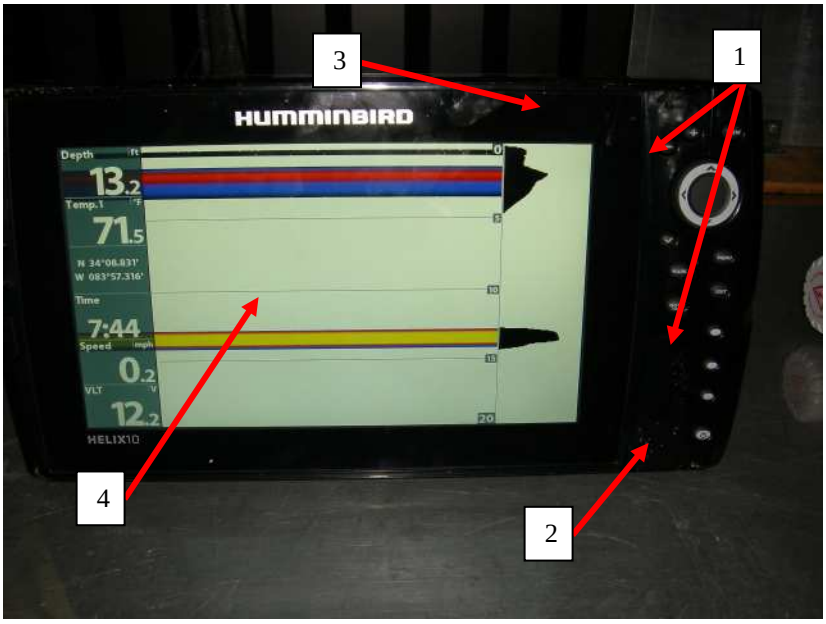
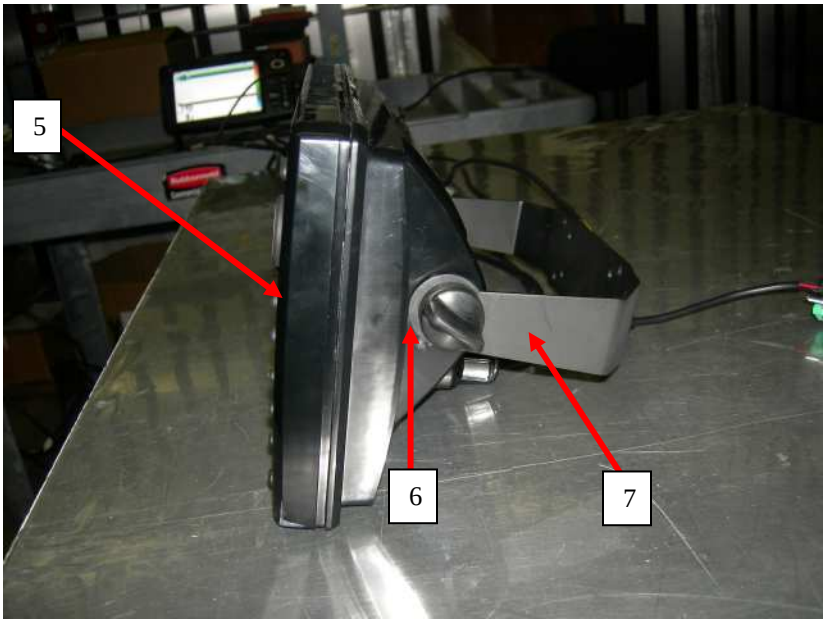


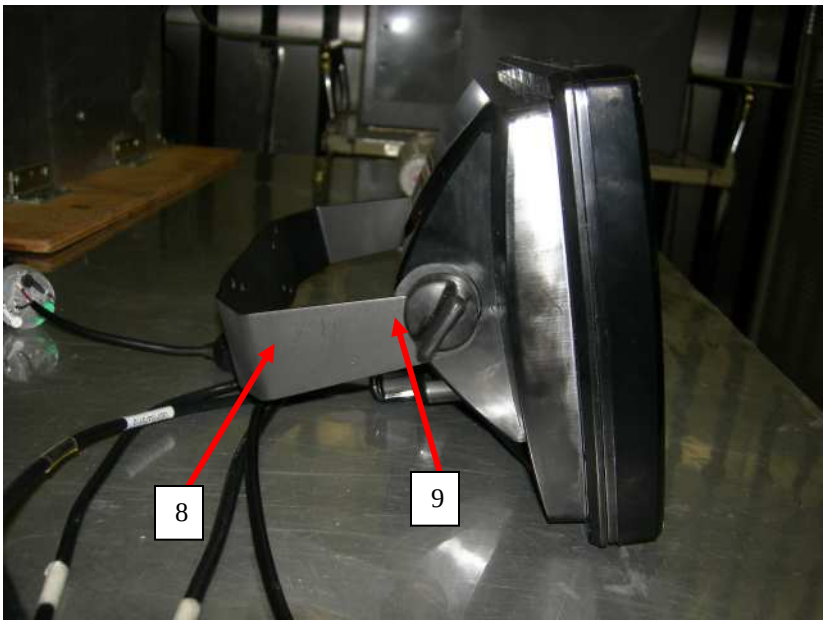

**Figure 7.4-1: Test Setup Photograph**

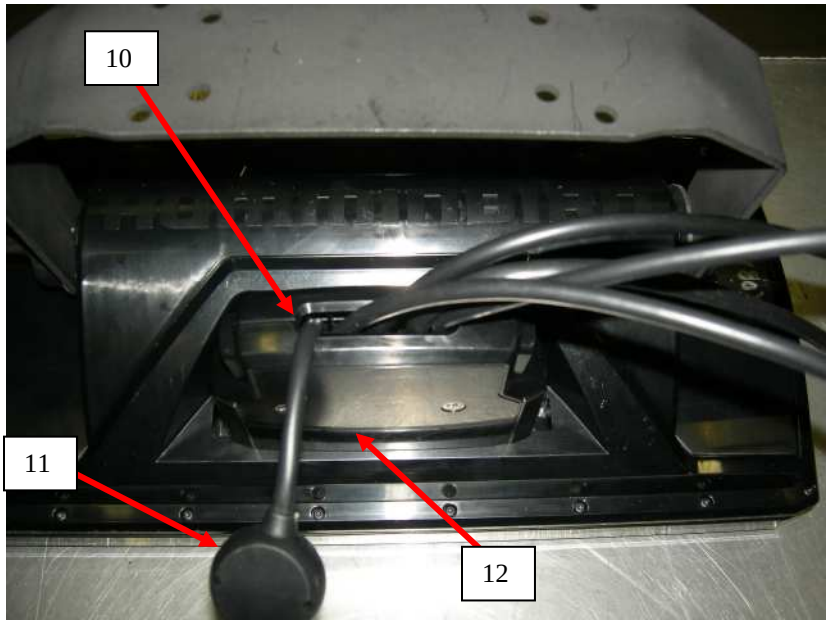
## 7.5 ESD Data Sheet

### Test Point Photograph:




8
9


10
11
12

**Test Point Selection:**

| TEST POINT# | DESCRIPTION | TYPE (C/A) | TEST POINT# | DESCRIPTION | TYPE (C/A) |
|---|---|---|---|---|---|
| 1 | Control Buttons | **Air** | 7 | Mounting Bracket-Right Side | **Contact** |
| 2 | Power Button | **Air** | 8 | Mounting Bracket-Left Side | **Contact** |
| 3 | Display Edges | **Air** | 9 | Mounting Screw-Left Side | **Air** |
| 4 | Display | **Air** | 10 | Multi port Connector Cables | **Air** |
| 5 | Enclosure Seams (All Sides) | **Air** | 11 | Molded Ferrite on Power Cable | **Air** |
| 6 | Mounting Screws- Right Side | **Air** | 12 | Multi Port Connector ( All sides and seams) | **Air** |

## 7.6 Test Data

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **July 2, 2015** | **Temperature (ºC)** | **42** |
| **Technician:** | **Tommy Payton** | **Humidity (%)** | **26** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1016** |
| | | ☒ **Pre-test Verification Complete** | |
| **Tested Modes:** | **EUT on; Monitoring GSP, Depth (12.7' ~ 13.2'), Temperature and Time.** | | |
| **AC Input Power:** | **N/A** | **VCP Resistor Value Check:** | **962k (Ohms)** |
| **DC Input Power:** | **12Vdc** | **HCP Resistor Value Check:** | **944k (Ohms)** |

**Indirect Contact Discharge:**

**Check All That Apply to This Data**

| Plane: | Polarity: | Tested Levels: | |
|---|---|---|---|
| ☐ Vertical Coupling Plane | ☐ Positive | ☒ 2kV | ☐ 8kV |
| ☐ Horizontal Coupling Plane | ☐ Negative | ☒ 4kV | ☐ 15kV |
| ☒ Both | ☒ Both | ☒ 6kV | ☐ Enter Other Level Here |

| Side | Result | Observation (Describe any detectable event) |
|---|---|---|
| Front | Pass | |
| Rear | Pass | |
| Left | Pass | |
| Right | Pass | |
| Bottom | Pass | |

**Air and Direct Contact Discharge:**

**Check All That Apply to This Data**

| Polarity: | Tested Levels: | |
|---|---|---|
| ☐ Positive | ☒ 2kV | ☒ 8kV |
| ☐ Negative | ☒ 4kV | ☐ 15kV |
| ☒ Both | ☒ 6kV | ☐ Enter Other Level Here |

| Test Point | Discharge Type | Result | Observation (Describe any detectable event) |
|---|---|---|---|
| 1 | Air | Pass | |
| 2 | Air | Pass | |
| 3 | Air | Pass | |
| 4 | Air | Pass | |
| 5 | Air | Pass | |
| 6 | Air | Pass | |
| 7 | Contact | Pass | |
| 8 | Contact | Pass | |
| 9 | Air | Pass | |
| 10 | Air | Pass | |
| 11 | Air | Pass | |
| 12 | Air | Pass | |

**Notes:**
**8kV for air discharges only**

# 8.0 Radio-Frequency Electromagnetic Fields

## 8.1 Test Site Description

The radiated fields test was performed in the semi or fully-anechoic chamber described in section 4.1.1.2 or 4.1.1.3 respectively.

## 8.2 Test Equipment

**Table 8.2-1: Test Equipment List**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 251 | Rohde & Schwarz | SML03 | Signal Generators | 102116 | 7/17/2015 | 7/17/2016 |
| 370 | IFI | CMX5002 | Amplifier | L364-0407 | NCR | NCR |
| RE89 | Amplifier Research | 25S1G4A | Amplifiers | 324609 | NCR | NCR |
| 590 | Fairview Microwave | SA6N5WA-10 | Immunity Equipment | 590 | NCR | NCR |
| 565 | United Microwave Products, Inc. | OO-190-15.00.0 | Cables | 565 | NCR | NCR |
| 566 | United Microwave Products, Inc. | OO-190-00-120.0 | Cables | 566 | NCR | NCR |
| 354 | ETS Lindgren | 3142C | Antennas | 78838 | NCR | NCR |
| 329 | A.H.Systems | SAS-571 | Antennas | 721 | 7/22/2015 | 7/22/2017 |
| 1201 | Wandel & Goltermann | 2244/99.22 | Probes | W-0004 | 10/8/2013 | 10/8/2015 |
| 1112 | Wandel & Goltermann | BN2244/21 | Probes | H0006 | 10/8/2013 | 10/8/2015 |

**NCR = No Calibration Required**

## 8.3 Test Methodology

IEC 61000-4-3 Ed. 3.- Electromagnetic compatibility (EMC) - Part 4. Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test, was the guiding document for this test. The purpose of this test is to verify the immunity of single devices or systems when subjected to radio-frequency electromagnetic field.

The EUT was configured and connected to satisfy its functional requirements. One representative sample was placed on the table and rotated 90° to expose all side of the EUT to the radiofrequency electromagnetic field. The table is non-conductive measuring 1.5 meters x 1.0 meters x 0.8 meters. The non-conductive table was placed 3 meters from the radiating antenna.

The frequency ranges to be considered are swept with the signal 80% amplitude modulated with a 400kHz AM sine wave, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1% of fundamental with linear interpolation between calibrated points.

The test shall normally be performed with the generating antenna facing each of the four sides of the EUT, however if the equipment can be used in different orientations, the test shall be performed on all sides, 6 total.

The polarization of the field generated by each antenna necessitates testing each side twice, once with the antenna positioned vertically and again with the antenna positioned horizontally.

### 8.3.1 Test Criteria

EN 60945:2002 requires criterion A to be met as described in section 1.4.2.

### 8.3.2 Test Justification

☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

## 8.4 Test Setup Photographs

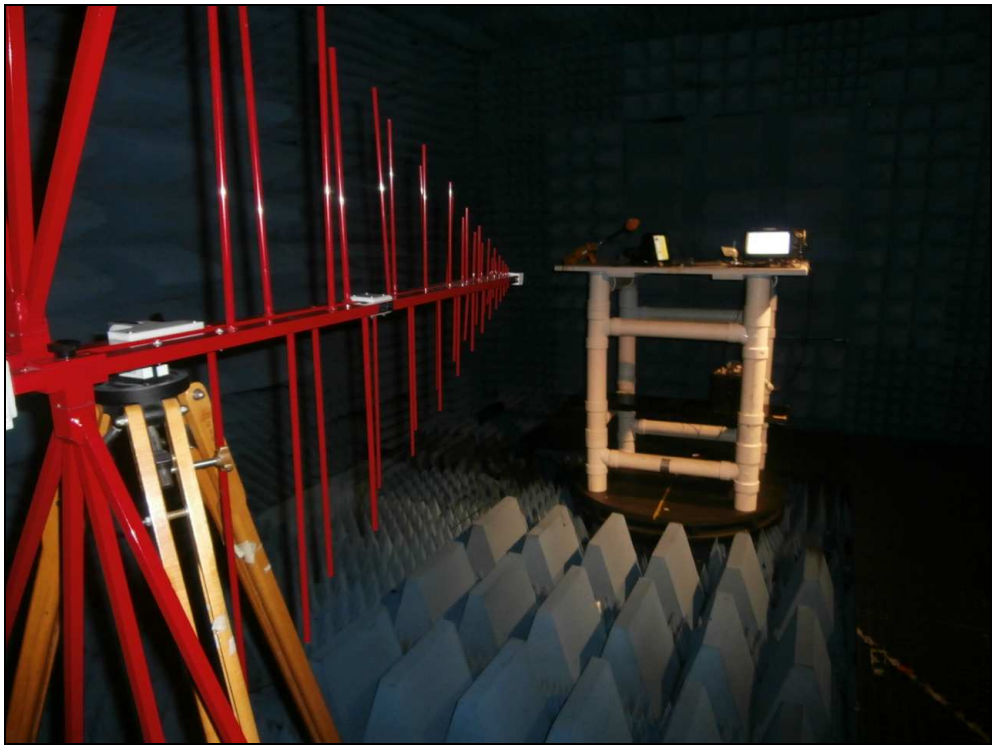


**Figure 8.4-1: Test Setup Photograph**

## 8.5 Test Results

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **July 1, 2015** | **Temperature (ºC)** | **26** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **35** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1016** |
| **Tested Modes:** | **EUT on; Monitoring GSP, Depth (12.7' ~ 13.2'), Temperature and Time.** | | |
| **AC Input Power:** | **N/A** | ☒ **Pre-test Verification Complete** | |
| **DC Input Power:** | **12Vdc** | | |

**Test Data:**

**Check All That Apply to This Data**

| Polarity | Field Strength: | Freq. Band: | Dwell Time |
|---|---|---|---|
| ☐ Horizontal | ☐ 3V/m | ☒ 80-1000MHz | ☐ 1 Second |
| ☐ Vertical | ☒ 10V/m | ☐ 80-2700MHz | ☒ 3 Seconds |
| ☒ Both | ☐ 8V/m | ☐ Enter Other Band Here | ☐ Enter Other |
| | ☐ Enter Other Level Here | | |

| Azimuth | Result | Observation (Describe any detectable event) |
|---|---|---|
| 0 | Pass | |
| 90 | Pass | |
| 180 | Pass | |
| 270 | Pass | |

**Notes:**
**The graph did show some noise during testing. Depth reading, GPS, Time and Temperature were all steady.**

**Test Data:**

**Check All That Apply to This Data**

| Polarity | Field Strength: | Freq. Band: | Dwell Time |
|---|---|---|---|
| ☐ Horizontal | ☐ 3V/m | ☐ 80-1000MHz | ☐ 1 Second |
| ☐ Vertical | ☒ 10V/m | ☒ 1000MHz-2000MHz | ☒ 3 Seconds |
| ☒ Both | ☐ 8V/m | ☐ Enter Other Band Here | ☐ Enter Other |
| | ☐ Enter Other Level Here | | |

| Azimuth | Result | Observation (Describe any detectable event) |
|---|---|---|
| 0 | Pass | |
| 90 | Pass | |
| 180 | Pass | |
| 270 | Pass | |

**Notes:**

# 9.0 Electrical Fast Transient/Bursts

## 9.1 Test Site Description

The EUT was configured and connected to satisfy its functional requirements. The EUT was placed in the center of a non-conductive support measuring 125cm x 96cm x 10 cm. The non-conductive support is placed on a 8 feet x 8 feet Ground Reference Plane (GRP). A minimum distance of 50 cm between the EUT and all other conductive structures was maintained. A minimum distance of 50 cm between the coupling clamp and all other conductive structures, except the GRP, was maintained. A 10 cm insulated support was placed between the capacitive coupling clamp and the GRP. The GRP was bonded to the EFT/B generator.

The input power port of the EUT was tested using the coupling/decoupling network. The +/-1kV bursts were applied to all lines individually as well as simultaneously.

The bursts were applied to the signal/control line ports, if present, using the capacitive coupling clamp.

## 9.2 Test Equipment

**Table 9.2-1: Test Equipment List**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 62 | Haefely Trench | EFT Clamp | Immunity Equipment | None | 10/2/2014 | 10/2/2015 |
| 474 | Keytek | EMC PRO | General Lab Equipment | 9808246 | 10/2/2014 | 10/2/2015 |

**NCR = No Calibration Required**

## 9.3 Test Methodology

IEC 61000-4-4 - Electromagnetic compatibility (EMC) - Part 4. Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMC Publication., was the guiding document for this test. The purpose of this test is to verify the immunity of single devices or systems when subjected to types of transient disturbances such as those originating from switching transients such as interruption of inductive loads or relay contact bounce.

### 9.3.1 Test Criteria

EN 60945:2002 requires criterion B to be met as described in section 1.4.2.

### 9.3.2 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

## 9.4 Test Setup Photographs

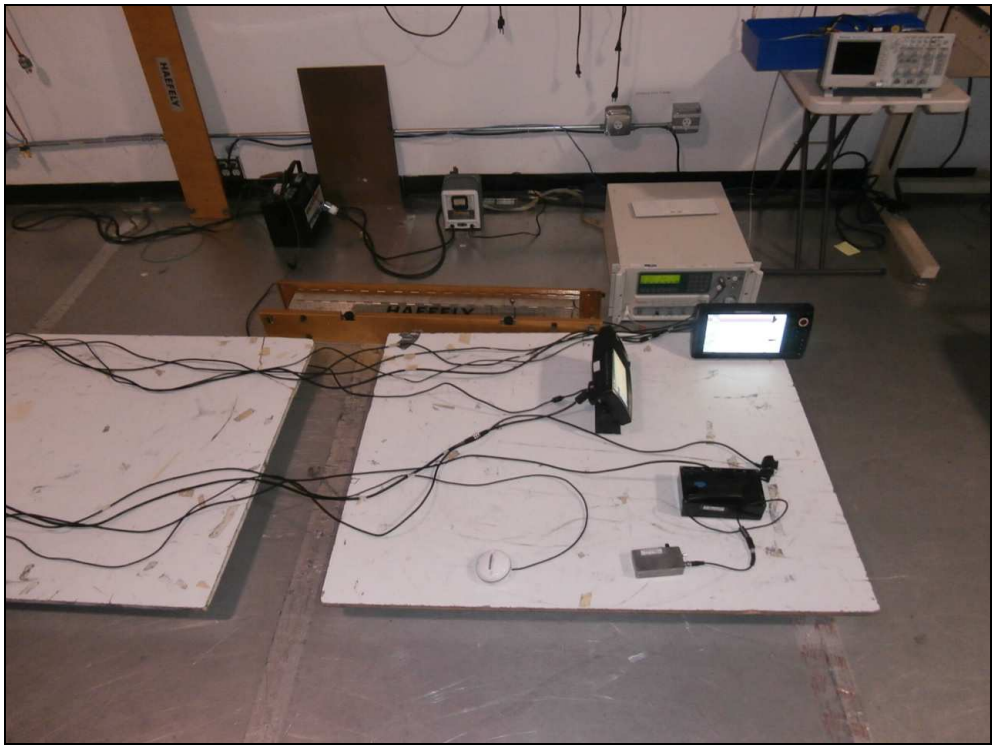


**Figure 9.4-1: Test Setup Photograph**

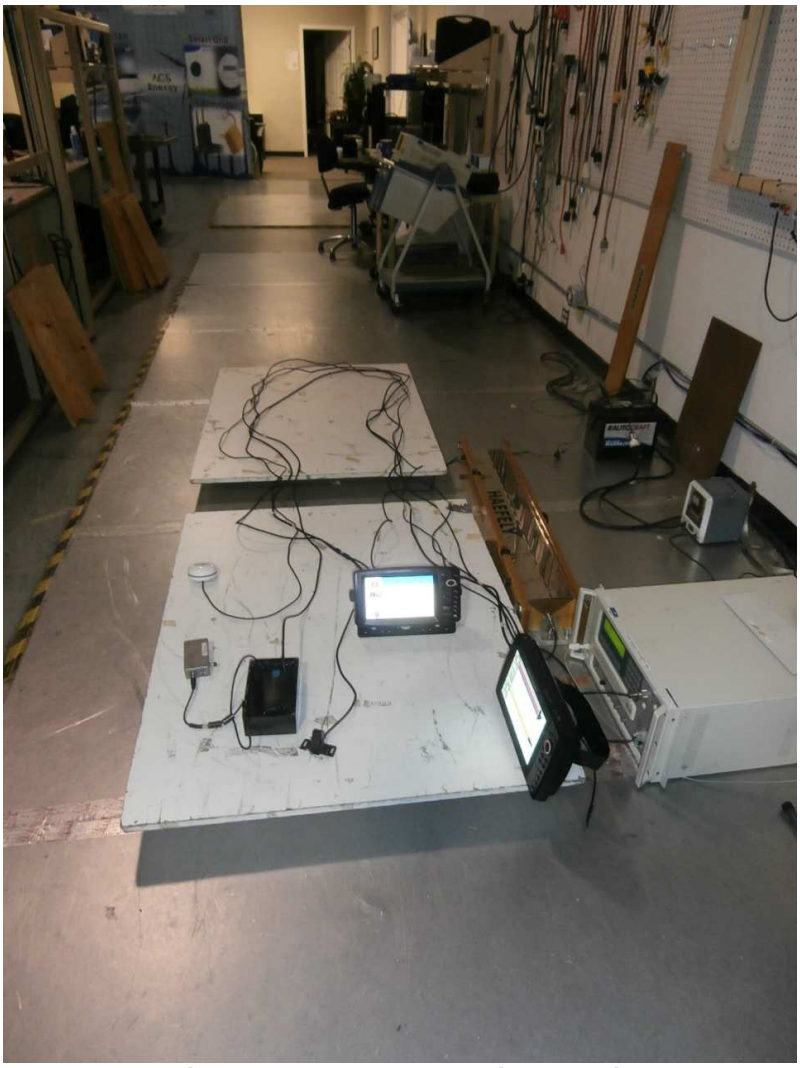


**Figure 9.4-2: Test Setup Photograph**

## 9.5 Test Results

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **June 29, 2015** | **Temperature (ºC)** | **27** |
| **Technician:** | **Wayne Orwig** | **Humidity (%)** | **35** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1014** |
| **Tested Modes:** | **Monitoring GPS, and the depth transducer** | | |
| **AC Input Power:** | **N/A** | ☒ **Pre-test Verification Complete** | |
| **DC Input Power:** | **12VDC** | | |

**Mains Test Data:**

**Check All That Apply to This Data**

| Polarity: | Tested Levels: | Interface Type: |
|---|---|---|
| ☐ Positive | ☒ .5kV | ☒ Input |
| ☐ Negative | ☒ 1kV | ☐ Output |
| ☒ Both | ☐ 2kV | ☐ Both |
| | ☐ | |

| Coupling Mode | Result | Observation (Describe any detectable event) |
|---|---|---|
| L1-L2 | Pass | |

**Notes:**

**Signal Line Test Data:**

**Check All That Apply to This Data**

| Polarity: | Tested Levels: |
|---|---|
| ☐ Positive | ☐ .25kV |
| ☐ Negative | ☒ .5kV |
| ☒ Both | ☒ 1kV |
| | ☐ 2kV |
| | ☐ Enter Other Level Here |

| Signal Line | Result | Observation (Describe any detectable event) |
|---|---|---|
| Transducer cable | Pass | |
| GPS cable | Pass | |
| Ethernet | Pass | |
| Speed sensor | Pass | |

**Notes:**
**3 minute duration**

# 10.0 Surge Immunity

## 10.1 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

**This test is not applicable, because the EUT is not powered through an AC Mains power supply.**

# 11.0 Radio-Frequency Common-Mode Immunity

## 11.1 Test Site Description

The EUT was configured and connected to satisfy its functional requirements. The EUT was placed on an insulating support of 0.1m height above a ground reference plane. All relevant cables were provided with the appropriate coupling and decoupling devices at a distance between 0.1m and 0.3m from the projected geometry of the EUT on the Ground Reference Plane (GRP).

## 11.2 Test Equipment

**Table 11.2-1: Test Equipment List**

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| 5 | Chase | CSP-8441 | Probes | 19 | 5/15/2015 | 5/15/2016 |
| 93 | Chase | 8101 | Clamp | 65 | 4/21/2015 | 4/21/2016 |
| 251 | Rohde & Schwarz | SML03 | Signal Generators | 102116 | 10/30/2014 | 10/30/2015 |
| 370 | IFI | CMX5002 | Amplifier | L364-0407 | NCR | NCR |
| 642 | Fairview Microwave | FMC0101951-200CM | Cables | N/A | NCR | NCR |
| 457 | Com Power | CDN-M2-25 | Coupler | 511023 | 10/29/2014 | 10/29/2015 |
| 425 | ACS | EMC Cable Set | Cable Set | 425 | NCR | NCR |

**NCR = No Calibration Required**

## 11.3 Test Methodology

IEC 61000-4-6 3rd Ed. - Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio- frequency fields, was the guiding document for this test. The purpose of this test is to verify the immunity of single devices or systems when subjected to radio-frequency electromagnetic field.

The EUT was caused to operate as intended and monitored for changes in performance. The frequency range is swept from 150 kHz to 80MHz, using the signal levels established during the setting process, and with the disturbance signal 80% amplitude modulated with a 400kHz AM sine wave, pausing to adjust the RF signal level or to switch coupling devices as necessary. The rate of sweep shall not exceed 1.5 x $10^{-3}$ decades. Where the frequency is swept incrementally, the step size shall not exceed 1% of the start and thereafter 1% of the preceding frequency value.

### 11.3.1 Test Criteria

EN 60945:2002 requires criterion A to be met as described in section 1.4.2.

### 11.3.2 Test Justification

☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

## 11.4 Test Setup Photographs

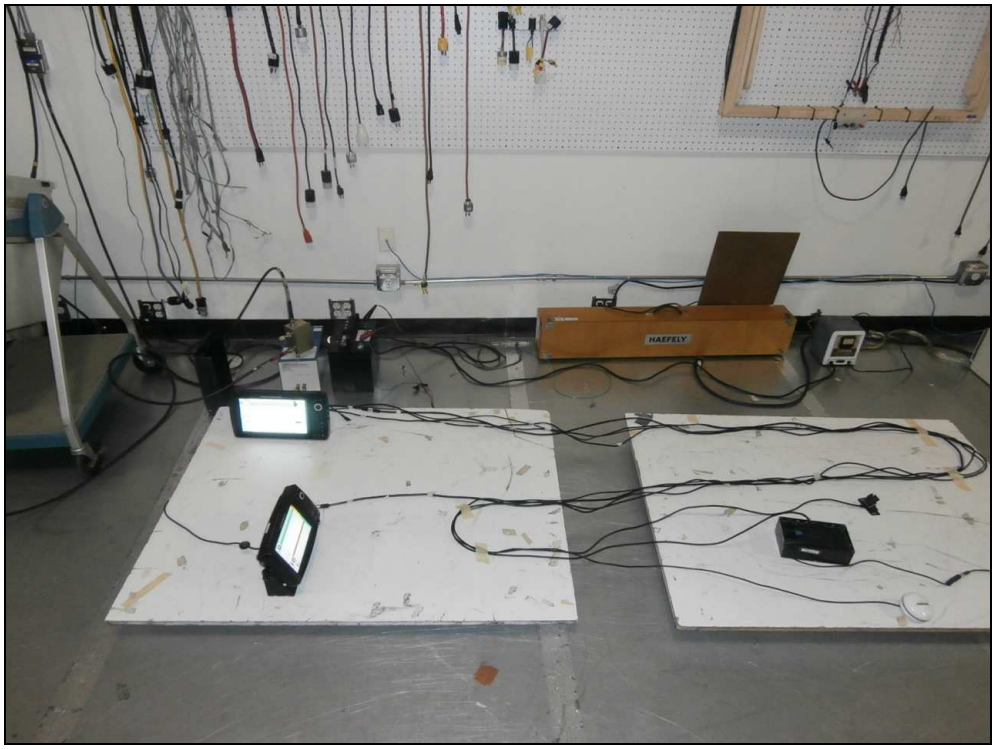



**Figure 11.4-1: Test Setup Photograph**

## 11.5 Test Results

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **July 1, 2015** | **Temperature (ºC)** | **25** |
| **Technician:** | **Wayne Orwig** | **Humidity (%)** | **38** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1017** |
| **Tested Modes:** | **Monitoring GPS Depth transducer, time, speed** | | |
| **AC Input Power:** | **N/A** | ☒ **Pre-Test Verification** | |
| **DC Input Power:** | **12VDC** | | |

**Mains Test Data:**

**Check All That Apply to This Data**

**Test Level:**
☒ 3Vrms
☐ 10Vrms
☐ 15Vrms
☐ Enter Other Level Here

**Freq. Band:**
☒ .150-80MHz
☐ Enter Other Band Here

| Coupling Mode | Result | Observation (Describe any detectable event) |
|---|---|---|
| CDN | Pass | |

**Notes:**
**Spot frequencies of 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 & 25MHz; tested at 10Vrms @ 400Hz modulation.**

**Signal Line Test Data:**

**Check All That Apply to This Data**

**Test Level:**
☒ 3Vrms
☐ 10Vrms
☐ 15Vrms
☐ Enter Other Level Here

**Freq. Band:**
☒ .150-80MHz
☐ Enter Other Band Here

| Signal Line | Result | Observation (Describe any detectable event) |
|---|---|---|
| GPS cable | Pass | |
| Transducer cable | Pass | |
| Ethernet | Pass | |
| Speed sensor | Pass | |

**Notes:**
**Spot frequencies of 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 & 25MHz; tested at 10Vrms @ 400Hz modulation.**

# 12.0 Power Frequency Magnetic Fields Immunity

## 12.1 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

**This test is not applicable, because the EUT does not employ magnetically sensitive components.**

# 13.0 Voltage Dips and Interruptions

## 13.1 Test Justification

☐ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☒ **The test method, standard, and/or test plan was deviated from for the following reason:**

**This test is not applicable, because the EUT is not powered through an AC Mains power supply.**

# SECTION D: MEASUREMENT UNCERTAINTY

**General**
Measurement Uncertainty is based on the following publications:

- CISPR 16-4-2: Uncertainties, statistics and limit modeling – Uncertainty in EMC measurements
- The Guide to the Expression of Uncertainty in Measurement(GUM): 1995
- ANSI / NCSL Z540.2-1997 (R2002) U.S. Guide to Expression of Uncertainty in Measurement

Calculations for measurement uncertainty are available upon request.

**Emissions:**

| Test Method | $U_{Lab}$ | $U_{CISPR}$ | Uncertainty Units |
|---|---|---|---|
| Radiated Emissions 30MHz-1000MHz | 3.68 | 5.2 | dB |
| Radiated Emissions 30MHz to 200MHz | 3.79 | 5.2 | dB |
| Radiated Emissions 200 to 1000MHz | 3.62 | 5.2 | dB |
| Radiated Emissions 1-18GHz | 3.65 | --- | dB |
| Conducted Emissions .150k-30MHz | 1.52 | 3.6 | dB |
| Radiated Disturbances 5MHz to 30MHz | 2.81 | 4.5 | dB |
| Radiated Disturbances 30MHz to 950MHz | 2.21 | 4.5 | dB |
| Harmonic Current Emissions | 1.7 | --- | % |
| Voltage Fluctuations & Flicker | 1.7 | --- | % |
| Insertion Loss/Internal Calibrations | .65 | --- | dB |
| Radiated Immunity 80-1000MHz | 1.21 | --- | dB |
| Conducted Immunity .150-80MHz | 1.64 | --- | dB |
| Frequency Interpolations | .81 (ave) | --- | dB |

**NOTE $U_{cispr}$ resembles a value of measurement uncertainty for a specific test, which was determined by considering uncertainties associated with the quantities listed in CISPR 16-4-2:2003 Section 4.2. Where no value is given for $U_{cispr}$ the procedure below does not apply.**

Compliance or non-compliance with a disturbance limit shall be determined in the following manner.

If $U_{Lab}$ is less than or equal to $U_{cispr}$ in Table 5.0-1, then:
- compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

If $U_{Lab}$ is greater than $U_{cispr}$, then:
- compliance is deemed to occur if no measured disturbance, increased by ($U_{Lab} – U_{cispr}$), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance, increased by ($U_{Lab} – U_{cispr}$), exceeds the disturbance limit.

The ACS calculated MU is much less than the internationally accepted MU, therefore an adjustment to the measured result as mentioned above is not necessary.

**Immunity**
The EUT was subjected to the appropriate test levels required by the standard with a confidence level of 95%(k=2).

# SECTION E: CONCLUSION
The EUT is determined to meet the requirements as defined in the applicable regulations.