ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY
For Scope of Accreditation Under Certificate Number: AT-2021

ACS Excellence in Compliance Solutions

EMI Test Report

In Accordance with:

FCC 47 CFR Part 15 Subpart B
ISED Canada ICES-003 Issue 6

Authorization Type: Verification

Manufacturer: Johnson Outdoors Marine Electronics
Model Covered: HELIX 10 SI GPS
Model Variants: See Product Description

ACS Report: 15-0212.C01.4A
Report Revision: A
Report Issue Date: November 3, 2016

Project Manager:

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Reviewed by:

Forrest Duncan
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Advanced Compliance Solutions, Inc.

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

This report contains 16 pages

REVISION HISTORY
Report Number: 15-0212.C01.4A
Manufacturer: Johnson Outdoors Marine Electronics
Model: HELIX 10 SI GPS

DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
November 3, 2016	---	A	Initial Release	All	Forrest Duncan

Project Information

ACS Project: 15-0212.C01.4A

Applicant Details

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

Phone: 334-687-6612
Fax:
Email: dvernon@johnsonoutdoors.com

Sample Information

Model: HELIX 10 SI GPS
Model Variant(s): See Product Description
Environment of Use: Commercial
Sample Receive Date: June 29, 2015
Sample Receive Condition: Good
Test Mode Description: Normal operation; monitoring depth, speed, and GPS

Highest Frequency Generated or Used: 800 MHz

Source: Microcontroller

Product Description

The Humminbird HELIX 10 SI GPS unit is a fishfinder/GPS product with Side Imaging sonar capability that uses a 10" Color Display along with sonar/GPS. It is used in the marine environment and is shipped with a transducer and power cable (6'). For purposes of testing the following accessories are added: Speed/Temp, External GPS, and Ethernet connector to ancillary display unit. The model variants are declared as follows:

HELIX 10 DI GPS and HELIX 10 SONAR GPS: These use same hardware with changes to sonar circuitry to allow different sonar frequencies to be used
HELIX 9 SI GPS, HELIX 9 DI GPS, and HELIX 9 SONAR GPS: These use the same main board as the HELIX10 units but a smaller 9" Display.

Test Information

Test Start Date: June 30, 2015
Test End Date: July 6, 2015
Emissions Pre-scan Site: SAC
Final Emissions Site: SAC
EMI Freq. Band: 150kHz - 6GHz
Radiated Emissions Equipment Class: Class B

Test Methods/Standards Applied

ANSI C63.4-2014 - American National Standard for Methods of Measurement of Radio-Noise Emissions from low-voltage electrical and electronic equipment in the range of 9kHz to 40 GHz.

US Code of Federal Regulations (CFR): Title 47, Part 15, Radio Frequency Devices, Subpart B, Unintentional Radiators.

Innovation, Science and Economic Development (ISED) Canada ICES-003 Issue 6: Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement

Table of Contents

1.0 Introduction

1.1 Scope

This report documents conformance with the Electromagnetic Interference requirements outlined in the product information sheet and details the results of testing performed on June 30, 2015 through July 6, 2015 on the model HELIX 10 SI GPS manufactured by Johnson Outdoors Marine Electronics.

1.2 Performance Criteria

For model HELIX 10 SI GPS the limits which apply are Class B. These limits are found in Table 1.2-1 below:

Table 1.2-1 Emissions Limits Class B

Emission Type	Frequency Range[2] (MHz)	Voltage limits[1] (dBuV)
Conducted Class B	0.15 to .5	66 to 56 QP 56 to 46 Ave
	.5 to 5	56 QP 46 Ave
	5 to 30	60 QP 50 Ave
Radiated Class B @ 3 meters	30.0 to 88.0	40.0
	88.0 to 216.0	43.5
	216.0 to 960.0	46.0
	Above 960.0	54.0

1 - Decreases Linearly with Logarithm of Frequency
2 – Limits <1GHz are Quasi-Peak and Peak >1GHz
Note: Lower Limit Applies at Transition Frequency

2.0 Test Facilities & Environment

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

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

The laboratory is fully equipped to carry out the tests outlined in the project information section on page 3.

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

ACS 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)

ACS 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 test are performed within the ambient temperature range of 40°F to 104°F.

3.0 Equipment Under Test (EUT)

3.1 Manufacturer
Johnson Outdoors Marine Electronics
678 Humminbird Lane
Eufaula, AL 36027
David Vernon
334-687-6612
dvernon@johnsonoutdoors.com

3.2 Modifications

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

Table 3.2-1: EUT Modifications

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

3.3 System Block Diagram and Support Equipment

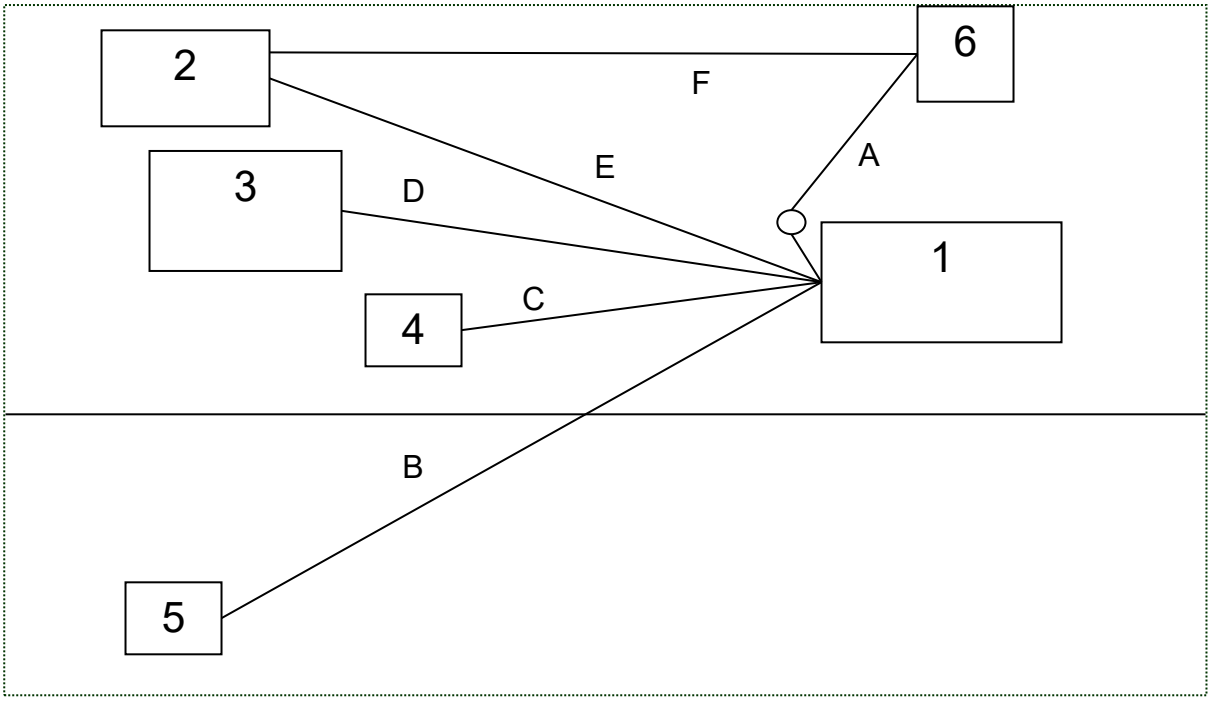

Figure 3.3-1: System Block Diagram

Table 3.3-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Johnson Outdoors	HELIX 10 SI GPS	ES#1
2	Aux Display	Johnson Outdoors	Matrix 899	13111503-0341
3	Depth Guage	N/A	N/A	N/A
4	Speedometer blade spinner	N/A	N/A	N/A
5	GPS Puck-style antenna	N/A	N/A	13091842-0045
6	12V Marine battery	Autocraft	24DC-1	6216457823

Table 3.3-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	DC leads	10’	No	1 – 6
B	GPS cable	20’	No	1 – 5
C	Speedometer cable	20’	No	1 – 4
D	I/O Cable	16’	Yes	1 – 3
E	Ethernet cable	500cm	Yes	1 - 2
F	DC leads	185cm	No	2 - 6

3.4 Observations

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

Table 3.4-1: Observations

Observation No.	Description

4.0 Radiated and Conducted Emissions

4.1 Radiated Emissions

4.1.1 Radiated Emissions Test Site

4.1.1.1 Open Area Test Site

The open area test site consists of a 40’ x 66’ concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8” holes that are staggered every 3/16”. The individual sheets are placed to overlap each other by 1/4” and are riveted together to provide a continuous seam. Rivets are spaced every 3” in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12’ beyond the turntable edge and 16’ beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8’ copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10’ flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40’ from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7’ x 7’ square and 4’ deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4” PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 4.1.1.1-1 below:

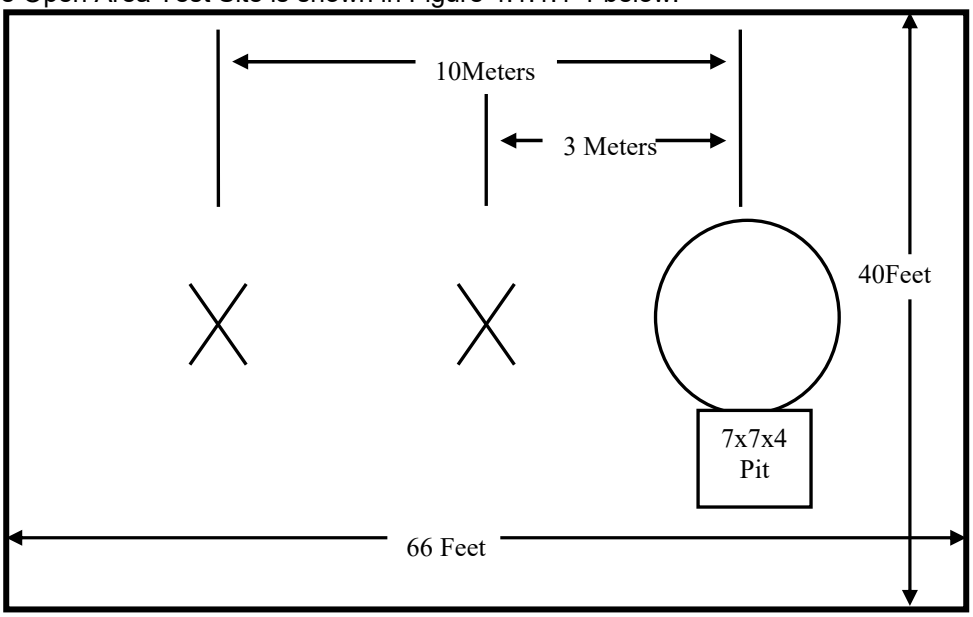

Figure 4.1.1.1-1: Open Area Test Site

4.1.1.2 Semi-Anechoic Chamber

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 4" x 4" x ¾" thick and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable. The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the turntable. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chase from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

To comply with the requirements of the test methods given on page 3, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, an 8 ft. patch of 12" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009. Next, three vertical structures (Fences) were created and covered with 8" pyramidal RF absorbing foam, two 4 ft. x 4 ft. and one 6 ft. x 4 ft. These fences were placed at locations to prevent high energy signals from reaching the back chamber wall and reflecting back to the receive antenna.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 4.1.1.2-1 below:

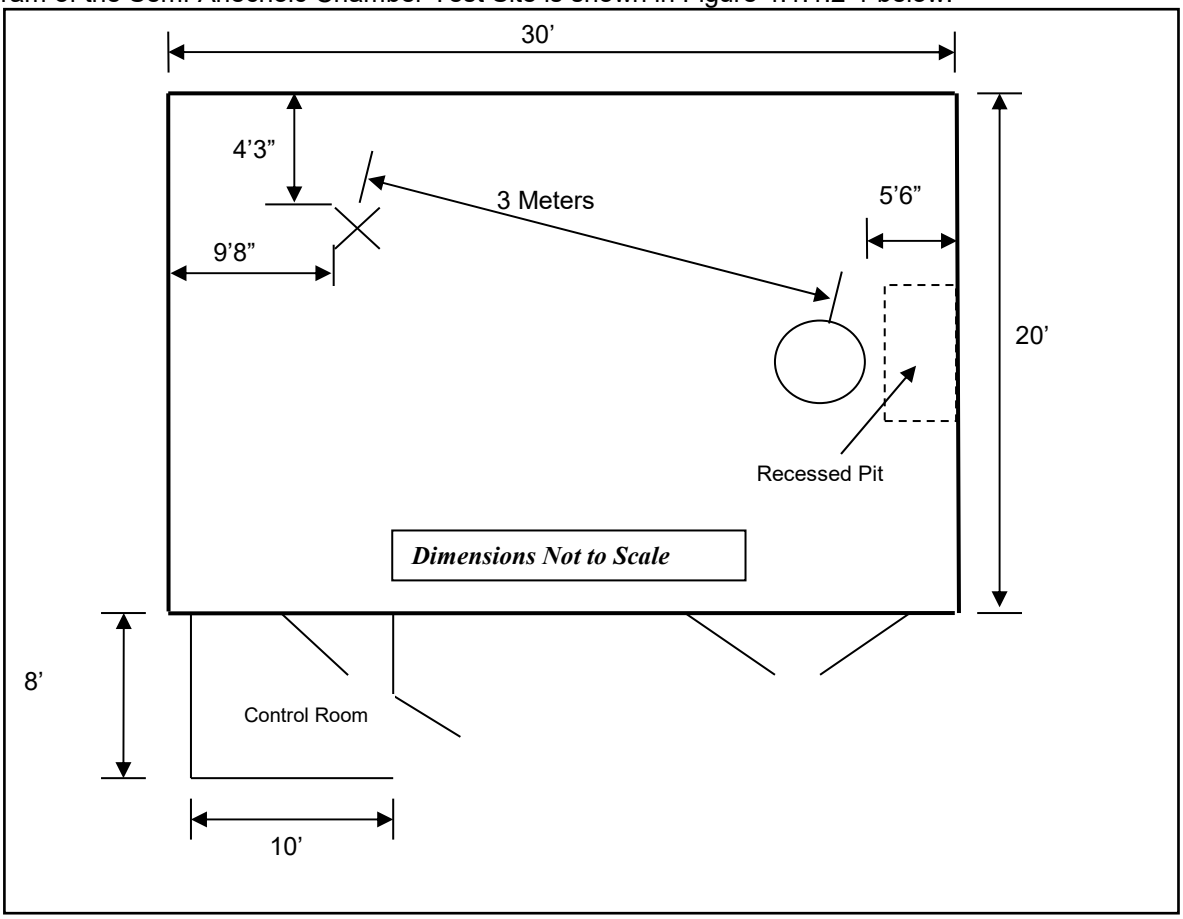

Figure 4.1.1.2-1: Semi-Anechoic Chamber Test Site

4.1.1.3 Fully Anechoic Chamber

The 3m fully anechoic chamber is used for pre-screening the EUT for emissions only. Final screening is performed on the OATS or in case of Class B EUT's, in the 3m semi-anechoic chamber. The Fully Anechoic Chamber has been characterized for field uniformity in accordance with IEC 61000-4-3 and can be used for final radiated fields immunity testing.

The Fully-Anechoic Chamber Test Site consists of a 24'L x 16'W x 12'H shielded enclosure. The chamber is fully lined with RF absorbing foam. The foam ranges in type from 8-24" conventional pyramidal cones, 8-12" conventional wedges and 6" and 16" Hybrid Foam over ferrite tile. The Hybrid material is placed in the 6 specular regions of the chamber for better low-frequency performance. The specular regions are 1) directly behind the receiving antenna, 2) on the floor between the receiving antenna and the EUT table, 3) the wall directly behind the EUT, 4&5) the side walls between the receiving antenna and the EUT table and 6) the ceiling between the receiving antenna and the EUT. The specular regions are 6' x 4' in size.

The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using 3/4" stainless steel braided cable.

The turntable is a remotely controlled EMCO Model 1060 and is 150cm in diameter and is located 1m from the absorber on the back wall of the chamber.

A diagram of the Fully Anechoic Chamber Test Site is shown in Figure 4.1.1.3-1 below:

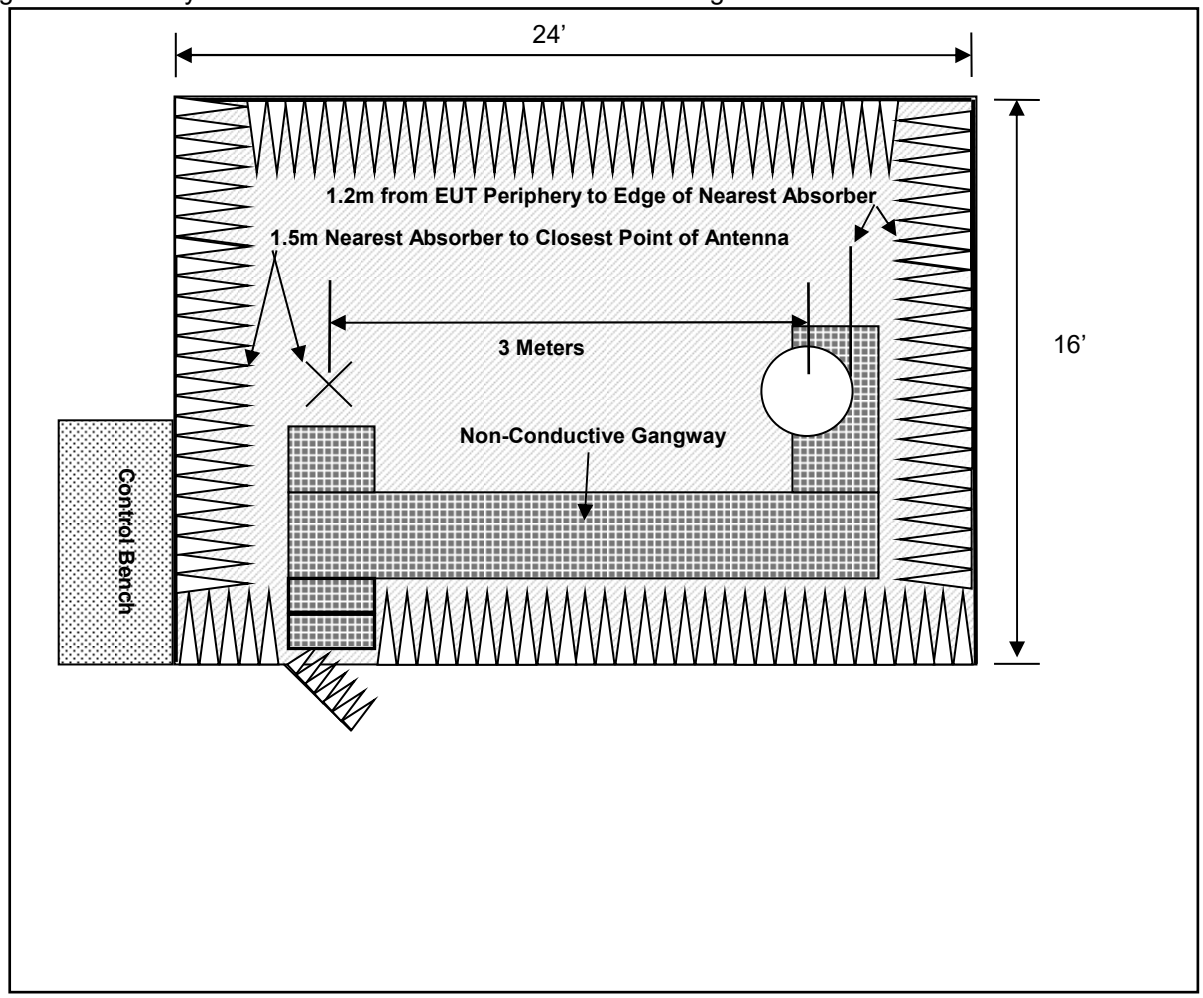

Figure 4.1.1.3-1: Fully Anechoic Chamber Test Site

4.1.2 Test Equipment

Table 4.1.2-1 identifies all equipment used for radiated emissions respectively.

Table 4.1.2-1 Test Equipment – Radiated Emissions

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/11/2014	7/11/2015
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/11/2014	7/11/2015
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2014	7/15/2015
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/30/2013	7/30/2015
167	ACS	Chamber EMI Cable Set	Cable Set	167	10/28/2014	10/28/2015
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/5/2014	11/5/2015
628	EMCO	6502	Antennas	9407-2877	2/7/2014	2/7/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016

NCR = No Calibration Required

4.1.3 Test Methodology

4.1.3.1 Pre-Scans

Radiated pre-scans are performed on all EUT's in either the 3m Semi-Anechoic or the 3m Fully-Anechoic Chamber. Final emission testing for Class A equipment is performed on the 3/10m Open Area Test Site (OATS) as described in section 4.1.1.1. Final emission testing on Class B equipment can be performed either in the 3m Semi-Anechoic chamber described in section 4.1.1.2 or on the OATS.

Pre-scans are a method by which the 10 highest emissions can be identified for final evaluation. This is achieved by taking automated emission snapshots of the EUT at various azimuths and antenna heights. The software is programmed to perform a peak sweep of the band using the maxhold function. This sweep is performed every 90º in both horizontal and vertical polarities and at antenna heights of 100cm and 300cm. Although not a fully maximized scan, the pre-scan gives a good indication of pass or fail.

4.1.3.2 Final Scans

Radiated emissions measurements were made over the frequency range of 30MHz – 6GHz. Quasi-Peak measurements are taken with the Spectrum Analyzer's resolution bandwidth was set to 120KHz and video bandwidth set to 300 kHz for measurements below 1000MHz. Average measurements are taken above 1000MHz with the RBW set to 1MHz and VBW set to 10Hz. The calculation for the radiated emissions field strength is as follows:

Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor – Amplifier Gain
Margin(dB) = Applicable Limit - Corrected Reading

4.1.3.3 Test Criteria

The EUT must meet the Class B Limits as given in section 1.2.

4.1.3.4 Test Justification

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

4.1.4 Test Setup Photographs

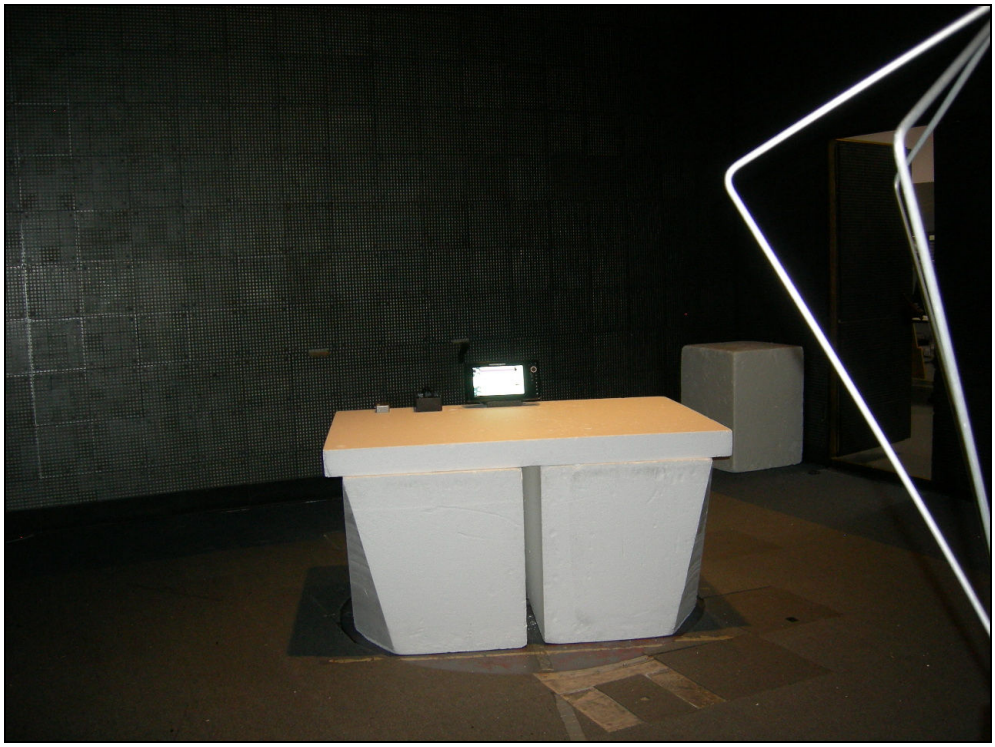

Figure 4.1.4-1: Radiated Emissions - Front View

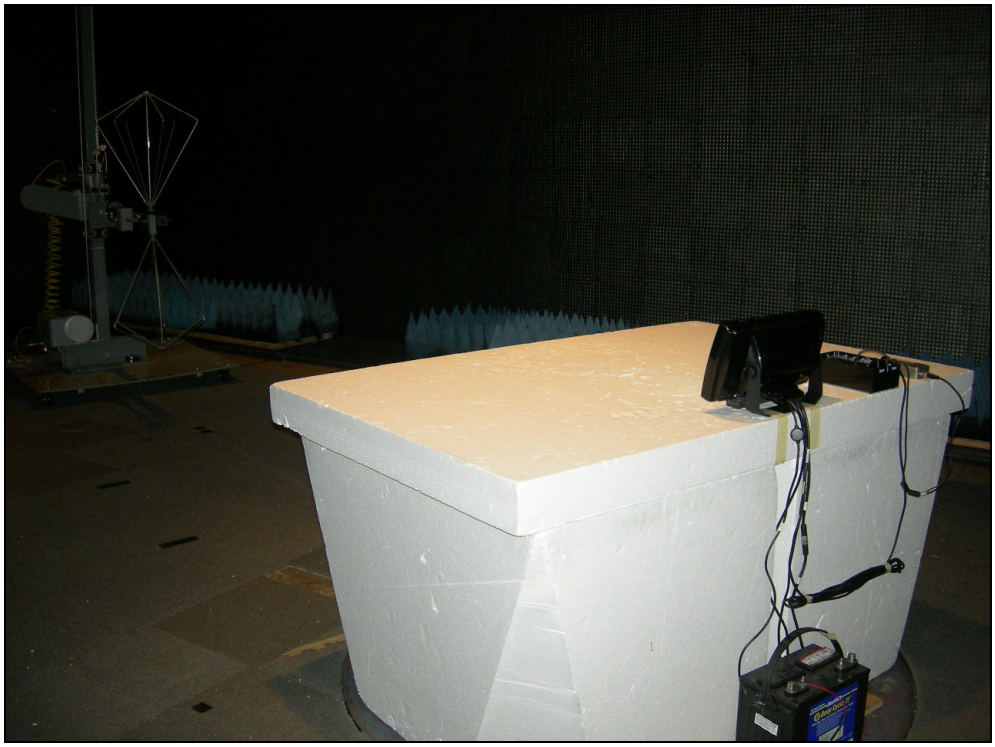

Figure 4.1.4-2: Radiated Emissions - Rear View

4.1.5 Test Data

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

Test Parameters:

Test Date:	**June 30, 2015**	**Temperature (ºC)**	**23**
Technician:	**Ryan McGann**	**Humidity (%)**	**39**
Equipment Class:	**Class B**	**Barometric Pressure (mBar)**	**1016**
Tested Modes:	**EUT & Transducer on table - Anscillary unit & Speed Temp Sensor under floor - GPS Antenna outside chamber with fix**		
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
34.64		42.90	V	100	347	-13.71	---------	29.19	--------	40.0	---------	10.8
310.22		41.15	H	100	180	-9.21	---------	31.94	--------	46.0	---------	14.1
329.19		52.22	H	100	228	-9.98	---------	42.24	--------	46.0	---------	3.8
375.69		43.21	H	100	224	-9.06	---------	34.15	--------	46.0	---------	11.8
422.72		40.80	H	100	229	-7.59	---------	33.21	--------	46.0	---------	12.8
469.68		46.56	V	117	167	-6.23	---------	40.33	--------	46.0	---------	5.7

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

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

4.2 Conducted Emissions

4.2.1 Test Justification

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

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

5.0 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:

Table 5.0-1: Values of U_{cispr} and U_{Lab}

Measurement	U_{cispr}	U_{Lab}
Conducted disturbance (mains port) (9 kHz – 150 kHz) (150 kHz – 30 MHz)	 4,0 dB 3,6 dB	2.54 dB
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1 000 MHz)	 5,2 dB	3.93 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.

Compliance or non-compliance with a disturbance limit shall be determined in the following manner.

If U_{Lab} is less than or equal to U_{cispr} in Table 5.0-1, then:

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

If U_{Lab} is greater than U_{cispr}, then:

- compliance is deemed to occur if no measured disturbance, increased by ($U_{Lab} – U_{cispr}$), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance, increased by ($U_{Lab} – U_{cispr}$), exceeds the disturbance limit.

The ACS calculated MU is much less than the internationally accepted MU, therefore an adjustment to the measured result as mentioned above is not necessary.

6.0 Conclusion

The EUT is determined to meet the requirements as defined in the applicable regulations.