1601 North A.W. Grimes Blvd., Suite B
Round Rock, TX 78665
https://www.nemko.com/contact
(512) 244-3371 Fax: (512) 244-1846

April 3, 2023

John Ruckdashel
Enovation Controls (Tulsa)
5311 S. 122nd East Avenue
Tulsa, OK 74146

Dear John:

Thank you for allowing Professional Testing (EMI), Inc. the opportunity to perform testing for Enovation Controls. Enclosed is the Electromagnetic Compatibility Test Report for the **Talisker**. This report describes the extent to which the **Talisker** conformed to the standards to which it was tested and the manner in which that testing was conducted.

If you have any questions, please contact me.

Sincerely,

Jose Elias
Site Manager, Nemko USA, Inc. – Austin

Enclosure

Project 23649-10

Enovation Controls
Talisker

Electromagnetic Compatibility Test Report

Prepared for:

Enovation Controls
5311 S. 122nd East Avenue
Tulsa, Oklahoma 74146

By

Nemko USA, Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

April 3, 2023

Reviewed by

Larry Finn
Lab Manager

Written by

Haletha Judkins
Technical Writer

Revision History

Revision Number	Description	Date
00	Initial Release	February 23, 2023
Final	Final Release	April 3, 2023

Table of Contents

Certificate of Compliance

Applicant: Enovation Controls
Applicant's Address: 5311 S. 122nd East Avenue, Tulsa, Oklahoma 74146

EUT: Talisker
Project Number: 23649-10

The **Talisker** test article provided by **Enovation Controls** was tested utilizing the client's test plan. Results presented in this report relate only to the item tested, as detailed in section 1.2.

IEC 60945, Fourth Edition, 2002-08				
Standard	**Class/Criteria Met**	**Test Level**	**Test Date(s)**	**Site**
Conducted Emissions CISPR-16-1:1999	Class A	150 kHz to 30 MHz 12 VDC	11/19/2022	45
Radiated Emissions CISPR 16-1:1999	Class A	150 kHz to 2 GHz 12 VDC	11/18/2022	45
IEC 61000-4-6:2013	Criterion A	3 Vrms/10 Vrms	11/19-20/2022	45
EN 55032:2015 +A1:2020				
Radiated Emissions CISPR 16-2-3:2016	Class A	30 MHz to 6 GHz 12 VDC	11/18/2022	45
IEC 61326-1: 2012 (Industrial Criteria)				
IEC 61000-4-3:2006 +A1:2007, +A2:2010	Criterion A	10 V/m: 80 MHz to 1 GHz 3 V/m: 1 GHz to 2.7 GHz	11/19/2022	45
IEC 61000-4-4:2012	Criterion A	DC: ±2 kV I/O: ±1 kV	11/20/2022	45
IEC 61000-4-5:2014 +A1: 2017	Criterion A	Line-to-earth: 2.0 kV Line-to-line: 1.0 kV	11/20/2022	45
IEC 61000-4-8:2009	Criterion A	30 A/m	11/20/2022	45

Test Site 45: 11400 Burnet Rd., Austin, TX 78758

I, Larry Finn, for Nemko USA, Inc., being familiar with the electromagnetic compatibility rules and test procedures, have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Larry Finn
Lab Manager

ANAB ANSI National Accreditation Board ACCREDITED ISO/IEC 17025 TESTING LABORATORY

This report has been reviewed and accepted by Enovation Controls. The undersigned is responsible for ensuring that the Enovation Controls Talisker will continue to comply with the applicable rules.

_____
Enovation Controls Representative

1.0 Introduction

1.1 Scope

The purpose of the EMC testing was to determine compliance with the client's test plan, which was based on specific emissions and immunity standards.

1.2 EUT Description

The EUT is the **Talisker** provided by **Enovation Controls**. Details about the system tested are provided in Table 1.2.1.

Table 1.2.1: Equipment Under Test

EUT Definition											Project #:	23649-10
EUT Manufacturer Name:	Enovation Controls											
Manufacturer Address:	5311 S. 122nd East Avenue, Tulsa, OK 74146											
EUT Name:	Talisker											
EUT Part Number:	None											
EUT Serial Number:	None											
Additional Electrically Equivalent EUT Model Numbers:	N/A											
EUT Description:	The EUT is a gauge.											
EUT Usage Type:	Fixed Installation				**EUT Usage Location:**	Commercial Industrial or Professional Only						
EUT Physical Information	**Depth:**	4.24	In		**Width:**	3.93	In		**Height:**	1.18	In	**Weight:**	25	lb
EUT Main Input Power	**Type:**	DC			**Voltage:**	12	VDC (min)		24	VDC (max)		**Freq. (Hz):**	N/A	
EUT Maximum Input Current/Power:		5	mA											

1.3 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

2.0 Applicable Documents

The following documents were used as reference for the test procedures specified herein.

Document Identifier/Revision	Title/Description	Date of Publication
IEC 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use. EMC Requirements – Part 1: General Requirements	2012
EN 60945	Maritime Navigation and Radio Communication Equipment and Systems – General Requirements Methods of Testing and Required Test Results	200-08
EN 55032	Electromagnetic Compatibility of Multimedia Equipment – Emission Requirements	2015 1:2019
IEC 61000-4-3	Electromagnetic Compatibility for Electrical and Electronic Equipment, Part 3: Immunity to Radiated, Radio Frequency, Electromagnetic Fields	2006 A1: 2007 A2: 2010
IEC 61000-4-4	Electromagnetic Compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test	2012
IEC 61000-4-5	Electromagnetic compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test	2014 A1: 2017
IEC 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields	2013
IEC 61000-4-8	Electromagnetic compatibility (EMC) – Part 4-8: Testing and Measurement Techniques – Power Frequency Magnetic Field Immunity Test	2009
CISPR 16-1	Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods, Part 1: Radio Disturbance and Immunity Measuring Apparatus	1999

3.0 Electromagnetic Emissions Testing

Nemko USA, Inc. follows the guidelines of ANSI National Accreditation Board (ANAB) for all uncertainty calculations, estimates and expressions thereof for EMC testing Nemko USA, Inc. has met the satisfactory requirements for performing measurements on the site. A copy of the Nemko USA, Inc. policy for EMC Measurement Uncertainty is provided in Appendix A.

3.1 Conducted Emissions Mains Terminal Measurements

Conducted emissions measurements were made on the mains terminals of the EUT to determine the line-to-ground radio noise emitted from each power-input terminal. Conducted emissions measurements on the mains terminals were performed at Nemko USA, Inc. Testing Site 45, located in Austin, Texas.

3.1.1 Test Procedure

The EUT was configured and operated in a manner consistent with typical applications. The EUT power cord in excess of one meter was folded back and forth forming a bundle 30 to 40 cm long in the approximate center of the cable. Power supply cords for the peripheral equipment were powered from an auxiliary line impedance stabilization network (LISN). Excess interface cable lengths were separately bundled in a non-inductive arrangement at the approximate center of the cable with the bundle 30 to 40 centimeters in length. The conducted emissions were maximized, by varying the operating states and configuration of the EUT. The tests were performed in a RayProof modular shielded room.

The EUT was placed on a metallic table 0.4 meters from a vertical metal reference plane and 0.8 meters from a horizontal metal reference plane. The measurements were taken using a LISN. The configuration of the shielded room showing the location of the EUT, and the measurement equipment is given as Figure 3.1.1.1.

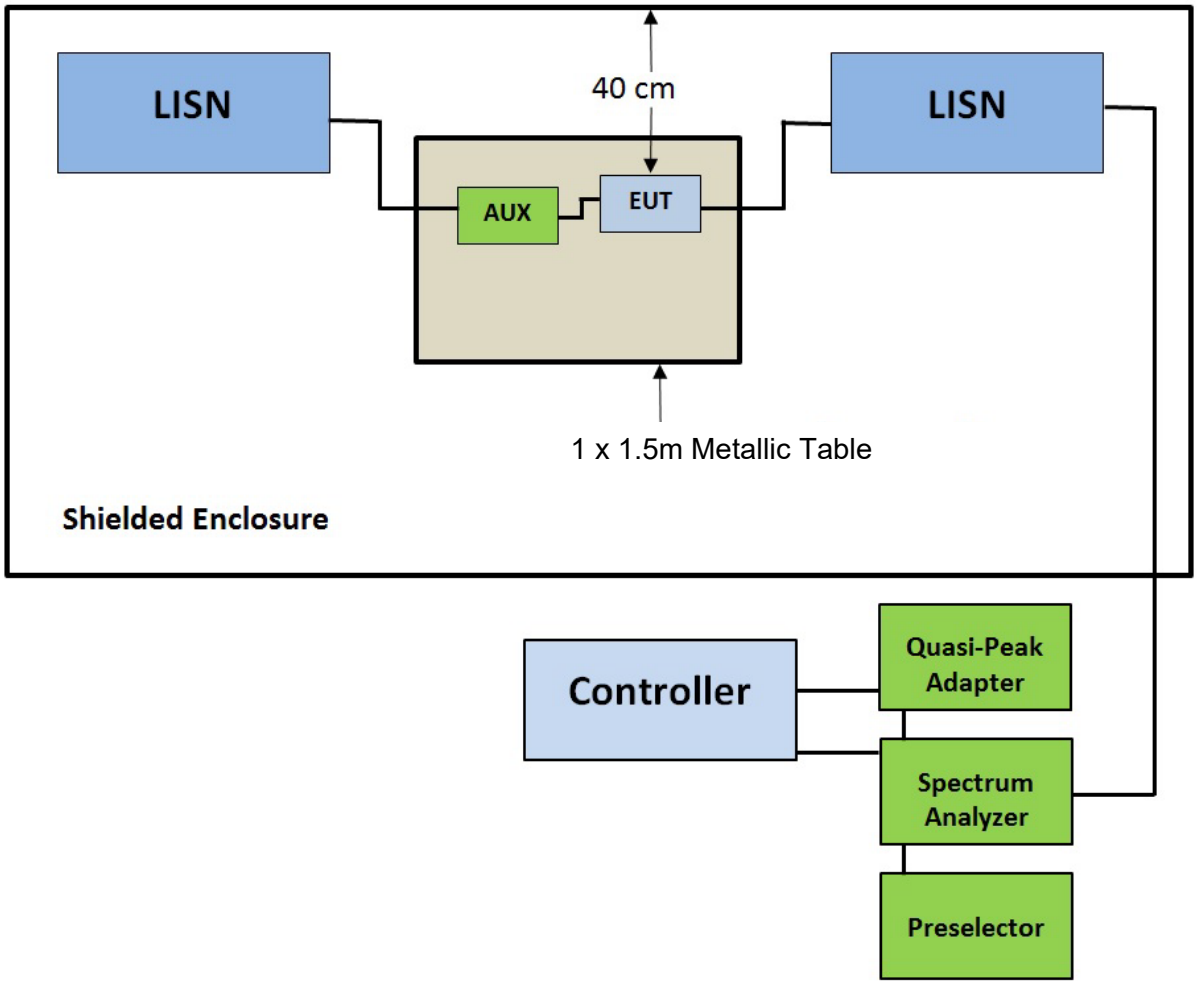


Figure 3.1.1.1: Conducted Emissions Mains Terminal Test Setup

3.1.2 Test Criteria

The EN 60945 (CISPR 16-1) Class A conducted emissions limits are given below.

Frequency (MHz)	Quasi-Peak Limit (dBµV)
0.01 to 0.15	96 to 50
0.15 to 0.35	60 to 50
0.35 to 30	50

3.1.3 Test Results

On November 19, 2022, the conducted emissions generated by the EUT as measured on the mains terminals were found to be below the EN 60945 Class A maximum emissions criteria.

Table 3.1.3.1: Conducted Emissions Test Log

Nemko USA, Inc.			
Test Method:	**CISPR 16-2: Specification for radio disturbance and immunity measuring apparatus and methods - Part 2: Methods of measurement of disturbance and immunity**		
In accordance with:	**IEC 60945: 2002-08 Maritime navigation and radio communication equipment and systems - General Requirements - Methods of testing and required test results**		
Section:	**Section 9.2 – Conducted emissions**		
Test Date(s):	**11/19/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician:**	**Daniel Ramirez**
Purchase Order #:	**7674233**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Conducted Emissions Test Log Sheet							
Temperature:	**20**	**°C**	**Humidity**	**36%**	**RH**	**Barometric Pressure:**	**29.5**	**inHg**
Test Location:	**Site 45 Conducted Emissions Chamber**							
Test Status:	**Testing Complete, EUT Passed**							

Table 3.1.3.2: Conducted Emissions Test Results – EN 60945

EUT Name	**Talisker**		**Serial #**	**None**	
EUT Line Voltage	**12**	**VDC**	**Frequency**	**-**	**Hz**
Emissions Limit Level	**Class A**		**EUT Test Mode or Configuration**	**Normal Operation**	

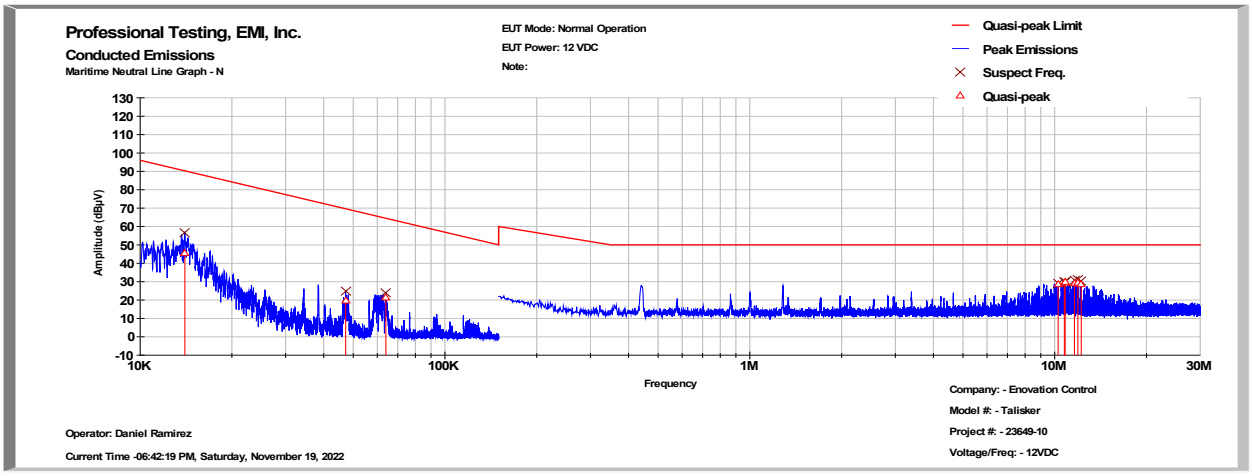
Frequency Range	**Line Tested**	**Test Results**
150kHz to 30MHz	**Neutral Line**	**Pass**
	Phase A (Line1)	**Pass**

Table 3.1.3.3: Conducted Emissions Test Equipment

Tile! Software Version:			Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM		
Test Profile:			2020_CE_TILE7_v4		
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
C192	HP	none	Cable, RF, BNC-BNC, 0.2032m, Grey	None	1/14/2024
C029	HP	HP92227C	Cable, RF, BNC-BNC, 4.06m, Grey	None	2/8/2023
C366	Alpha Wire	RG-58/U	Cable, RF, BNC-BNC, 1.7m, DC-1.5 GHz	None	10/22/2023
C303	Coleman Cable	RG-58A/U	Cable, BNC-BNC, 0.914m Black	None	2/24/2024
238	HP	85685A	RF Preselector	2887A00841	N/A
1145	HP	8568B	Spectrum Analyzer 100Hz-1.5GHz	2517A01821	7/21/2023
2113	HP	85662A	Spec Anal Dsply for A/N 1842	2403A07470	N/A
1279	HP	85650A	Quasi Peak Adapter	2521A00935	7/21/2023

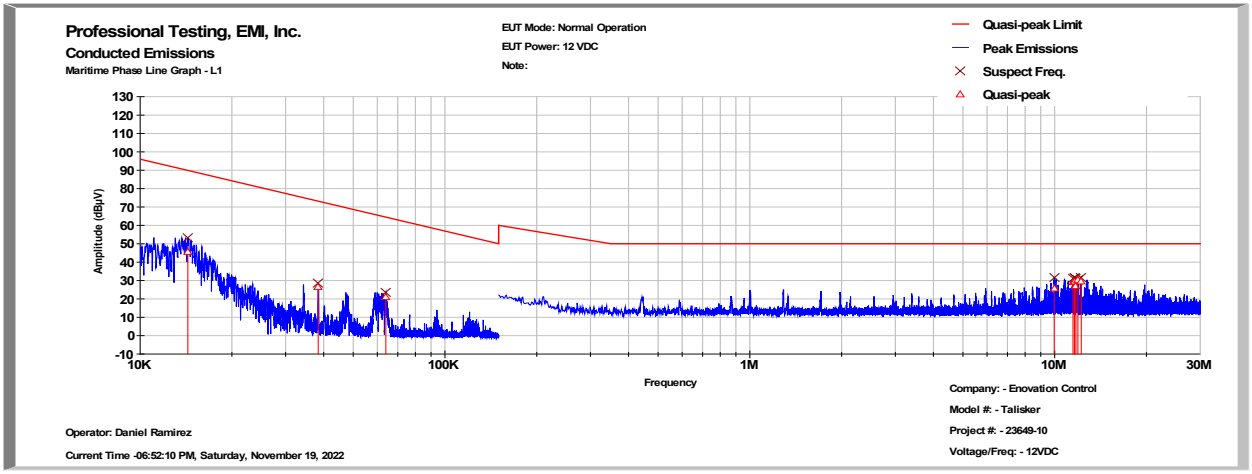
Conducted Emissions Test Data – EN 60945

Neutral Line Emission Data



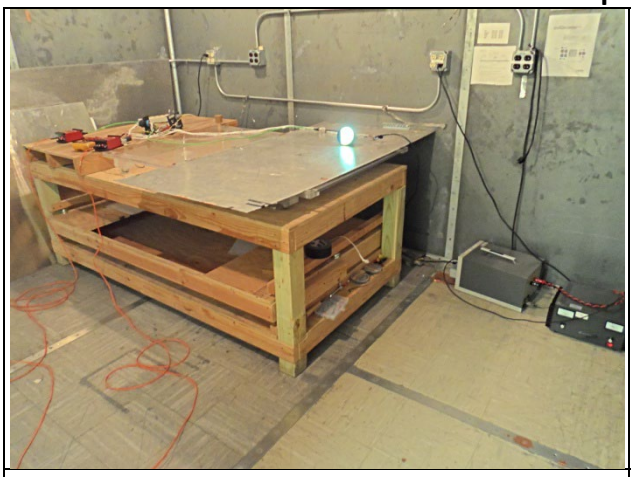
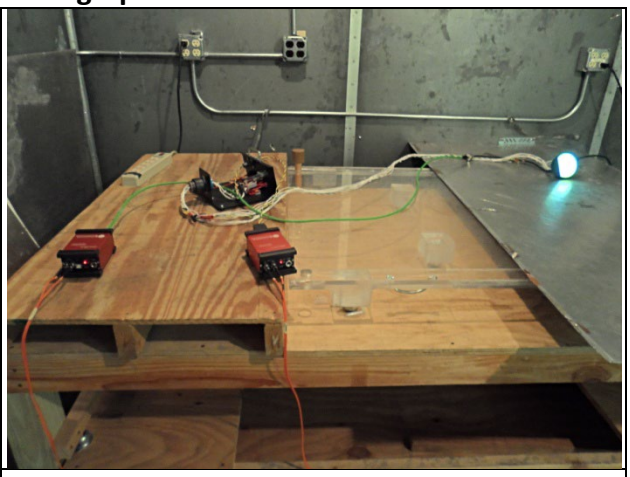
Frequency (MHz)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results (Pass/Fail)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results (Pass/Fail)	Peak Reading (dBµV)
0.014	45.619	90.260	-44.641	PASS	0.014	45.619	90.260	-44.641	PASS
0.047	19.552	69.633	-50.081	PASS	0.047	19.552	69.633	-50.081	PASS
0.064	21.449	64.474	-43.024	PASS	0.064	21.449	64.474	-43.024	PASS
10.262	28.531	50.000	-21.469	PASS	10.262	28.531	50.000	-21.469	PASS
10.757	29.307	50.000	-20.693	PASS	10.757	29.307	50.000	-20.693	PASS
10.817	29.934	50.000	-20.066	PASS	10.817	29.934	50.000	-20.066	PASS
11.610	29.233	50.000	-20.767	PASS	11.610	29.233	50.000	-20.767	PASS
11.915	29.271	50.000	-20.729	PASS	11.915	29.271	50.000	-20.729	PASS
12.218	28.635	50.000	-21.365	PASS	12.218	28.635	50.000	-21.365	PASS

Line 1 Emissions Data



Frequency (MHz)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results (Pass/Fail)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results (Pass/Fail)	Peak Reading (dBµV)
0.014	45.470	89.877	-44.407	PASS	0.014	45.470	89.877	-44.407	PASS
0.038	26.497	73.145	-46.649	PASS	0.038	26.497	73.145	-46.649	PASS
0.064	20.979	64.479	-43.499	PASS	0.064	20.979	64.479	-43.499	PASS
9.964	25.705	50.000	-24.295	PASS	9.964	25.705	50.000	-24.295	PASS
11.486	28.970	50.000	-21.030	PASS	11.486	28.970	50.000	-21.030	PASS
11.606	29.506	50.000	-20.494	PASS	11.606	29.506	50.000	-20.494	PASS
11.735	26.824	50.000	-23.176	PASS	11.735	26.824	50.000	-23.176	PASS
11.915	30.175	50.000	-19.825	PASS	11.915	30.175	50.000	-19.825	PASS
12.217	29.420	50.000	-20.580	PASS	12.217	29.420	50.000	-20.580	PASS

Table 3.1.3.4: Conducted Emissions Test Setup Photographs

	
Test Setup – Side	**Test Setup – Front**
	
Test Setup – Neutral Line	**Test Setup – Phase A (Line 1)**

3.2 Radiated Emissions Measurements

Radiated emissions measurements were made at Nemko USA, Inc. Testing Site 45, located in Austin, Texas, to determine the radio frequency noise radiated from the EUT.

3.2.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable that enables 360-degree rotation.

Measurement antenna placement during testing was as follows for the following frequency ranges:

- Below 30 MHz – antenna was positioned at a constant height of 1 meter and at a distance of 3 meters.
- From 30 MHz to 1 GHz – antenna was positioned at a distance of 10 meters as measured from the closest point of the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters. A spectrum analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing.
- 1 GHz to 2 GHz – antenna was positioned at a distance of 3 meters from the closest point of the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters. Average measurements were taken using a spectrum analyzer to find the maximums of the microwave radiated emissions.

A diagram showing the test setup is given as Figure 3.2.1.1.

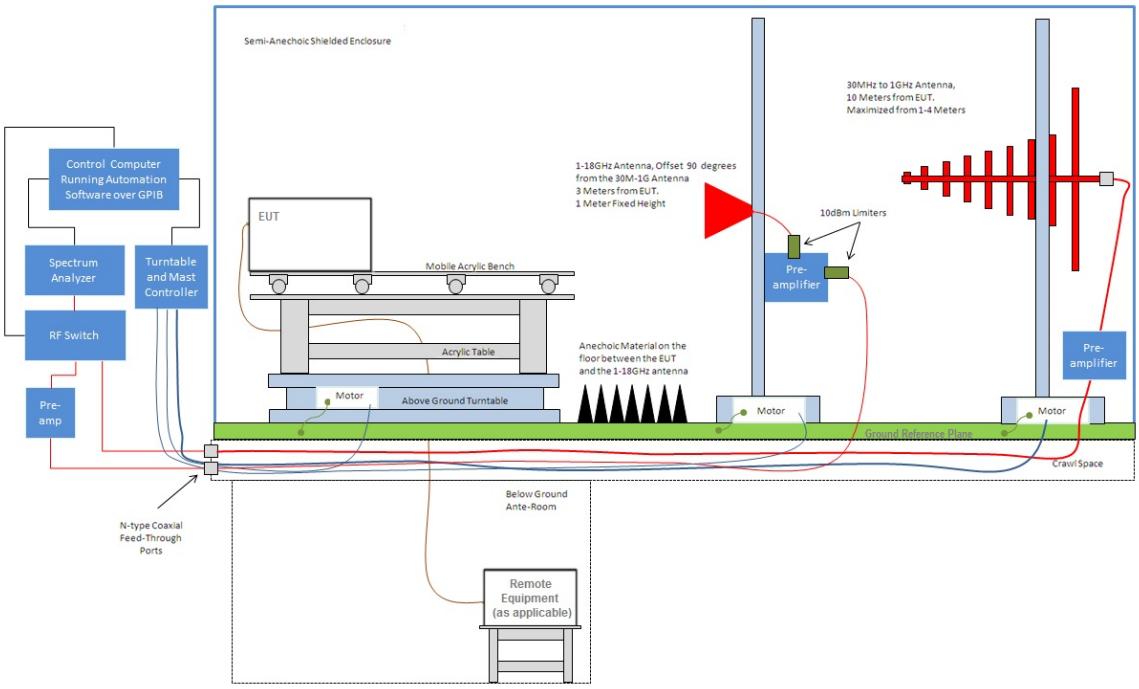


Figure 3.2.1.1: Radiated Emissions Test Setup

3.2.2 Test Criteria

The radiated emissions limits for IEC 60945 and EN 55032 are given in the tables below. Note that the lower limit shall apply at the transition frequency.

Table 3.2.2.1: IEC 60945 Class A Radiated Limits

Test Distance (Meters)	Frequency (MHz)	Quasi-Peak Limit dB(µV/m)
3	0.15 to 0.3	80 to 52
3	0.3 to 30	52 to 34
10	30 to156	42 to 47.59
10	156 to 165	24 (Peak: 30)
10	165 to 230	47.275 to 45
10	230 to 1000	52

Table 3.2.2.2: IEC 60945 Class A Microwave Limits

Test Distance (Meters)	Frequency (MHz)	Quasi-Peak Limit dB(µV/m)
3	1000 to 2000	54

Table 3.2.2.3: EN 55032 Class A Radiated Limits

Test Distance (Meters)	Frequency (MHz)	Quasi-Peak Limit dB(µV/m)
10	30 to 230	40
10	230 to 1000	47

3.2.3 Test Results

During testing on November 18, 2022, the emissions identified from the EUT were maximized at each frequency. The radiated emissions generated by the EUT were below the Class A maximum criteria for IEC 60945 and EN 55032.

Table 3.2.3.1: Radiated Emissions Test Log

Professional Testing, EMI, Inc.			
Test Method:	**CISPR 16-2: Specification for radio disturbance and immunity measuring apparatus and methods - Part 2: Methods of measurement of disturbance and immunity**		
In accordance with:	**IEC 60945: 2002-08 Maritime navigation and radio communication equipment and systems - General Requirements - Methods of testing and required test results**		
Section:	**Section 9.3 – Radiated emissions from enclosure port**		
Test Method:	**CISPR 16-2-3:2010 +A1:2010 +A2:2014, Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements**		
In accordance with:	**EN 55032:2015 +A11:2020, Electromagnetic compatibility of multimedia equipment – Emission requirements**		
Section:	**A.2 Requirements for radiated emissions**		
Test Date(s):	**11/18/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician(s):**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Radiated Emissions Test Log Sheet							
Temperature:	**21.3 °C**	**Humidity**	**34% RH**	**Barometric Pressure:**	**29.4 inHg**		
Test Location:	**10 Meter Chamber**						
Test Status:	**Testing Complete, EUT Passed**						

Table 3.2.3.2: Radiated Emissions Test Results – IEC 60945

EUT Name	Talisker		Serial #	None	
EUT Line Voltage	12	VDC	Frequency	-	Hz
Emissions Limit Level	Class A		EUT Test Mode or Configuration	Normal Operation	

Frequency Range	Test Distance (Meters)	Antenna Polarization	Test Results
150kHz to 30MHz	3	Parallel	Pass
		Perpendicular	Pass
30MHz to 1GHz	10	Vertical	Pass
		Horizontal	Pass
1GH to 2GHz	3	Vertical	Pass
		Horizontal	Pass

Table 3.2.3.3: Radiated Emissions Test Results – EN 55032

EUT Name	Talisker		Serial #	None	
EUT Line Voltage	12	VDC	Frequency	-	Hz
Emissions Limit Level	Class A		EUT Test Mode or Configuration	Normal Operation	

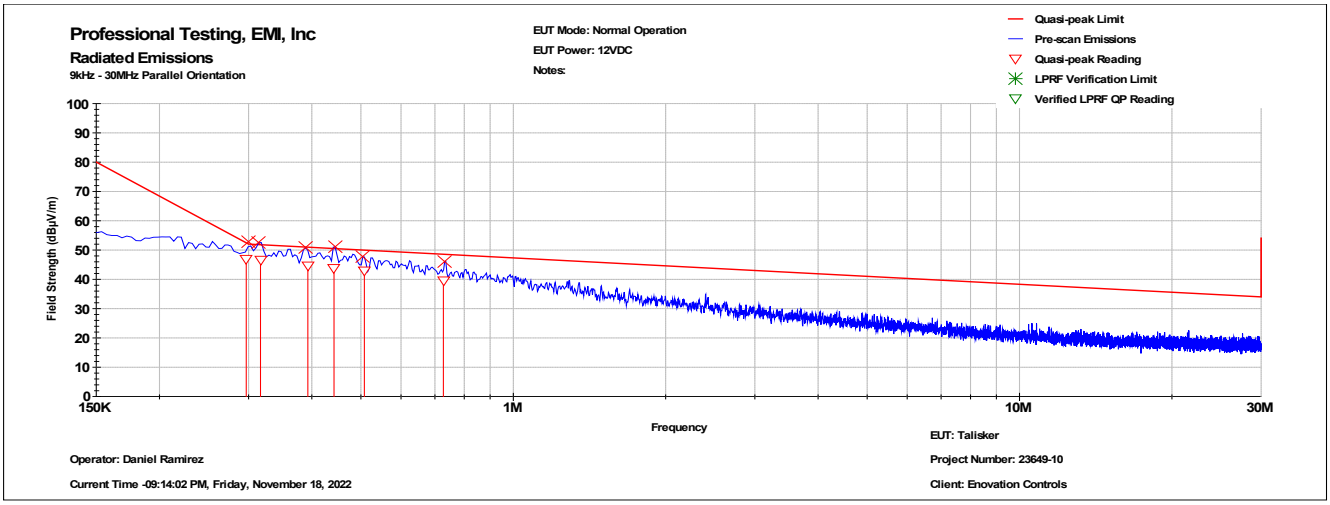
Frequency Range	Test Distance (Meters)	Antenna Polarization	Test Results
30MHz to 1GHz	10	Vertical	Pass
		Horizontal	Pass
1GHz to 6 GHz	3	Vertical	Pass
		Horizontal	Pass

Table 3.2.3.4: Radiated Emissions Test Equipment

Tile! Software Version:			Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM		
Test Profile:			2020_RE_Unintentional_TILE7_v4		
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	4/9/2023
1457	HP	8447D	Preamp, .1-1300MHz	1937A02800	10/28/2024
1937	Agilent	E4440A - AYZ	PSA , 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/16/2023
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	7/15/2024
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/9/2023
1327	EMCO	1050	Controller, Antenna Mast	None	N/A
942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
6	EMCO	6502	Antenna, Loop, Active, .01-30MHz	1030	5/11/2023
1509B	Braden	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	4/9/2023
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/14/2024
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/9/2023
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	4/16/2023
C137	Belden	M17/164	Cable, RF, N-N, 9.14m, Black, 9 kHz - 1 GHz	None	9/15/2023
C289	Pasternack	PE354-24	Cable, N-SMA, 0.610m Blue	1310	9/9/2024

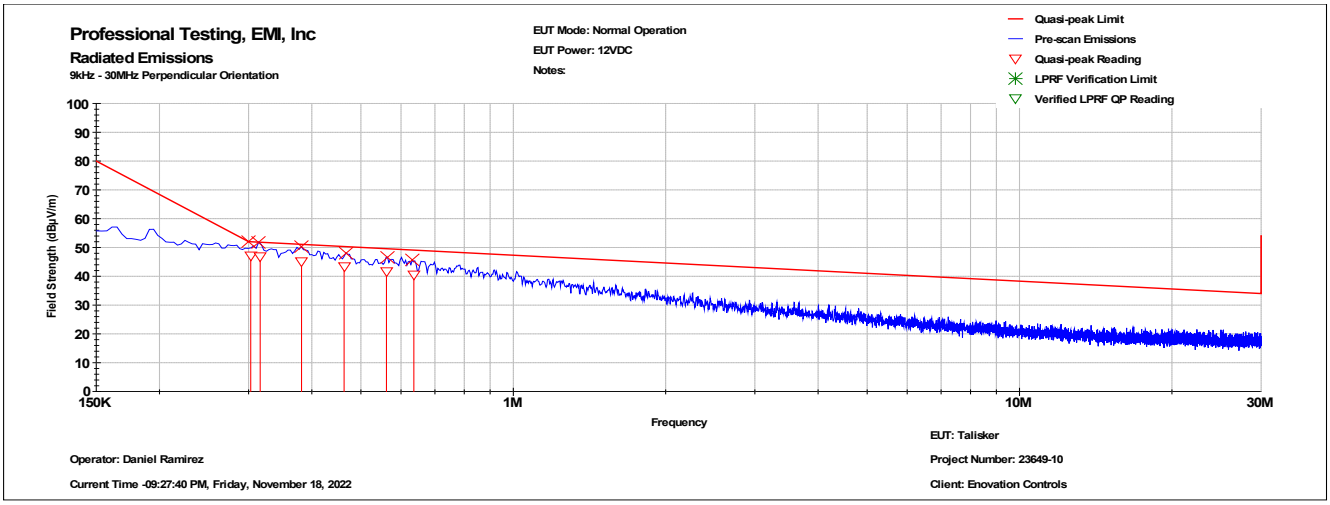
Radiated Emissions Test Data – IEC 60945

150kHz – 30MHz Parallel Measured Emissions Data



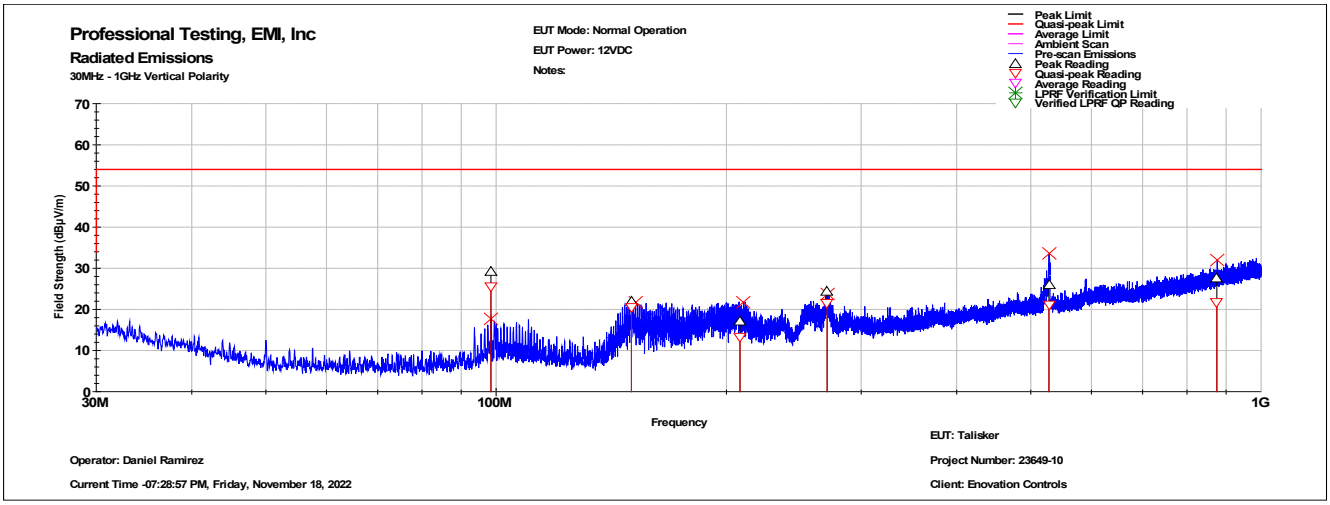
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results
0.297	347.000	100.000	46.954	52.424	-5.469	PASS
0.317	254.000	100.000	46.523	51.788	-5.265	PASS
0.393	93.000	100.000	44.705	50.947	-6.242	PASS
0.442	173.000	100.000	43.841	50.482	-6.641	PASS
0.508	112.000	100.000	42.919	49.943	-7.024	PASS
0.728	5.000	100.000	39.535	48.537	-9.002	PASS

150kHz – 30MHz Perpendicular Measured Orientation Emissions Data



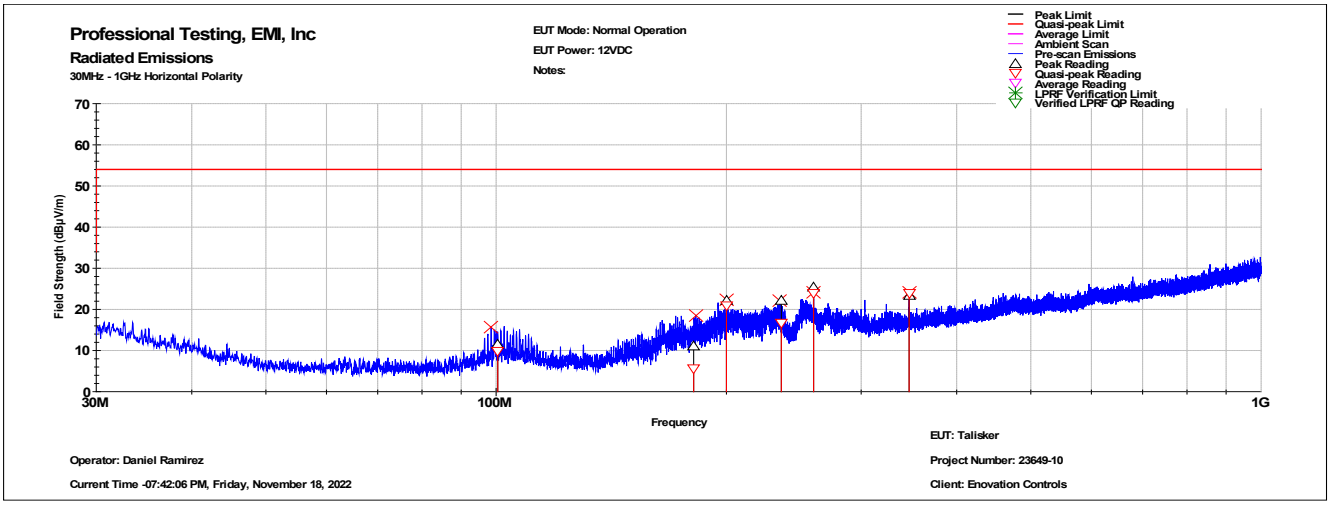
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results
0.303	352.000	100.000	47.216	51.962	-4.746	PASS
0.316	81.000	100.000	46.716	51.794	-5.078	PASS
0.382	151.000	100.000	45.186	51.058	-5.873	PASS
0.463	97.000	100.000	43.465	50.302	-6.837	PASS
0.562	235.000	100.000	41.775	49.550	-7.775	PASS
0.636	9.000	100.000	40.640	49.063	-8.423	PASS

30MHz - 1GHz Vertical Polarity Measured Emissions Data



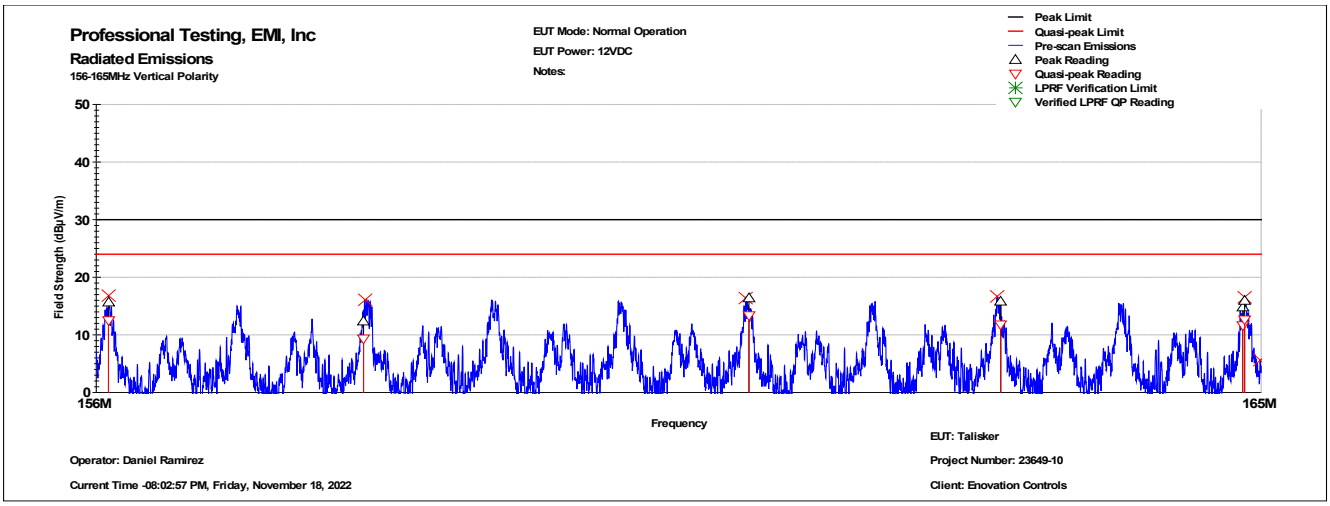
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
98.436	11.000	166.000	25.574	54.000	-28.426	PASS	29.160
150.253	327.000	124.000	20.543	54.000	-33.457	PASS	21.889
208.316	336.000	125.000	13.288	54.000	-40.712	PASS	17.143
270.808	351.000	114.000	21.515	54.000	-32.485	PASS	24.375
527.950	107.000	376.000	21.186	54.000	-32.814	PASS	26.039
875.347	197.000	125.000	21.761	54.000	-32.239	PASS	27.617

30MHz - 1GHz Horizontal Polarity Measured Emissions Data



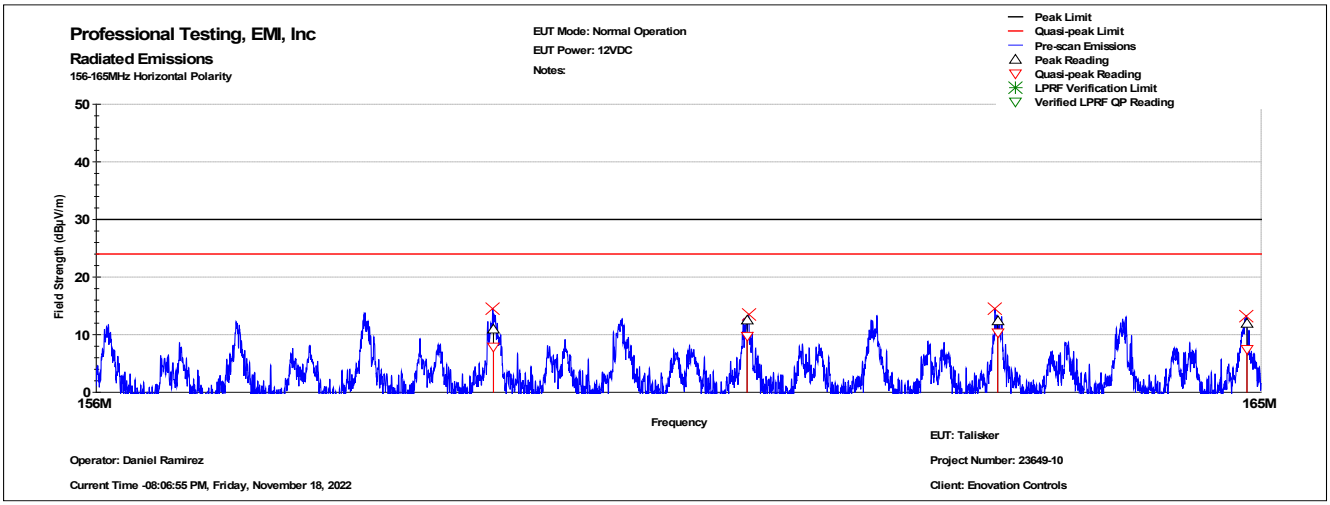
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
100.482	75.000	157.000	9.804	54.000	-44.196	PASS	11.391
181.194	5.000	110.000	5.546	54.000	-48.454	PASS	11.087
200.011	242.000	171.000	20.884	54.000	-33.116	PASS	22.054
235.947	179.000	110.000	16.689	54.000	-37.311	PASS	22.107
260.006	42.000	117.000	23.873	54.000	-30.127	PASS	25.293
346.656	291.000	151.000	23.930	54.000	-30.070	PASS	23.310

156MHz - 165MHz Vertical Polarity Measured Emissions Data



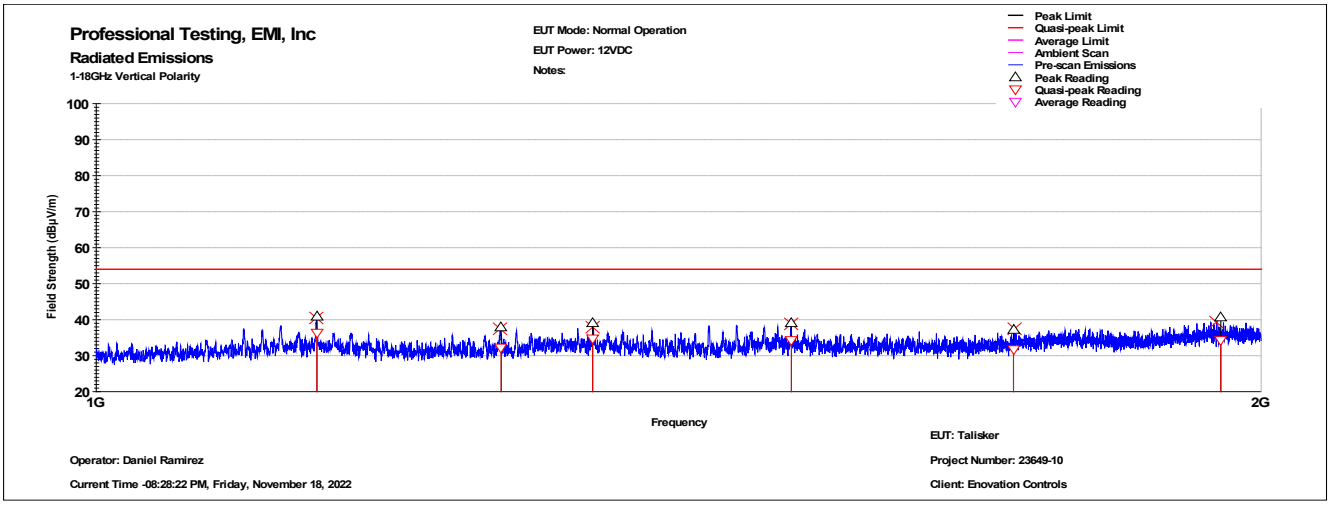
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results
156.092	111.000	129.000	12.553	24.000	-11.447	PASS	15.662	30.000	-14.338	PASS
158.021	73.000	118.000	9.336	24.000	-14.664	PASS	12.321	30.000	-17.679	PASS
160.981	111.000	121.000	13.407	24.000	-10.593	PASS	16.320	30.000	-13.680	PASS
162.944	338.000	124.000	11.783	24.000	-12.217	PASS	15.825	30.000	-14.175	PASS
164.854	111.000	122.000	11.680	24.000	-12.320	PASS	14.795	30.000	-15.205	PASS
164.869	337.000	133.000	12.680	24.000	-11.320	PASS	15.913	30.000	-14.087	PASS

156MHz – 165MHz Horizontal Polarity Measured Emissions Data



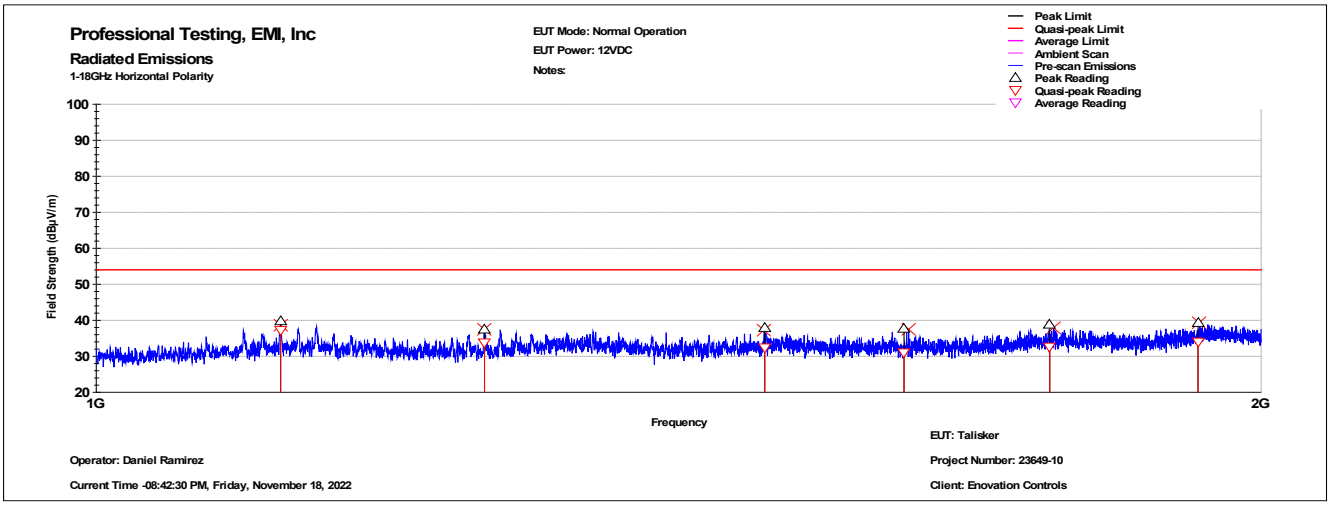
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results
159.013	248.000	171.000	7.864	24.000	-16.136	PASS	10.869	30.000	-19.131	PASS
160.967	279.000	258.000	9.704	24.000	-14.296	PASS	12.526	30.000	-17.474	PASS
162.921	279.000	200.000	10.334	24.000	-13.666	PASS	12.298	30.000	-17.702	PASS
164.888	294.000	215.000	7.500	24.000	-16.500	PASS	11.921	30.000	-18.079	PASS

1GHz - 2GHz Vertical Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
1140.31	48	127	36.238	54.000	-17.762	PASS	40.910
1272.51	205	388	32.253	54.000	-21.747	PASS	37.949
1343.69	181	202	34.811	54.000	-19.189	PASS	39.104
1512.37	355	273	34.175	54.000	-19.825	PASS	39.093
1726.06	352	258	31.621	54.000	-22.379	PASS	37.260
1952.69	96	172	34.336	54.000	-19.664	PASS	40.582

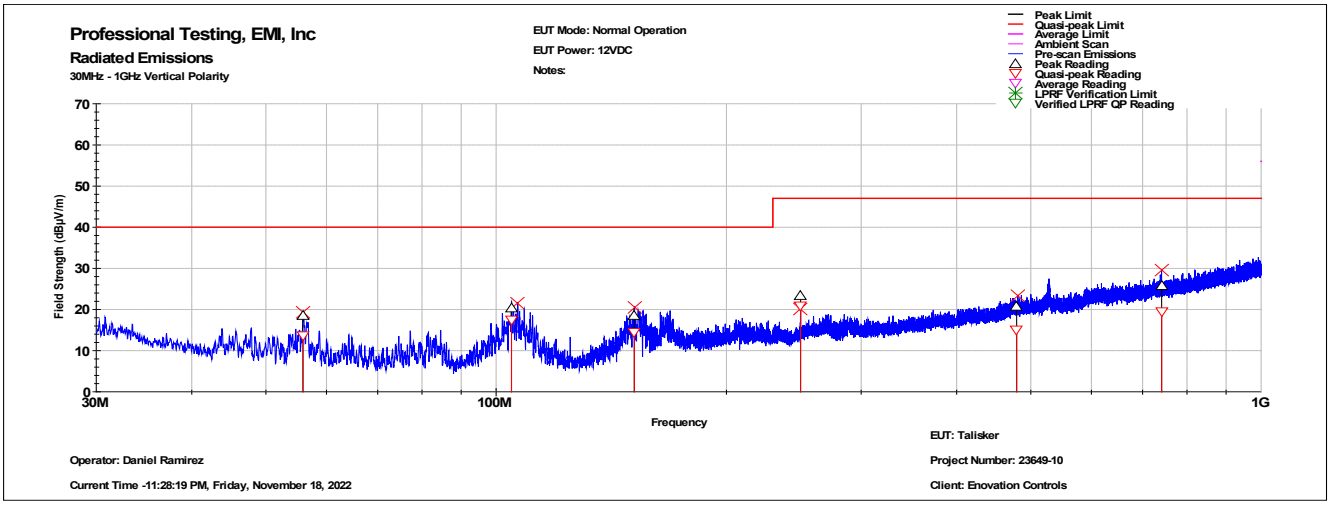
1GHz - 2GHz Horizontal Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
1115.99	6	263	37.139	54.000	-16.861	PASS	39.729
1259.94	235	224	33.895	54.000	-20.105	PASS	37.485
1488.52	178	341	32.310	54.000	-21.690	PASS	37.946
1617.22	353	185	30.907	54.000	-23.093	PASS	37.720
1763.65	60	293	32.628	54.000	-21.372	PASS	38.739
1926.32	7	178	33.949	54.000	-20.051	PASS	39.405

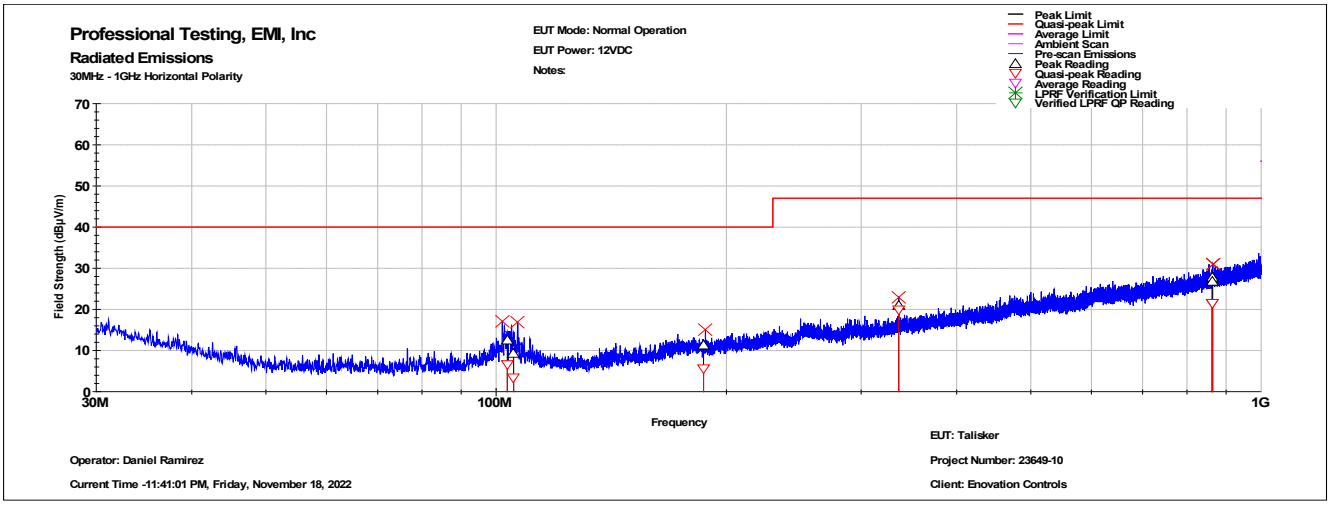
Radiated Emissions Test Data – EN 55032

30MHz - 1GHz Vertical Polarity Measured Emissions Data



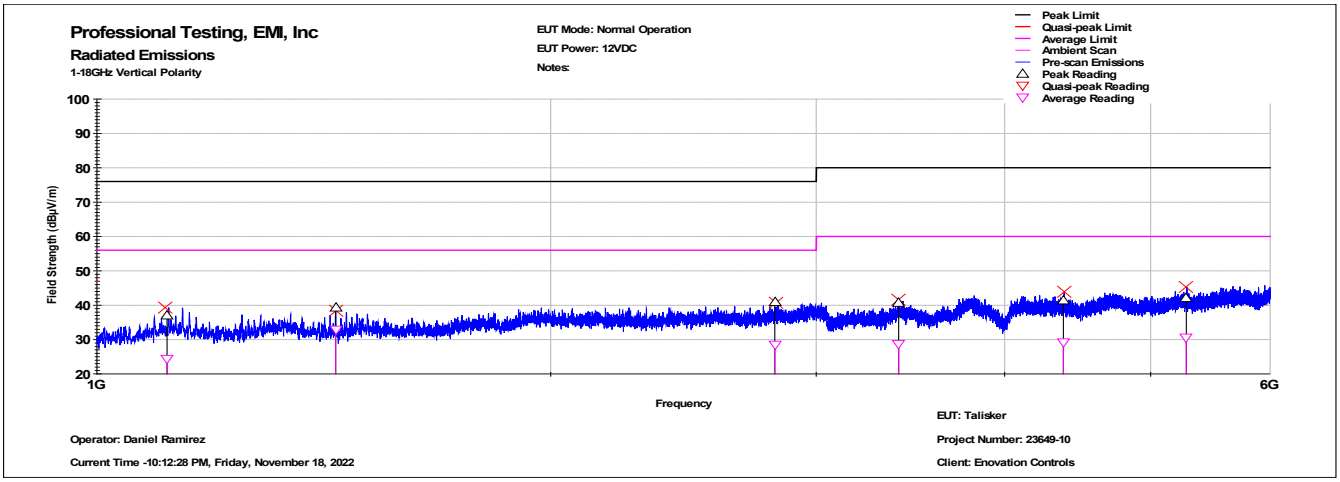
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
55.904	5.000	139.000	13.645	40.000	-26.355	PASS	18.419
104.711	212.000	152.000	17.402	40.000	-22.598	PASS	20.272
151.540	355.000	135.000	14.410	40.000	-25.590	PASS	18.492
249.993	222.000	124.000	20.914	47.000	-26.086	PASS	23.241
479.179	240.000	231.000	15.151	47.000	-31.849	PASS	20.793
741.433	352.000	124.000	19.560	47.000	-27.440	PASS	25.746

30MHz - 1GHz Horizontal Polarity Measured Emissions Data



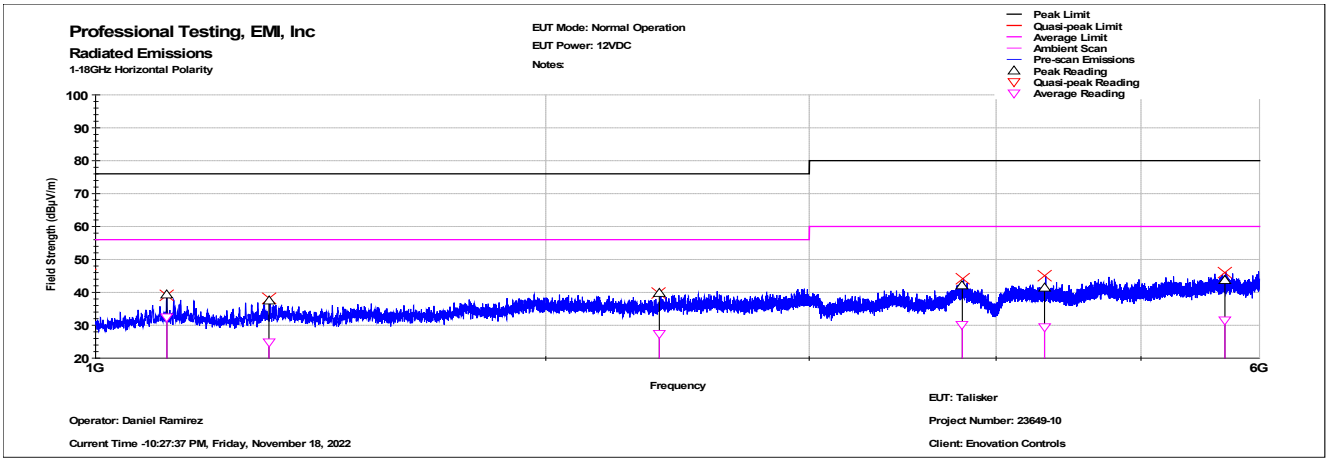
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
103.403	80.000	126.000	6.698	40.000	-33.302	PASS	12.371
105.385	7.000	146.000	3.404	40.000	-36.596	PASS	9.249
186.694	238.000	120.000	5.612	40.000	-34.388	PASS	11.239
335.988	297.000	219.000	19.875	47.000	-27.125	PASS	20.845
862.893	352.000	109.000	21.492	47.000	-25.508	PASS	27.721
864.439	240.000	158.000	21.579	47.000	-25.421	PASS	26.745

1GHz - 6GHz Vertical Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1113.25	9	196	36.895	76.000	-39.105	PASS	24.284	56.000	-31.716	PASS
1440.13	123	399	39.288	76.000	-36.712	PASS	32.794	56.000	-23.206	PASS
2815.95	15	360	40.887	76.000	-35.113	PASS	28.485	56.000	-27.515	PASS
3402.59	7	216	40.763	80.000	-39.237	PASS	28.738	60.000	-31.262	PASS
4375.87	14	316	41.324	80.000	-38.676	PASS	29.267	60.000	-30.733	PASS
5279.79	299	128	41.958	80.000	-38.042	PASS	30.476	60.000	-29.524	PASS

1GHz - 6GHz Horizontal Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1116.10	36	282	39.282	76.000	-36.718	PASS	32.295	56.000	-23.705	PASS
1306.01	271	205	37.576	76.000	-38.424	PASS	24.729	56.000	-31.271	PASS
2382.13	322	388	39.772	76.000	-36.228	PASS	27.408	56.000	-28.592	PASS
3797.35	254	150	41.954	80.000	-38.046	PASS	30.007	60.000	-29.993	PASS
4309.84	355	387	41.432	80.000	-38.568	PASS	29.336	60.000	-30.664	PASS
5689.52	195	125	43.684	80.000	-36.316	PASS	31.492	60.000	-28.508	PASS

Table 3.2.3.5: Radiated Emissions Test Setup Photographs – IEC 60945

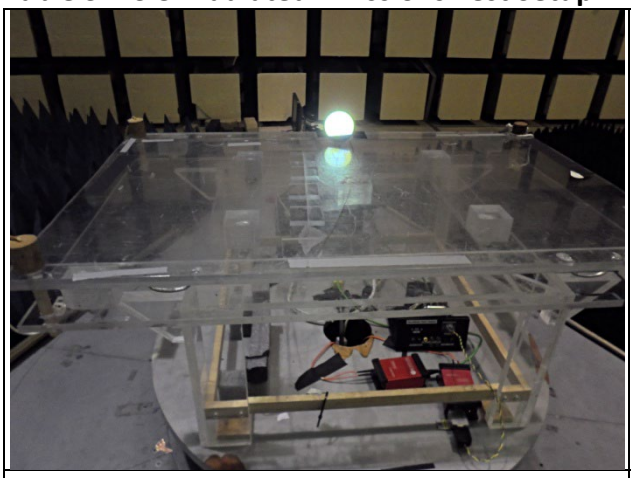
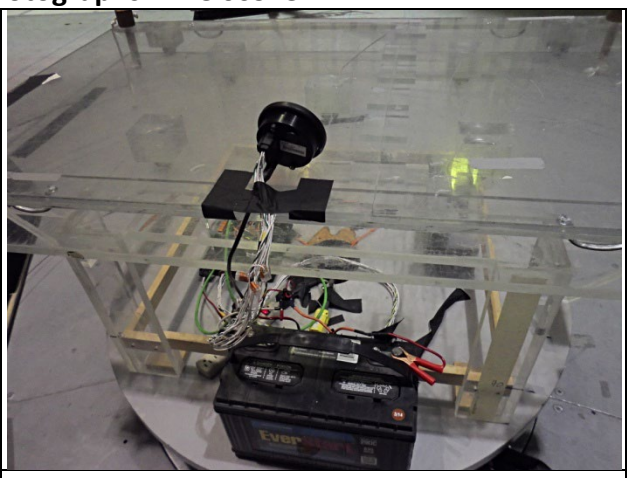
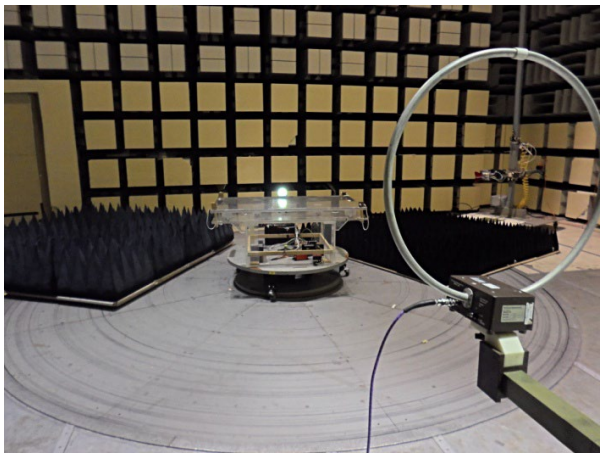
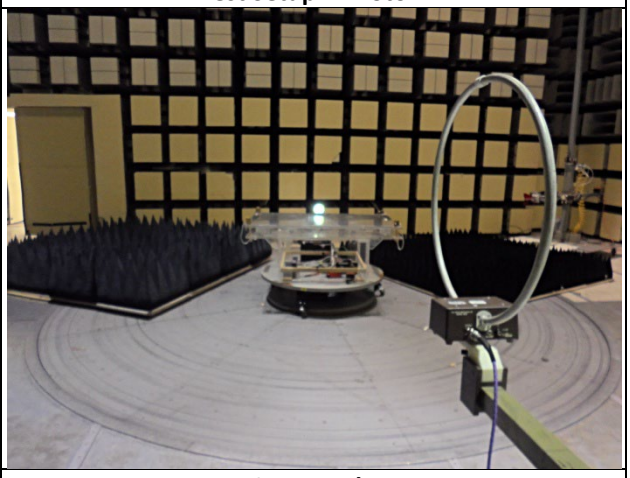
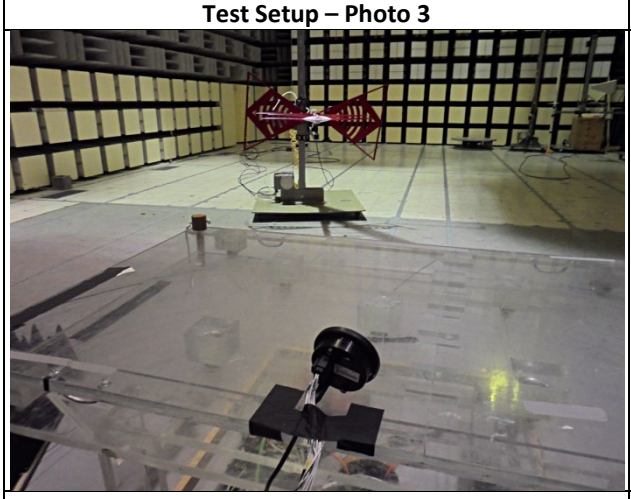
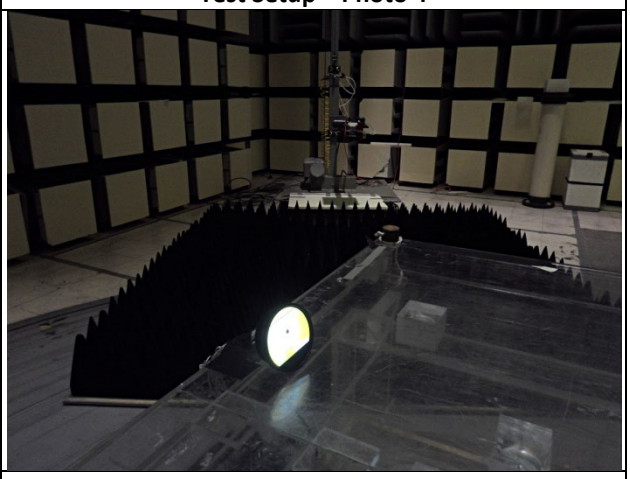
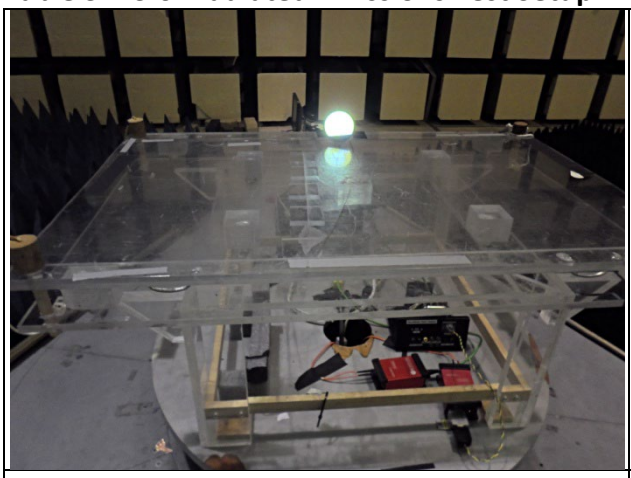
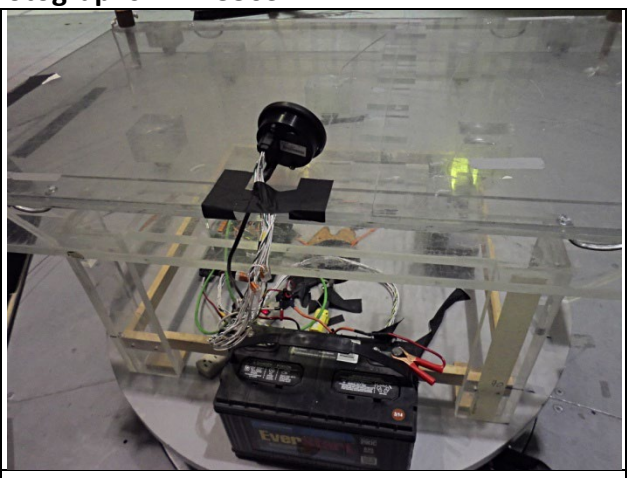
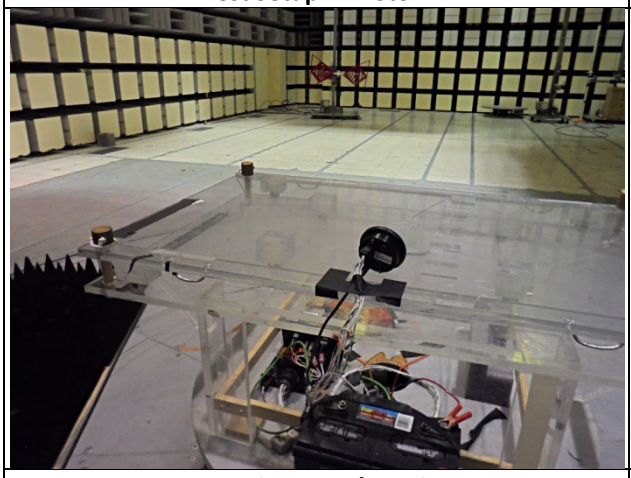
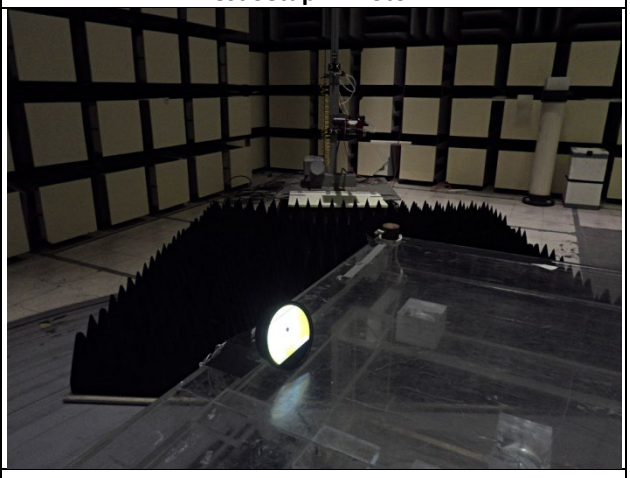
	
Test Setup – Photo 1	**Test Setup – Photo 2**
	
Test Setup – Photo 3	**Test Setup – Photo 4**
	
Test Setup – Photo 5	**Test Setup – Photo 6**

Table 3.2.3.6: Radiated Emissions Test Setup Photographs – EN 55032

	
Test Setup – Photo 1	**Test Setup – Photo 2**
	
Test Setup – Photo 3	

4.0 Electromagnetic Immunity Testing

4.1 Performance Criteria

Performance Criterion A	Normal performance within equipment specifications.
Performance Criterion B	Degradation or loss of function or performance that is self-recoverable when the interfering signal is removed.
Performance Criterion C	Degradation or loss of function or performance that requires system reset or operator intervention when the interfering signal is removed.

4.2 Radiated Immunity Testing

4.2.1 Test Procedures

Radiated immunity testing was performed on the EUT using the procedures of IEC 61000-4-3. The testing was performed to determine the ability of the EUT to function properly while immersed in electromagnetic fields of 10 V/m (80 MHz to 1 GHz) and 3 V/m (1 GHZ to 2.7 GHz) with 1 kHz at 80% amplitude modulation.

The testing was performed in a shielded enclosure with anechoic material placed throughout the enclosure to minimize reflections. The transmit antenna was located at a distance of 3 meters from the EUT. All other field generation equipment and monitoring equipment was placed outside the test enclosure. Drive levels to the transmit antenna were monitored and maintained at the levels established by the initial field calibration described in section 4.2.2 of this report. Testing was performed utilizing linearly polarized antennas, with the EUT exposed to both vertically and horizontally polarized fields. A diagram showing the test setup is given as Figure 4.2.1.1.

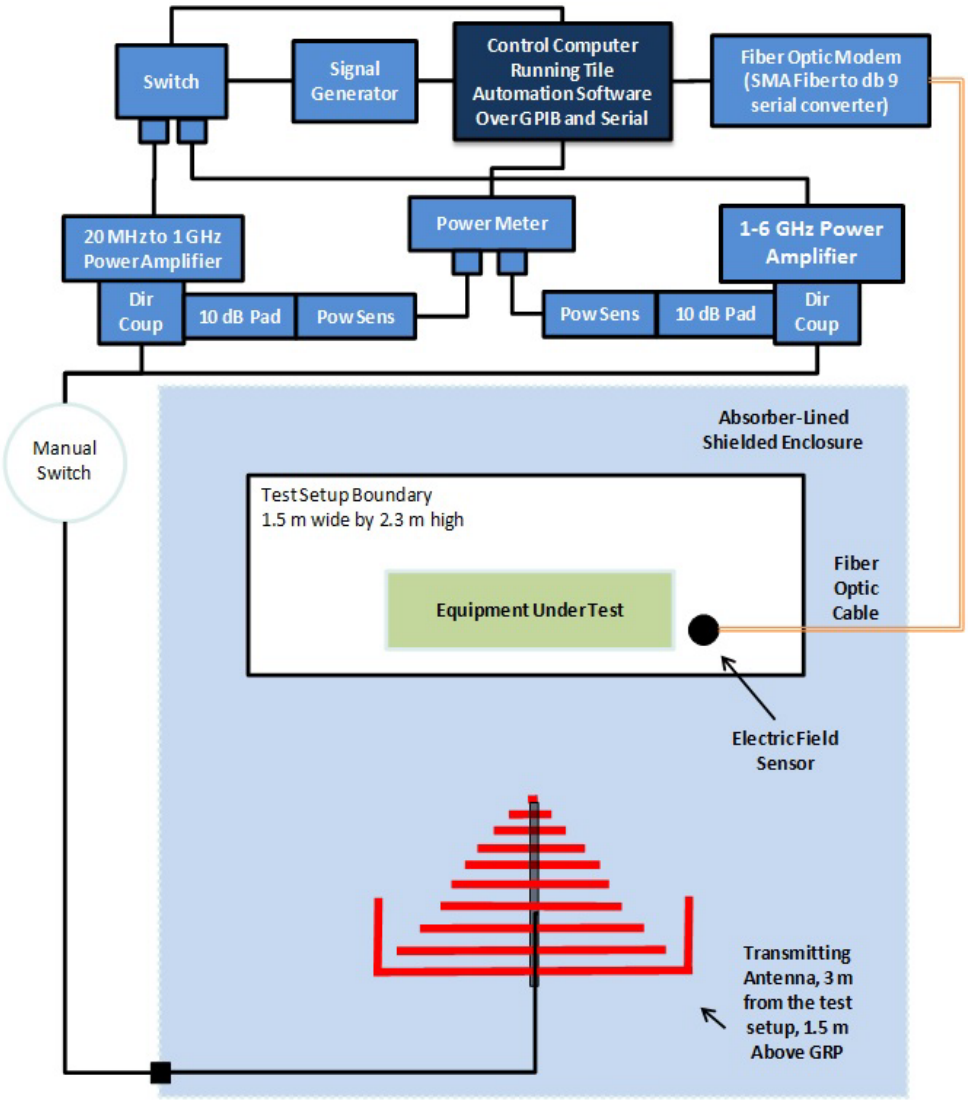


Figure 4.2.1.1: Radiated Immunity Test Setup

4.2.2 Field Generation

Calibration of the radiated field intensity was performed prior to testing of the EUT. The input power levels required to generate the desired continuous wave (CW) field intensities at the plane of the EUT were established. The frequency band was covered in steps of one percent of the fundamental frequency. The transmit antenna was placed 3 meters from the plane of the EUT. Calibration of the field was performed in both horizontal and vertical antenna polarizations.

4.2.3 Performance Criteria

During the performance of radiated immunity testing, only performance criteria A and B were allowed. Performance criterion C failures were disallowed.

4.2.4 Test Results

The EUT was subjected to radiated immunity testing in both vertical and horizontal polarizations on November 19, 2022. No adverse indications were noted during the performance of the test. Therefore, the EUT met performance criterion A.

Table 4.2.4.1: Radiated Immunity Test Log

Professional Testing, EMI, Inc.			
Test Method:	**IEC 61000-4-3, Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test**		
In accordance with:	**BS EN 61326-1:2013 - Electrical equipment for measurement, control and laboratory use - EMC requirements, Part 1: General requirements (Basic Electromagnetic Environment)**		
Section:	**Table 2 – Immunity test requirements for equipment intended to be used in an Industrial Electromagnetic Environment**		
Test Date(s):	**11/19/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician(s):**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Radiated Immunity Test Log Sheet							
Temperature:	**17.8**	**°C**	**Humidity**	**39%**	**RH**	**Barometric Pressure:**	**29.5**	**inHg**
Test Location:	**10 Meter Chamber**							
Test Status:	**Testing Complete, EUT Passed**							

Table 4.2.4.2: Radiated Immunity Test Results – 80 MHz to 1 GHz

Radiated Immunity Test Results -0.08 - 1.0 GHz							Page: 1 of 2		
EUT Mode of Operation:	Normal Operation								
EUT Line Voltage:	12 VDC			EUT Power Frequency:	- N/A				
Frequency Range	Antenna Polarity	Test Level	EUT Face Illuminated	Modulation Parameters	Frequency Step Size	Dwell Time at Each Frequency	Performance Criteria Required	Performance Criteria Achieved	Test Results / Notes
0.08 - 1.0 GHz	Horizontal	10 V/m	Front	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Vertical	10 V/m	Front	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Horizontal	10 V/m	Left Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Vertical	10 V/m	Left Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Horizontal	10 V/m	Rear	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Vertical	10 V/m	Rear	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Horizontal	10 V/m	Right Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
0.08 - 1.0 GHz	Vertical	10 V/m	Right Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass

EUT - Specific Spot Frequencies at 3Vrms			
Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
1800.0	2600.0	3500.0	5000.0

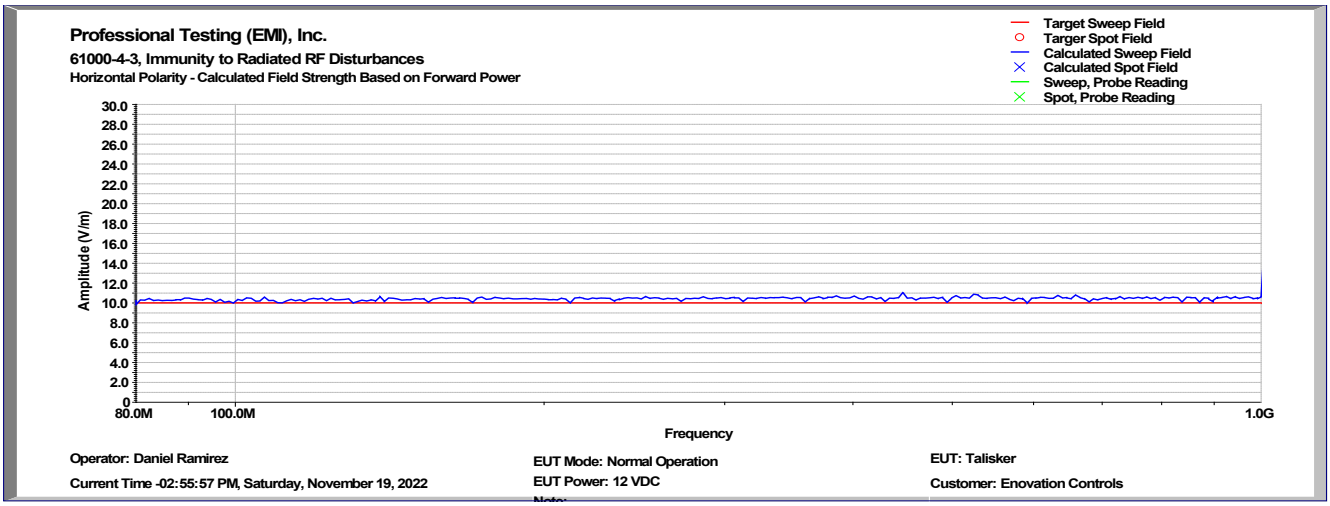
Table 4.2.4.3: Radiated Immunity Test Results – 1 GHz to 2.7 GHz

Radiated Immunity Test Results -1.0 - 2.7 GHz							Page: 2 of 2		
EUT Mode of Operation:	Normal Operation								
EUT Line Voltage:	12 VDC				EUT Power Frequency:	- N/A			
Frequency Range	**Antenna Polarity**	**Test Level**	**EUT Face Illuminated**	**Modulation Parameters**	**Frequency Step Size**	**Dwell Time at Each Frequency**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Results / Notes**
1.0 - 2.7 GHz	Horizontal	3 V/m	Front	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Vertical	3 V/m	Front	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Horizontal	3 V/m	Left Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Vertical	3 V/m	Left Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Horizontal	3 V/m	Rear	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Vertical	3 V/m	Rear	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Horizontal	3 V/m	Right Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass
1.0 - 2.7 GHz	Vertical	3 V/m	Right Side	80% AM (1 kHz)	0.01	Steps: 1 s, Spots: 60 s	A	A	Pass

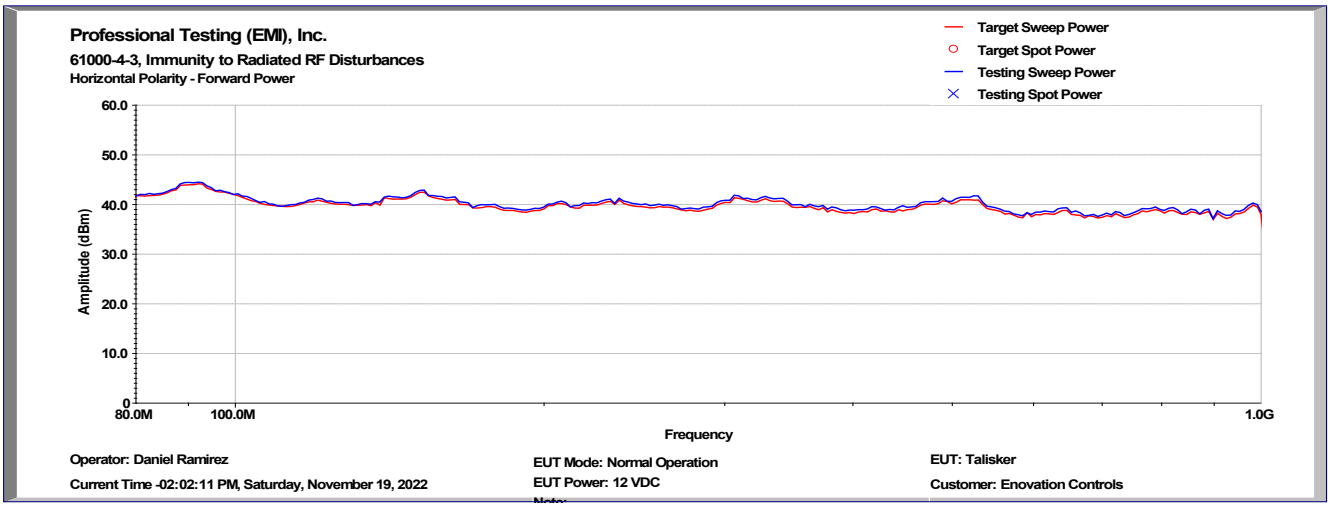
Table 4.2.4.4: Radiated Immunity Test Equipment

Test Software Version:			Version: 7.1.2.17		
Test Profile Used:			2020_RI_61000-4-3_TILE7_v6		
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
80-1000 MHz Test Equipment					
1509C	Braden	TDK 10M	TDK 10M Chamber, Radiated Immunity	DAC-012915-005	4/9/2023
1827	HP	437B	Power Meter	3125U23355	3/5/2024
1848	Ophir	5127FE	Amplifier, RF Power, 20-1000 MHz, 200W	1082	N/A
1025	Philco	642A-Z	Coupler, Directional 12 MHz-1GHz	171	N/A
PTI39	Amerest	1P2M-841EB	Camera, 1080P Pan / Tilt	AMC0146093FA73937B	N/A
1850	ETS-Lindgren	3140B	Antenna, Biconilog 26-3000 MHz	00126505	N/A
A042	Weinschel	KS-21100	Attenuator, N, 10dB	484	4/1/2023
1-2.7 GHz Test Equipment (additional to equipment above)					
2312	Associated Research	30HM1G6-45M1	Amplifier, 1-6 GHz, 50W	0344473	N/A
2314	Schwarzbeck	STLP 9149	Antenna, 0.7 - 10GHz	00526	N/A

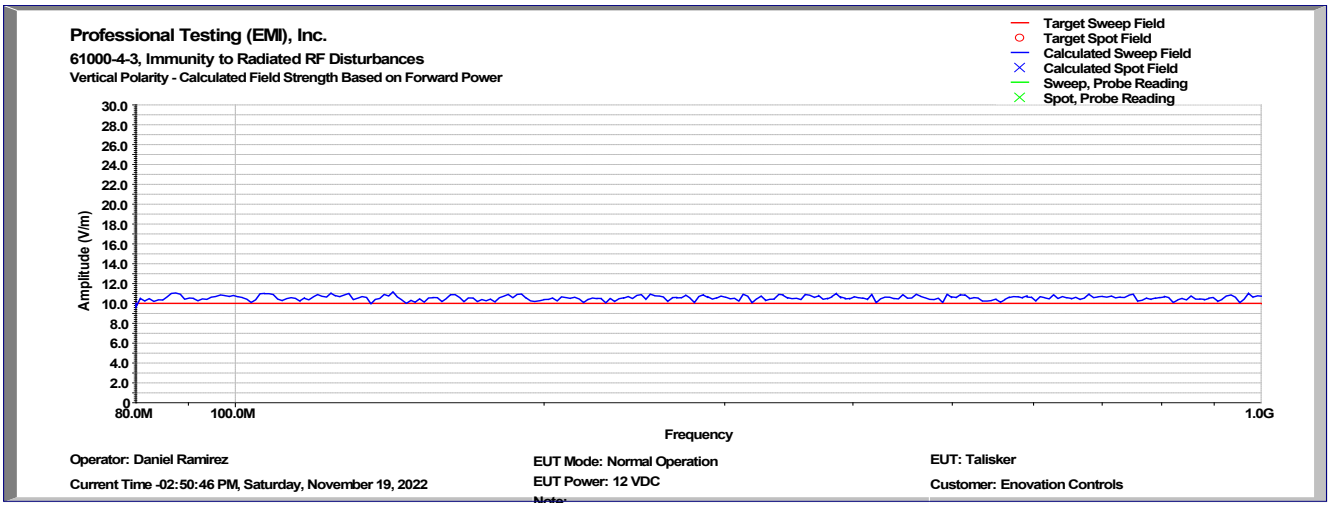
Radiated Immunity Test Data – 80 MHz to 1 GHz



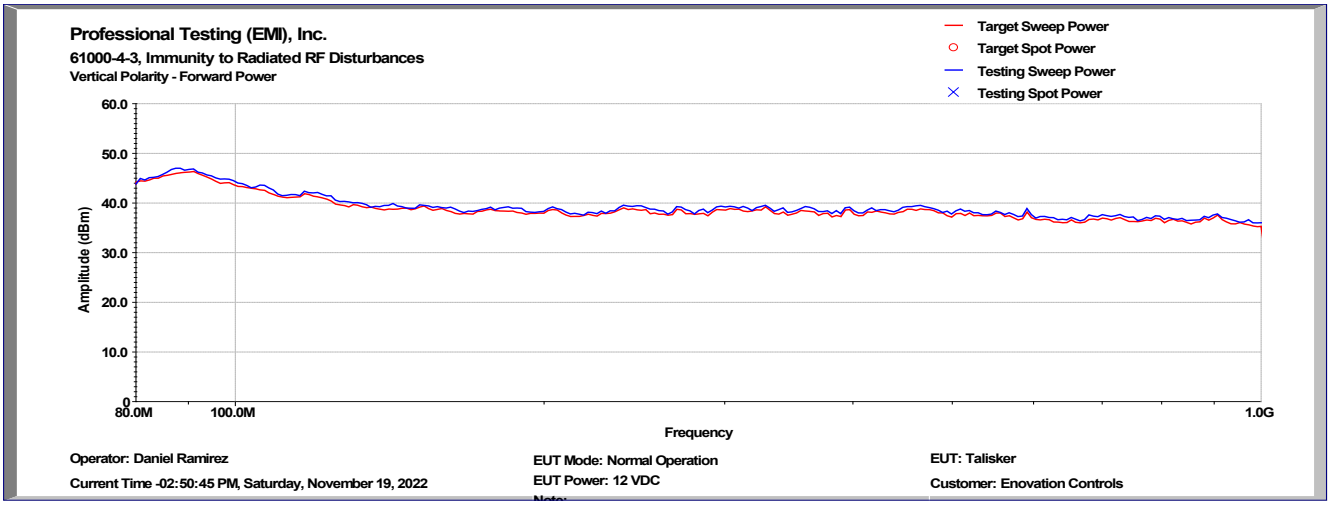
Horizontal Antenna Polarity Field Strength Plot



Horizontal Antenna Polarity Forward Power

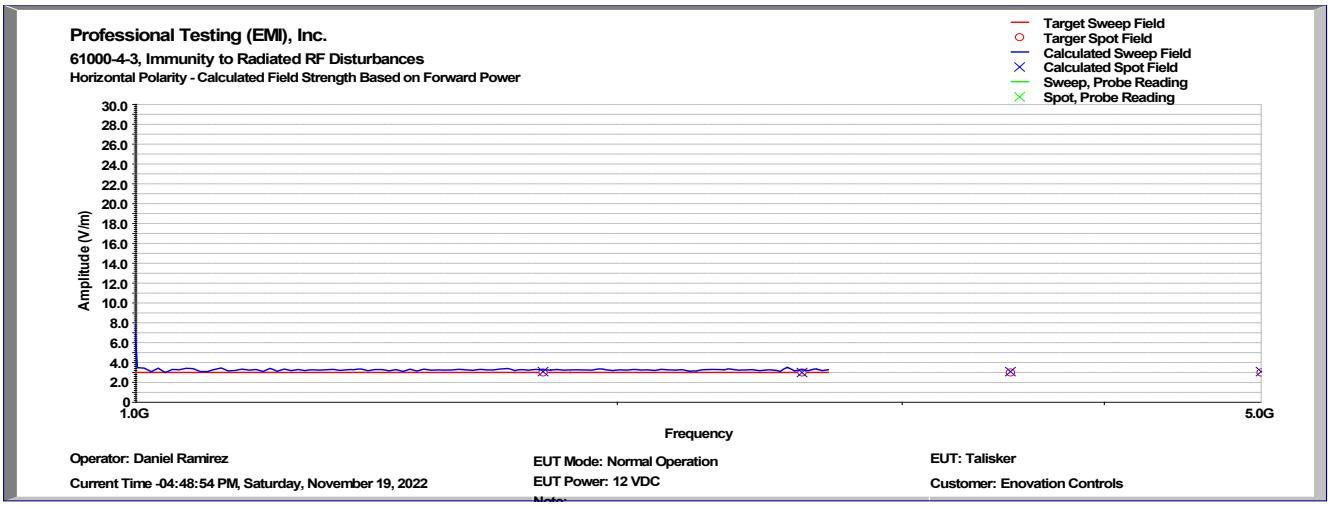


Vertical Antenna Polarity Field Strength Plot

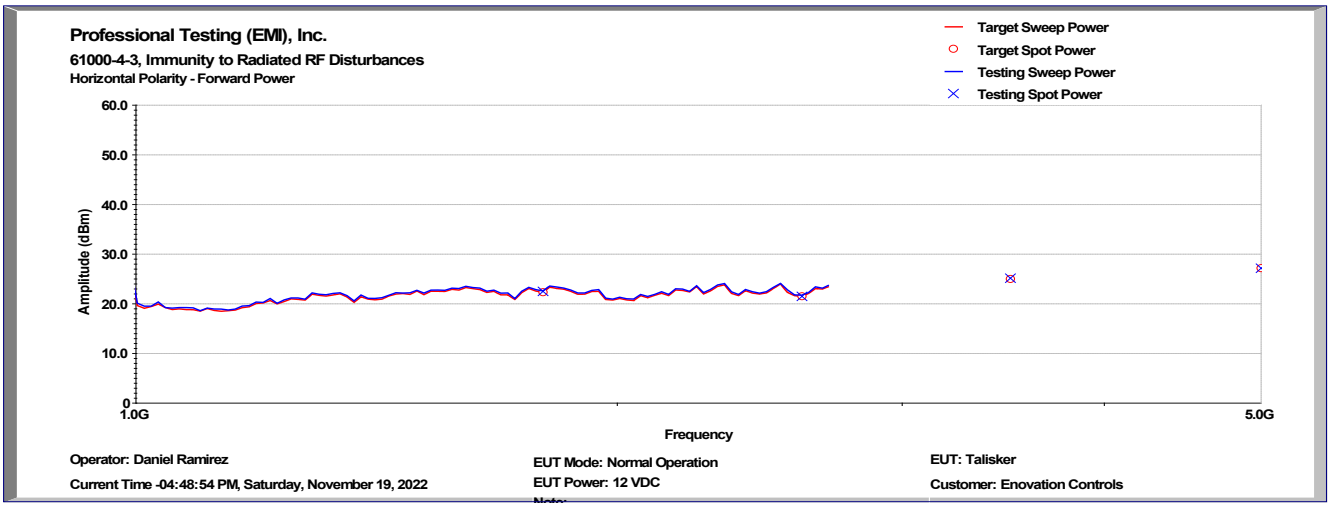


Vertical Antenna Polarity Forward Power

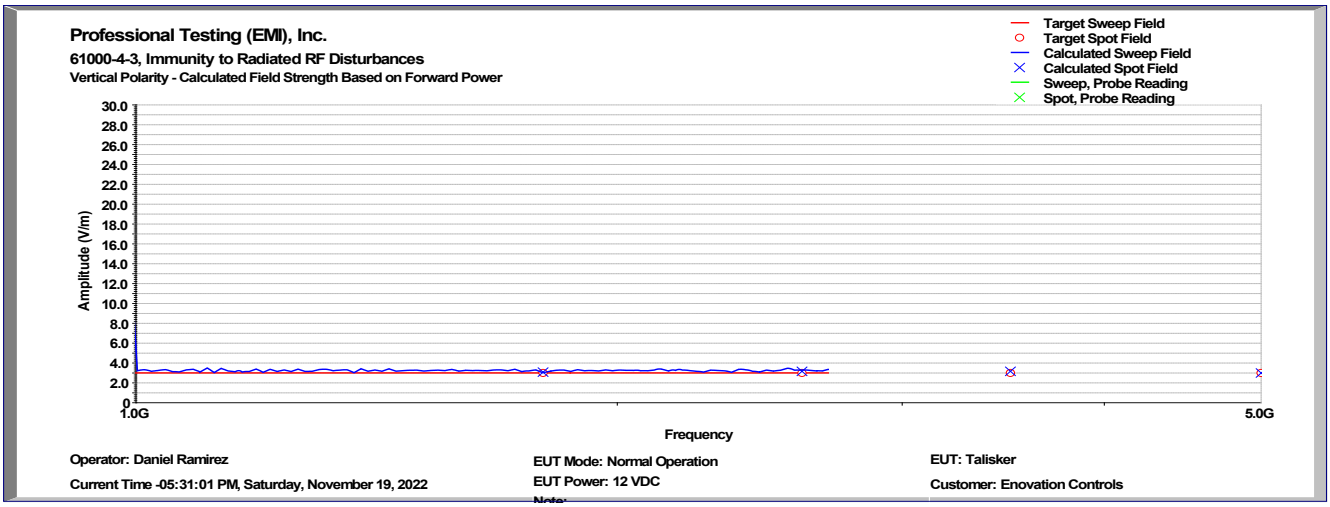
Radiated Immunity Test Data – 1 GHz to 2.7 GHz



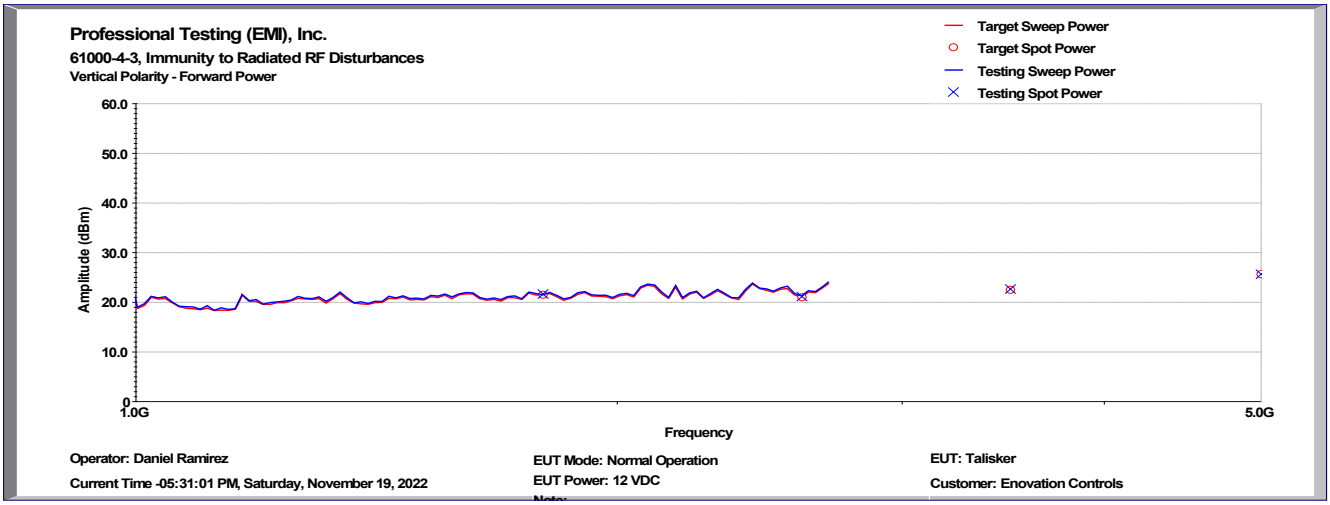
Horizontal Antenna Polarity Field Strength Plot



Horizontal Antenna Polarity Forward Power

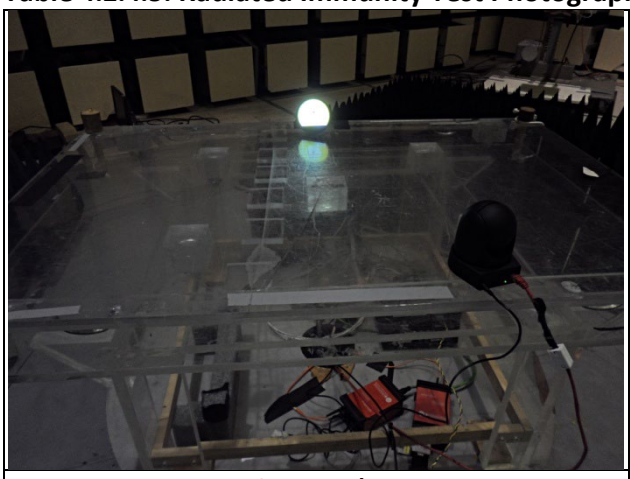
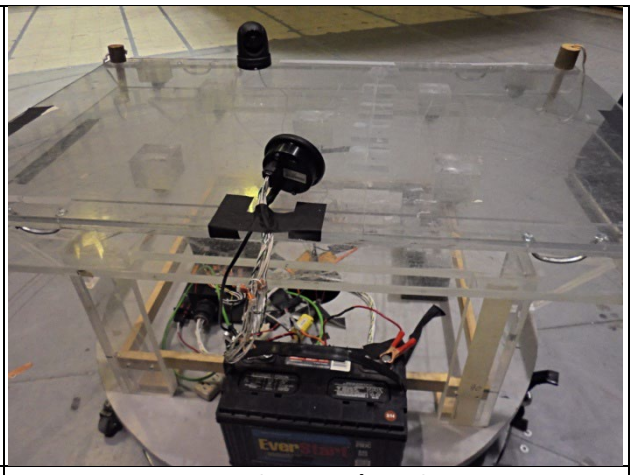
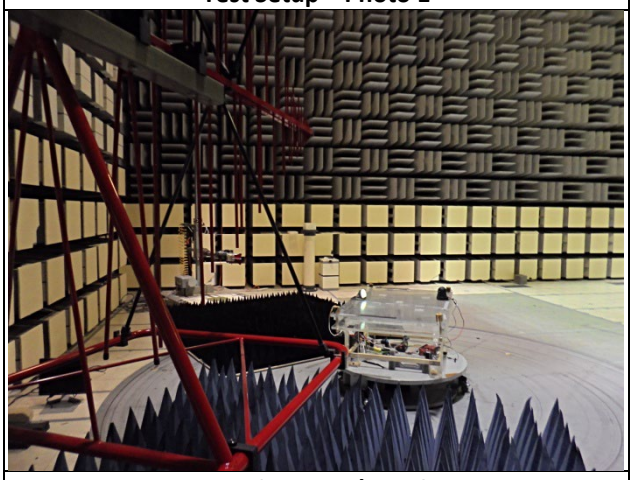
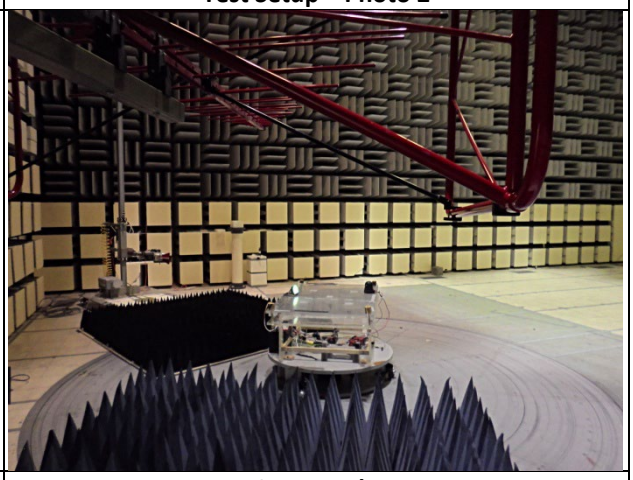
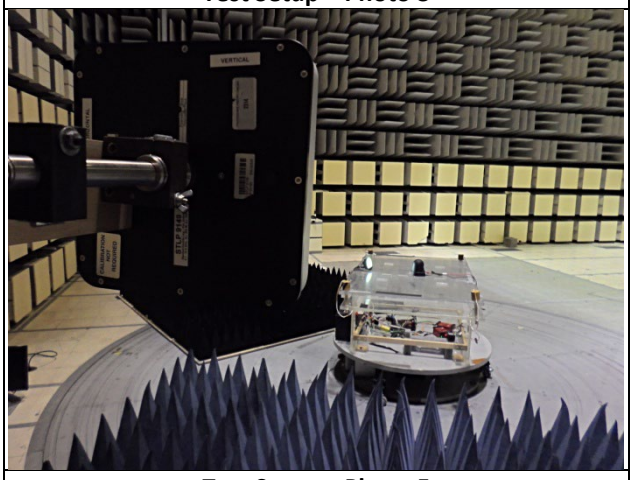
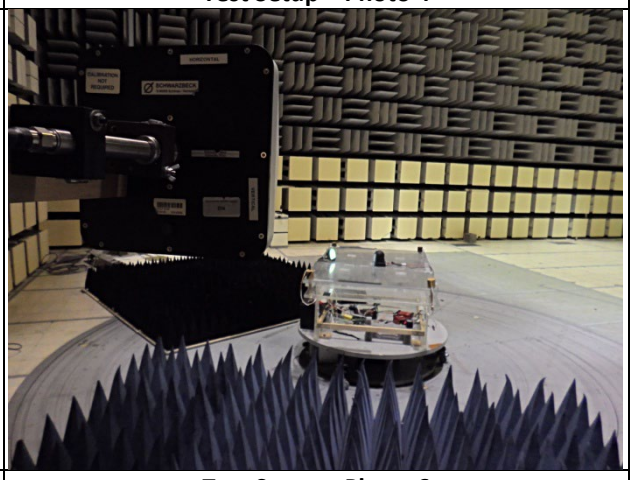


Vertical Antenna Polarity Field Strength Plot



Vertical Antenna Polarity Forward Power

Table 4.2.4.5: Radiated Immunity Test Photographs

	
Test Setup – Photo 1	**Test Setup – Photo 2**
	
Test Setup – Photo 3	**Test Setup – Photo 4**
	
Test Setup – Photo 5	**Test Setup – Photo 6**

4.3 Electrical Fast Transient/Burst Immunity Testing

4.3.1 Test Procedures

Electrical fast transient/burst immunity testing was performed on the EUT using the procedures of IEC 61000-4-4. The EUT was placed in the approximate center of the GRP and was powered and operated in a normal configuration. The EUT was observed for any indications of erratic operation. The capacitive clamp was used to apply transients to I/O lines, while transients were applied to any power leads through the use of the burst generators back-filters. For each discharge sequence, the duration was one minute with a one-minute pause between sequences.

The EUT was subjected to 0.5 kV, 1 kV, and 2 kV transients to DC power input leads and 0.5 kV and 1 kV transients to any interconnecting cables greater than 3 meters in length. The transient/burst pulse was performed with a 5 kHz repetition rate. Both positive and negative polarity transients were applied. A diagram showing the test setup are given as Figure 4.3.1.1.

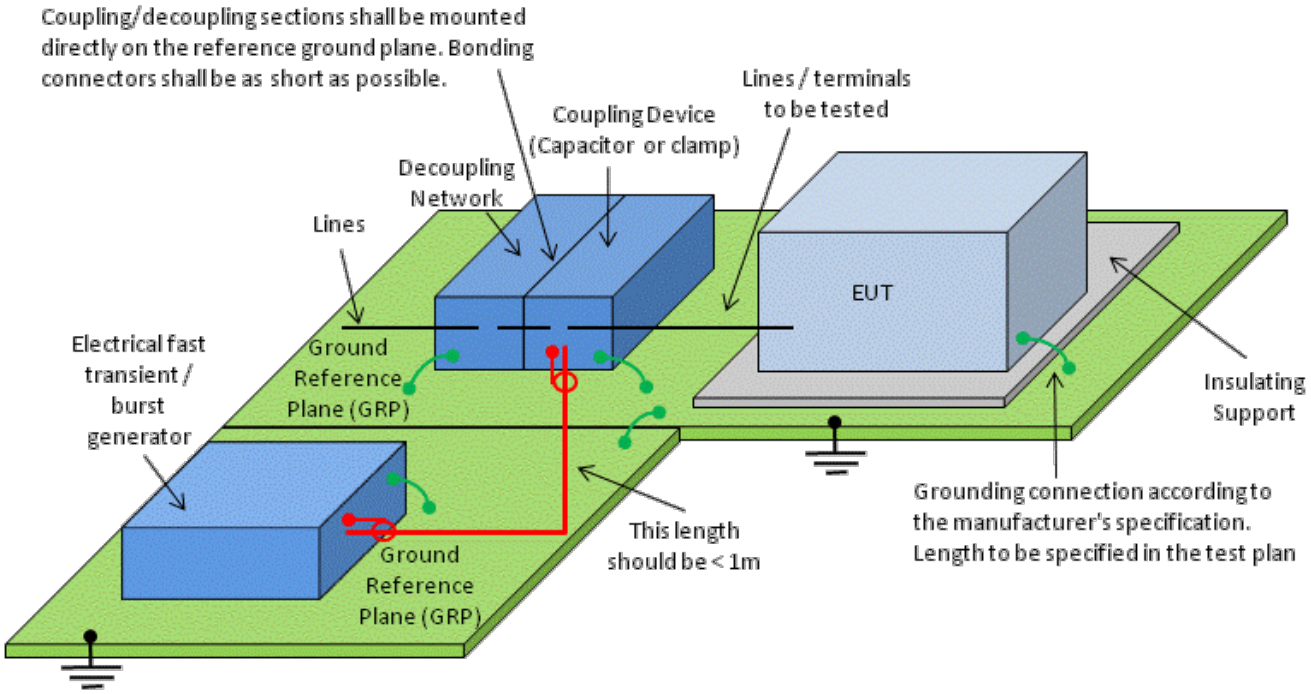


Figure 4.3.1.1: Electrical Fast Transient/Burst Immunity Test Setup

4.3.2 Performance Criteria

During the performance of electrical fast transient/burst immunity testing, only performance criterion A and performance criterion B were allowed. Performance criterion C failures were disallowed.

4.3.3 Test Results

The EUT was subjected to electrical fast transient/burst immunity testing on November 20, 2022. No adverse indications were noted during the performance of the test. Therefore, the EUT met performance criterion A.

Table 4.3.3.1: Electrical Fast Transient/Burst Immunity Test Log

Nemko USA, Inc.			
Test Method:	**IEC 61000-4-4, Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test**		
In accordance with:	**BS EN 61326-1:2013 – Electrical equipment for measurement, control and laboratory use – EMC requirements, Part 1: General requirements (Basic Electromagnetic Environment)**		
Section:	**Table 2 – Immunity test requirements for equipment intended to be used in an Industrial Electromagnetic Environment**		
Test Date(s):	**11/20/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician(s):**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Electrical Fast Transient/Burst Immunity Test Log Sheet							
Temperature:	**19.1**	**°C**	**Humidity**	**40%**	**RH**	**Barometric Pressure:**	**29.5** **inHg**
Test Location:	**Site 45 Immunity Laboratory**						
Test Status:	**Testing Complete, EUT Passed**						

Table 4.3.3.2: Electrical Fast Transient/Burst Immunity Test Equipment

Asset #	Manufacturer	Model	Equipment Nomenclature	Serial #	Calibration Due Date
1150	Haefely	PEFT 093 584.1	EFT Tester (used with Asset #1289)	083 383.11	7/11/2023
1289	EMCO	4610	Field Site Source	9002-1020	N/A
1302	Haefely	093 596.1	Clamp, Capacitive, EFT CISPR	083 369-19	11/29/2023

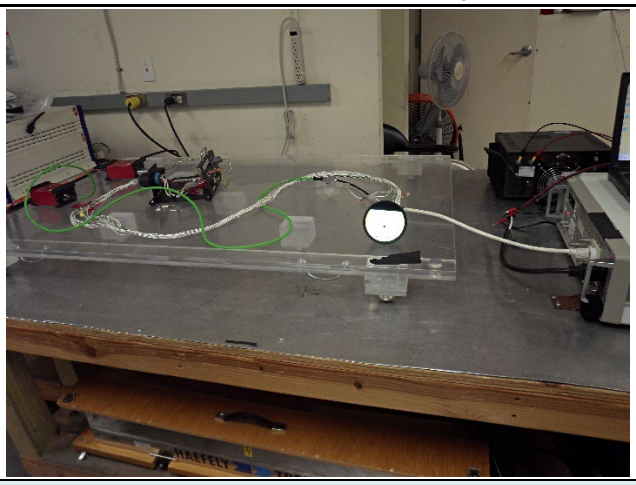
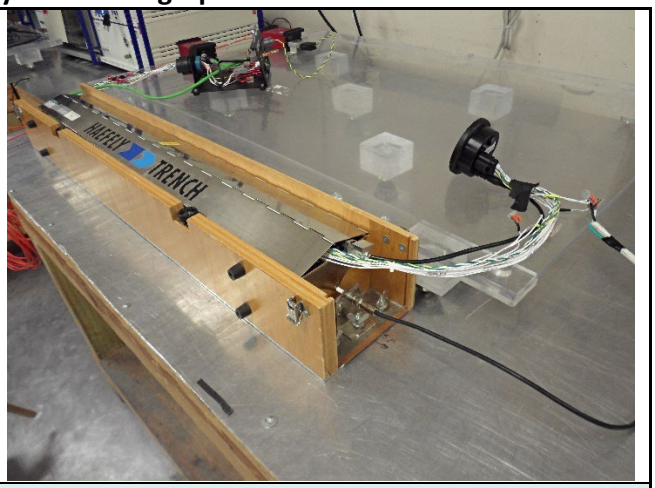
Table 4.3.3.3: Electrical Fast Transient/Burst Immunity Test Results – DC Power Ports

Part 2 - d.c. power ports (excluding equipment marketed with an a.c./d.c. power converter)									
EUT Mode of Operation:	**Normal Operation**								
EUT Line Voltage:	**12**	**VDC**							
Line Tested	**Test Level & Polarity**	**Pulse Repetition Frequency**	**Burst Duration**	**Burst Period**	**Test Duration**	**Coupling Method**	**Perfomance Criteria Required**	**Perfomance Criteria Achieved**	**Test Result**
L1 (Hot Lead)	0.5kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	0.5kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L1 (Hot Lead)	0.5kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	0.5kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L1 (Hot Lead)	1.0kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	1.0kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L1 (Hot Lead)	1.0kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	1.0kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L1 (Hot Lead)	2.0kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	2.0kV Positive	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L1 (Hot Lead)	2.0kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass
L2 (Return Lead)	2.0kV Negative	5 kHz	15 mS	300 mS	1 minute	CDN	B	A	Pass

Table 4.4.3.3: Electrical Fast Transient/Burst Immunity Test Results – I/O

Part 3 - Immunity, I/O Cables, Signal Cables, Telecommunications Cables, etc.									
EUT Mode of Operation:	**Normal Operation**								
EUT Line Voltage:	**12 VDC**				**EUT Power Frequency:**	**-**	**N/A**		
Line Tested	**Test Level & Polarity**	**Pulse Repetition Frequency**	**Burst Duration**	**Burst Period**	**Test Duration**	**Coupling Method**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Result**
Harness	0.5kV Positive	5 kHz	15 mS	300 mS	1 minute	Capacitive Clamp	B	A	Pass
	0.5kV Negative	5 kHz	15 mS	300 mS	1 minute	Capacitive Clamp	B	A	Pass
	1.0kV Positive	5 kHz	15 mS	300 mS	1 minute	Capacitive Clamp	B	A	Pass
	1.0kV Negative	5 kHz	15 mS	300 mS	1 minute	Capacitive Clamp	B	A	Pass

Table 4.3.3.4: Electrical Fast Transient/Burst Immunity Test Photographs

	
Test Setup – DC Mains	**Test Setup – DC Mains**

4.4 Surge Immunity

4.4.1 Test Procedures

Surge immunity testing was performed on the EUT using the procedures of IEC 61000-4-5. The EUT was placed in the approximate center of the GRP and was powered and operated in a normal configuration. EUT operation was observed for any indications of erratic operation. Transients were applied to DC leads through the use of the surge generator's back-filters. The surge was applied line-to-earth up to 2 kV and line-to-line up to 1 kV on any DC input leads. A series of five positive and five negative surges were applied, with a one-minute interval between surges. Diagrams showing the test setup are given as Figure 4.4.1.1 and Figure 4.4.1.2.

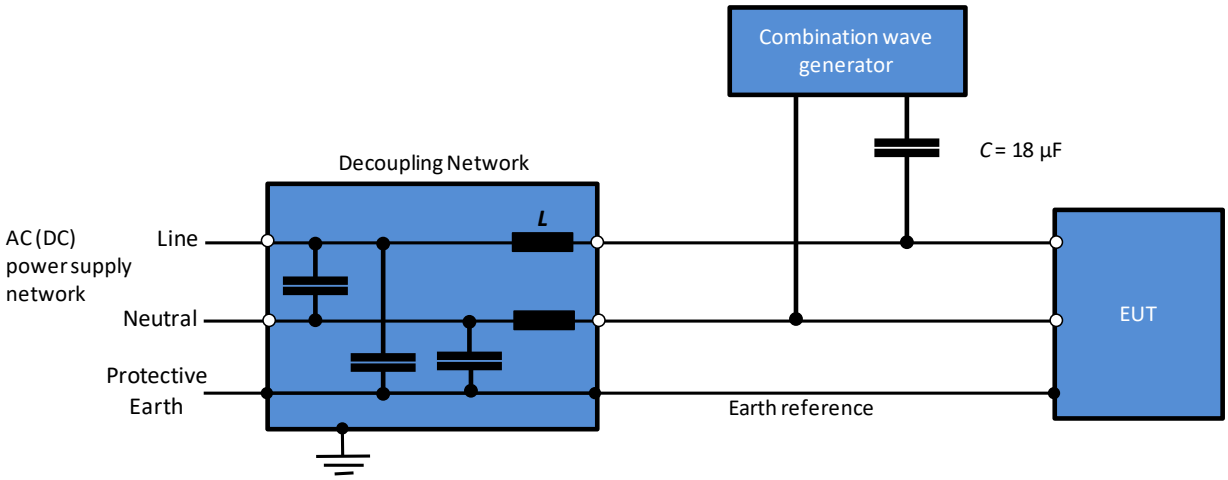


Figure 4.4.1.1: Surge Immunity Test Setup
Capacitive Coupling on AC/DC lines; Line-to-line Coupling (IEC 61000-4-5, Figure 7)

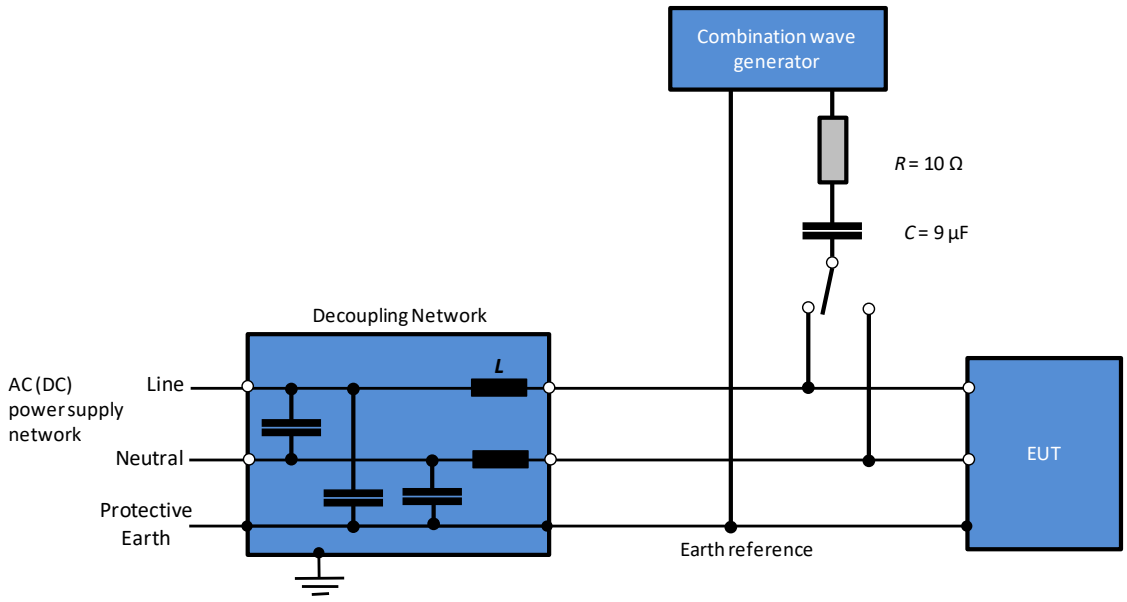


Figure 4.4.1.2: Surge Immunity Test Setup
Capacitive Coupling on AC/DC lines; Line-to-ground Coupling (IEC 61000-4-5, Figure 8)

4.4.2 Performance Criteria

During the performance of surge immunity testing, only performance criterion A and performance criterion B were allowed. Performance criterion C failures were disallowed.

4.4.3 Test Results

The EUT was subjected to surge immunity testing on November 20, 2022. No adverse indications were noted during the performance of the test. Therefore, the EUT met performance criterion A.

Table 4.4.3.1: Surge Immunity Test Log

Nemko USA, Inc.			
Test Method:	**IEC 61000-4-5, Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test**		
In accordance with:	**BS EN 61326-1:2013 – Electrical equipment for measurement, control and laboratory use – EMC requirements, Part 1: General requirements (Basic Electromagnetic Environment)**		
Section:	**Table 2 – Immunity test requirements for equipment intended to be used in an Industrial Electromagnetic Environment**		
Test Date(s):	**11/20/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician:**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Surge Immunity Test Log Sheet							
Temperature:	**19.1 °C**	**Humidity**	**40% RH**	**Barometric Pressure:**	**29.5 inHg**		
Test Location:	**Site 45 Immunity Laboratory**						
Test Status:	**Testing Complete, EUT Passed**						

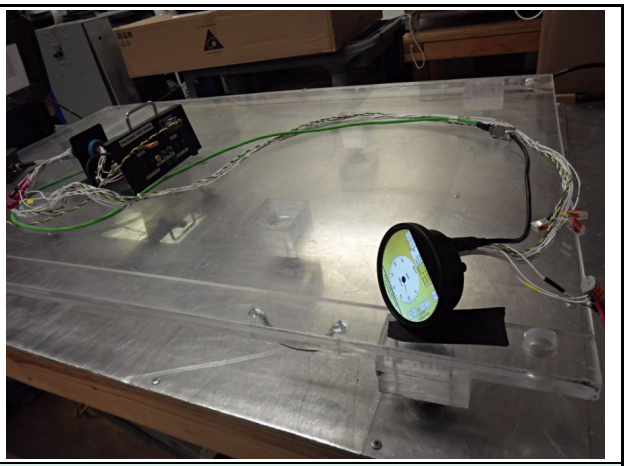
Table 4.4.3.2: Surge Immunity Test Equipment

Test Software Version:	**WinFeater Version 1.40, Haefely Technology**				
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial #**	**Calibration Due Date**
579	KeyTek	CE-50	Surge Generator	543932	5/12/2023
403	KeyTek	CE-50	Surge Source and Mains Coupler/Decoupler	9604190	5/12/2023

Table 4.4.3.3: Surge Immunity Test Results – DC Power Ports

Part 2 – D.C. Power Ports (excluding equipment marketed with an AC/DC power converter)								
EUT Mode of Operation:			**Normal Operation**					
EUT Line Voltage:			**12 VDC**		**EUT Power Frequency:**		**N/A**	
Coupling Mode	**Test Level**	**Surge Pulse Polarity**	**Generator Source Impedance**	**# of Surges Applied**	**Coupling Method**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Result**
L1-PE	0.5kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L1-PE	0.5kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	0.5kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	0.5kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L1-PE	1.0kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L1-PE	1.0kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	1.0kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	1.0kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L1-PE	2.0kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L1-PE	2.0kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	2.0kV	Positive	12 Ω	5	per Figure 8	B	A	Pass
L2-PE	2.0kV	Negative	12 Ω	5	per Figure 8	B	A	Pass
L1-L2	0.5kV	Positive	2 Ω	5	per Figure 7	B	A	Pass
L1-L2	0.5kV	Negative	2 Ω	5	per Figure 7	B	A	Pass
L1-L2	1.0kV	Positive	2 Ω	5	per Figure 7	B	A	Pass
L1-L2	1.0kV	Negative	2 Ω	5	per Figure 7	B	A	Pass

Table 4.4.3.4: Surge Immunity Test Photographs

	
Test Setup	**EUT Test Setup**

4.5 Conducted Immunity

4.5.1 Test Procedures

Conducted immunity testing was performed using the procedures of IEC 61000-4-6. The EUT was placed in the approximate center and 10 cm above the ground reference plane (GRP) and was powered and operated in a normal configuration. Injection to the DC power leads was performed with an M2 injection network. Testing of any signal input leads was performed via current clamp on the leads. Testing was performed using 3 Vrms and 10 Vrms (for spot frequencies) with 400 Hz at 80% amplitude modulation injection over the frequency range 150 kHz to 80 MHz. Diagrams showing the test setup are given as Figure 4.5.1.1 and Figure 4.5.1.2.

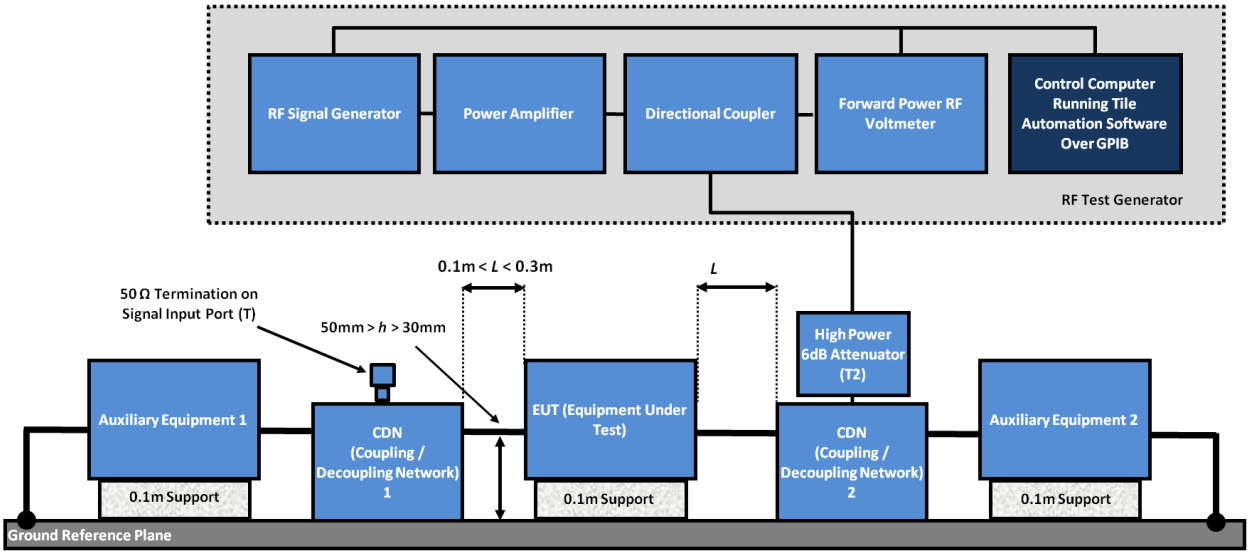


Figure 4.5.1.1: Conducted Immunity CDN (Coupling Decoupling Networks) Test Setup

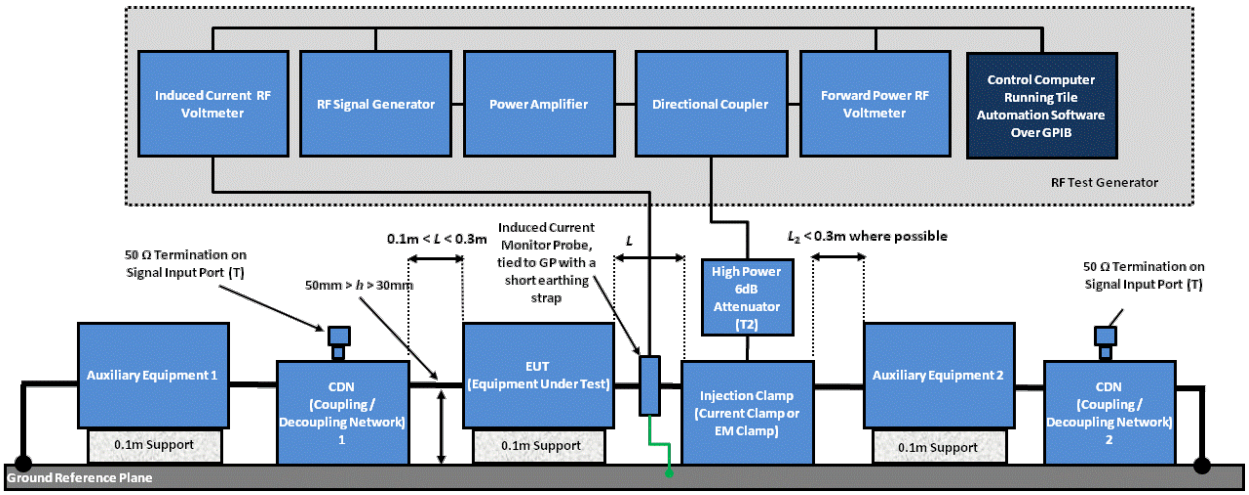


Figure 4.5.1.2: Conducted Immunity Test Setup
Injection Clamp (EM Clamp or Current Clamp) Tests

4.5.2 Performance Criteria

During performance of conducted radio frequency (RF) immunity testing, only performance criterion A was allowed. Performance criterion B or performance criterion C failures were disallowed.

4.5.3 Test Results

The EUT was subjected to the conducted RF immunity testing from November 19 to 20, 2022. No adverse indications were noted during the performance of the test. Therefore, the EUT met performance criterion A.

Table 4.5.3.1: Conducted Immunity Test Log

Nemko USA, Inc.			
Test Method:	**IEC 61000-4-6, Electromagnetic compatibility (EMC) - Testing and measurement techniques. Immunity to conducted disturbances by radio-frequency fields**		
In accordance with:	**BS EN 60945: 2002 Maritime navigation and radio communication equipment and systems - General Requirements - Methods of testing and required test results**		
Section:	**Table 6**		
Test Date(s):	**11/19-20/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician:**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Equip. Under Test:	**Talisker**	**Witness:**	**John Ruckdaschel**

Conducted Immunity Test Log Sheet							
Temperature:	**20**	**°C**	**Humidity**	**39%**	**RH**	**Barometric Pressure:**	**29.5**	**inHg**
Test Location:	**Site 45 Immunity Laboratory**							
Test Status:	**Testing Complete, EUT Passed**							

Table 4.5.3.2: Conducted Immunity Test Equipment

Test Software Version:			Tile Version 3.4.K.15, October 13, 2006, 11:21:00 AM		
Test Profile Used:			CI_2012_R4_CDN-010516.TIL and/or CI_2012_R4_CC-010516.TIL		
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
2211	Fluke	6060B	Synthesized RF Signal Generator, 10kHz - 1050MHz	5400211	12/6/2023
308	ENI	440LA	Amplifier, 35W, .15-300MHz, 45dB	104	N/A
1305	HD Com Corp	HDC5091-10	Coupler, Directional	31605-6	N/A
1043	JFW	50FH-006-300	Attenuator, N, 6dB 300W	None	2/23/2024
1132	AilTech	91550-1M	Probe, Current, 10kHz-100MHz	1856	2/28/2023
1366	HP	437B	Power Meter	3125U13078	11/27/2022
1710	Agilent	34401A	6.5 Digit Multimeter	US36105982	2/17/2024
1843	HP	8482A	Power Sensor, 50Ω 100kHz-4.2GHz	US37291158	5/10/2023
1409	FCC	801-M2-16A	CDN, 150kHz-230MHz, 16A	1019	10/13/2024
1359	Schaffner	CIC-8101	Clamp, EM Injection	238	N/A

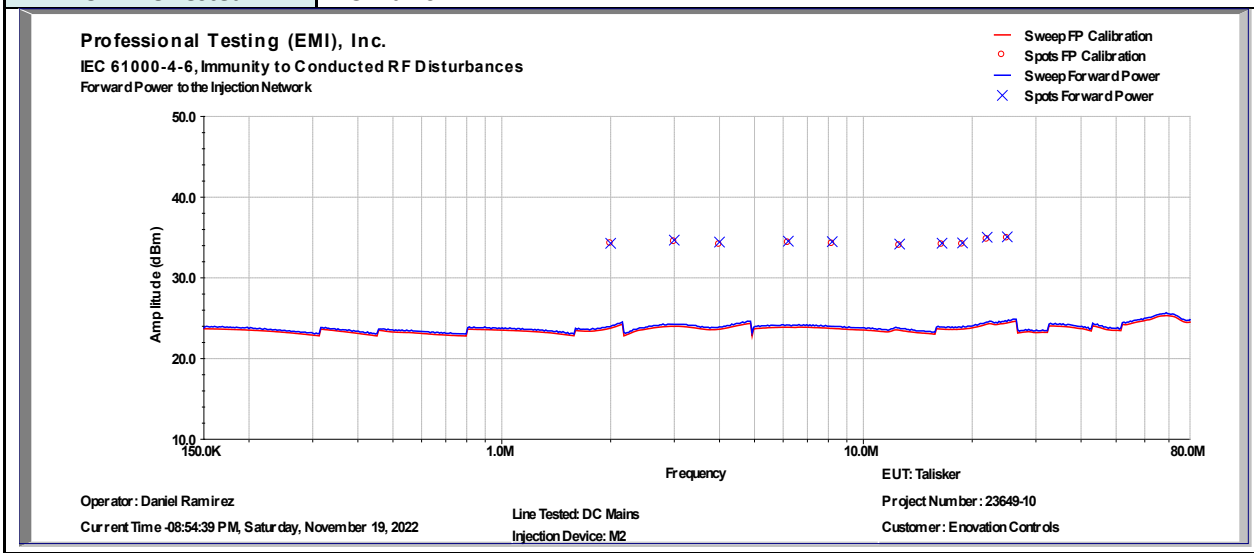
Table 4.5.3.3: Conducted Immunity Test Results – DC Mains

EUT Mode of Operation:	**Normal Operation**						
EUT Line Tested:	**DC Mains**						
Injection Method Used:	**M2 Network**						
EUT Line Voltage:	**12 VDC**		**EUT Power Frequency:**		**- N/A**		
Frequency Range (MHz)	**Test Level (Volts rms)**	**Modulation Parameters**	**Dwell Time**	**Frequency Step Size**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Results**
0.01 - 0.15	Not Applicable						
0.15 - 6.765	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
6.765 - 6.795	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
6.795 - 13.553	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
13.553 - 13.567	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
13.567 - 26.957	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
26.957 - 27.283	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
27.283 - 40.66	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
40.66 - 40.7	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
40.7 - 47	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
47 - 68	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
68 - 80	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
80 - 230	Not Applicable						

Conducted Immunity Spot Frequencies									
EUT - Specific Spot Frequencies					**Standard Specific Spot Frequencies**				
Frequency (MHz)	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**
					2.000	12.600			
					3.000	16.500			
					4.000	18.800			
					6.200	22.000			
					8.200	25.000			

Table 4.5.3.4: Conducted Immunity Test Results – DC Mains, Plot

EUT Line Tested:	DC Mains



Forward Power to the Coupling Device – 150 kHz to 80 MHz

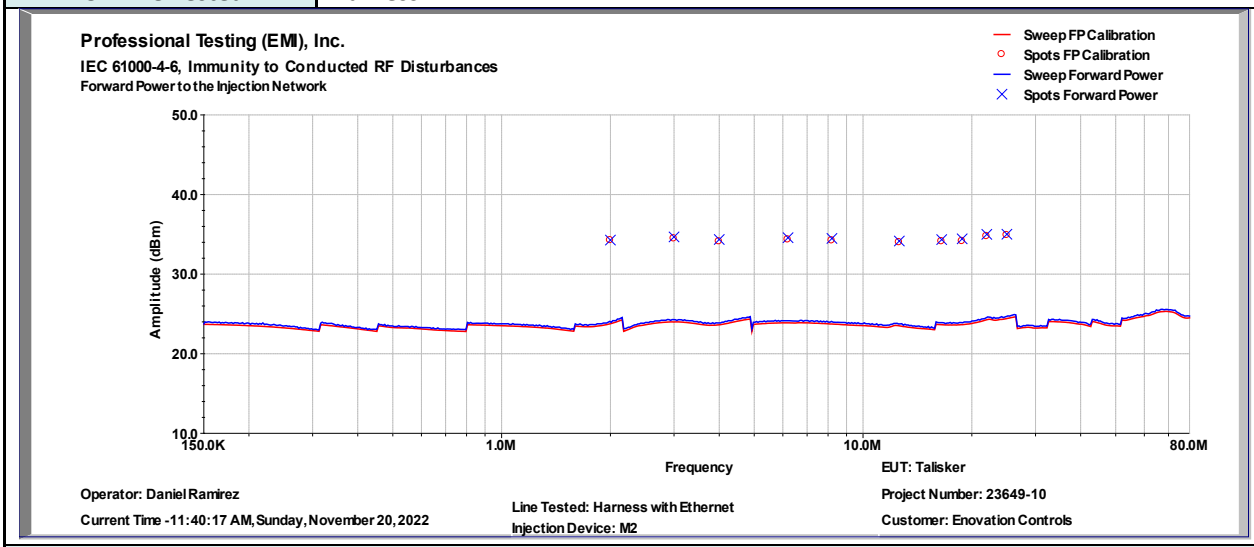
Table 4.5.3.5: Conducted Immunity Test Results – Harness

EUT Mode of Operation:	**Normal Operation**						
EUT Line Tested:	**Harness**						
Injection Method Used:	**Current Clamp**						
EUT Line Voltage:	**12 VDC**		**EUT Power Frequency:**	**- N/A**			
Frequency Range (MHz)	**Test Level (Volts rms)**	**Modulation Parameters**	**Dwell Time**	**Frequency Step Size**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Results**
0.01 - 0.15	Not Applicable						
0.15 - 80	Swept freq's 3Vrms, Spot freq's 10Vrms	AM, 400Hz ±10%, depth 80% ±10%	Step Freq's: 2 S, Spot Freq's: 60 S	1% fo	A	A	Pass
80 - 230	Not Applicable						

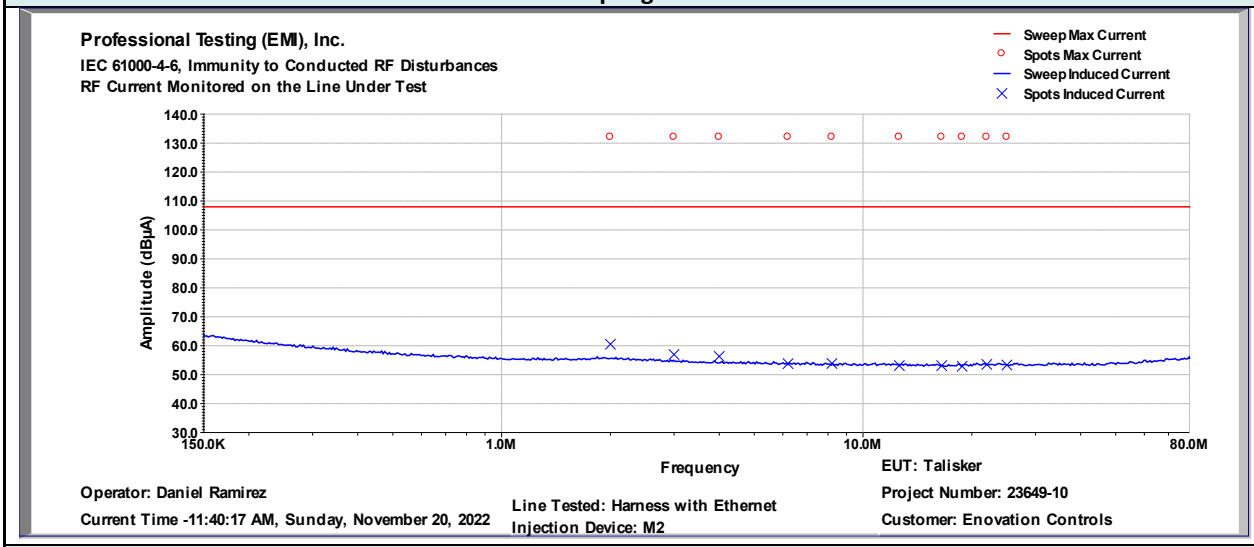
Conducted Immunity Spot Frequencies									
EUT - Specific Spot Frequencies					**Standard Specific Spot Frequencies**				
Frequency (MHz)	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**	**Frequency (MHz)**
					2.000	12.600			
					3.000	16.500			
					4.000	18.800			
					6.200	22.000			
					8.200	25.000			

Table 4.5.3.6: Conducted Immunity Test Results – Harness, Plots

EUT Line Tested:	Harness

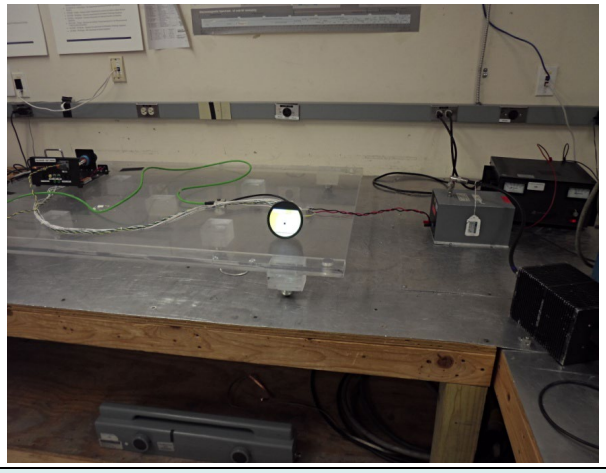
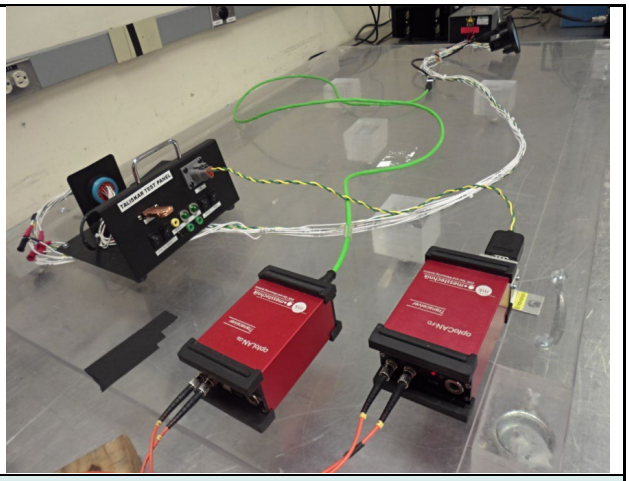
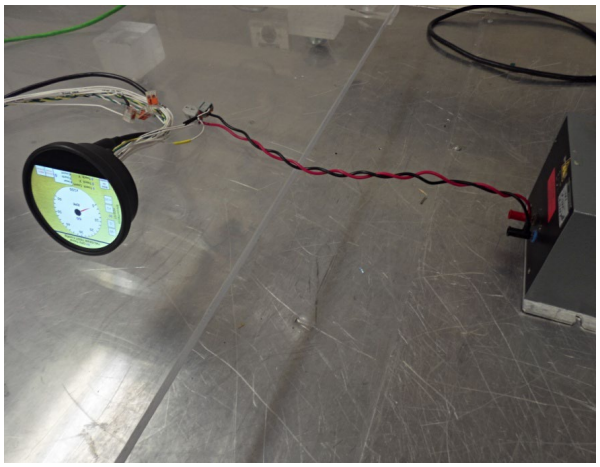
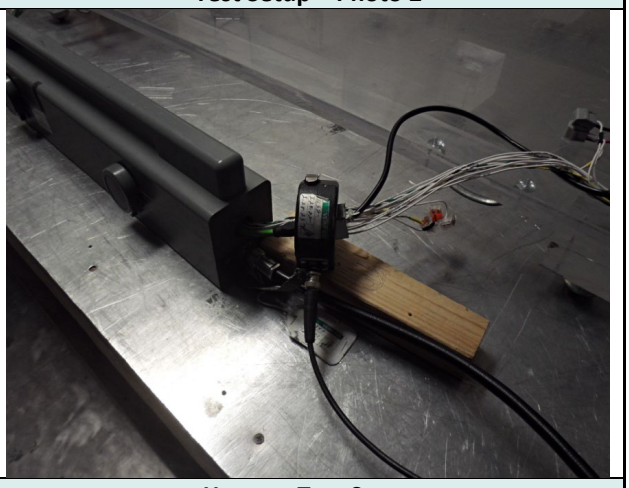


Forward Power to the Coupling Device – 150 kHz to 80 MHz



RF Current Measured on the Line Under Test – 150 kHz to 80 MHz

Table 4.5.3.7: Conducted Immunity Test Photographs

	
Test Setup – Photo 1	**Test Setup – Photo 2**
	
DC Mains Test Setup	**Harness Test Setup**

4.6 Power Frequency Magnetic Field Immunity

4.6.1 Test Procedures

Power frequency magnetic field immunity testing was performed using the procedures of IEC 61000-4-8. The EUT was placed in the approximate center and 10 cm above the ground reference plane (GRP) and was powered and operated in a normal configuration. The magnetic field was increased to 30 A/m and was applied to three axes of the EUT. The field was maintained for a period of approximately 5 minutes for each of the three axes, while the EUT was monitored for any indication of erratic operation. A diagram showing the test setup is given as Figure 4.6.1.1.

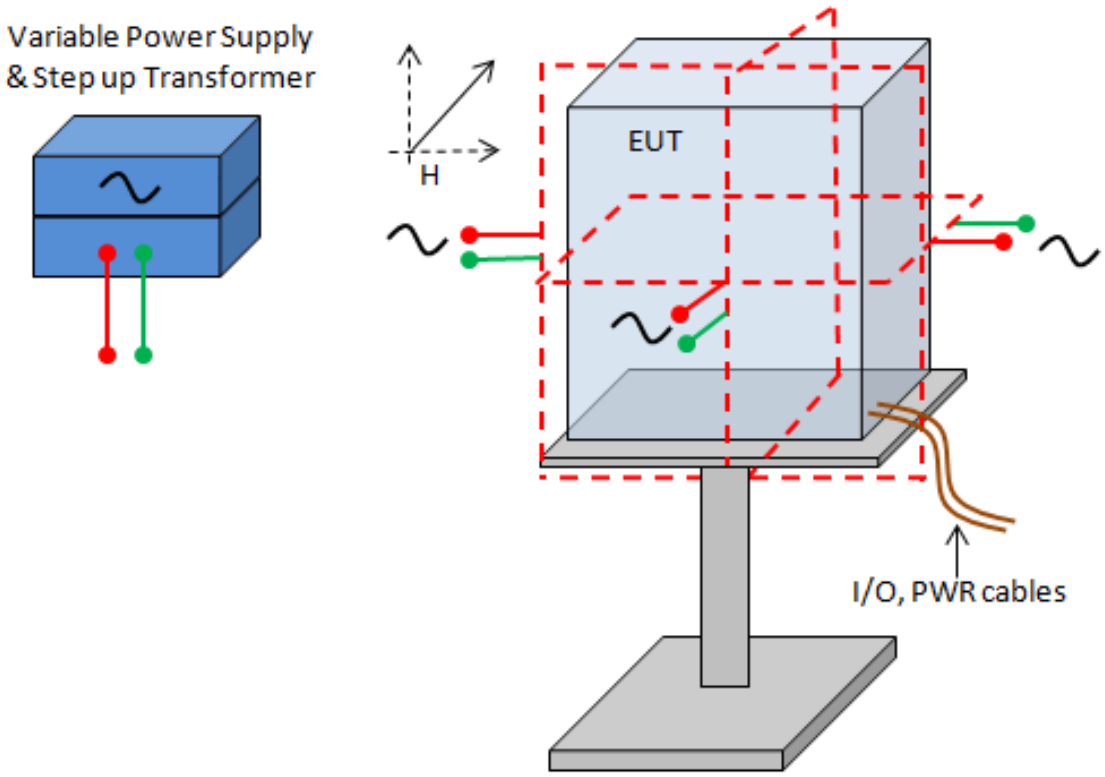


Figure 4.6.1.1: Power Frequency Magnetic Field Test Setup

4.6.2 Performance Criteria

During performance of magnetic field immunity testing, only performance criterion A was allowed. Performance criterion B or performance criterion C failures were disallowed.

4.6.3 Test Results

The EUT was subjected to power frequency magnetic field immunity testing on November 20, 2022. No adverse indications were noted during the performance of the test. Therefore, the EUT met performance criterion A.

Table 4.6.3.1: Power Frequency Magnetic Field Immunity Test Log

Nemko USA, Inc.			
Test Method:	**IEC 61000-4-8, Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test**		
In accordance with:	**BS EN 61326-1:2013 - Electrical equipment for measurement, control and laboratory use - EMC requirements, Part 1: General requirements (Basic Electromagnetic Environment)**		
Section:	**Table 2 – Immunity test requirements for equipment intended to be used in an Industrial Electromagnetic Environment**		
Test Date(s):	**11/20/2022**	**EUT Serial #:**	**None**
Customer:	**Enovation Controls**	**EUT Part #:**	**None**
Project Number:	**23649-10**	**Test Technician:**	**Daniel Ramirez**
Purchase Order #:	**7673486**	**Supervisor:**	**Larry Finn**
Test Date(s):	**Talisker**	**EUT Serial #:**	**John Ruchdaschel**

Power Frequency Magnetic Field Immunity Test Log Sheet							
Temperature:	**19**	**°C**	**Humidity**	**40%**	**RH**	**Barometric Pressure:**	**29.5** **inHg**
Test Location:	**Site 45 Immunity Laboratory**						
Test Status:	**Testing Complete, EUT Passed**						

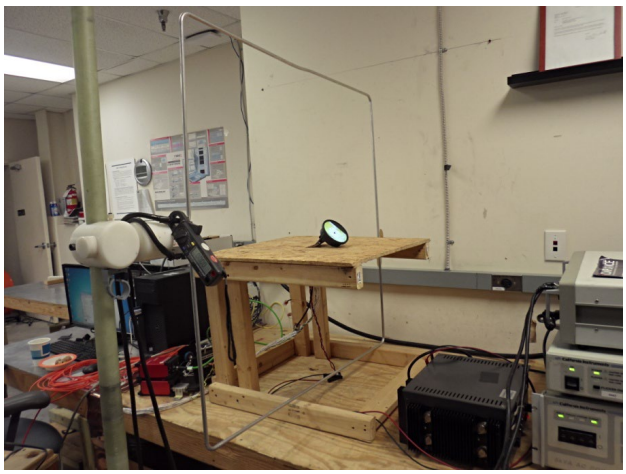
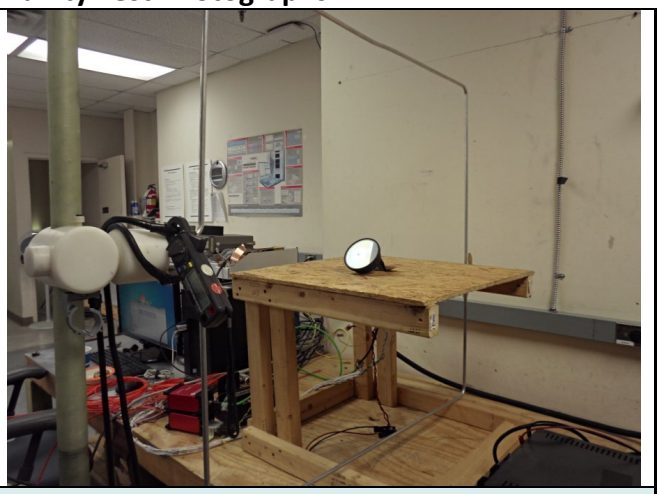
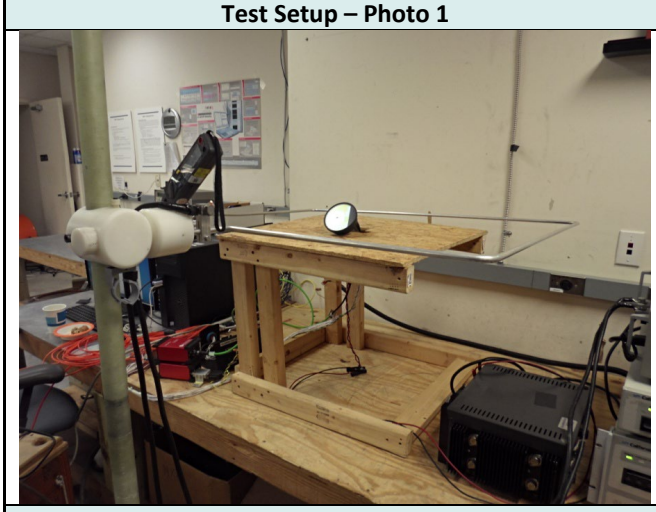
Table 4.6.3.2: Power Frequency Magnetic Field Immunity Test Equipment

Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1096	Extech	380941	Clamp, AC/DC Current	5060215	12/29/2022
1711	California Instruments	5001i	Power Supply, AC	HK53454	4/30/2023
1501	Haefely	MAG 100	Magnetic Tester	081896-07	N/A
1502	Haefely	MAG 100	Magnetic Tester w/tripod	081896-07	N/A
355	Superior	3PN136B	XFMR, SE Powerstat 240V Variable	None	N/A

Table 4.6.3.3: Power Frequency Magnetic Field Immunity Test Results

EUT Mode of Operation:	**Normal Operation**					
Part 1 – Continuous Field Test						
Axis Tested	**Test Level (A/m (r.m.s.))**	**Test Frequency (Hz)**	**Duration of Applied Field**	**Performance Criteria Required**	**Performance Criteria Achieved**	**Test Result**
X	30	50	5 Minutes	A	A	Pass
Y	30	50	5 Minutes	A	A	Pass
Z	30	50	5 Minutes	A	A	Pass
X	30	60	5 Minutes	A	A	Pass
Y	30	60	5 Minutes	A	A	Pass
Z	30	60	5 Minutes	A	A	Pass

Table 4.6.3.4: Power Frequency Magnetic Field Immunity Test Photographs

	
Test Setup – Photo 1	**Test Setup – Photo 2**
	
Test Setup – Photo 3	**Test Setup – Photo 4**

Appendix A: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with ANAB policy. Since Nemko USA, Inc operates in accordance with ANAB Document Number AR 2250: 2021/06/16, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by ANAB Document Number AR 2250.

Rationale and Summary of Expanded Uncertainty

Each piece of instrumentation at Nemko USA, Inc. that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of Nemko USA, Inc. measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.82
Marine Conducted Emissions	9 kHz to 30 MHz	N/A	2.82
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	3.48
Radiated Emissions	30 to 1,000 MHz	10 m	3.88
	1 to 6 GHz	3 m	4.00
	6 to 18 GHz	3 m	4.31
	18 to 26 GHz	3 m	4.91
	26 to 40 GHz	3 m	TBD

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Appendix B: Accreditations

Laboratory Accreditation

ANAB accreditation to ISO/IEC 17025: 2017 with the following scope of accreditation: ANAB Certification # AT-3165.01.

- EN 60945 (2002)
- IEC 61326-1, Ed. 3.0 (2020-10)
- EN 55032 (2015) +A11 (2020)
- CISPR 16-2-3 (2010) +A1 (2010) +A2 (2014)
- IEC 61000-4-3, Ed. 3.0 (2006-02) + A1 (2007) + A2 (2010)
- IEC 61000-4-4, Ed. 3.0 (2012-04)
- IEC 61000 4-5
- IEC 61000-4-6, Ed. 4.0 (2013)
- IEC 61000-4-8 (2009)

End of Report

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