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 the:
Electromagnetic Compatibility Directive – 2014/30/EU

Immunity Product Standard: EN 60945:2002
Emissions Product Standard(s):
EN 60945:2002

ACS Report: 16-0342.C08.3D
Report Revision: D
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.

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This report contains 59 pages

REVISION HISTORY
Report Number: 16-0342.C08.3D
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	Jeremy Pickens
October 28, 2016	A	B	Corrected model covered and variants per manufacturer and corrected street address	1, 3, 5, 7, 8	Jeremy Pickens
November 4, 2016	B	C	Revised model name in product description	3	Ray Verar
January 9, 2019	C	D	- 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

Project: 16-0342.C08.3D

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: Seth Bergman

Phone: 334-687-6613
Fax:
Email: sbergman@johnsonoutdoors.com

Sample Information

Model: HELIX 7X CHIRP MSI GPS G3N
Model Variant(s): See Product Description
Environment of Use: Residential
Sample Receive Date: July 25, 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 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: July 27, 2016
Test End Date: August 17, 2018
Emissions Pre-scan Site: SAC
Final Emissions Site: SAC
EMI Freq. Band: 10kHz - 10GHz
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 60945:2002 and details the results of testing performed on July 27, 2016 through August 17, 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 and conducted 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 Union's CE Marking arrangements.

1.3 Results Summary

Product Standard or Test Method Applied	Description	Result
Product Standards		
EN 60945:2002	Maritime navigation and radio communication equipment and systems General Requirements Methods of testing and required test results	Pass
EN 61000-3-2:2014	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 60945:2002		
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 series HELIX 7, the limits which apply are EN 60945:2002 Class B. These limits are found in Table 1.4.1-1 below:

Table 1.4.1-1 Emissions Limits EN 60945:2002 Class B

	Portable	Protected	Exposed	Submerged
Conducted emissions (9.2)		10 kHz – 150 kHz 150 kHz – 350 kHz 350 kHz – 30 MHz	63 mV – 0,3 mV (96 dBµV – 50 dBµV) 1 mV – 0,3 mV (60 dBµV – 50 dBµV) 0,3 mV (50 dBµV)	
Radiated emissions (9.3)	150 kHz – 300 kHz 300 kHz – 30 MHz 30 MHz – 2 GHz 156 MHz – 165 MHz	10 mV/m – 316 µV/m (80 dBµV/m – 52 dBµV/m) 316 µV/m – 50µV/m (52 dBµV/m – 34 dBµV/m) 500 µV/m (54 dBµV/m) except for 16 µV/m (24 dBµV/m) quasi-peak or 32 µV/m (30 dBµV/m) peak		

1.4.2 Immunity Performance Criteria

Each immunity test requires 1 of 3 performance criteria to be met. Below are descriptions of each.

Performance Criterion A: The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

Performance Criterion B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

Performance Criterion C: Temporary loss of function is allowed, provided the function is self recoverable or can be restored by the operation of the controls

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 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

TUV has been designated through NIST (US Identification Number: US0156) as a Phase I CAB under the APECTel MRA to perform testing for:

- Chinese Taipei's (Taiwan) Bureau of Standards, Metrology and Inspection: BSMI Number SL2-IN-E-1127R
- Hong Kong's Office of the Telecommunications Authority (OFTA)
- Singapore's Infocomm Development Authority of Singapore (IDA)
- Australia's Australian Communication and Media Authority (ACMA)

TUV test sites are also designated by Japan's Voluntary Control Council for Interference (VCCI) to perform testing in accordance with VCCI technical regulations. The VCCI has issued the following designation code in recognition of these test sites: A-0152.

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

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

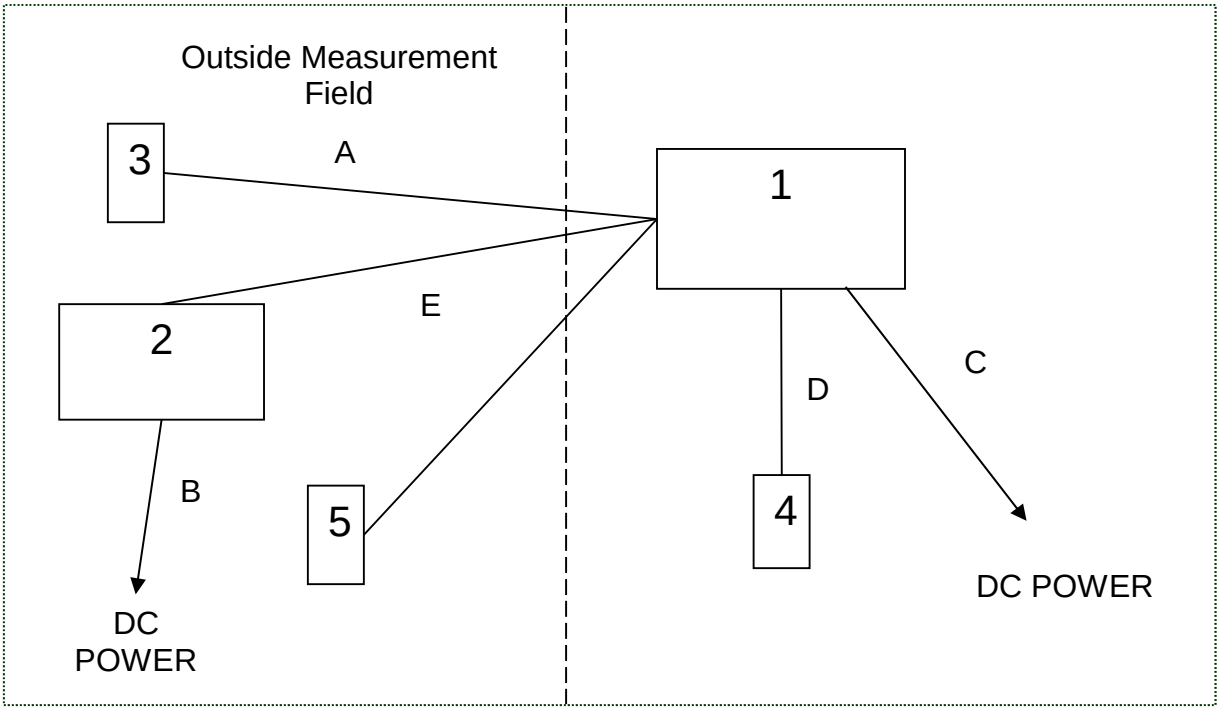


Figure 3.3-1: System Block Diagram

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

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: 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 (Buford Facility)

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:

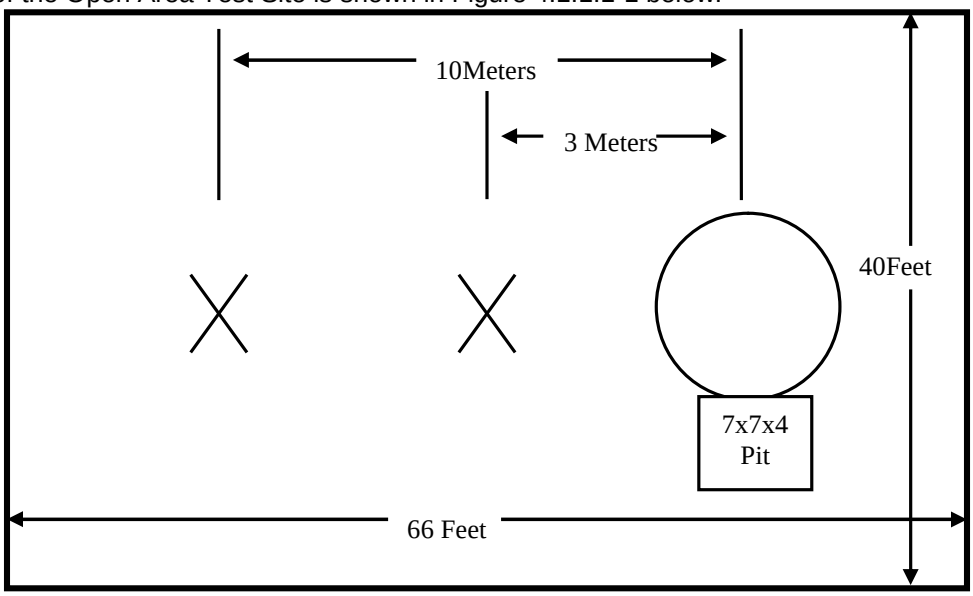


Figure 4.1.1.1-1: Open Area Test Site

4.1.1.2 Semi-Anechoic Chamber (Buford Facility)

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:

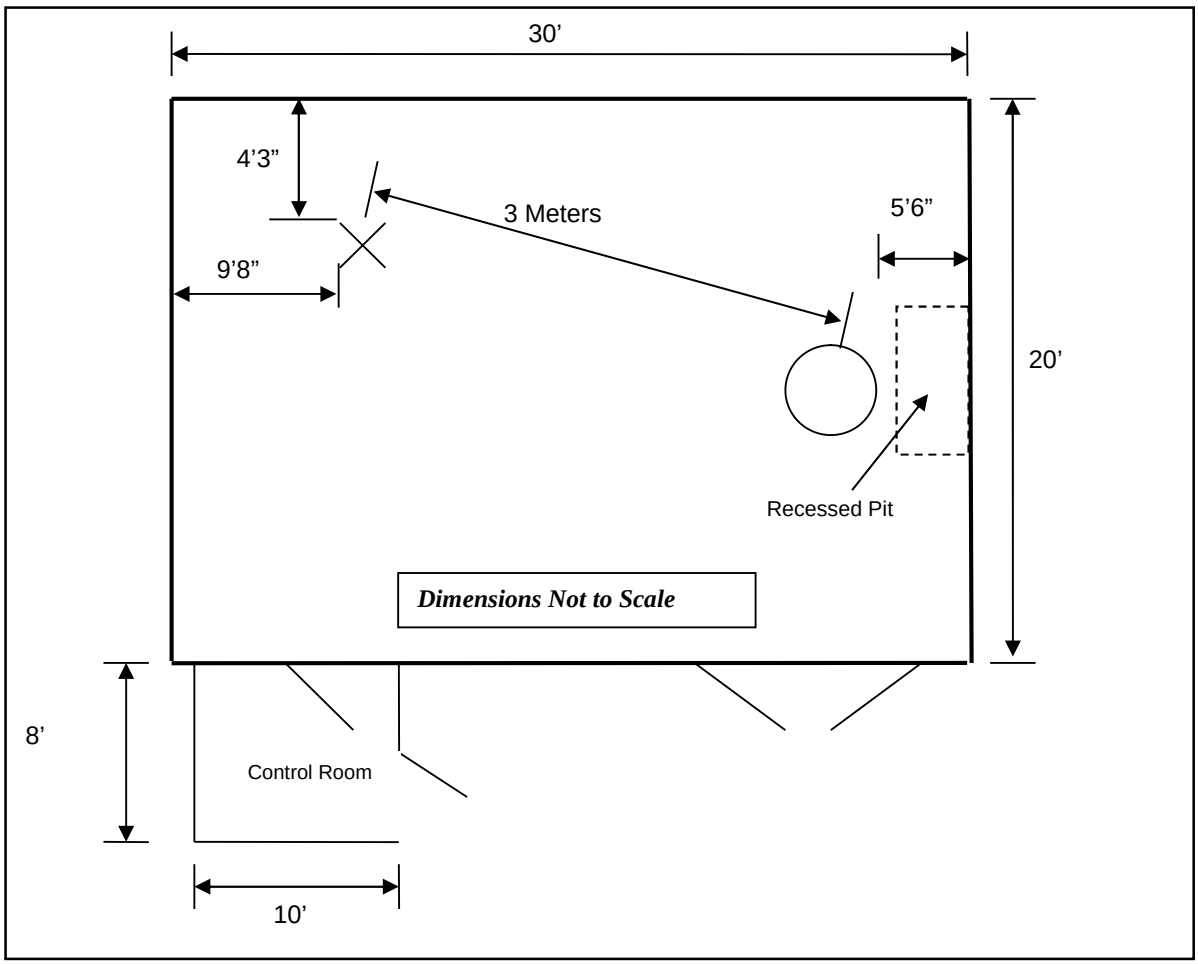


Figure 4.1.1.2-1: Semi-Anechoic Chamber Test Site

4.1.1.3 Semi-Anechoic Chamber Test Site (Alpharetta Facility)

The Semi-Anechoic Chamber Test Site consists of a 20’W x 30’L x 20’H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5’6” 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 shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

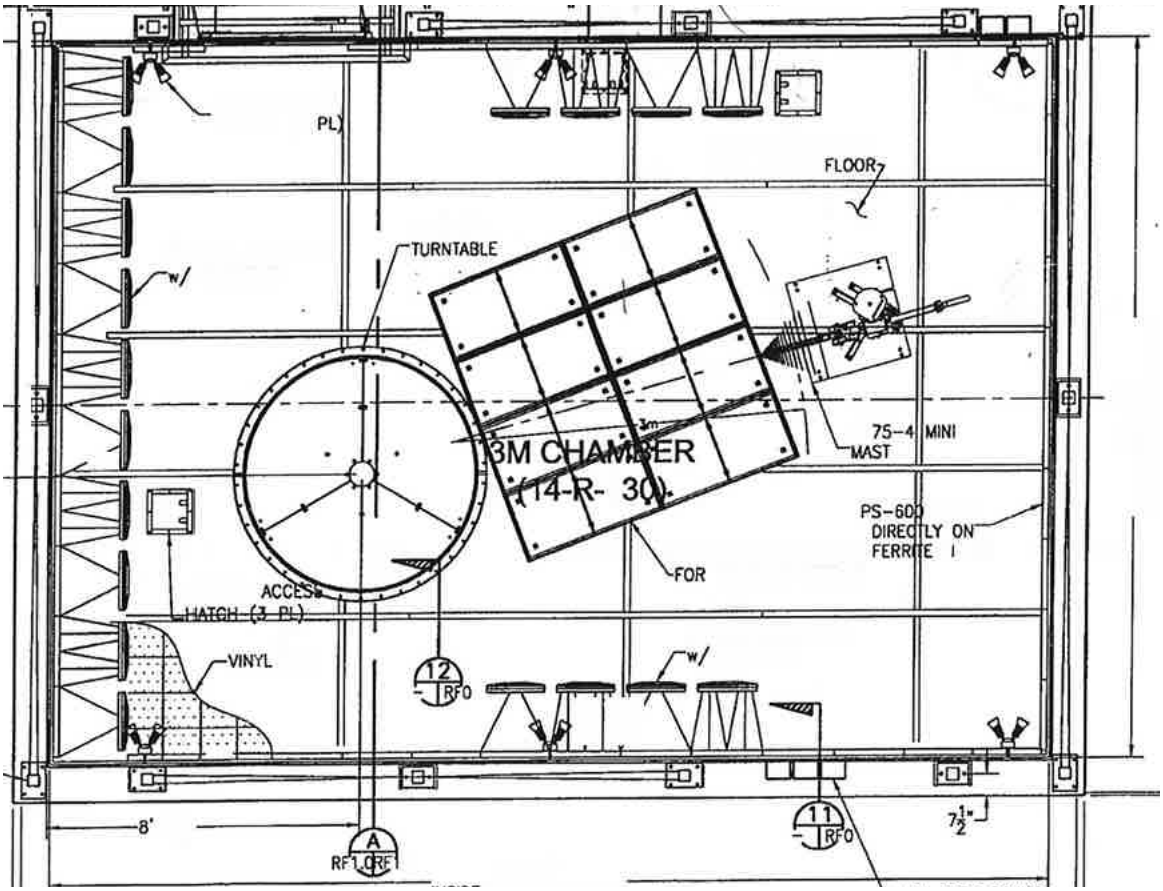


Figure 4.1.1.3-1: : Semi-Anechoic Chamber Test Site (Alpharetta Facility)

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	302.6005K26 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	IRE-200W-12.0-SM	Cables	N/A	9/2/2016	9/2/2017
422	Florida RF	MS-200AW-72.0-SM	Cables	805	10/30/2015	10/30/2016
167	ACS	hamber EMI Cable S	Cable Set	167	10/20/2015	10/20/2016
628	EMCO	6502	Antennas	9407-2877	2/11/2016	2/11/2018

NCR = No Calibration Required

Table 4.1.2-2 Test Equipment – SAC 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

Table 4.1.2-3 Test Equipment – Open Area Test Site (2018)

AssetID	Manufacturer	Model#	Equipment Type	Serial#	Calibration Performed Date	Calibration Due Date
90	Electro-metrics	LPA25	Antennas	1476	1/3/2018	1/3/2020
193	ACS	OATS Cable Set	Cable Set	0193	5/1/2018	5/1/2019
211	Eagle	C7RFM3NFNM	Filters	HLC-700	10/31/2018	10/31/2019
213	TEC	PA 102	Amplifiers	44927	7/19/2018	7/19/2019
731	EMCO	3104	Antennas	2659	11/09/2016	11/09/2018
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/06/2018	11/06/2019

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 150kHz – 4GHz. 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)

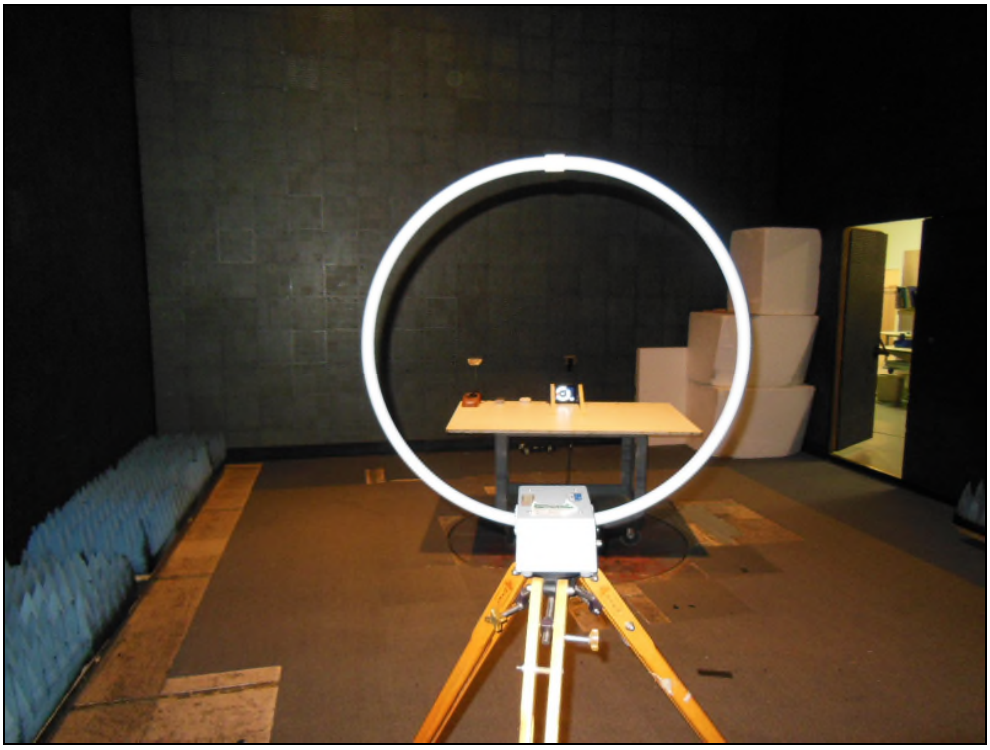


Figure 4.1.4-1: Radiated Emissions - Front View – Below 30MHz

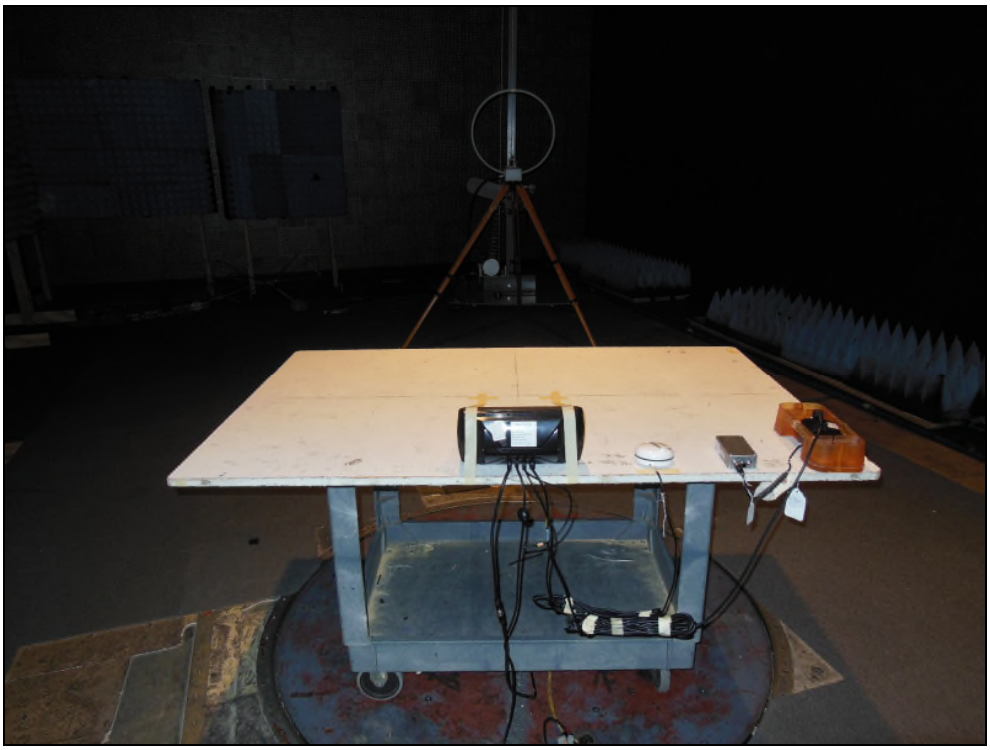


Figure 4.1.4-2: Radiated Emissions - Rear View – Below 30MHz

Figure 4.1.4-3: Radiated Emissions – Front View – Above 30MHz

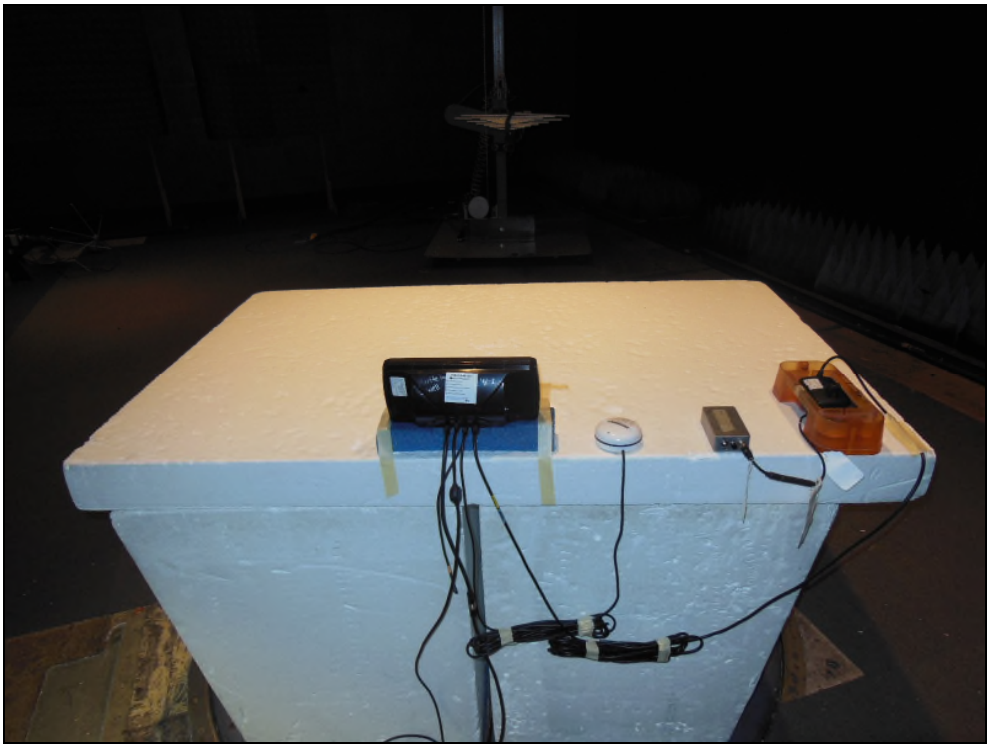


Figure 4.1.4-4: Radiated Emissions – Rear View – Above 30MHz

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:	**August 2, 2016**	**Temperature (ºC)**	**24**
Technician:	**Wayne Orwig**	**Humidity (%)**	**42**
Equipment Class:	**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:

☐ FAC ☒ SAC ☐ OATS
☐ 1 Meter ☒ 3 Meter ☐ 10 Meter

150KHz-30MHz

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
17.628		5.01	H	150	250	11.39	---------	16.40	--------	30.1	---------	13.7
23.397		4.40	H	150	185	10.62	---------	15.02	--------	35.0	---------	19.9

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

Notes:

Test Data Table:

Measurement Distance:

☐ FAC ☒ SAC ☐ OATS
☐ 1 Meter ☒ 3 Meter ☐ 10 Meter

30-2000MHz

Frequency (MHz)	Measured Level (dBuV)		Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	Pk	Qpk/Av					Pk	Qpk/Av	Pk	Qpk/Av	Pk	Qpk/Av
30.42		23.12	V	100	35	-12.21	---------	10.91	--------	54.0	---------	43.1
39		20.28	V	100	270	-13.72	---------	6.56	--------	54.0	---------	47.4
52.68		20.83	V	100	0	-13.65	---------	7.18	--------	54.0	---------	46.8
58.8		20.96	V	100	90	-13.75	---------	7.21	--------	54.0	---------	46.8
97.08		37.36	V	100	90	-13.43	---------	23.93	--------	54.0	---------	30.1
286.64		20.14	H	100	180	-9.27	---------	10.87	--------	54.0	---------	43.1

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

Notes:
There were no significant emissions found above 1GHz.

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:	**Class B**	**Barometric Pressure (mBar)**	**1012**
Tested Modes:	**GPS Active; Sonar Measuring Depth (7.2 ft), Speed/Temp Sensor Active**		
AC Input Power:	**N/A**		
DC Input Power:	**12Vdc**		

Test Data Table:

Measurement Distance:

☐ **FAC** ☒ **SAC** ☐ **OATS**
☐ **1 Meter** ☒ **3 Meter** ☐ **10 Meter**

Frequency (MHz)	Measured Level (dBuV)		Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	Pk	Qpk/Av					Pk	Qpk/Av	Pk	Qpk/Av	Pk	Qpk/Av
14.135	34.6	20.6	V	n/a	0	11.85	---------	32.45	--------	34	---------	1.6
25.56	27.3	12.1	H	n/a	0	10.48	---------	22.58	--------	34	---------	11.4
43.47	61.2	45.1	H	100	0	-13.33	---------	31.77	--------	54	---------	22.2
48.6	49	45.1	V	100	105	-13.16	---------	31.94	--------	54	---------	22.1
62	52.1	44	V	100	0	-13.02	---------	30.98	--------	54	---------	23
99.4	54.5	48	H	100	181	-11.52	---------	36.48	--------	54	---------	17.5
162.34	-----	37.4	V	100	108	-7.77	---------	29.63	--------	30	---------	0.4
163.5	-----	30.4	V	100	108	-7.65	---------	22.75	--------	40.5	---------	17.7
168.55	45.6	42.2	V	100	109	-6.93	---------	35.27	--------	54	---------	18.7
248.6	52.5	47.4	V	100	191	-10.12	---------	37.28	--------	54	---------	16.7
297.85	52.6	49.8	V	100	231	-9.76	---------	40.04	--------	54	---------	14

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

Notes:

4.2 Conducted Emissions

4.2.1 Conducted Emissions Test Site (Buford Facility)

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

A diagram of the room is shown below in figure 4.1.4-1:

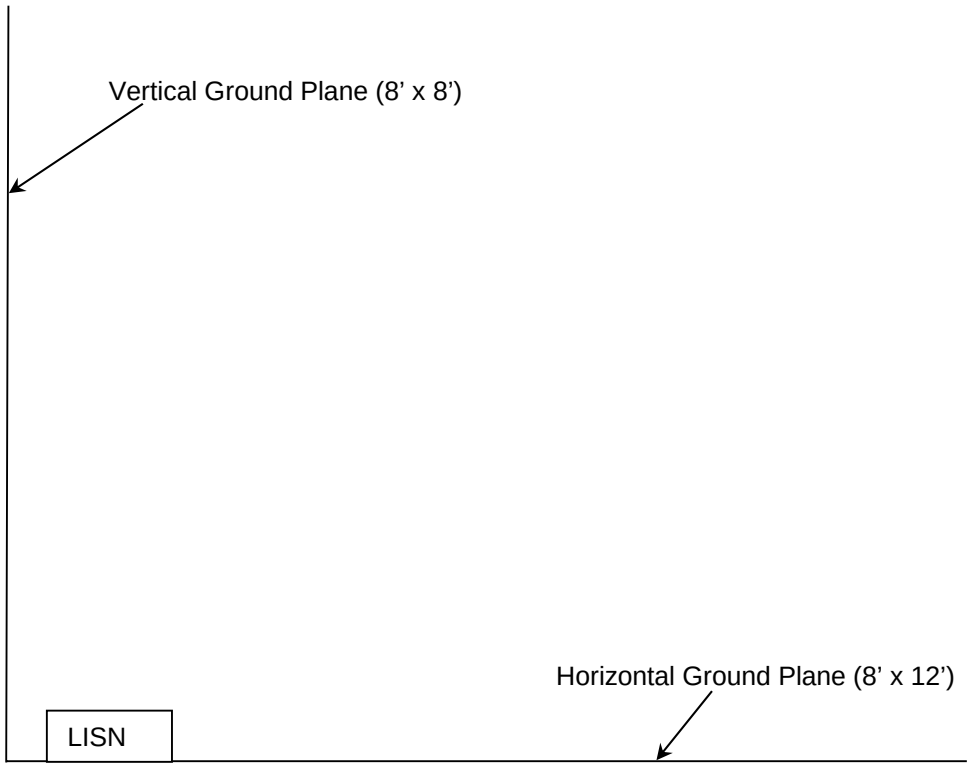


Figure 4.2-1: AC Mains Conducted EMI Site

4.2.2 Conducted Emissions Test Site (Alpharetta Facility)

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane(HCP) as well as a 12'x8' vertical coupling plane(VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4:2003 and 2009.

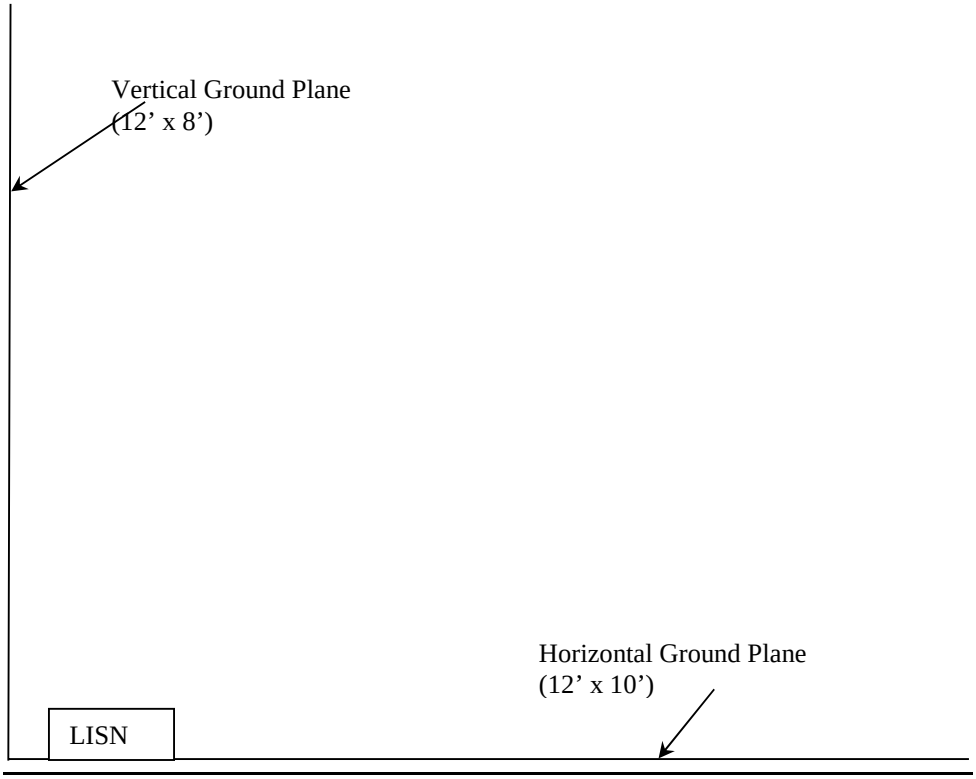


Figure 2.4.2: AC Mains Conducted EMI Site (Alpharetta Facility)

4.2.2 Test Equipment

Table 4.2.2-1 Test Equipment – Conducted Emissions (2018)

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
RE112	Rohde & Schwarz	ESIB26	Receiver	836119/012	7/13/2016	7/13/2017
324	ACS	Belden	Cables	8214	5/2/2016	5/2/2017
494	Omega	iBTHX-W	mate Monitoring Equipm	9460211	8/1/2016	8/1/2018
3010	Rohde & Schwarz	ENV216	LISN	3010	7/11/2016	7/11/2017

NCR=No Calibration Required

Table 4.2.2-2 Test Equipment – Conducted Emissions (2018)

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
144	Omega	RH411	Temp / Humidity Meter	H0103373	10/24/2018	10/24/2020
324	ACS	Belden	Conducted EMI Cable	8214	04/05/2018	04/05/2019
813	PMM	9010	EMI Receiver; RF Input 50ohm; 10Hz-	697WW30606	02/12/2018	02/12/2019
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	07/11/2018	07/11/2019

NCR = No Calibration Required

4.2.3 Test Methodology

Conducted emissions were performed from 9kHz to 150kHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

4.2.3.1 Test Criteria

The EUT must meet the Class B Limits as given in section 1.4.1.

4.2.3.2 Test Justification

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

4.2.4 Test Setup Photographs (2016 Testing)

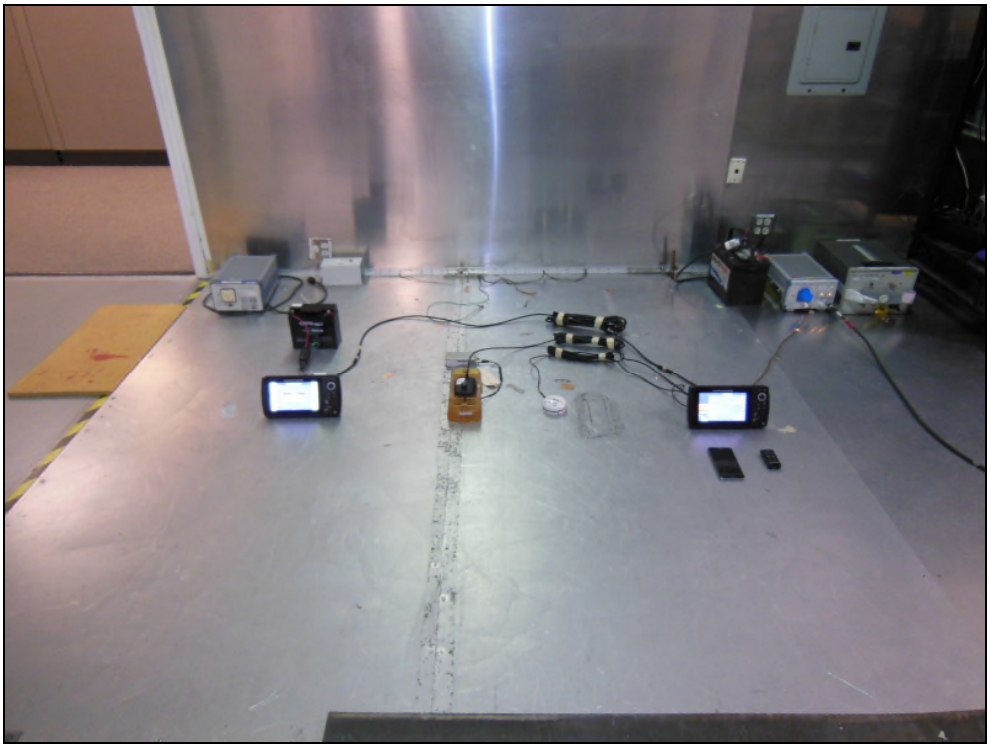


Figure 4.2.4-1: Conducted Emissions Test Setup – Front View

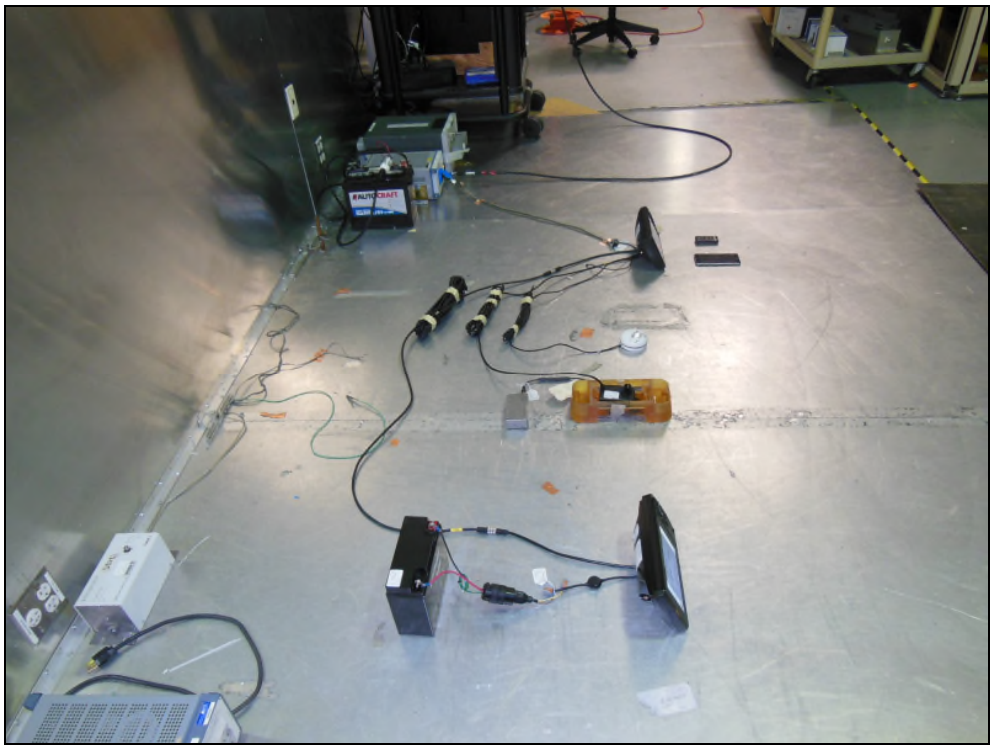


Figure 4.2.4-2: Conducted Emissions Test Setup – Side View

4.2.5 Test Setup Photographs (2018 Testing)

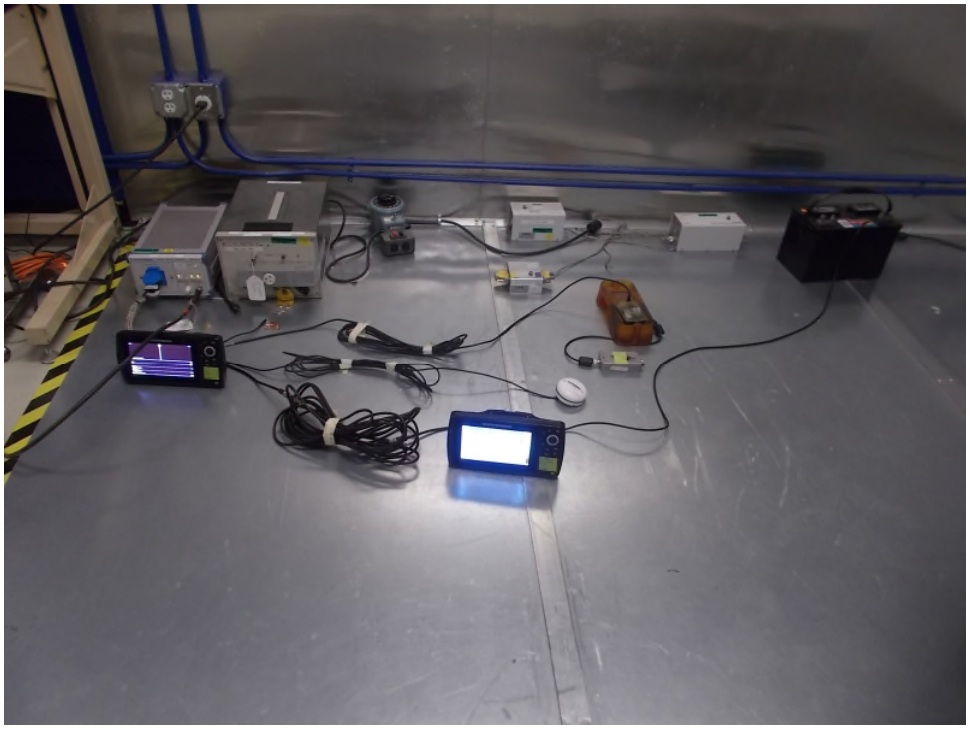


Figure 4.2.4-1: Conducted Emissions Test Setup – Front View

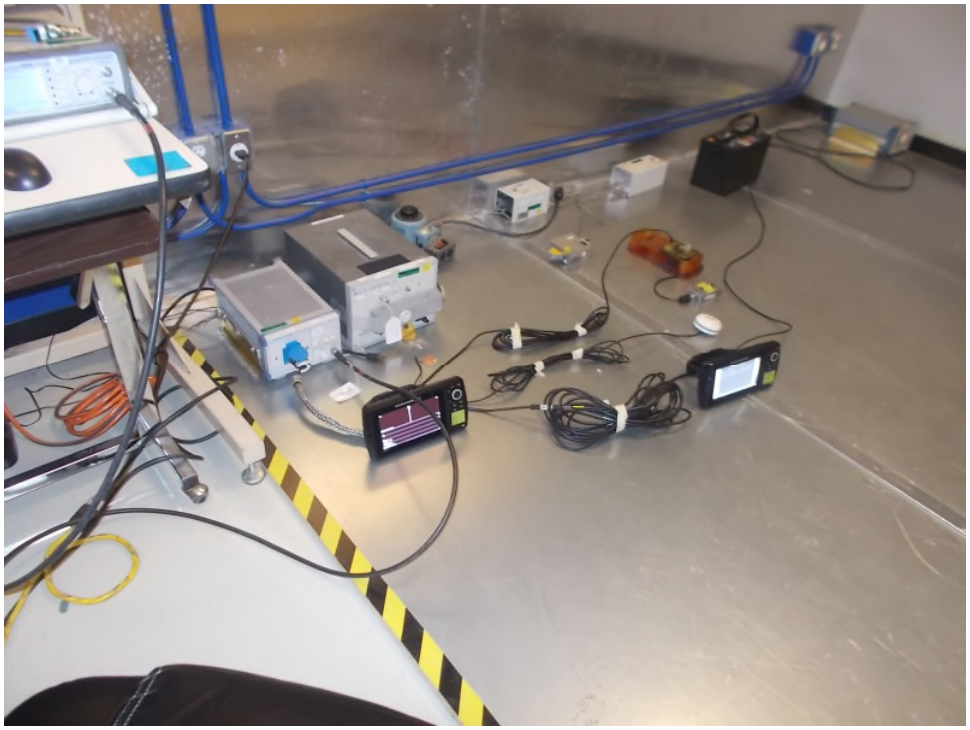


Figure 4.2.4-2: Conducted Emissions Test Setup – Side View

4.2.6 Test Data (2016)

Tabulated data is given in the Test Data Tables below.

Test Parameters:

Test Date:	**July 25, 2016**	**Temperature (ºC)**	**26.9**
Technician:	**Sean Vick**	**Humidity (%)**	**43.2**
Equipment Class:	**Class B**	**Barometric Pressure (mBar)**	**1014.3**
Tested Modes:	**EUT on; Monitoring depth; BT connected to phone and remote**		
AC Input Power:	**N/A**		
DC Input Power:	**12Vdc**		

Tested Leads:

☐ **AC Mains – Number of Lines:**
☒ **DC Mains – Number of Lines: 4**
☐ **Telecom Port – Quantity:**

Test Data Tables:

Check All That Apply to This Data
☒ **Line 1** ☐ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port _____**
☒ **dBµV** ☐ **dBµA**

Power Supply Description: 12Vdc

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.028106	---	23.24	---	---	L1	9.4
0.028106	28.53	---	74.85	46.32	L1	9.4
0.029962	---	49.49	---	---	L1	9.4
0.029962	49.31	---	73.70	24.39	L1	9.4
0.036012	---	24.93	---	---	L1	9.6
0.036012	34.12	---	70.51	36.39	L1	9.6
0.059914	---	41.91	---	---	L1	9.6
0.059914	41.81	---	62.37	20.56	L1	9.6
0.089882	---	33.03	---	---	L1	9.7
0.089882	33.24	---	56.56	23.32	L1	9.7
0.131148	---	7.16	---	---	L1	9.7
0.131148	10.67	---	51.64	40.97	L1	9.7

Notes:

Check All That Apply to This Data
☐ **Line 1** ☒ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port** _____
☒ **dBµV** ☐ **dBµA**

Power Supply Description: **12Vdc**

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.029984	---	49.22	---	---	N	9.4
0.029984	49.13	---	73.69	24.56	N	9.4
0.059902	---	41.94	---	---	N	9.6
0.059902	41.78	---	62.37	20.59	N	9.6
0.089405	---	10.84	---	---	N	9.7
0.089405	14.83	---	56.64	41.81	N	9.7
0.089858	---	33.31	---	---	N	9.7
0.089858	33.32	---	56.57	23.25	N	9.7
0.135605	---	8.10	---	---	N	9.7
0.135605	12.41	---	51.23	38.82	N	9.7
0.142632	---	12.43	---	---	N	9.7
0.142632	15.58	---	50.61	35.03	N	9.7

Notes:

Check All That Apply to This Data
☒ Line 1 ☐ Line 2 ☐ Line 3 ☐ Line 4
☐ To Ground ☒ Floating
☐ Telecom Port _____
☒ dBµV ☐ dBµA

Power Supply Description: 12Vdc

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
1.745191	---	2.56	---	---	L1	9.8
1.745191	22.24	---	50.00	27.76	L1	9.8
2.947996	---	-2.86	---	---	L1	9.8
2.947996	16.06	---	50.00	33.94	L1	9.8
3.731964	---	-4.19	---	---	L1	9.8
3.731964	15.72	---	50.00	34.28	L1	9.8
4.188878	---	-4.06	---	---	L1	9.9
4.188878	16.09	---	50.00	33.91	L1	9.9
6.758016	---	-0.65	---	---	L1	10.0
6.758016	13.45	---	50.00	36.55	L1	10.0
7.994056	---	2.68	---	---	L1	10.0
7.994056	11.34	---	50.00	38.66	L1	10.0

Notes:

Check All That Apply to This Data
☐ Line 1 ☒ Line 2 ☐ Line 3 ☐ Line 4
☐ To Ground ☒ Floating
☐ Telecom Port _____
☒ dBµV ☐ dBµA

Power Supply Description: 12Vdc

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
2.971443	---	3.37	---	---	N	9.8
2.971443	19.55	---	50.00	30.45	N	9.8
3.463026	---	-4.05	---	---	N	9.8
3.463026	16.94	---	50.00	33.06	N	9.8
3.739379	---	-3.77	---	---	N	9.8
3.739379	16.28	---	50.00	33.72	N	9.8
5.875651	---	1.70	---	---	N	10.0
5.875651	15.61	---	50.00	34.39	N	10.0
6.034569	---	-0.52	---	---	N	10.0
6.034569	23.07	---	50.00	26.93	N	10.0
6.261623	---	-1.90	---	---	N	10.0
6.261623	21.27	---	50.00	28.73	N	10.0

Notes:

4.2.7 Test Data (2018)

Tabulated data is given in the Test Data Tables below.

Test Parameters:

Test Date:	**8/17/2018**	**Temperature (ºC)**	**23**
Technician:	**A Sumner**	**Humidity (%)**	**44**
Equipment Class:	**Class B**	**Barometric Pressure (mBar)**	**1018**
Tested Modes:	**EUT on; Monitoring depth; BT connected to phone and remote**		
AC Input Power:	**N/A**		
DC Input Power:	**12Vdc**		

Tested Leads:

☐ **AC Mains – Number of Lines:**
☒ **DC Mains – Number of Lines: 4**
☐ **Telecom Port – Quantity:**

Test Data Tables:

Check All That Apply to This Data
☒ **Line 1** ☐ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port _____**
☒ **dBµV** ☐ **dBµA**

Power Supply Description: 12Vdc

72141218CE01L1 Helix 7x Final 9-150k 17/08/2018 16:12:48
Rel. SW 2.27 (August 2016)
Rel. FW 2.56 12/01/15
Margin: 100 dB

	Frequency [MHz]	QPeak [dBµV]	Limit CE AC mai.. [dBµV]	Delta [dB]	Factor LISN 3010.. [dB]	Factor AEMC00324.. [dB]
1	0.01	23.42	96.00	-72.58	10.07	0.00
2	0.121	35.87	53.65	-17.78	9.59	0.00

Notes:

Check All That Apply to This Data

☐ **Line 1** ☒ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port** _____
☒ **dBµV** ☐ **dBµA**

Power Supply Description: **12Vdc**

72141218CE01L2 Helix 7x Final 9-150k 17/08/2018 16:17:36
Rel. SW 2.27 (August 2016)
Rel. FW 2.56 12/01/15
Margin: 100 dB

	Frequency [MHz]	QPeak [dBµV]	Limit CE AC mai.. [dBµV]	Delta [dB]	Factor LISN 3010.. [dB]	Factor AEMC00324.. [dB]
1	0.01	23.35	96.00	-72.65	10.00	0.00
2	0.1209	38.24	53.66	-15.42	9.59	0.00
3	0.1405	30.81	51.11	-20.30	9.59	0.00

Notes:

Check All That Apply to This Data
☒ **Line 1** ☐ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port** _____
☒ **dBµV** ☐ **dBµA**

Power Supply Description: **12Vdc**

72141218CE02L1 Helix 7x Final 150-30M 17/08/2018 16:23:39
Rel. SW 2.27 (August 2016)
Rel. FW 2.56 12/01/15
Margin: 100 dB

	Frequency [MHz]	QPeak [dBµV]	Limit CE AC mai.. [dBµV]	Delta [dB]	Factor LISN 3010.. [dB]	Factor AEMC00324.. [dB]
1	0.15	26.65	50.00	-23.35	9.59	0.00
2	0.205	43.23	56.31	-13.08	9.58	0.00
3	2.8	19.02	50.00	-30.98	9.62	0.00
4	2.84	19.03	50.00	-30.97	9.62	0.00
5	2.88	19.04	50.00	-30.96	9.62	0.00
6	3	19.10	50.00	-30.90	9.62	0.00
7	6.535	25.32	50.00	-24.68	9.66	0.00
8	10.555	19.37	50.00	-30.63	9.69	0.01
9	11.11	19.40	50.00	-30.60	9.69	0.02
10	25.07	20.26	50.00	-29.74	9.78	0.10

Notes:

Check All That Apply to This Data
☐ **Line 1** ☒ **Line 2** ☐ **Line 3** ☐ **Line 4**
☐ **To Ground** ☒ **Floating**
☐ **Telecom Port** _____
☒ **dBµV** ☐ **dBµA**

Power Supply Description: **12Vdc**

72141218CE02L2 Helix 7x Final 150-30M 17/08/2018 16:28:14
Rel. SW 2.27 (August 2016)
Rel. FW 2.56 12/01/15
Margin: 100 dB

	Frequency [MHz]	QPeak [dBµV]	Limit CE AC mai.. [dBµV]	Delta [dB]	Factor LISN 3010.. [dB]	Factor AEMC00324.. [dB]
1	0.155	30.32	59.61	-29.29	9.58	0.00
2	0.2	43.54	56.60	-13.06	9.58	0.00
3	2.75	19.00	50.00	-31.00	9.62	0.00
4	2.82	19.02	50.00	-30.98	9.62	0.00
5	2.865	19.04	50.00	-30.96	9.62	0.00
6	3	19.10	50.00	-30.90	9.62	0.00
7	6.705	25.28	50.00	-24.72	9.66	0.00
8	9.97	20.08	50.00	-29.92	9.69	0.00
9	10.89	19.39	50.00	-30.61	9.70	0.02
10	26.325	26.95	50.00	-23.05	9.86	0.10

Notes:

5.0 Harmonic Current Emissions

5.1 Test Justification

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

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

6.0 Voltage Fluctuations & Flicker

6.1 Test Justification

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

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

SECTION C: IMMUNITY – TEST INFORMATION AND RESULTS

7.0 Electrostatic Discharge Immunity

7.1 Test Site Description

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

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

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

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

7.2 Test Equipment

Table 7.2-1: Test Equipment List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
582	Kikusui	KES4021A	ESD Gun	SA003046	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 60945:2002 requires performance criterion B to be met as described in section 1.4.2.

7.3.2 Test Justification

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

7.4 Test Setup Photograph

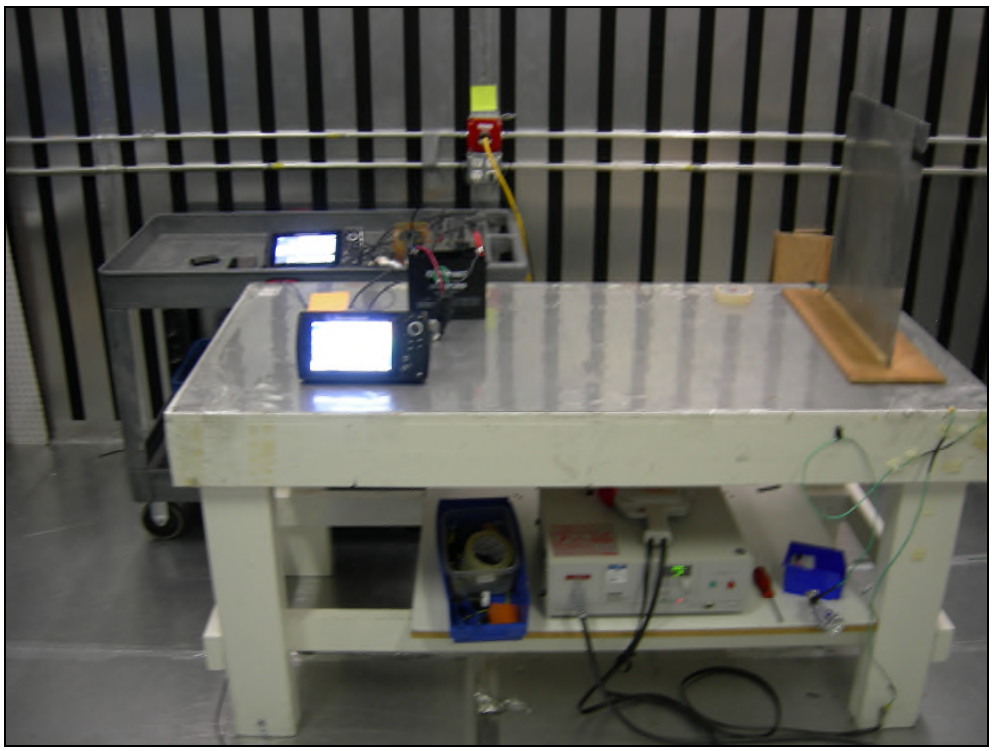
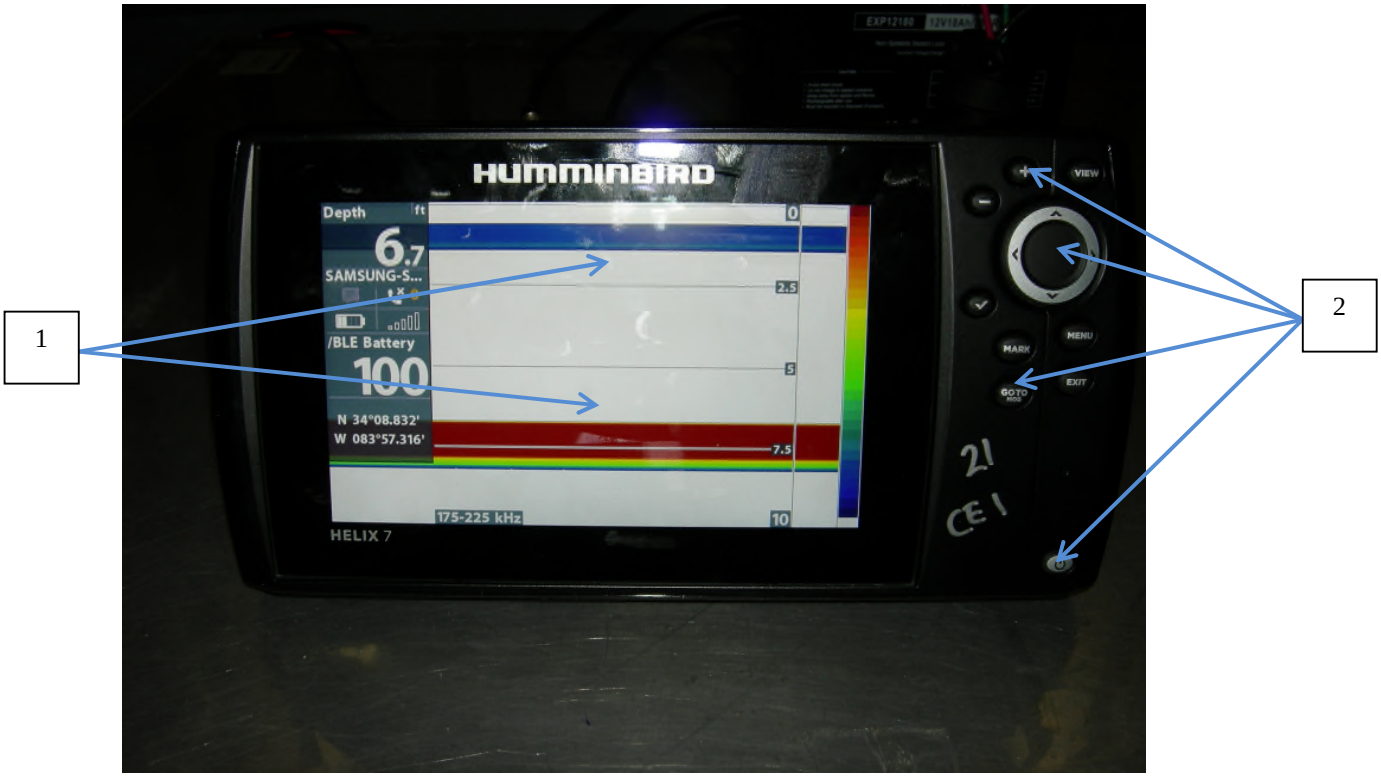
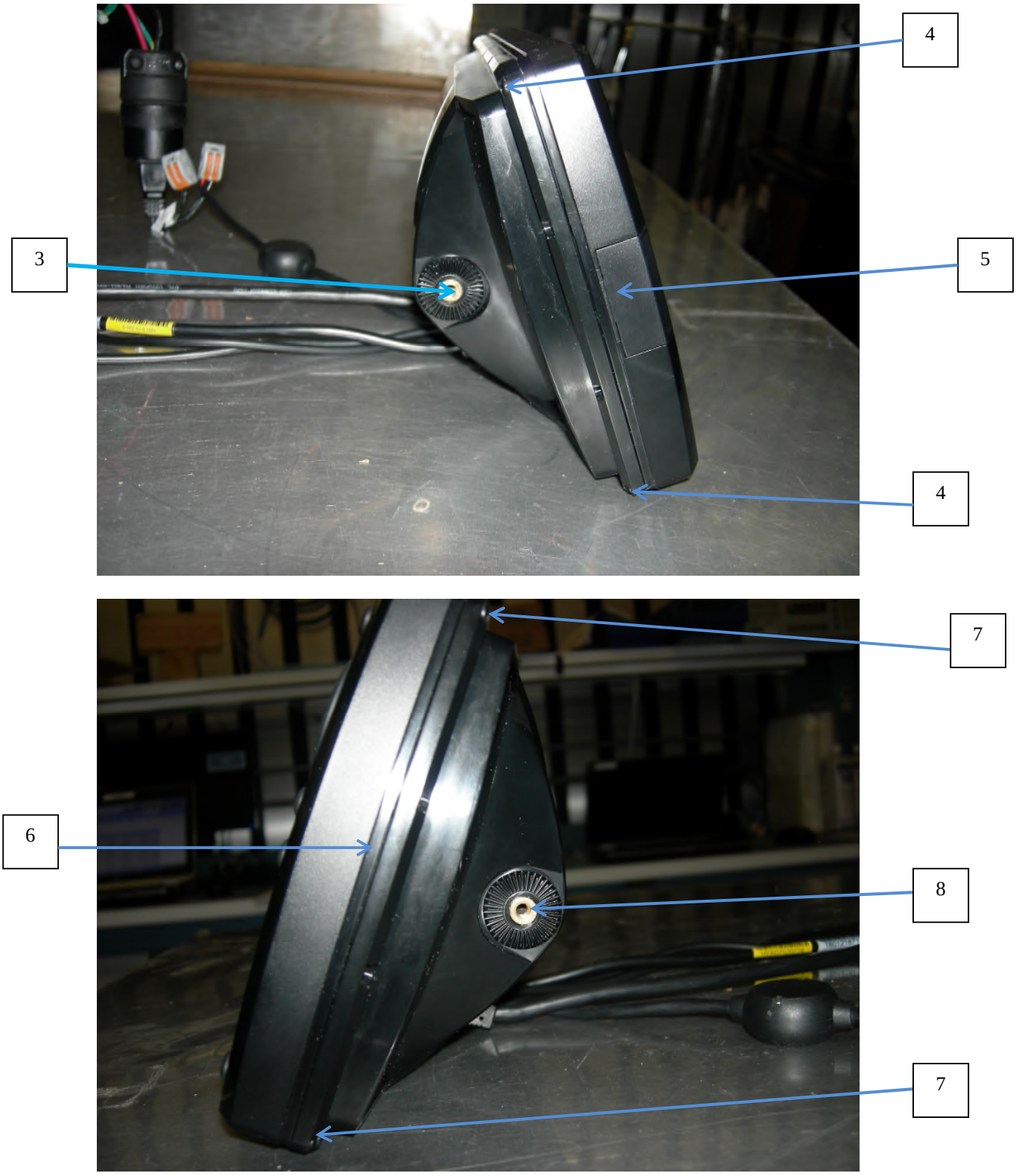


Figure 7.4-1: Test Setup Photograph

7.5 ESD Data Sheet

Test Point Photograph:

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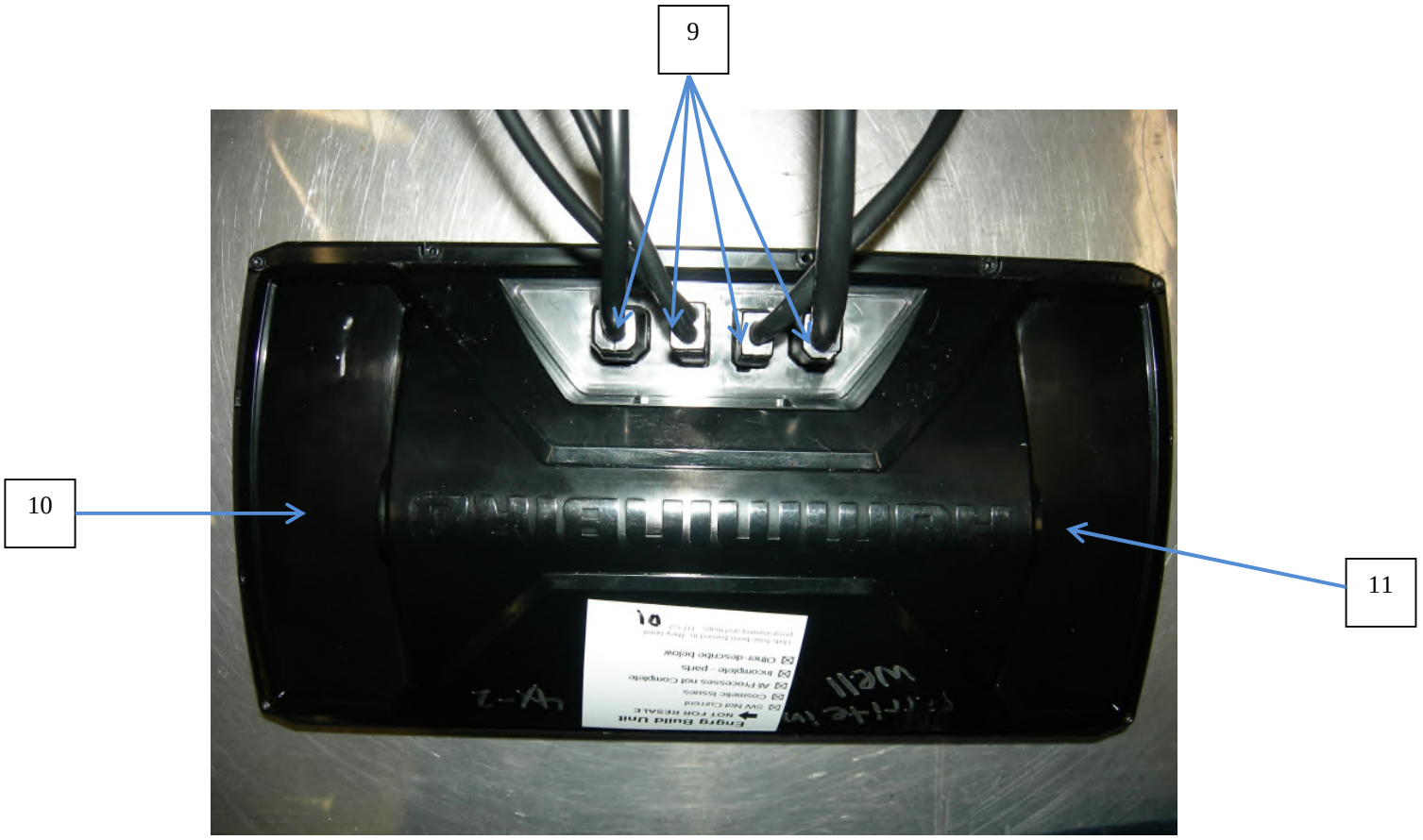

Test Point Selection:

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:**	**951k (Ohms)**
DC Input Power:	**12VDC**	**HCP Resistor Value Check:**	**945k (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	

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	

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 400 Hz AM sine wave, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1% of fundamental with linear interpolation between calibrated points.

The test shall normally be performed with the generating antenna facing each of the four sides of the EUT, however if the equipment can be used in different orientations, the test shall be performed on all sides, 6 total.

The polarization of the field generated by each antenna necessitates testing each side twice, once with the antenna positioned vertically and again with the antenna positioned horizontally.

8.3.1 Test Criteria

EN 60945:2002 requires criterion A to be met as described in section 1.4.2.

8.3.2 Test Justification

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

8.4 Test Setup Photographs

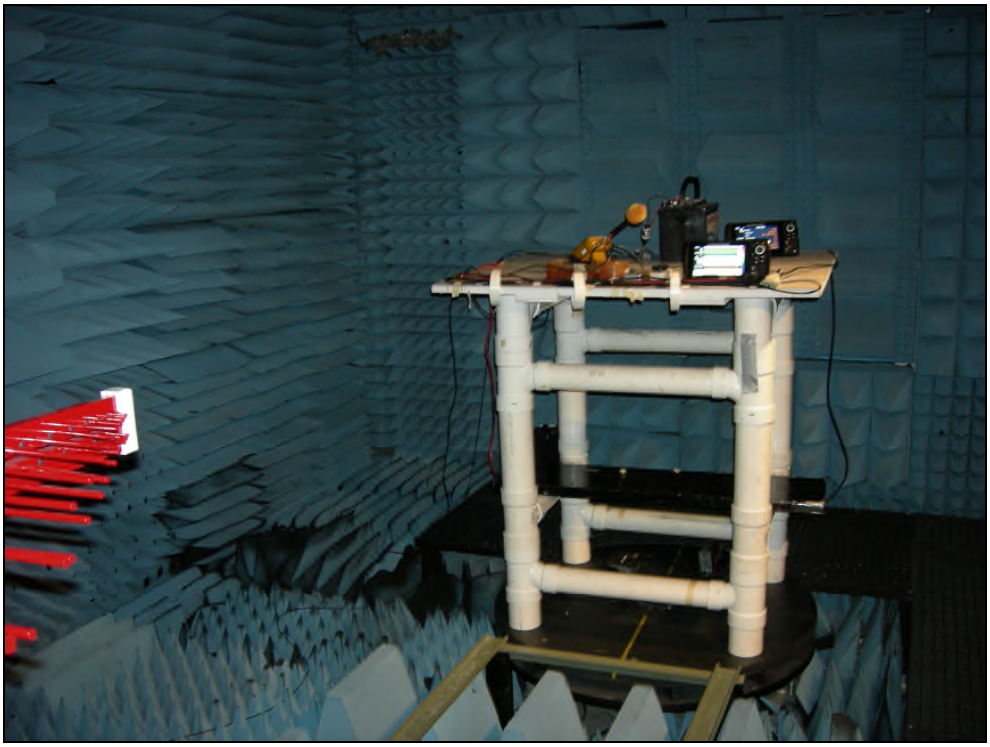

Figure 8.4-1: Test Setup Photograph

8.5 Test Results

Test Parameters:

Test Date:	**July 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	☒ 2.86 Seconds (80MHz – 1GHz)
☒ Both	☐ 8V/m	☒ 80MHz - 2GHz	☒ 8.6 Seconds (1GHz – 2GHz)
	☐ Enter Other Level Here		

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

Notes:

Testing was completed using a 400Hz modulation.

Spot frequencies less than 30MHz were seen during Conducted RF Immunity, those above 30MHz were seen during Radiated Fields Immunity as follows; 50MHz for Ethernet clock, 800MHz for Main internal processor, 1575.42MHz for the GPS receiver, and 2.4GHz for the Bluetooth radio.

9.0 Electrical Fast Transient/Bursts

9.1 Test Site Description

The EUT was configured and connected to satisfy its functional requirements. The EUT was placed in the center of a non-conductive support measuring 125cm x 96cm x 10 cm. The non-conductive support is placed on a 8 feet x 8 feet Ground Reference Plane (GRP). A minimum distance of 50 cm between the EUT and all other conductive structures was maintained. A minimum distance of 50 cm between the coupling clamp and all other conductive structures, except the GRP, was maintained. A 10 cm insulated support was placed between the capacitive coupling clamp and the GRP. The GRP was bonded to the EFT/B generator.

The input power port of the EUT was tested using the coupling/decoupling network. The +/-1kV bursts were applied to all lines individually as well as simultaneously.

The bursts were applied to the signal/control line ports, if present, using the capacitive coupling clamp.

9.2 Test Equipment

Table 9.2-1: Test Equipment List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Calibration Performed Date	Calibration Due Date
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

9.3 Test Methodology

IEC 61000-4-4 - Electromagnetic compatibility (EMC) - Part 4. Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMC Publication., was the guiding document for this test. The purpose of this test is to verify the immunity of single devices or systems when subjected to types of transient disturbances such as those originating from switching transients such as interruption of inductive loads or relay contact bounce.

9.3.1 Test Criteria

EN 60945:2002 requires criterion B to be met as described in section 1.4.2.

9.3.2 Test Justification

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

9.4 Test Setup Photographs

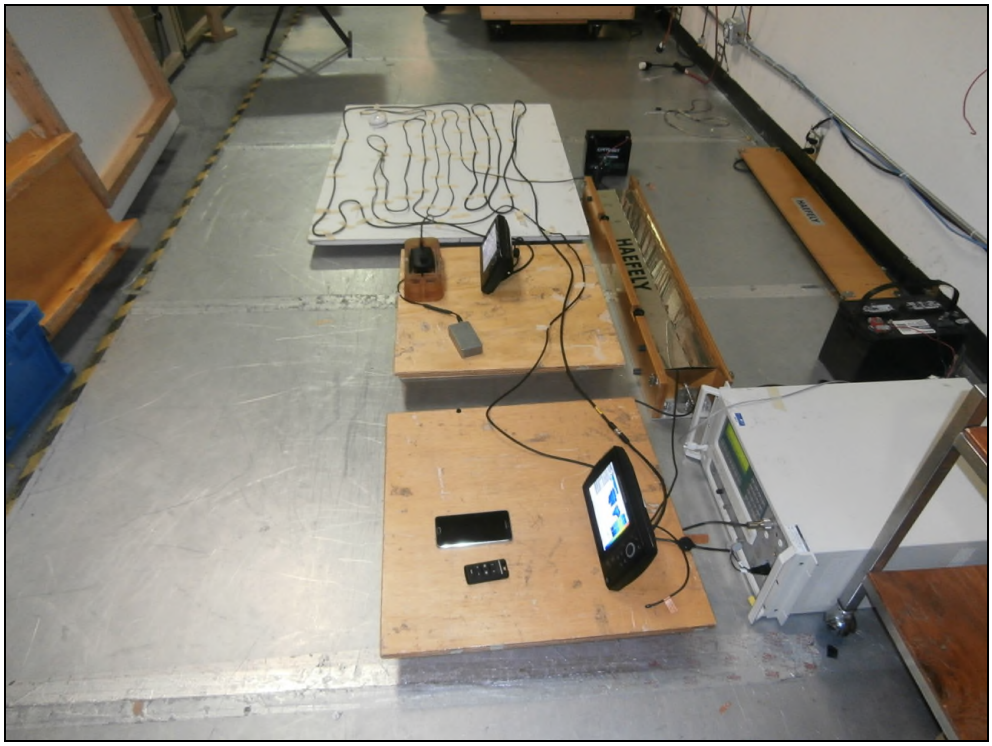

Figure 9.4-1: Test Setup Photograph

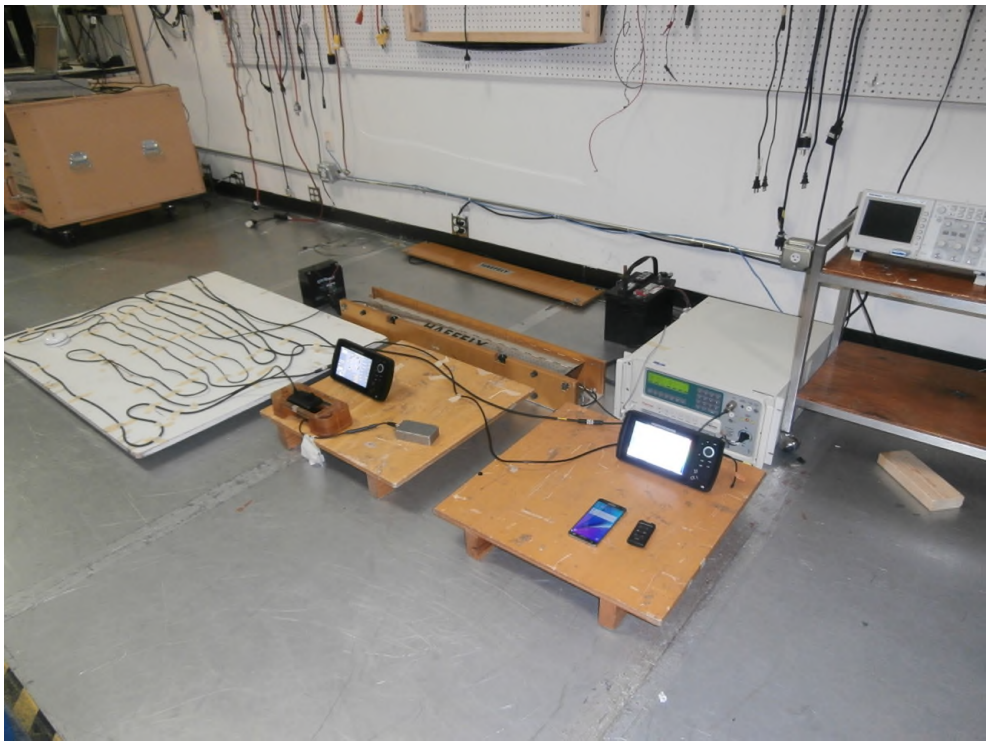

Figure 9.4-2: Test Setup Photograph

9.5 Test Results

Test Parameters:

Test Date:	**July 26, 2016**	**Temperature (ºC)**	**25.0**
Technician:	**Jaime Smith**	**Humidity (%)**	**46.2**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1015.4**
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)
GPS	**Pass**	
Transducer	**Pass**	
Ethernet	**Pass**	

Notes:
EFT testing per 60945 with burst duration at 3 minutes 5KHz repetition.

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 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.

11.3.1 Test Criteria

EN 60945:2002 requires criterion A to be met as described in section 1.4.2.

11.3.2 Test Justification

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

11.4 Test Setup Photographs

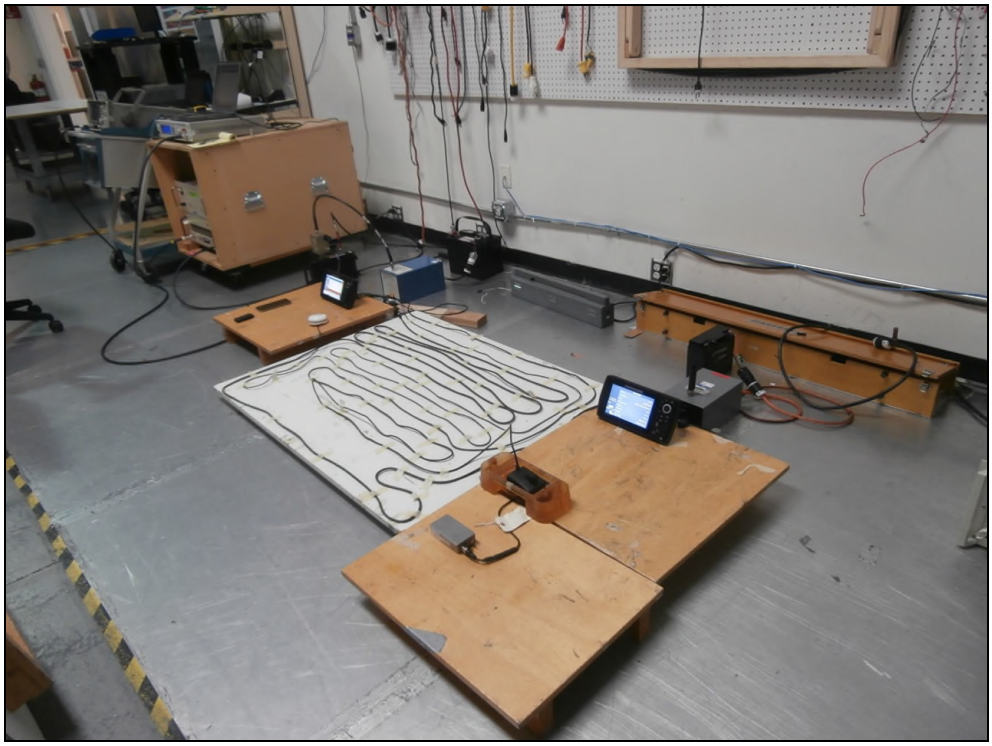

Figure 11.4-1: Test Setup Photograph

11.5 Test Results

Test Parameters:

Test Date:	**July 26, 2016**	**Temperature (ºC)**	**25.0**
Technician:	**Jaime Smith**	**Humidity (%)**	**46.2**
Equipment Class:	**N/A**	**Barometric Pressure (mBar)**	**1015.4**
Tested Modes:	**EUT on; Monitoring depth; BT connected to phone and remote**		
AC Input Power:	**N/A**	☒ **Pre-Test Verification**	
DC Input Power:	**12VDC**		

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)
GPS	**Pass**	
Transducer	**Pass**	
Ethernet	**Pass**	

Notes:
CI testing was performed with a 400Hz modulation. The spot frequencies were with 400Hz modulation at 10Vrms.
Spot frequency test at 10Vrms at 2.0, 3.0, 4.0, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 (MHz) discrete frequencies.
Backlight boost controller: 973 KHz
5V Buck regulator: 1.15 MHz
LCD Bias controller: 1.25 MHz
Boost switcher: 1.95 MHz
Power manager: 2.26 MHz
AM3354 TCXO: 24 MHz
DSP TCXO: 25 MHz
GPS TCXO: 26 MHz
Display clock: 29 MHz
Ethernet Clock: 50 MHz

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:
- o compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;
- o non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

If U_{Lab} is greater than U_{cispr}, then:
- o compliance is deemed to occur if no measured disturbance, increased by ($U_{Lab} – U_{cispr}$), exceeds the disturbance limit;
- o 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."