



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 7 SI GPS  
Model Variants: See Appendix A**

**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: 15-0004.C08.1B  
Report Revision: B  
Report Issue Date: May 6, 2015**

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**This report contains 44 pages**

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| <p>REVISION HISTORY</p> <p>Report Number: 15-0004.C08.1B</p> <p>Manufacturer: Johnson Outdoors Marine Electronics</p> <p>Model: Helix 7 SI GPS</p> |
|--|

Report Number: 15-0004.C08.1B

Manufacturer: Johnson Outdoors Marine Electronics

Model: Helix 7 SI GPS

[illegible]

# Project Information Sheet

ACS Project: 15-0004.C08.1B

## Applicant Details

**Manufacturer:** Johnson Outdoors Marine Electronics

**Street Address:** 678 Humminbird Ln

**City, State/Province and Postal Code:** Eufaula, AL 36027

**Country:** USA

**Contact:** Tambryn Freund

**Phone:**

**Fax:**

**Email:** Tambryn.Freund@johnsonoutdoors.com

## Sample Information

**Model:** Helix 7 SI GPS

**Model Variant(s):** See Appendix A

**Environment of Use:** Residential; Mounted on the main deck/consoles of small recreational vessels in an exposed environment.

**Sample Receive Date:** January 5, 2015

**Sample Receive Condition:** Good

**Test Mode Description:** GPS active, transducer active

**Failure Mode (Provided by Mfg.):** If the device fails to recover (i.e. GPS/Sonar Operation) upon reboot

**Highest Data Rate:** 266MHz

**Source:** Microcontroller

## Product Description

The HUMMINBIRD Helix 7 SI GPS is a fishfinder/GPS product with Side Imagine sonar capability to be used in the marine environment. It is comprised of a keyboard, LCD display, micro SD card slot, Internal GPS, transducer and power cable.

## Test Information

**Test Start Date:** January 5, 2015

**Test End Date:** January 7, 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 1<sup>st</sup> 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 2<sup>nd</sup> Ed.
- ☒ IEC 61000-4-6 3<sup>rd</sup> Ed.
- ☐ IEC 61000-4-8 2<sup>nd</sup> Ed.
- ☐ IEC 61000-4-11 2<sup>nd</sup> Ed.

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## **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 January 5, 2015 through January 7, 2015 on the model Helix 7 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 |
|--|---|--------|
| <b><u>Product Standards</u></b>                          |   |        |
| 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 $\leq$ 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 $\leq$ 16 A per phase and not subject to conditional connection | N/A    |
| <b><u>Basic Immunity Standards per EN 60945:2002</u></b> |   |        |
| 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 2 <sup>nd</sup> Ed.                        | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test  | N/A    |
| IEC 61000-4-6 3 <sup>rd</sup> 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 2 <sup>nd</sup> Ed.                        | Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test   | N/A    |
| IEC 61000-4-11 2 <sup>nd</sup> 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 7 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 dB $\mu$ V – 50 dB $\mu$ V)<br>1 mV – 0,3 mV (60 dB $\mu$ V – 50 dB $\mu$ V)<br>0,3 mV (50 dB $\mu$ V) |           |
| 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 $\mu$ V/m (80 dB $\mu$ V/m – 52 dB $\mu$ V/m)<br>316 $\mu$ V/m – 50 $\mu$ V/m (52 dB $\mu$ V/m – 34 dB $\mu$ V/m)<br>500 $\mu$ V/m (54 dB $\mu$ V/m) except for<br>16 $\mu$ V/m (24 dB $\mu$ V/m) quasi-peak<br>or 32 $\mu$ V/m (30 dB $\mu$ V/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](http://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 Ln  
Eufaula, AL 36027  
Tambryn Freund  
Tambryn.Freund@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.  
☐ Modifications were required to bring the EUT into compliance with the requirements.

### 3.3 System Block Diagram and Support Equipment

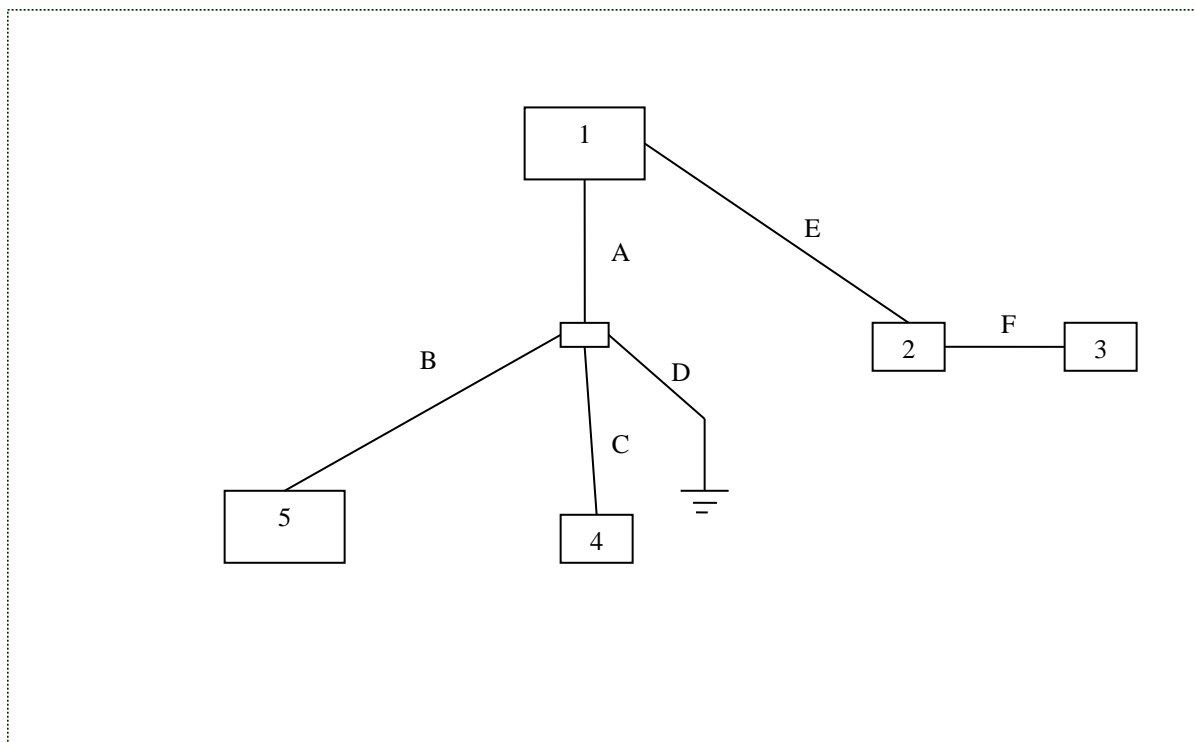


Figure 3.3-1: System Block Diagram

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

| Item # | Type Device     | Manufacturer     | Model/Part #       | Serial #      |
|--------|-----------------|------------------|--------------------|---------------|
| 1      | EUT             | Johnson Outdoors | Helix 7 SI GPS     | 14121724-0001 |
| 2      | Transducer      | Johnson Outdoors | N/A                | N/A           |
| 3      | Depth Simulator | Johnson Outdoors | N/A                | N/A           |
| 4      | GPS Antenna     | Humminbird       | AS GR50 GPS module | 10102742-0165 |
| 5      | 12Vdc Battery   | AUTOCRAFT        | M24-1              | N/A           |

Table 3.3-2: Cable Description

| Cable # | Cable Type       | Length | Shield | Termination       |
|---------|------------------|--------|--------|-------------------|
| A       | Signal cable     | 1m     | No     | 1 - junction      |
| B       | Power cable      | 1.8m   | No     | 5 - junction      |
| C       | Signal cable     | 6m     | No     | 4 - junction      |
| D       | Ground braid     | 1m     | No     | Junction - ground |
| E       | Transducer cable | 6m     | No     | 1 - 2             |
| F       | Transducer cable | 1m     | No     | 2 - 3             |

### 3.4 Observations

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

Table 3.4-1: Observations

| <u>Observation No.</u> | <u>Description</u> |
|------------------------|--------------------|
|                        |                    |
|                        |                    |
|                        |                    |
|                        |                    |
|                        |                    |
|                        |                    |

## 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:

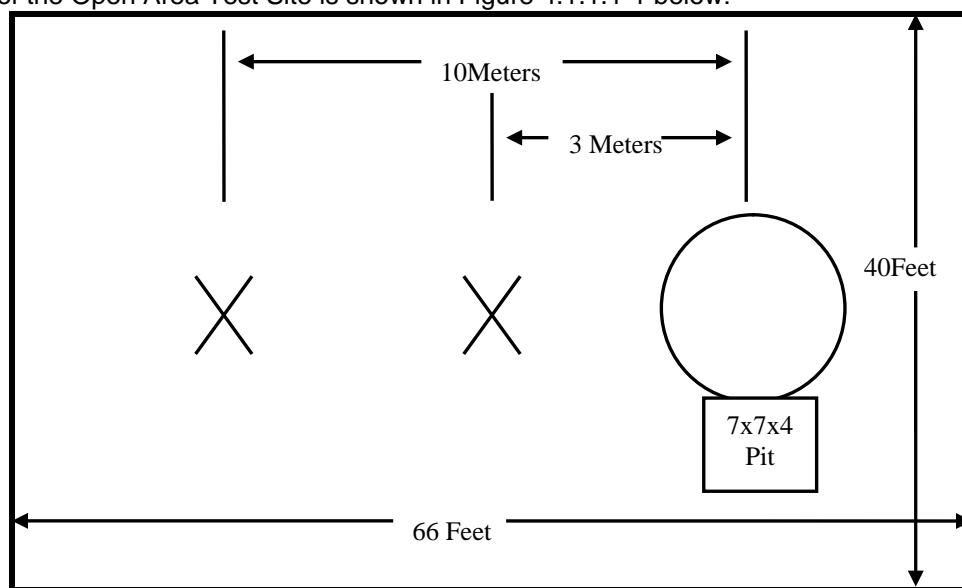


Figure 4.1.1.1-1: Open Area Test Site

#### 4.1.1.2 Semi-Anechoic Chamber

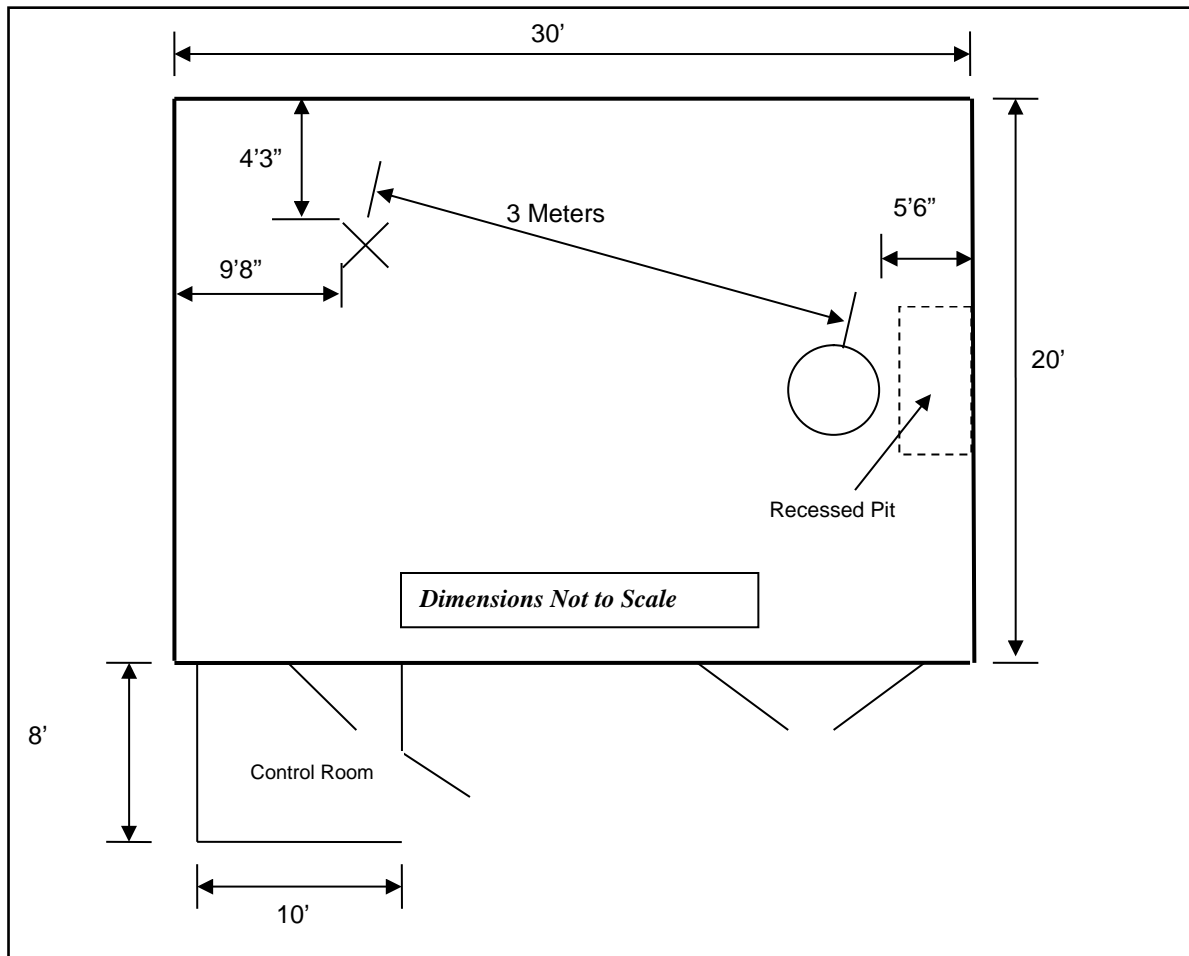
The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 4" x 4" x 3/4" thick and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly 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:

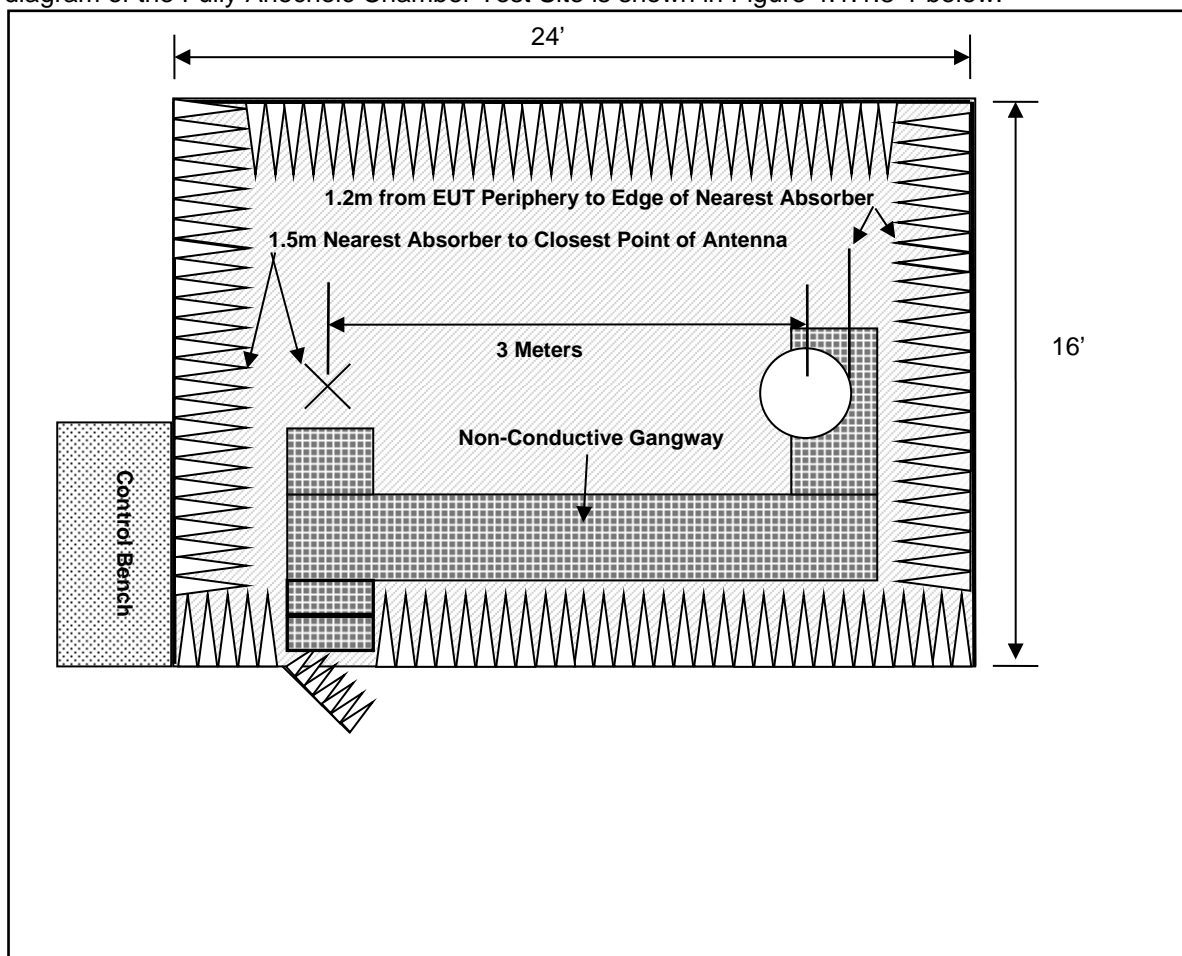


Figure 4.1.1.3-1: Fully Anechoic Chamber Test Site

#### 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     | Fluke           | 8010A                 | Meters             | 3385330    | NCR                   | NCR                  |
| 204     | ACS             | 204                   | Cables             | 204        | NCR                   | NCR                  |
| 167     | ACS             | Chamber EMI Cable Set | Cable Set          | 167        | 10/28/2014            | 10/28/2015           |
| 628     | EMCO            | 6502                  | Antennas           | 9407-2877  | 2/7/2014              | 2/7/2016             |
| 40      | EMCO            | 3104                  | Antennas           | 3211       | 2/14/2013             | 2/14/2015            |
| 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. Final emission testing on Class B equipment can be performed either in the 3m Semi-Anechoic chamber described in section 4.1.2 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 90° 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 – 1GHz. 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:

$$\begin{aligned} \text{Corrected Reading} &= \text{Analyzer Reading} + \text{Cable Loss} + \text{Antenna Factor} \\ \text{Margin(dB)} &= \text{Applicable Limit} - \text{Corrected Reading} \end{aligned}$$

##### 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

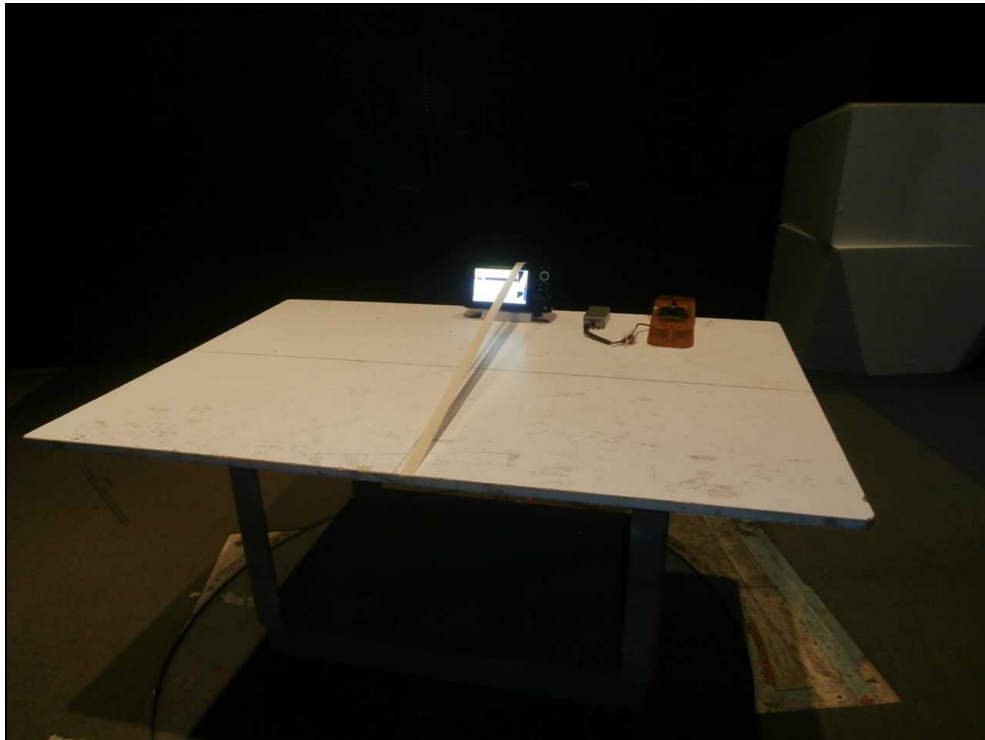


Figure 4.1.4-1: Radiated Emissions - Front View



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:**

|                         |   |                                   |             |
|-------------------------|---|-----------------------------------|-------------|
| <b>Test Date:</b>       | <b>January 5, 2015</b>                        | <b>Temperature (°C)</b>           | <b>22</b>   |
| <b>Technician:</b>      | <b>Art Sumner</b>                             | <b>Humidity (%)</b>               | <b>35</b>   |
| <b>Equipment Class:</b> | <b>Class B</b>                                | <b>Barometric Pressure (mBar)</b> | <b>1031</b> |
| <b>Tested Modes:</b>    | <b>Powered on; monitoring depth and speed</b> |                                   |             |
| <b>AC Input Power:</b>  | <b>N/A</b>                                    |                                   |             |
| <b>DC Input Power:</b>  | <b>12Vdc</b>                                  |                                   |             |

**Test Data Table:**

| Measurement Distance:  |                          |        |                              |                           |                              |                               |                             |        |                   |        |                |        |
|--|--------------------------|--------|------------------------------|---------------------------|------------------------------|-------------------------------|-----------------------------|--------|-------------------|--------|----------------|--------|
| <input type="checkbox"/> 1 Meter <input checked="" type="checkbox"/> 3 Meter <input type="checkbox"/> 10 Meter |                          |        |                              |                           |                              |                               |                             |        |                   |        |                |        |
| Frequency<br>(MHz)   | Measured Level<br>(dBuV) |        | Antenna<br>Polarity<br>(H/V) | Antenna<br>Height<br>(cm) | Turntable<br>Position<br>(°) | Correction<br>Factors<br>(dB) | Corrected Level<br>(dBuV/m) |        | Limit<br>(dBuV/m) |        | Margin<br>(dB) |        |
|  | Pk                       | Qpk/Av |                              |                           |                              |                               | Pk                          | Qpk/Av | Pk                | Qpk/Av | Pk             | Qpk/Av |
| 30.1   | 36.75                    | 32.15  | v                            | 100                       | 0                            | -13.22                        | -----                       | 18.93  | -----             | 54.0   | -----          | 35.1   |
| 40.38  | 51.28                    | 30.73  | v                            | 100                       | 0                            | -14.69                        | -----                       | 16.04  | -----             | 54.0   | -----          | 38.0   |
| 40.76  | 44.43                    | 29.41  | v                            | 100                       | 0                            | -14.68                        | -----                       | 14.73  | -----             | 54.0   | -----          | 39.3   |
| 42.08  | 34.27                    | 32.25  | v                            | 100                       | 0                            | -14.66                        | -----                       | 17.59  | -----             | 54.0   | -----          | 36.4   |
| 59.46  | 41.86                    | 23.95  | v                            | 100                       | 0                            | -14.03                        | -----                       | 9.92   | -----             | 54.0   | -----          | 44.1   |
| 70.42  | 33.94                    | 30.45  | v                            | 100                       | 0                            | -17.03                        | -----                       | 13.42  | -----             | 54.0   | -----          | 40.6   |
| 240  | 35.05                    | 30.78  | v                            | 100                       | 0                            | -13.50                        | -----                       | 17.28  | -----             | 54.0   | -----          | 36.7   |
| 472.88   | 31.60                    | 23.49  | v                            | 100                       | 0                            | -6.08                         | -----                       | 17.41  | -----             | 54.0   | -----          | 36.6   |
| 157.31   | 32.92                    | 27.27  | v                            | 100                       | 0                            | -10.68                        | -----                       | 16.59  | -----             | 24.0   | -----          | 7.4    |

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

AV = Average Measurement or Limit (>1GHz)

**Notes:** No emissions of concern 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:

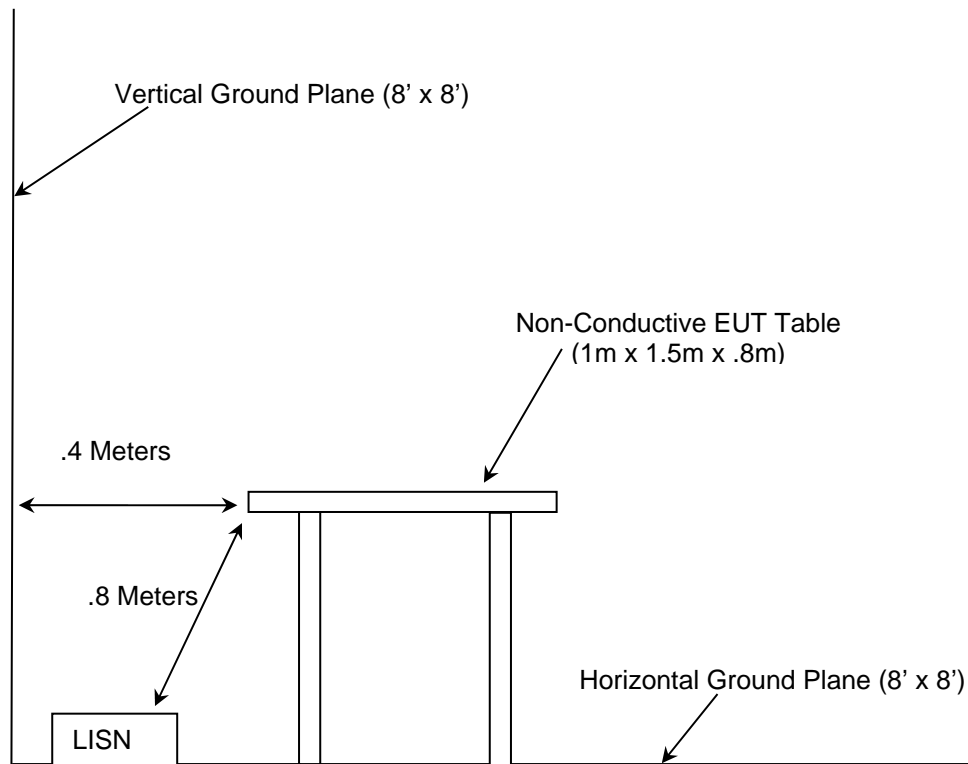


Figure 4.2.1-1: AC Mains Conducted EMI Site

#### 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 |
|---------|-----------------|-----------|----------------|------------|-----------------------|----------------------|
| 168     | Hewlett Packard | 11947A    | Attenuators    | 44829      | 1/19/2015             | 1/19/2016            |
| 324     | ACS             | Belden    | Cables         | 8214       | 6/4/2014              | 6/4/2015             |
| 316     | Rohde Schwarz   | ESH3-Z5   | LISN           | 861189-010 | 10/30/2014            | 10/30/2015           |
| RE361   | Agilent         | AT/E7405A | Analyzers      | MY42000089 | 5/30/2014             | 5/30/2015            |
| 321     | Hewlett Packard | HPC 8447D | Amplifiers     | 1937A02809 | 7/14/2014             | 7/14/2015            |

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:

$$\begin{aligned}\text{Corrected Reading} &= \text{Analyzer Reading} + \text{LISN Loss} + \text{Cable Loss} \\ \text{Margin} &= \text{Applicable Limit} - \text{Corrected Reading}\end{aligned}$$

##### 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

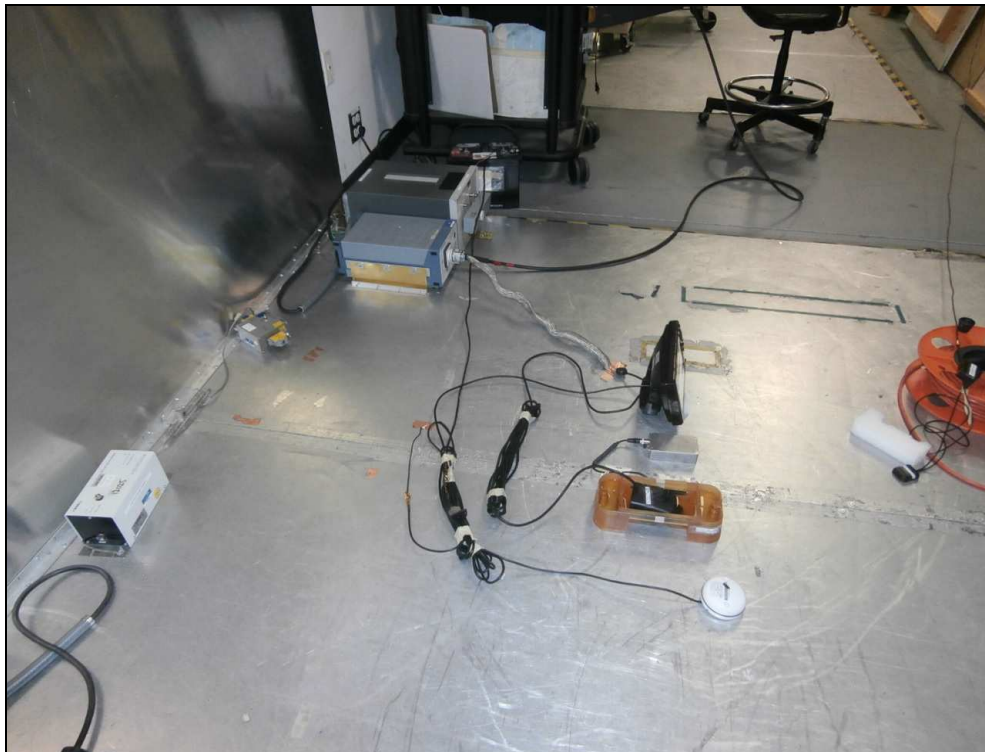


Figure 4.2.4-2: Conducted Emissions Test Setup – Side View

**4.2.5 Test Data**

Tabulated data is given in the Test Data Tables below.

**Test Parameters:**

|                         |  |                                   |             |
|-------------------------|--|-----------------------------------|-------------|
| <b>Test Date:</b>       | <b>January 15, 2015</b>                                    | <b>Temperature (°C)</b>           | <b>26</b>   |
| <b>Technician:</b>      | <b>Art Sumner</b>  | <b>Humidity (%)</b>               | <b>34</b>   |
| <b>Equipment Class:</b> | <b>Class B</b>   | <b>Barometric Pressure (mBar)</b> | <b>1016</b> |
| <b>Tested Modes:</b>    | <b>Powered on; Monitoring depth, speed, GPS connection</b> |                                   |             |
| <b>AC Input Power:</b>  | <b>N/A</b>   |                                   |             |
| <b>DC Input Power:</b>  | <b>12Vdc Battery</b>                                       |                                   |             |

**Tested Leads:**

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

**Test Data Tables:**

| <b>Check All That Apply to This Data</b><br><input checked="" type="checkbox"/> Line 1 <input type="checkbox"/> Line 2<br><input type="checkbox"/> Line 3 <input type="checkbox"/> Line 4<br><input type="checkbox"/> To Ground <input checked="" type="checkbox"/> Floating<br><input type="checkbox"/> Telecom Port _____<br><input checked="" type="checkbox"/> dBµV <input type="checkbox"/> dBµA<br><b>Power Supply Description: 12Vdc</b> |                     |         |                              |                 |         |            |         |             |         |
|---|---------------------|---------|------------------------------|-----------------|---------|------------|---------|-------------|---------|
| Frequency (MHz)   | Uncorrected Reading |         | Total Correction Factor (dB) | Corrected Level |         | Limit      |         | Margin (dB) |         |
|   | Quasi-Peak          | Average |                              | Quasi-Peak      | Average | Quasi-Peak | Average | Quasi-Peak  | Average |
| 0.011   | 9.92                | 6.83    | 15.16                        | 25.08           | 21.99   | 94.3811321 | 66.00   | 69.3        |         |
| 0.0368  | 24.89               | 23.67   | 11.19                        | 36.08           | 34.86   | 73.8696918 | 66.00   | 37.8        |         |
| 0.073   | 20.23               | 17.26   | 10.49                        | 30.72           | 27.75   | 62.2354429 | 66.00   | 31.5        |         |
| 0.0802  | 18.17               | 10.74   | 10.45                        | 28.62           | 21.19   | 60.6377405 | 66.00   | 32.0        |         |
| 0.096   | 16.06               | 8.45    | 10.42                        | 26.48           | 18.87   | 57.5833721 | 66.00   | 31.1        |         |
| 0.15  | 13.28               | 5.51    | 10.37                        | 23.65           | 15.88   | 50.0030709 | 66.00   | 26.4        |         |
| 1.25  | 24.63               | 23.42   | 10.19                        | 34.82           | 33.61   | 50         | 60.00   | 15.2        |         |

**Notes:**

**Check All That Apply to This Data**

☐ Line 1 ☒ Line 2  
☐ Line 3 ☐ Line 4  
☐ To Ground ☒ Floating  
☐ Telecom Port \_\_\_\_\_  
☒ dB $\mu$ V ☐ dB $\mu$ A

**Power Supply Description:** 12Vdc

| Frequency (MHz) | Uncorrected Reading |         | Total Correction Factor (dB) | Corrected Level |         | Limit      |         | Margin (dB) |         |
|-----------------|---------------------|---------|------------------------------|-----------------|---------|------------|---------|-------------|---------|
|                 | Quasi-Peak          | Average |                              | Quasi-Peak      | Average | Quasi-Peak | Average | Quasi-Peak  | Average |
| 0.011           | 11.66               | 7.41    | 15.16                        | 26.82           | 22.57   | 94.3811321 | 66.00   | 67.6        |         |
| 0.0368          | 17.04               | 14.53   | 11.19                        | 28.23           | 25.72   | 73.8696918 | 66.00   | 45.6        |         |
| 0.076           | 13.08               | 4.78    | 10.49                        | 23.57           | 15.27   | 61.5513804 | 66.00   | 38.0        |         |
| 0.081           | 13.06               | 4.79    | 10.45                        | 23.51           | 15.24   | 60.4691509 | 66.00   | 37.0        |         |
| 0.093           | 12.12               | 4.05    | 10.42                        | 22.54           | 14.47   | 58.1226319 | 66.00   | 35.6        |         |
| 1.252           | 27.17               | 25.92   | 10.19                        | 37.36           | 36.11   | 50         | 60.00   | 12.6        |         |

**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 | 2/20/2014             | 2/20/2015            |
| 144     | Omega        | RH411     | Climate Monitoring Equipment | H0103373 | 7/24/2014             | 7/24/2016            |
| RE80    | Tektronix    | TDS 784C  | Oscilloscope                 | 7846     | 7/30/2013             | 7/30/2015            |
| 371     | Fluke        | Fluke 115 | Meters                       | 93872717 | 7/10/2014             | 7/10/2016            |

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 negative 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

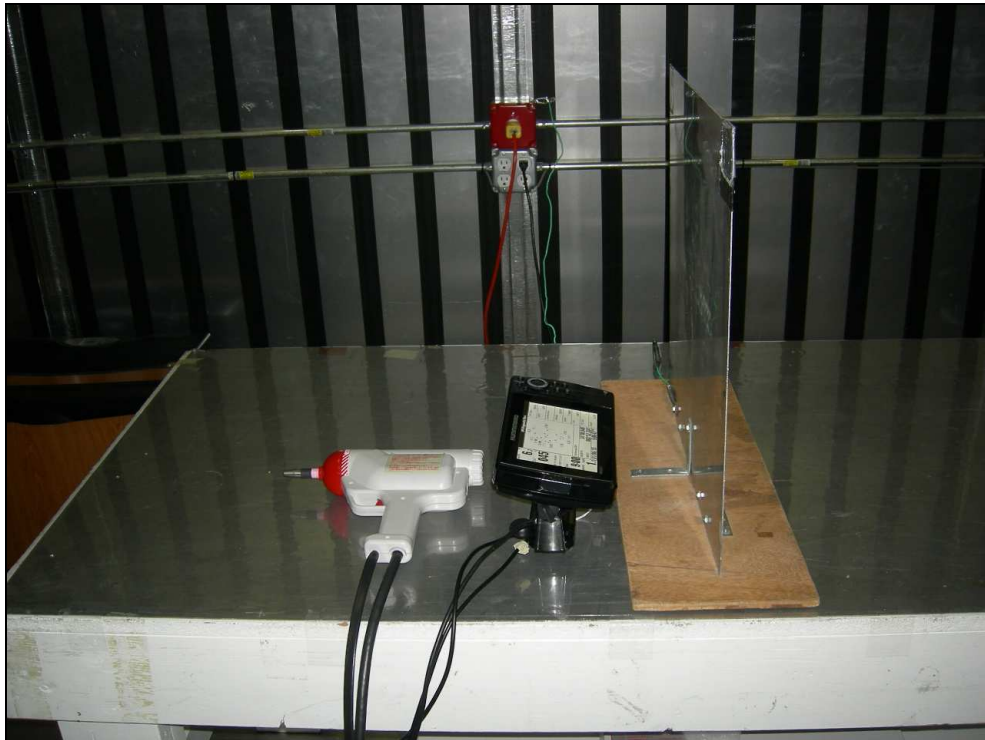
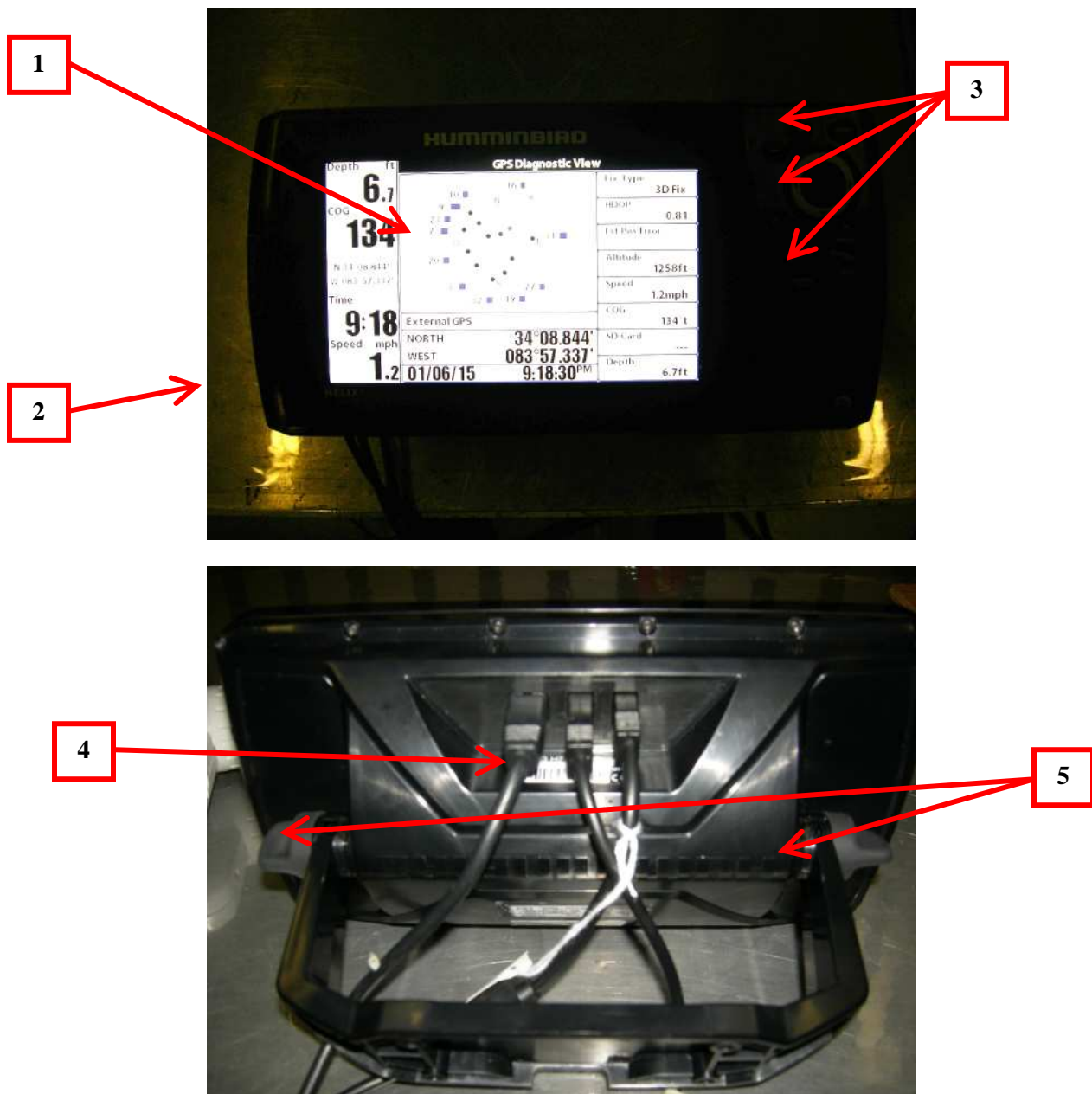


Figure 7.4-1: Test Setup Photograph

## 7.5 ESD Data Sheet

## Test Point Photograph:



## Test Point Selection:

| TEST POINT# | DESCRIPTION                     | TYPE (C/A) | TEST POINT# | DESCRIPTION                  | TYPE (C/A) |
|-------------|---------------------------------|------------|-------------|------------------------------|------------|
| 1           | Display screen center and edges | Air        | 4           | Molded connectors and cables | Air        |
| 2           | Cabinet edges and seem          | Air        | 5           | Mounting knob                | Air        |
| 3           | Buttons                         | Air        |             |                              |            |

## 7.6 Test Data

## Test Parameters:

|                  |                           |                            |           |
|------------------|---------------------------|----------------------------|-----------|
| Test Date:       | January 6, 2015           | Temperature (°C)           | 21        |
| Technician:      | Wayne Orwig               | Humidity (%)               | 34        |
| Equipment Class: | N/A                       | Barometric Pressure (mBar) | 1022      |
| Tested Modes:    | GPS and transducer active |                            |           |
| AC Input Power:  | N/A                       | VCP Resistor Value Check:  | 949k ohms |
| DC Input Power:  | 12Vdc Battery             | HCP Resistor Value Check:  | 936k ohms |

## Indirect Contact Discharge:

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

## Notes:

## Air and Direct Contact Discharge:

| 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   |   |

## Notes:

## 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    | 10/30/2014            | 10/30/2015           |
| 329     | A.H.Systems                     | SAS-571           | Antennas                     | 721       | 7/15/2013             | 7/15/2015            |
| 370     | IFI                             | CMX5002           | Amplifier                    | L364-0407 | NCR                   | NCR                  |
| 642     | Fairview Microwave              | FMC0101951-200CM  | Cables                       | N/A       | NCR                   | NCR                  |
| 326     | ACS                             | EMI Cable Set-FAC | Cables                       | 326       | 7/18/2014             | 7/18/2015            |
| 354     | ETS Lindgren                    | 3142C             | Antennas                     | 78838     | NCR                   | NCR                  |
| 1112    | Wandel & Goltermann             | BN2244/21         | Probes                       | H0006     | 11/11/2014            | 11/11/2015           |
| 1201    | Wandel & Goltermann             | 2244/99.22        | Probes                       | W-0004    | 11/11/2014            | 11/11/2015           |
| 494     | Omega                           | iBTHX-W           | Climate Monitoring Equipment | 9460211   | 8/12/2014             | 8/12/2016            |
| RE89    | Amplifier Research              | 25S1G4A           | Amplifiers                   | 324609    | NCR                   | NCR                  |
| 564     | United Microwave Products, Inc. | AO-190-00.36.0    | Cables                       | 564       | 7/18/2014             | 7/18/2015            |

**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 1kHz 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

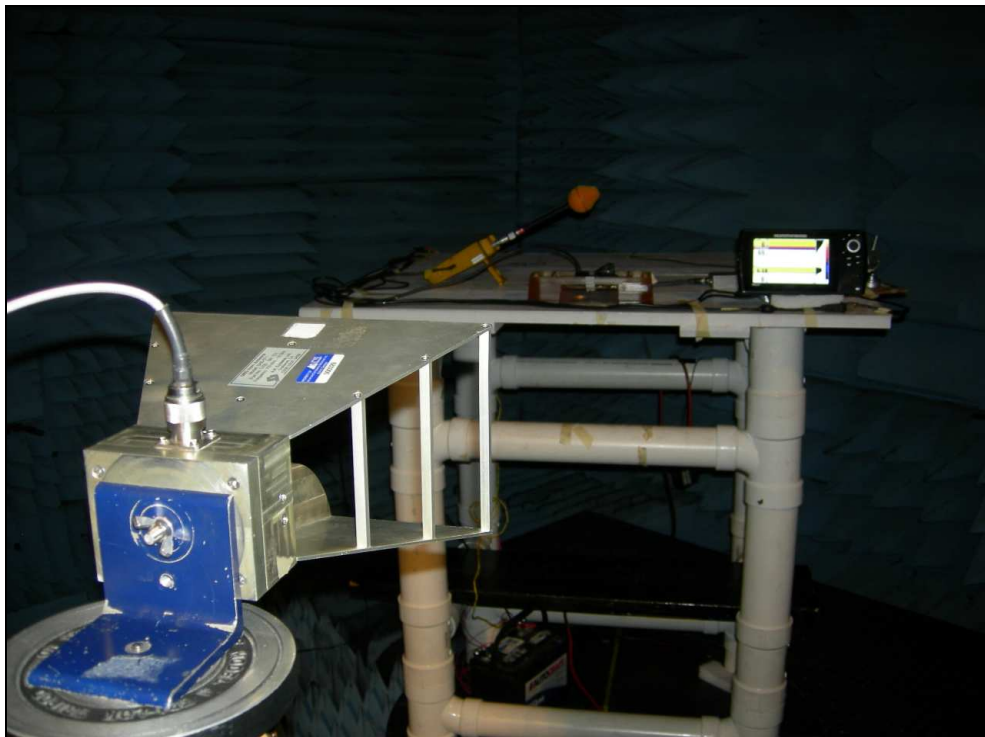


Figure 8.4-2: Test Setup Photograph

## 8.5 Test Results

## Test Parameters:

|                  |   |                            |      |
|------------------|---|----------------------------|------|
| Test Date:       | January 5, 2015   | Temperature (°C)           | 23   |
| Technician:      | Art Sumner / Sean Vick                                    | Humidity (%)               | 34   |
| Equipment Class: | N/A   | Barometric Pressure (mBar) | 1029 |
| Tested Modes:    | Monitoring depth, speed, temperature, and GPS coordinates |                            |      |
| AC Input Power:  | N/A   |                            |      |
| DC Input Power:  | 12Vdc Battery   |                            |      |

## Test Data:

| Check All That Apply to This Data   |  |   |   |
|---|--|---|---|
| <b>Polarity</b><br><input type="checkbox"/> Horizontal<br><input type="checkbox"/> Vertical<br><input checked="" type="checkbox"/> Both | <b>Field Strength:</b><br><input type="checkbox"/> 3V/m<br><input checked="" type="checkbox"/> 10V/m<br><input type="checkbox"/> 8V/m<br><input type="checkbox"/> Enter Other Level Here | <b>Freq. Band:</b><br><input checked="" type="checkbox"/> 80-1000MHz<br><input type="checkbox"/> 80-2700MHz<br><input type="checkbox"/> Enter Other Band Here | <b>Dwell Time</b><br><input type="checkbox"/> 1 Second<br><input checked="" type="checkbox"/> 3 Seconds<br><input type="checkbox"/> Enter Other |
| Azimuth   | Result   | Observation (Describe any detectable event)   |   |
| 0   | Pass   |   |   |
| 90  | Pass   |   |   |
| 180   | Pass   |   |   |
| 270   | Pass   |   |   |

## Notes:

400Hz modulation to a depth of 80%

## Test Data:

| Check All That Apply to This Data   |  |  |   |
|---|--|--|---|
| <b>Polarity</b><br><input type="checkbox"/> Horizontal<br><input type="checkbox"/> Vertical<br><input checked="" type="checkbox"/> Both | <b>Field Strength:</b><br><input type="checkbox"/> 3V/m<br><input checked="" type="checkbox"/> 10V/m<br><input type="checkbox"/> 8V/m<br><input type="checkbox"/> Enter Other Level Here | <b>Freq. Band:</b><br><input type="checkbox"/> 80-1000MHz<br><input type="checkbox"/> 80-2700MHz<br><input checked="" type="checkbox"/> 1.0-2.0GHz | <b>Dwell Time</b><br><input type="checkbox"/> 1 Second<br><input type="checkbox"/> 3 Seconds<br><input checked="" type="checkbox"/> 8.6 Seconds |
| Azimuth   | Result   | Observation (Describe any detectable event)  |   |
| 0   | Pass   |  |   |
| 90  | Pass   |  |   |
| 180   | Pass   |  |   |
| 270   | Pass   |  |   |

## Notes:

400Hz modulation to a depth of 80%



## 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            |
| 494     | Omega          | iBTHX-W   | Climate Monitoring Equipment | 9460211  | 8/12/2014             | 8/12/2016            |
| 336     | Tektronix      | TDS 1012B | Scopes                       | C010189  | 7/12/2014             | 7/12/2015            |
| 611     | Teseq          | INA 265B  | Attenuators                  | 73054    | 9/12/2013             | 9/12/2015            |
| 503     | Key Tek        | TC-50     | Cables                       | n/a      | 12/30/2014            | 12/30/2015           |

**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

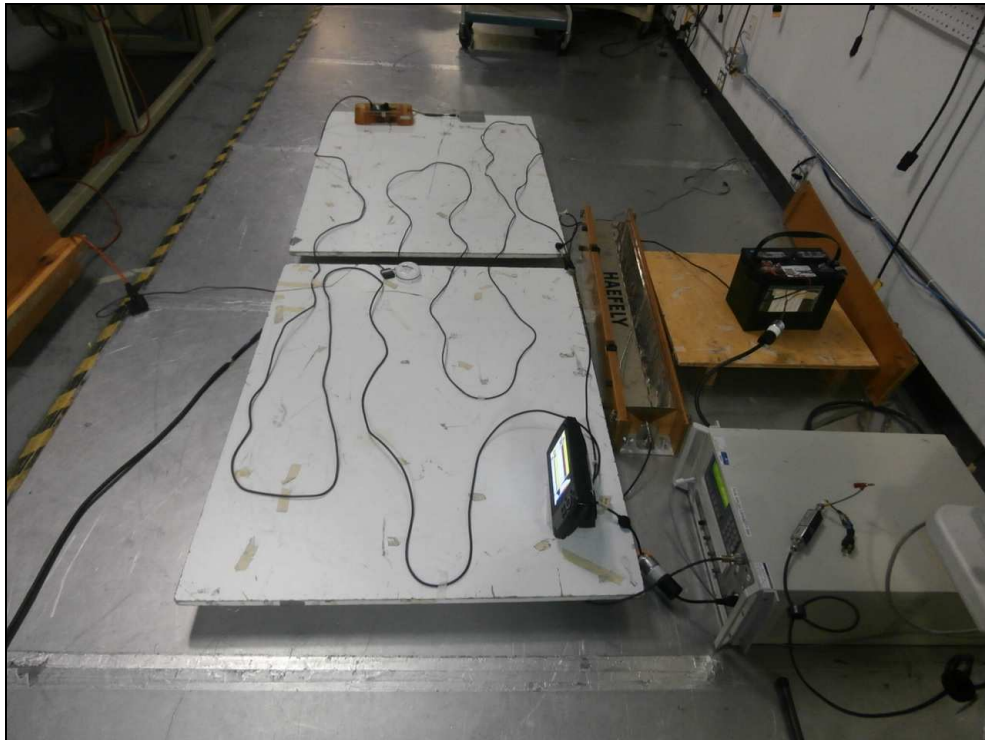


Figure 9.4-1: Test Setup Photograph



Figure 9.4-2: Test Setup Photograph

## 9.5 Test Results

## Test Parameters:

|                  |                              |                            |      |
|------------------|------------------------------|----------------------------|------|
| Test Date:       | January 6, 2015              | Temperature (°C)           | 22   |
| Technician:      | Wayne Orwig                  | Humidity (%)               | 30   |
| Equipment Class: | N/A                          | Barometric Pressure (mBar) | 1022 |
| Tested Modes:    | GPS and transducer operating |                            |      |
| AC Input Power:  | N/A                          |                            |      |
| DC Input Power:  | 12Vdc                        |                            |      |

## Mains Test Data:

| Check All That Apply to This Data   |  |  |
|---|--|--|
| Polarity:<br><input type="checkbox"/> Positive<br><input type="checkbox"/> Negative<br><input checked="" type="checkbox"/> Both | Tested Levels:<br><input checked="" type="checkbox"/> .5kV<br><input type="checkbox"/> 1kV<br><input type="checkbox"/> 2kV<br><input type="checkbox"/> | Interface Type:<br><input checked="" type="checkbox"/> Input<br><input type="checkbox"/> Output<br><input type="checkbox"/> Both |
| Coupling Mode   | Result   | Observation (Describe any detectable event)  |
| L1  | Pass   |  |
| L2  | Pass   |  |
| L1-L2   | Pass   |  |

## Notes:

## Signal Line Test Data:

| Check All That Apply to This Data   |  |   |
|---|--|---|
| Polarity:<br><input type="checkbox"/> Positive<br><input type="checkbox"/> Negative<br><input checked="" type="checkbox"/> Both | Tested Levels:<br><input checked="" type="checkbox"/> .25kV<br><input checked="" type="checkbox"/> .5kV<br><input type="checkbox"/> 1kV<br><input type="checkbox"/> 2kV<br><input type="checkbox"/> Enter Other Level Here |   |
| Signal Line   | Result   | Observation (Describe any detectable event) |
| GPS cable   | Pass   |   |
| Transducer cable  | Pass   |   |

## Notes:

## 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 |
|---------|-------------------------|------------------|--------------------|-----------|-----------------------|----------------------|
| 370     | IFI                     | CMX5002          | Amplifier          | L364-0407 | NCR                   | NCR                  |
| 251     | Rohde & Schwarz         | SML03            | Signal Generators  | 102116    | 10/30/2014            | 10/30/2015           |
| 425     | ACS                     | EMC Cable Set    | Cable Set          | 425       | NCR                   | NCR                  |
| 642     | Fairview Microwave      | FMC0101951-200CM | Cables             | N/A       | NCR                   | NCR                  |
| 624     | Advantest               | R3261C           | Spectrum Analyzers | 31720426  | NCR                   | NCR                  |
| 471     | Bird Technologies Group | 150-A-FFN-06     | Attenuators        | 914       | NCR                   | NCR                  |
| 457     | Com Power               | CDN-M2-25        | Coupler            | 511023    | 10/29/2014            | 10/29/2015           |
| 364     | Amplifier Research      | DC2600A          | Coupler            | 322466    | NCR                   | NCR                  |
| 181     | COM-POWER               | m1-25            | CDN's              | 501001    | NCR                   | NCR                  |
| 93      | Chase                   | 8101             | Clamp              | 65        | 5/7/2014              | 5/7/2015             |

NCR = No Calibration Required

### 11.3 Test Methodology

IEC 61000-4-6 3<sup>rd</sup> 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 1kHz AM sine wave, pausing to adjust the RF signal level or to switch coupling devices as necessary. The rate of sweep shall not exceed  $1.5 \times 10^{-3}$  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

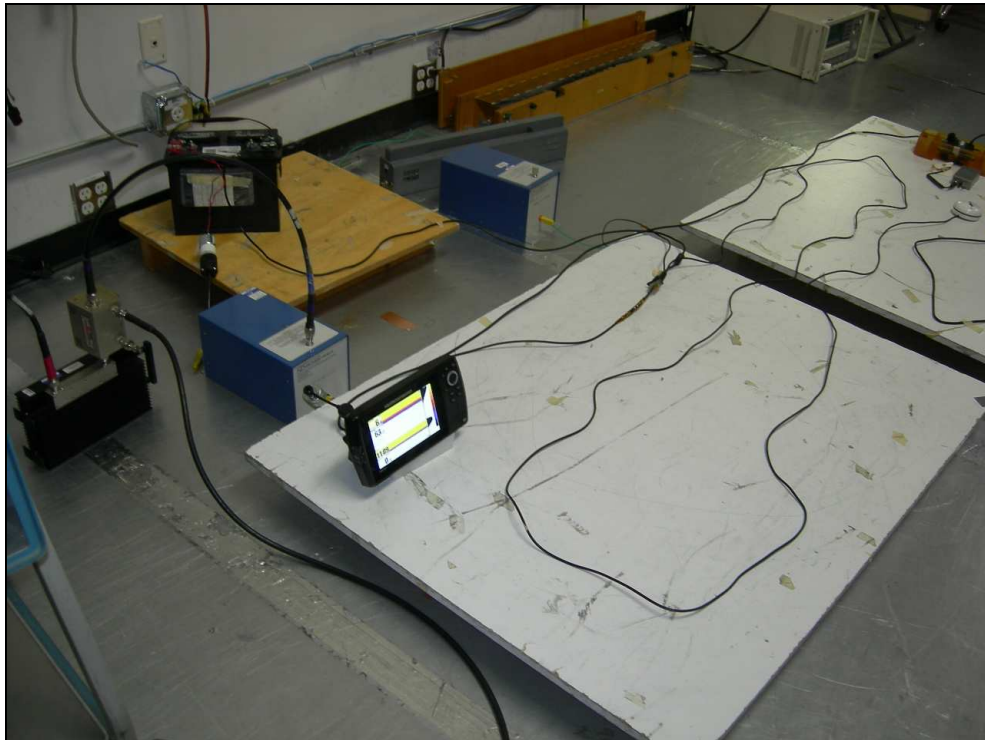


Figure 11.4-1: Test Setup Photograph

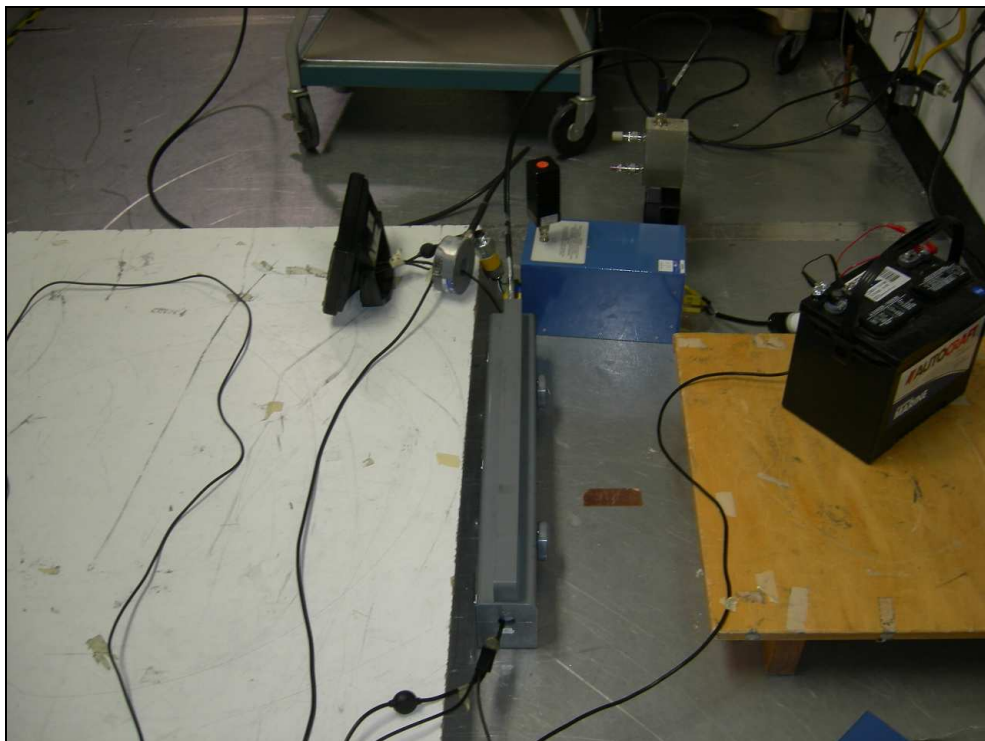


Figure 11.4-2: Test Setup Photograph

## 11.5 Test Results

## Test Parameters:

|                  |   |                            |      |
|------------------|---|----------------------------|------|
| Test Date:       | January 6, 2015   | Temperature (°C)           | 22   |
| Technician:      | Tommy Payton  | Humidity (%)               | 30   |
| Equipment Class: | N/A   | Barometric Pressure (mBar) | 1023 |
| Tested Modes:    | Monitoring Depth 6.7" & Graphics, Temperature, GPS, Time and Speed at 0mph. |                            |      |
| AC Input Power:  | N/A   |                            |      |
| DC Input Power:  | 12Vdc   |                            |      |

## Mains Test Data:

| Check All That Apply to This Data   |   |   |
|---|---|---|
| Test Level:<br><input checked="" type="checkbox"/> 3Vrms<br><input type="checkbox"/> 10Vrms<br><input type="checkbox"/> 15Vrms<br><input type="checkbox"/> Enter Other Level Here | Freq. Band:<br><input checked="" type="checkbox"/> .150-80MHz<br><input type="checkbox"/> Enter Other Band Here |   |
| Coupling Mode   | Result  | Observation (Describe any detectable event) |
| CDN   | Pass  |   |

## Notes:

Spot frequency test at 10Vrms for 2.0, 3.0, 4.0, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz. All at 400Hz AM@80%.

## Signal Line Test Data:

| Check All That Apply to This Data   |   |  |
|---|---|--|
| Test Level:<br><input checked="" type="checkbox"/> 3Vrms<br><input type="checkbox"/> 10Vrms<br><input type="checkbox"/> 15Vrms<br><input type="checkbox"/> Enter Other Level Here | Freq. Band:<br><input checked="" type="checkbox"/> .150-80MHz<br><input type="checkbox"/> Enter Other Band Here |  |
| Signal Line   | Result  | Observation (Describe any detectable event)  |
| GPS Cable   | Pass  | Graphics have noise from around 150k to 280kHz. Depth, Temperature, GPS, Time and Speed function properly. |
| Transducer Cable  | Pass  | Graphics have noise from around 150k to 630kHz. Depth, Temperature, GPS, Time and Speed function properly. |

## Notes:

Spot frequency test at 10Vrms for 2.0, 3.0, 4.0, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz. All at 400Hz AM@80%.

## 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.

## **Appendix A: Model Variants**

**ACS Report: 15-0004.C08.1B**  
**Report Revision: B**  
**Report Issue Date: May 6, 2015**

The same display is used on all models. Sonar components change values for the various models.. Sonar only models don't populate the GPS and SD circuitry.

|                            |                             |
|----------------------------|-----------------------------|
| <b>HELIX 7x SONAR ,</b>    | <b>2dSonar Only</b>         |
| <b>HELIX 7x DI ,</b>       | <b>DI Sonar Only</b>        |
| <b>HELIX 7x SONAR GPS,</b> | <b>2dSonar / GPS Combo</b>  |
| <b>HELIX 7x DI GPS,</b>    | <b>DI Sonar / GPS Combo</b> |
| <b>HELIX 7x XD GPS ,</b>   | <b>XD Sonar / GPS Combo</b> |
| <b>HELIX 7x SI GPS ,</b>   | <b>SI Sonar / GPS Combo</b> |
| <b>HELIX 7x GPS,</b>       | <b>GPS Only</b>             |