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EMC Technical Report

Prepared For: JOHNSON OUTDOORS

Model Covered: HELIX 9X MSI GPS G3N
Model Variants: HELIX 9 CHIRP GPS G3N, HELIX 9X CHIRP GPS G3N, HELIX 9 MDI GPS G3N, HELIX 9X MDI GPS G3N, HELIX 9 MSI GPS G3N, HELIX 9X MSI GPS G3N

In Accordance with the Conformity Assessment Procedure for Electromagnetic Interference (RRA Announce 2018-99, Oct 12, 2018)

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

Report Number: AT72141977.9K4
Report Revision: D
Report Issue Date: March 22, 2019

This report contains Page 38 pages

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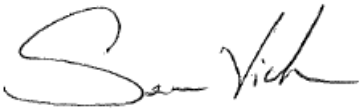


Sean Vick
EMC Team Lead
TÜV SÜD America Inc.

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.

REVISION HISTORY Report Number: AT72141977.9K4 Manufacturer: JOHNSON OUTDOORS Model: HELIX 9X MSI GPS G3N					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
December 3, 2018	---	A	Initial Release	All	Sean Vick
January 10, 2019	A	B	Updated Page 4 Highest Data Rate and Source. Updated Page 4 Degradation.	1, 4	Sean Vick
March 15, 2019	B	A	Removed HELIX 8 references	All	Sean Vick
March 22, 2019	C	D	Revised basic and variant model names	All	Sean Vick

Project Information Sheet

Applicant Details

Manufacturer: JOHNSON OUTDOORS
Street Address: 1220 Old Alpharetta Road Suite 340
City, State/Province and Postal Code: Alpharetta, GA 30005
Country: USA
Contact: Kim Lincoln

Phone: +177088862921076
Fax:
Email: Kim.Lincoln@johnsonoutdoors.com

Sample Information

Model: HELIX 9X MSI GPS G3N
Model Variant(s): FORMTEXT **|**HELIX 9 CHIRP GPS G3N, HELIX 9X CHIRP GPS G3N, HELIX 9 MDI GPS G3N, HELIX 9X MDI GPS G3N, HELIX 9 MSI GPS G3N, HELIX 9X MSI **GPS G3N**
Environment of Use: Residential
Sample Receive Date: October 2, 2018
Sample Receive Condition: Good
Test Mode Description: Powered ON; Monitoring depth, speed, temp, GPS
Unacceptable Degradation (Provided by Mfg.): The Depth Reading should stay within ±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

Helix 9X Chirp MSI GPS G3N – main unit – supports 2D, MDI and MSI Sonar with GNSS receiver, BT/BLE and Ether net port
Helix 9X Chirp MDI GPS G3N – same as main but MSI Sonar is disabled via software
Helix 9X Chirp GPS G3N – same as main unit but MSI and MDI Sonar disabled via software

Test Information

Test Start Date: October 2, 2018
Test End Date: October 26, 2018
EMI Freq. Band: 150KHz-6GHz
RFI Site: SAC

Test Methods Applied

(Check all that apply)

☒ Annex 1-13 (KN 61000-4-2)
☒ Annex 1-14 (KN 61000-4-3)
☒ Annex 1-15 (KN 61000-4-4)
☐ Annex 1-16 (KN 61000-4-5)
☒ Annex 1-17 (KN 61000-4-6)
☐ Annex 1-18 (KN 61000-4-8)
☐ Annex 1-19 (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 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17) in accordance with the Conformity Assessment Procedure for Electromagnetic Interference (RRA Announce 2018-99) and details the results of testing performed on October 2, 2018 through October 26, 2018 on the model HELIX 9X MSI GPS G3N manufactured by JOHNSON OUTDOORS .

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 2018-99) arrangements.

1.3 Results Summary

Product Standard or Test Method Applied	Description	Result
Immunity Standards per Annex 8-1 (KN 301 489-1), Annex 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17)		
Annex 1-13 (KN 61000-4-2)	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	Pass
Annex 1-14 (KN 61000-4-3)	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Pass
Annex 1-15 (KN 61000-4-4)	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Pass
Annex 1-16 (KN 61000-4-5)	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	N/A
Annex 1-17 (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 1-18 (KN 61000-4-8)	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	N/A
Annex 1-19 (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

1.4.4 Immunity Performance Criteria

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 address:

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 section 1.0

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. 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). TÜV SÜD America Inc. 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, TÜV SÜD America Inc. has been assigned US Identification Number US0156 by the US National Institute of Standards and Technology (NIST).

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by the ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

2.3 Test Environment

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

Where the manufacturer does not specify climate parameters for the EUT, all tests 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
1220 Old Alpharetta Road Suite 340
Alpharetta, GA 30005

Kim Lincoln
+177088862921076
Kim.Lincoln@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

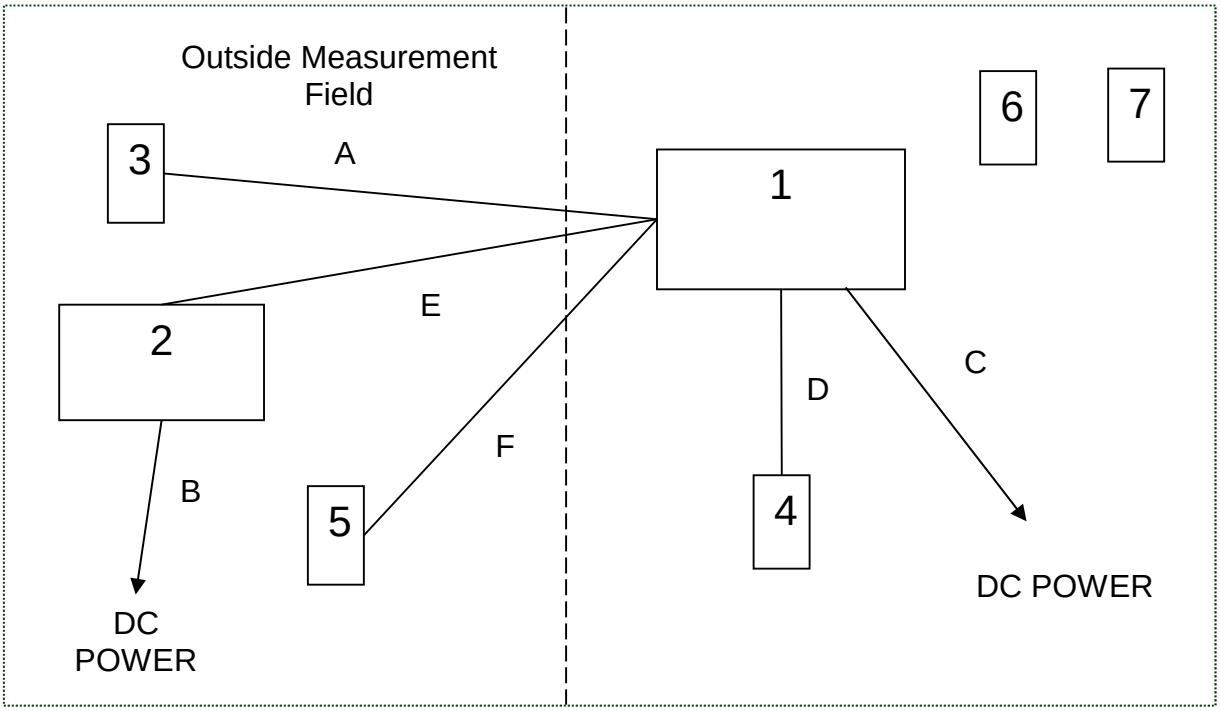


Figure 3.3-1: System Block Diagram

Table 3.3-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Johnson Outdoors	H9 G3N ENG	18080854-0015
2	Auxiliary Equipment	Johnson Outdoors	HELIX 7	180424220007
3	Precision GPS Module	Humminbird	AS*GPS	18081742-0006
4	Transducer	Johnson Outdoors	N/A	N/A
5	Speed sensor	Johnson Outdoors	N/A	N/A
6	Cellular Phone	N/A	N/A	N/A
7	Remote Control	Johnson Outdoors	RMT 1	N/A

Table 3.3-2: Cable Description

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

3.4 Observations

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

Table 3.4-1: Observations

Observation No.	Description

3.5 EUT Photographs

Figure 3.5-1: EUT Photo – Front

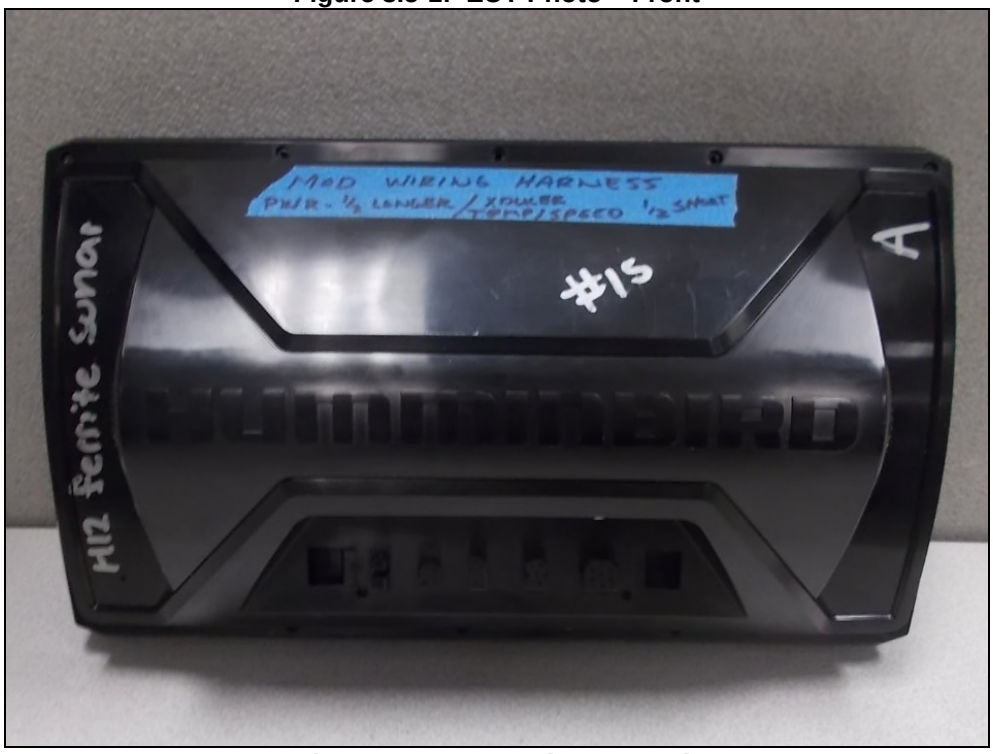


Figure 3.5-2: EUT Photo – Back

SECTION B: TEST INFORMATION AND RESULTS

4.0 Annex 1-13 (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 7.2-1: Test Equipment List

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
144	Omega	RH411	Climate Monitoring Equipment	H0103373	9/1/2016	9/1/2018
375	Fluke	Fluke 115	Meters	93771446	7/10/2018	7/10/2020
582	Kikusui	KES4021A	ESD Gun	SA003046	5/17/2018	5/17/2019

NCR = No Calibration Required

4.3 Test Methodology

Annex 1-13 (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 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17) requires performance criterion B to be met as described in section 1.4.4

4.3.2 Test Justification

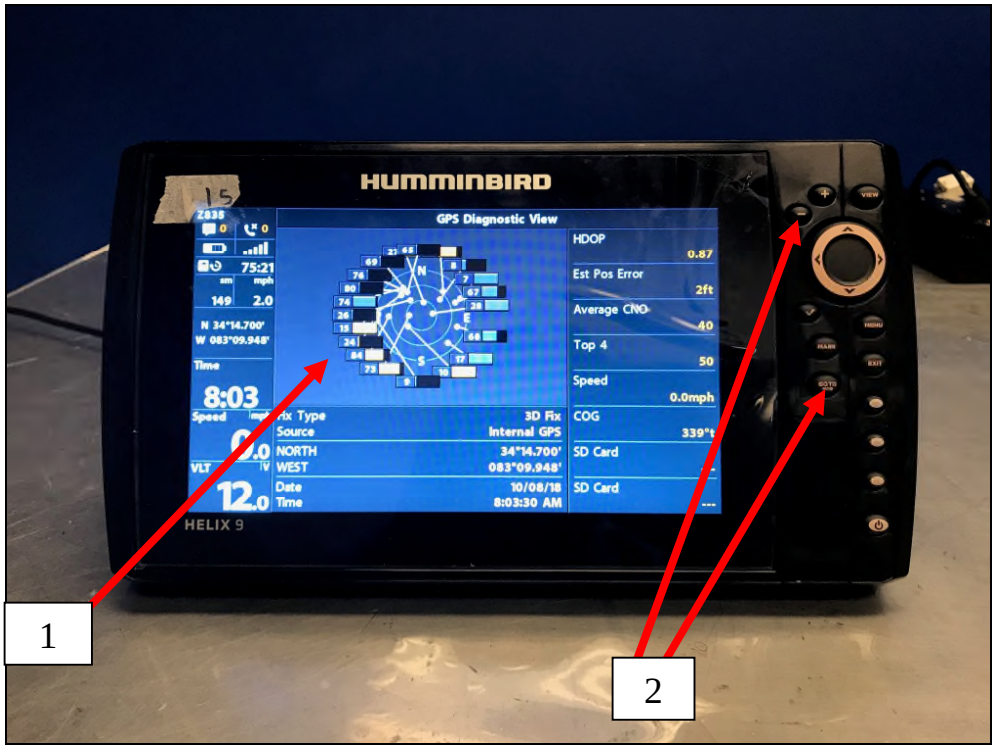
☒ **No justification - The EUT was tested per the appropriate test methods and test plan.**
☐ **The test method, standard, and/or test plan was deviated from for the following reason:**

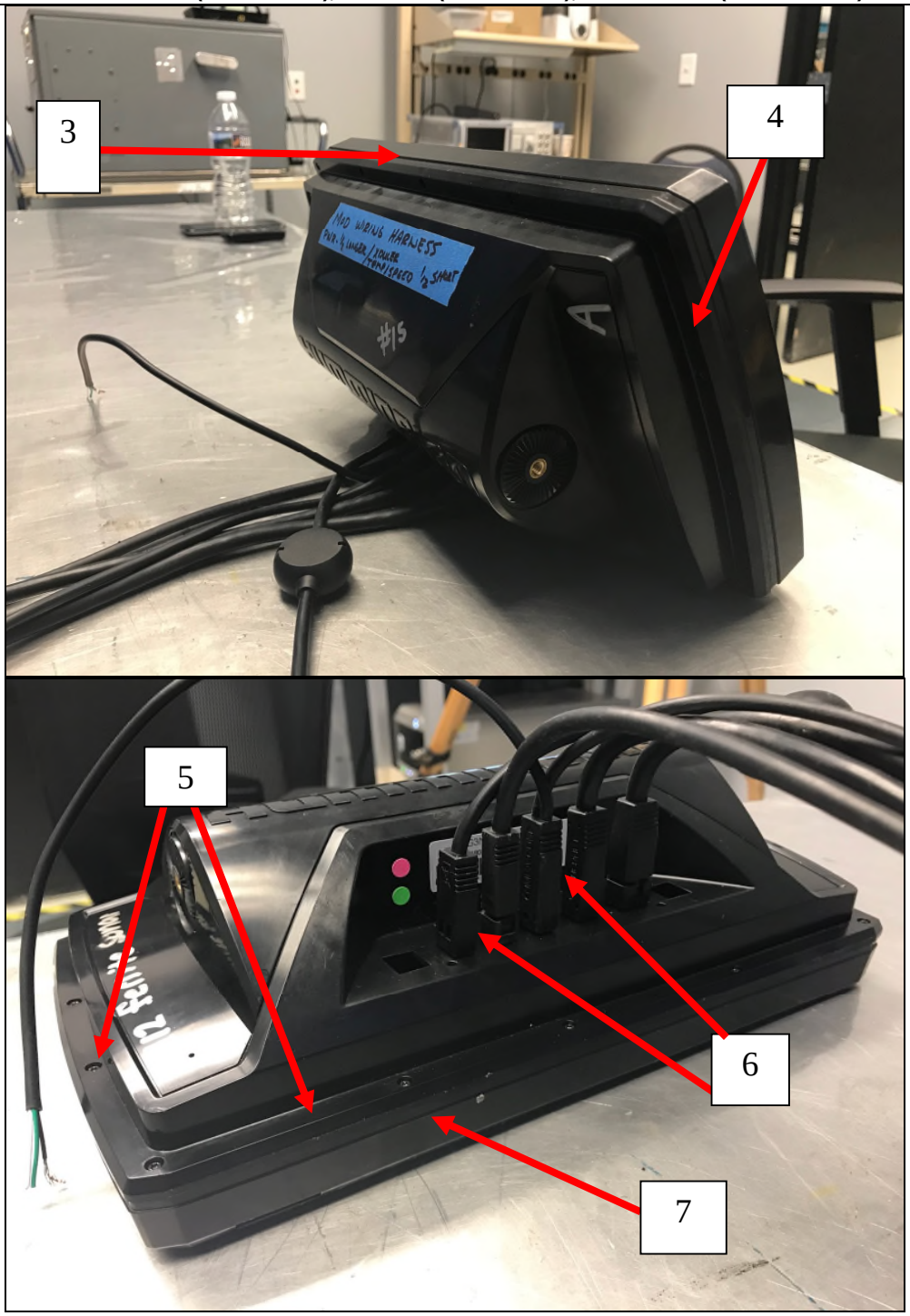
4.4 Test Setup Photograph

Figure 7.4-1: Test Setup Photograph

7.5 ESD Data Sheet

Test Point Photograph:

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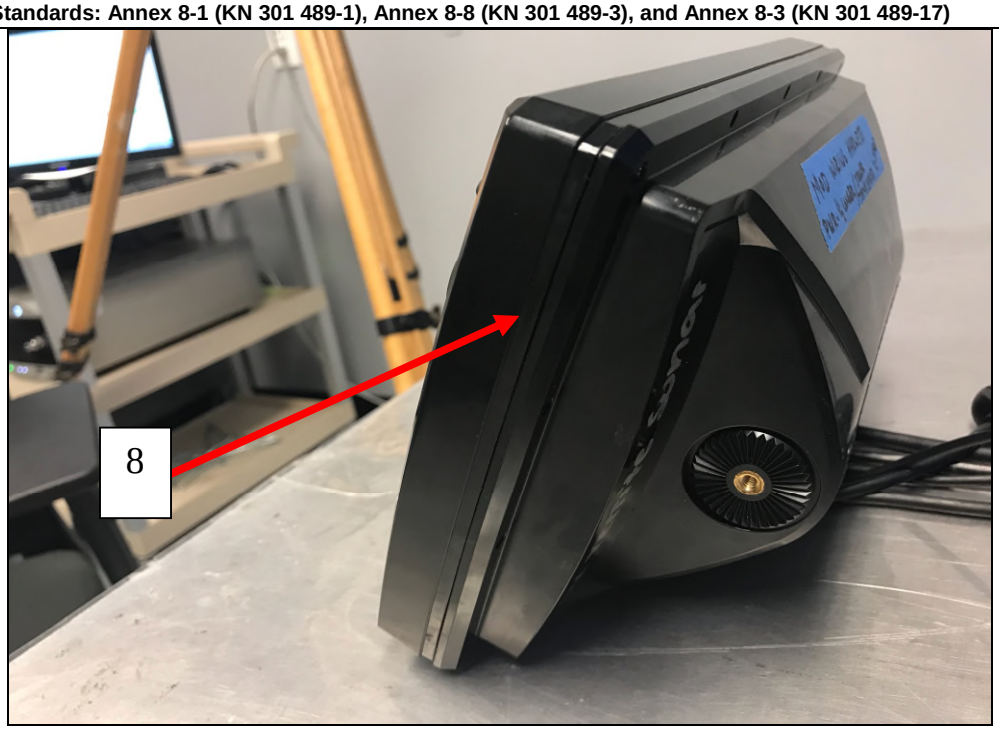


Test Point Selection:

TEST POINT#	DESCRIPTION	TYPE (C/A)	TEST POINT#	DESCRIPTION	TYPE (C/A)
1	Touchscreen	**Air**	5	Connecting Screws	**Contact**
2	Pushbuttons	**Air**	6	I/O Ports	**Air**
3	Top Seam	**Air**	7	Bottom Seam	**Air**
4	Right Seam	**Air**	8	Left Seam	**Air**

4.6 Test Data

Test Parameters:

Test Date:	**August 20, 2018**	**Temperature (ºC)**	**21.5**
Technician:	**Eugene Sello**	**Humidity (%)**	**57.6**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**982**
		☒ **Pre-test Verification Complete**	
Tested Modes:	**Powered On; GPS active; Bluetooth conected**		
AC Input Power:	**N/A**	**VCP Resistor Value Check:**	**950k (Ohms)**
DC Input Power:	**12VDC Battery**	**HCP Resistor Value Check:**	**955k (Ohms)**

Indirect Contact Discharge:

Check All That Apply to This Data

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

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

Air and Direct Contact Discharge:

Check All That Apply to This Data

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

Test Point	Discharge Type	Result	Observation (Describe any detectable event)
1	**Air**	**Pass**	
2	**Air**	**Pass**	
3	**Air**	**Pass**	
4	**Air**	**Pass**	
5	**Contact**	**Pass**	
6	**Air**	**Pass**	
7	**Air**	**Pass**	
8	**Air**	**Pass**	

Notes:
8KV applied for air discharge

5.0 Annex 1-14 (KN 61000-4-3) Radio-Frequency Electromagnetic Fields

5.1 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.

5.2 Test Equipment

Table 8.2-1: Test Equipment List

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
197	Amplifier Research	DC6080	Coupler	307006	NCR	NCR
354	ETS Lindgren	3142C	Antennas	00078838	NCR	NCR
370	IFI	CMX5002	Amplifier	L364-0407	NCR	NCR
144	Omega	RH411	Climate Monitoring Equipment	H0103373	9/1/2016	3/11/2019
684	Rohde & Schwarz	SML03	Signal Generators	103503	7/11/2018	7/11/2019
711	Hewlett Packard	8648B	Signal Generators	3623A01926	7/11/2018	7/11/2019
214	Holaday	HI-4433-GRE	Probes	00034096	4/12/2018	4/12/2019
836	ETS Lindgren	Chamber B EMI Cable Set	Cable Set	836	5/1/2018	5/1/2019
824	IFI	CMX5001	Amplifier	932-1095	NCR	NCR

High Frequency RFI

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
329	A.H. Systems	SAS-571	Antennas	721	8/3/2017	8/3/2019
144	Omega	RH411	Climate Monitoring Equipment	H0103373	9/1/2016	3/11/2019
836	ETS Lindgren	Chamber B EMI Cable Set	Cable Set	836	5/1/2018	5/1/2019
684	Rohde & Schwarz	SML03	Signal Generators	103503	7/11/2018	7/11/2019
214	Holaday	HI-4433-GRE	Probes	00034096	4/12/2018	4/12/2019
1115	Varian	VZC6961G1	Amplifier	884	NCR	NCR
1116	Varian	VZM6991G5	Amplifier	1147	NCR	NCR
814	Ophir	5293FE	Amplifier	1046	NCR	NCR

Semi-Anechoic Chamber - RFI

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
354	ETS Lindgren	3142C	Antennas	00078838	NCR	NCR
370	IFI	CMX5002	Amplifier	L364-0407	NCR	NCR
144	Omega	RH411	Climate Monitoring Equipment	H0103373	9/1/2016	3/11/2019
619	Teledyne Storm Microwave	90-195-456	Cables	13-10-601	NCR	NCR
620	Teledyne Storm Microwave	90-195-456	Cables	13-10-602	NCR	NCR
624	Advantest	R3261C	Spectrum Analyzers	31720426	NCR	NCR
214	Holaday	HI-4433-GRE	Probes	00034096	4/12/2018	4/12/2019

NCR = No Calibration Required

5.3 Test Methodology

Annex 1-14 (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 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17) requires criterion A to be met as described in section 1.4.4.

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

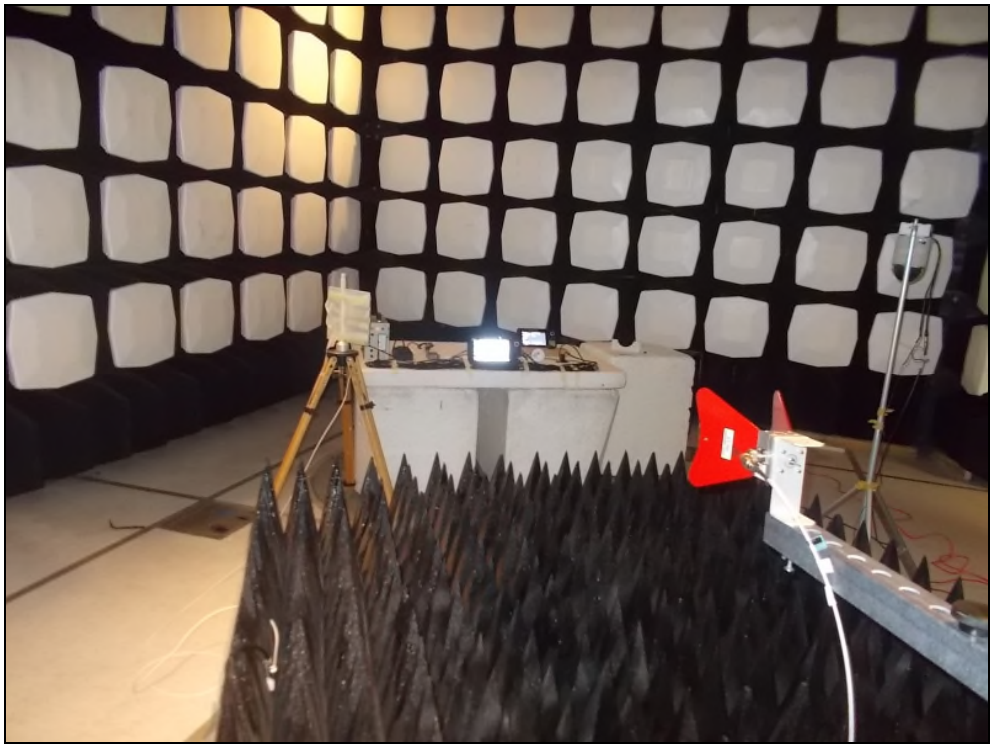


Figure 8.4-1: Test Setup Photograph

5.5 Test Results

Test Parameters:

Test Date:	**October 4, 2018**	**Temperature (ºC)**	**24**
Technician:	**A Sumner**	**Humidity (%)**	**47**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1008**
Tested Modes:	**Powered On; GPS active; Bluetooth conected**		
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	☒ 80-6000MHz	☒ 3 Seconds
☒ Both	☐ 8V/m	☐ Enter other band here	☐ Enter Other
	☐ Enter Other Level Here		

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

Notes:

6.0 Annex 1-15 (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 9.2-1: Test Equipment List

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
62	Haefely Trench	EFT Clamp	Immunity Equipment	N/A	3/13/2018	3/13/2019
494	Omega	iBTHX-W	Climate Monitoring Equipment	9460211	10/2/2018	10/2/2020
474	Keytek	EMC PRO	General Lab Equipment	9808246	3/13/2018	3/13/2019

NCR = No Calibration Required

6.3 Test Methodology

Annex 1-15 (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 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17) requires criterion B to be met as described in section 1.4.4.

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:**

6.4 Test Setup Photographs

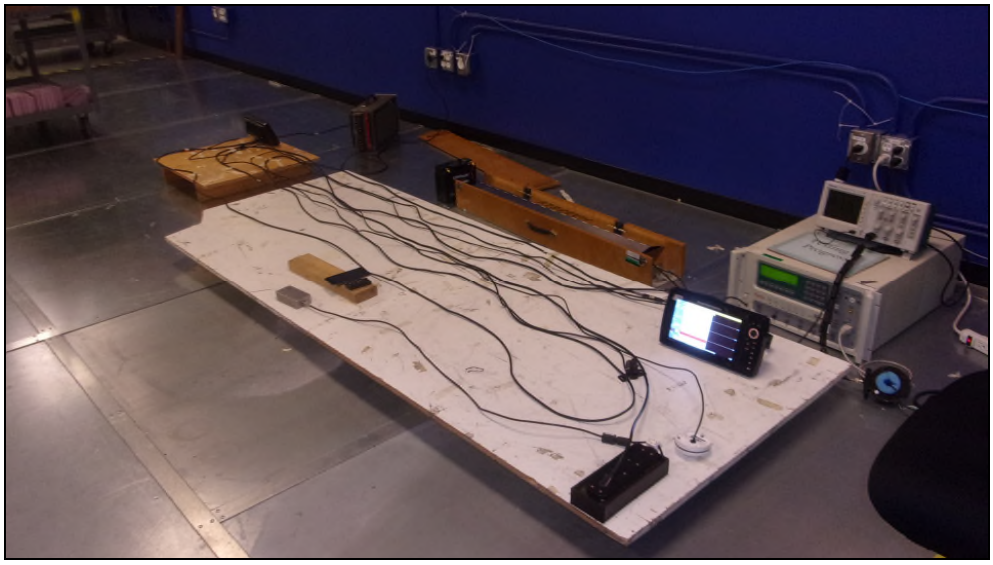


Figure 9.4-1: Test Setup Photograph

6.5 Test Results

Test Parameters:

Test Date:	**October 9, 2018**	**Temperature (ºC)**	**21**
Technician:	**Eugene Sello**	**Humidity (%)**	**58**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1018**
Tested Modes:	**EUT on; GPS simulator connected, phone connected via bluetooth; Wireless remote connected; Sonar Transducer on**		
AC Input Power:	**N/A**	**☒ Pre-test Verification Complete**	
DC Input Power:	**12VDC**		

Mains Test Data:

Check All That Apply to This Data

Polarity:
- ☐ Positive
- ☐ Negative
- ☒ Both

Tested Levels:
- ☒ .5kV
- ☒ 1kV
- ☐ 2kV
- ☐

Interface Type:
- ☒ Input
- ☐ Output
- ☐ 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:
- ☐ Positive
- ☐ Negative
- ☒ Both

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

Signal Line	Result	Observation (Describe any detectable event)
GPS input	Pass	
Ethernet	Pass	
Speedometer	Pass	
SONAR Transducer	Pass	

Notes:

7.0 Annex 1-16 (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:

Surge testing was not performed as per the following test justification provided the manufacturer.

Our product is installed in a marine environment and the cables are buried in the boat and not exposed to the outside environment except where it makes connection with the unit. Based on installation and use of the product we feel that this test is not necessary.

8.0 Annex 1-17 (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 7.2-1: Test Equipment List
Test Equipment List – Conducted Immunity

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
5	Chase	CSP-8441	Probes	19	6/19/2018	6/19/2020
93	Chase	8101	Clamp	65	5/24/2018	5/24/2019
96	Chase	1000-M3-25	CDN	9806	5/1/2018	5/1/2019
364	Amplifier Research	DC2600A	Coupler	0322466	NCR	NCR
370	IFI	CMX5002	Amplifier	L364-0407	NCR	NCR
418	Teseq	ISN-S501	LISN	24543	5/1/2018	5/1/2019
425	ACS	EMC Cable Set	Cable Set	425	NCR	NCR
457	Com Power	CDN-M2-25	Coupler	511023	7/11/2018	7/11/2019
471	Bird Technologies Group	150-A-FFN-06	Attenuators	0914	NCR	NCR
144	Omega	RH411	Climate Monitoring Equipment	H0103373	9/1/2016	3/11/2019
634	Fischer Custom Communications Inc.	FCC-801-M3-16	CDN	9730	5/22/2018	5/22/2019
711	Hewlett Packard	8648B	Signal Generators	3623A01926	7/11/2018	7/11/2019
684	Rohde & Schwarz	SML03	Signal Generators	103503	7/11/2018	7/11/2019

NCR = No Calibration Required

8.3 Test Methodology

Annex 1-17 (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 1.5×10^{-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.

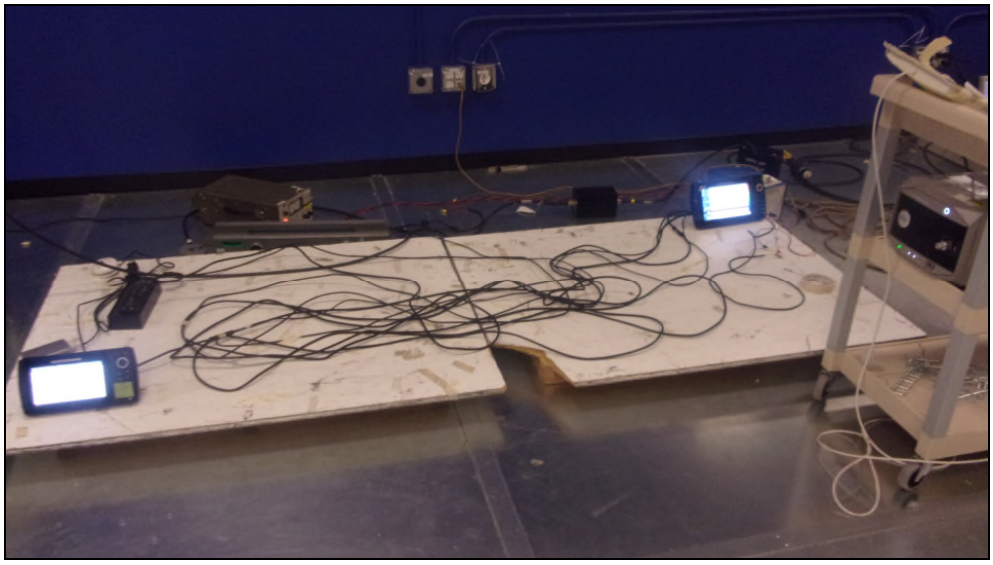
8.3.1 Test Criteria

Annex 8-1 (KN 301 489-1), Annex 8-8 (KN 301 489-3), and Annex 8-3 (KN 301 489-17) 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



8.5 Test Results

Test Parameters:

Test Date:	**October 26, 2018**	**Temperature (ºC)**	**23**
Technician:	**Tyler Leeson**	**Humidity (%)**	**44**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**987**
Tested Modes:	**Powered ON; displaying depth, speed info, GPS and BT active; connected to AUX unit**		
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 input	Pass	
Ethernet	Pass	
Speedometer	Pass	
SONAR Transducer	Pass	

Notes:

9.0 Annex 1-18 (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:

PFMF testing was not performed as per the following test justification provided the manufacturer.

Again, based on usage and environment we feel that this test is not applicable. In addition, there are no magnetically sensitive components used in our devices that would be affected by other AC powered devices.

10.0 Annex 1-19 (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:**

The EUT is DC powered; therefore, this test is not applicable and was not performed because the EUT is not directly connected to the AC power lines during operation.

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 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.