EMC Technical Report

Prepared For: Johnson Outdoors Marine Electronics, Inc.

Models Tested: HELIX 7X CHIRP MSI GPS G3N
HELIX 7 CHIRP GPS G2N
Model Variants: See Product Description

In Accordance with:
Radio & Telecommunications
Terminal Equipment (R&TTE) Directive – 99/5/EC

Product Standard: EN 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 with respect to EN 301 489-1 V1.9.2

ACS Report: 16-0342.C09.4E
Report Revision: E
Report Issue Date: January 9, 2019

For Scope of Accreditation Under Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

Project Manager:

Arthur Sumner
EMC Engineer
TÜV SÜD America Inc.

Reviewed by:

Jeremy Pickens
Senior Wireless Engineer
TÜV SÜD America Inc.

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This report contains 53 pages

REVISION HISTORY
Report Number: 16-0342.C09.4E
Manufacturer: Johnson Outdoors Marine Electronics, Inc.
Model: HELIX 7X CHIRP MSI GPS G3N

DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
October 18, 2016	---	A	Initial Release	All	Ray Verar
October 28, 2016	A	B	Corrected model covered and variants per manufacturer and corrected street address	1, 3, 5, 7, 14	Ray Verar
November 4, 2016	B	C	Revised model name in product description	3	Ray Verar
May 3, 2017	C	D	Added EN 301 489-17 product standard	1, 5, 6, 26, 33, 36, 41	Steve O'Steen
January 9, 2019	D	E	- Added emissions test data for G3N family of products - Added new test site descriptions - Added manufacturer declaration (Appendix B) for G3N series models	All	Jeremy Pickens

Project Information Sheet

ACS Project: 16-0342.C09.4E

Applicant Details

Manufacturer: Johnson **Outdoors Marine Electronics, Inc.**
Street Address: 678 Humminbird Lane
City, State/Province and Postal Code:
Country:
Contact:

Phone:
Fax:
Email:

Sample Information

Model: HELIX 7X CHIRP MSI GPS G3N
Model Variant(s): See Product Description
Environment of Use: Residential
Sample Receive Date:
Sample Receive Condition: Good
Test Mode Description: GPS, BLE, BT, and depth simulator active and monitored.
Unacceptable Degradation (Provided by Mfg.): The Depth reading should stay with +/- 1ft. We also declare an exclusion band in the range 195kHz to 205kHz range sine the device is tuned to and designed to operate at 200kHz during normal
Highest Data Rate: 800MHz
Source: Main processor

Product Description

The Humminbird HELIX 7 CHIRP SI G2N is a Sonar/Fishfinder product to be used in the marine environment. Product has a 7" display, 10 keypad buttons and displays Sonar return information on the screen. It differs from the H7 G2 by including Ethernet and Bluetooth (Classic and BLE). The client declares all models are identical and differ only in software. The HELIX 7 CHIRP SI G2N having the most functionality, was submitted for testing to represent the above model variants.

The Humminbird Helix 7X CHIRP MSI GPS G3N (411080-1M) is a fishfinder/GPS product with side imaging sonar capability. It is comprised of a keypad, 7" LCD display, two SD card slots, internal GPS, Bluetooth capability, Ethernet capability, transducer and power cable. All G3N CHIRP model variations are built exactly the same. The non G3N variations do not have Bluetooth. They all differ by installed options, SELV circuits and languages.

HELIX 7 CHIRP GPS G3
HELIX 7X CHIRP GPS G3
HELIX 7 CHIRP MDI GPS G3
HELIX 7X CHIRP MDI GPS G3
HELIX 7 CHIRP MSI GPS G3
HELIX 7X CHIRP MSI GPS G3
HELIX 7 CHIRP GPS G3N
HELIX 7X CHIRP GPS G3N
HELIX 7 CHIRP MDI GPS G3N
HELIX 7X CHIRP MDI GPS G3N
HELIX 7 CHIRP MSI GPS G3N
HELIX 7X CHIRP MSI GPS G3N (Tested variant)
ICE HELIX 7 CHIRP GPS G2N
HELIX 7 CHIRP GPS G2N (Tested variant)
HELIX 7 CHIRP DI GPS G2N
HELIX 7 CHIRP SI GPS G2N
HELIX 7X CHIRP GPS G2N
HELIX 7X CHIRP DI GPS G2N
HELIX 7X CHIRP SI GPS G2N

Test Information

Test Start Date:
Test End Date: December 3, 2018
Emissions Pre-scan Site: SAC
Final Emissions Site: SAC
EMI Freq. Band:
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 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 with respect to EN 301 489-1 V1.9.2 and details the results of testing performed on through December 3, 2018 on the model HELIX 7X CHIRP MSI GPS G3N manufactured by Johnson Outdoors Marine Electronics, Inc..

On August 13, 2018 the model HELIX 7X CHIRP MSI GPS G3N manufactured by Johnson Outdoors Marine Electronics, Inc. was evaluated to the radiated emissions requirements. Johnson Outdoors Marine Electronics, Inc.declares that, based on electrical similarity, the model HELIX 7X CHIRP MSI GPS G3N continues to comply with the applicable immunity requirements. Refer to Appendix B for details.

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 V1.9.2	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements	Pass
EN 301 489-3 V1.6.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz	Pass
EN 301 489-17 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems	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 301 489-3 and EN 301 489-17	
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 Series products, the limits which apply are shown in Table 1.4.1-1 below:

Table 1.4.1-1 Emissions Limits Error! Reference source not found.

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] 40 to 30 (I)[1,3]	74 to 64 (V)[1,2] 30 to 20 (I)[1,3]
	0.50 to 30	87 (V)[2] 43 (I)[3]	74 (V)[2] 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

EN 301 489-3

EN 301 489-3 defines equipment into three types based on the technical nature of the primary function of the EUT. They are defined below:

Table 1.4.4-1: Equipment Type Description

Equipment Type	Technical nature of the primary function
I	Transfer of messages (digital or analogue signals)
II	Transfer of audio (speech or music)
III	Others

Further, the product family of Short Range Devices (SRD) is divided into three classes of equipment, each having its own set of minimum performance criteria. This classification is based upon the impact on persons and/or goods in case the equipment does not operate above the specified minimum performance level under EMC stress. The different classifications are given below.

Table 1.4.4-2: SRD Classification

Class of SRD Equipment	Risk assessment of receiver performance
1	Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person)
2	Medium reliable SRD communication media; e.g. causing inconvenience to persons, which cannot simply be overcome by other means
3	Standard reliable SRD communication media; e.g. inconvenience to persons, which can simply be overcome by other means (e.g. manual)

Each immunity test requires 1 of 3 performance criteria to be met depending on the classification of the SRD. The performance criteria are:

- performance criteria A for immunity tests with phenomena of a continuous nature (CT);
- performance criteria B for immunity tests with phenomena of a transient nature (TT);
- performance criteria for immunity tests with power interruptions exceeding a certain time are handled on a case-by-case basis. See the specific test criteria for each test

The equipment shall meet the minimum performance criteria as specified by the following:

Table 1.4.4-3: Performance Table

Class 1 SRD equipment		
Criteria	**During test**	**After test**
A	Operate as intended No loss of function For equipment type II the minimum performance shall be 12 dB SINAD No unintentional responses	Operate as intended For equipment type II the communication link shall be maintained No loss of function No degradation of performance No loss of stored data or user programmable functions
B	May be loss of function (one or more) No unintentional responses	Operate as intended Lost function(s) shall be self-recoverable No degradation of performance No loss of stored data or user programmable functions
Class 2 SRD equipment		
Criteria	**During test**	**After test**
A	Operate as intended No loss of function For equipment type II the minimum performance shall be 6 dB SINAD No unintentional responses	Operate as intended For equipment type II the communication link shall be maintained No loss of function No degradation of performance No loss of stored data or user programmable functions
B	May be loss of function (one or more) No unintentional responses	Operate as intended Lost function(s) shall be self-recoverable No degradation of performance No loss of stored data or user programmable functions
Class 3 SRD equipment		
Criteria	**During test**	**After test**
A and B	May be loss of function (one or more) No unintentional responses	Operate as intended, for equipment type II the communication link may be lost, but shall be recoverable by user No degradation of performance Lost functions shall be self-recoverable

Performance criteria for Continuous phenomena applied to Transmitters (CT)
For equipment of type I or II including ancillary equipment tested on a stand alone basis, the performance criteria A of the applicable class as given in table 1.5.4-1 shall apply.

For equipment of type II or type III that requires a communication link that is maintained during the test, it shall be verified by appropriate means supplied by the manufacturer that the communication link is maintained during each individual exposure in the test sequence.

Where the EUT is a transmitter, tests shall be repeated with the EUT in standby mode to ensure that any unintentional transmission does not occur.

Performance criteria for Transient phenomena applied to Transmitters (TT)
For equipment of type I or II, including ancillary equipment tested on a stand alone basis, the performance criteria B of the applicable class as given in table 1.5.4-1 shall apply, except for power interruptions exceeding a certain time the performance criteria deviations are specified in section 13.3.1.
For equipment of type II or type III that requires a communication link that is maintained during the test, this shall be verified by appropriate means supplied by the manufacturer during each individual exposure in the test sequence.

Where the EUT is a transmitter, tests shall be repeated with the EUT in standby mode to ensure that any unintentional transmission does not occur.

Performance criteria for Continuous phenomena applied to Receivers (CR)
For equipment of type I or II, including ancillary equipment tested on a stand alone basis, the performance criteria A of the applicable class as given in table 1.5.4-1 shall apply.

For equipment of type II or III that requires a communication link that is maintained during the test, it shall be verified by appropriate means supplied by the manufacturer that the communication link is maintained during each individual exposure in the test sequence.

Where the EUT is a transceiver, under no circumstances shall the transmitter operate unintentionally during the test.

Performance criteria for Transient phenomena applied to Receivers (TR)
For equipment of type I or II, including ancillary equipment tested on a stand alone basis, the performance criteria B of the applicable class as given in table 1.5.4-1 shall apply, except for power interruptions exceeding a certain time the performance criteria deviations are specified in section 13.3.1

For equipment of type II or type III that requires a communication link that is maintained during the test, this shall be verified by appropriate means supplied by the manufacturer during each individual exposure in the test sequence.

Where the EUT is a transceiver, under no circumstances shall the transmitter operate unintentionally during the test.

EN 301 489-17

Each immunity test requires 1 of 3 performance criteria to be met. The performance criteria is given as:

- performance criteria A for immunity tests with phenomena of a continuous nature;
- performance criteria B for immunity tests with phenomena of a transient nature;
- performance criteria C for immunity tests with power interruptions exceeding a certain time.

The equipment shall meet the minimum performance criteria as defined in table 1.4.4-1 below:

Table: 1.4.4-1

Criteria	During test	After test
A	Shall operate as intended May show degradation of performance (see note 1) Shall be no loss of function Shall be no unintentional transmissions	Shall operate as intended Shall be no degradation of performance (see note 2) Shall be no loss of function Shall be no loss of stored data or user programmable functions
B	May show loss of function (one or more) May show degradation of performance (see note 1) No unintentional transmissions	Functions shall be self-recoverable Shall operate as intended after recovering Shall be no degradation of performance (see note 2) Shall be no loss of stored data or user programmable functions
C	May be loss of function (one or more)	Functions shall be recoverable by the operator Shall operate as intended after recovering Shall be no degradation of performance (see note 2)
NOTE 1:	Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.	
NOTE 2:	No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. After the test no change of actual operating data or user retrievable data is allowed. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.	

Performance criteria for Continuous phenomena applied to Transmitters (CT)
The performance criteria A shall apply. Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an ACKnowledgement (ACK) or Not ACKnowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

Performance criteria for Transient phenomena applied to Transmitters (TT)
The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5000ms duration, for which performance criteria C shall apply. Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an acknowledgement (ACK) or not-acknowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

Performance criteria for Continuous phenomena applied to Receivers (CR)
The performance criteria A shall apply. Where the EUT is a transceiver, under no circumstances, shall the transmitter operate unintentionally during the test. In systems using acknowledgement signals, it is recognized that an ACK or NACK transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

Performance criteria for Transient phenomena applied to Receivers (TR)
The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5000ms duration for which performance criteria C shall apply. Where the EUT is a transceiver, under no circumstances, shall the transmitter operate unintentionally during the test. In systems using acknowledgement signals, it is recognized that an ACK or NACK transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

2.0 Test Facilities & Environment

2.1 Test Facilities

All testing was performed at the following addresses:

TÜV SÜD America Inc.
5945 Cabot Parkway
Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900
www.TUVamerica.com

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 the project information section on page 3.

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. (Buford Facility) 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.

TÜV SÜD America, Inc. (Alpharetta Facility) is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites, Open Area Test Sites (OATS) and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

Buford Facility

FCC Registration Number:	391271
ISED Canada Lab Code:	23597
VCCI Member Number:	1831
• VCCI Registration Number	A-0259

Alpharetta Facility

FCC Registration Number:	967699
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

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 Lane
Eufaula, AL 36027
David Vernon
334-687-6613 ext 1148
dvernon@johnsonoutdoors.com

3.2 Modifications

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

Table 3.2-1: EUT Modifications

☒ **Modifications were not required to bring the EUT into compliance with the requirements.** ☐ **Modifications were required to bring the EUT into compliance with the requirements.**

3.3 System Block Diagram and Support Equipment

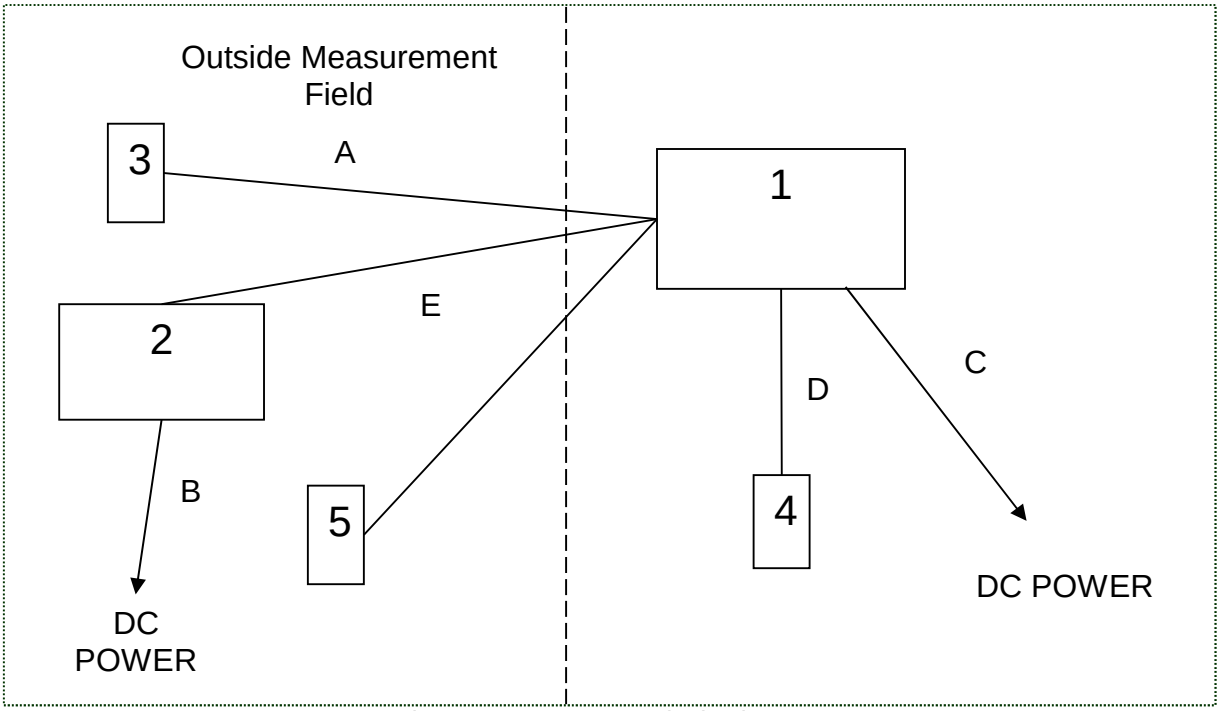


Figure 3.3-1: System Block Diagram

Table 3.3-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Johnson Outdoors	HELIX 7 CHIRP G3	n/a
2	Auxiliary Equipment	Johnson Outdoors	HELIX 7	n/a
3	GPS antenna	Humminbird	AS*GPS HS	12071842-0039
4	Transducer	Johnson Outdoors	n/a	n/a
5	Speed sensor	Johnson Outdoors	n/a	n/a

Table 3.3-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	GPS	20’	No	1 - 4
B	DC leads	4’	No	3 – DC power
C	DC leads	5’	No	1 – DC power
D	Transducer cable	20’	No	1 - 5
E	Ethernet	30’	No	1 - 2

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:

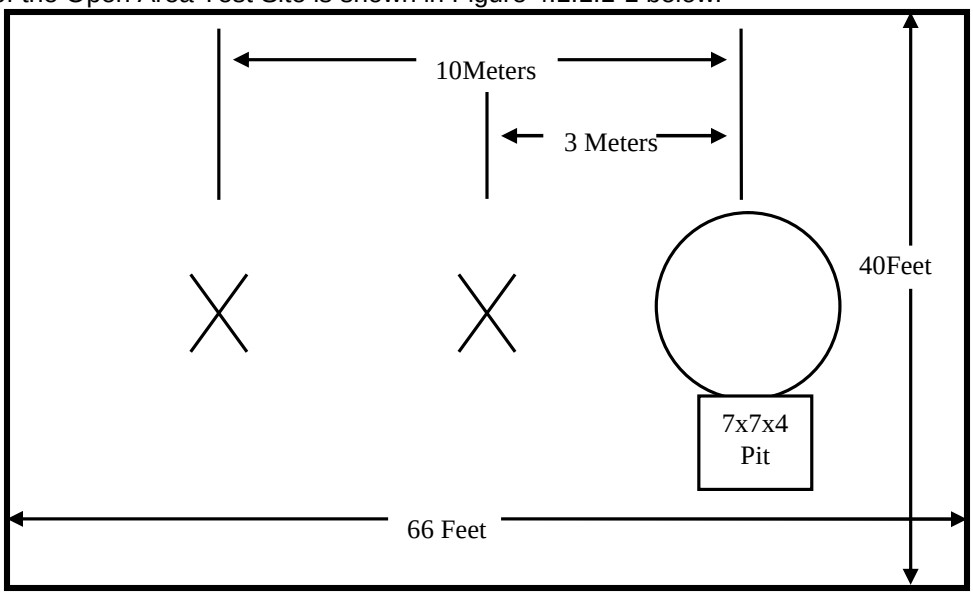


Figure 4.1.1.1-1: Open Area Test Site

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:

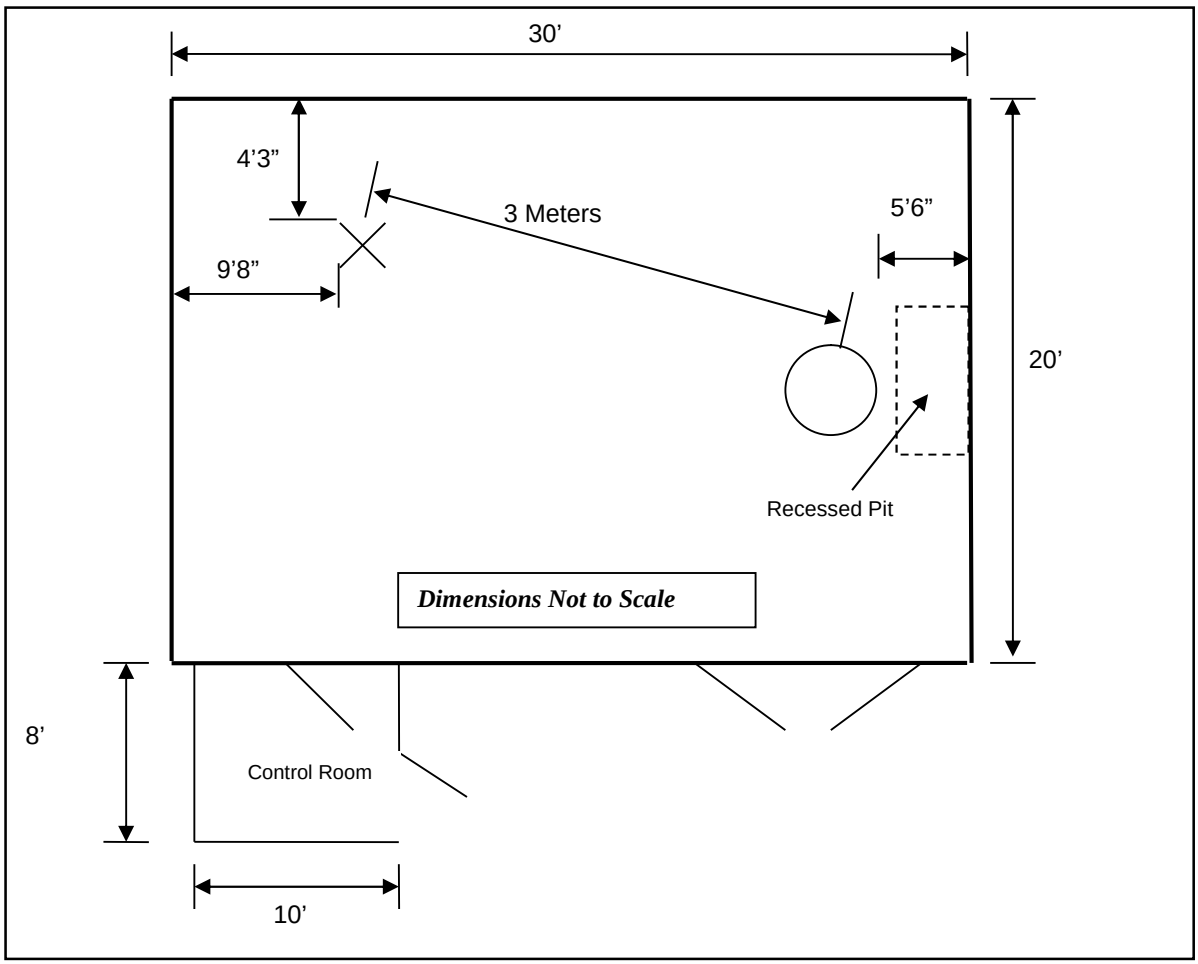


Figure 4.1.1.2-1: Semi-Anechoic Chamber Test Site

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:

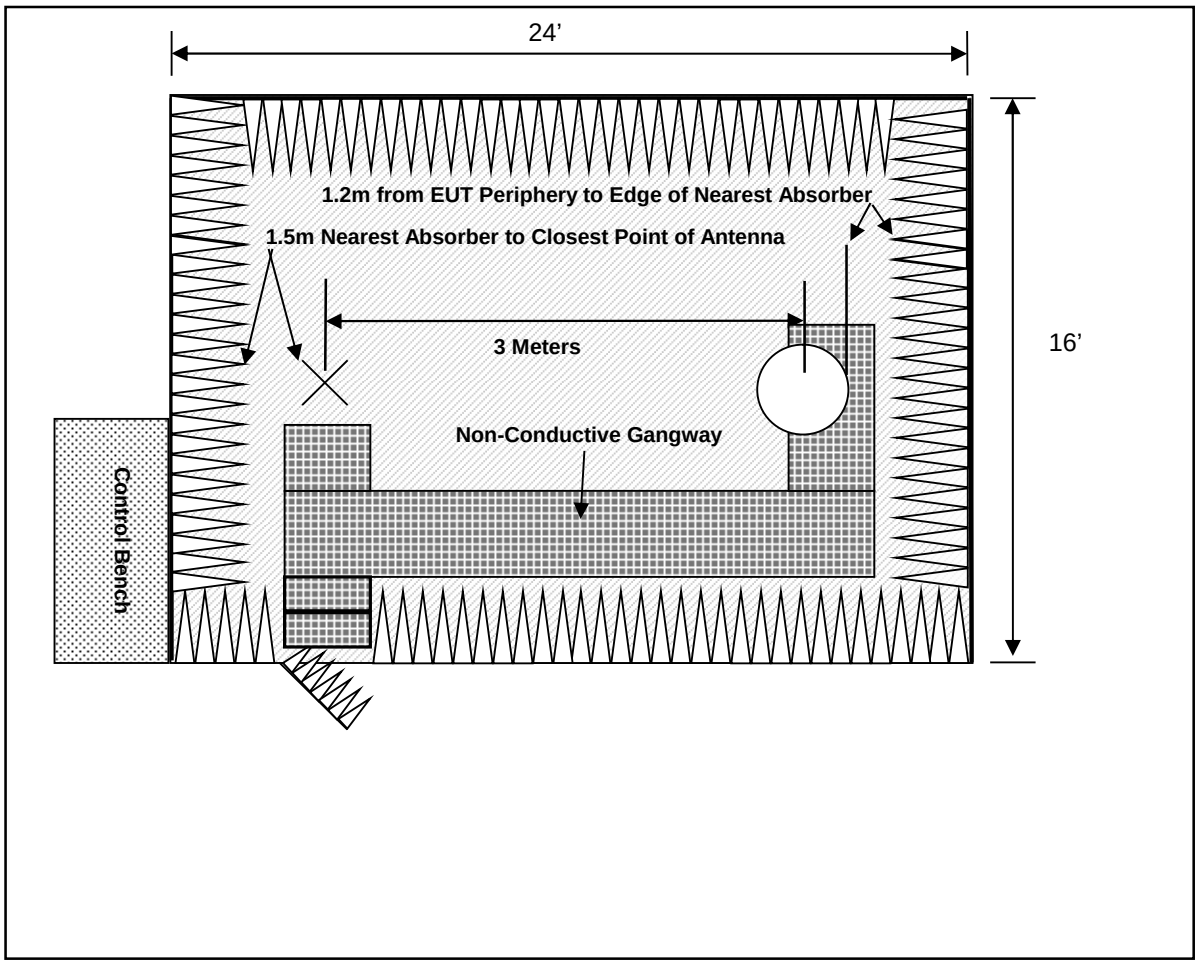


Figure 4.1.1.3-1: Fully Anechoic Chamber Test Site

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 (2016)

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
RE619	Rhode & Schwarz	ESU26	Spectrum Analyzers	02.6005K26 Ser. 1001	11/5/2014	11/5/2016
73	Agilent	8447D	Amplifiers	2727A05624	7/21/2016	7/21/2017
412	Electro Metrics	LPA-25	Antennas	1241	8/8/2016	8/8/2018
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	6/8/2016	6/8/2018
616	Florida RF Cables	RE-200W-12.0-SM	Cables	N/A	9/3/2015	9/3/2016
422	Florida RF	MS-200AW-72.0-SM	Cables	805	10/30/2015	10/30/2016
167	ACS	amber EMI Cable S	Cable Set	167	10/20/2015	10/20/2016

NCR = No Calibration Required

Table 4.1.2-2 Test Equipment –Radiated Emissions (2018)

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
30	Spectrum Technologies	DRH-0118	1-18GHz Horn Antenna	970102	05/09/2017	05/09/2019
90	Electro-metrics	LPA25	LPA Antenna	1476	01/03/2018	01/03/2020
144	Omega	RH411	Temp / Humidity Meter	H0103373	10/24/2018	10/24/2020
213	TEC	PA 102	Amplifier	44927	07/19/2018	07/19/2019
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/11/2017	07/11/2019
412	Electro Metrics	LPA-25	Log Periodic Antenna	1241	08/22/2018	08/22/2020
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/06/2018	11/06/2019
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/01/2018	05/01/2019
853	Teseq	CBL 6112D; 6804.17.A	Bilog Antenna; Attenuator	51616; 20181110A	10/15/2018	10/15/2019

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 1000MHz. 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 (2016 Testing)

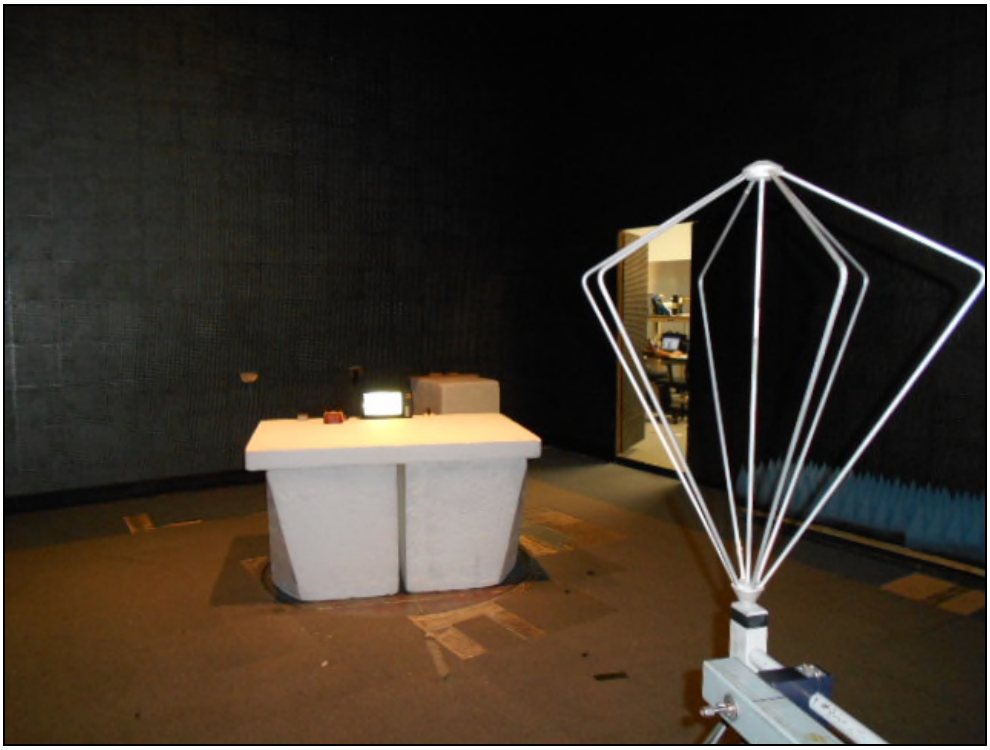


Figure 4.1.4-1: Radiated Emissions - Front View

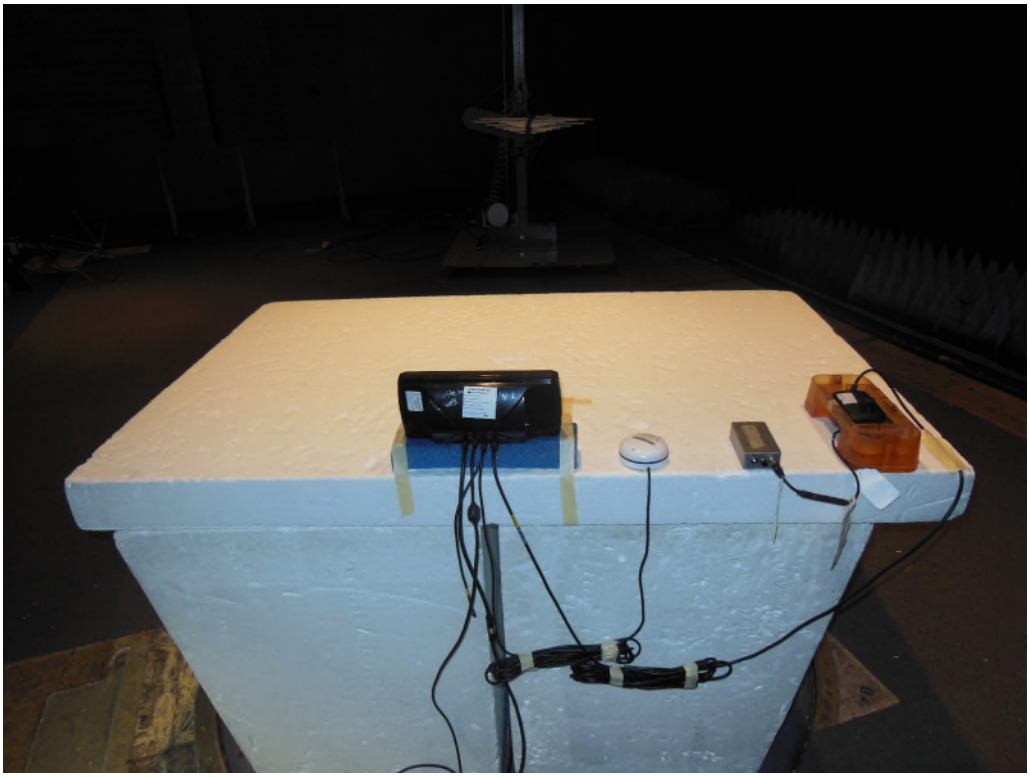


Figure 4.1.4-2: Radiated Emissions - Rear View

4.1.5 Test Setup Photographs (2018 Testing)

Figure 4.1.5-1: Radiated Emissions - Front View

Figure 4.1.5-2: Radiated Emissions - Rear View

4.1.6 Test Data (2016 Testing)

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

Test Parameters:

Test Date:	**8/2/2016**	**Temperature (ºC)**	**24**
Technician:	**Wayne Orwig**	**Humidity (%)**	**42**
Equipment Class:	**B**	**Barometric Pressure (mBar)**	**1015**
Tested Modes:	**GPS active and depth gauge operating**		
AC Input Power:	**N/A**		
DC Input Power:	**12VDC**		

Test Data Table:

Measurement Distance:

☐ **1 Meter** ☒ **3 Meter** ☐ **10 Meter**

Frequency (MHz)	Measured Level (dBuV)		Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	Pk	Qpk/Av					Pk	Qpk/Av	Pk	Qpk/Av	Pk	Qpk/Av
31.105		45.50	V	301	100	-12.39	---------	33.11	--------	40.5	---------	7.3
32.799		45.51	V	118	277	-12.83	---------	32.68	--------	40.5	---------	7.8
60.89		48.52	V	100	205	-13.89	---------	34.63	--------	40.5	---------	5.8
87.449		38.87	V	100	95	-14.98	---------	23.89	--------	40.5	---------	16.6
234.91		37.12	H	100	104	-12.11	---------	25.01	--------	47.5	---------	22.4
328.859		52.86	H	100	230	-8.21	---------	44.65	--------	47.5	---------	2.8
1921.475	51.83	34.62	H	136	249	-8.06	43.77	26.56	70.0	50.0	26.2	23.4

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

Notes:

4.1.7 Test Data (2018 Testing)

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

Test Parameters:

Test Date:	**8/13/2018**	**Temperature (ºC)**	**25**
Technician:	**A Sumner**	**Humidity (%)**	**47**
Equipment Class:	**B**	**Barometric Pressure (mBar)**	**1012**
Tested Modes:	**GPS active and depth gauge operating**		
AC Input Power:	**N/A**		
DC Input Power:	**12VDC**		

Test Data Table:

Measurement Distance:

☐ **1 Meter** ☒ **3 Meter** ☐ **10 Meter**

Frequency (MHz)	Measured Level (dBuV)		Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	Pk	Qpk/Av					Pk	Qpk/Av	Pk	Qpk/Av	Pk	Qpk/Av
43.47	61.20	45.10	H	100	0	-13.33	---------	31.77	--------	40.5	---------	8.7
62	52.10	44.00	V	100	0	-13.02	---------	30.98	--------	40.5	---------	9.5
99.4	54.50	48.00	H	100	181	-11.52	---------	36.48	--------	40.5	---------	4.0
48.6	49.00	45.10	V	100	105	-13.16	---------	31.94	--------	40.5	---------	8.5
168.55	45.60	42.20	V	100	109	-6.93	---------	35.27	--------	40.5	---------	5.2
248.6	52.50	47.40	V	100	191	-10.12	---------	37.28	--------	47.5	---------	10.2
297.85	52.60	49.80	V	100	231	-9.76	---------	40.04	--------	47.5	---------	7.4

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 not powered through an AC Mains power supply; therefore, conducted emissions testing was not performed.

5.0 Harmonic Current Emissions

5.1 Test Justification

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

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

6.0 Voltage Fluctuations & Flicker

6.1 Test Justification

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

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

SECTION C: IMMUNITY – TEST INFORMATION AND RESULTS

7.0 Electrostatic Discharge Immunity

7.1 Test Site Description

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

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

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

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

7.2 Test Equipment

Table 7.2-1: Test Equipment List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
582	Kikusui	KES4021A	ESD Gun	SA003046	4/28/2016	4/28/2017
144	Omega	RH411	Climate Monitoring Equipment	H0103373	7/24/2014	7/24/2016

NCR = No Calibration Required

7.3 Test Methodology

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

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

Direct Contact Discharge

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

Indirect Contact Discharge

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

Air Discharge

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

7.3.1 Test Criteria

EN 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 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:

See Appendix B – Additional Test Justification

7.4 Test Setup Photograph

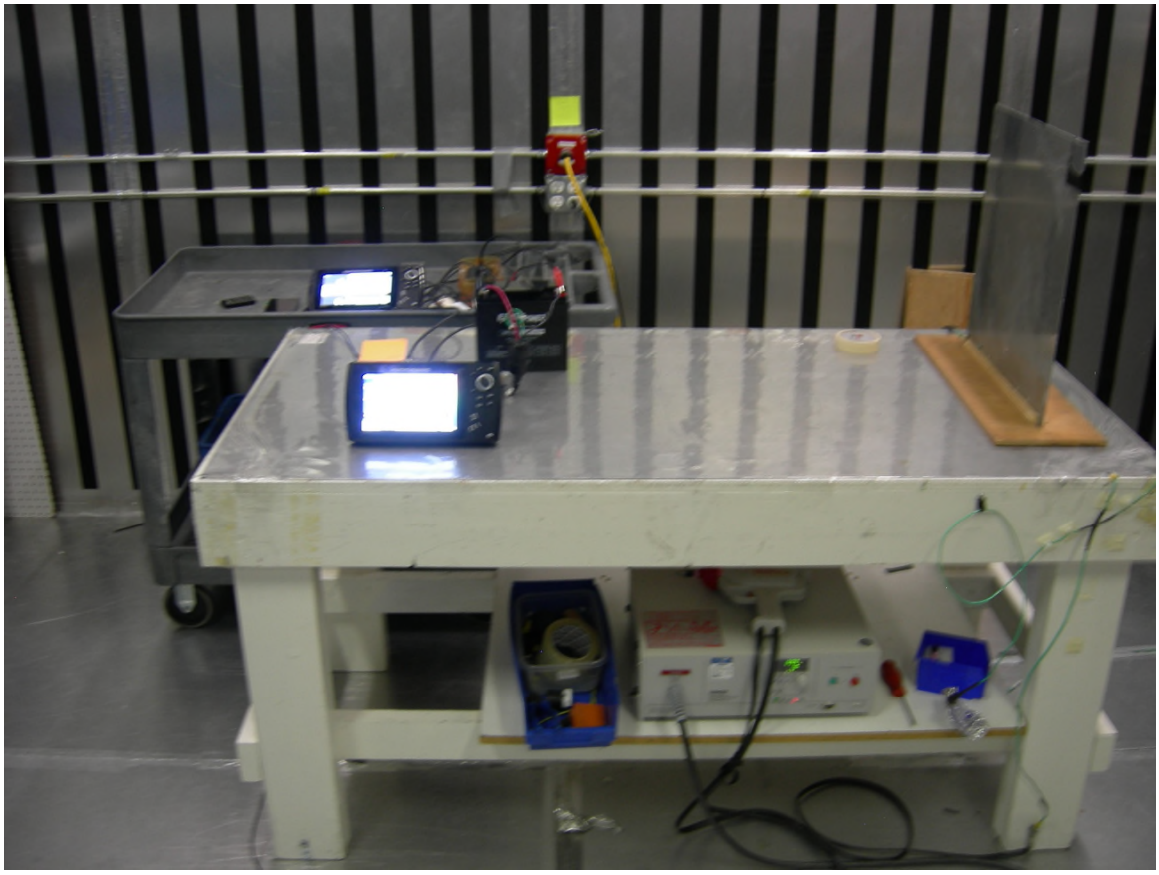
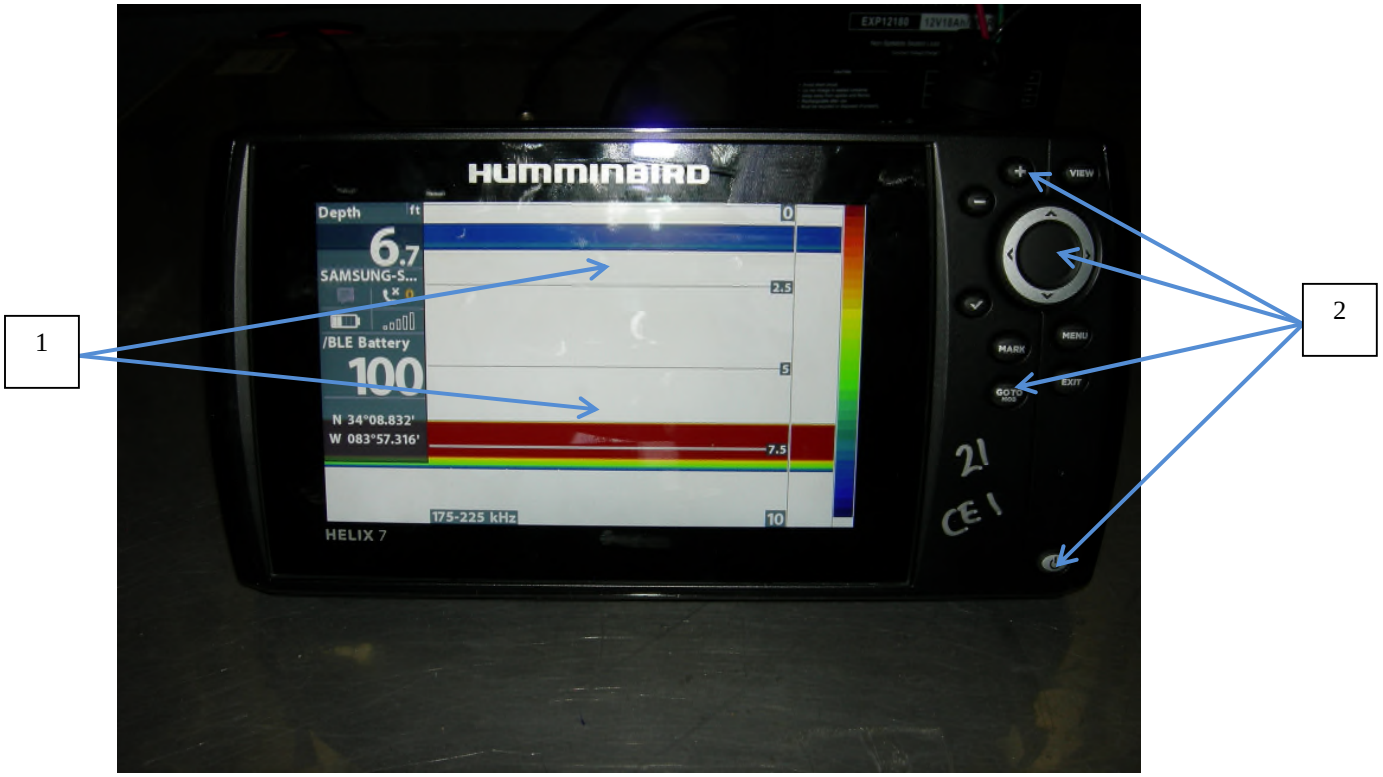
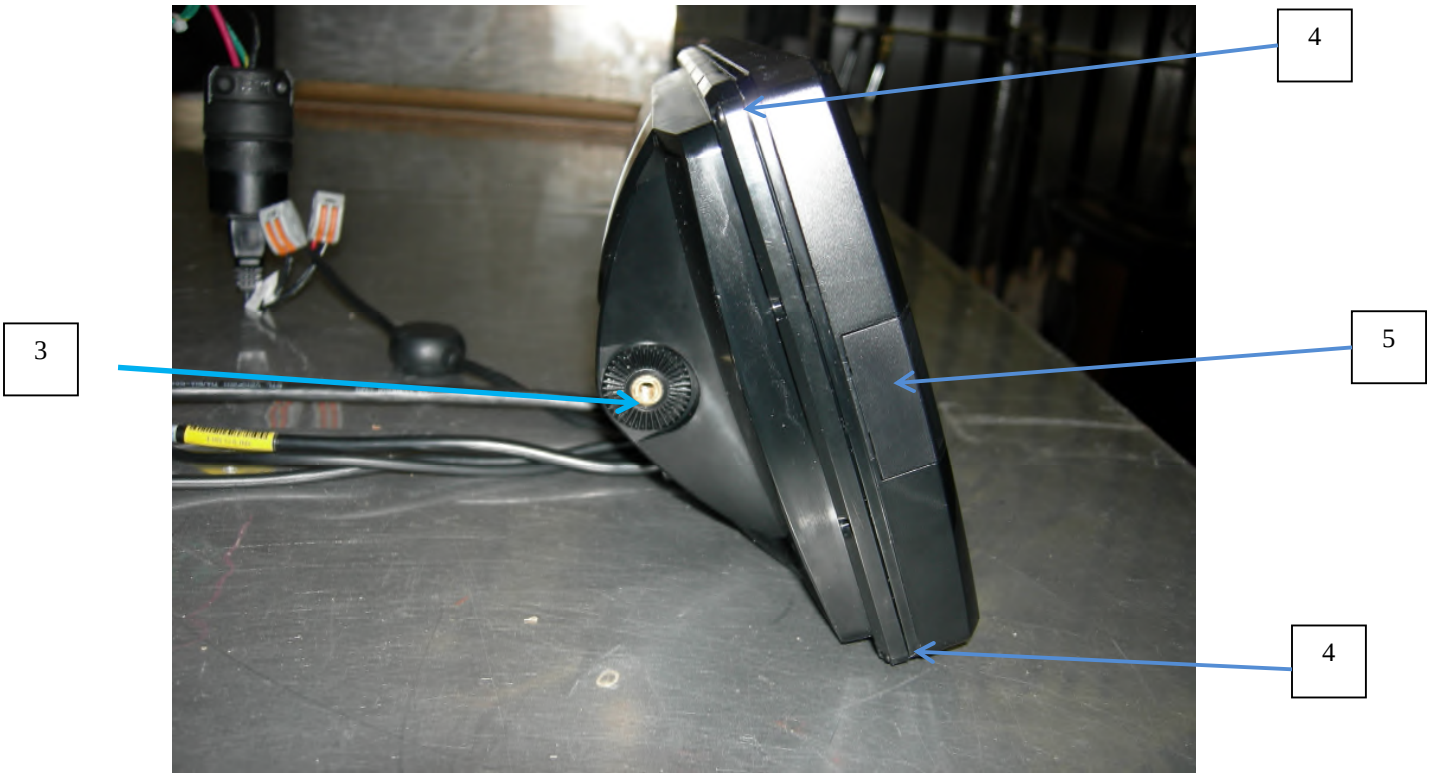


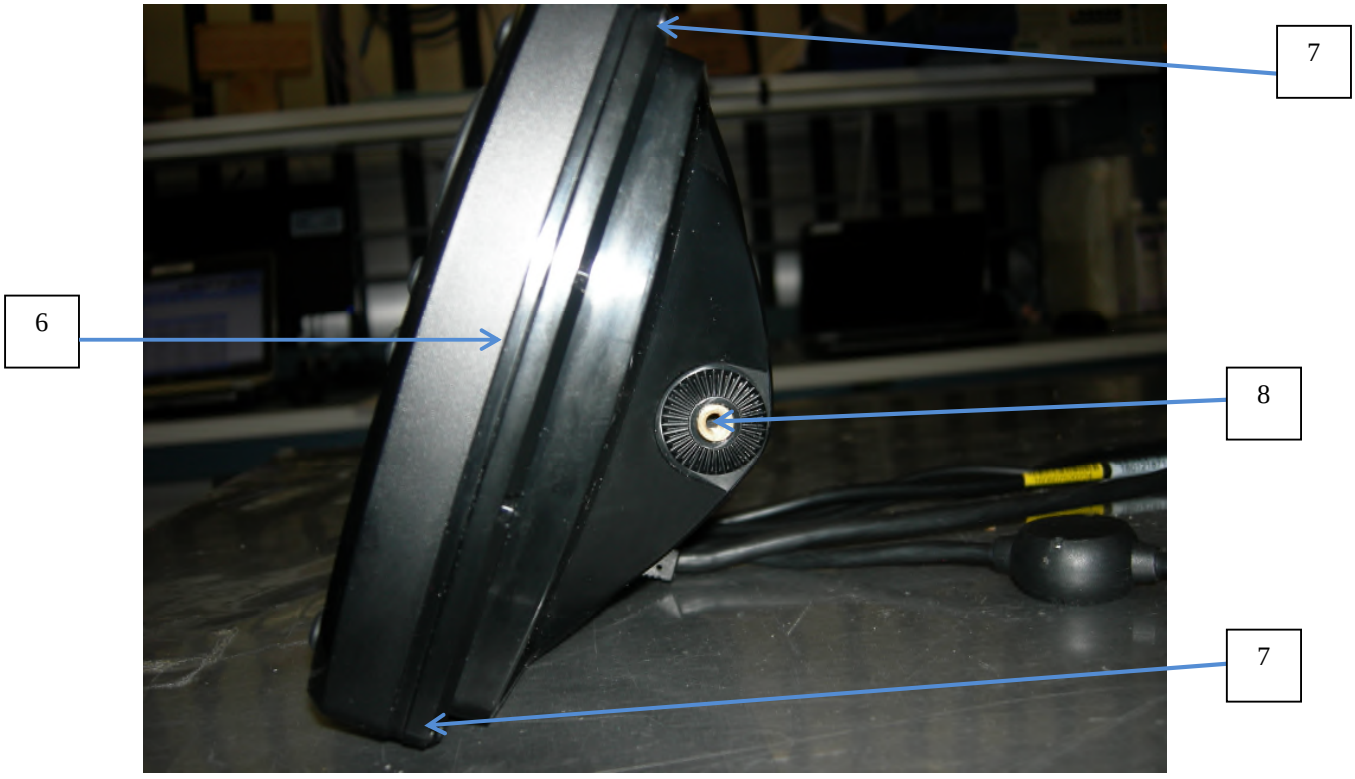
Figure 7.4-1: Test Setup Photograph

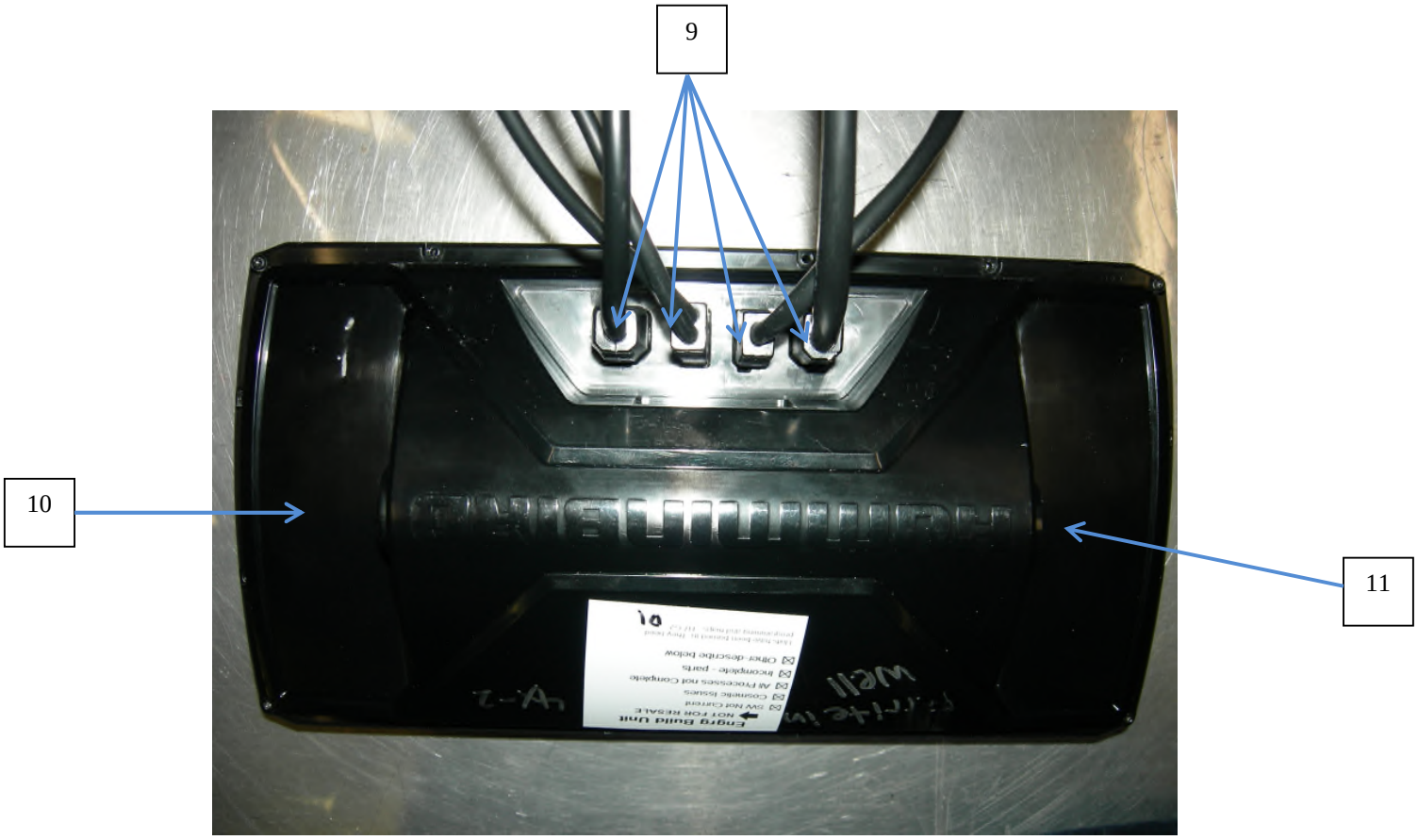
7.5 ESD Data Sheet

Test Point Photograph:




4
3
5
4


7
6
8
7



Test Point Selection:

TEST POINT#	DESCRIPTION	TYPE (C/A)	TEST POINT#	DESCRIPTION	TYPE (C/A)
1	EUT display screen	**Air**	11	EUT chassis rear right side	**Air**
2	EUT user interface buttons	**Air**			
3	Left mounting bracket connection	**Contact**			
4	EUT chassis rear screws: left	**Contact**			
5	EUT chassis left side seam	**Air**			
6	EUT chassis right side seam	**Air**			
7	EUT chassis rear screws :right	**Contact**			
8	Right mounting bracket connection	**Contact**			
9	EUT cable connections	**Air**			
10	EUT chassis rear left side	**Air**			

7.6 Test Data

Test Parameters:

Test Date:	**7-27-2016**	**Temperature (ºC)**	**22**
Technician:	**Chris O'Steen**	**Humidity (%)**	**40**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1017**
		☒ **Pre-test Verification Complete**	
Tested Modes:	**EUT on; Monitoring depth; BT connected to phone and remote**		
AC Input Power:	**N/A**	**VCP Resistor Value Check:**	**951**
DC Input Power:	**12VDC**	**HCP Resistor Value Check:**	**945**

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	Contact	Pass	
4	Contact	Pass	
5	Air	Pass	
6	Air	Pass	
7	Contact	Pass	
8	Contact	Pass	
9	Air	Pass	
10	Air	Pass	
11	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	06-17-2016	06-17-2017
1115	Varian	VZC6961G1	Amplifier	884	NCR	NCR
329	A.H.Systems	SAS-571	Antennas	721	07-22-2015	07-22-2017
354	ETS Lindgren	3142C	Antennas	78838	NCR	NCR
370	IFI	CMX5002	Amplifier	L364-0407	NCR	NCR
494	Omega	iBTHX-W	Climate Monitoring Equipment	9460211	12/8/2014	12/8/2016
564	United Microwave Products, Inc.	AO-190-00.36.0	Cables	564	07-29-2016	07-29-2017
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
642	Fairview Microwave	FMC0101951-200CM	Cables	N/A	NCR	NCR
711	Hewlett Packard	8648B	Signal Generators	3623A01926	07-25-2016	07-25-2017
1112	Wandel & Goltermann	BN2244/21	Probes	H0006	12/3/2015	12/3/2016
1201	Wandel & Goltermann	2244/99.22	Probes	W-0004	12/3/2015	12/3/2016
711	Hewlett Packard	8648B	Signal Generators	3623A01926	07-25-2016	07-25-2017
RE89	Amplifier Research	25S1G4A	Amplifiers	324609	NCR	NCR

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

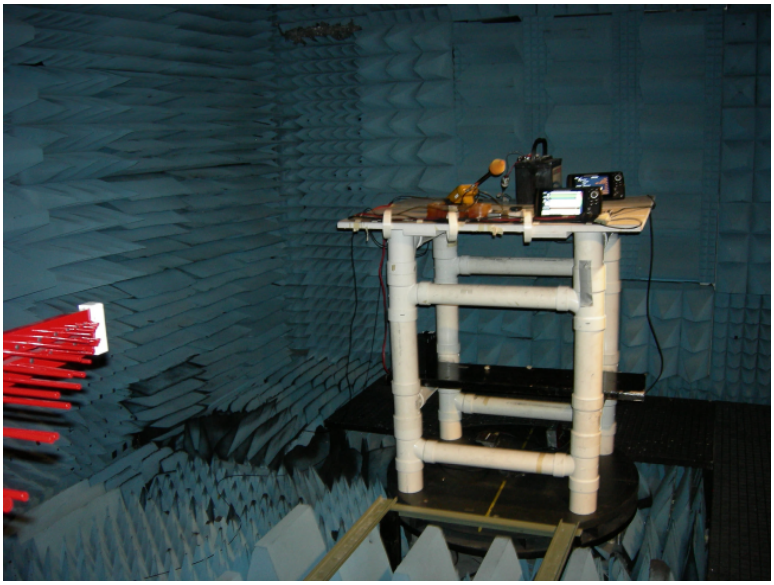
EN 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 requires criterion A to be met as described in section 1.4.4.

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:

See Appendix B – Additional Test Justification

8.4 Test Setup Photographs



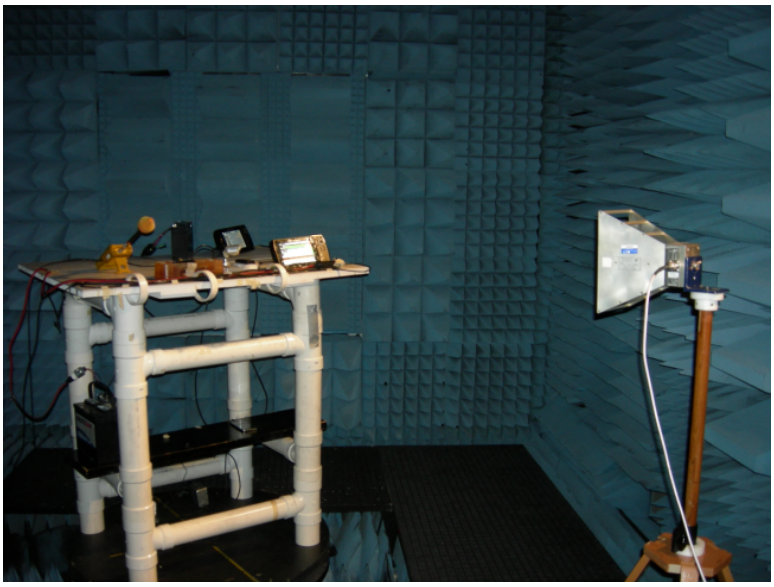


Figure 8.4-1: Test Setup Photograph

8.5 Test Results

Test Parameters:

Test Date:	**7/31/2016**	**Temperature (ºC)**	**24**
Technician:	**Chris O'Steen**	**Humidity (%)**	**45**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1017**
Tested Modes:	**GPS, BLE, BT, and depth simulator active and monitored.**		
AC Input Power:	**N/A**	☒ **Pre-test Verification Complete**	
DC Input Power:	**12VDC**		

Test Data:

Check All That Apply to This Data

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

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

Notes:

Check All That Apply to This Data

Polarity	Field Strength:	Freq. Band:	Dwell Time
☐ Horizontal	☒ 3V/m	☐ 80-1000MHz	☐ 1 Second
☐ Vertical	☐ 10V/m	☒ 1400-2700MHz	☒ 3 Seconds
☒ Both	☐ 8V/m	☐ Enter Other Band Here	☐ Enter Other
	☐ Enter Other Level Here		

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

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 +/-1.0 kV 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
474	Keytek	EMC PRO	General Lab Equipmen	9808246	10/7/2015	10/7/2016
62	Haefely Trench	EFT Clamp	Immunity Equipment	None	7/15/2016	7/15/2017

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 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 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:**

See Appendix B – Additional Test Justification

9.4 Test Setup Photographs

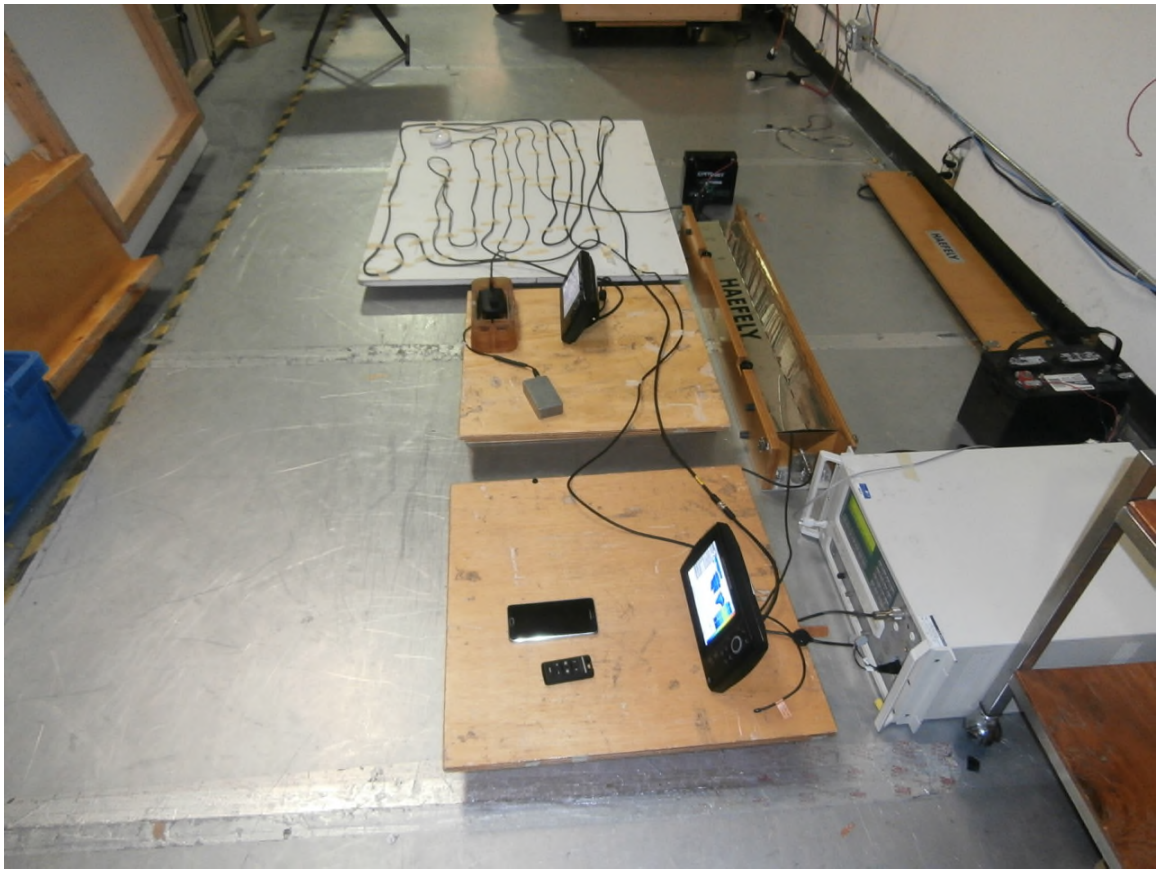


Figure 9.4-1: Test Setup Photograph

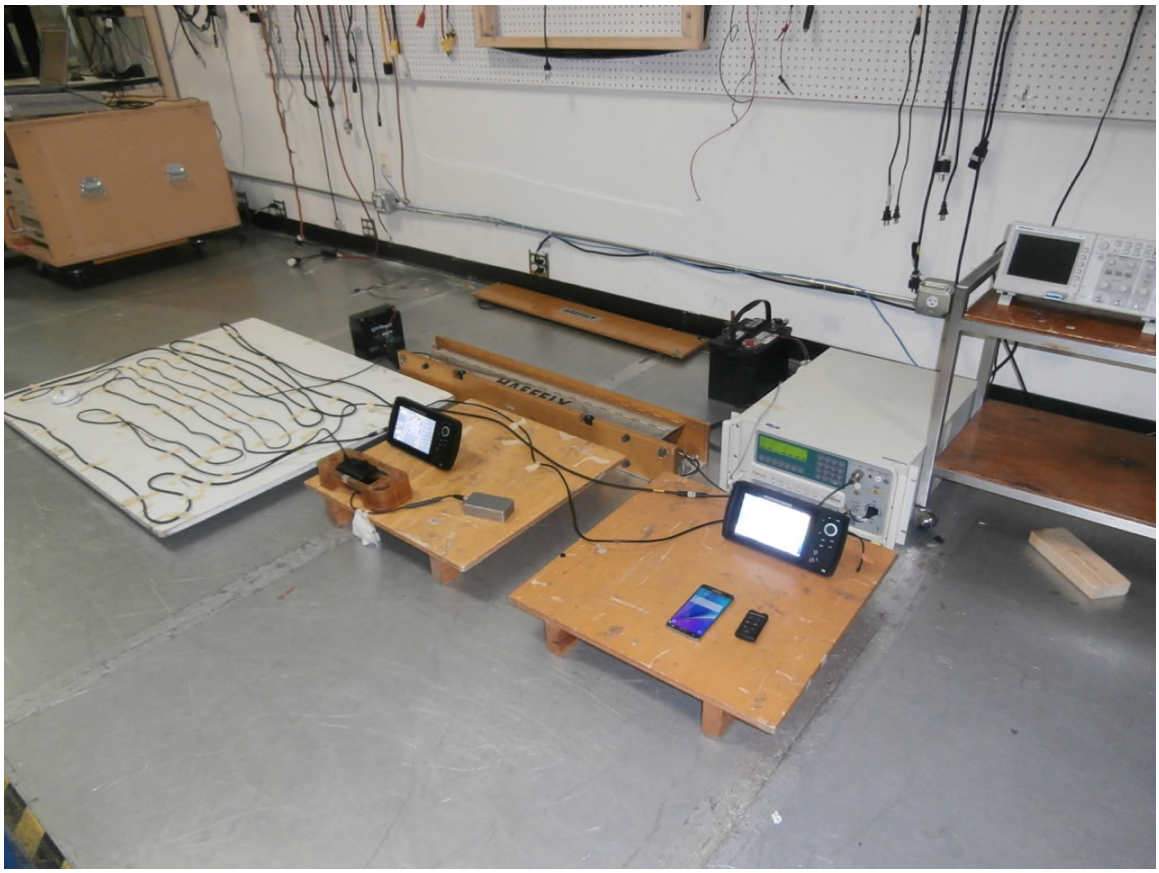


Figure 9.4-2: Test Setup Photograph

9.5 Test Results

Test Parameters:

Test Date:		**Temperature (ºC)**	**Enter**
Technician:	**Jaime Smith**	**Humidity (%)**	**Enter**
Equipment Class:	**A**	**Barometric Pressure (mBar)**	**Enter**
Tested Modes:			
AC Input Power:	**N/A**	☒ **Pre-test Verification Complete**	
DC Input Power:	**12VDC Battery**		

Mains Test Data:

Check All That Apply to This Data

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

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

Notes:

Signal Line Test Data:

Check All That Apply to This Data

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

Signal Line	Result	Observation (Describe any detectable event)
Describe	Pass	
Describe	Pass	
Describe	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
448	IFR	2023A	Signal Generators	202302/190	2/11/2016	2/11/2017
14	IFI	PS5000	Power Supplies	0492-4147	NCR	NCR
15	IFI	AMP5580	Amplifiers	0492-4147	NCR	NCR
471	Bird Technologies Group	150-A-FFN-06	Attenuators	914	NCR	NCR
457	Com Power	CDN-M2-25	Coupler	511023	7/13/2016	7/13/2017
364	Amplfier Research	DC2600A	Coupler	322466	NCR	NCR
96	Chase	1000-M3-25	CDN's	9806	3/10/2016	3/10/2017
93	Chase	8101	Clamp	65	5/6/2016	5/6/2017

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 400Hz AM sine wave, pausing to adjust the RF signal level or to switch coupling devices as necessary. The rate of sweep shall not exceed 1.5×10^{-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 301 489-3 V1.6.1 and EN 301 489-17 V2.2.1 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

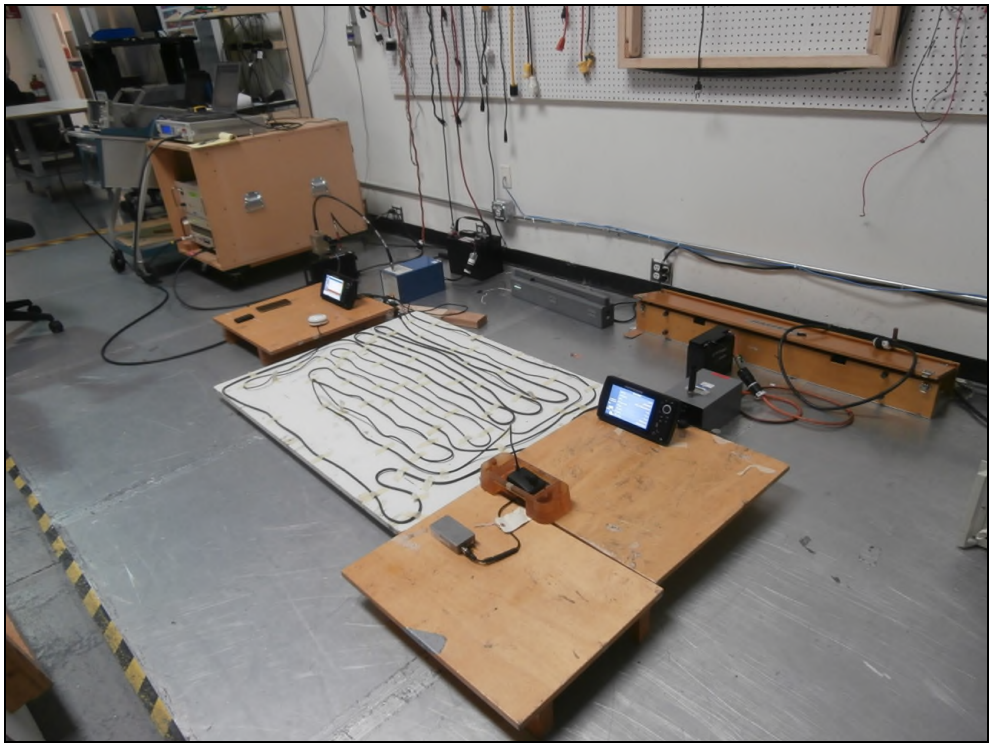


Figure 11.4-1: Test Setup Photograph

11.5 Test Results

Test Parameters:

Test Date:		**Temperature (ºC)**	
Technician:	**Jaime Smith**	**Humidity (%)**	
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	
Tested Modes:			
AC Input Power:	**N/A**	☒ **Pre-Test Verification**	
DC Input Power:	**12VDC Battery**		

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 Level 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 Level Here

Signal Line	Result	Observation (Describe any detectable event)
	Pass	
	Pass	
	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.

Appendix A – ANAB Accreditation Certificate

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

TÜV SÜD America, Inc.
5015 B. U. Bowman Drive
Buford, GA 30518

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

while demonstrating technical competence in the field of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of tests to which this accreditation applies.

AT-2021
Certificate Number

ANAB Approval

Certificate Valid: 03/14/2018 - 12/17/2018
Version No. 013 Issued: 03/14/2018

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Appendix B – Additional Test Justification

The manufacturer has declared the following statement:

"The radiated and conducted emissions scans of the Helix G3 models are slightly different from the scans of the Helix G2 models done previously. However, even with these differences the G3 models pass both the radiated and conducted emission limits as specified in the test results. The base circuit design (processor, memory, interfaces and power supplies), is the same between the G2 and G3 versions. Using the same base design means the power port along with signal and control ports on the G3 units are the same as those on the G2 units. The major change for the G3 series is a different external sonar transducer and minor circuitry variations to support that transducer.

Based on the fact that we passed the radiated and conducted emissions scans and that the power port, and signal and control ports are the same between the two series, we deem that the Helix series of products provide a significant amount of immunity to warrant our declining to have the immunity portion of the testing done on the Helix G3 models."