For Scope of Accreditation Under Certificate Number: AT-2021

EMS Technical Report

Prepared For: Johnson Outdoors Marine Electronics, Inc.

Base Model: Helix 9X CHIRP SI GPS G2N
Models Tested: Helix 9X CHIRP GPS G2N, Helix 9X CHIRP DI GPS G2N, Helix 9X CHIRP SI GPS G2N

Product Type: Sonar Fish Finder
Product Category: Information Technology Equipment

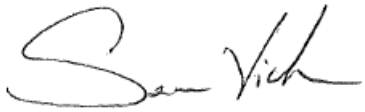
KC ID: MSIP-REM-Jom-H9G2N

In Accordance with the:
Conformity Assessment Procedure for Electromagnetic Interference
(RRA Announce 2015-110, Dec 3, 2015)

EMS Product Standard: Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17)
Annex 8-8 (KN 301 489-3)

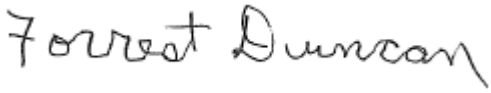
Report: 16-0345.C08.11B
Report Revision: B
Report Issue Date: May 3, 2017

Project Manager:



Sean Vick
EMC Technician
Advanced Compliance Solutions, Inc.

Reviewed by:



Forrest Duncan
Operations Manager Commercial EMC
Advanced Compliance Solutions, Inc.

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

This report contains 35 pages

REVISION HISTORY Report Number: 16-0345.C08.11B Manufacturer: Johnson Outdoors Marine Electronics, Inc. Model: Helix 9X CHIRP SI GPS G2N					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
March 17, 2017	---	A	Initial Release	All	Forrest Duncan
May 3, 2017	A	B	Added KN 301 489-17 (Annex 8-3) product standard	1, 5, 7-10, 17, 22, 25, 29	Steve O'Steen

Project Information Sheet

ACS Project: 16-0345.C08.11B

Applicant Details

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

Phone: 334-687-6613 ext 1148
Fax:
Email: dvernon@johnsonoutdoors.com

Sample Information

Model: Helix 9X CHIRP SI GPS G2N
Model Variant(s): Helix 9X CHIRP GPS G2N, Helix 9X CHIRP DI GPS G2N, Helix 9X CHIRP SI GPS G2N
Environment of Use: Residential
Sample Receive Date: August 22, 2016
Sample Receive Condition: Good
Test Mode Description: GPS Active; Sonar mode measuring depth (7.2 ft), Speed/Temp Sensor Active
Unacceptable Degradation (Provided by Mfg.): The Depth reading should stay with +/- 2ft. The manufacturer declares an exclusion band for the SONAR and GPS frequencies of +/-5%. The sonar frequency is designed to work at 200kHz during normal operation.
Highest Data Rate: 800MHz
Source: Main processor

Product Description

The HUMMINBIRD HELIX 9 CHIRP G2N is a fishfinder/GPS product with Side Imaging sonar capability to be used in the marine environment. It is comprised of a keypad, LCD display, Internal GPS, Ethernet, External GPS capable, External Temp/Speed input, and power cable. This device is mounted on the main deck/consoles of small recreational vessels in an exposed environment (directly exposed to the weather).

The model variants are defined as follows, per the manufacturer:
- Helix 9X CHIRP GPS G2N – 2D Sonar – Smaller 9” Display
- Helix 9X CHIRP DI GPS G2N – 2D and DI Sonar – Smaller 9” Display
- Helix 9X CHIRP SI GPS G2N – 2D, DI, and SI Sonar – Smaller 9” Display

Sonar differences are handled in S/W. All the boards are populated the same in the sonar area. The main differences is the displays.

Test Information

Test Start Date: August 22, 2016
Test End Date: September 6, 2016
Emissions Pre-scan Site: SAC
Final Emissions Site: SAC
EMI Freq. Band: 150kHz - 4GHz
RFI Site: FAC
Radiated Emissions Equipment Class: Class B

Test Methods Applied

(Check all that apply)

☒ Annex 1-1 (KN 61000-4-2)
☒ Annex 1-2 (KN 61000-4-3)
☒ Annex 1-3 (KN 61000-4-4)
☐ Annex 1-4 (KN 61000-4-5)
☒ Annex 1-5 (KN 61000-4-6)
☐ Annex 1-6 (KN 61000-4-8)
☐ Annex 1-7 (KN 61000-4-11)

Table of Contents

SECTION A: GENERAL INFORMATION

1.0 Introduction

1.1 Scope

This report documents conformance with the requirements set forth in Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17) and Annex 8-8 (KN 301 489-3) in accordance with the Conformity Assessment Procedure for Electromagnetic Interference (RRA Announce 2015-110) and details the results of testing performed on August 22, 2016 through September 6, 2016 on the model Helix 9X CHIRP SI GPS G2N manufactured by Johnson Outdoors Marine Electronics, Inc..

1.2 Purpose

Testing was performed to evaluate the EUT with regard to EMC regulatory requirements in accordance with the Conformity Assessment Procedures for Electromagnetic Interference (RRA Announce 2015-110) arrangements.

1.3 Results Summary

Product Standard or Test Method Applied	Description	Result
	Immunity Standards per Annex 5 (KN24)	
Annex 1-1 (KN 61000-4-2)	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	Pass
Annex 1-2 (KN 61000-4-3)	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Pass
Annex 1-3 (KN 61000-4-4)	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Pass
Annex 1-4 (KN 61000-4-5)	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	N/A
Annex 1-5 (KN 61000-4-6)	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	Pass
Annex 1-6 (KN 61000-4-8)	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	N/A
Annex 1-7 (KN 61000-4-11)	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 Immunity Performance Criteria

KN 301 489-3

KN 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 1.4.1-1: 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 1.4.1-2: 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 1.4.1-3: 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: 1.4.1-4

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.

Manufacturers Performance Criterion: See Sample Information on page 3 of this report.

2.0 Test Facilities & Environment

2.1 Test Facilities

All testing was performed at the following address:

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

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

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS has been recognized by the Radio Research Agency (RRA) Korea Communications Commission (KCC) under the Asian Pacific Economic Cooperation Mutual Recognition Arrangement (APEC Tel MRA). ACS is designated to act as a Conformity Assessment Body (CAB) under Appendix B, Phase 1 procedures of the aforementioned MRA.

As part of the APEC Tel MRA, ACS has been assigned US Identification Number US0156 by the US National Institute of Standards and Technology (NIST).

ACS 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

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 <u>were not</u> required to bring the EUT into compliance with the requirements.** ☐ **Modifications <u>were</u> required to bring the EUT into compliance with the requirements.**

3.3 System Block Diagram and Support Equipment

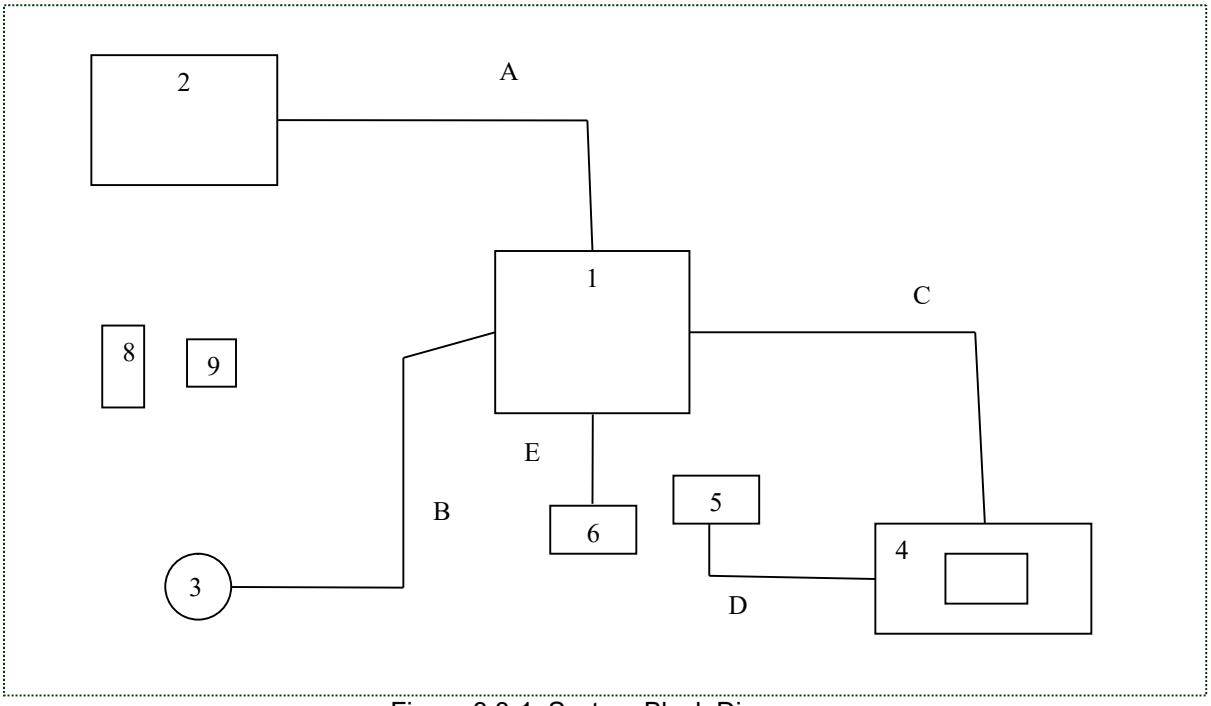


Figure 3.3-1: System Block Diagram

Table 3.3-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	GPS Display	Humminbird	410120-1M	N/A
2	12V Battery	AutoCraft	24DC-1	N/A
3	GPS Puck	Humminbird	N/A	13091842-0045
4	Transducer	Humminbird	N/A	N/A
5	Depth simulator	Humminbird	N/A	N/A
6	Speed Detector	Humminbird	N/A	N/A
8	Support Cell Phone	Samsung	SM-N920V	N/A
9	Wireless Remote	Humminbird	AS RC1 - RMT 1	15040701-0031

Table 3.3-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power Cable	100 cm	No	1 - 2
B	GPS Cable	605 cm	No	1 - 3
C	Transducer Cable	600 cm	No	1 - 4
D	Coax Cable	35 cm	Yes	4 - 5
E	Speed Detector Cable	500 cm	No	1 - 6

3.4 Observations

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

Table 3.4-1: Observations

Observation No.	Description

SECTION B: TEST INFORMATION AND RESULTS

4.0 Annex 1-1 (KN 61000-4-2) Electrostatic Discharge Immunity

4.1 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.

4.2 Test Equipment

Table 4.2-1: 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

4.3 Test Methodology

Annex 1-1 (KN 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.

4.3.1 Test Criteria

Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17) and Annex 8-8 (KN 301 489-3) requires performance criterion B to be met as described in section 1.4.1.

4.3.2 Test Justification

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

4.4 Test Setup Photograph

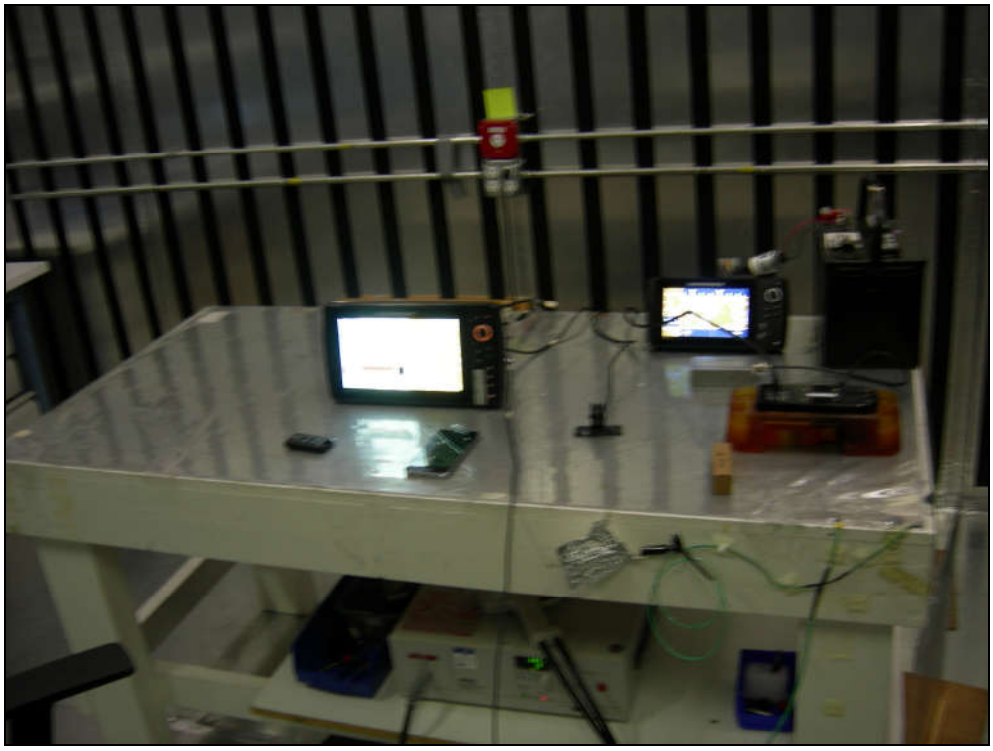
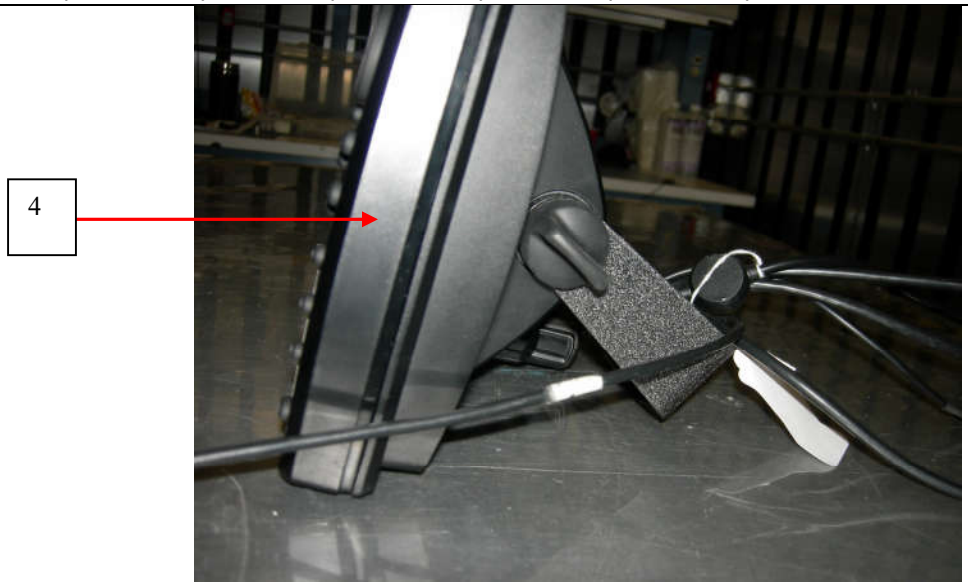


Figure 4.4-1: Test Setup Photograph

4.5 ESD Data Sheet

Test Point Photograph: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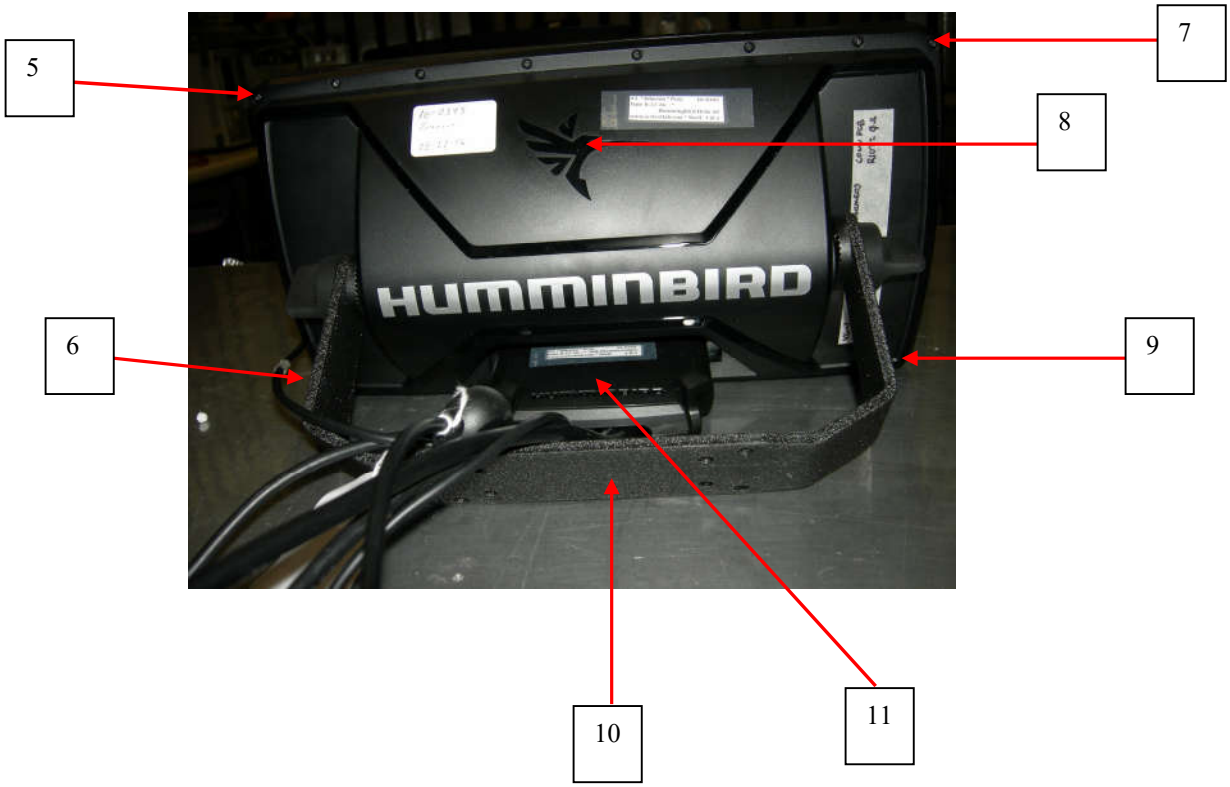
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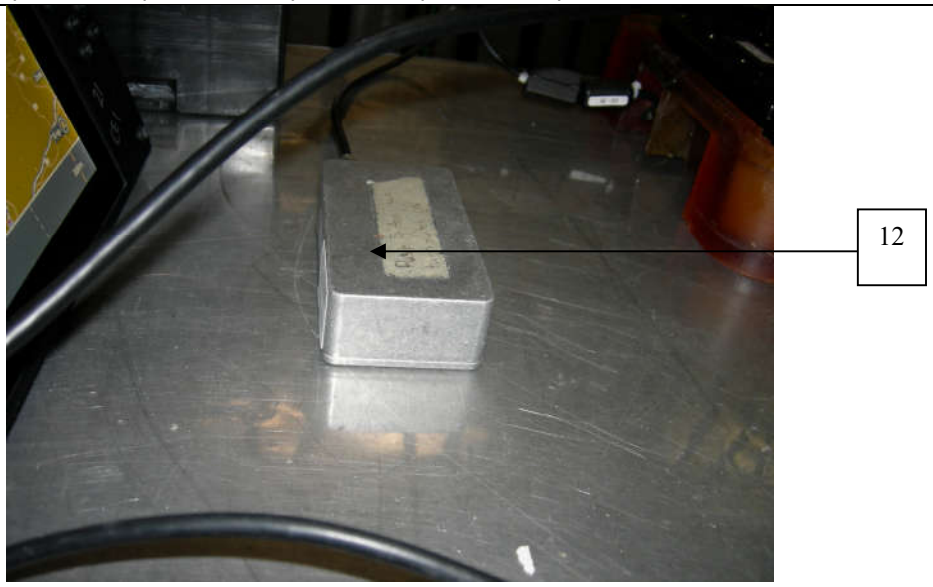
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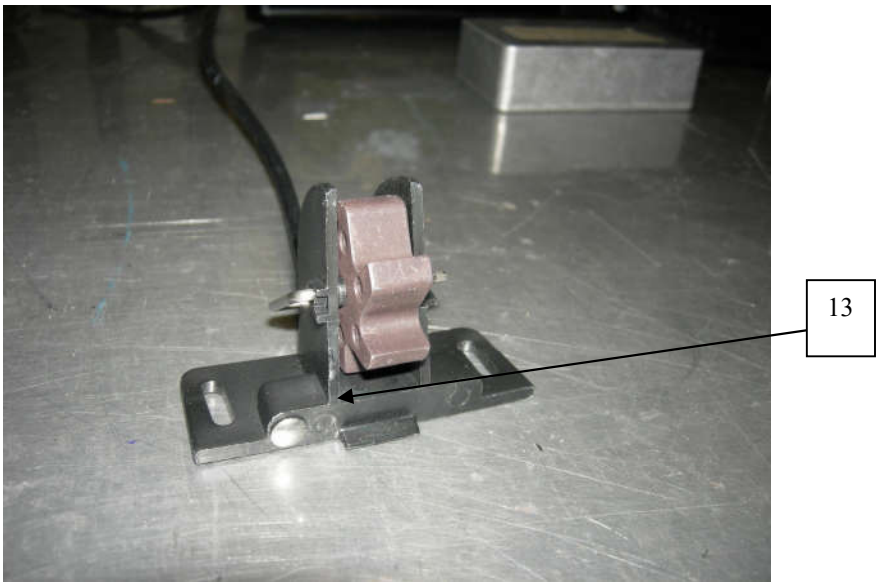
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Test Point Selection:

TEST POINT#	DESCRIPTION	TYPE (C/A)
1	Display screen	**Air**
2	User interface	**Air**
3	EUT left side	**Air**
4	EUT right side	**Air**
5	Rear top right screw	**Contact**
6	Rear bottom right screw	**Contact**
7	Rear top left screw	**Contact**
8	Rear EUT center	**Air**
9	Rear bottom left screw	**Contact**
10	Rear bracket	**Contact**
11	Cable bundle (X3)	**Air**
12	Depth simulator	**Contact**
13	Temp. sensor	**Air**

4.6 Test Data

Test Parameters:

Test Date:	**8/29/2016**	**Temperature (ºC)**	**24**
Technician:	**Chris O'Steen**	**Humidity (%)**	**35**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1012.4**
		☒ **Pre-test Verification Complete**	
Tested Modes:	**GPS, BTE, BLE, Temp, and depth. A slave unit to exercise another port all active and monitored.**		
AC Input Power:	**N/A**	**VCP Resistor Value Check:**	**961 (Ohms)**
DC Input Power:	**12Vdc**	**HCP Resistor Value Check:**	**942 (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	
Back	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	
5	Contact	Pass	
6	Contact	Pass	
7	Contact	Pass	
8	Air	Pass	
9	Contact	Pass	
10	Contact	Pass	
11	Air	Pass	

12	Contact	Pass	
13	Air	Pass	

Notes:

5.0 Annex 1-2 (KN 61000-4-3) Radio-Frequency Electromagnetic Fields

5.1 Test Site Description

The radiated fields test was performed in a fully-anechoic chamber.

5.2 Test Equipment

Table 5.2-1: 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
326	ACS	EMI Cable Set-FAC	Cables	326	07-21-2016	07-21-2017
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
644	Fairview Microwave	SA12N5W-10	Attenuator	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

NCR = No Calibration Required

5.3 Test Methodology

Annex 1-2 (KN 61000-4-3)- 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.

5.3.1 Test Criteria

Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17) and Annex 8-8 (KN 301 489-3) requires criterion A to be met as described in section 1.4.1.

5.3.2 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:**

5.4 Test Setup Photographs

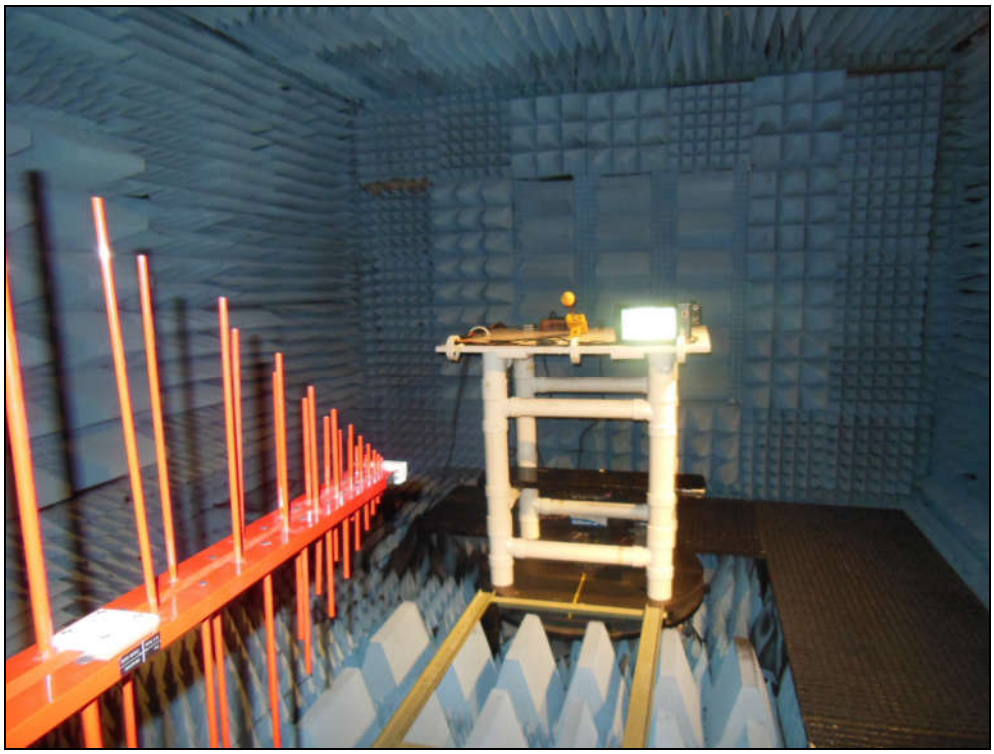

Figure 5.4-1: Test Setup Photograph

5.5 Test Results

Test Parameters:

Test Date:	**August 24, 2016**	**Temperature (ºC)**	**23.5**
Technician:	**Sean Vick**	**Humidity (%)**	**44.4**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1024**
Tested Modes:	**EUT on; Monitoring Depth; GPS, BT and BLE active and connected.**		
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:

6.0 Annex 1-3 (KN 61000-4-4) Electrical Fast Transient/Bursts

6.1 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.

6.2 Test Equipment

Table 6.2-1: Test Equipment List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Calibration Performed Date	Calibration Due Date
474	Keytek	EMC PRO	General Lab Equipment	9808246	10/7/2015	10/7/2016
62	Haefely Trench	EFT Clamp	Immunity Equipment	None	07-15-2016	07-15-2017

NCR = No Calibration Required

6.3 Test Methodology

Annex 1-3 (KN 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.

6.3.1 Test Criteria

Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17) and Annex 8-8 (KN 301 489-3) requires criterion B to be met as described in section 1.4.1.

6.3.2 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

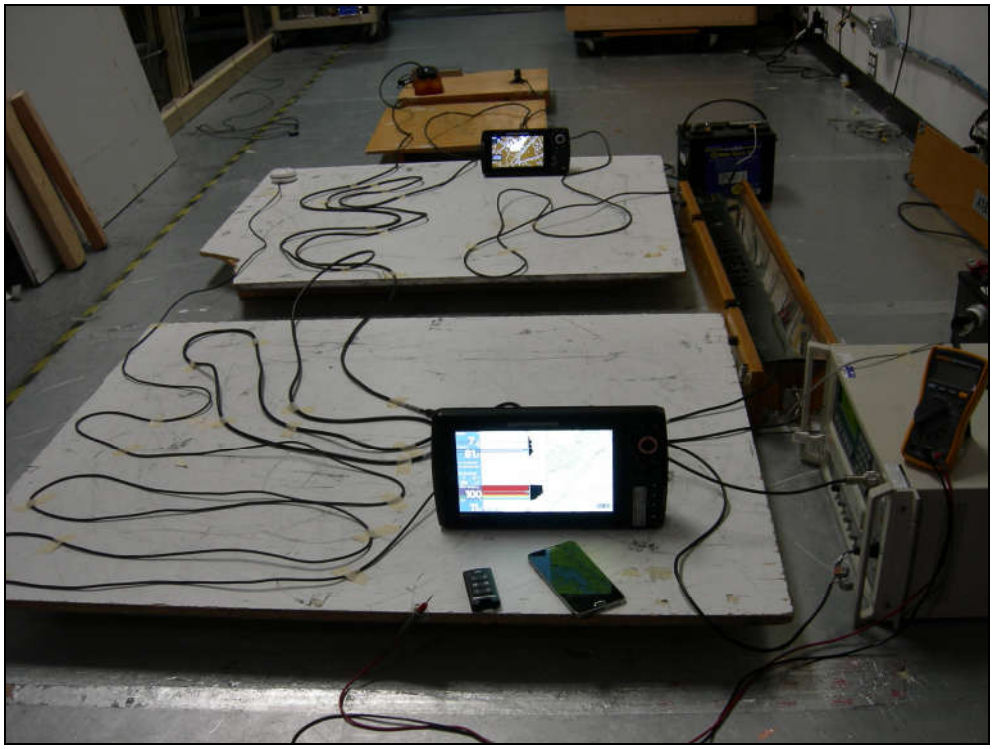

Figure 9.4-1: Test Setup Photograph

9.5 Test Results

Test Parameters:

Test Date:	**8/26/2016**	**Temperature (ºC)**	**27**
Technician:	**Christopher O'Steen**	**Humidity (%)**	**37**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1021**
Tested Modes:	**GPS, Depth, BTE, BLE, and temp running.**		
AC Input Power:	**N/A**	☒ **Pre-test Verification Complete**	
DC Input Power:	**12VDC**		

Signal Line Test Data:

Check All That Apply to This Data

Polarity:
- ☐ Positive
- ☐ Negative
- ☒ Both

Tested Levels:
- ☒ .25kV
- ☒ .5kV
- ☒ 1kV
- ☐ 2kV
- ☐ Enter Other Level Here

Signal Line	Result	Observation (Describe any detectable event)
Acc. Cable to second unit. Helix 7	Pass	
GPS	Pass	
Depth	Pass	
Temp.	Pass	

Notes:

7.0 Annex 1-4 (KN 61000-4-5) Surge Immunity

7.1 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.

8.0 Annex 1-5 (KN 61000-4-6) Radio-Frequency Common-Mode Immunity

8.1 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).

8.2 Test Equipment

Table 8.2-1: Test Equipment List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Calibration Performed Date	Calibration Due Date
448	IFR	2023A	Signal Generators	202302/190	11/2/2016	11/2/2017
14	IFI	PS5000	Power Supplies	0492-4147	NCR	NCR
15	IFI	AMP5580	Amplifiers	0492-4147	NCR	NCR
457	Com Power	CDN-M2-25	Coupler	511023	07-13-2016	07-13-2017
471	Bird Technologies Group	150-A-FFN-06	Attenuators	914	NCR	NCR
645	Fairview Microwave	SA12N5W-10	Attenuator	N/A	NCR	NCR
425	ACS	EMC Cable Set	Cable Set	425	NCR	NCR
93	Chase	8101	Clamp	65	6/5/2016	6/5/2017
96	Chase	1000-M3-25	CDN's	9806	10/3/2016	10/3/2017
364	Amplfier Research	DC2600A	Coupler	322466	NCR	NCR

NCR = No Calibration Required

8.3 Test Methodology

Annex 1-5 (KN 61000-4-6) - 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.

8.3.1 Test Criteria

Annex 8-1 (KN 301 489-1), Annex 8-3 (KN 301 489-17) and Annex 8-8 (KN 301 489-3) requires criterion A to be met as described in section 1.4.1.

8.3.2 Test Justification

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

8.4 Test Setup Photographs

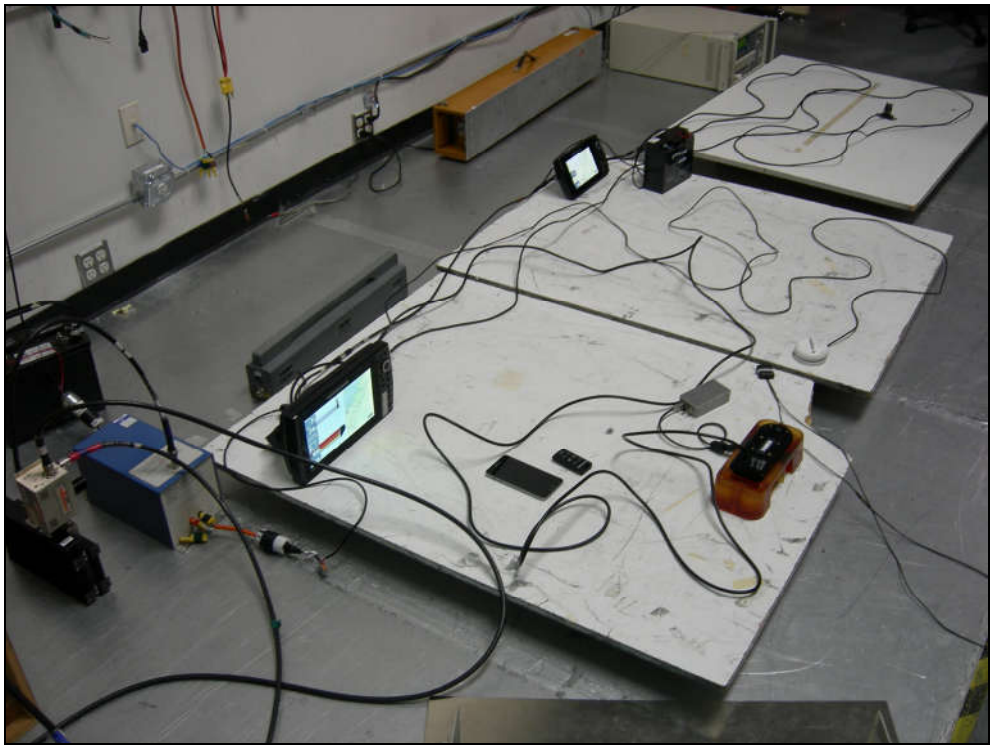

Figure 8.4-1: Test Setup Photograph

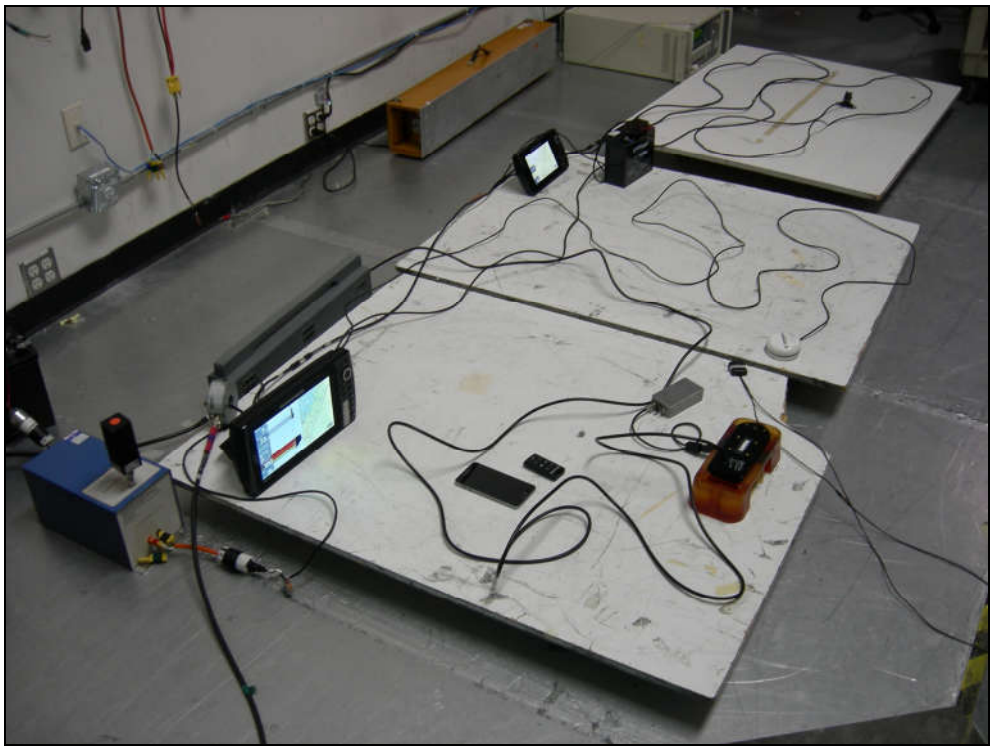

Figure 8.4-2: Test Setup Photograph

8.5 Test Results

Test Parameters:

Test Date:	**8/25/2016**	**Temperature (ºC)**	**24.6**
Technician:	**Chris O'Steen**	**Humidity (%)**	**39.5**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1021**
Tested Modes:	**GPS, BT, BLE, Depth, and temp being watched.**		
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)
GPS	Pass	
Depth	Pass	
Temp	Pass	
Acc. Cable to second unit. Helix 7	Pass	

Notes:
CI testing was performed with 1KHz and 400Hz modulation.

9.0 Annex 1-6 (KN 61000-4-8) Power Frequency Magnetic Fields Immunity

9.1 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.

10.0 Annex 1-7 (KN 61000-4-11) Voltage Dips and Interruptions

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.

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.