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# EMC Technical Report

## Prepared For: Johnson Outdoors Marine Electronics, Inc

## Model Covered: Helix 7 CHIRP SI GPS G2N

**Model Variants: Helix 7 SONAR G2, Helix 7X SONAR G2, Helix 7 CHIRP DI G2, Helix 7X CHIRP DI G2, Helix 7 CHIRP GPS G2, Helix 7X CHIRP GPS G2, Helix 7 CHIRP DI GPS G2, Helix 7X CHIRP DI GPS G2, Helix 7X CHIRP SI GPS G2, Helix 7 CHIRP SI GPS G2, Helix 7 CHIRP GPS G2N, Helix 7X CHIRP GPS G2N, Helix 7 CHIRP DI GPS G2N, Helix 7X CHIRP DI GPS G2N, Helix 7X CHIRP SI GPS G2N, Helix 7X GPS G2, Helix 7 SI GPS NAV PLUS, ICE Helix 7 CHIRP GPS G2, ICE Helix 7X CHIRP GPS G2**

**In Accordance with:**
**Radio Equipment Directive (RED) – 2014/53/EU**

**Product Standard: EN 301 489-19 V2.1.0, EN 55032:2012, and EN 55024:2010 with respect to EN 301 489-1 V2.2.0 (Guide EG203367 V1.1.1)**

**Report Number: AT72128131.2R3**
**Report Revision: D**
**Report Issue Date: September 6, 2017**

**This report contains Page 44 pages**

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REVISION HISTORY
Report Number: AT72128131.2R3
Manufacturer: Johnson Outdoors Marine Electronics, Inc
Model: Helix 7 CHIRP SI GPS G2N

| DATE | OLD REVISION | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY |
|---|---|---|---|---|---|
| July 17, 2017 | --- | A | Initial Release | All | Forrest Duncan |
| July 28, 2017 | A | B | Revised model covered and variants, and product description | 1, 3, 4, 5, 7, 9, 13 | Forrest Duncan |
| July 31, 2017 | B | C | Revised model name in Scope | 7 | Forrest Duncan |
| September 6, 2017 | C | D | Corrected EN 301 489-1 standard revision and added EN 55032:2012 and EN 55024:2010 product standards | 1, 7, 8 | Steve O'Steen |
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# Project Information Sheet

## Applicant Details

**Manufacturer:** Johnson Outdoors Marine Electronics, Inc
**Street Address:** 678 Humminbird Ln
**City, State/Province and Postal Code:** Eufaula, AL 36027
**Country:** USA
**Contact:** Nancy Rimedio

**Phone:** (770) 888-6292 x1049
**Fax:**
**Email:** nrimedio@johnsonoutdoors.com

## Sample Information

**Model:** Helix 7 CHIRP SI GPS G2N
**Model Variant(s):** Helix 7 SONAR G2, Helix 7X SONAR G2, Helix 7 CHIRP DI G2, Helix 7X CHIRP DI G2, Helix 7 CHIRP GPS G2, Helix 7X CHIRP GPS G2, Helix 7 CHIRP DI GPS G2, Helix 7X CHIRP DI GPS G2, Helix 7X CHIRP SI GPS G2, Helix 7 CHIRP SI GPS G2, Helix 7 CHIRP GPS G2N, Helix 7X CHIRP GPS G2N, Helix 7 CHIRP DI GPS G2N, Helix 7X CHIRP DI GPS G2N, Helix 7X CHIRP SI GPS G2N, Helix 7X GPS G2, Helix 7 SI GPS NAV PLUS, ICE Helix 7 CHIRP GPS G2, ICE Helix 7X CHIRP GPS G2
**Environment of Use:** Residential
**Sample Receive Date:** May 19, 2017
**Sample Receive Condition:** Good
**Test Mode Description:** EUT is tested monitoring GSP, Depth and Temperature
**Unacceptable Degradation (Provided by Mfg.):** If the device fails to recover (i.e. GPS/Sonar Operation) upon reboot.
**Highest Data Rate:** 800 MHz
**Source:** Microcontroller

## Product Description

The Humminbird Helix 7 CHIRP SI GPS G2N (410340-1) is a fishfinder/GPS product with side imaging sonar capability. It is comprised of a keypad, LCD display, micro SD card slot, internal GPS, Bluetooth capability, Ethernet capability, transducer and power cable. All G2N CHIRP model variations are built exactly the same. The G2 CHIRP variations do not have Ethernet or Bluetooth populated. They differ by installed options, SELV circuits, languages and packaging. The only difference in the -1 (7) and -1M (7X) models are languages included in the model. The differences of -1 and -1NAV is only in packaging. Other differences will be listed below.

| | |
|---|---|
| 410270-1 | Helix 7 SONAR G2 does not have GPS circuitry populated |
| 410270-1M | Helix 7X SONAR G2 does not have GPS circuitry populated |
| 410280-1 | Helix 7 CHIRP DI G2 does not have GPS circuitry populated |
| 410280-1M | Helix 7X CHIRP DI G2 does not have GPS circuitry populated |
| 410290-1 | Helix 7 CHIRP GPS G2 |
| 410290-1M | Helix 7X CHIRP GPS G2 |
| 410300-1 | Helix 7 CHIRP DI GPS G2 |
| 410300-1M | Helix 7X CHIRP DI GPS G2 |
| 410310-1 | Helix 7 CHIRP SI GPS G2 |
| 410310-1M | Helix 7X CHIRP SI GPS G2 |
| 410320-1 | Helix 7 CHIRP GPS G2N |
| 410320-1M | Helix 7X CHIRP GPS G2N |
| 410330-1 | Helix 7 CHIRP DI GPS G2N |

| | |
|---|---|
| 410330-1M | Helix 7X CHIRP DI GPS G2N |
| 410340-1M | Helix 7X CHIRP SI GPS G2N |
| 410350-1M | Helix 7X GPS G2 does not have any sonar circuitry populated |
| 409850-1NAV | Helix 7 SI GPS NAV PLUS |
| 410440-1 | ICE Helix 7 CHIRP GPS G2 |
| 410440-1M | ICE Helix 7X CHIRP GPS G2 |

# Test Information

**Test Start Date:** May 25, 2017
**Test End Date:** June 12, 2017
**Emissions Pre-scan Site:** SAC
**Final Emissions Site:** SAC
**EMI Freq. Band:** 150KHz-6GHz
**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. 2.0
☐ 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 301 489-19 V2.1.0, EN 55032:2012, and EN 55024:2010 with respect to EN 301 489-1 V2.2.0 and details the results of testing performed on May 25, 2017 through June 12, 2017 on the model Helix 7 CHIRP SI GPS G2N manufactured by Johnson Outdoors Marine Electronics, Inc.

The purpose of this test report is to document the gap analysis testing performed on the Helix 7 CHIRP SI GPS G2N to bring it into compliance with the current RE Directive and applicable product standards. The original test data can be found in ACS report number 15-0383.C09.2A.

### 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 301 489-1 V2.2.0 | Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements | Pass |
| EN 301 489-19 V2.1.0 | ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band (ROGNSS) providing positioning, navigation, and timing data; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU | Pass |
| EN 55032:2012 | Electromagnetic compatibility of multimedia equipment – Emission requirements | Pass |
| EN 55024:2010 | Information technology equipment – Immunity characteristics – Limits and methods of measurement | Pass |
| EN 61000-3-2:2014 | Electromagnetic compatibility (EMC) -- Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase) | N/A |
| EN 61000-3-3:2013 | 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 301 489-19/EN 55024** | |
| 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. 2.0 | 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 = Test Not Applicable to this EUT N/P = Not Performed. See Test Justification for Details

## 1.4 Performance Criteria

### 1.4.1 Emissions Performance Criteria

For model Helix 7 CHIRP SI GPS G2N the limits which apply are shown in Table 1.4.1-1 below:

**Table 1.4.1-1 Emissions Limits Class B**

| Emission Type | Frequency Range (MHz) | Quasi-Peak/Peak[4] Limits | Average Limits |
|---|---|---|---|
| Conducted Class B (Mains Port) (dBµV) | 0.15 to 0.50 | 66 to 56[1] | 56 to 46[1] |
| | 0.50 to 5.00 | 56 | 46 |
| | 5.00 to 30.0 | 60 | 50 |
| Conducted Class B (Telecom Ports) | 0.15 to 0.50 | 84 to 74 (V)[1,2]<br>40 to 30 (I)[1,3] | 74 to 64 (V)[1,2]<br>30 to 20 (I)[1,3] |
| | 0.50 to 30 | 87 (V)[2]<br>43 (I)[3] | 74 (V)[2]<br>30 (I)[3] |
| Radiated Class B at 3 Meters (dBµV/m) | 30.0 to 230.0 | 40.5 | |
| | 230.0 to 1000.0 | 47.5 | |
| | 1000 to 3000 | 70 | 50 |
| | 3000 to 6000 | 74 | 54 |

1 - Decreases Linearly with Logarithm of Frequency **Note: Lower Limit Applies at Transition Frequency**
2 – (V) Indicates voltage limits in dBµV
3 – (I) Indicates current limits in dBµA
4 – Limits <1GHz are Quasi-Peak and Peak >1GHz

### 1.4.2 Harmonic Current Emissions Criteria

Harmonic current emissions for Class A equipment must not exceed the levels as given in table 1.4.2-1 below:

**Table 1.4.2-1**

| Harmonic Order (n) | Maximum Permissible Harmonic Current (A) |
|---|---|
| **Odd Harmonics** | |
| **3** | **2.30** |
| **5** | **1.14** |
| **7** | **0.77** |
| **9** | **0.40** |
| **11** | **0.33** |
| **13** | **0.21** |
| **15 ≤ n ≤ 39** | **0.15(15/n)** |
| **Even Harmonics** | |
| **2** | **1.08** |
| **4** | **0.43** |
| **6** | **0.30** |
| **8 ≤ n ≤ 40** | **0.23(8/n)** |

### 1.4.3 Voltage Fluctuations & Flicker Criteria

The following limits apply:

- The value of $P_{ST}$ shall not be greater than 1.0
- The value of $P_{LT}$ shall not be greater than .65
- The relative steady-state voltage change, $d_c$, shall not exceed 3.3%
- The maximum voltage change, $d_{max}$, shall not exceed 4%
- The relative voltage change characteristics value of d(t) during a voltage change shall not exceed 3.3% for more that 200mS.

Where:

- $P_{ST}$ is the short term flicker indicator. The flicker severity is evaluated over a short period (in minutes). $P_{ST}$ = 1 is the conventional threshold of irritability.
- $P_{LT}$ is the long term flicker indicator. The flicker severity is evaluated over a long period (in hours) using successive $P_{ST}$ values.
- d(t), $d_{max}$ and $d_c$ are ratios of the absolute magnitudes to the phase-to-neutral values of the nominal voltages.

### 1.4.4 Immunity Performance Criteria

**General performance criteria**

If the EUT is of a non specialized nature or the EUT is combined with an ancillary equipment, the test modulation, test arrangements, etc. as required in clause 4 shall apply.
The EUT, for all immunity tests according to the present document, except the spot frequency test of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2), shall be assessed for:
• the storage of messages in the memory of the EUT at the start of the test;
• unintentional responses of the EUT during the test;
• the maintenance of the EUT memory assessed at the conclusion of the test;
• the ability to receive and store messages at the conclusion of the test.
For the spot frequency test of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2) the EUT shall be assessed by monitoring the accuracy of the call received alert signal.

**Performance criteria for Continuous phenomena applied to ROMES and ROGNSS receivers (CR)**

For the EUT, excluding spot frequency tests as part of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2):
• the general performance criteria set out in clause 6.1;
• during the test no false calls shall occur;
• at the conclusion of the test comprising the series of individual exposures the EUT shall operate as intended with no loss of functions or stored data (messages), as declared by the manufacturer.
For the spot frequency test as part of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2) the EUT shall be assessed by monitoring the accuracy of the call received alert signal.

**Performance criteria for Transient phenomena applied to ROMES and ROGNSS receivers (TR)**

For the EUT:
• the general performance criteria set out in clause 6.1;
• during the test no false calls shall occur;
• at the conclusion of the test comprising the series of individual exposures, the EUT shall operate as intended with no loss of function and/or stored data (messages), as declared by the manufacturer.

**Performance criteria for equipment which does not provide a continuous communication link**

The provision of ETSI EN 301 489-1 [1], clause 6.3 shall apply with the following modifications.

For EUTs of a specialized nature and/or ancillary equipment tested on a stand alone basis the manufacturer shall define the method of test to determine the acceptable level of performance or degradation of performance during and/or after the test. Under these circumstances the manufacturer will also provide the following information:

• the primary functions of the equipment to be tested during and after EMC stress;
• the intended functions of the EUT which shall be in accordance with the documentation accompanying the equipment;
• the pass/failure criteria for the equipment;
• the method of observing a degradation of performance of the equipment.

The assessment of the performance or the degradation of performance which shall be carried out during and/or at the conclusion of the tests, shall be simple, but at the same time give adequate proof that the primary functions of the equipment are operational.

# 2.0 Test Facilities & Environment

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

TÜV SÜD America Inc.
5015 B.U. Bowman Drive
Buford GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598
www.TUVamerica.com

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

### 2.2 Laboratory Accreditations/Recognitions/Certifications
TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by the ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. 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

All test equipment was operated within climate specifications as defined by the manufacturer.

### 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, Inc
678 Humminbird Ln
Eufaula, AL 36027
Nancy Rimedio
(770) 888-6292 x1049
nrimedio@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 <u>were not</u> required to bring the EUT into compliance with the requirements.**<br>☐ **Modifications <u>were</u> required to bring the EUT into compliance with the requirements.** |

### 3.3 System Block Diagram and Support Equipment

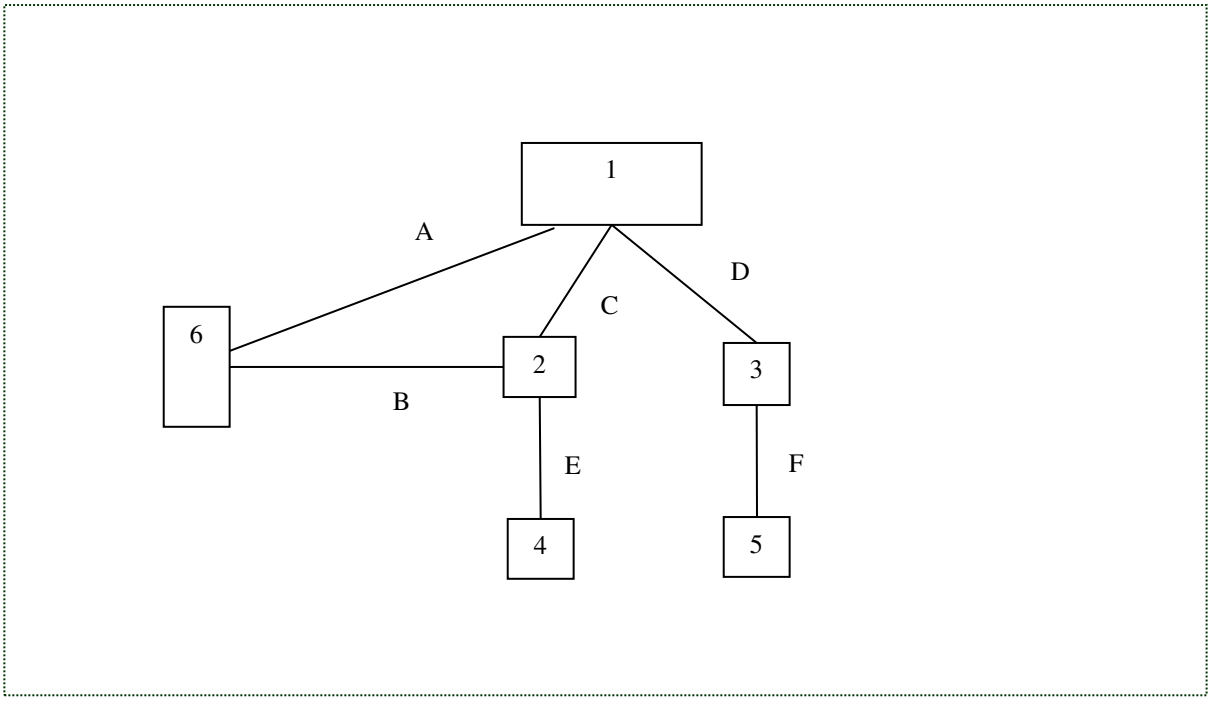


**Table 3.3-1: EUT and Support Equipment Description**

| Item # | Type Device | Manufacturer | Model/Part # | Serial # |
|---|---|---|---|---|
| 1 | EUT | Johnson Outdoors | Helix 7 CHIRP SI GPS G2N | 15090903-0010 |
| 2 | Spliter | Johnson Outdoors | N/A | N/A |
| 3 | Transducer | Johnson Outdoors | N/A | ACS 4 |
| 4 | Antenna | Johnson Outdoors | GR50 | 10102742-0165 |
| 5 | Depth Simulator | Johnson Outdoors | N/A | ACS 5 |
| 6 | Battery | AutoCraft | 12VDC | 4G03AHIS |

**Table 3.3-2: Cable Description**

| Cable # | Cable Type | Length | Shield | Termination |
|---|---|---|---|---|
| A | Power | 180cm | No | 1 - 6 |
| B | Power | 180cm | No | 2 - 6 |
| C | GPS | 100cm | No | 1 - 2 |
| D | Transducer | 600cm | No | 1 - 3 |
| E | GPS | 600cm | No | 2 - 4 |
| F | Simulator | 40cm | N0 | 3 - 5 |

### 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 |
|---|---|
| | |
| | |
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# 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:

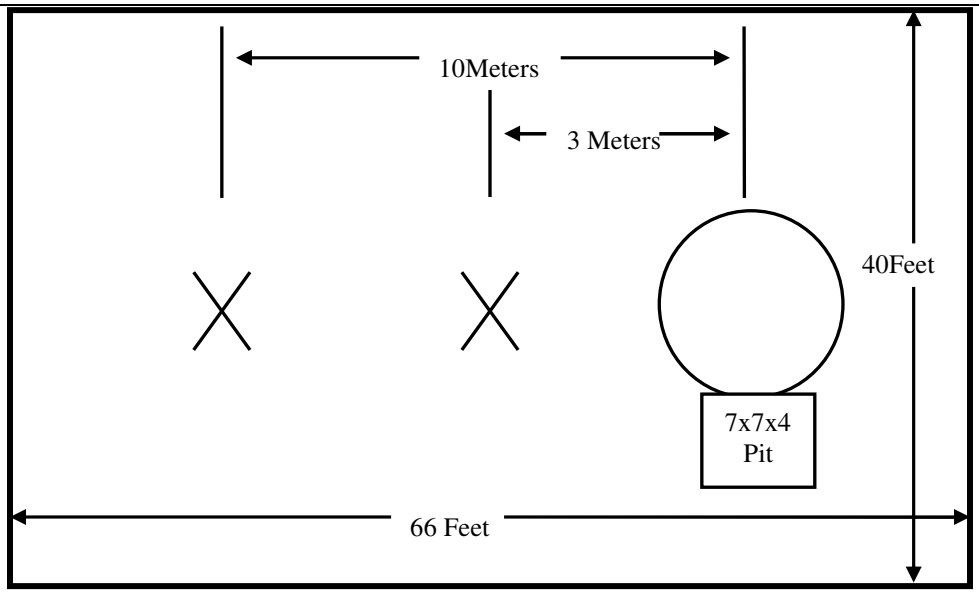



**Figure 4.1.1.1-1: Open Area Test Site**

### 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:

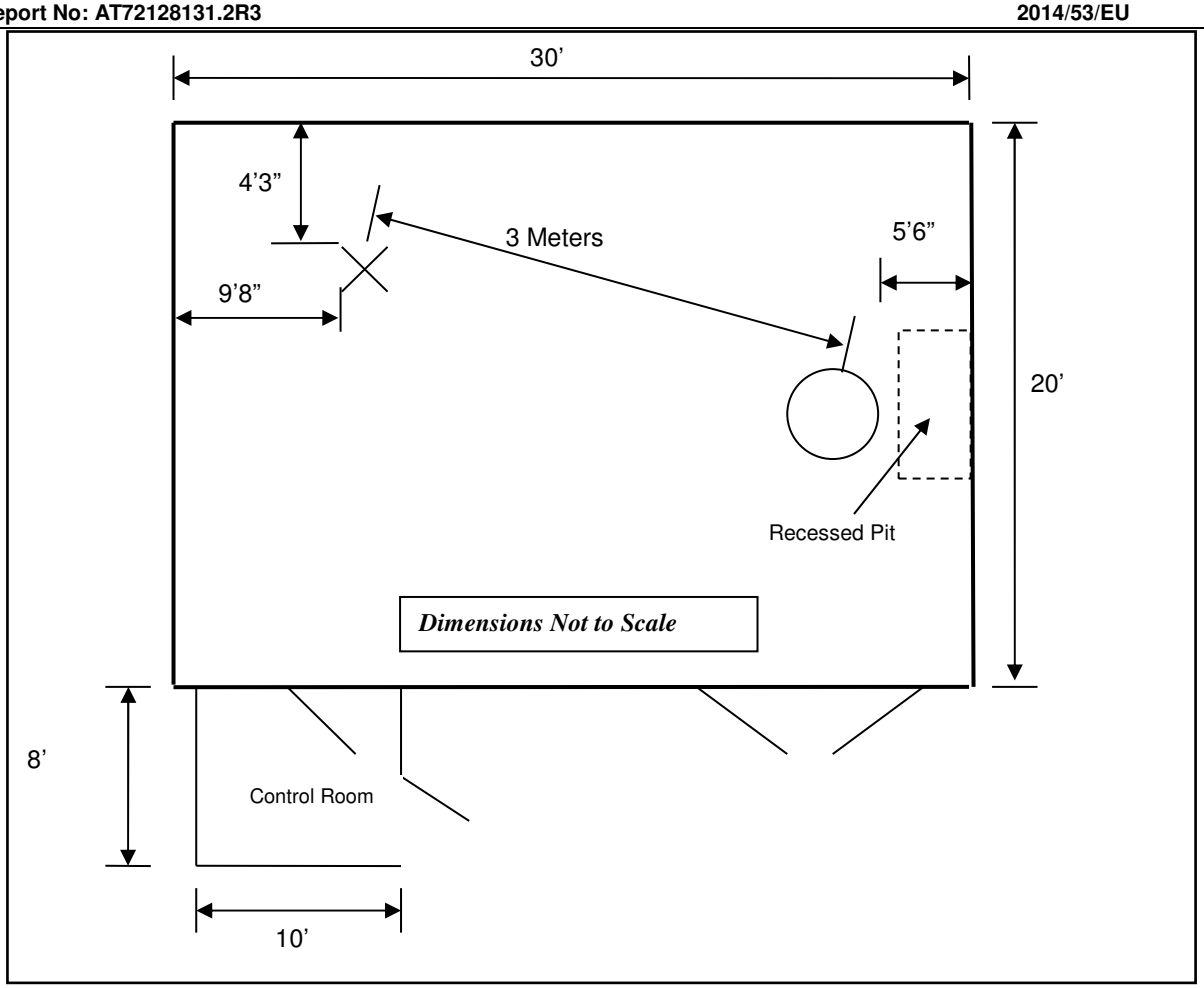



**Figure 4.1.1.2-1: Semi-Anechoic Chamber Test Site**

**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:

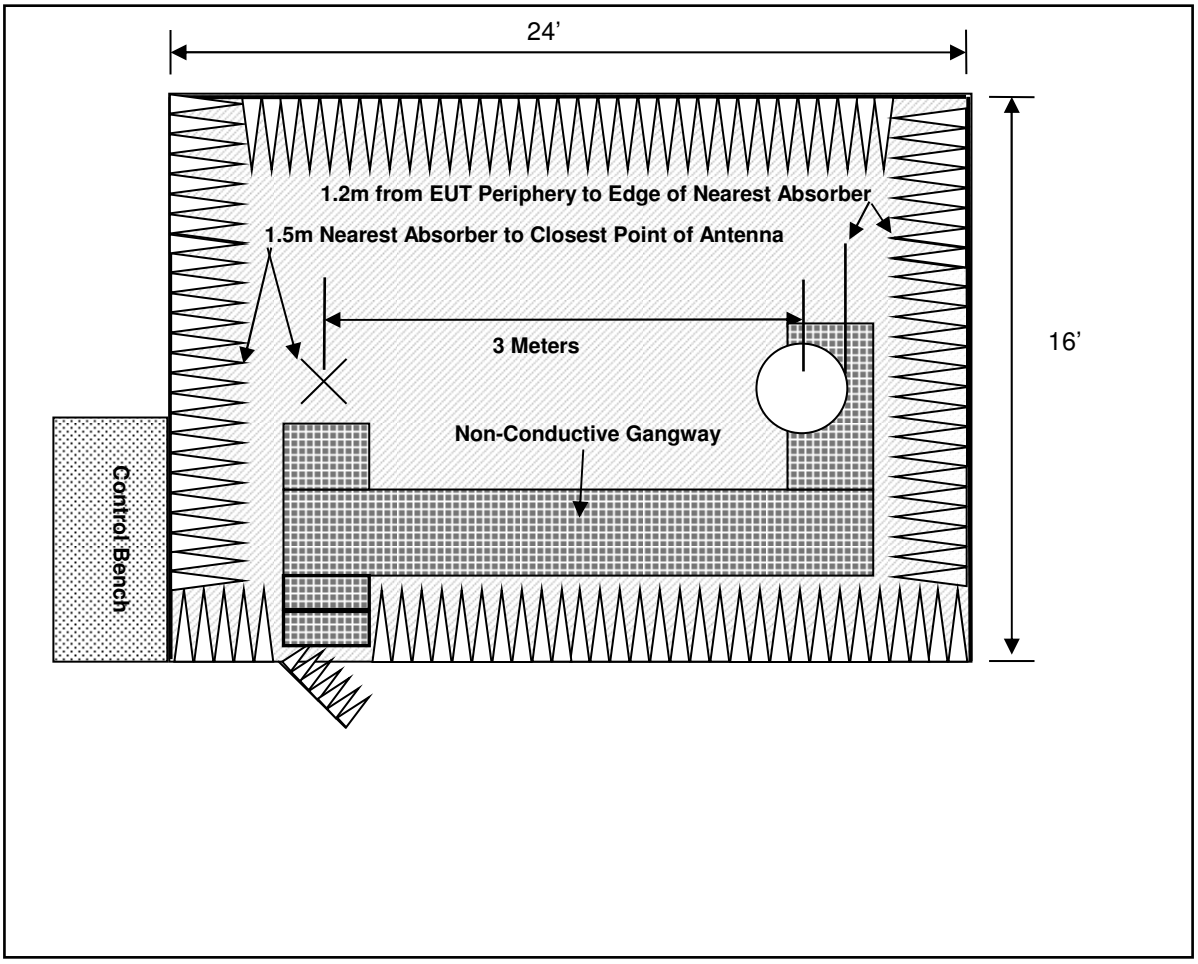



**Figure 4.1.1.3-1: Fully Anechoic Chamber Test Site**

### 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**

**Semi-Anechoic Chamber**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **40** | EMCO | 3104 | Antennas | 3211 | 6/8/2016 | 6/8/2018 |
| **73** | Agilent | 8447D | Amplifiers | 2727A05624 | 7/21/2016 | 7/21/2017 |
| **167** | ACS | Chamber EMI Cable Set | Cable Set | 167 | 9/30/2016 | 9/30/2017 |
| **412** | Electro Metrics | LPA-25 | Antennas | 1241 | 8/8/2016 | 8/8/2018 |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **RE135** | Rohde & Schwarz | FSP30 | Spectrum Analyzers | 835618/031 | 10/31/2016 | 10/31/2017 |

**Semi-Anechoic Chamber High Frequency**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **30** | Spectrum Technologies | DRH-0118 | Antennas | 970102 | 5/9/2017 | 5/9/2019 |
| **338** | Hewlett Packard | 8449B | Amplifiers | 3008A01111 | 8/21/2015 | 8/21/2017 |
| **422** | Florida RF | SMS-200AW-72.0-SMR | Cables | 0805 | 10/27/2016 | 10/27/2017 |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **616** | Florida RF Cables | SMRE-200W-12.0-SMRE | Cables | N/A | 9/2/2016 | 9/2/2017 |
| **676** | Florida RF Labs | SMS-290AW-480.0-SMS | Cables | MFR2Y194 | 11/4/2016 | 11/4/2017 |
| **RE135** | Rohde & Schwarz | FSP30 | Spectrum Analyzers | 835618/031 | 10/31/2016 | 10/31/2017 |

**Fully Anechoic Chamber**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **321** | Hewlett Packard | HPC 8447D | Amplifiers | 1937A02809 | 7/21/2016 | 7/21/2017 |
| **326** | ACS | EMI Cable Set-FAC | Cables | 326 | 7/21/2016 | 7/21/2017 |
| **354** | ETS Lindgren | 3142C | Antennas | 00078838 | NCR | NCR |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **812** | PMM | 9030 | Receiver | 121WW30401 | 2/6/2017 | 2/6/2018 |
| **813** | PMM | 9010 | Receiver | 697WW30606 | 2/6/2017 | 2/6/2018 |

**Open Area Test Site**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **90** | Electro-Metrics | LPA25 | Antennas | 1476 | 12/10/2015 | 12/10/2017 |
| **193** | ACS | OATS Cable Set | Cable Set | 0193 | 7/21/2016 | 7/21/2017 |
| **211** | Eagle | C7RFM3NFNM | Filters | HLC-700 | 10/13/2016 | 10/13/2017 |
| **213** | TEC | PA 102 | Amplifiers | 44927 | 8/8/2016 | 8/8/2017 |
| **486** | Hewlett Packard | 8591E | Analyzers | 3543A04709 | 7/12/2016 | 7/12/2017 |
| **544** | ETS Lindgren | 3110B | Antennas | 3361 | 12/7/2015 | 12/7/2017 |

**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 30MHz to 6GHz. 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

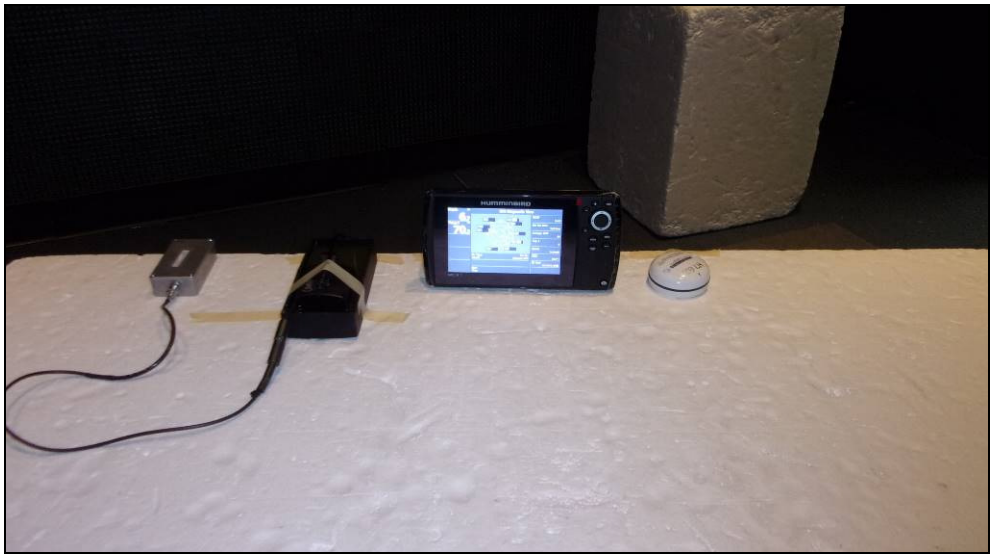


**Figure 4.1.4-1: Radiated Emissions - Front View**

**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:** | **5/25/2017** | **Temperature (ºC)** | **24** |
| **Technician:** | **Wayne Orwig** | **Humidity (%)** | **37** |
| **Equipment Class:** | **B** | **Barometric Pressure (mBar)** | **1009** |
| **Tested Modes:** | **GPS, transducer & remote display active** | | |
| **AC Input Power:** | **N/A** | | |
| **DC Input Power:** | **12Vdc** | | |

**Test Data Table:**

**Measurement Distance:**

☐ FAC ☒ SAC ☐ OATS
☐ 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 |
| **30.624** | | 48.37 | V | 100 | 22 | -12.37 | --------- | 36.00 | -------- | 40.5 | --------- | 4.5 |
| **47.08** | | 45.81 | H | 173 | 74 | -13.92 | --------- | 31.89 | -------- | 40.5 | --------- | 8.6 |
| **77.192** | | 54.55 | V | 100 | 183 | -17.63 | --------- | 36.92 | -------- | 40.5 | --------- | 3.5 |
| **79.264** | | 54.08 | V | 100 | 202 | -17.76 | --------- | 36.32 | -------- | 40.5 | --------- | 4.1 |
| **81.2** | | 53.48 | V | 100 | 186 | -17.54 | --------- | 35.94 | -------- | 40.5 | --------- | 4.5 |
| **97.1** | | 39.98 | V | 100 | 90 | -13.52 | --------- | 26.46 | -------- | 40.5 | --------- | 14.0 |

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

**Notes:**

## 4.2 Conducted Emissions

### 4.2.1 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:**

**The EUT is DC powered and does not include Telecommunication lines; therefore, this test is not applicable.**

# 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# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **144** | Omega | RH411 | Climate Monitoring Equipment | H0103373 | 9/1/2016 | 9/1/2018 |
| **371** | Fluke | Fluke 115 | Meters | 93872717 | 7/14/2016 | 7/14/2018 |
| **582** | Kikusui | KES4021A | ESD Gun | SA003046 | 5/12/2017 | 5/12/2018 |

**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 301 489-19 V2.1.0 requires performance criterion B to be met as described in section 1.4.4

### 7.3.2 Test Justification

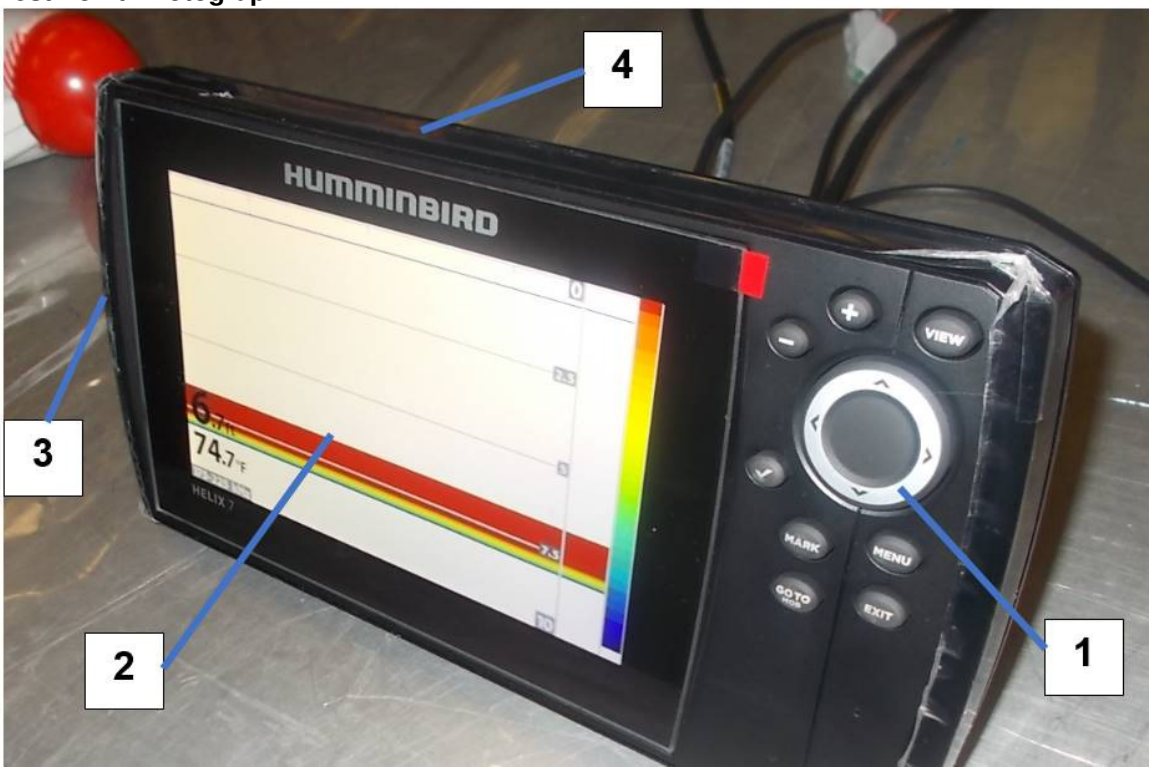
☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

### 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) |
|---|---|---|
| 1 | Control buttons / Power button | **Air** |
| 2 | LCD screen | **Air** |
| 3 | Seam on casing | **Air** |
| 4 | Seam on casing | **Air** |

## 7.6 Test Data

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **6/2/17** | **Temperature (ºC)** | **27** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **31** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1016** |
| | | ☒ **Pre-test Verification Complete** | |
| **Tested Modes:** | **Powered ON, tracking satellites from simulator** | | |
| **AC Input Power:** | **N/A** | **VCP Resistor Value Check:** | **958K Ohms** |
| **DC Input Power:** | **12Vdc** | **HCP Resistor Value Check:** | **959K 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 | |

**Notes:**

**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 | |

**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# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **197** | Amplifier Research | DC6080 | Coupler | 307006 | NCR | NCR |
| **354** | ETS Lindgren | 3142C | Antennas | 00078838 | NCR | NCR |
| **370** | IFI | CMX5002 | Amplifier | L364-0407 | NCR | NCR |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **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 |
| **642** | Fairview Microwave | FMC0101951-200CM | Cables | N/A | NCR | NCR |
| **711** | Hewlett Packard | 8648B | Signal Generators | 3623A01926 | 7/25/2016 | 7/25/2017 |
| **1112** | Wandel & Goltermann | BN2244/21 | Probes | H0006 | 12/9/2016 | 12/9/2017 |

**High Frequency**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **329** | A.H. Systems | SAS-571 | Antennas | 721 | 7/22/2015 | 7/22/2017 |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **564** | United Microwave Products, Inc. | AO-190-00.36.0 | Cables | 564 | 7/29/2016 | 7/29/2017 |
| **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 |
| **684** | Rohde & Schwarz | SML03 | Signal Generators | 103503 | 8/19/2016 | 8/19/2017 |
| **1112** | Wandel & Goltermann | BN2244/21 | Probes | H0006 | 12/9/2016 | 12/9/2017 |
| **1115** | Varian | VZC6961G1 | Amplifier | 884 | NCR | NCR |
| **1116** | Varian | VZM6991G5 | Amplifier | 1147 | NCR | NCR |
| **RE89** | Amplifier Research | 25S1G4A | Amplifier | 0324609 | NCR | NCR |

**Semi-Anechoic Chamber**

| AssetID | Manufacturer | Model# | Equipment Type | Serial# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **354** | ETS Lindgren | 3142C | Antennas | 00078838 | NCR | NCR |
| **370** | IFI | CMX5002 | Amplifier | L364-0407 | NCR | NCR |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **619** | Teledyne Storm Microwave | 90-195-456 | Cables | 13-10-601 | 10/20/2016 | 10/20/2017 |
| **620** | Teledyne Storm Microwave | 90-195-456 | Cables | 13-10-602 | 10/20/2016 | 10/20/2017 |
| **624** | Advantest | R3261C | Spectrum Analyzers | 31720426 | NCR | NCR |
| **1112** | Wandel & Goltermann | BN2244/21 | Probes | H0006 | 12/9/2016 | 12/9/2017 |

**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 301 489-19 V2.1.0 requires criterion A to be met as described in section 1.4.4.

#### 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:** | **5/31/17** | **Temperature (ºC)** | **21** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **40** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1020** |
| **Tested Modes:** | **Powered ON; GPS active** | | |
| **AC Input Power:** | **N/A** | ☒ **Pre-test Verification Complete** | |
| **DC Input Power:** | **12Vdc battery** | | |

**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 | ☐ 80-6000MHz | ☒ 3 Seconds |
| ☒ Both | ☐ 8V/m | ☐ Enter Other Band Here | ☐ Enter Other |
| | ☐ Enter Other Level Here | | |

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

**Notes:**
**Spot frequencies also tested:**
**80 MHz;**
**104 MHz;**
**136 MHz;**
**165 MHz;**
**200 MHz;**
**260 MHz;**
**330 MHz;**
**430 MHz;**
**560 MHz;**
**715 MHz ± 1 MHz;**
**Vector Signal Generator level = -75.1 dBm**
**Distance = 300 cm**

**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 | ☒ 80-6000MHz | ☒ 3 Seconds |
| ☒ Both | ☐ 8V/m | ☐ Enter Other Band Here | ☐ Enter Other |
| | ☐ Enter Other Level Here | | |

| Azimuth | Result | Observation (Describe any detectable event) |
|---|---|---|
| 0 | Pass | Lost GPS fix around 1.580 GHz, recovered by itself after RFI went past the 1.580 GHz range |
| 180 | Pass | Lost GPS fix around 1.580 GHz, recovered by itself after RFI went past the 1.580 GHz range |

**Notes:**
**Spot frequencies also tested:**
**80 MHz;**
**104 MHz;**
**136 MHz;**
**165 MHz;**
**200 MHz;**
**260 MHz;**
**330 MHz;**
**430 MHz;**
**560 MHz;**
**715 MHz ± 1 MHz;**
**Vector Signal Generator level = -75.1 dBm**
**Distance = 300 cm**

# 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# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **62** | Haefely Trench | EFT Clamp | Immunity Equipment | N/A | 7/15/2016 | 7/15/2017 |
| **248** | Keytek | EMC PRO | EMC Tester | 9803353 | 12/16/2016 | 12/16/2017 |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |

**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 301 489-19 V2.1.0 requires criterion B to be met as described in section 1.4.4.

### 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

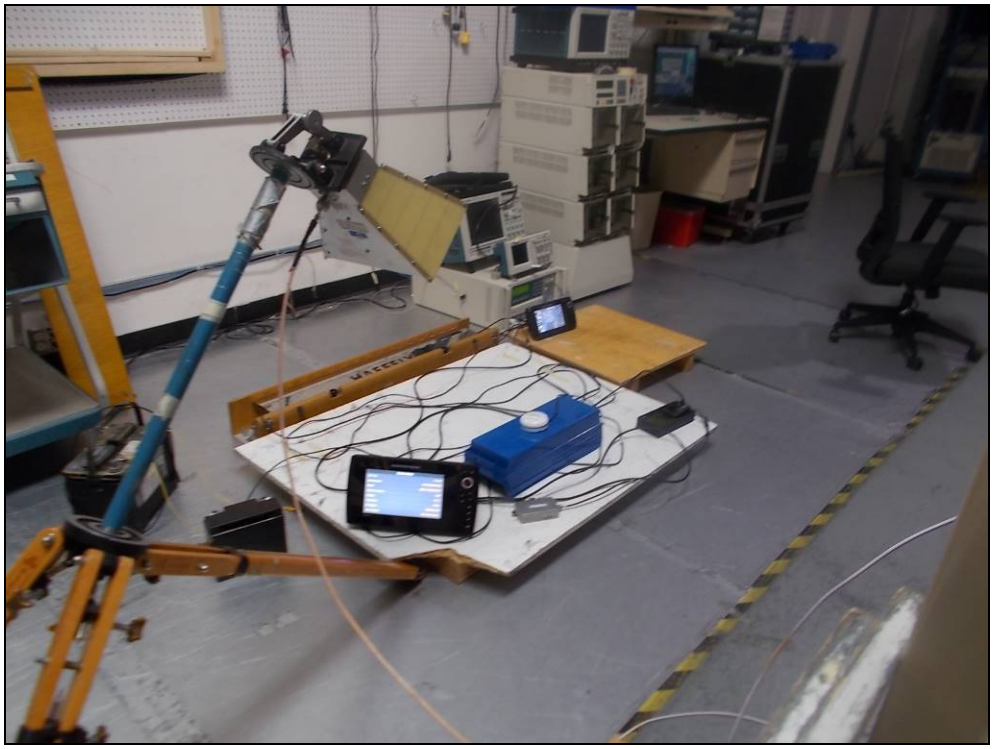


**Figure 9.4-1: Test Setup Photograph**

## 9.5 Test Results

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **6/1/2017** | **Temperature (ºC)** | **21** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **40** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1020** |
| **Tested Modes:** | **Powered ON; tracking satellites, speed, and temperature.** | | |
| **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) |
|---|---|---|
| N/A | N/A | No AC Mains on EUT |

**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) |
|---|---|---|
| DC mains | Pass | |
| GPS puck cable | Pass | |
| Transducer cable | Pass | |
| Network 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# | Calibration Performed Date | Calibration Due Date |
|---|---|---|---|---|---|---|
| **5** | Chase | CSP-8441 | Probes | 19 | 5/24/2016 | 5/24/2017 |
| **93** | Chase | 8101 | Clamp | 65 | 5/6/2016 | 5/6/2017 |
| **96** | Chase | 1000-M3-25 | CDN | 9806 | 4/10/2017 | 4/10/2018 |
| **364** | Amplifier Research | DC2600A | Coupler | 0322466 | NCR | NCR |
| **370** | IFI | CMX5002 | Amplifier | L364-0407 | NCR | NCR |
| **418** | Teseq | ISN-S501 | LISN | 24543 | 3/27/2017 | 3/27/2018 |
| **425** | ACS | EMC Cable Set | Cable Set | 425 | NCR | NCR |
| **457** | Com Power | CDN-M2-25 | Coupler | 511023 | 7/13/2016 | 7/13/2017 |
| **471** | Bird Technologies Group | 150-A-FFN-06 | Attenuators | 0914 | NCR | NCR |
| **494** | Omega | iBTHX-W | Climate Monitoring Equipment | 9460211 | 8/1/2016 | 8/1/2018 |
| **634** | Fischer Custom Communications Inc. | FCC-801-M3-16 | CDN | 9730 | 5/10/2017 | 5/10/2018 |
| **711** | Hewlett Packard | 8648B | Signal Generators | 3623A01926 | 7/25/2016 | 7/25/2017 |

**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 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 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 301 489-19 V2.1.0 requires criterion A to be met as described in section 1.4.4.

### 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

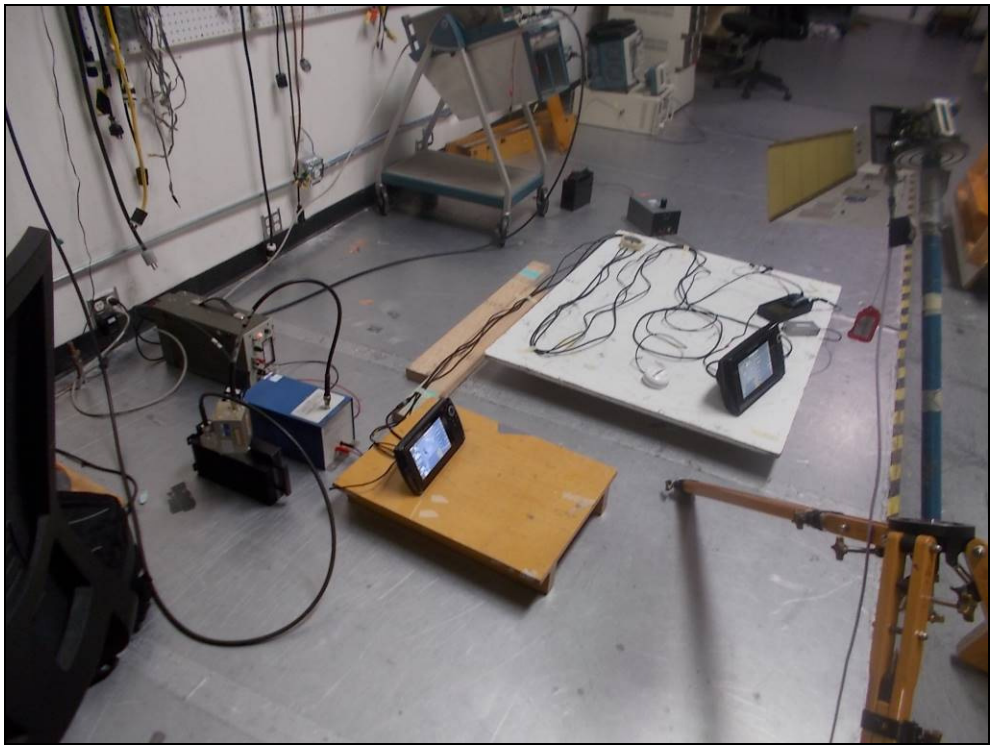


**Figure 11.4-1: Test Setup Photograph**

## 11.5 Test Results

**Test Parameters:**

| | | | |
|---|---|---|---|
| **Test Date:** | **5/31/17** | **Temperature (ºC)** | **23** |
| **Technician:** | **Art Sumner** | **Humidity (%)** | **40** |
| **Equipment Class:** | **N/A** | **Barometric Pressure (mBar)** | **1018** |
| **Tested Modes:** | **Monitoring Depth, 3D fix on satellites** | | |
| **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:**

**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) |
|---|---|---|
| Network | Pass | |
| GPS puck | Pass | |
| Transducer cable | Pass | |

**Notes:**

# 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.