NTS Labs, LLC
MIL-STD-461G Test Report for the Ethernet Switch Box

Prepared For
Amphenol Aerospace | 40-60 Delaware Ave. | Sidney, NY 13838

Prepared By
NTS Labs, LLC | 36 Gilbert Street South | Tinton Falls, NJ 07701 | 732-936-0800 | www.nts.com

Kerrin Spinney	Jeff Maselli	Mark Betts
Senior Technical Writer	EMI Project Engineer	Quality Management Representative

Distribution Statement D: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Critical Technology: January 5, 2011. Other requests shall be referred to NAVSEA.
WARNING: This document contains technical data whose export is restricted by Arms Export Control Act (Title 22, U.S.C., Sec. 2751, et seq.) or the Export Administration Act of 1979, as amended, Title 50, U.S.C., App. 2401, et seq.). Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with the provisions of DoD Directive 5230.25.
Destruction Notice. For unclassified, limited documents, destroy by any method that will prevent disclosure of contents or reconstruction of the document.
No public releases or public displays of any kind are authorized without the expressed written consent of COMNAVSEASYSCOM (SEA OOD) or higher authority.

This report and the information contained herein represent the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. NTS Labs, LLC makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS Labs, LLC of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS Labs, LLC.

Revision History

Rev.	Description	Issue Date
0	Initial Release	December 8, 2022

Table of Contents

1.0 Introduction **5**
1.1 Purpose 5
1.2 Acronyms 5
1.3 Definitions 6

2.0 References **7**

3.0 Equipment Under Test **8**
3.1 Description 8
3.2 EUT System Setup 8
3.3 EUT Operation and Monitoring 8
3.4 Pass/Fail Criteria 8
3.5 EMI Suppression Devices 9
3.6 EUT Bonding / Grounding Requirements 9
3.7 EUT Cabling 9
3.8 Non-Developmental Items (NDI) and Government Furnished Equipment (GFE) 9
3.9 Security Classification 9

4.0 Test Requirements **10**
4.1 Test Facility Location 10
4.2 Test Resources 10
4.2.1 Test Equipment 10
4.2.2 Test Automation and Data Collection Software 10
4.3 General Test Requirements 10
4.3.1 Test Facility 10
4.3.2 Ground Plane 10
4.3.3 Power Source Impedance 11
4.4 Emissions Testing 11
4.5 Susceptibility Testing 12

5.0 Test Methods, Procedures and Test Results **13**
5.1 CS114, Conducted Susceptibility: Bulk Cable Injection, 10 kHz to 200 MHz 14
5.1.1 CS114 Purpose 14
5.1.2 CS114 Limits 14
5.1.3 CS114 Current Injection Probes 14
5.1.4 CS114 EUT Test Setup 15
5.1.5 CS114 Calibration and Verification 15
5.1.6 CS114 Test Procedure 17
5.1.7 CS114 Test Results, Conclusions and Recommendations 19
5.1.8 CS114 Test Datasheets and Log Sheet 19
5.1.9 CS114 Photographs 21
5.1.10 CS114 Data 23
5.1.11 CS114 Test Equipment List 32

Appendix A: Test Software Description **33**
ETS-Lindgren Totally Integrated Laboratory Environment (TILE!) 34

Appendix B: LISN Impedance **37**

Appendix C: Correction Factors **38**

List of Figures

Figure 3.2-1: Ethernet Switch Box Setup Overview 8
Figure 4.3-2: LISN Impedance Example 11
Figure 5.1-1: CS114 Calibration Limit 14
Figure 5.1-2: CS114 Maximum Insertion Loss for Injection Probes 15
Figure 5.1-3: CS114 Calibration Setup 16
Figure 5.1-4: CS114 Verification Setup 17
Figure 5.1-5: CS114 Bulk Cable Injection Evaluation 18

List of Tables

Table 2.0-1: Government Specifications, Standards, and Handbooks 7
Table 2.0-2: Other Documents, Drawings, and Publications 7
Table 3.1-1: EUT Information 8
Table 3.1-2: EUT Power Input Information 8
Table 4.4-1: Bandwidth and Measurement Times 11
Table 4.5-1: Susceptibility Scanning 12
Table 5.0-1: Test Methods and Test Results Summary 13
Table 5.1-1: CS114, Conducted Susceptibility Test Equipment List 32
Table A-1: Test Automation and Data Collection Software Revision 33

1.0 Introduction

1.1 Purpose

The purpose of this report is to document the procedural steps for testing and criteria for evaluating the results of the MIL-STD-461G Electromagnetic Interference (EMI) testing of the Ethernet Switch Box. The test program was conducted to determine the ability of the Ethernet Switch Box to successfully satisfy the requirements specified in Section 4.

This EMI Test Report (EMITR) is contracted by Amphenol Aerospace. It is the end user who is ultimately responsible for the compliance of the equipment installed. The contracted test facility is NTS Labs, LLC in Tinton Falls, New Jersey.

1.2 Acronyms

BIT	Built-In-Test	**EUT**	Equipment Under Test
CE	Conducted Emissions	**FCC**	Federal Communications Commission
CI	Commercial Item	**FFT**	Fast Fourier Transform
CS	Conducted Susceptibility	**FWHM**	Full Width Half Maximum
DID	Data Item Description	**GFE**	Government Furnished Equipment
DoD	Department of Defense	**ISO**	International Organization for Standardization
DSPO	Defense Standardization Program Office	**LISN**	Line Impedance Stabilization Network
E3	Electromagnetic Environmental Effects	**MAD**	Magnetic Anomaly Detectors
EMC	Electromagnetic Compatibility	**NDI**	Non-Developmental Item
EME	Electromagnetic Environment	**RE**	Radiated Emissions
EMI	Electromagnetic Interference	**RF**	Radio Frequency
EMICP	Electromagnetic Interference Control Procedures	**RMS**	Root Mean Square
EMITP	Electromagnetic Interference Test Procedures	**RS**	Radiated Susceptibility
EMITR	Electromagnetic Interference Test Report	**TEM**	Transverse Electromagnetic
ERP	Effective Radiated Power	**TPD**	Transient Protection Device
ESD	Electrostatic Discharge		

1.3 Definitions

Above Deck is an area on ships which is not considered to be "below deck" as defined herein.

Below Deck is an area on ships which is surrounded by a metallic structure, or an area which provides significant attenuation to electromagnetic radiation, such as the metal hull or superstructure of a surface ship, the pressure hull of a submarine and the screened rooms in non-metallic ships.

Decibel (dB) is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level.

Metric Units are a system of measures defined by the International System on Units based on the "Le System International d' Unites (SI)", of the International Bureau of Weights and Measures. These units are described in ASTM E3380.

Non-Developmental Item is a broad, generic term that covers material available from a wide variety of sources both industry and Government with little or no development effort required by the procuring activity.

Octave refers to the interval between one frequency and another with double its frequency.

Semi-Anechoic Chamber refers to a chamber with RF absorber lining on all walls and ceiling, but not the floor.

Safety Critical is a category of subsystems and equipment whose degraded performance could result in loss of life or loss of vehicle platform.

Test Setup Boundary includes all enclosures of the EUT and interconnecting and power leads required by MIL-STD-461G.

2.0 References

The following listed in Tables 2.0-1 and 2.0-2 form a part of this document to the extent specified herein.

Table 2.0-1: Government Specifications, Standards, and Handbooks

No	Specification	Title
1	MIL-STD-461G	*Department of Defense Interface Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment,* dated December 11, 2015
2	DI-EMCS-80200C	*Data Item Description Electromagnetic Interference Test Report (EMITR),* dated November 30, 2007

Table 2.0-2: Other Documents, Drawings, and Publications

No	Document	Title
3	ISO/IEC 17025:2017(E)	*General Requirements for the Competence of Testing and Calibration Laboratories*, dated 11/01/2017
4	NTS QPM	NTS Labs, LLC Quality Policy Manual, Rev 10 dated 8/1/2019
5	ANSI NCSL Z540-1	*Calibration Laboratories and Measuring and Test Equipment—General Requirements*
6	460557	Amphenol Aerospace Purchase Order, dated 11/15/2022
7	OP0629094-0	NTS Labs, LLC Quotation, dated 11/08/2022
8	L-40978-192	Qualification Test Plan and Procedure for Ethernet Switch Part No. CF-020400-062, Revision A, dated 08/01/2022

3.0 Equipment Under Test

3.1 Description

The Equipment Under Test (EUT) for this test program is the Ethernet Switch Box.

Table 3.1-1: EUT Information

Item	Qty.	Name/Description	Part Number	Serial Number
1	1	Ethernet Switch Box	CF-020400-06	N/A

Table 3.1-2: EUT Power Input Information

Voltage:	28 VDC
Frequency:	DC
Current:	6 Amps max
Power Factor:	1

The Ethernet Switch Box is assembled using a specially configured ruggedized 1/10 GbE network switch. The intended installation is the U-2 airborne system.

3.2 EUT System Setup

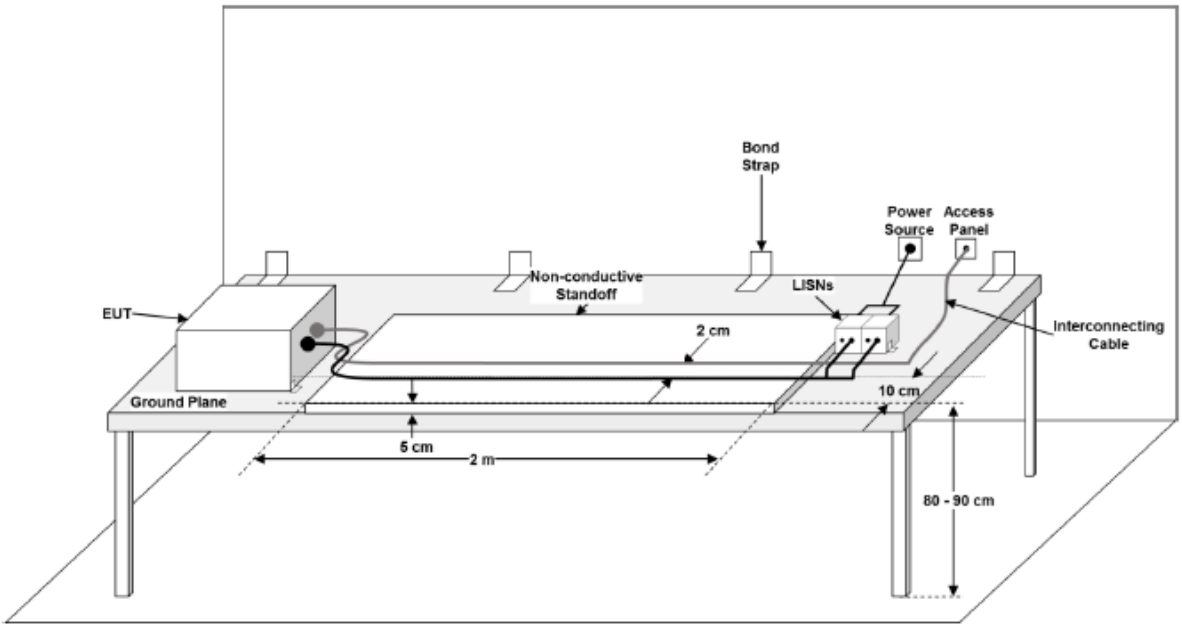


Figure 3.2-1: Ethernet Switch Box Setup Overview

3.3 EUT Operation and Monitoring

The Ethernet Switch Box was operated and monitored by Amphenol Aerospace personnel.

3.4 Pass/Fail Criteria

The Pass/Fail criteria for the Ethernet Switch Box was defined by the EMITP, specified in Table 2.0-2.

3.5 EMI Suppression Devices

At the time of testing, no EMI suppression devices were added to the EUT in order to achieve compliance.

3.6 EUT Bonding / Grounding Requirements

The bonding / grounding requirements for the Ethernet Switch Box was defined by the EMITP, specified in Table 2.0-2.

3.7 EUT Cabling

The EUT cabling requirements for the Ethernet Switch Box was defined by the EMITP, specified in Table 2.0-2.

3.8 Non-Developmental Items (NDI) and Government Furnished Equipment (GFE)

The Ethernet Switch Box does not contain any Non-Developmental Items (NDI) and Government Furnished Equipment (GFE).

3.9 Security Classification

The Ethernet Switch Box is considered an unclassified defense article. While unclassified, it should be handled only by authorized personnel. This equipment contains technical data within the definition of the International Traffic in Arms Regulations, and is subject to the export control laws of the USG. Retransfer of this data by any means to any Foreign Person, whether in the United States or abroad, without the written approval of the U. S. Department of State, is prohibited. See CFR 22 Parts 120-130.

4.0 Test Requirements

This section provides an overview of the EMI test requirements and general information.

4.1 Test Facility Location

All testing was performed at NTS Labs, LLC, located in Tinton Falls, NJ, USA.

4.2 Test Resources

4.2.1 Test Equipment

Lists of the NTS Labs, LLC-provided equipment used during testing are included in each test section. This equipment is calibrated according to ISO/IEC 17025, and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at NTS Labs, LLC.

Measurement Tolerances
Unless otherwise stated for a particular measurement, the tolerance shall be as follows:

- Distance: ±5%
- Frequency: ±2%
- Amplitude, measurement receiver: ±2 dB
- Amplitude, measurement system (includes measurement receivers, transducers, cables, and so forth): ±3 dB
- Time (waveforms): ±5%
- Resistors: ±5%
- Capacitors: ±20%

4.2.2 Test Automation and Data Collection Software

Various software packages are used for test automation and data collection, depending on the test type. Refer to Appendix A for detailed information on the software used for each test.

4.3 General Test Requirements

4.3.1 Test Facility

The NTS Labs, LLC laboratory, located in Tinton Falls, NJ, is accredited to ISO/IEC 17025.

All testing occurred within a shielded semi anechoic enclosure or shielded room, located in Tinton Falls, NJ. Semi anechoic chambers are lined with anechoic Radio Frequency (RF) absorbing tiles and cones on the walls and the ceiling. Peripheral equipment is located outside the shielded enclosure. All power leads entering the shielded enclosures will be routed via electromagnetic interference filters to provide at least 80 dB of attenuation above 10 kHz when measured in accordance with MIL-STD-220B. Interconnecting cables are routed via feed-through ports when practical. Shielding effectiveness to electric fields and plane waves of this EMI test chamber exceed 80 dB from 14 kHz-10 GHz, and 60 dB from 10 GHz-40 GHz.

4.3.2 Ground Plane

The table-top ground plane was copper, measuring at least 2.5 square meters in area with the smaller side no less than 76 cm. The ground plane is electrically bonded to the floor of the shielded enclosure at least once every 1 meter. The metallic bond straps are solid and maintain a five-to-one ratio or less in length to width. The DC resistance between the ground plane and the shielded enclosure is less than 2.5 mΩ.

4.3.3 Power Source Impedance

The impedance of power sources providing input power to the EUT are controlled by LISNs for all measurement procedures of this document unless otherwise stated in a particular test procedure. LISNs are not be used on output power leads. The LISNs are located at the power source end of the exposed length of power leads. The LISN impedance characteristics are in accordance with Figure 4.3-2. The LISN impedance are measured periodically under the following conditions:

- The impedance shall be measured between the power output lead on the load side of the LISN and the metal enclosure of the LISN.
- The LISN signal output port has a 50 Ω termination.
- The power input terminal on the power source side of the LISN shall be un-terminated.

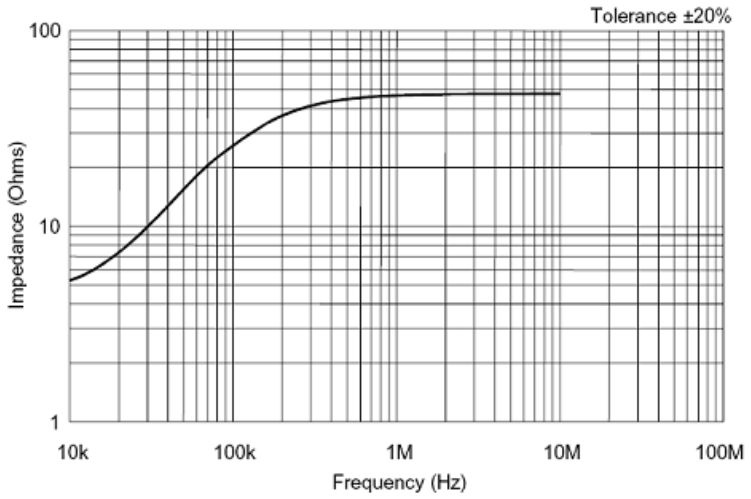


Figure 4.3-2: LISN Impedance Example

Refer to Appendix B for LISN Impedance plots for the specific LISNs used for tests in this report.

4.4 Emissions Testing

Receiver Bandwidth and Measurement Time

The measurement receiver bandwidths listed in Table 4.4-1, which are derived from MIL-STD-461G, are used for emissions testing. These bandwidths are specified at the 6 dB down points for the overall selectivity curve of the receivers. Video filtering is not used to bandwidth limit the receiver response. A controlled video bandwidth is available on the measurement receivers used; it was set to its greatest value. This value was 50MHz.

Table 4.4-1: Bandwidth and Measurement Times

Frequency Range	6 dB Bandwidth	Dwell Time[1]	Min Measurement Time of Analog Measurement Receiver
30 Hz-1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz-10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz-150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz-30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz-1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
> 1GHz	1 MHz	0.015 sec	15 sec/GHz

Ambient Electromagnetic Level
During testing, the ambient electromagnetic level is measured with EUT de-energized and all auxiliary equipment turned on and shall be at least 6 dB below the allowable specified limits. Ambient conducted levels on power leads are measured with the leads disconnected from the EUT and connected to a resistive load which draws the same current as the EUT. The ambient are recorded in the EMITR.

4.5 Susceptibility Testing

For susceptibility measurements, the entire frequency range for each applicable test are scanned. For swept frequency susceptibility testing, frequency scan rates and frequency step sizes of signal sources did not exceed the values listed in Table 4.5-1. The rates and step sizes are specified in terms of a multiplier of the tuned frequency (f_o) of the signal source. Analog scans refer to signal sources which are continuously tuned. Stepped scans refer to signal sources which are sequentially tuned to discrete frequencies. Stepped scans dwell at each tuned frequency for 3 seconds. Scan rates and step sizes are decreased when necessary to permit observation of a response.

Table 4.5-1: Susceptibility Scanning

Frequency Range	Analog Scans Max Scan Rates	Stepped Scans Max Step Size
30 Hz - 1 MHz	0.0333f_o/sec	0.05 f_o
1 MHz - 30 MHz	0.00667 f_o/sec	0.01 f_o
30 MHz - 1 GHz	0.00333 f_o/sec	0.005 f_o
1 GHz - 40 GHz	0.00167 f_o/sec	0.0025 f_o

Susceptibility Criteria
The susceptibility criteria are defined by Section 3.4.

Modulation of Susceptibility RF Signals
Susceptibility test signals for CS114 are pulse modulated (on/off ratio of 40 dB minimum) at 1 kHz rate with a 50% duty cycle.

Thresholds of Susceptibility
When susceptibility indications are noticed in EUT operation, a threshold level shall be determined when possible, and where the susceptible condition shall be no longer present. Thresholds of susceptibility are determined as follows:

- When a susceptibility condition is detected, the interference signal shall be reduced until the EUT recovered.
- The interference shall be reduced by an additional 6 dB.
- The interference signal shall be gradually increased until the susceptibility condition reoccurred.
- The level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable will be recorded.

5.0 Test Methods, Procedures and Test Results

Table 5.0-1: Test Methods and Test Results Summary

Section	Test	Specification	Test Facility	Test Date	Part #	Serial #	Test Result
5.1	CS114, Conducted Susceptibility	MIL-STD-461G and 062-QTP_final draft	Tinton Falls	November 16 – 17, 2022	CF-020400-06	N/A	Passed

The decision rule for Test Results was based on the Test Information provided by the customer.

5.1 CS114, Conducted Susceptibility: Bulk Cable Injection, 10 kHz to 200 MHz

5.1.1 CS114 Purpose

This test verifies the ability of the EUT to withstand RF signals coupled onto all interconnecting cables including power cables. For EUTs intended to be installed on ships or submarines, an additional common mode limit of 77 dBµA is applicable from 4 kHz to 1 MHz on complete power cables (common mode).

5.1.2 CS114 Limits

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystems specification when subjected to an injection probe drive signal level which has been pre-calibrated to the appropriate current limit as shown in Figure 5.1-1 and modulated according to Section 4.5.

Requirements are also met if the EUT is not susceptible at forward power levels sensed by the directional coupler that are below those determined during calibration provided that the actual current induced in the cable under test is Curve 5 = 115 dBµA, Curve 4 = 103 dBµA, Curve 3 = 95 dBµA, Curve 2 = 89 dBµA and Curve 1 = 83 dBµA across the frequency range.

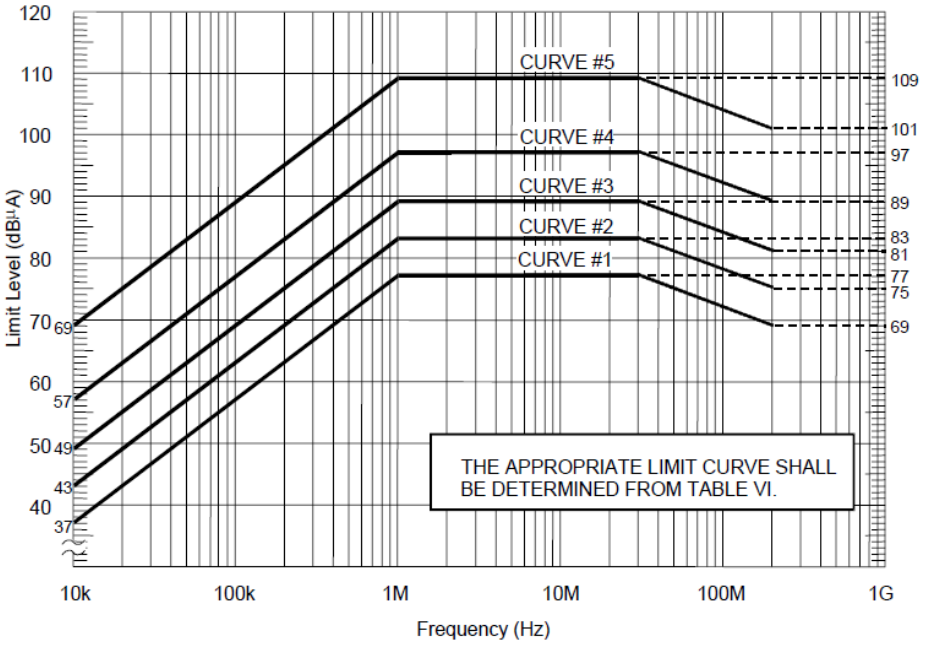


Figure 5.1-1: CS114 Calibration Limit

5.1.3 CS114 Current Injection Probes

All current injection probes met the requirement for maximum insertion loss as shown in Figure 5.1-2.

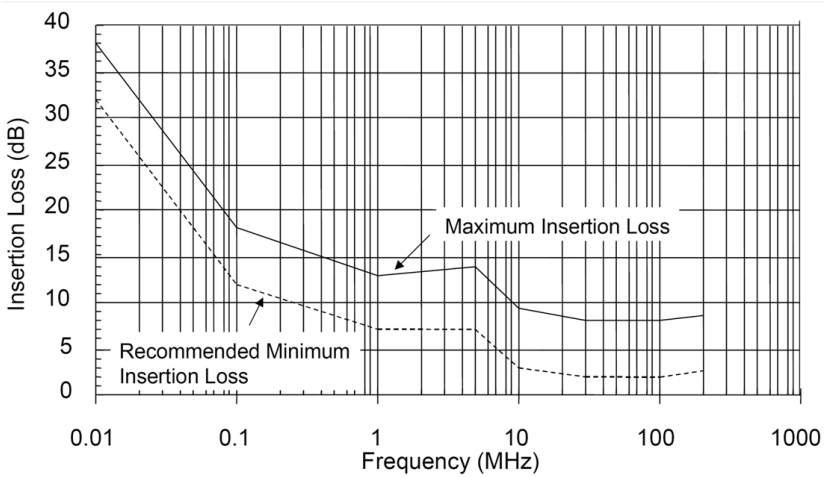


Figure 5.1-2: CS114 Maximum Insertion Loss for Injection Probes

5.1.4 CS114 EUT Test Setup

The EUT was set up in accordance with Section 3.2, Figure 3.2-1, and operated according to Section 3.3.

5.1.5 CS114 Calibration and Verification

Calibration Procedure:

The test equipment was configured according to Figure 5.1-3.

1. The signal generator was set to lowest test frequency, unmodulated.
2. The applied signal was increased until measurement receiver A indicates that the current level specified in the limit exists on the center conductor of the calibration fixture.
3. A correction factor for the Attenuator is added to the raw data collected from receiver A. For example: *Raw Data (dBµA) + Attenuator insertion loss (dB) = corrected data (dBµA).*
4. The forward power to the injection probe indicated on measurement receiver B was recorded.
5. A correction factor for the Directional Coupler is added to the raw data collected from receiver B. For example: *Raw Data (dBm) + Directional Coupler insertion loss (dB) = corrected data (dBm).*
6. The frequency band up to 200 MHz was scanned, using the step size indicated in Table 4.5-1.
7. The forward power needed to maintain the required current amplitude was recorded.

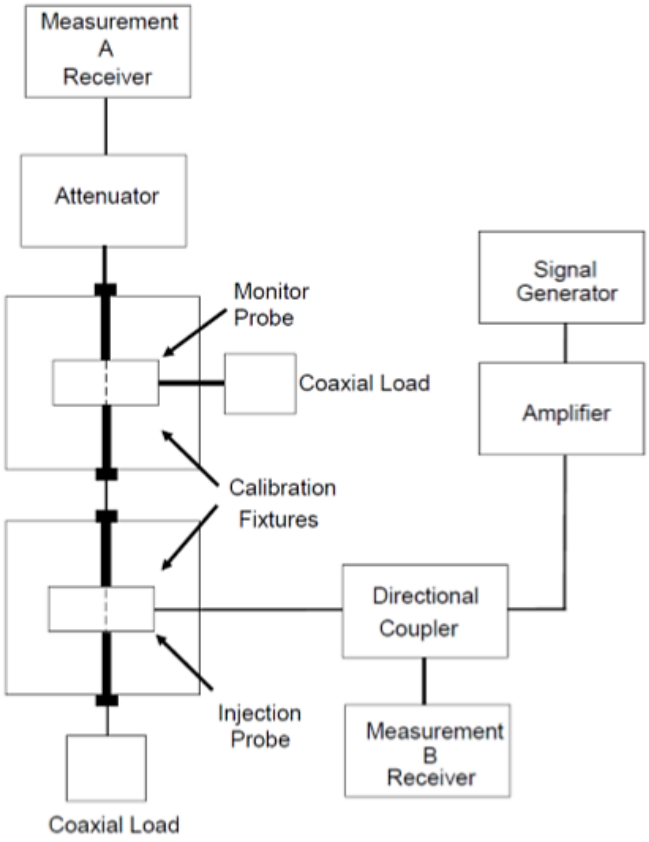


Figure 5.1-3: CS114 Calibration Setup

Verification Procedure:

1. The test equipment was configured according to Figure 5.1-4.
2. Set the signal generator to the lowest test frequency.
3. The forward power level determined during calibration of the injection probe was applied, while monitoring the induced current on the monitor probe.
4. A correction factor for the Directional Coupler is added to the raw data collected from receiver B. For example: *Raw Data (dBm) + Directional Coupler insertion loss (dB) = corrected data (dBm).*
5. A correction factor for the Monitor Probe is added to the raw data collected from receiver A. For example: *Raw Data (dBµA) + Monitor Probe insertion loss (dB) = corrected data (dBµA).*
6. The required frequency range was scanned, with a step sizes twice those in Table 4.5-1, while maintaining the forward power level at the calibrated level determined during calibration.
7. The monitored current was verified to be within ±3 dB of the calibrated current level.
8. If the current was not within ±3 dB, then the problem was identified and corrected before testing proceeded.

Modulation Verification Procedure:

The signal generator modulation was verified as follows:

1. The output of the signal generator was connected to the spectrum analyzer input.
2. The same software used for testing was used to set the frequency and modulation of the carrier wave.
3. The spectrum analyzer waveform was captured and the modulation was verified to be 1 kHz pulse modulated, with a 50% duty cycle and a with a modulation depth of at least 40dB.

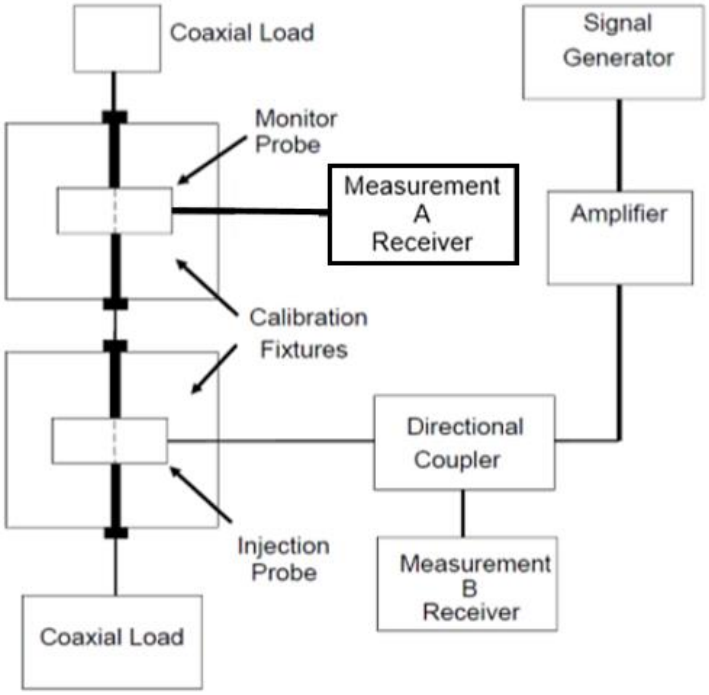


Figure 5.1-4: CS114 Verification Setup

5.1.6 CS114 Test Procedure

The test setup was configured in accordance with Figure 4.3-1, Figure 5.1-5, and as follows:

1. The injection and monitor probes were placed around the cable bundle interfacing with a EUT connector, with the EUT turned on and put into operation mode.
2. The monitor probe was placed 5 cm from the EUT connector. If the connector and back shell's overall length exceed 5 cm, the monitor probe was positioned as close to the connector's back shell as possible.
3. The injection probe was positioned 5 cm from the monitor probe.

Testing proceeded as follows, on all required cables:

1. The signal generator was set to the lowest test frequency, with 1 kHz pulse modulation, 50% duty cycle.
2. The forward power from Measurement System Calibration was applied to the injection probe while the induced current is monitored.
3. The required frequency range was scanned in accordance with Table 4.5-1, while maintaining the forward power level at the calibration level determined in the Measurement System Calibration, or the maximum monitored current level for the applicable limit (whichever is less stringent).
4. A correction factor for the Directional Coupler is added to the raw data collected from receiver B. For example: *Raw Data (dBm) + Directional Coupler insertion loss (dB) = corrected data (dBm).*
5. A correction factor for the Monitor Probe is added to the raw data collected from receiver A. For example: *Raw Data (dBµA) + Monitor Probe insertion loss (dB) = corrected data (dBµA).*
6. The EUT was monitored for degradation of performance.
7. Whenever susceptibility is noted, the threshold level was determined in accordance with Section 4.5.

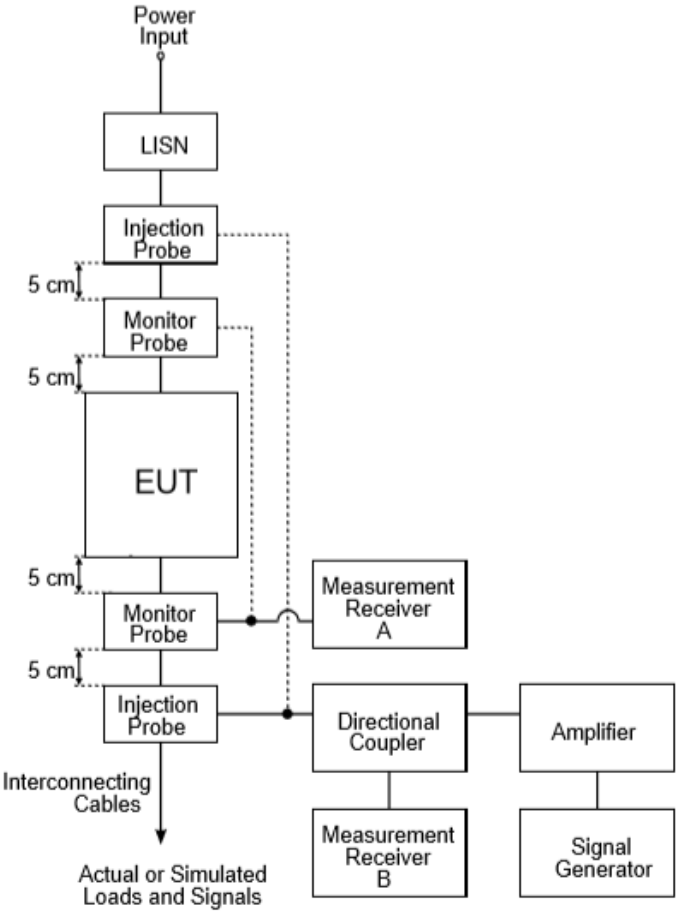


Figure 5.1-5: CS114 Bulk Cable Injection Evaluation

5.1.7 CS114 Test Results, Conclusions and Recommendations

The EUT Passed.

At the time of testing, no remedial actions were taken in order to achieve compliance with the requirements.

No corrective measures have been recommended.

5.1.8 CS114 Test Datasheets and Log Sheet

NTS Labs LLC					
MIL-STD-461 Bonding and Grounding Worksheet					
Project :	PR167248		Customer:	Amphenol Aerospace	
EUT:	Ethernet SwitchBox		Model:	CF-020400-06	
Procedure:	062-QTP_final draft		Date:	11/23/2022	
Test Point	Reference	Specification (mΩ), (</=)	Measured (mΩ)	Results	Note
Ground Plane	Chamber	2.5	0.64	PASS	
EUT Chassis	Ground Plane	2.5	0.79	PASS	
Notes:					
Test Performed By:		Tristian Gaines		Date:	11/23/2022

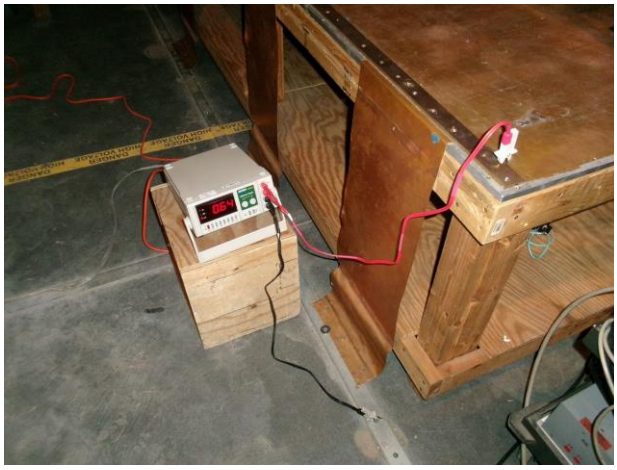
NTS Labs LLC				
MIL-STD-461 CS114 Log Sheet				
Project :	PR163842	Customer:	Amphenol Aerospace	
EUT:	Ethernet Switch	Model:	CF-020400-06	
Procedure:	062-QTP_final draft	Date:	11/16/2022 - 11/17/2022	
Date	Time	Log Entries		Initials
11/16/22	08:00	Customer arrived. Discussion about ethernet loopback test point.		TG
	08:30	Reconfiguring ethernet cable loop.		↓
	09:00	Began CS114 power bundle.		↓
	09:40	Issues with data collections.		TG
	10:11	Resweeping.		↓
	16:04	Paused at step 144 on hot lead.		↓
11/17/22	08:30	Continued hot lead.		↓
	09:20	Hot lead and bundle pass.		↓
	11:30	CS114 Pass.		
Test Performed By:		Tristian Gaines		

NTS Labs LLC					
MIL-STD-461 CS114 Conducted Susceptibility Scan Rates					
Project :	PR163842			Customer:	Amphenol Aerospace
EUT:	Ethernet Switch			Model:	CF-020400-06
Procedure:	062-QTP_final draft			Date:	11/16/2022 - 11/17/2022
Start Frequency (MHz)	**Stop Frequency (MHz)**	**Table III Analog Scan Rates Maximum Scan Rates (percentage of frequency per second)**	**Table III Stepped Scans Maximum Step Size (percentage of frequency)**		**Stepped Scan Dwell Time per step (seconds)**
0.004	1	0.0333f/sec	5%		3.0
1	30	0.00667f/sec	1%		3.0
30	200	0.00333f/sec	0.50%		3.0

NTS Labs LLC								
MIL-STD-461 CS114 Modulation Verification								
Project :	PR163842				Customer:	Amphenol Aerospace		
EUT:	Ethernet Switch				Model:	CF-020400-06		
Procedure:	062-QTP_final draft				Date:	11/16/2022 - 11/17/2022		
Remarks: Verification that the correct modulation is present on the drive signal for each signal generator is required. Ensure that the modulation frequency, waveform and depth (40 dB minimum from peak to baseline) are correct.								
Signal Generator Asset Number, Model Number, Serial Number and Range:				**Frequency Verified (MHz)**	**Modulation Source Signal Generator Settings**	**Verified Modulation Duty Cycle (%)**	**Verified Modulation Frequencey (kHz)**	**Measured Modulation Depth (dB)**
WC005872	Amplifier Research SG1200	3844A00809	9kHz - 1.2GHz	10	1kHz PM, 50% Duty Cycle	50	1	60
Test Performed By:		Tristian Gaines						

NTS Labs LLC						
MIL-STD-461 CS114 Data Sheet						
Project :	PR163842			Customer:	Amphenol Aerospace	
EUT:	Ethernet Switch			Model:	CF-020400-06	
Procedure:	062-QTP_final draft			Date:	11/16/2022 - 11/17/2022	
Input Voltage:	28VDC	Frequency:	DC			
Pre-Test Physical Inspection:	PASS	Observation:	None			
Pre-Test Operational Inspection:	PASS	Observation:	None			
Service Branch:	Undefined	Test Level:	Unknown			
0.01 - 2MHz Limit Level:	Curve 5	2 - 30MHz Limit Level:	Curve 5			
30 - 200MHz Limit Level:	Curve 5	200 - 500MHz Limit Level:	N/A			
Frequency Range (MHz)	**Line Tested**	**Modulation Used**		**Test Results**	**Observations**	
.01 - 200	Power Bundle	1kHz PM, 50% duty cycle		PASS		
.01 - 200	+28VDC Line Only	1kHz PM, 50% duty cycle		PASS		
.01 - 200	Ethernet	1kHz PM, 50% duty cycle		PASS		
Post-Test Physical Inspection:	PASS	Observation:	None			
Post-Test Operational Inspection:	PASS	Observation:	None			
Test Performed By:	Tristian Gaines		Test Date:	11/16/2022 - 11/17/2022		

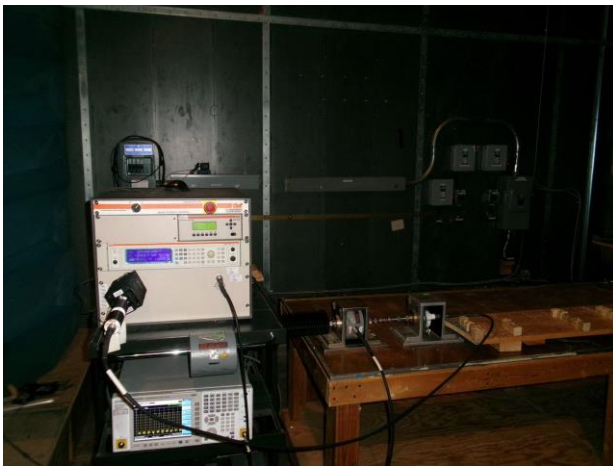
5.1.9 CS114 Photographs



01 - Shielded Room to GP Bond

02 - EUT to GP Bond

03 - CS114 Modulation Verification

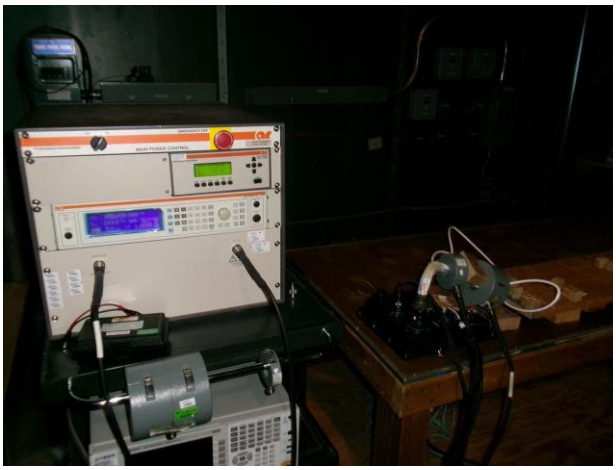


04 - CS114 Calibration

05 - CS114 Verification

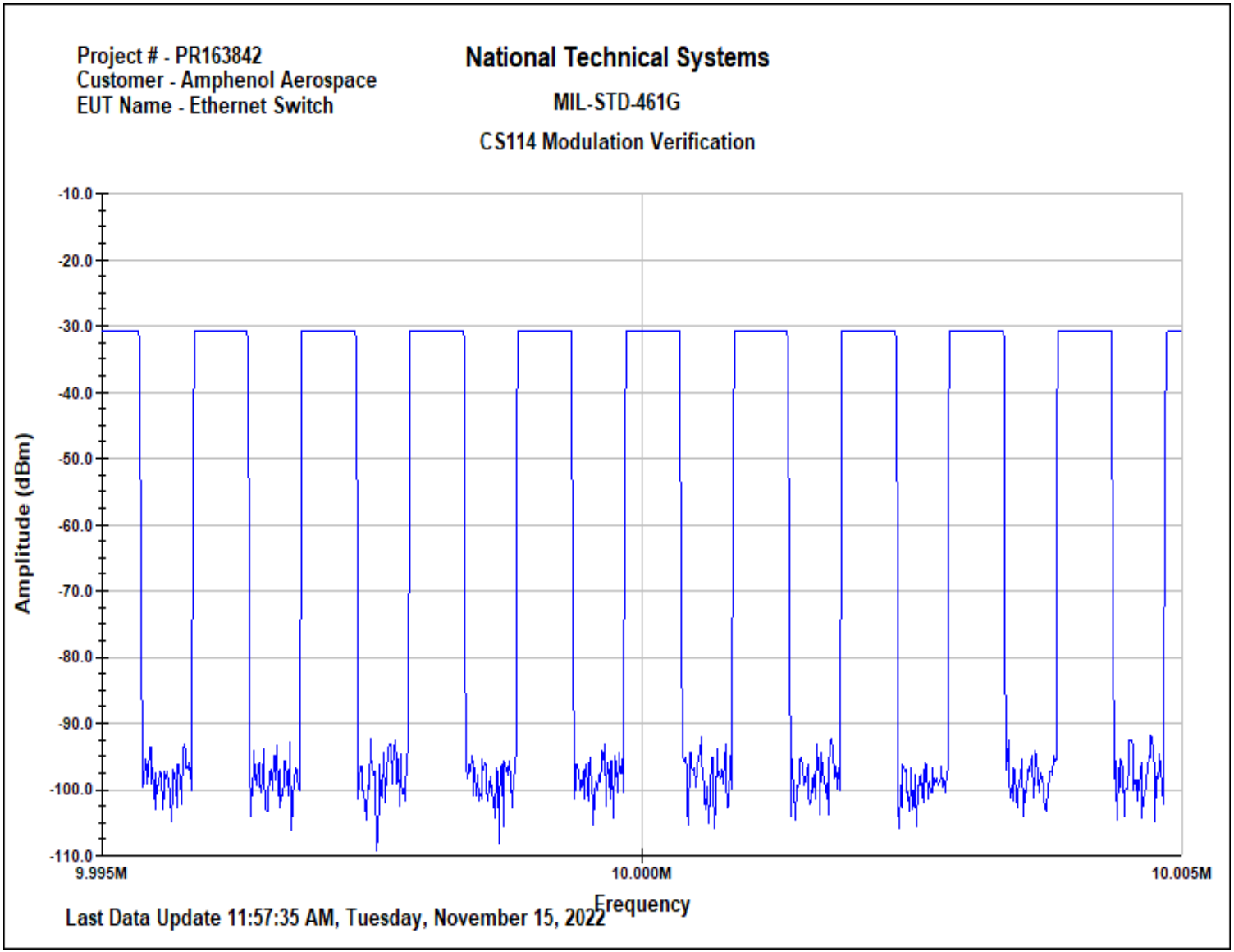
06 - CS114 Test, Power Bundle

07 - CS114 Test, Hot Lead Only

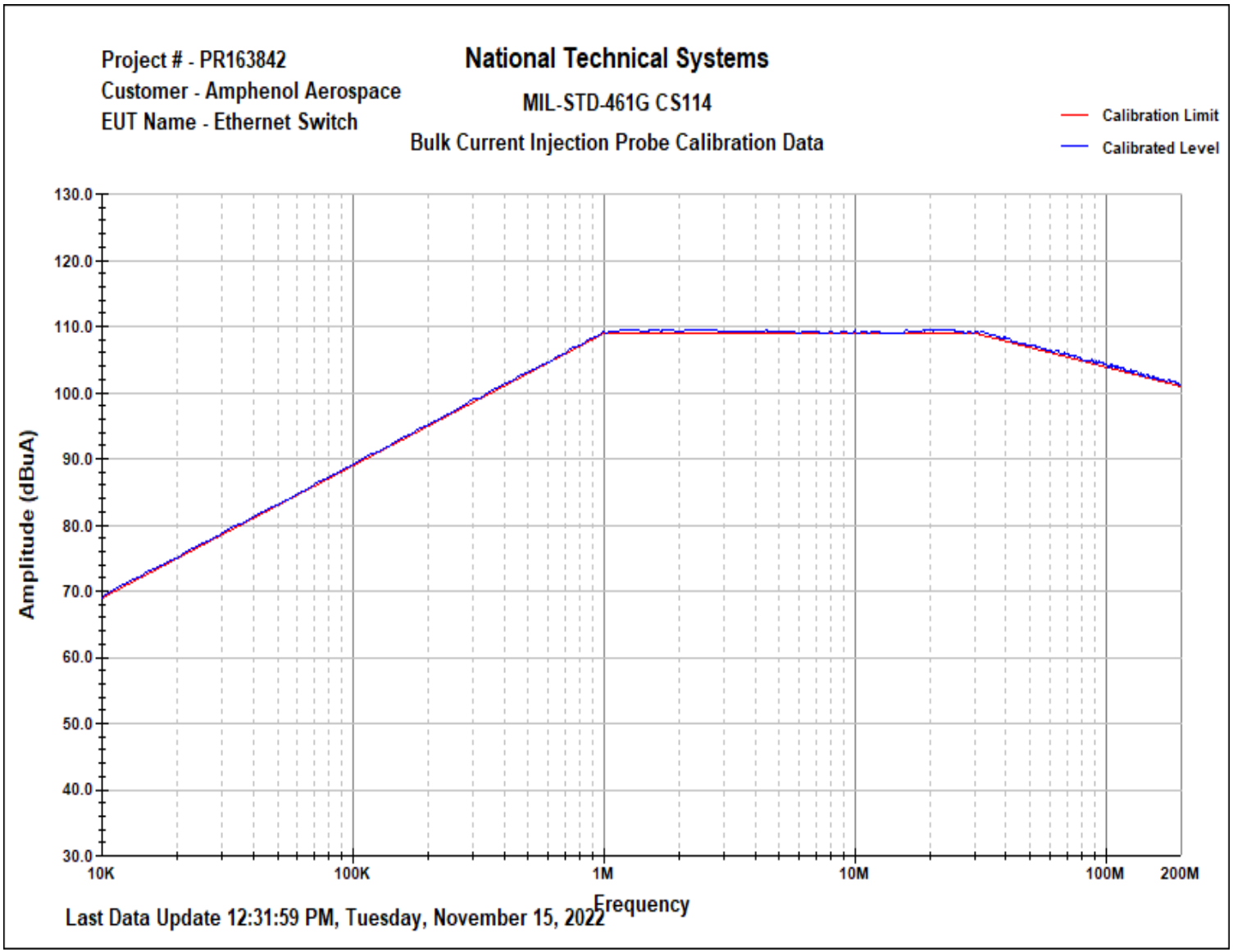


08 - CS114 Test, Ethernet

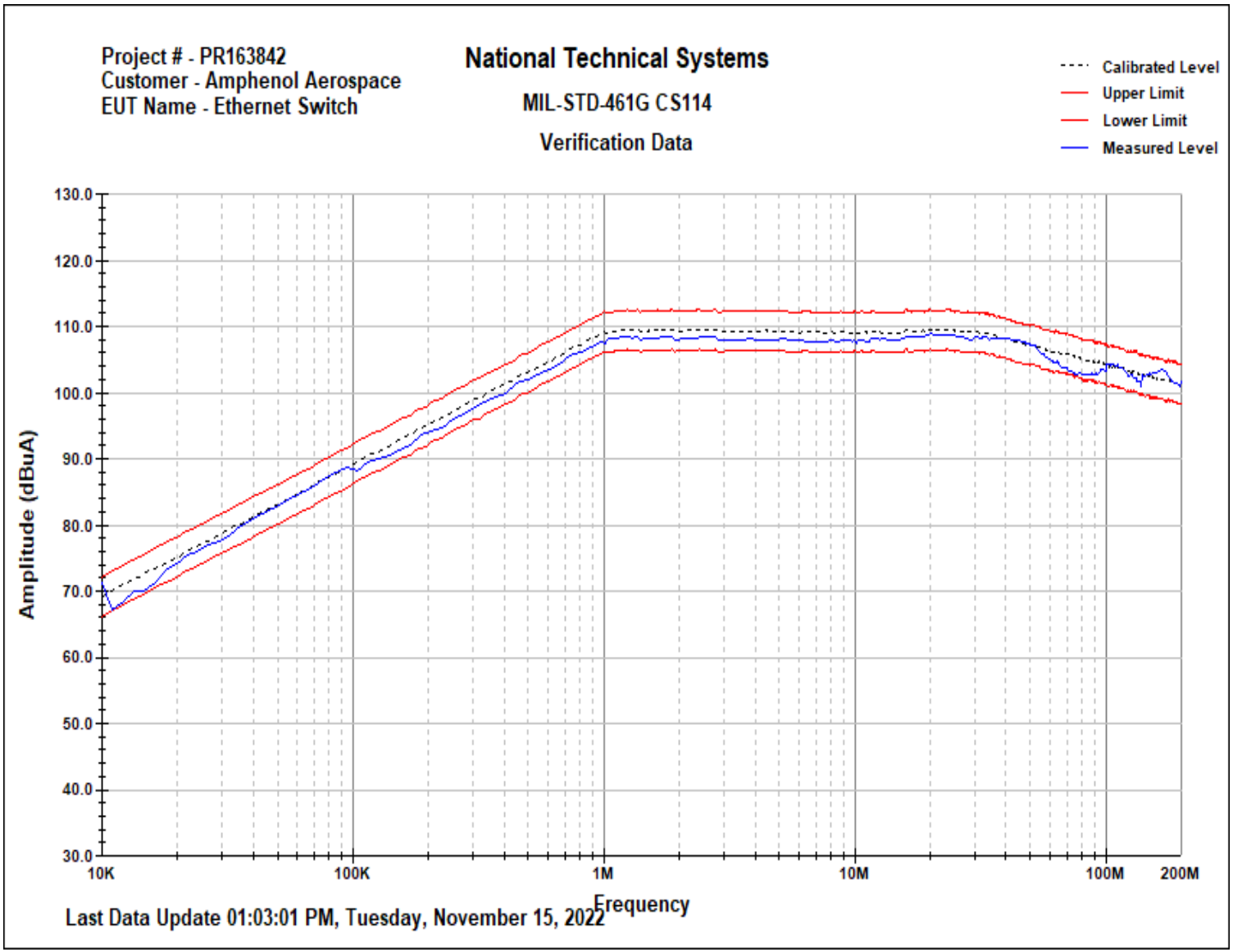
5.1.10 CS114 Data



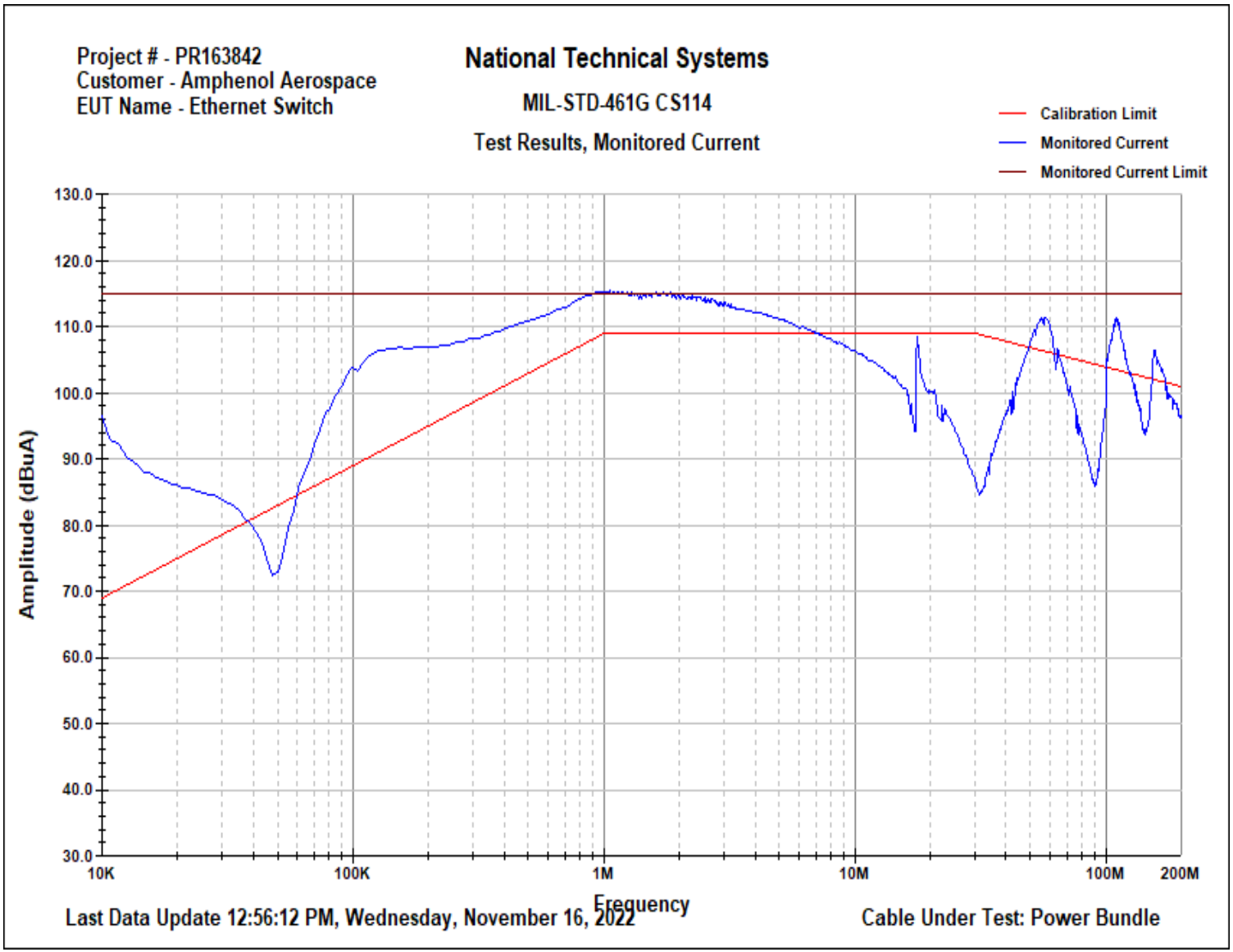
01 - CS114 Modulation Verification



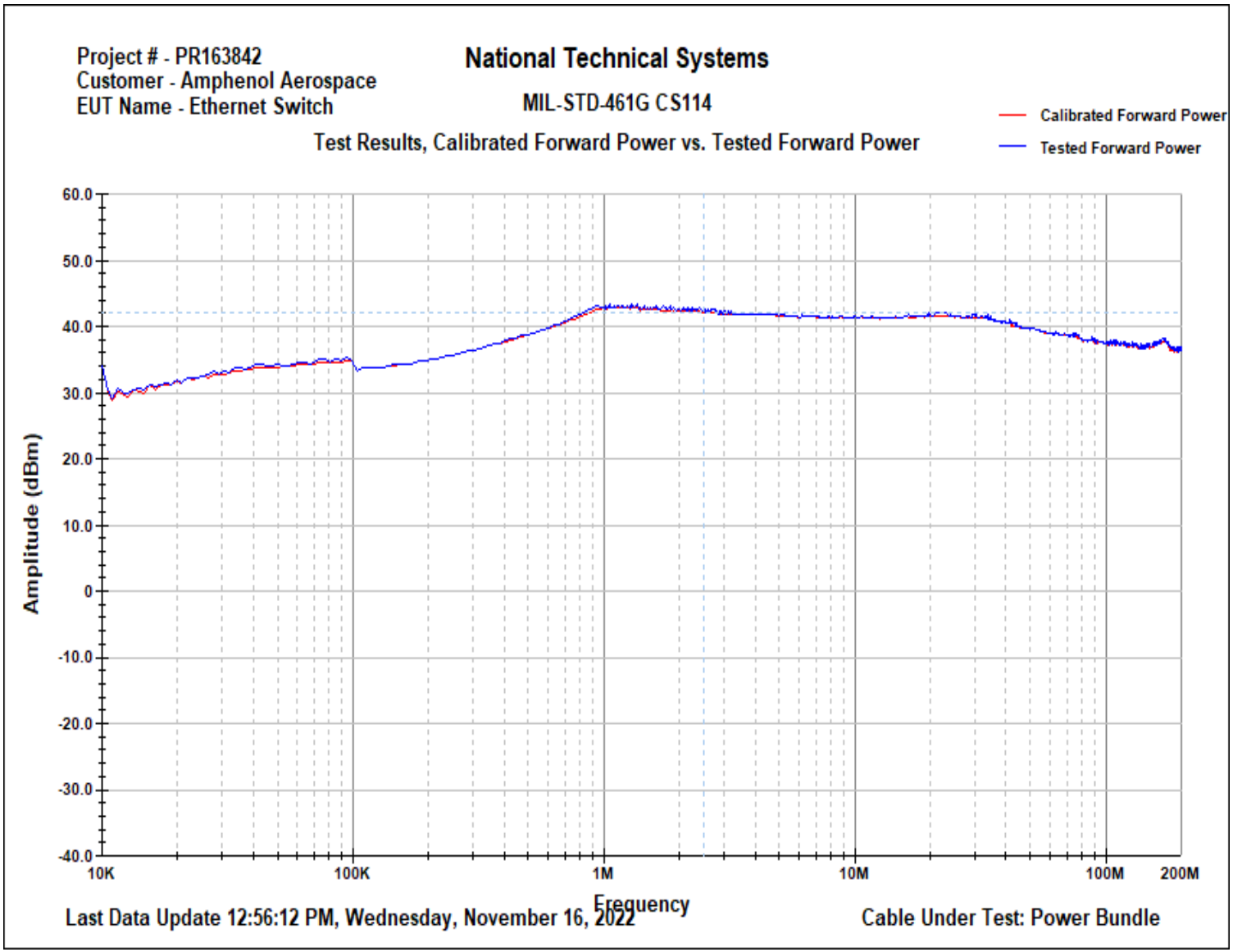
02 - Bulk Current Injection Probe Calibration Data



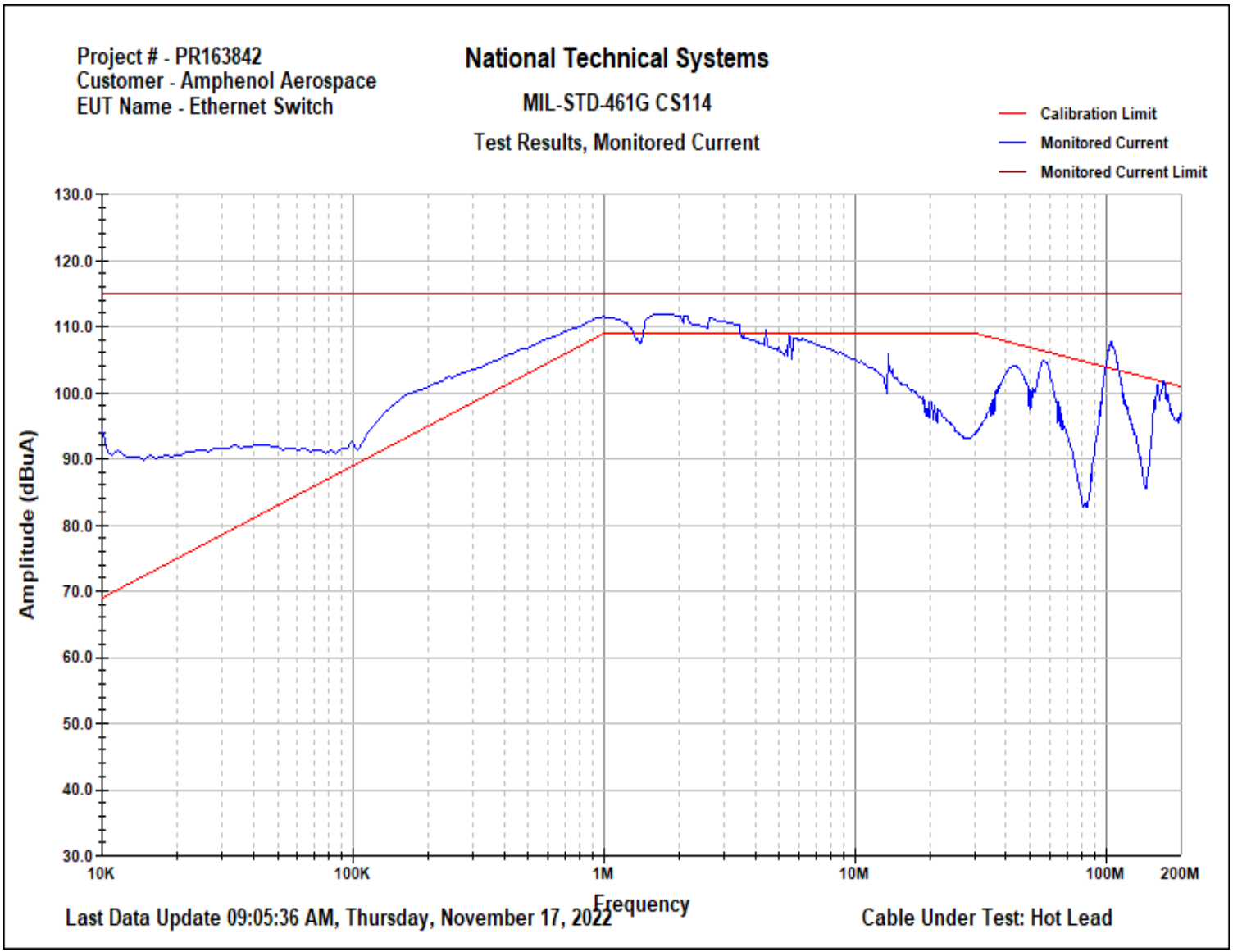
03 - Verification Data



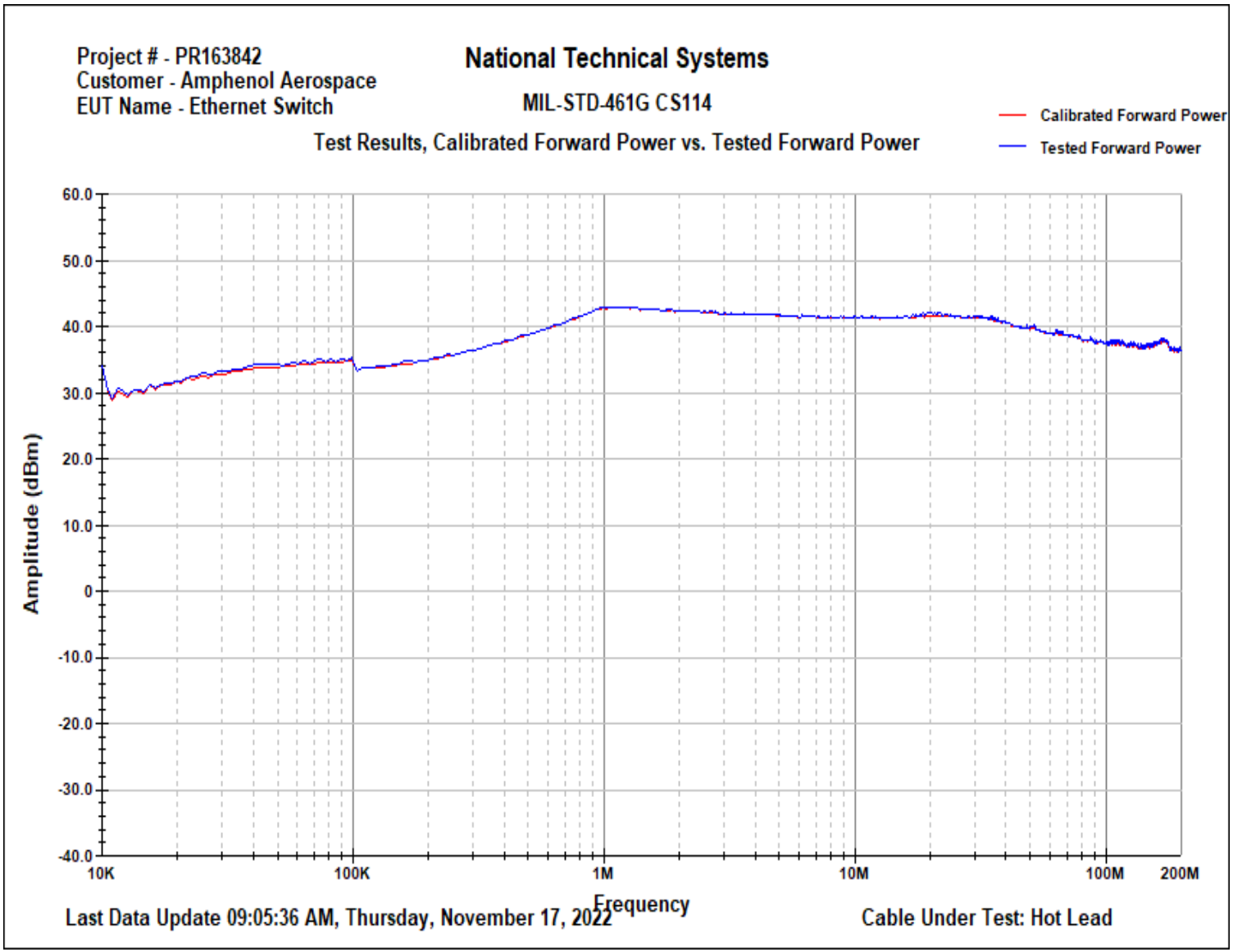
04 - Power Bundle, Test Results, Monitored Current



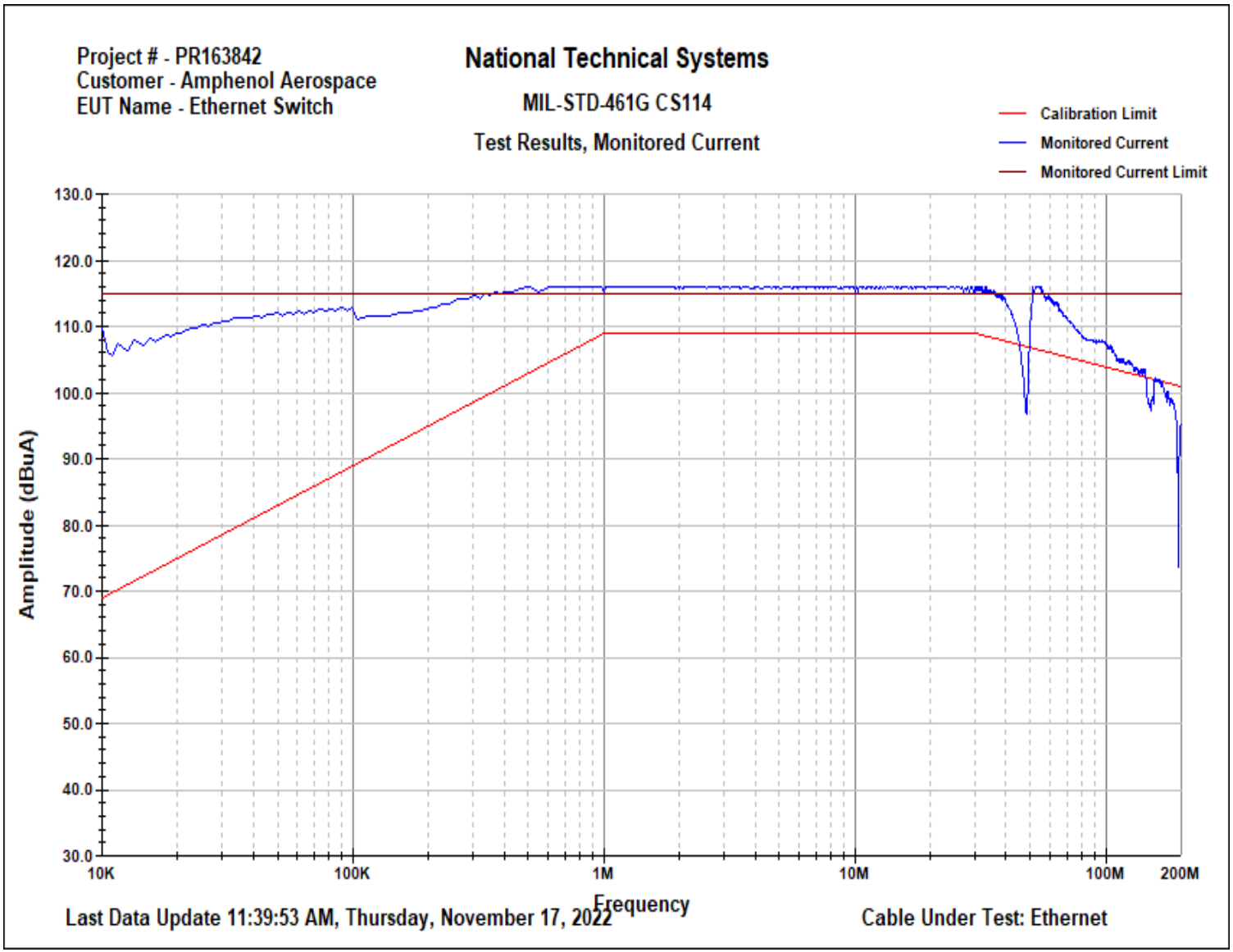
05 - Power Bundle, Test Results, Calibrated Forward Power vs. Tested Forward Power



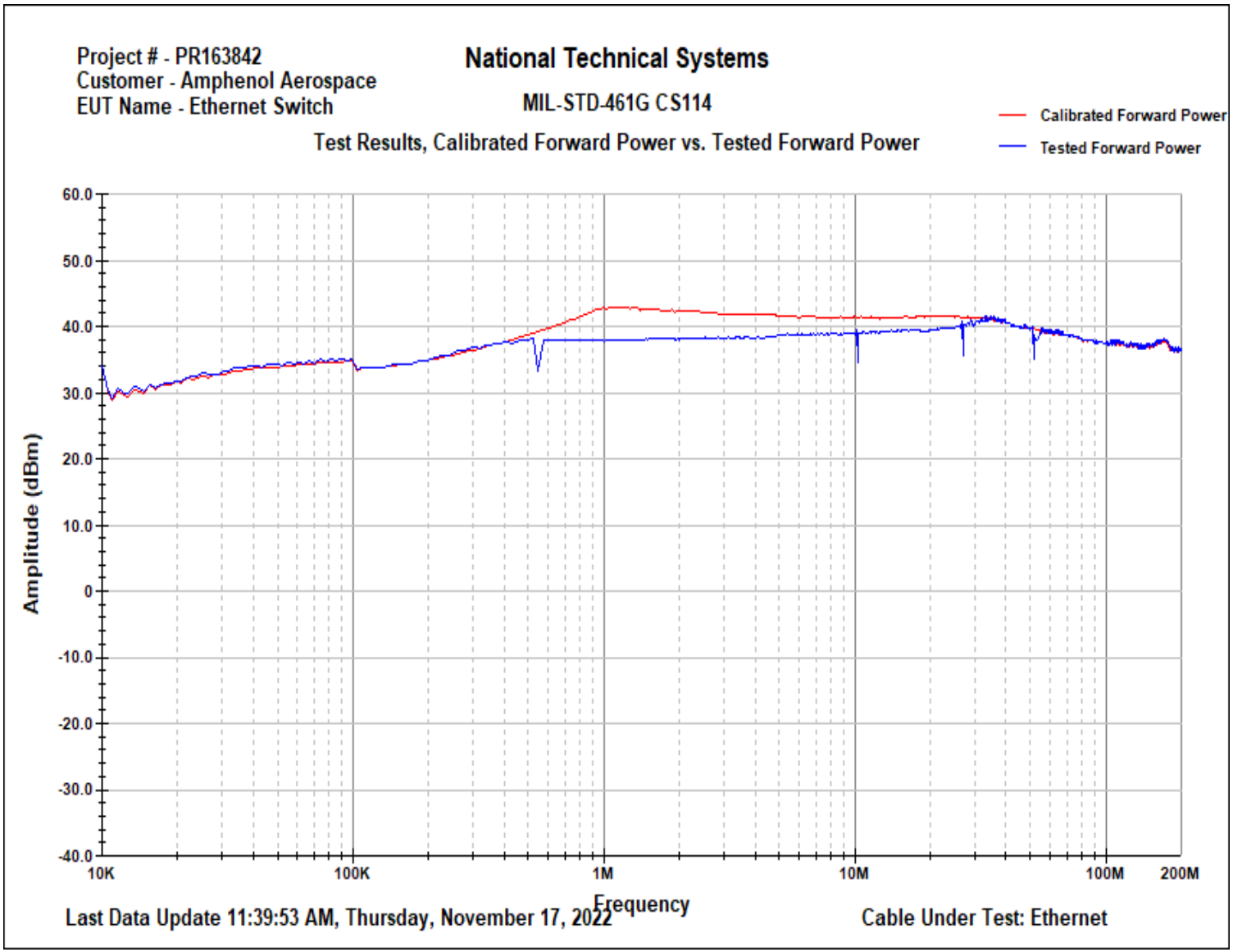
06 - Hot Lead Only, Test Results, Monitored Current



07 - Hot Lead Only, Test Results, Calibrated Forward Power vs. Tested Forward Power



08 - Ethernet - Test Results, Monitored Current



09 - Ethernet - Test Results, Calibrated Forward Power vs. Tested Forward Power

5.1.11 CS114 Test Equipment List

Table 5.1-1: CS114, Conducted Susceptibility Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC005675	Chamber (EMI, Shielded Screen)	National Technical Systems	27 x 20 x19	NCR	NCR
WC005802	Attenuator (Coaxial)	Amplifier Research	AF10050	10/27/2021	11/27/2024
WC005803	Attenuator (Coaxial)	Amplifier Research	AF20050	10/27/2021	10/27/2024
WC005804	Attenuator (Coaxial)	Amplifier Research	AF06250	04/13/2022	04/13/2025
WC006566	Coupler (Directional)	Amplifier Research	DC3400A	09/01/2020	09/01/2023
WC005727	Fixture (Calibration)	Fischer Custom Communications	FCC-BCICF-1	NCR	NCR
WC005807	Fixture (Calibration)	Amplifier Research	CF00400	06/17/2011	NCR
WC005872	Generator (Signal)	Amplifier Research	SG1200	08/26/2022	08/26/2023
WC024101	Head (Power Sensing)	Amplifier Research	PH2000	04/20/2022	04/20/2023
WC024103	Head (Power Sensing)	Amplifier Research	PH2001	04/20/2022	04/20/2023
WC024100	Meter (RF Power)	Amplifier Research	PM2003	04/20/2022	04/20/2023
WC005289	Network (LISN)	Solar Electronics	8028-50-TS-24-BNC	03/17/2022	03/17/2025
WC005292	Network (LISN)	Solar Electronics	8028-50-TS-24-BNC	01/28/2022	01/28/2025
WC005806	Probe (Current)	Amplifier Research	B100400	06/16/2011	NCR
WC005809	Probe (Current)	Fischer Custom Communications	F-35A	08/23/2021	08/23/2023
WC005801	System (Conducted Immunity)	Amplifier Research	C100400AM4	07/14/2014	NCR
WC058416	Load (RF)	Fairview Microwave	ST4N257	NCR	NCR
WC058519	Load (RF)	Fairview Microwave	ST4N257	NCR	NCR

NCR = No Calibration Required; as per NTS Labs, LLC QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

Appendix A: Test Software Description

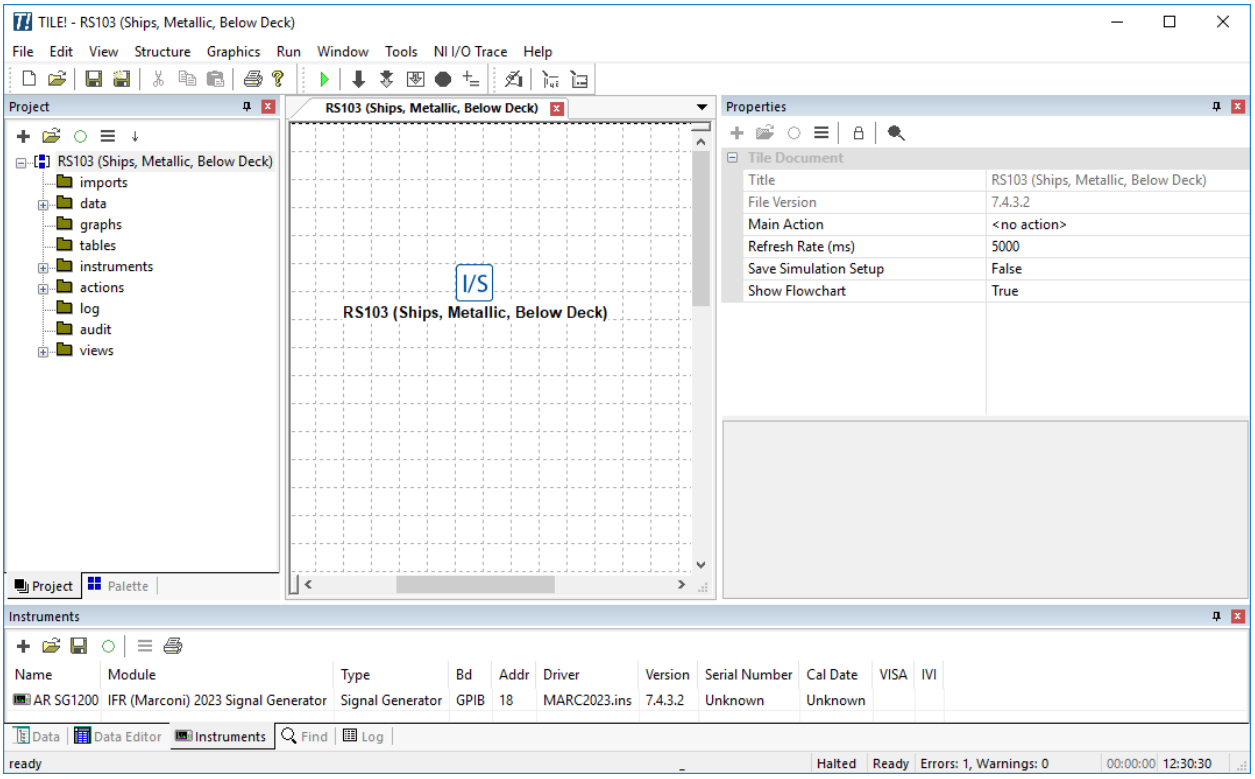
Table A-1: Test Automation and Data Collection Software Revision

Test	Manufacturer	Model	Rev	Date Verified
CS114	ETS Lindgren	TILE!	7.6.0.15	7/20/2021

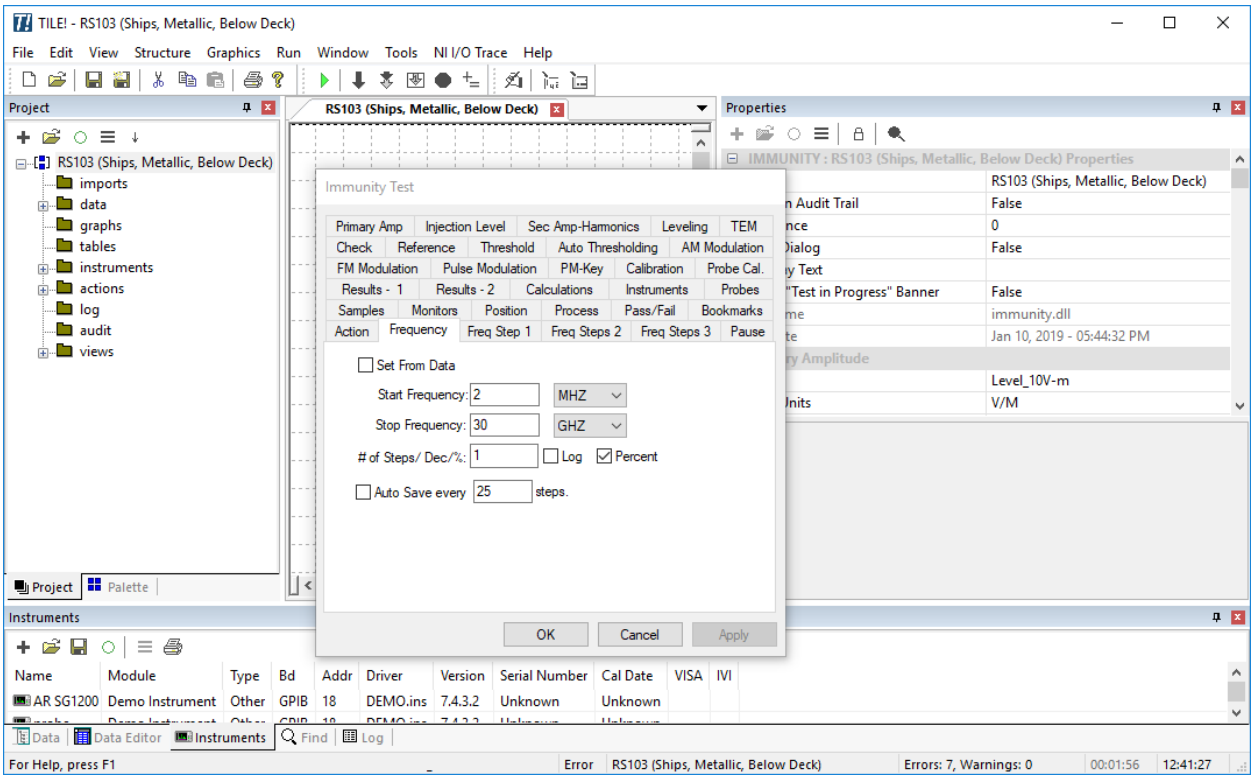
ETS-Lindgren Totally Integrated Laboratory Environment (TILE!)

The C++ compiled Totally Integrated Laboratory Environment (TILE! ™) software by ETS-Lindgren is used for CS114 testing.

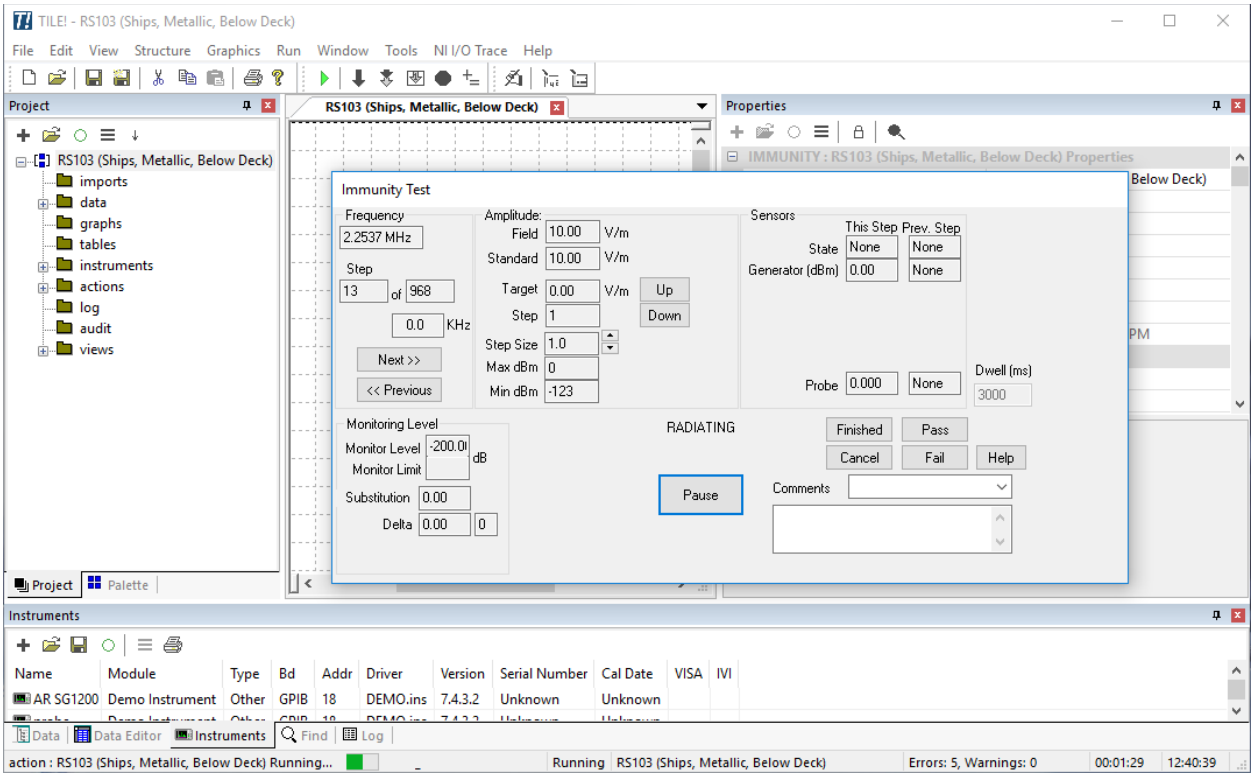
The screen below shows the main TILE! Program with the Administrator defined profile opened for MIL-STD-461 RS103 (Ships, Metallic, Below Deck). A similar profile has been defined for CS114.



The screen below shows the properties tabs of the Administrator defined profile. In these tabs, the administrator has defined the frequency range, step size, test level, modulation type, dwell time, instrumentation, etc.

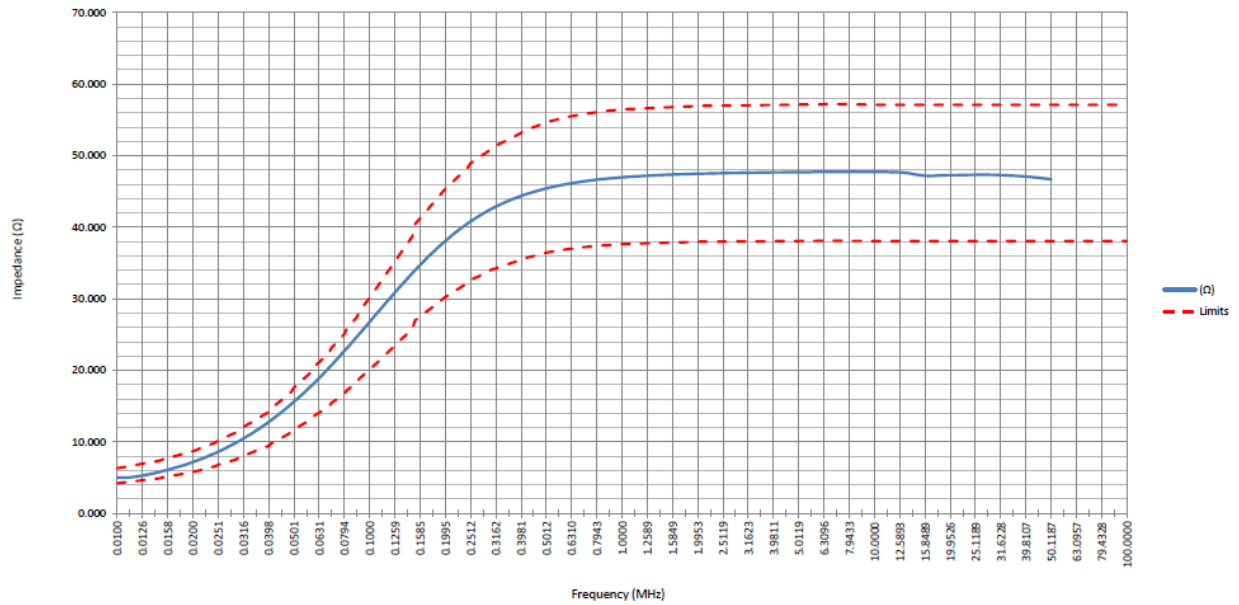


The screen below shows the running profile, where the user can monitor the test in progress.

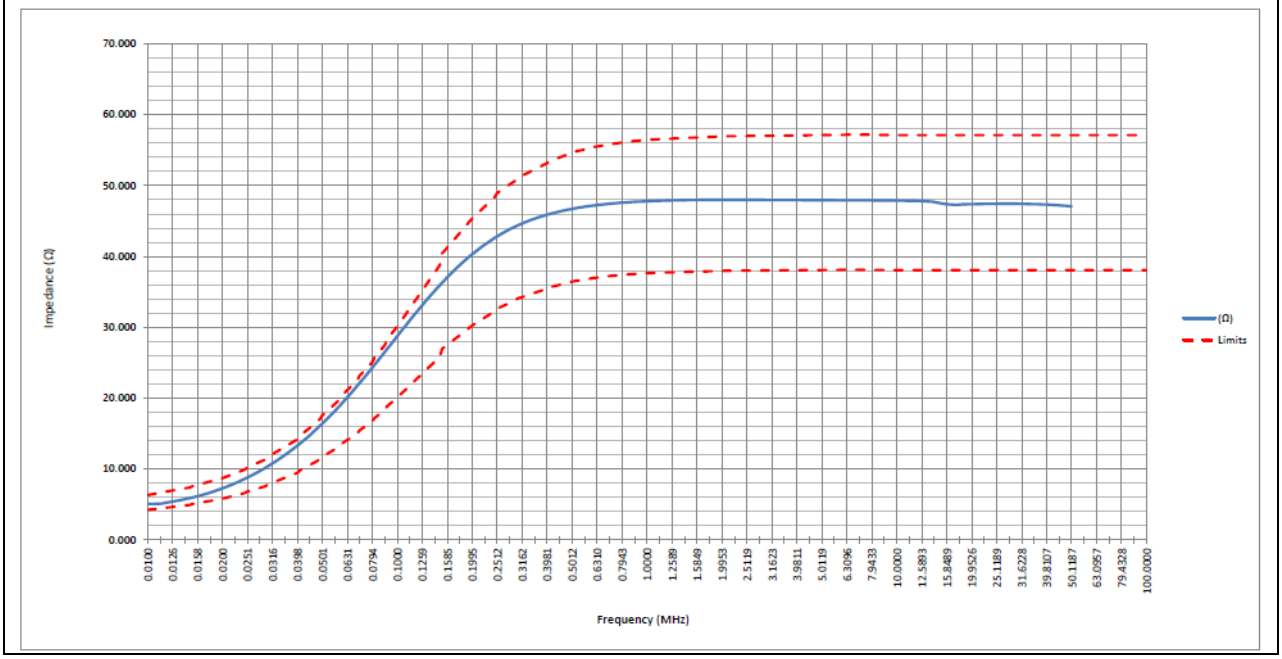


Appendix B: LISN Impedance

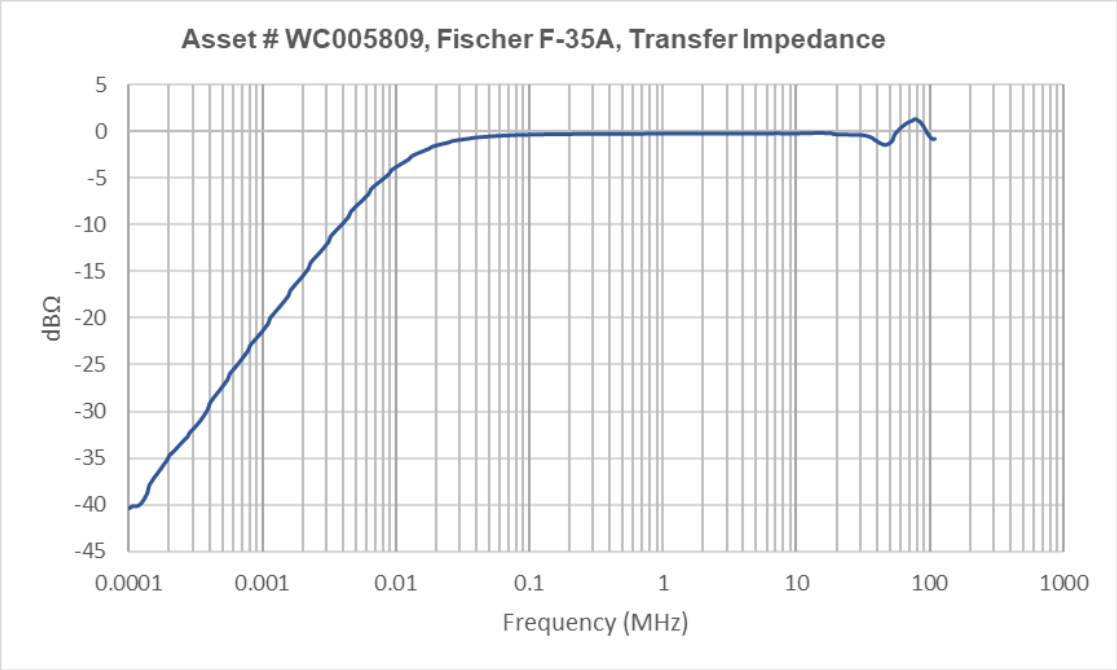
Asset Number	Manufacturer	Model
WC005292	Solar Electronics	8028-50-TS-24-BNC

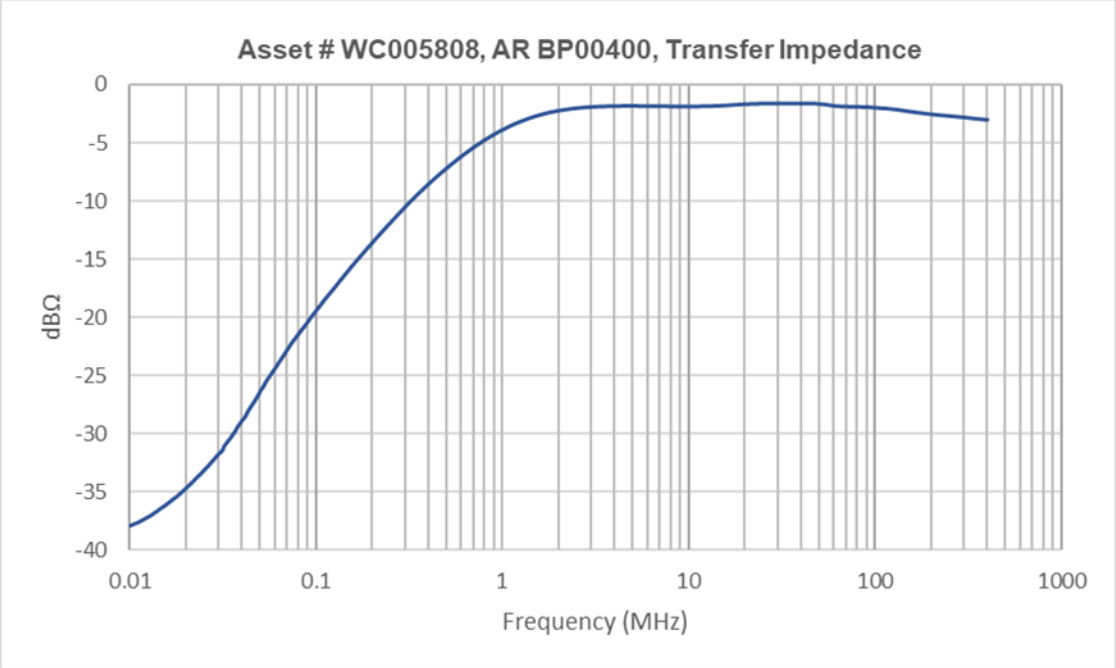


Asset Number	Manufacturer	Model
WC005289	Solar Electronics	8028-50-TS-24-BNC



Appendix C: Correction Factors





End of Test Report

Unclassified Defense Technical Data
***** Refer to restrictions on first page *****