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Examination of Space Vehicle Ethernet Interconnects

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NASA Engineering and Safety Center Technical Assessment Report

Examination of Space Vehicle Ethernet Interconnects

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1.0	Initial Release	Robert F. Hodson, NASA Technical Fellow for Avionics, LaRC	8/29/2023

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Technical Assessment Report

1.0 Notification and Authorization

The NASA Engineering and Safety Center (NESC) was requested to examine the performance of Ethernet in space vehicle configurations at the physical layer and develop guidance for system designers to ensure correct Ethernet operation in these systems. The objective of the assessment was to develop guidance and requirements for Ethernet cable and connectors for spaceflight environments and make recommendations for Ethernet systems used in flight-critical space applications.

Mr. Robert Hodson, NASA Technical Fellow for Avionics, was selected to lead this assessment, and Mr. George Slenski (wire and cable subject matter expert (SME)) was selected as the technical lead. The stakeholders for this assessment are the Commercial Crew Program (CCP) Chief Engineer; Gateway Program Chief Engineer; Gateway Habitation and Logistics Outpost (HALO) Chief Engineer; and the Human Landing System (HLS) Integrated Avionics Insight Team Lead.

2.0 Signatures

Submitted by: NESC Lead

Original signatures on file.

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Signatories declare the findings, observations, and NESC recommendations compiled in the report are factually based from data extracted from program/project documents, contractor reports, and open literature, and/or generated from independently conducted tests, analyses, and inspections.

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3.1 Acknowledgments

The team gratefully acknowledges the technical review provided by the following peer reviewers: Steven Gentz, Suzanne Davidson, Joseph Minow, Paul Paulick, Jon Holladay, James Butler, Robert Donnelly, and Mark Terrone.

4.0 Executive Summary

The NASA Engineering and Safety Center was requested to develop guidance and requirements for Ethernet cable and connectors for spaceflight environments and make recommendations for Ethernet systems used in flight-critical[1] space applications. Presently, most deployed spacecraft systems use Ethernet protocols based on Category (Cat)5e 100 megabits per second (Mbps) (10/100BASE-T), which operate up to 100 megahertz (MHz). NASA spacecraft under development are using Cat6 Ethernet, which supports 1 gigabit per second (Gbps) Ethernet (1000BASE-T) and operates up to 250 MHz, and Cat6a Ethernet, which supports 10 Gbps Ethernet (10GBASE-T) and operates up to 500 MHz. This assessment demonstrated a cable analyzer (e.g., Fluke DSX 5000) to be an effective tool for certifying that an Ethernet cable will reliably operate as a communication link for an Ethernet network. A cable analyzer can be used to validate and troubleshoot connectorized Ethernet cables prior to and post installation in a vehicle. During this assessment, a review of past and present aerospace Ethernet system issues and testing demonstrated that when qualified Cat6a Ethernet cables and connectors are used, the connector and its termination process most influence Ethernet performance. Ethernet cables and connectors that do not meet Ethernet Cat6a requirements may maintain network links, but the cable is more susceptible to loss of network data packets and other errors when operating in electromagnetic interference (EMI) environments.

Building functional Ethernet cables is technically challenging and is best accomplished by personnel who routinely build high-speed data cables. It is critical to maintain Ethernet twisted-pair twists and shielding as close as possible (less than 0.125 inch (3.17 millimeters (mm)) in connector terminations to meet the Cat6a performance requirements, which exceed Ethernet specification requirements. Ethernet cables are highly susceptible to subtle manufacturing variations that can negatively impact Ethernet performance for Cat6 and above. For the most consistent and reliable Ethernet cable performance, connectorized cable assemblies should be procured directly from component manufacturers or vendors that specialize in building Ethernet cable assemblies for aerospace applications.

When using Ethernet cables to communicate between computer systems, the cable assembly's susceptibility to EMI (e.g., electrostatic discharge (ESD) events) should be evaluated, as these can create network data errors. A significant finding was that networked computers did not lose the network link at a 1000BASE-T data rate when ESD discharges (up to a 16 kilovolts (kV)) were applied to the evaluated Ethernet cables and connectors. Testing revealed that Ethernet systems should use a cable that has individually shielded twisted pairs and an overall shield surrounding all pairs with a 360-degree cable shield termination to each connector. A cable connector electrically bonded directly to the system ground plan exhibited fewer data packet errors than a connector connected to the ground plane indirectly through the cable shielding. The commercial off-the-shelf (COTS) Ethernet cables and connectors that were evaluated by the NESC assessment team did not perform as well as qualified cables (e.g., AS6070) and connectors (MIL-DTL-32554) in meeting Cat6a cable requirements with multiple connector

[1] NASA NPR 8715.3D defines *critical* as "A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware."

segments and in the number of lost data packets during ESD discharge testing. Cable and connector standards are designed to meet Cat6a requirements in aerospace environments. Use of COTS Ethernet cables and connectors should require additional review and independent testing. Finally, a NASA handbook or industry guide should be developed for procuring, building, and testing Ethernet cable assemblies.

5.0 Assessment Plan

Multiple space systems (both fielded and under development) have flight-critical high-speed Ethernet systems. The environments and harness implementation can vary significantly from terrestrial systems. Multiple space vehicles have experienced anomalous behavior on Ethernet links, demonstrating a lack of robustness in these implementations. Deeper understanding and guidance are needed to reduce project/program risk for Ethernet-based systems.

Recent flight anomalies [Lessons Learned Information System (LLIS) 31403] associated with Ethernet networks fielded on space systems have resulted in both corruption of synchronization symbols (false carriers) and loss of data (dropped Ethernet frames). These anomalies point to implementations that have vulnerabilities leading to bit error rates beyond what is typically considered acceptable for Ethernet systems. There has been a notable increase in Ethernet-based command and control designs at NASA and in the aerospace community. Application of Ethernet in space vehicles has unique challenges (e.g., ESD resilience, controlling impedance through long runs with multiple connectors, shielding through interconnects, shock/vibration environment, etc.) that must be overcome.

The NESC was requested to examine the performance of Ethernet in space vehicle configurations at the physical layer and develop guidance for system designers to ensure correct Ethernet operation in these systems. The objective of the assessment was to develop guidance and requirements for Ethernet cable and connectors for spaceflight environments and make recommendations for Ethernet systems used in flight-critical space applications.

The key deliverable is this NESC final report documenting test results and findings and including guidance and/or requirements for future NASA spacecraft high-speed Ethernet designs.

The assessment was divided into seven tasks:

- Task 1 – Review existing studies on best Ethernet design and manufacturing practices.
- Task 2 – Consult NASA SMEs on recent challenges with Ethernet spacecraft systems.
- Task 3 – Select and procure cables and connectors/build harnesses.
- Task 4 – Identify Ethernet cable electrical and environmental tests to be conducted.
- Task 5 – Identify required lab equipment.
- Task 6 – Conduct testing.
- Task 7 – Analyze test data and prepare test reports and final report with findings, observations, and NESC recommendations.

The NESC assessment team met virtually weekly to accomplish the tasks, with the laboratory work and testing conducted at Goddard Space Flight Center (GSFC) by government and contractor personnel.

6.0 Problem Description, Evaluation Techniques, Test Results, and Analysis

6.1 Task 1: Review Existing Studies on Best Ethernet Design and Manufacturing Practices

A number of NASA reports and technical papers were reviewed to establish the type of local area networks (LANs) used and expected to be used on new spacecraft to provide command and control and other critical functions. Presently, most deployed spacecraft Ethernet systems use 100 Mbps Ethernet (e.g., 100BASE-TX) over Cat5e, which operates up to 100 MHz. Spacecraft under development are using Ethernet systems up to 1 Gbps Ethernet (e.g. 1000BASE-T) over Cat6, which operates up to 250 MHz, and Cat6a, which supports 10 Gbps Ethernet (10GBASE-T) and operates up to 500 MHz [Paul and McKnight, 1979a, 1979b; Knobloch et al., 1998; Lefferson, 1971; Baltag et al., 2017].

Ethernet SMEs supporting United States (US) Department of Defense (DoD) Ethernet activities provided the NESC assessment team with common problems and challenges of Ethernet systems used on military aircraft. The DoD maintains a group responsible for qualifying wiring and connectors that are based on military specifications and aerospace standards developed by SAE International. Due to inconsistencies in Ethernet performance, this group helped develop an SAE Ethernet cable specification [AS6070] designed for two-pair 100BASE-T [AS6060/1], four-pair 1000BASE-T [AS6070/5], and four-pair Cat6a [AS6070/6] operations, depending on the specification slant sheet (see Figure 6.1-1). Most of these cables operate over a temperature range of –55 to +200 °C, are qualified for aerospace applications, and use materials that would be expected to meet NASA outgassing requirements in vacuum [NASA-STD-6001]. Standardizing Ethernet cables and impedance-controlled Ethernet connectors reduces supportability burdens (e.g., install procedures, required tooling, spares/parts, training); ensures specification compliance, quality level, and reliability; and reduces the dependence on sole-source vendors, which has become a major issue with limited product availability.

DoD SMEs indicated that Ethernet network systems initially attempted to use MIL-DTL-38999 connectors, which are not impedance matched to 100-ohm twisted-pair Ethernet cables [MIL-DTL-38999]. Typical MIL-DTL-38999 connectors lack shielding between the wire terminations (i.e., sockets and pins) that enter the connector, which can allow for crosstalk between the four twisted pairs and any other circuits that may be adjacent to the Ethernet lines. Most COTS connectors that are not specifically designed or intended for Ethernet applications share these same characteristics. As a result, connector selection, signal line termination, and shielding topology are typically the source of most Ethernet problems related to Ethernet errors (e.g., dropped data packets or corrupted data). This is especially true when operating at and above 100 Mbps, 100BASE-T, where cable and connector impedance mismatches may introduce nonlinear effects able to reduce signal-to-noise ratio through one or more connector interfaces.

Many Ethernet connector vendors demonstrate the stability and performance of their connector systems by placing up to five or six connectors in series with a 1-meter (m) (39.4 inches) or longer segment of cable between each connector. The assembled cable is tested with a cable analyzer designed to certify that the Ethernet system meets electrical performance requirements for Category cables (e.g., Cat5, Cat6, and Cat6a). A commonly used Ethernet cable analyzer is the Fluke DSX 5000, which was tested during this assessment. Figure 6.1-2 shows a typical cable analyzer performance output for near-end crosstalk (NEXT) when multiple connectors are used. In the figure, one connector system used standard MIL-DTL-38999 connectors that are not controlled impedance. In this configuration, five mated connectors failed Cat5e and Cat6a NEXT limits over the entire frequency range. A second connector system used five TE Conductivity® CeeLok FAS-X® impedance-matched connectors designed and qualified to MIL-DTL-32546 (i.e., a high-speed data bus connector military specification specifically for high-speed data bus lines and Cat6a-level requirements) and designed to pass the NEXT requirement for both Cat5e and Cat6a [MIL-DTL-32546]. This configuration passed Cat5e and Cat6a NEXT limits, as shown in Figure 6.1-2. The figure graphically illustrates one reason the military developed MIL-DTL-32546. There are now several vendors qualified to this specification.

Another challenge is that termination of a connector requires untwisting of the Ethernet pairs, which increases the potential for crosstalk interference between Ethernet pairs and between Ethernet pairs and other signals located near the Ethernet lines. Standard ANSI/TIA-568.0-E specifies (para. 6.2.3.1) a maximum un-twist of 0.5 inches for Cat5e Ethernet and for higher-speed Ethernet cables that are terminated at a connector [ANSI/TIA-568.0-E]. It was noted that some original equipment manufacturers (OEMs) allow up to 1 inch of untwist when terminating a connector used in an Ethernet system. Typical examples of connector terminations are shown in Figure 6.1-3. Maintaining twisted-pair wire twist and shielding of individual pairs up to the connector edge is not a requirement for most wiring applications. For Ethernet systems based on Cat5e and higher data rates, the wire twist but not the shield is required to be maintained to within 0.5 inches of the connector edge. There is no requirement for replacing the shield that is removed from the twisted pairs during the termination process. The overall shield that surrounds all four pairs is required to be maintained after connector termination and to be electrically bonded to the connector housing. Most Ethernet cable and connector vendors provide detailed instructions for terminating Ethernet lines to connectors and advise maintaining the pair twist as close as possible to the connector contacts. These instructions were followed during the fabrication of the Ethernet cables used in this assessment (see Appendix A).

While this assessment focuses on the Ethernet cables, the NESC assessment team considered features and functions in physical layer devices (PHYs) that could aid in identifying Ethernet cable issues. A PHY transceiver is an integrated circuit that connects the cable interface (two to four copper pairs or optical fiber) of the Ethernet to implement the hardware send and receive functions of Ethernet frames to a digital format. Its purpose is to provide analog signal physical access to the network link by decoding and encoding the transmitted data using various error detection and correction routines [Knobloch et al., 1998]. The PHY is commonly connected to a media access control (MAC) chip in a microcontroller or other system that receives and processes transmitted data (Figure 6.1-4). PHY functions are defined in Institute of Electrical and Electronics Engineers (IEEE) 802.3 (i.e., Ethernet standard that defines the physical layer and the MAC of the data link layer for wired Ethernet networks) [IEEE 802.3]. While not required by IEEE 802.3, a number of PHY vendors have incorporated Ethernet cable diagnostics in their devices by including a built-in time domain reflectometry (TDR) capability. A TDR operates fundamentally similar to radar by transmitting a narrow, pulsed signal into one or more pairs of conductors in a cable. If and when the transmitted pulse encounters an impedance discontinuity (e.g., associated with a connector termination or a physical change in the conductor twist or shielding configuration), then the pulse is partially reflected back toward the TDR source and partially transmitted past the discontinuity with a corresponding loss of energy. The instrument records the time of initial pulse transmission and determines the amount of time between transmission and when a reflected signal arrives back at the source. This information is converted into a distance along the cable, thereby providing the location of the cable fault. The velocity of propagation (VoP), measured in meters per second (m/sec), in the cable under test (CUT) directly relates to the distance calculation of the instrument. The width of the transmitted pulse determines the distance over which the pulse is able to travel and return to the source without suffering loss of data caused by the attenuation of the CUT. A wider pulse contains greater energy and travels further. As an example, the Texas Instruments (TI) DP83561-SP technical data sheet [Rashid, 1978] describes a feature that transmits a test pulse of known amplitude down each of the four pairs of an attached cable. The transmitted signal continues down the cable and reflects from each cable, connector, or fault from the end of the cable. After the pulse transmission, the DP83561-SP measures the return time and amplitude of the reflected pulses with a reported accuracy of ±1-m over a 100-m cable. The TDR feature of the DP83561-SP can be programmed to automatically activate when an Ethernet link fails or is dropped, with the results saved in TDR registers that can be accessed through the vendor's control software. Vendors (e.g., TI, Marvell, and Microsemi) offer various types of cable diagnostics on their PHYs and software for accessing and analyzing TDR results.

Image removed due to Copyright restrictions.

Figure 6.1-1. Qualified AS6070 Ethernet Cables that Meet Cat6a Requirements are Available from Multiple Sources[2]

Image removed due to copyright restrictions.

Figure 6.1-2. NEXT with a Cable Analyzer for Two-pair Cat5e and a Four-pair Cat6a Ethernet System with Five Mated Connectors and Six Cable Segments[3]
The connector system on the left uses five mated standard MIL-DTL-38999 connectors that fail Cat5e and Cat6a NEXT limits over the entire frequency range. The connector system on the right uses five CeeLok FAS-X impedance matched connectors designed and qualified to MIL-DTL-32546, high-speed data bus lines, and Cat6a requirements, and passes the NEXT requirement for both Cat5e and Cat6a [TE Connectivity, 2021]

[2] See AS6070/5. "Cable, High Performance, 4 Pair, Shielded, 100 ohm, 200 °C, Ethernet 1000 BASE-T," SAE AS6070/5B, October 13, 2022. AS6070/6. "Cable, High Performance, 4 Pair, Shielded, 100 ohm, 200 °C, Ethernet 10G BASE T," SAE AS6070/6.

[3] See TE Connectivity (2021). "TE CeeLok FAS-X Connectors: The High-speed Solution for 10G Ethernet Data Delivery using Rugged, MIL-SPEC Components," February 2021 pg 4.

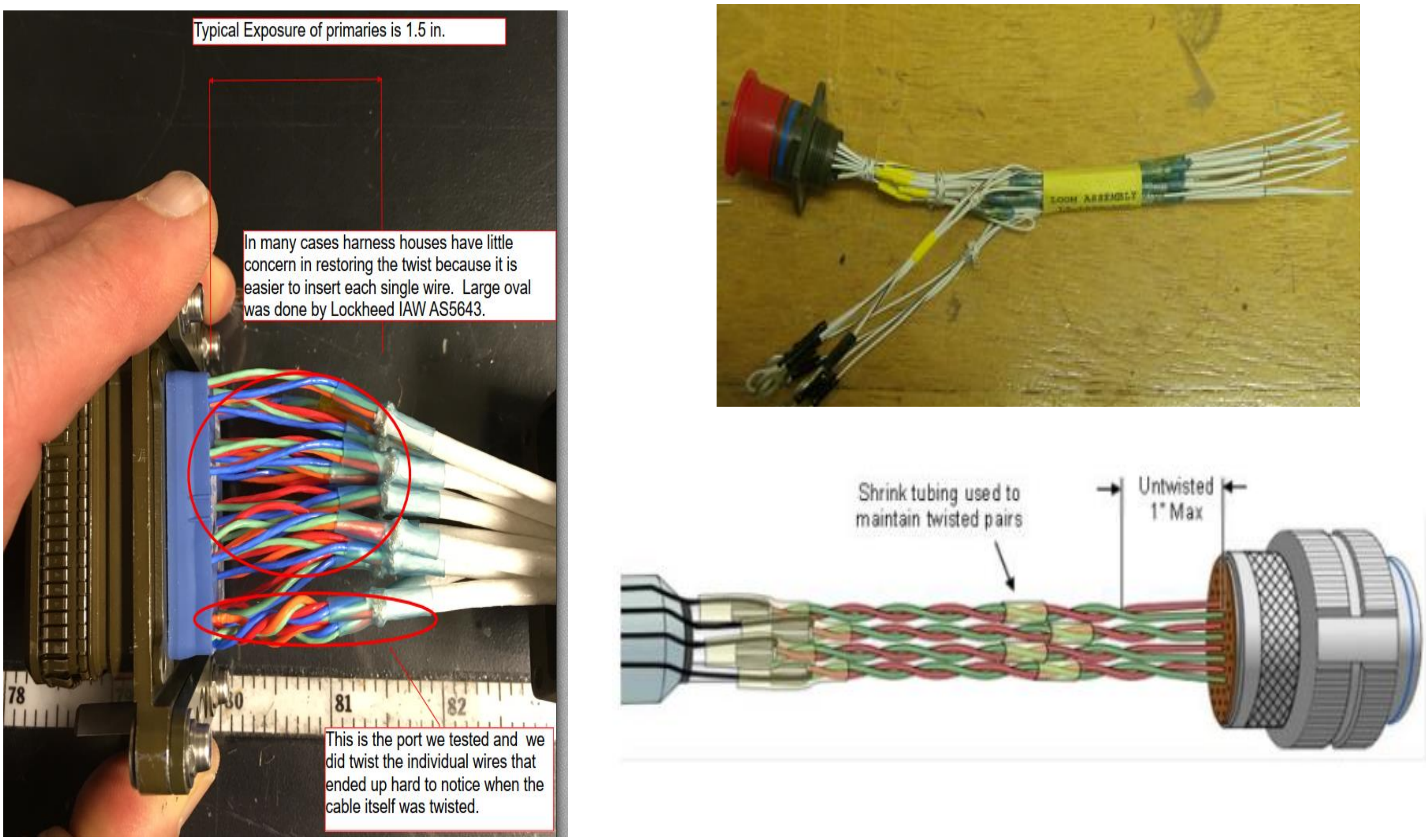

Figure 6.1-3. M38999 Connectors Designed for Hookup Wire Applications
Workmanship for hookup wire does not address the needs of of high data rate or Ethernet cables, which must maintain wire pair twist to less than 0.5 inches to meet crosstalk and return loss (RL) requirements [ANSI/TIA-568.0-E, para. 6.2.3.1]. There is no published requirement to maintain shielding within 0.5 inches if individual twisted pairs are shielded, but this assessment found that continuation of the shielding as close as physically possible to the entry into the connector was criticial to successful performance.

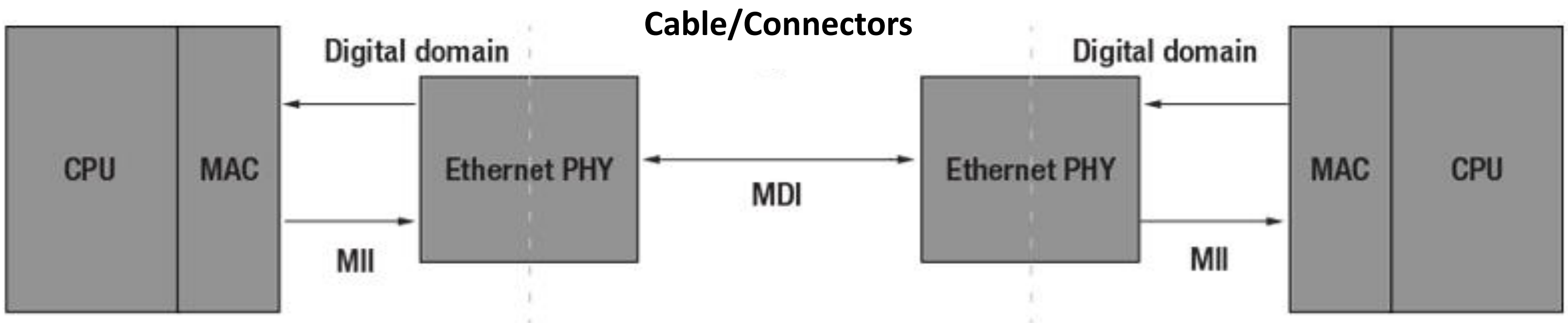

Figure 6.1-4. LAN Block Diagram showing How Ethernet Cable and Connectors (analog domain) provide Digital Information Transfer between Two Computers (CPUs)
The PHY provides analog signal physical access to the network link by decoding and encoding the transmitted data using various error detection and correction routines. A media-independent interface (MII) transfers digital data between the MAC and the PHY, and the MAC chip receives and processes transmitted data to the CPU. The two PHY devices shown in the figure communicate over a media-dependent interface (MDI). In some applications, a media-dependent interface crossover (MDIX) is used.

As part of the process of reviewing Ethernet system development, a number of documents were collected regarding Ethernet design and manufacturing best practices:

- Ethernet papers:
  - Gateway Avionics Concept of Operations for Command and Data Handling Architecture [Muri et al., 2021].
  - Comparative study of Ethernet technologies for next-generation satellite on-board networks [Chaine et al., 2021].
  - A Beginners Guide to Ethernet 802.3 [Neuhaus, 2005].
  - Development of Data Bus Technology in Next Generation Spacecraft [Wei et al, 2020].
  - Ruggedized Connectors for 10 Gigabit Military Applications [Moore, 2018].
- List of standards that can be downloaded from NASA servers:
  - IEEE STD 802.3, IEEE Standard for Ethernet
  - SAE AS6070, Aerospace Cable, High Speed Data, Copper
  - AS6070/5, Cable, High Performance, 4 Pair, Shielded, 100-ohm, 200 °C, Ethernet 1000BASE T, SAE J3117/2, 1000BASE-T1 Un-Shielded and Shielded Balanced Single Twisted Pair Ethernet Cable, Qualified Parts List (QPL) sources available
  - AS6070/6, Cable, High Performance, 4 PAIR, Shielded, 100-ohm, 200 °C, Ethernet 10G BASE T, QPL sources available
  - MIL-DTL-32546, Connectors, Electrical, Circular, for High-speed Data Bus Transmission, Copper Conductor, General Specification for
  - ANSI/TIA-568.0-E, Generic Telecommunications Cabling for Customer Premises
  - ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  - ANSI/TIA-1152-A-2016 Requirements for Field Test Instruments and Measurements for Balanced Twisted- Pair Cabling
  - TIA-1005-A, Telecommunications Infrastructure Standard for Industrial Premises
  - NASA-STD 8739.4 with Change 6, Crimping, Interconnecting Cables, Harnesses, and Wiring
- Gore papers on designing and manufacturing Ethernet systems (publicly available):
  - TE Connectivity CeeLok FAS-X Connector System Electrical Performance [Gore, 2022a].
  - Risk of Transmitting High-speed Data in Aircraft Using 38999 Connector Systems [Gore, 2022b].
  - Installing the Right Ethernet Interconnect to Ensure Reliable Performance in Aircraft [Gore, 2015].
  - Selecting the Right Ethernet Cables to Increase High-Speed Data Transmission in Aircraft [Gore, 2016].
- Ethernet wiring, connector, and PHY data sheets:
  - Gore_Cat6a_RCN9047-26_Rev F (see Figure 6.3-2).

- Gore_Ethernet_RCN9034-24 (see Figure 6.3-3).
- Gore Ethernet Cables four-pair data sheet AS6070-6 [Gore, 2023].
- Gore termination process for a CeeLok FAS-X connector (see Appendix A).
- Gore termination process for a Mil-DTL-38999 connector (see Appendix A).
- TE Connectivity Cat6a CeeLok FAS-Xconnectors high speed data cables [TE Connectivity, 2021].
- CeeLok FAS-X Cat6a connector termination process (see Appendix A).
- PIC Wire & Cable Cat6e cable and connector technical data [PIC, 2023a].
- PIC Wire & Cable Cat6A connector termination process (see Appendix A).
- Stewart Cat8 RJ45 connector control drawing and termination process (see Appendix A).
- TI DP83561-SP radiation-hardness-assured (RHA), 10/100/1000 Ethernet PHY transceiver [TI, 2021].

6.2 Task 2: Consult NASA SMEs on Challenges with Ethernet Spacecraft Systems

NASA programs were contacted, and the following basic Ethernet design information was obtained:

- NASA's Exploration System Development programs are reportedly using an eight-wire (four-pair) 1000BASE-T Ethernet system and a four-wire (two-pair) 100BASE-TX (Cat5) and 1000BASE-CX Ethernet system (Cat6). An Ethernet system uses the four-wire 1000BASE-CX for a time-triggered gigabit Ethernet as the vehicle data bus consisting of Gore cables and connectors/contacts from Smiths (Sabritec). A 1000BASE-T is used for payloads and is a 100-ohm controlled-impedance four-pair cable that is terminated into MIL-DTL-38999 and Glenair 791 type connectors using standard contacts that are not impedance controlled [MIL-DTL-38999]. The Glenair 791 connector is a Micro-D rectangular connector similar to a MIL-DTL-24308 D sub-type rack and panel connector that uses standard contacts [MIL-DTL-24308]. For test equipment, some programs are using a bit error rate tester (BERT) to perform post-installation testing of the 1000BASE-CX and a network analyzer for the 1000BASE-T for post fabrication and installation testing.
- The human-tended space station that will orbit the Moon and provide a stopover for commercial space systems is reported to be using a 100BASE-T (four-wire) and 1000BASE-T (eight-wire) Ethernet system.
- The International Space Station (ISS) uses a 10, 100, and 1,000BASE-T with MIL-DTL-38999 connectors and standard contacts.
- A future system being built for NASA use will reportedly include 100BASE-T and 1000BASE-T Ethernet systems using MIL-DTL-38999 and MIL-DTL-24308D subconnectors using standard contacts.
- Several NASA programs are using Ethernet systems to interconnect and communicate between flight-critical avionic boxes.
- Commercial space programs are using a four-wire (two-pair) 100 and 1000BASE-T (Cat5) Ethernet with MIL-DTL-38999 connectors with up to seven connectors in series through multiple bulkheads.

The NESC assessment team consulted with NASA wiring SMEs on challenges with Ethernet spacecraft systems and the following list of technical issues regarding Ethernet failure causes/mechanisms was generated:

- Cable and/or connector ESD events at or near connectors have caused Ethernet data packet errors and false carriers when a static discharge occurs. An Ethernet false carrier indicates a corrupted idle symbol or bit error. Ethernet transmits idle symbols when data are not otherwise being transmitted to maintain synchronization between transmitters and receivers. In terrestrial networks, false carriers tend to be extremely rare events since an Ethernet link typically exhibits a bit error rate on the order of 1 in 10 billion. On multiple flights, high false carrier counts (i.e., several hundred) were noted between launch vehicle stage communication links during ascent at an altitude of between 10 and 15 km (Max Q region). Lower false carrier counts were noted on all three redundant Ethernet links used to communicate from the spacecraft to the launch vehicle. Although false carriers do not necessarily result in a loss of Ethernet communication, they are an indicator of a degraded connection. Of particular concern was the common cause nature of the anomaly occurring simultaneously on all three redundant Ethernet links. A NASA Lessons Learned topic was created [LLIS 31403, 2022]. In addition, IEEE standard 802.3-2018 (para. 126.9.2, Network Safety) cautions that a direct electrical safety hazard to network systems is the buildup of static charge from various sources on Ethernet cables and components (e.g., connectors). Recommendations within these lessons learned are to take measures to protect network systems from this type of hazard, which requires testing and analysis if there is a static discharge concern.
- Intermittent electrical contact in mated connectors (i.e., contact fretting) as a result of high vibration and shock levels can create Ethernet errors due to signal interruption. This is an example of impedance discontinuity.
- Inadequate shielding at the connector interface and/or cable can inject noise into the Ethernet pairs and lead to data errors (e.g., impedance discontinuity).
- Crosstalk between cable pairs or other wires in a cable can result in Ethernet data errors when wire pairs are untwisted to terminate into a connector. Ethernet specifications recommend no more than a one-half untwist of the pairs when terminating into a connector. This is another example of impedance discontinuity.
- Excessive cable length and bending introduces increased cable attenuation and impedance changes, respectively. Increased cable attenuation can result in an inadequate signal-to-noise ratio over the link. The introduction of impedance change related to excessive bending of the cable results in increased signal reflection and a low RL margin.
- Ethernet data packet errors can occur due to impulse noise generated by internal charging or triboelectric charging. Triboelectric charging can occur when a cable is moved or flexed due to vibration and/or shock stresses. Electrostatic charges can accumulate when dielectric materials come into contact and are then separated or rubbed together. These types of effects are attributable to poor cable shielding integrity.
- Oxides and/or contamination on connector electrical contacts can result in intermittent connection and introduce noise into an Ethernet system, leading to data errors (e.,g impedance discontinuity).

- Radiated EMI can be imposed on the Ethernet data cables; the resulting EMI-induced signals can cause data errors as a result of an inadequate signal-to-noise ratio. Sources of EMI include lightning indirect effects, static charging, and high-intensity radiated field generators (e.g., radars and other transmitters). These types of effects are attributable to poor cable shielding integrity.
- Cable electrical characteristics are not adequate for length of cable (TIA standards recommend cable lengths less than 100 m) and when there are multiple connectors in series. At each connector termination, there is an impedance mismatch that produces reflections and a resulting signal attenuation. When multiple connectors are present, signal quality can become marginal, and the Ethernet system can become susceptible to errors as a result of noise from multiple sources. As signal degradation increases, the Ethernet error correcting routines will eventually be unable to sustain the data speed, and errors (e.g., false carriers and dropped data packets) may occur. Under severe degradation, loss of the Ethernet link can occur, and the Ethernet system will need to renegotiate the link, making the system unavailable (up to several seconds) for communication between computer systems (i.e., excessive cable attenuation and multiple impedance discontinuities).
- At least one OEM suggested there may be a concern with Ethernet cable and/or connector signal degradation at cold temperatures (below –55 °C).
- Based on conversations with NASA SMEs and OEMs, connectors used in Ethernet systems are the source of most Ethernet performance issues. Inadequate shielding and untwisting of the twisted pairs at the termination or through the connector allow noise to be injected into the Ethernet system. As mentioned, impedance mismatches at the termination and connector can create reflections that attenuate the signals and make the Ethernet system more sensitive to data errors and lost data packets.
- As stated for aerospace applications, the Naval Air Systems Command (NAVAIR) recommends using only Ethernet cables qualified to AS6070 and connectors qualified to MIL-DTL-32546.
- Use of commercial Ethernet connectors and cables for aerospace applications can lead to poor Ethernet system performance as the components likely will not meet the minimum requirements for the selected Ethernet system application. Use of qualified cables and connectors is preferred and strongly recommended.

The NESC supported an effort to investigate the cause of Ethernet errors that occurred during a CCP launch [LLIS 31403, 2022]. Flight anomalies associated with Ethernet networks have resulted in both corruption of synchronization symbols (false carriers) and loss of data (dropped Ethernet frames). While the Ethernet system never lost link and command and control was never lost, the observed anomalies demonstrate cable and/or connector vulnerabilities that most likely led to bit error rates beyond what is typically considered acceptable for Ethernet systems. To better understand the cause of the false carriers and dropped data packets, a simplified fishbone chart was created to show conditions that can cause Ethernet errors (see Figure 6.2-1). The fishbone chart was divided into four potential failure areas that could cause data errors of one or more Ethernet lines. During the investigation, a number of failure causes were considered unlikely based on the telemetry data and laboratory testing (see black text in Figure 6.2-1). Failure causes shown as red text were considered possible, and those shown in bold red text were considered the most likely sources of Ethernet data errors. Many of the potential failure causes are discussed in Section 6.3 of this report.

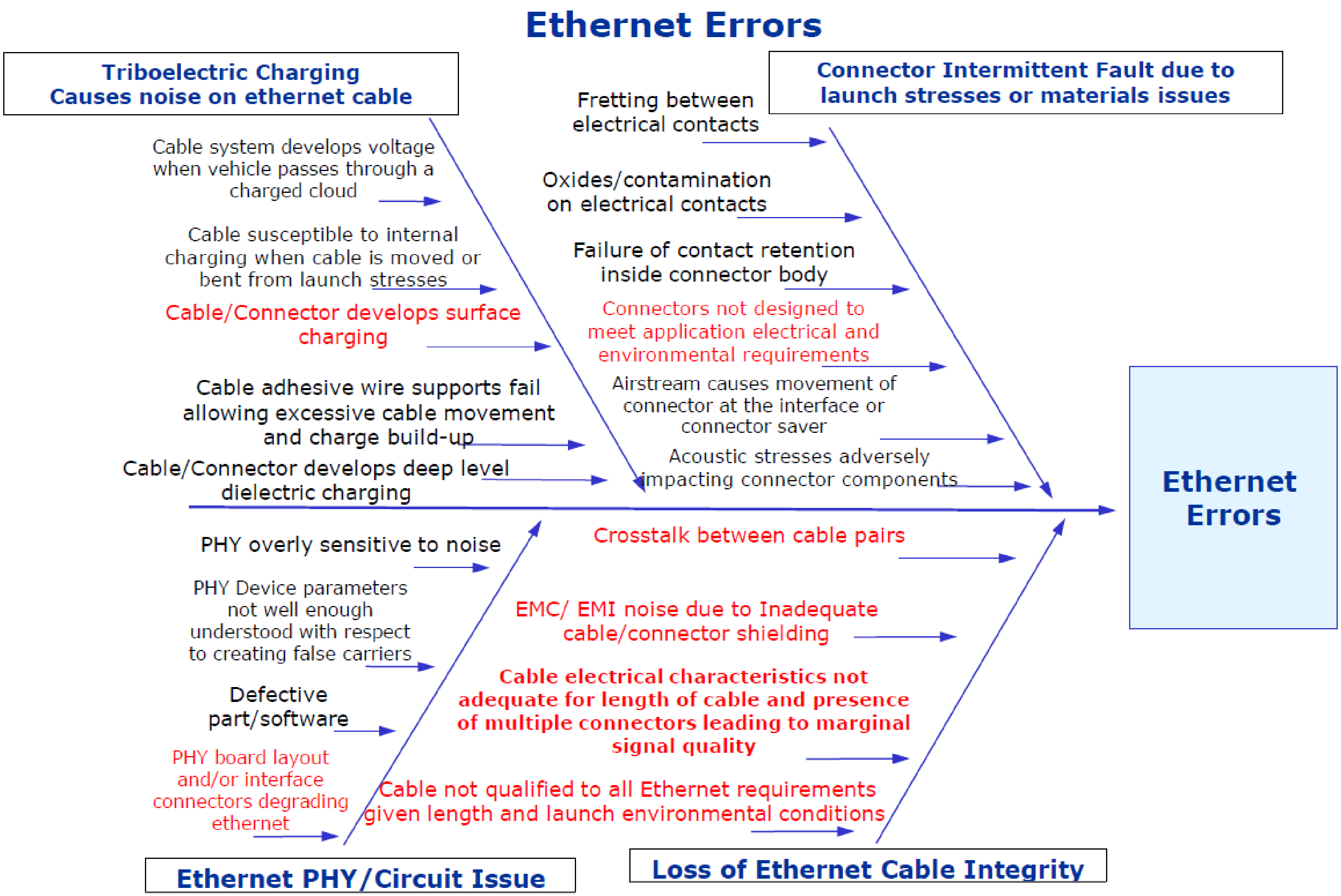

Figure 6.2-1. Simplified Ethernet Error Fishbone Chart

6.3 Task 3: Select and Procure Cables and Connectors/Build Harnesses

A primary focus of the assessment was to evaluate Ethernet connectorized cable systems using Ethernet designed cables, impedance-controlled connectors, and standard MIL-DTL-38999 connectors that are not impedance matched to four- or eight-wire Ethernet systems. The NESC assessment team noted in their examination of NASA programs that use Ethernet that most existing systems use a Cat5 or Cat5e with 100BASE-T. Most NASA systems under development have selected Cat6 and Cat6a Ethernet systems. In some cases, programs are using standard MIL-DTL-38999 connectors, while other programs are selecting impedance-controlled connectors. As a goal for this assessment, the NESC assessment team selected a Cat6a Ethernet system that fully supports 1000BASE-T), which has a frequency requirement up to 500 MHz.

Basic Cat6a cable is offered with and without various levels of shielding and is typically maintained in a specific geometry to minimize crosstalk between the four twisted pairs and external noise sources. This is accomplished by twisting the wire pairs, providing extra internal airspace and an internal separator between the pairs, and adding shielding around each pair and around all four wire pairs. The various cable and shielding configurations are shown in Figure 6.3-1. The best option for noise rejection from between the twisted pairs and from external noise sources is shown, where each twisted pair is shielded individually and an overall shield is used over the entire cable.

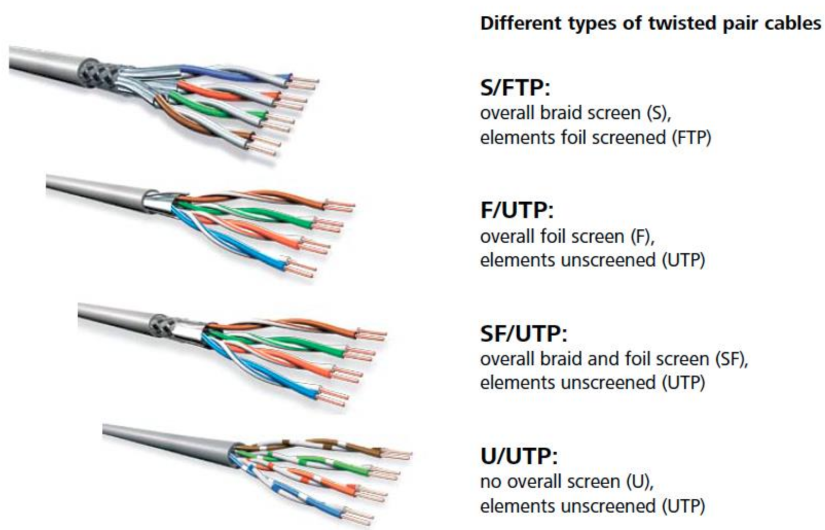

Figure 6.3-1. Examples of Ethernet Twisted Cables with Various Types of Shielding and Nomenclature
The best performing cable is shown at the top, where each twisted pair is shielded (S/FTP) and an overall shield surrounds all four twisted pairs. All four cable types are certified for Cat6a applications.

For the cable evaluation, the NESC assessment team selected a Gore Ethernet cable designed for aerospace applications. The primary cable selected meets and is qualified to industry standard AS6070/6, four-pair, shielded, 100-ohm, 200 °C, Ethernet 10GBASE-T. Each twisted pair in the cable is foil shielded (using one-sided aluminized polyimide tape), with an overall braided shield over the four twisted pairs (i.e., S/FTP). Cables were manufactured by Gore in 24 and 26 American Wire Gauge (AWG), with outer diameters of 0.28 and 0.22 inches, respectively. The

Gore part numbers were RCN9034 for the 24 AWG cable and RCN9047 for the 26 AWG cable. The Gore cable construction details and physical and electrical requirements for the selected cables are given in Figures 6.3-2 through 6.3-5.

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Figure 6.3-2. Gore Drawing for RCN9034 Cat6a 24 AWG Cable[4]

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Figure 6.3-3. Gore Drawing RCN9047 Cat6a 26 AWG Cable[5]

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Figure 6.3-4. Gore Cat6a Performance Requirements for Part Numbers RCN9024 and RCN9047 [reprinted from Gore, 2023]

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Figure 6.3-5. Physical and Materials Construction of Gore Cat6a Ethernet Cable Note that each twisted pair is shielded and there is an additional shield over all four twisted pairs [reprinted from Gore, 2023]

A commercial aerospace grade Cat6a cable was procured from PIC Wire & Cable (part number E6A0826) for comparison with the aerospace-grade industry-standard-qualified Cat6a cable. This cable was only available with four 26-AWG twisted pairs unshielded and a braid and foil shield over the four twisted pairs (SF/UTP), with an overall diameter of 0.22 inches (5.59 mm). Basic construction details and physical and electrical requirements for the PIC cable are given in Figure 6.3-6.

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Figure 6.3-6. PIC Wire & Cable Data Sheet for Procured Cat6a Ethernet Cable, PN E6A0826 26-AWG Cable [PIC, 2022]

The NESC assessment team reviewed multiple impedance-controlled Cat6a Ethernet connectors. Connector manufacturers have chosen several connector configurations that match Cat6a cable

[4] Reprinted from RCN9034_24 Gore Drawing

[5] Reprinted from RCN9047_26 Gore Drawing

impedance to minimize reflections and shielding methods to minimize crosstalk between Ethernet pairs, as shown in Figures 6.3-7 and 6.3-8. Each approach is supposed to result in a connector that closely matches the 100-ohm impedance of four-pair Cat5 and Cat6 Ethernet cables to minimize reflection losses and maintain shield integrity throughout the connector. As noted, a standard MIL-DTL-38999 connector does not match impedance or maintain shielding between individual power or signal lines inside the connector, making the Ethernet system susceptible to both attenuation due to high reflections at each connector and external and internal signal noise or crosstalk from various sources.

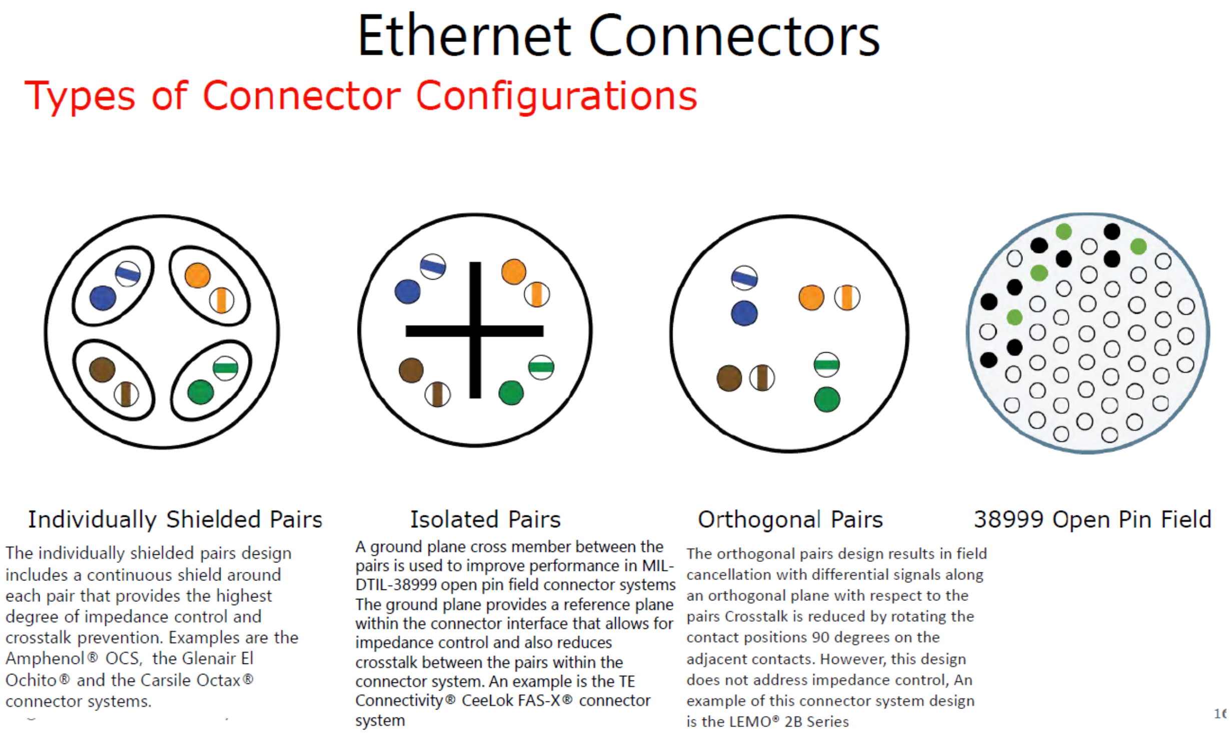

Figure 6.3-7. Manufacturer-chosen Connector Configurations that Match Cat6 Cable Impedance to Minimize Reflections and Shielding Methods to Minimize Crosstalk between Ethernet Pairs These three approaches have been shown to be effective as Ethernet systems. The far right is a standard M38999 connector that is not impedance matched to four-pair Cat6a Ethernet cable [Gore, 2022b].

Image removed due to copyright restrictions.

Figure 6.3-8. Examples of Commercially Available Aerospace-grade Cat6a Connectors [Gore, 2015]

After reviewing the connector designs and input from NAVAIR and considering availability of parts, the TE Connectivity CeeLok FAS-X Ethernet connector was selected since it is qualified to MIL-DTL-32546 (i.e., high-speed data connector military specification) [MIL-DTL-32546]. The TE CFX34 Jam Nut Receptacle (Braid Clamp Backshell) and CFX36 EMI/RFI Plug (Braid Clamp Backshell) were procured. A specification sheet for the connector type selected and the vendor-supplied physical, electrical, and Ethernet performance data are shown in Figures 6.3-9 and 6.3-10.

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Figure 6.3-9. TE Connectivity Technical Requirements for CeeLok FAS-X Ethernet Connector This connector is qualified to MIL-DTL-32546A as a Cat6a high-data-rate connector [TE Connectivity, 2021].

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Figure 6.3-10. TE Connectivity Cat6a Cable Analyzer Results showing TE Connectors Passing Cat6a 10Gb Requirements using Six 1-m (39.4-inch) Cable Segments and Five Mated Ethernet FASX Connectors [TE Connectivity, 2021]

Connectors qualified to MIL-DTL-32546 are designed for 10GBASE-T Ethernet, over four-pair cabling with cable lengths up to 328 feet (ft) (100 m). CeeLok FAS-X connectors were procured and used to create six 1-m (39.4-inch) segments of Cat6a cable, which were terminated with CeeLok FAS-X connectors. Each segment was connected in series, as shown in Figure 6.3-10. Adaptor cables were created with one side terminated with a CeeLok FAS-X connector and the other end with a shielded Cat8 RJ45 connector using the ANSI/TIA-568B color coding so the cables could be evaluated using a network card or with a network cable analyzer designed to evaluate Cat6a, Cat6, and Cat5e cable performance, as specified in ANSI/TIA-568-C.2 and ANSI/TIA-1152-A [ANSI/TIA-568B; ANSI/TIA-568-C.2; ANSI/TIA-1152-A].

As mentioned, the NESC assessment team selected a commercial Ethernet cable and connector for evaluation. Several team members had OEM partners that have evaluated PIC Wire & Cable commercial aerospace Ethernet cables. Arrangements were made to procure PIC Wire & Cable four-pair Cat6a cables and connectors. PIC Wire & Cable recommended Ethernet connector MF3817PPWN-ED MachForce SZ 17, Purple Plug Kit, and MF3817FSWN-ED SZ 17, Purple Receptacle Kit, for the Ethernet evaluation. The PIC Ethernet connector construction details and the reported vendor physical and electrical properties are given in Figures 6.3-11 through 6.3-14. Note that this connector is not qualified to a military or industry standard.

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Figure 6.3-11. PIC Wire & Cable Connector and Wire Termination (PIC Wire & Cable recommended Ethernet connector MF3817PPWN-ED MachForce SZ 17) Note that wire twist is maintained up to the electrical contact, and each pair is unshielded. The connector on the right is a M38999 configuration; however, the company is not qualified to the standard [PIC, 2023a].

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Figure 6.3-12. PIC Wire & Cable Ethernet Connector Test Results
This connector is not qualified to M38999, and test results were unavailable for review [PIC, 2022].

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Figure 6.3-13. PIC Wire & Cable Ethernet Connector Information from Technical Brochure
This is the connector type that was procured for this assessment [PIC, 2023a].

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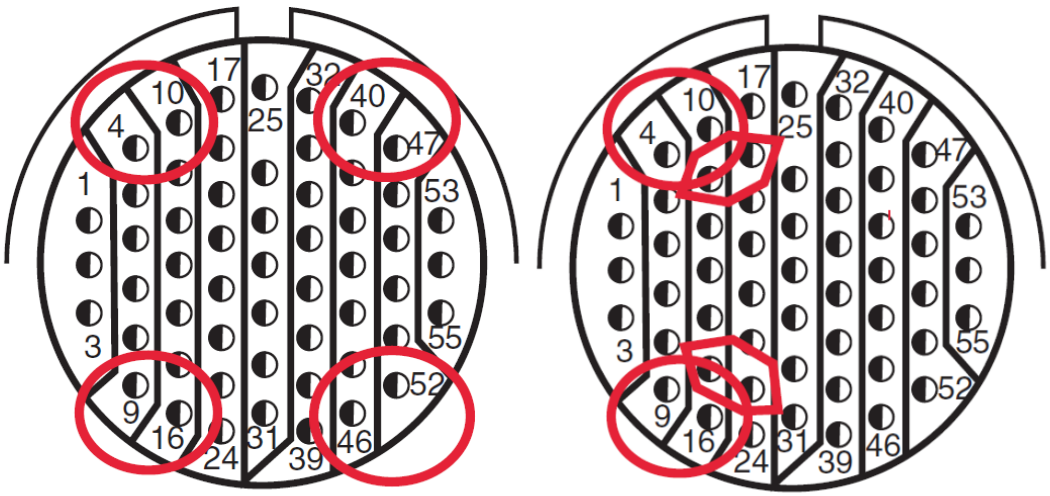
Figure 6.3-14. PIC Wire & Cable Analyzer (Fluke DSX-5000) Results from Technical Brochure using Connectors and Cables procured for this Evaluation
Results show that four cable segments connected to five Ethernet connectors can pass Cat6a requirements [PIC, 2023b].

Because several NASA programs use standard MIL-DTL-38999 connectors in Cat5 and Cat5e higher frequency and data rate Ethernet systems, the NESC assessment team evaluated standard M38999 connectors connected to Ethernet cabling. As before, five 1-m (39.4-inch) segments of Cat6a cable were built. Ethernet performance using the M39888 connectorized cables was compared with selected controlled-impedance Ethernet connectors. A Series III M38999 connector was selected in shell size 17 using insert arrangement 35, which has 55 contacts. The M38999 connector and pinouts used for the Ethernet pairs is shown in Figure 6.3-15. The assessment team planned to evaluate a composite M38999 connector, which is made of a nonconductive thermoset material that has an electroless nickel layer to provide shielding and electrical grounding; unfortunately, composite connectors could not be procured in time to evaluate for this assessment.

M38999 Ethernet Connector Pinout
Series III
Shell size 17
Insert 35
55 contacts



Cavity	Wire Color
4	Blue/White
10	Blue
9	Orange/White
16	Orange
52	Green/White
46	Green
47	Brown/white
40	Brown

Figure 6.3-15. MIL-DTL-38999 Series 3 55 Pin Connector used to Build Five 1-m (39.4-inch) Ethernet Cable Segments
The connector drawing on the left shows how four Ethernet pairs were arranged in the connector for maximum separation. The connector was also evaluated with the Ethternet pairs adjacent (drawing on right).

6.4 Task 4: Identify Ethernet Cable Electrical and Environmental Tests to be Conducted

A Fluke DSX 5000 cable analyzer was selected as the primary instrument for evaluating Ethernet cable performance. The Ethernet cable analyzer is capable of measuring cable signal attenuation, NEXT, and RLs for Cat5 and Cat6 Ethernet systems.

Two cable types and three connector types were evaluated using the cable analyzer with up to six connectors mated between 1-m (39.4-inch) cable segments. The NESC assessment team used technicians from GSFC certified to NASA-STD-8739.4 to build and terminate the Ethernet cables with the selected connectors [NASA-STD-8739.4].

A flex test using the cable analyzer was conducted on each cable type to evaluate the impact of tight bends on cable performance. A cable flex fixture was constructed based on a Gore cable design that used mandrels based on a 0.5-inch radius (1-inch diameter), which is a worst-case condition according to a Gore white paper [Gore, 2016].

The GSFC EMI laboratory conducted a transfer impedance test on a Gore cable terminated with CeeLok FAS-X connectors. Electromagnetic compatibility of the Ethernet cable was evaluated by measuring transfer impedance, crosstalk, and RL using a Keysight E5061B network analyzer. Circuit cards were designed and built so the Ethernet cables could be ported to a 50-ohm source to create a differential pair to conduct the transfer impedance test.

Two CeeLok FAS-X connectors with short pigtails were attached to the impedance matching boxes that convert the 100-ohm Ethernet cables to 50-ohm differential outputs so the transfer impedance measurement could be made with the available EMI lab spectrum analyzer.

The PWB transformers were limited to 300 MHz because higher frequencies (e.g., 600 MHz) cause significant RLs in the circuit. This limited the transfer impedance measurement to no higher than 300 MHz.

An Ethernet network was set up using two laboratory computers with standard network cards designed to operate up to 1 Gbps Ethernet (1000BASE-T). The intent was to use the as-built Ethernet cables and connector segments to establish network communication between the two computers. A computer program was set up to detect and record network data errors. An NSG 438 ESD gun and a calibration system were obtained to conduct the cable high-voltage discharge test.

Once the network was running, a data stream was set up and the ESD gun was applied to the Ethernet connector at various voltages to induce potential Ethernet data packet errors, bit errors, or slowing/loss of network communication between the two computers. The test method for applying the ESD discharge is given in Appendix C.

The original assessment test plan included connectorized cable testing under vibration and at low temperatures (–55 °C). This testing was not completed due to delays in obtaining cable components and building functional Ethernet cables. Qualified connectors and wiring selected for this evaluation were cerified to operate from –65 °C to 200 °C as Ethernet cables.

6.5 Task 5: Identify Required Lab Equipment

After reviewing the Ethernet test requirements, the NESC assessment team selected a Fluke DSX-5000 cable analyzer as the primary instrument for evaluating Ethernet cable performance. This test instrument was recommended by NAVAIR and used by several NASA OEMs for testing and evaluating Ethernet systems used in spacecraft. The Fluke DSX-5000 is a handheld instrument specifically designed for cable analysis and certification. The instrument consists of two units. One unit is the controller and transmitter, and the other is designed to reflect data back and re-transmit data so Ethernet cable characteristics can be evaluated in both directions. The instrument measures Ethernet parameters as specified in Cat5e, Cat6, and Cat6a standards [IEEE 802.3, ANSI/TIA/EIA-568-C.2] for up to 10-gigabit Ethernet systems. The cable analyzer uses an RJ45 connector system for interconnection with Ethernet cables under test. For this assessment, patch cords or adapter cables were built by GSFC technicians using qualified Cat6a Ethernet cable and shielded Cat8 RJ45 connectors (i.e., Steward Connector P/N SS-39300-10) using the ANSI/TIA/EIA-568B color coding for wire pairs [ANSI/TIA/EIA-568B]. One end of the cable was terminated with the type of connector system required by the cable under evaluation (see Figures 6.5-1 and 6.5-2). Termination instructions for the RJ45 and a control drawing with materials and electrical requirements are given in Appendix A. An example of the cable analyzer setup for a Cat6a Ethernet system and typical Ethernet Cat6a cable performance results are shown in Figures 6.5-2 and 6.5-3, respectively.

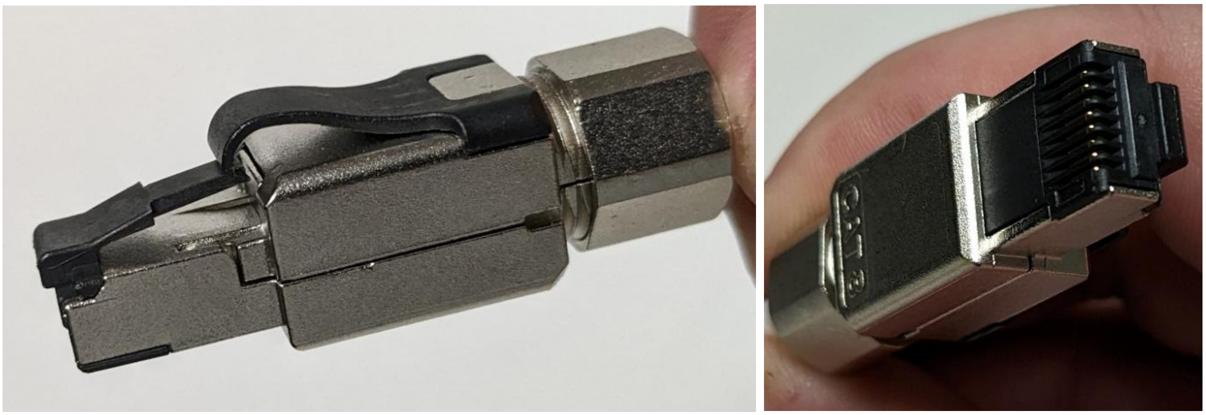


Figure 6.5-1. RJ45 Cat8 (Steward Connector P/N SS-39300-10) Metal Shielded Connector used with Adaptor Cables for Connecting to Fluke Meter

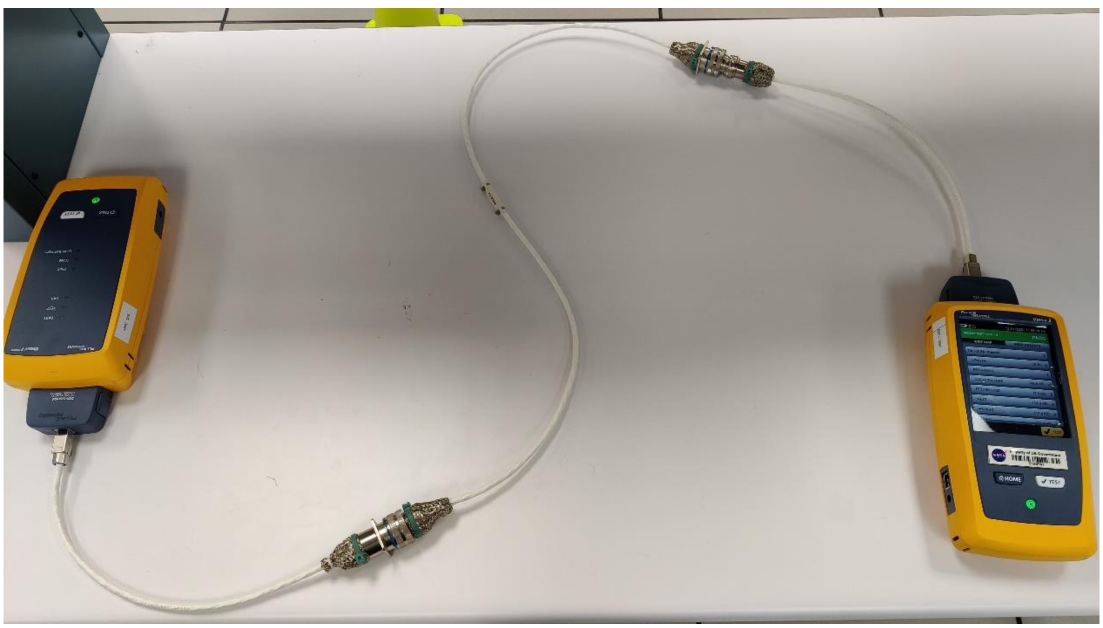


Figure 6.5-2. Fluke DSX-5000 Connected to RJ45 Adaptor Cable and 1-m (39.4-inch) Ethernet Cable Terminated with Ethernet Connectors
Ethernet cable meter with transmitter is shown on the right, and the unit on the left reflects the transmitted data back to characterize the Ethernet cable.

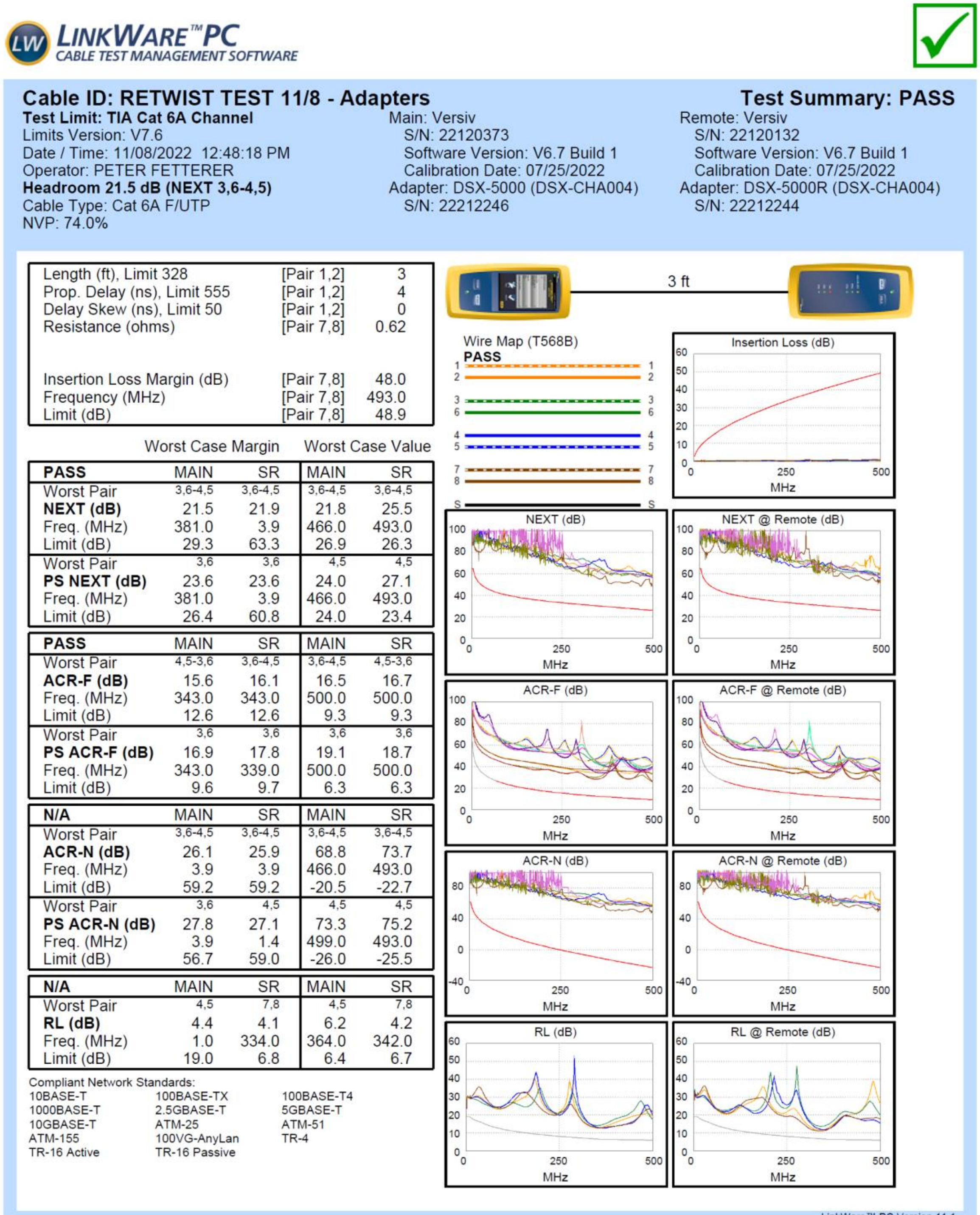


Figure 6.5-3. Type of Ethernet System Performance Report Generated by Fluke Meter

The data shown indicate the Ethernet system under test meets Cat6a performance requirements, including wire connections, insertion loss (IL), NEXT measurements, and RL. The measurement capabilities of the Fluke DSX-5000 cable analyzer are:

- Cable test parameters are evaluated and stored in ~10 seconds (sec). Test results can be displayed numerically and as graphs showing specification limits with collected data superimposed. The test data displayed on the meter can be downloaded graphically or as a Microsoft Excel file. Ethernet system parameters that were evaluated are listed. For the purposes of this evaluation, the NESC assessment team focused on the listed parameters. Parameter definitions and test levels are based on the Fluke DSX-5000 manual and technical specifications provided by Fluke [Fluke 2019, 2023a, 2023b].

- Wire map:
  - Continuity to the remote end.
  - Shorts between any two or more conductors.
  - Reversed pairs.
  - Split pairs.
  - Transposed pairs.
  - Distance to open on shield.
  - Any other miswiring.
- Length:
  - The pass/fail criteria are based on the maximum length allowed for the permanent link, as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a permanent link, the length measurement can be 325 ft (99 m) before a failure is reported.
- Propagation delay:
  - Time required for a signal to reach the end of the link.
  - The measurement shall be made at 10 MHz, per ANSI/TIA-1152.
  - The propagation delay of each balanced twisted pair shall be recorded.
  - Not to exceed 498 nanoseconds (ns) per ANSI/TIA-568-C.2, Section 6.3.18.
- Delay skew:
  - Difference in propagation delay at 10 MHz between the shortest delay and the delays of the other wire pairs.
  - The delay skew of each balanced twisted pair shall be recorded.
  - Not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.
- Direct current (DC) loop resistance:
  - Reported as resistance, the combined DC loop resistance of both conductors in the pair.
  - The DC resistance shall be reported for all four pairs.
  - Not to exceed 21 ohms for all four pairs per ANSI/TIA-568-C.2, Section 6.3.1.
- DC resistance unbalance between pairs:
  - The difference in DC parallel resistance of the conductors of a pair compared with the DC parallel resistance of another pair.
- IL (insertion loss):
  - Energy through the cable’s insulation. At higher frequencies, signals tend to travel only near the surface of a conductor. This “skin effect,” along with the cabling’s inductance and capacitance, causes IL to increase with frequency.

        - Loss of signal strength over the cabling (in decibels (dB)).
        - The frequency resolution shall be:
            - 1 through 31.25 MHz: 150 kilohertz (kHz)
            - 31.25 through 100 MHz: 250 kHz
            - 100 through 250 MHz: 500 kHz
            - 250 through 500 MHz: 1000 kHz
        - Worst case and margins are reported in one direction for all four pairs.
        - Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
        - Not to exceed Cat6A permanent link limits in ANSI/TIA-568-C.2 Section 6.3.7.
    - NEXT (near-end crosstalk):
        - NEXT results show the crosstalk attenuation between cable pairs. NEXT is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other cable pairs at the same end of the cabling. Higher NEXT values correspond to better cabling performance. Because of IL, crosstalk signals occurring farther from the signal source are weaker and cause less trouble than crosstalk nearer the source. For this reason, NEXT is measured from both ends of the cabling.
        - Difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling. A higher value is desirable, which indicates the signal is higher larger than the detected noise from other pairs.
        - Frequency resolution shall be:
            - 1 through 31.25 MHz: 150 kHz
            - 31.25 through 100 MHz: 250 kHz
            - 100 through 250 MHz: 500 kHz
            - 250 through 500 MHz: 1000 kHz
        - Worst case and margins are given in both directions.
        - Not to exceed Cat6A Permanent Link limits given in ANSI/TIA-568-C.2 Section 6.3.8.
        - Margins within the accuracy of the field tester shall be marked with an *.
    - PS NEXT (power sum near-end crosstalk):
        - Difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling. PS NEXT is a measure of the difference in signal strength between disturbing pairs and a disturbed pair; a larger number (i.e., less crosstalk) is more desirable than a smaller number (i.e., more crosstalk).
        - The frequency resolution:
            - 1 through 31.25 MHz: 150 kHz
            - 31.25 through 100 MHz: 250 kHz
            - 100 through 250 MHz: 500 kHz
            - 250 through 500 MHz: 1000 kHz
        - Worst case and margins are reported in both directions for all four pairs.

    - Not to exceed the Cat6A Permanent Link limits given in ANSI/TIA-568-C.2 Section 6.3.9.
    - Margins found to be within the accuracy of the field tester marked with an *.
- ACR-N (attenuation to crosstalk ratio near-end):
    - ACR-N is a signal-to-noise ratio. ACR-N values indicate how the amplitude of signals received from a far-end transmitter compares with the amplitude of crosstalk produced by near-end transmissions. Higher ACR-N values mean received signals are larger than crosstalk signals. Higher ACR-N values correspond to better cabling performance.
    - The instrument calculates ACR-N as the difference (in dB) between NEXT and attenuation (IL).
    - The frequency resolution:
        - 1 through 31.25 MHz: 150 kHz
        - 31.25 through 100 MHz: 250 kHz
        - 100 through 250 MHz: 500 kHz
        - 250 through 500 MHz: 1000 kHz
    - Worst case and margins shall be reported in both directions.
    - Not specified in ANSI/TIA-568-C.2.
- PS ACR-N (power sum attenuation to crosstalk ratio near-end):
    - PS ACR-N values indicate how the amplitude of signals received from a far-end transmitter compares with the combined amplitudes of crosstalk produced by near-end transmissions on the other cable pairs. PS ACR-N is the difference (in dB) between PS NEXT and attenuation (IL). Higher PS ACR-N values mean received signals are larger than the crosstalk from all the other cable pairs. Higher PS ACR-N values correspond to better cabling performance.
    - The instrument uses the PS NEXT and attenuation results to calculate PS ACR-N values.
    - The frequency resolution:
        - 1 through 31.25 MHz: 150 kHz
        - 31.25 through 100 MHz: 250 kHz
        - 100 through 250 MHz: 500 kHz
        - 250 through 500 MHz: 1000 kHz
    - Both worst case and margins shall be reported in both directions for all four pairs.
    - Not specified in ANSI/TIA-568-C.2.
- ACR-F (attenuation to crosstalk ratio far-end):
    - PS ACR-F results show how much the far end of each cable pair is affected by the combined far-end crosstalk from the other pairs. PS ACR-F is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the far end of the cabling. The tester uses the ACR-F values to calculate PS ACR-F. Higher PS ACR-F values correspond to better cabling performance. PS ACR-F results are typically a few dB lower than worst-case ACR-F results**.**
    - The instrument uses the ACR-F values to calculate PS ACR-F.

- Frequency resolution:
  - 1 through 31.25 MHz: 150 kHz
  - 31.25 through 100 MHz: 250 kHz
  - 100 through 250 MHz: 500 kHz
  - 250 through 500 MHz: 1000 kHz
- Worst case and margins are reported in both directions.
- Not to exceed the Cat6A permanent link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
- Reported margins found to be within the accuracy of the field tester marked with an *.

- PS ACR-F (power sum attenuation to crosstalk ratio far-end):
  - While NEXT is measured at the same end as the signal source, far-end crosstalk (FEXT) is measured at the far end. Because all FEXT signals travel the same distance, they experience the same amount of attenuation, as shown in Figure 6.3-10. This means all crosstalk signals contribute equally to noise at the far end. This is different from NEXT. At the near end, crosstalk occurring closer to the source contributes more to noise than crosstalk occurring farther from the source.
  - The instrument uses the PS NEXT and IL results to calculate PS ACR-F values.
  - The frequency resolution:
    - 1 through 31.25 MHz: 150 kHz
    - 31.25 through 100 MHz: 250 kHz
    - 100 through 250 MHz: 500 kHz
    - 250 through 500 MHz: 1000 kHz
  - Both worst case and margins reported in both directions for all four pairs.
  - Not to exceed the Cat6A permanent link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
  - Margins found to be within the accuracy of the field tester marked with an *.
- RL:
  - RL is the power ratio of the transmitted to reflected signals. It can be described as the difference between the power of a transmitted signal and the power of the signals reflected back. The signal reflections are caused by variations in the cable impedance. Figure 6.5-4 shows common sources of reflections that create RL. High RL means the cabling reflects little of the transmitted signal back to the source. High RL is more critical for 1000BASE-T Ethernet. The bi-directional (full duplex) transceivers used in these systems use directional couplers to distinguish between incoming and outgoing signals. The couplers may interpret strong reflected signals as incoming data, resulting in data errors. A RL plot indicates how well a cable’s impedance matches its rated impedance over a range of frequencies. According to Fluke troubleshooting documents, failures of RL below 50 MHz suggest a cable issue, and failures above 50 MHz suggest a connector or connector termination issue (see Figure 6.5-4).

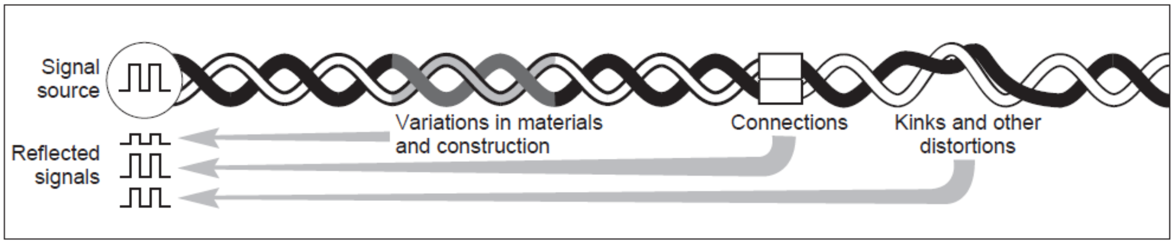


Figure 6.5-4. Sources of RL [Fluke, 2023b]

- The instrument measures the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
- The frequency resolution:
  - 1 through 31.25 MHz: 150 kHz
  - 31.25 through 100 MHz: 250 kHz
  - 100 through 250 MHz: 500 kHz
  - 250 through 500 MHz: 1000 kHz
- Worst case and margins reported in both directions for all four pairs.
- Not to exceed the Category 6A Permanent Link limits in ANSI/TIA-568-C.2 Section 6.3.6.
- Margins found to be within the accuracy of the field tester marked with an *.
- Time-domain reflectometer data are stored for any marginal or failing RL results.

6.6 Testing of Ethernet Cables

The NESC assessment team obtained Ethernet cables and both impedance matched and standard connectors, and used GSFC technicians certified to NASA Standard 8739.4 to build and terminate the desired cables with selected connectors. The Gore Ethernet cable was qualified to AS6070/6, four-pair, shielded, 100-ohm, 200 °C, Ethernet 10GBASE-T standard. The CeeLok FAS-X connector was qualified to MIL-DTL-32554.

Five 1-m (39.4-inch) Gore 26-AWG Cat6a Ethernet cables were initially terminated with CeeLok FAS-X Ethernet receptacle and plug connectors using the manufacturer's guidelines, which are shown in Appendix A.2. As mentioned in Section 6.5, two 1-m (39.4-inch) adaptor cables were built with the 26-AWG Gore Ethernet cable and terminated with a CeeLok FAS-X connector at one end and a shielded RJ45 connector at the other end to connect to the Fluke meter.

Cable and connector assembly instructions from the cable and connector manufacturers were used by the technicians to build the cables. These instructions reportedly meet ANSI/TIA/EIA-568.0-E, which specifies (para. 6.2.3.1) a maximum un-twist of 0.5 inches for Cat5e Ethernet and for higher-speed Ethernet cables terminated at a connector. The cable and connector termination instructions from TE Connectivity and Gore Cable were used to terminate the cables (see Appendix A for detailed assembly instructions). Both vendors recommended the wire pair twist be maintained to within less than 0.5 inch of the connector grommet. After assembling the adaptor cables and five 1-m (39.4-inch) segments with Gore 26-AWG Cat6a Ethernet cable and CeeLok FAS-X connectors, the cables were tested using the Fluke cable analyzer.

Each adaptor cable and five segments were evaluated using the Fluke cable analyzer and passed a Cat6 test requirement. Cables and the Fluke meter test results are shown in Appendix B, Figures B-1 through B-18. For these tests, the Fluke meter was set to Cat6, thus limiting the test to 250 MHz instead of 500 MHz, which is for a Cat6a cable. Each of the five cable segments passed all Cat6 requirements, including wiring configuration, NEXT performance, and cable RL. These data were compared with published requirements for a Cat6 cable, as defined in the Ethernet test standard (ANSI/TIA-568-C.2) (see Figures 6.6-1 and 6.6-2). The test results show each cable was connected and passed the NEXT and FEXT tests and the RL test with margin, as documented in Appendix B (Figures B-1 through B-8). Note the NEXT graph in the top right of Figure 6.6-1 shows the NEXT dB signal is larger than the limit across all Cat6 frequencies. A higher NEXT value is desirable and indicates the signal amplitude is higher than the noise created by the other Ethernet pairs in the cable/connector. The RL shown at the bottom left in Figure 6.6-1 has a higher dB value than the requirement across all Cat6 frequencies, where a higher value is desirable and indicates a small portion of the transmitted signal is reflected back to the transmission source.

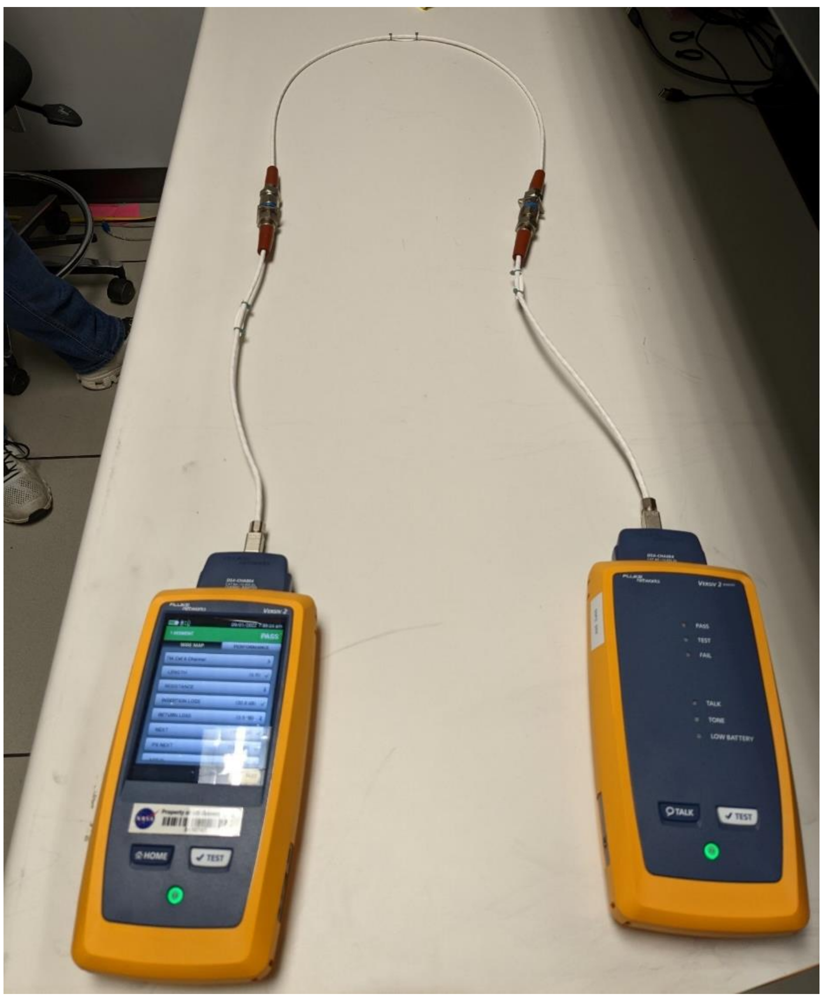


Figure 6.6-1. One Ethernet Cable Segment with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Connected to Fluke DSX-5000 Meter

LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: SEG001 TEST

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:00:47 AM
Operator: PETER FETTERER
Headroom 17.8 dB (NEXT 3,6-7,8)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

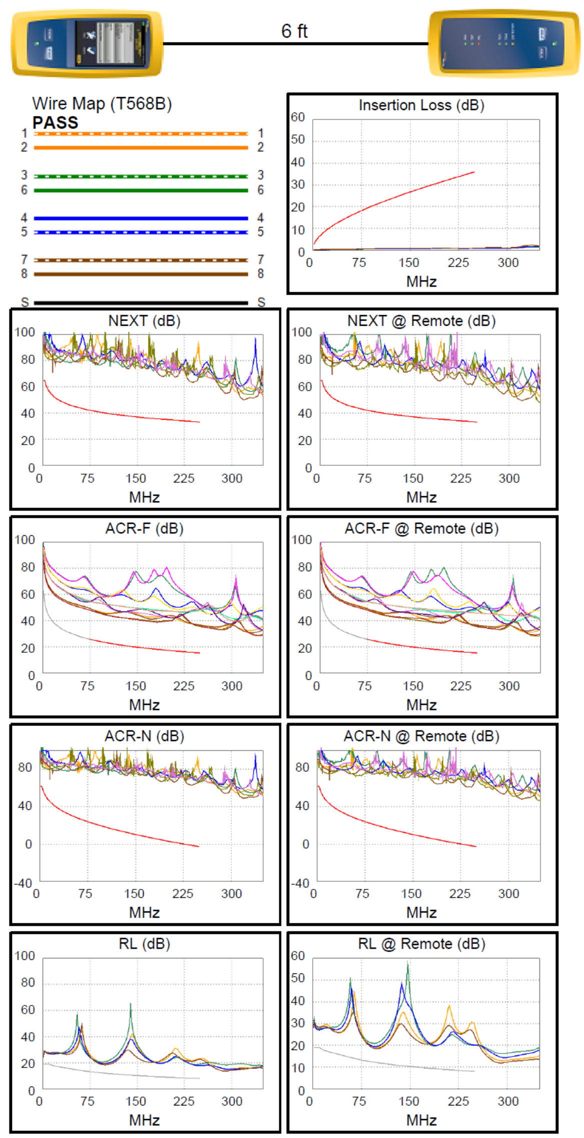
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 4,5]	31.2
Frequency (MHz)	[Pair 4,5]	207.0
Limit (dB)	[Pair 4,5]	32.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	19.7	17.8	30.0	27.9
Freq. (MHz)	3.6	3.5	239.5	237.0
Limit (dB)	63.7	64.0	33.4	33.5
Worst Pair	3,6	3,6	4,5	3,6
PS NEXT (dB)	19.9	18.5	31.4	29.8
Freq. (MHz)	3.8	3.9	239.5	237.0
Limit (dB)	61.0	60.8	30.5	30.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	20.1	20.1	20.1	20.1
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	15.3	15.3	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.8	20.6	20.8	20.6
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	12.3	12.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	23.4	21.3	64.4	62.1
Freq. (MHz)	3.6	2.9	239.5	237.0
Limit (dB)	59.9	61.6	-1.6	-1.3
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-N (dB)	23.5	22.1	65.9	63.9
Freq. (MHz)	3.1	3.3	239.5	237.0
Limit (dB)	58.4	58.4	-4.6	-4.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	4,5	7,8
RL (dB)	5.1	6.3	9.7	6.4
Freq. (MHz)	1.0	96.5	250.0	100.0
Limit (dB)	19.0	12.2	8.0	12.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure 6.6-2. All Five One-segment Cables with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6 Test Requirements
Results are for segment 1; cable was connected and passed NEXT tests and RL with margin.

After verifying that each cable segment met Cat6 requirements, additional segments were connected together. Cable segments 1 and 2 were connected (three mated connectors) with each end attached to the adaptor cables so the assembled cable could be tested with the Fluke cable analyzer, as shown in Appendix B, Figure B-9. Cable analyzer results are shown in Appendix B, Figure B-10. The cable was connected and passed all Cat6 tests; the NEXT tests and the RL passed with less margin than the single segment. As an example, the worst-case NEXT test limit was 4.2 dB above the requirement for two segments compared with 20 dB for one segment. The worst-case RL for two segments was 3.5 dB above the limit, compared with 5 dB above the limit for one segment (Appendix B, Figure B-10).

Cable segments 1, 2, and 3 were connected (four mated connectors in the Ethernet cable), as shown Appendix B, Figure B-11. Cable analyzer results showed that the cable was connected and passed all Cat6 tests; the NEXT tests and the RL were degraded compared with the two-segment test and passed the Cat6 requirement with minimal margin (Appendix B, Figure B-12). The worst-case NEXT test limit was within 1.8 dB for three segments compared with 4.2 dB for two segments. The worst-case RL for three segments was 1.6 dB above the limit compared with 3.5 dB for one segment. Note in the RL graph that the losses are close to the limits, which are most likely due to impedance mismatches at the connector terminations.

Cable segments 1, 2, 3, and 4 were connected (five mated connectors), as shown in Appendix B, Figure B-13. The cable was connected and failed the Cat6 NEXT test but passed the other Cat6 tests, including the RL with minimal margin (Appendix B, Figure B-14). The worst-case NEXT test limit was below the requirement near the 250-MHz range. The worst-case RL for four segments was 0.5 dB above the limit compared with 1.6 dB for three segments. The test failure and low margins are most likely due to impedance mismatches at the connector terminations since the selected cables and connectors are rated for Cat6a (see Figures 6.1-1 and 6.1-2).

The four-segment test was repeated by replacing segment 4 with segment 5 so the four segments tested were segments 1, 2, 3, and 5. The cable analyzer indicated the cable was connected, and the connector passed all Cat6 tests with minimal NEXT and RL margins (Appendix B, Figure B-15). The worst-case NEXT test limit was below the requirement at a number of frequencies below 250 MHz (top left graph labeled NEXT). The worst-case RL was 0.5 dB above the requirement, as can be seen from the table output and in the RL graph (bottom left of the figure). This result shows that variations between the segments can result in a Cat6 pass or fail condition. Marginal performance is most likely due to impedance mismatches at each of the connector terminations. An additional cable segment was added so that five segments and six connectors could be tested using the cable analyzer (Appendix B, Figure B-16). However, the test was conducted using Cat5e versus Cat6 parameters, with the results shown in Appendix B, Figure B-17. Under Cat5e test conditions, the cable was connected and passed all CAT5 tests with good NEXT and RL margins. The selected cables and connectors are designed for Cat6a applications, and vendor test data show that four Ethernet connector segments (five mated connectors) can pass Fluke DSX-5000 Cat6a test requirements (see Figure 6.3-10).

The NESC assessment team reviewed test results and based on the team's experience and discussion with Ethernet vendors postulated the poor NEXT and RL results were most likely due to not maintaining adequate twist in the four wire pairs at the connector terminations. Twisting of conductor pairs is an effective way to minimize signal interference and crosstalk and increase cable performance. The twist rate (i.e., pitch) is usually measured as the number of twists per inch or meter. Twist rate is typically not specified in standards and is left to the manufacturer to determine. Cat5e typically has a twist rate of four to five twists per inch, whereas Cat6 cables have a twist rate of five or more twists per inch. To further reduce crosstalk, not all conductor pairs in a cable will have the same twist rate. Untwist in the wire pairs terminated to the connectors was confirmed when the connectors were disassembled for inspection. A detailed discussion on twist rates is given in Section 7. A technician re-terminated the twisted pairs so the twist could be maintained as close as possible (less than 0.125 inch (3.17 mm)) to the connector. Figure 6.6-3 shows an example of the vendor-recommended termination practice (left), the pair twist of the tested terminated connector (middle), and the reworked termination (right). The connector on the left in Figure 6.6-3 is the recommended vendor approach, which leaves ~1 inch of untwist in the wire pairs after termination but less than 0.5 inch when the metal follower/pair separator (red arrow) is considered. In Figure 6.6-3, the connector in the center was the first attempt by the technician to terminate the cable to the connector; the technician maintained the wire twist just past the metal follower/pair separator and ~0.75 inches from the connector edge. The connector on the right is the second attempt by the technician, where the wire pair twist was maintained up to the connector grommet edge and through the metal follower/pair separator with less than 0.125 inches of untwist. This last configuration provided improved cable analyzer Ethernet performance compared with test results from the first termination attempt (compare Appendix B, Figures B-12 and B-26). Standard ANSI/TIA-568-D.2 requires 0.5 inches (12.7 mm) or less of untwisted wire between the end of the cable and the termination of the connector for Cat6 and higher data-transfer cables. Note that for Cat5 applications some aerospace OEMs allow for up to 1 inch (25.4 mm) of untwist at the connector termination. A tighter tolerance is required for Cat6 and higher data rate Ethernet systems since signals are bi-directional (full duplex), and high levels of signal reflections from impedance mismatches make it difficult to distinguish between incoming and outgoing signals. The bidirectional transceivers can interpret strong reflected signals as incoming data, resulting in data errors. Cables that fail the Cat6 Fluke meter test may transmit data in an Ethernet network given the error-correction capabilities of network systems. The concern would be external conditions (e.g., environmental and physical changes, electrical charging and discharging, and other external noise sources) causing sufficient signal loss to result in data packet errors or loss of the network link.

After re-terminating the connectors on all five segments, the cables were retested with the cable analyzer. Results are given in Appendix B, Figures B-19 through B-24. Test results show that each segment could pass Cat6a requirements and may not have performed as well as in the earlier tests although those tests were conducted as Cat6 cable, so a direct comparison was not possible. The intent of this assessment was to build and test Cat6a Ethernet cables. After verifying that each cable segment met Cat6a requirements, the next step was to connect additional segments. Cable segments 1 and 2 were connected, with each end connected to the adaptor cables so the assembled cable could be tested with the Fluke cable analyzer, as shown in Appendix B, Figure B-25. The cable was shown to be connected and passed all Cat6a tests; the NEXT tests and the RL passed with less margin than the single-segment cable test. For example, the worst-case NEXT test limit was 6.3 dB above the requirement for two segments, compared with 9.5 dB for one segment. The worst-case RL for two segments was 1.5 dB above the limit, compared with 1.9 dB above the limit for a single segment (Appendix B, Figure B-25).

Three cable segments (1, 2, and 3) were connected (i.e., four mated connectors), as shown in Appendix B, Figure B-26. Cable analyzer results show the cable was connected and passed all Cat6a tests; the NEXT tests and the RL were degraded compared with the two-segment test and passed the Cat6a requirement with minimal margin. The worst-case NEXT test limit was within 6.5 dB for three segments compared with 6.3 dB for two segments. The worst-case RL for three segments was 3.8 dB above the limit, compared with 1.9 dB for two segments. The cause of the minimal improvement using three rather than two segments was not determined, although mating and de-mating connectors and the positioning of the cables can affect impedance matching at the connector terminations. Note in the RL graph that the losses are close to the limits, which is most likely due to impedance mismatches at the connector terminations (see Appendix B, Figure B-26).

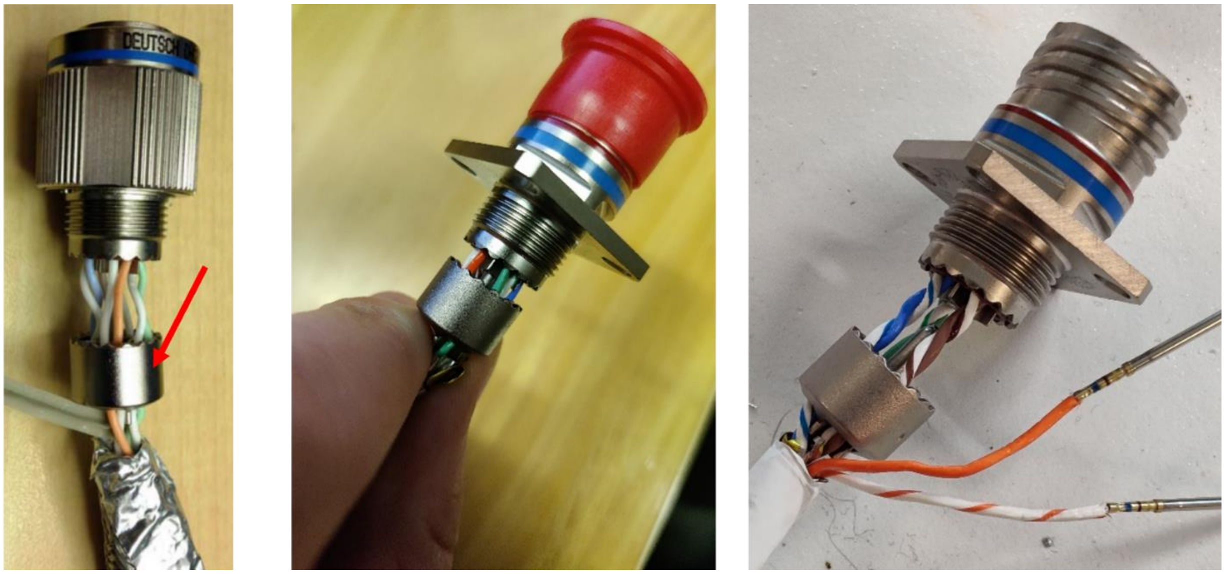


Figure 6.6-3. Examples of Two Pair Twist Termination into CeeLok FAS-X Connector
The connector on the left is the recommended vendor approach, which leaves ~1 inch of untwist in the wire pairs after termination but less than 0.5 inch when the metal follower/pair separator (red arrow) is considered. The example in the center has wire twist maintained just past the metal follower/pair separator and ~0.75 inches from the connector grommet edge. The connector on the right has wire pair twist maintained up to the connector grommet edge and through the metal follower/pair separator with less than 0.125 inch of untwist.

Four cable segments (1, 2, 3, and 4) were connected (five mated connectors) as shown in Appendix B, Figure B-27. The cable failed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin, but failed the RL test (see Appendix B, Figure B-27). The test failure and low margins are most likely due to impedance mismatches at the connector terminations since the selected cables and connectors are rated for Cat6a (see Figure 6.1-2). Note that RL values below the Cat6a requirements are over 100 MHz, which according to Fluke meter diagnostic references suggests a connector termination issue.

The NESC assessment team reviewed the test results and consulted with NAVAIR Ethernet SMEs and Ethernet manufacturers. After some discussion, it was suspected that the inability to pass Cat6a requirements using the cable analyzer was due to impedance mismatches in the connector terminations. The termination process was reviewed, and it was noted that the shield had been removed from each wire pair ~1 inch (25.4 mm) from the connector edge. It was postulated that maintaining the shielding as close as possible to the connector could improve impedance matching since a shielded two-pair wire is essentially a transmission line, and the shield provides a stable ground plane for signal propagation. Breaks in the shield would change the twisted pair impedance. For the first re-termination, the wire pair twist was maintained up to the connector, but each pair was unshielded ~1 inch (25.4 mm) from the connector end. The cable vendor suggested shielding each twisted pair as close as possible to the connector end. For the second re-termination, each cable segment connector was re-terminated with the wire pair twist maintained up to the connector and with foil shielding added as close as possible to the connector, as shown in Figure 6.6-4. The termination process was documented, as shown in Figure 6.6-5. When possible, the removed foil shield from the wire pairs was used to re-shield the twisted pairs as close as possible to the connector grommet (less than 0.125 inch) and inside the metal insert. When the removed foil shield could not be reused, a foil shield was added using NEPTAPE® 1001 (aluminum foil on a polyester tape used for shielding twisted pairs, 0.00035 inch (9µ) Al/ 0.00048-inch (12µ) polyester film), which is similar to that used in the Gore cable inner shield. The Gore cable control drawing indicates the twisted pair shield is made from a one-sided aluminum metalized polyimide tape that is wrapped around the twisted pair (see Figure 6.3-3).

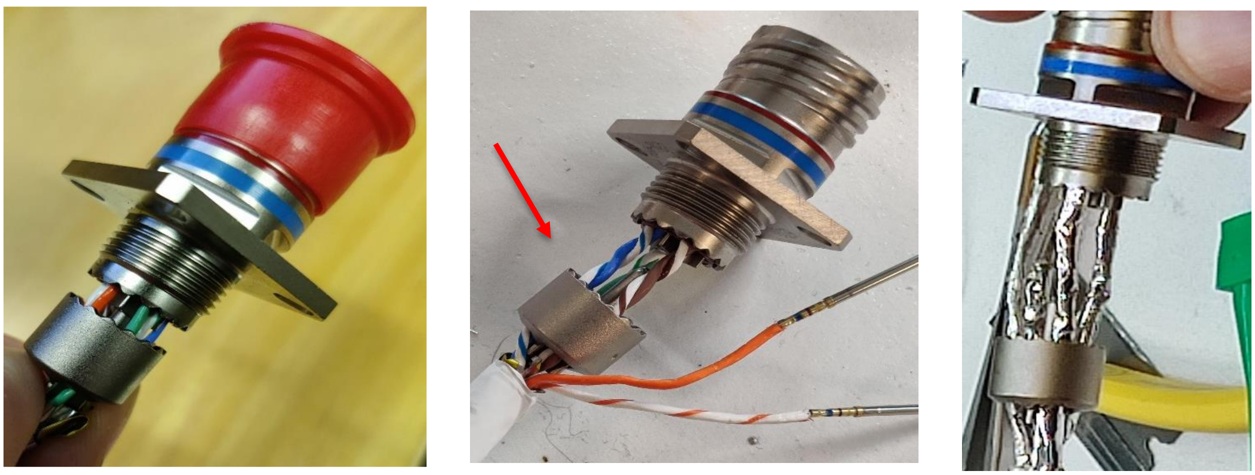


Figure 6.6-4. Second Connector Re-termination Attempt
On the left, the initial cable termination had four wire pairs untwisted at least 0.5 inch or more from the connector grommet (failed Cat6 testing using four cable segments). In the center, the connector was re-terminated so each wire pair was twisted to the connector grommet with no shielding ~1 inch from the connector grommet and ~0.5 inch from the end of the metal connector insert (red arrow in center image). This configuration failed Cat6a testing using four cable segments. The right side shows the second re-termination, where the wire pair twist was maintained to the connector grommet, with foil tape added to shield each wire pair up to the connector grommet and with shielding inside the metal insert (passed Cat6a testing with five cable segments).

Figure 6.6-5. Detailed Second Re-termination Process (Ethernet cable re-termination that maintained wire pair twist and shielding added to each connector, resulting in passing cable analyzer Cat6a test using five cable segments and six connectors)
Note each twisted pair is shielded so that shield is as close as possible to the connector grommet (less than 0.125 inch) when the contacts are inserted into the connector.

After the connectors were re-terminated for the second time on the five segments (six connectors) and adaptor cables, each was tested with the cable analyzer (Appendix B, Figures B-31 through B-36). During testing, cable segment 2 exhibited marginal performance in the RL test, as shown in Appendix B, Figure B-41. The cable analyzer was used to troubleshoot the segment 2 cable. Testing revealed the cable was connected and passed the NEXT tests with margin but passed the RL test with only a minimal margin. Test results were improved in the NEXT test (12.5 versus 9.5 dB) but degraded in the RL test (1.4 versus 2.7 dB) compared with the first rework results in Appendix B, Figure B-21. Note in the lower left RL graph the 1,2 pair (shown by the orange line in the figure) had a lower margin compared with the other three pairs (over 4 dB) (see Figure 6.6-6). This suggests a connector termination issue with the 1,2 twisted pair. The two connectors in this cable were reworked by the technician and retested with the cable analyzer. Test results show that after the rework the cable passed the NEXT tests and the RL with margin (Appendix B, Figure B-33). Test results were improved for NEXT tests (13.6 versus 12.4 dB) and RL (4.6 dB versus 1.4 dB) compared with results of the first rework, shown in Appendix B, Figure B-41. The RL graph of the reworked segment 2 cable is shown in Figure 6.6-7; the results are improved compared with the results prior to the rework (see Figure 6.6-6). Note that the margins for all wire pairs over the 500-MHz range are above the requirement. A higher RL means less of the signal is reflected back as noise as the signal passes through the cable and three connectors.

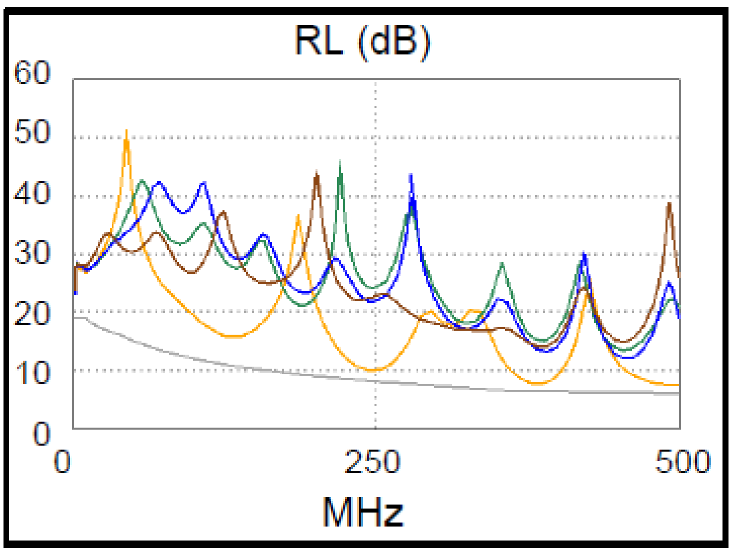


Figure 6.6-6. RL Margin from Segment 2 Cat6a Cable Analyzer Test
The graph shows the 1,2 pair (orange line) had a lower margin compared with the other three pairs (red, green, and blue lines), suggesting there may be a connector termination issue with the 1,2 twisted pair (Appendix B, Figure B-41).

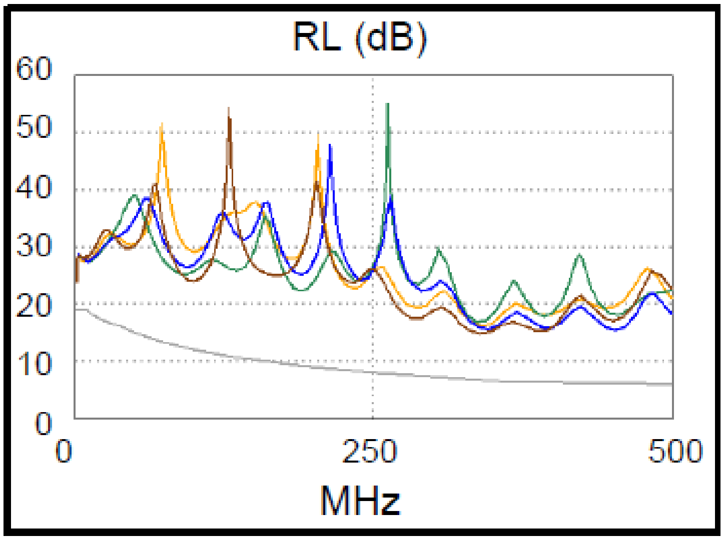


Figure 6.6-7. Cable Analyzer Cat6a RL Margin after Reworking Cable Segment 2 Connectors Note that the margins for all wire pairs over the 500-MHz range are above the requirement. A higher RL means less of the signal is reflected back as noise as the signal passes through the cable and three connectors (Appendix B, Figure B-41).

The second rework of the connectors produced improved Cat6a cable analyzer results, as shown in Appendix B, Figures B-31 through B-42. Cable analyzer test results showed each segment could pass Cat6a requirements and performed better than the same cable prior to the addition of the extra shielding to each twisted pair. After verifying that each cable segment met Cat6a requirements (Appendix B, Figures B-31 through B-36), the additional segments were connected. Two cable segments (1 and 2) were connected (three mated connectors), with each end connected to adaptor cables so the assembled cable could be tested with the Fluke cable analyzer, as shown in Appendix B, Figure B-9. The cable was shown to be connected and passed all Cat6a tests; the NEXT tests and the RL passed with margin (Appendix B, Figure B-37). Test results were improved in the NEXT tests (12.6 dB versus 6.3 dB) and RL (4.6 dB versus 1.5 dB) as compared with the first rework results shown in Appendix B, Figure B-25. Similar results were obtained as additional cable segments were added (see Appendix B, Figures B-38 through B-42). The second rework of five cable segments (1, 2, 3, 4, and 5) with six CeeLok FAS-X connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests and RL with margin (Appendix B, Figure B-40). This configuration failed the Cat6a test prior to this last rework (without the addition of shielding at the connector termination). Test results for NEXT (7.9 dB versus 3.4 dB) and RL (6.5 dB versus –0.3 dB) improved compared with the first rework results, as shown in Appendix B, Figure B-29.

The NESC assessment team built adaptor cables and five 1-m (39.4-inch) cable segments using the Gore 24-AWG Cat6a Ethernet cables terminated with M38999 receptacle and plug connectors (see Figure 6.3-15). The manufacturer's guidelines were followed (see Appendix A, Section A.3). The Gore Ethernet cable was the same construction used for the Gore cable and CeeLok FAS-X connector segments, except the conductors were 24 AWG where the former were 26-AWG conductors. The Gore Ethernet cable has shielded twisted pairs with an overall shield surrounding the four twisted pairs (see Figure 6.3-5). The connectors were terminated using the same process used in the first rework process for the CeeLok FAS-X connector cables since they were built in the same time period (see Appendix A). The wire pair twists were maintained up to the connector grommet, and as before, the individual pair shields were removed ~1 inch (25.4 mm) from the connector end. As-built M38999 cables were evaluated using the Fluke DSX-5000 cable analyzer. Each adaptor and individual segment cable passed the Cat6a test requirement. Cable analyzer results are shown in Appendix B, Figures B-44 through B-53. The Cat6a cable analyzer results for the four segments showed that each can pass NEXT requirements with margin (14 to as low as 11.1 dB), while the RL gave low margin values that were close to the requirement (2.3 to as low as 0.7 dB) (see Figure 6.6-8 and Appendix B, Figures B-45 through B-48). Additional segments were connected to determine how this impacted the Cat6a test results. Two segments (1 and 2) with three M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (7.3 dB) and passed the RL test with minimal margin (0.2 dB) (Appendix B, Figure B-49). Three segments (1, 2, and 3) with four M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (3.8 dB) and the RL with minimal margin (0.9 dB) (Appendix B, Figure 50). With four segments (1, 2, 3, and 4) and five M38999 connectors in series, the cable failed Fluke meter Cat6a test requirements (Appendix B, Figure 51). The cable was connected and passed the NEXT tests with margin (2.7 dB) but failed the RL test (1.6 dB below specification). The RL graph (lower left) shows the cable failed the requirement starting at ~125 MHz (see Appendix B, Figure B-51). Cables were unmated and remated, and the four segments (1, 2, 3, and 4) with five M38999 connectors in series with adaptor cables failed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (2.3 compared with 2.7 dB) and failed the RL test (1.6 dB below specification, with the same values in both measurements) .(see Appendix B, Figure B-52). Overall, the cable analyzer results were close to the earlier values shown in Appendix B, Figure B-51. Next, the segments were moved to different locations in the cable. Four segments (1, 4, 2, and 3) and five M38999 connectors in series with adaptor cables failed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (1.5 dB compared with 2.7 dB in the initial segment sequence) and failed the RL test (1.6 dB below specification for both cables) (see Appendix B, Figure B-53). The NEXT margin decreased when the positions of the cable segments were changed, but the RL did not change with the position changes.

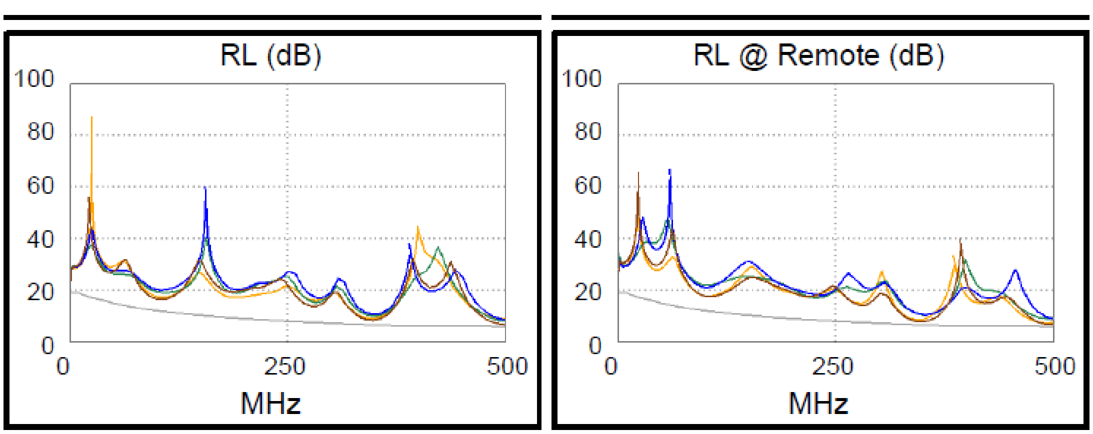


Figure 6.6-8. Segment 2 Cable Analyzer Cat6a NEXT and RL Results with M38999 Connector Note the RLs over the frequency range fall close to the Cat6a requirement (Appendix B, Figure B-46).

After reviewing the Cat6a M38999 cable analyzer results, the NESC assessment team noted, similar to the CeeLok FAS-X connector testing, that after the first rework the Cat6a test failure occurred in the RL measurements, suggesting a termination issue. The M38999 connectors had the wire twist maintained to the connector edge, but the shield on each pair was missing about 0.5 inch from the connector edge (not a specification requirement). The M38999 connectors were reworked by adding shielding up to edge of the connectors (see Figure 6.6-4), and the segments were retested using the cable analyzer. Cable analyzer results were improved after the shielding was added, compared with the results without shielding near the connector termination (see Appendix B, Figures B-54 through B-63). Each segment passed the cable analyzer Cat6a requirements with NEXT margins (16 dB above the Cat6a requirement) and with margin for the RL (2.6 dB above the Cat6a requirement) (see Appendix B, Figures B-54 through B-59). The reworked segment 2 cable passed the NEXT tests with margin (17.4 compared with 11.4 dB for the cable prior to rework) and passed the RL with margin (2.9 compared with 0.7 dB prior to rework) (see Appendix B, Figures B-56 and B-46). The NEXT and RL graph for segment 2 is shown in Figure 6.6-9 and shows the RL was improved with the addition of shielding near each connector termination. There was little to no improvement in the NEXT results for the cable prior to and after the rework (Figure 6.6-9). Since the Ethernet cables were able to pass the cable analyzer Cat6a requirements, cable segments were added, and the cable was retested using the cable analyzer. Reworked segments 1 and 2 with three M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (12.9 compared with the 7.3 dB value prior to rework) and passed the RL with margin (3.6 compared with the 0.2 dB value prior to rework) (see Appendix B, Figure B-60 and Figure B-49). An interesting observation was that the RL margin for the two connected segments improved (3.6 dB) compared with the RL margins for the segment 1 and 2 test results of 2.6 and 2.9 dB, respectively. The NEXT margin decreased to 12.9 dB, while the NEXT margins for segments 1 and 2 were 17.2 and 17.4 dB, respectively. Reworked segments 1, 2, and 3 with four M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (11.7 compared with 3.8 dB for the cable prior to rework) and passed the RL with margin (3.5 compared with 0.9 dB for the cable prior to rework) (see Appendix B, Figures B-61 and B-50). The four reworked segments (1, 2, 3, and 4) with five M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements. The cable was connected and passed the NEXT tests with margin (9.3 compared with 2.7 dB for the cable prior to rework) and the RL test with margin (3.6 compared with 1.6 dB below specification for the cable prior to rework) (see Appendix B, Figures B-62 and B-51). Five reworked segments (1, 2, 3, 4, and 5) with six M38999 connectors in series with adaptor cables passed the Fluke meter Cat6a test requirements (see Appendix B, Figure B-63). The cable was connected and passed the NEXT tests with margin (7.8 dB) and passed the RL test with margin (6.6 dB). These results are similar to the Gore cable and CeeLok FAS-X connector cable analyzer values (compare Figure B-63 with B-40 in Appendix B). Note that five segments were not tested prior to adding the additional shielding (Appendix B, Figure B-63). As before, adding additional segments and connectors resulted in an improved RL margin for five segments (6.6 dB) compared with individual segments (in the range of a 3-dB margin and compared with two, three, and four segments (in the range of a 3.8-dB margin). The NEXT margins decreased each time a segment and connector were added. NEXT margin values for one segment were in the range of 17 dB; for two segments, in the range of 12.9 dB; for three segments, in the range of 11.7 dB; for four segments, in the range of 9.3 dB; and for five segments, in the range of 7.8 dB.

The NESC assessment team concluded that the overall ability of six M38999 connectors to pass the cable analyzer Cat6a requirements may be related to the fact that each of the four Ethernet pairs had maximum separation in the connector, as shown in Figure 6.3-15. One option would be additional tests to determine whether moving the pairs closer together changed the cable analyzer Cat6a results (see Figure 6.3-15). At least one study attempted to optimize Ethernet performance by moving Ethernet pairs to different locations with an M38999 connector [Gore, 2022b]. Figure 6.6-10 shows cable analyzer results for two Gore cable segments connected to M38999 connectors, with maximum separation of twisted pairs and two Gore cable segments connected to M38999 connectors with two pairs adjacent to one another. Cable analyzer results were similar for both configurations, showing that placement had little impact on the cable analyzer results with respect to NEXT margins between the four Ethernet pairs. This test did not include other signals in the 55-pin connectors, which could generate noise and crosstalk in the Ethernet pairs since no shielding is used between the connector pins in the M38999 connector.

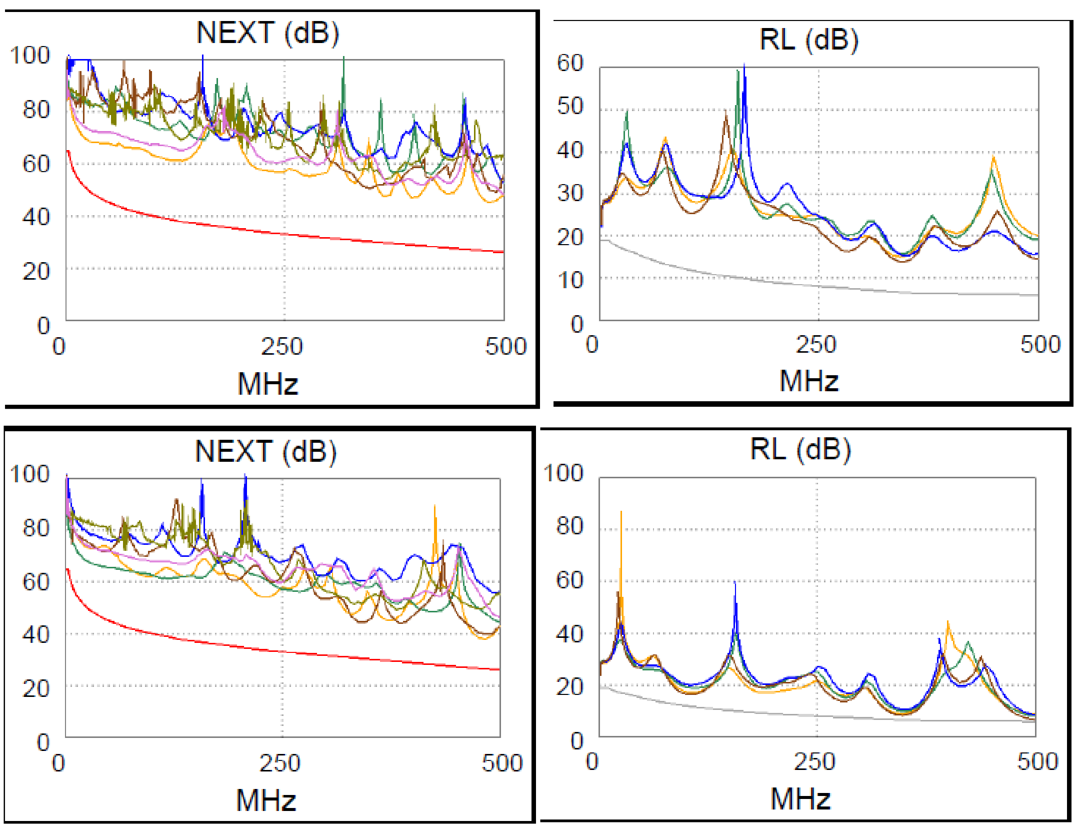


Figure 6.6-9. Reworked Segment 2 M38999 Connector Cable Analyzer Results for NEXT and RL (top left and right graphs)
Note the improved RL for the reworked cable (top right) compared with cable prior to the rework (bottom right). Little to no improvement was noted in the NEXT results for the cable prior to (bottom left) and after the rework (top left). The rework added a shield around each twisted pair where they entered the connector (~0.5 inch) (see Appendix B, Figures B-56 and B-46).

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	12.8	11.1	12.8	11.1
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	26.1	26.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	13.7	13.6	13.8	13.7
Freq. (MHz)	477.0	499.0	478.0	500.0
Limit (dB)	23.8	23.3	23.7	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	14.2	14.9	14.2	15.0
Freq. (MHz)	483.0	484.0	483.0	486.0
Limit (dB)	9.6	9.6	9.6	9.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	17.1	17.4	17.1	17.5
Freq. (MHz)	483.0	484.0	483.0	487.0
Limit (dB)	6.6	6.6	6.6	6.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	20.4	20.5	60.8	59.1
Freq. (MHz)	2.8	1.3	500.0	500.0
Limit (dB)	61.5	62.0	-23.2	-23.2
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	21.0	21.4	60.5	61.7
Freq. (MHz)	3.3	3.3	478.0	500.0
Limit (dB)	58.2	58.2	-24.4	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	4,5	7,8
RL (dB)	4.6	4.4	5.5	4.5
Freq. (MHz)	1.0	342.0	487.0	345.0
Limit (dB)	19.0	6.7	6.0	6.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	12.9	13.1	13.0	13.9
Freq. (MHz)	357.0	357.0	500.0	499.0
Limit (dB)	30.1	30.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	15.3	15.2	15.3	16.0
Freq. (MHz)	500.0	358.0	500.0	499.0
Limit (dB)	23.2	27.1	23.2	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	18.2	18.2	18.2	18.3
Freq. (MHz)	486.0	484.0	486.0	486.0
Limit (dB)	9.5	9.6	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.4	19.5	20.1	19.9
Freq. (MHz)	343.0	343.0	484.0	483.0
Limit (dB)	9.6	9.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.3	24.0	61.0	61.8
Freq. (MHz)	7.8	1.1	500.0	499.0
Limit (dB)	52.7	62.0	-23.2	-23.1
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	22.6	22.7	63.3	64.0
Freq. (MHz)	3.9	3.3	500.0	499.0
Limit (dB)	56.7	58.2	-26.1	-26.0
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	3.6	6.8	7.5	6.8
Freq. (MHz)	1.0	346.0	343.0	346.0
Limit (dB)	19.0	6.6	6.6	6.6

Figure 6.6-10. Cable Analyzer Results for Two Gore Cable Segments Connected to M38999 Connectors with Maximum Separation of Twisted Pairs (right) and with Two Pairs Adjacent to One Another (left)
Cable analyzer results for NEXT margins were similar for both configurations.

Five 1-m (39.4-inch) PIC Wire & Cable 26-AWG Cat6a Ethernet cables (see Figure 6.3-6) were terminated with PIC Ethernet connectors (P/N MF3817PPWN-ED MachForce SZ 17). The termination process used is given in Appendix A.4. Note that the PIC cable has no shielding on each twisted pair; the shield only surrounds all four twisted pairs (see Figure 6.3-6), which could impact NEXT, RL, and impedance matching at each connector termination [PIC, 2023c]. Figure 6.6-11 shows the PIC Ethernet connector with twisted pairs inside the connector and separated by metal channels and illustrates how the four twisted pairs are aligned in the connector. The design is similar to an RJ45 connector, as shown in Figure 6.5-1. During the termination process, the technician commented that the mating of the PIC connectors was difficult compared with the CeeLok FAS-X connector design since it required several screws to mate the connector. There were several plastic wafers that had to be positioned properly to assemble the connectors.

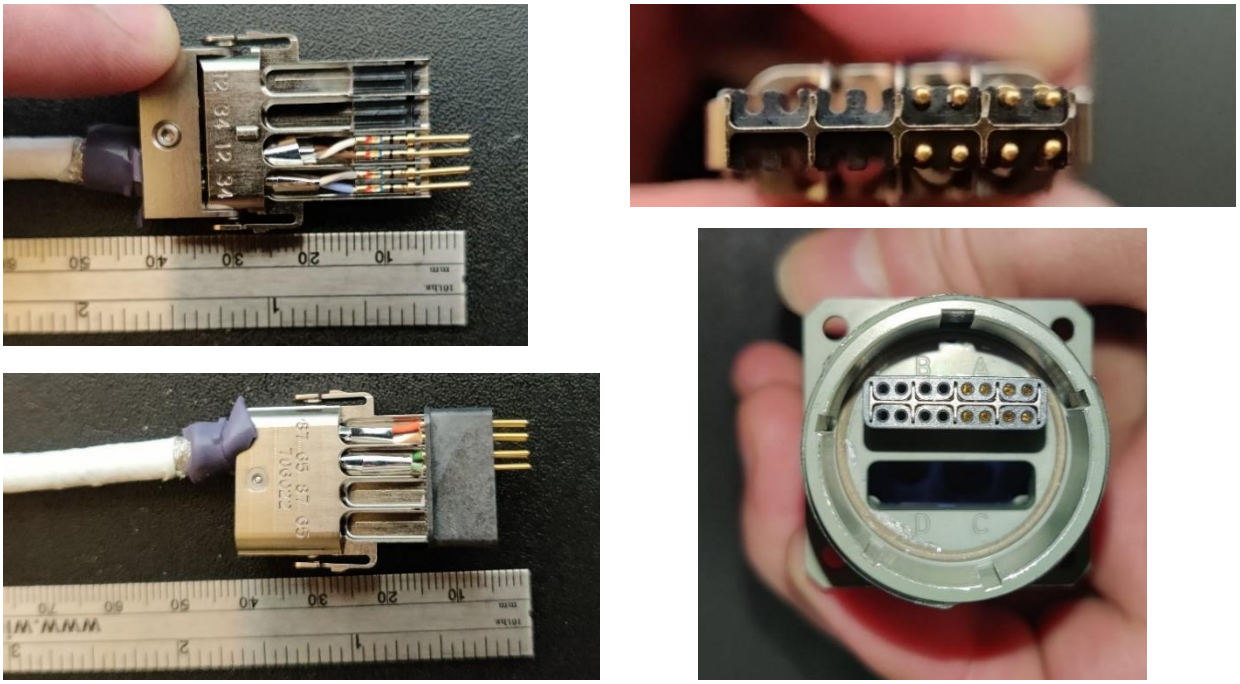


Figure 6.6-11. PIC Ethernet Connector (P/N MF3817PPWN-ED MachForce SZ 17) showing Twisted Pairs Inside Connector and Separated by Metal Channels and Alignment of Four Twisted Pairs in Connector
This is similar to an RJ45 connector (see Figure 6.5-1).

After completing the build, the adaptor cables and the segments were tested using the Fluke cable analyzer set to a Cat6a type cable (see Figure 6.6-12). In the first pass with the cable analyzer, all cables failed due to an open in one of the twisted pairs (Appendix B, Figures B-64 and B-65). The cables were returned for rework, and the PIC connectors were re-terminated since there was evidence several wire pairs were open and not making electrical contact. After reworking the cables, they were tested using the cable analyzer, and the cable mapping showed the cables were connected. Cable analyzer Cat6a results are shown in Appendix B, Figures B-66 through B-72. Only the adaptor cable with the PIC cable and one connector met the Cat6a requirements (Appendix B, Figure B-67). All four 1-m (39.4-inch) PIC cable segments with two PIC connectors in series with adaptor cables failed the Fluke meter Cat6a test requirements (see Appendix B, Figures B-68 through B-70). All cables passed NEXT requirements with margin (in the range of 5.6 to 7.8 dB) but failed the RL with cable margins below the requirement (0.8 through 2.3 dB). The PIC cables were retested with the cable analyzer and passed the Cat5e requirements with up to four segments in series with five PIC connectors (see Appendix B, Figures B-72 through B-76).

The NESC assessment team reviewed the results and consulted with PIC Wire & Cable technical representatives to determine why the PIC Cat6a cables and connectors were unable to pass the cable analyzer Cat6a requirements. PIC Wire & Cable reports the procured cables and connectors are designed for Cat6a Ethernet systems (see Figure 6.3-14). As discussed, different twist rates are used on twisted pairs to improve NEXT performance, and this is more critical if the twisted pairs are not individually shielded, as is the case for the PIC cable evaluated in this assessment. Differences in twist rates between the individual pairs in the PIC cable are shown in Figures 6.6-13 and 6.6-14. As noted, twist rates are not specified in the standards and are deferred to the manufacturer. Inspection revealed the proper twist rates were maintained in the terminated connector (Figure 6.6-15). Twist rates affect capacitance, inductance, and therefore the impedance of the wire pairs; varying the twist rates between pairs can reduce crosstalk between each pair. A detailed discussion on the impact of wire twist is given in Section 7.

Figure 6.6-12. Cable Analyzer Setup with PIC Connectors showing Two 1-m (39.4-inch) Segments Connected through Three PIC Connectors

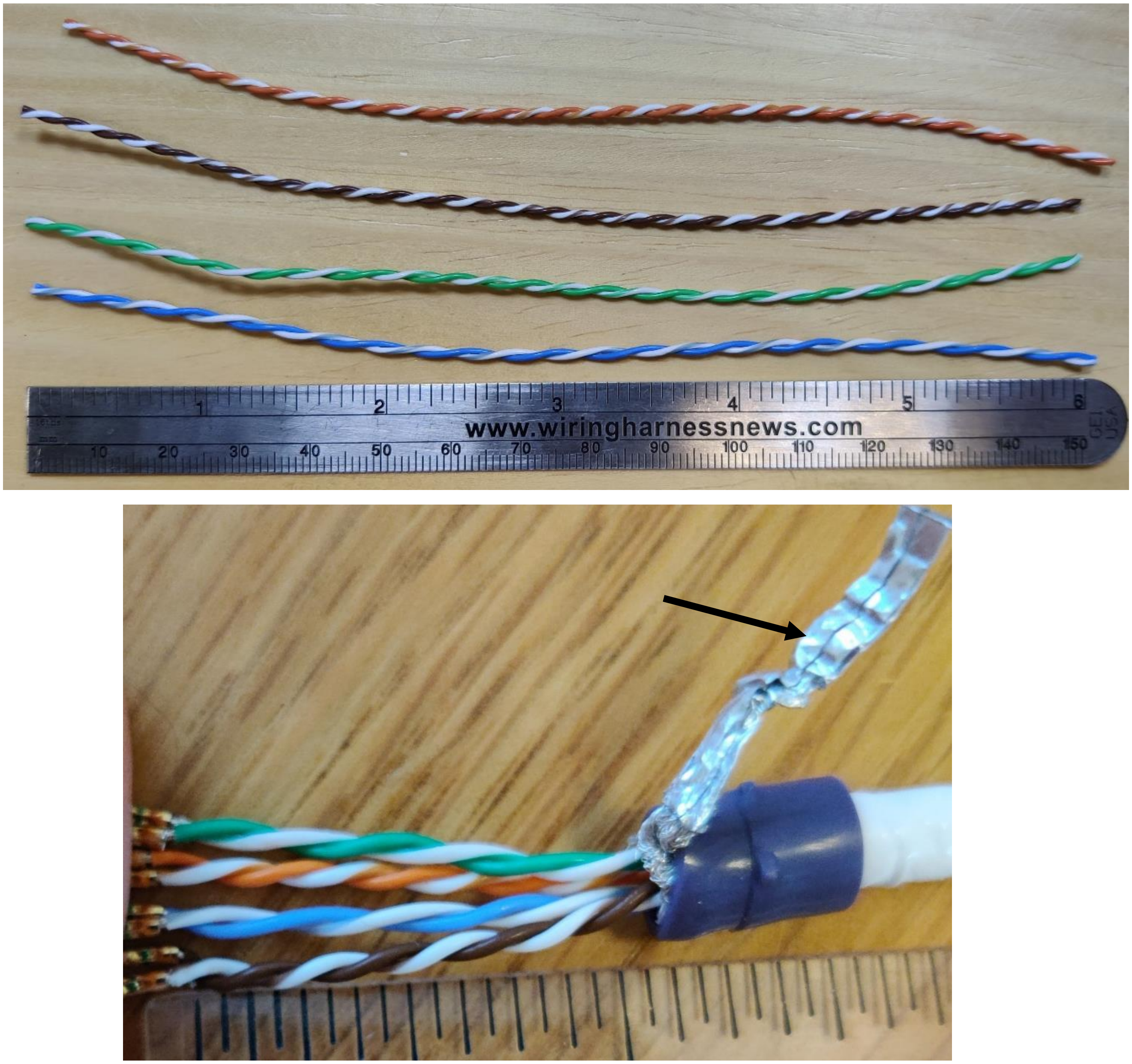


Figure 6.6-13. Four PIC Wire & Cable Twisted Pairs showing Different Twist Rates
In the top image, starting from bottom, blue/white pair with five twists/inch, green/white pair with six twists/inch, brown/white pair with eight twists/inch, and orange/white pair with seven twists/inch. Terminated PIC cable and connector (bottom image) showing twist rate maintained in the termination. Note the outer shield has been twisted together (see arrow).

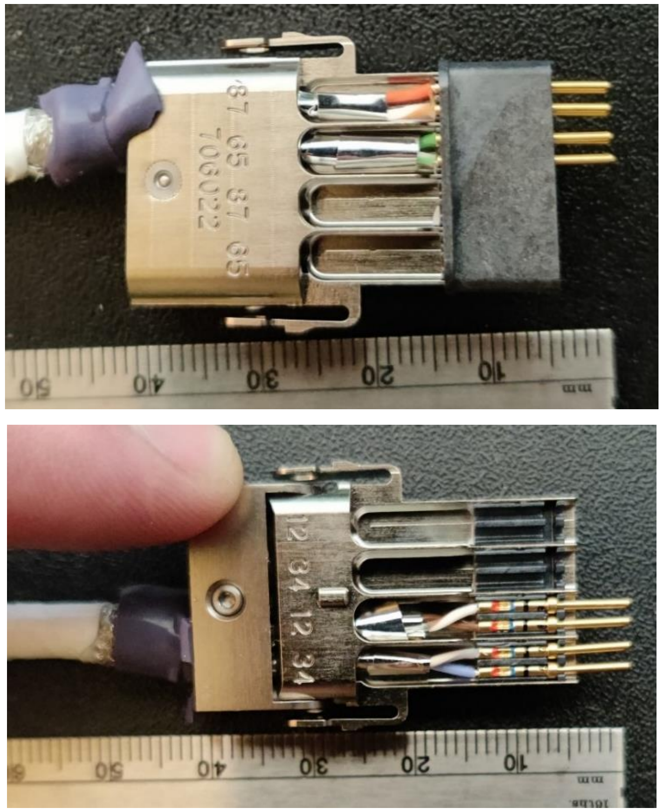


Figure 6.6-14. PIC Connector Termination showing Four Ethernet Pairs placed in Connector Note how blue grommet (top image) is distorted due to tension placed on the cable since there is no stress relief.

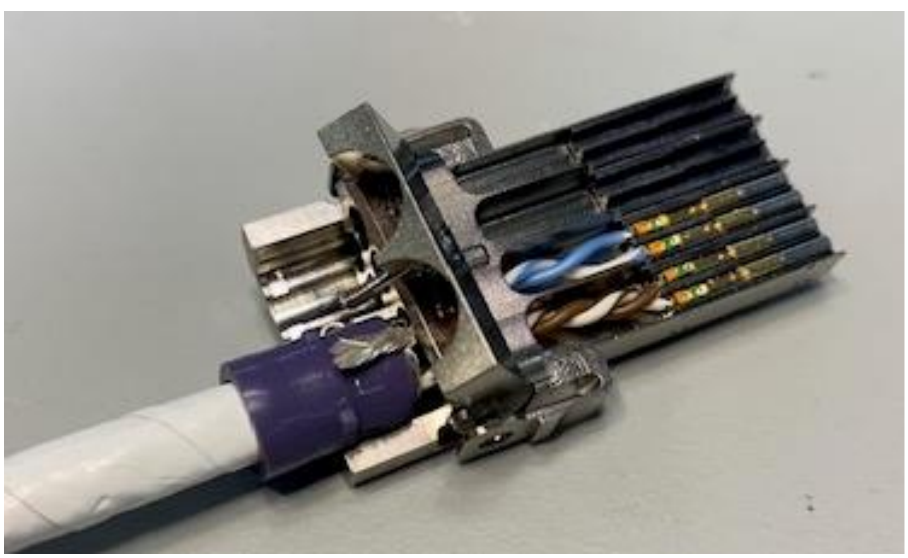


Figure 6.6-15. PIC Connector disassembled to Inspect Wire Twist, which was Properly Maintained After discussion with PIC cable, it was noted the shield was twisted into a single drain wire and placed between the metal clam shell of the connector to electrically bond the shield to the connector shell.

PIC Wire & Cable suggested the NESC assessment team review the termination process and inspect the built cables. Inspection revealed that the shield should have been twisted into two drain wires instead of one to create an electrical bond between the shield and the connector housing (Figure 6.6-16). The adaptor connectors and two segments were re-terminated and retested with the Fluke meter. There was some improvement in the RL when two drain wires were used (Figure 6.6-17). The RL was improved after the PIC connector shields were re-terminated (RL margin was 1.7 db above the requirement (re-terminated with two shield drain wires)) compared with an RL of –0.8 dB, which failed the Cat6a requirement when one shield drain wire was used.

The PIC adaptor cables and one segment were returned to PIC Wire & Cable for inspection of the cables and re-termination to determine whether the Cat6a performance could be improved. PIC Wire & Cable tested the as-received NASA-built cable and added a second Ethernet cable to the PIC connector since it was designed to accommodate two Ethernet lines. PIC Wire & Cable Fluke meter DSX 5000 Cat6a test results for the NASA cable as received were better than the PIC Wire & Cable in-house terminated PIC connector when comparing NEXT and RL results (Figure 6.6-18). After discussion, PIC Wire & Cable indicated they had terminated one end of the cable with an unshielded RJ45 connector, which connected to the Fluke meter. Note the lower NEXT value for the unshielded RJ45 connector compared with that of a shielded RJ45 connector (Figure 6.6-18). PIC Wire & Cable re-terminated the cable with a shielded Cat8 RJ45 connector, and the results were similar to the NASA terminated cable (Figure 6.6-19). These results indicate that an unshielded RJ45 connector degrades the Fluke meter Cat6a cable performance for NEXT and RL when compared with the shielded Cat8 RJ45 Fluke meter results.

The NESC assessment team reviewed the PIC cable results with PIC Wire & Cable technical staff, which claimed RL performance is most affected by a discontinuity or change in impedance. Impedance in a twisted pair wiring system is determined by the distance between the pairs. If they are crumpled and/or bowed, this can change the impedance and contribute to RL. After discussion, the assessment team concluded the marginal PIC Cat6a performance was most likely associated with the PIC connector and its shield termination process, which uses two drain connections to electrically bond the cable shield to the connector. The preferred shield bonding technique is a 360-degree shield attachment to the connector, which is used for the MIL-DTL-38999 and MIL-DTL-32546 (CeeLok FAS-X) connectors. Gore cables terminated to M38999 and FASX connectors with one cable segment have considerably higher NEXT and RL values (higher values are better) compared with those of a PIC cable and PIC connector (Figure 6.6-20). Improved NEXT performance was expected since the Gore cable has shielding on each Ethernet pair and an overall shield surrounding all four pairs, with the shield terminated 360 degrees to the M38999 connector; the PIC cable has unshielded pairs and overall shield surrounding all four Ethernet pairs, with the shield terminated to the PIC connector using two drain wires. A Gore cable terminated to an unmatched impedance M38999 connector had a better RL value than a PIC cable terminated to a matched impedance PIC connector. This is most likely due to the individually shielded pairs in the Gore cable compared with the unshielded pairs in the PIC cable. In addition, the M38999 connector provides a 360-degree shield around the Gore connector, while the PIC cable only has two drain wires for connecting the shield to the PIC connector. The assessment team terminated a PIC cable to an M38999 connector and compared the Fluke meter Cat6a test with a PIC cable terminated to a PIC connector. Cable analyzer NEXT and RL attenuation values were higher for the PIC cable terminated to an M38999 connector (NEXT, 17.2 dB, and RL, 2.6 dB), compared with the PIC cable terminated to a PIC connector (NEXT, 8.8 dB, and RL, 1.2 dB) (see Figure 6.6-21). This testing demonstrated that a 360-degree shielding bond to a connector is superior with respect to crosstalk to using two drain wires to electrically bond the cable to a connector. A considerable number of technical articles and papers demonstrate that drain wires or “pigtails” are inferior to a 360-degree shield termination to a connector. Several studies report increased crosstalk and a lower shielding effectiveness for pigtails on the order of 10 to 35 dB compared with a 360-degree shield terminated to a connector [Paul, 1979; Bhooma et al., 2016; Armstrong, 2022]. The explanation for a higher RL (higher is better) in the M38999 connector compared with the PIC connector was less apparent. One possible explanation is that, as noted by PIC Wire & Cable, bending and misalignment of the Ethernet pairs results in poor RL performance, and this may have been more of an issue with the PIC connector as opposed to the M38999 connector. Another explanation is that the PIC cable shield was electrically bonded 360 degrees around the M38999 connector, while the PIC cable uses two drain wires to electrically bond the shield to the PIC connector.

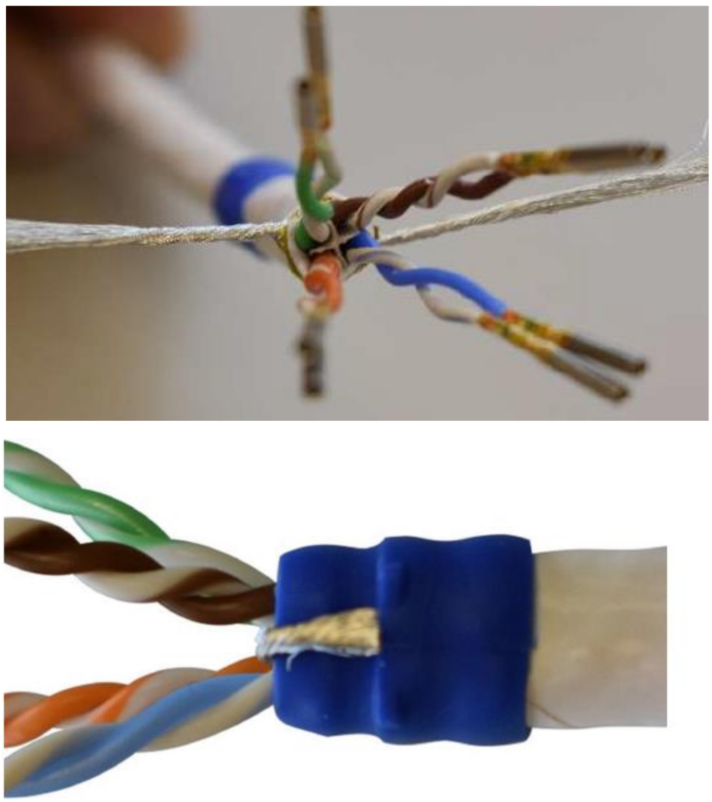


Figure 6.6-16. Proper PIC Wire & Cable Termination of Shield, which uses Two Drain Wires to Electrically Bond the Shield to the Outer Connector Shell

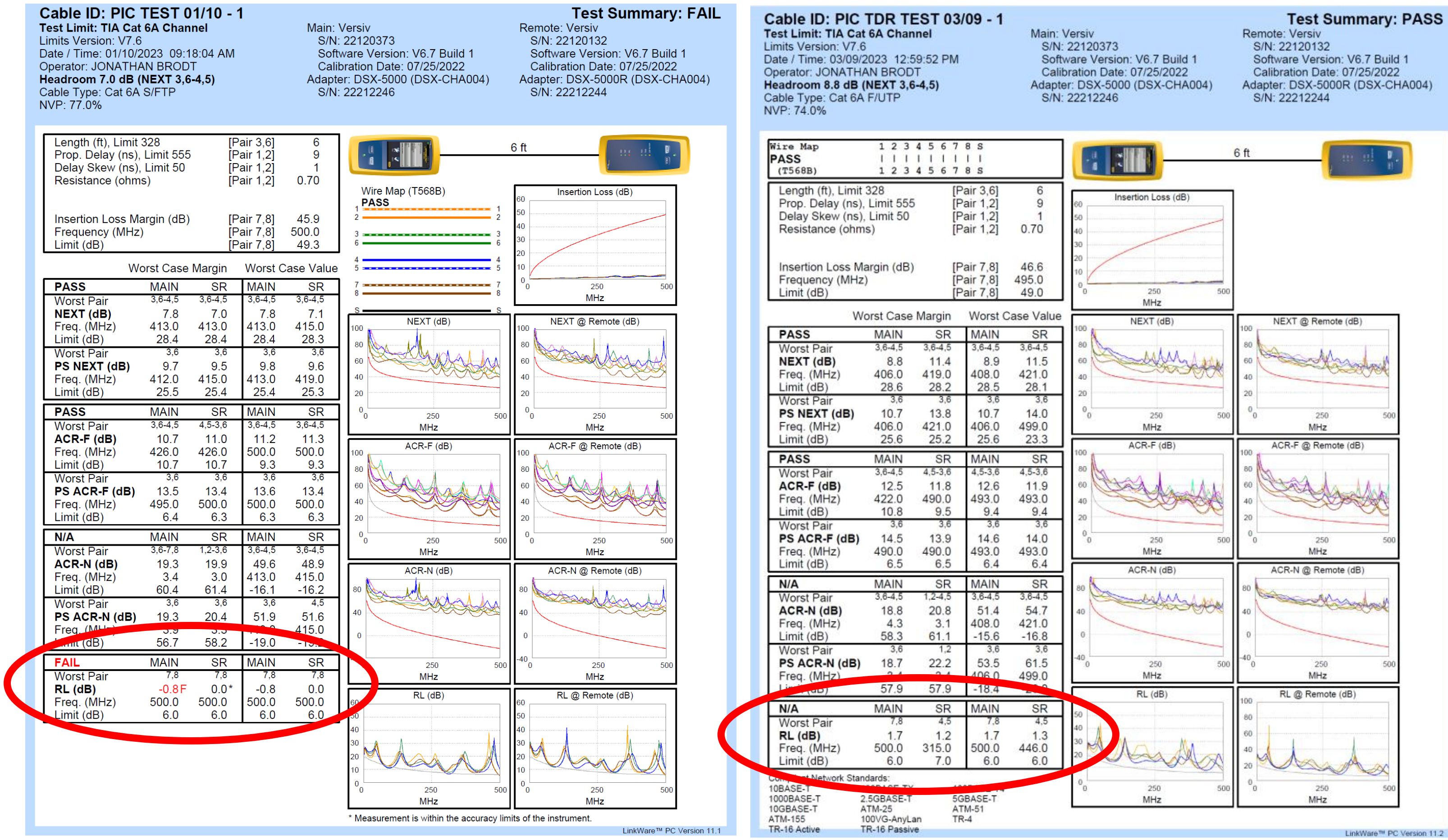


Figure 6.6-17. Fluke Meter Cat6a Results for One Segment of PIC Wire & Cable and Connectors (left) and after Properly Re-terminating the PIC Connector Shield (right)

Note the RL (see red circles) was improved after re-terminating the PIC connector shields (RL Main was 1.7 db above the requirement (right) compared with 0.8 dB below the requirement (left).

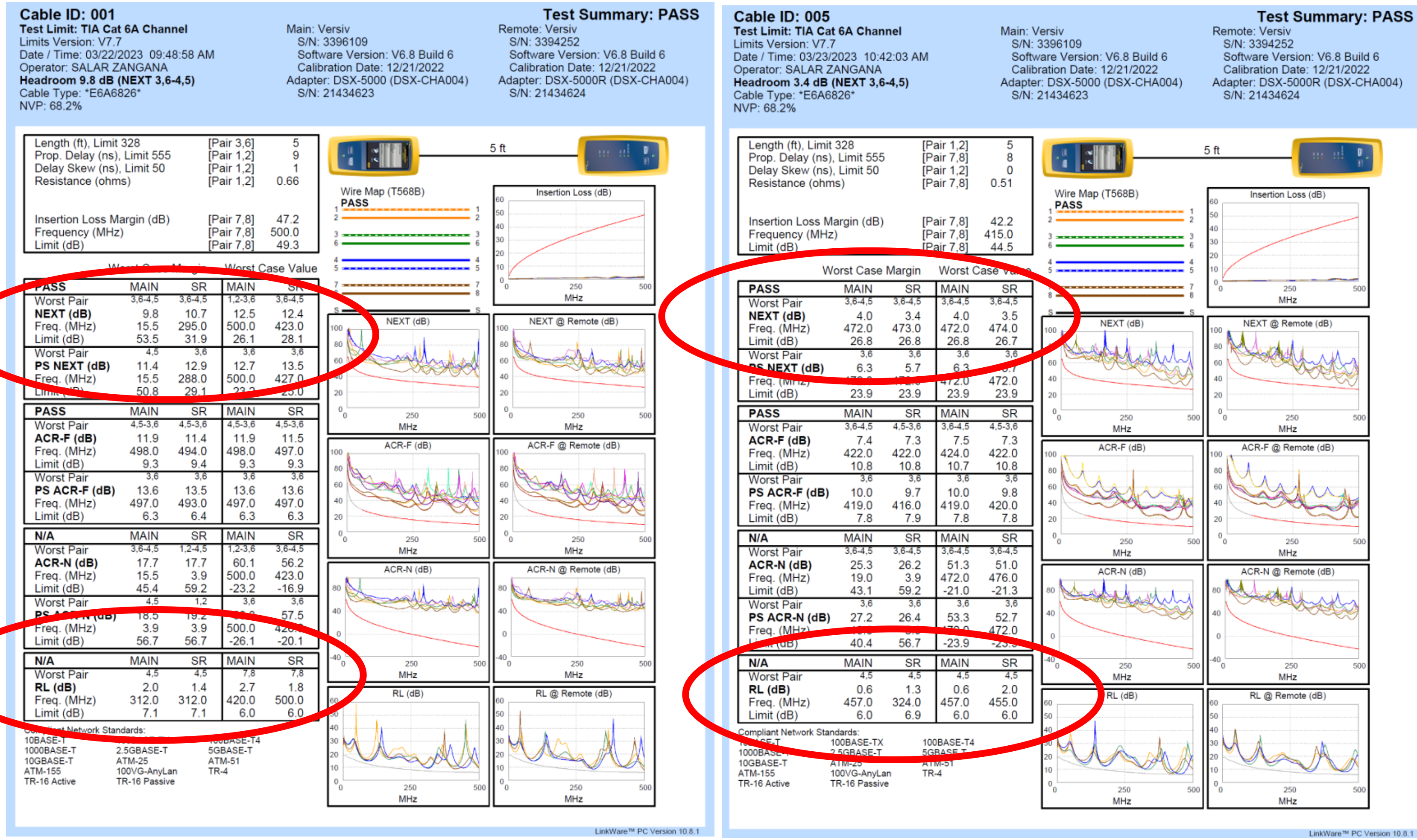


Figure 6.6-18. PIC Wire & Cable Fluke Meter DSX 5000 Cat6a Test Results for NASA Cable as received (left) and for a PIC Wire & Cable Vendor added to Existing PIC Connector (right) using Vendor's Termination Process

The NASA terminated cable performed better than the PIC terminated cable when comparing the NEXT and RL results (red circles). This was due to the vendor using an unshielded RJ45. When it was replaced with a Cat8 shielded RJ45 connector, there was a significant improvement in the Fluke meter results (see Figure 6.6-19).

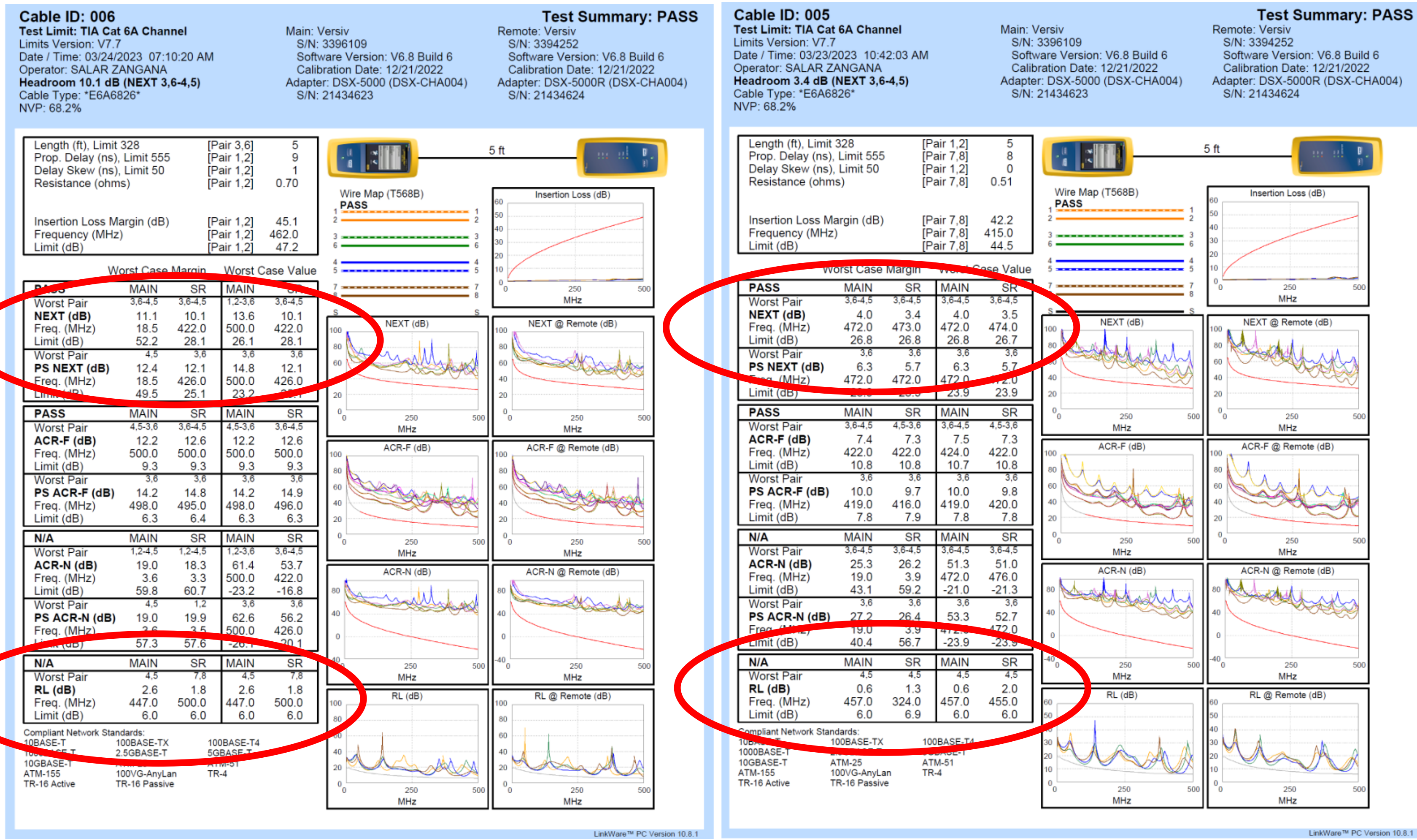


Figure 6.6-19. PIC Wire & Cable Fluke Meter DSX 5000 Cat6a Test Results for PIC Terminated Cable with an Unshielded RJ45 Connector (right) and for the Same PIC Wire & Cable with a Shielded Cat8 RJ45 Connector (left)
When PIC Wire & Cable used a Cat8 shielded RJ45 connector, the PIC Fluke test results were improved (see red circles) but were better than the NASA-terminated PIC cable, which used a shielded Cat8 RJ45 connector (RL 1.4 dB and crosstalk 9.8 dB) (see Figure 6.6-18).

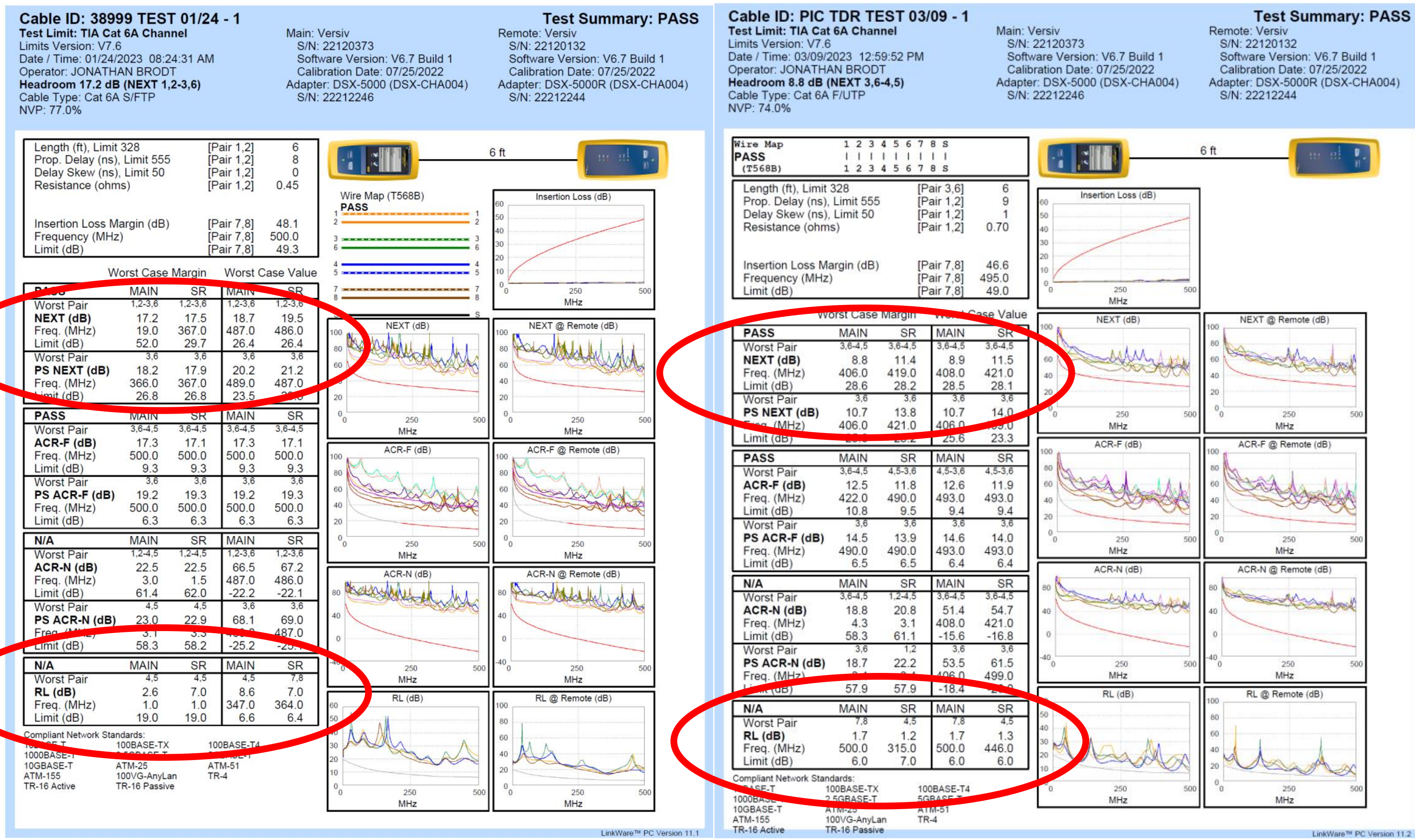


Figure 6.6-20. NASA Fluke Meter Cat6a Results for PIC Wire & Cable with One PIC Connector Segment (right) and Fluke Meter Results for Gore Cable with One M38999 Connector Segment (left) (see red circles)
Worst-case NEXT and RL are better for the M38999 connector (NEXT 17.2 dB and RL 2.6 dB) compared with PIC connector results (NEXT 8.8 dB and RL 1.2 dB).

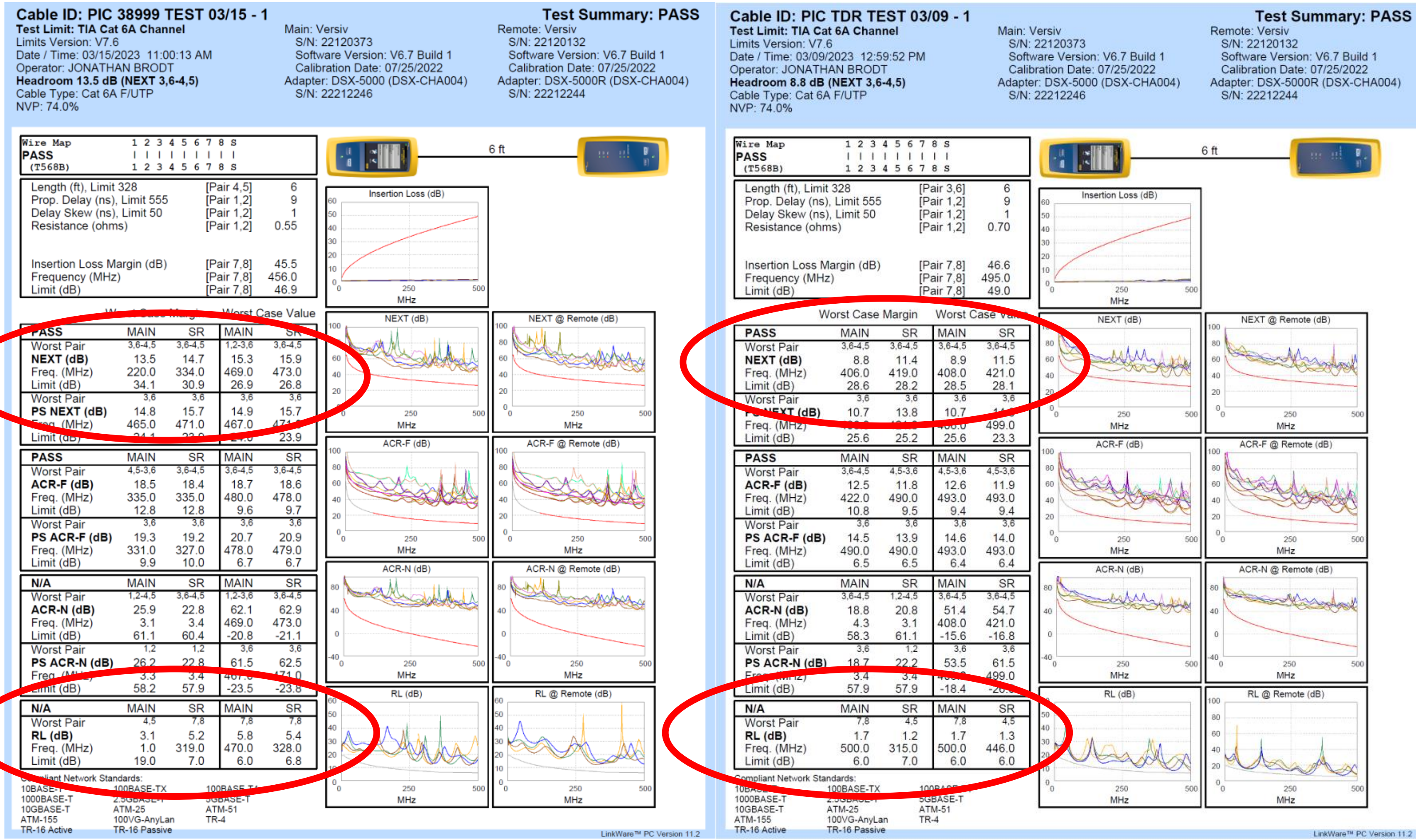


Figure 6.6-21. Fluke Meter Test Results show Improved Performance (see red circles) when an Unmatched Impedance M38999 Connector was terminated to a PIC Wire & Cable (left, RL 3.1 dB, and NEXT, 13.5 dB) compared with a Matched Impedance PIC Connector terminated to a PIC Wire & Cable (right, RL 1.2 dB, and NEXT, 8.8 dB).

The PIC adaptor cables and one segment that were reworked by PIC Wire & Cable were returned to the NESC assessment team and retested using the cable analyzer. The cable passed Cat6a crosstalk requirements with margin and passed RL with minimal margin (see Figure 6.6-22). An additional PIC cable and connector were added (two segments and three connectors), and when tested passed Cat6a crosstalk with margin and passed RL with minimal margin (see Figure 6.6-23). This was an improvement since in earlier testing adding two PIC cable segments and three PIC connectors resulted in failure of the cable analyzer Cat6a requirements (see Appendix B, Figure B-71). When three segments and four connectors were added, the PIC cable failed the Cat6a RL requirement (see Figure 6.6-24). As noted, Gore cables with CeeLok FAS-X and M38999 connectors were able to pass Cat6a requirements with up to five Ethernet segments and six connectors.

Cable ID: 6_9_23_PIC_TEST_SAMPLE_2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.7
Date / Time: 06/09/2023 06:27:13 AM
Operator: PETER FETTERER
Headroom 14.9 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.55
Insertion Loss Margin (dB)	[Pair 7,8]	47.4
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	15.8	14.9	15.8	14.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	26.1	26.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	17.0	16.0	17.0	16.1
Freq. (MHz)	500.0	498.0	500.0	500.0
Limit (dB)	23.2	23.3	23.2	23.2

PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	4,5-3,6	4,5-3,6
ACR-F (dB)	12.0	12.3	12.0	12.3
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.2	14.6	14.2	14.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3

N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	22.0	23.3	64.3	63.4
Freq. (MHz)	3.1	2.9	500.0	500.0
Limit (dB)	61.1	61.4	-23.2	-23.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	21.9	23.2	64.6	63.7
Freq. (MHz)	3.1	3.4	500.0	500.0
Limit (dB)	58.3	57.9	-26.1	-26.1

N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	1,2	4,5
RL (dB)	1.6	3.0	3.5	3.1
Freq. (MHz)	1.0	334.0	392.0	341.0
Limit (dB)	19.0	6.8	6.1	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

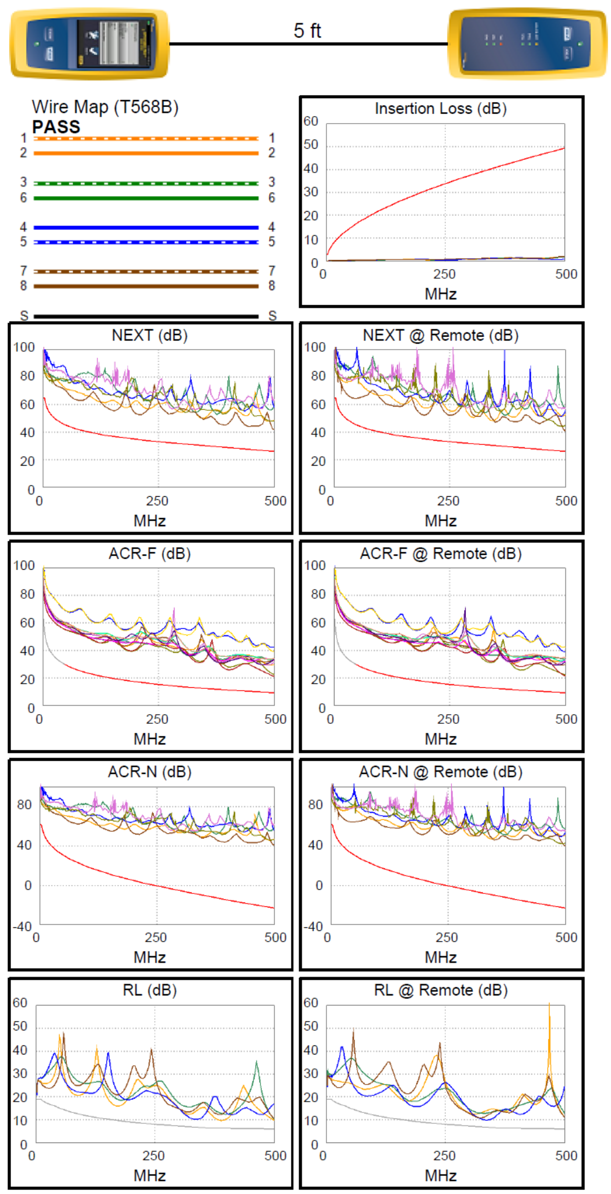


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Figure 6.6-22. Reworked Segment 1 PIC Wire & Cable with two PIC Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was connected and passed NEXT tests with margin (14.9 dB) and RL with margin (1.6 dB).

Cable ID: 6_9_23_PIC_TEST_SAMPLE_3 **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.7
Date / Time: 06/09/2023 06:29:53 AM
Operator: PETER FETTERER
Headroom 9.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	9
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 7,8]	0.83
Insertion Loss Margin (dB)	[Pair 1,2]	45.9
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-7,8
NEXT (dB)	10.0	9.5	11.9	12.5
Freq. (MHz)	304.0	305.0	500.0	500.0
Limit (dB)	31.6	31.6	26.1	26.1
Worst Pair	3,6	4,5	3,6	7,8
PS NEXT (dB)	11.5	11.3	12.8	13.8
Freq. (MHz)	404.0	308.0	500.0	500.0
Limit (dB)	25.7	28.6	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	4,5-3,6
ACR-F (dB)	12.6	13.0	12.6	13.1
Freq. (MHz)	500.0	412.0	500.0	500.0
Limit (dB)	9.3	11.0	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.3	14.8	14.3	14.8
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	3,6-7,8
ACR-N (dB)	19.4	18.0	59.8	58.4
Freq. (MHz)	3.1	3.0	500.0	500.0
Limit (dB)	61.1	61.4	-23.2	-23.2
Worst Pair	3,6	3,6	3,6	7,8
PS ACR-N (dB)	19.9	18.9	59.4	59.7
Freq. (MHz)	3.1	3.5	500.0	500.0
Limit (dB)	58.3	57.6	-26.1	-26.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	4,5	4,5
RL (dB)	3.8	0.9	0.4	-0.5
Freq. (MHz)	500.0	500.0	375.0	329.0
Limit (dB)	6.0	6.0	6.3	6.8

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

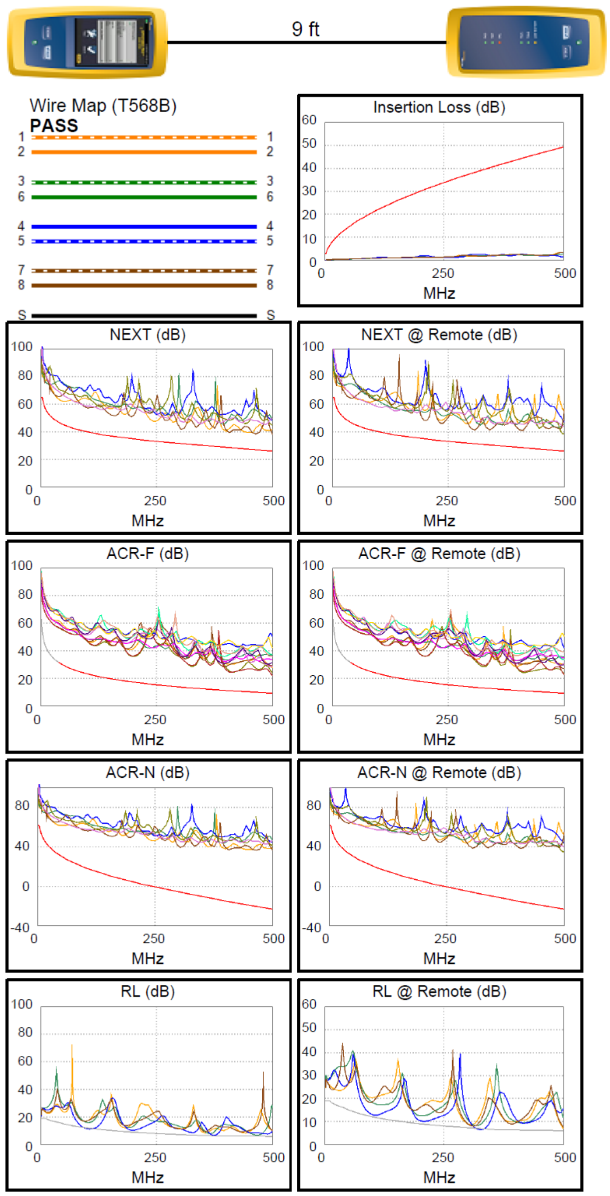

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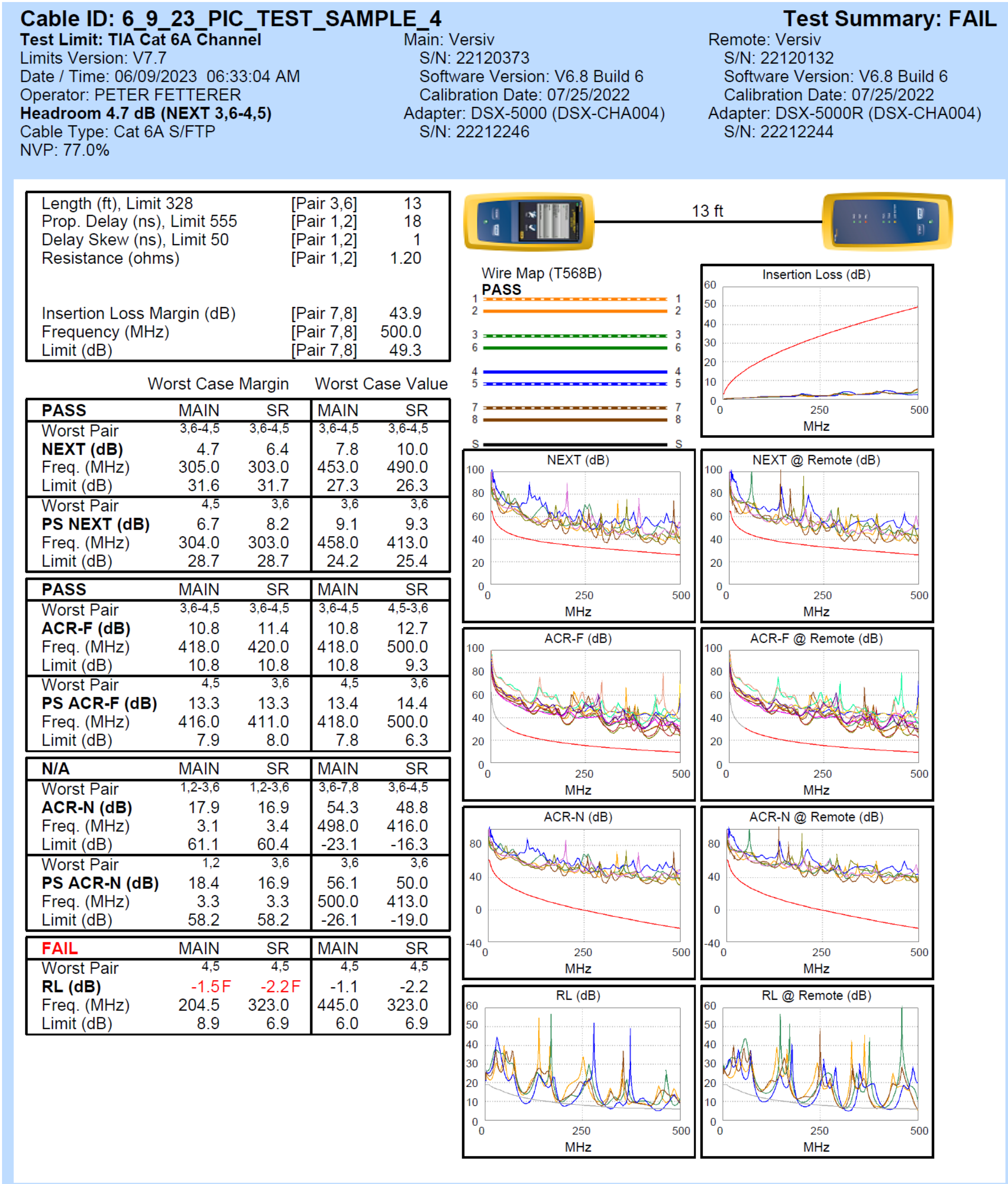
Figure 6.6-23. Reworked PIC Wire & Cable with Segments 1 and 3 and Three Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was connected and passed NEXT tests with margin (10.0 dB) and RL test with minimal margin (0.4 dB).



Cable ID: 6_9_23_PIC_TEST_SAMPLE_4 — **Test Summary: FAIL**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.7
Date / Time: 06/09/2023 06:33:04 AM
Operator: PETER FETTERER
Headroom 4.7 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.8 Build 6
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	13
Prop. Delay (ns), Limit 555	[Pair 1,2]	18
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	1.20
Insertion Loss Margin (dB)	[Pair 7,8]	43.9
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	4.7	6.4	7.8	10.0
Freq. (MHz)	305.0	303.0	453.0	490.0
Limit (dB)	31.6	31.7	27.3	26.3
Worst Pair	4,5	3,6	3,6	3,6
PS NEXT (dB)	6.7	8.2	9.1	9.3
Freq. (MHz)	304.0	303.0	458.0	413.0
Limit (dB)	28.7	28.7	24.2	25.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	10.8	11.4	10.8	12.7
Freq. (MHz)	418.0	420.0	418.0	500.0
Limit (dB)	10.8	10.8	10.8	9.3
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.3	13.3	13.4	14.4
Freq. (MHz)	416.0	411.0	418.0	500.0
Limit (dB)	7.9	8.0	7.8	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-7,8	3,6-4,5
ACR-N (dB)	17.9	16.9	54.3	48.8
Freq. (MHz)	3.1	3.4	498.0	416.0
Limit (dB)	61.1	60.4	-23.1	-16.3
Worst Pair	1,2	3,6	3,6	3,6
PS ACR-N (dB)	18.4	16.9	56.1	50.0
Freq. (MHz)	3.3	3.3	500.0	413.0
Limit (dB)	58.2	58.2	-26.1	-19.0
FAIL	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	-1.5F	-2.2F	-1.1	-2.2
Freq. (MHz)	204.5	323.0	445.0	323.0
Limit (dB)	8.9	6.9	6.0	6.9

Figure 6.6-24. Reworked PIC Wire & Cable with Three Segments (1, 3 and 4) and Four Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements Cable was connected and passed NEXT tests with margin (4.7 dB) and failed RL margin requirements (–1.5 dB).

The Ethernet cables evaluated in this assessment were built by engineers and technicians as part of the NESC assessment team at GSFC using standard NASA wiring practices as defined in

NASA-STD 8739.4. The GSFC assembly team provided the following review of the cable fabrication process, terminating the cables to the connectors and mating and de-mating the connectors.

> *The Gore cable and M38999 and CeeLok FAS-X connectors were straightforward to assemble and mate and de-mate during testing operations. Technicians were provided with Ethernet termination instructions from Gore Cable, specifically for M38999 connectors. Testing with the Fluke meter revealed the connectors were not shielded up to the point of termination (within 0.5 inch). To compensate for this drawback, shielding foil was added to each twisted pair from the removal of the shielded jack to as close to the contacts as possible. Technicians found the best method for shielding the cables up to the connector grommet was to use the original shield removed from the cable. When this was not possible, an aluminum shield foil was used, similar to the cable shield foil.*
>
> *The PIC connector had some attributes that made mating and de-mating difficult. For the connector to be de-mated, the "anti-decoupling ring" is retracted. This extra step made the process difficult, as the ring was prone to not pull back and had to be rotated for de-mating to proceed. Pulling back on the ring helped mate the connectors when there was a snag. Therefore, the connector needed to be pushed or pulled to ensure there was no mechanical snag so the contacts would properly mate. Additionally, this connector had a cable seal within the backshell that would catch on the cable when affixing the backshell to the connector. This resulted in torsion being applied through the cable to the high-speed module (HSM), which held the contacts and a grommet. The resulting torsion would damage the rubber seal, making the electrical grounding unreliable (see Figure 6.6-14). Therefore, the cable seal had to be rotated the opposite direction from the backshell or held in place during mating/de-mating to ensure the grommet was not disrupted.*
>
> *During manufacturing of each cable type, a number of fabrication errors were related to miswiring (i.e., placement of the wrong twisted pair in the connector) and improper attachment of the shield to the terminated connectors. This was attributed to personnel not being familiar with building Ethernet terminated cables and the complexity of the connectors. In addition, use of 26- and 24-AWG wires made it difficult to maintain wire location. The Fluke cable analyzer was effective in confirming correct wire arrangement in the connector and verifying continuity of the Ethernet pairs and proper connection of the shield to the connectors.*
>
> *There was a connection issue associated with the COTS RJ45 connectors (i.e., Steward Connector P/N SS-39300-10). The connector can reportedly accommodate wire sizes from 22 to 26A WG, but only 26 AWG engaged the connector's metal barbs used to contact the conductor through the insulation. When 24-AWG wire was used (a larger diameter than 26 AWG), the barbs did not always contact the conductor through the insulation until the connector housing was pressed several times. This could be an issue if the connector is subjected to vibration conditions or extereme temperature changes.*

The Fluke cable analyzer testing led to several unexpected observations. When the cable segment order was rearranged, the results varied, which could make a difference between a marginal pass or a failure. The adapter cables used a shielded RJ45 connector, which occasionally produced an open circuit during testing since the contacts were mechanically held to the Ethernet conductor by snapping the connector shell together.

As part of the Ethernet characterization, the NESC assessment team compared the crosstalk between Ethernet cables that were adjacent and those that were spread out or looped. The test was set up by loosely tying the Ethernet cables together and testing the cable with the cable analyzer; test setup and test results are shown in Appendix B, Figures B-77 through B-89. Comparison of Cat6a cable analyzer results with the cables adjacent versus looped (i.e., spread out) showed no significant difference in the crosstalk values between the two configurations for cable segments of 1, 2, 3, 4, and 5 (Appendix B, Figures B-77 through B-89, Figure B-40).

Controlled impedance cables (e.g., Ethernet cables) are known to be sensitive to bending, which can degrade their electrical performance. Typically, Ethernet cables should not exceed a bend radius of four times (4x) the cable diameter [IPC/WHMA-A-620D, para. 14.3.2 and Table 1]. A severe bend radius (one times (1x) the cable diameter) can distort the position of the twisted pairs and insulation and change the impedance of the cable to cause additional signal attenuation and increased crosstalk between twisted pairs. A cable bend fixture was built based on a Gore paper [Gore, 2016], and the Gore and PIC cables were evaluated under bend radius within the bend radius limit (i.e., 4x the cable diameter) and a bend radius below the minimum limit. A 24-AWG Ethernet cable is 0.28 inches in diameter, and the minimum bend radius for a Cat6a cable is 4x the cable diameter. Thus, the minimum bend radius would be 1.12 inches, which is comparable to the 1.5-inch diameter mandrel used in the bend fixture.

An example of a Gore cable with an estimated 4x cable bend radius and a 1x cable bend radius is shown in Figure 6.6-25. Gore cables are shown in the bend fixture in Appendix B, Figures B-90 and B-91, and the cable analyzer results are given in Appendix B, Figures B-96 through B-103. Two connectors were added in the bend flex tests, as shown in Appendix B, Figures B-92 and B-93. In all cases, no significant differences were noted in the Cat6a cable analyzer crosstalk and RL values when comparing the results for little to no cable bending, significant cable bending (i.e., 4x cable diameter), and severe bending (e.g., 1x cable diameter) for the Gore cable (see Appendix B, Figures B-102 and B-103).

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
NEXT (dB)	7.9	8.2	11.1	10.3
Freq. (MHz)	112.5	114.0	461.0	461.0
Limit (dB)	39.1	39.0	27.1	27.1
Worst Pair	3,6	1,2	7,8	1,2
PS NEXT (dB)	7.7	8.1	11.1	10.6
Freq. (MHz)	3.9	114.5	461.0	462.0
Limit (dB)	60.8	36.1	24.2	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	18.7	18.6	18.7	18.7
Freq. (MHz)	488.0	466.0	488.0	488.0
Limit (dB)	9.5	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	18.8	19.3	18.8
Freq. (MHz)	468.0	468.0	468.0	468.0
Limit (dB)	6.9	6.9	6.9	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
ACR-N (dB)	11.6	12.5	54.4	53.4
Freq. (MHz)	3.1	3.3	461.0	461.0
Limit (dB)	61.1	60.7	-20.1	-20.1
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.4	11.9	54.3	53.7
Freq. (MHz)	3.3	3.3	460.0	463.0
Limit (dB)	58.2	58.2	-22.9	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	1,2	1,2
RL (dB)	7.8	6.5	7.9	6.5
Freq. (MHz)	342.0	344.0	344.0	344.0
Limit (dB)	6.7	6.6	6.6	6.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
NEXT (dB)	8.1	7.7	10.5	11.0
Freq. (MHz)	114.0	112.5	462.0	462.0
Limit (dB)	39.0	39.1	27.0	27.0
Worst Pair	1,2	3,6	1,2	1,2
PS NEXT (dB)	8.0	7.7	10.7	11.1
Freq. (MHz)	114.5	3.3	462.0	461.0
Limit (dB)	36.1	62.0	24.1	24.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	4,5-3,6	3,6-4,5
ACR-F (dB)	18.5	18.5	18.8	18.7
Freq. (MHz)	468.0	468.0	487.0	488.0
Limit (dB)	9.9	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	19.5	19.5	19.5
Freq. (MHz)	468.0	468.0	487.0	468.0
Limit (dB)	6.9	6.9	6.5	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
ACR-N (dB)	12.2	11.7	53.5	54.2
Freq. (MHz)	3.1	3.3	462.0	462.0
Limit (dB)	61.1	60.7	-20.2	-20.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.7	11.2	53.8	54.2
Freq. (MHz)	3.3	3.3	462.0	461.0
Limit (dB)	58.2	58.2	-23.1	-23.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	3,6	4,5
RL (dB)	7.6	7.1	7.6	7.1
Freq. (MHz)	340.0	341.0	340.0	341.0
Limit (dB)	6.7	6.7	6.7	6.7

Figure 6.6-25. Cat6a Cable Analyzer Results Comparison between Segments 1,2 3, 4, and 5 Looped (right, Appendix B, Figure B-40) and Cable and Connectors Tied Together (left, Appendix B, Figure B-89) to assess Crosstalk
Crosstalk parameters did not differ significantly between the cable configurations.

A 26-AWG PIC cable with and without two connectors was evaluated in the bend fixture testing (Appendix B, Figures B-94 and B-95). A 26-AWG Ethernet cable is 0.22 inches in diameter, and the minimum bend radius for a Cat6a cable is 4x the cable diameter. Thus, the minimum bend radius would be 0.88 inches, which is smaller than the 1.5-inch diameter mandrel used in the bend fixture. Cable analyzer results for the PIC cable are given in Appendix B, Figures B-94 through B-111. There were no significant differences in the Cat6a cable analyzer crosstalk and RL values when comparing the results for little to no cable bending, significant cable bending (i.e., 4x cable diameter), and severe bending (e.g., 1x cable diameter) for the PIC cable (see Appendix B, Figure B-110). When two mated connectors were added, the PIC assembly failed the cable anlyzer RL test when subjected to severe cable bending (1x cable diameter), and the crosstalk was lower than the result for significant cable bending (4x cable diameter) (see Figures 6.6-26 and 6.6-27).

This assessment did not evaluate the impact of long-term severe cable bending, which over time would be expected to degrade Ethernet cable performance since bending distorts the alignment of the twist pairs inside the cable and can impact the cable RL and attenuate the network signal.

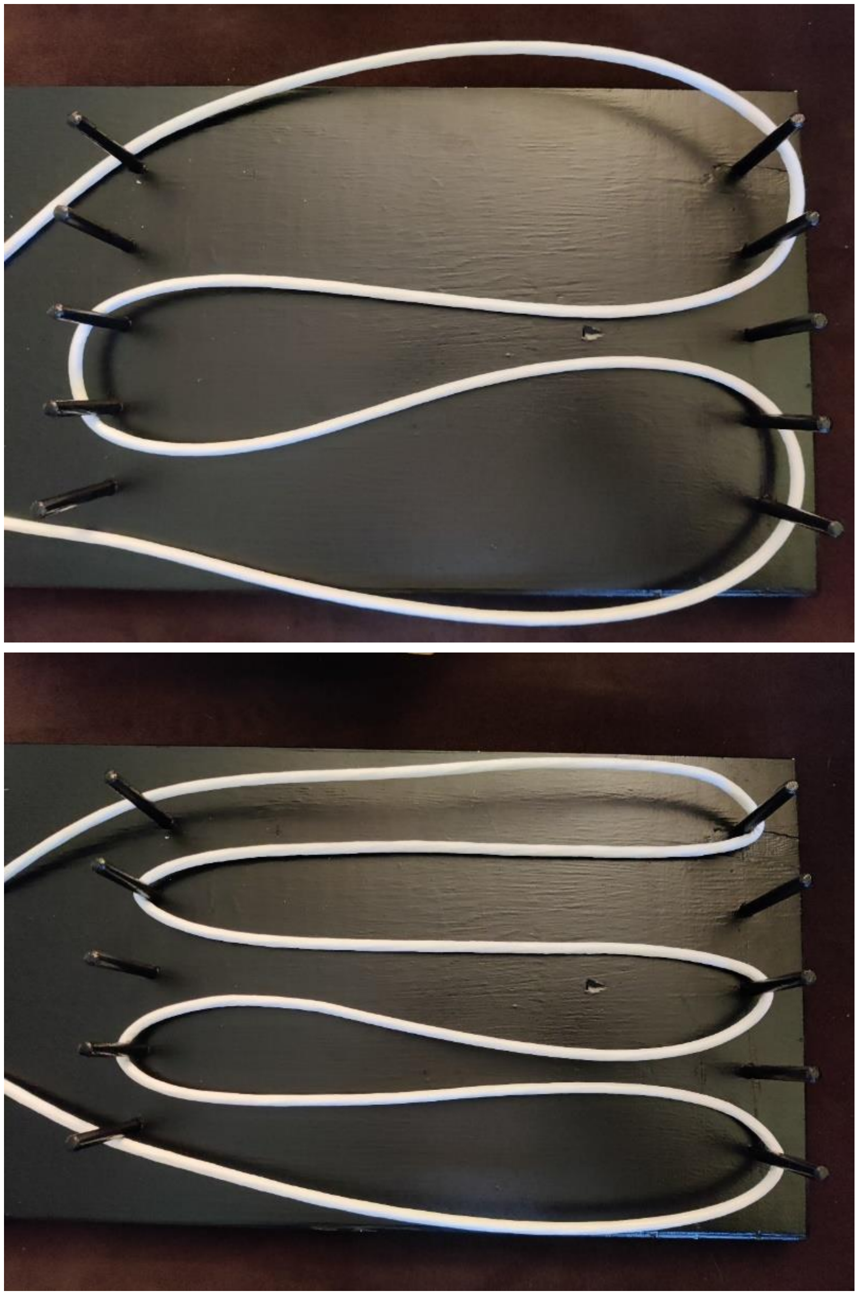


Figure 6.6-26. Ethernet Cable Bend Fixture
Gore Ethernet cable in bend fixture with three bends, each with a bend radius greater than the 4x cable diameter requirement for an Ethernet cable (top) and a Gore Ethernet cable bend fixture with three severe bends (1x of the cable diameter) with each a bend radius less than the 4x cable diameter requirement for an Ethernet cable (bottom).

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.0	7.7	9.1	7.7
Freq. (MHz)	485.0	422.0	488.0	422.0
Limit (dB)	26.5	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	11.0	9.9	11.4	11.3
Freq. (MHz)	419.0	422.0	488.0	487.0
Limit (dB)	25.3	25.2	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.1	10.7	11.2
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	10.6	10.6	10.5	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.6	13.7	13.7
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	7.6	7.6	7.5	7.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.4	19.3	55.6	50.4
Freq. (MHz)	3.1	3.0	485.0	422.0
Limit (dB)	61.1	61.4	-22.0	-16.8
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-N (dB)	18.0	20.2	58.2	52.7
Freq. (MHz)	3.6	3.3	488.0	421.0
Limit (dB)	57.3	58.2	-25.1	-19.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	7,8	4,5
RL (dB)	0.4	-0.1	1.0	-0.1
Freq. (MHz)	317.0	444.0	500.0	444.0
Limit (dB)	7.0	6.0	6.0	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.3	6.9	10.6	6.9
Freq. (MHz)	415.0	422.0	486.0	422.0
Limit (dB)	28.3	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.6	9.3	12.2	9.3
Freq. (MHz)	415.0	422.0	495.0	422.0
Limit (dB)	25.4	25.2	23.3	25.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.7	11.3	10.8	11.4
Freq. (MHz)	426.0	426.0	428.0	430.0
Limit (dB)	10.7	10.7	10.6	10.6
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.7	13.8	13.8	13.8
Freq. (MHz)	426.0	427.0	428.0	427.0
Limit (dB)	7.7	7.6	7.6	7.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	13.9	18.5	57.4	49.5
Freq. (MHz)	3.1	3.1	486.0	422.0
Limit (dB)	61.1	61.1	-22.1	-16.8
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	16.0	18.6	59.6	52.1
Freq. (MHz)	3.1	3.9	495.0	422.0
Limit (dB)	58.3	56.7	-25.7	-19.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	4,5	1,2
RL (dB)	0.2	0.2	0.8	0.2
Freq. (MHz)	90.0	500.0	449.0	500.0
Limit (dB)	12.5	6.0	6.0	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.8	7.7	7.8	7.7
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	26.5	28.2	26.5	28.2
Worst Pair	4,5	3,6	4,5	3,6
PS NEXT (dB)	10.4	10.1	10.4	10.1
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	23.6	25.2	23.6	25.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.2	10.6	11.4
Freq. (MHz)	429.0	426.0	429.0	433.0
Limit (dB)	10.6	10.7	10.6	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.8	13.6	13.8
Freq. (MHz)	429.0	431.0	429.0	431.0
Limit (dB)	7.6	7.6	7.6	7.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.9	21.0	54.3	50.3
Freq. (MHz)	3.3	3.0	483.0	420.0
Limit (dB)	60.7	61.4	-21.9	-16.7
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	19.1	22.2	57.3	52.9
Freq. (MHz)	3.3	3.9	489.0	420.0
Limit (dB)	58.2	56.7	-25.2	-19.6
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	4,5
RL (dB)	-0.1 F	0.4*	-0.1	0.1
Freq. (MHz)	500.0	500.0	500.0	439.0
Limit (dB)	6.0	6.0	6.0	6.0

Figure 6.6-27. Fluke Meter Cat6a Results for a PIC 26 AWG Ethernet Cable with Two PIC Connectors
Left panel shows cable with no significant bends; center panel shows cable in the bend fixture with a bend within 4x of the cable diameter (the minimum bend radius); right panel shows cable with a severe bend radius (estimated to be 1x of the cable diameter). There were no significant changes with respect to crosstalk and RL for the no significant bend case and the 4x cable diameter case. With a severe bend (estimated to be 1x of the cable diameter), the cable failed the RL requirement and exhibited a lower crosstalk margin (7.8 versus 9.3 dB) compared with the cable in a minimum bend radius condition.

6.7 Electromagentic Compatibility Testing of Ethernet Cables

Electromagnetic compatibility analysis was conducted on the Gore cable and CeeLok FAS-X connectors by measuring transfer impedance, crosstalk, and RL using a Keysight E5061B network analyzer. Since the network analyzer requires a 50-ohm differential input, a conversion box was built to covert each of the four twisted-pair 100-ohm impedances to 50-ohm impedance differential pairs using a step-down transformer (2:1 ratio) mounted onto a shielded printed wiring assembly. The 100-ohm twisted pairs are connected to the conversion box using a CeeLok FAS-X connector that is mated to each end of the Ethernet cable under test (see Figure 6.7-1). Each converter box is connected to the network analyzer using 50-ohm differential connections with SMA (SubMiniature version A) coaxial radio frequency connectors attached to the network analyzer. The converter box is shown Appendix B, Figures B-125 and B-126. Transformers used in the converter box were designed to operate between 3 and 300 MHz; the component specification is given in Appendix D.1. Ethernet performance below and above these frequencies would be expected to be impacted by the transformer.

The network analyzer and impedance conversion box test setup for measuring Ethernet properties is shown in Figure 6.7-1. Initially, a signal propagation test was conducted to determine whether all four channels are propagating a signal through the impedance converter boxes and Ethernet cables. Full documentation of the test setup and test results is provided in Appendix D.2

The test showed that three twisted pairs or channels were propagating a signal, while one twisted pair channel had an electrical open (Figure 6.7-2). Based on previous testing, the electrical open was most likely in the impedance conversion box since in earlier testing several solder connections in the converter box had to be repaired after several channel opens were detected. Testing continued with the three functioning channels.

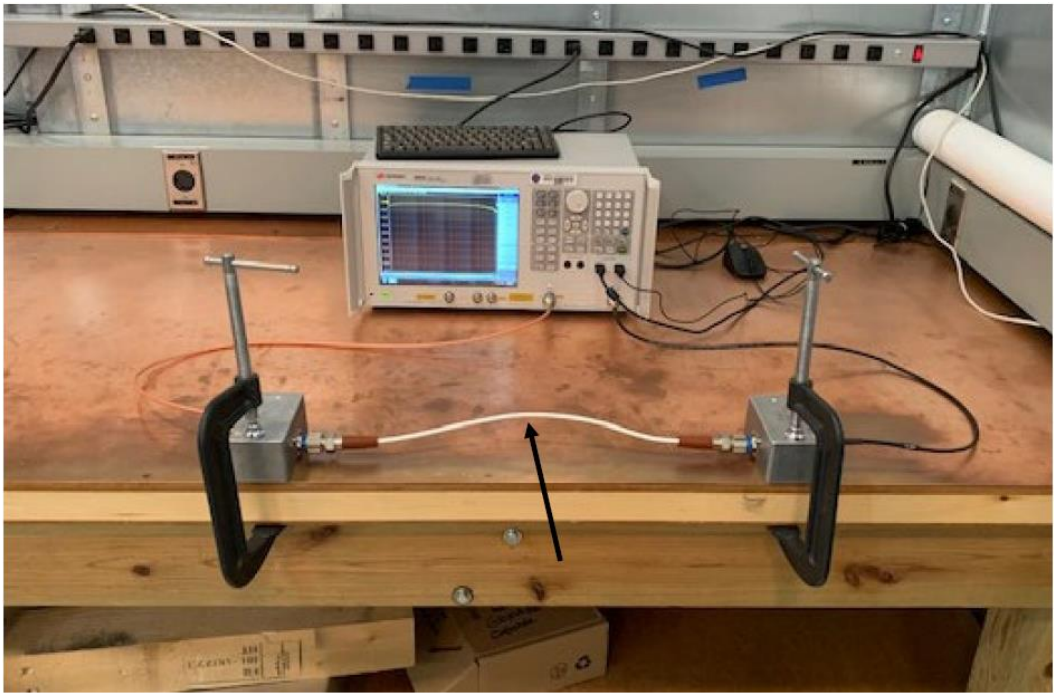


Figure 6.7-1. Basic Network Analyzer and Impedance Conversion Box Setup for Measuring Properties of Ethernet Cable (see black arrow in center)
The ~21 inch (53 centimeter (cm)) Gore Ethernet cable terminated with CeeLok FAS-X connectors averaging ~5 cm above the ground plane.

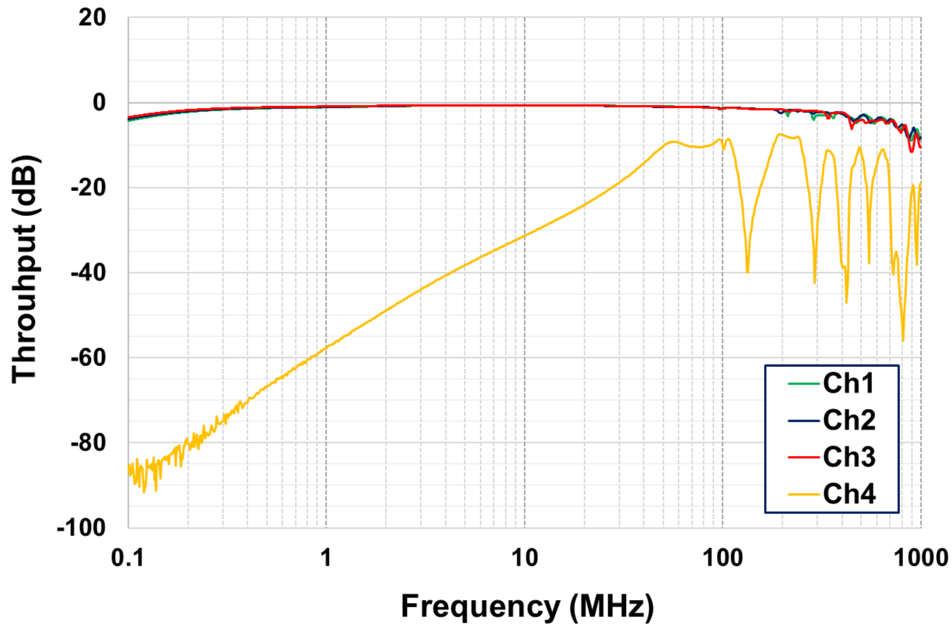


Figure 6.7-2. Signal Propagation Test to determine whether all Four Channels (twisted pairs) were Propagating a Signal
Test showed that channel 4 was open. Based on previous testing, the issue was most likely in the impedance conversion box. Testing continued with the three functioning channels.

Ethernet cable measurements of interest were shield transfer impedance, crosstalk on each channel, and RL of each channel. The basic test setup is shown in Figure 6.7-3, with the current injection probe (grey cylinder) and the network analyzer used to make measurements on a ~21-inch (53-cm) Gore Ethernet cable terminated with CeeLok FAS-X connectors ~2 inches (5 cm) above the ground plane. A current injection probe per MIL-STD-461G CS114 was used to make the transfer impedance measurements.

Shield transfer impedance is defined as the voltage per unit length induced on wiring contained within a shield by the current flowing on the shield. Shield transfer impedance is an intrinsic physical property independent of connector design and shield termination and provides a measure of shield effectiveness against susceptibility to external signal sources. Shields with a lower transfer impedance are more effective than shields with higher transfer impedance values.

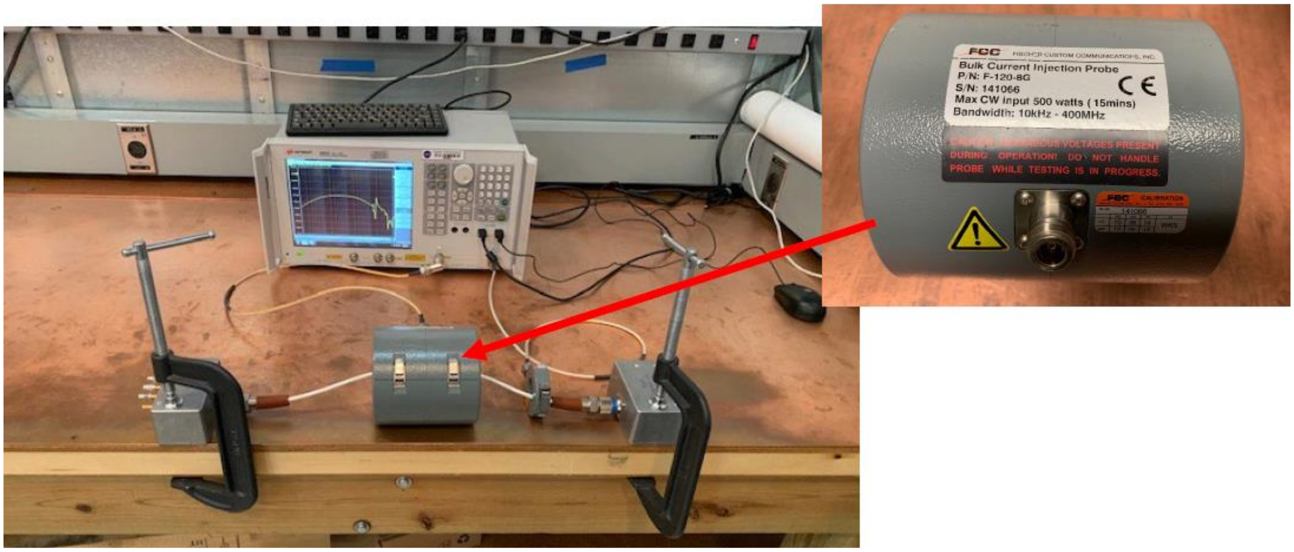


Figure 6.7-3. Basic Test Setup for measuring Electromagnetic Compatibility (EMC) Parameters The Ethernet cable of interest is inside the current injection probe (grey cylinder), and the network analyzer is used to obtain shield transfer impedance, crosstalk, and RL measurements on a ~21-inch (53-cm) Gore Ethernet cable terminated with CeeLok FAS-X connectors averaging ~2 inches (5 cm) above the ground plane.

The measured shield current is shown in Figure 6.7-4, and the measured coupled potential on each of the three functioning channels is shown in Figure 6.7-5. The shield transfer impedance obtained by directly subtracting the measured current from coupled potential is shown in Figure 6.7-6. For frequencies below 10 MHz, the shield transfer impedance is approximately –60 dBohms = 1 megaohm. Thus, for 1 milliampere of shield current, the coupled potential on a signal wire will be ~1 microvolt.

The cable length of 53 cm will equal 1/20 of a wavelength at a frequency of 28 MHz. Below this frequency, the cable is “electrically short” (i.e., transmission line effects are not significant, and the measured values can be taken as true measures of the bulk cable’s performance). Above 28 MHz, the cable is “electrically long” (i.e., transmission line effects become more significant, and the measured values are affected by cable length and geometry), as shown by the resonances indicated in Figure 6.7-6. The shield transfer impedance of the measured cable revealed excellent attenuation in the range of –70 dBohms. Over 70 MHz, the peaks in the curve are due to cable resonances that are a function of the cable length and frequency rather than the shielding (see Figure 6.7-4).

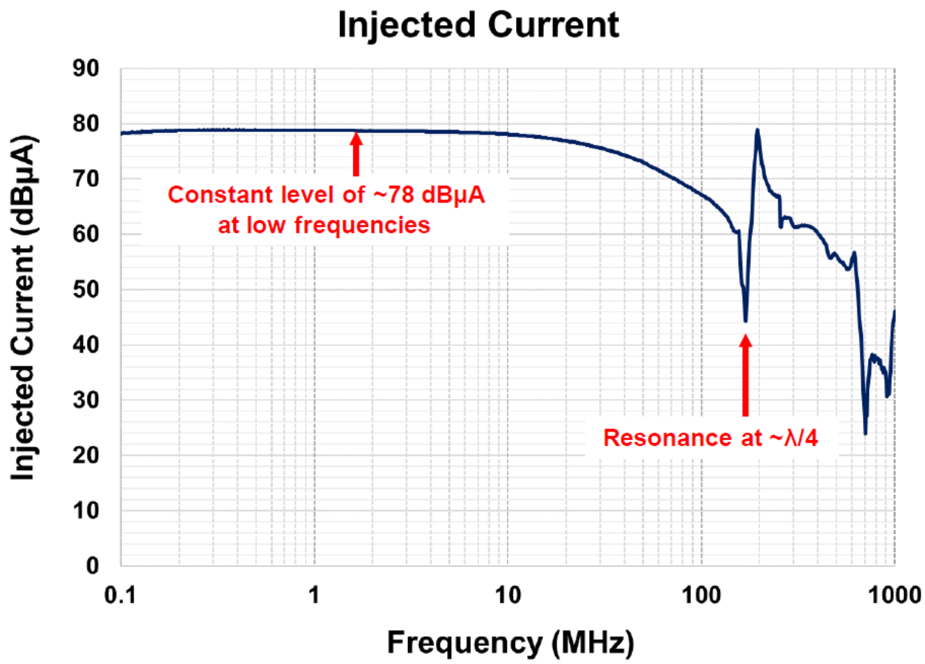


Figure 6.7-4. Measured Shield Current for Shield Transfer Impedance Measurements

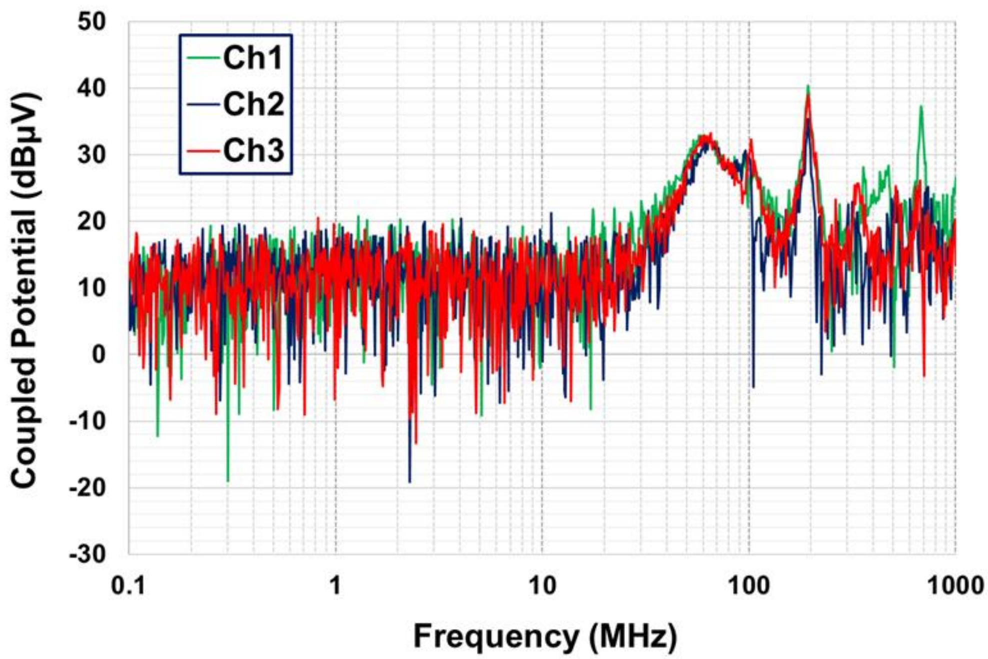


Figure 6.7-5. Measured Potential for Shield Transfer Impedance Measurements

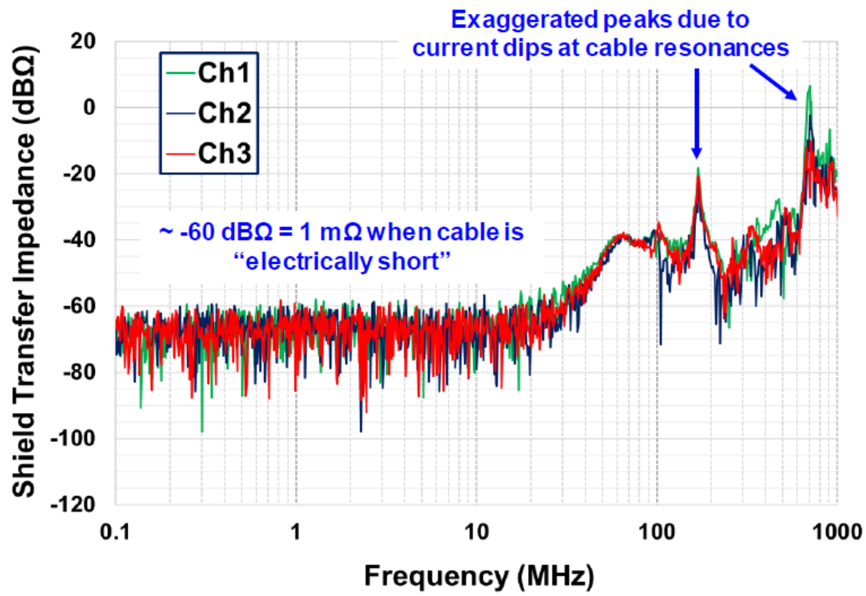


Figure 6.7-6. Shield Transfer Impedance Result showed Excellent Attenuation in the Range of –70 dBohms
Above 70 MHz, the peaks in the curve (see arrows) are due to cable resonances that are a function of the cable length and frequency and not the shielding (see Figure 6.7-4).

The crosstalk between the channels or Ethernet twisted pairs was measured as shown in Figure 6.7-7. Crosstalk between the three functioning channels (twisted pairs) showed a high signal rejection or attenuation (–70 dB) between the channels up to 70 MHz. Cat6a crosstalk link limits are given in ANSI/TIA-568-C.2 Section 6.3.8 and are based on signal frequency. The reference value for 1 MHz is a –65-dB signal rejection; at 100 MHz, it is a –45.8-dB signal rejection for NEXT.

RL for the three functioning channels (twisted pairs) is shown in Figure 6.7-8. The graph shows about a –13-dB RL at 1 MHz and a –19-bD RL at 100 MHz. RL is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back. A higher value indicates there is little reflected signal, which is desirable. Cat6a RL limits are given in ANSI/TIA-568-C.2 Section 6.3.6 and are based on signal frequency. Reference values are –19.1-dB signal rejection at 1 MHz and –14-dB signal rejection at 100 MHz for RL. The Fluke meter measurements for the cable under test showed a RL of –24.2 dB at 1 MHz and more than a 27.2-dB loss at 100 to 500 MHz. The differences may be due to RLs in the convertor boxes associated with the circuit traces, which were not designed as transmission lines, and from losses in the step-down transformers. The transformer specification is given in Appendix D.1.

The measurements were repeated with the cable placed ~3 inches (7.5 cm) from the ground plane, as shown in Figure 6.7-9, to determine whether increasing the distance from the ground plane adversely impacted the cable measurements. Test results showed little to no change when compared with the original results where the cable was placed ~2 inches (5 cm) from the ground (Figures 6.7-6 and 6.7-10). The RL for the three functioning channels (twisted pairs) is shown Figure 6.7-11 and was similar to the measurements made with the cable ~3 inches (7.5 cm) from the ground plane (Figure 6.7-8). Full documentation of the EMC test setup and test results is given in Appendix D.2, which can be used as a guideline for conducting transfer impedance testing.

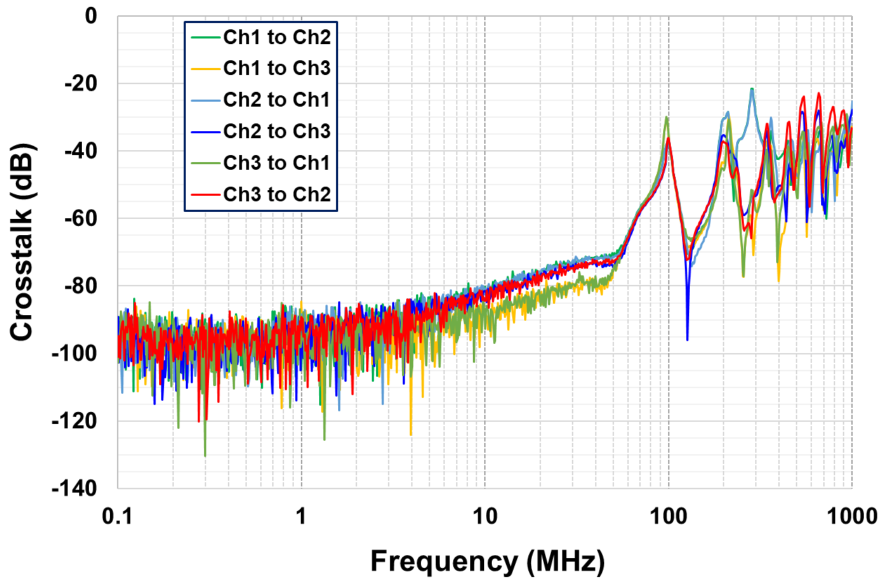


Figure 6.7-7. Crosstalk between Three Functioning Channels (twisted pairs), showing a High Signal Rejection or Attenuation of –90 dB at 1 MHz and ~70 dB at 70 MHz
Higher rejection values imply less crosstalk or interference between channels. Cat6a crosstalk link limits are given in ANSI/TIA-568-C.2 Section 6.3.8 and are based on signal frequency. Reference values are a –65-dB signal rejection for 1 MHz and a –45.8-dB signal rejection at 100 MHz for crosstalk or NEXT.

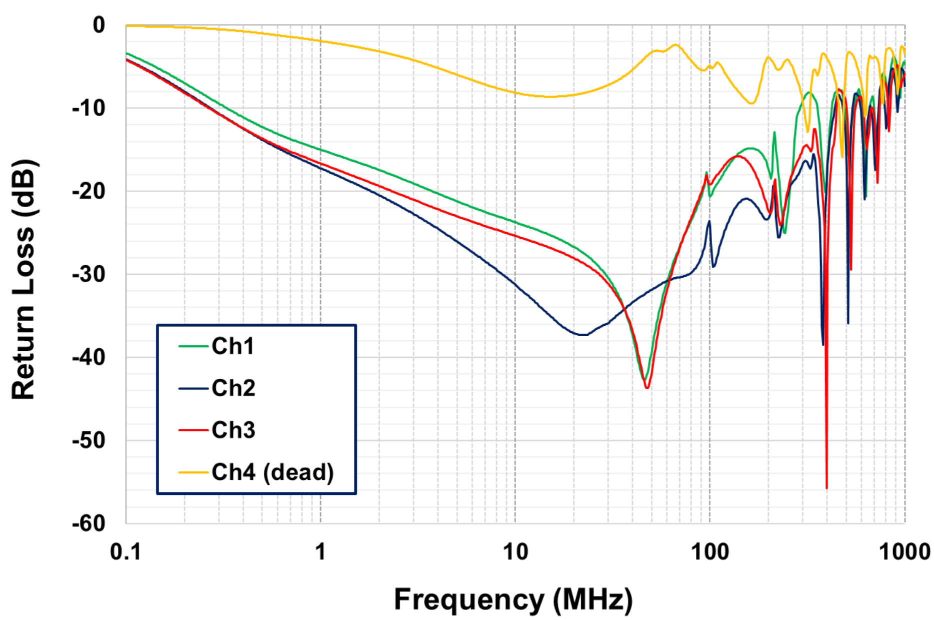


Figure 6.7-8. RL for Three Functioning Channels (twisted pairs)
Graph shows about a –13-dB RL at 1 MHz and a –19-bD RL at 100 MHz. Cat6A RL limits are given in ANSI/TIA-568-C.2 Section 6.3.6 and are based on signal frequency. Reference values are –19.1 dB signal rejection at 1 MHz and –14 dB at 100 MHz signal rejection for RL.

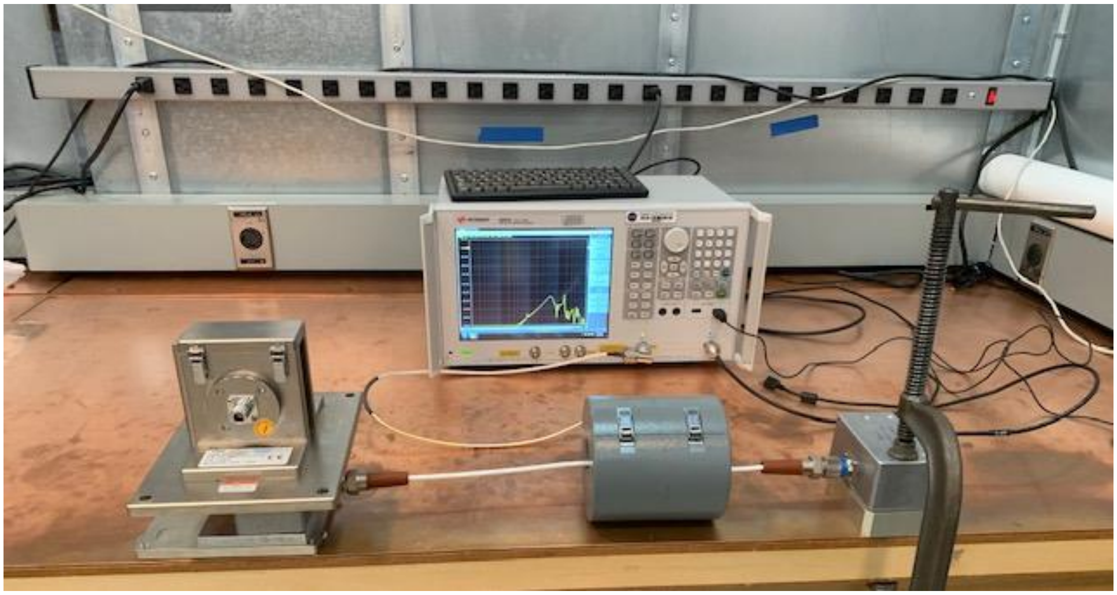


Figure 6.7-9. Basic Test Setup
Ethernet cable of interest is inside the current injection probe (grey cylinder), and the network analyzer used to make transfer impedance, crosstalk, and RL measurements on a 21-inch (53-cm) Gore Ethernet cable is terminated with CeeLok FAS-X connectors averaging ~3 inches (7.5 cm) above the ground plane.

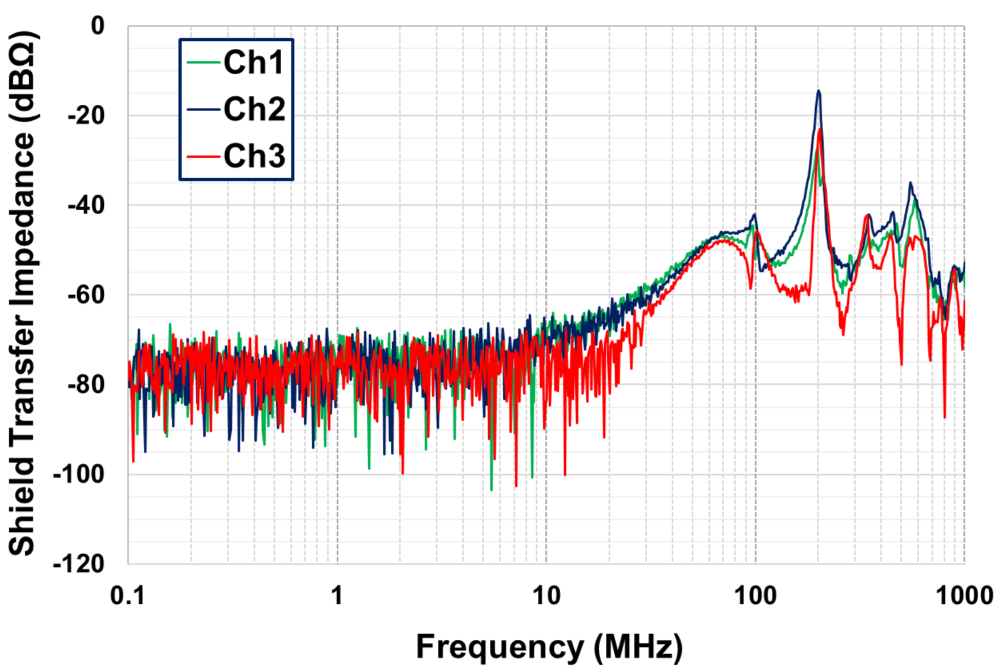


Figure 6.7-10. Shield Transfer Impedance Result with Cable Placed ~5 inches (7.5 cm) above Ground Plane
Results were similar to the measurements made with the cable ~2 inches (5 cm) from the ground plane (Figure 6.6-22)

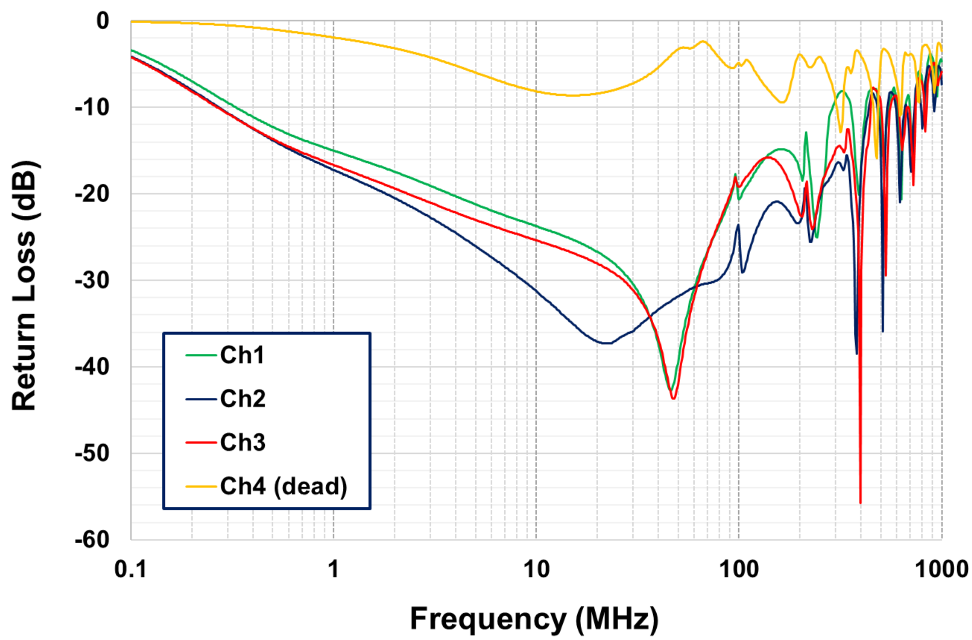


Figure 6.7-11. RL for Three Functioning Channels (twisted pairs)
Results were similar to measurements made with the cable ~3 inches (7.5 cm) from ground plane (Figure 6.7-8).

6.8 Testing of a Computer Ethernet Network System using as Built Ethernet Cables

The NESC assessment team set up a computer 1000BASE-T (eight-wire) Ethernet network using two PC-based computers connected to Ethernet cables. Computer one is a custom-built computer (server) with an 82572GI Intel PRO/1000 PT RJ45 1-Gbps 10BASE-T/100BASE-T/1000BASE-T Gigabit Ethernet PCI Express Server Network interface card. Computer two (client) is a Dell computer with a similar network card, an 82572GI Intel PRO/1000 PT RJ45 1-Gbps 10BASE-T/100BASE-TX/1000BASE-T Gigabit Ethernet PCI Express Server Network interface card. Network cards connect to the Ethernet cable using standard RJ45 connectors, which were connected to the as-built Ethernet cables. The network was monitored with the iPerf program, which is a software tool that monitors IP networks and can report the network bandwidth, loss of network link, and data packet losses. For the network setup, User Datagram Protocol (UDP) was used, which does not resend lost or corrupted data packets if there are errors. IPERF Commands used for the test: Client: iperf -c 172.17.0.1 -u -i 1 -b 400M --full-duplex --time 70 --e | tee -a ${logfile} Server: iperf -s -u -i 1 -b 400M -e -t 70 | tee -a ${logfile}. Networks can use a Transmission Control Protocol (TCP), which requires an established connection before it can transmit traffic. TCP will attempt to re-transmit any packets discarded during periods of high latency and resend the packets until the packets arrive at their destination. Both Ethernet protocol systems depend on error-correction algorithms in the network PHY to correct lost or corrupted packets.

The test procedure was to start the iPerf program in UDP full duplex mode and fill each channel with 50 megabytes (MB) of data transferred over a 1-sec interval at a 419 Mbps rate with a full duplex rate of 839 Mbps, for a 70-sec run. The network data stream condition was reported every 1 sec. Once iPerf was started, at ~2 sec the ESD gun was discharged into the Ethernet cable connector for ~60 sec. When a lost data packet was detected, the iPerf program reported a lost UDP data packet on the link. Test runs with the network operating and discharging the ESD gun into the connector were conducted on Ethernet cables consisting of a Gore cable with CeeLok FAS-X connectors, a Gore cable with MIL-DTL-38999 connectors, and PIC cable and connectors (Figure 6.8-1). In all cases, each Ethernet cable and connector system was able to communicate between the two computers without losing link at a 1000BASE-T data rate while being exposed to up to 16 kV using the ESD gun contacting the Ethernet cable connector. The basic network setup, with two PC computers connected to the as-built Ethernet cables through an Ethernet connector, is shown in Figure 6.8-2. An NSG 438/438A ESD simulator gun was used to apply a static discharge to the Ethernet connector to induce network data packet errors by inducing a voltage on the Ethernet pairs. The ESD simulator was equipped with a 150-pF/ 330-ohm discharge network (machine model), which meets IEC/EN 61000-4-2 and ISO 10605 standards. The ESD gun was able to discharge from 1 to 16 kV every 50 milliseconds (ms) for a repetition rate of 20 discharges per minute for a full 60 sec (Figure 6.8-3). The test procedure in Appendix E was used to apply the ESD discharges. Discharges were conducted over 1 minute.

Two test campaigns were conducted using the ESD gun to discharge into the Ethernet connector while operating the network. No network data packet errors were detected when discharging the ESD gun to 16 kV into the Ethernet connector when the connector was placed in electrical contact with the aluminum ground plane, which was connected to Earth ground (Figure 6.8-4). Dropped or corrupted data packets using the ESD gun were detected when the Ethernet connector was electrically isolated from the aluminum ground plane (see Figure 6.8-5). The iPerf program was run while discharging the ESD gun to the Ethernet connector, and after the test a control run was conducted using the iPerf program to verify the network and the computers were operational since there was a concern the network cards and/or other computer components could be damaged by application of static discharges into the network cables. During application of ESD discharges, no computer operations were conducted. A number of lost data packets were recorded during the control runs when no ESD pulse was applied, primarily on the client computer (26 with packet losses out of 41 control test runs) with only one instance of packet losses on the server computer out of 29 test runs (see Appendix F). While the cause is unknown, it was speculated that during the control test the network computers were saving files and running other tasks in support of the testing. Running programs, saving files, and consuming memory can result in the CPU being too busy to monitor network traffic, resulting in lost packets. Another consideration is that both PC computers use a Microsoft operating system, which is designed to multitask by managing which devices have access to the CPU. The operating system can prioritize operations over network communication, which could lead to data packet loss. An overall summary of iPerf test results over the two days of testing is given in Appendix F. Most recorded ESD discharge packet losses were on the client computer network card (both computers used Intel 82572GI network cards), with 29 out of 41 ESD discharge test runs having lost packets (Appendix F). Of 41 ESD test runs, there were only eight instances of packet losses when the ESD discharge was applied on the server computer network card (Appendix F). Detailed iPerf results showing lost packets during test runs with and without the ESD discharge are given in Appendix F. As noted, there were primarily data packet losses on the client network card when control tests were conducted (no ESD discharges). The NESC assessment team was unable to determine why the client computer was more susceptible to data packet losses. One possibility was that during application of ESD discharges the combination of both conducted and radiated emissions caused by the ESD discharge process destabilized the client computer network card, making it more susceptible to lost data packets.

Figure 6.8-1. Connectors used in Network/ESD Discharge Test (left, CeeLok FAS-X connectors; center, MIL-DTL-38999 connectors; right, PIC connector)

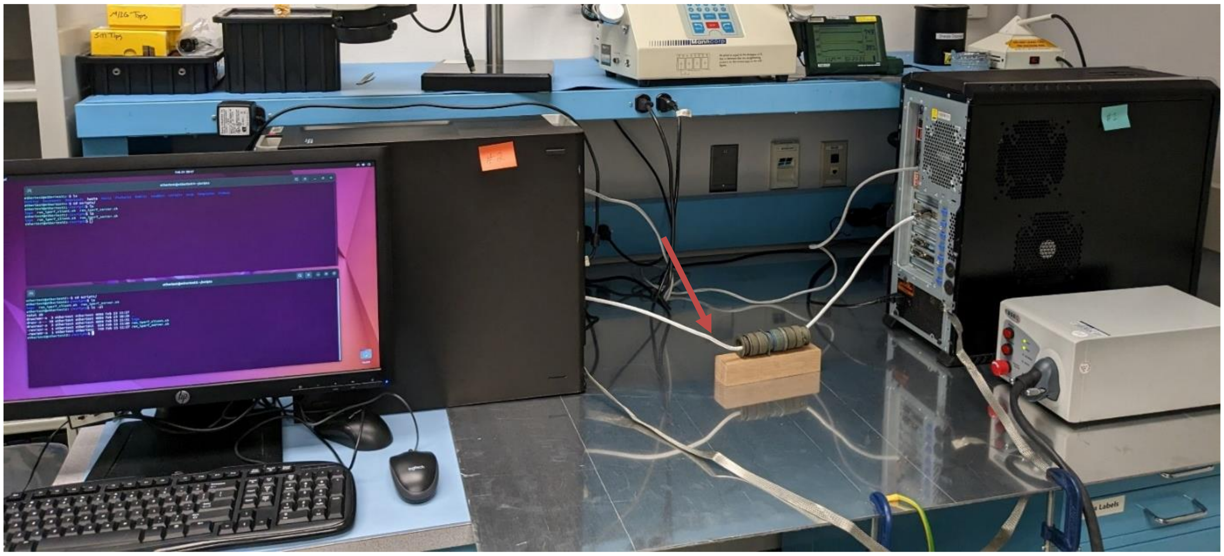


Figure 6.8-2. Basic Network Communication Setup for applying ESD to the Ethernet Connector (center)
While applying the ESD discharge, data packet errors were captured using the IPerf network error detection program. The Ethernet connector was isolated from the aluminum ground plane by placing it on a wooden block (arrow). The server is on the right, and the client computer is on the left. Both computers had the same type of Intel network card.

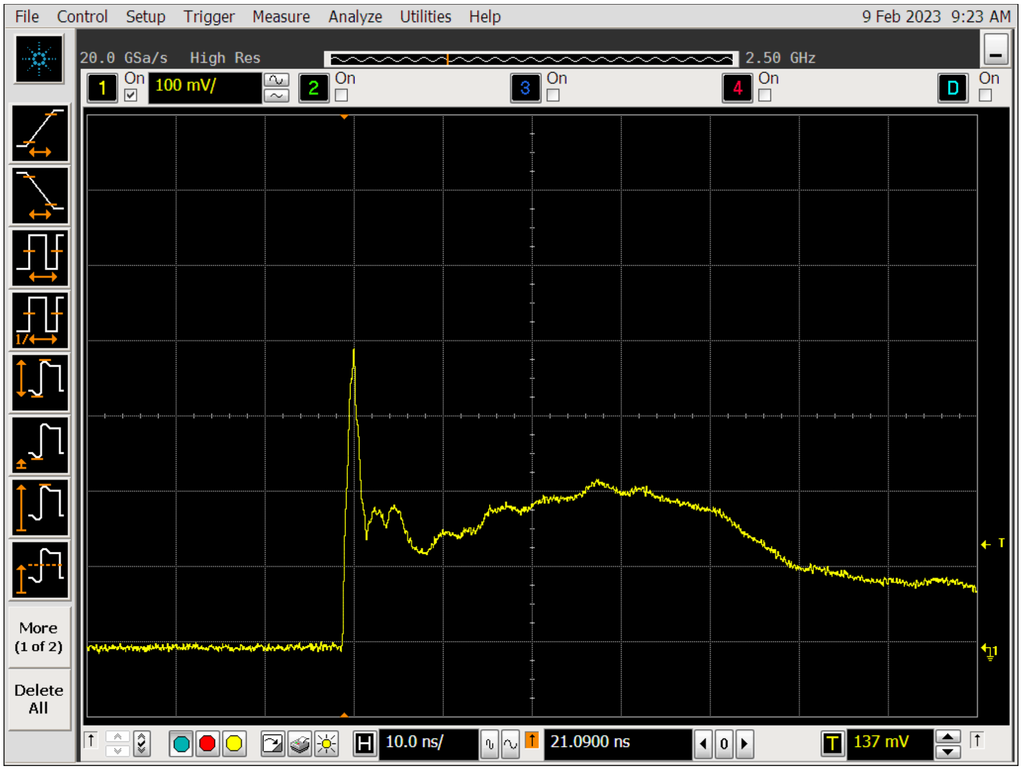


Figure 6.8-3. Single 1-kV Discharge Pulse using ESG 438 ESD Gun Captured with Oscilloscope The value does not display 1 kV due to the scaling factor of the oscilloscope probe. The calibration target was used to verify the 1-kV pulse level.

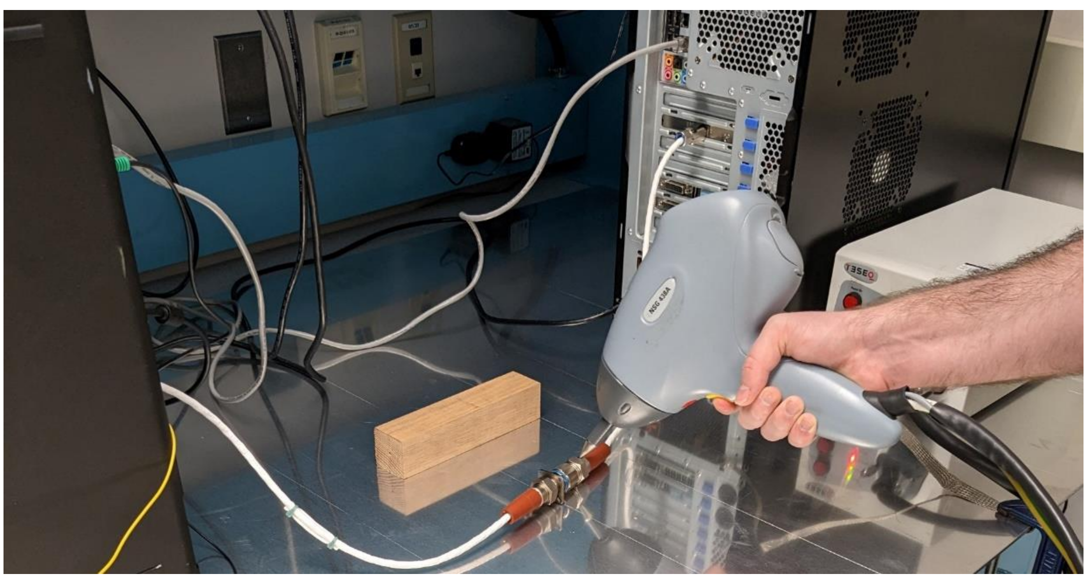


Figure 6.8-4. Application of Static Discharge using ESD Gun to Network Connector No data packet errors were detected when the connector was placed in electrical contact with the aluminum ground plane that was connected to Earth ground.

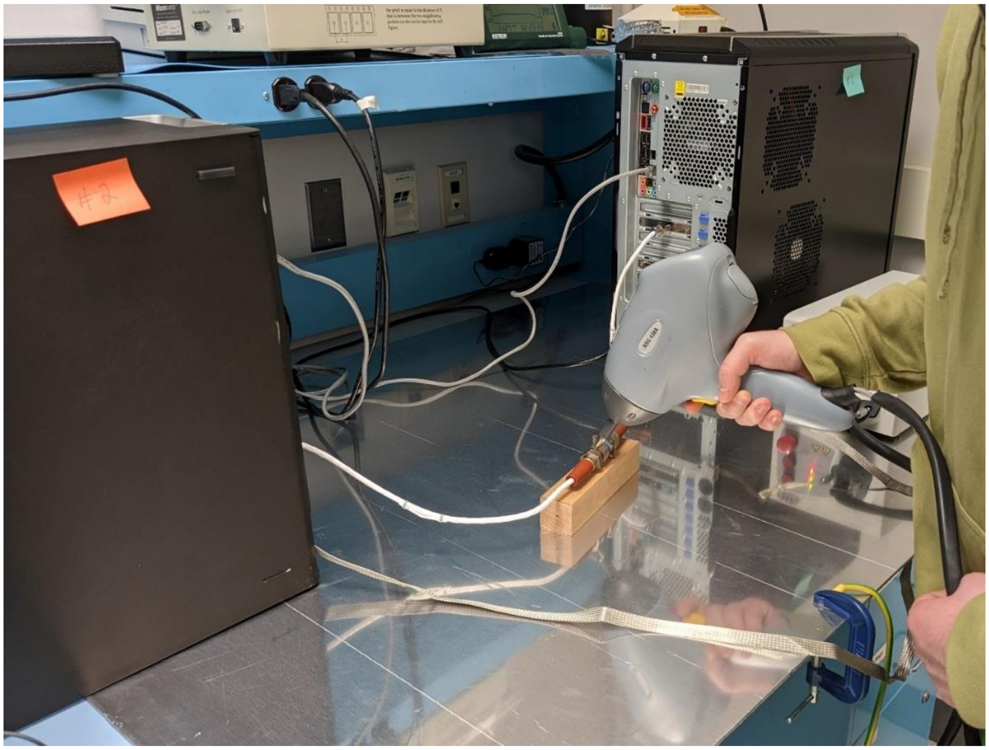


Figure 6.8-5. Application of Static Discharge using ESD Gun to Network Connector Electrically Isolated using a Wooden Block ~1 inch from Aluminum Ground Plane Connected to Earth Ground Data packet errors were detected under high-voltage static discharge levels; the network link was never lost or interrupted during testing.

As noted, the majority of data packet losses occurred on the client computer. A summary of packet loss intervals and the total number of packet losses during application of ESD discharges to the connector are given in Tables 6.8-1 and 6.8-2. In all cases, the network link was not lost during any test runs with or without ESD applied to the connector. Figures 6.8-6 and 6.8-7 show summary plots of the packet loss data for the number of time intervals that had a lost data packet and the number of total packet losses with respect to the cable configuration. The PIC cable and connector exhibited packet losses at lower ESD levels (1 kV) than the Gore cable with FASX or M38999 connectors (10 kV). It continued to have increased packet losses as the ESD discharge level was increased to 4 and 6 kV. There was a case where the PIC shield cable was inadvertently not connected to the PIC connector; in this condition, there was a significant number of time intervals with lost packets (58) during application of ESD discharges as low as 2 kV (see Table 6.8-1). Reconnecting the shield improved the results, with fewer packet losses at 2 and 4 kV compared with the results using a connected shield (see Tables 6.8-1 and 6.8-2 and Figures 6.8-6 and 6.8-7). Adding an additional connector cable segment or extension cable significantly reduced the ESD threshold level that caused packet losses. This was from 10 to 4 kV for the Gore cable with CeeLok FASX connector, and to 2 kV for the Gore cable with M38999 connectors (see Table 6.8-2 and Figure 6.8-6). Adding an extension cable and connector resulted in significantly more packet loss intervals for the PIC cable (Figure 6.8-6). A summary of the lost packets recorded by the iPerf program under control tests (no ESD applied) is given in Table 6.8-3, and plots of the data are given in Figures 6.8-8 and 6.8-9. No detectable pattern was noted in the plots since packet intervals and total packet losses did not appear to be related to the cable configuration or to the application of ESD discharges prior to the control test. Comparison of Tables 6.8-1 and 6.8-3 and the plots in Figures 6.8-6 and 6.8-8 indicates there were more packet loss intervals with the application of ESD discharges as compared with the control run where no ESD was applied.

Table 6.8-1. ESD Testing showing iPerf Results over 2 Days of Testing for the Client Computer

Client iPerf Run Time ET1 – Server/ET2 – Client	Setup Cable/ Connector	ESD	Hits	CDPs	Notes
055_10:15:49/055_10:15:38	PIC/PIC	1 kV	3	31	No shield attached to connector
055_10:20:39/055_10:20:28	PIC/PIC	2 kV	58	334	No shield attached to connector
058_11:09:11 / 058_11:08:32	PIC/PIC	1 kV	1	62	Shield reattached to connector
058_11:12:12 / 058_11:11:34	PIC/PIC	2 kV	3	433	1% data packet loss over a 1-sec interval
058_11:15:23 / 058_11:14:44	PIC/PIC	4 kV	14	298	
058_11:18:46 / 058_11:18:08	PIC/PIC	6 kV	60	248	
055_10:27:06/055_10:26:55	Gore/M38999	1 kV	0	0	
055_10:31:03/055_10:40:52	Gore/M38999	2 kV	0	0	
055_10:35:04/055_10:34:53	Gore/M38999	4 kV	0	0	
055_10:38:37/055_10:38:26	Gore/M38999	6 kV	0	0	
055_10:42:13/055_10:42:03	Gore/M38999	8 kV	0	0	
055_11:12:44/055_11:12:33	Gore/M38999	10 kV	3	392	
055_11:16:11/055_11:16:00	Gore/M38999	16 kV	10	1240	
055_10:47:15/055_10:47:04	Gore/CeeLok FAS-X	1 kV	0	0	
055_10:50:38/055_10:50:27	Gore/CeeLok FAS-X	2 kV	0	0	
055_10:53:52/055_10:53:40	Gore/CeeLok FAS-X	4 kV	0	0	
055_10:57:16/055_10:57:05	Gore/CeeLok FAS-X	6 kV	0	0	
055_11:00:45/055_11:00:34	Gore/CeeLok FAS-X	8 kV	0	0	
55_11:04:34/055_11:04:24	Gore/CeeLok FAS-X	10 kV	4	520	
055_11:08:43/055_11:08:31	Gore/CeeLok FAS-X	16 kV	8	1182	

Hits- iPerf 1-sec time intervals that recorded one or more lost packets.

CDPs (corrupted data packets) - iPerf total number of CDPs over the total time interval, and a total of 2,496,608 packets were transmitted over the 70-sec time period.

The network was configured as 1 Gbps/full duplex, 50.0 MB of data transferred over 1 sec at 419 Mbps rate with a full duplex rate of 839 Mbps. Running iPerf for 70 sec, with the ESD gun applied to the connector for 60 sec. The PIC cable and PIC connector were the most sensitive to ESD discharges, with values as low as 1 kV ESD causing some data packet loss and continuing to have increased packet losses as the ESD level was increased to 4 and 6 kV. Note that two ESD tests were run where the shield was inadvertently not connected to the PIC connector (first two tests at the top of the table), making the cable susceptible to lost data packets. The Gore cable with a CeeLok FAS-X or M38999 connector exhibited packet losses once the ESD discharge reached 10 kV. In all cases, the network link was never lost.

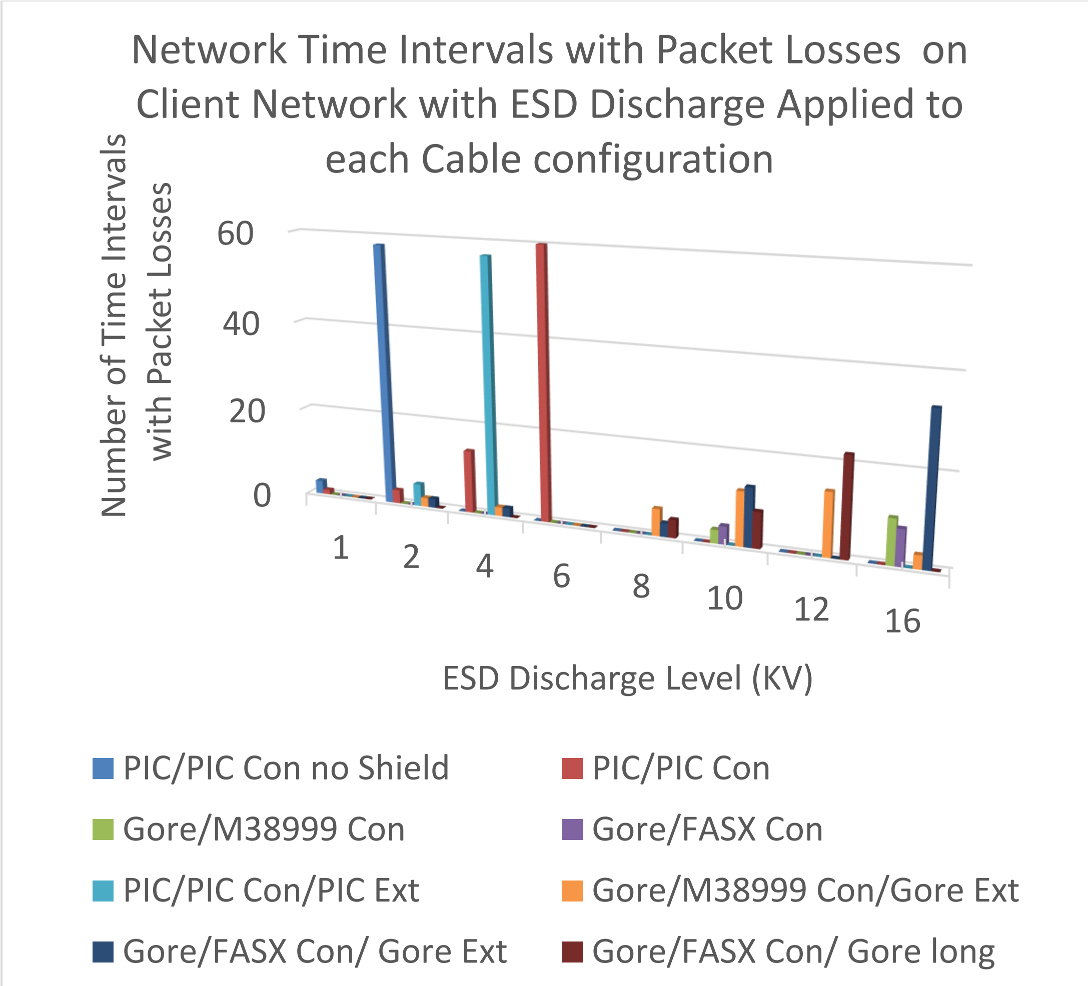
Table 6.8-2. ESD Testing that resulted in Packet Losses Over Two Days of Testing showing iPerf Results for Client Computer

Client IPerf Run Time ET1 – Server/ET2 -- Client	Setup Cable/ Connector/Ext (3 ft)	ESD	Hits	CDPs	Notes
058_10:39:05 / 058_10:38:26	Gore/CeeLok FAS-X/Gore	2 kV	2	15	
058_10:42:48 / 058_10:42:09	Gor/CeeLok FAS-X/Gore	4 kV	2	82	
058_10:46:34 / 058_10:45:55	Gore/CeeLok FAS-X/Gore	8 kV	3	359	
058_11:41:25 / 058_11:40:46	Gore/CeeLok FAS-X/Gore	10 kV	13	1195	1% data packet loss over 1 sec
058_11:41:25 / 058_11:40:46	Gore/CeeLok FAS-X/Gore	16 kV	33	3012	
058_10:55:41 / 058_10:55:02	Gore/M38999/Gore	2 kV	2	282	
058_11:01:04 / 058_11:00:25	Gore/M38999/Gore	4 kV	2	412	
058_11:04:10 / 058_11:03:31	Gore/M38999/Gore	8 kV	6	1145	1% data packet loss over 1 sec
058_11:32:14 / 058_11:31:35	Gore/M38999/Gore	10 kV	12	1162	1% data packet loss over 1 sec
058_11:34:02 / 058_11:33:23	Gore/M38999/Gore	12 kV	14	1845	computer glitches
058_11:36:30 / 058_11:35:51	Gore/M38999/Gore	16 kV	3	327	computer glitches
058_11:24:38 / 058_11:23:58	PIC/PIC/PIC	2 kV	5	321	
058_11:28:01 / 058_11:27:22	PIC/PIC/PIC	4 kV	57	254	
058_11:47:05 / 058_11:46:26	Gore/CeeLok FAS-X/Gore Ex long Ext (15 ft)	8 kV	4	532	
058_11_48_43/058_11_50_07	Gore/CeeLok FAS-X/Gore Ex long Ext (15 ft)	10 kV	8	909	
058_11:52:15 / 058_11:51:37	Gore/CeeLok FAS-X/Gore Ex long Ext (15 ft)	12 kV	22	1909	

Hits- iPerf 1-sec time intervals that recorded on or more lost packets.

CDPs - iPerf total number of CDPs over the total time interval.

The network was configured as 1 Gbps/full duplex, 50.0 MB of data transferred over 1 sec at 419 Mbps rate with a full duplex rate of 839 Mbps. iPerf was run for 70 sec, with the ESD gun applied to the connector for 60 sec. Adding an additional connector cable segment or extension cable significantly reduced the ESD threshold level that caused packet losses in all cable configurations. The Gore cables with M38999 and CeeLok FAS-X connectors exhibited packet losses starting at 2 kV, compared with 10 kV with no cable extension. Adding an extension cable and connector resulted in more packet loss intervals for the PIC cable with an additional cable segment, as compared with the PIC connector at 2 and 4 kV. In all cases, the network link was never lost.

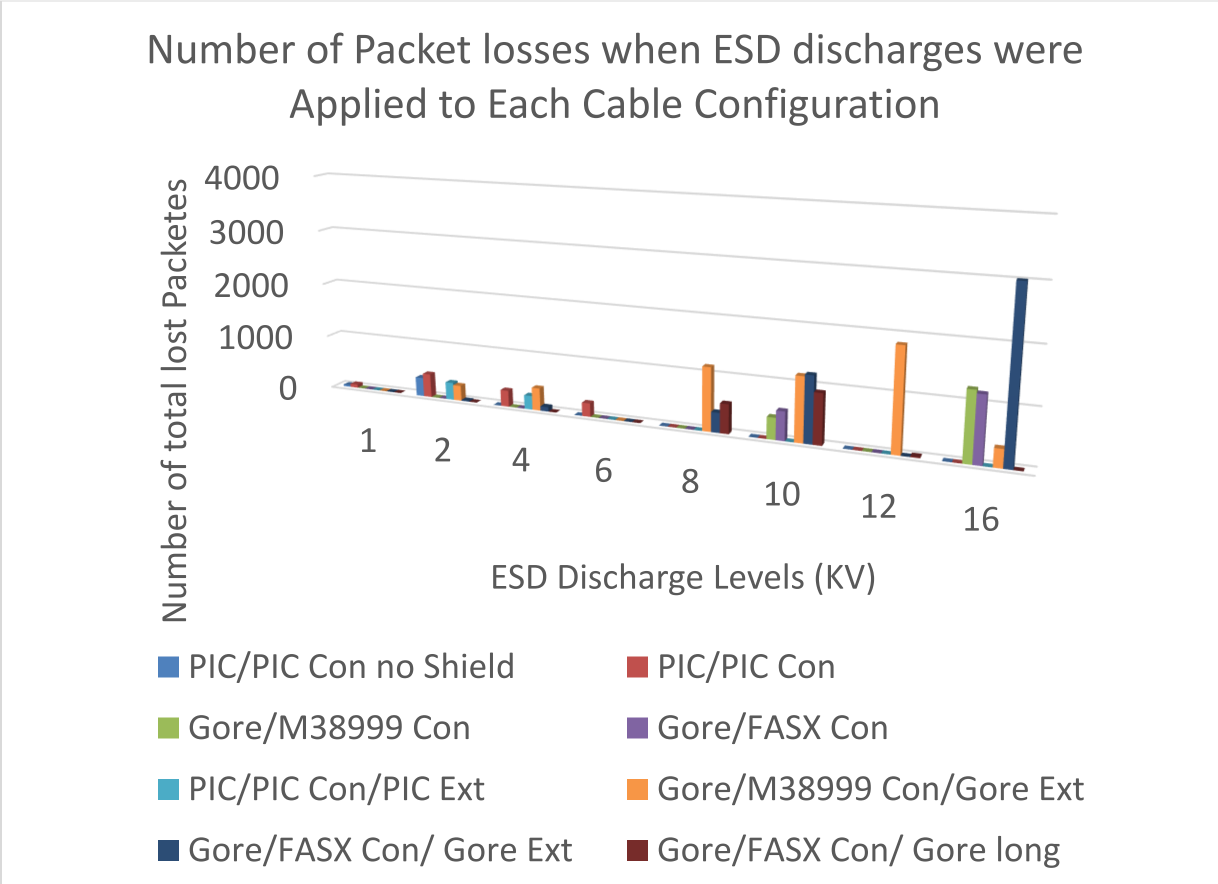


Hits - iPerf 1-second time intervals that recorded on or more lost packets.

CDPs - iPerf total number of CDP over the total time interval.

Figure 6.8-6. Lost Packet Test Results from Tables 6.8-1 and 6.8-2 plotted for Number of Time Intervals with Data Packet Losses during Application of ESD to Network Connector

PIC cable was the most sensitive to data packet loss when the ESD discharges were applied (2 kV), while the Gore cable connected to the CeeLok FAS-X or M38999 connectors exhibited data packet losses starting at 10K ESD discharges. Note that loss of the shield connection to the PIC connector resulted in a significant number of packet loss intervals at a 2-kV ESD discharge. There was a case where the PIC shield cable was not connected to the PIC connector, which resulted in a significant number of time intervals with lost packets (58) during application of ESD discharges as low as 2 kV. Table 6.8-2 and Figure 6.8-6 show ESD threshold levels that caused packet losses were significantly reduced when an additional cable segment was added (from 10 to 4 kV for the FASX connector and 2 kV for the M38999 connector, and significantly more packet loss intervals for the PIC cable and PIC connector at 4 kV.



Hits - iPerf 1-second time intervals that recorded on or more lost packets.
CDPs - iPerf total number of CDPs over the total time interval.

Figure 6.8-7. Lost Packet Test Results from Tables 6.8-1 and 6.8-2 plotted for Total Number of Data Packet Losses during Application of ESD to Network Connector
PIC cable was the most sensitive to data packet loss when ESD discharges were applied (2 kV), while the Gore cable connected to either the CeeLok FAS-X or M38999 connectors exhibited data packet losses starting with 10-kV ESD discharges. Table 6.8-2 and Figure 6.8-7 show that ESD threshold levels that caused packet losses were significantly reduced when an additional cable segment was added (from 10 to 4 kV for the FASX and M38999 connectors). There were considerably more packet losses when the ESD discharge level was 8 kV and above for all cable configurations.

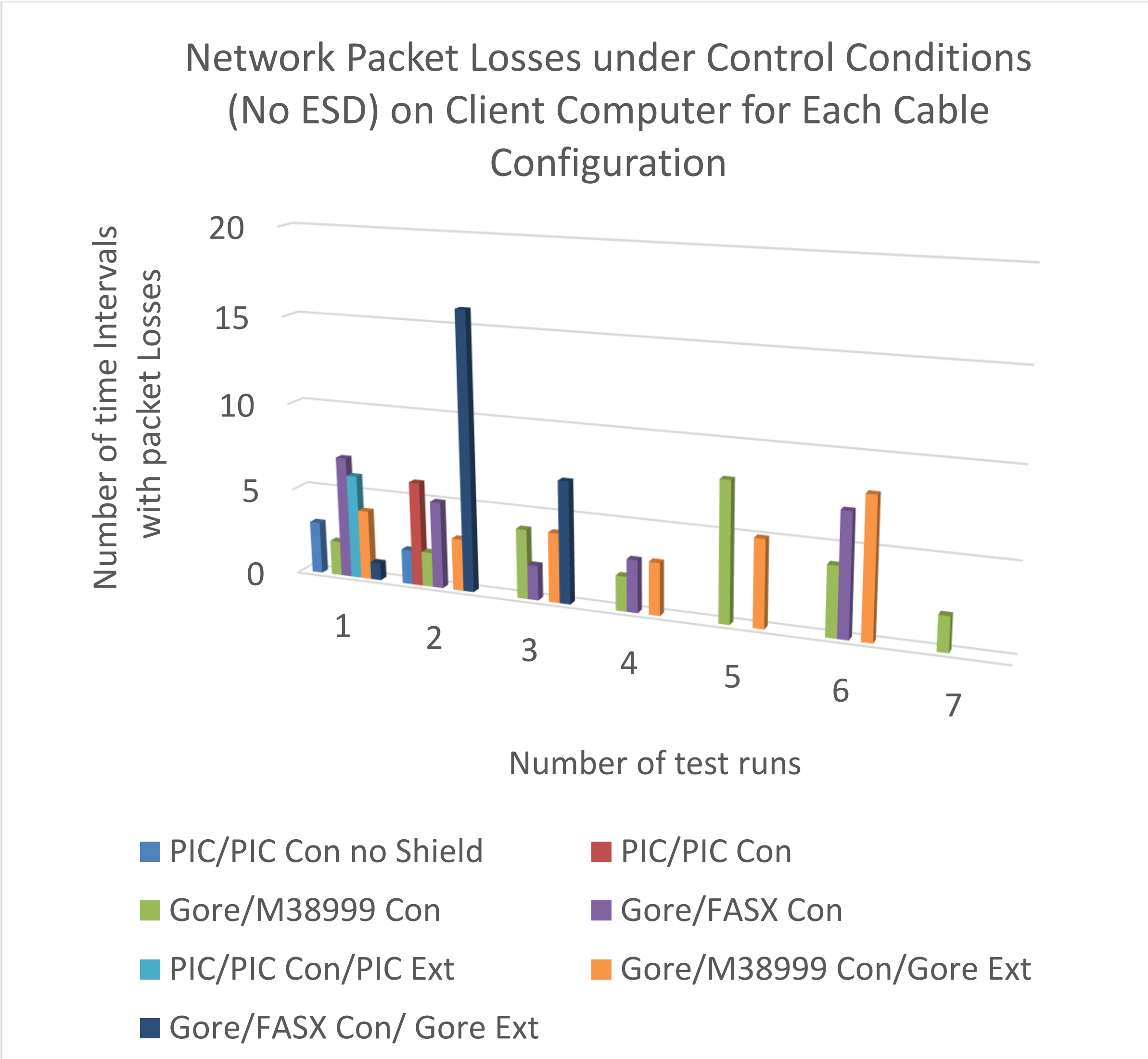
Table 6.8-3. Summary of Time Intervals with Lost Packets and Total Number of Lost Packets under Control Tests (no ESD) showing iPerf Results for Client Computer (26 of 29 control tests had lost packets)

Client iPerf run time ET1 – Server/ET2 -- Client	Setup Cable/connector	Hits	CDPs	Notes
055_10:18:36/055_10:18:24	PIC/PIC	3	347	No shield attached to connector
055_10:24:19/055_10:24:07	PIC/PIC	2	694	No shield attached to connector
058_11:26:16 / 058_11:25:37	PIC/PIC	6	51	Shield re-attached to connector
058_11:29:53 / 058_11:29:14	PIC/PIC	0	0	
055_10:29:12/055_10:29:01	Gore/M38999	2	106	
055_10:33:07/055_10:32:56	Gore/M38999	2	70	
055_10:36:39/055_10:36:27	Gore/M38999	4	624	
055_10:40:08/055_10:39:56	Gore/M38999	2	191	
055_10:43:53/055_10:43:41	Gore/M38999	8	227	
055_11:14:18/055_11:14:07	Gore/M38999	4	154	
055_11:18:20/055_11:18:09	Gore/M38999	2	349	
055_10:48:43/055_10:48:31	Gore/CeeLok FAS-X	7	564	
055_10:52:08/055_10:51:56	Gore/CeeLok FAS-X	5	732	
055_10:55:22/055_10:55:10	Gore/CeeLok FAS-X	2	169	
055_10:58:48/055_10:58:36	Gore/CeeLok FAS-X	3	284	
055_11:02:37/055_11:02:25	Gore/CeeLok FAS-X	3	325	
055_11:06:26/055_11:06:16	Gore/CeeLok FAS-X	0	0	
055_11:10:28/055_11:10:17	Gore/CeeLok FAS-X	7	1321	
Sever/ Client iPerf run time	Setup Cable/connector/ Ext #1(3 ft)	Hits	CDPs	Notes
058_10:33:12 / 058_10:32:33	Gore/CeeLok FAS-X/Gore	1	64	
058_10:37:13 / 058_10:36:34	Gore/CeeLok FAS-X/Gore	16	2694	
058_10:40:41 / 058_10:40:02	Gore /CeeLok FAS-X/Gore	7	1275	
058_10:44:34 / 058_10:43:34	Gore/M38999/Gore	4	218	
058_10:48:52 / 058_10:48:13	Gore/M38999/Gore	3	359	
058_10:53:31 / 058_10:52:52	Gore/M38999/Gore	4	614	
058_10:57:07 / 058_10:56:28	Gore/M38999/Gore	3	303	
058_11:02:31 / 058_11:01:51	Gore/M38999/Gore	5	219	
058_11:05:46 / 058_11:05:07	Gore/M38999/Gore	8	534	
058_11:26:16 / 058_11:25:37	PIC/PIC/PIC	6	151	
058_11:13:36 / 058_11:12:56	PIC/PIC/PIC	0	0	

Hits - iPerf 1-sec time intervals that recorded one or more lost packets.

CDPs - iPerf total number of CDPs over the total time interval.

No detectable pattern was noted in the table since packet intervals and total packet losses did not appear to be related to the cable configuration or to the application of ESD prior to the control test. The network was configured as 1 Gbps/full duplex, 50.0 MB of data transferred over 1 sec at 419 Mbps rate with a full duplex rate of 839 Mbps. iPerf was run for 70 sec.

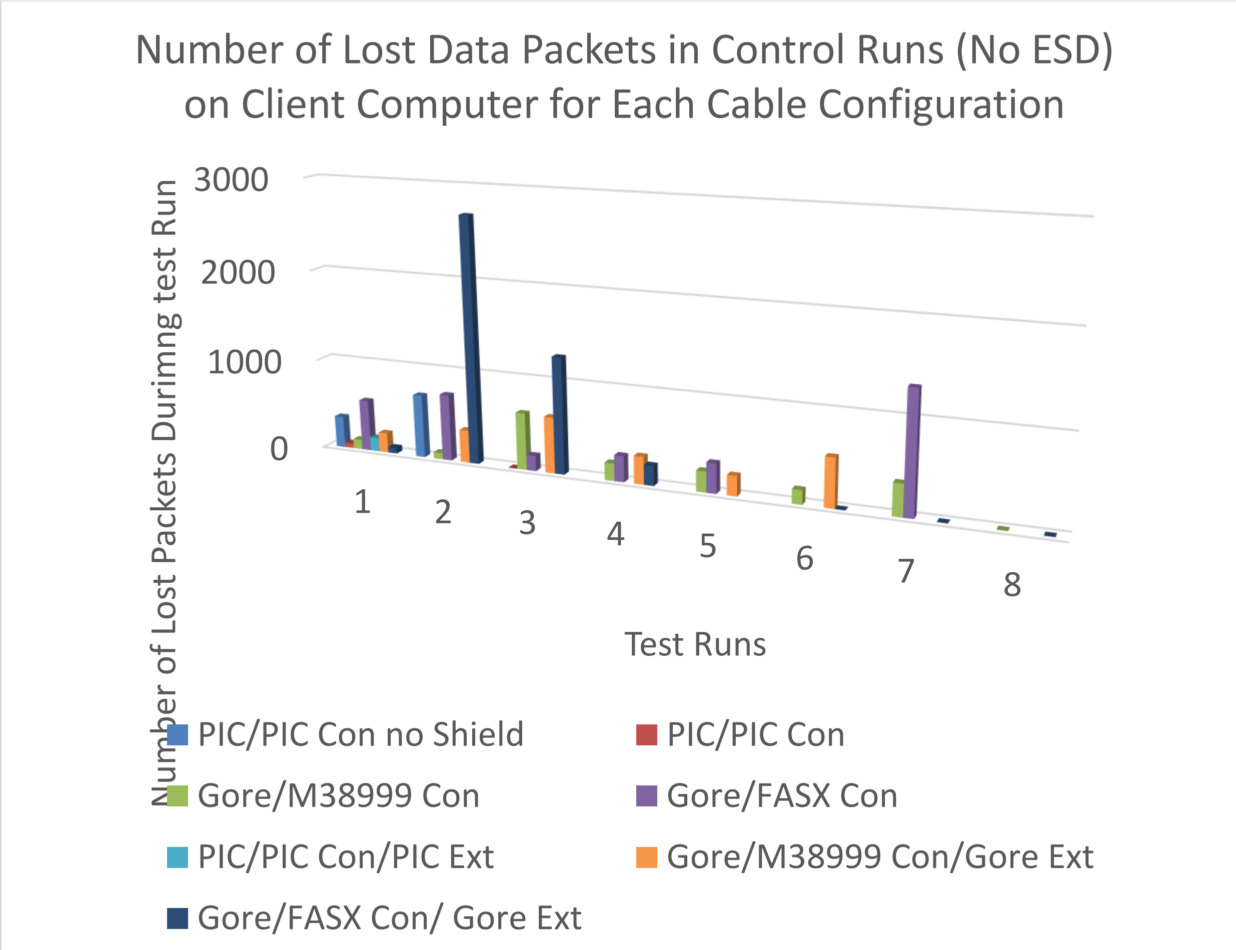


Hits - iPerf 1-sec time intervals that recorded one or more lost packets.

CDPs - iPerf total number of CDPs over the total time interval.

No detectable pattern was noted in the figure since packet intervals and total packet losses did not appear to be related to the cable configuration or to the application of ESD prior to the control test. The network was configured as 1 Gbps/full duplex, 50.0 MB of data transferred over 1 sec at 419-Mbps rate with a full duplex rate of 839 Mbps. iPerf was run for 70 sec.

Figure 6.8-8. Plotted Summary of Number of Time Intervals with Lost Packets Under Control Tests (no ESD) showing iPerf Results for Client Computer (Table 6.8-3)



Hits - iPerf 1-sec time intervals that recorded one or more lost packets.

CDPs - iPerf total number of CDPs over the total time interval.

No detectable pattern was noted in the figure since packet intervals and total packet losses did not appear to be related to the cable configuration or the application of ESD prior to the control test. Network was configured at 1 Gbps/full duplex, 50.0 MB of data transferred over 1 sec at 419-Mbps rate with a full duplex rate of 839 Mbps. iPerf was run for 70 sec.

Figure 6.8-9. Summary of Total Number of Lost Packets Under Control Tests (no ESD) showing iPerf Results for Client Computer

7.0 Analysis

7.1 Twist Rates in Twisted Pair Transmission Lines

Twist rate (i.e., pitch) in a wire pair has a significant impact on the capacitance of the pair and the transmission line characteristic impedance. This is true for unshielded and shielded wire pairs. In both cases, an equivalent dielectric constant can be determined that is a function of the relative dielectric constants of the surrounding environment and the wire insulation, and the pitch or twist rate of the pair.

A simple expression capturing this effect for unshielded twisted pair is:

$$\epsilon_{r_{eq}} = \epsilon_{r_1} + \beta\left(\epsilon_{r_2} - \epsilon_{r_1}\right) \quad \text{(Eq. 1)}$$

where $\epsilon_{r_{eq}}$ equals the equivalent relative dielectric constant of the combination of the insulation surrounding the conductor(s) (it is assumed the insulation is the same on each wire in the twisted pair) and the environment surrounding the conductor pair, with

ϵ_{r_1} = the relative dielectric constant of the surrounding environment ($\epsilon_{r_1} \cong 1$ for air)

ϵ_{r_2} = the relative dielectric constant of the conductor insulation

β = the twist angle correction factor

The twist angle correction factor for a typical pair of 24-AWG wires with polytetrafluoroethylene (PTFE) insulation is approximately given by:

$$\beta = 0.25 + 0.001\theta^2 \qquad \text{(Eq. 2)}$$

where θ equals the twist angle in degrees.

The twist angle can be found from:

$$\tan\theta = \pi T D \qquad \text{(Eq. 3)}$$

where T equals the number of twists/m and D equals the outer diameter of each conductor with insulation, in mm.

The wires in a typical Ethernet pair are equivalent to a 24-AWG PTFE-insulated stranded silver-coated copper conductor in accordance with MIL-W-16878/5. Per multiple vendor sources, T (the nominal twist rate) for Cat5, Cat5E, and Cat6 falls between 60 and 200 twists/m (TPM) (~1.50 to 5.00 twists/inch (TPI)). Assuming each wire in the pair has an overall diameter (conductor plus insulation) of ~1.37 mm, Equation 3 yields θ between 14.5° and 40.7°.

Experimental data suggest that a twist angle between 20° and 45° provides optimal performance. At a twist angle <20°, the wires in the pair become increasingly subject to deformation caused by flexure of the pair. Loss of line geometrical uniformity introduces a randomness that can dominate the characteristic impedance of the line. At a twist angle >45°, a typical copper conductor may be approaching a yield point that could reduce its break strength.

To increase the twist angle to equal the minimum recommended 20°, the number of twists/m must be increased to 85 twists/m (~2.16 TPI). Note that a twist angle of 45° is equivalent to a twist rate of 232.34 twists/m (~5.90 TPI).

Substituting twist angles (TPM) between 20° and 45° in Equation 2, β falls between 0.650 and 2.275.

Assuming air surrounds the pair, $\epsilon_{r_1} = 1$, each wire in the wire pair is covered with PTFE insulation, and $\epsilon_{r_2} = 2.1$ using the values determined for β using Equation 2 and the bounding twist angles 20° and 45°, yields:

$$\epsilon_{r_{eq}} = 1 + 0.650(2.1 - 1) = 1.715 \qquad \text{(Eq. 4)}$$

or

$$\epsilon_{r_{eq}} = 1 + 2.275(2.1 - 1) = 3.503 \qquad \text{(Eq. 5)}$$

Equation 4 generates an effective dielectric constant less than that of the PTFE. This follows because the electric field propagating along the pair is contained partially in the wire insulation and partially in the surrounding air. Equation 5 generates an effective dielectric constant greater than that of the PTFE. This follows because the electric field propagating along the pair is contained almost wholly within the wire insulation.

The capacitance (C) for two parallel conductors having the same diameter is:

$$C = \frac{\pi\epsilon}{\cosh^{-1}\left(\frac{D}{d}\right)} \qquad \text{(Eq. 6)}$$

where $D =$ the separation distance between the conductor centers, $D = 1.37$ mm.

$d =$ the diameter of each 24-AWG conductor without insulation, $d = 0.635$ mm.

$\epsilon =$ the product of the permittivity of free space and the relative dielectric constant of the insulation covering the conductors.

For comparison, C is determined assuming the insulation has a relative dielectric constant of PTFE, or the equivalent relative dielectric constant as calculated using Equation (4) or (5).

$$C_{PTFE} = \frac{\pi\epsilon}{\cosh^{-1}\left(\frac{D}{d}\right)} = \frac{\pi\epsilon_0\epsilon_{PTFE}}{\cosh^{-1}\left(\frac{D}{d}\right)} = 41.56\ \text{pF/m} \qquad \text{(Eq. 7)}$$

$$C_{(4)} = \frac{\pi\epsilon_0\epsilon_{req(4)}}{\cosh^{-1}\left(\frac{D}{d}\right)} = 29.81\ \text{pF/m} \qquad \text{(Eq. 8)}$$

$$C_{(5)} = \frac{\pi\epsilon_0\epsilon_{req(5)}}{\cosh^{-1}\left(\frac{D}{d}\right)} = 69.33\ \text{pF/m} \qquad \text{(Eq. 9)}$$

Assuming the conductors and their insulation coverings are non-magnetic, the inductance of the line can be determined using Equation 10:

$$L = \frac{\mu_0}{\pi}\cosh^{-1}\left(\frac{D}{d}\right) = 0.561\ \mu\text{H/m} \qquad \text{(Eq. 10)}$$

The resultant line impedance is:

$$Z_{PTFE} = \sqrt{\frac{L}{C_{PTFE}}} = 116.18\ \Omega \qquad \text{(Eq. 11)}$$

$$Z_{(4)} = \sqrt{\frac{L}{C_{(4)}}} = 137.18\ \Omega \qquad \text{(Eq. 12)}$$

$$Z_{(5)} = \sqrt{\frac{L}{C_{(5)}}} = 89.95\ \Omega \qquad \text{(Eq. 13)}$$

The adjusted dielectric constant accounting for the twist rate yielded corresponding changes in the line capacitance and the line impedance compared using the original, unadjusted PTFE dielectric constant. The lower twist rate yields a higher impedance.

Cat6 shielded Ethernet cables using 24-AWG COTS conductors exhibit a typical capacitance of ~56 pF/m and a characteristic impedance near 100 ohms, ±15 ohms. The data should be compared with the results in Equations 7 through 9, and 11 through 13.

The impact of using the same twist rate for multiple pairs is most easily understood by considering the placement of two helices next to each other with the same wire diameters and twist rates. This results in the same two wires of each pair coming into proximity every other twist, consequently increasing the inductive and capacitive coupling between the wire pairs. By using different twist rates, this coupling and thus the crosstalk between the pairs can be dramatically reduced.

7.2 Changes in Transmission Line Capacitance as a Function of the Presence of Wire Shielding

The three diagrams in Figure 7.2-1 highlight the capacitances that exist in a twisted wire pair configuration. The image on the left is a pictorial representation; the middle image illustrates capacitances between the conductors, and between the conductors and the local “ground” reference for an unshielded pair; and the image on the right illustrates the additional capacitances between conductors associated with the presence of the shield. It is assumed in this last diagram that the shield is electrically common with the local ground reference.

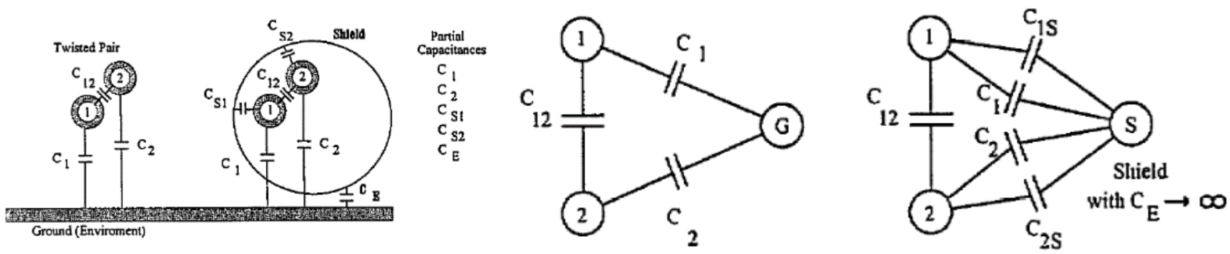


Figure 7.2-1. Capacitances that exist in a Twisted Wire Pair Configuration

The preceding calculations (Equations 7 through 9) capture the capacitance between the two conductors, identified as C_{12} in Figure 7.2-1. The unshielded wire pair capacitances C_1 and C_2 vary as a function of the height of the unshielded wire pair above a local ground reference. When a shield is added to the configuration, capacitances between each of the two wires in the pair and the shield are introduced. If the shield is electrically common to the local ground reference, then the capacitances to the local ground, C_1 and C_2, and to the shield, C_{1S} and C_{2S}, are in parallel. With the shield in place, the separation between the wire pair and the local ground reference will be fixed such that the capacitances C_1 and C_2 will no longer vary as a function of height above the local ground reference. These capacitances can be modeled as single capacitances, respectively equal to the sums of $(C_1 + C_{1S})$ and $(C_2 + C_{2S})$. Using this assumption, the total capacitance for the shielded wire pair, accounting for the interaction between the several capacitances, can be expressed based on this schematic representation as:

$$C_T = C_{12} + \frac{(C_1 + C_{1s}) * (C_2 + C_{2s})}{C_1 + C_{1s} + C_2 + C_{2s}} = C_{12} + \frac{(C_{1Par}) * (C_{2Par})}{(C_{1Par}) + (C_{2Par})} \qquad \text{(Eq. 14)}$$

Figure 7.2-2 illustrates two equal circular wires placed symmetrically inside a shield. It is assumed for the analysis that the wire radii are small compared with the shield radius and that the insulation filling the volume is homogeneous. Note that this is not strictly true as the wire insulation will not fill the void.

Conformal mapping can account for the regions where the wire insulation is not present. Other approaches have been used, most of them employing a matrix-based numerical solution.

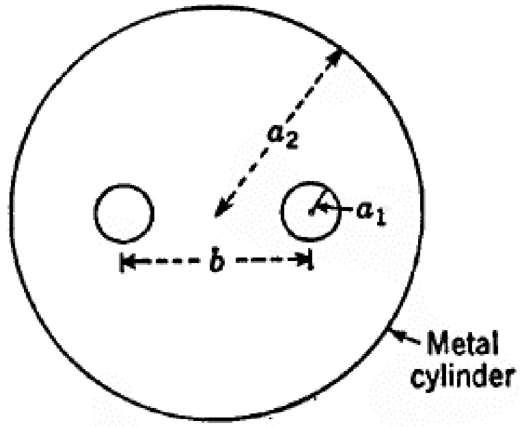


Figure 7.2-2. Illustrating a Two-wire Shielded Configuration [reprinted from Gore, 2022b, Figure 9.2]

Using the Method of Images, a reasonably accurate analytical estimate that results in a closed-form solution for the twisted shielded pair can be obtained [Gore, 2022b]. Two different modes of operation can be employed in a twisted shielded pair: a "normal" or differential mode (sometimes referred to as odd or metallic mode) and a common mode (sometimes referred to as the even or longitudinal mode). The capacitance of the cable is different for each of these two modes.

The odd mode capacitance between the wires in the presence of the shield is:

$$C_{OM} = \frac{\pi\epsilon}{\ln\left(\frac{b}{a_1} * \frac{a_2^2 - b^2/_4}{a_2^2 + b^2/_4}\right)} \text{ F/m} \qquad \text{(Eq. 15)}$$

The even mode capacitance between the wires in the presence of the shield is:

$$C_{EM} = \frac{4\pi\epsilon}{\ln\left(\frac{a_2^4 - b^4/_{16}}{b a_1 a_2^2}\right)} \text{ F/m} \qquad \text{(Eq. 16)}$$

These two capacitances can be determined using the parameters from Equation 6, plus the radius of the shield, which will be chosen based on the constraint:

$$a_2^2 - \frac{b^2}{4} \gg a_1^2 \qquad \text{(Eq. 17)}$$

where $a_1 = \frac{d}{2} = 0.3175$ mm, and $b = D = 1.37$ mm. For this sample calculation, a_2 is chosen as 2.39 mm, which is a limiting value in accordance with Equation 17.

Using the dielectric constant of PTFE in Equations 15 and 16, these choices yield:

$$C_{OM} = \left| \frac{\pi\epsilon}{\ln\left(\frac{b}{a_1} * \frac{a_2^2 - b^2/_4}{a_2^2 + b^2/_4}\right)} \right| = 44.97 \text{ pF/m} \qquad \text{(Eq. 18)}$$

$$C_{EM} = \left| \frac{4\pi\epsilon}{\ln\left(\frac{a_2^4 - b^4/_{16}}{b a_1 a_2^2}\right)} \right| = 63.46 \text{ pF/m} \qquad \text{(Eq. 19)}$$

The result in Equation 18 is greater than the result in Equation 7, suggesting that the presence of the shield has a small but measurable impact on the differential mode.

If Equation 14 is used for comparison with Equation 19, then a couple of single-wire above-ground plane calculations must be performed to solve for $C_1, C_{1s}, C_2,$ and C_{2s}.

Given the geometry in the preceding Figure 7.2-2, the values for the parallel combination of C_1 and C_{1s} can be estimated.

The capacitance of a single wire above a reference plane is:

$$C = \frac{2\pi\epsilon}{\cosh^{-1}\left(\frac{h}{r}\right)} \qquad \text{(Eq. 20)}$$

where:

> $h =$ the separation distance between the conductor center and the reference plane.
>
> $h = 2.39$ mm, which is the limiting value determined in Equation 17.
>
> $r =$ the radius of a 24 AWG conductor without insulation, $r = \frac{d}{2} = 0.3175$ mm.
>
> $\epsilon =$ the product of the permittivity of free space and the relative dielectric constant of the insulation covering the conductors.

Using the relative dielectric constant of PTFE in Equation 20 yields a value of 43.1 pF/m. This represents the value of each of the parallel combinations of $(C_1 + C_{1s})$ and $(C_2 + C_{2s})$. Using this value in Equation 14 and the result in Equation 7 for C_{12} yields a value of 63.11 pF/m, which is directly comparable and nearly identical to the result in Equation 19. Note the presence of the shield has introduced an even mode capacitance for the cable that is independent of the cable spacing with respect to the local ground reference. The foregoing calculations may be repeated using the effective dielectric constants accounting for the twist rate.

Summary points include:

- The impedance of the twisted pair increases as the overall wire dimension decreases.
- The impedance of the twisted pair decreases as the twist rate increases.
- As the twist rate increases, the effective dielectric constant is increasingly dominated by the contribution of the relative dielectric constant of the wire insulation.
- The range of optimal twist angle falls between 20° to maintain line uniformity and 45° to avoid damage to the insulation or conductor(s).
- The presence of a shield increases the differential (odd) mode capacitance of the twisted pair.
- The presence of a shield introduces a stable common (even) mode capacitance of the twisted pair, independent of the separation distance between the shielded wire pair and nearby structure.
- The combination of the twisted pair with the presence of a shield acts to mitigate inductive and capacitive coupling (crosstalk) between adjacent wire pairs compared with the amount of crosstalk without the presence of the shield.

7.3 Considerations for the Location of Transient Protective Devices in an Ethernet Circuit Interface

A typical Ethernet circuit comprises an interconnecting cable interface, which is often an RJ45 connector; an interface transformer including a series common mode choke; and the Ethernet device (PHY) input (see Figure 7.3-1).

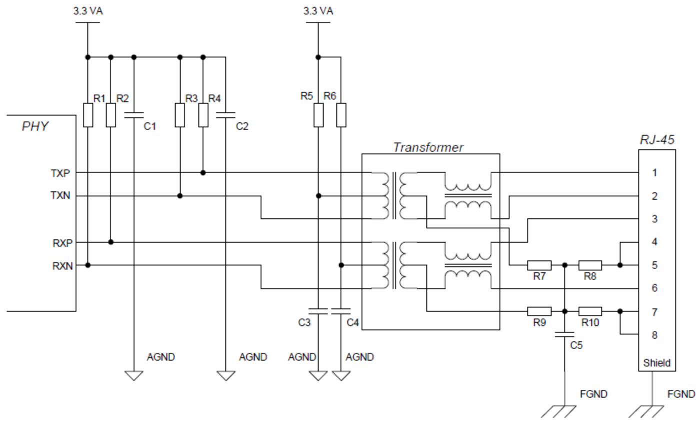


Figure 7.3-1. Twisted Pair Ethernet Interface Circuit with External Magnetics [reprinted from Gore, 2022b, Figure 3-4]

Transients caused by ESD events may appear on aerospace electrical wiring resulting from actions that include handling by personnel, triboelectrification effects during launch/ascent or descent operational phases, and spacecraft plasma charging. Regardless of the source, these transients tend to be similar in waveshape while differing in magnitudes and repetition rates. Other transient sources that require a similar form of protection include cable discharge events (CDEs), electrical fast transients (EFTs), and lightning surges.

Generally superior and robust transient protection combines considerations for the transient threats mentioned with the final design depending on potential exposure in the intended application. Some of the parameters and characteristics to consider include:

- Operating voltage of the devices to be protected.
- Number of lines requiring protection.
- Trigger voltage and clamping levels for the protective devices and their requisite current handling capability.
- Leakage current of the devices and their configuration.
- Capability of assembly controls specifically designed to provide protection from ESD and CDE caused by handling processes.
- Isolation capability of the interface transformer and any common mode filtering in series with the data lines.
- Tolerance of the protected circuity to the capacitive loading of the transient protective devices.

Several options to provide transient protection are available. Primary protective devices include transient voltage suppressor (TVS) diodes and diode arrays, transient current suppressor (TCS) devices, high withstanding type ESD suppressors, steering diodes and diode arrays, gas discharge tube (GDT) devices, positive temperature coefficient (PTC) resistors, and combinations of the above and others not mentioned. Each of the foregoing offer advantages and disadvantages, and these are discussed at some length in the references identified (see Section 15.1).

Basic options for where transient protection devices/networks should be located for Ethernet circuitry protection include between the interconnecting cable interface and the interface transformer and/or between the interface transformer and the input to the Ethernet device (PHY). Although it may be apparent, one design solution cannot be used for all cases. The characteristics of the surrounding circuitry and the various device options drive the transient protection topology.

- **Locating transient protection between the line and the interface transformer.** Traditional thinking might place transient protection circuitry between the line and the interface transformer. Depending on the expected severity of the transient behavior on the line, this may well be "good enough." Placing the transient protection circuitry in this location levies the entire burden of protection on the protection device(s), requiring voltage breakdown and current flow handling entirely on the device(s). To ensure operational margin, this can necessitate the use of physically larger devices to enable adequate heat dissipation. These larger devices will likely have high capacitance values that can load the databus and reduce data rate capability.
- **Locating transient protection between the interface transformer and the PHY input.** An option may be to locate transient protection circuitry between the interface transformer output and the PHY input. This approach leverages the transformer inductance to slow the transient and attenuate its magnitude, allowing the use of smaller protective devices. The transformer provides some degree of isolation between the line and the PHY, reducing the impact of the transient protection circuitry on the line. It may impact the data rate capability, but considering the devices used can be smaller in physical size, their capacitance is expected to be lower and have a lesser impact. This approach may be lower in system cost, but if the operational environment is expected to have large transients, then this design can lead to damage to, or reduction of the life expectancy of, the transformer.
- **Locating transient protection between the line and the interface transformer and between the interface transformer input to the PHY.** This version permits a balance between the necessary characteristics of the interface transformer and the devices on either side. This approach leverages the advantages of the previous options but is expected to carry the highest system cost.

8.0 Findings, Observations, and NESC Recommendations

8.1 Findings

F-1. A cable analyzer is an effective tool for certifying an Ethernet cable will properly operate as a communication link for an Ethernet network. It is an effective tool for troubleshooting and verifying the cable is connected to the proper Ethernet pairs.

F-2. An Ethernet cable can fail cable analyzer Cat6a test parameter requirements and adequately maintain a network connection between two computers. The system may be more susceptible to loss of network data packets and other errors when operating in EMI environments.

F-3. It is critical to follow Ethernet connector vendor termination processes and maintain Ethernet twisted-pair twists and shielding as close as possible (i.e., < 3.175 mm (0.125 inch)) in connector terminations to meet Cat6a performance requirements.

F-4. A 360-degree cable shield termination to the connector provides better overall cable analyzer Cat6a performance with respect to NEXT and RL compared with using two drain wires to terminate a cable shield to a connector.

F-5. It is critical to use a metal shielded RJ45 type connector rated at or above the data speed for terminating to a network card in an Ethernet cable application or when connecting to a cable analyzer.

F-6. A review of past and present aerospace Ethernet systems issues and testing in this assessment demonstrate that when qualified Cat6a Ethernet cables and connectors are used, the connector and its termination process most influence Ethernet performance with respect to NEXT and RL.

F-7. When qualified Ethernet cables and connectors are used (e.g., Gore cable, CeeLok FAS-X connector, or M38999 connector), an Ethernet cable can pass cable analyzer Cat6a requirements with up to five 1-m (39.4-inch) segments and six mated connectors.

- This was only achieved when the cable was terminated to the connector by exceeding the specification (ANSI/TIA-568.0-E) requirement for maintaining pair twist and shielding within 0.5 inch of the connector edge.
- With respect to the M38999 connector, adding other signals in the 55-pin connector could generate noise and crosstalk in the Ethernet pairs since no shielding is used between the connector pins in the M38999 connector.

F-8. A COTS Ethernet cable could only pass cable analyzer Cat6a requirements with two 1-m (39.4-inch) segments and three mated connectors.

F-9. A properly shielded Ethernet Cat6a cable can operate adjacent to other Ethernet cables without exhibiting significant degradation in NEXT or RL.

F-10. Exceeding cable minimum bend radius requirements (i.e., 1x cable diameter) of a qualified (Gore) Ethernet cable with up to two connectors does not appear to instantly degrade Cat6a cable performance.

- Exceeding the cable minimum bend radius (i.e., 1x cable diameter) of a COTS Ethernet cable with two connectors instantly degraded Cat6A crosstalk margin and resulted in failure to meet the RL margin requirement.
- Over time, exceeding the minimum bend radius requirement (i.e., 4x cable diameter) would be expected to degrade any Ethernet cable performance.

F-11. An Ethernet cable with individually shielded twisted pairs and overall shielding around the four twisted pairs performed significantly better than a cable with unshielded twisted pairs with an overall shield around the twisted pairs in Cat6a testing and in application of ESD discharges to the cable.

F-12. Building functional Ethernet cables is technically challenging and is best accomplished by personnel who are certified to build high-speed data cables.

F-13. A COTS Ethernet cable terminated to a qualified unmatched impedance M38999 connector had better cable analyzer Cat6a results than a COTS cable terminated to a matched impedance COTS connector.

F-14. Conducting EMC shield transfer impedance and susceptibility tests is an effective method for evaluating the susceptibility of Ethernet cables and connectors to external EMI sources.

F-15. Transients caused by ESD events may appear on aerospace electrical wiring as a result of triboelectrification effects during launch/ascent or descent operational phases and spacecraft plasma charging, resulting in loss of data on Ethernet networks.

F-16. An Ethernet connector physically electrically bonded to a ground plane significantly reduced data errors on a 1000BASE-T data rate network system when applying ESD discharges (up to 16 kV).

F-17. An Ethernet connector electrically grounded only through the cable shielding exhibited data errors on a 1000BASE-T network when applying ESD discharges at low level to an Ethernet connector.

F-18. Two PC computers did not lose network link at a 1000BASE-T data rate while ESD discharges (up to 16 kV) were applied to the evaluated Ethernet cables and connectors.

F-19. The COTS cable assembly, which used two drain wires to connect the cable shield to the connector, lost more data packets than the cable assemblies built with 360-degree shielded connectors (i.e., CeeLok FAS-X and M38999).

F-20. The ESD threshold level that caused packet losses was significantly reduced (from 10 to 4 kV) when an additional cable segment and connector were added to the Ethernet cable assemblies.

F-21. A COTS cable and connector exhibited more data packet losses at a lower ESD discharge level than a cable and connector qualified to meet Cat6a Ethernet requirements (i.e., Gore cable and CeeLok FAS-X connector).

F-22. There are no known NASA standards that provide detailed guidance on how to terminate an Ethernet cable to a connector for optimal performance.

F-23. Several evaluations were not conducted due to time constraints and available funding. The following areas could use more evaluation:

- Comparison of bulkhead and composite connectors with respect to transfer impedance and susceptibility to ESD events during network operation.
- Impact of short- (1 to 3 m) and long-length cables (30 m or more) and multiple connectors with a cable analyzer and under network operation while subjected to ESD discharges at the connector interface.
- Analysis of existing NASA platform Ethernet cable and connectors using a cable analyzer for comparison with recently built Ethernet cables.
- Impact of high and low temperatures and vibration on Ethernet cables and connectors.
- Power over Ethernet systems and 10GBASE-T Ethernet systems.

8.2 Observations

The following observations were identified:

O-1. NASA spacecraft under development are using Cat6, which supports 1-Gbps Ethernet (1000BASE-T) and operates up to 250 MHz, and Cat6a, which supports 10-Gbps Ethernet (10GBASE-T) and operates to 500 MHz. Compared with a Cat5 Ethernet system, Cat6 and higher speed systems are far more sensitive to impedance mismatches in connectors and overall shield integrity in the cable and the connector.

O-2. A PHY transceiver may have an embedded cable diagnostic capability that can be used to locate cable faults.

O-3. Electrical transient protection devices for network cards are most effective when located between the interconnecting cable interface and the interface transformer and between the interface transformer and the input to the Ethernet device (PHY).

O-4. Cable analyzers are COTS equipment used extensively by the telecommunications industry. Considerable time was required to learn how to correctly use the Fluke cable analyzer, and limited training was available through the Internet.

O-5. While most Ethernet cables and connectors are COTS parts, there are Ethernet cables and connectors that meet aerospace standards and can be procured from qualified sources (i.e., sources that have been independently verified to meet standard technical requirements and consistently perform at a higher level than the COTS parts).

O-6. The four twisted pairs in a Cat6 or higher cable may have different twist rates in each pair. Maintaining the proper twist rates in each of the four pairs helps reduce crosstalk and signal attenuation in Ethernet cables at connector terminations. Additional insight with respect to twisted pairs includes:

- The impedance of the twisted pair increases as the overall wire dimension decreases.
- The impedance of the twisted pair decreases as the twist rate increases.
- As the twist rate increases, the effective dielectric constant is increasingly dominated by the contribution of the relative dielectric constant of the wire insulation.
- The range of optimal twist angle falls between 20° to maintain line uniformity and 45° to avoid tensile damage to the conductor(s).
- The presence of a shield increases the differential mode capacitance of the twisted pair.
- The presence of a shield introduces a stable common mode capacitance of the twisted pair, independent of the separation distance between the shielded wire pair and nearby structure.
- The combination of the twisted pair with the presence of a shield acts to mitigate both inductive and capacitive coupling (crosstalk) between adjacent wire pairs as compared with the amount of crosstalk without the presence of the shield.
- Using a cable with individually shielded twisted pairs reduces the impact of variable twisting rates on Ethernet cable analyzer crosstalk and signal attenuation.

O-7. A MIL-DTL-38999 (M38999) metal connector is not designed for high-speed data transmission and does not match the 100-ohm impedance of Ethernet cables.

O-8. Studies have shown Ethernet susceptibility to crosstalk when Ethernet pairs are adjacent or when additional signals are present in a M38999 connector.

- Two of the Ethernet twisted pairs were placed next to each other in an M38999 connector, and the corresponding cable analyzer results were compared with the results with maximum separation between the twisted pairs. In this case, the adjacent twisted pair cable analyzer performance was similar to results with maximum separation between the twisted pairs. No additional wires were placed in the connectors, which could introduce crosstalk noise as noted in the referenced paper [Gore, 2022b].

O-9. Gore cables terminated to M38999 and CeeLok FAS-X connectors with one cable segment had considerably higher Cat6a NEXT and RL values (higher values are better) compared with a PIC cable and PIC connector.

O-10. Gore cables and M38999 and CeeLok FAS-X connectors were straightforward to assemble and mate and de-mate during cable testing operations.

- The PIC connector had some attributes that made mating and de-mating difficult.

O-11. The cable analyzer was effective in identifying cable characteristics and specifically which twisted pairs exhibited marginal Cat6a NEXT and RL values. These cables could then be reworked to improve Cat6a performance.

O-12. During manufacturing of each cable type, there were a number of fabrication errors related to miswiring (placement of the wrong twisted pair in the connector), improper attachment of the shield to the terminated connectors, and multiple reworks on all cable terminated connectors. The cable analyzer was effective in detecting these errors.

O-13. Impedance matching circuits, other interface circuits, and connector terminations can adversely impact Ethernet cable performance.

O-14. Shield transfer impedance is an intrinsic physical property independent of connector design and shield termination and provides a measure of shield effectiveness against susceptibility to external signal sources. Shields with lower transfer impedance are more effective than shields with higher transfer impedance.

O-15. Network data packet errors were detected when ESD discharges were applied to the Ethernet connector cables when the connector was electrically isolated from the aluminum ground plane. Monitoring data packets lost over each 1-sec interval provided the most insight on the impact of ESD discharges into the Ethernet connectors.

O-16. Network data packet errors were detected on Gore cables with both CeeLok FAS-X and M38999 connectors (two RJ45 connectors that were connected using a single CeeLok FAS-X or M38999 connector) once the ESD discharge reached 10 kV and above (set to the human body model, for 60 sec at 20 discharges per minute). There were no data packet errors at lower ESD discharge levels. As expected, increasing the voltage to 16 kV resulted in additional data packet errors on the CeeLok FAS-X and M38999 connectors.

O-17. Network data packet errors were detected on the PIC cable and PIC connector (two RJ45 connectors that were connected using a single PIC connector) when the ESD discharge reached 1 kV and above (set to the human body model, for 60 sec at 20 discharges per minute).

O-18. The PIC cable and PIC connector exhibited packet losses at lower ESD levels (1 kV) than the Gore cable with a CeeLok FAS-X or M38999 connector (10 kV). The PIC cable continued to have higher numbers of time intervals with lost packets as the ESD level was increased to 4 and 6 kV, compared with the Gore cable with a CeeLok FAS-X or M38999 connector.

O-19. Disconnecting the Ethernet cable shield to the connector (on the PIC cable assembly) resulted in more data packet losses at lower voltages (1 kV) when the ESD gun was discharged to the Ethernet connector than when the shield was connected to the Ethernet connector.

8.3 NESC Recommendations

The following NESC recommendations are directed to all NASA spacecraft development efforts using Ethernet systems.

R-1. Prior to installation in a system, an Ethernet cable should be tested with a calibrated cable analyzer using the intended network category in a configuration that matches the use application as closely as possible. ***(F-1, O-11, O12)***

- This should include the design cable lengths with all connectors mated and each segment separately tested.
- A summary of the cable analyzer results should include wire mapping and the amount of margin the cable configuration provides over the category level requirements for crosstalk and RL.
- Cable analyzer results and all raw data used to generate the results should be provided to the organization(s) responsible for certifying that a network meets the application requirement.

R-2. Ethernet cables for critical network data rates of Cat6 and above, with or without individual pair shields, should be terminated with wire twists maintained as close as possible to the connector grommet edge (i.e., < 3.175 mm (0.125 inch)). ***(F-3, F-7, O-6)***

R-3. Ethernet systems should employ cables that have individually shielded twisted pairs and an overall shield surrounding all pairs that is circumferentially terminated in a 360-degree cable shield termination at each connector. The use of drain wires (i.e., pigtails) to attach the cable shielding to the connector is strongly discouraged. Maximum shielding effectiveness is also best accomplished by direct electrical bonding of all cable connectors to structure common reference. ***(F-4, F-7, F-9, F-11, F-19, O-9, O-18)***

R-4. The Ethernet cable and connector selected for a Cat6 application should be qualified to AS6070 and MIL-DTL-32546, respectively. ***(F-6, F-7, F-9, F-11, F-13, F-21, O-5, O-9, O-18)***

R-5. Ethernet systems should use impedance-matched connectors designed for aerospace Ethernet applications that are qualified to MIL-DTL-32546. ***(F-4, F-6, F-7, F-21, O-7, O-10)***

R-6. Use of COTS Ethernet cables and connectors should require additional review and independent testing. ***(F-1, F-3, F-6, F-7, F-8, F-19, F-21, O-5, O-18)***

- Consider using a cable analyzer to enable demonstration that the system can operate under worst-case environmental conditions (e.g., transfer impedance, susceptibility to triboelectric charging, thermal, and vibration) while using the maximum cable length and number of connectors required for the application.

R-7. If M38999 connectors are used in an Ethernet application, then the connector should not contain additional wiring that could introduce interference or crosstalk sources to the Ethernet pairs. ***(F-6, O-7, O-8)***

- If additional wiring is required, then a cable analyzer test should be conducted while worst-case signals are applied to the wiring to ensure minimum NEXT requirements are maintained.

R-8. For the most consistent and reliable Ethernet cable performance, procure connectorized cable assemblies directly from component manufacturers or vendors that specialize in building and testing Ethernet cable assemblies for aerospace applications. ***(F-2, F-3, F-6, F-12, O-12)***

R-9. When building Ethernet cable assemblies in house (cables terminated to connectors), follow cable and connector vendor manufacturing guidelines. ***(F-3, F-6, F-9, F-12, O-10, O-12)***

R-10. When using Ethernet cables to communicate between computer systems, evaluate the cable assembly's susceptibility to EMI events (e.g., ESD charging and discharging), which can create network data errors. ***(F-2, F-5, F-6, F-9, F-11, F-14, F-15, F-16, F-19, O-14, O-15, O-16, O-17)***

- Connectors are the most sensitive part of the Ethernet cable with respect to EMI events and should be electrically bonded to chassis ground.
- The EMC environment should be reviewed for potential exposure to ESD events and other EMI sources during launch and flight operations.

9.0 Alternate Technical Opinion(s)

No alternate technical opinions were identified during the course of this assessment by the NESC assessment team or the NESC Review Board (NRB).

10.0 Other Deliverables

No unique hardware, software, or data packages, other than those contained in this report, were disseminated to other parties outside this assessment.]

11.0 Recommendations for the NASA Lessons Learned Database

No recommendations for NASA lessons learned were identified as a result of this assessment.

12.0 Recommendations for NASA Standards, Specifications, Handbooks, and Procedures

The Agency Ethernet community, under the direction of the NASA Technical Fellow for Avionics, should create a handbook for procuring, building, and testing Ethernet cable assemblies. This assessment report can be used as a resource for creating the handbook.

13.0 Definition of Terms

ACR-F	(Attenuation To Crosstalk Ratio Far-End): PS ACR-F results show how much the far end of each cable pair is affected by the combined far-end crosstalk from the other pairs. PS ACR-F is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the far end of the cabling. The tester uses the ACR-F values to calculate PS ACR-F. Higher PS ACR-F values correspond to better cabling performance. PS ACR-F results are typically a few dB lower than worst-case ACR-F results.
ACR-N	(Attenuation To Crosstalk Ratio Near-End): ACR-N is a signal-to-noise ratio. ACR-N values indicate how the amplitude of signals received from a far-end transmitter compares to the amplitude of crosstalk produced by near-end transmissions. Higher ACR-N values mean received signals are larger than crosstalk signals. Higher ACR-N values correspond to better cabling performance.
Category 5 (Cat5)	Designation that applies to two-pair 100-ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 100 MHz.
Category 5e (Cat5e)	Designation that applies to four-pair 100-ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 100 MHz.
Category 6 (Cat6)	Designation that applies to four-pair 100-ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 250 MHz.
Category 6a (Cat6a)	Designation that applies to four-pair 100-ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 500 MHz.
Category 8 (Cat8)	Designation that applies to four-pair 100-ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 2000 MHz.
Far End Crosstalk	(FEXT): The same as NEXT, but FEXT is measured at the far end of the Ethernet connection and thus suffers from attenuation in the CUT. This parameter requires removal of the CUT attenuation or IL to yield data comparable to NEXT data. CUT attenuation or IL may not be accurately known, making FEXT data less useful than NEXT data. TIA has renamed this parameter Attenuation to Crosstalk Ratio, Far-end (ACRF).

Finding	A relevant factual conclusion and/or issue that is within the assessment scope and that the team has rigorously based on data from their independent analyses, tests, inspections, and/or reviews of technical documentation.
IEEE 802.3	Ethernet standard that defines the physical layer and the MAC of the data link layer for wired Ethernet networks.
Insertion Loss	(IL): Loss of signal strength over the cabling. IL is caused by the resistance of the copper wire and connecting hardware and by leakage of electrical energy through the cable's insulation. At higher frequencies, signals tend to travel only near the surface of a conductor. This "skin effect," along with the inductance and capacitance of the cabling, causes IL to increase with frequency.
Near End Crosstalk	(NEXT): NEXT results show the crosstalk attenuation between cable pairs. NEXT is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other cable pairs at the same end of the cabling. A high NEXT is desirable.
Observation	A noteworthy fact, issue, and/or risk, which is not directly within the assessment scope, but could generate a separate issue or concern if not addressed. Alternatively, an observation can be a positive acknowledgement of a Center/Program/Project/Organization's operational structure, tools, and/or support.
PS NEXT	(Power Sum Near-End Crosstalk): Difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling. PS NEXT is a measure of difference in signal strength between disturbing pairs and a disturbed pair; a larger number (i.e., less crosstalk) is more desirable than a smaller number (i.e., more crosstalk).
PS ACR-F	(Power Sum Attenuation to Crosstalk Ratio, Far-End): While NEXT is measured at the same end as the signal source, FEXT (far-end crosstalk) is measured at the far end. Because all far-end crosstalk signals travel the same distance, they experience the same amount of attenuation, as shown in Figure 6.3-10. This means all crosstalk signals contribute equally to noise at the far end. This is different from NEXT. At the near end, crosstalk occurring closer to the source contributes more to noise than crosstalk occurring farther from the source.
PS ACR-N	(Power Sum Attenuation to Crosstalk Ratio, Near-End): PS ACR-N values indicate how the amplitude of signals received from a far-end transmitter compares with the combined amplitudes of crosstalk produced by near-end transmissions on the other cable pairs. PS ACR-N is the difference (in dB) between PS NEXT and attenuation (IL). Higher PS ACR-N values mean received signals are larger than the crosstalk from all other cable pairs. Higher PS ACR-N values correspond to better cabling performance.

Recommendation	A proposed measurable stakeholder action directly supported by specific finding(s) and/or observation(s) that will correct or mitigate an identified issue or risk.
Return Loss	The power ratio of the transmitted to reflected signals. High RL means the cabling reflects little of the transmitted signal back to the source.

14.0 Acronyms and Nomenclature List

1x	one times [a cable diameter], bend radius
4x	four times [a cable diameter], bend radius
ACRF	Attenuation to Crosstalk Ratio, Far-end
AWG	American Wire Gauge
BERT	Bit Error Rate Tester
Cat	Category
CCP	Commercial Crew Program
CDE	Cable Discharge Event
CDP	Corrupted Data Packet
cm	centimeter
COTS	Commercial off the Shelf
CUT	Cable Under Test
dB	decibel
DC	Direct Current
DoD	Department of Defense
EFT	Electrical Fast Transient
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FEXT	Far-end Crosstalk
ft	feet
Gbps	gigabits per second
GDT	Gas Discharge Tube
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
HALO	Habitation and Logistics Outpost
HLS	Human Landing System
HSM	High-speed Module
IL	Insertion Loss
ISS	International Space Station
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KHz	kilohertz
KSC	Kennedy Space Center
kV	kilovolts
LAN	Local Area Network
LaRC	Langley Research Center
m	meter
MAC	Media Access Control

MB	megabyte
Mbps	megabits per second
MDI	Media-dependent Interface
MDIX	Media-dependent Interface Crossover
MHz	megahertz
MII	Media-independent Interface
mm	millimeter
ms	millisecond
MSFC	Marshall Space Flight Center
NAVAIR	Naval Air Systems Command
NESC	NASA Engineering and Safety Center
NEXT	Near-end Crosstalk
ns	nanosecond
NVP	Nominal Velocity of Propagation
OD	Outer Diameter
OEM	Original Equipment Manufacturer
PHY	Physical Layer Device
PoE	Power over Ethernet
PTC	Positive Temperature Coefficient
PTFE	Polytetrafluoroethylene
RHA	Radiation-Hardness Assured
RL	Return Loss
sec	second
S/FTP	shielded with foiled twisted pairs, cable
SF/UTP	Shielded and foiled with unshielded twisted pairs, cable
SMA	SubMiniature version A, coaxial cable connector
SME	Subject Matter Expert
TCP	Transmission Control Protocol
TCS	Transient Current Suppressor
TDR	Time Domain Reflectometry
TI	Texas Instruments
TPI	Twists per Inch
TPM	Twists per Meter
TVS	Transient Voltage Suppressor
UDP	User Datagram Protocol
US	United States
VoP	Velocity of Propagation

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16.0 Appendices

Appendix A. Connector Termination Processes

Appendix B. Initial Ethernet Cables Built from 26-AWG Gore Cable Cat6a Ethernet Cables and Terminated with TE Connectivity Cat6a CeeLok FAS-X Connectors as Tested with Fluke DSX-5000 Meter

Appendix C. Ethernet Cable and ESD Gun Test Plan

Appendix D. EMC Cable Measurements

Appendix E. ESD and Control iPerf Test Results for Client and Server Networks

Appendix F. iPerf Test Runs

Appendix A. Connector Termination Processes

A.1 TE Connectivity® Assembly Instructions for CFX High-speed Connectors

Image removed due to copyright restrictions.[6]

A.2 TE Connectivity® CeeLok FAS-X® Connector System Termination Instructions

Image removed due to copyright restrictions.[7]

A.3 MIL-DTL-38999 Gore® Aerospace Ethernet Cables with General Purpose Connector System Termination Instructions

Image removed due to copyright restrictions.[8]

A.4 PIC MachForce Cable Connector Termination Instructions

Image removed due to copyright restrictions.[9]

[6] gore-ad-ethernet-term-te-ceelok-fas-x-us-apr-22.pdf

[7] gore-ad-ethernet-term-te-ceelok-fas-x-us-apr-22.pdf

[8] GORE-AD-Etherent-Term-General-Purpose-US-APR22.pdf

[9] Microsoft Word - Termination Instructions - MachForce-Rev_4.docx (picwire.com)

A.5 Detailed Process for Shielding Ethernet Pairs as Close as Possible to Connector Grommet

Figure A-1. Photo Documentation of Ethernet Cable Retermination that maintained Wire Pair Twist and added Shielding to Each Connector, Resulting in Passing the Cable Analyzer Cat6 Test using Five Cable Segments and Six Connectors

Image removed due to copyright restrictions.[10]

Figure A-2. Control Drawing for RJ45 Connector used with Adaptor Cables

A.6 Stewart Connector Cable Termination Instructions

Image removed due to copyright restrictions.[11]

A.7 RJ45 Connector Termination Instructions (Stewart Connector P/N SS-39300-10)

RJ45 punch-down modular plugs have a unique design for ease of use as a field terminated connector. No special termination tooling is required: insert a wire into the wire manager load bar, insert that into the connector body, and close to terminate. These are designed to comply

[10] dr-STW-cat-8.1-field-terminated-plug.pdf (belfuse.com)

[11] Microsoft Word - MN390032.docx (belfuse.com)

with industry-standard Category 8.1 performance that supports 25 Gbps and 40 Gbps Ethernet speeds and are backward compatible with existing RJ45 connectors used for Cat5e through Cat6a speeds. The plugs are built to be universal modular plug connections for shielded or unshielded cable, accepting a cable outer diameter (OD) range of 5 millimeter (mm) (0.197 inch) to 7 mm (0.275 inch), and terminate 22 American Wire Gauge (AWG) to 26-AWG solid or stranded cable with an OD insulation up to 1.6 mm (0.063 inch). These plugs feature compression strain relief to keep the cable and connector tightly terminated, offer 360° of shielding, and are built to handle Power over Ethernet (PoE) applications.

Features:

- No special termination tooling required.
- Color-coded conductor preload wire manager for easy assembly.
- Can be re-terminated to larger AWG if smaller AWG was terminated previously.
- Accepts cable OD ranges of 5 mm (0.197 inch) to 7 mm (0.275 inch).
- Terminates 22-AWG to 26-AWG cable with an insulation OD of up to 1.6 mm (0.063 inch).
- 360° shielding.
- Compression strain relief.
- Industry-standard eight-position/eight-contact RJ45 modular plug.
- Compliance: IEC 60603-7-1 and TIA-1096.

Images removed due to copyright restrictions.[12][13]

[12] ds-STW-category-8.1-RJ45-punch-down-plugs.pdf (belfuse.com)
[13] Microsoft Word - MN390032.docx (belfuse.com)

Appendix B. Initial Ethernet Cables Built from 26-AWG Gore Cable Cat6a Ethernet Cables and Terminated with TE Connectivity Cat6a CeeLok FAS-X Connectors as Tested with Fluke DSX-5000 Meter

Figure B-1. Adaptor Cables with Single CeeLok FAS-X Connector Configuration passed Fluke meter Cat6 test.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST REF CABLE

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 08/31/2022 12:10:15 PM
Operator: PETER FETTERER
Headroom 21.0 dB (NEXT 3,6-4,5)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

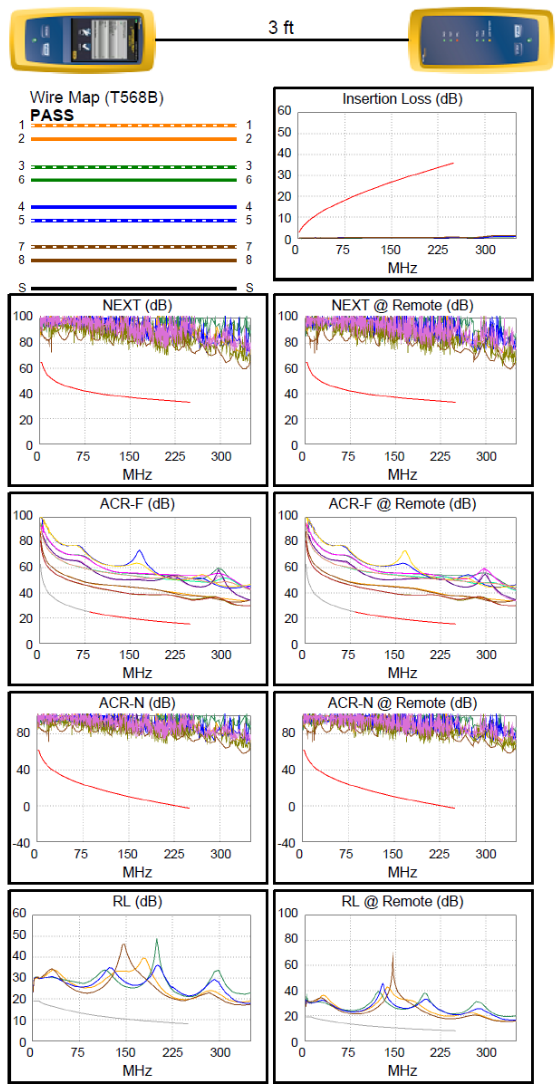
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	3
Prop. Delay (ns), Limit 555	[Pair 1,2]	4
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.41
Insertion Loss Margin (dB)	[Pair 7,8]	35.3
Frequency (MHz)	[Pair 7,8]	250.0
Limit (dB)	[Pair 7,8]	35.9

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	21.1	21.0	39.2	39.5
Freq. (MHz)	3.9	7.8	229.5	250.0
Limit (dB)	63.3	58.4	33.8	33.1
Worst Pair	3,6	3,6	7,8	3,6
PS NEXT (dB)	22.3	22.7	40.7	40.5
Freq. (MHz)	3.9	3.9	210.0	230.5
Limit (dB)	60.8	60.8	31.5	30.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	19.1	19.2	19.2	19.2
Freq. (MHz)	248.5	250.0	250.0	250.0
Limit (dB)	15.4	15.3	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.2	20.5	20.3	20.7
Freq. (MHz)	248.5	1.0	250.0	250.0
Limit (dB)	12.4	60.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	25.0	25.0	73.2	75.0
Freq. (MHz)	3.9	3.9	229.5	250.0
Limit (dB)	59.3	59.3	-0.4	-2.8
Worst Pair	3,6	3,6	7,8	3,6
PS ACR-N (dB)	26.2	26.7	72.8	74.5
Freq. (MHz)	2.0	3.9	210.0	230.5
Limit (dB)	59.0	56.8	-1.0	-3.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.1	8.1	10.9	9.4
Freq. (MHz)	1.0	1.0	242.5	246.0
Limit (dB)	19.0	19.0	8.2	8.1

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-2. Adaptor Cables with Single CeeLok FAS-X Connector Passed all Cat6 Test Requirements
Cable was properly connected and passed NEXT tests and return loss (RL) with significant margin.

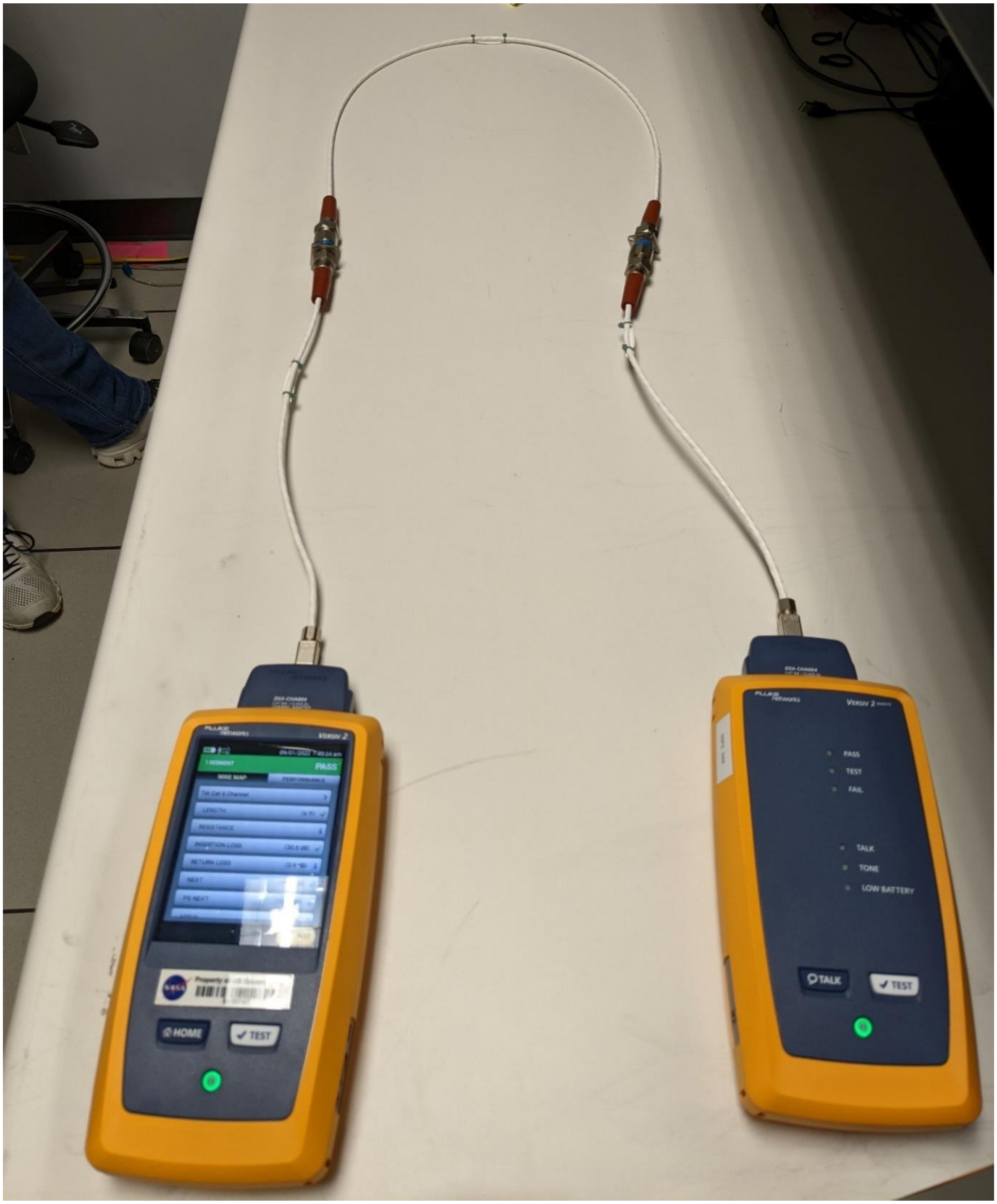


Figure B-3. One Segment with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Connected to DSX-5000 Meter

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

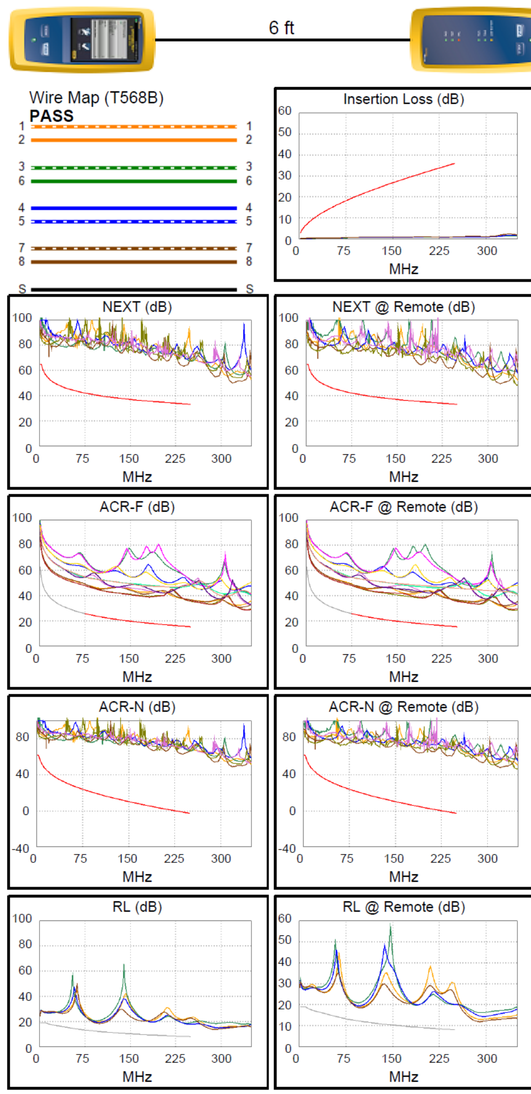
Cable ID: SEG001 TEST		**Test Summary: PASS**
Test Limit: TIA Cat 6 Channel	Main: Versiv	Remote: Versiv
Limits Version: V7.6	S/N: 22120373	S/N: 22120132
Date / Time: 09/01/2022 08:00:47 AM	Software Version: V6.7 Build 1	Software Version: V6.7 Build 1
Operator: PETER FETTERER	Calibration Date: 07/25/2022	Calibration Date: 07/25/2022
Headroom 17.8 dB (NEXT 3,6-7,8)	Adapter: DSX-5000 (DSX-CHA004)	Adapter: DSX-5000R (DSX-CHA004)
Cable Type: Cat 6 U/UTP	S/N: 22212246	S/N: 22212244
NVP: 69.0%		

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 4,5]	31.2
Frequency (MHz)	[Pair 4,5]	207.0
Limit (dB)	[Pair 4,5]	32.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	19.7	17.8	30.0	27.9
Freq. (MHz)	3.6	3.5	239.5	237.0
Limit (dB)	63.7	64.0	33.4	33.5
Worst Pair	3,6	3,6	4,5	3,6
PS NEXT (dB)	19.9	18.5	31.4	29.8
Freq. (MHz)	3.8	3.9	239.5	237.0
Limit (dB)	61.0	60.8	30.5	30.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	20.1	20.1	20.1	20.1
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	15.3	15.3	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.8	20.6	20.8	20.6
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	12.3	12.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	23.4	21.3	64.4	62.1
Freq. (MHz)	3.6	2.9	239.5	237.0
Limit (dB)	59.9	61.6	-1.6	-1.3
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-N (dB)	23.5	22.1	65.9	63.9
Freq. (MHz)	3.1	3.3	239.5	237.0
Limit (dB)	58.4	58.4	-4.6	-4.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	4,5	7,8
RL (dB)	5.1	6.3	9.7	6.4
Freq. (MHz)	1.0	96.5	250.0	100.0
Limit (dB)	19.0	12.2	8.0	12.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-4. Segment 1 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6 Test Requirements
Cable was properly connected and passed NEXT tests and RL with significant margin.

LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: SEG002 TEST

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 07:55:35 AM
Operator: PETER FETTERER
Headroom 13.4 dB (NEXT 1,2-7,8)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

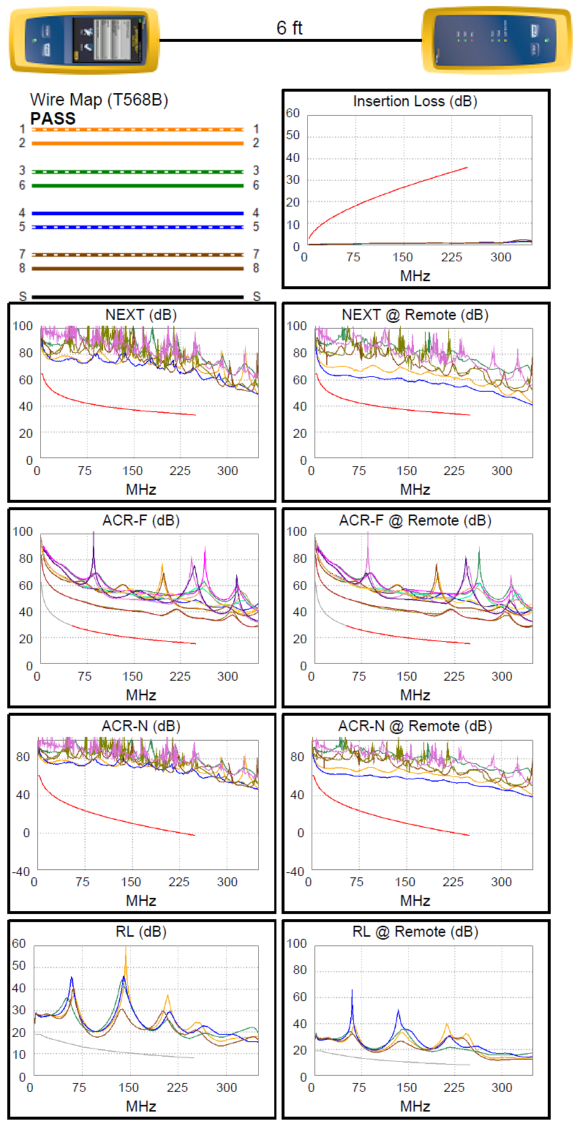
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 3,6]	31.0
Frequency (MHz)	[Pair 3,6]	205.5
Limit (dB)	[Pair 3,6]	32.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-7,8	1,2-7,8	1,2-7,8
NEXT (dB)	16.7	13.4	30.2	20.8
Freq. (MHz)	3.1	11.1	229.0	250.0
Limit (dB)	64.8	55.8	33.8	33.1
Worst Pair	3,6	1,2	1,2	1,2
PS NEXT (dB)	17.3	14.0	32.6	22.9
Freq. (MHz)	3.1	3.3	229.0	250.0
Limit (dB)	62.0	62.0	30.8	30.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	4,5-3,6	3,6-4,5
ACR-F (dB)	19.1	19.0	19.7	19.7
Freq. (MHz)	188.5	188.5	250.0	250.0
Limit (dB)	17.8	17.8	15.3	15.3
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-F (dB)	21.9	21.5	22.0	22.1
Freq. (MHz)	192.5	188.5	250.0	250.0
Limit (dB)	14.6	14.8	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-7,8	1,2-7,8	1,2-7,8
ACR-N (dB)	20.2	17.7	63.7	55.8
Freq. (MHz)	3.1	3.3	229.0	250.0
Limit (dB)	61.2	60.9	-0.4	-2.8
Worst Pair	3,6	1,2	1,2	1,2
PS ACR-N (dB)	20.8	17.5	66.0	58.0
Freq. (MHz)	3.1	3.3	229.0	250.0
Limit (dB)	58.4	58.4	-3.3	-5.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	3,6	7,8
RL (dB)	4.8	5.7	9.0	5.8
Freq. (MHz)	1.0	98.8	243.5	100.0
Limit (dB)	19.0	12.1	8.1	12.0

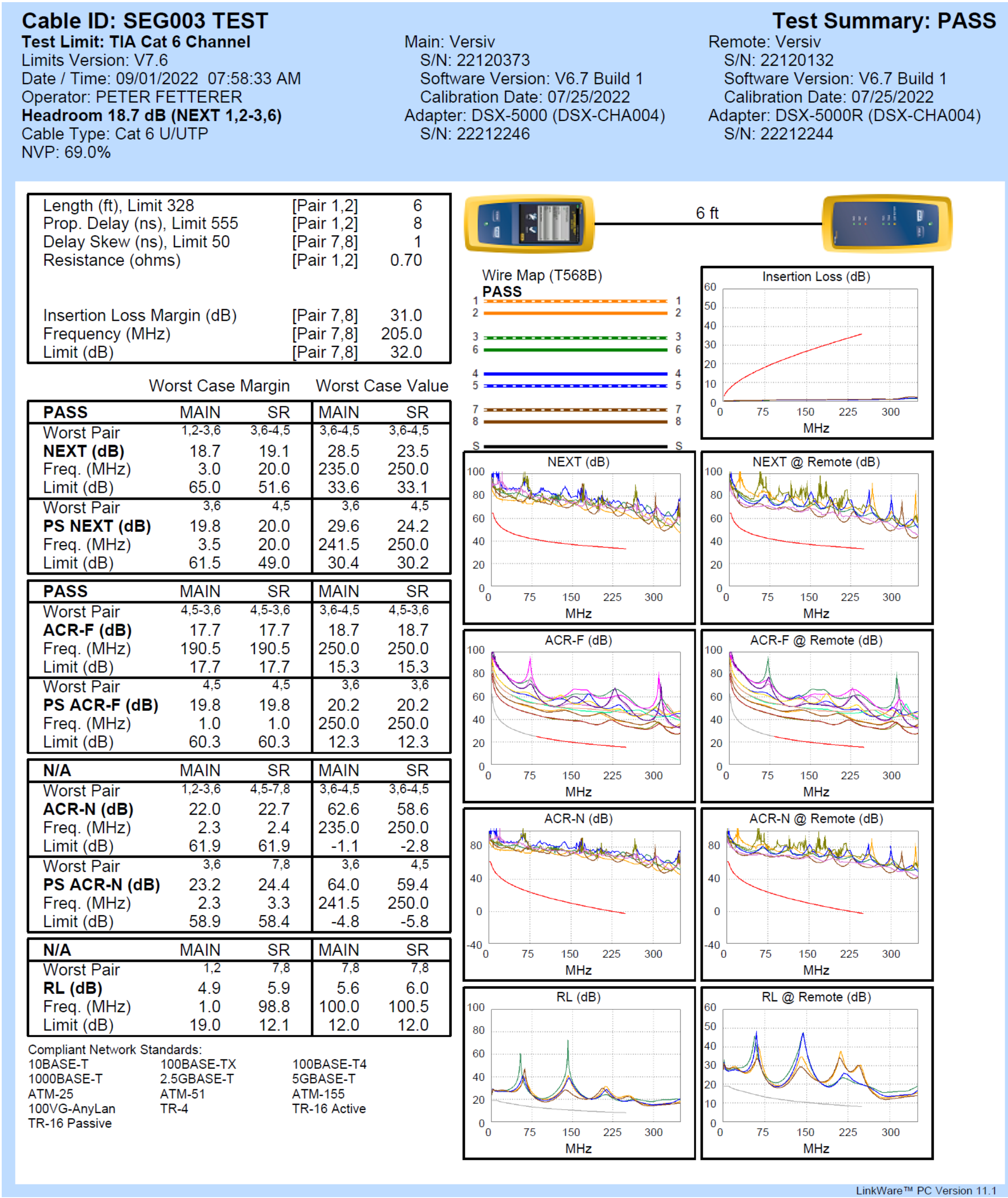
Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-5. Segment 2 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6 Test Requirements
Cable was properly connected and passed NEXT tests and RL with significant margin.



Cable ID: SEG003 TEST | **Test Summary: PASS**

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 07:58:33 AM
Operator: PETER FETTERER
Headroom 18.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 7,8]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	31.0
Frequency (MHz)	[Pair 7,8]	205.0
Limit (dB)	[Pair 7,8]	32.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	18.7	19.1	28.5	23.5
Freq. (MHz)	3.0	20.0	235.0	250.0
Limit (dB)	65.0	51.6	33.6	33.1
Worst Pair	3,6	4,5	3,6	4,5
PS NEXT (dB)	19.8	20.0	29.6	24.2
Freq. (MHz)	3.5	20.0	241.5	250.0
Limit (dB)	61.5	49.0	30.4	30.2

PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	17.7	17.7	18.7	18.7
Freq. (MHz)	190.5	190.5	250.0	250.0
Limit (dB)	17.7	17.7	15.3	15.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-F (dB)	19.8	19.8	20.2	20.2
Freq. (MHz)	1.0	1.0	250.0	250.0
Limit (dB)	60.3	60.3	12.3	12.3

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	4,5-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	22.0	22.7	62.6	58.6
Freq. (MHz)	2.3	2.4	235.0	250.0
Limit (dB)	61.9	61.9	-1.1	-2.8
Worst Pair	3,6	7,8	3,6	4,5
PS ACR-N (dB)	23.2	24.4	64.0	59.4
Freq. (MHz)	2.3	3.3	241.5	250.0
Limit (dB)	58.9	58.4	-4.8	-5.8

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.9	5.9	5.6	6.0
Freq. (MHz)	1.0	98.8	100.0	100.5
Limit (dB)	19.0	12.1	12.0	12.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		

Figure B-6. Segment 3 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6 Test Requirements
Cable was properly connected and passed NEXT tests and RL with significant margin.

LinkWare™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: SEG004 TEST

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 07:40:16 AM
Operator: PETER FETTERER
Headroom 19.5 dB (NEXT 3,6-7,8)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

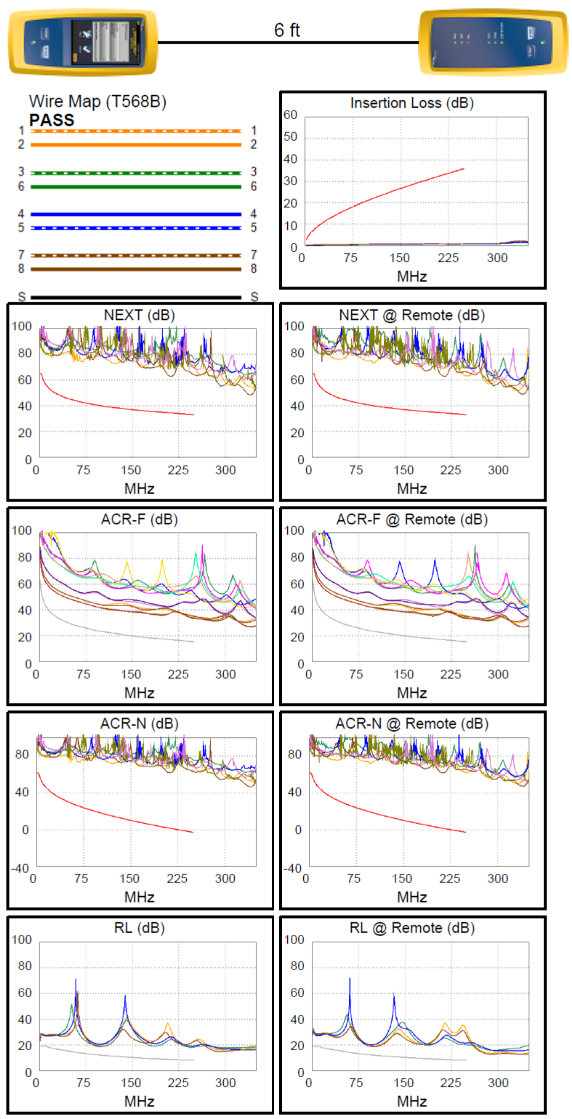
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 7,8]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	30.8
Frequency (MHz)	[Pair 7,8]	202.5
Limit (dB)	[Pair 7,8]	31.8

	Worst Case Margin MAIN	Worst Case Margin SR	Worst Case Value MAIN	Worst Case Value SR
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	19.5	19.9	28.2	28.1
Freq. (MHz)	3.4	3.3	212.0	214.0
Limit (dB)	64.2	64.5	34.3	34.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.6	20.9	30.2	30.6
Freq. (MHz)	3.3	3.3	212.0	250.0
Limit (dB)	62.0	62.0	31.4	30.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	17.7	17.6	18.0	18.0
Freq. (MHz)	192.5	188.5	250.0	250.0
Limit (dB)	17.6	17.8	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.8	18.7	18.8	18.7
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	12.3	12.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	23.1	23.2	59.9	60.1
Freq. (MHz)	3.4	2.8	212.0	214.0
Limit (dB)	60.5	61.6	1.7	1.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	23.1	24.4	61.9	65.8
Freq. (MHz)	3.3	3.3	212.0	250.0
Limit (dB)	58.4	58.4	-1.2	-5.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	3,6	7,8
RL (dB)	3.9	6.4	9.9	6.5
Freq. (MHz)	1.0	98.8	246.5	100.5
Limit (dB)	19.0	12.1	8.1	12.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-7. Segment 4 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6 Test Requirements
Cable was properly connected and passed NEXT tests and RL with significant margin.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: SEG005 TEST

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:02:39 AM
Operator: PETER FETTERER
Headroom 19.9 dB (NEXT 3,6-7,8)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

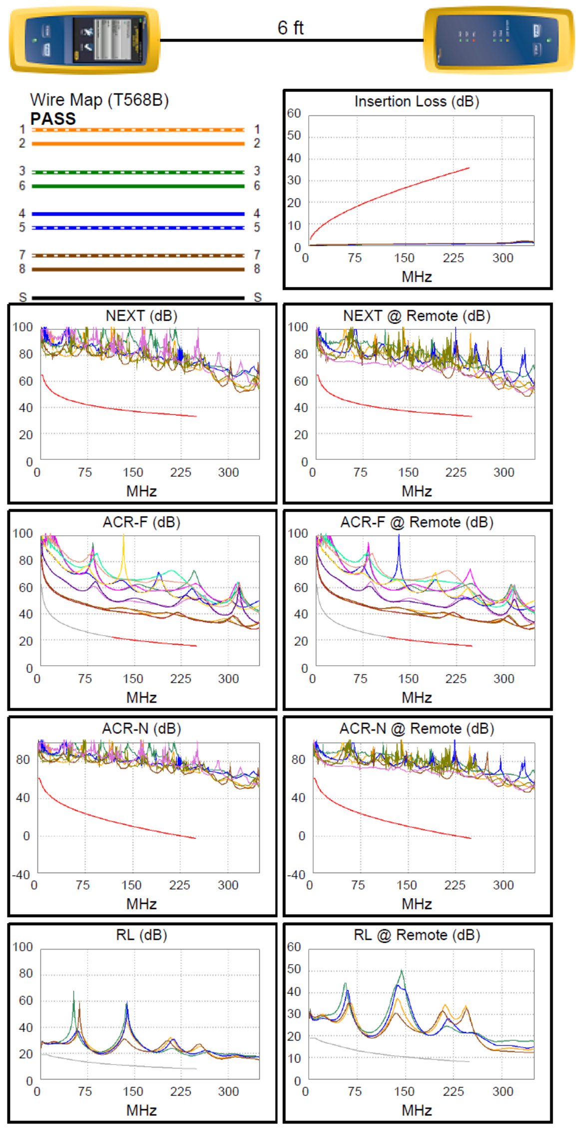
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	30.5
Frequency (MHz)	[Pair 7,8]	200.0
Limit (dB)	[Pair 7,8]	31.5

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	20.0	19.9	32.0	28.0
Freq. (MHz)	3.8	2.9	235.5	211.5
Limit (dB)	63.5	65.0	33.6	34.4
Worst Pair	3,6	3,6	3,6	4,5
PS NEXT (dB)	21.1	21.2	33.1	30.4
Freq. (MHz)	3.8	3.3	235.5	249.0
Limit (dB)	61.0	62.0	30.6	30.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	18.9	18.9	19.6	19.6
Freq. (MHz)	190.5	190.5	250.0	250.0
Limit (dB)	17.7	17.7	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.4	19.5	19.8	19.9
Freq. (MHz)	1.0	1.0	250.0	250.0
Limit (dB)	60.3	60.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	23.7	23.2	66.1	59.7
Freq. (MHz)	2.4	2.9	235.5	211.5
Limit (dB)	61.9	61.6	-1.1	1.8
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	24.9	24.7	67.0	65.5
Freq. (MHz)	3.8	3.3	235.5	249.0
Limit (dB)	57.1	58.4	-4.1	-5.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	7,8	3,6	7,8
RL (dB)	5.0	6.8	9.8	7.0
Freq. (MHz)	1.0	96.3	241.5	100.0
Limit (dB)	19.0	12.2	8.2	12.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-8. Segment 5 Cable with two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6 Test Requirements
Cable was properly connected and passed all Cat6 tests; NEXT tests and RL were passed with significant margin.

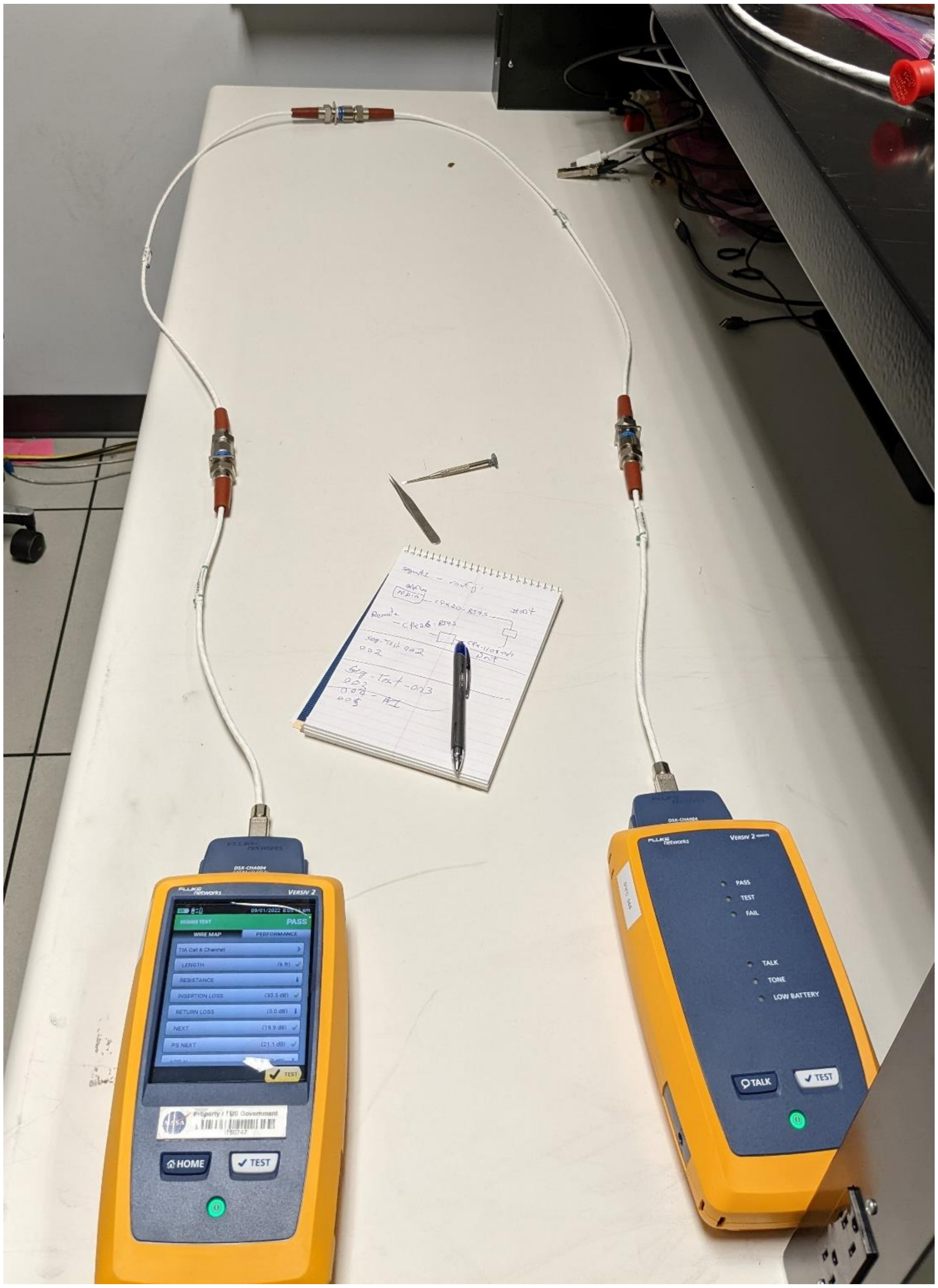
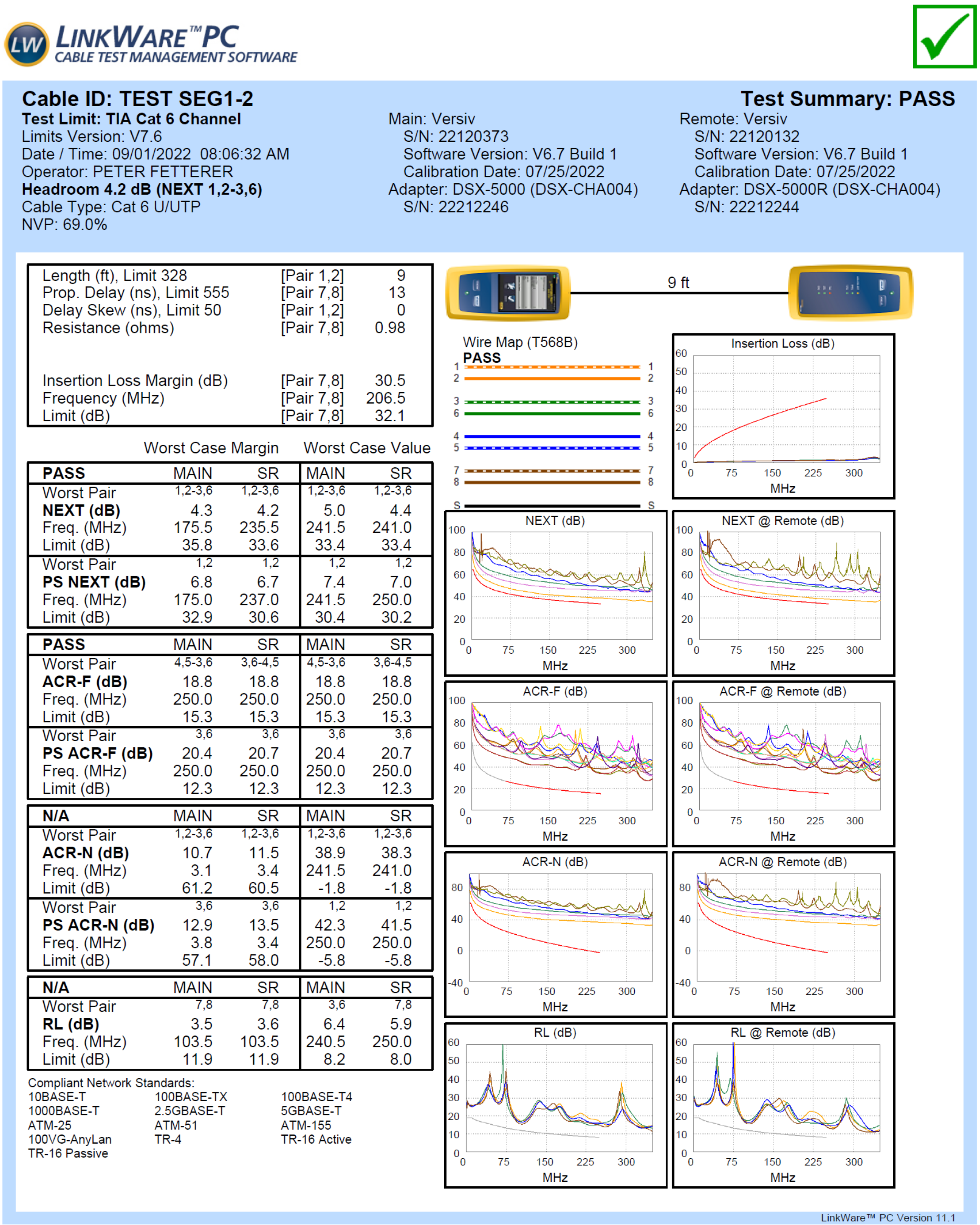


Figure B-9. Ethernet Cable Segments 1 and 2 Connected Together, which added Additional Cable Length and Three Connectors in Series with Adaptor Cables Connected to DSX-5000 Meter



LINKWARE™PC CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST SEG1-2 | **Test Summary: PASS**

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:06:32 AM
Operator: PETER FETTERER
Headroom 4.2 dB (NEXT 1,2-3,6)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	9
Prop. Delay (ns), Limit 555	[Pair 7,8]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.98
Insertion Loss Margin (dB)	[Pair 7,8]	30.5
Frequency (MHz)	[Pair 7,8]	206.5
Limit (dB)	[Pair 7,8]	32.1

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	4.3	4.2	5.0	4.4
Freq. (MHz)	175.5	235.5	241.5	241.0
Limit (dB)	35.8	33.6	33.4	33.4
Worst Pair	1,2	1,2	1,2	1,2
PS NEXT (dB)	6.8	6.7	7.4	7.0
Freq. (MHz)	175.0	237.0	241.5	250.0
Limit (dB)	32.9	30.6	30.4	30.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	18.8	18.8	18.8	18.8
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	15.3	15.3	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.4	20.7	20.4	20.7
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	12.3	12.3	12.3	12.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	10.7	11.5	38.9	38.3
Freq. (MHz)	3.1	3.4	241.5	241.0
Limit (dB)	61.2	60.5	-1.8	-1.8
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	12.9	13.5	42.3	41.5
Freq. (MHz)	3.8	3.4	250.0	250.0
Limit (dB)	57.1	58.0	-5.8	-5.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	3,6	7,8
RL (dB)	3.5	3.6	6.4	5.9
Freq. (MHz)	103.5	103.5	240.5	250.0
Limit (dB)	11.9	11.9	8.2	8.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		

LinkWare™ PC Version 11.1

Figure B-10. Two Ethernet Cable Segments with Three CeeLok FAS-X Connectors in Series with Adaptor Cables

Cable was properly connected and passed all Cat6 tests; NEXT tests and RL passed with some margin. Worst-case NEXT test limit was within 4.2 dB for two segments, compared with 20 dB for one segment. Worst-case RL for two segments was 3.5 dB above the limit, compared with 5 dB for one segment.

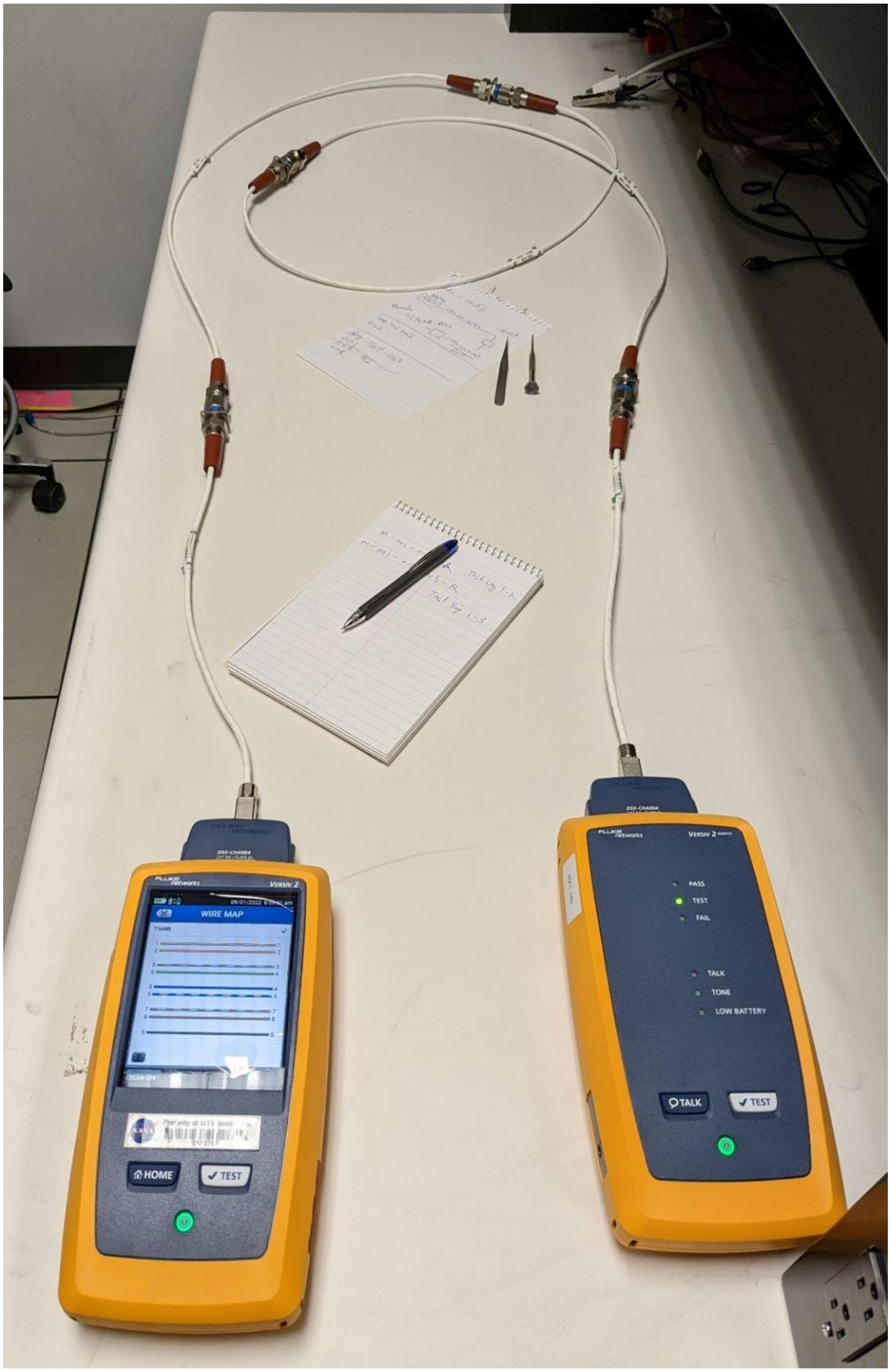


Figure B-11. Three Ethernet Cable Segments with Four Connectors in Series with Adaptor Cables Connected to DSX-5000 Meter

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST SEG1-3

Test Summary: PASS

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:09:09 AM
Operator: PETER FETTERER
Headroom 1.8 dB (NEXT 1,2-3,6)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	11
Prop. Delay (ns), Limit 555	[Pair 7,8]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.24
Insertion Loss Margin (dB)	[Pair 3,6]	31.4
Frequency (MHz)	[Pair 3,6]	222.0
Limit (dB)	[Pair 3,6]	33.5

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	1.8	2.1	1.8	2.1
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	33.1	33.1	33.1	33.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	3.7	4.2	3.7	4.2
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	30.2	30.2	30.2	30.2

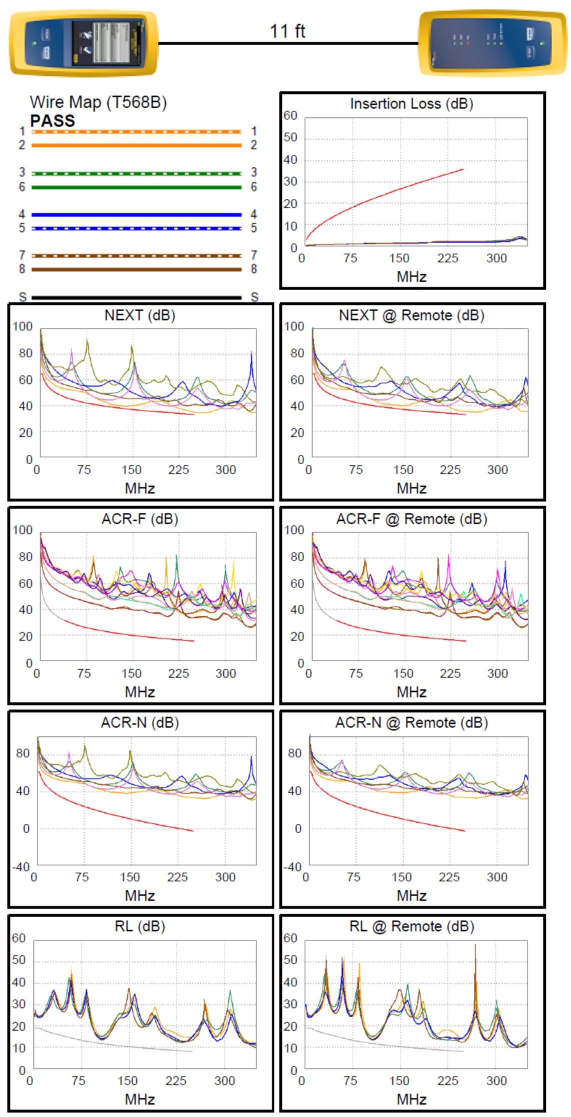
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	17.4	17.4	18.0	18.0
Freq. (MHz)	204.0	204.0	250.0	250.0
Limit (dB)	17.1	17.1	15.3	15.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.1	19.2	19.2	19.4
Freq. (MHz)	245.5	245.5	246.0	250.0
Limit (dB)	12.5	12.5	12.4	12.3

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	8.1	8.4	35.9	36.2
Freq. (MHz)	3.3	3.1	250.0	250.0
Limit (dB)	60.9	61.2	-2.8	-2.8
Worst Pair	1,2	3,6	3,6	3,6
PS ACR-N (dB)	10.1	10.1	37.9	38.4
Freq. (MHz)	3.3	3.3	250.0	250.0
Limit (dB)	58.4	58.4	-5.8	-5.8

N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	3,6	7,8
RL (dB)	1.7	1.6	3.8	4.3
Freq. (MHz)	107.5	105.5	234.5	248.5
Limit (dB)	11.7	11.8	8.3	8.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
ATM-25	ATM-51	ATM-155
100VG-AnyLan	TR-4	TR-16 Active
TR-16 Passive		



LinkWare™ PC Version 11.1

Figure B-12. Three Segments with Four Connectors in Series with Adaptor Cables
Cable was properly connected and passed all Cat6 tests; NEXT tests and RL with a slight margin. Worst-case NEXT test limit was within 1.8 dB for three segments, compared with 4.2 dB for two segments. Worst-case RL for three segments was 1.6 dB above the limit, compared with 3.5 dB for one segment. Note in the RL graph that losses are close to limits, which are most likely due to impedance mismatches at connector terminations.

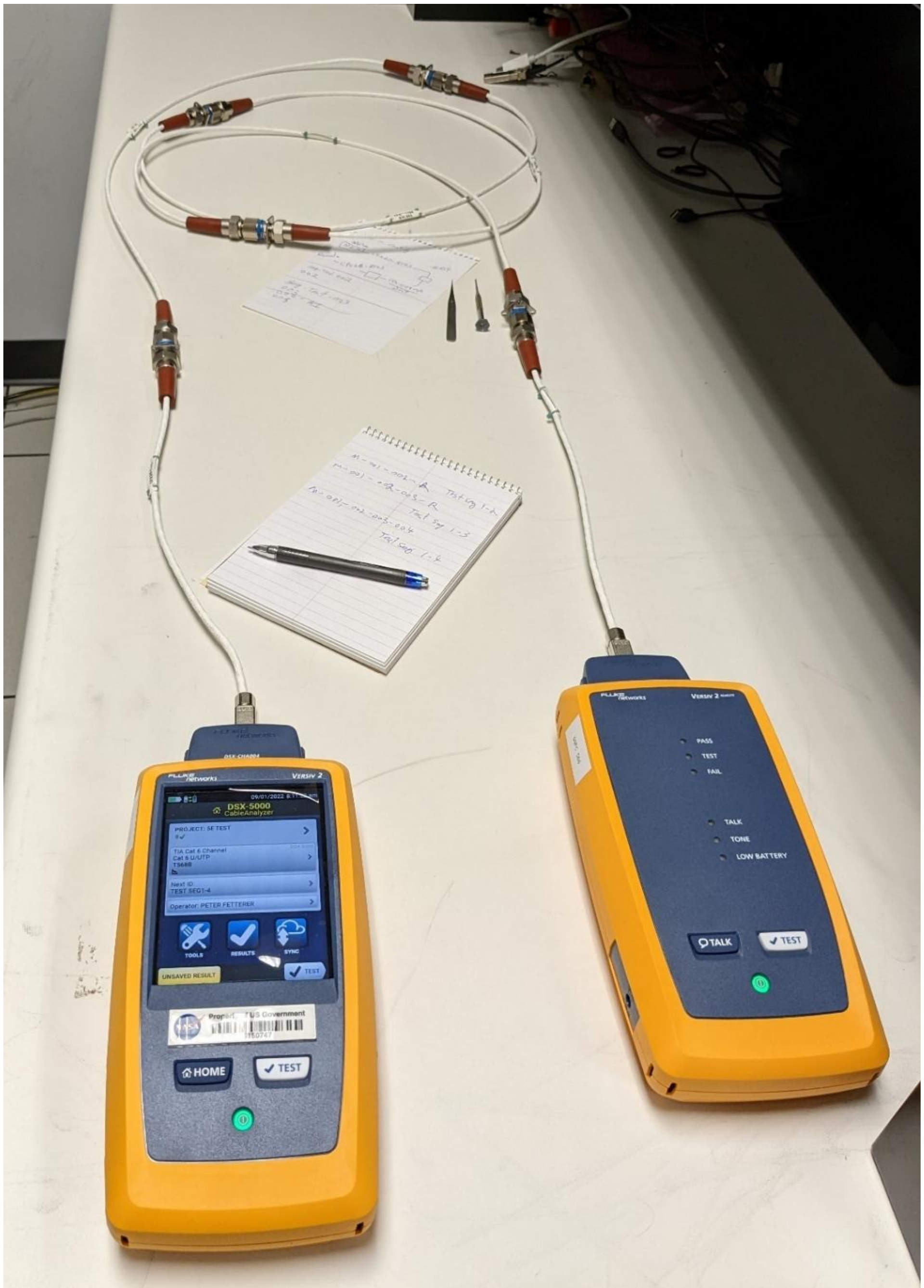
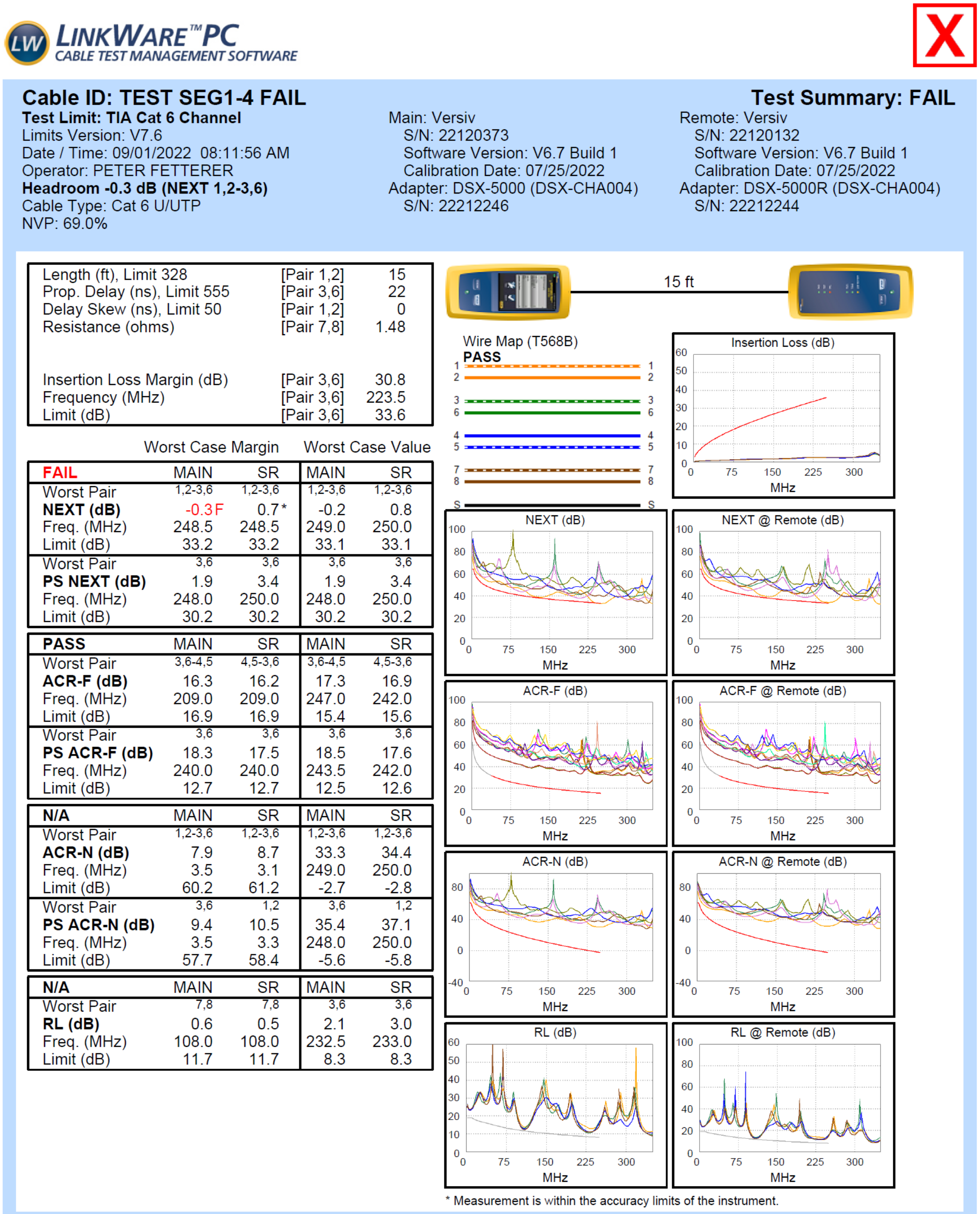


Figure B-13. Four Ethernet Cable Segments (1,2,3,4) with Five Connectors in Series with Adaptor Cables Connected to DSX-5000 Meter



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST SEG1-4 FAIL **Test Summary: FAIL**

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:11:56 AM
Operator: PETER FETTERER
Headroom -0.3 dB (NEXT 1,2-3,6)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 3,6]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	1.48
Insertion Loss Margin (dB)	[Pair 3,6]	30.8
Frequency (MHz)	[Pair 3,6]	223.5
Limit (dB)	[Pair 3,6]	33.6

	Worst Case Margin		Worst Case Value	
FAIL	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	-0.3 F	0.7 *	-0.2	0.8
Freq. (MHz)	248.5	248.5	249.0	250.0
Limit (dB)	33.2	33.2	33.1	33.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	1.9	3.4	1.9	3.4
Freq. (MHz)	248.0	250.0	248.0	250.0
Limit (dB)	30.2	30.2	30.2	30.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.3	16.2	17.3	16.9
Freq. (MHz)	209.0	209.0	247.0	242.0
Limit (dB)	16.9	16.9	15.4	15.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.3	17.5	18.5	17.6
Freq. (MHz)	240.0	240.0	243.5	242.0
Limit (dB)	12.7	12.7	12.5	12.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	7.9	8.7	33.3	34.4
Freq. (MHz)	3.5	3.1	249.0	250.0
Limit (dB)	60.2	61.2	-2.7	-2.8
Worst Pair	3,6	1,2	3,6	1,2
PS ACR-N (dB)	9.4	10.5	35.4	37.1
Freq. (MHz)	3.5	3.3	248.0	250.0
Limit (dB)	57.7	58.4	-5.6	-5.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	3,6	3,6
RL (dB)	0.6	0.5	2.1	3.0
Freq. (MHz)	108.0	108.0	232.5	233.0
Limit (dB)	11.7	11.7	8.3	8.3

* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-14. Four Segments (1,2,3,4) with Five Connectors in Series with Adaptor Cables Cable was properly connected and failed Cat6 NEXT test but passed the other Cat6 tests, including RL with minimal margin. Worst-case NEXT test limit was slightly below the requirement near the 250-MHz range. Worst-case RL for four segments was 0.5 dB above the limit. compared with 1.6 dB for three segments. Test failure and low margins are most likely due to impedance mismatches at connector terminations.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST SEG1-3_5 | **Test Summary: PASS**

Test Limit: TIA Cat 6 Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:16:27 AM
Operator: PETER FETTERER
Headroom 0.1 dB (NEXT 1,2-3,6)
Cable Type: Cat 6 U/UTP
NVP: 69.0%

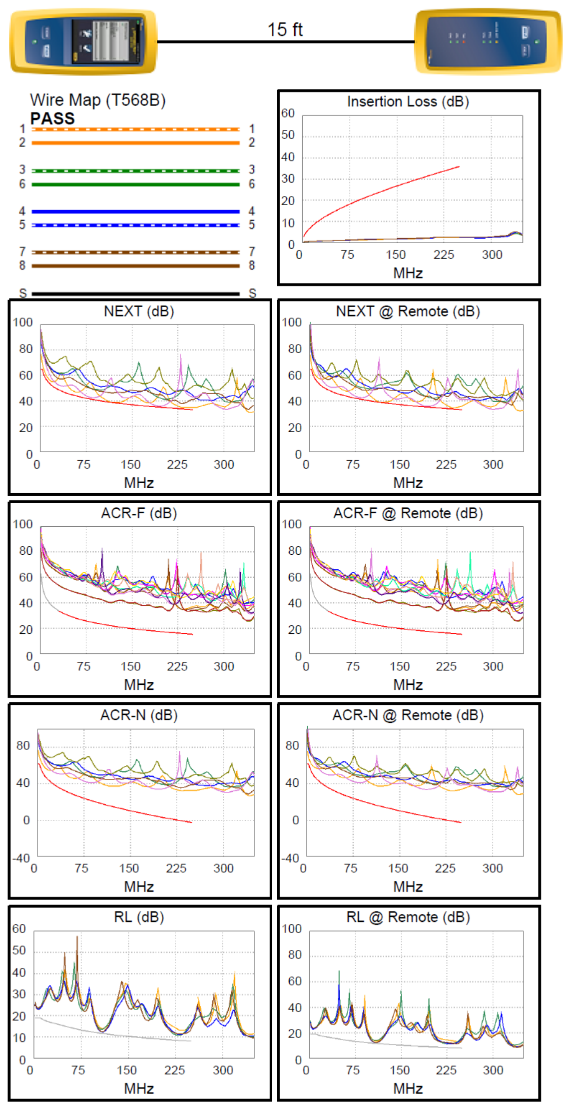
Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 3,6]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.49
Insertion Loss Margin (dB)	[Pair 3,6]	31.1
Frequency (MHz)	[Pair 3,6]	225.5
Limit (dB)	[Pair 3,6]	33.8

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	0.2*	0.1*	1.1	0.9
Freq. (MHz)	118.5	115.5	239.0	236.0
Limit (dB)	38.7	38.9	33.5	33.5
Worst Pair	3,6	4,5	3,6	1,2
PS NEXT (dB)	2.1	2.2	2.3	3.5
Freq. (MHz)	116.0	192.0	235.5	235.5
Limit (dB)	36.0	32.2	30.6	30.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	16.8	16.9	17.9	17.8
Freq. (MHz)	210.5	210.5	244.5	244.5
Limit (dB)	16.8	16.8	15.5	15.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.6	18.2	18.7	18.4
Freq. (MHz)	240.0	240.0	241.0	244.0
Limit (dB)	12.7	12.7	12.6	12.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	7.7	6.8	33.6	33.2
Freq. (MHz)	3.1	3.0	237.5	236.0
Limit (dB)	61.2	61.5	-1.4	-1.2
Worst Pair	1,2	1,2	3,6	3,6
PS ACR-N (dB)	9.6	8.7	34.1	35.8
Freq. (MHz)	3.3	3.3	232.0	236.0
Limit (dB)	58.4	58.4	-3.7	-4.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	3,6	7,8
RL (dB)	0.7	0.5	2.3	3.1
Freq. (MHz)	108.0	108.0	230.5	240.5
Limit (dB)	11.7	11.7	8.4	8.2

Compliant Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, ATM-25, ATM-51, ATM-155, 100VG-AnyLan, TR-4, TR-16 Active, TR-16 Passive



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-15. Four Segments (1,2,3,5) with Five Connectors in Series with Adaptor Cables Cable was properly connected and passed all Cat6 tests but with minimal NEXT and RL margins. Worst-case NEXT test limit was slightly below requirement at a number of frequencies below 250 MHz (see top left graph labeled NEXT). Worst-case RL was only 0.5 dB above requirement, as shown in table output and bottom left graph (RL). Results also show that variations between segments can result in Cat6 pass or fail conditions. Marginal performance is most likely due to impedance mismatches at each connector termination.

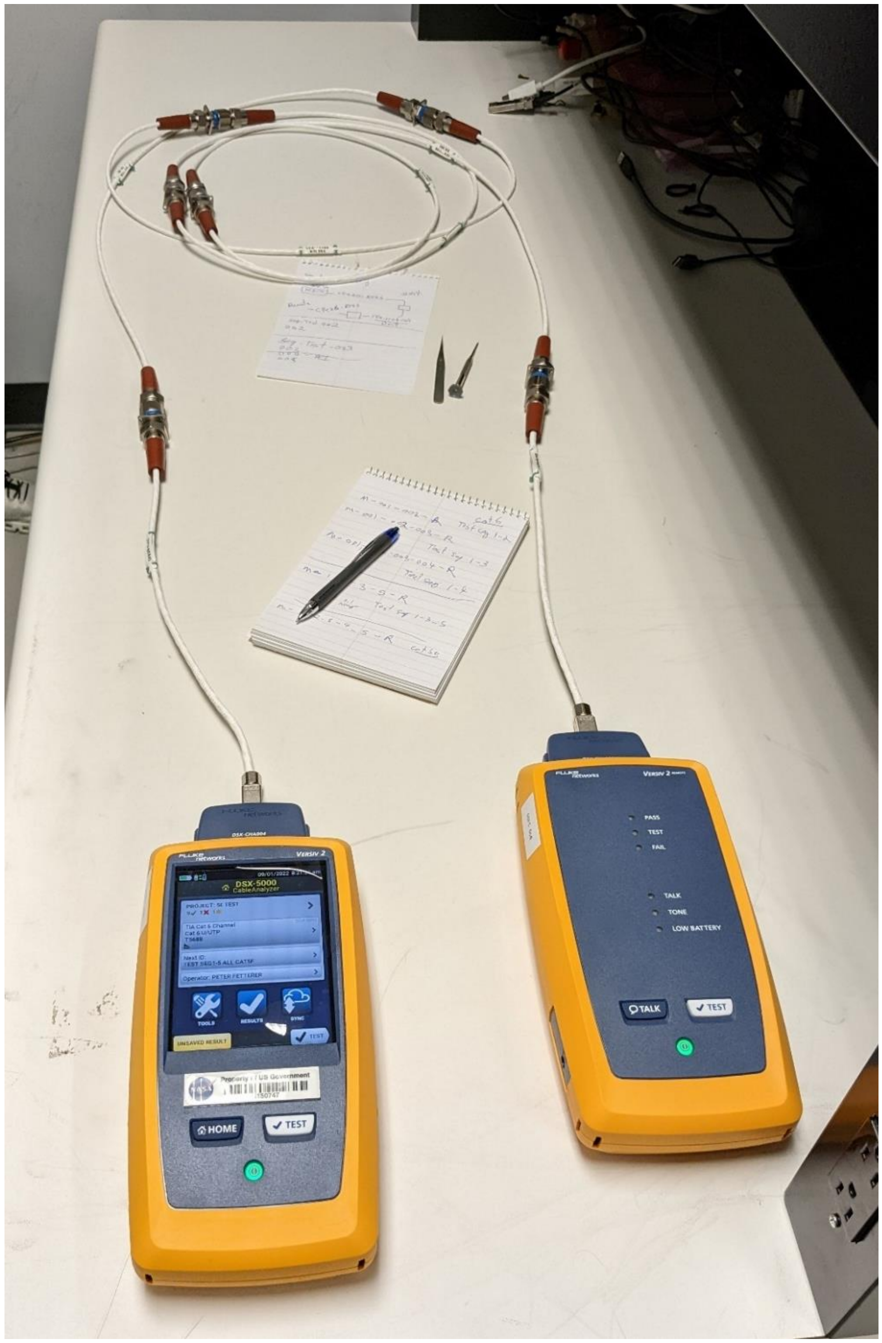


Figure B-16. Five Ethernet Cable Segments with Six Connectors in Series with Adaptor Cables Connected to DSX-5000 Meter

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: TEST SEG1-5 ALL CAT5E

Test Summary: PASS

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 09/01/2022 08:18:55 AM
Operator: PETER FETTERER
Headroom 9.5 dB (NEXT 4,5-7,8)
Cable Type: Cat 5e U/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

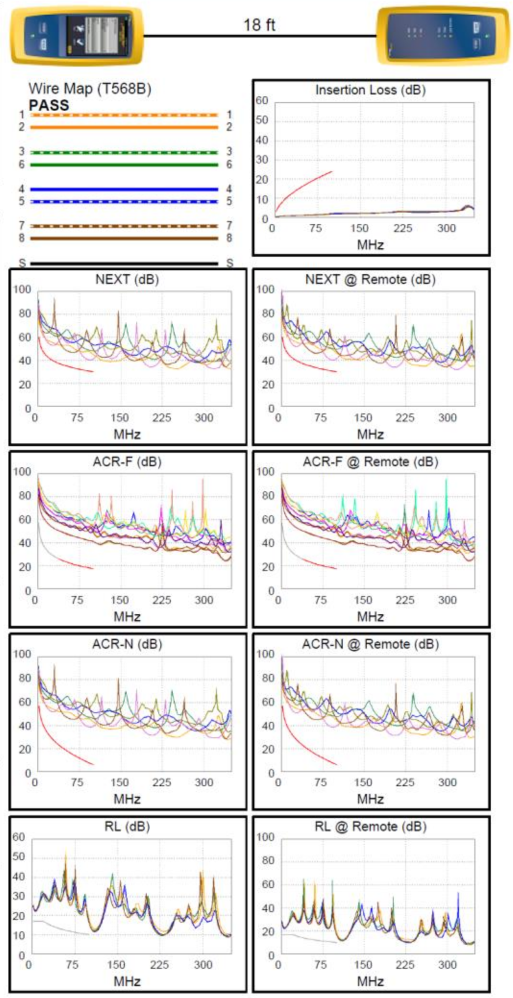
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	18
Prop. Delay (ns), Limit 555	[Pair 7,8]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.74
Insertion Loss Margin (dB)	[Pair 1,2]	22.3
Frequency (MHz)	[Pair 1,2]	100.0
Limit (dB)	[Pair 1,2]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	4,5-7,8	4,5-7,8	4,5-7,8
NEXT (dB)	9.8	9.5	10.0	9.7
Freq. (MHz)	93.8	92.5	95.8	94.0
Limit (dB)	30.6	30.7	30.4	30.5
Worst Pair	4,5	4,5	4,5	4,5
PS NEXT (dB)	12.1	12.0	12.3	12.2
Freq. (MHz)	93.8	93.8	97.5	96.3
Limit (dB)	27.6	27.6	27.3	27.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	23.4	23.4	23.7	23.7
Freq. (MHz)	4.0	4.0	100.0	100.0
Limit (dB)	45.4	45.4	17.4	17.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	25.2	25.0	25.9	25.7
Freq. (MHz)	2.9	1.6	100.0	100.0
Limit (dB)	45.2	50.2	14.4	14.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	4,5-7,8	4,5-7,8
ACR-N (dB)	17.5	17.1	31.8	31.6
Freq. (MHz)	1.9	1.8	95.8	95.0
Limit (dB)	55.8	56.4	7.0	7.1
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-N (dB)	19.0	18.4	34.4	34.2
Freq. (MHz)	1.9	2.3	97.5	96.3
Limit (dB)	52.8	51.3	3.6	3.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	4,5	3,6	4,5
RL (dB)	5.1	5.1	5.9	6.1
Freq. (MHz)	5.6	5.3	100.0	100.0
Limit (dB)	17.0	17.0	10.0	10.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive



LinkWare™ PC Version 11.1

Figure B-17. Five Segments (1,2,3,4,5) with Six Connectors in Series with Adaptor Cables Cable was properly connected and passed all Cat5 tests with good NEXT and RL margin.

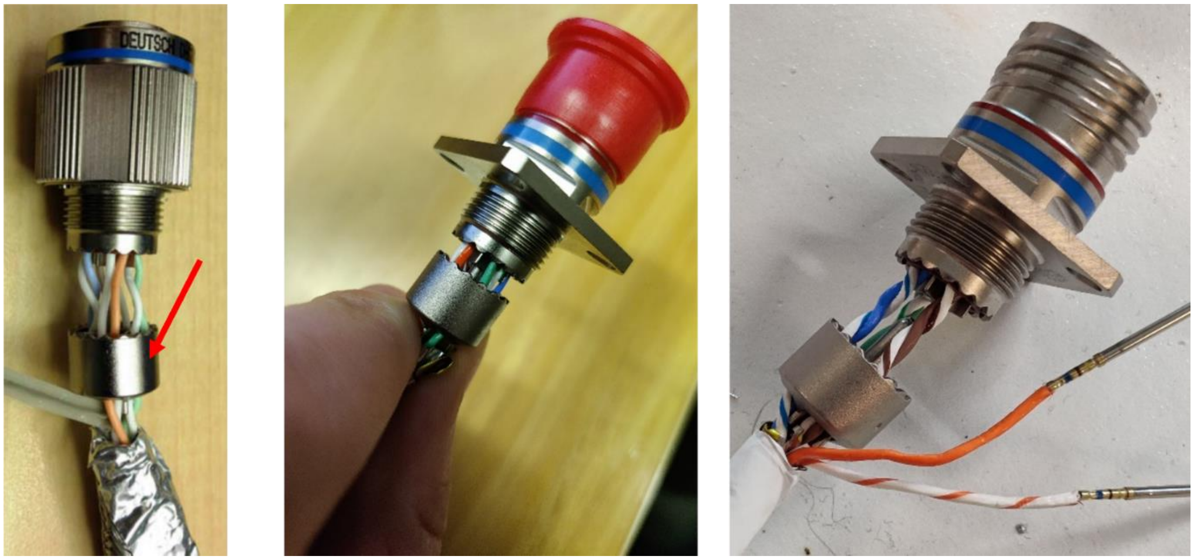


Figure B-18. Examples of Two Pair Twist Termination into CeeLok FAS-X Connector
Example on left is the recommended vendor approach, which leaves about 1 inch of untwist in the wire pairs after termination but less than 0.5 inch when the metal follower/pair separator (red arrow) is considered. Example in the center was the first attempt by the technician, which maintained the wire twist just past the metal follower/pair separator and about 0.75 inch from the connector edge. The example on right is the second attempt by the technician, maintaining the wire pair twist up to the connector edge and through the metal follower/pair separator with less than 0.125 inch of untwist.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Adapters

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 12:48:18 PM
Operator: PETER FETTERER
Headroom 21.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

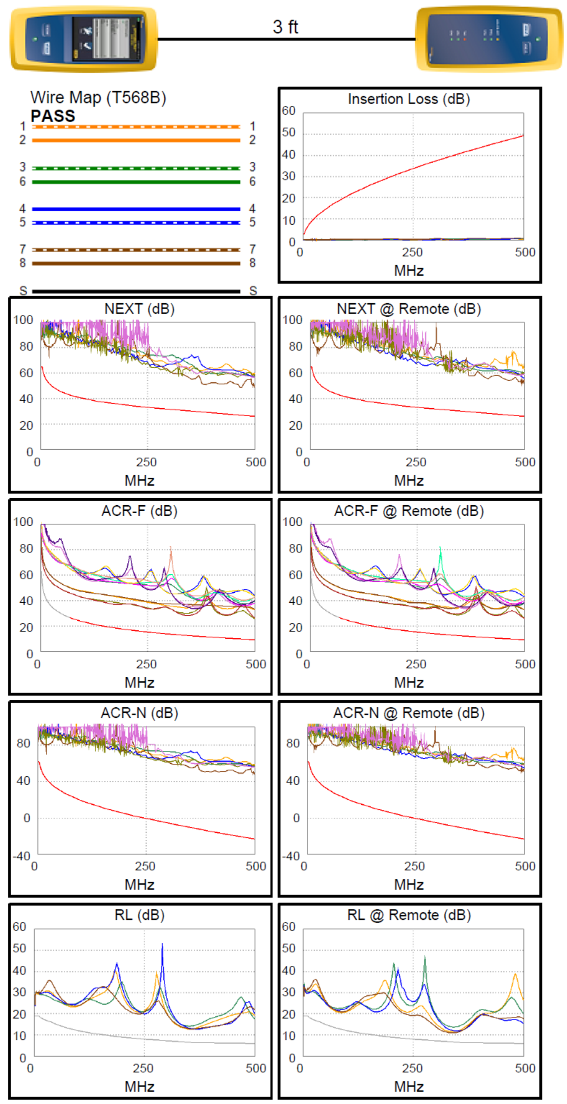
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	3
Prop. Delay (ns), Limit 555	[Pair 1,2]	4
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.62
Insertion Loss Margin (dB)	[Pair 7,8]	48.0
Frequency (MHz)	[Pair 7,8]	493.0
Limit (dB)	[Pair 7,8]	48.9

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	21.5	21.9	21.8	25.5
Freq. (MHz)	381.0	3.9	466.0	493.0
Limit (dB)	29.3	63.3	26.9	26.3
Worst Pair	3,6	3,6	4,5	4,5
PS NEXT (dB)	23.6	23.6	24.0	27.1
Freq. (MHz)	381.0	3.9	466.0	493.0
Limit (dB)	26.4	60.8	24.0	23.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	15.6	16.1	16.5	16.7
Freq. (MHz)	343.0	343.0	500.0	500.0
Limit (dB)	12.6	12.6	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	16.9	17.8	19.1	18.7
Freq. (MHz)	343.0	339.0	500.0	500.0
Limit (dB)	9.6	9.7	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	26.1	25.9	68.8	73.7
Freq. (MHz)	3.9	3.9	466.0	493.0
Limit (dB)	59.2	59.2	-20.5	-22.7
Worst Pair	3,6	4,5	4,5	4,5
PS ACR-N (dB)	27.8	27.1	73.3	75.2
Freq. (MHz)	3.9	1.4	499.0	493.0
Limit (dB)	56.7	59.0	-26.0	-25.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	4,5	7,8
RL (dB)	4.4	4.1	6.2	4.2
Freq. (MHz)	1.0	334.0	364.0	342.0
Limit (dB)	19.0	6.8	6.4	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-19. Reworked Adaptor Cable, which Passed Fluke Meter Cat6a Test Requirements Cable was properly connected and passed NEXT tests with very good margin (21.5 dB) and the RL with good margin (4.1 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension1

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 12:54:53 PM
Operator: PETER FETTERER
Headroom 6.7 dB (NEXT 4,5-7,8)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

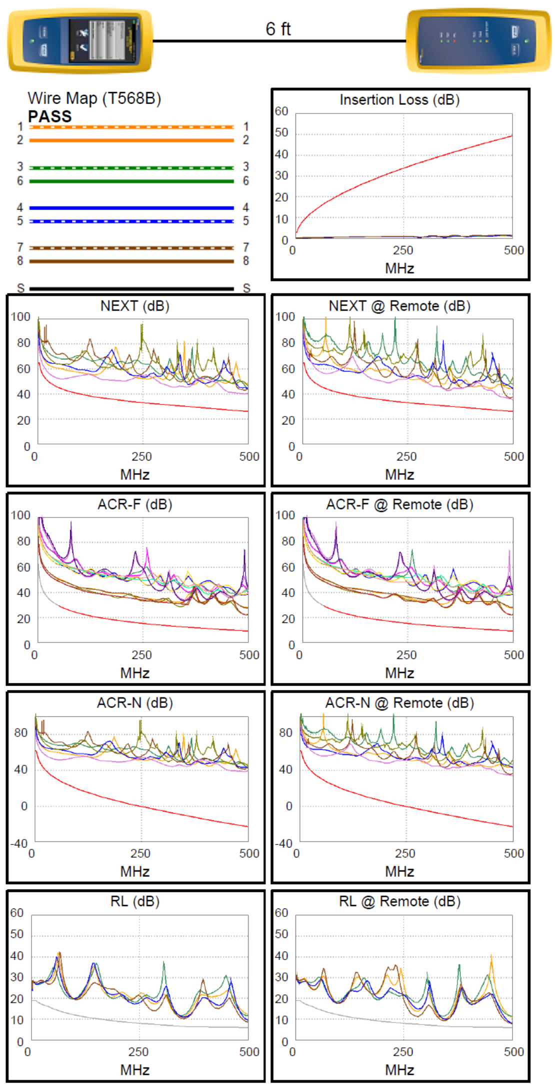
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	47.0
Frequency (MHz)	[Pair 7,8]	489.0
Limit (dB)	[Pair 7,8]	48.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	4,5-7,8	4,5-7,8	4,5-7,8
NEXT (dB)	6.7	9.2	13.7	9.2
Freq. (MHz)	34.5	500.0	489.0	500.0
Limit (dB)	47.7	26.1	26.4	26.1
Worst Pair	7,8	4,5	4,5	4,5
PS NEXT (dB)	8.7	9.9	14.5	10.0
Freq. (MHz)	31.0	499.0	495.0	500.0
Limit (dB)	45.8	23.3	23.3	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	12.7	12.6	12.8	12.6
Freq. (MHz)	495.0	494.0	497.0	494.0
Limit (dB)	9.4	9.4	9.3	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.7	14.7	14.8	14.8
Freq. (MHz)	495.0	495.0	497.0	497.0
Limit (dB)	6.4	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	1,2-7,8	4,5-7,8	4,5-7,8
ACR-N (dB)	13.4	18.4	60.7	57.1
Freq. (MHz)	3.6	3.0	489.0	500.0
Limit (dB)	59.8	61.4	-22.3	-23.2
Worst Pair	7,8	7,8	4,5	4,5
PS ACR-N (dB)	15.0	19.9	62.0	57.7
Freq. (MHz)	3.4	3.5	494.0	496.0
Limit (dB)	57.9	57.6	-25.6	-25.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	2.6	1.9	2.6	1.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-20. Reworked Segment 1 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (6.7 dB) and RL with a slight margin (1.9dB). Test was run as a Cat6a so cannot be directly compared with the earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:12:57 PM
Operator: PETER FETTERER
Headroom 9.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

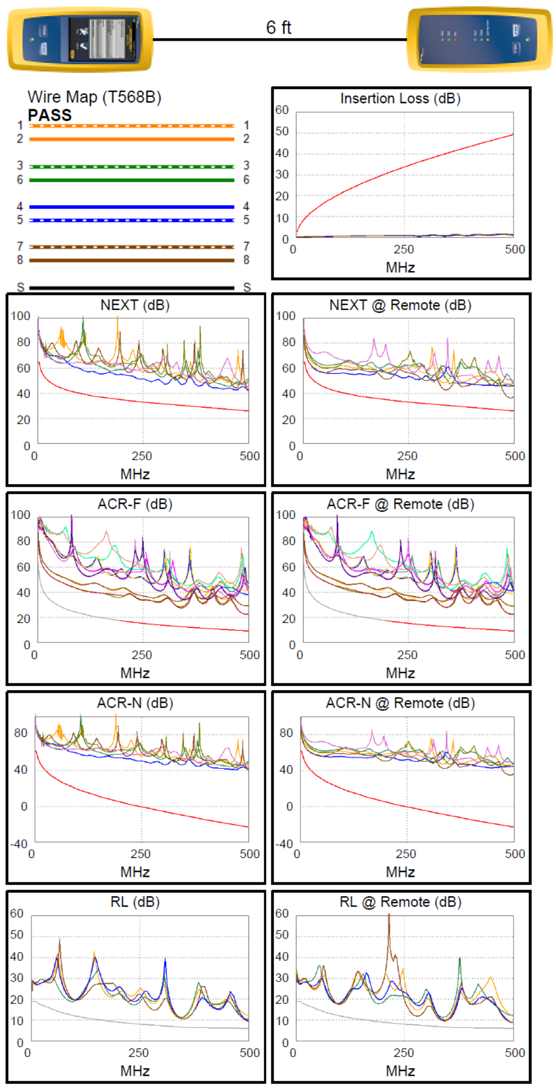
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	46.5
Frequency (MHz)	[Pair 7,8]	479.0
Limit (dB)	[Pair 7,8]	48.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	15.4	9.5	15.4	10.0
Freq. (MHz)	500.0	18.5	500.0	493.0
Limit (dB)	26.1	52.2	26.1	26.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	16.2	10.0	16.2	12.2
Freq. (MHz)	500.0	18.5	500.0	493.0
Limit (dB)	23.2	49.5	23.2	23.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	13.0	13.1	13.0	13.1
Freq. (MHz)	495.0	495.0	495.0	495.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.1	15.2	15.1	15.3
Freq. (MHz)	495.0	495.0	495.0	498.0
Limit (dB)	6.4	6.4	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	23.2	15.2	63.7	57.4
Freq. (MHz)	3.1	3.3	500.0	491.0
Limit (dB)	61.1	60.7	-23.2	-22.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	21.9	15.8	64.3	59.5
Freq. (MHz)	3.3	3.4	500.0	490.0
Limit (dB)	58.2	57.9	-26.1	-25.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	4,5
RL (dB)	3.4	2.7	3.4	2.9
Freq. (MHz)	500.0	341.0	500.0	500.0
Limit (dB)	6.0	6.7	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-21. Reworked Segment 2 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (9.5 dB) and RL with some margin(2.7 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension3 — **Test Summary: PASS**

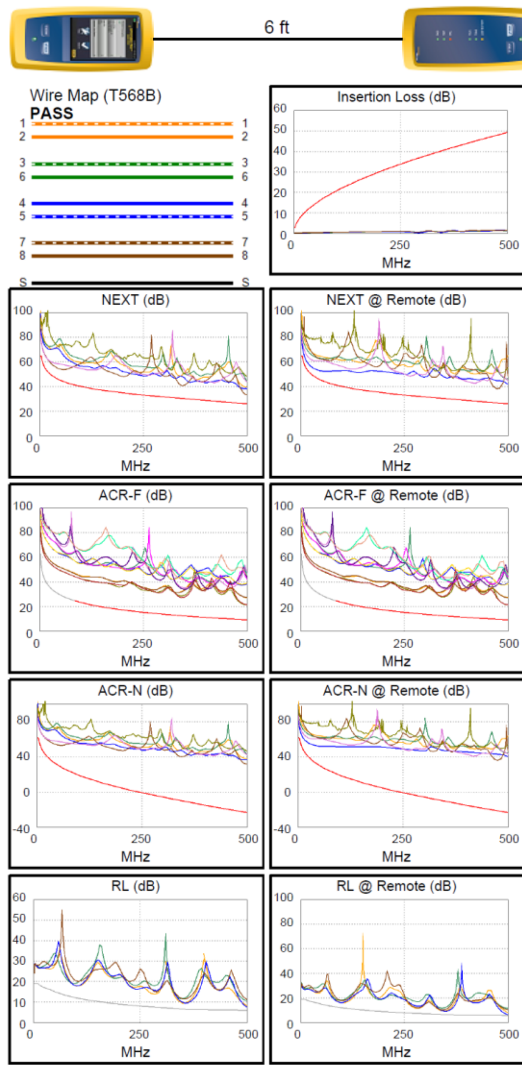
Test Limit: TIA Cat 6A Channel	Main: Versiv	Remote: Versiv
Limits Version: V7.6	S/N: 22120373	S/N: 22120132
Date / Time: 11/08/2022 01:15:51 PM	Software Version: V6.7 Build 1	Software Version: V6.7 Build 1
Operator: PETER FETTERER	Calibration Date: 07/25/2022	Calibration Date: 07/25/2022
Headroom 6.0 dB (NEXT 1,2-7,8)	Adapter: DSX-5000 (DSX-CHA004)	Adapter: DSX-5000R (DSX-CHA004)
Cable Type: Cat 6A F/UTP	S/N: 22212246	S/N: 22212244
NVP: 74.0%		

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.69
Insertion Loss Margin (dB)	[Pair 4,5]	47.1
Frequency (MHz)	[Pair 4,5]	490.0
Limit (dB)	[Pair 4,5]	48.8

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	7.2	6.0	7.2	11.1
Freq. (MHz)	500.0	24.9	500.0	475.0
Limit (dB)	26.1	50.1	26.1	26.7
Worst Pair	3,6	7,8	3,6	3,6
PS NEXT (dB)	9.1	7.6	9.1	13.7
Freq. (MHz)	500.0	23.6	500.0	475.0
Limit (dB)	23.2	47.8	23.2	23.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	12.2	12.3	12.2	12.3
Freq. (MHz)	498.0	498.0	498.0	498.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.3	14.3	14.3	14.3
Freq. (MHz)	499.0	499.0	499.0	499.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	1,2-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	15.3	11.8	55.2	57.4
Freq. (MHz)	4.1	3.1	500.0	475.0
Limit (dB)	58.6	61.1	-23.2	-21.2
Worst Pair	4,5	7,8	3,6	4,5
PS ACR-N (dB)	14.8	12.9	57.2	60.3
Freq. (MHz)	3.4	3.3	500.0	477.0
Limit (dB)	57.9	58.2	-26.1	-24.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	1.5	0.5	1.5	0.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-22. Reworked Segment 3 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements

Cable was properly connected and passed NEXT test with good margin (6.0 dB) and the RL with a slight margin (0.5 dB). Cable segment had less RL margin than other segments. Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:18:12 PM
Operator: PETER FETTERER
Headroom 5.5 dB (NEXT 1,2-7,8)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

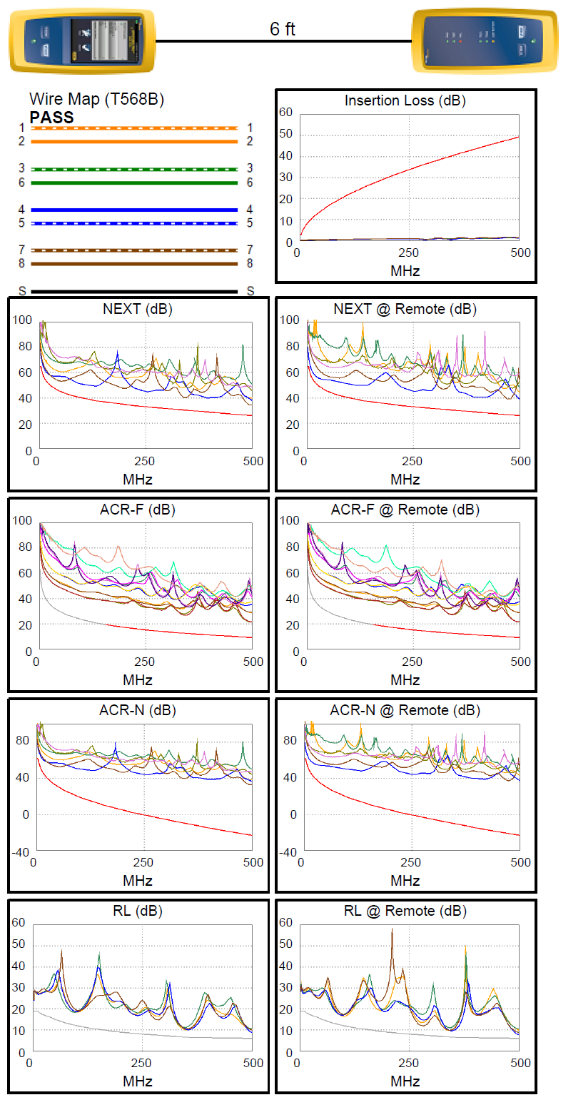
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 4,5]	46.7
Frequency (MHz)	[Pair 4,5]	483.0
Limit (dB)	[Pair 4,5]	48.4

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-7,8	1,2-7,8	3,6-4,5	1,2-7,8
NEXT (dB)	7.0	5.5	8.2	12.7
Freq. (MHz)	14.0	16.6	496.0	500.0
Limit (dB)	54.2	53.0	26.2	26.1
Worst Pair	1,2	7,8	3,6	1,2
PS NEXT (dB)	8.8	7.9	9.8	14.2
Freq. (MHz)	13.3	12.5	496.0	500.0
Limit (dB)	52.0	52.4	23.3	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	12.4	12.4	12.4	12.5
Freq. (MHz)	495.0	495.0	499.0	499.0
Limit (dB)	9.4	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.6	14.7	14.6	14.7
Freq. (MHz)	499.0	500.0	499.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-7,8	1,2-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	11.7	10.8	56.0	58.4
Freq. (MHz)	3.5	3.8	496.0	473.0
Limit (dB)	60.1	59.5	-22.9	-21.1
Worst Pair	1,2	7,8	3,6	1,2
PS ACR-N (dB)	13.5	12.9	57.6	62.4
Freq. (MHz)	3.5	3.8	496.0	500.0
Limit (dB)	57.6	57.0	-25.8	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	2.8	1.8	2.8	1.8
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-23. Reworked Segment 4 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT test with some margin (5.8 dB) and the RL with a slight margin (1.8 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension5

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:20:24 PM
Operator: PETER FETTERER
Headroom 6.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

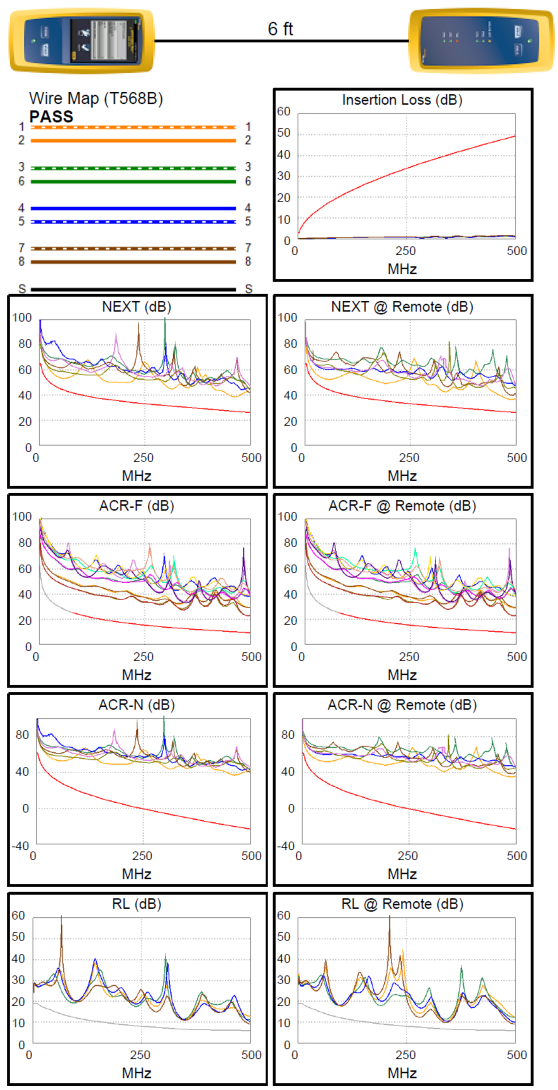
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	46.9
Frequency (MHz)	[Pair 7,8]	487.0
Limit (dB)	[Pair 7,8]	48.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	8.4	6.9	11.6	10.2
Freq. (MHz)	44.5	34.3	466.0	492.0
Limit (dB)	45.9	47.8	26.9	26.3
Worst Pair	3,6	1,2	1,2	3,6
PS NEXT (dB)	9.2	8.7	13.9	11.1
Freq. (MHz)	38.0	32.8	466.0	492.0
Limit (dB)	44.3	45.4	24.0	23.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	13.3	13.3	13.4	13.3
Freq. (MHz)	495.0	494.0	497.0	494.0
Limit (dB)	9.4	9.4	9.3	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.5	15.4	15.5	15.5
Freq. (MHz)	497.0	495.0	497.0	497.0
Limit (dB)	6.3	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	17.8	13.2	57.6	57.4
Freq. (MHz)	5.0	3.1	466.0	488.0
Limit (dB)	56.9	61.1	-20.5	-22.3
Worst Pair	3,6	1,2	1,2	3,6
PS ACR-N (dB)	16.4	14.6	59.9	58.2
Freq. (MHz)	5.0	3.4	466.0	488.0
Limit (dB)	54.3	57.9	-23.4	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	3.1	3.0	3.1	3.2
Freq. (MHz)	500.0	342.0	500.0	500.0
Limit (dB)	6.0	6.7	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-24. Reworked Segment 5 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (6.9 dB) and the RL with some margin (3.0 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension1,2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 12:57:57 PM
Operator: PETER FETTERER
Headroom 6.3 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	10
Prop. Delay (ns), Limit 555	[Pair 7,8]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.98
Insertion Loss Margin (dB)	[Pair 7,8]	45.2
Frequency (MHz)	[Pair 7,8]	471.0
Limit (dB)	[Pair 7,8]	47.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	3,6-4,5	4,5-7,8	3,6-4,5
NEXT (dB)	11.5	6.3	12.2	7.9
Freq. (MHz)	336.0	339.0	497.0	479.0
Limit (dB)	30.8	30.7	26.2	26.6
Worst Pair	4,5	3,6	7,8	4,5
PS NEXT (dB)	12.7	8.2	13.2	9.2
Freq. (MHz)	339.0	337.0	497.0	481.0
Limit (dB)	27.7	27.8	23.3	23.7

PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	13.2	13.1	13.3	13.1
Freq. (MHz)	479.0	478.0	480.0	478.0
Limit (dB)	9.7	9.7	9.6	9.7
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.1	15.2	15.1	15.2
Freq. (MHz)	478.0	482.0	478.0	482.0
Limit (dB)	6.7	6.6	6.7	6.6

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	4,5-7,8	3,6-4,5
ACR-N (dB)	22.1	20.0	59.4	53.8
Freq. (MHz)	4.0	3.3	497.0	478.0
Limit (dB)	58.9	60.7	-23.0	-21.5
Worst Pair	3,6	4,5	7,8	4,5
PS ACR-N (dB)	20.9	21.8	60.3	55.3
Freq. (MHz)	3.3	4.9	497.0	480.0
Limit (dB)	58.2	54.6	-25.8	-24.5

N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	2.5	1.5	2.5	1.6
Freq. (MHz)	346.0	342.0	346.0	343.0
Limit (dB)	6.6	6.7	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

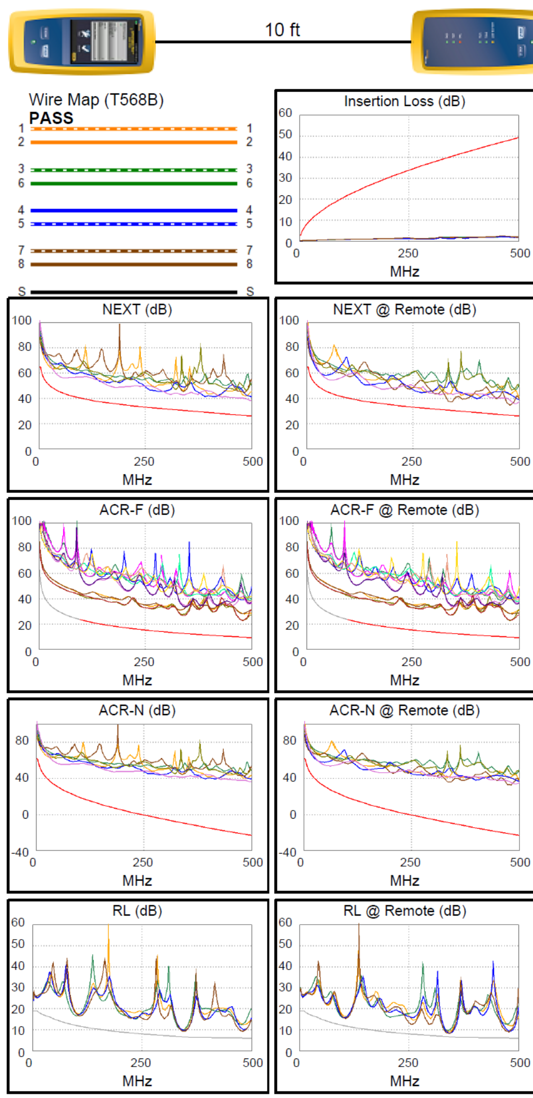


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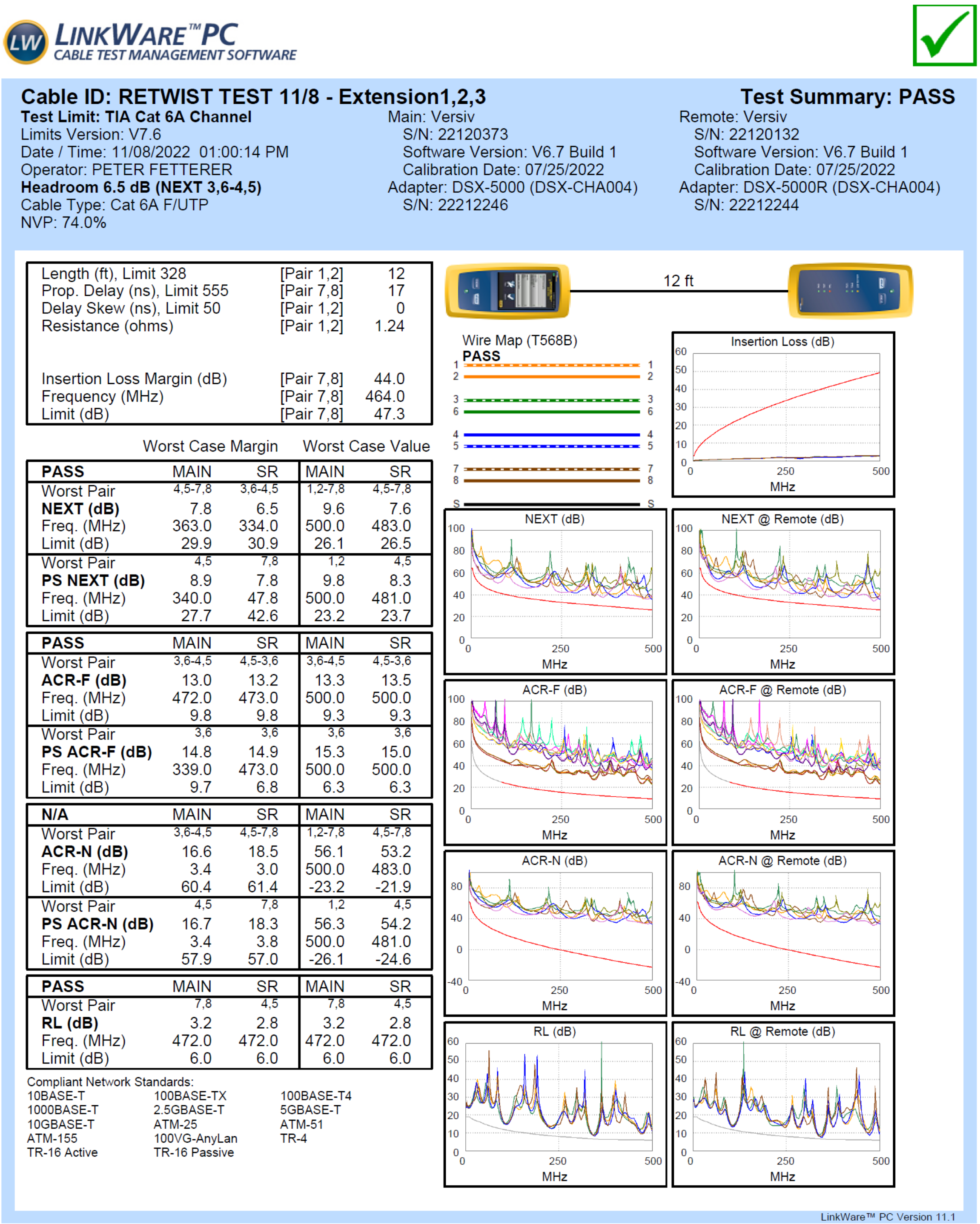
Figure B-25. Reworked Segments 1 and 2 Cable with Three CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (6.5 dB) and the RL with some margin (1.5 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.



LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension1,2,3 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:00:14 PM
Operator: PETER FETTERER
Headroom 6.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	12
Prop. Delay (ns), Limit 555	[Pair 7,8]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.24
Insertion Loss Margin (dB)	[Pair 7,8]	44.0
Frequency (MHz)	[Pair 7,8]	464.0
Limit (dB)	[Pair 7,8]	47.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	3,6-4,5	1,2-7,8	4,5-7,8
NEXT (dB)	7.8	6.5	9.6	7.6
Freq. (MHz)	363.0	334.0	500.0	483.0
Limit (dB)	29.9	30.9	26.1	26.5
Worst Pair	4,5	7,8	1,2	4,5
PS NEXT (dB)	8.9	7.8	9.8	8.3
Freq. (MHz)	340.0	47.8	500.0	481.0
Limit (dB)	27.7	42.6	23.2	23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	13.0	13.2	13.3	13.5
Freq. (MHz)	472.0	473.0	500.0	500.0
Limit (dB)	9.8	9.8	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.8	14.9	15.3	15.0
Freq. (MHz)	339.0	473.0	500.0	500.0
Limit (dB)	9.7	6.8	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-7,8	1,2-7,8	4,5-7,8
ACR-N (dB)	16.6	18.5	56.1	53.2
Freq. (MHz)	3.4	3.0	500.0	483.0
Limit (dB)	60.4	61.4	-23.2	-21.9
Worst Pair	4,5	7,8	1,2	4,5
PS ACR-N (dB)	16.7	18.3	56.3	54.2
Freq. (MHz)	3.4	3.8	500.0	481.0
Limit (dB)	57.9	57.0	-26.1	-24.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	7,8	4,5
RL (dB)	3.2	2.8	3.2	2.8
Freq. (MHz)	472.0	472.0	472.0	472.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, 10GBASE-T, ATM-25, ATM-51, ATM-155, 100VG-AnyLan, TR-4, TR-16 Active, TR-16 Passive

Figure B-26. Reworked Segments 1, 2, and 3 Cable with Four CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (6.5 dB)) and the RL with some margin (2.8 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

X

Cable ID: RETWIST TEST 11/8 - Extension1,2,3,4

Test Summary: FAIL

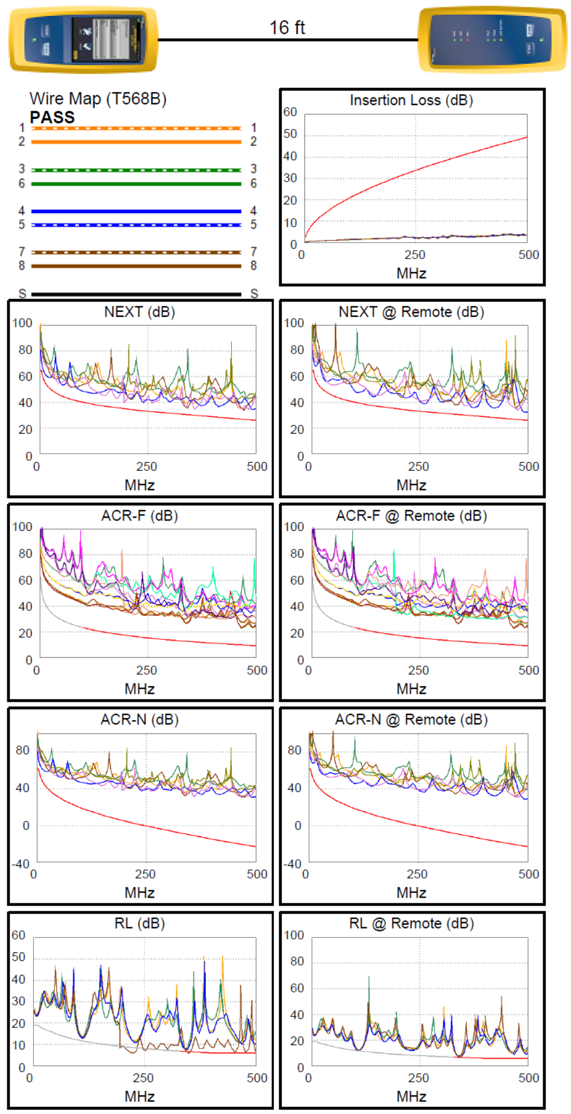
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:36:43 PM
Operator: PETER FETTERER
Headroom 4.6 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	16
Prop. Delay (ns), Limit 555	[Pair 3,6]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	Open
Insertion Loss Margin (dB)	[Pair 1,2]	43.3
Frequency (MHz)	[Pair 1,2]	465.0
Limit (dB)	[Pair 1,2]	47.4

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-7,8	3,6-4,5	1,2-7,8
NEXT (dB)	4.6	5.7	7.1	6.1
Freq. (MHz)	339.0	261.0	473.0	497.0
Limit (dB)	30.7	32.8	26.8	26.2
Worst Pair	4,5	7,8	3,6	4,5
PS NEXT (dB)	5.1	6.7	7.2	7.7
Freq. (MHz)	339.0	261.0	472.0	476.0
Limit (dB)	27.7	29.8	23.9	23.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.5	12.7	12.5	12.7
Freq. (MHz)	468.0	468.0	468.0	468.0
Limit (dB)	9.9	9.9	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.4	14.5	14.7	14.6
Freq. (MHz)	339.0	468.0	469.0	470.0
Limit (dB)	9.7	6.9	6.8	6.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-7,8	1,2-7,8	3,6-4,5	1,2-7,8
ACR-N (dB)	10.6	12.0	51.4	51.2
Freq. (MHz)	3.5	3.0	472.0	494.0
Limit (dB)	60.1	61.4	-21.0	-22.7
Worst Pair	7,8	7,8	3,6	7,8
PS ACR-N (dB)	12.4	13.1	51.2	53.4
Freq. (MHz)	3.5	3.3	470.0	492.0
Limit (dB)	57.6	58.2	-23.7	-25.5
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	7,8	4,5
RL (dB)	-2.5 F	0.1*	-0.1	0.1
Freq. (MHz)	226.0	340.0	480.0	340.0
Limit (dB)	8.5	6.7	6.0	6.7



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-27. Reworked Segments 1, 2, 3 and 4 Cable with Five CeeLok FAS-X Connectors in Series with Adaptor Cables Failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin (4.6 dB) but failed the RL test (2.5 dB below requirement). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension1,2,3,5

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:23:59 PM
Operator: PETER FETTERER
Headroom 5.2 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

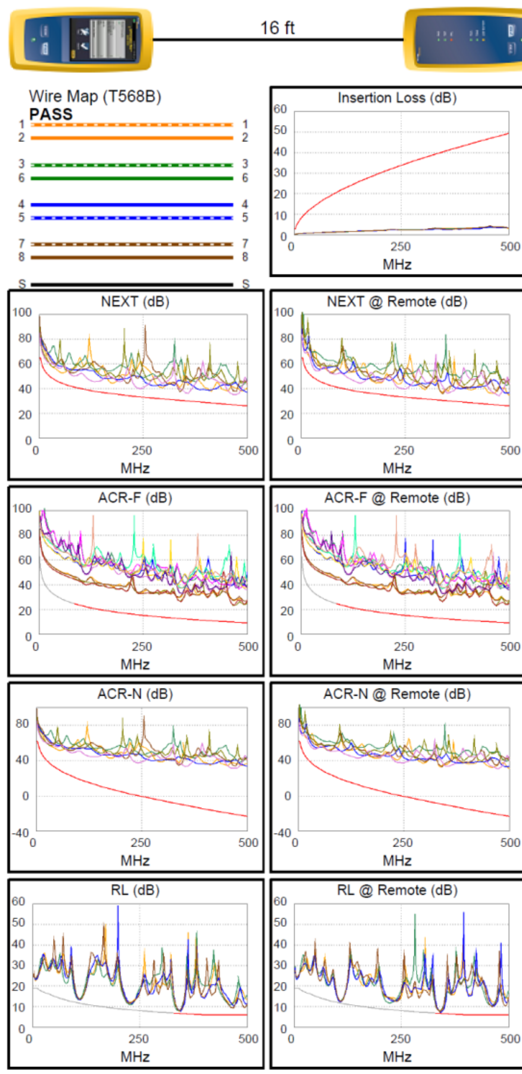
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	16
Prop. Delay (ns), Limit 555	[Pair 7,8]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.49
Insertion Loss Margin (dB)	[Pair 7,8]	42.9
Frequency (MHz)	[Pair 7,8]	460.0
Limit (dB)	[Pair 7,8]	47.1

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	3,6-4,5	4,5-7,8	4,5-7,8
NEXT (dB)	5.8	5.2	8.5	7.4
Freq. (MHz)	356.0	339.0	476.0	475.0
Limit (dB)	30.1	30.7	26.7	26.7
Worst Pair	3,6	3,6	4,5	1,2
PS NEXT (dB)	7.5	5.3	8.9	9.1
Freq. (MHz)	340.0	339.0	473.0	500.0
Limit (dB)	27.7	27.7	23.9	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	13.0	13.0	13.0	13.1
Freq. (MHz)	469.0	468.0	469.0	470.0
Limit (dB)	9.8	9.9	9.8	9.8
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.3	14.4	14.9	14.8
Freq. (MHz)	339.0	338.0	468.0	469.0
Limit (dB)	9.7	9.7	6.9	6.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	4,5-7,8	4,5-7,8	4,5-7,8
ACR-N (dB)	15.2	13.7	52.0	51.8
Freq. (MHz)	4.3	3.5	466.0	475.0
Limit (dB)	58.3	60.1	-20.5	-21.2
Worst Pair	7,8	7,8	4,5	1,2
PS ACR-N (dB)	15.4	14.3	52.9	55.2
Freq. (MHz)	4.6	3.6	469.0	500.0
Limit (dB)	55.1	57.3	-23.6	-26.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	0.9	0.6*	1.0	0.6
Freq. (MHz)	342.0	342.0	343.0	342.0
Limit (dB)	6.7	6.7	6.6	6.7

Compliant Network Standards:

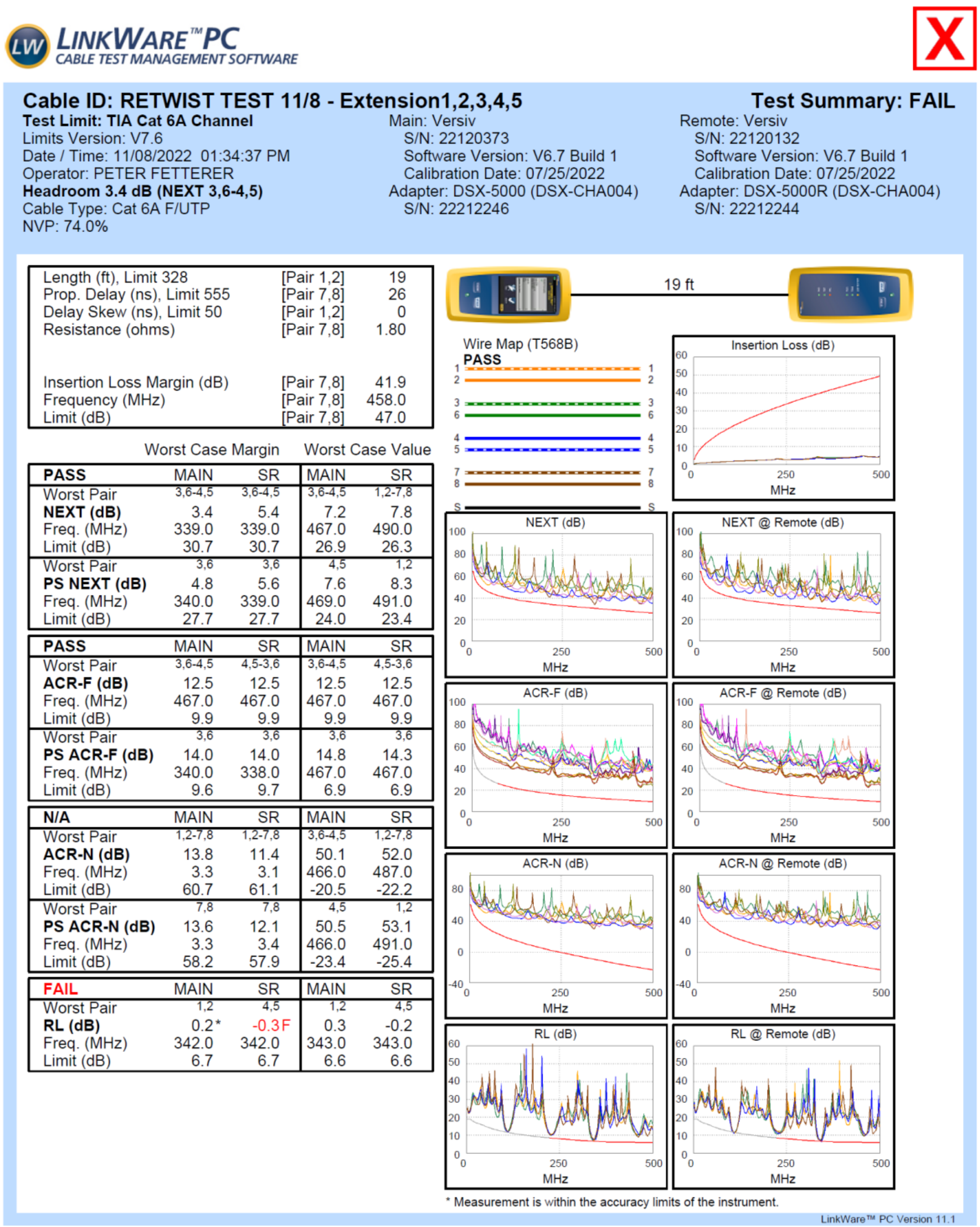
10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-28. Reworked Segments 1, 2, 3 and 5 Cable with Five CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin (5.2 dB) and passed RL with a slight margin (0.6 dB). The asterisk indicates the measurement was with the instrument error range. Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension1,2,3,4,5 — **Test Summary: FAIL**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:34:37 PM
Operator: PETER FETTERER
Headroom 3.4 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

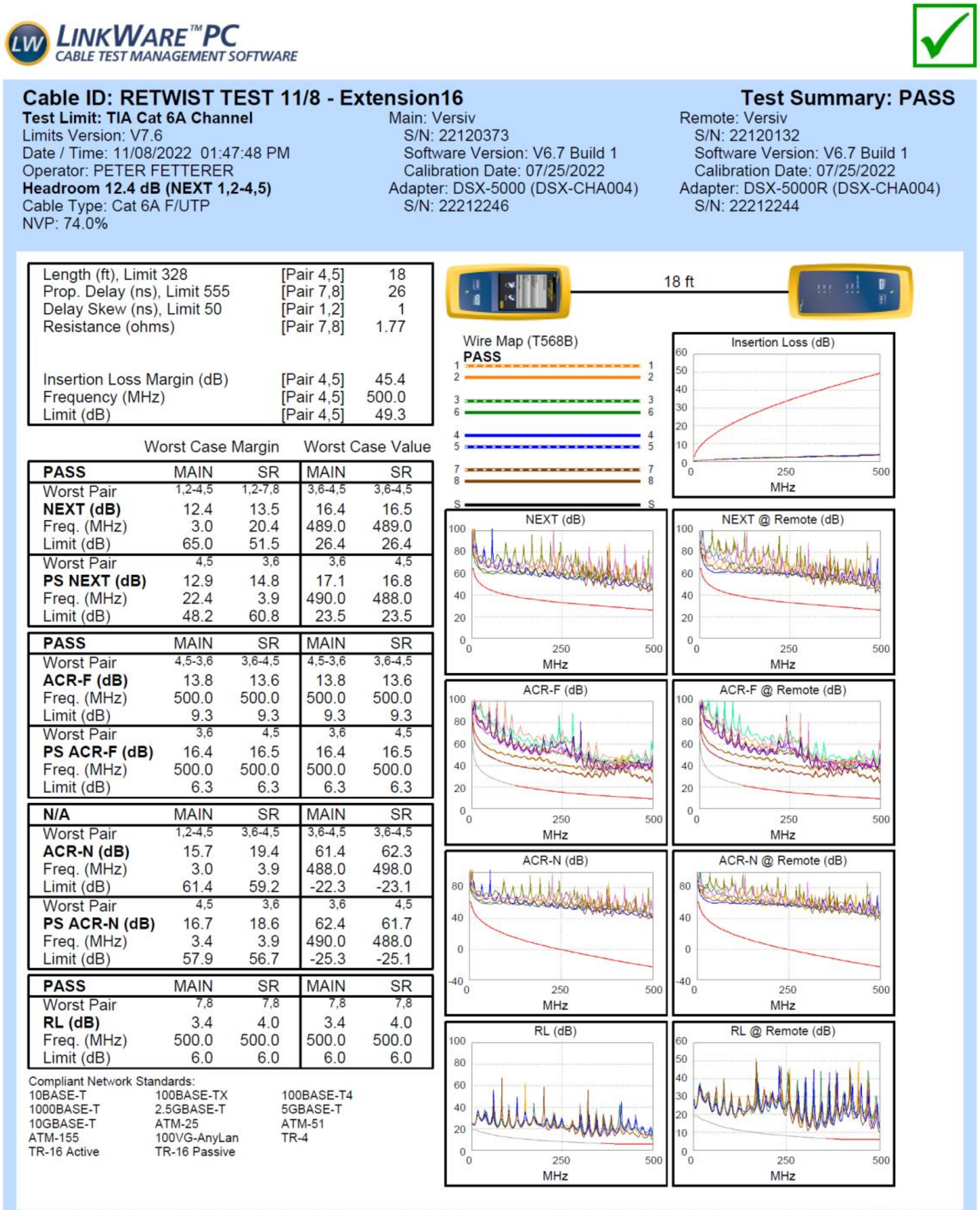
Length (ft), Limit 328	[Pair 1,2]	19
Prop. Delay (ns), Limit 555	[Pair 7,8]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	1.80
Insertion Loss Margin (dB)	[Pair 7,8]	41.9
Frequency (MHz)	[Pair 7,8]	458.0
Limit (dB)	[Pair 7,8]	47.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	1,2-7,8
NEXT (dB)	3.4	5.4	7.2	7.8
Freq. (MHz)	339.0	339.0	467.0	490.0
Limit (dB)	30.7	30.7	26.9	26.3
Worst Pair	3,6	3,6	4,5	1,2
PS NEXT (dB)	4.8	5.6	7.6	8.3
Freq. (MHz)	340.0	339.0	469.0	491.0
Limit (dB)	27.7	27.7	24.0	23.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.5	12.5	12.5	12.5
Freq. (MHz)	467.0	467.0	467.0	467.0
Limit (dB)	9.9	9.9	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.0	14.0	14.8	14.3
Freq. (MHz)	340.0	338.0	467.0	467.0
Limit (dB)	9.6	9.7	6.9	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-7,8	1,2-7,8	3,6-4,5	1,2-7,8
ACR-N (dB)	13.8	11.4	50.1	52.0
Freq. (MHz)	3.3	3.1	466.0	487.0
Limit (dB)	60.7	61.1	-20.5	-22.2
Worst Pair	7,8	7,8	4,5	1,2
PS ACR-N (dB)	13.6	12.1	50.5	53.1
Freq. (MHz)	3.3	3.4	466.0	491.0
Limit (dB)	58.2	57.9	-23.4	-25.4
FAIL	MAIN	SR	MAIN	SR
Worst Pair	1,2	4,5	1,2	4,5
RL (dB)	0.2*	-0.3F	0.3	-0.2
Freq. (MHz)	342.0	342.0	343.0	343.0
Limit (dB)	6.7	6.7	6.6	6.6

* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-29. Reworked Segments 1, 2, 3, 4 and 5 Cable with Six CeeLok FAS-X Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin and failed the RL test (0.3 dB below requirement). The asterisk indicates measurement was within the instrument error range. Test was run as a Cat6a so it cannot be directly compared with earlier results run using Cat6 requirements.



LINKWARE™ PC CABLE TEST MANAGEMENT SOFTWARE

Cable ID: RETWIST TEST 11/8 - Extension16 | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 11/08/2022 01:47:48 PM
Operator: PETER FETTERER
Headroom 12.4 dB (NEXT 1,2-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

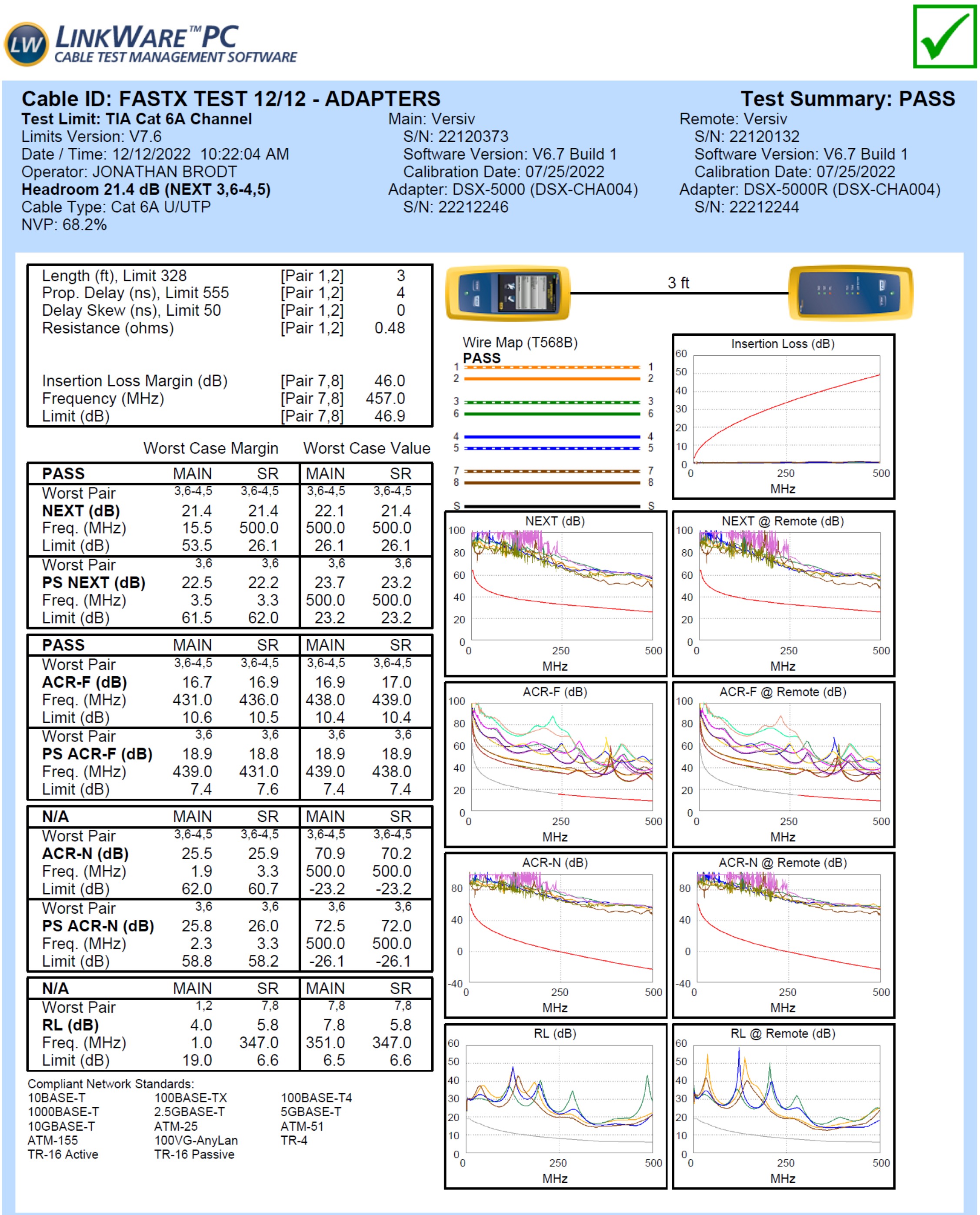
Length (ft), Limit 328	[Pair 4,5]	18
Prop. Delay (ns), Limit 555	[Pair 7,8]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 7,8]	1.77
Insertion Loss Margin (dB)	[Pair 4,5]	45.4
Frequency (MHz)	[Pair 4,5]	500.0
Limit (dB)	[Pair 4,5]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-7,8	3,6-4,5	3,6-4,5
NEXT (dB)	12.4	13.5	16.4	16.5
Freq. (MHz)	3.0	20.4	489.0	489.0
Limit (dB)	65.0	51.5	26.4	26.4
Worst Pair	4,5	3,6	3,6	4,5
PS NEXT (dB)	12.9	14.8	17.1	16.8
Freq. (MHz)	22.4	3.9	490.0	488.0
Limit (dB)	48.2	60.8	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	13.8	13.6	13.8	13.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	4,5	3,6	4,5
PS ACR-F (dB)	16.4	16.5	16.4	16.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	15.7	19.4	61.4	62.3
Freq. (MHz)	3.0	3.9	488.0	498.0
Limit (dB)	61.4	59.2	-22.3	-23.1
Worst Pair	4,5	3,6	3,6	4,5
PS ACR-N (dB)	16.7	18.6	62.4	61.7
Freq. (MHz)	3.4	3.9	490.0	488.0
Limit (dB)	57.9	56.7	-25.3	-25.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	3.4	4.0	3.4	4.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-30. Reworked 16-ft Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (12.4 dB) and the RL with good margin (3.4 dB). Test was run as a Cat6a so cannot be directly compared with earlier results run using Cat6 requirements.



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/12 - ADAPTERS | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/12/2022 10:22:04 AM
Operator: JONATHAN BRODT
Headroom 21.4 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	3
Prop. Delay (ns), Limit 555	[Pair 1,2]	4
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 7,8]	46.0
Frequency (MHz)	[Pair 7,8]	457.0
Limit (dB)	[Pair 7,8]	46.9

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	21.4	21.4	22.1	21.4
Freq. (MHz)	15.5	500.0	500.0	500.0
Limit (dB)	53.5	26.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	22.5	22.2	23.7	23.2
Freq. (MHz)	3.5	3.3	500.0	500.0
Limit (dB)	61.5	62.0	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	16.7	16.9	16.9	17.0
Freq. (MHz)	431.0	436.0	438.0	439.0
Limit (dB)	10.6	10.5	10.4	10.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.9	18.8	18.9	18.9
Freq. (MHz)	439.0	431.0	439.0	438.0
Limit (dB)	7.4	7.6	7.4	7.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	25.5	25.9	70.9	70.2
Freq. (MHz)	1.9	3.3	500.0	500.0
Limit (dB)	62.0	60.7	-23.2	-23.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	25.8	26.0	72.5	72.0
Freq. (MHz)	2.3	3.3	500.0	500.0
Limit (dB)	58.8	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.0	5.8	7.8	5.8
Freq. (MHz)	1.0	347.0	351.0	347.0
Limit (dB)	19.0	6.6	6.5	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

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Figure B-31. Rework #2 of Adaptor Cables that passed Fluke Meter Cat6a Test Requirements Cable was properly connected and passed NEXT tests with very good margin (16.7 dB) and the RL with good margin (4.0 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 1
Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:29:54 PM
Operator: JONATHAN BRODT
Headroom 11.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 7,8]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	47.6
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	11.9	13.1	15.9	15.7
Freq. (MHz)	15.5	3.0	500.0	500.0
Limit (dB)	53.5	65.0	26.1	26.1
Worst Pair	3,6	1,2	1,2	1,2
PS NEXT (dB)	12.2	14.2	16.7	16.6
Freq. (MHz)	15.5	11.4	500.0	500.0
Limit (dB)	50.8	53.1	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.5	15.8	15.5	15.8
Freq. (MHz)	498.0	500.0	498.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.8	17.6	17.8	17.6
Freq. (MHz)	500.0	498.0	500.0	498.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	15.9	16.6	64.1	63.9
Freq. (MHz)	3.0	3.0	500.0	500.0
Limit (dB)	61.4	61.4	-23.2	-23.2
Worst Pair	1,2	3,6	1,2	1,2
PS ACR-N (dB)	17.1	17.9	64.7	64.6
Freq. (MHz)	3.3	3.4	500.0	500.0
Limit (dB)	58.2	57.9	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	7,8	7,8	4,5
RL (dB)	4.2	6.9	7.7	7.8
Freq. (MHz)	1.0	285.0	347.0	500.0
Limit (dB)	19.0	7.5	6.6	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

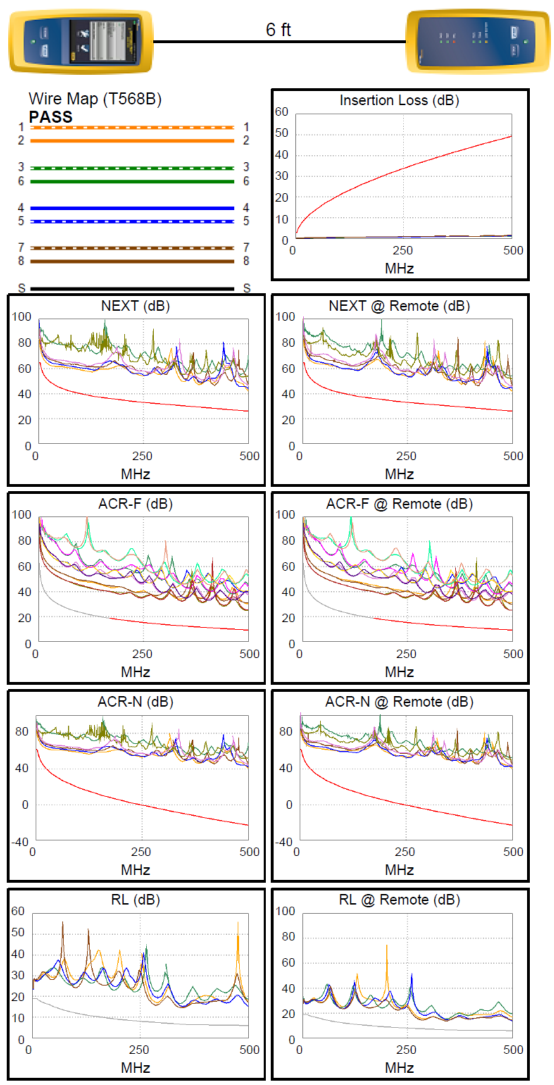

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Figure B-32. Second Rework of Segment 1 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and the RL with good margins. Test results were significantly improved for NEXT tests (11.9 vs 6.7 dB) and RL (4.2 vs 1.9 dB) when compared with first rework results in Figure B-20.

LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:38:27 PM
Operator: JONATHAN BRODT
Headroom 13.6 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

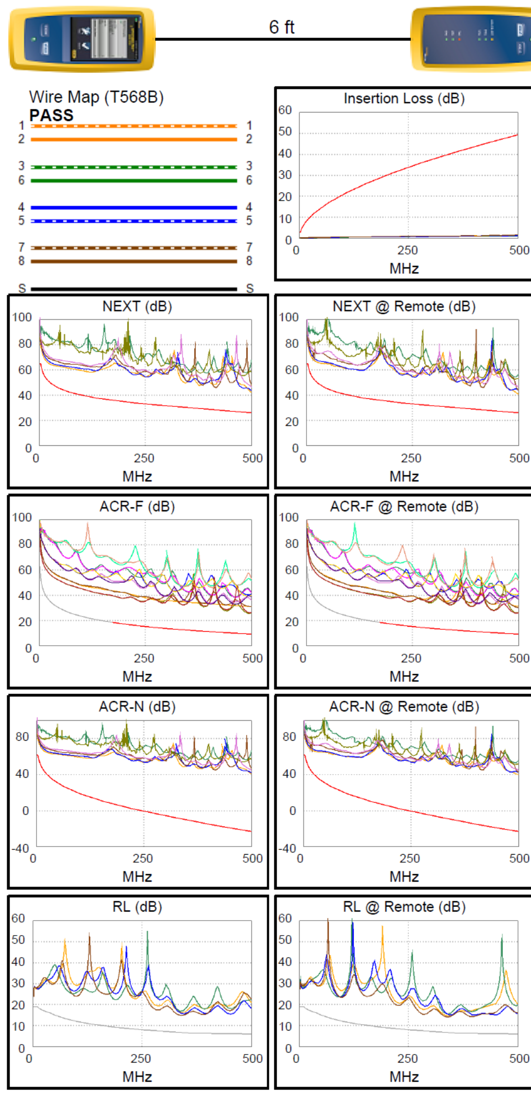
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	47.7
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	13.6	14.3	15.9	14.6
Freq. (MHz)	12.0	15.5	500.0	500.0
Limit (dB)	55.3	53.5	26.1	26.1
Worst Pair	1,2	3,6	1,2	3,6
PS NEXT (dB)	14.2	15.0	16.5	15.5
Freq. (MHz)	14.5	15.5	500.0	500.0
Limit (dB)	51.3	50.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.3	16.5	16.4	16.6
Freq. (MHz)	495.0	495.0	496.0	496.0
Limit (dB)	9.4	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.2	18.5	18.3
Freq. (MHz)	498.0	495.0	498.0	496.0
Limit (dB)	6.3	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	17.7	18.8	64.1	62.8
Freq. (MHz)	3.1	3.1	500.0	500.0
Limit (dB)	61.1	61.1	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	18.3	19.5	64.3	63.5
Freq. (MHz)	3.3	3.3	500.0	500.0
Limit (dB)	58.2	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	7,8	7,8	7,8
RL (dB)	4.6	7.3	8.2	7.3
Freq. (MHz)	1.0	342.0	344.0	342.0
Limit (dB)	19.0	6.7	6.6	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-33. Third Rework of Segment 2 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and RL with good margins. Test results were improved for NEXT tests (14.2 vs 9.5 dB) and RL (4.6 vs 2.7 dB) as compared with first rework results in Figure B-21 and second rework in Figure B-41.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:39:46 PM
Operator: JONATHAN BRODT
Headroom 12.2 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	47.7
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	12.2	13.2	16.6	14.8
Freq. (MHz)	3.5	3.0	500.0	500.0
Limit (dB)	64.0	65.0	26.1	26.1
Worst Pair	3,6	3,6	1,2	3,6
PS NEXT (dB)	12.6	13.8	17.6	15.1
Freq. (MHz)	7.8	3.9	500.0	500.0
Limit (dB)	55.8	60.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.4	15.6	15.4	15.6
Freq. (MHz)	498.0	500.0	498.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.6	17.4	17.6	17.4
Freq. (MHz)	500.0	498.0	500.0	498.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	15.9	16.7	64.7	62.9
Freq. (MHz)	3.0	3.0	500.0	500.0
Limit (dB)	61.4	61.4	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	16.4	17.7	65.4	63.2
Freq. (MHz)	3.5	3.3	500.0	500.0
Limit (dB)	57.6	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	1,2	1,2
RL (dB)	4.4	6.9	8.2	6.9
Freq. (MHz)	1.0	348.0	348.0	348.0
Limit (dB)	19.0	6.6	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

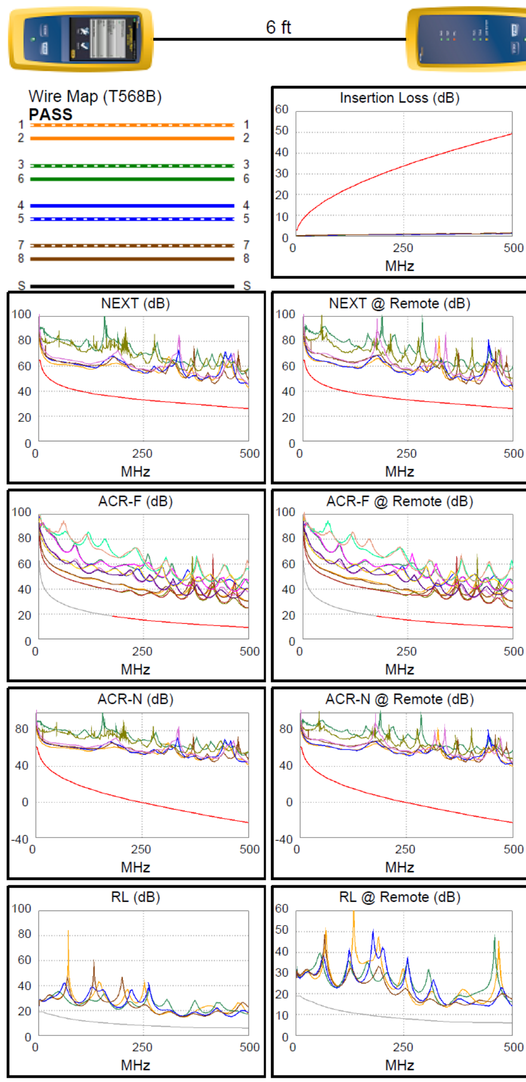


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Figure B-34. Second Rework of Segment 3 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed the Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and the RL with good margins. Test results were significantly improved for NEXT tests (12.2 vs 6.0 dB) and RL (4.4 vs 0.5 dB) when compared with first rework results in Figure B-22.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:41:19 PM
Operator: JONATHAN BRODT
Headroom 13.0 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

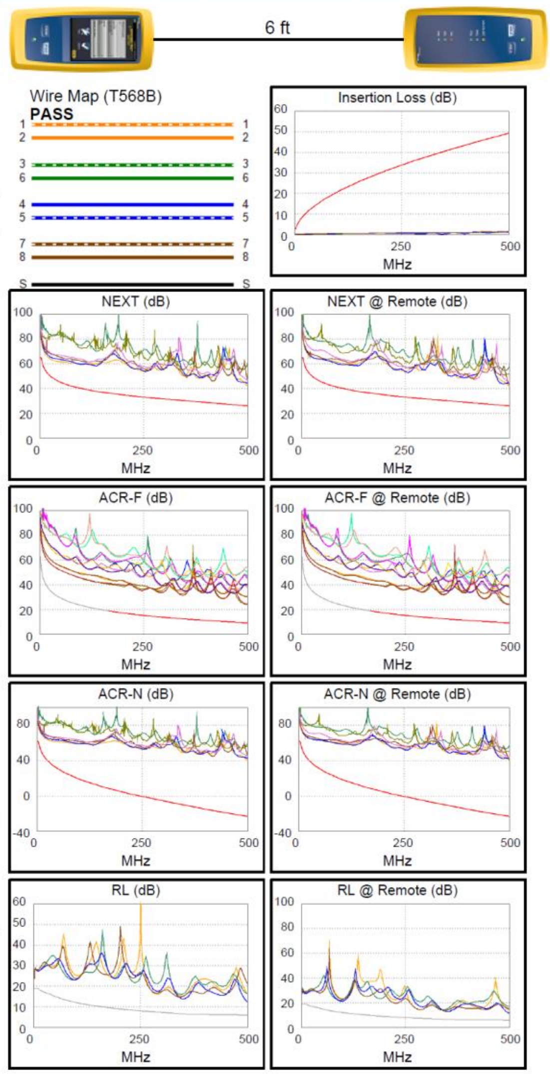
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	47.7
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	13.0	13.9	15.3	15.7
Freq. (MHz)	13.3	15.5	500.0	500.0
Limit (dB)	54.6	53.5	26.1	26.1
Worst Pair	1,2	3,6	1,2	3,6
PS NEXT (dB)	13.4	13.5	16.3	15.9
Freq. (MHz)	13.3	15.5	500.0	500.0
Limit (dB)	52.0	50.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	14.9	14.9	14.9	14.9
Freq. (MHz)	496.0	498.0	496.0	498.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.0	16.9	17.0	16.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	17.2	18.0	63.3	63.7
Freq. (MHz)	3.1	3.5	500.0	500.0
Limit (dB)	61.1	60.1	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	17.8	17.9	64.1	63.9
Freq. (MHz)	3.1	3.5	500.0	500.0
Limit (dB)	58.3	57.6	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	4,5	4,5
RL (dB)	4.5	5.5	6.4	5.5
Freq. (MHz)	1.0	500.0	500.0	500.0
Limit (dB)	19.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-35. Second Rework of Segment 4 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and the RL with good margins. Test results were significantly improved for NEXT tests (13.0 vs 5.5 dB) and RL (4.5 vs 1.8 dB) when compared with the first rework results in Figure B-23.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 5 | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:28:17 PM
Operator: JONATHAN BRODT
Headroom 12.4 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

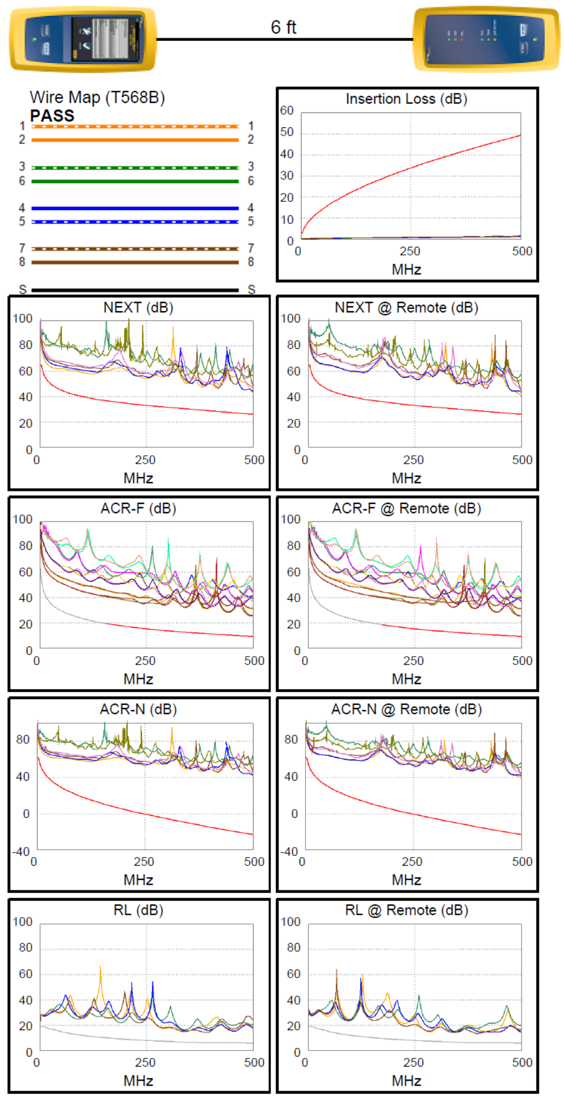
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.73
Insertion Loss Margin (dB)	[Pair 7,8]	47.7
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	12.4	14.2	16.7	14.4
Freq. (MHz)	15.5	15.5	500.0	500.0
Limit (dB)	53.5	53.5	26.1	26.1
Worst Pair	3,6	1,2	1,2	1,2
PS NEXT (dB)	12.9	14.7	17.1	15.5
Freq. (MHz)	15.5	15.5	500.0	500.0
Limit (dB)	50.8	50.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.1	16.2	16.1	16.3
Freq. (MHz)	497.0	495.0	497.0	497.0
Limit (dB)	9.3	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.3	18.1	18.3	18.2
Freq. (MHz)	500.0	495.0	500.0	500.0
Limit (dB)	6.3	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	16.9	18.3	64.8	62.5
Freq. (MHz)	3.0	3.0	500.0	500.0
Limit (dB)	61.4	61.4	-23.2	-23.2
Worst Pair	3,6	1,2	1,2	1,2
PS ACR-N (dB)	17.7	19.1	65.0	63.4
Freq. (MHz)	3.9	3.3	500.0	500.0
Limit (dB)	56.7	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	1,2	7,8	7,8
RL (dB)	4.2	7.2	8.2	7.5
Freq. (MHz)	1.0	285.0	392.0	395.0
Limit (dB)	19.0	7.5	6.1	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-36. Second Rework of Segment 5 cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and the RL with good margins. Test results were significantly improved for NEXT tests (12.4 vs 6.9 dB) and RL (4.2 vs 3.0 dB) when compared with the first rework results in Figure B-24.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 1+2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 12:43:35 PM
Operator: JONATHAN BRODT
Headroom 12.6 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	10
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.99
Insertion Loss Margin (dB)	[Pair 1,2]	46.6
Frequency (MHz)	[Pair 1,2]	493.0
Limit (dB)	[Pair 1,2]	48.9

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
NEXT (dB)	13.1	12.6	13.2	12.7
Freq. (MHz)	489.0	489.0	491.0	494.0
Limit (dB)	26.4	26.4	26.3	26.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	13.3	12.4	13.3	12.5
Freq. (MHz)	493.0	490.0	493.0	492.0
Limit (dB)	23.4	23.5	23.4	23.4

PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.6	16.7	16.6	16.7
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.4	18.3	18.4	18.3
Freq. (MHz)	483.0	482.0	483.0	482.0
Limit (dB)	6.6	6.6	6.6	6.6

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
ACR-N (dB)	16.9	18.5	60.1	59.6
Freq. (MHz)	3.0	3.4	491.0	494.0
Limit (dB)	61.4	60.4	-22.5	-22.7
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	17.3	18.2	60.2	59.5
Freq. (MHz)	3.9	3.4	493.0	492.0
Limit (dB)	56.7	57.9	-25.5	-25.5

N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	4,5	7,8
RL (dB)	4.6	6.9	8.5	7.8
Freq. (MHz)	1.0	8.1	344.0	340.0
Limit (dB)	19.0	19.0	6.6	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

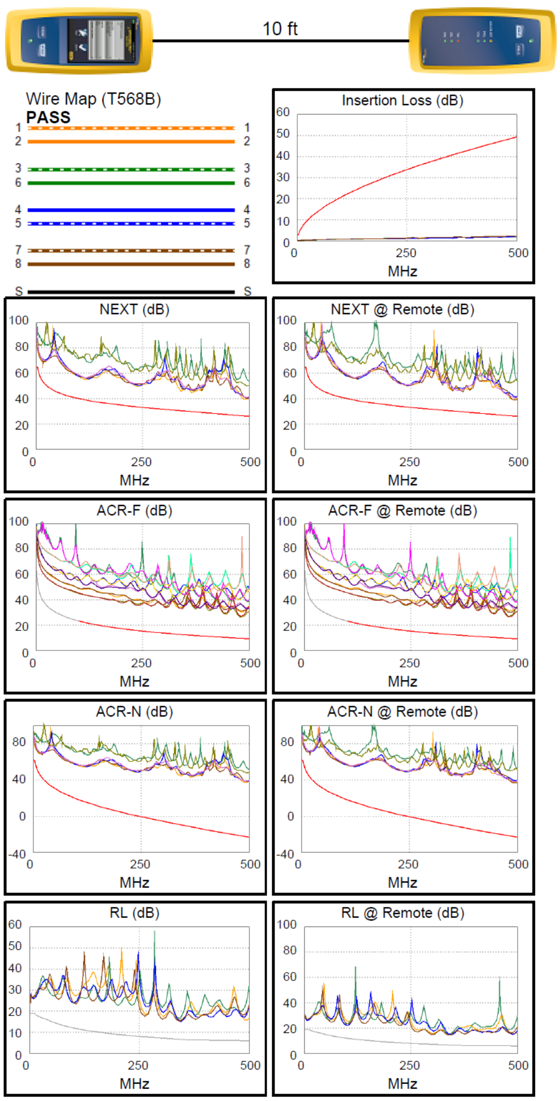


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Figure B-37. Second Rework of Segments 1 and 2 Cable with Three CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed the NEXT tests and the RL with good margins. Test results were improved for NEXT tests (12.6 vs 6.3 dB) and RL (4.6 vs 1.5 dB) when compared with the first rework results in Figure B-25.

LinkWare™PC CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 1+2+3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 01:02:46 PM
Operator: JONATHAN BRODT
Headroom 10.6 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	13
Prop. Delay (ns), Limit 555	[Pair 7,8]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.24
Insertion Loss Margin (dB)	[Pair 1,2]	46.3
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	10.6	11.8	13.7	12.7
Freq. (MHz)	3.1	342.0	479.0	478.0
Limit (dB)	64.8	30.6	26.6	26.6
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.6	11.4	14.0	12.6
Freq. (MHz)	3.8	3.3	481.0	481.0
Limit (dB)	61.0	62.0	23.7	23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.8	16.9	16.8	16.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.4	18.2	18.4	18.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	14.1	15.4	59.3	58.2
Freq. (MHz)	3.1	3.3	479.0	478.0
Limit (dB)	61.1	60.7	-21.6	-21.5
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	14.4	15.0	59.1	58.3
Freq. (MHz)	3.8	3.3	475.0	481.0
Limit (dB)	57.0	58.2	-24.1	-24.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	4,5	3,6
RL (dB)	11.7	9.0	8.5	7.6
Freq. (MHz)	479.0	477.0	344.0	341.0
Limit (dB)	6.0	6.0	6.6	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

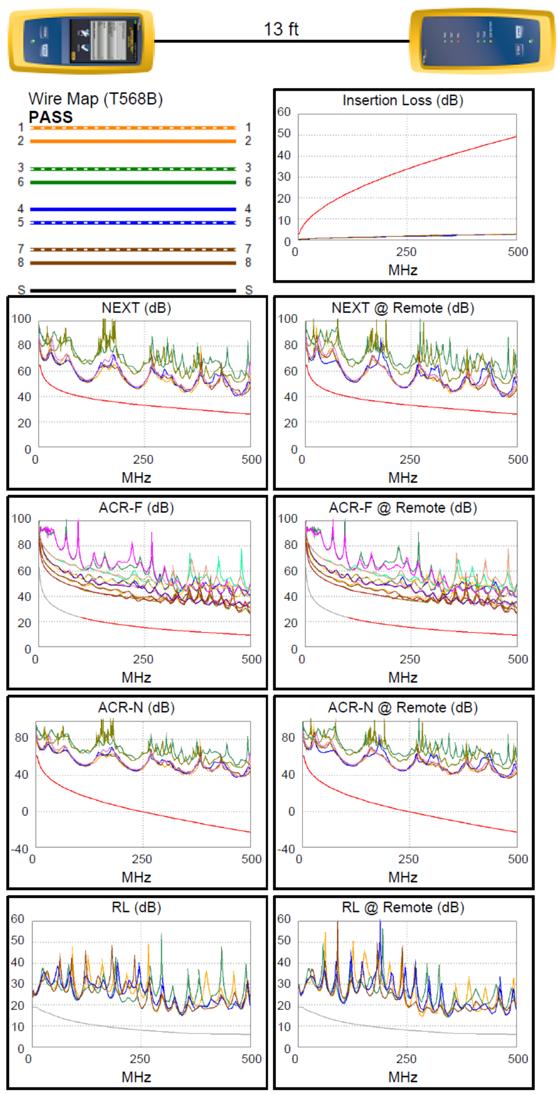

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Figure B-38. Second Rework of Segments 1, 2, and 3 Cable with Four CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
The cable was properly connected and passed NEXT tests and RL with good margins. NEXT margins (10.6 vs 6.5 dB), and RL margins (9.0 vs 2.8 dB) were significantly improved compared with the first rework results shown in Figure B-26.

LinkWare™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 1+2+3+4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 01:04:15 PM
Operator: JONATHAN BRODT
Headroom 8.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	17
Prop. Delay (ns), Limit 555	[Pair 7,8]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.52
Insertion Loss Margin (dB)	[Pair 1,2]	45.4
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
NEXT (dB)	8.7	9.5	12.4	11.9
Freq. (MHz)	4.3	342.0	465.0	470.0
Limit (dB)	62.6	30.6	27.0	26.8
Worst Pair	3,6	3,6	7,8	1,2
PS NEXT (dB)	8.6	9.1	12.5	11.8
Freq. (MHz)	3.9	3.4	465.0	464.0
Limit (dB)	60.8	61.7	24.1	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.5	16.9	16.5	16.9
Freq. (MHz)	494.0	494.0	494.0	494.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.1	18.5	18.1
Freq. (MHz)	494.0	496.0	494.0	496.0
Limit (dB)	6.4	6.3	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
ACR-N (dB)	12.2	13.2	56.6	56.1
Freq. (MHz)	3.0	3.4	465.0	470.0
Limit (dB)	61.4	60.4	-20.4	-20.8
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	12.2	12.7	56.6	55.6
Freq. (MHz)	3.6	3.4	465.0	464.0
Limit (dB)	57.3	57.9	-23.3	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	4,5	1,2	4,5
RL (dB)	7.9	6.2	7.9	6.2
Freq. (MHz)	345.0	499.0	345.0	499.0
Limit (dB)	6.6	6.0	6.6	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

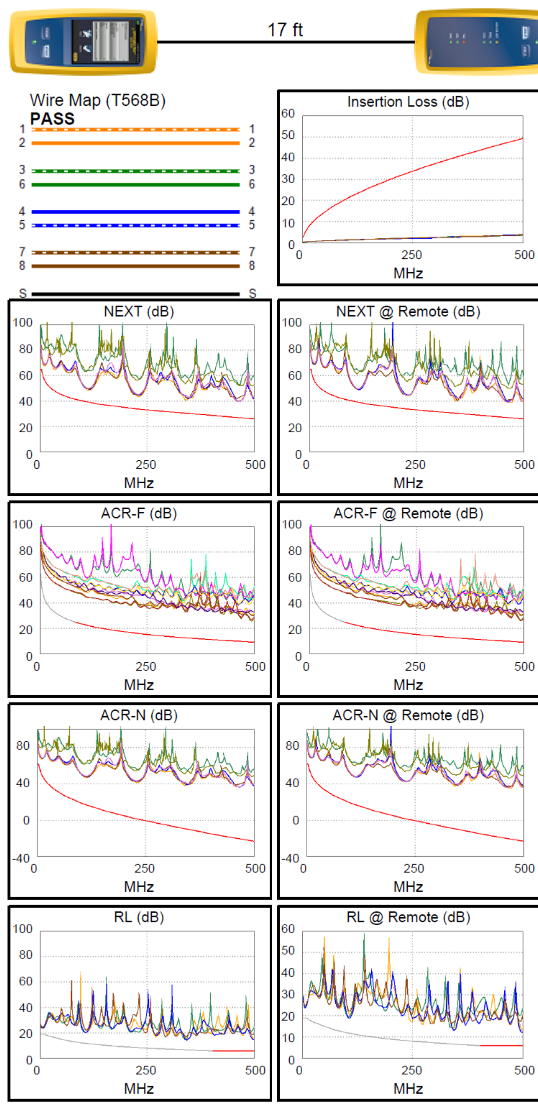

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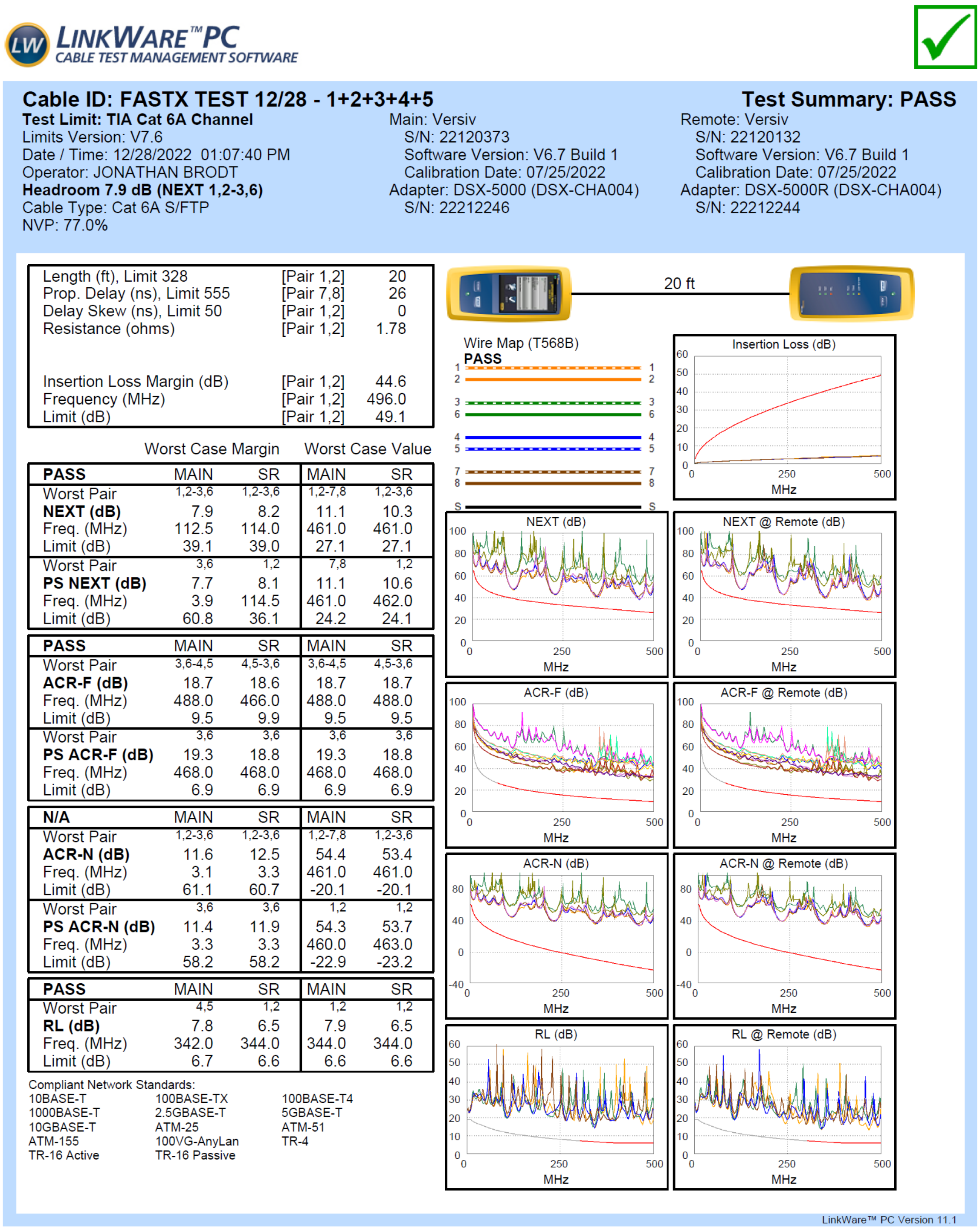
Figure B-39. Second Rework of Segments 1, 2, 3 and 4 Cable with Five CeeLok FAS-X Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements Cable was properly connected and passed NEXT tests and RL with good margins. This configuration failed the Cat6a test prior to this last rework. Test results were improved in NEXT (8.7 vs 4.6 dB) and the RL (6.2 vs –2.5 dB) when compared with the first rework results in Figure B-27.



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/28 - 1+2+3+4+5 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/28/2022 01:07:40 PM
Operator: JONATHAN BRODT
Headroom 7.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	20
Prop. Delay (ns), Limit 555	[Pair 7,8]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.78
Insertion Loss Margin (dB)	[Pair 1,2]	44.6
Frequency (MHz)	[Pair 1,2]	496.0
Limit (dB)	[Pair 1,2]	49.1

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
NEXT (dB)	7.9	8.2	11.1	10.3
Freq. (MHz)	112.5	114.0	461.0	461.0
Limit (dB)	39.1	39.0	27.1	27.1
Worst Pair	3,6	1,2	7,8	1,2
PS NEXT (dB)	7.7	8.1	11.1	10.6
Freq. (MHz)	3.9	114.5	461.0	462.0
Limit (dB)	60.8	36.1	24.2	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	18.7	18.6	18.7	18.7
Freq. (MHz)	488.0	466.0	488.0	488.0
Limit (dB)	9.5	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	18.8	19.3	18.8
Freq. (MHz)	468.0	468.0	468.0	468.0
Limit (dB)	6.9	6.9	6.9	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
ACR-N (dB)	11.6	12.5	54.4	53.4
Freq. (MHz)	3.1	3.3	461.0	461.0
Limit (dB)	61.1	60.7	-20.1	-20.1
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.4	11.9	54.3	53.7
Freq. (MHz)	3.3	3.3	460.0	463.0
Limit (dB)	58.2	58.2	-22.9	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	1,2	1,2
RL (dB)	7.8	6.5	7.9	6.5
Freq. (MHz)	342.0	344.0	344.0	344.0
Limit (dB)	6.7	6.6	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-40. Second Rework of Segments 1, 2, 3, 4, and 5 Cable with Six CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements Cable was properly connected and passed NEXT tests and RL with good margins. This configuration failed the Cat6a test prior to this last rework. Test results were improved in NEXT (7.9 vs 3.4 dB) and the RL (6.5 vs –0.3 dB) when compared with the first rework results in Figure B-29.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/12 - 2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/12/2022 01:50:42 PM
Operator: JONATHAN BRODT
Headroom 12.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 1,2]	44.9
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	1,2-7,8	3,6-4,5
NEXT (dB)	12.5	12.9	14.7	13.0
Freq. (MHz)	15.5	493.0	500.0	496.0
Limit (dB)	53.5	26.3	26.1	26.2
Worst Pair	4,5	4,5	1,2	4,5
PS NEXT (dB)	13.5	13.9	15.7	13.9
Freq. (MHz)	15.5	496.0	500.0	496.0
Limit (dB)	50.8	23.3	23.2	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	15.5	15.3	15.5	15.3
Freq. (MHz)	441.0	441.0	441.0	441.0
Limit (dB)	10.4	10.4	10.4	10.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.0	17.3	18.0	17.3
Freq. (MHz)	443.0	444.0	443.0	444.0
Limit (dB)	7.3	7.3	7.3	7.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	1,2-7,8	3,6-4,5
ACR-N (dB)	18.5	20.8	62.3	60.5
Freq. (MHz)	3.3	4.0	500.0	496.0
Limit (dB)	60.7	58.9	-23.2	-22.9
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	18.6	20.1	60.6	60.5
Freq. (MHz)	3.8	3.3	500.0	500.0
Limit (dB)	57.0	58.2	-26.1	-26.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	1.4	1.6	1.4	1.6
Freq. (MHz)	494.0	369.0	494.0	369.0
Limit (dB)	6.0	6.3	6.0	6.3

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

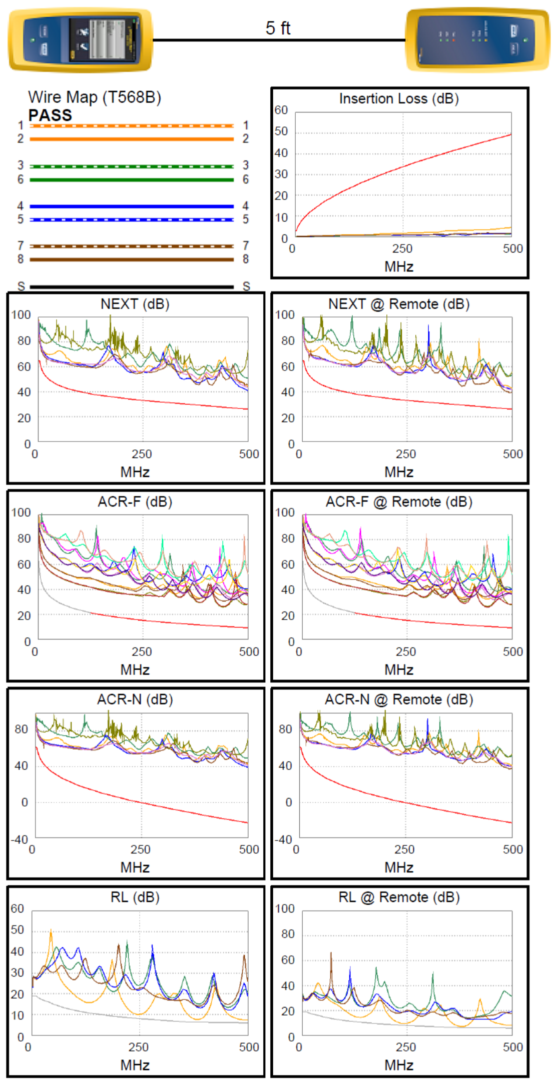


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Figure B-41. Second Rework of Segment 2 Cable with Two CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin yet only passed the RL test with a slight margin. Test results were improved in the NEXT test (12.5 vs 9.5 dB) yet degraded in the RL test (1.4 vs 2.7 dB) when compared with the first rework results in Figure B-21. Note in the lower left RL graph the 1,2 pair (orange line) had a much lower margin compared with the other three pairs (over 4 dB). This suggests there may be a connector termination issue with the 1,2 twisted pair.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX TEST 12/12 - 1+2 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/12/2022 01:58:10 PM
Operator: JONATHAN BRODT
Headroom 11.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	9
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.94
Insertion Loss Margin (dB)	[Pair 1,2]	44.3
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	12.8	11.5	12.8	11.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	26.1	26.1	26.1	26.1
Worst Pair	3,6	4,5	7,8	4,5
PS NEXT (dB)	13.1	13.1	13.5	13.5
Freq. (MHz)	7.8	478.0	478.0	497.0
Limit (dB)	55.8	23.7	23.7	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.5	15.8	15.5	15.8
Freq. (MHz)	443.0	443.0	443.0	443.0
Limit (dB)	10.3	10.3	10.3	10.3
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	18.4	17.4	18.4	17.4
Freq. (MHz)	444.0	447.0	444.0	447.0
Limit (dB)	7.3	7.3	7.3	7.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	17.0	17.9	58.9	57.6
Freq. (MHz)	3.9	3.4	500.0	500.0
Limit (dB)	59.2	60.4	-23.2	-23.2
Worst Pair	3,6	1,2	1,2	1,2
PS ACR-N (dB)	17.4	18.3	57.2	58.1
Freq. (MHz)	3.9	3.4	477.0	485.0
Limit (dB)	56.7	57.9	-24.3	-24.9
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	0.8	1.4	0.8	1.4
Freq. (MHz)	500.0	366.0	500.0	366.0
Limit (dB)	6.0	6.4	6.0	6.4

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

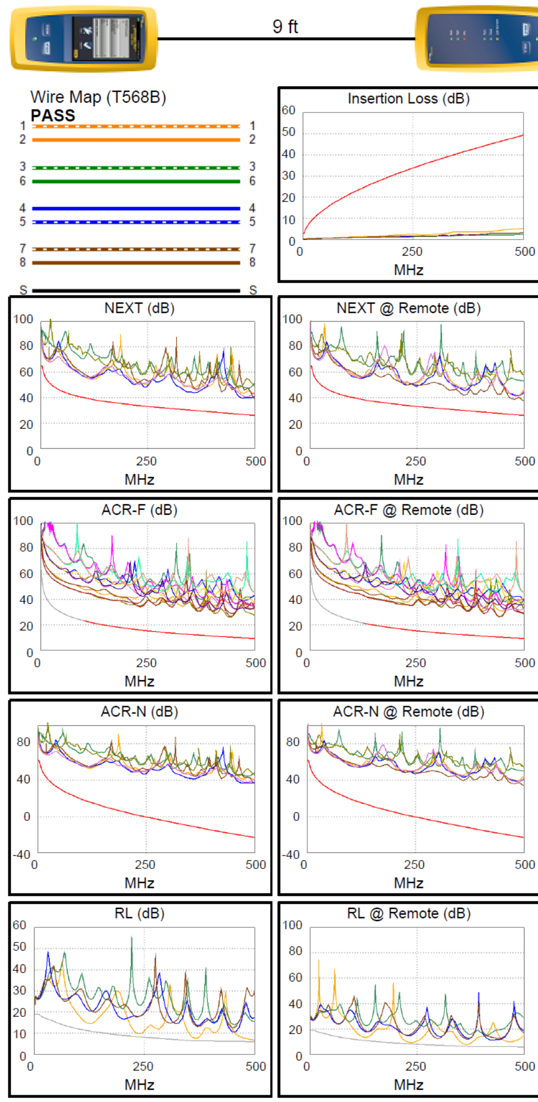

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Figure B-42. Second Rework of Segments 1 and 2 Cable with Three CeeLok FAS-X Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin yet barely passed the RL test. Test results were improved in the NEXT test (11.5 vs 6.3 dB) while they degraded in the RL test (0.8 vs 1.5 dB) when compared with the first rework results in Figure B-25. Again, the 1,2 pair (orange line) in the lower RL graph had a much lower margin than the other Ethernet pairs.

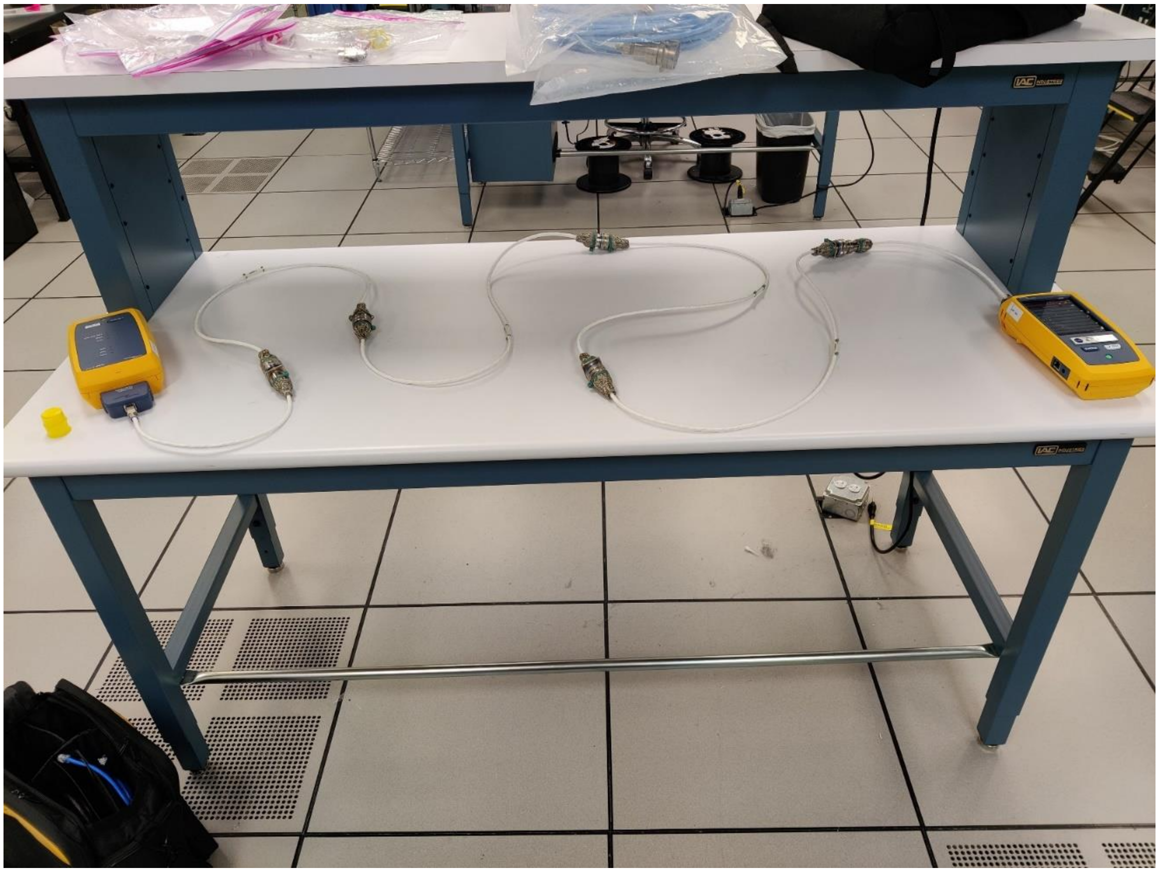


Figure B-43. Cable Analyzer Setup with M38999 Connectors showing Four 1-m Segments Connected through Five M38999 Connectors

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - ADAPTERS

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:38:11 AM
Operator: JONATHAN BRODT
Headroom 21.4 dB (NEXT 1,2-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

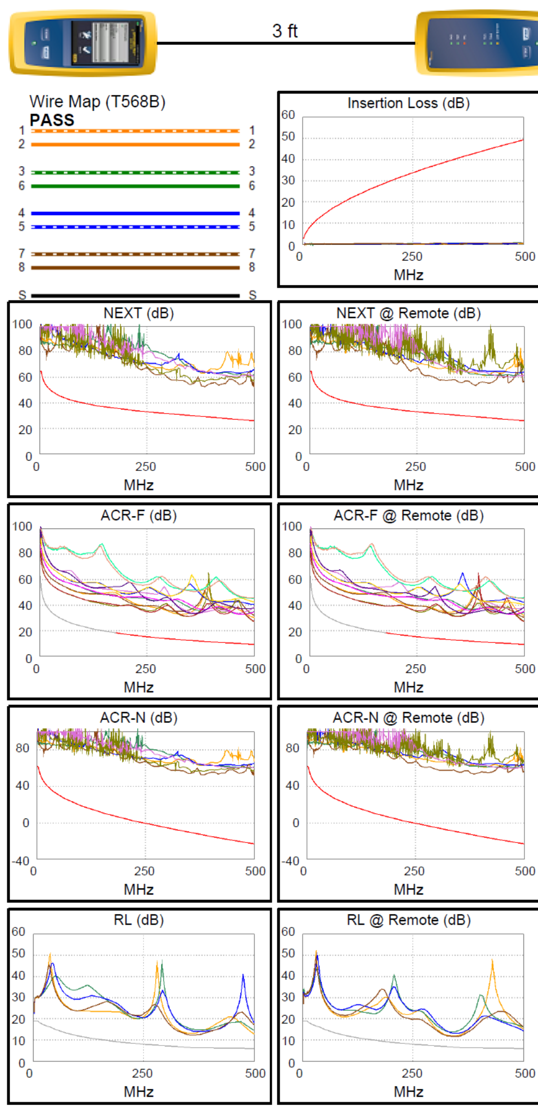
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	3
Prop. Delay (ns), Limit 555	[Pair 1,2]	4
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.27
Insertion Loss Margin (dB)	[Pair 3,6]	48.3
Frequency (MHz)	[Pair 3,6]	495.0
Limit (dB)	[Pair 3,6]	49.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	21.4	21.7	26.0	24.5
Freq. (MHz)	3.3	2.1	500.0	387.0
Limit (dB)	64.5	65.0	26.1	29.1
Worst Pair	1,2	4,5	3,6	4,5
PS NEXT (dB)	22.5	22.9	27.6	26.6
Freq. (MHz)	3.3	3.3	500.0	387.0
Limit (dB)	62.0	62.0	23.2	26.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	17.8	17.8	17.8	17.8
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.9	18.9	19.4
Freq. (MHz)	347.0	347.0	500.0	500.0
Limit (dB)	9.5	9.5	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	24.5	24.7	74.7	66.8
Freq. (MHz)	1.3	1.1	500.0	384.0
Limit (dB)	62.0	62.0	-23.2	-13.5
Worst Pair	1,2	1,2	3,6	4,5
PS ACR-N (dB)	26.1	26.4	76.3	69.3
Freq. (MHz)	2.4	1.1	500.0	387.0
Limit (dB)	58.7	59.0	-26.1	-16.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	3.4	4.8	5.9	4.9
Freq. (MHz)	1.0	334.0	367.0	343.0
Limit (dB)	19.0	6.8	6.4	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-44. Adaptor Cable with Two M38999 Connectors Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and RL with good margins.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 1
Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:43:38 AM
Operator: JONATHAN BRODT
Headroom 12.9 dB (NEXT 1,2-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

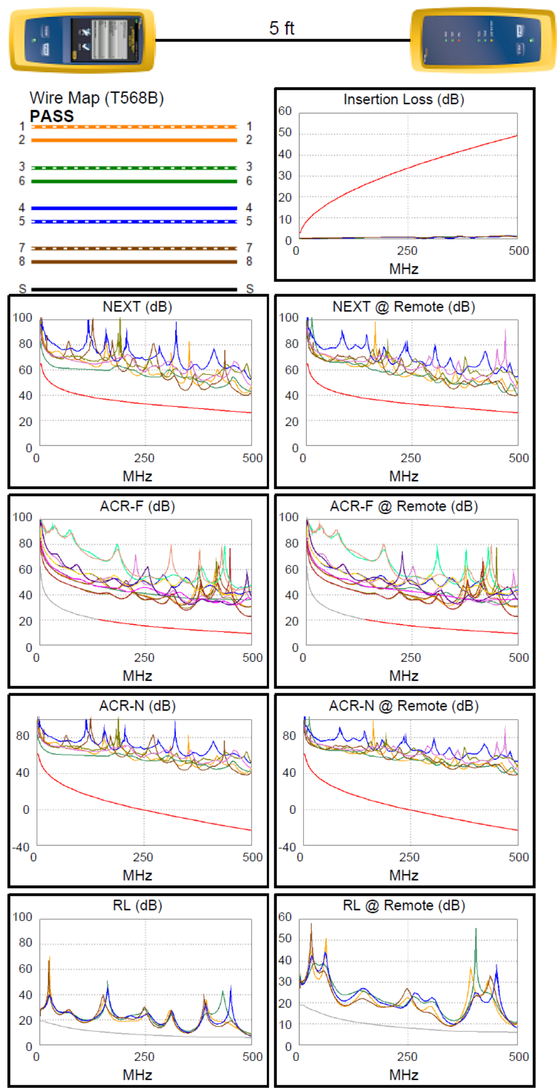
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 4,5]	46.9
Frequency (MHz)	[Pair 4,5]	483.0
Limit (dB)	[Pair 4,5]	48.4

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	12.9	13.2	13.4	13.3
Freq. (MHz)	3.0	489.0	487.0	494.0
Limit (dB)	65.0	26.4	26.4	26.2
Worst Pair	3,6	4,5	3,6	4,5
PS NEXT (dB)	14.1	13.4	14.1	13.4
Freq. (MHz)	487.0	500.0	487.0	500.0
Limit (dB)	23.5	23.2	23.5	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	4,5-3,6
ACR-F (dB)	13.4	13.5	13.5	13.5
Freq. (MHz)	495.0	495.0	498.0	500.0
Limit (dB)	9.4	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.7	15.6	15.7	15.6
Freq. (MHz)	498.0	500.0	498.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	16.4	22.0	60.6	61.0
Freq. (MHz)	3.0	1.9	487.0	494.0
Limit (dB)	61.4	62.0	-22.2	-22.7
Worst Pair	4,5	4,5	3,6	4,5
PS ACR-N (dB)	18.5	22.2	61.4	61.8
Freq. (MHz)	3.0	3.3	487.0	500.0
Limit (dB)	58.4	58.2	-25.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	1.1	2.3	1.1	2.3
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-45. Segment 1 Cable with Two M38999 Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (12.9 dB) and passed RL with a slight margin (1.1 db).

Cable ID: 38999 TEST 12/01 - 2 | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:59:29 AM
Operator: JONATHAN BRODT
Headroom 11.4 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

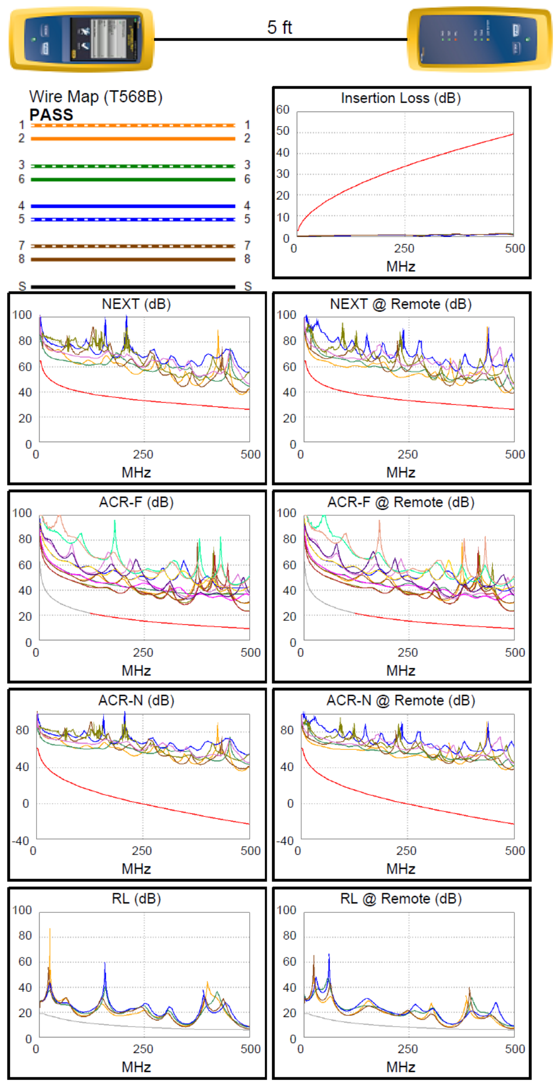
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 1,2]	46.3
Frequency (MHz)	[Pair 1,2]	472.0
Limit (dB)	[Pair 1,2]	47.8

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
NEXT (dB)	11.4	12.7	11.5	12.7
Freq. (MHz)	481.0	480.0	483.0	495.0
Limit (dB)	26.6	26.6	26.5	26.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	11.9	13.2	12.0	13.2
Freq. (MHz)	481.0	485.0	483.0	485.0
Limit (dB)	23.7	23.6	23.6	23.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	4,5-3,6	4,5-3,6
ACR-F (dB)	13.6	13.6	13.7	13.7
Freq. (MHz)	495.0	495.0	496.0	497.0
Limit (dB)	9.4	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.6	15.6	15.7	15.7
Freq. (MHz)	495.0	495.0	496.0	497.0
Limit (dB)	6.4	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	19.8	22.2	58.5	59.5
Freq. (MHz)	3.0	3.8	483.0	480.0
Limit (dB)	61.4	59.5	-21.9	-21.6
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-N (dB)	21.1	21.8	59.0	60.3
Freq. (MHz)	3.4	3.9	483.0	485.0
Limit (dB)	57.9	56.7	-24.8	-24.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	0.7	0.9	0.7	0.9
Freq. (MHz)	500.0	499.0	500.0	499.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-46. Segment 2 Cable with Two M38999 Connectors in Series with Adaptor Cables Passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (11.4 dB) and passed the RL with a very slight margin (0.7 dB).

LinkWare™ PC CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:57:48 AM
Operator: JONATHAN BRODT
Headroom 14.0 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

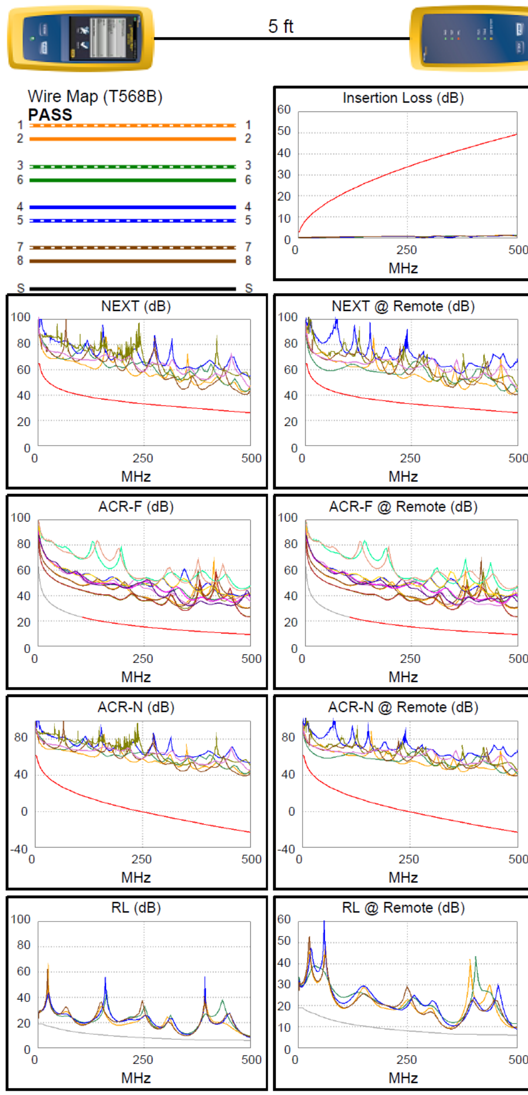
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 1,2]	46.6
Frequency (MHz)	[Pair 1,2]	476.0
Limit (dB)	[Pair 1,2]	48.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	14.0	14.0	14.2	14.2
Freq. (MHz)	344.0	41.5	488.0	495.0
Limit (dB)	30.5	46.4	26.4	26.2
Worst Pair	3,6	3,6	4,5	3,6
PS NEXT (dB)	14.8	14.4	14.9	14.4
Freq. (MHz)	484.0	487.0	491.0	487.0
Limit (dB)	23.6	23.5	23.4	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	4,5-3,6
ACR-F (dB)	13.8	13.9	13.8	13.9
Freq. (MHz)	498.0	495.0	498.0	500.0
Limit (dB)	9.3	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.9	15.8	15.9	15.9
Freq. (MHz)	498.0	495.0	498.0	500.0
Limit (dB)	6.3	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	25.0	21.8	61.6	62.1
Freq. (MHz)	3.6	4.0	488.0	495.0
Limit (dB)	59.8	58.9	-22.3	-22.8
Worst Pair	3,6	4,5	4,5	3,6
PS ACR-N (dB)	24.4	21.5	62.1	61.7
Freq. (MHz)	3.9	4.0	488.0	487.0
Limit (dB)	56.7	56.4	-25.1	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	4,5	4,5
RL (dB)	2.3	2.3	2.3	2.9
Freq. (MHz)	500.0	350.0	500.0	500.0
Limit (dB)	6.0	6.6	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-47. Segment 3 Cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (14 dB) and RL with some margin (2.3 dB).

LinkWare™ PC CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:54:34 AM
Operator: JONATHAN BRODT
Headroom 11.1 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

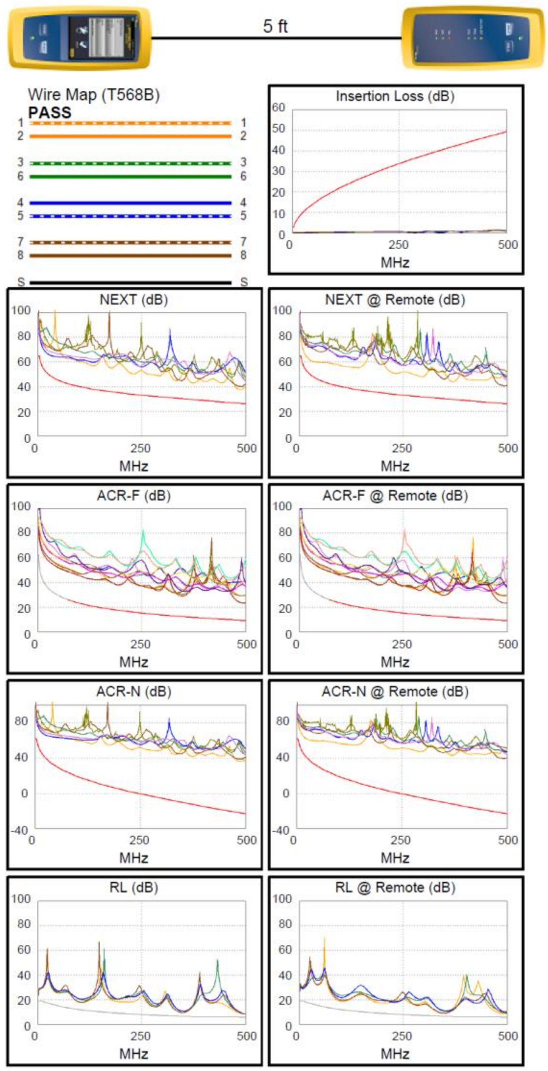
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	5
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 1,2]	46.3
Frequency (MHz)	[Pair 1,2]	473.0
Limit (dB)	[Pair 1,2]	47.8

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
NEXT (dB)	11.1	11.3	11.1	14.3
Freq. (MHz)	488.0	20.0	488.0	494.0
Limit (dB)	26.4	51.6	26.4	26.2
Worst Pair	3,6	1,2	3,6	4,5
PS NEXT (dB)	12.0	13.3	12.2	15.5
Freq. (MHz)	486.0	17.0	491.0	500.0
Limit (dB)	23.6	50.2	23.4	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	4,5-3,6
ACR-F (dB)	13.8	14.0	13.9	14.0
Freq. (MHz)	495.0	494.0	496.0	496.0
Limit (dB)	9.4	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.8	15.8	15.9	15.9
Freq. (MHz)	495.0	494.0	496.0	496.0
Limit (dB)	6.4	6.4	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-7,8	1,2-3,6	1,2-3,6	3,6-4,5
ACR-N (dB)	20.7	17.9	58.5	62.1
Freq. (MHz)	3.3	6.5	488.0	494.0
Limit (dB)	60.7	54.4	-22.3	-22.7
Worst Pair	1,2	1,2	3,6	4,5
PS ACR-N (dB)	21.0	19.0	59.7	63.7
Freq. (MHz)	3.4	3.5	491.0	498.0
Limit (dB)	57.9	57.6	-25.4	-25.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	2.4	2.5	2.4	2.9
Freq. (MHz)	500.0	342.0	500.0	493.0
Limit (dB)	6.0	6.7	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-48. Segment 4 Cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (11.1 dB) and the RL with some margin (2.4 dB).

LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 1+2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:45:27 AM
Operator: JONATHAN BRODT
Headroom 7.3 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

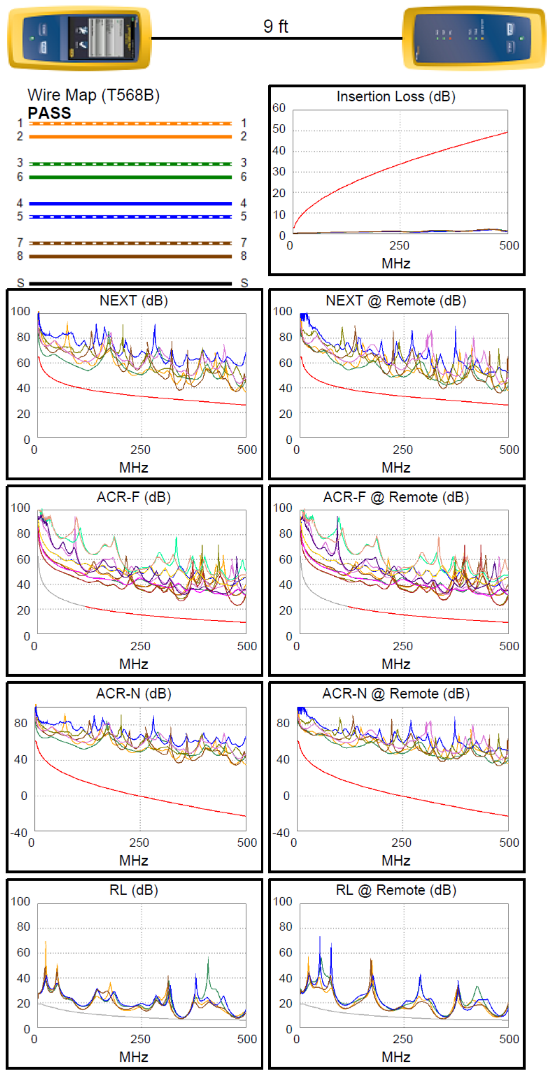
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	9
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.63
Insertion Loss Margin (dB)	[Pair 1,2]	44.9
Frequency (MHz)	[Pair 1,2]	463.0
Limit (dB)	[Pair 1,2]	47.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.3	8.4	9.8	8.8
Freq. (MHz)	342.0	345.0	477.0	477.0
Limit (dB)	30.6	30.5	26.7	26.7
Worst Pair	3,6	4,5	3,6	4,5
PS NEXT (dB)	9.1	9.6	10.3	9.9
Freq. (MHz)	340.0	345.0	477.0	484.0
Limit (dB)	27.7	27.5	23.8	23.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	13.1	13.1	13.2	13.1
Freq. (MHz)	478.0	481.0	480.0	481.0
Limit (dB)	9.7	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.2	15.4	15.7	15.4
Freq. (MHz)	346.0	481.0	481.0	481.0
Limit (dB)	9.5	6.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	15.5	20.7	55.9	54.9
Freq. (MHz)	3.1	3.3	477.0	477.0
Limit (dB)	61.1	60.7	-21.4	-21.4
Worst Pair	4,5	4,5	3,6	4,5
PS ACR-N (dB)	16.8	20.0	56.3	56.6
Freq. (MHz)	3.3	3.3	477.0	483.0
Limit (dB)	58.2	58.2	-24.3	-24.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	0.4	0.2	0.4	0.3
Freq. (MHz)	346.0	342.0	346.0	345.0
Limit (dB)	6.6	6.7	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-49. Two Segments (1 and 2) with Three M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (7.3 dB) and passed the RL with almost no margin (0.2 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 1+2+3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:46:46 AM
Operator: JONATHAN BRODT
Headroom 3.8 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	11
Prop. Delay (ns), Limit 555	[Pair 1,2]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.84
Insertion Loss Margin (dB)	[Pair 1,2]	43.8
Frequency (MHz)	[Pair 1,2]	463.0
Limit (dB)	[Pair 1,2]	47.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	3.8	5.4	7.3	6.9
Freq. (MHz)	342.0	344.0	472.0	472.0
Limit (dB)	30.6	30.5	26.8	26.8
Worst Pair	3,6	4,5	3,6	4,5
PS NEXT (dB)	6.0	6.8	8.5	8.5
Freq. (MHz)	342.0	345.0	471.0	475.0
Limit (dB)	27.6	27.5	23.9	23.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.5	12.4	12.5	12.4
Freq. (MHz)	475.0	476.0	475.0	476.0
Limit (dB)	9.7	9.7	9.7	9.7
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.1	14.4	15.2	14.8
Freq. (MHz)	343.0	345.0	475.0	476.0
Limit (dB)	9.6	9.5	6.7	6.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	17.8	19.6	52.3	51.9
Freq. (MHz)	3.3	3.4	472.0	472.0
Limit (dB)	60.7	60.4	-21.0	-21.0
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-N (dB)	17.9	20.4	53.3	53.3
Freq. (MHz)	3.4	3.4	471.0	470.0
Limit (dB)	57.9	57.9	-23.8	-23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	4,5	1,2
RL (dB)	1.1	0.9	0.2	0.9
Freq. (MHz)	469.0	469.0	348.0	469.0
Limit (dB)	6.0	6.0	6.6	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

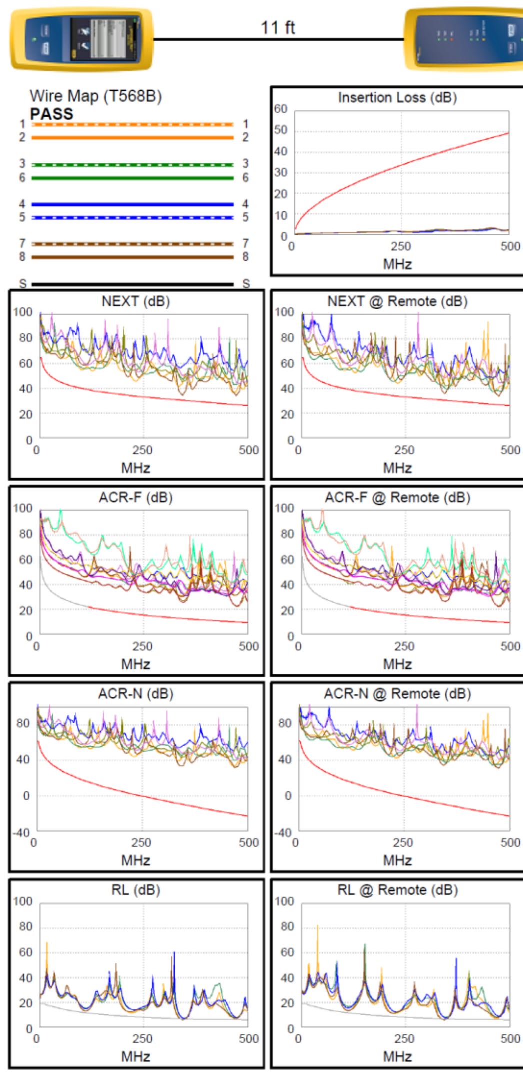


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Figure B-50. Three Segments (1, 2, and 3) Four M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin (3.8 dB) and passed the RL with a slight margin (0.9 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/01 - 1+2+3+4

Test Summary: FAIL

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 11:51:00 AM
Operator: JONATHAN BRODT
Headroom 2.7 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	14
Prop. Delay (ns), Limit 555	[Pair 1,2]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.91
Insertion Loss Margin (dB)	[Pair 1,2]	42.6
Frequency (MHz)	[Pair 1,2]	461.0
Limit (dB)	[Pair 1,2]	47.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	2.7	3.8	2.8	5.8
Freq. (MHz)	342.0	343.0	343.0	469.0
Limit (dB)	30.6	30.5	30.5	26.9
Worst Pair	3,6	4,5	3,6	3,6
PS NEXT (dB)	4.4	5.4	6.9	7.5
Freq. (MHz)	343.0	343.0	467.0	469.0
Limit (dB)	27.6	27.6	24.0	24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.2	12.2	12.3	12.2
Freq. (MHz)	468.0	472.0	470.0	472.0
Limit (dB)	9.9	9.8	9.8	9.8
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	13.4	13.8	14.6	14.6
Freq. (MHz)	345.0	345.0	468.0	472.0
Limit (dB)	9.5	9.5	6.9	6.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-3,6	1,2-3,6	3,6-4,5
ACR-N (dB)	15.1	10.8	50.6	49.9
Freq. (MHz)	3.1	4.0	466.0	469.0
Limit (dB)	61.1	58.9	-20.5	-20.8
Worst Pair	1,2	1,2	3,6	3,6
PS ACR-N (dB)	15.5	12.8	50.4	51.0
Freq. (MHz)	3.5	4.0	466.0	466.0
Limit (dB)	57.6	56.4	-23.4	-23.4
FAIL	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	-1.6F	-1.6F	-1.6	-1.5
Freq. (MHz)	345.0	342.0	345.0	344.0
Limit (dB)	6.6	6.7	6.6	6.6

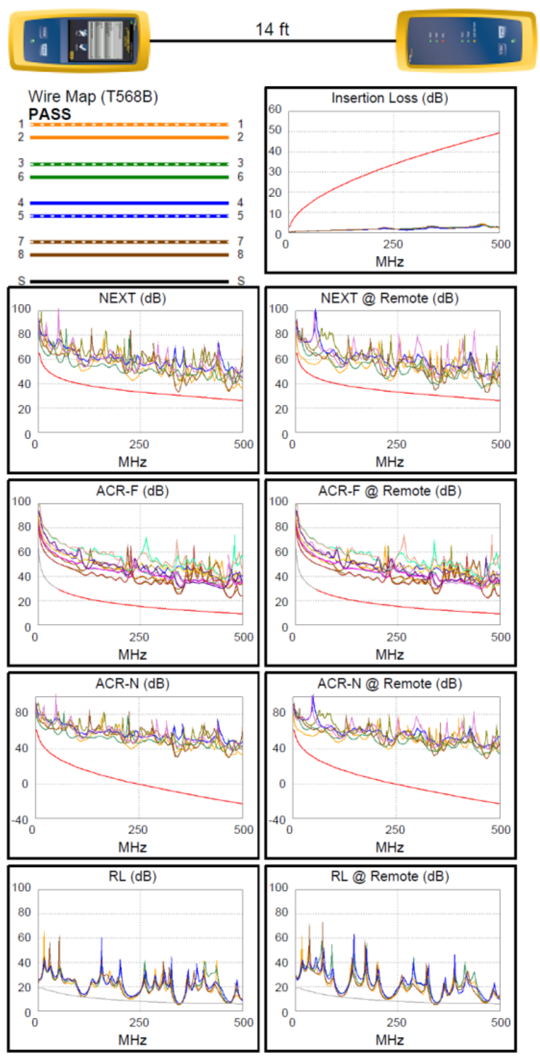

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Figure B-51. Four Segments (1, 2, 3, and 4) five M38999 Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin (2.7 dB) and failed the RL test (1.6 dB below specification). The RL graph (lower left) shows the cable fails the requirement starting at about 125 Mhz.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/09 - 1+2+3+4 | **Test Summary: FAIL**

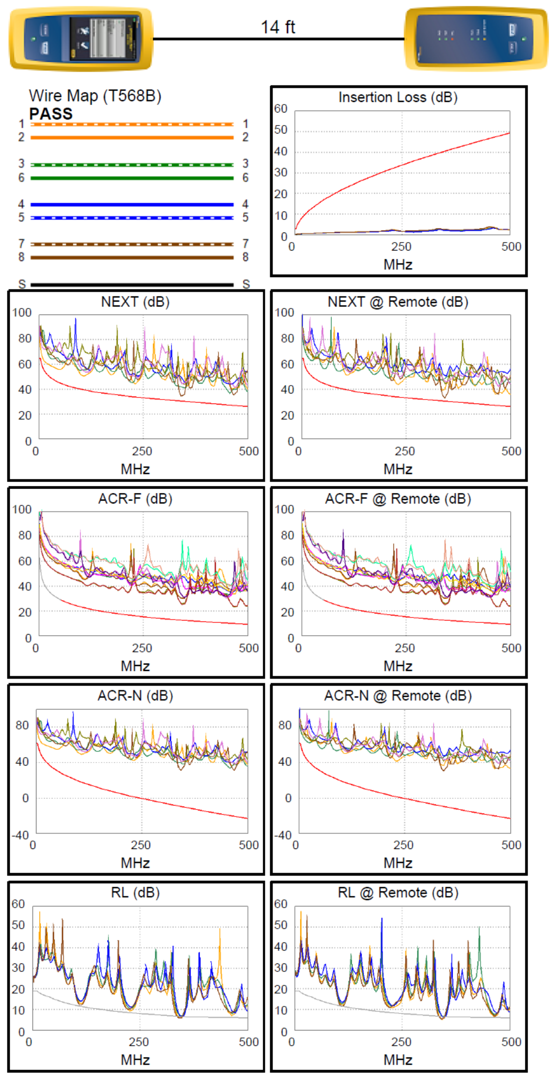
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/09/2022 10:20:13 AM
Operator: JONATHAN BRODT
Headroom 2.3 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	14
Prop. Delay (ns), Limit 555	[Pair 1,2]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.91
Insertion Loss Margin (dB)	[Pair 1,2]	42.9
Frequency (MHz)	[Pair 1,2]	462.0
Limit (dB)	[Pair 1,2]	47.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	3.2	2.3	3.2	2.4
Freq. (MHz)	344.0	342.0	344.0	343.0
Limit (dB)	30.5	30.6	30.5	30.5
Worst Pair	4,5	3,6	4,5	3,6
PS NEXT (dB)	5.1	4.3	5.2	4.3
Freq. (MHz)	343.0	342.0	344.0	342.0
Limit (dB)	27.6	27.6	27.5	27.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.4	12.3	12.9	13.0
Freq. (MHz)	345.0	343.0	469.0	469.0
Limit (dB)	12.5	12.6	9.8	9.8
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-F (dB)	13.5	13.5	15.8	15.8
Freq. (MHz)	345.0	345.0	469.0	469.0
Limit (dB)	9.5	9.5	6.8	6.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	12.1	15.9	41.2	40.1
Freq. (MHz)	3.5	3.1	344.0	342.0
Limit (dB)	60.1	61.1	-9.7	-9.5
Worst Pair	1,2	1,2	3,6	3,6
PS ACR-N (dB)	14.0	15.9	42.8	41.3
Freq. (MHz)	3.5	3.3	343.0	342.0
Limit (dB)	57.6	58.2	-12.6	-12.5
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	-1.1 F	-1.6 F	-1.0	-1.5
Freq. (MHz)	342.0	342.0	344.0	344.0
Limit (dB)	6.7	6.7	6.6	6.6



LinkWare™ PC Version 11.1

Figure B-52. Cables were Unmated and Remated and Four Segments (1, 2, 3, and 4) Five M38999 Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements Cable was properly connected and passed NEXT tests with some margin (2.3 vs 2.7dB) and failed RL test (1.6 dB below specification, same values in both measurements). Overall, cable analyzer results were close to earlier values shown in Figure B-51.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 12/09 - 1+4+2+3

Test Summary: FAIL

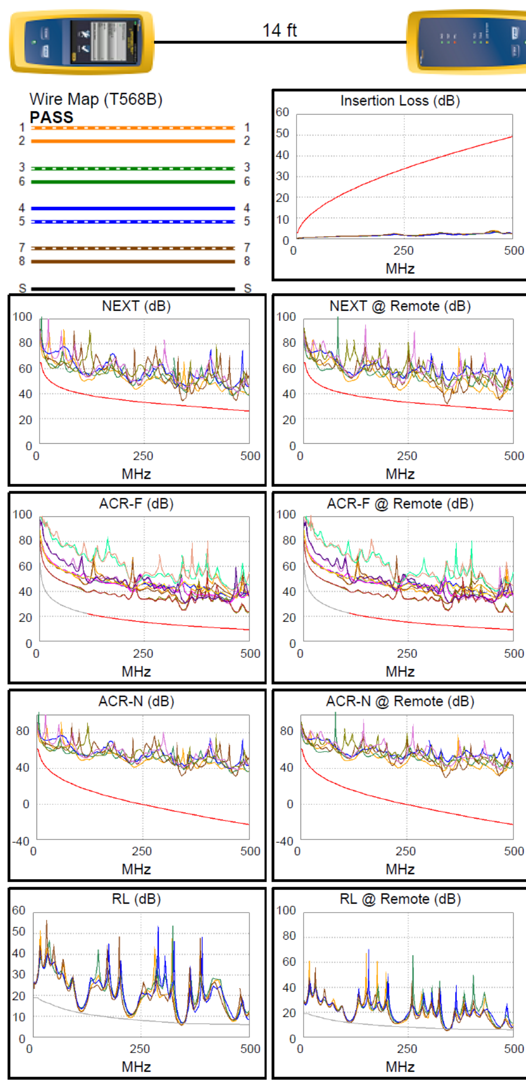
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/09/2022 10:35:30 AM
Operator: JONATHAN BRODT
Headroom 1.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	14
Prop. Delay (ns), Limit 555	[Pair 1,2]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.88
Insertion Loss Margin (dB)	[Pair 1,2]	42.9
Frequency (MHz)	[Pair 1,2]	461.0
Limit (dB)	[Pair 1,2]	47.2

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	3.3	1.5*	3.3	1.6
Freq. (MHz)	343.0	342.0	343.0	343.0
Limit (dB)	30.5	30.6	30.5	30.5
Worst Pair	4,5	3,6	4,5	3,6
PS NEXT (dB)	5.3	3.8	5.3	3.8
Freq. (MHz)	344.0	342.0	344.0	342.0
Limit (dB)	27.5	27.6	27.5	27.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	11.7	11.8	12.7	12.7
Freq. (MHz)	343.0	343.0	471.0	472.0
Limit (dB)	12.6	12.6	9.8	9.8
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-F (dB)	13.1	13.2	15.6	15.5
Freq. (MHz)	345.0	345.0	471.0	472.0
Limit (dB)	9.5	9.5	6.8	6.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	15.7	15.0	52.1	39.4
Freq. (MHz)	3.4	3.5	468.0	343.0
Limit (dB)	60.4	60.1	-20.7	-9.6
Worst Pair	3,6	1,2	4,5	3,6
PS ACR-N (dB)	16.8	14.7	53.6	40.9
Freq. (MHz)	3.4	3.9	468.0	342.0
Limit (dB)	57.9	56.7	-23.6	-12.5
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	-1.1 F	-1.6 F	-1.0	-1.5
Freq. (MHz)	342.0	342.0	344.0	344.0
Limit (dB)	6.7	6.7	6.6	6.6



* Measurement is within the accuracy limits of the instrument.

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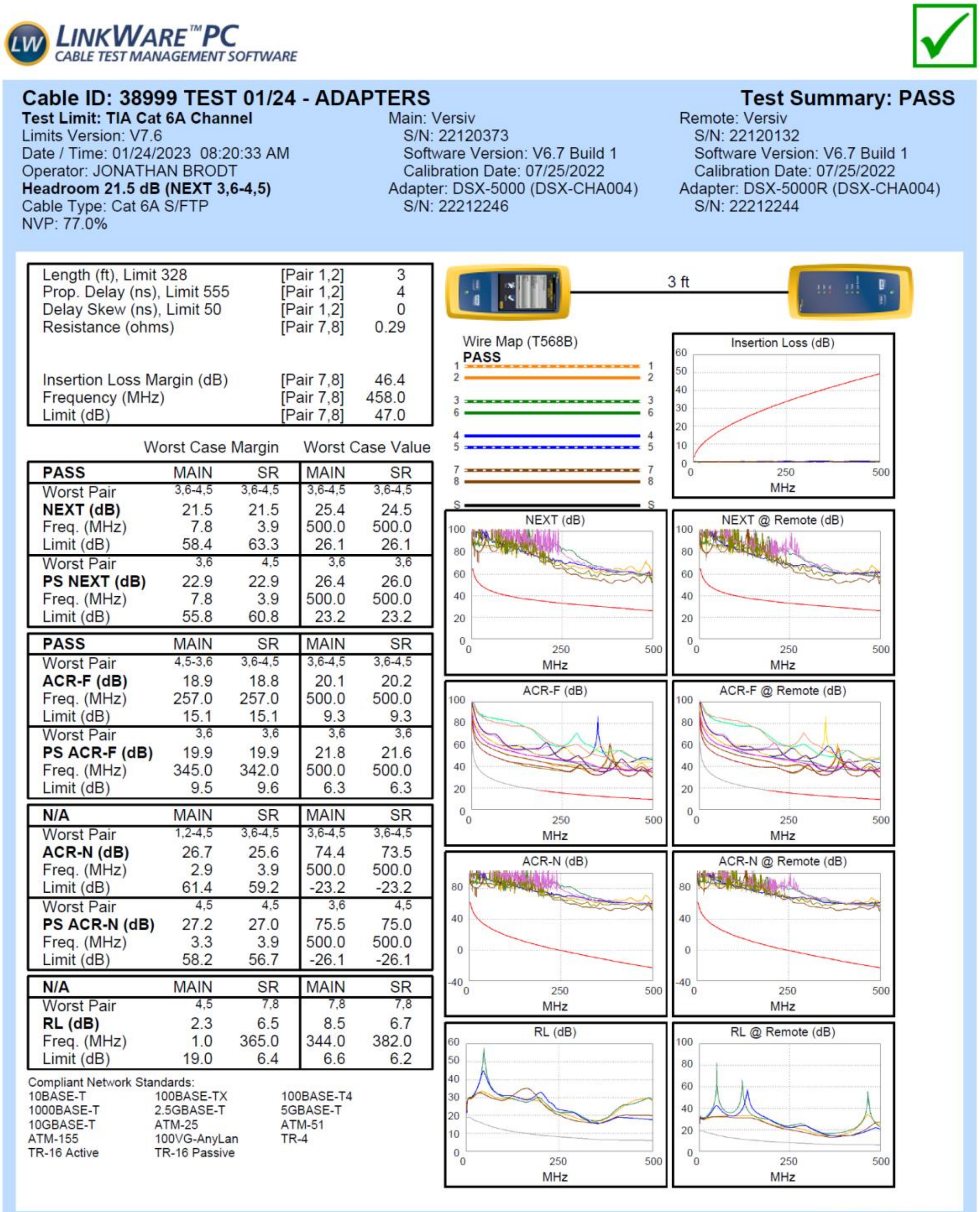
Figure B-53. Wire Segments were moved to Different Positions to Determine Impact on Cable Performance; Four Segments (1, 4, 2, and 3) Five M38999 Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements

Cable was properly connected and passed the NEXT tests with some margin (1.5 dB compared with 2.7 dB in the initial segment sequence) and failed the RL test (1.6 dB below specification for both cables). The NEXT margin decreased with changing the positions of the cable segments, but the RL did not change with the segment changes.



LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - ADAPTERS **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:20:33 AM
Operator: JONATHAN BRODT
Headroom 21.5 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	3
Prop. Delay (ns), Limit 555	[Pair 1,2]	4
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.29
Insertion Loss Margin (dB)	[Pair 7,8]	46.4
Frequency (MHz)	[Pair 7,8]	458.0
Limit (dB)	[Pair 7,8]	47.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	21.5	21.5	25.4	24.5
Freq. (MHz)	7.8	3.9	500.0	500.0
Limit (dB)	58.4	63.3	26.1	26.1
Worst Pair	3,6	4,5	3,6	3,6
PS NEXT (dB)	22.9	22.9	26.4	26.0
Freq. (MHz)	7.8	3.9	500.0	500.0
Limit (dB)	55.8	60.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	18.9	18.8	20.1	20.2
Freq. (MHz)	257.0	257.0	500.0	500.0
Limit (dB)	15.1	15.1	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.9	19.9	21.8	21.6
Freq. (MHz)	345.0	342.0	500.0	500.0
Limit (dB)	9.5	9.6	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	26.7	25.6	74.4	73.5
Freq. (MHz)	2.9	3.9	500.0	500.0
Limit (dB)	61.4	59.2	-23.2	-23.2
Worst Pair	4,5	4,5	3,6	4,5
PS ACR-N (dB)	27.2	27.0	75.5	75.0
Freq. (MHz)	3.3	3.9	500.0	500.0
Limit (dB)	58.2	56.7	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	2.3	6.5	8.5	6.7
Freq. (MHz)	1.0	365.0	344.0	382.0
Limit (dB)	19.0	6.4	6.6	6.2

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-54. Reworked Adaptor Cable with Two M38999 Connectors passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests and RL with good margins.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 1

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:24:31 AM
Operator: JONATHAN BRODT
Headroom 17.2 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

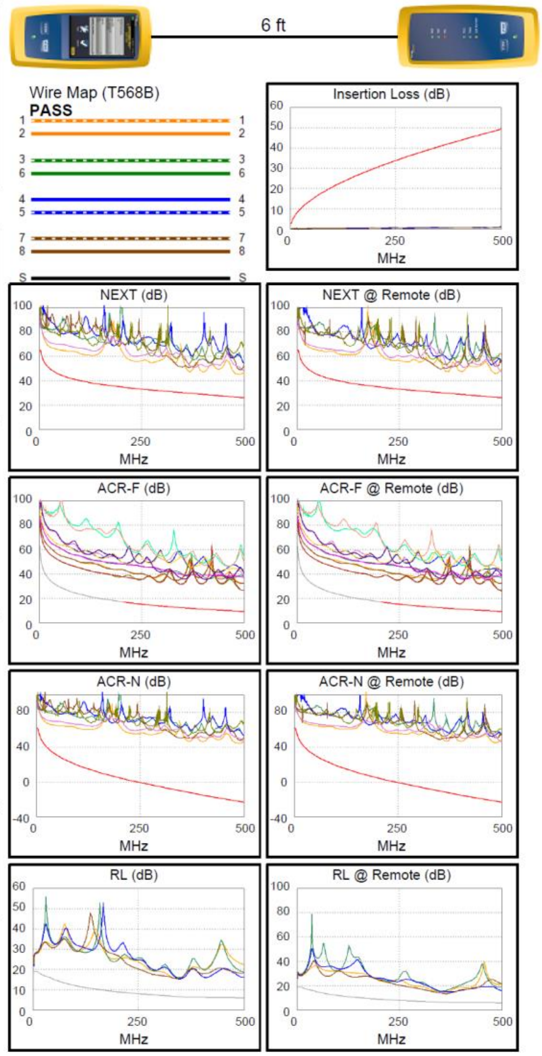
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.45
Insertion Loss Margin (dB)	[Pair 7,8]	48.1
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	17.2	17.5	18.7	19.5
Freq. (MHz)	19.0	367.0	487.0	486.0
Limit (dB)	52.0	29.7	26.4	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.2	17.9	20.2	21.2
Freq. (MHz)	366.0	367.0	489.0	487.0
Limit (dB)	26.8	26.8	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.3	17.1	17.3	17.1
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.2	19.3	19.2	19.3
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.5	22.5	66.5	67.2
Freq. (MHz)	3.0	1.5	487.0	486.0
Limit (dB)	61.4	62.0	-22.2	-22.1
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	23.0	22.9	68.1	69.0
Freq. (MHz)	3.1	3.3	489.0	487.0
Limit (dB)	58.3	58.2	-25.2	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	7,8
RL (dB)	2.6	7.0	8.6	7.0
Freq. (MHz)	1.0	1.0	347.0	364.0
Limit (dB)	19.0	19.0	6.6	6.4

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-55. Reworked Segment 1 Cable with Additional Shielding added with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
The rework improved the Ethernet Cat6A performance (see Figure B-45). As shown here, cable was properly connected and passed NEXT tests with good margin (17.1 vs 12.9 dB) and RL with some margin (2.6 vs 1.1 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 2

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:27:18 AM
Operator: JONATHAN BRODT
Headroom 17.4 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.45
Insertion Loss Margin (dB)	[Pair 7,8]	48.0
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	17.4	17.6	18.5	19.9
Freq. (MHz)	366.0	365.0	485.0	485.0
Limit (dB)	29.8	29.8	26.5	26.5
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.5	17.9	20.2	18.0
Freq. (MHz)	366.0	364.0	487.0	365.0
Limit (dB)	26.8	26.9	23.5	26.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.5	17.3	17.5	17.4
Freq. (MHz)	499.0	495.0	499.0	499.0
Limit (dB)	9.3	9.4	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	19.5	19.3	19.5
Freq. (MHz)	499.0	499.0	499.0	499.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	4,5-7,8	1,2-3,6	1,2-3,6
ACR-N (dB)	23.9	24.3	66.2	67.6
Freq. (MHz)	3.5	2.4	485.0	485.0
Limit (dB)	60.1	61.7	-22.0	-22.0
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	24.0	23.6	68.0	58.9
Freq. (MHz)	3.5	3.3	487.0	365.0
Limit (dB)	57.6	58.2	-25.1	-14.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	2.9	6.1	7.1	6.2
Freq. (MHz)	1.0	350.0	344.0	352.0
Limit (dB)	19.0	6.6	6.6	6.5

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

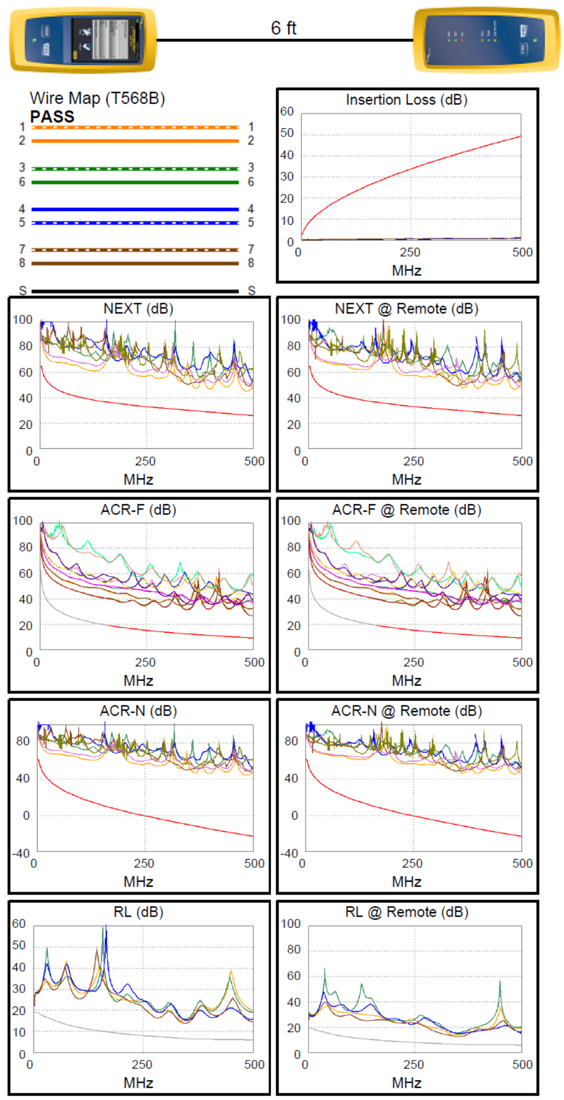


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Figure B-56. Reworked Segment 2 cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (17.4 vs 11.4 dB) and RL with some margin (2.9 vs 0.7 dB) (compare with Figure B-46).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:29:37 AM
Operator: JONATHAN BRODT
Headroom 16.6 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

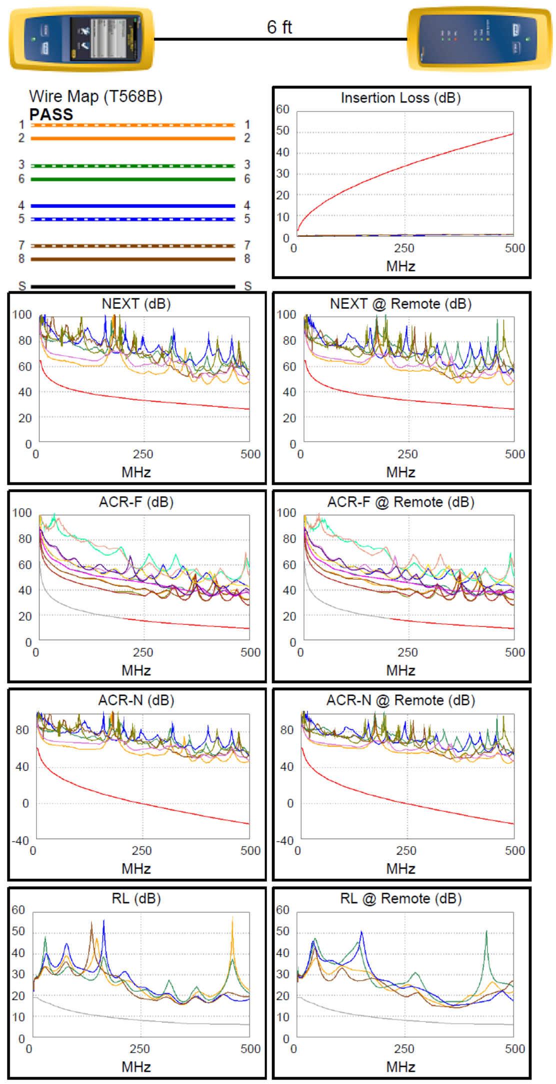
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 7,8]	48.2
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	16.6	17.1	17.4	19.1
Freq. (MHz)	19.0	368.0	401.0	488.0
Limit (dB)	52.0	29.7	28.7	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.6	17.7	21.7	17.8
Freq. (MHz)	366.0	364.0	487.0	365.0
Limit (dB)	26.8	26.9	23.5	26.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	18.6	18.5	18.6	18.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.0	20.1	20.1	20.3
Freq. (MHz)	347.0	346.0	497.0	500.0
Limit (dB)	9.5	9.5	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	4,5-7,8	1,2-3,6	1,2-3,6
ACR-N (dB)	23.9	24.3	60.3	67.0
Freq. (MHz)	3.6	3.1	401.0	488.0
Limit (dB)	59.8	61.1	-15.0	-22.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	23.4	22.9	69.5	58.6
Freq. (MHz)	3.4	3.3	487.0	365.0
Limit (dB)	57.9	58.2	-25.1	-14.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	1,2	7,8
RL (dB)	2.8	7.3	8.8	7.7
Freq. (MHz)	1.0	1.0	348.0	373.0
Limit (dB)	19.0	19.0	6.6	6.3

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-57. Reworked Segment 3 Cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (16.6 vs 14 dB) and RL with some margin (2.8 vs 2.3 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 4 | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:31:15 AM
Operator: JONATHAN BRODT
Headroom 16.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.45
Insertion Loss Margin (dB)	[Pair 7,8]	47.9
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	16.9	17.5	18.3	18.9
Freq. (MHz)	369.0	366.0	488.0	486.0
Limit (dB)	29.7	29.8	26.4	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	17.9	17.7	19.3	20.1
Freq. (MHz)	369.0	365.0	489.0	486.0
Limit (dB)	26.7	26.8	23.5	23.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	16.1	15.9	16.1	15.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.2	18.4	18.2	18.4
Freq. (MHz)	499.0	500.0	499.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	23.3	22.6	66.2	66.6
Freq. (MHz)	2.9	1.1	488.0	486.0
Limit (dB)	61.4	62.0	-22.3	-22.1
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	23.7	22.9	67.2	67.9
Freq. (MHz)	3.4	3.5	489.0	486.0
Limit (dB)	57.9	57.6	-25.2	-25.0
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	3.0	5.6	7.1	5.6
Freq. (MHz)	1.0	354.0	346.0	354.0
Limit (dB)	19.0	6.5	6.6	6.5

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

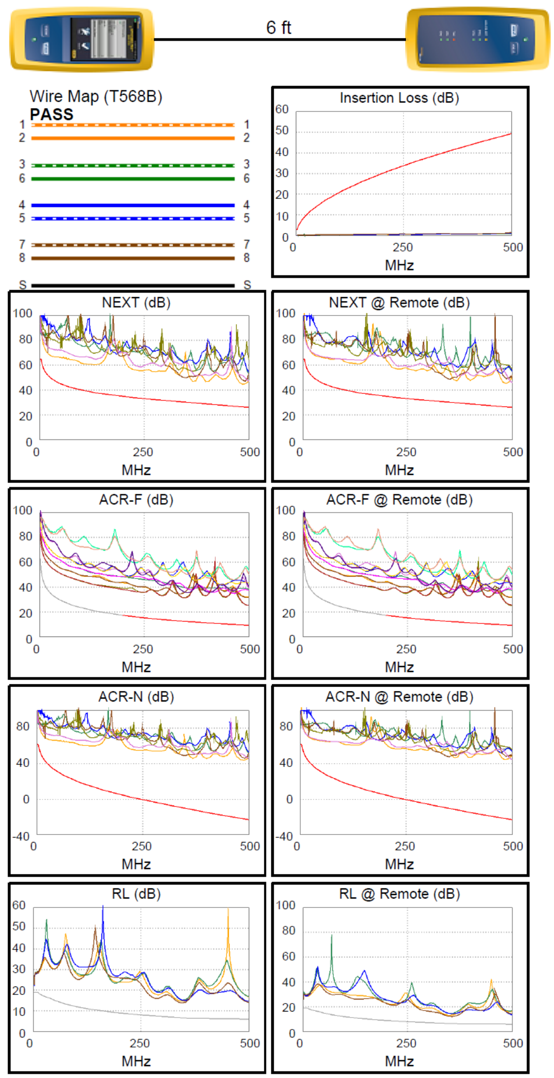


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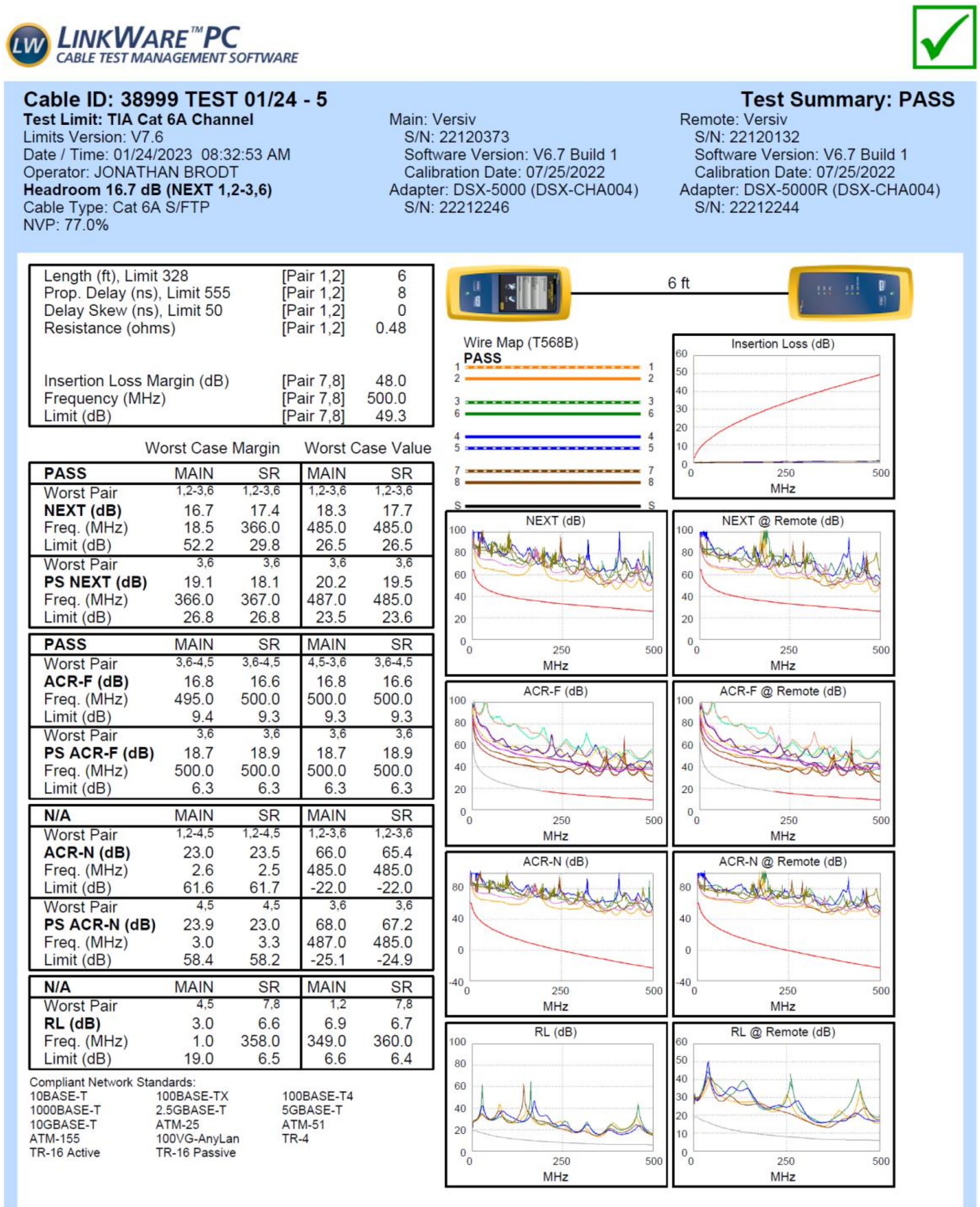
Figure B-58. Reworked Segment 4 Cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (16.9 vs 11.1 dB) and RL with some margin (3 vs 2.4 dB) (see Figure B-48).


LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 5
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:32:53 AM
Operator: JONATHAN BRODT
Headroom 16.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Test Summary: PASS
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 7,8]	48.0
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	16.7	17.4	18.3	17.7
Freq. (MHz)	18.5	366.0	485.0	485.0
Limit (dB)	52.2	29.8	26.5	26.5
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.1	18.1	20.2	19.5
Freq. (MHz)	366.0	367.0	487.0	485.0
Limit (dB)	26.8	26.8	23.5	23.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	16.8	16.6	16.8	16.6
Freq. (MHz)	495.0	500.0	500.0	500.0
Limit (dB)	9.4	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.7	18.9	18.7	18.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	23.0	23.5	66.0	65.4
Freq. (MHz)	2.6	2.5	485.0	485.0
Limit (dB)	61.6	61.7	-22.0	-22.0
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	23.9	23.0	68.0	67.2
Freq. (MHz)	3.0	3.3	487.0	485.0
Limit (dB)	58.4	58.2	-25.1	-24.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	1,2	7,8
RL (dB)	3.0	6.6	6.9	6.7
Freq. (MHz)	1.0	358.0	349.0	360.0
Limit (dB)	19.0	6.5	6.6	6.4

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-59. Reworked Segment 5 Cable with Two M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (16.7 dB) and RL with some margin (3.0 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 1+2 | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:40:48 AM
Operator: JONATHAN BRODT
Headroom 12.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	9
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.63
Insertion Loss Margin (dB)	[Pair 7,8]	47.3
Frequency (MHz)	[Pair 7,8]	494.0
Limit (dB)	[Pair 7,8]	49.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	12.9	13.1	13.0	13.9
Freq. (MHz)	357.0	357.0	500.0	499.0
Limit (dB)	30.1	30.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	15.3	15.2	15.3	16.0
Freq. (MHz)	500.0	358.0	500.0	499.0
Limit (dB)	23.2	27.1	23.2	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	18.2	18.2	18.2	18.3
Freq. (MHz)	486.0	484.0	486.0	486.0
Limit (dB)	9.5	9.6	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.4	19.5	20.1	19.9
Freq. (MHz)	343.0	343.0	484.0	483.0
Limit (dB)	9.6	9.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.3	24.0	61.0	61.8
Freq. (MHz)	7.8	1.1	500.0	499.0
Limit (dB)	52.7	62.0	-23.2	-23.1
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	22.6	22.7	63.3	64.0
Freq. (MHz)	3.9	3.3	500.0	499.0
Limit (dB)	56.7	58.2	-26.1	-26.0
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	3.6	6.8	7.5	6.8
Freq. (MHz)	1.0	346.0	343.0	346.0
Limit (dB)	19.0	6.6	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

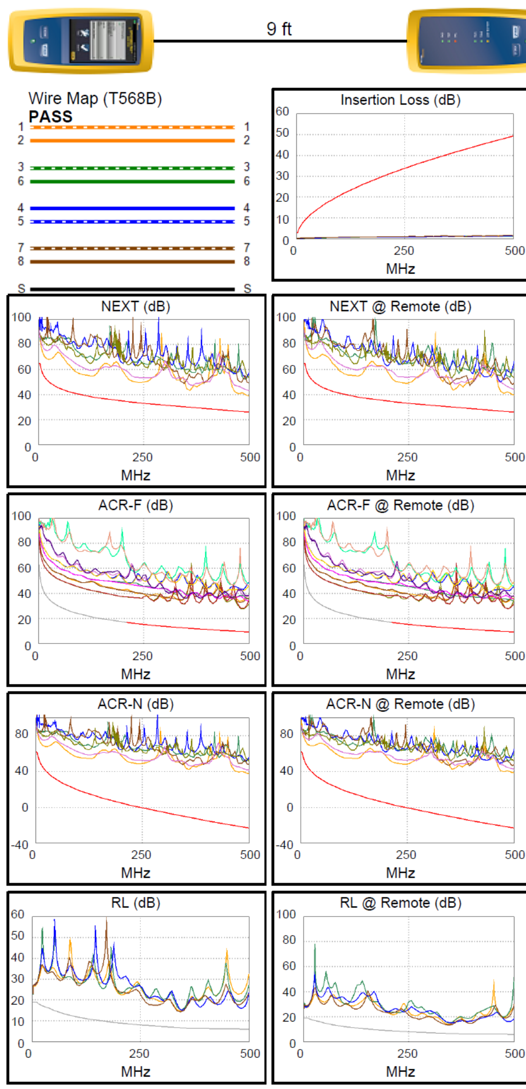


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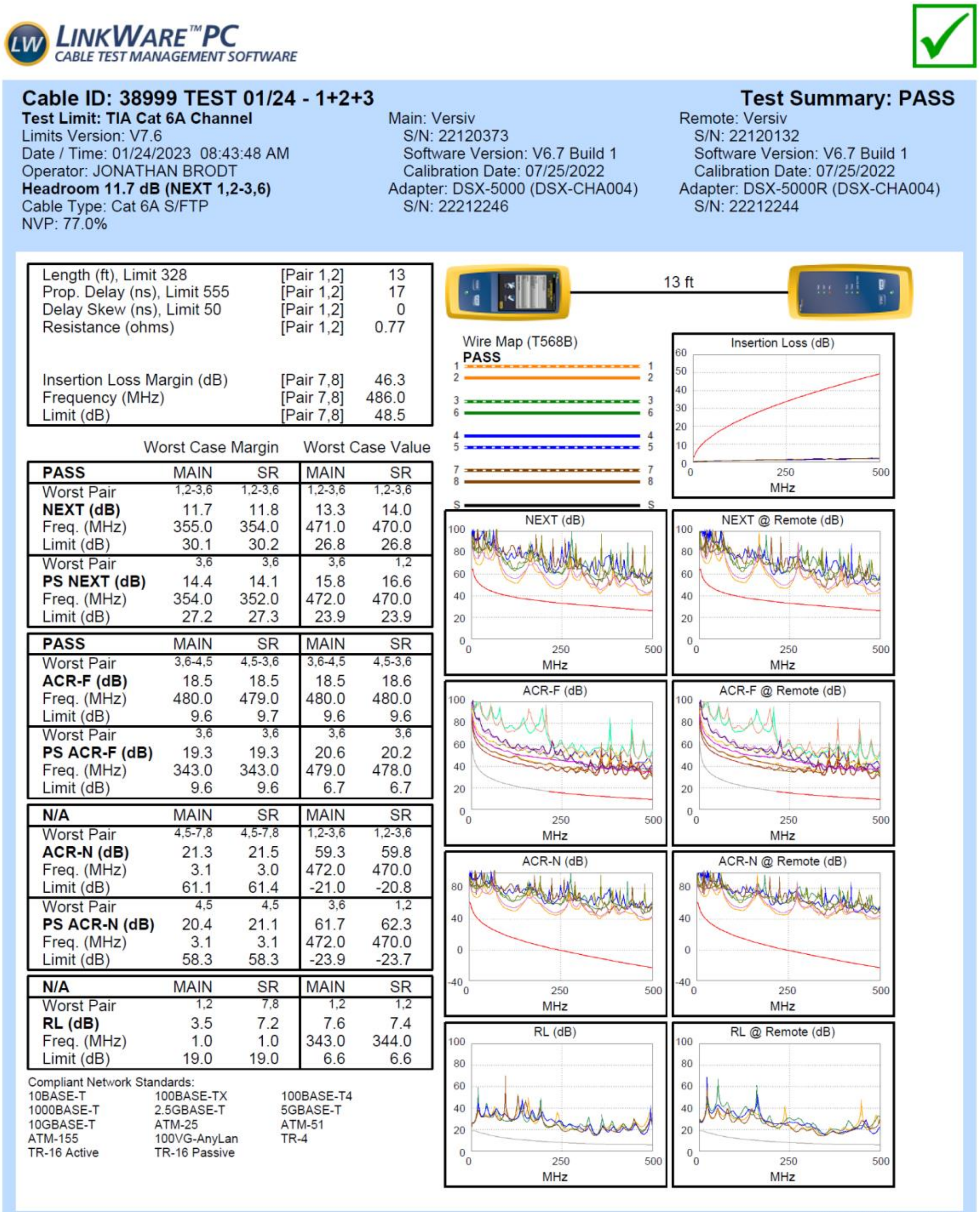
Figure B-60. Reworked Two Segments (1 and 2) with Three M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (12.9 vs 7.3 dB for cable prior to rework) and RL with some margin (3.6 vs 0.2 dB for cable prior to rework) (see Figure B-49).



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 1+2+3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:43:48 AM
Operator: JONATHAN BRODT
Headroom 11.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	13
Prop. Delay (ns), Limit 555	[Pair 1,2]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.77
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	486.0
Limit (dB)	[Pair 7,8]	48.5

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	11.7	11.8	13.3	14.0
Freq. (MHz)	355.0	354.0	471.0	470.0
Limit (dB)	30.1	30.2	26.8	26.8
Worst Pair	3,6	3,6	3,6	1,2
PS NEXT (dB)	14.4	14.1	15.8	16.6
Freq. (MHz)	354.0	352.0	472.0	470.0
Limit (dB)	27.2	27.3	23.9	23.9
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	18.5	18.5	18.5	18.6
Freq. (MHz)	480.0	479.0	480.0	480.0
Limit (dB)	9.6	9.7	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	19.3	20.6	20.2
Freq. (MHz)	343.0	343.0	479.0	478.0
Limit (dB)	9.6	9.6	6.7	6.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5-7,8	4,5-7,8	1,2-3,6	1,2-3,6
ACR-N (dB)	21.3	21.5	59.3	59.8
Freq. (MHz)	3.1	3.0	472.0	470.0
Limit (dB)	61.1	61.4	-21.0	-20.8
Worst Pair	4,5	4,5	3,6	1,2
PS ACR-N (dB)	20.4	21.1	61.7	62.3
Freq. (MHz)	3.1	3.1	472.0	470.0
Limit (dB)	58.3	58.3	-23.9	-23.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	1,2	1,2
RL (dB)	3.5	7.2	7.6	7.4
Freq. (MHz)	1.0	1.0	343.0	344.0
Limit (dB)	19.0	19.0	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-61. Reworked Three Segments (1, 2, and 3) Four M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (11.7 vs 3.8 dB for cable prior to rework) and RL with good margin (3.5 vs 0.9 dB for cable prior to rework) (see Figure B-50).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 1+2+3+4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:46:43 AM
Operator: JONATHAN BRODT
Headroom 9.3 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

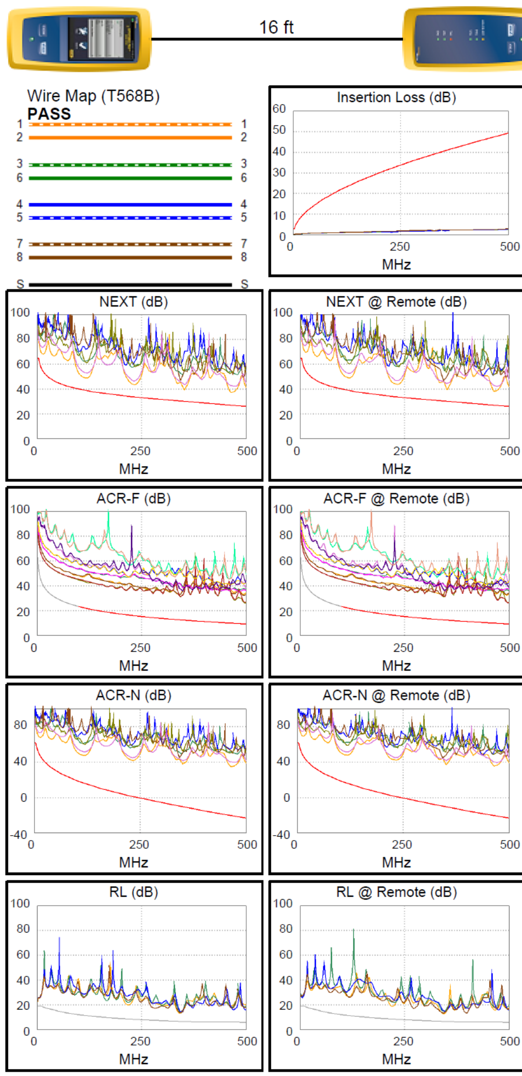
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	16
Prop. Delay (ns), Limit 555	[Pair 1,2]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.88
Insertion Loss Margin (dB)	[Pair 7,8]	46.4
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	9.3	9.4	10.0	10.9
Freq. (MHz)	353.0	351.0	467.0	467.0
Limit (dB)	30.2	30.3	26.9	26.9
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	12.0	11.9	12.7	13.5
Freq. (MHz)	352.0	351.0	467.0	467.0
Limit (dB)	27.3	27.3	24.0	24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.9	17.1	16.9	17.1
Freq. (MHz)	498.0	498.0	498.0	498.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.7	19.6	19.0
Freq. (MHz)	1.0	343.0	498.0	498.0
Limit (dB)	60.3	9.6	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	17.3	18.8	55.1	56.0
Freq. (MHz)	6.5	5.3	467.0	467.0
Limit (dB)	54.4	56.4	-20.6	-20.6
Worst Pair	1,2	4,5	3,6	3,6
PS ACR-N (dB)	19.1	19.4	57.8	58.6
Freq. (MHz)	3.5	3.4	467.0	467.0
Limit (dB)	57.6	57.9	-23.5	-23.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	3.6	6.0	6.4	6.0
Freq. (MHz)	1.0	344.0	344.0	344.0
Limit (dB)	19.0	6.6	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-62. Reworked Four Segments (1, 2, 3, and 4) Five M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (9.3 vs 2.7 dB for cable prior to rework) and RL test with good margin (3.6 vs 1.6 dB below specification for cable prior to rework) (see Figure B-51).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 38999 TEST 01/24 - 1+2+3+4+5

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 08:50:52 AM
Operator: JONATHAN BRODT
Headroom 7.8 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	20
Prop. Delay (ns), Limit 555	[Pair 1,2]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.99
Insertion Loss Margin (dB)	[Pair 7,8]	45.5
Frequency (MHz)	[Pair 7,8]	495.0
Limit (dB)	[Pair 7,8]	49.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	7.8	8.0	8.8	9.1
Freq. (MHz)	232.5	350.0	464.0	465.0
Limit (dB)	33.7	30.3	27.0	27.0
Worst Pair	1,2	3,6	1,2	3,6
PS NEXT (dB)	10.7	10.5	11.6	12.0
Freq. (MHz)	232.5	349.0	464.0	466.0
Limit (dB)	30.7	27.4	24.1	24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	17.0	17.1	17.0	17.1
Freq. (MHz)	492.0	492.0	492.0	492.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-F (dB)	18.1	18.0	19.7	19.1
Freq. (MHz)	343.0	343.0	492.0	492.0
Limit (dB)	9.6	9.6	6.4	6.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	15.2	16.0	53.3	53.6
Freq. (MHz)	3.9	3.8	464.0	465.0
Limit (dB)	59.2	59.5	-20.4	-20.4
Worst Pair	3,6	4,5	1,2	1,2
PS ACR-N (dB)	16.8	16.8	55.5	56.0
Freq. (MHz)	3.9	3.3	464.0	465.0
Limit (dB)	56.7	58.2	-23.2	-23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	6.7	6.6	6.8	6.6
Freq. (MHz)	342.0	343.0	343.0	343.0
Limit (dB)	6.7	6.6	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

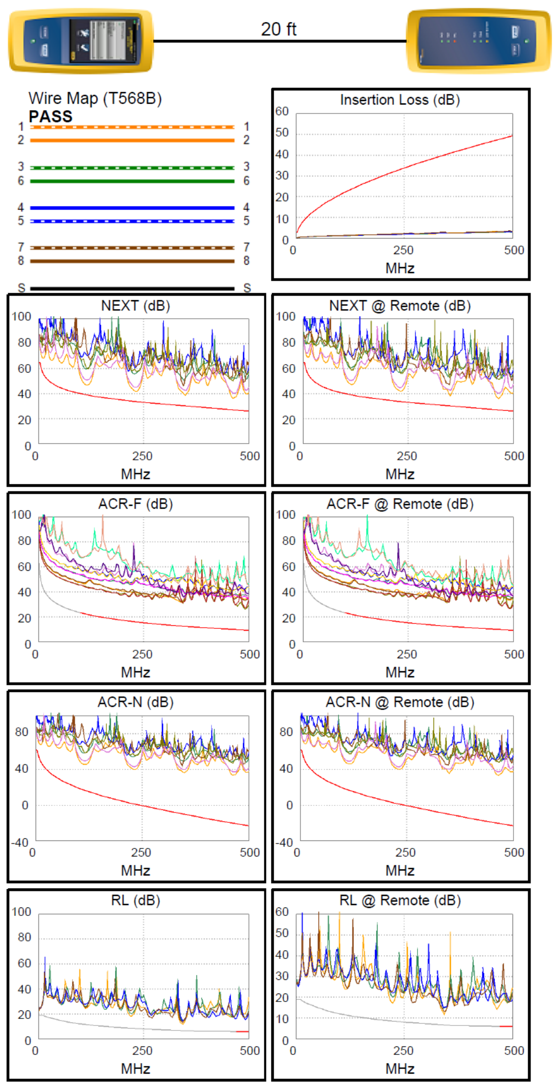


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Figure B-63. Reworked Five Segments (1, 2, 3, 4, and 5) Six M38999 Connectors in Series with Adaptor Cables passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (7.8 dB for cable prior to rework) and RL test with good margin (6.6 dB for cable prior to rework). Note that segment 5 was not tested previously.

Figure B-64. Cable Analyzer Setup with PIC Connectors showing Three 1-m Segments connected through Four PIC Connectors

LINKWARE™ PC CABLE TEST MANAGEMENT SOFTWARE

X

Cable ID: PIC TEST 11/29 - 1

Test Summary: FAIL

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 12/01/2022 12:28:34 AM
Operator: JONATHAN BRODT
Headroom -27.1 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A U/UTP
NVP: 68.2%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 7,8]	N/A
Prop. Delay (ns), Limit 555	[Pair 7,8]	No Reflec F
Delay Skew (ns), Limit 50	[Pair 7,8]	no reflecti F
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 4,5]	-0.6 F
Frequency (MHz)	[Pair 4,5]	1.5
Limit (dB)	[Pair 4,5]	3.0

	Worst Case Margin		Worst Case Value	
FAIL	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	-27.1 F	-26.4 F	-11.1	-13.8
Freq. (MHz)	1.0	1.0	406.0	248.0
Limit (dB)	65.0	65.0	28.6	33.2
Worst Pair	4,5	4,5	4,5	3,6
PS NEXT (dB)	-27.9 F	-27.5 F	-7.8	-11.8
Freq. (MHz)	1.0	3.3	500.0	248.0
Limit (dB)	62.0	62.0	23.2	30.2
FAIL	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	-28.3 F	-28.5 F	2.3	3.5
Freq. (MHz)	1.0	1.0	486.0	485.0
Limit (dB)	63.3	63.3	9.5	9.5
Worst Pair	4,5	4,5	4,5	4,5
PS ACR-F (dB)	-29.3 F	-29.3 F	4.3	5.8
Freq. (MHz)	1.0	1.0	486.0	500.0
Limit (dB)	60.3	60.3	6.5	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	-27.7	-27.0	33.4	35.3
Freq. (MHz)	1.0	1.0	500.0	489.0
Limit (dB)	62.0	62.0	-23.2	-22.3
Worst Pair	4,5	4,5	4,5	4,5
PS ACR-N (dB)	-28.5	-28.0	33.2	37.7
Freq. (MHz)	1.0	1.0	500.0	489.0
Limit (dB)	59.0	59.0	-26.1	-25.2
FAIL	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	3,6	4,5
RL (dB)	-8.9 F	-8.8 F	-6.0	-1.4
Freq. (MHz)	1.1	1.4	500.0	447.0
Limit (dB)	19.0	19.0	6.0	6.0

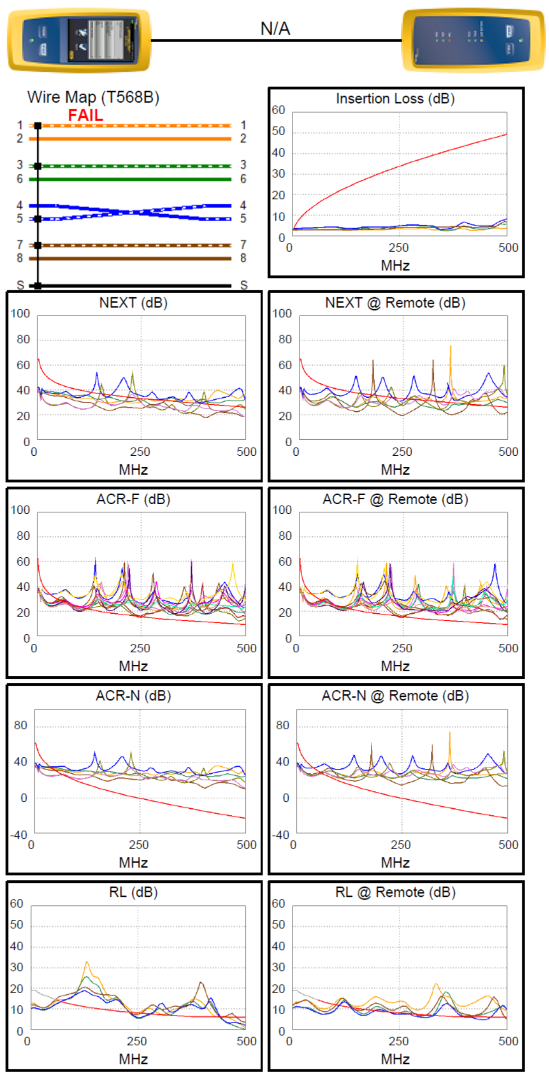

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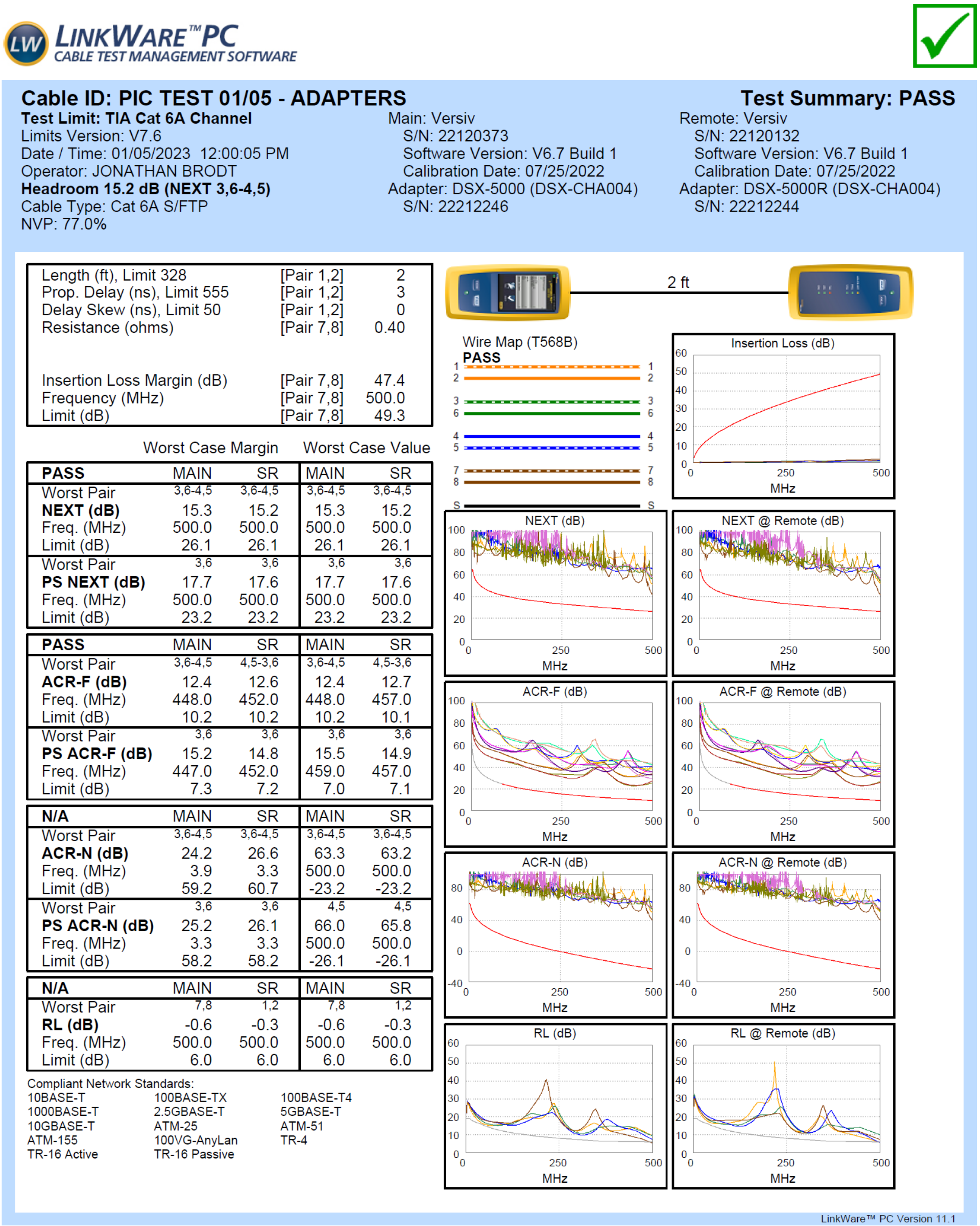
Figure B-65. Segment 1 Cable with Two PIC Ethernet Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable had an open twisted pair 1,2 and all tests were failed. All PIC segments gave similar results, so all cables were returned to technician for rework.



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/05 - ADAPTERS | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/05/2023 12:00:05 PM
Operator: JONATHAN BRODT
Headroom 15.2 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	2
Prop. Delay (ns), Limit 555	[Pair 1,2]	3
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.40
Insertion Loss Margin (dB)	[Pair 7,8]	47.4
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	15.3	15.2	15.3	15.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	26.1	26.1	26.1	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	17.7	17.6	17.7	17.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	23.2	23.2	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	12.4	12.6	12.4	12.7
Freq. (MHz)	448.0	452.0	448.0	457.0
Limit (dB)	10.2	10.2	10.2	10.1
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	15.2	14.8	15.5	14.9
Freq. (MHz)	447.0	452.0	459.0	457.0
Limit (dB)	7.3	7.2	7.0	7.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	24.2	26.6	63.3	63.2
Freq. (MHz)	3.9	3.3	500.0	500.0
Limit (dB)	59.2	60.7	-23.2	-23.2
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-N (dB)	25.2	26.1	66.0	65.8
Freq. (MHz)	3.3	3.3	500.0	500.0
Limit (dB)	58.2	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	7,8	1,2
RL (dB)	-0.6	-0.3	-0.6	-0.3
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-66. Adaptor PIC Cable with One PIC Connector passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (15.3 dB) and RL with a slight margin (–0.3 dB).

LinkWare™PC
CABLE TEST MANAGEMENT SOFTWARE

X

Cable ID: PIC TEST 01/10 - 1

Test Summary: FAIL

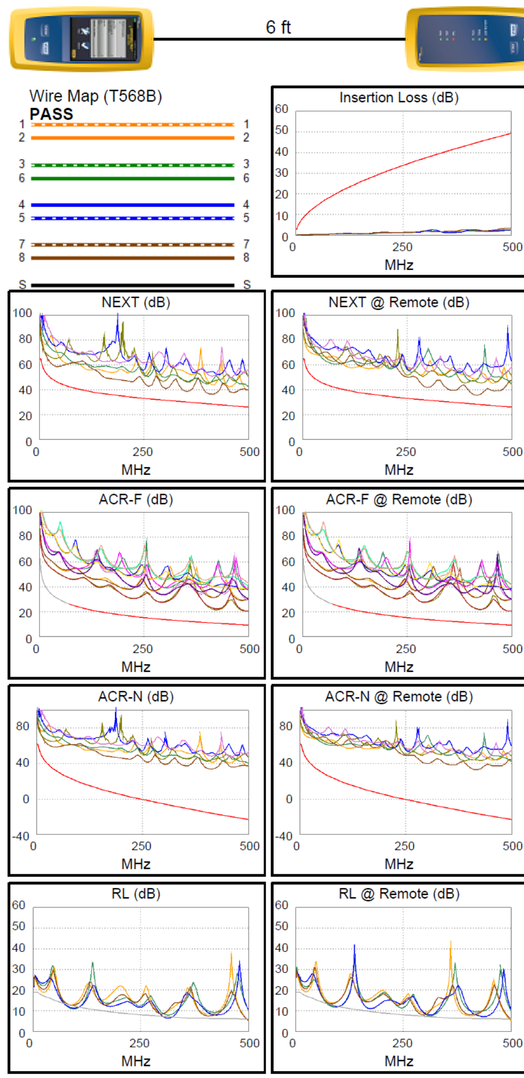
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/10/2023 09:18:04 AM
Operator: JONATHAN BRODT
Headroom 7.0 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	45.9
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.8	7.0	7.8	7.1
Freq. (MHz)	413.0	413.0	413.0	415.0
Limit (dB)	28.4	28.4	28.4	28.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	9.7	9.5	9.8	9.6
Freq. (MHz)	412.0	415.0	413.0	419.0
Limit (dB)	25.5	25.4	25.4	25.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	3,6-4,5
ACR-F (dB)	10.7	11.0	11.2	11.3
Freq. (MHz)	426.0	426.0	500.0	500.0
Limit (dB)	10.7	10.7	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	13.5	13.4	13.6	13.4
Freq. (MHz)	495.0	500.0	500.0	500.0
Limit (dB)	6.4	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	19.3	19.9	49.6	48.9
Freq. (MHz)	3.4	3.0	413.0	415.0
Limit (dB)	60.4	61.4	-16.1	-16.2
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	19.3	20.4	51.9	51.6
Freq. (MHz)	3.9	3.3	413.0	415.0
Limit (dB)	56.7	58.2	-19.0	-19.2
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	-0.8 F	0.0*	-0.8	0.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-67. Segment 1 PIC Cable with Two PIC Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (7.0 dB) and failed the RL with a negative margin (0.8 dB).

Cable ID: PIC TEST 01/10 - 2 | **Test Summary: FAIL**

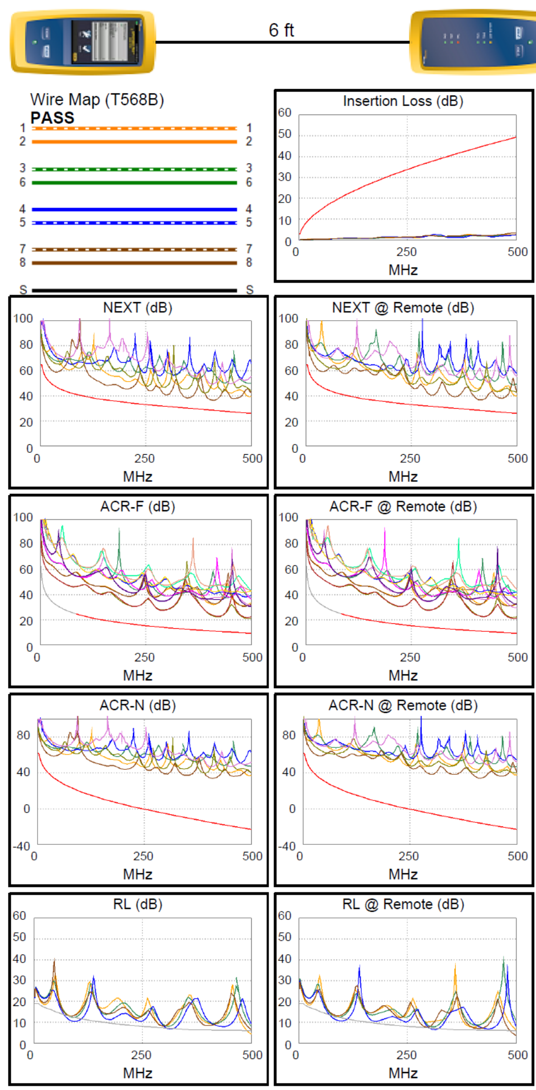
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/10/2023 09:29:29 AM
Operator: JONATHAN BRODT
Headroom 7.8 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	45.9
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.8	8.2	7.9	8.3
Freq. (MHz)	350.0	411.0	410.0	415.0
Limit (dB)	30.3	28.4	28.4	28.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.1	10.1	10.3	10.1
Freq. (MHz)	350.0	411.0	410.0	411.0
Limit (dB)	27.3	25.5	25.5	25.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	11.4	11.6	11.9	11.9
Freq. (MHz)	417.0	417.0	500.0	497.0
Limit (dB)	10.9	10.9	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.3	14.1	14.4	14.1
Freq. (MHz)	417.0	494.0	490.0	494.0
Limit (dB)	7.9	6.4	6.5	6.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	19.0	21.0	49.6	50.3
Freq. (MHz)	15.5	7.8	410.0	415.0
Limit (dB)	45.4	52.7	-15.8	-16.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	20.1	21.9	52.2	51.9
Freq. (MHz)	3.8	4.6	410.0	409.0
Limit (dB)	57.0	55.1	-18.7	-18.6
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	1,2	7,8
RL (dB)	0.5*	-2.3 F	-1.7	-2.3
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-68. Segment 2 PIC Cable with Two PIC Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (7.8 dB) and failed the RL with a negative margin (2.3 dB).

Cable ID: PIC TEST 01/10 - 3 **Test Summary: FAIL**

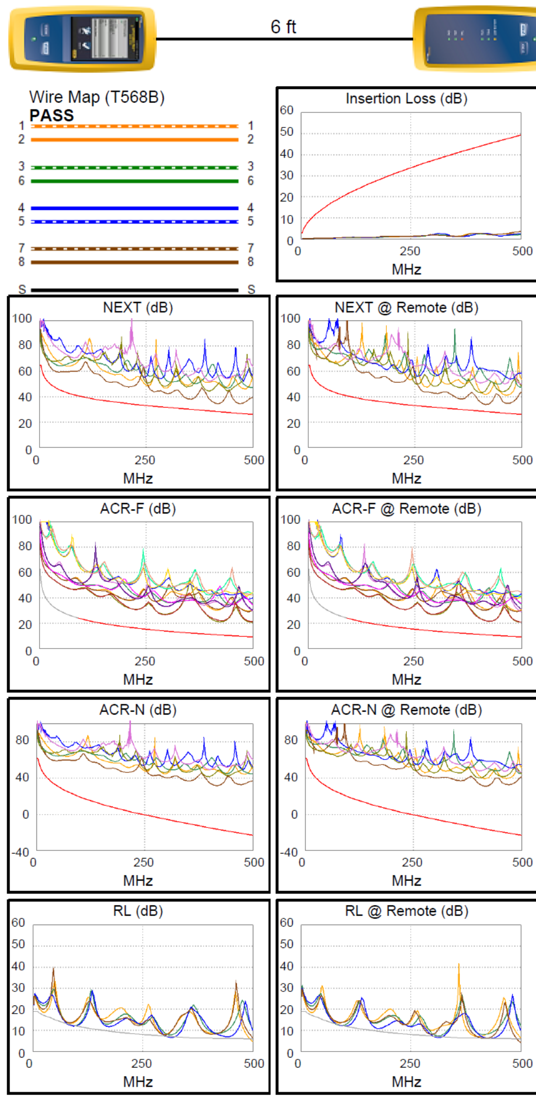
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/10/2023 09:31:12 AM
Operator: JONATHAN BRODT
Headroom 5.6 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	45.8
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	6.2	5.6	6.3	5.7
Freq. (MHz)	416.0	416.0	420.0	418.0
Limit (dB)	28.3	28.3	28.2	28.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	8.9	7.5	10.5	7.6
Freq. (MHz)	415.0	415.0	475.0	416.0
Limit (dB)	25.4	25.4	23.8	25.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	10.3	10.8	11.5	11.6
Freq. (MHz)	422.0	425.0	500.0	497.0
Limit (dB)	10.8	10.7	9.3	9.3
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-F (dB)	13.3	13.2	14.1	14.0
Freq. (MHz)	422.0	422.0	499.0	499.0
Limit (dB)	7.8	7.8	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	19.7	21.7	48.3	47.5
Freq. (MHz)	3.5	3.4	420.0	418.0
Limit (dB)	60.1	60.4	-16.7	-16.5
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-N (dB)	21.6	23.1	51.2	49.6
Freq. (MHz)	3.9	3.4	420.0	414.0
Limit (dB)	56.7	57.9	-19.6	-19.1
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	4,5	7,8
RL (dB)	0.5*	-1.8 F	-0.5	-1.8
Freq. (MHz)	500.0	500.0	315.0	500.0
Limit (dB)	6.0	6.0	7.0	6.0



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-69. Segment 3 PIC Cable with Two PIC Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (5.6 dB) and failed the RL with a negative margin (1.8 dB).

LinkWare™PC CABLE TEST MANAGEMENT SOFTWARE

X

Cable ID: PIC TEST 01/10 - 4

Test Summary: FAIL

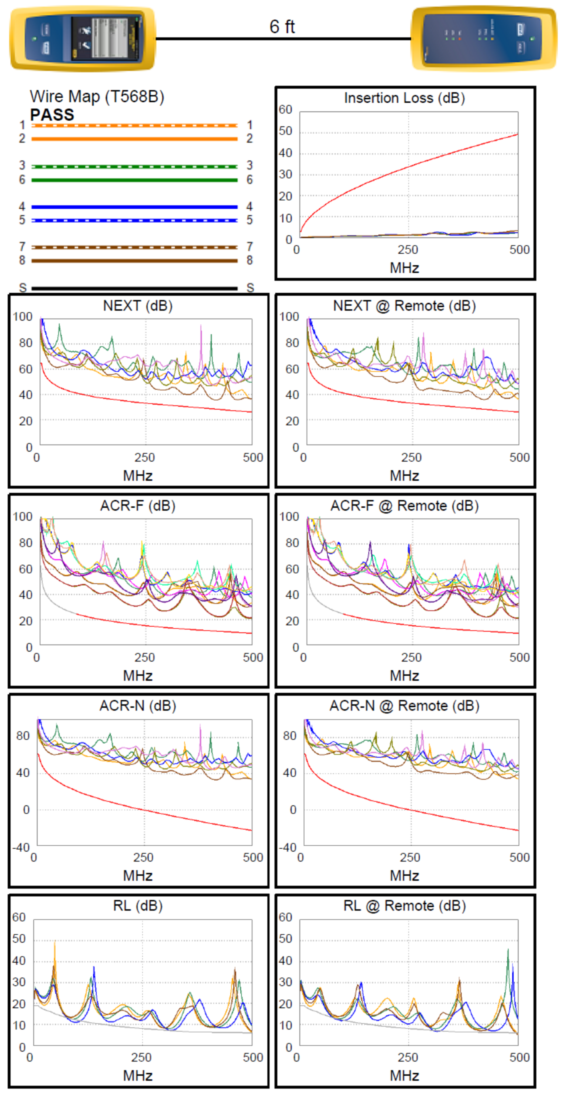
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/10/2023 09:33:39 AM
Operator: JONATHAN BRODT
Headroom 7.0 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	46.0
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.0	7.5	7.1	7.5
Freq. (MHz)	413.0	416.0	415.0	416.0
Limit (dB)	28.4	28.3	28.3	28.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	9.5	9.5	10.2	9.5
Freq. (MHz)	415.0	416.0	500.0	416.0
Limit (dB)	25.4	25.3	23.2	25.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	11.2	11.3	11.8	11.9
Freq. (MHz)	424.0	422.0	500.0	500.0
Limit (dB)	10.7	10.8	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	14.0	13.7	14.5	14.1
Freq. (MHz)	422.0	422.0	498.0	499.0
Limit (dB)	7.8	7.8	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	19.7	19.2	49.1	49.6
Freq. (MHz)	3.1	3.0	415.0	416.0
Limit (dB)	61.1	61.4	-16.2	-16.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	20.0	19.6	57.3	51.8
Freq. (MHz)	3.9	3.1	500.0	416.0
Limit (dB)	56.7	58.3	-26.1	-19.3
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	1,2	7,8
RL (dB)	0.6*	-0.9F	0.1	-0.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-70. Segment 4 PIC Cable with Two PIC Connectors in Series with Adaptor Cables failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with good margin (7.0 dB) and failed the RL with a negative margin (0.9 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/10 - 1+2 **Test Summary: FAIL**

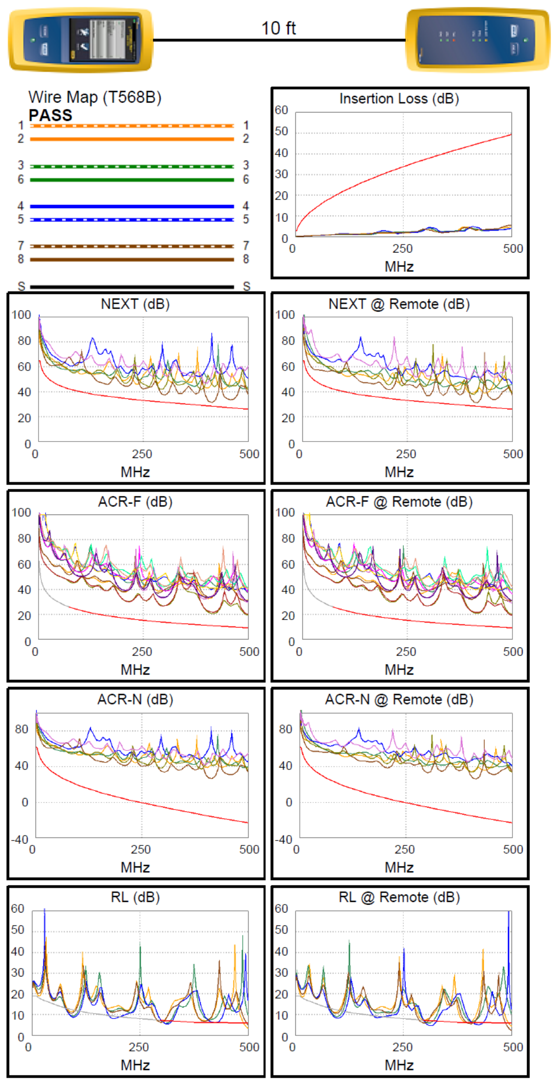
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/10/2023 09:38:05 AM
Operator: JONATHAN BRODT
Headroom 2.7 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 4,5]	10
Prop. Delay (ns), Limit 555	[Pair 1,2]	14
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.95
Insertion Loss Margin (dB)	[Pair 7,8]	43.8
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	2.9	2.7	2.9	2.7
Freq. (MHz)	413.0	415.0	413.0	415.0
Limit (dB)	28.4	28.3	28.4	28.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	5.6	4.3	5.7	4.3
Freq. (MHz)	412.0	412.0	414.0	412.0
Limit (dB)	25.5	25.5	25.4	25.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	9.7	9.9	10.2	10.0
Freq. (MHz)	417.0	417.0	500.0	500.0
Limit (dB)	10.9	10.9	9.3	9.3
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	12.7	12.5	13.1	12.5
Freq. (MHz)	417.0	500.0	500.0	500.0
Limit (dB)	7.9	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	18.1	17.0	42.5	42.3
Freq. (MHz)	3.0	20.0	413.0	414.0
Limit (dB)	61.4	42.5	-16.1	-16.2
Worst Pair	3,6	3,6	4,5	3,6
PS ACR-N (dB)	19.8	17.6	45.3	44.7
Freq. (MHz)	3.9	3.5	413.0	412.0
Limit (dB)	56.7	57.6	-19.0	-18.9
FAIL	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	1,2	7,8
RL (dB)	-2.7 F	-3.7 F	-2.7	-3.7
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.0	6.0	6.0	6.0



LinkWare™ PC Version 11.1

Figure B-71. Segments 1 and 2 PIC Cable with Three PIC Connectors in Series with Adaptor Cables Failed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with some margin (2.7 dB) and failed RL with a negative margin (3.7 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/24 - ADAPTERS

Test Summary: PASS

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 01/24/2023 11:10:31 AM
Operator: JONATHAN BRODT
Headroom 28.8 dB (NEXT 3,6-4,5)
Cable Type: Cat 5e F/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

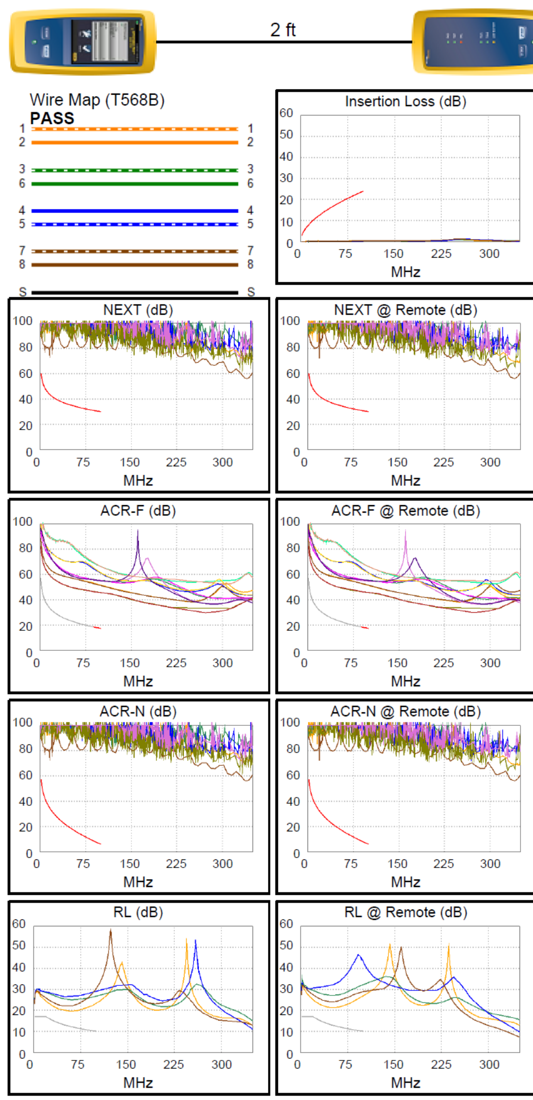
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	2
Prop. Delay (ns), Limit 555	[Pair 1,2]	3
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.48
Insertion Loss Margin (dB)	[Pair 1,2]	23.7
Frequency (MHz)	[Pair 1,2]	100.0
Limit (dB)	[Pair 1,2]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	29.7	28.8	32.1	33.3
Freq. (MHz)	2.0	1.5	15.5	19.0
Limit (dB)	58.4	60.0	43.8	42.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	30.2	30.5	35.1	36.1
Freq. (MHz)	1.6	1.5	15.5	19.0
Limit (dB)	56.9	57.0	40.8	39.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	25.7	25.8	28.2	28.2
Freq. (MHz)	5.4	9.4	100.0	100.0
Limit (dB)	42.8	38.0	17.4	17.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	26.8	26.9	29.8	30.0
Freq. (MHz)	1.0	1.3	100.0	100.0
Limit (dB)	54.4	52.5	14.4	14.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	32.8	31.8	40.9	43.1
Freq. (MHz)	2.0	1.5	15.5	19.0
Limit (dB)	55.3	57.0	34.9	32.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	33.2	33.5	43.9	45.9
Freq. (MHz)	1.6	1.5	15.5	19.0
Limit (dB)	53.9	54.0	31.9	29.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	1,2	1,2
RL (dB)	6.0	7.7	7.7	8.7
Freq. (MHz)	1.0	41.3	64.5	54.8
Limit (dB)	17.0	13.9	11.9	12.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive



LinkWare™ PC Version 11.1

Figure B-72. Adaptor PIC Cable with One PIC Connector passed Fluke Meter Cat6a Test Requirements
Cable was properly connected and passed NEXT tests with a good margin (28.8 dB) and RL with a good margin (6.0 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/24 - 1

Test Summary: PASS

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 01/24/2023 11:12:05 AM
Operator: JONATHAN BRODT
Headroom 28.2 dB (NEXT 3,6-4,5)
Cable Type: Cat 5e F/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

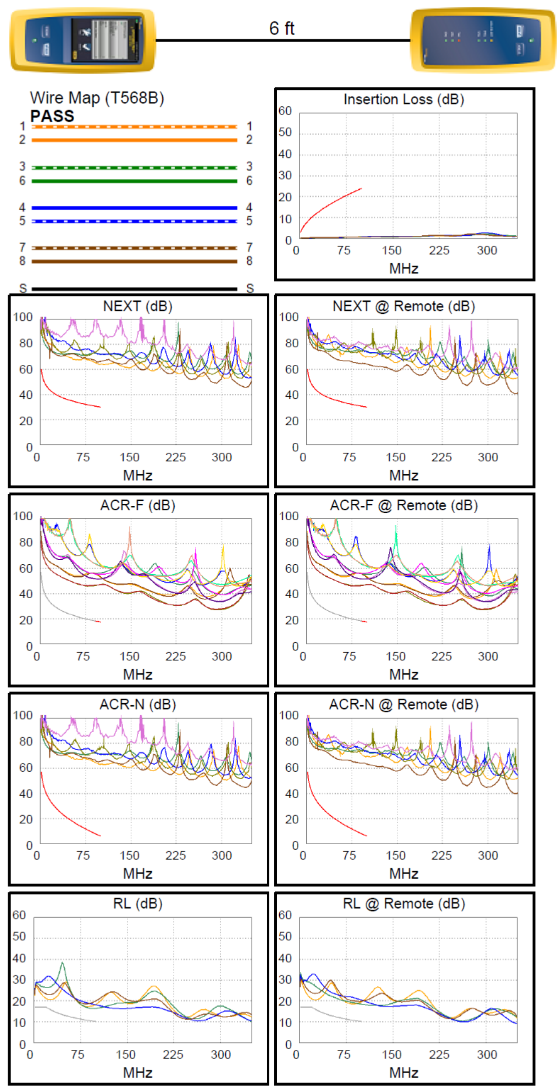
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 1,2]	23.3
Frequency (MHz)	[Pair 1,2]	100.0
Limit (dB)	[Pair 1,2]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	1,2-3,6	3,6-4,5
NEXT (dB)	28.2	29.1	33.8	34.1
Freq. (MHz)	15.5	1.8	99.3	100.0
Limit (dB)	43.8	59.4	30.1	30.1
Worst Pair	3,6	4,5	3,6	3,6
PS NEXT (dB)	29.1	29.4	34.6	35.9
Freq. (MHz)	1.4	1.3	98.8	100.0
Limit (dB)	57.0	57.0	27.2	27.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	4,5-3,6
ACR-F (dB)	25.9	25.9	27.3	27.3
Freq. (MHz)	6.9	5.6	84.8	85.5
Limit (dB)	40.7	42.4	18.8	18.8
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	26.8	27.0	29.6	29.0
Freq. (MHz)	1.0	1.1	87.5	85.5
Limit (dB)	54.4	53.4	15.6	15.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	1,2-3,6	3,6-4,5
ACR-N (dB)	32.0	32.0	57.0	57.4
Freq. (MHz)	1.4	1.8	99.3	100.0
Limit (dB)	57.0	56.4	6.2	6.1
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	32.1	32.4	57.8	59.2
Freq. (MHz)	1.4	1.3	98.8	100.0
Limit (dB)	54.0	54.0	3.3	3.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	3,6	3,6
RL (dB)	4.1	3.9	6.3	8.4
Freq. (MHz)	21.6	20.0	100.0	100.0
Limit (dB)	16.7	17.0	10.0	10.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive



LinkWare™ PC Version 11.1

Figure B-73. Segment 1 PIC Cable with Two PIC Connectors in Series with Adaptor Cables passed Fluke Meter Cat5e Test Requirements
Cable was properly connected and passed NEXT tests with a good margin (28.1 dB) and the RL with a good margin (3.9 dB).

LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/24 - 1+2

Test Summary: PASS

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 01/24/2023 11:14:24 AM
Operator: JONATHAN BRODT
Headroom 24.8 dB (NEXT 3,6-7,8)
Cable Type: Cat 5e F/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	9
Prop. Delay (ns), Limit 555	[Pair 1,2]	14
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 7,8]	0.90
Insertion Loss Margin (dB)	[Pair 4,5]	22.7
Frequency (MHz)	[Pair 4,5]	100.0
Limit (dB)	[Pair 4,5]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-7,8	3,6-7,8	3,6-7,8
NEXT (dB)	24.9	24.8	25.2	25.7
Freq. (MHz)	1.4	38.3	95.5	93.5
Limit (dB)	60.0	37.2	30.4	30.6
Worst Pair	1,2	3,6	3,6	3,6
PS NEXT (dB)	25.3	24.6	25.7	25.3
Freq. (MHz)	74.5	41.0	100.0	100.0
Limit (dB)	29.3	33.7	27.1	27.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	26.0	26.1	26.3	26.4
Freq. (MHz)	81.8	79.8	84.0	84.3
Limit (dB)	19.2	19.4	18.9	18.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	27.3	27.4	28.7	28.5
Freq. (MHz)	1.0	1.3	84.3	84.0
Limit (dB)	54.4	52.5	15.9	15.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-7,8	1,2-4,5
ACR-N (dB)	27.9	28.4	47.5	49.2
Freq. (MHz)	1.4	1.4	95.5	100.0
Limit (dB)	57.0	57.0	7.0	6.1
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	30.0	29.0	48.5	48.1
Freq. (MHz)	2.0	1.6	100.0	100.0
Limit (dB)	52.3	53.9	3.1	3.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	4,5	4,5
RL (dB)	2.5	3.0	2.6	3.5
Freq. (MHz)	99.0	18.3	100.0	100.0
Limit (dB)	10.1	17.0	10.0	10.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive

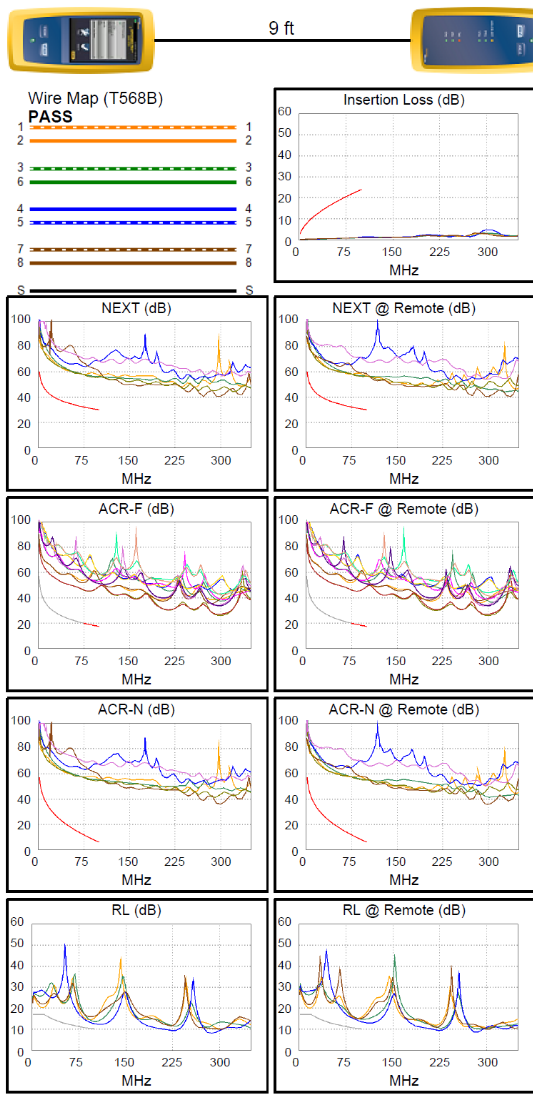


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Figure B-74. Segments 1 and 2 PIC Cable with Three PIC Connectors in Series with Adaptor Cables passed Fluke Meter Cat5e Test Requirements
Cable was properly connected and passed NEXT tests with good margin (24.8 dB) and the RL with some margin (2.5 dB).

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/24 - 1+2+3 | **Test Summary: PASS**

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 01/24/2023 11:15:57 AM
Operator: JONATHAN BRODT
Headroom 23.1 dB (NEXT 1,2-4,5)
Cable Type: Cat 5e F/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	12
Prop. Delay (ns), Limit 555	[Pair 1,2]	19
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	1.24
Insertion Loss Margin (dB)	[Pair 4,5]	22.1
Frequency (MHz)	[Pair 4,5]	100.0
Limit (dB)	[Pair 4,5]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	3,6-7,8	3,6-7,8	3,6-7,8
NEXT (dB)	23.1	23.5	23.4	23.6
Freq. (MHz)	71.8	93.8	95.3	94.5
Limit (dB)	32.6	30.6	30.4	30.5
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	23.7	23.9	24.1	24.5
Freq. (MHz)	91.3	90.0	100.0	100.0
Limit (dB)	27.8	27.9	27.1	27.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	25.7	25.7	25.8	26.0
Freq. (MHz)	86.3	85.5	87.5	88.3
Limit (dB)	18.7	18.8	18.6	18.5
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-F (dB)	27.0	27.2	27.8	28.0
Freq. (MHz)	1.0	1.0	89.8	90.3
Limit (dB)	54.4	54.4	15.3	15.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-7,8	3,6-7,8
ACR-N (dB)	27.8	28.1	45.2	45.4
Freq. (MHz)	1.4	1.4	95.3	94.5
Limit (dB)	57.0	57.0	7.1	7.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	29.3	28.9	46.3	46.7
Freq. (MHz)	2.0	1.5	100.0	100.0
Limit (dB)	52.3	54.0	3.1	3.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	0.4	1.1	0.4	1.1
Freq. (MHz)	100.0	100.0	100.0	100.0
Limit (dB)	10.0	10.0	10.0	10.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive

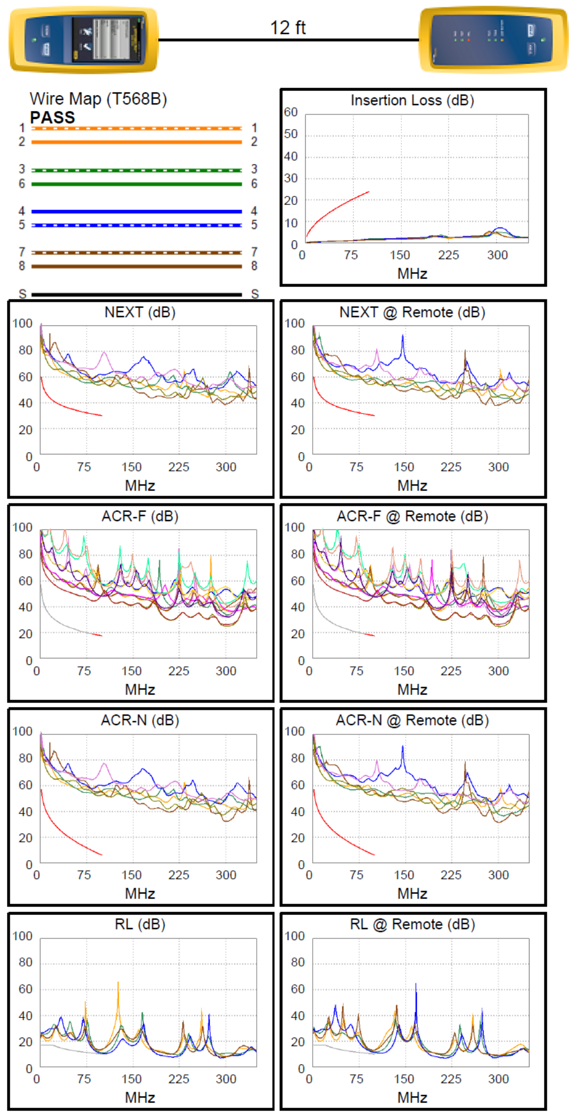

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Figure B-75. Segments 1, 2, and 3 PIC Cable with Four PIC Connectors in Series with Adaptor Cables passed Fluke Meter Cat5e Test Requirements
Cable was properly connected and passed NEXT tests with good margin (23.1 dB) and the RL with some margin (0.4 dB).

LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: PIC TEST 01/24 - 1+2+3+4

Test Summary: PASS

Test Limit: TIA Cat 5e Channel
Limits Version: V7.6
Date / Time: 01/24/2023 11:17:13 AM
Operator: JONATHAN BRODT
Headroom 20.6 dB (NEXT 3,6-7,8)
Cable Type: Cat 5e F/UTP
NVP: 69.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	16
Prop. Delay (ns), Limit 555	[Pair 1,2]	24
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	1.52
Insertion Loss Margin (dB)	[Pair 4,5]	21.5
Frequency (MHz)	[Pair 4,5]	100.0
Limit (dB)	[Pair 4,5]	24.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-7,8	3,6-7,8
NEXT (dB)	20.6	21.3	20.6	21.5
Freq. (MHz)	94.8	93.8	94.8	95.5
Limit (dB)	30.5	30.6	30.5	30.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	21.0	22.5	21.0	22.7
Freq. (MHz)	94.8	93.8	94.8	96.0
Limit (dB)	27.5	27.6	27.5	27.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	25.3	25.3	25.5	25.4
Freq. (MHz)	89.5	88.5	90.8	90.0
Limit (dB)	18.4	18.5	18.2	18.3
Worst Pair	3,6	4,5	4,5	3,6
PS ACR-F (dB)	27.3	27.3	27.4	27.5
Freq. (MHz)	1.1	1.1	92.0	91.3
Limit (dB)	53.4	53.4	15.1	15.2
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-7,8	3,6-7,8
ACR-N (dB)	25.8	27.5	42.0	43.0
Freq. (MHz)	2.1	1.9	94.8	95.5
Limit (dB)	54.8	55.8	7.2	7.0
Worst Pair	1,2	1,2	3,6	3,6
PS ACR-N (dB)	27.2	28.3	43.0	45.0
Freq. (MHz)	1.8	1.8	97.3	100.0
Limit (dB)	53.4	53.4	3.6	3.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	4,5	4,5
RL (dB)	-1.3	-1.1	-1.3	-1.1
Freq. (MHz)	100.0	100.0	100.0	100.0
Limit (dB)	10.0	10.0	10.0	10.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	ATM-25
ATM-51	ATM-155	100VG-AnyLan
TR-4	TR-16 Active	TR-16 Passive

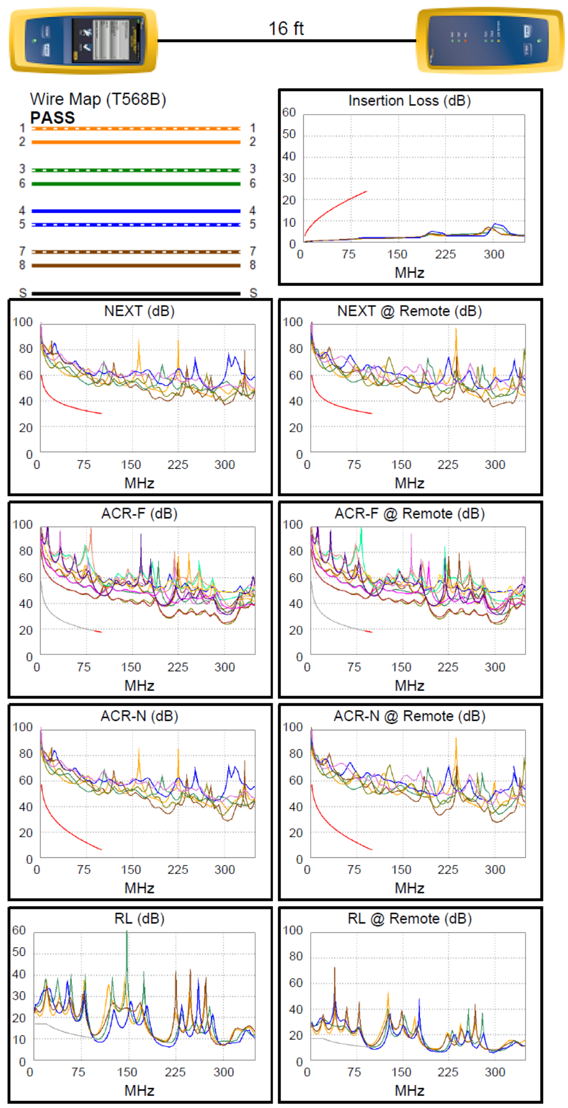

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Figure B-76. Segments 1, 2, 3, and 4 PIC Cable with Five PIC Connectors in Series with Adaptor Cables passed Fluke Meter Cat5e Test Requirements
Cable was properly connected and passed NEXT tests with good margin (20.6 dB) and the RL with some margin (1.1 dB).

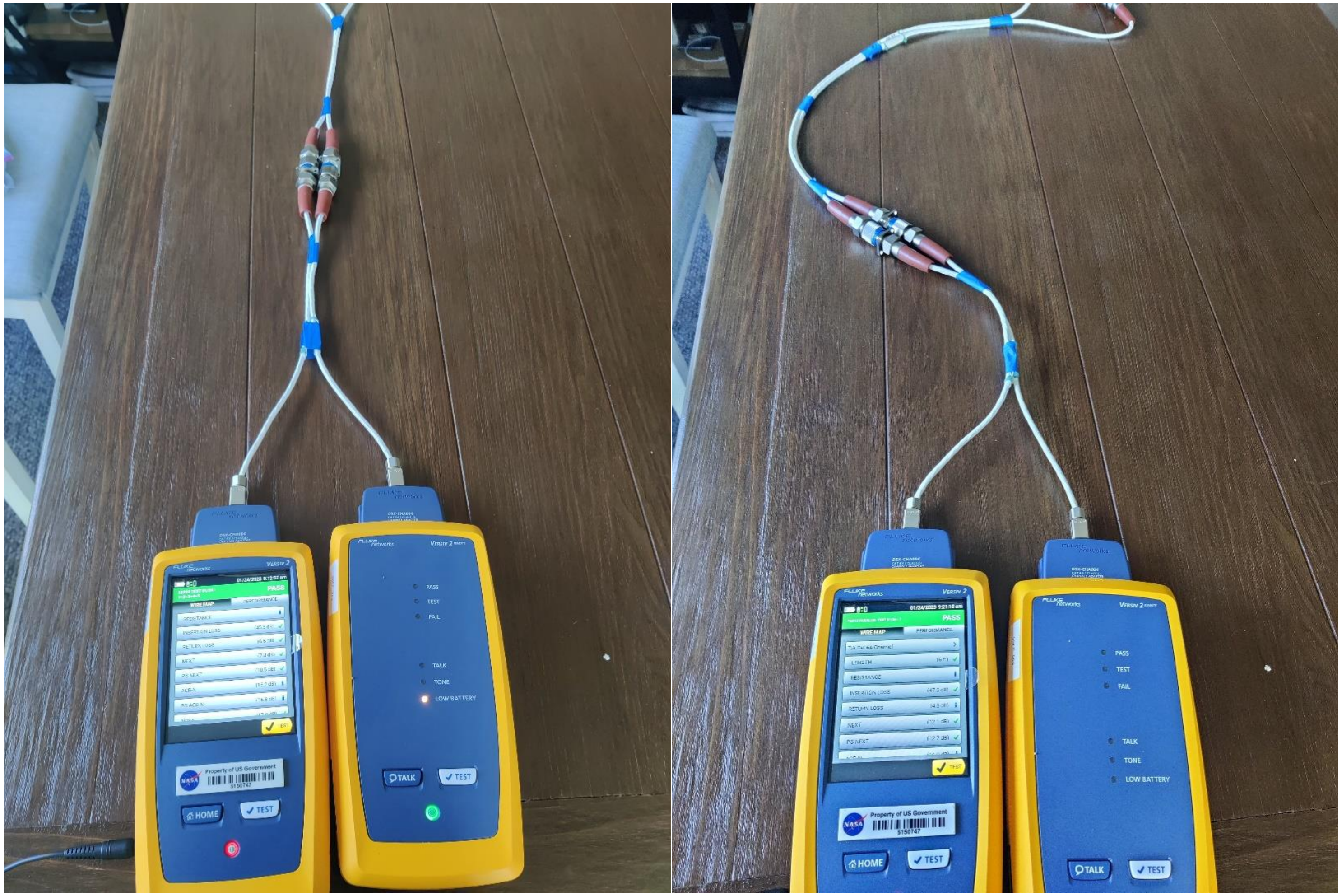


Figure B-77. Cable Analyzer Test with One and Two Gore Cable and CeeLok FAS-X Connector Segments adjacent to Measure Potential Crosstalk between Ethernet Pairs

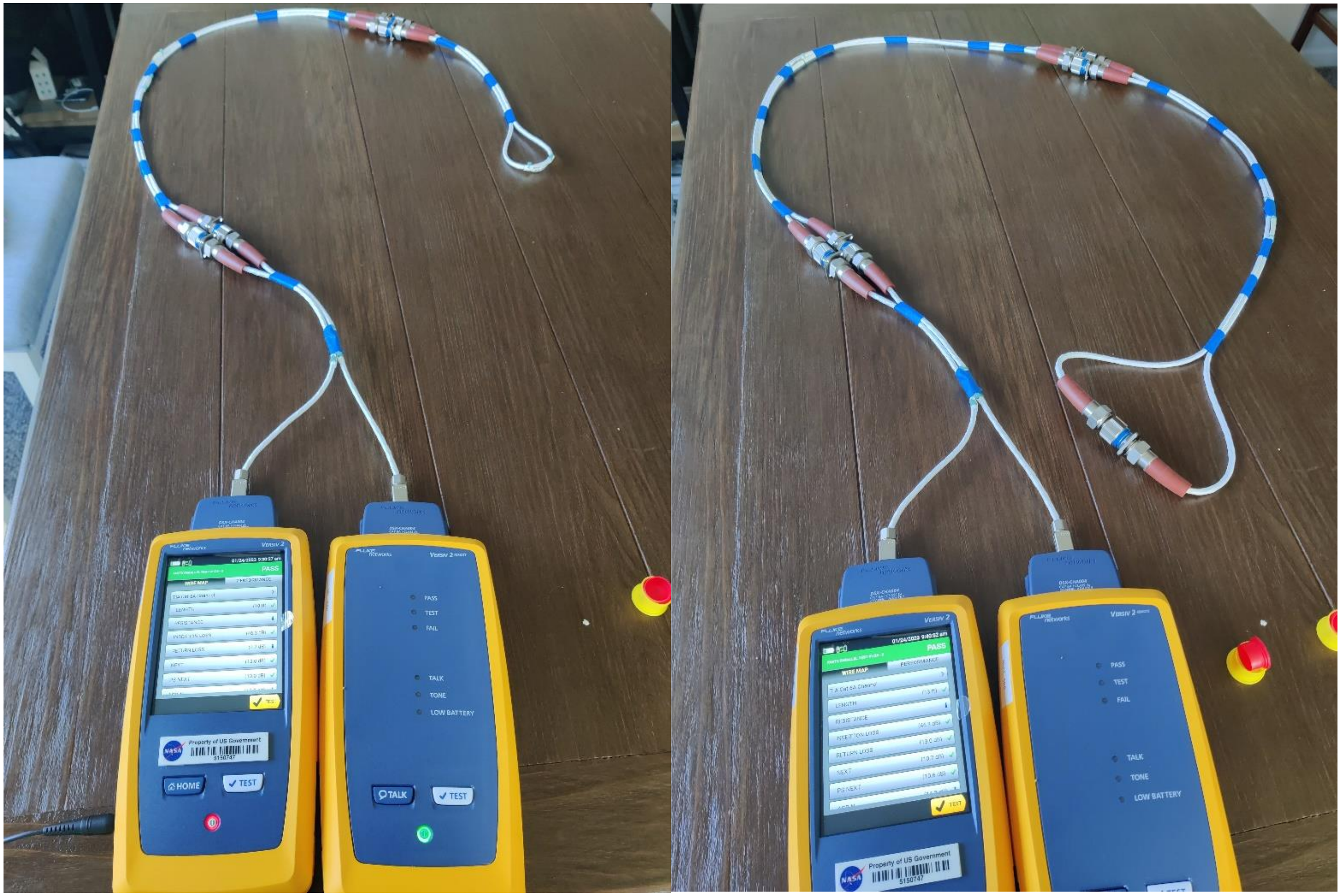


Figure B-78. Cable Analyzer Test with Three and Four Gore Cable and CeeLok FAS-X Connector Segments Adjacent to Measure Potential Crosstalk between Ethernet Pairs

Figure B-79. Cable Analyzer Test with Five Gore Cable and CeeLok FAS-X Connector Segments adjacent to Measure Potential Crosstalk between Ethernet Pairs

LinkWare™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX PARALLEL TEST 01/24 - 1

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 09:13:14 AM
Operator: JONATHAN BRODT
Headroom 12.1 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	47.5
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	13.2	12.1	15.3	16.1
Freq. (MHz)	4.6	13.4	500.0	500.0
Limit (dB)	62.0	54.5	26.1	26.1
Worst Pair	3,6	3,6	1,2	1,2
PS NEXT (dB)	14.0	12.7	16.4	16.7
Freq. (MHz)	4.6	7.8	500.0	500.0
Limit (dB)	59.5	55.8	23.2	23.2

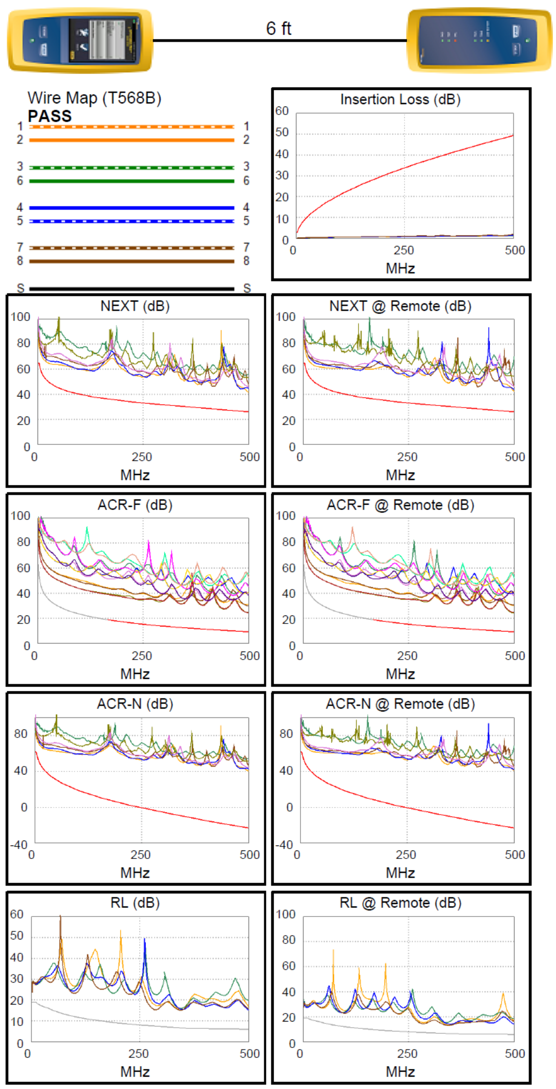
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.3	15.0	15.3	15.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.2	17.4	17.2	17.4
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	16.7	16.0	63.4	64.2
Freq. (MHz)	3.0	3.1	500.0	500.0
Limit (dB)	61.4	61.1	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	17.8	16.9	64.3	64.6
Freq. (MHz)	3.3	3.3	500.0	500.0
Limit (dB)	58.2	58.2	-26.1	-26.1

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.5	6.4	8.4	6.5
Freq. (MHz)	1.0	342.0	345.0	348.0
Limit (dB)	19.0	6.7	6.6	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



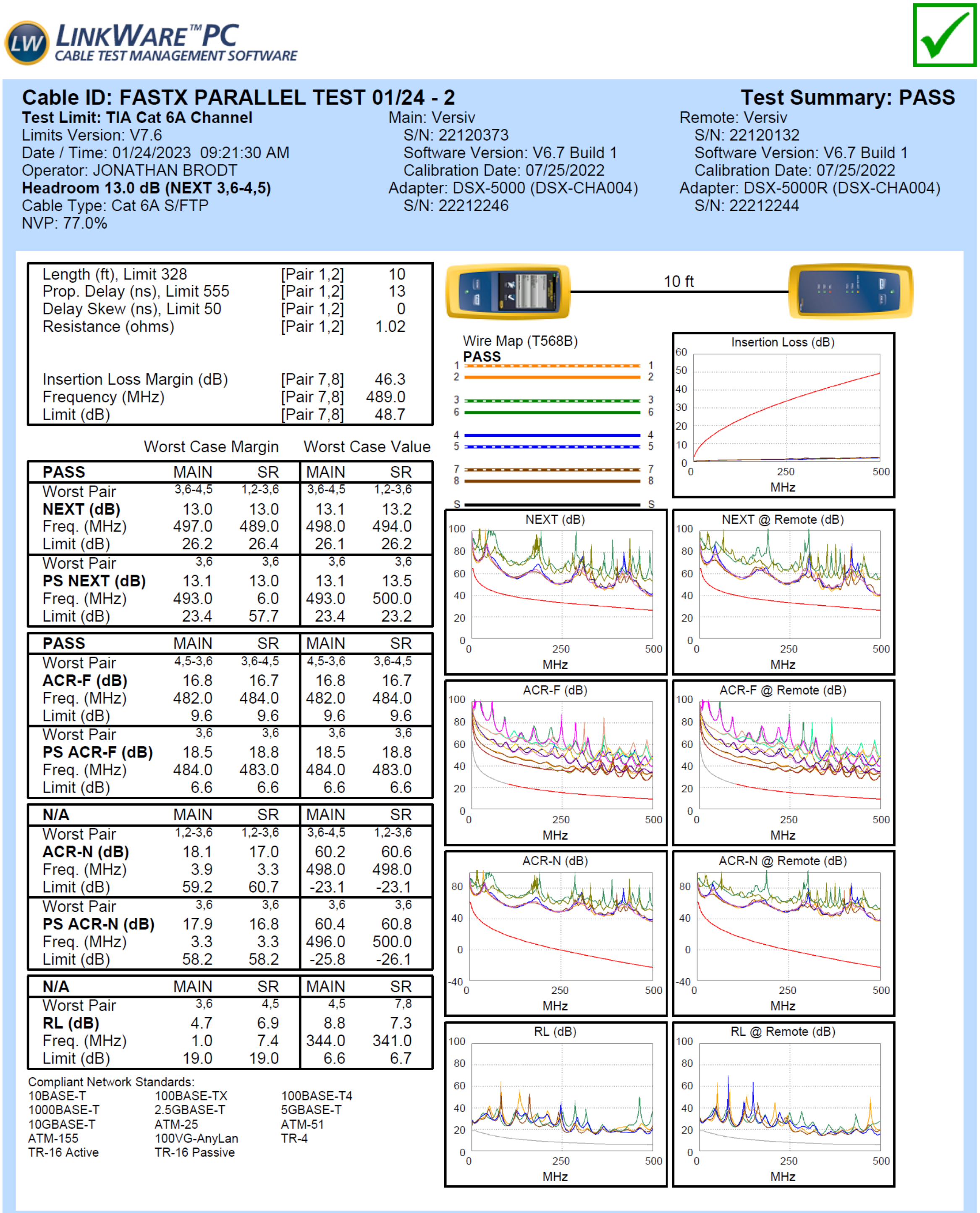
LinkWare™ PC Version 11.1

Figure B-80. Cat6a Cable Analyzer Test with One Gore Cable and CeeLok FAS-X Connector Segment adjacent (see Figure B-77) to Measure Potential Crosstalk between Ethernet Pairs Segment 1 cable was properly connected and passed NEXT tests and the RL with good margins.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	11.9	13.1	15.9	15.7
Freq. (MHz)	15.5	3.0	500.0	500.0
Limit (dB)	53.5	65.0	26.1	26.1
Worst Pair	3,6	1,2	1,2	1,2
PS NEXT (dB)	12.2	14.2	16.7	16.6
Freq. (MHz)	15.5	11.4	500.0	500.0
Limit (dB)	50.8	53.1	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.5	15.8	15.5	15.8
Freq. (MHz)	498.0	500.0	498.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.8	17.6	17.8	17.6
Freq. (MHz)	500.0	498.0	500.0	498.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	15.9	16.6	64.1	63.9
Freq. (MHz)	3.0	3.0	500.0	500.0
Limit (dB)	61.4	61.4	-23.2	-23.2
Worst Pair	1,2	3,6	1,2	1,2
PS ACR-N (dB)	17.1	17.9	64.7	64.6
Freq. (MHz)	3.3	3.4	500.0	500.0
Limit (dB)	58.2	57.9	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	7,8	7,8	4,5
RL (dB)	4.2	6.9	7.7	7.8
Freq. (MHz)	1.0	285.0	347.0	500.0
Limit (dB)	19.0	7.5	6.6	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	13.2	12.1	15.3	16.1
Freq. (MHz)	4.6	13.4	500.0	500.0
Limit (dB)	62.0	54.5	26.1	26.1
Worst Pair	3,6	3,6	1,2	1,2
PS NEXT (dB)	14.0	12.7	16.4	16.7
Freq. (MHz)	4.6	7.8	500.0	500.0
Limit (dB)	59.5	55.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.3	15.0	15.3	15.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.2	17.4	17.2	17.4
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	16.7	16.0	63.4	64.2
Freq. (MHz)	3.0	3.1	500.0	500.0
Limit (dB)	61.4	61.1	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	17.8	16.9	64.3	64.6
Freq. (MHz)	3.3	3.3	500.0	500.0
Limit (dB)	58.2	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.5	6.4	8.4	6.5
Freq. (MHz)	1.0	342.0	345.0	348.0
Limit (dB)	19.0	6.7	6.6	6.6

Figure B-81. Cat6a Cable Analyzer Results Comparison between Segment One Looped (right, Figure B-32) and Cable and Connectors Tied Together (left, Figure B-80) to Assess Crosstalk Crosstalk parameters were not significantly different between cable configurations.



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX PARALLEL TEST 01/24 - 2 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 09:21:30 AM
Operator: JONATHAN BRODT
Headroom 13.0 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	10
Prop. Delay (ns), Limit 555	[Pair 1,2]	13
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.02
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	489.0
Limit (dB)	[Pair 7,8]	48.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-3,6	3,6-4,5	1,2-3,6
NEXT (dB)	13.0	13.0	13.1	13.2
Freq. (MHz)	497.0	489.0	498.0	494.0
Limit (dB)	26.2	26.4	26.1	26.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	13.1	13.0	13.1	13.5
Freq. (MHz)	493.0	6.0	493.0	500.0
Limit (dB)	23.4	57.7	23.4	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	16.8	16.7	16.8	16.7
Freq. (MHz)	482.0	484.0	482.0	484.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.8	18.5	18.8
Freq. (MHz)	484.0	483.0	484.0	483.0
Limit (dB)	6.6	6.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	1,2-3,6
ACR-N (dB)	18.1	17.0	60.2	60.6
Freq. (MHz)	3.9	3.3	498.0	498.0
Limit (dB)	59.2	60.7	-23.1	-23.1
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	17.9	16.8	60.4	60.8
Freq. (MHz)	3.3	3.3	496.0	500.0
Limit (dB)	58.2	58.2	-25.8	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	4,5	7,8
RL (dB)	4.7	6.9	8.8	7.3
Freq. (MHz)	1.0	7.4	344.0	341.0
Limit (dB)	19.0	19.0	6.6	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

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Figure B-82. Cat6a Cable Analyzer Test with Two Gore Cable and CeeLok FAS-X Connector Segments Adjacent (see Figure B-77) to Measure Potential Crosstalk between Ethernet Pairs Cable was properly connected and passed NEXT tests and RL with good margins.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
NEXT (dB)	13.1	12.6	13.2	12.7
Freq. (MHz)	489.0	489.0	491.0	494.0
Limit (dB)	26.4	26.4	26.3	26.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	13.3	12.4	13.3	12.5
Freq. (MHz)	493.0	490.0	493.0	492.0
Limit (dB)	23.4	23.5	23.4	23.4
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.6	16.7	16.6	16.7
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.4	18.3	18.4	18.3
Freq. (MHz)	483.0	482.0	483.0	482.0
Limit (dB)	6.6	6.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	3,6-4,5
ACR-N (dB)	16.9	18.5	60.1	59.6
Freq. (MHz)	3.0	3.4	491.0	494.0
Limit (dB)	61.4	60.4	-22.5	-22.7
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	17.3	18.2	60.2	59.5
Freq. (MHz)	3.9	3.4	493.0	492.0
Limit (dB)	56.7	57.9	-25.5	-25.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	4,5	7,8
RL (dB)	4.6	6.9	8.5	7.8
Freq. (MHz)	1.0	8.1	344.0	340.0
Limit (dB)	19.0	19.0	6.6	6.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	13.2	12.1	15.3	16.1
Freq. (MHz)	4.6	13.4	500.0	500.0
Limit (dB)	62.0	54.5	26.1	26.1
Worst Pair	3,6	3,6	1,2	1,2
PS NEXT (dB)	14.0	12.7	16.4	16.7
Freq. (MHz)	4.6	7.8	500.0	500.0
Limit (dB)	59.5	55.8	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	15.3	15.0	15.3	15.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.2	17.4	17.2	17.4
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	16.7	16.0	63.4	64.2
Freq. (MHz)	3.0	3.1	500.0	500.0
Limit (dB)	61.4	61.1	-23.2	-23.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	17.8	16.9	64.3	64.6
Freq. (MHz)	3.3	3.3	500.0	500.0
Limit (dB)	58.2	58.2	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2	7,8	7,8	7,8
RL (dB)	4.5	6.4	8.4	6.5
Freq. (MHz)	1.0	342.0	345.0	348.0
Limit (dB)	19.0	6.7	6.6	6.6

Figure B-83. Cat6a Cable Analyzer Results Comparison between Segments 1 and 2 Looped (right, Figure B-37) and Cable and Connectors Tied Together (left, Figure B-80) to assess Crosstalk
Crosstalk parameters were not significantly different between cable configurations.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX PARALLEL TEST 01/24 - 3

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 09:30:32 AM
Operator: JONATHAN BRODT
Headroom 10.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

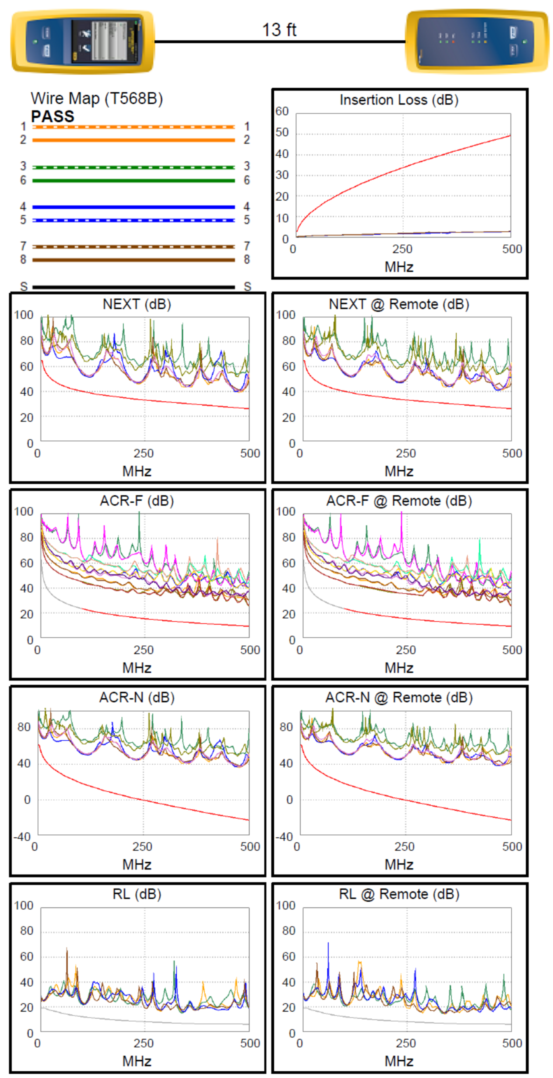
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	13
Prop. Delay (ns), Limit 555	[Pair 7,8]	17
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	1.30
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
NEXT (dB)	11.3	10.7	12.4	13.7
Freq. (MHz)	4.1	5.9	478.0	468.0
Limit (dB)	62.8	60.3	26.6	26.9
Worst Pair	3,6	3,6	1,2	1,2
PS NEXT (dB)	11.3	10.6	12.9	14.1
Freq. (MHz)	3.5	4.9	476.0	469.0
Limit (dB)	61.5	59.1	23.8	24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.1	16.2	16.1	16.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.9	17.6	17.9	17.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
ACR-N (dB)	14.8	14.2	57.8	58.8
Freq. (MHz)	3.0	3.1	478.0	469.0
Limit (dB)	61.4	61.1	-21.5	-20.8
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	15.0	14.4	58.2	59.5
Freq. (MHz)	3.5	3.4	476.0	474.0
Limit (dB)	57.6	57.9	-24.2	-24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	3,6	1,2
RL (dB)	13.0	15.7	8.3	7.5
Freq. (MHz)	500.0	500.0	341.0	340.0
Limit (dB)	6.0	6.0	6.7	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-84. Cat6a Cable Analyzer Test with Three Gore Cable and CeeLok FAS-X Connector Segments Adjacent (see Figure B-78) to Measure Potential Crosstalk between Ethernet Pairs Cable was properly connected and passed NEXT tests and RL with good margins.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	10.6	11.8	13.7	12.7
Freq. (MHz)	3.1	342.0	479.0	478.0
Limit (dB)	64.8	30.6	26.6	26.6
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.6	11.4	14.0	12.6
Freq. (MHz)	3.8	3.3	481.0	481.0
Limit (dB)	61.0	62.0	23.7	23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.8	16.9	16.8	16.9
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.4	18.2	18.4	18.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	14.1	15.4	59.3	58.2
Freq. (MHz)	3.1	3.3	479.0	478.0
Limit (dB)	61.1	60.7	-21.6	-21.5
Worst Pair	3,6	3,6	1,2	3,6
PS ACR-N (dB)	14.4	15.0	59.1	58.3
Freq. (MHz)	3.8	3.3	475.0	481.0
Limit (dB)	57.0	58.2	-24.1	-24.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	1,2	4,5	3,6
RL (dB)	11.7	9.0	8.5	7.6
Freq. (MHz)	479.0	477.0	344.0	341.0
Limit (dB)	6.0	6.0	6.6	6.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
NEXT (dB)	11.3	10.7	12.4	13.7
Freq. (MHz)	4.1	5.9	478.0	468.0
Limit (dB)	62.8	60.3	26.6	26.9
Worst Pair	3,6	3,6	1,2	1,2
PS NEXT (dB)	11.3	10.6	12.9	14.1
Freq. (MHz)	3.5	4.9	476.0	469.0
Limit (dB)	61.5	59.1	23.8	24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.1	16.2	16.1	16.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.9	17.6	17.9	17.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
ACR-N (dB)	14.8	14.2	57.8	58.8
Freq. (MHz)	3.0	3.1	478.0	469.0
Limit (dB)	61.4	61.1	-21.5	-20.8
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	15.0	14.4	58.2	59.5
Freq. (MHz)	3.5	3.4	476.0	474.0
Limit (dB)	57.6	57.9	-24.2	-24.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	3,6	1,2
RL (dB)	13.0	15.7	8.3	7.5
Freq. (MHz)	500.0	500.0	341.0	340.0
Limit (dB)	6.0	6.0	6.7	6.7

Figure B-85. Cat6a Cable Analyzer Results Comparison between Segments 1, 2, and 3 Looped (right, Figure B-38) and Cable and Connectors Tied Together (left, Figure B-84) to Assess Crosstalk

Crosstalk parameters were not significantly different between cable configurations.

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX PARALLEL TEST 01/24 - 4

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 09:40:57 AM
Operator: JONATHAN BRODT
Headroom 8.6 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

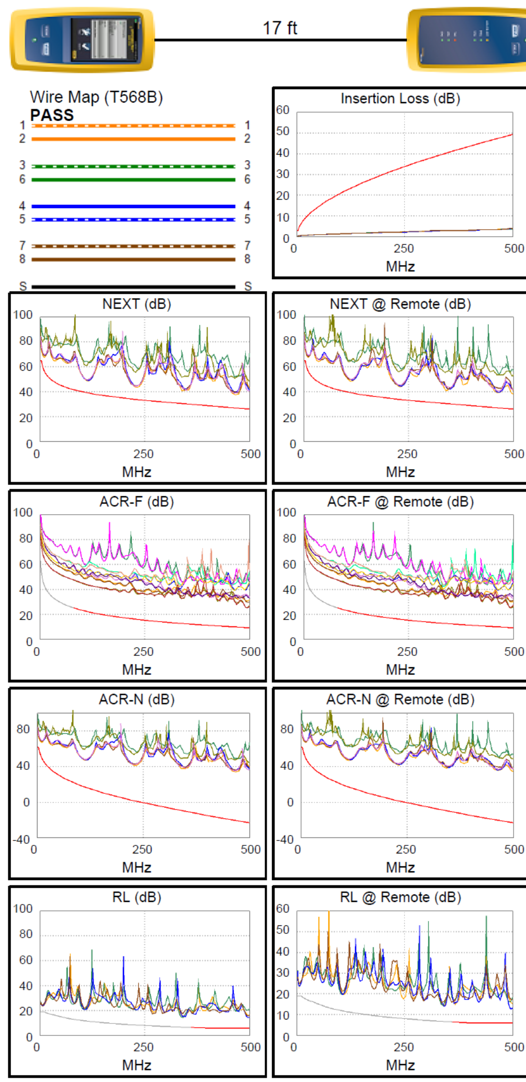
Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	17
Prop. Delay (ns), Limit 555	[Pair 7,8]	22
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	1.52
Insertion Loss Margin (dB)	[Pair 4,5]	45.4
Frequency (MHz)	[Pair 4,5]	499.0
Limit (dB)	[Pair 4,5]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	8.7	8.6	10.6	12.3
Freq. (MHz)	3.9	3.5	470.0	500.0
Limit (dB)	63.3	64.0	26.8	26.1
Worst Pair	3,6	3,6	3,6	1,2
PS NEXT (dB)	8.4	8.4	11.1	12.0
Freq. (MHz)	3.9	3.5	471.0	464.0
Limit (dB)	60.8	61.5	23.9	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	15.9	15.7	15.9	15.7
Freq. (MHz)	494.0	495.0	494.0	495.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.4	17.6	17.4	17.6
Freq. (MHz)	494.0	495.0	494.0	495.0
Limit (dB)	6.4	6.4	6.4	6.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	12.1	12.1	54.7	58.0
Freq. (MHz)	3.1	3.1	470.0	500.0
Limit (dB)	61.1	61.1	-20.8	-23.2
Worst Pair	3,6	3,6	3,6	1,2
PS ACR-N (dB)	12.1	12.0	55.3	55.9
Freq. (MHz)	3.3	3.5	471.0	464.0
Limit (dB)	58.2	57.6	-23.8	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	3,6	4,5
RL (dB)	7.6	6.8	7.6	6.8
Freq. (MHz)	340.0	497.0	340.0	497.0
Limit (dB)	6.7	6.0	6.7	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 11.1

Figure B-86. Cat6a Cable Analyzer Test with Four Gore Cable and CeeLok FAS-X Connector Segments Adjacent (see Figure B-78) to Measure Potential Crosstalk between Ethernet Pairs Cable was properly connected and passed NEXT tests and RL with good margins.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
NEXT (dB)	8.7	9.5	12.4	11.9
Freq. (MHz)	4.3	342.0	465.0	470.0
Limit (dB)	62.6	30.6	27.0	26.8
Worst Pair	3,6	3,6	7,8	1,2
PS NEXT (dB)	8.6	9.1	12.5	11.8
Freq. (MHz)	3.9	3.4	465.0	464.0
Limit (dB)	60.8	61.7	24.1	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	16.5	16.9	16.5	16.9
Freq. (MHz)	494.0	494.0	494.0	494.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	18.5	18.1	18.5	18.1
Freq. (MHz)	494.0	496.0	494.0	496.0
Limit (dB)	6.4	6.3	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
ACR-N (dB)	12.2	13.2	56.6	56.1
Freq. (MHz)	3.0	3.4	465.0	470.0
Limit (dB)	61.4	60.4	-20.4	-20.8
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	12.2	12.7	56.6	55.6
Freq. (MHz)	3.6	3.4	465.0	464.0
Limit (dB)	57.3	57.9	-23.3	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2	4,5	1,2	4,5
RL (dB)	7.9	6.2	7.9	6.2
Freq. (MHz)	345.0	499.0	345.0	499.0
Limit (dB)	6.6	6.0	6.6	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	8.7	8.6	10.6	12.3
Freq. (MHz)	3.9	3.5	470.0	500.0
Limit (dB)	63.3	64.0	26.8	26.1
Worst Pair	3,6	3,6	3,6	1,2
PS NEXT (dB)	8.4	8.4	11.1	12.0
Freq. (MHz)	3.9	3.5	471.0	464.0
Limit (dB)	60.8	61.5	23.9	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	15.9	15.7	15.9	15.7
Freq. (MHz)	494.0	495.0	494.0	495.0
Limit (dB)	9.4	9.4	9.4	9.4
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	17.4	17.6	17.4	17.6
Freq. (MHz)	494.0	495.0	494.0	495.0
Limit (dB)	6.4	6.4	6.4	6.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
ACR-N (dB)	12.1	12.1	54.7	58.0
Freq. (MHz)	3.1	3.1	470.0	500.0
Limit (dB)	61.1	61.1	-20.8	-23.2
Worst Pair	3,6	3,6	3,6	1,2
PS ACR-N (dB)	12.1	12.0	55.3	55.9
Freq. (MHz)	3.3	3.5	471.0	464.0
Limit (dB)	58.2	57.6	-23.8	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	3,6	4,5
RL (dB)	7.6	6.8	7.6	6.8
Freq. (MHz)	340.0	497.0	340.0	497.0
Limit (dB)	6.7	6.0	6.7	6.0

Figure B-87. Cat6a Cable Analyzer Results Comparison between Segments 1, 2, 3, and 4 Looped (right, Figure B-39) and Cable and Connectors Tied Together (left, Figure B-86) to Assess Crosstalk

Crosstalk parameters were not significantly different between cable configurations.

LinkWare™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: FASTX PARALLEL TEST 01/24 - 5

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 01/24/2023 09:55:19 AM
Operator: JONATHAN BRODT
Headroom 7.7 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	20
Prop. Delay (ns), Limit 555	[Pair 3,6]	26
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	1.77
Insertion Loss Margin (dB)	[Pair 4,5]	44.5
Frequency (MHz)	[Pair 4,5]	495.0
Limit (dB)	[Pair 4,5]	49.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
NEXT (dB)	8.1	7.7	10.5	11.0
Freq. (MHz)	114.0	112.5	462.0	462.0
Limit (dB)	39.0	39.1	27.0	27.0
Worst Pair	1,2	3,6	1,2	1,2
PS NEXT (dB)	8.0	7.7	10.7	11.1
Freq. (MHz)	114.5	3.3	462.0	461.0
Limit (dB)	36.1	62.0	24.1	24.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	4,5-3,6	3,6-4,5
ACR-F (dB)	18.5	18.5	18.8	18.7
Freq. (MHz)	468.0	468.0	487.0	488.0
Limit (dB)	9.9	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	19.5	19.5	19.5
Freq. (MHz)	468.0	468.0	487.0	468.0
Limit (dB)	6.9	6.9	6.5	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
ACR-N (dB)	12.2	11.7	53.5	54.2
Freq. (MHz)	3.1	3.3	462.0	462.0
Limit (dB)	61.1	60.7	-20.2	-20.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.7	11.2	53.8	54.2
Freq. (MHz)	3.3	3.3	462.0	461.0
Limit (dB)	58.2	58.2	-23.1	-23.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	3,6	4,5
RL (dB)	7.6	7.1	7.6	7.1
Freq. (MHz)	340.0	341.0	340.0	341.0
Limit (dB)	6.7	6.7	6.7	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

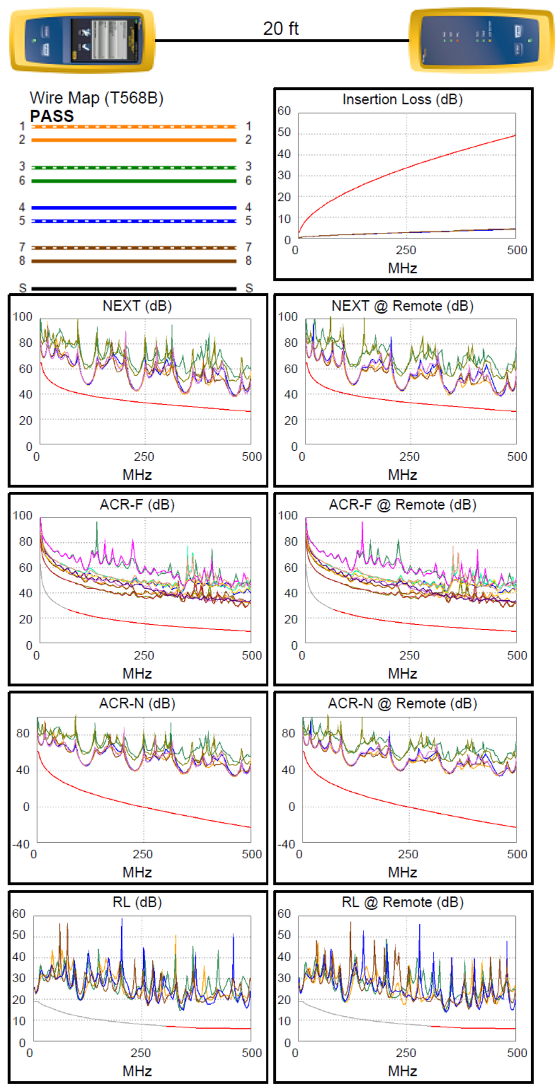


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Figure B-88. Cat6a Cable Analyzer Test with Five Gore Cable and CeeLok FAS-X Connector Segments Adjacent (see Figure B-79) to Measure Potential Crosstalk between Ethernet Pairs Cable was properly connected and passed NEXT tests and RL with good margins.

	Worst Case Margin MAIN	Worst Case Margin SR	Worst Case Value MAIN	Worst Case Value SR
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
NEXT (dB)	7.9	8.2	11.1	10.3
Freq. (MHz)	112.5	114.0	461.0	461.0
Limit (dB)	39.1	39.0	27.1	27.1
Worst Pair	3,6	1,2	7,8	1,2
PS NEXT (dB)	7.7	8.1	11.1	10.6
Freq. (MHz)	3.9	114.5	461.0	462.0
Limit (dB)	60.8	36.1	24.2	24.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	18.7	18.6	18.7	18.7
Freq. (MHz)	488.0	466.0	488.0	488.0
Limit (dB)	9.5	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	18.8	19.3	18.8
Freq. (MHz)	468.0	468.0	468.0	468.0
Limit (dB)	6.9	6.9	6.9	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-7,8	1,2-3,6
ACR-N (dB)	11.6	12.5	54.4	53.4
Freq. (MHz)	3.1	3.3	461.0	461.0
Limit (dB)	61.1	60.7	-20.1	-20.1
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.4	11.9	54.3	53.7
Freq. (MHz)	3.3	3.3	460.0	463.0
Limit (dB)	58.2	58.2	-22.9	-23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	1,2	1,2
RL (dB)	7.8	6.5	7.9	6.5
Freq. (MHz)	342.0	344.0	344.0	344.0
Limit (dB)	6.7	6.6	6.6	6.6

	Worst Case Margin MAIN	Worst Case Margin SR	Worst Case Value MAIN	Worst Case Value SR
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
NEXT (dB)	8.1	7.7	10.5	11.0
Freq. (MHz)	114.0	112.5	462.0	462.0
Limit (dB)	39.0	39.1	27.0	27.0
Worst Pair	1,2	3,6	1,2	1,2
PS NEXT (dB)	8.0	7.7	10.7	11.1
Freq. (MHz)	114.5	3.3	462.0	461.0
Limit (dB)	36.1	62.0	24.1	24.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	4,5-3,6	3,6-4,5
ACR-F (dB)	18.5	18.5	18.8	18.7
Freq. (MHz)	468.0	468.0	487.0	488.0
Limit (dB)	9.9	9.9	9.5	9.5
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.3	19.5	19.5	19.5
Freq. (MHz)	468.0	468.0	487.0	468.0
Limit (dB)	6.9	6.9	6.5	6.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-7,8
ACR-N (dB)	12.2	11.7	53.5	54.2
Freq. (MHz)	3.1	3.3	462.0	462.0
Limit (dB)	61.1	60.7	-20.2	-20.2
Worst Pair	3,6	3,6	1,2	1,2
PS ACR-N (dB)	11.7	11.2	53.8	54.2
Freq. (MHz)	3.3	3.3	462.0	461.0
Limit (dB)	58.2	58.2	-23.1	-23.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6	4,5	3,6	4,5
RL (dB)	7.6	7.1	7.6	7.1
Freq. (MHz)	340.0	341.0	340.0	341.0
Limit (dB)	6.7	6.7	6.7	6.7

Figure B-89. Cat6a Cable Analyzer Results Comparison between Segments 1, 2, 3, 4, and 5 Looped (right, Figure B-40) and Cable and Connectors Tied Together (left, Figure B-88) to Assess Crosstalk

Crosstalk parameters were not significantly different between cable configurations.

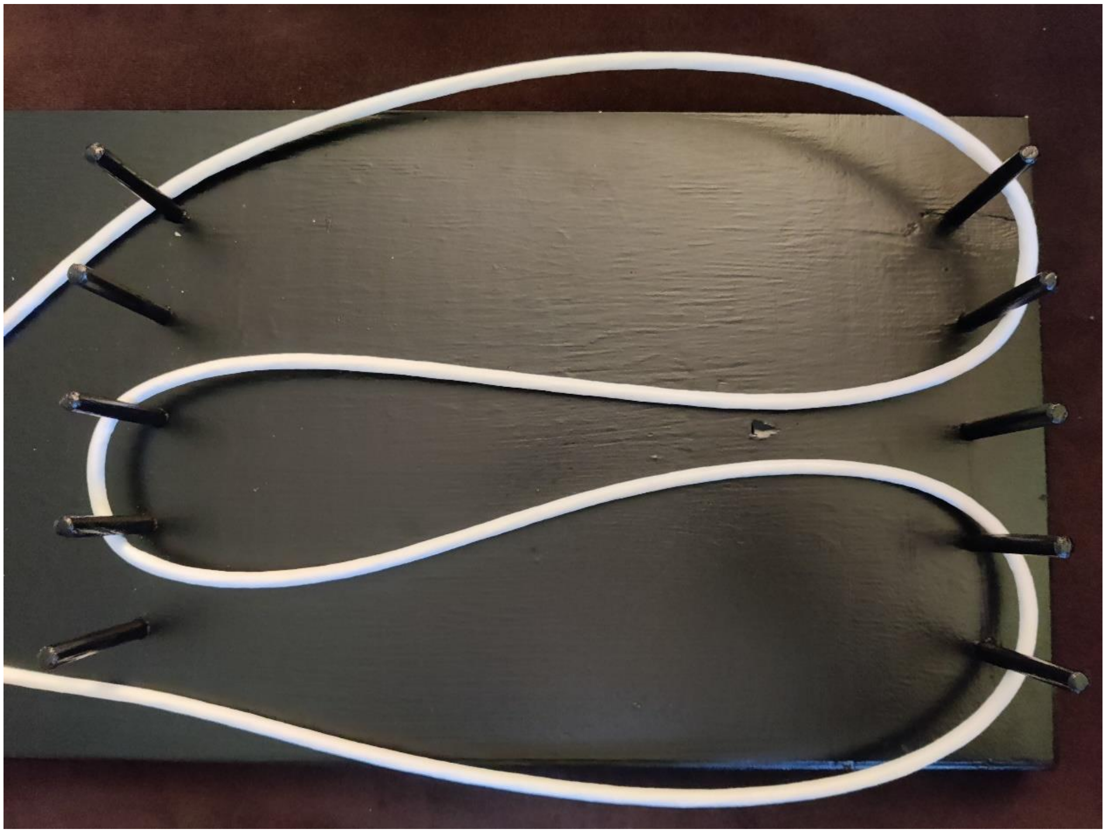

Figure B-90. Gore Ethernet Cable in Bend Fixture with Three Bends, Each with Bend Radius Greater than Four Times (4x) Cable Diameter Requirement for Ethernet Cable

Figure B-91. Gore Ethernet Cable in Bend Fixture with Three Severe Bends (one times (1x) the cable diameter), Each with a Bend Radius much less than 4x Cable Diameter Requirement for Ethernet Cable

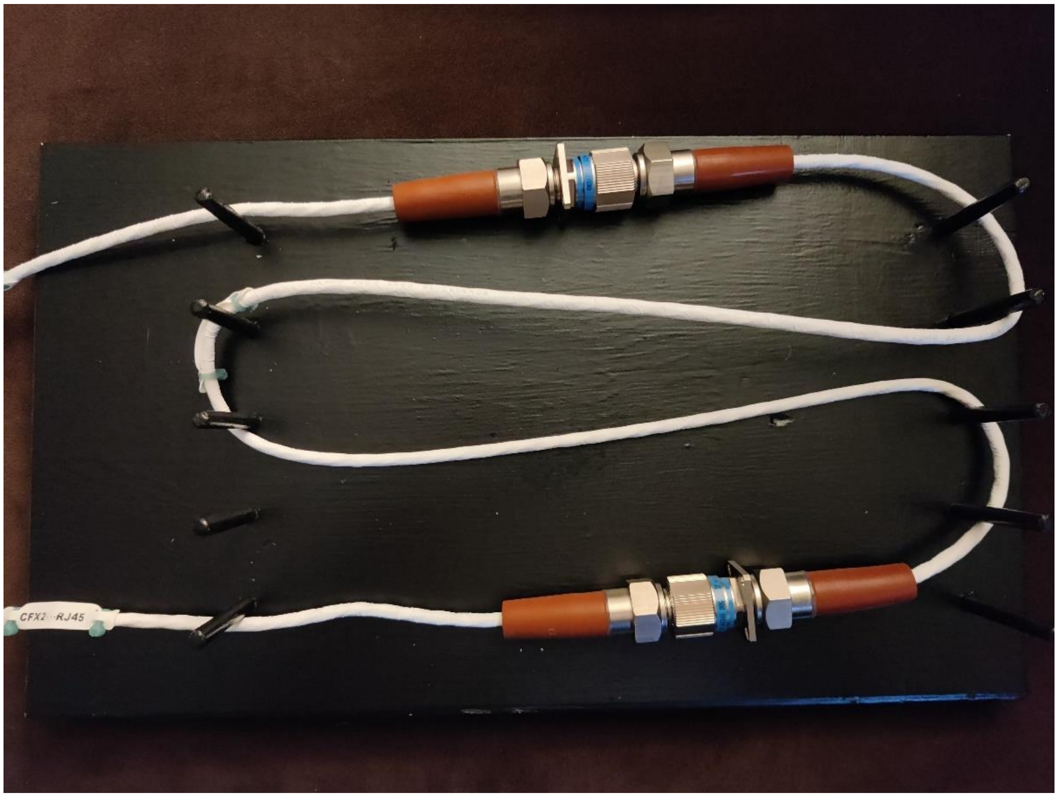

Figure B-92. Gore Ethernet Cable with CeeLok FAS-X Connectors in Bend Fixture with Three Bends, each with Bend Radius Greater than 4x Cable Diameter Requirement for an Ethernet Cable

Figure B-93. Gore Ethernet Cable with CeeLok FAS-X Connectors in Bend Fixture with Three Severe Bends (1x the cable diameter) each with a Bend Radius much less than the 4x Cable Diameter Requirement for an Ethernet Cable

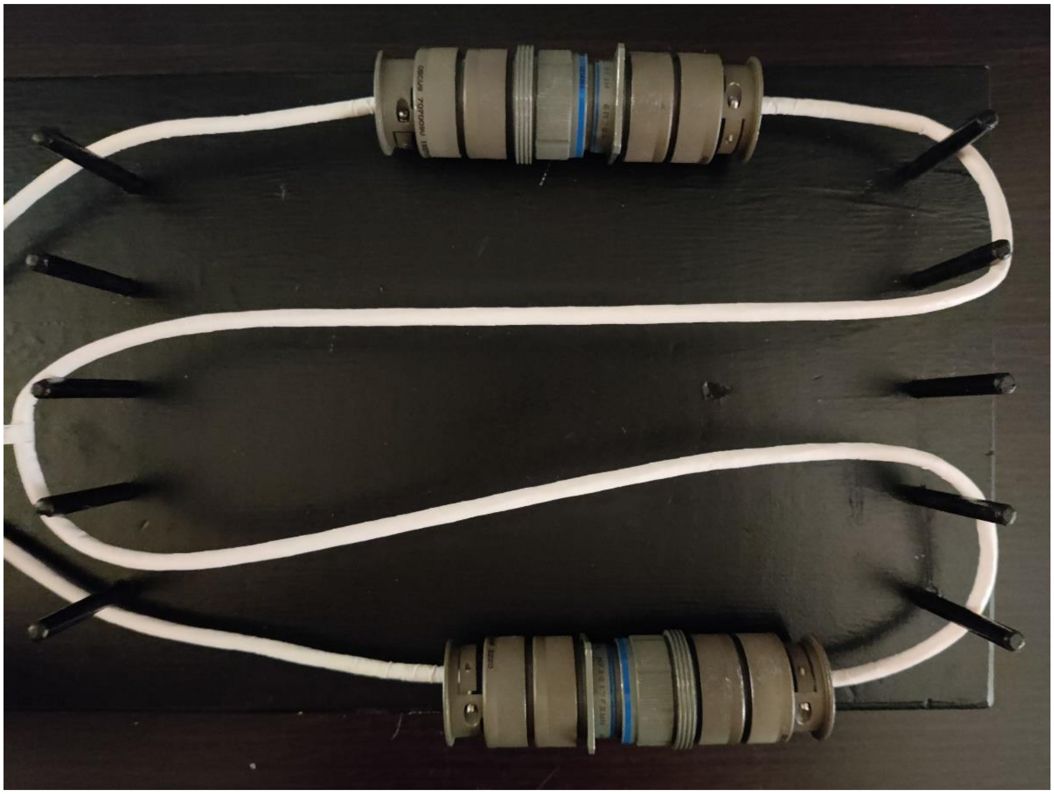

Figure B-94. PIC Ethernet Cable with PIC Connectors in Bend Fixture with Three Bends, each with a Bend Radius Greater than the 4x Cable Diameter Requirement for Ethernet Cable

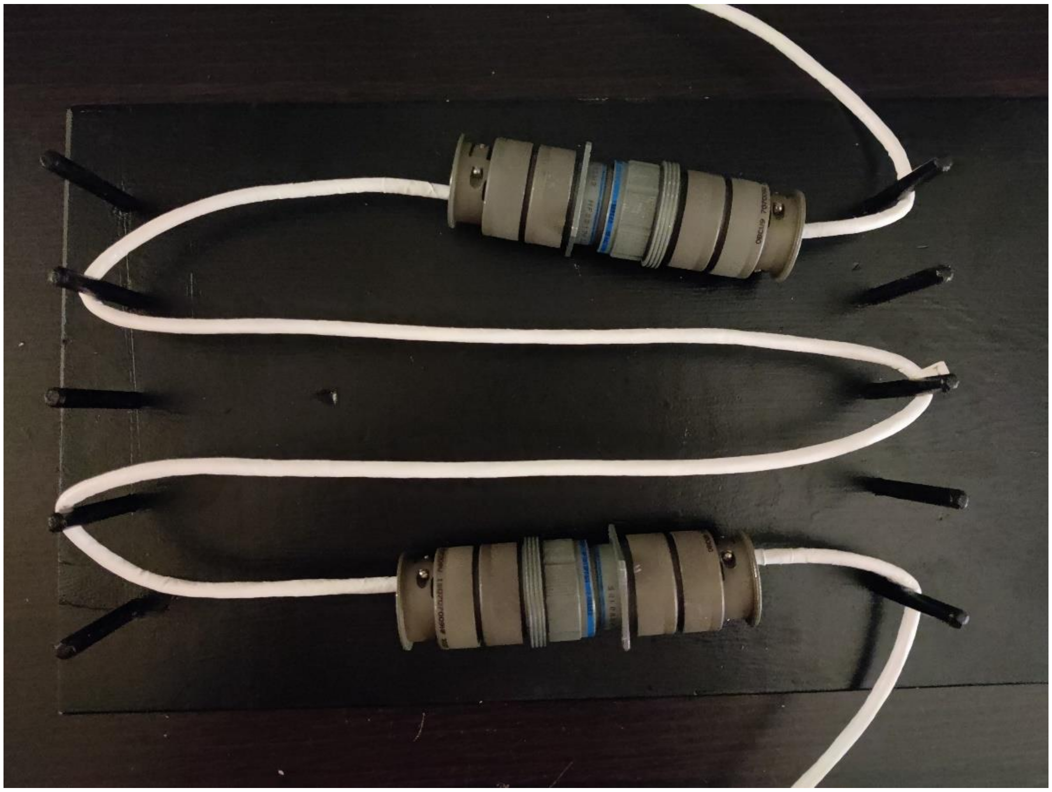

Figure B-95. PIC Ethernet Cable with PIC Connectors in Bend Fixture with Three Severe Bends (1x the cable diameter) each with a Bend Radius much less than the 4x Cable Diameter Requirement for Ethernet Cable

Cable ID: GORE24 BEND TEST 02/20 - 16FT - CONTROL **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/20/2023 03:02:47 PM
Operator: JONATHAN BRODT
Headroom 19.2 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.95
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	487.0
Limit (dB)	[Pair 7,8]	48.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	19.2	21.1	25.6	27.0
Freq. (MHz)	3.0	2.0	478.0	500.0
Limit (dB)	65.0	65.0	26.6	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.5	21.2	28.1	28.3
Freq. (MHz)	3.0	3.3	478.0	500.0
Limit (dB)	62.0	62.0	23.7	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	19.2	19.0	19.2	19.0
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-F (dB)	20.3	20.1	20.5	20.4
Freq. (MHz)	1.0	1.0	481.0	482.0
Limit (dB)	60.3	60.3	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.6	24.0	71.7	74.3
Freq. (MHz)	3.0	2.0	478.0	500.0
Limit (dB)	61.4	62.0	-21.5	-23.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	22.9	24.8	74.3	75.7
Freq. (MHz)	3.0	3.3	478.0	500.0
Limit (dB)	58.4	58.2	-24.4	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	7,8	7,8
RL (dB)	3.9	6.7	11.2	10.1
Freq. (MHz)	1.0	5.1	336.0	374.0
Limit (dB)	19.0	19.0	6.7	6.3

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

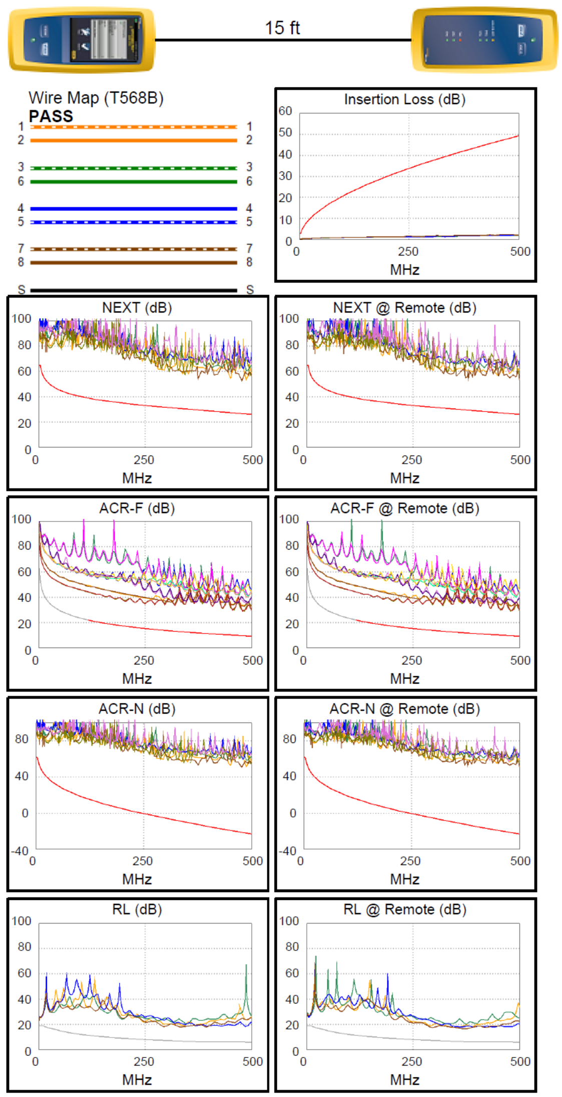

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Figure B-96. Fluke Meter Cat6a Results for Gore 24 American Wire Gauge (AWG) Ethernet Cable with No Significant Bends

Cable ID: GORE24 BEND TEST 02/20 - 16FT - 1 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/20/2023 03:07:01 PM
Operator: JONATHAN BRODT
Headroom 18.3 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.95
Insertion Loss Margin (dB)	[Pair 7,8]	46.4
Frequency (MHz)	[Pair 7,8]	488.0
Limit (dB)	[Pair 7,8]	48.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	18.9	18.3	25.8	24.5
Freq. (MHz)	3.1	1.4	481.0	375.0
Limit (dB)	64.8	65.0	26.6	29.5
Worst Pair	3,6	4,5	3,6	3,6
PS NEXT (dB)	18.6	20.3	29.0	28.8
Freq. (MHz)	3.1	1.4	500.0	500.0
Limit (dB)	62.0	62.0	23.2	23.2

PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	19.3	19.1	19.3	19.1
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.7	19.7	20.6	20.6
Freq. (MHz)	1.0	1.0	482.0	482.0
Limit (dB)	60.3	60.3	6.6	6.6

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.4	21.2	72.0	75.3
Freq. (MHz)	3.1	1.4	481.0	500.0
Limit (dB)	61.1	62.0	-21.7	-23.2
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	22.1	23.2	76.3	76.1
Freq. (MHz)	3.1	1.4	500.0	500.0
Limit (dB)	58.3	59.0	-26.1	-26.1

N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	7,8	7,8
RL (dB)	4.2	6.8	10.5	9.9
Freq. (MHz)	1.0	4.4	335.0	368.0
Limit (dB)	19.0	19.0	6.7	6.3

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

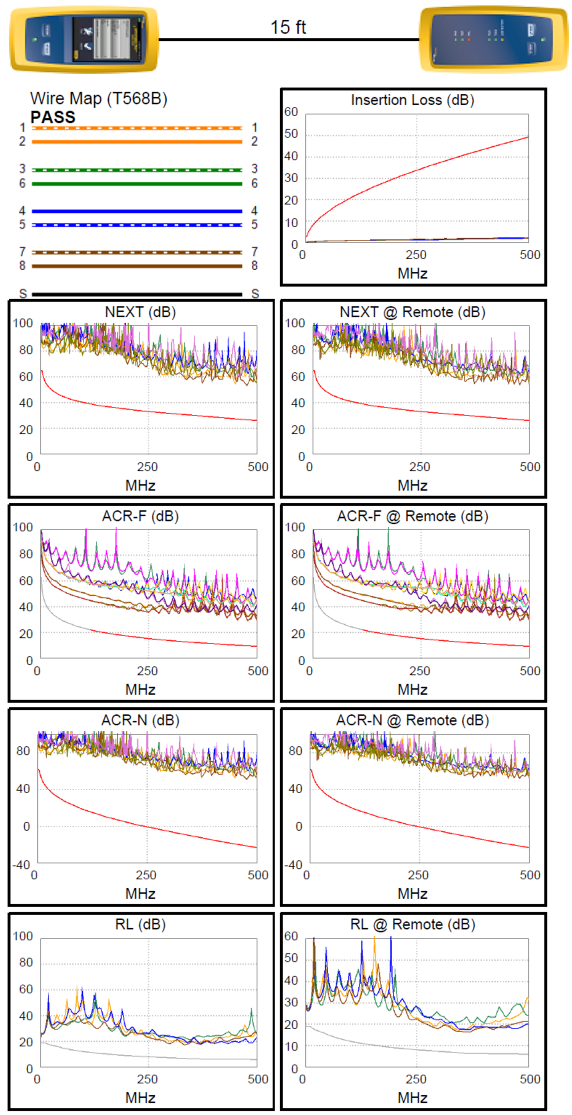

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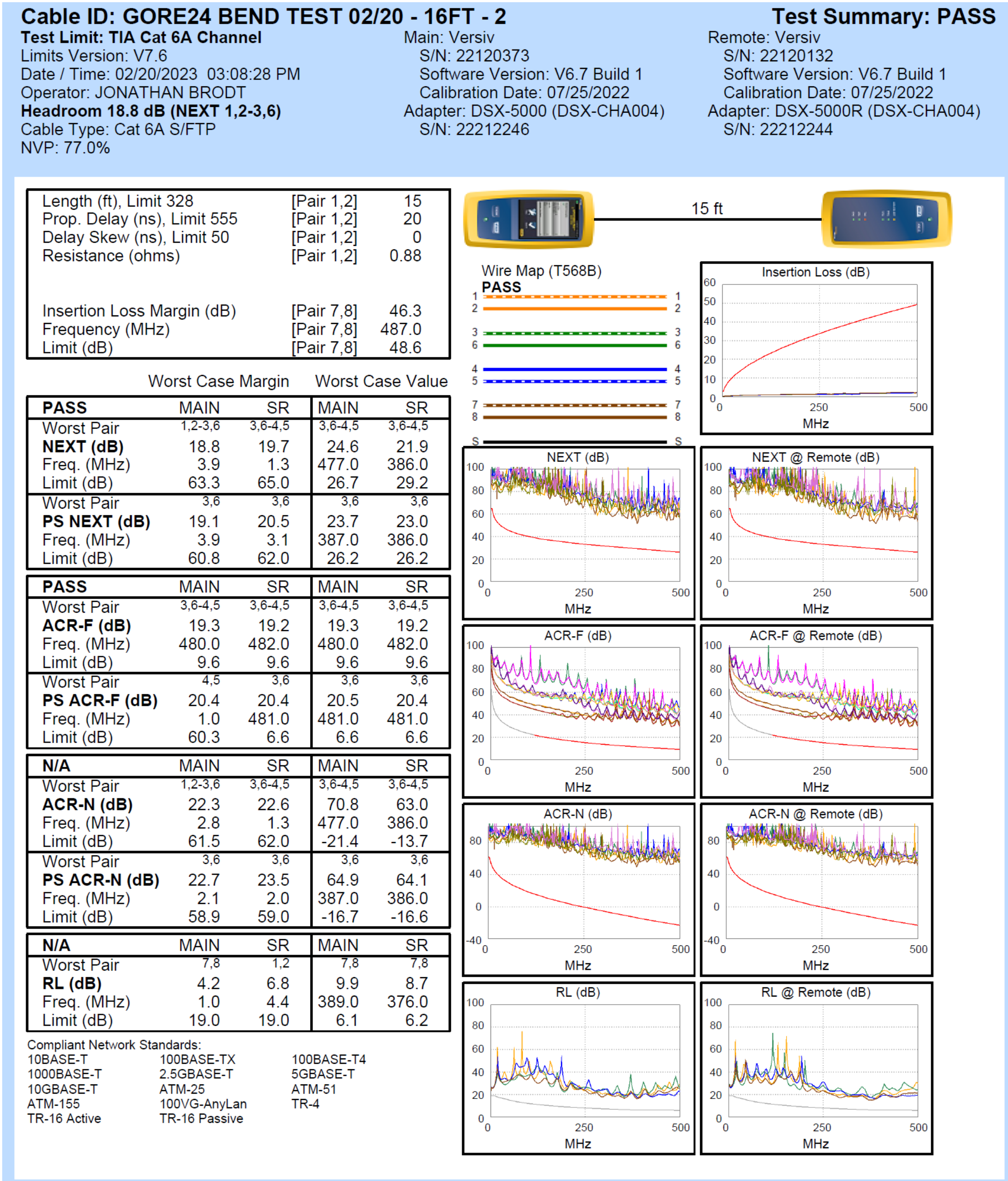
Figure B-97. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable in the Bend Fixture with Three Bends that are within 4x the Cable Diameter (the minimum bend radius is 4x cable diameter (Figure B-90))



Cable ID: GORE24 BEND TEST 02/20 - 16FT - 2 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/20/2023 03:08:28 PM
Operator: JONATHAN BRODT
Headroom 18.8 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.88
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	487.0
Limit (dB)	[Pair 7,8]	48.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	18.8	19.7	24.6	21.9
Freq. (MHz)	3.9	1.3	477.0	386.0
Limit (dB)	63.3	65.0	26.7	29.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.1	20.5	23.7	23.0
Freq. (MHz)	3.9	3.1	387.0	386.0
Limit (dB)	60.8	62.0	26.2	26.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	19.3	19.2	19.3	19.2
Freq. (MHz)	480.0	482.0	480.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-F (dB)	20.4	20.4	20.5	20.4
Freq. (MHz)	1.0	481.0	481.0	481.0
Limit (dB)	60.3	6.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.3	22.6	70.8	63.0
Freq. (MHz)	2.8	1.3	477.0	386.0
Limit (dB)	61.5	62.0	-21.4	-13.7
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	22.7	23.5	64.9	64.1
Freq. (MHz)	2.1	2.0	387.0	386.0
Limit (dB)	58.9	59.0	-16.7	-16.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	7,8	7,8
RL (dB)	4.2	6.8	9.9	8.7
Freq. (MHz)	1.0	4.4	389.0	376.0
Limit (dB)	19.0	19.0	6.1	6.2

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

Figure B-98. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable in the Bend Fixture with Three Severe Bends that are ~1x the Cable Diameter (the minimum bend radius is 4x cable diameter (Figure B-91))

Cable ID: GORE24 BEND TEST 02/20 - 1 - CONTROL **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/21/2023 09:08:19 AM
Operator: JONATHAN BRODT
Headroom 17.3 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 7,8]	0.58
Insertion Loss Margin (dB)	[Pair 7,8]	48.0
Frequency (MHz)	[Pair 7,8]	499.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	17.7	17.3	19.0	18.9
Freq. (MHz)	19.0	368.0	485.0	490.0
Limit (dB)	52.0	29.7	26.5	26.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.4	18.6	20.6	20.1
Freq. (MHz)	367.0	365.0	487.0	488.0
Limit (dB)	26.8	26.8	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	16.9	17.0	16.9	17.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.0	19.2	19.0	19.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.7	23.5	66.8	66.9
Freq. (MHz)	3.0	1.1	485.0	490.0
Limit (dB)	61.4	62.0	-22.0	-22.4
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	22.6	23.7	68.5	68.0
Freq. (MHz)	3.3	3.4	487.0	488.0
Limit (dB)	58.2	57.9	-25.1	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	4,5	7,8
RL (dB)	2.8	6.2	9.0	6.8
Freq. (MHz)	1.0	1.0	379.0	340.0
Limit (dB)	19.0	19.0	6.2	6.7

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

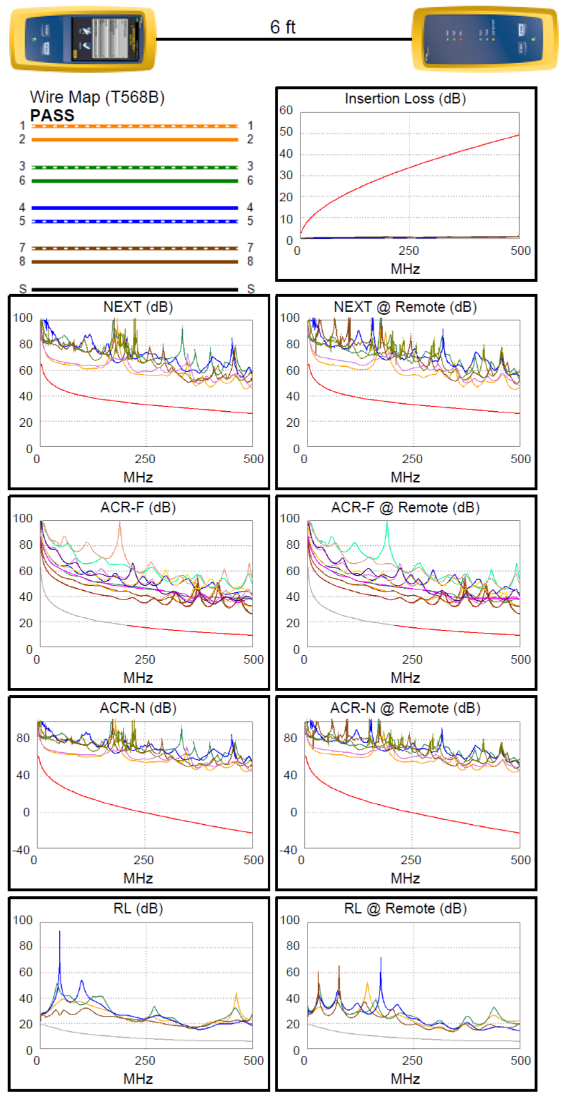


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Figure B-99. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable with Two CeeLok FAS-X Connectors with No Significant Bends in Cable

Cable ID: GORE24 BEND TEST 02/20 - 1 - 1 **Test Summary: PASS**

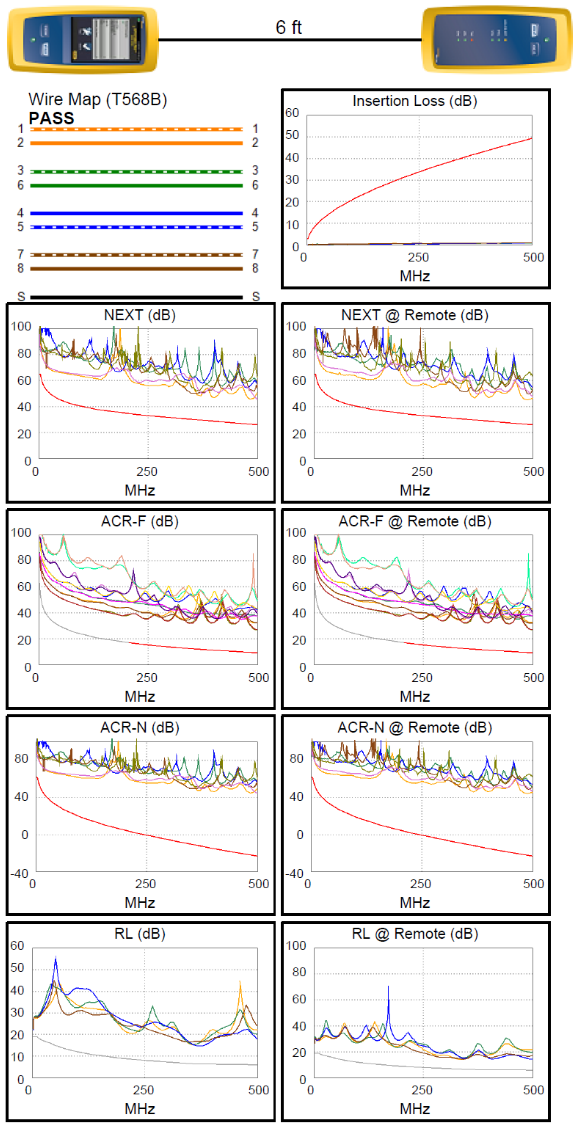
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/21/2023 09:12:04 AM
Operator: JONATHAN BRODT
Headroom 16.9 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.41
Insertion Loss Margin (dB)	[Pair 7,8]	48.2
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	4,5-7,8	1,2-3,6
NEXT (dB)	18.2	16.9	19.5	18.8
Freq. (MHz)	402.0	367.0	500.0	488.0
Limit (dB)	28.7	29.7	26.1	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.2	18.0	21.1	20.3
Freq. (MHz)	367.0	367.0	486.0	488.0
Limit (dB)	26.8	26.8	23.6	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.5	17.6	17.5	17.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.6	19.6	19.6	19.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	4,5-7,8	1,2-3,6
ACR-N (dB)	22.0	22.2	67.7	66.7
Freq. (MHz)	1.4	1.3	500.0	488.0
Limit (dB)	62.0	62.0	-23.2	-22.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	21.9	23.0	68.9	68.1
Freq. (MHz)	3.3	3.4	486.0	488.0
Limit (dB)	58.2	57.9	-25.0	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	7,8	1,2
RL (dB)	2.9	7.3	8.3	7.4
Freq. (MHz)	1.0	334.0	368.0	339.0
Limit (dB)	19.0	6.8	6.3	6.7



Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

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Figure B-100. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable with Two CeeLok FAS-X Connectors in Bend Fixture with Three Bends that are within 4x Cable Diameter (the minimum bend radius is 4x cable diameter (Figure B-92))

Cable ID: GORE24 BEND TEST 02/20 - 1 - 2 **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/21/2023 09:14:03 AM
Operator: JONATHAN BRODT
Headroom 16.8 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A S/FTP
NVP: 77.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	8
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.41
Insertion Loss Margin (dB)	[Pair 7,8]	48.2
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	18.0	16.8	19.1	19.1
Freq. (MHz)	370.0	368.0	485.0	488.0
Limit (dB)	29.7	29.7	26.5	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.2	17.9	21.0	20.6
Freq. (MHz)	365.0	367.0	488.0	485.0
Limit (dB)	26.8	26.8	23.5	23.6

PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.5	17.5	17.5	17.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.5	19.6	19.5	19.6
Freq. (MHz)	499.0	500.0	499.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.3	22.6	66.8	67.0
Freq. (MHz)	2.9	1.1	485.0	488.0
Limit (dB)	61.4	62.0	-22.0	-22.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	22.0	23.3	68.8	68.3
Freq. (MHz)	3.3	3.3	488.0	485.0
Limit (dB)	58.2	58.2	-25.1	-24.9

N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	3.0	7.0	7.8	7.1
Freq. (MHz)	1.0	342.0	363.0	346.0
Limit (dB)	19.0	6.7	6.4	6.6

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

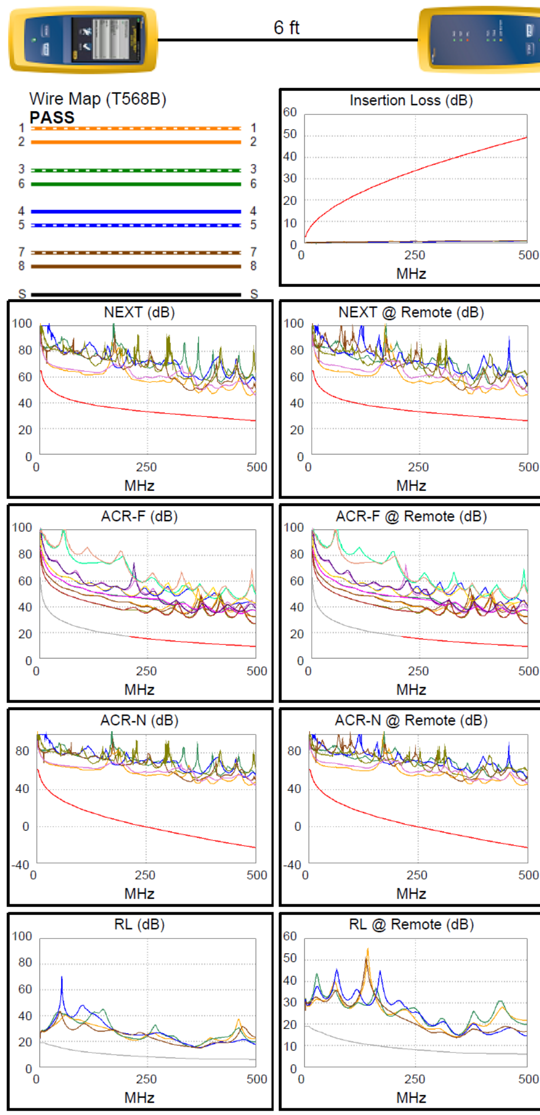

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Figure B-101. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable with Two CeeLok FAS-X Connectors in Bend Fixture with Three Severe Bends that are ~1x Cable Diameter (the minimum bend radius is 4x cable diameter (Figure B-93))

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.95
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	487.0
Limit (dB)	[Pair 7,8]	48.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	19.2	21.1	25.6	27.0
Freq. (MHz)	3.0	2.0	478.0	500.0
Limit (dB)	65.0	65.0	26.6	26.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.5	21.2	28.1	28.3
Freq. (MHz)	3.0	3.3	478.0	500.0
Limit (dB)	62.0	62.0	23.7	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	19.2	19.0	19.2	19.0
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-F (dB)	20.3	20.1	20.5	20.4
Freq. (MHz)	1.0	1.0	481.0	482.0
Limit (dB)	60.3	60.3	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.6	24.0	71.7	74.3
Freq. (MHz)	3.0	2.0	478.0	500.0
Limit (dB)	61.4	62.0	-21.5	-23.2
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	22.9	24.8	74.3	75.7
Freq. (MHz)	3.0	3.3	478.0	500.0
Limit (dB)	58.4	58.2	-24.4	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	4,5	7,8	7,8
RL (dB)	3.9	6.7	11.2	10.1
Freq. (MHz)	1.0	5.1	336.0	374.0
Limit (dB)	19.0	19.0	6.7	6.3

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.95
Insertion Loss Margin (dB)	[Pair 7,8]	46.4
Frequency (MHz)	[Pair 7,8]	488.0
Limit (dB)	[Pair 7,8]	48.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	18.9	18.3	25.8	24.5
Freq. (MHz)	3.1	1.4	481.0	375.0
Limit (dB)	64.8	65.0	26.6	29.5
Worst Pair	3,6	4,5	3,6	3,6
PS NEXT (dB)	18.6	20.3	29.0	28.8
Freq. (MHz)	3.1	1.4	500.0	500.0
Limit (dB)	62.0	62.0	23.2	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	19.3	19.1	19.3	19.1
Freq. (MHz)	482.0	482.0	482.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.7	19.7	20.6	20.6
Freq. (MHz)	1.0	1.0	482.0	482.0
Limit (dB)	60.3	60.3	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.4	21.2	72.0	75.3
Freq. (MHz)	3.1	1.4	481.0	500.0
Limit (dB)	61.1	62.0	-21.7	-23.2
Worst Pair	3,6	4,5	3,6	3,6
PS ACR-N (dB)	22.1	23.2	76.3	76.1
Freq. (MHz)	3.1	1.4	500.0	500.0
Limit (dB)	58.3	59.0	-26.1	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	7,8	7,8
RL (dB)	4.2	6.8	10.5	9.9
Freq. (MHz)	1.0	4.4	335.0	368.0
Limit (dB)	19.0	19.0	6.7	6.3

Length (ft), Limit 328	[Pair 1,2]	15
Prop. Delay (ns), Limit 555	[Pair 1,2]	20
Delay Skew (ns), Limit 50	[Pair 1,2]	0
Resistance (ohms)	[Pair 1,2]	0.88
Insertion Loss Margin (dB)	[Pair 7,8]	46.3
Frequency (MHz)	[Pair 7,8]	487.0
Limit (dB)	[Pair 7,8]	48.6

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	18.8	19.7	24.6	21.9
Freq. (MHz)	3.9	1.3	477.0	386.0
Limit (dB)	63.3	65.0	26.7	29.2
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	19.1	20.5	23.7	23.0
Freq. (MHz)	3.9	3.1	387.0	386.0
Limit (dB)	60.8	62.0	26.2	26.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	19.3	19.2	19.3	19.2
Freq. (MHz)	480.0	482.0	480.0	482.0
Limit (dB)	9.6	9.6	9.6	9.6
Worst Pair	4,5	3,6	3,6	3,6
PS ACR-F (dB)	20.4	20.4	20.5	20.4
Freq. (MHz)	1.0	481.0	481.0	481.0
Limit (dB)	60.3	6.6	6.6	6.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	3,6-4,5	3,6-4,5	3,6-4,5
ACR-N (dB)	22.3	22.6	70.8	63.0
Freq. (MHz)	2.8	1.3	477.0	386.0
Limit (dB)	61.5	62.0	-21.4	-13.7
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-N (dB)	22.7	23.5	64.9	64.1
Freq. (MHz)	2.1	2.0	387.0	386.0
Limit (dB)	58.9	59.0	-16.7	-16.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	7,8	1,2	7,8	7,8
RL (dB)	4.2	6.8	9.9	8.7
Freq. (MHz)	1.0	4.4	389.0	376.0
Limit (dB)	19.0	19.0	6.1	6.2

Figure B-102. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable
Left panel shows cable with no significant bends; center panel shows the cable in the bend fixture with a bend that is within 4x the cable diameter, the minimum bend radius; right panel shows the cable with a severe bend radius (estimated to be 1x the cable diameter). In each case, there were no significant changes with respect to crosstalk and RL.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	17.7	17.3	19.0	18.9
Freq. (MHz)	19.0	368.0	485.0	490.0
Limit (dB)	52.0	29.7	26.5	26.3
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.4	18.6	20.6	20.1
Freq. (MHz)	367.0	365.0	487.0	488.0
Limit (dB)	26.8	26.8	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	16.9	17.0	16.9	17.0
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.0	19.2	19.0	19.2
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.7	23.5	66.8	66.9
Freq. (MHz)	3.0	1.1	485.0	490.0
Limit (dB)	61.4	62.0	-22.0	-22.4
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	22.6	23.7	68.5	68.0
Freq. (MHz)	3.3	3.4	487.0	488.0
Limit (dB)	58.2	57.9	-25.1	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	4,5	7,8
RL (dB)	2.8	6.2	9.0	6.8
Freq. (MHz)	1.0	1.0	379.0	340.0
Limit (dB)	19.0	19.0	6.2	6.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	4,5-7,8	1,2-3,6
NEXT (dB)	18.2	16.9	19.5	18.8
Freq. (MHz)	402.0	367.0	500.0	488.0
Limit (dB)	28.7	29.7	26.1	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.2	18.0	21.1	20.3
Freq. (MHz)	367.0	367.0	486.0	488.0
Limit (dB)	26.8	26.8	23.6	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.5	17.6	17.5	17.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.6	19.6	19.6	19.6
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	4,5-7,8	1,2-3,6
ACR-N (dB)	22.0	22.2	67.7	66.7
Freq. (MHz)	1.4	1.3	500.0	488.0
Limit (dB)	62.0	62.0	-23.2	-22.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	21.9	23.0	68.9	68.1
Freq. (MHz)	3.3	3.4	486.0	488.0
Limit (dB)	58.2	57.9	-25.0	-25.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	7,8	1,2
RL (dB)	2.9	7.3	8.3	7.4
Freq. (MHz)	1.0	334.0	368.0	339.0
Limit (dB)	19.0	6.8	6.3	6.7

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	1,2-3,6	1,2-3,6
NEXT (dB)	18.0	16.8	19.1	19.1
Freq. (MHz)	370.0	368.0	485.0	488.0
Limit (dB)	29.7	29.7	26.5	26.4
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	18.2	17.9	21.0	20.6
Freq. (MHz)	365.0	367.0	488.0	485.0
Limit (dB)	26.8	26.8	23.5	23.6
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
ACR-F (dB)	17.5	17.5	17.5	17.5
Freq. (MHz)	500.0	500.0	500.0	500.0
Limit (dB)	9.3	9.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	19.5	19.6	19.5	19.6
Freq. (MHz)	499.0	500.0	499.0	500.0
Limit (dB)	6.3	6.3	6.3	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	22.3	22.6	66.8	67.0
Freq. (MHz)	2.9	1.1	485.0	488.0
Limit (dB)	61.4	62.0	-22.0	-22.3
Worst Pair	4,5	4,5	3,6	3,6
PS ACR-N (dB)	22.0	23.3	68.8	68.3
Freq. (MHz)	3.3	3.3	488.0	485.0
Limit (dB)	58.2	58.2	-25.1	-24.9
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	7,8	7,8	7,8
RL (dB)	3.0	7.0	7.8	7.1
Freq. (MHz)	1.0	342.0	363.0	346.0
Limit (dB)	19.0	6.7	6.4	6.6

Figure B-103. Fluke Meter Cat6a Results for a Gore 24-AWG Ethernet Cable with Two CeeLok FAS-X Connectors
Left panel shows the cable with no significant bends; center panel shows the cable in the bend fixture with a bend that is within 4x the cable diameter, the minimum bend radius; right panel shows the cable with a severe bend radius (estimated to be 1x the cable diameter). In each case, there were no significant changes with respect to crosstalk and RL.

Cable ID: PIC BEND TEST 02/23 - 8FT - CONTROL | **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/23/2023 10:39:20 AM
Operator: JONATHAN BRODT
Headroom 14.1 dB (NEXT 1,2-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	8
Prop. Delay (ns), Limit 555	[Pair 3,6]	12
Delay Skew (ns), Limit 50	[Pair 3,6]	1
Resistance (ohms)	[Pair 1,2]	0.81
Insertion Loss Margin (dB)	[Pair 7,8]	47.3
Frequency (MHz)	[Pair 7,8]	495.0
Limit (dB)	[Pair 7,8]	49.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
NEXT (dB)	14.1	14.4	14.4	14.7
Freq. (MHz)	213.0	211.0	455.0	469.0
Limit (dB)	34.3	34.4	27.2	26.9
Worst Pair	4,5	4,5	1,2	1,2
PS NEXT (dB)	15.8	16.5	17.0	17.3
Freq. (MHz)	194.5	202.5	493.0	500.0
Limit (dB)	32.1	31.8	23.4	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	1,2-3,6	3,6-1,2
ACR-F (dB)	19.1	18.8	22.0	21.6
Freq. (MHz)	224.0	224.0	463.0	463.0
Limit (dB)	16.3	16.3	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.2	20.5	22.8	23.7
Freq. (MHz)	1.1	298.0	467.0	500.0
Limit (dB)	59.2	10.8	6.9	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	23.6	21.2	59.5	61.5
Freq. (MHz)	3.0	3.0	448.0	473.0
Limit (dB)	61.4	61.4	-19.0	-21.1
Worst Pair	3,6	4,5	1,2	1,2
PS ACR-N (dB)	24.0	22.3	64.8	65.4
Freq. (MHz)	3.0	3.9	493.0	500.0
Limit (dB)	58.4	56.7	-25.5	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	7,8
RL (dB)	2.5	3.4	7.5	7.2
Freq. (MHz)	1.0	19.4	500.0	393.0
Limit (dB)	19.0	17.6	6.0	6.1

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

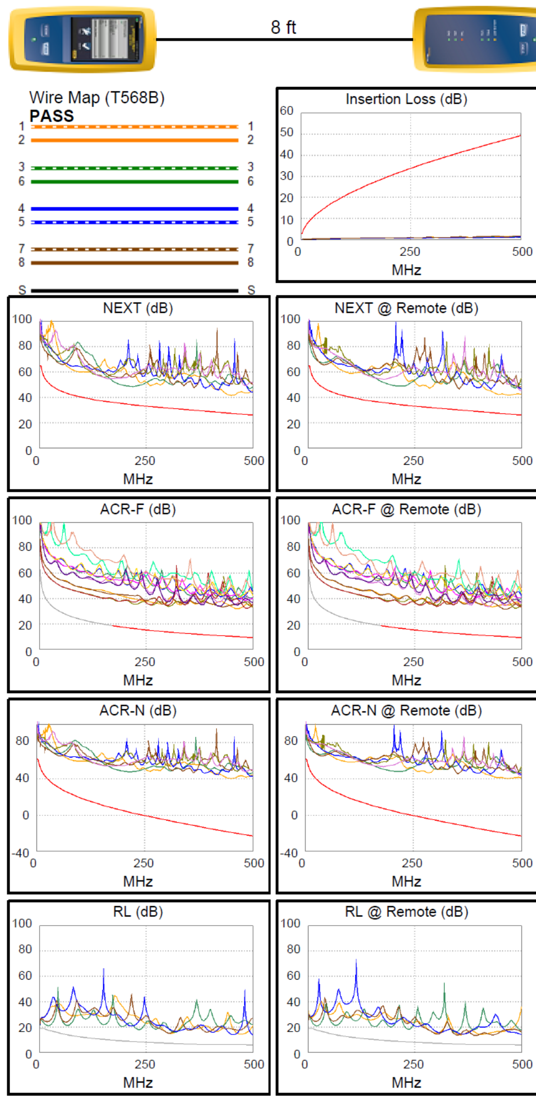

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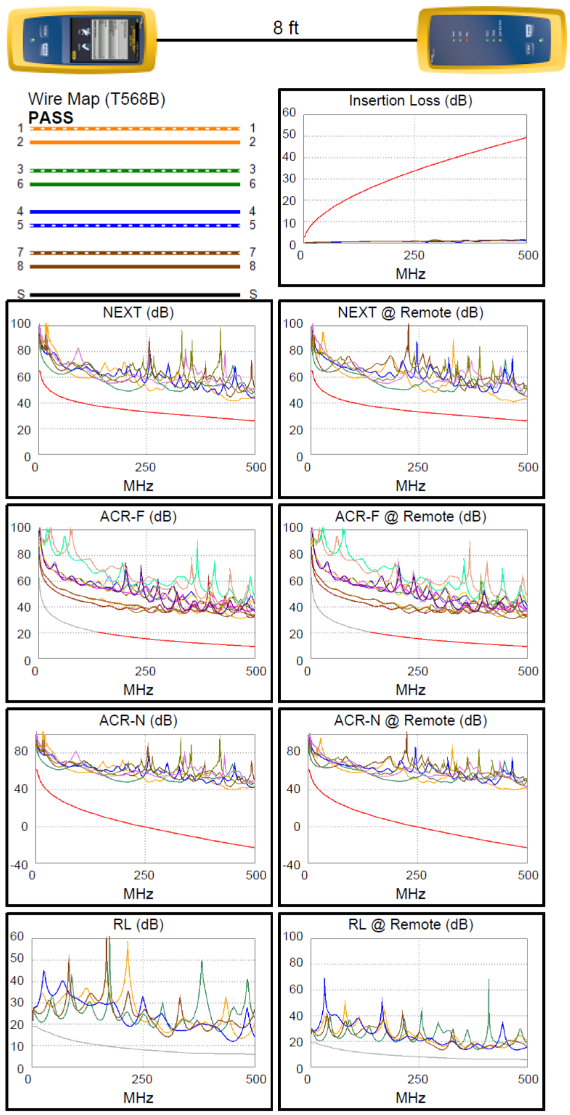
Figure B-104. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable with No Significant Bends



Cable ID: PIC BEND TEST 02/23 - 8FT - 1 — **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/23/2023 10:41:01 AM
Operator: JONATHAN BRODT
Headroom 13.3 dB (NEXT 1,2-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	8
Prop. Delay (ns), Limit 555	[Pair 3,6]	12
Delay Skew (ns), Limit 50	[Pair 3,6]	1
Resistance (ohms)	[Pair 1,2]	0.84
Insertion Loss Margin (dB)	[Pair 7,8]	47.5
Frequency (MHz)	[Pair 7,8]	497.0
Limit (dB)	[Pair 7,8]	49.1

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	1,2-3,6	1,2-3,6
NEXT (dB)	14.2	13.3	14.4	14.2
Freq. (MHz)	445.0	12.0	459.0	470.0
Limit (dB)	27.5	55.3	27.1	26.8
Worst Pair	3,6	4,5	3,6	1,2
PS NEXT (dB)	15.2	14.8	15.3	16.6
Freq. (MHz)	444.0	19.0	446.0	478.0
Limit (dB)	24.6	49.3	24.5	23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	1,2-3,6	3,6-1,2
ACR-F (dB)	19.2	19.0	21.2	21.0
Freq. (MHz)	224.0	226.5	468.0	466.0
Limit (dB)	16.3	16.2	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.3	20.6	22.6	23.1
Freq. (MHz)	1.0	1.0	493.0	500.0
Limit (dB)	60.3	60.3	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	20.7	17.5	60.3	60.5
Freq. (MHz)	3.1	3.1	459.0	470.0
Limit (dB)	61.1	61.1	-19.9	-20.8
Worst Pair	1,2	1,2	3,6	1,2
PS ACR-N (dB)	22.1	19.2	60.4	63.4
Freq. (MHz)	3.1	3.1	446.0	478.0
Limit (dB)	58.3	58.3	-21.8	-24.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	4,5
RL (dB)	2.6	2.8	5.9	7.3
Freq. (MHz)	1.0	18.5	453.0	479.0
Limit (dB)	19.0	17.7	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

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Figure B-105. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable in the Bend Fixture with Three Bends that are within 4x the Cable Diameter (the minimum bend radius is 4x cable diameter)

Cable ID: PIC BEND TEST 02/23 - 8FT - 2 **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/23/2023 10:42:20 AM
Operator: JONATHAN BRODT
Headroom 13.8 dB (NEXT 1,2-3,6)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 1,2]	8
Prop. Delay (ns), Limit 555	[Pair 7,8]	12
Delay Skew (ns), Limit 50	[Pair 3,6]	1
Resistance (ohms)	[Pair 1,2]	0.88
Insertion Loss Margin (dB)	[Pair 1,2]	47.6
Frequency (MHz)	[Pair 1,2]	500.0
Limit (dB)	[Pair 1,2]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-3,6	1,2-7,8	3,6-4,5
NEXT (dB)	15.0	13.8	16.4	17.2
Freq. (MHz)	211.5	286.0	496.0	498.0
Limit (dB)	34.4	32.1	26.2	26.1
Worst Pair	4,5	1,2	1,2	4,5
PS NEXT (dB)	16.3	15.4	16.5	18.2
Freq. (MHz)	213.5	281.0	492.0	498.0
Limit (dB)	31.4	29.3	23.4	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-1,2	3,6-1,2
ACR-F (dB)	19.5	19.4	21.8	21.6
Freq. (MHz)	263.0	224.0	500.0	500.0
Limit (dB)	14.9	16.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.2	20.2	22.5	23.3
Freq. (MHz)	1.0	1.1	495.0	500.0
Limit (dB)	60.3	59.2	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-4,5	1,2-7,8	3,6-4,5
ACR-N (dB)	25.0	23.4	64.1	65.2
Freq. (MHz)	3.1	3.9	497.0	498.0
Limit (dB)	61.1	59.2	-23.0	-23.1
Worst Pair	3,6	3,6	1,2	7,8
PS ACR-N (dB)	25.3	24.0	63.9	66.1
Freq. (MHz)	3.9	3.9	492.0	500.0
Limit (dB)	56.7	56.7	-25.5	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	4,5
RL (dB)	2.7	3.7	6.4	4.7
Freq. (MHz)	1.0	17.8	410.0	367.0
Limit (dB)	19.0	17.8	6.0	6.4

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

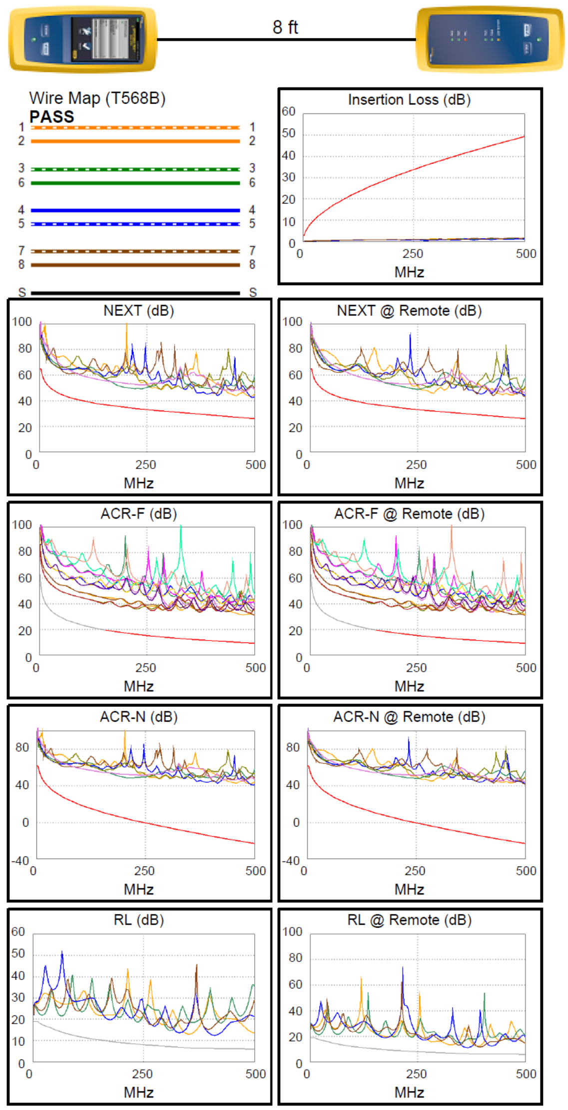

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Figure B-106. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable in the Bend Fixture with Three Severe Bends that are about 1x the Cable Diameter (the minimum bend radius is 4x cable diameter)

Cable ID: PIC BEND TEST 02/27 - 1 - CONTROL **Test Summary: PASS**

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/27/2023 03:34:50 PM
Operator: JONATHAN BRODT
Headroom 7.7 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 7,8]	0.69
Insertion Loss Margin (dB)	[Pair 7,8]	46.4
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.0	7.7	9.1	7.7
Freq. (MHz)	485.0	422.0	488.0	422.0
Limit (dB)	26.5	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	11.0	9.9	11.4	11.3
Freq. (MHz)	419.0	422.0	488.0	487.0
Limit (dB)	25.3	25.2	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.1	10.7	11.2
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	10.6	10.6	10.5	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.6	13.7	13.7
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	7.6	7.6	7.5	7.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.4	19.3	55.6	50.4
Freq. (MHz)	3.1	3.0	485.0	422.0
Limit (dB)	61.1	61.4	-22.0	-16.8
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-N (dB)	18.0	20.2	58.2	52.7
Freq. (MHz)	3.6	3.3	488.0	421.0
Limit (dB)	57.3	58.2	-25.1	-19.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	7,8	4,5
RL (dB)	0.4	-0.1	1.0	-0.1
Freq. (MHz)	317.0	444.0	500.0	444.0
Limit (dB)	7.0	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

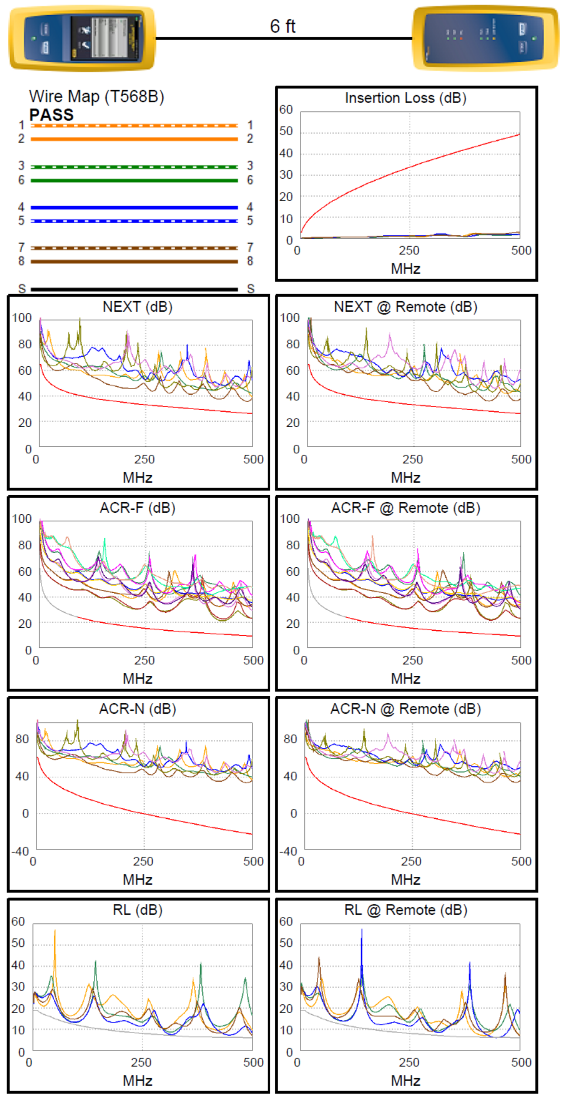

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Figure B-107. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable with Two PIC Connectors with No Significant Bends in Cable

Cable ID: PIC BEND TEST 02/27 - 1 - 1

Test Summary: PASS

Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/27/2023 03:30:44 PM
Operator: JONATHAN BRODT
Headroom 6.9 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.70
Insertion Loss Margin (dB)	[Pair 7,8]	46.6
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.3	6.9	10.6	6.9
Freq. (MHz)	415.0	422.0	486.0	422.0
Limit (dB)	28.3	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.6	9.3	12.2	9.3
Freq. (MHz)	415.0	422.0	495.0	422.0
Limit (dB)	25.4	25.2	23.3	25.2

PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.7	11.3	10.8	11.4
Freq. (MHz)	426.0	426.0	428.0	430.0
Limit (dB)	10.7	10.7	10.6	10.6
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.7	13.8	13.8	13.8
Freq. (MHz)	426.0	427.0	428.0	427.0
Limit (dB)	7.7	7.6	7.6	7.6

N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	13.9	18.5	57.4	49.5
Freq. (MHz)	3.1	3.1	486.0	422.0
Limit (dB)	61.1	61.1	-22.1	-16.8
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	16.0	18.6	59.6	52.1
Freq. (MHz)	3.1	3.9	495.0	422.0
Limit (dB)	58.3	56.7	-25.7	-19.8

N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	4,5	1,2
RL (dB)	0.2	0.2	0.8	0.2
Freq. (MHz)	90.0	500.0	449.0	500.0
Limit (dB)	12.5	6.0	6.0	6.0

Compliant Network Standards:

10BASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	

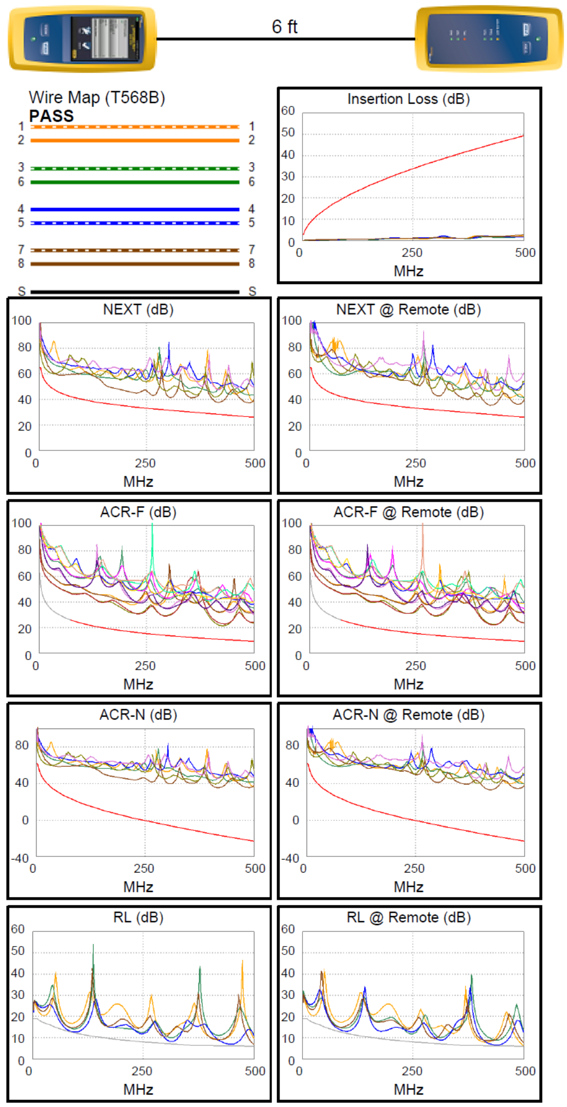

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Figure B-108. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable with Two PIC Connectors in Bend Fixture with Three Bends that are within 4x the Cable Diameter (the minimum bend radius is 4x the cable diameter (Figure B-94))

Cable ID: PIC BEND TEST 02/27 - 1 - 2 | **Test Summary: FAIL**

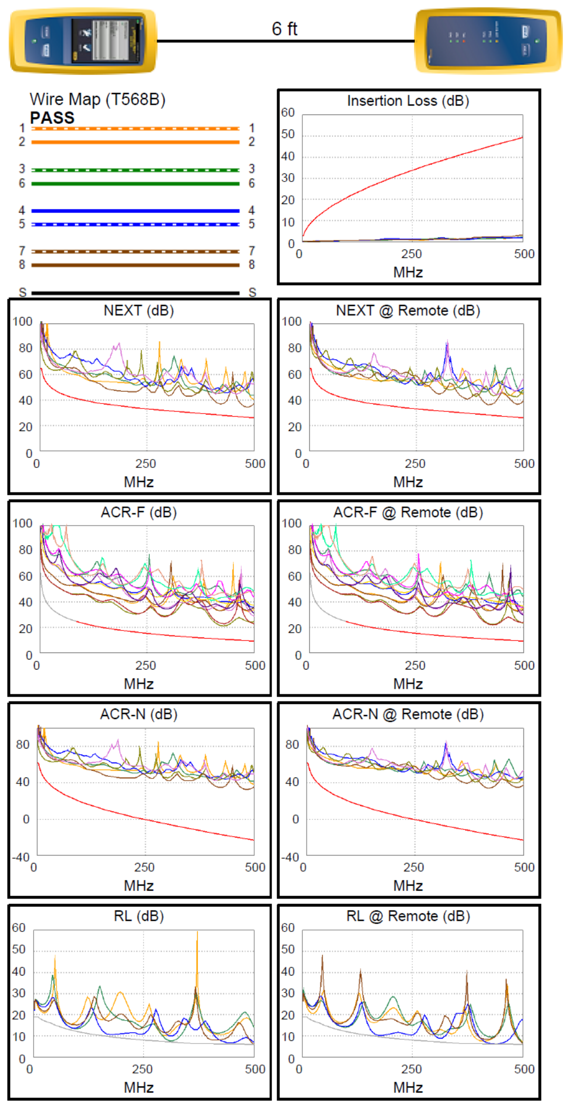
Test Limit: TIA Cat 6A Channel
Limits Version: V7.6
Date / Time: 02/27/2023 03:33:40 PM
Operator: JONATHAN BRODT
Headroom 7.7 dB (NEXT 3,6-4,5)
Cable Type: Cat 6A F/UTP
NVP: 74.0%

Main: Versiv
S/N: 22120373
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000 (DSX-CHA004)
S/N: 22212246

Remote: Versiv
S/N: 22120132
Software Version: V6.7 Build 1
Calibration Date: 07/25/2022
Adapter: DSX-5000R (DSX-CHA004)
S/N: 22212244

Length (ft), Limit 328	[Pair 3,6]	6
Prop. Delay (ns), Limit 555	[Pair 1,2]	9
Delay Skew (ns), Limit 50	[Pair 1,2]	1
Resistance (ohms)	[Pair 1,2]	0.66
Insertion Loss Margin (dB)	[Pair 7,8]	46.2
Frequency (MHz)	[Pair 7,8]	500.0
Limit (dB)	[Pair 7,8]	49.3

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.8	7.7	7.8	7.7
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	26.5	28.2	26.5	28.2
Worst Pair	4,5	3,6	4,5	3,6
PS NEXT (dB)	10.4	10.1	10.4	10.1
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	23.6	25.2	23.6	25.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.2	10.6	11.4
Freq. (MHz)	429.0	426.0	429.0	433.0
Limit (dB)	10.6	10.7	10.6	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.8	13.6	13.8
Freq. (MHz)	429.0	431.0	429.0	431.0
Limit (dB)	7.6	7.6	7.6	7.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.9	21.0	54.3	50.3
Freq. (MHz)	3.3	3.0	483.0	420.0
Limit (dB)	60.7	61.4	-21.9	-16.7
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	19.1	22.2	57.3	52.9
Freq. (MHz)	3.3	3.9	489.0	420.0
Limit (dB)	58.2	56.7	-25.2	-19.6
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	4,5
RL (dB)	-0.1 F	0.4 *	-0.1	0.1
Freq. (MHz)	500.0	500.0	500.0	439.0
Limit (dB)	6.0	6.0	6.0	6.0



* Measurement is within the accuracy limits of the instrument.

LinkWare™ PC Version 11.1

Figure B-109. Fluke Meter Cat6a results for PIC 24-AWG Ethernet Cable with Two PIC Connectors in Bend Fixture with Three Severe Bends that are ~1x the Cable Diameter (the minimum bend radius is 4x cable diameter (Figure B-95))

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
NEXT (dB)	14.1	14.4	14.4	14.7
Freq. (MHz)	213.0	211.0	455.0	469.0
Limit (dB)	34.3	34.4	27.2	26.9
Worst Pair	4,5	4,5	1,2	1,2
PS NEXT (dB)	15.8	16.5	17.0	17.3
Freq. (MHz)	194.5	202.5	493.0	500.0
Limit (dB)	32.1	31.8	23.4	23.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	1,2-3,6	3,6-1,2
ACR-F (dB)	19.1	18.8	22.0	21.6
Freq. (MHz)	224.0	224.0	463.0	463.0
Limit (dB)	16.3	16.3	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.2	20.5	22.8	23.7
Freq. (MHz)	1.1	298.0	467.0	500.0
Limit (dB)	59.2	10.8	6.9	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	23.6	21.2	59.5	61.5
Freq. (MHz)	3.0	3.0	448.0	473.0
Limit (dB)	61.4	61.4	-19.0	-21.1
Worst Pair	3,6	4,5	1,2	1,2
PS ACR-N (dB)	24.0	22.3	64.8	65.4
Freq. (MHz)	3.0	3.9	493.0	500.0
Limit (dB)	58.4	56.7	-25.5	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	7,8
RL (dB)	2.5	3.4	7.5	7.2
Freq. (MHz)	1.0	19.4	500.0	393.0
Limit (dB)	19.0	17.6	6.0	6.1

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-4,5	1,2-3,6	1,2-3,6
NEXT (dB)	14.2	13.3	14.4	14.2
Freq. (MHz)	445.0	12.0	459.0	470.0
Limit (dB)	27.5	55.3	27.1	26.8
Worst Pair	3,6	4,5	3,6	1,2
PS NEXT (dB)	15.2	14.8	15.3	16.6
Freq. (MHz)	444.0	19.0	446.0	478.0
Limit (dB)	24.6	49.3	24.5	23.7
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	1,2-3,6	3,6-1,2
ACR-F (dB)	19.2	19.0	21.2	21.0
Freq. (MHz)	224.0	226.5	468.0	466.0
Limit (dB)	16.3	16.2	9.9	9.9
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.3	20.6	22.6	23.1
Freq. (MHz)	1.0	1.0	493.0	500.0
Limit (dB)	60.3	60.3	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-4,5	1,2-3,6	1,2-3,6
ACR-N (dB)	20.7	17.5	60.3	60.5
Freq. (MHz)	3.1	3.1	459.0	470.0
Limit (dB)	61.1	61.1	-19.9	-20.8
Worst Pair	1,2	1,2	3,6	1,2
PS ACR-N (dB)	22.1	19.2	60.4	63.4
Freq. (MHz)	3.1	3.1	446.0	478.0
Limit (dB)	58.3	58.3	-21.8	-24.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	4,5
RL (dB)	2.6	2.8	5.9	7.3
Freq. (MHz)	1.0	18.5	453.0	479.0
Limit (dB)	19.0	17.7	6.0	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	1,2-4,5	1,2-3,6	1,2-7,8	3,6-4,5
NEXT (dB)	15.0	13.8	16.4	17.2
Freq. (MHz)	211.5	286.0	496.0	498.0
Limit (dB)	34.4	32.1	26.2	26.1
Worst Pair	4,5	1,2	1,2	4,5
PS NEXT (dB)	16.3	15.4	16.5	18.2
Freq. (MHz)	213.5	281.0	492.0	498.0
Limit (dB)	31.4	29.3	23.4	23.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	4,5-3,6	3,6-1,2	3,6-1,2
ACR-F (dB)	19.5	19.4	21.8	21.6
Freq. (MHz)	263.0	224.0	500.0	500.0
Limit (dB)	14.9	16.3	9.3	9.3
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	20.2	20.2	22.5	23.3
Freq. (MHz)	1.0	1.1	495.0	500.0
Limit (dB)	60.3	59.2	6.4	6.3
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-4,5	1,2-7,8	3,6-4,5
ACR-N (dB)	25.0	23.4	64.1	65.2
Freq. (MHz)	3.1	3.9	497.0	498.0
Limit (dB)	61.1	59.2	-23.0	-23.1
Worst Pair	3,6	3,6	1,2	7,8
PS ACR-N (dB)	25.3	24.0	63.9	66.1
Freq. (MHz)	3.9	3.9	492.0	500.0
Limit (dB)	56.7	56.7	-25.5	-26.1
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6	3,6	4,5	4,5
RL (dB)	2.7	3.7	6.4	4.7
Freq. (MHz)	1.0	17.8	410.0	367.0
Limit (dB)	19.0	17.8	6.0	6.4

Compliant Network Standards:

Figure B-110. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable
Left panel shows cable with no significant bends; center panel shows cable in the bend fixture with a bend that is within 4x the cable diameter, which is the minimum bend radius; right panel shows cable with a severe bend radius (estimated to be 1x the cable diameter). In each case, there were no significant changes with respect to crosstalk and RL.

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.0	7.7	9.1	7.7
Freq. (MHz)	485.0	422.0	488.0	422.0
Limit (dB)	26.5	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	11.0	9.9	11.4	11.3
Freq. (MHz)	419.0	422.0	488.0	487.0
Limit (dB)	25.3	25.2	23.5	23.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.1	10.7	11.2
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	10.6	10.6	10.5	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.6	13.7	13.7
Freq. (MHz)	431.0	431.0	432.0	434.0
Limit (dB)	7.6	7.6	7.5	7.5
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.4	19.3	55.6	50.4
Freq. (MHz)	3.1	3.0	485.0	422.0
Limit (dB)	61.1	61.4	-22.0	-16.8
Worst Pair	3,6	3,6	4,5	4,5
PS ACR-N (dB)	18.0	20.2	58.2	52.7
Freq. (MHz)	3.6	3.3	488.0	421.0
Limit (dB)	57.3	58.2	-25.1	-19.7
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	4,5	7,8	4,5
RL (dB)	0.4	-0.1	1.0	-0.1
Freq. (MHz)	317.0	444.0	500.0	444.0
Limit (dB)	7.0	6.0	6.0	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	9.3	6.9	10.6	6.9
Freq. (MHz)	415.0	422.0	486.0	422.0
Limit (dB)	28.3	28.1	26.4	28.1
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	10.6	9.3	12.2	9.3
Freq. (MHz)	415.0	422.0	495.0	422.0
Limit (dB)	25.4	25.2	23.3	25.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.7	11.3	10.8	11.4
Freq. (MHz)	426.0	426.0	428.0	430.0
Limit (dB)	10.7	10.7	10.6	10.6
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.7	13.8	13.8	13.8
Freq. (MHz)	426.0	427.0	428.0	427.0
Limit (dB)	7.7	7.6	7.6	7.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	13.9	18.5	57.4	49.5
Freq. (MHz)	3.1	3.1	486.0	422.0
Limit (dB)	61.1	61.1	-22.1	-16.8
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	16.0	18.6	59.6	52.1
Freq. (MHz)	3.1	3.9	495.0	422.0
Limit (dB)	58.3	56.7	-25.7	-19.8
N/A	MAIN	SR	MAIN	SR
Worst Pair	4,5	1,2	4,5	1,2
RL (dB)	0.2	0.2	0.8	0.2
Freq. (MHz)	90.0	500.0	449.0	500.0
Limit (dB)	12.5	6.0	6.0	6.0

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	3,6-4,5	3,6-4,5	3,6-4,5
NEXT (dB)	7.8	7.7	7.8	7.7
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	26.5	28.2	26.5	28.2
Worst Pair	4,5	3,6	4,5	3,6
PS NEXT (dB)	10.4	10.1	10.4	10.1
Freq. (MHz)	484.0	420.0	484.0	420.0
Limit (dB)	23.6	25.2	23.6	25.2
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-4,5	4,5-3,6	3,6-4,5	4,5-3,6
ACR-F (dB)	10.6	11.2	10.6	11.4
Freq. (MHz)	429.0	426.0	429.0	433.0
Limit (dB)	10.6	10.7	10.6	10.5
Worst Pair	4,5	3,6	4,5	3,6
PS ACR-F (dB)	13.6	13.8	13.6	13.8
Freq. (MHz)	429.0	431.0	429.0	431.0
Limit (dB)	7.6	7.6	7.6	7.6
N/A	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-4,5	3,6-4,5
ACR-N (dB)	16.9	21.0	54.3	50.3
Freq. (MHz)	3.3	3.0	483.0	420.0
Limit (dB)	60.7	61.4	-21.9	-16.7
Worst Pair	3,6	3,6	3,6	4,5
PS ACR-N (dB)	19.1	22.2	57.3	52.9
Freq. (MHz)	3.3	3.9	489.0	420.0
Limit (dB)	58.2	56.7	-25.2	-19.6
FAIL	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	4,5
RL (dB)	-0.1 F	0.4*	-0.1	0.1
Freq. (MHz)	500.0	500.0	500.0	439.0
Limit (dB)	6.0	6.0	6.0	6.0

Figure B-111. Fluke Meter Cat6a Results for a PIC 24-AWG Ethernet Cable with Two PIC Connectors
Left panel shows cable with no significant bends; center panel shows cable in the bend fixture with a bend that is within the 4x the cable diameter, which is the minimum bend radius; right panel shows cable with a severe bend radius (estimated to be 1x the cable diameter). There were no significant changes with respect to crosstalk and RL with no significant bends and with bends 4x the diameter of the cable. With a severe bend (estimated to be 1x of the cable diameter), the cable failed the RL requirement and exhibited a lower crosstalk margin (7.8 dB vs 9.3 dB) compared twitho the cable in a minimium bend radius condition.

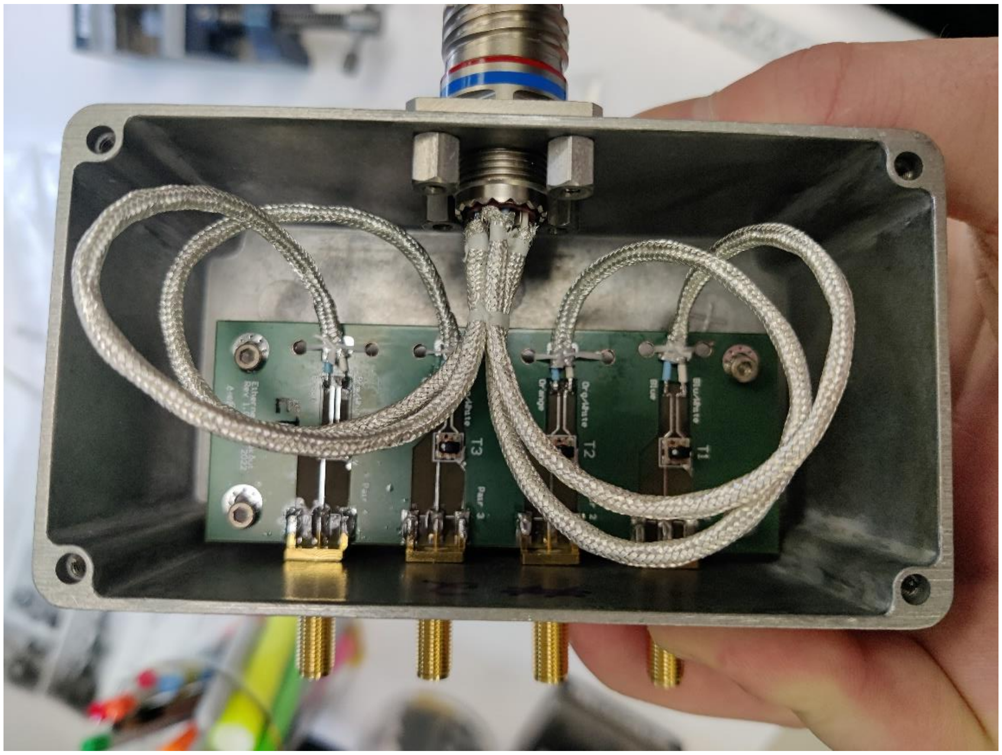


Figure B-112. Impedance Conversion Box for conducting Transfer Impedance Measurements using a Network Analyzer
The CeeLok FAS-X connector (top) connects the four twisted pairs from the Ethernet cable under test. The signals pass through a step-down transformer, which coverts the 100-ohm twisted pair impedance to a 50-ohm impedance. Each is shunted to a SubMiniature version A (SMA) coaxial connector (bottom), which is then connected to the network analyzer channel inputs.

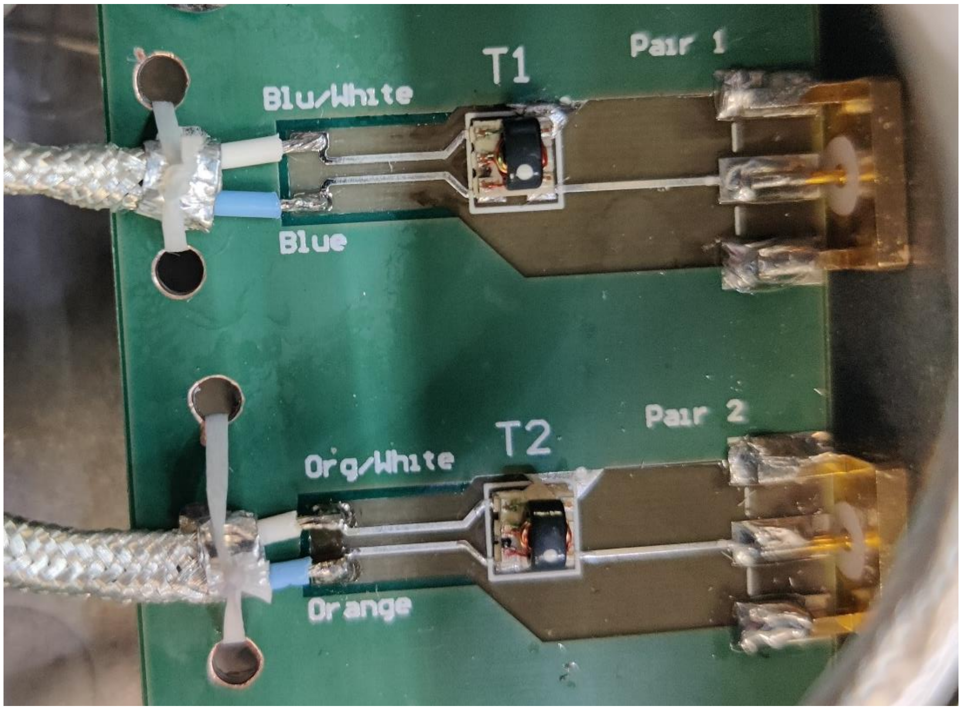


Figure B-113. Impedance Conversion Box for Conducting Transfer Impedance Measurements using a Network Analyzer showing Two of the Twisted Pairs (left side) Connected to Printed Wiring Board containing Step-down (2:1 ratio) Transformers
The transformer output traces are connected to coaxial SMA connectors (inner pin and the outer shield), which are connected to two of the network analyzer inputs. Note the PWB traces are not shielded on the top, which can create a more lossy circuit when propagating signals in the megahertz range.

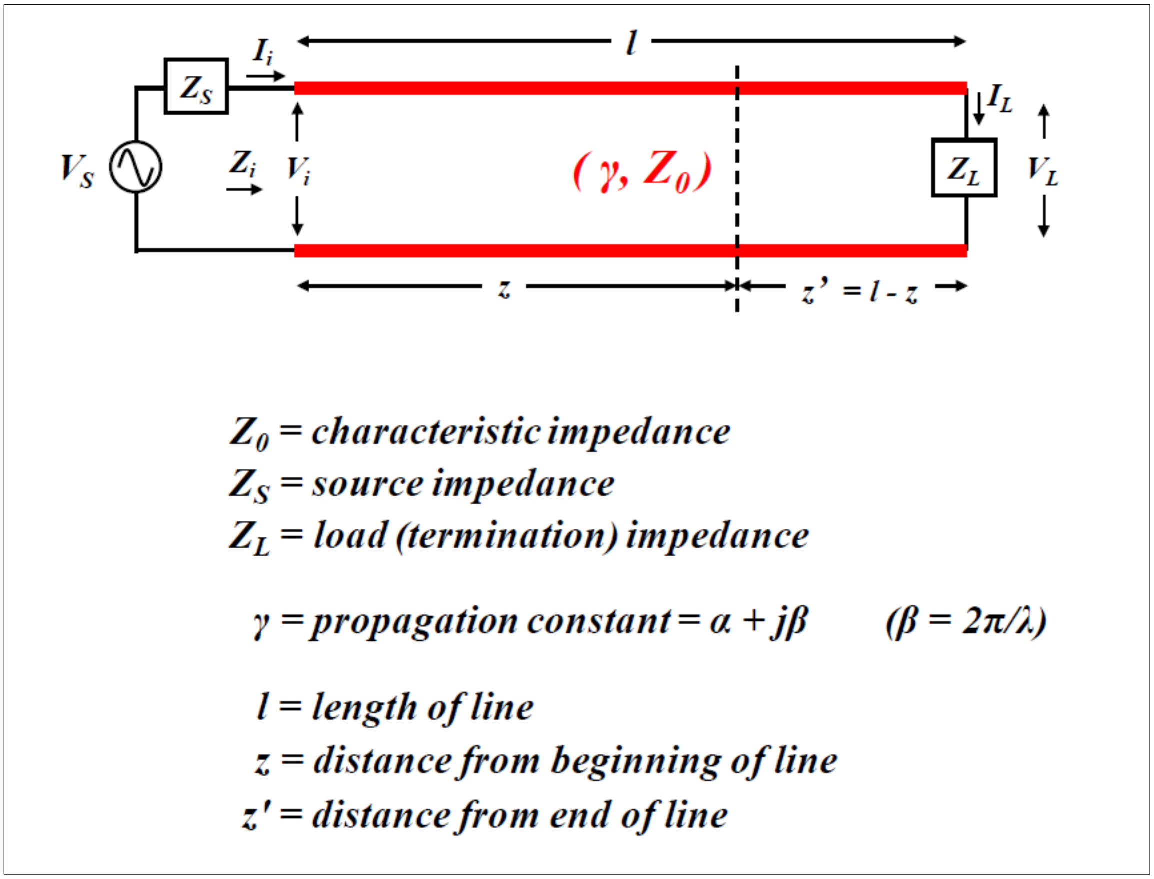


Figure B-114. Basic Setup showing Transmission Line Theory for making the Transfer Impedance Measurement

Appendix C. Ethernet Cable and ESD Gun Test Plan

Purpose: to determine whether ESD pulses applied to an Ethernet cable and connector system creates sufficient noise in the twisted pair Ethernet cables to cause data errors when an Ethernet network link is established between two computers.

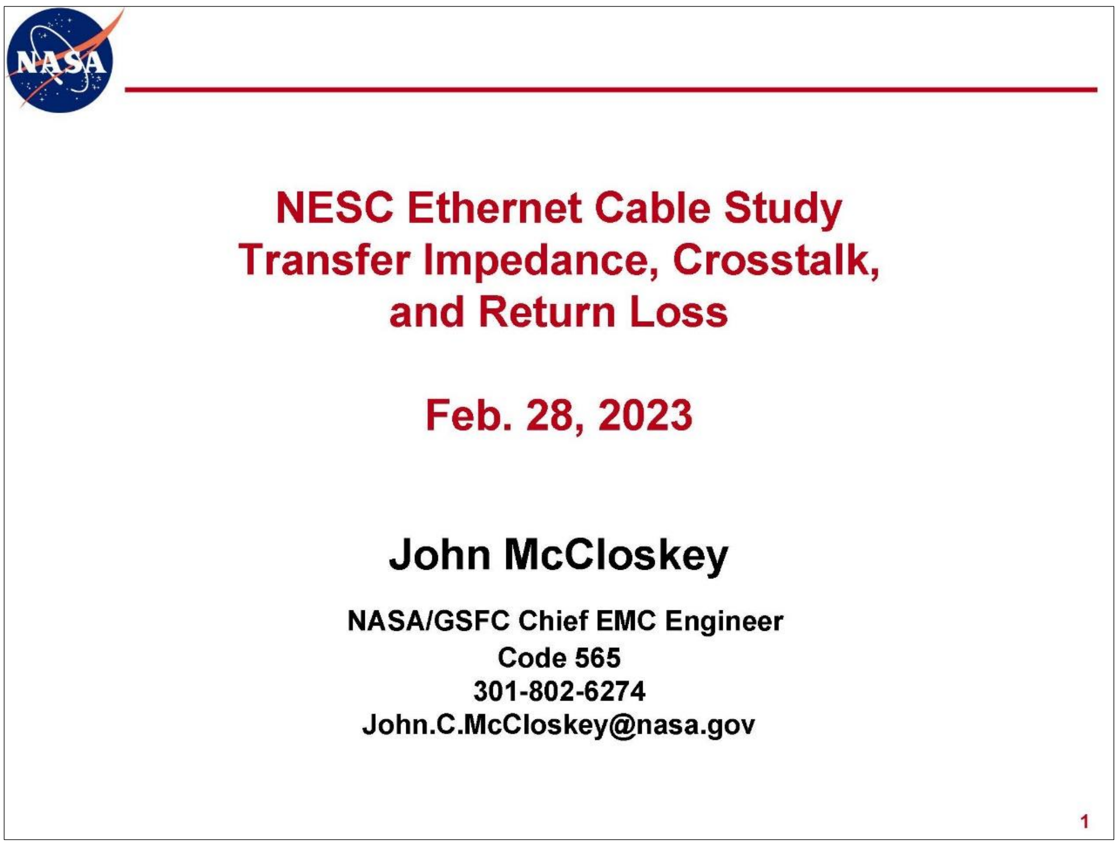
1. Review ESD gun manual and follow safety guidelines. Be familiar with the setup and the discharging of the gun into the area of interest. An NSG 438 ESD gun and a calibration system were obtained.
2. Measure and record temperature and humidity prior to testing since both impact discharge waveforms.
3. Conduct calibration tests using the target at several test voltages with the waveforms captured using an oscilloscope.
4. Place the two test computers on a conductive table (1/4 aluminum plate) to maintain a ground plane and connect the ground plane computers and ESD simulator all to an Earth ground. Establish an Ethernet (1000 Base-T) link between two computers.
5. Monitor Ethernet network data transfer during application of the ESD pulses to detect dropped data packets and potential loss of the network link.
6. Apply ESD pulse to a mated Ethernet connector by touching the ESD gun discharge surface to the connector shell after following the setup procedure below:
   - Voltage levels: start at 1 kV and initially set the ESD gun to single pulse mode. Verify that data errors are detected. If none are detected, then apply multiple pulses and check for data errors. If none are detected, then set to a 20-Hz (50-msec) repetition rate and apply for 1 minute.
   - If no data errors are detected, then move to 2 kV with a 50-ms pulse rate for 1 minute.
   - If no errors are detected, then repeat the same process at 4, 6, 8, and 10 kV, and stop at 6kV using the same process as above.

Appendix D. Electromagnetic Compatibility (EMC) Cable Measurements

D.1 Surface Mount Radio Frequency (RF) Transformer Typical Performance Data

Image removed due to copyright restrictions.[14]

D.2 NESC Ethernet Cable Study Transfer Impedance, Crosstalk, and Return Loss (RL), February 28, 2023



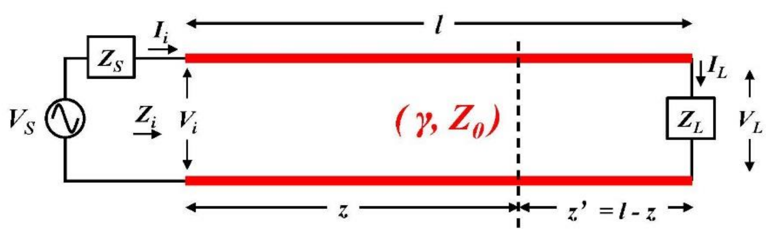
[14] [TC2-1TG2+.pdf (minicircuits.com)]

New Sample Cable

- New sample cable received
- Length = 21” = 53 cm

2

Transmission Line Impedance



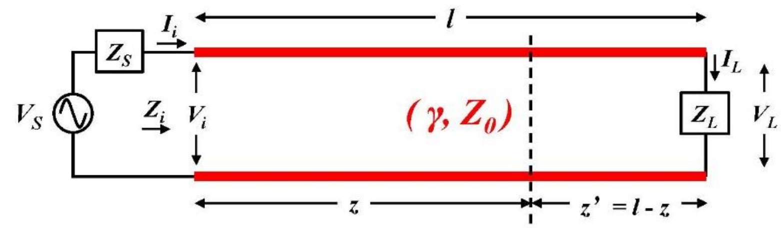
Z_0 = *characteristic impedance*
Z_S = *source impedance*
Z_L = *load (termination) impedance*

γ = *propagation constant* = $\alpha + j\beta$ $\quad (\beta = 2\pi/\lambda)$

l = *length of line*
z = *distance from beginning of line*
z' = *distance from end of line*

3

Transmission Line Impedance (cont.)



$$Z_i = Z(l) = Z_0 \frac{Z_L + Z_0 \tanh(\gamma l)}{Z_0 + Z_L \tanh(\gamma l)}$$ **INPUT IMPEDANCE OF LOSSY TRANSMISSION LINE**

INPUT IMPEDANCE OF LOSSLESS TRANSMISSION LINE:

$$\boxed{Z_i = Z(l) = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)}}$$

4

Transmission Line Impedance (cont.)

$$Z_i = Z(l) = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)} \quad (\beta = 2\pi/\lambda)$$

$l = \lambda/4$: $\tan\frac{\pi}{2} = \infty \longrightarrow Z_i = \frac{Z_0^2}{Z_L}$ ***Short circuit termination measures as open-circuit***
Open-circuit termination measures as short-circuit

$l = \lambda/2$: $\tan\pi = 0 \longrightarrow Z_i = Z_L$

$l = \lambda/8$: $\tan\frac{\pi}{4} = 1 \longrightarrow |Z_i| = Z_0$ ***Reflected energy sees Z_0***

Test cable length = 21 feet = 53 cm

$\lambda = \frac{300}{f_{MHz}}$

$\lambda/2$ @ 282 MHz
$\lambda/4$ @ 141 MHz
$\lambda/8$ @ 70 MHz

5

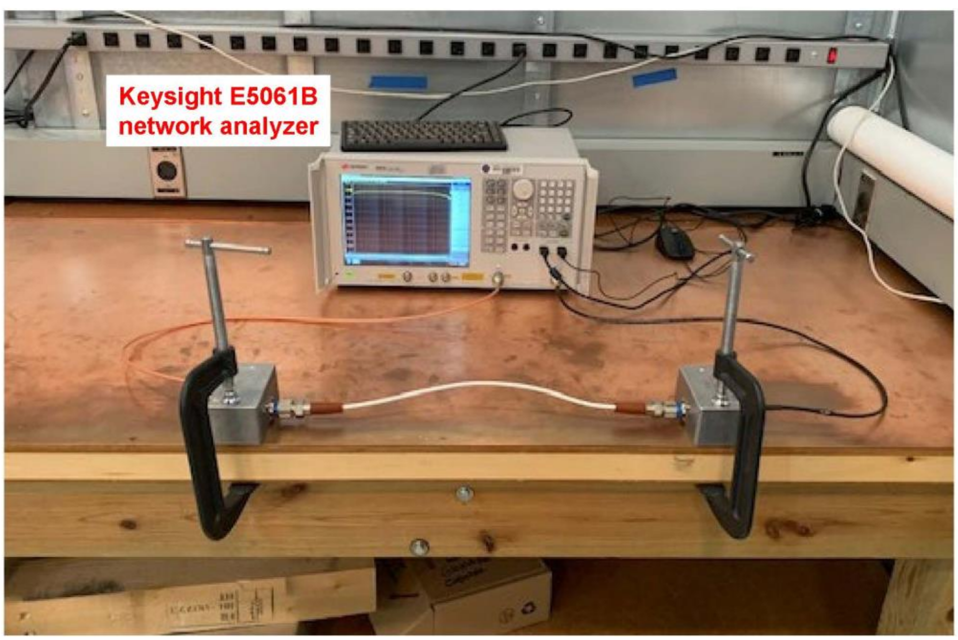
Measurements

- **Throughput (functionality)**
- **Channel-to-Channel Crosstalk**
- **Shield Transfer Impedance**
- **Return Loss (S11)**

- **All data taken with:**
  - Keysight E5061B network analyzer
  - Frequency range: 100 kHz to 1 GHz

6

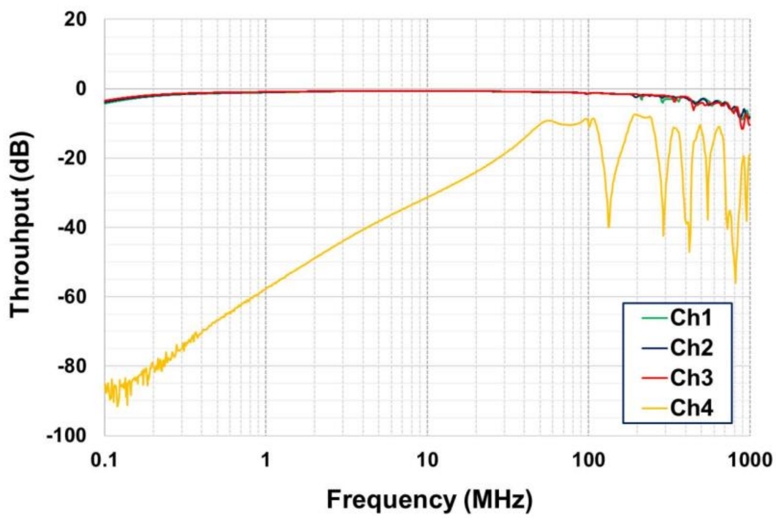
Basic Setup - Throughput and Crosstalk



7

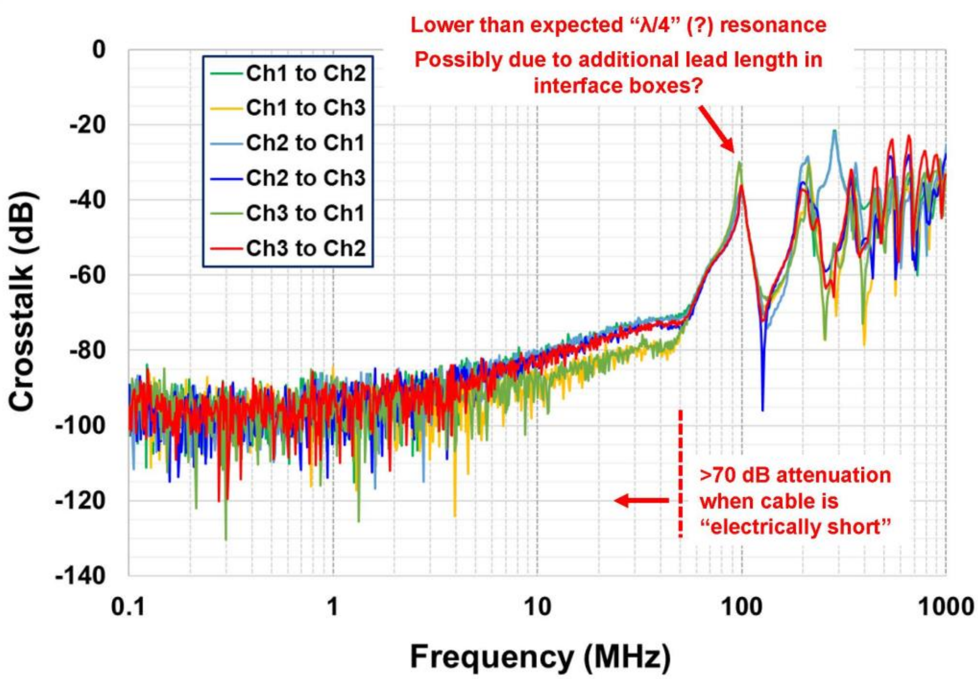
Throughput

- Channel 4 appears open-circuited
- Channels 1-3 appear nominal; used for all further measurements



8

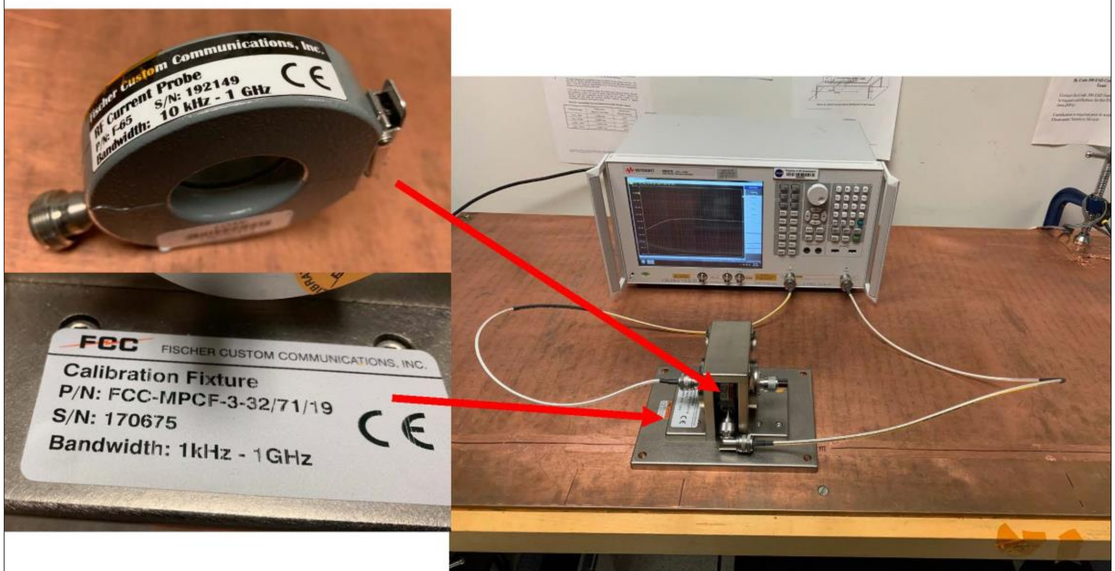
Channel-to-Channel Crosstalk



9

Shield Transfer Impedance

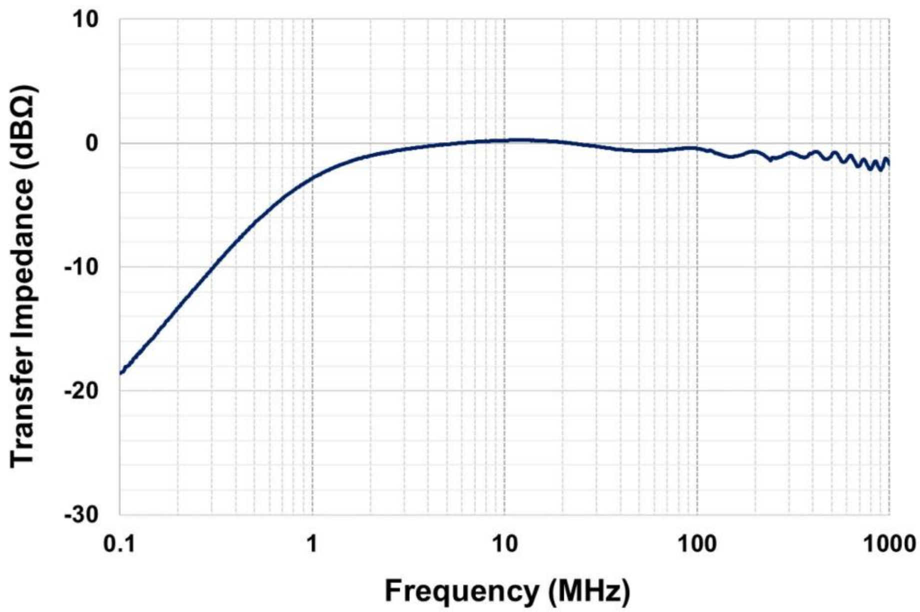
- **Step 1: Current Probe Calibration**



10

Shield Transfer Impedance (cont.)

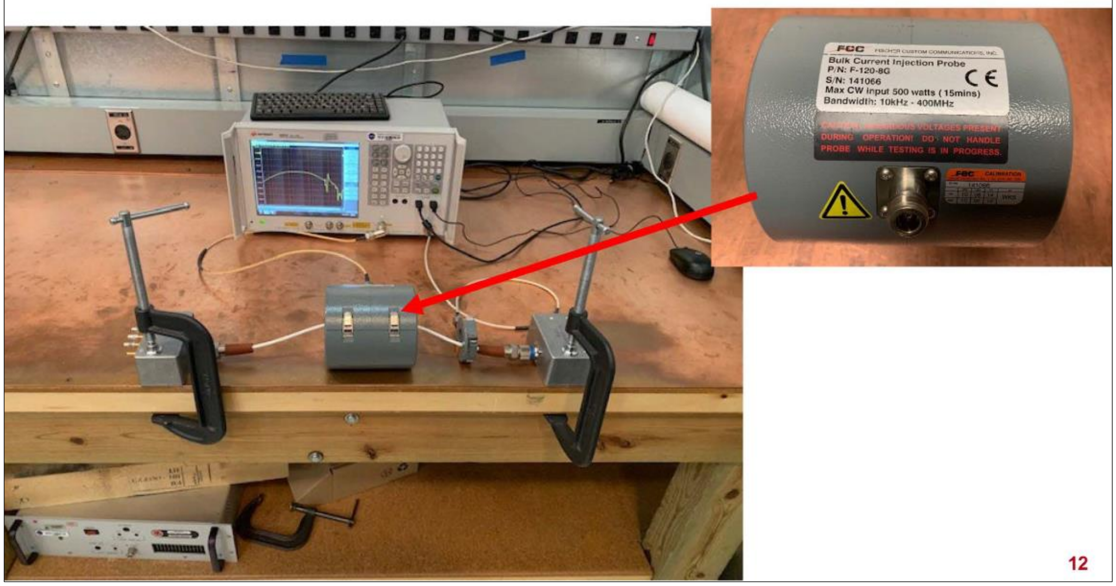
F-65 Current Probe Transfer Impedance



11

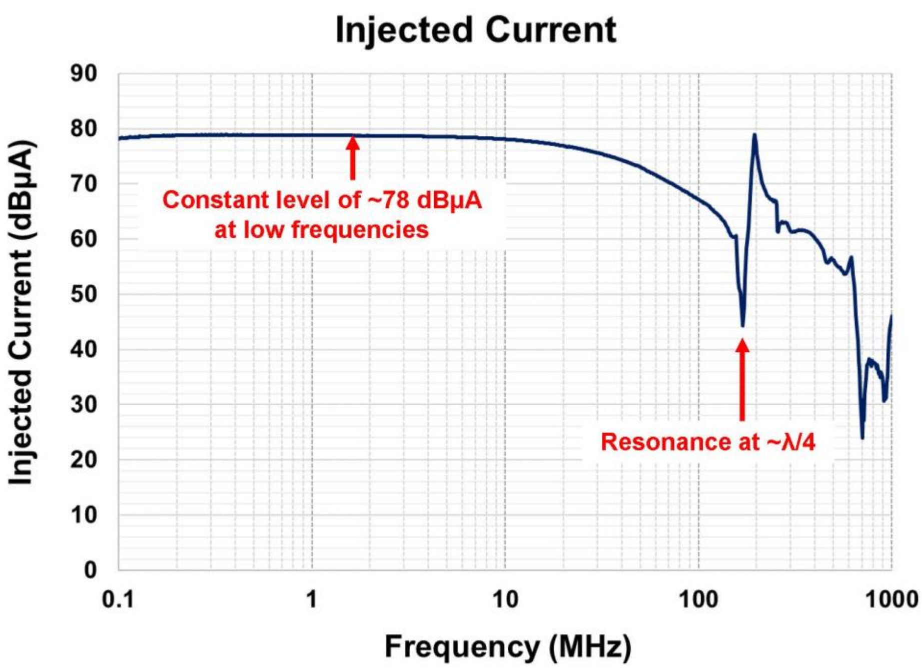
Shield Transfer Impedance (cont.)

- **Step 2: Measurement of injected current**
  - Bulk current injection probe per MIL-STD-461G CS114



12

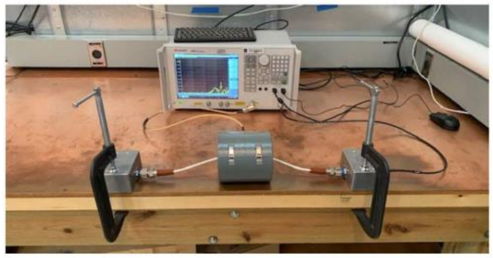
Shield Transfer Impedance (cont.)

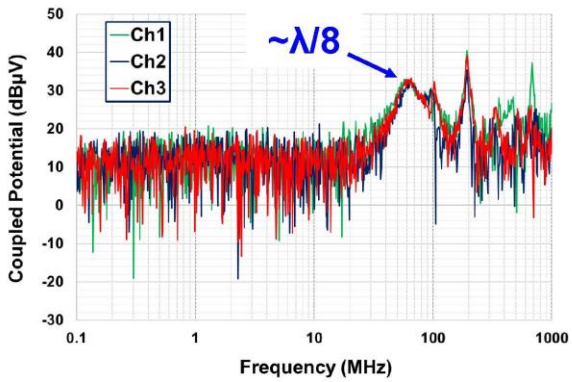


13

Shield Transfer Impedance (cont.)

- **Step 3: Measurement of coupled potential**

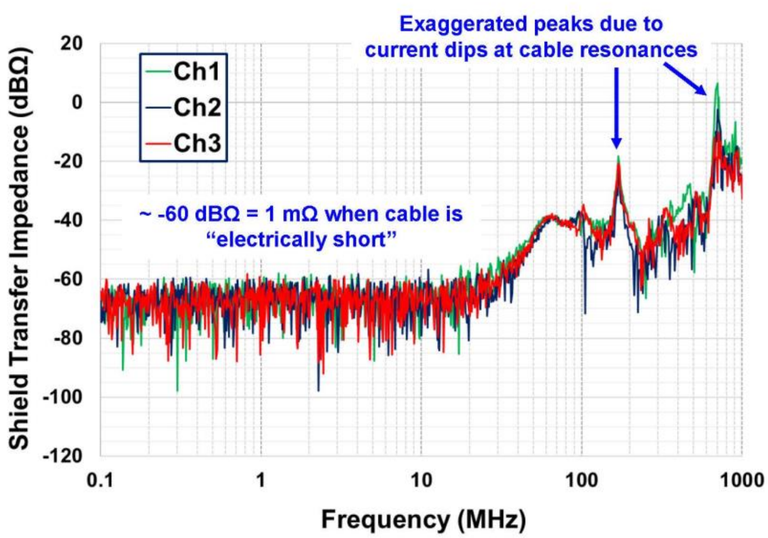




14

Shield Transfer Impedance (cont.)

- **Step 4: Calculation of shield transfer impedance**
  - Coupled potential – injected current (in dB-space)
  - "Brute force" method: Direct subtraction of measured values



15

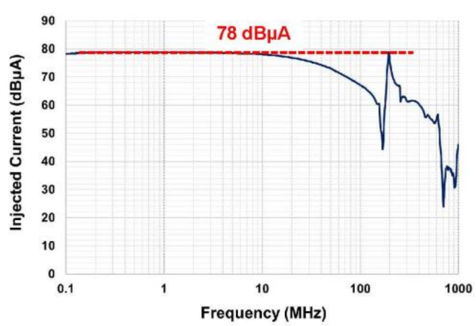
Shield Transfer Impedance (cont.)

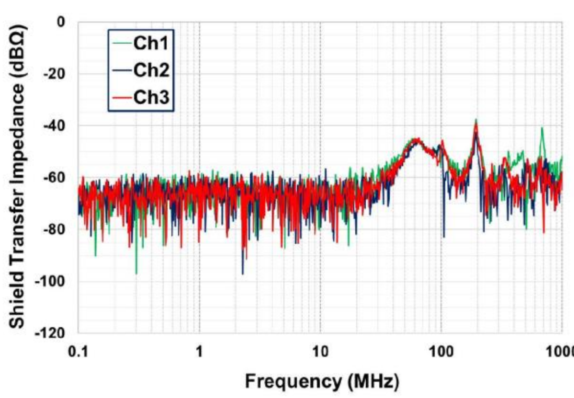
- "Brute force" method is affected by cable geometry at high frequencies (l > λ/10) and gives less accurate indication of cable's true performance
- Measured current at high frequencies highly dependent on monitor probe location
- Exaggerated current readings at cable resonances give exaggerated transfer impedance values at these frequencies

16

Shield Transfer Impedance (cont.)

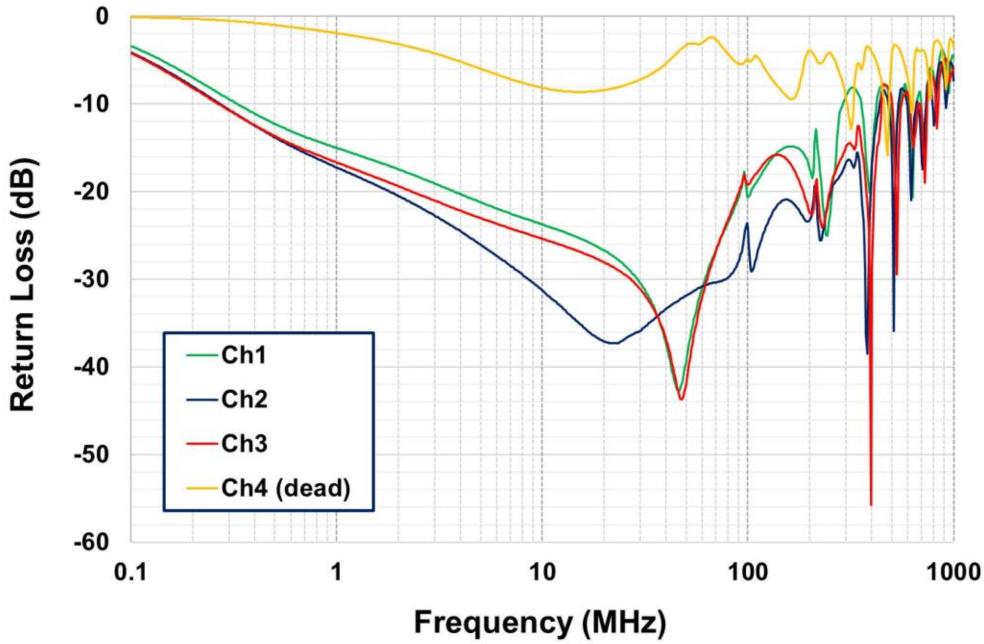
- In the meantime, it may be approximated by recognizing that drive level is constant over frequency (0 dBm)
- 2nd example calculation performed assuming constant current level of 78 dBµA





17

Return Loss (S11)



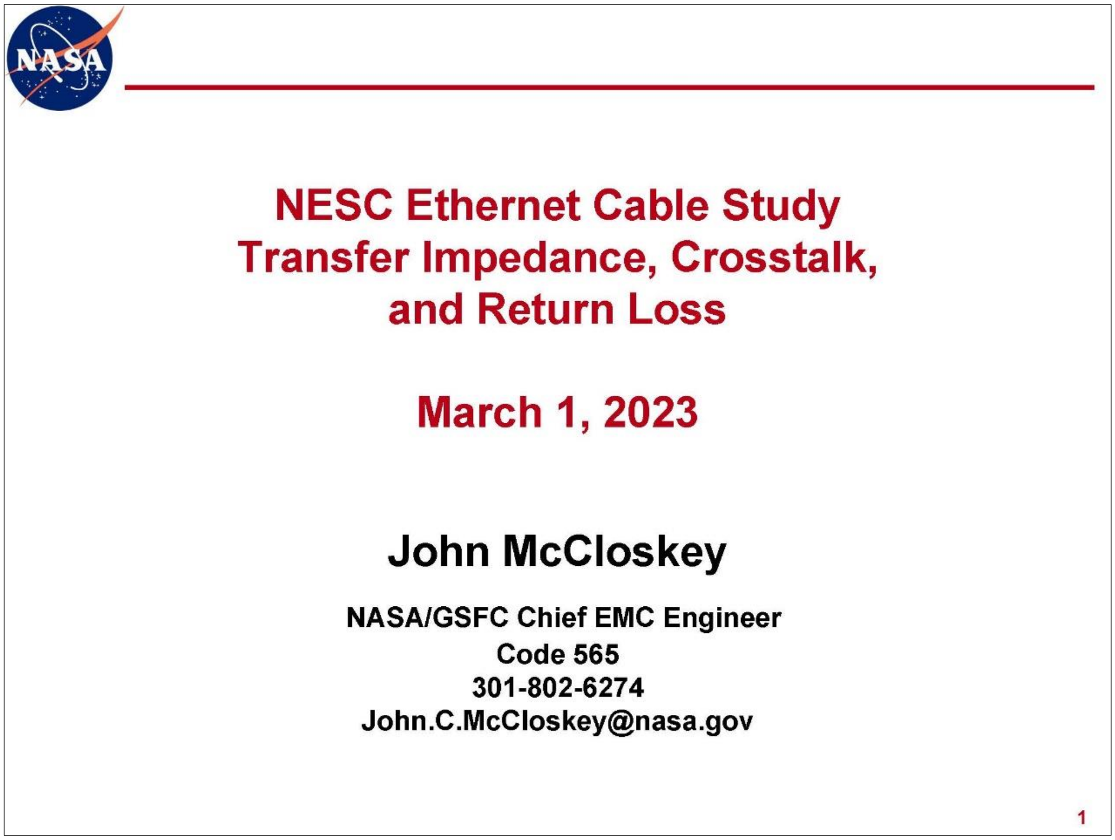
18

Summary

- **Crosstalk and shield transfer impedance results look promising**
  - > 70 crosstalk attenuation when cable is "electrically short"
  - ~1 mΩ transfer impedance when cable is "electrically short"
- **Request for additional transfer impedance measurements with test cable at different heights above ground plane**
- **Additional measurements?**

19

D.3 NESC Ethernet Cable Study Transfer Impedance, Crosstalk, and RL, with Cable 3.5 inches above the Ground Plane, March 1, 2023

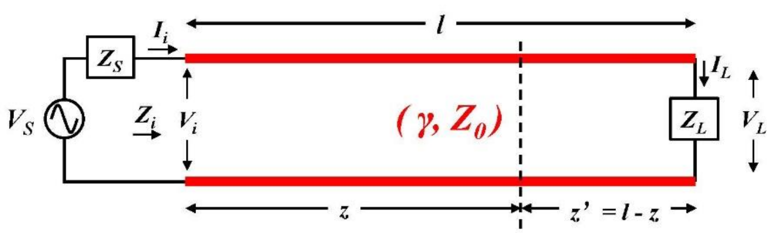


New Sample Cable

- New sample cable received
- Length = 21” = 53 cm

2

Transmission Line Impedance



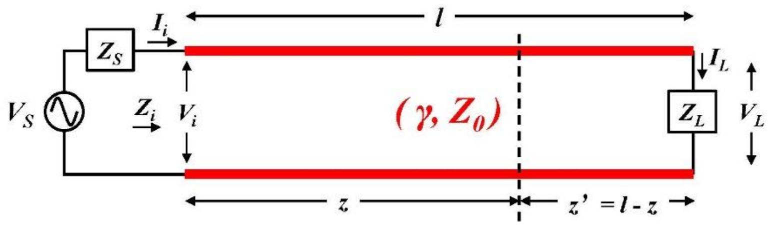
Z_0 = *characteristic impedance*
Z_S = *source impedance*
Z_L = *load (termination) impedance*

γ = *propagation constant* = $\alpha + j\beta$ $\quad (\beta = 2\pi/\lambda)$

l = *length of line*
z = *distance from beginning of line*
z' = *distance from end of line*

3

Transmission Line Impedance (cont.)



$$Z_i = Z(l) = Z_0 \frac{Z_L + Z_0 \tanh(\gamma l)}{Z_0 + Z_L \tanh(\gamma l)}$$ INPUT IMPEDANCE OF LOSSY TRANSMISSION LINE

INPUT IMPEDANCE OF LOSSLESS TRANSMISSION LINE:

$$\boxed{Z_i = Z(l) = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)}}$$

4

Transmission Line Impedance (cont.)

$$Z_i = Z(l) = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)} \quad (\beta = 2\pi/\lambda)$$

$l = \lambda/4$: $\tan\frac{\pi}{2} = \infty \longrightarrow Z_i = \frac{Z_0^2}{Z_L}$ *Short circuit termination measures as open-circuit*
Open-circuit termination measures as short-circuit

$l = \lambda/2$: $\tan\pi = 0 \longrightarrow Z_i = Z_L$

$l = \lambda/8$: $\tan\frac{\pi}{4} = 1 \longrightarrow |Z_i| = Z_0$ *Reflected energy sees Z_0*

Test cable length = 21 feet = 53 cm

$\lambda = \frac{300}{f_{MHz}}$

$\lambda/2$ @ 282 MHz
$\lambda/4$ @ 141 MHz
$\lambda/8$ @ 70 MHz

5

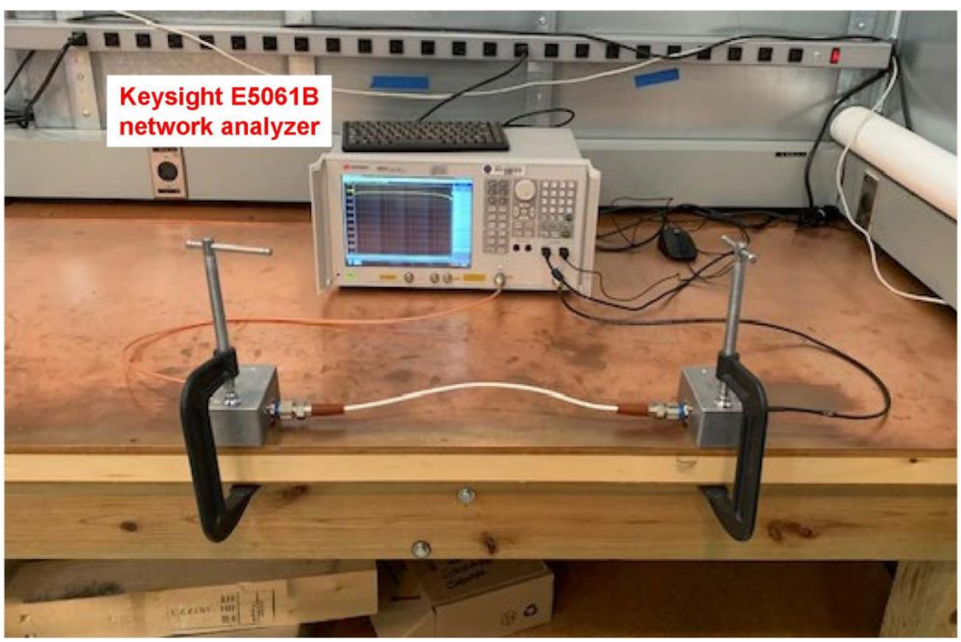
Measurements

- **Throughput (functionality)**
- **Channel-to-Channel Crosstalk**
- **Shield Transfer Impedance**
- **Return Loss (S11)**

- **All data taken with:**
  - Keysight E5061B network analyzer
  - Frequency range: 100 kHz to 1 GHz

6

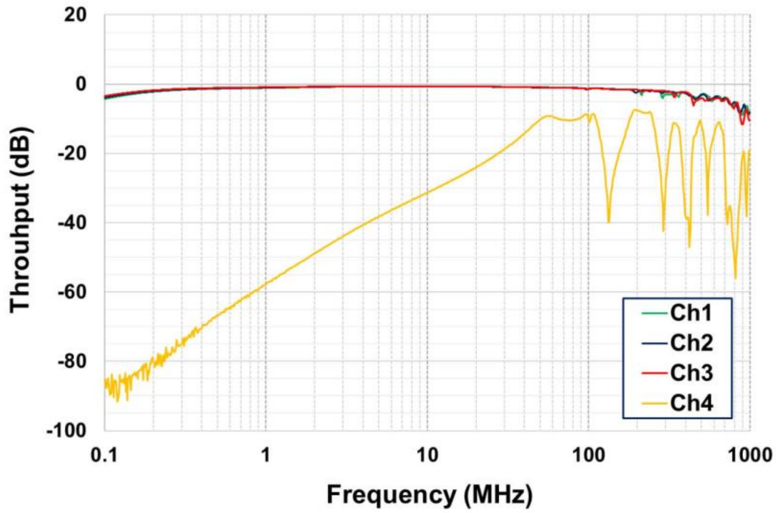
Basic Setup - Throughput and Crosstalk



7

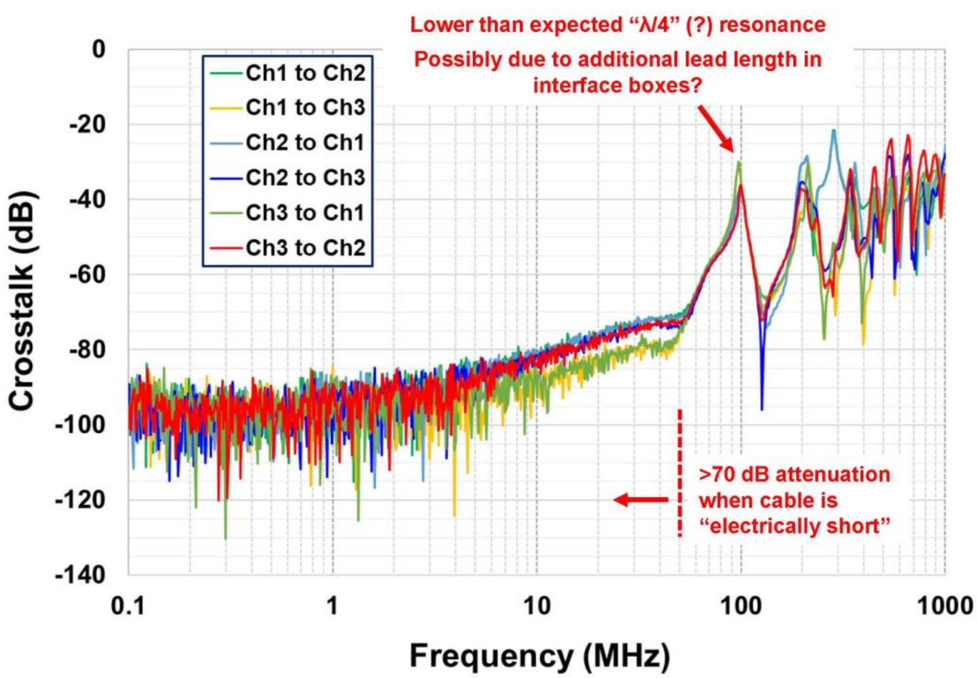
Throughput

- Channel 4 appears open-circuited
- Channels 1-3 appear nominal; used for all further measurements



8

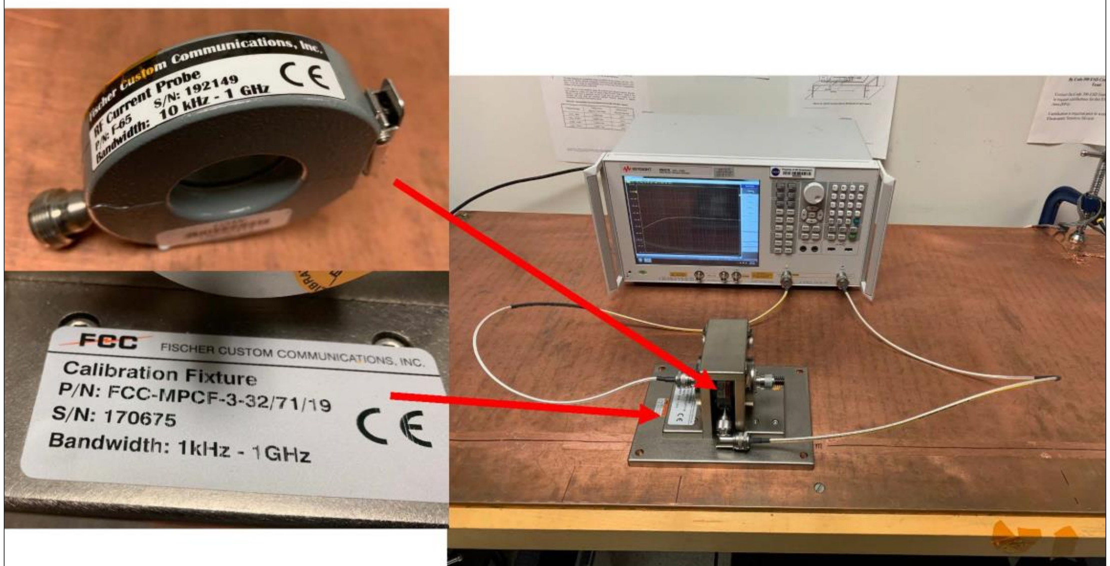
Channel-to-Channel Crosstalk



9

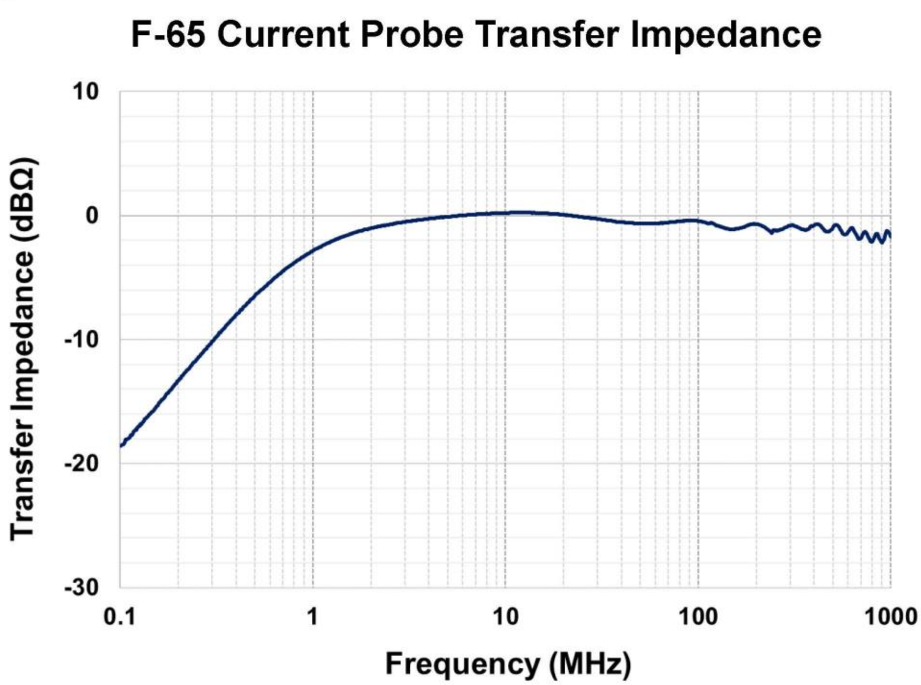
Shield Transfer Impedance

- **Step 1: Current Probe Calibration**



10

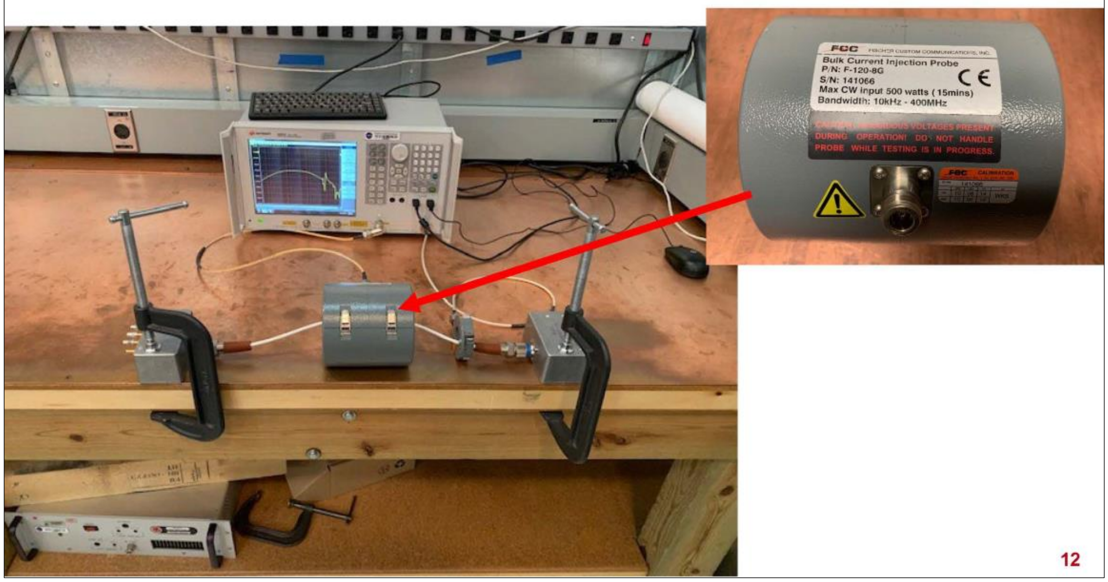
Shield Transfer Impedance (cont.)



11

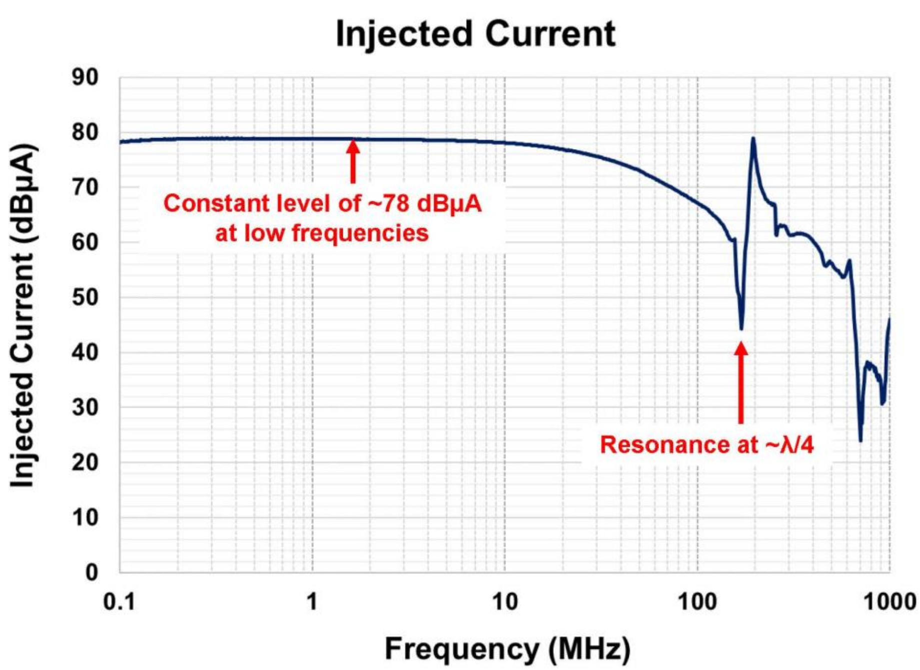
Shield Transfer Impedance (cont.)

- **Step 2: Measurement of injected current**
  - Bulk current injection probe per MIL-STD-461G CS114



12

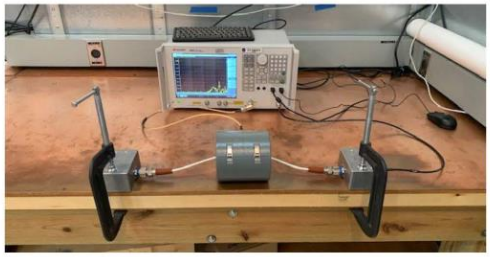
Shield Transfer Impedance (cont.)

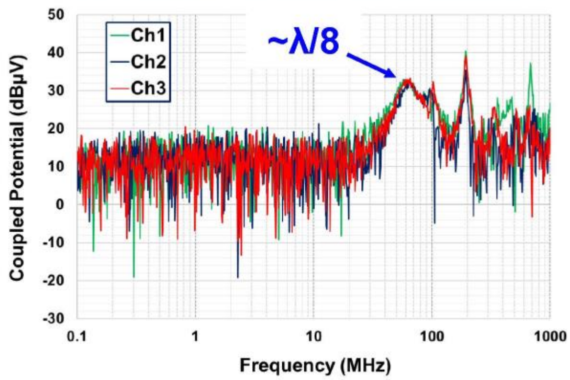


13

Shield Transfer Impedance (cont.)

- **Step 3: Measurement of coupled potential**

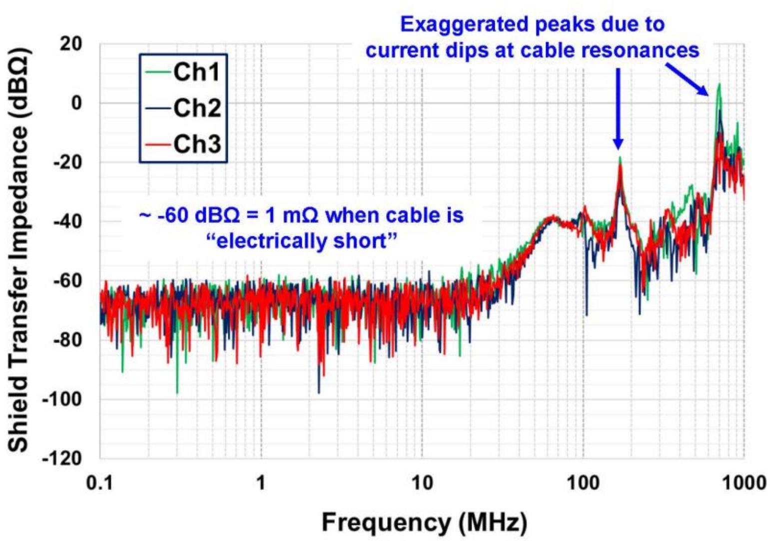




14

Shield Transfer Impedance (cont.)

- **Step 4: Calculation of shield transfer impedance**
  - Coupled potential – injected current (in dB-space)
  - "Brute force" method: Direct subtraction of measured values



15

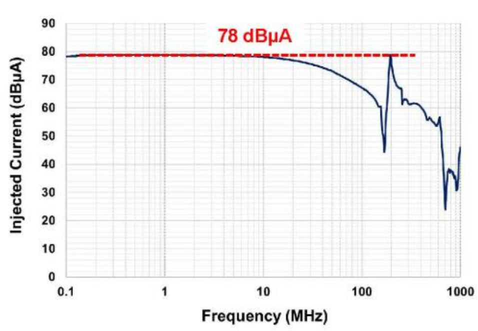
Shield Transfer Impedance (cont.)

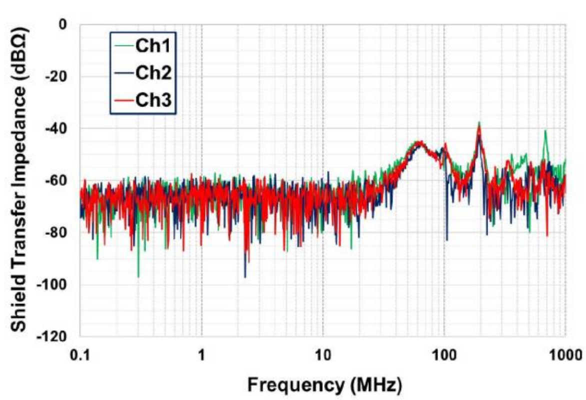
- "Brute force" method is affected by cable geometry at high frequencies (l > λ/10) and gives less accurate indication of cable's true performance
- Measured current at high frequencies highly dependent on monitor probe location
- Exaggerated current readings at cable resonances give exaggerated transfer impedance values at these frequencies

16

Shield Transfer Impedance (cont.)

- In the meantime, it may be approximated by recognizing that drive level is constant over frequency (0 dBm)
- 2nd example calculation performed assuming constant current level of 78 dBμA

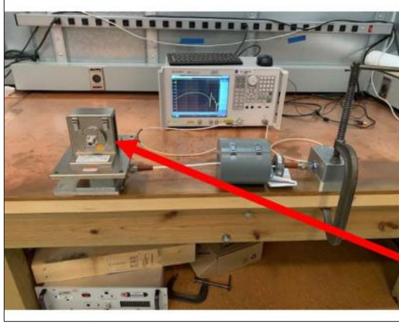


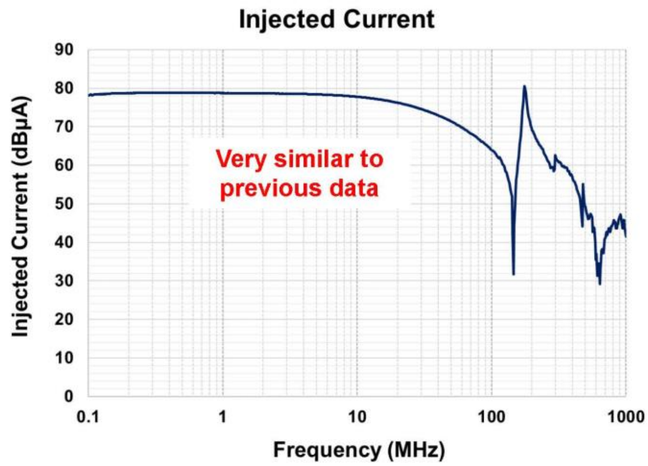


17

Shield Transfer Impedance (cont.)

- Follow up measurements with interface boxes on conductive standoffs



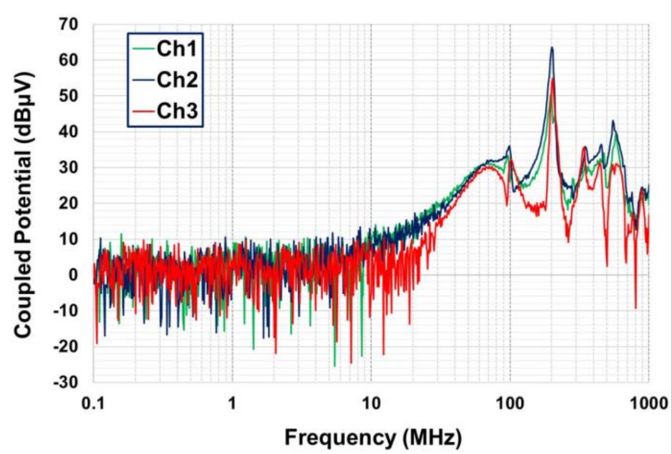


High-tech weight to ensure good metal-to-metal contact with ground plane

18

Shield Transfer Impedance (cont.)

- Voltage measurements on channels 1-3
- 1 kHz bandwidth used to reduce noise floor (instead of 10 kHz for previous measurements)

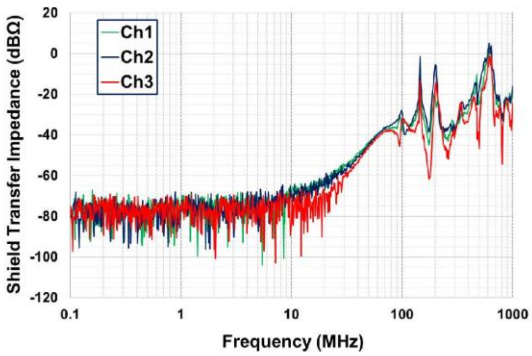


19

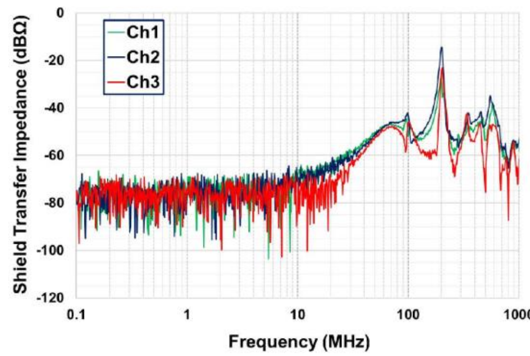
Shield Transfer Impedance (cont.)

- ~20 dB higher peak at 200 MHz (?)
- Otherwise, transfer impedance comparable to previous measurements
  - Noise floor reduced by 10 dB due to 1 kHz BW instead of 10 kHz
  - -70 dBΩ ≈ 0.3 mΩ below 10 MHz

Direct subtraction of measured current

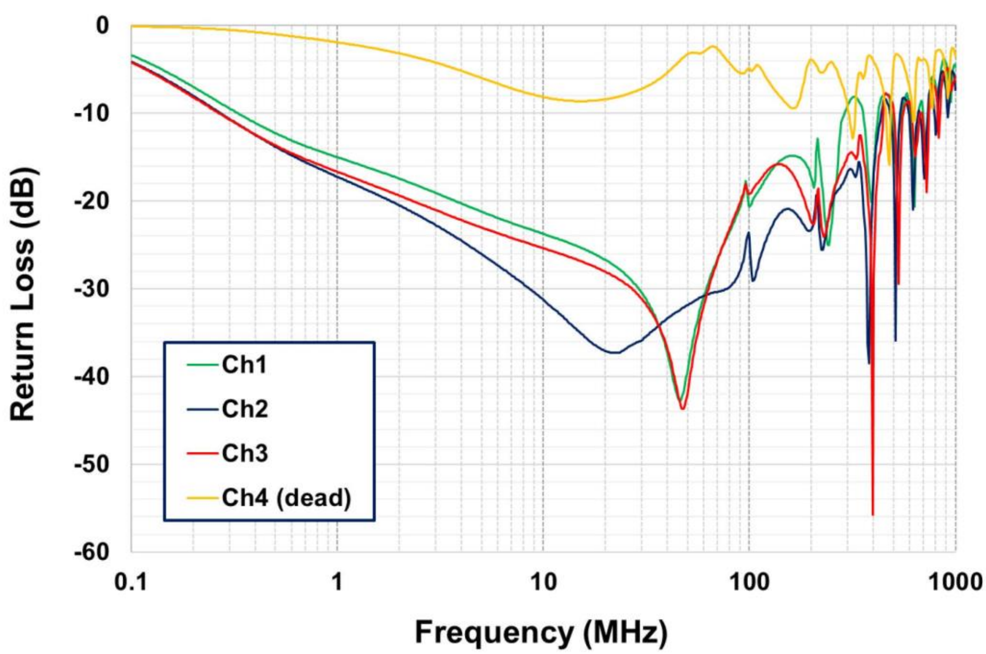


Subtraction of constant level of 78 dBμA



20

Return Loss (S11)



21

Summary

- **Crosstalk and shield transfer impedance results look promising**
  - > 70 crosstalk attenuation when cable is “electrically short”
  - ~1 mΩ transfer impedance when cable is “electrically short”
- **Request for additional transfer impedance measurements with test cable at different heights above ground plane**
- **Additional measurements?**

22

Appendix E. Electrostatic Discharge (ESD) and Control iPerf Test Results for Client and Server Networks

Testing notes for DOY 55 ESD testing activity (2/24/2023)

ethertest1 is running a faster than ethertest2 (13 seconds)
1Gbps/Full Duplex
50.0 Mbytes of data transferred over 1 second at 419 Mbits/sec rate with a full duplex rate of 839 Mbits/sec
Full duplex Run using iPerf for 70 seconds
ESD Gun applied to the connector for 60 seconds
Hits- iPerf 1 second time intervals that recorded a lost packet
CDPs- Corrupted Data packets- iPerf total number of corrupted data packets over the total time interval
iPerf client monitoring had hits or lost packets on 6 tests with ESD applied over 16 test runs
iPerf client monitoring had hits or lost packets on 15 tests with no ESD applied over 16 test runs

ET1 – Server/ET2 -- Client

Log Timestamp (ET1/ET2) to test event performed

055_10:15:49/055_10:15:38 -- 1 KV 60s,50ms,rep-rate PIC cable + Conn shield issue iPerf Client 3 hits 31 CDPs
055_10_15_49 ESD 1KV 60s 50ms PIC cable+PIC Conn shield issue iPerf Sever hits 15 16 CDPs
055_10:18:36/055_10:18:24 -- PIC cable no ESD control run iPerf Client shield issue 3 hits 347 CDPs

055_10:20:39/055_10:20:28 -- 2 KV 60s,50ms,rep-rate PIC cable + Conn iPerf shield issue Client 59 hits 347 CDPs
iPerf_server_23-055_10_20_39_est ESD 2KV 60s 50ms PIC Cable + PIC Conn shield issue hits 317
CDPs055_10:24:19/055_10:24:07 -- PIC cable no ESD control run iPerf Client shield issue 2 hits 694 CDPs

055_10:27:06/055_10:26:55 -- 1 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 0 hits 0 CDPs

055_10:29:12/055_10:29:01 -- Gore cable + MM38999 Conn no ESD control run iPerf Client 2 hits 106 CDPs

055_10:31:03/055_10:40:52 -- 2 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 0 hits 0 CDPs

055_10:33:07/055_10:32:56 -- Gore cable + M38999 Conn no ESD control run iPerf Client 2 hits 70 CDPs

055_10:35:04/055_10:34:53 -- 4 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 0 hits 0 CDPs

055_10:36:39/055_10:36:27 -- Gore cable + M38999 Conn no ESD control run iPerf Client 4 hits 624 CDPs

055_10:38:37/055_10:38:26 -- 6 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 0 hits 0 CDPs

055_10:40:08/055_10:39:56 -- Gore cable + M38999 Conn no ESD control run iPerf Client 2 hits 191 CDPs

055_10:42:13/055_10:42:03 -- 8 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 0 hits 0 CDPs

055_10:43:53/055_10:43:41 -- Gore cable + M38999 Conn no ESD control run iPerf Client 6 hits 227 CDPs

055_10:47:15/055_10:47:04 -- 1 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 0 hits 0 CDPs

Z055_10:48:43/055_10:48:31 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 5 hits 564 CDPs

055_10:50:38/055_10:50:27 -- 2 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 0 hits 0 CDPs

055_10:52:08/055_10:51:56 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 5 hits 732 CDPs

055_10:53:52/055_10:53:40 -- 4 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 0 hits 0 CDPs

055_10:55:22/055_10:55:10 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 2 hits 169 CDPs

055_10:57:16/055_10:57:05 -- 6 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 0 hits 0 CDPs

055_10:58:48/055_10:58:36 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 3 hits 284 CDPs

055_11:00:45/055_11:00:34 -- 8 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 0 hits 0 CDPs

055_11:02:37/055_11:02:25 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 3 hits 325 CDPs

055_11:04:34/055_11:04:23 -- 10 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 4 hits 520 CDPs

055_11:06:26/055_11:06:16 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 0 hits 0 CDPs
23-055_11_06_26_est Gore cable + FASX conn no ESD control iPerf_server_1 hits 30 CDPs

055_11:08:43/055_11:08:31 -- 16 KV 60s, 50 ms rep-rate Gore cable + FAS-X Conn iPerf Client 8 hits 1182 CDPs

055_11:10:28/055_11:10:17 -- Gore cable + FAS-X Conn no ESD control run iPerf Client 5 hits 1% 1321 CDPs

055_11:12:44/055_11:12:33 -- 10 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 3 hits 392 CDPs

055_11:14:18/055_11:14:07 -- Gore cable + M38999 Conn no ESD control run iPerf Client 4 hits 154 CDPs

055_11:16:11/055_11:16:00 -- 16 KV 60s, 50 ms rep-rate Gore cable + M38999 iPerf Client 10 hits 1240 CDPs
055_11:18:20/055_11:18:09 -- Gore cable + M38999 Conn no ESD control run iPerf Client 2 hits 339 CDPs

ESD Testing 24 Feb 23 iPerf Server Results

ethertest1 is running faster than ethertest2 (13 seconds)
1Gbps/Full Duplex
50.0 Mbytes of data transferred over 1 second at 419 Mbits/sec rate with a full duplex rate of 839 Mbits/sec
Full duplex Run using iPerf for 70 seconds
ESD Gun applied to the connector for 60 seconds
Hits- iPerf 1 second time intervals that recorded a lost packet
CDPs- Corrupted Data packets- iPerf total number of corrupted data packets over the total time interval
iPerf server monitoring had lost data packets on 4 runs with ESD applied over 16 test runs
iPerf server monitoring had lost data packets on 2 runs with no ESD applied over 16 test runs

ET1 – Server/ET2 – Client
Log Timestamp ET1 to test event performed

iPerf_server_23-055_10_15_49_est ESD 1KV 60s 50ms PIC cable + PIC Conn shield issue hits 15 16 CDPs
iPerf_server_23-055_10_18_36_est control PIC Cable 0 hits 0 CDPs

iPerf_server_23-055_10_20_39_est ESD 2KV 60s 50ms PIC Cable + PIC Conn shield issue hits 60 317 CDPs
iPerf_server_23-055_10_24_19_est control PIC Cable 0 hits 0 CDPs

iPerf_server_23-055_10_27_06_est ESD 1KV 60s 50ms Gore M38999 0 hits 0 CDPs
iPerf_server_23-055_10_29_12_est control Gore cable + M38999 conn 0 hits 0 CDPs

iPerf_server_23-055_10_31_03_est ESD 2KV 60s 50ms Gore cable + M38999 Conn 0 hits 0 CDPs
iPerf_server_23-055_10_33_07_est control Gore Cable + M38999 Conn 0 hits 0 CDPs

iPerf_server_23-055_10_35_04_est ESD 4KV 60s 50ms Gore + M38999 Conn 0 hits 0 CDPs
iPerf_server_23-055_10_36_39_est Control Gore cable + M38999 Conn 0 hits 0 CDPs

iPerf_server_23-055_10_38_37_est ESD 6KV 60s 50ms rep Gore cable + M38999 conn 0 hits 0 CDPs
iPerf_server_23-055_10_40_08_est Control Gore cable + M38999 conn 0 hits 0 CDPs

iPerf_server_23-055_10_42_13_est ESD 8KV 60s 50ms rep Gore cable + M38999 conn 0 hits 0 CDPs
iPerf_server_23-055_10_43_53_est Control Gore Cable + M38999 conn 0 hits 0 CDPs

iPerf_server_23-055_10_47_15_est ESD 1KV 60s 50ms rep Gore cable + FASX conn 0 hits 0 CDPs
iPerf_server_23-055_10_48_43_est Control Gore cable + FASX conn 0 hits 0 CDPs

iPerf_server_23-055_10_50_38_est ESD 2KV 60s 50ms rep Gore cable +FASX Conn 0 Hits 0 CDPs
iPerf_server_23-055_10_52_08_est Control Gore cable +FASX Conn 0 Hits 0 CDPs

iPerf_server_23-055_10_53_52_est 0 ESD 4KV 60s 50ms rep Gore cable +FASX Conn 0 Hits 0 CDPs
iPerf_server_23-055_10_55_22_est Control Gore cable +FASX Conn 0 Hits 0 CDPs

iPerf_server_23-055_10_57_16_est ESD 4KV 60s 50ms rep Gore cable +FASX Conn 0 Hits 0 CDPs
iPerf_server_23-055_10_58_48_est Control Gore cable +FASX Conn 0 Hits 0 CDPs

iPerf_server_23-055_11_00_45_est ESD 8KV 60s 50ms rep Gore cable +FASX Conn 0 Hits 0 CDPs
iPerf_server_23-055_11_02_37_est Control Gore cable +FASX Conn 0 Hits 0 CDPs

iPerf_server_23-055_11_04_34_est ESD 10KV 60s 50ms Gore cable + FAS-x conn 0 hits 0 CDPs
iPerf_server_23-055_11_06_26_est Gore cable + FASX conn no ESD control 1 hits 30 CDPs

iPerf_server_23-055_11_08_43_est ESD 16KV 60s 50ms Gore Cable + FASX Conn 0 hits 0 CDPs
iPerf_server_23-055_11_10_28_est Control Gore cable +FASX Conn 0 Hits 0 CDPs

iPerf_server_23-055_11_12_44_est ESD 10KV 60s 50ms rep Gore cable +M38999 Conn 0 Hits 0 CDPs
iPerf_server_23-055_11_14_18_est Control Gore cable + M38999 Conn 1 hit 6 CDPs

iPerf_server_23-055_11_16_11_est ESD 16KV 60s 50ms rep Gore cable +M38999 Conn 0 Hits 0 CDPs
iPerf_server_23-055_11_18_20_est Control Gore cable +M38999 Conn 0 hits 0CDPs

Testing notes for DOY 58 ESD discharge in connector testing Server and Client (Feb-27 2023)
ethertest1 is running a faster than ethertest2 (13 seconds)
Log Timestamp (ET1/ET2) to test event performed using iPerf
1Gbps/Full Duplex
50.0 Mbytes of data transferred over 1 second at 419 Mbits/sec rate with a full duplex rate of 839 Mbits/sec
Full duplex Run using iPerf for 70 seconds
ESD Gun applied to the connector for 60 seconds
Hits- iPerf 1 second time intervals that recorded one or more lost packets
CDPs- Corrupted Data packets- iPerf total number of corrupted data packets over the total time interval
iPerf client monitoring had hits or lost packets on 23 test runs with ESD applied out of 25 test runs
iPerf client monitoring had hits or lost packets on 14 test runs with no ESD applied out of 16 test runs

ET1 – Server/ET2 – Client
The majority of recorded packet losses were on the Client computer network card with only three instances of packet losses on the sever computer network card

Gore Cable + FASX Conn w/EXT1
058_10:25:32 / 058_10:24:53 -- 500V `60s,50ms,rep-rate` Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 0 hits 0 CDPs
058_10:33:12 / 058_10:32:33 -- control Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 1 hits 64 CDPs

058_10:25:32 / 058_10:24:53 -- 1KV `60s,50ms,rep-rate` Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 1 hits 220 CDPs
058_10:37:13 / 058_10:36:34 -- control Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 16 hits 2694 CDPs

058_10:39:05 / 058_10:38:26 -- 2KV `60s,50ms,rep-rate` Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 2 hits 15 CDPs
058_10:40:41 / 058_10:40:02 -- control Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 7 hits 1275 CDPs

058_10:42:48 / 058_10:42:09 -- 4KV Gore `60s,50ms,rep-rate` Cable+FAS-X Conn w/EXT1 `iPerf` Client 2 hits 82 CDPs
058_10:44:34 / 058_10:44:34 -- control Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 4 hits 218 CDPs

058_10:46:34 / 058_10:45:55 -- 8KV `60s,50ms rep-rate` Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 8 hits 547 CDPs
058_10:48:52 / 058_10:48:13 -- control Gore Cable+FAS-X Conn w/EXT1 `iPerf` Client 3 hits 359 CDPs

Gore Cable+M38999 Conn w/Ext1
058_10:52:06 / 058_10:51:27 -- 1KV `60s,50ms,rep-rate` Gore Cable+38999 Conn w/Ext1 `iPerf` Client 1 hits 122 CDPs
058_10:53:31 / 058_10:52:52 -- control Gore Cable+38999 Conn w/Ext1 `iPerf` Client 4 hits 614 CDPs

058_10:55:41 / 058_10:55:02 -- 2KV `60s,50ms,rep-rate` Gore Cable+38999 Conn w/Ext1 `iPerf` Client 2 hits 282 CDPs
058_10:57:07 / 058_10:56:28 -- control Gore Cable+38999 Conn w/Ext1 `iPerf` Client 3 hits 303 CDPs

058_11:01:04 / 058_11:00:25 -- 4KV `60s,50ms,rep-rate` Gore Cable+38999 Conn w/Ext1 `iPerf` Client 2 hits 412 CDPs
058_11:02:31 / 058_11:01:51 -- control Gore Cable+38999 Conn w/Ext1 `iPerf` Client 5 hits 219 CDPs

058_11:04:10 / 058_11:03:31 -- 8KV `60s,50ms,rep-rate` Gore Cable+38999 Conn w/Ext1 `iPerf`
Client 6 hits 1% 1145 CDPs
058_11:05:46 / 058_11:05:07 -- control Gore Cable+38999 Conn w/Ext1 `iPerf` Client 8 hits 909 CDPs

Pic Conn with PIC cable (shield connected on this run..)
058_11:09:11 / 058_11:08:32 -- 1KV `60s,50ms,rep-rate` PIC Cable+PIC Conn `iPerf` Client 1 hits 62 CDPs
058_11:10:35 / 058_11:09:56 -- control no ESD PIC Cable+PIC Conn `iPerf` Client 3 hits 1% 506 CDPs

058_11:12:12 / 058_11:11:34 -- 2KV `60s,50ms,rep-rate` PIC Cable+PIC Conn `iPerf` Client 3 hits 1% 433 CDPs
058_11:13:36 / 058_11:12:56 -- control no ESD PIC Cable+PIC Conn `iPerf` Client 6 hits 172 CDPs

058_11:15:23 / 058_11:14:44 -- 4KV 60s,50ms,rep-rate PIC Cable+PIC(packet hits) iPerf Client 14 hits 298 CDPs
058_11:16:55 / 058_11:16:16 -- control no ESD PIC Cable+PIC Conn iPerf Client 0 hits 0 CDPs

058_11:18:46 / 058_11:18:08 -- 6KV 60s,50ms,rep-rate PIC Cable+PIC Conn (packet hits) iPerf Client 60 hits 248 CDPs
23-058_11_18_46_ 6KV 60s 50ms rep-rate PIC Cable + PTC Conn iPerf_server_Hits 53 141 CDPs
058_11:20:17 / 058_11:19:38 -- control PIC Cable+PIC Conn iPerf Client 4 hits 405 CDPs
(cable unplugged 1/2 way through)

Pic Conn with PIC cable (shield connected on this run w/Ext1
058_11:24:38 / 058_11:23:58 -- 2KV 60s,50ms,rep-rate PIC Cable+PIC Conn w/Ext1 iPerf Client 5 hits 321 CDPs
058_11:26:16 / 058_11:25:37 -- control PIC Cable+PIC Conn w/Ext1 iPerf Client 6 hits 151 CDPs

058_11:28:01 / 058_11:27:22 -- 4KV 60s,50ms,rep-rate PIC Cable+PIC Conn w/Ext1 (packet hits)
iPerf Client 55 hits 254 CDPs
23-058_11_28:01 4KV 60s 50ms rep-rate PIC Cable +PIC Conn w/Ext1 iPerf Server 49 hits 150 CDPs
058_11:29:53 / 058_11:29:14 -- control PIC Cable+PIC Conn w/Ext1 iPerf Client 0 hits 0 CDPs

38999 Conn with Gore Cable w/Ext1
058_11:32:14 / 058_11:31:35 -- 10KV 60s,50ms,rep-rate Gore Cable+38999 w/Ext1
iPerf Client 12 hits 1162 CDPs
1/2 run, cable fell off block, packet drops

058_11:34:02 / 058_11:33:23 -- 12KV 60s,50ms,rep-rate Gore Cable+38999 w/Ext1
iPerf Client 14 hits 1845 CDPs
packet drops, but not consistent, started to get computer glitches.

058_11:36:30 / 058_11:35:51 -- 16KV,60s,50ms,rep-rate Gore Cable+38999 w/Ext1 iPerf Client 3 hits 327 CDPs
Computer glitches some packet drops
058_11:39:14 / 058_11:38:35 -- control Gore Cable+38999 w/Ext1 iPerf Client 6 hits 167 CDPs

Gore Cable + FAS-X Conn w/Ext1
058_11:41:25 / 058_11:40:46 -- 10KV 60s,50ms,rep-rate Gore Cable+FAS-X Conn w/EXT1 iPerf Client 13 hits 1195 CDPs
Computer Glitches, but nothing much above baseline

058_11:41:25 / 058_11:42:56 -- 16KV 60s,50ms,rep-rate Gore Cable+FAS-X Conn w/EXT1 iPerf Client 33 hits 3012 CDPs
Packet drops

Gore Cabe + FAS-X Conn w/very long extension
058_11:47:05 / 058_11:46:26 -- 8KV 60s,50ms,rep-rate Gore Cable+FAS-X Conn w/long EXT iPerf Client 4 hits 532 CDPs

058_11_48_43 /058_11_50_07--10KV 60s, 50ms, rep-rate Gore Cable+FAS-X Conn w/long EXT
iPerf Client 8 hits 909 CDPs
058_11:52:15 / 058_11:51:37 -- 12KV 60s,50ms,rep-rate Gore Cable+FAS-X Conn w/long EXT
iPerf Client 22 hits 1909 CDPs

23-058_11_52_15_ 12KV 60s. 50ms, rep-rate Gore Cable+FAS-X Conn w/long EXT
iPerf_Server_14 Hits 43 CDPs Computer glitching

058_11:54:46 / 058_11:54:08 -- 10KV 60s,50ms,rep-rate Gore Cable+FAS-X Conn w/long EXT
iPerf Client 0 hits 0 CDPs (Connector on ET1 machine side)

ESD Testing 27 Feb 23 iPerf Server Results

1Gbps/Full Duplex
50.0 Mbytes of data transferred over 1 second at 419 Mbits/sec rate with a full duplex rate of 839 Mbits/sec
Full duplex Run using iPerf for 70 seconds
ESD Gun applied to the connector for 60 seconds
Hits- iPerf 1 second time intervals that recorded a lost packet
CDPs- Corrupted Data packets- iPerf total number of corrupted data packets over the total time interval
iPerf server monitoring lost data packets only on 6 runs with ESD applied out of 25 test runs, 5 runs were on PIC connectors
iPerf server monitoring lost data packets only on 0 runs with no ESD applied out of 25 test runs

ET1 – Server/ET2 -- Client

Log Timestamp ET1 to test event performed

iPerf_server_23-058_10_25_32_est ESD 500V 60s 50ms rep Gore cable+FASX+Ext 0 hits 0CDPs
iPerf_server_23-058_10_33_12_est Control Gore Cable +FASX Conn + Ext 0 hits 0 CDPs

iPerf_server_23-058_10_35_51_est ESD 1KV 60s 50ms Gore Cable +FASC Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_10_37_13_est control Gore cable +FASX +ext 0 hits 0CDPs

iPerf_server_23-058_10_39_05_est ESD 2KV 60s 50ms Gore Cable +FASC Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_10_40_41_est Control Cable +FASC Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_10_42_48_est ESD 4KV 60s 50ms Gore Cable +FASC Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_10_44_13_est Control Gore Cable +FASX Conn + Ext 0 hits 0 CDPs

iPerf_server_23-058_10_46_34_est ESD 8KV 60s 50ms Gore Cable +FASC Conn +Ext 0 hits 0 CD
PsiPerf_server_23-058_10_48_52_est Control Gore Cable +FASC Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_10_52_06_est ESD 1KV 60s 50ms Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_10_53_31_est Control Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_10_55_41_est ESD 2KV 60s 50ms Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_10_57_07_est Control Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_11_01_04_est ESD 4KV 60s 50ms Gore Cable +M38999 Conn +Ext 1 hit 19 CDPs
iPerf_server_23-058_11_02_31_est Control Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_11_04_10_est ESD 8KV 60s 50ms Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs
iPerf_server_23-058_11_05_46_est Control Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_11_09_11_est ESD 1KV 60s 50ms PIC Cable +PIC Conn 0 hits 0 CDPs
iPerf_server_23-058_11_10_35_est Control PIC Cable +PIC Conn 0 hits 0 CDPs

iPerf_server_23-058_11_12_12_est ESD 2KV 60s 50ms PIC Cable +PIC Conn 0 hits 0 CDPs
iPerf_server_23-058_11_13_36_est Control PIC Cable +PIC Conn 0 hits 0 CDPs

iPerf_server_23-058_11_15_23_est ESD 4KV 60s 50ms PIC Cable +PIC Conn 7 hits 10 CDPs
iPerf_server_23-058_11_16_55_est Control PIC Cable +PIC Conn 0 hits 0 CDPs

iPerf_server_23-058_11_18_46_est ESD 6KV 60s 50ms rep PIC Cable + PIC Conn Hits 57 141 CDPs
iPerf_server_23-058_11_20_17_est Control cable unplugged part of test PIC Cable + PIC Conn 0 hits 0 CDPs

iPerf_server_23-058_11_24_38_est ESD 2KV 60s 50ms PIC Cable +PIC Conn + Ext 1 hit 1 CDP
iPerf_server_23-058_11_26_16_est Control PIC Cable + PIC Conn + Ext 0 hits 0 CDPs

iPerf_server_23-058_11_28_01_est ESD 4KV 60s 50ms Rep PIC Cable + PIC Conn +Ext 49 hits 150 CDPs
iPerf_server_23-058_11_29_53_est Control PIC cable +PIC Conn + Ext 0 hits 0 CDPs

iPerf_server_23-058_11_32_14_est ESD 10KV 60s 50ms Gore M38999 +ext 0 hits 0 CDPs

iPerf_server_23-058_11_34_02_est ESD 12KV 60s 50ms Gore M38999 +ext 0 hits 0 CDPs

iPerf_server_23-058_11_36_30_est ESD 16KV 60s 50ms Gore Cable +Gore Conn+Ext 0 hits 0 CDPs
iPerf_server_23-058_11_39_14_est Control Gore Cable +M38999 Conn +Ext 0 hits 0 CDPs

iPerf_server_23-058_11_41_25_est ESD 10KV 60s 50ms rep Gore cable+FASX+Ext 1 hit 1 CDP

iPerf_server_23-058_11_43_35_est ESD 16KV 60s 50ms rep Gore cable+FASX+Ext 0 hit 0 CDP

iPerf_server_23-058_11_47_05_est ESD 8KV 60s 50ms rep Gore cable+FASX+Long Ext 0 hit 0 CDP

iPerf_server_23-058_11_48_43_est ESD 10KV 60s 50ms rep Gore cable+FASX+Long Ext 0 hit 0 CDP

iPerf_server_23-058_11_52_15_est ESD 12KV Gore Cable FASX + Long Ext ESD 14 Hits 43 CDPs

iPerf_server_23-058_11_54_46_est ESD 10KV 60s 50ms rep Gore cable+FASX Conn ET1 side +Long Ext 0 hit 0 CDP

Appendix F. iPerf Test Runs

Test configuration with 4KV ESD applied for 60 s at a rep. rate 50ms on a PIC Cable + PIC Conn + a PIC cable Ext
There were 57 intervals with lost data packets (highlighted) with a total loss of 254 data packets out of 2,496,608 packets transmitted (0.01% packet loss) on the client computer
iperf_client_23-058_11_27_22_est

--- DMESG at start of run --------------
Hostname: ethertest2
[264481.516493] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[264481.516497] usb 2-1.2: Product: USB Optical Mouse
[264481.516500] usb 2-1.2: Manufacturer: Logitech
[264481.520281] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.0021/input/input39
[264481.520646] hid-generic 0003:046D:C077.0021: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[264650.064013] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[264716.836908] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265442.792030] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[265625.764939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265733.008238] perf: interrupt took too long (3981 > 3961), lowering kernel.perf_event_max_sample_rate to 50000
---- Start IPERF TEST -------------------

Client connecting to 172.17.0.1, UDP port 5001 with pid 13396 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size: 208 KByte (default)
----
[1] local 172.17.0.2%enp6s0 port 53638 connected with 172.17.0.1 port 5001 (full-duplex) (no-udp-fin) (sock=3) on 2023-02-27 11:27:22 (EST)
[ID] Interval Transfer Bandwidth Jitter Lost/Total Latency avg/min/max/stdev PPS NetPwr
[*1] 0.0000-1.0000 sec 49.9 MBytes 419 Mbits/sec 0.009 ms 0/35629 (0%) -/-/-/- ms 35669 pps
[ID] Interval Transfer Bandwidth Write/Err PPS
[1] 0.0000-1.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[ID] Interval Transfer Bandwidth Datagrams PPS
[FD1] 0.0000-1.0000 sec 100 MBytes 838 Mbits/sec 71298 71302 pps
[*1] 1.0000-2.0000 sec 50.0 MBytes 419 Mbits/sec 0.035 ms 0/35666 (0%) -/-/-/- ms 35664 pps
[1] 1.0000-2.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 1.0000-2.0000 sec 100 MBytes 839 Mbits/sec 71331 71327 pps
[*1] 2.0000-3.0000 sec 50.0 MBytes 419 Mbits/sec 0.045 ms 0/35664 (0%) -/-/-/- ms 35669 pps
[1] 2.0000-3.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 2.0000-3.0000 sec 100 MBytes 839 Mbits/sec 71332 71328 pps
[*1] 3.0000-4.0000 sec 50.0 MBytes 419 Mbits/sec 0.029 ms 7/35667 (0.02%) -/-/-/- ms 35659 pps
[1] 3.0000-4.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 3.0000-4.0000 sec 100 MBytes 839 Mbits/sec 71324 71322 pps
[*1] 4.0000-5.0000 sec 50.0 MBytes 420 Mbits/sec 0.018 ms 2/35674 (0.0056%) -/-/-/- ms 35666 pps
[1] 4.0000-5.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 4.0000-5.0000 sec 100 MBytes 839 Mbits/sec 71330 71324 pps
[*1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0.011 ms 2/35667 (0.0056%) -/-/-/- ms 35668 pps
[1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 5.0000-6.0000 sec 100 MBytes 839 Mbits/sec 71322 71331 pps
[*1] 6.0000-7.0000 sec 50.0 MBytes 419 Mbits/sec 0.012 ms 3/35664 (0.0084%) -/-/-/- ms 35664 pps
[1] 6.0000-7.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 6.0000-7.0000 sec 100 MBytes 839 Mbits/sec 71316 71326 pps
[*1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0.009 ms 1/35667 (0.0028%) -/-/-/- ms 35665 pps
[1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 7.0000-8.0000 sec 100 MBytes 839 Mbits/sec 71318 71330 pps
[*1] 8.0000-9.0000 sec 50.0 MBytes 419 Mbits/sec 0.024 ms 5/35670 (0.014%) -/-/-/- ms 35664 pps

[1] 8.0000-9.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 8.0000-9.0000 sec 100 MBytes 839 Mbits/sec 71315 71328 pps
[*1] 9.0000-10.0000 sec 50.0 MBytes 419 Mbits/sec 0.034 ms 3/35661 (0.0084%) -/-/-/- ms 35653 pps
[1] 9.0000-10.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 9.0000-10.0000 sec 100 MBytes 839 Mbits/sec 71302 71311 pps
[*1] 10.0000-11.0000 sec 50.0 MBytes 419 Mbits/sec 0.014 ms 3/35670 (0.0084%) -/-/-/- ms 35675 pps
[1] 10.0000-11.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 10.0000-11.0000 sec 100 MBytes 839 Mbits/sec 71312 71331 pps
[*1] 11.0000-12.0000 sec 50.0 MBytes 419 Mbits/sec 0.041 ms 2/35667 (0.0056%) -/-/-/- ms 35660 pps
[1] 11.0000-12.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 11.0000-12.0000 sec 100 MBytes 839 Mbits/sec 71305 71321 pps
[*1] 12.0000-13.0000 sec 50.0 MBytes 419 Mbits/sec 0.024 ms 4/35671 (0.011%) -/-/-/- ms 35669 pps
[1] 12.0000-13.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 12.0000-13.0000 sec 100 MBytes 839 Mbits/sec 71305 71333 pps
[*1] 13.0000-14.0000 sec 50.0 MBytes 419 Mbits/sec 0.013 ms 3/35663 (0.0084%) -/-/-/- ms 35662 pps
[1] 13.0000-14.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 13.0000-14.0000 sec 100 MBytes 839 Mbits/sec 71294 71325 pps
[*1] 14.0000-15.0000 sec 50.0 MBytes 419 Mbits/sec 0.035 ms 4/35669 (0.011%) -/-/-/- ms 35660 pps
[1] 14.0000-15.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35660 pps
[FD1] 14.0000-15.0000 sec 100 MBytes 839 Mbits/sec 71293 71318 pps
[*1] 15.0000-16.0000 sec 50.0 MBytes 419 Mbits/sec 0.033 ms 1/35664 (0.0028%) -/-/-/- ms 35666 pps
[1] 15.0000-16.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[FD1] 15.0000-16.0000 sec 100 MBytes 839 Mbits/sec 71293 71337 pps
[*1] 16.0000-17.0000 sec 50.0 MBytes 420 Mbits/sec 0.009 ms 2/35676 (0.0056%) -/-/-/- ms 35668 pps
[1] 16.0000-17.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35662 pps
[FD1] 16.0000-17.0000 sec 100 MBytes 839 Mbits/sec 71298 71327 pps
[*1] 17.0000-18.0000 sec 50.0 MBytes 419 Mbits/sec 0.009 ms 0/35662 (0%) -/-/-/- ms 35665 pps
[1] 17.0000-18.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 17.0000-18.0000 sec 100 MBytes 839 Mbits/sec 71286 71328 pps
[*1] 18.0000-19.0000 sec 50.0 MBytes 419 Mbits/sec 0.013 ms 5/35670 (0.014%) -/-/-/- ms 35663 pps
[1] 18.0000-19.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35670 pps
[FD1] 18.0000-19.0000 sec 100 MBytes 839 Mbits/sec 71290 71328 pps
[*1] 19.0000-20.0000 sec 50.0 MBytes 419 Mbits/sec 0.048 ms 4/35663 (0.011%) -/-/-/- ms 35662 pps
[1] 19.0000-20.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 19.0000-20.0000 sec 100 MBytes 839 Mbits/sec 71278 71325 pps
[*1] 20.0000-21.0000 sec 50.0 MBytes 419 Mbits/sec 0.052 ms 0/35666 (0%) -/-/-/- ms 35666 pps
[1] 20.0000-21.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 20.0000-21.0000 sec 100 MBytes 839 Mbits/sec 71283 71330 pps
[*1] 21.0000-22.0000 sec 50.0 MBytes 419 Mbits/sec 0.018 ms 5/35666 (0.014%) -/-/-/- ms 35664 pps
[1] 21.0000-22.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35660 pps
[FD1] 21.0000-22.0000 sec 100 MBytes 839 Mbits/sec 71271 71320 pps
[*1] 22.0000-23.0000 sec 50.0 MBytes 419 Mbits/sec 0.040 ms 5/35662 (0.014%) -/-/-/- ms 35658 pps
[1] 22.0000-23.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35672 pps
[FD1] 22.0000-23.0000 sec 100 MBytes 839 Mbits/sec 71269 71326 pps
[*1] 23.0000-24.0000 sec 50.0 MBytes 420 Mbits/sec 0.012 ms 3/35677 (0.0084%) -/-/-/- ms 35668 pps
[1] 23.0000-24.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 23.0000-24.0000 sec 100 MBytes 839 Mbits/sec 71279 71329 pps
[*1] 24.0000-25.0000 sec 50.0 MBytes 419 Mbits/sec 0.011 ms 3/35666 (0.0084%) -/-/-/- ms 35665 pps
[1] 24.0000-25.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 24.0000-25.0000 sec 100 MBytes 839 Mbits/sec 71265 71329 pps
[*1] 25.0000-26.0000 sec 50.0 MBytes 419 Mbits/sec 0.010 ms 4/35670 (0.011%) -/-/-/- ms 35661 pps
[1] 25.0000-26.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 25.0000-26.0000 sec 100 MBytes 839 Mbits/sec 71262 71319 pps
[*1] 26.0000-27.0000 sec 50.0 MBytes 419 Mbits/sec 0.008 ms 1/35665 (0.0028%) -/-/-/- ms 35667 pps
[1] 26.0000-27.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 26.0000-27.0000 sec 100 MBytes 839 Mbits/sec 71264 71325 pps

[*1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 2/35665 (0.0056%) -/-/-/- ms 35666 pps
[1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71257   71329 pps
[*1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec   0.009 ms 4/35674 (0.011%) -/-/-/- ms 35665 pps
[1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71257   71320 pps
[*1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec   0.014 ms 3/35660 (0.0084%) -/-/-/- ms 35660 pps
[1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 71248   71320 pps
[*1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 1/35664 (0.0028%) -/-/-/- ms 35666 pps
[1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71245   71331 pps
[*1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 4/35674 (0.011%) -/-/-/- ms 35664 pps
[1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71257   71327 pps
[*1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec   0.015 ms 2/35661 (0.0056%) -/-/-/- ms 35666 pps
[1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 71238   71326 pps
[*1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec   0.009 ms 3/35674 (0.0084%) -/-/-/- ms 35666 pps
[1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71249   71326 pps
[*1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 2/35666 (0.0056%) -/-/-/- ms 35663 pps
[1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71240   71329 pps
[*1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec   0.017 ms 4/35666 (0.011%) -/-/-/- ms 35665 pps
[1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71233   71330 pps
[*1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 3/35663 (0.0084%) -/-/-/- ms 35663 pps
[1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71229   71326 pps
[*1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 1/35672 (0.0028%) -/-/-/- ms 35666 pps
[1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 71238   71328 pps
[*1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 5/35667 (0.014%) -/-/-/- ms 35661 pps
[1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71224   71323 pps
[*1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec   0.034 ms 6/35668 (0.017%) -/-/-/- ms 35664 pps
[1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 71224   71326 pps
[*1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 4/35664 (0.011%) -/-/-/- ms 35663 pps
[1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71214   71326 pps
[*1] 41.0000-42.0000 sec 50.0 MBytes   419 Mbits/sec   0.047 ms 6/35670 (0.017%) -/-/-/- ms 35659 pps
[1] 41.0000-42.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35662 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 71213   71319 pps
[*1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec   0.054 ms 5/35664 (0.014%) -/-/-/- ms 35662 pps
[1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35669 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71203   71331 pps
[*1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec   0.026 ms 5/35664 (0.014%) -/-/-/- ms 35661 pps
[1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 71199   71323 pps
[*1] 44.0000-45.0000 sec 50.0 MBytes   419 Mbits/sec   0.039 ms 2/35666 (0.0056%) -/-/-/- ms 35664 pps
[1] 44.0000-45.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71197   71329 pps
[*1] 45.0000-46.0000 sec 50.0 MBytes   420 Mbits/sec   0.011 ms 4/35677 (0.011%) -/-/-/- ms 35667 pps
[1] 45.0000-46.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35661 pps

[FD1] 45.0000-46.0000 sec 100 MBytes 839 Mbits/sec 71203 71325 pps
[*1] 46.0000-47.0000 sec 50.0 MBytes 419 Mbits/sec 0.012 ms 5/35665 (0.014%) -/-/-/- ms 35662 pps
[1] 46.0000-47.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35668 pps
[FD1] 46.0000-47.0000 sec 100 MBytes 839 Mbits/sec 71190 71328 pps
[*1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0.016 ms 4/35664 (0.011%) -/-/-/- ms 35663 pps
[1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35669 pps
[FD1] 47.0000-48.0000 sec 100 MBytes 839 Mbits/sec 71183 71332 pps
[*1] 48.0000-49.0000 sec 50.0 MBytes 419 Mbits/sec 0.037 ms 4/35669 (0.011%) -/-/-/- ms 35659 pps
[1] 48.0000-49.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 48.0000-49.0000 sec 100 MBytes 839 Mbits/sec 71183 71319 pps
[*1] 49.0000-50.0000 sec 50.0 MBytes 419 Mbits/sec 0.021 ms 4/35663 (0.011%) -/-/-/- ms 35663 pps
[1] 49.0000-50.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 49.0000-50.0000 sec 100 MBytes 839 Mbits/sec 71175 71324 pps
[*1] 50.0000-51.0000 sec 50.0 MBytes 419 Mbits/sec 0.022 ms 6/35664 (0.017%) -/-/-/- ms 35660 pps
[1] 50.0000-51.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 50.0000-51.0000 sec 100 MBytes 839 Mbits/sec 71168 71325 pps
[*1] 51.0000-52.0000 sec 50.0 MBytes 420 Mbits/sec 0.015 ms 2/35679 (0.0056%) -/-/-/- ms 35671 pps
[1] 51.0000-52.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 51.0000-52.0000 sec 100 MBytes 839 Mbits/sec 71182 71332 pps
[*1] 52.0000-53.0000 sec 50.0 MBytes 419 Mbits/sec 0.018 ms 3/35666 (0.0084%) -/-/-/- ms 35664 pps
[1] 52.0000-53.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35660 pps
[FD1] 52.0000-53.0000 sec 100 MBytes 839 Mbits/sec 71163 71320 pps
[*1] 53.0000-54.0000 sec 50.0 MBytes 419 Mbits/sec 0.036 ms 1/35657 (0.0028%) -/-/-/- ms 35661 pps
[1] 53.0000-54.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35672 pps
[FD1] 53.0000-54.0000 sec 100 MBytes 839 Mbits/sec 71159 71331 pps
[*1] 54.0000-55.0000 sec 50.0 MBytes 420 Mbits/sec 0.025 ms 2/35675 (0.0056%) -/-/-/- ms 35667 pps
[1] 54.0000-55.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 54.0000-55.0000 sec 100 MBytes 839 Mbits/sec 71170 71325 pps
[*1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0.009 ms 1/35667 (0.0028%) -/-/-/- ms 35668 pps
[1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 55.0000-56.0000 sec 100 MBytes 839 Mbits/sec 71164 71330 pps
[*1] 56.0000-57.0000 sec 50.0 MBytes 419 Mbits/sec 0.013 ms 3/35662 (0.0084%) -/-/-/- ms 35662 pps
[1] 56.0000-57.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35661 pps
[FD1] 56.0000-57.0000 sec 100 MBytes 839 Mbits/sec 71153 71316 pps
[*1] 57.0000-58.0000 sec 50.0 MBytes 419 Mbits/sec 0.022 ms 4/35668 (0.011%) -/-/-/- ms 35659 pps
[1] 57.0000-58.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[FD1] 57.0000-58.0000 sec 100 MBytes 839 Mbits/sec 71159 71321 pps
[*1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0.017 ms 3/35670 (0.0084%) -/-/-/- ms 35669 pps
[1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 58.0000-59.0000 sec 100 MBytes 839 Mbits/sec 71156 71333 pps
[*1] 59.0000-60.0000 sec 50.0 MBytes 419 Mbits/sec 0.010 ms 4/35664 (0.011%) -/-/-/- ms 35663 pps
[1] 59.0000-60.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 59.0000-60.0000 sec 100 MBytes 839 Mbits/sec 71146 71326 pps
[*1] 60.0000-61.0000 sec 50.0 MBytes 419 Mbits/sec 0.009 ms 2/35670 (0.0056%) -/-/-/- ms 35663 pps
[1] 60.0000-61.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 60.0000-61.0000 sec 100 MBytes 839 Mbits/sec 71151 71324 pps
[*1] 61.0000-62.0000 sec 50.0 MBytes 419 Mbits/sec 0.019 ms 0/35666 (0%) -/-/-/- ms 35668 pps
[1] 61.0000-62.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 61.0000-62.0000 sec 100 MBytes 839 Mbits/sec 71145 71332 pps
[*1] 62.0000-63.0000 sec 50.0 MBytes 419 Mbits/sec 0.036 ms 0/35664 (0%) -/-/-/- ms 35664 pps
[1] 62.0000-63.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 62.0000-63.0000 sec 100 MBytes 839 Mbits/sec 71143 71329 pps
[*1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0.014 ms 0/35670 (0%) -/-/-/- ms 35672 pps
[1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 63.0000-64.0000 sec 100 MBytes 839 Mbits/sec 71150 71336 pps
[*1] 64.0000-65.0000 sec 50.0 MBytes 419 Mbits/sec 0.035 ms 0/35668 (0%) -/-/-/- ms 35662 pps

[1] 64.0000-65.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 71149   71324 pps
[*1] 65.0000-66.0000 sec 50.0 MBytes   419 Mbits/sec   0.026 ms 0/35668 (0%) -/-/-/- ms 35671 pps
[1] 65.0000-66.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 71148   71334 pps
[*1] 66.0000-67.0000 sec 50.0 MBytes   419 Mbits/sec   0.043 ms 0/35664 (0%) -/-/-/- ms 35663 pps
[1] 66.0000-67.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 71145   71327 pps
[*1] 67.0000-68.0000 sec 50.0 MBytes   419 Mbits/sec   0.015 ms 0/35665 (0%) -/-/-/- ms 35667 pps
[1] 67.0000-68.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35667 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 71143   71334 pps
[*1] 68.0000-69.0000 sec 50.0 MBytes   419 Mbits/sec   0.027 ms 0/35666 (0%) -/-/-/- ms 35661 pps
[1] 68.0000-69.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 71143   71319 pps
[*1] 69.0000-69.9985 sec 49.8 MBytes   419 Mbits/sec   0.014 ms 68/35619 (0.19%) -/-/-/- ms 35603 pps
[*1] 0.0000-69.9985 sec 3.42 GBytes   419 Mbits/sec   0.014 ms 254/2496608 (0.01%) -/-/-/- ms 35663 pps
[1] 69.0000-70.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[1] 0.0000-70.0002 sec 3.42 GBytes   419 Mbits/sec 0/0   35666 pps
[1] Sent 2496616 datagrams
[FD1] 69.0000-70.0002 sec 99.8 MBytes   837 Mbits/sec 71038   0 pps
[FD1] 0.0000-70.0002 sec 6.84 GBytes   839 Mbits/sec 4986109   71328 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[264481.516493] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[264481.516497] usb 2-1.2: Product: USB Optical Mouse
[264481.516500] usb 2-1.2: Manufacturer: Logitech
[264481.520281] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.0021/input/input39
[264481.520646] hid-generic 0003:046D:C077.0021: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[264650.064013] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[264716.836908] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265442.792030] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[265625.764939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265733.008238] perf: interrupt took too long (3981 > 3961), lowering kernel.perf_event_max_sample_rate to 50000
---- DONE -------------------------------

Test configuration Control no ESD PIC Cable + PIC Connector + PIC cable Ext overall results were 6 intervals with lost packet intervals for a total of 151 lost packets out of 2,496,615 (0.006% packet loss)

iperf_client_23-058_11_25_37_est
---- DMESG at start of run --------------
Hostname: ethertest2
[264481.516493] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[264481.516497] usb 2-1.2: Product: USB Optical Mouse
[264481.516500] usb 2-1.2: Manufacturer: Logitech
[264481.520281] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.0021/input/input39
[264481.520646] hid-generic 0003:046D:C077.0021: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[264650.064013] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[264716.836908] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265442.792030] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[265625.764939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265733.008238] perf: interrupt took too long (3981 > 3961), lowering kernel.perf_event_max_sample_rate to 50000
---- Start IPERF TEST -------------------

Client connecting to 172.17.0.1, UDP port 5001 with pid 13366 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size: 208 KByte (default)
----
[1] local 172.17.0.2%enp6s0 port 36287 connected with 172.17.0.1 port 5001 (full-duplex) (no-udp-fin) (sock=3) on 2023-02-27 11:25:37 (EST)
[ID] Interval Transfer Bandwidth Write/Err PPS
[1] 0.0000-1.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[ID] Interval Transfer Bandwidth Jitter Lost/Total Latency avg/min/max/stdev PPS NetPwr
[*1] 0.0000-1.0000 sec 50.0 MBytes 419 Mbits/sec 0.028 ms 0/35632 (0%) -/-/-/- ms 35668 pps
[ID] Interval Transfer Bandwidth Datagrams PPS
[FD1] 0.0000-1.0000 sec 100 MBytes 839 Mbits/sec 71302 71304 pps
[1] 1.0000-2.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35660 pps
[*1] 1.0000-2.0000 sec 50.0 MBytes 419 Mbits/sec 0.010 ms 0/35664 (0%) -/-/-/- ms 35665 pps
[FD1] 1.0000-2.0000 sec 100 MBytes 839 Mbits/sec 71325 71323 pps
[1] 2.0000-3.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[*1] 2.0000-3.0000 sec 50.0 MBytes 419 Mbits/sec 0.016 ms 0/35668 (0%) -/-/-/- ms 35671 pps
[FD1] 2.0000-3.0000 sec 100 MBytes 839 Mbits/sec 71334 71340 pps
[1] 3.0000-4.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 3.0000-4.0000 sec 49.9 MBytes 419 Mbits/sec 0.035 ms 79/35672 (0.22%) -/-/-/- ms 35587 pps
[FD1] 3.0000-4.0000 sec 99.9 MBytes 838 Mbits/sec 71264 71253 pps
[1] 4.0000-5.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 4.0000-5.0000 sec 50.0 MBytes 419 Mbits/sec 0.027 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[FD1] 4.0000-5.0000 sec 100 MBytes 839 Mbits/sec 71248 71333 pps
[1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0.010 ms 0/35664 (0%) -/-/-/- ms 35666 pps
[FD1] 5.0000-6.0000 sec 100 MBytes 839 Mbits/sec 71253 71328 pps
[1] 6.0000-7.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 6.0000-7.0000 sec 50.0 MBytes 420 Mbits/sec 0.010 ms 0/35674 (0%) -/-/-/- ms 35668 pps
[FD1] 6.0000-7.0000 sec 100 MBytes 839 Mbits/sec 71258 71326 pps
[1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0.037 ms 0/35663 (0%) -/-/-/- ms 35663 pps
[FD1] 7.0000-8.0000 sec 100 MBytes 839 Mbits/sec 71250 71329 pps
[1] 8.0000-9.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 8.0000-9.0000 sec 50.0 MBytes 419 Mbits/sec 0.043 ms 0/35668 (0%) -/-/-/- ms 35667 pps

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[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71255   71332 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71254   71326 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35665 (0%) -/-/-/- ms 35669 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71254   71333 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35669 (0%) -/-/-/- ms 35663 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71254   71322 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec   0.055 ms 4/35664 (0.011%) -/-/-/- ms 35663 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71246   71326 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35667 (0%) -/-/-/- ms 35670 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71253   71330 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35669 (0%) -/-/-/- ms 35663 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71250   71321 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35667 (0%) -/-/-/- ms 35669 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 71250   71333 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.052 ms 0/35664 (0%) -/-/-/- ms 35665 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71246   71331 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec   0.042 ms 0/35665 (0%) -/-/-/- ms 35667 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 71249   71329 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   420 Mbits/sec   0.011 ms 0/35675 (0%) -/-/-/- ms 35673 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 71257   71336 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35660 (0%) -/-/-/- ms 35663 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71243   71326 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 20.0000-21.0000 sec  50.0 MBytes   420 Mbits/sec   0.048 ms 0/35674 (0%) -/-/-/- ms 35669 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71257   71329 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35662 (0%) -/-/-/- ms 35665 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 71247   71326 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35667 (0%) -/-/-/- ms 35668 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71247   71333 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35669 (0%) -/-/-/- ms 35665 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71252   71326 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71251   71326 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-/- ms 35669 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71248   71331 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   420 Mbits/sec   0.021 ms 0/35672 (0%) -/-/-/- ms 35666 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 71255   71326 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[*1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 0/35665 (0%) -/-/-/- ms 35668 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71246   71333 pps
[1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35664 (0%) -/-/-/- ms 35668 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71246   71331 pps
[1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 29.0000-30.0000 sec 50.0 MBytes   420 Mbits/sec   0.033 ms 0/35675 (0%) -/-/-/- ms 35668 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 71262   71332 pps
[1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec   0.023 ms 0/35661 (0%) -/-/-/- ms 35664 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71240   71329 pps
[1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec   0.016 ms 0/35667 (0%) -/-/-/- ms 35670 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71251   71332 pps
[1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35663 pps
[*1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec   0.016 ms 0/35668 (0%) -/-/-/- ms 35664 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 71251   71326 pps
[1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35669 pps
[*1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35666 (0%) -/-/-/- ms 35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71249   71332 pps
[1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec   0.050 ms 18/35666 (0.05%) -/-/-/- ms 35651 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71230   71315 pps
[1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 35.0000-36.0000 sec 50.0 MBytes   420 Mbits/sec   0.014 ms 0/35672 (0%) -/-/-/- ms 35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71236   71325 pps
[1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec   0.026 ms 0/35664 (0%) -/-/-/- ms 35671 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71230   71328 pps
[1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec   0.009 ms 0/35666 (0%) -/-/-/- ms 35665 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 71230   71329 pps
[1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec   0.008 ms 0/35669 (0%) -/-/-/- ms 35668 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71234   71333 pps
[1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 8/35667 (0.022%) -/-/-/- ms 35658 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 71221   71320 pps
[1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec   0.041 ms 0/35665 (0%) -/-/-/- ms 35660 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71225   71325 pps
[1] 41.0000-42.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[*1] 41.0000-42.0000 sec 50.0 MBytes   420 Mbits/sec   0.011 ms 0/35672 (0%) -/-/-/- ms 35675 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 71232   71333 pps
[1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35667 pps
[*1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec   0.040 ms 0/35660 (0%) -/-/-/- ms 35664 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71214   71330 pps
[1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec   0.033 ms 0/35668 (0%) -/-/-/- ms 35667 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 71227   71331 pps
[1] 44.0000-45.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35661 pps
[*1] 44.0000-45.0000 sec 50.0 MBytes   420 Mbits/sec   0.010 ms 0/35672 (0%) -/-/-/- ms 35670 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71225   71331 pps
[1] 45.0000-46.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35671 pps
[*1] 45.0000-46.0000 sec 50.0 MBytes   419 Mbits/sec   0.017 ms 0/35660 (0%) -/-/-/- ms 35664 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 71217   71333 pps

[1] 46.0000-47.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 46.0000-47.0000 sec 50.0 MBytes 420 Mbits/sec 0.010 ms 0/35678 (0%) -/-/-/- ms 35671 pps
[FD1] 46.0000-47.0000 sec 100 MBytes 839 Mbits/sec 71236 71331 pps
[1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0.011 ms 0/35662 (0%) -/-/-/- ms 35665 pps
[FD1] 47.0000-48.0000 sec 100 MBytes 839 Mbits/sec 71219 71328 pps
[1] 48.0000-49.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 48.0000-49.0000 sec 50.0 MBytes 420 Mbits/sec 0.042 ms 0/35672 (0%) -/-/-/- ms 35668 pps
[FD1] 48.0000-49.0000 sec 100 MBytes 839 Mbits/sec 71229 71329 pps
[1] 49.0000-50.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 49.0000-50.0000 sec 50.0 MBytes 419 Mbits/sec 0.011 ms 0/35666 (0%) -/-/-/- ms 35668 pps
[FD1] 49.0000-50.0000 sec 100 MBytes 839 Mbits/sec 71226 71329 pps
[1] 50.0000-51.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 50.0000-51.0000 sec 50.0 MBytes 419 Mbits/sec 0.018 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[FD1] 50.0000-51.0000 sec 100 MBytes 839 Mbits/sec 71219 71331 pps
[1] 51.0000-52.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 51.0000-52.0000 sec 50.0 MBytes 419 Mbits/sec 0.020 ms 0/35667 (0%) -/-/-/- ms 35662 pps
[FD1] 51.0000-52.0000 sec 100 MBytes 839 Mbits/sec 71226 71324 pps
[1] 52.0000-53.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 52.0000-53.0000 sec 49.9 MBytes 419 Mbits/sec 0.011 ms 41/35664 (0.11%) -/-/-/- ms 35631 pps
[FD1] 52.0000-53.0000 sec 99.9 MBytes 838 Mbits/sec 71176 71293 pps
[1] 53.0000-54.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 53.0000-54.0000 sec 50.0 MBytes 419 Mbits/sec 0.012 ms 0/35668 (0%) -/-/-/- ms 35667 pps
[FD1] 53.0000-54.0000 sec 100 MBytes 839 Mbits/sec 71186 71332 pps
[1] 54.0000-55.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 54.0000-55.0000 sec 50.0 MBytes 419 Mbits/sec 0.040 ms 0/35669 (0%) -/-/-/- ms 35664 pps
[FD1] 54.0000-55.0000 sec 100 MBytes 839 Mbits/sec 71183 71323 pps
[1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0.039 ms 1/35670 (0.0028%) -/-/-/- ms 35671 pps
[FD1] 55.0000-56.0000 sec 100 MBytes 839 Mbits/sec 71182 71336 pps
[1] 56.0000-57.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 56.0000-57.0000 sec 50.0 MBytes 419 Mbits/sec 0.033 ms 0/35657 (0%) -/-/-/- ms 35661 pps
[FD1] 56.0000-57.0000 sec 100 MBytes 839 Mbits/sec 71174 71321 pps
[1] 57.0000-58.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 57.0000-58.0000 sec 50.0 MBytes 420 Mbits/sec 0.016 ms 0/35675 (0%) -/-/-/- ms 35673 pps
[FD1] 57.0000-58.0000 sec 100 MBytes 839 Mbits/sec 71194 71337 pps
[1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0.028 ms 0/35665 (0%) -/-/-/- ms 35665 pps
[FD1] 58.0000-59.0000 sec 100 MBytes 839 Mbits/sec 71176 71326 pps
[1] 59.0000-60.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 59.0000-60.0000 sec 50.0 MBytes 419 Mbits/sec 0.047 ms 0/35666 (0%) -/-/-/- ms 35666 pps
[FD1] 59.0000-60.0000 sec 100 MBytes 839 Mbits/sec 71181 71331 pps
[1] 60.0000-61.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 60.0000-61.0000 sec 50.0 MBytes 419 Mbits/sec 0.037 ms 0/35668 (0%) -/-/-/- ms 35671 pps
[FD1] 60.0000-61.0000 sec 100 MBytes 839 Mbits/sec 71183 71334 pps
[1] 61.0000-62.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35664 pps
[*1] 61.0000-62.0000 sec 50.0 MBytes 420 Mbits/sec 0.023 ms 0/35673 (0%) -/-/-/- ms 35666 pps
[FD1] 61.0000-62.0000 sec 100 MBytes 839 Mbits/sec 71190 71327 pps
[1] 62.0000-63.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35667 pps
[*1] 62.0000-63.0000 sec 50.0 MBytes 419 Mbits/sec 0.023 ms 0/35664 (0%) -/-/-/- ms 35663 pps
[FD1] 62.0000-63.0000 sec 100 MBytes 839 Mbits/sec 71175 71325 pps
[1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0.014 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[FD1] 63.0000-64.0000 sec 100 MBytes 839 Mbits/sec 71182 71327 pps
[1] 64.0000-65.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[*1] 64.0000-65.0000 sec 50.0 MBytes 419 Mbits/sec 0.013 ms 0/35671 (0%) -/-/-/- ms 35670 pps

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[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 71188   71334 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-/-/- ms 35668 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 71173   71332 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35666 (0%) -/-/-/- ms 35665 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 71184   71324 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35671 (0%) -/-/-/- ms 35667 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 71185   71327 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35667 (0%) -/-/-/- ms 35667 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 71183   71326 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 69.0000-69.9987 sec  49.9 MBytes   419 Mbits/sec   0.024 ms 0/35620 (0%) -/-/-/- ms 35665 pps
[ *1] 0.0000-69.9987 sec  3.42 GBytes   419 Mbits/sec   0.024 ms 151/2496615 (0.006%) -/-/-/- ms 35664 pps
[  1] 0.0000-70.0000 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496614 datagrams
[FD1] 69.0000-70.0000 sec  99.9 MBytes   838 Mbits/sec 71137       0 pps
[FD1] 0.0000-70.0000 sec  6.84 GBytes   839 Mbits/sec 4986055   71330 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[264481.516493] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[264481.516497] usb 2-1.2: Product: USB Optical Mouse
[264481.516500] usb 2-1.2: Manufacturer: Logitech
[264481.520281] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.0021/input/input39
[264481.520646] hid-generic 0003:046D:C077.0021: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[264650.064013] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[264716.836908] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265442.792030] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[265625.764939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[265733.008238] perf: interrupt took too long (3981 > 3961), lowering kernel.perf_event_max_sample_rate to 50000
---- DONE ------------------------------
```

Test Configuration 8KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector No packet loss intervals detected by iPerf or packet; losses out of 2,496,615 (0%)
Client computer

```
---- DMESG at start of run --------------
Hostname: ethertest2
[  118.157977] audit: type=1400 audit(1677249529.072:50): apparmor="DENIED"
operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=1912
comm="snap-confine" capability=38  capname="perfmon"
[  118.340053] audit: type=1326 audit(1677249529.256:51): auid=1000 uid=1000 gid=1000
ses=3 subj=snap.snapd-desktop-integration.snapd-desktop-integration pid=1999
comm="snapd-desktop-i" exe="/snap/snapd-desktop-integration/49/usr/bin/snapd-desktop-
integration" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fdc3884173d code=0x50000
[  508.244925] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[  508.245178] IPv6: ADDRCONF(NETDEV_CHANGE): enp6s0: link becomes ready
[  879.752018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 1052.360931] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 2946.940026] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 2968.612935] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 4112.256024] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 4127.048939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 3853 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 34889 connected with 172.17.0.1 port 5001 (full-
duplex) (no-udp-fin) (sock=3) on 2023-02-24 11:00:34 (EST)
[ ID] Interval            Transfer     Bandwidth      Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ ID] Interval            Transfer     Bandwidth        Jitter   Lost/Total  Latency
avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35632 (0%) -/-/-/-
ms 35669 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec   100 MBytes   838 Mbits/sec 71300   71306 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35667 (0%) -/-/-/-
ms 35668 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71334   71331 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35662 (0%) -/-/-/-
ms 35664 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71328   71325 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35667 (0%) -/-/-/-
ms 35669 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71331   71334 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35658 (0%) -/-/-/-
ms 35660 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71324   71324 pps
[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 5.0000-6.0000 sec  50.0 MBytes   420 Mbits/sec   0.011 ms 0/35673 (0%) -/-/-/-
ms 35670 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71341   71336 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35663 (0%) -/-/-/-
ms 35665 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71327   71331 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35665 (0%) -/-/-/-
ms 35663 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71331   71328 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35665 (0%) -/-/-/-
ms 35666 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71329   71331 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35665 (0%) -/-/-/-
ms 35667 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71332   71330 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   420 Mbits/sec   0.009 ms 0/35674 (0%) -/-/-
/- ms 35668 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71340   71327 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71332   71331 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71330   71324 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35656 (0%) -/-/-
/- ms 35659 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71324   71330 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35669 (0%) -/-/-
/- ms 35671 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71335   71335 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35669 (0%) -/-/-
/- ms 35662 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 71334   71320 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71331   71331 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35669 (0%) -/-/-
/- ms 35671 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 71335   71335 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 71328   71328 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35662 (0%) -/-/-
/- ms 35666 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71328   71328 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 20.0000-21.0000 sec  50.0 MBytes   420 Mbits/sec   0.047 ms 0/35673 (0%) -/-/-
/- ms 35665 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71339   71323 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 71331   71333 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35662 (0%) -/-/-
/- ms 35665 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71330   71323 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35671 (0%) -/-/-
/- ms 35668 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71334   71327 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35665 (0%) -/-/-
/- ms 35667 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71333   71329 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35657 (0%) -/-/-
/- ms 35660 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71322   71324 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35670 (0%) -/-/-
/- ms 35672 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 71336   71336 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35668 (0%) -/-/-
/- ms 35661 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71334   71320 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71327   71331 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 71338   71328 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35665 (0%) -/-/-
/- ms 35667 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71328   71333 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35669 (0%) -/-/-
/- ms 35666 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71332   71326 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 71331   71325 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71331   71331 pps
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35663 (0%) -/-/-
/- ms 35665 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71329   71329 pps
[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 35.0000-36.0000 sec  50.0 MBytes   420 Mbits/sec   0.014 ms 0/35675 (0%) -/-/-
/- ms 35667 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71340   71325 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35663 (0%) -/-/-
/- ms 35664 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71332   71326 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 71325   71329 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71331   71333 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35671 (0%) -/-/-
/- ms 35666 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 71337   71326 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71330   71330 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35669 (0%) -/-/-
/- ms 35671 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 71332   71326 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71332   71332 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35665 (0%) -/-/-
/- ms 35668 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 71329   71334 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35667 (0%) -/-/-
/- ms 35661 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71333   71320 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35665 (0%) -/-/-
/- ms 35667 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 71331   71331 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec   0.041 ms 0/35668 (0%) -/-/-
/- ms 35668 pps
[FD1] 46.0000-47.0000 sec   100 MBytes   839 Mbits/sec 71335   71333 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 71326   71329 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 71328   71320 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   420 Mbits/sec   0.016 ms 0/35675 (0%) -/-/-
/- ms 35668 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 71344   71329 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35656 (0%) -/-/-
/- ms 35659 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 71320   71324 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35671 (0%) -/-/-
/- ms 35672 pps
[FD1] 51.0000-52.0000 sec   100 MBytes   839 Mbits/sec 71339   71334 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35665 (0%) -/-/-
/- ms 35667 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 71330   71332 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 71330   71330 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 71336   71323 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 71325   71329 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   420 Mbits/sec   0.012 ms 0/35672 (0%) -/-/-
/- ms 35673 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 71337   71338 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 71330   71325 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35664 (0%) -/-/-
/- ms 35662 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 71328   71324 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   420 Mbits/sec   0.011 ms 0/35673 (0%) -/-/-
/- ms 35671 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 71341   71336 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35665 (0%) -/-/-
/- ms 35665 pps
[FD1] 60.0000-61.0000 sec   100 MBytes   839 Mbits/sec 71333   71329 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35658 (0%) -/-/-
/- ms 35661 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 71322   71325 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35668 (0%) -/-/-
/- ms 35671 pps
[FD1] 62.0000-63.0000 sec   100 MBytes   839 Mbits/sec 71334   71334 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35668 (0%) -/-/-
/- ms 35665 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 71335   71329 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 71328   71332 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35669 (0%) -/-/-
/- ms 35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 71336   71331 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35659 (0%) -/-/-
/- ms 35661 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 71324   71326 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35671 (0%) -/-/-
/- ms 35673 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 71336   71338 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35669 (0%) -/-/-
/- ms 35662 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 71335   71322 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 71332   71331 pps
[  1] 0.0000-70.0001 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496614 datagrams
[ *1] 0.0000-70.0014 sec  3.42 GBytes   419 Mbits/sec   0.035 ms 0/2496615 (0%) -/-/-
/- ms 35665 pps
[FD1] 0.0000-70.0014 sec  6.84 GBytes   839 Mbits/sec 4993229   71330 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[  118.157977] audit: type=1400 audit(1677249529.072:50): apparmor="DENIED"
operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=1912
comm="snap-confine" capability=38  capname="perfmon"
[  118.340053] audit: type=1326 audit(1677249529.256:51): auid=1000 uid=1000 gid=1000
ses=3 subj=snap.snapd-desktop-integration.snapd-desktop-integration pid=1999
comm="snapd-desktop-i" exe="/snap/snapd-desktop-integration/49/usr/bin/snapd-desktop-
integration" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fdc3884173d code=0x50000
[  508.244925] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[  508.245178] IPv6: ADDRCONF(NETDEV_CHANGE): enp6s0: link becomes ready
[  879.752018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 1052.360931] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 2946.940026] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 2968.612935] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 4112.256024] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 4127.048939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
---- DONE -------------------------------
```

Test Configuration 8KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector plus Gore cable extension There were 8 packet loss intervals detected and 547lost data packets out of 2,496,610(0.022%)
Client Computer

```
---- DMESG at start of run --------------
Hostname: ethertest2
[262914.611613] audit: type=1400 audit(1677512297.819:104): apparmor="STATUS"
operation="profile_replace" profile="unconfined" name="snap.firefox.geckodriver"
pid=11394 comm="apparmor_parser"
[262915.564957] audit: type=1400 audit(1677512298.775:105): apparmor="DENIED"
operation="open" profile="snap-update-ns.firefox" name="/var/lib/" pid=11429 comm="5"
requested_mask="r" denied_mask="r" fsuid=0 ouid=0
[262939.496631] perf: interrupt took too long (3169 > 3148), lowering
kernel.perf_event_max_sample_rate to 63000
[263205.344819] wlx687f747712ec: authenticate with 18:64:72:23:49:b1
[263205.407027] wlx687f747712ec: send auth to 18:64:72:23:49:b1 (try 1/3)
[263205.407624] wlx687f747712ec: authenticated
[263205.411901] wlx687f747712ec: associate with 18:64:72:23:49:b1 (try 1/3)
[263205.412362] wlx687f747712ec: RX AssocResp from 18:64:72:23:49:b1 (capab=0x1
status=0 aid=2)
[263205.423461] wlx687f747712ec: associated
[263205.500724] wlx687f747712ec: Limiting TX power to 30 (30 - 0) dBm as advertised
by 18:64:72:23:49:b1
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 11636 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 56431 connected with 172.17.0.1 port 5001 (full-
duplex) (no-udp-fin) (sock=3) on 2023-02-27 10:45:55 (EST)
[ ID] Interval            Transfer     Bandwidth      Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ ID] Interval            Transfer     Bandwidth        Jitter   Lost/Total  Latency
avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35638 (0%) -/-/-/-
ms 35676 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec   100 MBytes   839 Mbits/sec 71307   71311 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35670 (0%) -/-/-/-
ms 35664 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71337   71325 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec   0.023 ms 0/35659 (0%) -/-/-/-
ms 35658 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71323   71322 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35671 (0%) -/-/-/-
ms 35674 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71338   71336 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35671 (0%) -/-/-/-
ms 35669 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71336   71333 pps
[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
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[ *1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35664 (0%) -/-/-/-
ms 35667 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71330   71334 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35663 (0%) -/-/-/-
ms 35667 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71329   71329 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   420 Mbits/sec   0.014 ms 0/35675 (0%) -/-/-/-
ms 35668 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71342   71329 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 4/35663 (0.011%) -/-
/-/- ms 35662 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71321   71326 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35664 (0%) -/-/-/-
ms 35669 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71328   71327 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35670 (0%) -/-/-
/- ms 35666 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71331   71327 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71328   71328 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   420 Mbits/sec   0.013 ms 0/35674 (0%) -/-/-
/- ms 35667 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71334   71325 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.041 ms 0/35662 (0%) -/-/-
/- ms 35666 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71321   71325 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.054 ms 0/35668 (0%) -/-/-
/- ms 35667 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71332   71334 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35668 (0%) -/-/-
/- ms 35671 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 71332   71339 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71328   71332 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec   0.056 ms 0/35666 (0%) -/-/-
/- ms 35661 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 71328   71322 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35662 (0%) -/-/-
/- ms 35665 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 71324   71328 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   420 Mbits/sec   0.015 ms 0/35673 (0%) -/-/-
/- ms 35671 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71335   71335 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
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[ *1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35665 (0%) -/-/-
/- ms 35669 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71325   71327 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 21.0000-22.0000 sec  49.9 MBytes   418 Mbits/sec   0.039 ms 87/35664 (0.24%) -
/-/-/- ms 35575 pps
[FD1] 21.0000-22.0000 sec  99.9 MBytes   838 Mbits/sec 71236   71237 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   420 Mbits/sec   0.041 ms 0/35672 (0%) -/-/-
/- ms 35666 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71250   71329 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35664 (0%) -/-/-
/- ms 35671 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71240   71329 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35669 (0%) -/-/-
/- ms 35664 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71243   71324 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71242   71337 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec   0.007 ms 0/35671 (0%) -/-/-
/- ms 35670 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 71246   71335 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35661 (0%) -/-/-
/- ms 35661 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71237   71324 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 2/35673 (0.0056%) -
/-/-/- ms 35670 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71246   71335 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35666 (0%) -/-/-
/- ms 35669 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 71238   71333 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35665 (0%) -/-/-
/- ms 35664 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71233   71324 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.054 ms 0/35663 (0%) -/-/-
/- ms 35666 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71241   71324 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 32.0000-33.0000 sec  49.9 MBytes   418 Mbits/sec   0.010 ms 94/35677 (0.26%) -
/-/-/- ms 35576 pps
[FD1] 32.0000-33.0000 sec  99.9 MBytes   838 Mbits/sec 71153   71232 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71142   71325 pps
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35671 (0%) -/-/-
/- ms 35670 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71151   71334 pps
[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
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[ *1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35668 (0%) -/-/-
/- ms 35667 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71147   71332 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35665 (0%) -/-/-
/- ms 35668 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71142   71333 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 71140   71325 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   420 Mbits/sec   0.047 ms 0/35675 (0%) -/-/-
/- ms 35669 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71155   71330 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 71143   71334 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71140   71327 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35662 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   420 Mbits/sec   0.042 ms 0/35672 (0%) -/-/-
/- ms 35667 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 71149   71326 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35668 (0%) -/-/-
/- ms 35670 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71148   71339 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 43.0000-44.0000 sec  49.9 MBytes   418 Mbits/sec   0.049 ms 86/35662 (0.24%) -
/-/-/- ms 35578 pps
[FD1] 43.0000-44.0000 sec  99.9 MBytes   838 Mbits/sec 71055   71241 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   420 Mbits/sec   0.015 ms 0/35674 (0%) -/-/-
/- ms 35668 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71065   71326 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35656 (0%) -/-/-
/- ms 35664 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 71050   71321 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 46.0000-47.0000 sec  49.9 MBytes   419 Mbits/sec   0.012 ms 70/35677 (0.2%) -/-
/-/- ms 35600 pps
[FD1] 46.0000-47.0000 sec  99.9 MBytes   838 Mbits/sec 70999   71259 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 47.0000-48.0000 sec  49.9 MBytes   419 Mbits/sec   0.037 ms 72/35661 (0.2%) -/-
/-/- ms 35592 pps
[FD1] 47.0000-48.0000 sec  99.9 MBytes   838 Mbits/sec 70913   71248 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35669 (0%) -/-/-
/- ms 35670 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 70921   71337 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35668 (0%) -/-/-
/- ms 35670 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 70915   71334 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
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[ *1] 50.0000-51.0000 sec  50.0 MBytes   420 Mbits/sec   0.010 ms 0/35672 (0%) -/-/-
/- ms 35667 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 70927   71332 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[FD1] 51.0000-52.0000 sec   100 MBytes   839 Mbits/sec 70911   71329 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35663 (0%) -/-/-
/- ms 35667 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 70916   71328 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 70924   71326 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 54.0000-55.0000 sec  49.8 MBytes   418 Mbits/sec   0.034 ms 132/35662 (0.37%) -
/-/-/- ms 35535 pps
[FD1] 54.0000-55.0000 sec  99.8 MBytes   837 Mbits/sec 70780   71197 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35671 (0%) -/-/-
/- ms 35670 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 70791   71336 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35663 (0%) -/-/-
/- ms 35667 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 70777   71332 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 70793   71325 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35670 (0%) -/-/-
/- ms 35670 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 70785   71333 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   420 Mbits/sec  0/0    35666 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35665 (0%) -/-/-
/- ms 35668 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 70790   71325 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[ *1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35669 (0%) -/-/-
/- ms 35665 pps
[FD1] 60.0000-61.0000 sec   100 MBytes   839 Mbits/sec 70782   71321 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ *1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 70784   71334 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[FD1] 62.0000-63.0000 sec   100 MBytes   839 Mbits/sec 70788   71333 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35668 (0%) -/-/-
/- ms 35671 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 70784   71337 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35669 (0%) -/-/-
/- ms 35664 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 70790   71326 pps
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[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 70784   71333 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-
/- ms 35670 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 70787   71332 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35670 (0%) -/-/-
/- ms 35664 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 70784   71320 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35666 (0%) -/-/-
/- ms 35669 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 70785   71331 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 69.0000-69.9985 sec  49.9 MBytes   419 Mbits/sec   0.012 ms 0/35612 (0%) -/-/-
/- ms 35660 pps
[ *1] 0.0000-69.9985 sec  3.42 GBytes   419 Mbits/sec   0.012 ms 547/2496610 (0.022%)
-/-/-/- ms 35659 pps
[  1] 0.0000-70.0002 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496616 datagrams
[FD1] 69.0000-70.0002 sec  99.9 MBytes   838 Mbits/sec 70738       0 pps
[FD1] 0.0000-70.0002 sec  6.84 GBytes   839 Mbits/sec 4977289   71324 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[263419.154717] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.001B/input/input33
[263419.154985] hid-generic 0003:046D:C077.001B: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[263426.443534] usb 2-1.2: USB disconnect, device number 31
[263426.723860] usb 2-1.2: new low-speed USB device number 32 using ehci-pci
[263426.836412] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[263426.836424] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[263426.836429] usb 2-1.2: Product: USB Optical Mouse
[263426.836432] usb 2-1.2: Manufacturer: Logitech
[263426.839198] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.001C/input/input34
[263426.839484] hid-generic 0003:046D:C077.001C: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- DONE ------------------------------
```

Test Configuration 10KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector There were 4 packet losses intervals detected by iPerf and a total of 520 lost packets out of 2,496,611 (0.021%) Client computer 23-055_11_04_23

```
---- DMESG at start of run --------------
Hostname: ethertest2
[  118.157977] audit: type=1400 audit(1677249529.072:50): apparmor="DENIED"
operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=1912
comm="snap-confine" capability=38  capname="perfmon"
[  118.340053] audit: type=1326 audit(1677249529.256:51): auid=1000 uid=1000 gid=1000
ses=3 subj=snap.snapd-desktop-integration.snapd-desktop-integration pid=1999
comm="snapd-desktop-i" exe="/snap/snapd-desktop-integration/49/usr/bin/snapd-desktop-
integration" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fdc3884173d code=0x50000
[  508.244925] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[  508.245178] IPv6: ADDRCONF(NETDEV_CHANGE): enp6s0: link becomes ready
[  879.752018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 1052.360931] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 2946.940026] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 2968.612935] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 4112.256024] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 4127.048939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 3901 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 47884 connected with 172.17.0.1 port 5001 (full-
duplex) (no-udp-fin) (sock=3) on 2023-02-24 11:04:23 (EST)
[ ID] Interval            Transfer     Bandwidth        Jitter   Lost/Total  Latency
avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  49.9 MBytes   419 Mbits/sec   0.035 ms 0/35627 (0%) -/-/-/-
ms 35664 pps
[ ID] Interval            Transfer     Bandwidth      Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec  99.9 MBytes   838 Mbits/sec 71296   71300 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35671 (0%) -/-/-/-
ms 35665 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71333   71321 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35668 (0%) -/-/-/-
ms 35669 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71333   71335 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-/-/-
ms 35665 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71335   71325 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.036 ms 0/35660 (0%) -/-/-/-
ms 35662 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71322   71319 pps
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[ *1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-/-
ms 35668 pps
[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71332   71334 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.053 ms 0/35671 (0%) -/-/-/-
ms 35665 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71338   71326 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec   0.036 ms 0/35662 (0%) -/-/-/-
ms 35667 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71327   71327 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35666 (0%) -/-/-/-
ms 35668 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71332   71332 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35665 (0%) -/-/-/-
ms 35664 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71334   71332 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.040 ms 0/35659 (0%) -/-/-
/- ms 35662 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71321   71326 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   420 Mbits/sec   0.034 ms 0/35673 (0%) -/-/-
/- ms 35666 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71340   71326 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 9/35669 (0.025%) -
/-/-/- ms 35662 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71330   71332 pps
[ *1] 13.0000-14.0000 sec  49.7 MBytes   417 Mbits/sec   0.009 ms 237/35665 (0.66%) -
/-/-/- ms 35430 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 13.0000-14.0000 sec  99.7 MBytes   836 Mbits/sec 71081   71094 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35663 (0%) -/-/-
/- ms 35664 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71082   71318 pps
[ *1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35668 (0%) -/-/-
/- ms 35662 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 71088   71321 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35662 (0%) -/-/-
/- ms 35668 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71081   71340 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35662 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 71092   71324 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 71087   71333 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71084   71330 pps
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[ *1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71083   71329 pps
[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.043 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 71082   71328 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35672 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71088   71338 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71088   71320 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35662 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71086   71319 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.057 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71082   71332 pps
[ *1] 26.0000-27.0000 sec  49.9 MBytes   418 Mbits/sec   0.036 ms 86/35670 (0.24%) -
/-/-/- ms 35583 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 26.0000-27.0000 sec  99.9 MBytes   838 Mbits/sec 71007   71246 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35668 (0%) -/-/-
/- ms 35668 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 70999   71325 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35671 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 70993   71331 pps
[ *1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35660 (0%) -/-/-
/- ms 35662 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 70994   71326 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35669 (0%) -/-/-
/- ms 35667 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71003   71331 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35667 (0%) -/-/-
/- ms 35665 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35662 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71003   71322 pps
[ *1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 70998   71333 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.040 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 70998   71332 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   420 Mbits/sec   0.043 ms 0/35672 (0%) -/-/-
/- ms 35666 pps
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71006   71325 pps
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[ *1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71000   71332 pps
[ *1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec   0.053 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35668 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71000   71332 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35663 (0%) -/-/-
/- ms 35666 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35669 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 70996   71333 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71002   71326 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35670 (0%) -/-/-
/- ms 35670 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35661 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 70999   71331 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71003   71322 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 70994   71326 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35670 (0%) -/-/-
/- ms 35671 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35671 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71003   71336 pps
[ *1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35664 (0%) -/-/-
/- ms 35667 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35661 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 70999   71319 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec   0.053 ms 0/35668 (0%) -/-/-
/- ms 35662 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35667 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71003   71323 pps
[ *1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35662 (0%) -/-/-
/- ms 35668 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 70994   71338 pps
[ *1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35670 (0%) -/-/-
/- ms 35663 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 46.0000-47.0000 sec   100 MBytes   839 Mbits/sec 71004   71323 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 71001   71321 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35663 (0%) -/-/-
/- ms 35665 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 70997   71329 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35666 (0%) -/-/-
/- ms 35663 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35671 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 71005   71331 pps
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[ *1] 50.0000-51.0000 sec  49.7 MBytes   417 Mbits/sec   0.028 ms 188/35665 (0.53%) -
/-/-/- ms 35480 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35667 pps
[FD1] 50.0000-51.0000 sec  99.7 MBytes   837 Mbits/sec 70805   71142 pps
[ *1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35661 pps
[FD1] 51.0000-52.0000 sec   100 MBytes   839 Mbits/sec 70813   71320 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 70808   71332 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 70811   71325 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 54.0000-55.0000 sec  50.0 MBytes   420 Mbits/sec   0.039 ms 0/35674 (0%) -/-/-
/- ms 35668 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 70820   71327 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35661 (0%) -/-/-
/- ms 35662 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 70807   71327 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35669 (0%) -/-/-
/- ms 35670 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35668 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 70817   71337 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35669 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 70809   71333 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35660 (0%) -/-/-
/- ms 35662 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35661 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 70803   71319 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   420 Mbits/sec   0.030 ms 0/35677 (0%) -/-/-
/- ms 35670 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 70823   71328 pps
[ *1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec   0.039 ms 0/35663 (0%) -/-/-
/- ms 35665 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[FD1] 60.0000-61.0000 sec   100 MBytes   839 Mbits/sec 70808   71328 pps
[ *1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 70810   71330 pps
[ *1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35663 (0%) -/-/-
/- ms 35664 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 62.0000-63.0000 sec   100 MBytes   839 Mbits/sec 70809   71329 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35666 (0%) -/-/-
/- ms 35669 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35672 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 70811   71336 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35662 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 70819   71325 pps
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[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 70809   71331 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35665 (0%) -/-/-
/- ms 35667 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 70812   71319 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 70812   71332 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 70813   71336 pps
[ *1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 70813   71320 pps
[ *1] 0.0000-70.0012 sec  3.42 GBytes   419 Mbits/sec   0.039 ms 520/2496611 (0.021%)
-/-/-/- ms 35658 pps
[  1] 0.0000-70.0000 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496612 datagrams
[FD1] 0.0000-70.0001 sec  6.84 GBytes   839 Mbits/sec 4971128   71324 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[ 5279.399675] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.0004/input/input10
[ 5279.400062] hid-generic 0003:046D:C077.0004: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[ 5302.327298] usb 2-1.2: USB disconnect, device number 5
[ 5302.591847] usb 2-1.2: new low-speed USB device number 6 using ehci-pci
[ 5302.704426] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[ 5302.704439] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[ 5302.704444] usb 2-1.2: Product: USB Optical Mouse
[ 5302.704447] usb 2-1.2: Manufacturer: Logitech
[ 5302.706983] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.0005/input/input11
[ 5302.707293] hid-generic 0003:046D:C077.0005: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- DONE ------------------------------
```

Test Configuration 16KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector There were 10 packet losse intervals detected by iPerf and a total of 1182 packet losses out of 2,496,611 (0.047%)

```
---- DMESG at start of run --------------
Hostname: ethertest2
[ 5279.399675] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.0004/input/input10
[ 5279.400062] hid-generic 0003:046D:C077.0004: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[ 5302.327298] usb 2-1.2: USB disconnect, device number 5
[ 5302.591847] usb 2-1.2: new low-speed USB device number 6 using ehci-pci
[ 5302.704426] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[ 5302.704439] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[ 5302.704444] usb 2-1.2: Product: USB Optical Mouse
[ 5302.704447] usb 2-1.2: Manufacturer: Logitech
[ 5302.706983] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.0005/input/input11
[ 5302.707293] hid-generic 0003:046D:C077.0005: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 4012 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 53465 connected with 172.17.0.1 port 5001 (full-
duplex) (no-udp-fin) (sock=3) on 2023-02-24 11:08:31 (EST)
[ ID] Interval           Transfer     Bandwidth        Jitter   Lost/Total  Latency
avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  49.9 MBytes   419 Mbits/sec   0.019 ms 0/35630 (0%) -/-/-/-
ms 35667 pps
[ ID] Interval           Transfer     Bandwidth      Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec  99.9 MBytes   838 Mbits/sec 71296   71305 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   420 Mbits/sec   0.016 ms 0/35673 (0%) -/-/-/-
ms 35667 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71339   71327 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35660 (0%) -/-/-/-
ms 35667 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71329   71323 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   420 Mbits/sec   0.031 ms 0/35672 (0%) -/-/-/-
ms 35666 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71334   71322 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35661 (0%) -/-/-/-
ms 35663 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71332   71322 pps
[ *1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35665 (0%) -/-/-/-
ms 35667 pps
[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71327   71332 pps
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[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35668 (0%) -/-/-/-
ms 35669 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71332   71334 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35660 (0%) -/-/-/-
ms 35662 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71327   71325 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35670 (0%) -/-/-/-
ms 35662 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71335   71319 pps
[ *1] 9.0000-10.0000 sec  49.8 MBytes   418 Mbits/sec   0.021 ms 153/35663 (0.43%) -
/-/-/- ms 35516 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 9.0000-10.0000 sec  99.8 MBytes   837 Mbits/sec 71175   71177 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35671 (0%) -/-/-
/- ms 35670 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   420 Mbits/sec  0/0    35666 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71190   71331 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35662 (0%) -/-/-
/- ms 35663 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71171   71327 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35671 (0%) -/-/-
/- ms 35665 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71185   71325 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 20/35663 (0.056%) -
/-/-/- ms 35645 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71153   71310 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35670 (0%) -/-/-
/- ms 35671 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71163   71335 pps
[ *1] 15.0000-16.0000 sec  49.6 MBytes   416 Mbits/sec   0.027 ms 310/35662 (0.87%) -
/-/-/- ms 35355 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 15.0000-16.0000 sec  99.6 MBytes   835 Mbits/sec 70848   71015 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.047 ms 0/35668 (0%) -/-/-
/- ms 35664 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 70853   71328 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 70841   71329 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 70846   71330 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35668 (0%) -/-/-
/- ms 35670 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 70850   71335 pps
[ *1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec   0.006 ms 0/35666 (0%) -/-/-
/- ms 35665 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 70853   71328 pps
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[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35668 (0%) -/-/-
/- ms 35664 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 70847   71322 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.049 ms 0/35664 (0%) -/-/-
/- ms 35667 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 70848   71329 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 70846   71331 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.023 ms 0/35670 (0%) -/-/-
/- ms 35664 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 70853   71324 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 70851   71334 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec   0.036 ms 0/35666 (0%) -/-/-
/- ms 35665 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 70853   71326 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35661 (0%) -/-/-
/- ms 35665 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35667 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 70839   71330 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 70850   71327 pps
[ *1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35669 (0%) -/-/-
/- ms 35669 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 70849   71332 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.045 ms 0/35667 (0%) -/-/-
/- ms 35661 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 70850   71320 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 70847   71330 pps
[ *1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35666 (0%) -/-/-
/- ms 35666 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 70854   71326 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35663 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 70844   71327 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec   0.044 ms 0/35663 (0%) -/-/-
/- ms 35666 pps
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35669 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 70843   71332 pps
[ *1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 70852   71333 pps
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[ *1] 36.0000-37.0000 sec  49.9 MBytes   419 Mbits/sec   0.014 ms 68/35670 (0.19%) -
/-/-/- ms 35596 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 36.0000-37.0000 sec  99.9 MBytes   838 Mbits/sec 70789   71260 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35669 (0%) -/-/-
/- ms 35669 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 70779   71330 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35666 (0%) -/-/-
/- ms 35665 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 70780   71329 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 70781   71330 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35657 (0%) -/-/-
/- ms 35660 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 70775   71320 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   420 Mbits/sec   0.015 ms 0/35674 (0%) -/-/-
/- ms 35671 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 70785   71330 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 70777   71328 pps
[ *1] 43.0000-44.0000 sec  49.7 MBytes   417 Mbits/sec   0.016 ms 191/35669 (0.54%) -
/-/-/- ms 35474 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 43.0000-44.0000 sec  99.7 MBytes   837 Mbits/sec 70594   71138 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35663 (0%) -/-/-
/- ms 35667 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 70587   71329 pps
[ *1] 45.0000-46.0000 sec  49.8 MBytes   418 Mbits/sec   0.012 ms 124/35667 (0.35%) -
/-/-/- ms 35543 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 45.0000-46.0000 sec  99.8 MBytes   837 Mbits/sec 70466   71208 pps
[ *1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35664 (0%) -/-/-
/- ms 35660 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 46.0000-47.0000 sec   100 MBytes   839 Mbits/sec 70464   71322 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35660 (0%) -/-/-
/- ms 35667 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 70463   71323 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   420 Mbits/sec   0.022 ms 0/35672 (0%) -/-/-
/- ms 35673 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 70472   71338 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35670 (0%) -/-/-
/- ms 35664 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 70466   71319 pps
[ *1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35662 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 70467   71322 pps
```

```
[ *1] 51.0000-52.0000 sec  49.7 MBytes   417 Mbits/sec   0.009 ms 203/35666 (0.57%) -
/-/-/- ms 35462 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[FD1] 51.0000-52.0000 sec  99.7 MBytes   837 Mbits/sec 70267   71132 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 70255   71325 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35672 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 70261   71333 pps
[ *1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 70258   71329 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   420 Mbits/sec   0.032 ms 0/35672 (0%) -/-/-
/- ms 35665 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 70274   71329 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 70258   71329 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35664 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 70262   71320 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 70262   71331 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35668 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 70265   71336 pps
[ *1] 60.0000-61.0000 sec  49.8 MBytes   418 Mbits/sec   0.032 ms 113/35670 (0.32%) -
/-/-/- ms 35551 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 60.0000-61.0000 sec  99.8 MBytes   838 Mbits/sec 70151   71207 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec   0.043 ms 0/35665 (0%) -/-/-
/- ms 35665 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 70148   71331 pps
[ *1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec   0.045 ms 0/35663 (0%) -/-/-
/- ms 35666 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 62.0000-63.0000 sec   100 MBytes   839 Mbits/sec 70150   71326 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 70150   71334 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 70144   71328 pps
[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 70154   71322 pps
```

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[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 70152   71334 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.049 ms 0/35663 (0%) -/-/-
/- ms 35665 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 70149   71326 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 70152   71330 pps
[ *1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35660 (0%) -/-/-
/- ms 35662 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 70145   71324 pps
[ *1] 0.0000-70.0011 sec  3.42 GBytes   419 Mbits/sec   0.055 ms 1182/2496607
(0.047%) -/-/-/- ms 35648 pps
[  1] 0.0000-70.0002 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496617 datagrams
[FD1] 0.0000-70.0002 sec  6.83 GBytes   839 Mbits/sec 4948963   71315 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[ 5552.572487] hid-generic 0003:046D:C077.000B: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[ 5561.143344] usb 2-1-port2: disabled by hub (EMI?), re-enabling...
[ 5561.143364] usb 2-1.2: USB disconnect, device number 12
[ 5561.415852] usb 2-1.2: new low-speed USB device number 13 using ehci-pci
[ 5561.532525] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[ 5561.532536] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[ 5561.532540] usb 2-1.2: Product: USB Optical Mouse
[ 5561.532543] usb 2-1.2: Manufacturer: Logitech
[ 5561.535412] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.000C/input/input18
[ 5561.536507] hid-generic 0003:046D:C077.000C: input,hidraw0: USB HID v1.11 Mouse
[Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- DONE -------------------------------
```

Test Configuration 16KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector There were 8 packet losses intervals detected by iPerf `and a total of 1240 lost packets` out of 2,496,611 `(0.05%)`

```
---- DMESG at start of run --------------
Hostname: ethertest2
[ 5729.948930] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex,
Flow Control: Rx/Tx
[ 5799.479390] usb 2-1-port2: disabled by hub (EMI?), re-enabling...
[ 5799.479409] usb 2-1.2: USB disconnect, device number 13
[ 5799.743884] usb 2-1.2: new low-speed USB device number 14 using ehci-pci
[ 5799.864416] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[ 5799.864428] usb 2-1.2: New USB device strings: Mfr=1, Product=2,
SerialNumber=0
[ 5799.864432] usb 2-1.2: Product: USB Optical Mouse
[ 5799.864435] usb 2-1.2: Manufacturer: Logitech
[ 5799.866933] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.000D/input/input19
[ 5799.867171] hid-generic 0003:046D:C077.000D: input,hidraw0: USB HID v1.11
Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 4294 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 39701 connected with 172.17.0.1 port 5001
(full-duplex) (no-udp-fin) (sock=3) on 2023-02-24 11:16:00 (EST)
[ ID] Interval            Transfer     Bandwidth       Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ ID] Interval            Transfer     Bandwidth         Jitter   Lost/Total
Latency avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  49.9 MBytes   419 Mbits/sec   0.009 ms 0/35629 (0%) -/-
/-/- ms 35675 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec  99.9 MBytes   838 Mbits/sec 71294   71305 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec   0.042 ms 0/35668 (0%) -/-
/-/- ms 35662 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71335   71324 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35670 (0%) -/-
/-/- ms 35671 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71339   71330 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-
/-/- ms 35666 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71331   71332 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-
/-/- ms 35665 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71326   71328 pps
[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35663 (0%) -/-
```

```
/-/- ms 35665 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71328   71330 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35671 (0%) -/-
/-/- ms 35665 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71339   71326 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 32/35667 (0.09%)
-/-/-/- ms 35637 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71302   71305 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35657 (0%) -/-
/-/- ms 35662 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71290   71324 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35666 (0%) -/-
/-/- ms 35664 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71299   71326 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35664 (0%) -
/-/-/- ms 35667 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71298   71330 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35671 (0%) -
/-/-/- ms 35664 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 71304   71323 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35667 (0%) -
/-/-/- ms 35669 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71300   71334 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35666 (0%) -
/-/-/- ms 35667 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71300   71331 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35664 (0%) -
/-/-/- ms 35666 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71300   71328 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35668 (0%) -
/-/-/- ms 35666 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 71299   71326 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35666 (0%) -
/-/-/- ms 35668 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71302   71330 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 17.0000-18.0000 sec  49.8 MBytes   418 Mbits/sec   0.011 ms 109/35662
(0.31%) -/-/-/- ms 35555 pps
[FD1] 17.0000-18.0000 sec  99.8 MBytes   838 Mbits/sec 71186   71220 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 18.0000-19.0000 sec  49.8 MBytes   418 Mbits/sec   0.011 ms 149/35671
(0.42%) -/-/-/- ms 35516 pps
[FD1] 18.0000-19.0000 sec  99.8 MBytes   837 Mbits/sec 71045   71174 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35660 (0%) -
/-/-/- ms 35666 pps
```

```
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71037   71325 pps
[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35668 (0%) -
/-/-/- ms 35669 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71044   71334 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.036 ms 0/35671 (0%) -
/-/-/- ms 35664 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 71047   71323 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35664 (0%) -
/-/-/- ms 35666 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71044   71324 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35661 (0%) -
/-/-/- ms 35663 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71036   71326 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35667 (0%) -
/-/-/- ms 35668 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71039   71331 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35665 (0%) -
/-/-/- ms 35667 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71041   71331 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec   0.044 ms 0/35671 (0%) -
/-/-/- ms 35664 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 71049   71326 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35665 (0%) -
/-/-/- ms 35666 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71039   71330 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35665 (0%) -
/-/-/- ms 35667 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71041   71330 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 29.0000-30.0000 sec  49.9 MBytes   419 Mbits/sec   0.019 ms 41/35662
(0.11%) -/-/-/- ms 35623 pps
[FD1] 29.0000-30.0000 sec  99.9 MBytes   838 Mbits/sec 70997   71287 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35664 (0%) -
/-/-/- ms 35666 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 70999   71329 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35667 (0%) -
/-/-/- ms 35660 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71002   71319 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35667 (0%) -
/-/-/- ms 35669 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 71002   71333 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35671 (0%) -
/-/-/- ms 35672 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71004   71336 pps
```

```
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec   0.023 ms 16/35660
(0.045%) -/-/-/- ms 35648 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 70981   71308 pps
[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35665 pps
[ *1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35662 (0%) -
/-/-/- ms 35664 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 70984   71324 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35667 (0%) -
/-/-/- ms 35666 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 70985   71331 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35663 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35671 (0%) -
/-/-/- ms 35663 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 70988   71319 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35669 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35666 (0%) -
/-/-/- ms 35668 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 70988   71335 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.036 ms 0/35671 (0%) -
/-/-/- ms 35671 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 70987   71334 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35660 (0%) -
/-/-/- ms 35665 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 70977   71328 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35671 (0%) -
/-/-/- ms 35664 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 70991   71325 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35660 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35665 (0%) -
/-/-/- ms 35666 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 70982   71321 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35671 pps
[ *1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec   0.025 ms 0/35661 (0%) -
/-/-/- ms 35661 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 70981   71328 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 44.0000-45.0000 sec  49.9 MBytes   418 Mbits/sec   0.010 ms 98/35671
(0.27%) -/-/-/- ms 35575 pps
[FD1] 44.0000-45.0000 sec  99.9 MBytes   838 Mbits/sec 70895   71236 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35661 pps
[ *1] 45.0000-46.0000 sec  49.5 MBytes   415 Mbits/sec   0.012 ms 344/35660
(0.96%) -/-/-/- ms 35317 pps
[FD1] 45.0000-46.0000 sec  99.5 MBytes   835 Mbits/sec 70533   70976 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35670 pps
[ *1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35670 (0%) -
/-/-/- ms 35667 pps
[FD1] 46.0000-47.0000 sec   100 MBytes   839 Mbits/sec 70550   71334 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35662 (0%) -
/-/-/- ms 35665 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 70539   71329 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0     35666 pps
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[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35666 (0%) -
/-/-/- ms 35667 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 70540   71331 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35666 (0%) -
/-/-/- ms 35668 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 70543   71332 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35671 (0%) -
/-/-/- ms 35665 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 70551   71327 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 51.0000-52.0000 sec  49.8 MBytes   418 Mbits/sec   0.024 ms 123/35665
(0.34%) -/-/-/- ms 35544 pps
[FD1] 51.0000-52.0000 sec  99.8 MBytes   837 Mbits/sec 70418   71209 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35664 (0%) -
/-/-/- ms 35665 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 70419   71327 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35661 (0%) -
/-/-/- ms 35662 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 70414   71329 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35665 (0%) -
/-/-/- ms 35667 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 70420   71329 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec   0.048 ms 0/35665 (0%) -
/-/-/- ms 35658 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 70415   71313 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec   0.048 ms 0/35671 (0%) -
/-/-/- ms 35673 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 70428   71331 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35669 (0%) -
/-/-/- ms 35670 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 70424   71337 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35663 (0%) -
/-/-/- ms 35665 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 70415   71326 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35665 (0%) -
/-/-/- ms 35666 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 70416   71331 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35662 (0%) -
/-/-/- ms 35664 pps
[FD1] 60.0000-61.0000 sec   100 MBytes   839 Mbits/sec 70416   71328 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 61.0000-62.0000 sec  49.9 MBytes   418 Mbits/sec   0.028 ms 98/35665
(0.27%) -/-/-/- ms 35558 pps
[FD1] 61.0000-62.0000 sec  99.9 MBytes   838 Mbits/sec 70325   71220 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 62.0000-63.0000 sec  49.7 MBytes   417 Mbits/sec   0.040 ms 230/35676
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(0.64%) -/-/-/- ms 35446 pps
[FD1] 62.0000-63.0000 sec  99.7 MBytes   836 Mbits/sec 70101   71111 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.039 ms 0/35660 (0%) -
/-/-/- ms 35665 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 70083   71329 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.024 ms 0/35663 (0%) -
/-/-/- ms 35664 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 70089   71329 pps
[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35664 (0%) -
/-/-/- ms 35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 70092   71328 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   420 Mbits/sec   0.029 ms 0/35672 (0%) -
/-/-/- ms 35664 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 70094   71318 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35672 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35667 (0%) -
/-/-/- ms 35668 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 70094   71336 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35662 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.047 ms 0/35664 (0%) -
/-/-/- ms 35666 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 70091   71321 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[ *1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec   0.049 ms 0/35662 (0%) -
/-/-/- ms 35665 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 70087   71332 pps
[  1] 0.0000-70.0001 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496613 datagrams
[ *1] 0.0000-70.0013 sec  3.42 GBytes   419 Mbits/sec   0.039 ms 1240/2496614
(0.05%) -/-/-/- ms 35648 pps
[FD1] 0.0000-70.0013 sec  6.83 GBytes   839 Mbits/sec 4957982   71313 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[ 6000.967686] hid-generic 0003:046D:C077.0014: input,hidraw0: USB HID v1.11
Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[ 6010.935432] usb 2-1-port2: disabled by hub (EMI?), re-enabling...
[ 6010.935451] usb 2-1.2: USB disconnect, device number 22
[ 6011.211851] usb 2-1.2: new low-speed USB device number 23 using ehci-pci
[ 6011.328440] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077,
bcdDevice=72.00
[ 6011.328459] usb 2-1.2: New USB device strings: Mfr=1, Product=2,
SerialNumber=0
[ 6011.328461] usb 2-1.2: Product: USB Optical Mouse
[ 6011.328463] usb 2-1.2: Manufacturer: Logitech
[ 6011.330744] input: Logitech USB Optical Mouse as
/devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-
1.2:1.0/0003:046D:C077.0015/input/input27
[ 6011.330929] hid-generic 0003:046D:C077.0015: input,hidraw0: USB HID v1.11
Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- DONE -------------------------------
```

Test Configuration 12KV ESD applied for 60s at a rep rate of 50 ms Gore Cable with a FASX connector plus a long Gore cable extension overall results; 22 intervals with lost data packets (highlighted intervals) with an over loss of 1,909 data packets out of 2,496,611 (0.076% lost)

Iperf client time stamp 2023 02-27 23-058 11:51:37

---- DMESG at start of run --------------
Hostname: ethertest2
[267281.860239] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077, bcdDevice=72.00
[267281.860249] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[267281.860254] usb 2-1.2: Product: USB Optical Mouse
[267281.860257] usb 2-1.2: Manufacturer: Logitech
[267281.862535] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.0053/input/input89
[267281.862695] hid-generic 0003:046D:C077.0053: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
[267282.245899] pcieport 0000:00:02.0: AER: Corrected error received: 0000:00:02.0
[267282.245929] pcieport 0000:00:02.0: PCIe Bus Error: severity=Corrected, type=Physical Layer, (Receiver ID)
[267282.245931] pcieport 0000:00:02.0:   device [8086:0e04] error status/mask=00000001/00002000
[267282.245933] pcieport 0000:00:02.0:   [0] RxErr
---- Start IPERF TEST -------------------

Client connecting to 172.17.0.1, UDP port 5001 with pid 14573 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size: 208 KByte (default)
----
[1] local 172.17.0.2%enp6s0 port 39969 connected with 172.17.0.1 port 5001 (full-duplex) (no-udp-fin) (sock=3) on 2023-02-27 11:51:37 (EST)
[ID] Interval   Transfer   Bandwidth   Write/Err PPS
[1] 0.0000-1.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35671 pps
[ID] Interval   Transfer   Bandwidth   Jitter   Lost/Total Latency avg/min/max/stdev PPS NetPwr
[*1] 0.0000-1.0000 sec 50.0 MBytes   419 Mbits/sec   0.027 ms 0/35632 (0%) -/-/-/- ms 35672 pps
[ID] Interval   Transfer   Bandwidth   Datagrams   PPS
[FD1] 0.0000-1.0000 sec   100 MBytes   838 Mbits/sec 71301   71305 pps
[1] 1.0000-2.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 1.0000-2.0000 sec 50.0 MBytes   419 Mbits/sec   0.032 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71331   71335 pps
[1] 2.0000-3.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 2.0000-3.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 0/35665 (0%) -/-/-/- ms 35664 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71335   71327 pps
[1] 3.0000-4.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 3.0000-4.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35663 (0%) -/-/-/- ms 35663 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71326   71325 pps
[1] 4.0000-5.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 4.0000-5.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 1/35671 (0.0028%) -/-/-/- ms 35670 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71339   71333 pps

[1] 5.0000-6.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 5.0000-6.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 2/35656 (0.0056%) -/-/-/- ms 35662 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71317   71322 pps
[1] 6.0000-7.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 6.0000-7.0000 sec 49.9 MBytes   418 Mbits/sec   0.013 ms 96/35672 (0.27%) -/-/-/- ms 35569 pps
[FD1] 6.0000-7.0000 sec 99.9 MBytes   838 Mbits/sec 71237   71227 pps
[1] 7.0000-8.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 7.0000-8.0000 sec 49.7 MBytes   417 Mbits/sec   0.014 ms 243/35666 (0.68%) -/-/-/- ms 35425 pps
[FD1] 7.0000-8.0000 sec 99.7 MBytes   836 Mbits/sec 70992   71087 pps
[1] 8.0000-9.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35661 pps
[*1] 8.0000-9.0000 sec 50.0 MBytes   419 Mbits/sec   0.027 ms 0/35667 (0%) -/-/-/- ms 35667 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 70988   71326 pps
[1] 9.0000-10.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35670 pps
[*1] 9.0000-10.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 0/35663 (0%) -/-/-/- ms 35665 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 70986   71333 pps
[1] 10.0000-11.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 10.0000-11.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 0/35666 (0%) -/-/-/- ms 35660 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 70992   71321 pps
[1] 11.0000-12.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 11.0000-12.0000 sec 49.7 MBytes   417 Mbits/sec   0.011 ms 222/35673 (0.62%) -/-/-/- ms 35452 pps
[FD1] 11.0000-12.0000 sec 99.7 MBytes   836 Mbits/sec 70777   71115 pps
[1] 12.0000-13.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 12.0000-13.0000 sec 50.0 MBytes   419 Mbits/sec   0.021 ms 2/35657 (0.0056%) -/-/-/- ms 35661 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 70758   71320 pps
[1] 13.0000-14.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 13.0000-14.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 3/35671 (0.0084%) -/-/-/- ms 35662 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 70763   71318 pps
[1] 14.0000-15.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 14.0000-15.0000 sec 50.0 MBytes   419 Mbits/sec   0.032 ms 4/35670 (0.011%) -/-/-/- ms 35664 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 70765   71330 pps
[1] 15.0000-16.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 15.0000-16.0000 sec 50.0 MBytes   419 Mbits/sec   0.039 ms 0/35662 (0%) -/-/-/- ms 35665 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 70755   71327 pps
[1] 16.0000-17.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 16.0000-17.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 1/35668 (0.0028%) -/-/-/- ms 35670 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 70757   71336 pps
[1] 17.0000-18.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 17.0000-18.0000 sec 50.0 MBytes   419 Mbits/sec   0.027 ms 1/35670 (0.0028%) -/-/-/- ms 35666 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 70766   71330 pps
[1] 18.0000-19.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 18.0000-19.0000 sec 50.0 MBytes   419 Mbits/sec   0.048 ms 0/35661 (0%) -/-/-/- ms 35663 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 70727   71305 pps
[1] 19.0000-20.0000 sec 50.0 MBytes   420 Mbits/sec 0/0   35660 pps
[*1] 19.0000-20.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 25/35671 (0.07%) -/-/-/- ms 35644 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 70756   71282 pps
[1] 20.0000-21.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35672 pps
[*1] 20.0000-21.0000 sec 50.0 MBytes   419 Mbits/sec   0.015 ms 0/35665 (0%) -/-/-/- ms 35666 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 70734   71336 pps
[1] 21.0000-22.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps

[*1] 21.0000-22.0000 sec 50.0 MBytes   419 Mbits/sec   0.018 ms 2/35665 (0.0056%) -/-/-/- ms 35664 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 70727   71330 pps
[1] 22.0000-23.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 22.0000-23.0000 sec 50.0 MBytes   419 Mbits/sec   0.041 ms 0/35665 (0%) -/-/-/- ms 35663 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 70731   71328 pps
[1] 23.0000-24.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 23.0000-24.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 0/35663 (0%) -/-/-/- ms 35668 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 70728   71328 pps
[1] 24.0000-25.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 24.0000-25.0000 sec 50.0 MBytes   420 Mbits/sec   0.041 ms 0/35673 (0%) -/-/-/- ms 35667 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 70737   71327 pps
[1] 25.0000-26.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 25.0000-26.0000 sec 50.0 MBytes   419 Mbits/sec   0.025 ms 0/35666 (0%) -/-/-/- ms 35667 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 70725   71328 pps
[1] 26.0000-27.0000 sec 50.0 MBytes   420 Mbits/sec 0/0   35666 pps
[*1] 26.0000-27.0000 sec 50.0 MBytes   419 Mbits/sec   0.016 ms 0/35664 (0%) -/-/-/- ms 35668 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 70734   71324 pps
[1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35661 pps
[*1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 0/35669 (0%) -/-/-/- ms 35667 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 70728   71325 pps
[1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35671 pps
[*1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec   0.030 ms 0/35666 (0%) -/-/-/- ms 35667 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 70730   71334 pps
[1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[*1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec   0.031 ms 0/35667 (0%) -/-/-/- ms 35664 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 70734   71328 pps
[1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec   0.021 ms 0/35666 (0%) -/-/-/- ms 35669 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 70728   71334 pps
[1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35661 pps
[*1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec   0.032 ms 0/35664 (0%) -/-/-/- ms 35663 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 70726   71321 pps
[1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35667 pps
[*1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 0/35663 (0%) -/-/-/- ms 35666 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 70728   71330 pps
[1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35670 pps
[*1] 33.0000-34.0000 sec 50.0 MBytes   420 Mbits/sec   0.015 ms 0/35675 (0%) -/-/-/- ms 35670 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 70741   71332 pps
[1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec   0.036 ms 2/35656 (0.0056%) -/-/-/- ms 35652 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 70713   71312 pps
[1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 35.0000-36.0000 sec 50.0 MBytes   420 Mbits/sec   0.016 ms 0/35674 (0%) -/-/-/- ms 35677 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 70740   71335 pps
[1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec   0.034 ms 0/35666 (0%) -/-/-/- ms 35665 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 70730   71330 pps
[1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[*1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 0/35670 (0%) -/-/-/- ms 35668 pps

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[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 70725   71325 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 38.0000-39.0000 sec  49.8 MBytes   418 Mbits/sec   0.011 ms 114/35659 (0.32%) -/-/-/- ms 35552 pps
[FD1] 38.0000-39.0000 sec  99.8 MBytes   838 Mbits/sec 70612   71207 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35668 (0%) -/-/-/- ms 35664 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 70616   71325 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35668 (0%) -/-/-/- ms 35665 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 70618   71331 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35665 (0%) -/-/-/- ms 35665 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 70610   71328 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 70616   71338 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec   0.043 ms 0/35663 (0%) -/-/-/- ms 35664 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 70611   71329 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35665 (0%) -/-/-/- ms 35668 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 70613   71330 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec   0.017 ms 0/35668 (0%) -/-/-/- ms 35665 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 70615   71326 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 46.0000-47.0000 sec  49.8 MBytes   417 Mbits/sec   0.019 ms 179/35667 (0.5%) -/-/-/- ms 35485 pps
[FD1] 46.0000-47.0000 sec  99.7 MBytes   837 Mbits/sec 70434   71146 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35665 (0%) -/-/-/- ms 35668 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 70436   71338 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.018 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 70433   71330 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   420 Mbits/sec   0.012 ms 0/35676 (0%) -/-/-/- ms 35670 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 70440   71325 pps
[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec   0.029 ms 0/35665 (0%) -/-/-/- ms 35665 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 70437   71319 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35670 pps
[ *1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec   0.011 ms 0/35658 (0%) -/-/-/- ms 35665 pps
[FD1] 51.0000-52.0000 sec   100 MBytes   839 Mbits/sec 70429   71331 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.023 ms 0/35668 (0%) -/-/-/- ms 35667 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 70434   71329 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   420 Mbits/sec   0.011 ms 0/35674 (0%) -/-/-/- ms 35667 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 70445   71329 pps
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[1] 54.0000-55.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[*1] 54.0000-55.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 0/35662 (0%) -/-/-/- ms 35667 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 70429   71329 pps
[1] 55.0000-56.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 55.0000-56.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 0/35666 (0%) -/-/-/- ms 35665 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 70436   71331 pps
[1] 56.0000-57.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 56.0000-57.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 14/35665 (0.039%) -/-/-/- ms 35653 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 70421   71316 pps
[1] 57.0000-58.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[*1] 57.0000-58.0000 sec 49.7 MBytes   417 Mbits/sec   0.010 ms 240/35672 (0.67%) -/-/-/- ms 35426 pps
[FD1] 57.0000-58.0000 sec 99.7 MBytes   836 Mbits/sec 70182   71082 pps
[1] 58.0000-59.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 58.0000-59.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 0/35659 (0%) -/-/-/- ms 35664 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 70179   71321 pps
[1] 59.0000-60.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 59.0000-60.0000 sec 50.0 MBytes   420 Mbits/sec   0.009 ms 0/35674 (0%) -/-/-/- ms 35671 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 70188   71333 pps
[1] 60.0000-61.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 60.0000-61.0000 sec 49.7 MBytes   417 Mbits/sec   0.016 ms 215/35661 (0.6%) -/-/-/- ms 35444 pps
[FD1] 60.0000-61.0000 sec 99.7 MBytes   836 Mbits/sec 69957   71105 pps
[1] 61.0000-62.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 61.0000-62.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35665 (0%) -/-/-/- ms 35670 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 69968   71328 pps
[1] 62.0000-63.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 62.0000-63.0000 sec 49.8 MBytes   418 Mbits/sec   0.013 ms 129/35672 (0.36%) -/-/-/- ms 35539 pps
[FD1] 62.0000-63.0000 sec 99.8 MBytes   837 Mbits/sec 69844   71201 pps
[1] 63.0000-64.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 63.0000-64.0000 sec 49.6 MBytes   416 Mbits/sec   0.038 ms 260/35665 (0.73%) -/-/-/- ms 35407 pps
[FD1] 63.0000-64.0000 sec 99.6 MBytes   836 Mbits/sec 69575   71072 pps
[1] 64.0000-65.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 64.0000-65.0000 sec 50.0 MBytes   419 Mbits/sec   0.008 ms 0/35665 (0%) -/-/-/- ms 35667 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 69575   71331 pps
[1] 65.0000-66.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 65.0000-66.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 0/35662 (0%) -/-/-/- ms 35665 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 69575   71326 pps
[1] 66.0000-67.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 66.0000-67.0000 sec 49.9 MBytes   419 Mbits/sec   0.024 ms 49/35676 (0.14%) -/-/-/- ms 35619 pps
[FD1] 66.0000-67.0000 sec 99.9 MBytes   838 Mbits/sec 69537   71276 pps
[1] 67.0000-68.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 67.0000-68.0000 sec 49.8 MBytes   418 Mbits/sec   0.027 ms 105/35660 (0.29%) -/-/-/- ms 35558 pps
[FD1] 67.0000-68.0000 sec 99.8 MBytes   838 Mbits/sec 69420   71218 pps
[1] 68.0000-69.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 68.0000-69.0000 sec 50.0 MBytes   419 Mbits/sec   0.015 ms 0/35665 (0%) -/-/-/- ms 35667 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 69419   71332 pps
[1] 69.0000-70.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[*1] 69.0000-70.0000 sec 50.0 MBytes   419 Mbits/sec   0.018 ms 0/35661 (0%) -/-/-/- ms 35664 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 69416   71329 pps
[1] 0.0000-70.0001 sec 3.42 GBytes   419 Mbits/sec 0/0   35666 pps

[1] Sent 2496613 datagrams
[*1] 0.0000-70.0003 sec 3.42 GBytes   419 Mbits/sec   0.046 ms 1909/2496611 (0.076%) -/-/-/- ms 35638 pps
[FD1] 0.0000-70.0003 sec 6.83 GBytes   839 Mbits/sec 4937732   71304 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[267381.068428] pcieport 0000:00:02.0:   [0] RxErr
[267381.073283] usb 2-1-port2: disabled by hub (EMI?), re-enabling...
[267381.073300] usb 2-1.2: USB disconnect, device number 125
[267381.347877] usb 2-1.2: new low-speed USB device number 126 using ehci-pci
[267381.464400] usb 2-1.2: New USB device found, idVendor=046d, idProduct=c077, bcdDevice=72.00
[267381.464405] usb 2-1.2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[267381.464407] usb 2-1.2: Product: USB Optical Mouse
[267381.464409] usb 2-1.2: Manufacturer: Logitech
[267381.467029] input: Logitech USB Optical Mouse as /devices/pci0000:00/0000:00:1d.0/usb2/2-1/2-1.2/2-1.2:1.0/0003:046D:C077.005D/input/input99
[267381.467125] hid-generic 0003:046D:C077.005D: input,hidraw0: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-0000:00:1d.0-1.2/input0
---- DONE -------------------------------

Test Condition control test (No ESD) with a Gore cable and FAS-pX connector. There were 3 intervals with lost packets and a total of 284 lost packets out of 2,496,606 (0.011%)

```
---- DMESG at start of run --------------
Hostname: ethertest2
[  118.157977] audit: type=1400 audit(1677249529.072:50): apparmor="DENIED"
operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=1912
comm="snap-confine" capability=38  capname="perfmon"
[  118.340053] audit: type=1326 audit(1677249529.256:51): auid=1000 uid=1000 gid=1000
ses=3 subj=snap.snapd-desktop-integration.snapd-desktop-integration pid=1999
comm="snapd-desktop-i" exe="/snap/snapd-desktop-integration/49/usr/bin/snapd-desktop-
integration" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fdc3884173d code=0x50000
[  508.244925] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[  508.245178] IPv6: ADDRCONF(NETDEV_CHANGE): enp6s0: link becomes ready
[  879.752018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 1052.360931] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 2946.940026] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 2968.612935] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 4112.256024] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 4127.048939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
---- Start IPERF TEST -------------------
------------------------------------------------------------
Client connecting to 172.17.0.1, UDP port 5001 with pid 3797 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 172.17.0.2%enp6s0 port 52514 connected with 172.17.0.1 port 5001 (full-
duplex) (no-udp-fin) (sock=3) on 2023-02-24 10:58:36 (EST)
[ ID] Interval            Transfer     Bandwidth       Write/Err  PPS
[  1] 0.0000-1.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ ID] Interval            Transfer     Bandwidth        Jitter   Lost/Total  Latency
avg/min/max/stdev PPS NetPwr
[ *1] 0.0000-1.0000 sec  49.9 MBytes   419 Mbits/sec   0.012 ms 0/35620 (0%) -/-/-/-
ms 35665 pps
[ ID] Interval       Transfer     Bandwidth    Datagrams   PPS
[FD1] 0.0000-1.0000 sec  99.9 MBytes   838 Mbits/sec 71289   71293 pps
[  1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35662 pps
[ *1] 1.0000-2.0000 sec  50.0 MBytes   419 Mbits/sec   0.035 ms 0/35661 (0%) -/-/-/-
ms 35664 pps
[FD1] 1.0000-2.0000 sec   100 MBytes   839 Mbits/sec 71325   71321 pps
[  1] 2.0000-3.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 2.0000-3.0000 sec  50.0 MBytes   420 Mbits/sec   0.012 ms 0/35675 (0%) -/-/-/-
ms 35668 pps
[FD1] 2.0000-3.0000 sec   100 MBytes   839 Mbits/sec 71341   71327 pps
[  1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 3.0000-4.0000 sec  50.0 MBytes   419 Mbits/sec   0.008 ms 0/35664 (0%) -/-/-/-
ms 35665 pps
[FD1] 3.0000-4.0000 sec   100 MBytes   839 Mbits/sec 71329   71330 pps
[  1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 4.0000-5.0000 sec  50.0 MBytes   419 Mbits/sec   0.054 ms 0/35664 (0%) -/-/-/-
ms 35667 pps
[FD1] 4.0000-5.0000 sec   100 MBytes   839 Mbits/sec 71330   71330 pps
```

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[  1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 5.0000-6.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35665 (0%) -/-/-/-
ms 35666 pps
[FD1] 5.0000-6.0000 sec   100 MBytes   839 Mbits/sec 71330   71331 pps
[  1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 6.0000-7.0000 sec  50.0 MBytes   419 Mbits/sec   0.049 ms 0/35663 (0%) -/-/-/-
ms 35666 pps
[FD1] 6.0000-7.0000 sec   100 MBytes   839 Mbits/sec 71330   71328 pps
[  1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 7.0000-8.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 32/35675 (0.09%) -/-
/-/- ms 35637 pps
[FD1] 7.0000-8.0000 sec   100 MBytes   839 Mbits/sec 71309   71297 pps
[  1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 8.0000-9.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35661 (0%) -/-/-/-
ms 35663 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 71295   71326 pps
[  1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 9.0000-10.0000 sec  50.0 MBytes   419 Mbits/sec   0.040 ms 0/35665 (0%) -/-/-/-
ms 35666 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 71299   71324 pps
[  1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 10.0000-11.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 71304   71336 pps
[  1] 11.0000-12.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35667 pps
[ *1] 11.0000-12.0000 sec  49.9 MBytes   419 Mbits/sec   0.033 ms 31/35659 (0.087%) -
/-/-/- ms 35629 pps
[FD1] 11.0000-12.0000 sec  99.9 MBytes   838 Mbits/sec 71259   71293 pps
[  1] 12.0000-13.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 12.0000-13.0000 sec  50.0 MBytes   420 Mbits/sec   0.029 ms 0/35676 (0%) -/-/-
/- ms 35670 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 71280   71330 pps
[  1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 13.0000-14.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 71268   71325 pps
[  1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ *1] 14.0000-15.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35659 (0%) -/-/-
/- ms 35662 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 71266   71331 pps
[  1] 15.0000-16.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 15.0000-16.0000 sec  49.7 MBytes   417 Mbits/sec   0.015 ms 221/35668 (0.62%) -
/-/-/- ms 35447 pps
[FD1] 15.0000-16.0000 sec  99.7 MBytes   836 Mbits/sec 71046   71109 pps
[  1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 16.0000-17.0000 sec  50.0 MBytes   419 Mbits/sec   0.045 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 71043   71325 pps
[  1] 17.0000-18.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 17.0000-18.0000 sec  50.0 MBytes   420 Mbits/sec   0.010 ms 0/35676 (0%) -/-/-
/- ms 35669 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 71057   71327 pps
[  1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35665 pps
[ *1] 18.0000-19.0000 sec  50.0 MBytes   419 Mbits/sec   0.043 ms 0/35660 (0%) -/-/-
/- ms 35662 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 71042   71325 pps
[  1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 19.0000-20.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 71046   71330 pps
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[  1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 20.0000-21.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 71049   71333 pps
[  1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 21.0000-22.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 71043   71327 pps
[  1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 22.0000-23.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35671 (0%) -/-/-
/- ms 35668 pps
[FD1] 22.0000-23.0000 sec   100 MBytes   839 Mbits/sec 71053   71331 pps
[  1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 23.0000-24.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 71047   71325 pps
[  1] 24.0000-25.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 24.0000-25.0000 sec  50.0 MBytes   420 Mbits/sec   0.010 ms 0/35676 (0%) -/-/-
/- ms 35669 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 71054   71324 pps
[  1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 25.0000-26.0000 sec  50.0 MBytes   419 Mbits/sec   0.023 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 71049   71324 pps
[  1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 26.0000-27.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 71045   71332 pps
[  1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 27.0000-28.0000 sec  50.0 MBytes   419 Mbits/sec   0.019 ms 0/35661 (0%) -/-/-
/- ms 35663 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 71041   71328 pps
[  1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 28.0000-29.0000 sec  50.0 MBytes   419 Mbits/sec   0.026 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 71048   71334 pps
[  1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35660 pps
[ *1] 29.0000-30.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35667 (0%) -/-/-
/- ms 35665 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 71047   71323 pps
[  1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35671 pps
[ *1] 30.0000-31.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35666 (0%) -/-/-
/- ms 35668 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 71049   71337 pps
[  1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 31.0000-32.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35663 (0%) -/-/-
/- ms 35665 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 71045   71329 pps
[  1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 32.0000-33.0000 sec  50.0 MBytes   419 Mbits/sec   0.039 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 71053   71323 pps
[  1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 33.0000-34.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 71046   71329 pps
[  1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35663 pps
[ *1] 34.0000-35.0000 sec  50.0 MBytes   419 Mbits/sec   0.038 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 71046   71323 pps
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[  1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35669 pps
[ *1] 35.0000-36.0000 sec  50.0 MBytes   419 Mbits/sec   0.040 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 71046   71332 pps
[  1] 36.0000-37.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 36.0000-37.0000 sec  50.0 MBytes   420 Mbits/sec   0.043 ms 0/35675 (0%) -/-/-
/- ms 35669 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 71058   71331 pps
[  1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 37.0000-38.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35664 (0%) -/-/-
/- ms 35665 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 71045   71331 pps
[  1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 38.0000-39.0000 sec  50.0 MBytes   419 Mbits/sec   0.034 ms 0/35655 (0%) -/-/-
/- ms 35662 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 71037   71321 pps
[  1] 39.0000-40.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 39.0000-40.0000 sec  50.0 MBytes   420 Mbits/sec   0.010 ms 0/35676 (0%) -/-/-
/- ms 35669 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 71058   71329 pps
[  1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 40.0000-41.0000 sec  50.0 MBytes   419 Mbits/sec   0.020 ms 0/35654 (0%) -/-/-
/- ms 35662 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 71036   71320 pps
[  1] 41.0000-42.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 41.0000-42.0000 sec  50.0 MBytes   420 Mbits/sec   0.018 ms 0/35675 (0%) -/-/-
/- ms 35668 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 71057   71326 pps
[  1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 42.0000-43.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35661 (0%) -/-/-
/- ms 35664 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 71044   71326 pps
[  1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 43.0000-44.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 71051   71331 pps
[  1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 44.0000-45.0000 sec  50.0 MBytes   419 Mbits/sec   0.033 ms 0/35668 (0%) -/-/-
/- ms 35669 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 71046   71332 pps
[  1] 45.0000-46.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 45.0000-46.0000 sec  50.0 MBytes   420 Mbits/sec   0.009 ms 0/35672 (0%) -/-/-
/- ms 35665 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 71054   71323 pps
[  1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 46.0000-47.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35664 (0%) -/-/-
/- ms 35667 pps
[FD1] 46.0000-47.0000 sec   100 MBytes   839 Mbits/sec 71047   71329 pps
[  1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 47.0000-48.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35657 (0%) -/-/-
/- ms 35660 pps
[FD1] 47.0000-48.0000 sec   100 MBytes   839 Mbits/sec 71039   71323 pps
[  1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 48.0000-49.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35669 (0%) -/-/-
/- ms 35670 pps
[FD1] 48.0000-49.0000 sec   100 MBytes   839 Mbits/sec 71049   71335 pps
[  1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 49.0000-50.0000 sec  50.0 MBytes   419 Mbits/sec   0.056 ms 0/35666 (0%) -/-/-
/- ms 35660 pps
[FD1] 49.0000-50.0000 sec   100 MBytes   839 Mbits/sec 71047   71318 pps
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[  1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 50.0000-51.0000 sec  50.0 MBytes   419 Mbits/sec   0.021 ms 0/35669 (0%) -/-/-
/- ms 35670 pps
[FD1] 50.0000-51.0000 sec   100 MBytes   839 Mbits/sec 71052   71334 pps
[  1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 51.0000-52.0000 sec  50.0 MBytes   419 Mbits/sec   0.030 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 51.0000-52.0000 sec   100 MBytes   839 Mbits/sec 71048   71323 pps
[  1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 52.0000-53.0000 sec  50.0 MBytes   419 Mbits/sec   0.046 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[FD1] 52.0000-53.0000 sec   100 MBytes   839 Mbits/sec 71048   71335 pps
[  1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 53.0000-54.0000 sec  50.0 MBytes   419 Mbits/sec   0.022 ms 0/35658 (0%) -/-/-
/- ms 35660 pps
[FD1] 53.0000-54.0000 sec   100 MBytes   839 Mbits/sec 71039   71325 pps
[  1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 54.0000-55.0000 sec  50.0 MBytes   419 Mbits/sec   0.014 ms 0/35670 (0%) -/-/-
/- ms 35671 pps
[FD1] 54.0000-55.0000 sec   100 MBytes   839 Mbits/sec 71052   71336 pps
[  1] 55.0000-56.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 55.0000-56.0000 sec  50.0 MBytes   420 Mbits/sec   0.013 ms 0/35676 (0%) -/-/-
/- ms 35668 pps
[FD1] 55.0000-56.0000 sec   100 MBytes   839 Mbits/sec 71058   71326 pps
[  1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 56.0000-57.0000 sec  50.0 MBytes   419 Mbits/sec   0.009 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 56.0000-57.0000 sec   100 MBytes   839 Mbits/sec 71043   71329 pps
[  1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 57.0000-58.0000 sec  50.0 MBytes   419 Mbits/sec   0.032 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 57.0000-58.0000 sec   100 MBytes   839 Mbits/sec 71048   71332 pps
[  1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 58.0000-59.0000 sec  50.0 MBytes   419 Mbits/sec   0.048 ms 0/35660 (0%) -/-/-
/- ms 35663 pps
[FD1] 58.0000-59.0000 sec   100 MBytes   839 Mbits/sec 71042   71326 pps
[  1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 59.0000-60.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35669 (0%) -/-/-
/- ms 35666 pps
[FD1] 59.0000-60.0000 sec   100 MBytes   839 Mbits/sec 71051   71329 pps
[  1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 60.0000-61.0000 sec  50.0 MBytes   419 Mbits/sec   0.049 ms 0/35662 (0%) -/-/-
/- ms 35664 pps
[FD1] 60.0000-61.0000 sec   100 MBytes   839 Mbits/sec 71044   71328 pps
[  1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 61.0000-62.0000 sec  50.0 MBytes   419 Mbits/sec   0.010 ms 0/35667 (0%) -/-/-
/- ms 35668 pps
[FD1] 61.0000-62.0000 sec   100 MBytes   839 Mbits/sec 71049   71333 pps
[  1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 62.0000-63.0000 sec  50.0 MBytes   419 Mbits/sec   0.012 ms 0/35671 (0%) -/-/-
/- ms 35665 pps
[FD1] 62.0000-63.0000 sec   100 MBytes   839 Mbits/sec 71052   71324 pps
[  1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 63.0000-64.0000 sec  50.0 MBytes   419 Mbits/sec   0.037 ms 0/35665 (0%) -/-/-
/- ms 35668 pps
[FD1] 63.0000-64.0000 sec   100 MBytes   839 Mbits/sec 71046   71331 pps
[  1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 64.0000-65.0000 sec  50.0 MBytes   419 Mbits/sec   0.015 ms 0/35666 (0%) -/-/-
/- ms 35667 pps
[FD1] 64.0000-65.0000 sec   100 MBytes   839 Mbits/sec 71053   71327 pps
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[  1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35664 pps
[ *1] 65.0000-66.0000 sec  50.0 MBytes   419 Mbits/sec   0.016 ms 0/35664 (0%) -/-/-
/- ms 35666 pps
[FD1] 65.0000-66.0000 sec   100 MBytes   839 Mbits/sec 71044   71327 pps
[  1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35668 pps
[ *1] 66.0000-67.0000 sec  50.0 MBytes   419 Mbits/sec   0.054 ms 0/35663 (0%) -/-/-
/- ms 35661 pps
[FD1] 66.0000-67.0000 sec   100 MBytes   839 Mbits/sec 71043   71324 pps
[  1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35661 pps
[ *1] 67.0000-68.0000 sec  50.0 MBytes   419 Mbits/sec   0.028 ms 0/35665 (0%) -/-/-
/- ms 35666 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 71045   71322 pps
[  1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35672 pps
[ *1] 68.0000-69.0000 sec  50.0 MBytes   419 Mbits/sec   0.013 ms 0/35667 (0%) -/-/-
/- ms 35669 pps
[FD1] 68.0000-69.0000 sec   100 MBytes   839 Mbits/sec 71051   71340 pps
[  1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec  0/0    35666 pps
[ *1] 69.0000-70.0000 sec  50.0 MBytes   419 Mbits/sec   0.031 ms 0/35671 (0%) -/-/-
/- ms 35664 pps
[FD1] 69.0000-70.0000 sec   100 MBytes   839 Mbits/sec 71052   71322 pps
[  1] 0.0000-70.0001 sec  3.42 GBytes   419 Mbits/sec  0/0    35666 pps
[  1] Sent 2496613 datagrams
[ *1] 0.0000-70.0012 sec  3.42 GBytes   419 Mbits/sec   0.019 ms 284/2496606 (0.011%)
-/-/-/- ms 35661 pps
[FD1] 0.0000-70.0012 sec  6.84 GBytes   839 Mbits/sec 4976935   71326 pps
---- EOF OF IPERF TEST ------------------
---- DMESG at start of run --------------
[  118.157977] audit: type=1400 audit(1677249529.072:50): apparmor="DENIED"
operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=1912
comm="snap-confine" capability=38  capname="perfmon"
[  118.340053] audit: type=1326 audit(1677249529.256:51): auid=1000 uid=1000 gid=1000
ses=3 subj=snap.snapd-desktop-integration.snapd-desktop-integration pid=1999
comm="snapd-desktop-i" exe="/snap/snapd-desktop-integration/49/usr/bin/snapd-desktop-
integration" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fdc3884173d code=0x50000
[  508.244925] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[  508.245178] IPv6: ADDRCONF(NETDEV_CHANGE): enp6s0: link becomes ready
[  879.752018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 1052.360931] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 2946.940026] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 2968.612935] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
[ 4112.256024] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[ 4127.048939] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow
Control: Rx/Tx
---- DONE -------------------------------
```

Test condition control (No ESD) with a Gore cable and FAS-X Connector plus a cable extension. iPerf detected 14 intervals with packet losses and a total of 2694 lost packets out of 2,496,613 (0.11%)

---- DMESG at start of run -------------
Hostname: ethertest2
[261753.923320] IPv6: ADDRCONF(NETDEV_CHANGE): wlx687f747712ec: link becomes ready
[261753.963906] wlx687f747712ec: Limiting TX power to 30 (30 - 0) dBm as advertised by 18:64:72:23:1a:51
[261942.100018] e1000e 0000:06:00.0 enp6s0: NIC Link is Down
[261961.772908] e1000e 0000:06:00.0 enp6s0: NIC Link is Up 1000 Mbps Full Duplex, Flow Control: Rx/Tx
[262187.216536] audit: type=1400 audit(1677511570.426:56): apparmor="DENIED" operation="capable" profile="/snap/snapd/17950/usr/lib/snapd/snap-confine" pid=9522 comm="snap-confine" capability=12 capname="net_admin"
[262187.312976] audit: type=1400 audit(1677511570.522:57): apparmor="DENIED" operation="open" profile="snap-update-ns.firefox" name="/var/lib/" pid=9548 comm="5" requested_mask="r" denied_mask="r" fsuid=0 ouid=0
[262187.313071] audit: type=1400 audit(1677511570.522:58): apparmor="DENIED" operation="open" profile="snap-update-ns.firefox" name="/var/lib/" pid=9548 comm="5" requested_mask="r" denied_mask="r" fsuid=0 ouid=0
[262187.313172] audit: type=1400 audit(1677511570.522:59): apparmor="DENIED" operation="open" profile="snap-update-ns.firefox" name="/var/lib/" pid=9548 comm="5" requested_mask="r" denied_mask="r" fsuid=0 ouid=0
[262187.313266] audit: type=1400 audit(1677511570.522:60): apparmor="DENIED" operation="open" profile="snap-update-ns.firefox" name="/var/lib/" pid=9548 comm="5" requested_mask="r" denied_mask="r" fsuid=0 ouid=0
[262189.380036] audit: type=1326 audit(1677511572.590:61): auid=1000 uid=1000 gid=1000 ses=3 subj=snap.firefox.firefox pid=9522 comm="firefox" exe="/snap/firefox/2277/usr/lib/firefox/firefox" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7f9750fbf73d code=0x50000
---- Start IPERF TEST ------------------

Client connecting to 172.17.0.1, UDP port 5001 with pid 10752 (1 flows)
TOS set to 0x0 (Nagle on)
Sending 1470 byte datagrams, IPG target: 28.04 us (kalman adjust)
UDP buffer size: 208 KByte (default)
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[1] local 172.17.0.2%enp6s0 port 37598 connected with 172.17.0.1 port 5001 (full-duplex) (no-udp-fin) (sock=3) on 2023-02-27 10:36:34 (EST)
[ID] Interval Transfer Bandwidth Jitter Lost/Total Latency avg/min/max/stdev PPS NetPwr
[*1] 0.0000-1.0000 sec 49.9 MBytes 419 Mbits/sec 0.041 ms 0/35626 (0%) -/-/-/- ms 35669 pps
[ID] Interval Transfer Bandwidth Write/Err PPS
[1] 0.0000-1.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35671 pps
[ID] Interval Transfer Bandwidth Datagrams PPS
[FD1] 0.0000-1.0000 sec 99.9 MBytes 838 Mbits/sec 71292 71302 pps
[*1] 1.0000-2.0000 sec 49.5 MBytes 415 Mbits/sec 0.044 ms 29/35323 (0.082%) -/-/-/- ms 35640 pps
[1] 1.0000-2.0000 sec 49.6 MBytes 416 Mbits/sec 0/0 35663 pps
[FD1] 1.0000-2.0000 sec 99.1 MBytes 831 Mbits/sec 70697 71217 pps
[*1] 2.0000-3.0000 sec 50.0 MBytes 419 Mbits/sec 0.017 ms 359/36010 (1%) -/-/-/- ms 35308 pps
[1] 2.0000-3.0000 sec 50.4 MBytes 423 Mbits/sec 0/0 35668 pps
[FD1] 2.0000-3.0000 sec 100 MBytes 842 Mbits/sec 71552 70892 pps
[*1] 3.0000-4.0000 sec 50.0 MBytes 420 Mbits/sec 0.039 ms 0/35674 (0%) -/-/-/- ms 35668 pps
[1] 3.0000-4.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 3.0000-4.0000 sec 100 MBytes 839 Mbits/sec 70951 71327 pps
[*1] 4.0000-5.0000 sec 50.0 MBytes 420 Mbits/sec 0.015 ms 0/35672 (0%) -/-/-/- ms 35671 pps
[1] 4.0000-5.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 4.0000-5.0000 sec 100 MBytes 839 Mbits/sec 70949 71334 pps
[*1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0.032 ms 0/35661 (0%) -/-/-/- ms 35665 pps
[1] 5.0000-6.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 5.0000-6.0000 sec 100 MBytes 839 Mbits/sec 70940 71325 pps
[*1] 6.0000-7.0000 sec 50.0 MBytes 419 Mbits/sec 0.012 ms 0/35667 (0%) -/-/-/- ms 35670 pps
[1] 6.0000-7.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 6.0000-7.0000 sec 100 MBytes 839 Mbits/sec 70944 71334 pps
[*1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0.024 ms 0/35671 (0%) -/-/-/- ms 35665 pps
[1] 7.0000-8.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 7.0000-8.0000 sec 100 MBytes 839 Mbits/sec 70949 71326 pps

[*1] 8.0000-9.0000 sec 50.0 MBytes   419 Mbits/sec   0.030 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[1] 8.0000-9.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35662 pps
[FD1] 8.0000-9.0000 sec   100 MBytes   839 Mbits/sec 70947   71326 pps
[*1] 9.0000-10.0000 sec 50.0 MBytes   420 Mbits/sec   0.013 ms 0/35672 (0%) -/-/-/- ms 35668 pps
[1] 9.0000-10.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35669 pps
[FD1] 9.0000-10.0000 sec   100 MBytes   839 Mbits/sec 70949   71330 pps
[*1] 10.0000-11.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[1] 10.0000-11.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 10.0000-11.0000 sec   100 MBytes   839 Mbits/sec 70944   71328 pps
[*1] 11.0000-12.0000 sec 50.0 MBytes   419 Mbits/sec   0.032 ms 0/35658 (0%) -/-/-/- ms 35662 pps
[1] 11.0000-12.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 11.0000-12.0000 sec   100 MBytes   839 Mbits/sec 70934   71326 pps
[*1] 12.0000-13.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 0/35671 (0%) -/-/-/- ms 35670 pps
[1] 12.0000-13.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 12.0000-13.0000 sec   100 MBytes   839 Mbits/sec 70949   71335 pps
[*1] 13.0000-14.0000 sec 50.0 MBytes   420 Mbits/sec   0.017 ms 0/35675 (0%) -/-/-/- ms 35668 pps
[1] 13.0000-14.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 13.0000-14.0000 sec   100 MBytes   839 Mbits/sec 70952   71327 pps
[*1] 14.0000-15.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 0/35668 (0%) -/-/-/- ms 35668 pps
[1] 14.0000-15.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 14.0000-15.0000 sec   100 MBytes   839 Mbits/sec 70946   71334 pps
[*1] 15.0000-16.0000 sec 50.0 MBytes   419 Mbits/sec   0.008 ms 0/35668 (0%) -/-/-/- ms 35668 pps
[1] 15.0000-16.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 15.0000-16.0000 sec   100 MBytes   839 Mbits/sec 70946   71333 pps
[*1] 16.0000-17.0000 sec 50.0 MBytes   419 Mbits/sec   0.020 ms 0/35664 (0%) -/-/-/- ms 35663 pps
[1] 16.0000-17.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 16.0000-17.0000 sec   100 MBytes   839 Mbits/sec 70941   71328 pps
[*1] 17.0000-18.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 0/35666 (0%) -/-/-/- ms 35669 pps
[1] 17.0000-18.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 17.0000-18.0000 sec   100 MBytes   839 Mbits/sec 70944   71332 pps
[*1] 18.0000-19.0000 sec 50.0 MBytes   419 Mbits/sec   0.035 ms 0/35665 (0%) -/-/-/- ms 35668 pps
[1] 18.0000-19.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 18.0000-19.0000 sec   100 MBytes   839 Mbits/sec 70942   71332 pps
[*1] 19.0000-20.0000 sec 50.0 MBytes   420 Mbits/sec   0.014 ms 0/35672 (0%) -/-/-/- ms 35666 pps
[1] 19.0000-20.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 19.0000-20.0000 sec   100 MBytes   839 Mbits/sec 70951   71328 pps
[*1] 20.0000-21.0000 sec 50.0 MBytes   419 Mbits/sec   0.012 ms 0/35661 (0%) -/-/-/- ms 35665 pps
[1] 20.0000-21.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 20.0000-21.0000 sec   100 MBytes   839 Mbits/sec 70939   71326 pps
[*1] 21.0000-22.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[1] 21.0000-22.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 21.0000-22.0000 sec   100 MBytes   839 Mbits/sec 70946   71334 pps
[*1] 22.0000-23.0000 sec 49.7 MBytes   417 Mbits/sec   0.011 ms 222/35672 (0.62%) -/-/-/- ms 35444 pps
[1] 22.0000-23.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 22.0000-23.0000 sec 99.7 MBytes   836 Mbits/sec 70731   71107 pps
[*1] 23.0000-24.0000 sec 50.0 MBytes   419 Mbits/sec   0.008 ms 0/35663 (0%) -/-/-/- ms 35669 pps
[1] 23.0000-24.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 23.0000-24.0000 sec   100 MBytes   839 Mbits/sec 70716   71332 pps
[*1] 24.0000-25.0000 sec 50.0 MBytes   419 Mbits/sec   0.039 ms 0/35667 (0%) -/-/-/- ms 35666 pps
[1] 24.0000-25.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 24.0000-25.0000 sec   100 MBytes   839 Mbits/sec 70722   71331 pps
[*1] 25.0000-26.0000 sec 50.0 MBytes   419 Mbits/sec   0.042 ms 0/35666 (0%) -/-/-/- ms 35666 pps
[1] 25.0000-26.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 25.0000-26.0000 sec   100 MBytes   839 Mbits/sec 70722   71331 pps
[*1] 26.0000-27.0000 sec 50.0 MBytes   420 Mbits/sec   0.028 ms 0/35678 (0%) -/-/-/- ms 35672 pps
[1] 26.0000-27.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 26.0000-27.0000 sec   100 MBytes   839 Mbits/sec 70734   71331 pps
[*1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec   0.028 ms 0/35664 (0%) -/-/-/- ms 35668 pps

[1] 27.0000-28.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 27.0000-28.0000 sec   100 MBytes   839 Mbits/sec 70723   71327 pps
[*1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec   0.031 ms 0/35660 (0%) -/-/-/- ms 35664 pps
[1] 28.0000-29.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35665 pps
[FD1] 28.0000-29.0000 sec   100 MBytes   839 Mbits/sec 70713   71328 pps
[*1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec   0.019 ms 0/35671 (0%) -/-/-/- ms 35669 pps
[1] 29.0000-30.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 29.0000-30.0000 sec   100 MBytes   839 Mbits/sec 70727   71333 pps
[*1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec   0.016 ms 0/35669 (0%) -/-/-/- ms 35665 pps
[1] 30.0000-31.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 30.0000-31.0000 sec   100 MBytes   839 Mbits/sec 70725   71327 pps
[*1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec   0.021 ms 0/35664 (0%) -/-/-/- ms 35667 pps
[1] 31.0000-32.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 31.0000-32.0000 sec   100 MBytes   839 Mbits/sec 70720   71330 pps
[*1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec   0.018 ms 0/35670 (0%) -/-/-/- ms 35666 pps
[1] 32.0000-33.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 32.0000-33.0000 sec   100 MBytes   839 Mbits/sec 70726   71328 pps
[*1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec   0.014 ms 0/35668 (0%) -/-/-/- ms 35670 pps
[1] 33.0000-34.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 33.0000-34.0000 sec   100 MBytes   839 Mbits/sec 70723   71335 pps
[*1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec   0.016 ms 0/35664 (0%) -/-/-/- ms 35668 pps
[1] 34.0000-35.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 34.0000-35.0000 sec   100 MBytes   839 Mbits/sec 70720   71330 pps
[*1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec   0.014 ms 0/35669 (0%) -/-/-/- ms 35668 pps
[1] 35.0000-36.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 35.0000-36.0000 sec   100 MBytes   839 Mbits/sec 70725   71334 pps
[*1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec   0.021 ms 0/35665 (0%) -/-/-/- ms 35665 pps
[1] 36.0000-37.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 36.0000-37.0000 sec   100 MBytes   839 Mbits/sec 70721   71331 pps
[*1] 37.0000-38.0000 sec 50.0 MBytes   420 Mbits/sec   0.027 ms 0/35674 (0%) -/-/-/- ms 35669 pps
[1] 37.0000-38.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 37.0000-38.0000 sec   100 MBytes   839 Mbits/sec 70729   71329 pps
[*1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 0/35668 (0%) -/-/-/- ms 35671 pps
[1] 38.0000-39.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 38.0000-39.0000 sec   100 MBytes   839 Mbits/sec 70726   71332 pps
[*1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec   0.011 ms 0/35663 (0%) -/-/-/- ms 35666 pps
[1] 39.0000-40.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 39.0000-40.0000 sec   100 MBytes   839 Mbits/sec 70717   71331 pps
[*1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec   0.009 ms 0/35667 (0%) -/-/-/- ms 35667 pps
[1] 40.0000-41.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 40.0000-41.0000 sec   100 MBytes   839 Mbits/sec 70725   71330 pps
[*1] 41.0000-42.0000 sec 50.0 MBytes   419 Mbits/sec   0.032 ms 0/35670 (0%) -/-/-/- ms 35665 pps
[1] 41.0000-42.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 41.0000-42.0000 sec   100 MBytes   839 Mbits/sec 70724   71324 pps
[*1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec   0.010 ms 0/35668 (0%) -/-/-/- ms 35673 pps
[1] 42.0000-43.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 42.0000-43.0000 sec   100 MBytes   839 Mbits/sec 70726   71332 pps
[*1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec   0.027 ms 0/35670 (0%) -/-/-/- ms 35665 pps
[1] 43.0000-44.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 43.0000-44.0000 sec   100 MBytes   839 Mbits/sec 70726   71325 pps
[*1] 44.0000-45.0000 sec 50.0 MBytes   419 Mbits/sec   0.013 ms 0/35661 (0%) -/-/-/- ms 35665 pps
[1] 44.0000-45.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 44.0000-45.0000 sec   100 MBytes   839 Mbits/sec 70715   71328 pps
[*1] 45.0000-46.0000 sec 50.0 MBytes   419 Mbits/sec   0.048 ms 0/35666 (0%) -/-/-/- ms 35669 pps
[1] 45.0000-46.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 45.0000-46.0000 sec   100 MBytes   839 Mbits/sec 70721   71333 pps
[*1] 46.0000-47.0000 sec 50.0 MBytes   420 Mbits/sec   0.014 ms 0/35673 (0%) -/-/-/- ms 35668 pps
[1] 46.0000-47.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps

[FD1] 46.0000-47.0000 sec 100 MBytes 839 Mbits/sec 70730 71330 pps
[*1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0.021 ms 0/35667 (0%) -/-/-/- ms 35670 pps
[1] 47.0000-48.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35665 pps
[FD1] 47.0000-48.0000 sec 100 MBytes 839 Mbits/sec 70726 71328 pps
[*1] 48.0000-49.0000 sec 50.0 MBytes 419 Mbits/sec 0.015 ms 0/35670 (0%) -/-/-/- ms 35665 pps
[1] 48.0000-49.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35667 pps
[FD1] 48.0000-49.0000 sec 100 MBytes 839 Mbits/sec 70724 71324 pps
[*1] 49.0000-50.0000 sec 49.9 MBytes 418 Mbits/sec 0.056 ms 92/35663 (0.26%) -/-/-/- ms 35574 pps
[1] 49.0000-50.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 49.0000-50.0000 sec 99.9 MBytes 838 Mbits/sec 70624 71240 pps
[*1] 50.0000-51.0000 sec 50.0 MBytes 420 Mbits/sec 0.026 ms 0/35673 (0%) -/-/-/- ms 35672 pps
[1] 50.0000-51.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35661 pps
[FD1] 50.0000-51.0000 sec 100 MBytes 839 Mbits/sec 70638 71329 pps
[*1] 51.0000-52.0000 sec 50.0 MBytes 419 Mbits/sec 0.010 ms 0/35662 (0%) -/-/-/- ms 35666 pps
[1] 51.0000-52.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35670 pps
[FD1] 51.0000-52.0000 sec 100 MBytes 839 Mbits/sec 70625 71335 pps
[*1] 52.0000-53.0000 sec 50.0 MBytes 420 Mbits/sec 0.010 ms 0/35674 (0%) -/-/-/- ms 35668 pps
[1] 52.0000-53.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 52.0000-53.0000 sec 100 MBytes 839 Mbits/sec 70638 71328 pps
[*1] 53.0000-54.0000 sec 49.5 MBytes 415 Mbits/sec 0.012 ms 350/35668 (0.98%) -/-/-/- ms 35318 pps
[1] 53.0000-54.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 53.0000-54.0000 sec 99.5 MBytes 835 Mbits/sec 70281 70983 pps
[*1] 54.0000-55.0000 sec 49.9 MBytes 419 Mbits/sec 0.014 ms 40/35661 (0.11%) -/-/-/- ms 35624 pps
[1] 54.0000-55.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 54.0000-55.0000 sec 99.9 MBytes 838 Mbits/sec 70236 71285 pps
[*1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0.037 ms 13/35661 (0.036%) -/-/-/- ms 35653 pps
[1] 55.0000-56.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 55.0000-56.0000 sec 100 MBytes 839 Mbits/sec 70226 71309 pps
[*1] 56.0000-57.0000 sec 49.8 MBytes 418 Mbits/sec 0.019 ms 153/35677 (0.43%) -/-/-/- ms 35518 pps
[1] 56.0000-57.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35661 pps
[FD1] 56.0000-57.0000 sec 99.8 MBytes 837 Mbits/sec 70080 71173 pps
[*1] 57.0000-58.0000 sec 49.8 MBytes 418 Mbits/sec 0.041 ms 162/35667 (0.45%) -/-/-/- ms 35505 pps
[1] 57.0000-58.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35672 pps
[FD1] 57.0000-58.0000 sec 99.8 MBytes 837 Mbits/sec 69917 71176 pps
[*1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0.042 ms 0/35668 (0%) -/-/-/- ms 35666 pps
[1] 58.0000-59.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35662 pps
[FD1] 58.0000-59.0000 sec 100 MBytes 839 Mbits/sec 69911 71327 pps
[*1] 59.0000-60.0000 sec 49.7 MBytes 417 Mbits/sec 0.009 ms 214/35665 (0.6%) -/-/-/- ms 35455 pps
[1] 59.0000-60.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35670 pps
[FD1] 59.0000-60.0000 sec 99.7 MBytes 836 Mbits/sec 69697 71125 pps
[*1] 60.0000-61.0000 sec 50.0 MBytes 420 Mbits/sec 0.020 ms 0/35673 (0%) -/-/-/- ms 35669 pps
[1] 60.0000-61.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 60.0000-61.0000 sec 100 MBytes 839 Mbits/sec 69675 71301 pps
[*1] 61.0000-62.0000 sec 50.0 MBytes 419 Mbits/sec 0.014 ms 0/35667 (0%) -/-/-/- ms 35666 pps
[1] 61.0000-62.0000 sec 50.0 MBytes 420 Mbits/sec 0/0 35666 pps
[FD1] 61.0000-62.0000 sec 100 MBytes 839 Mbits/sec 69732 71299 pps
[*1] 62.0000-63.0000 sec 49.9 MBytes 419 Mbits/sec 0.014 ms 73/35666 (0.2%) -/-/-/- ms 35593 pps
[1] 62.0000-63.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 62.0000-63.0000 sec 99.9 MBytes 838 Mbits/sec 69620 71254 pps
[*1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0.040 ms 0/35659 (0%) -/-/-/- ms 35667 pps
[1] 63.0000-64.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 63.0000-64.0000 sec 100 MBytes 839 Mbits/sec 69619 71324 pps
[*1] 64.0000-65.0000 sec 49.5 MBytes 415 Mbits/sec 0.011 ms 357/35672 (1%) -/-/-/- ms 35313 pps
[1] 64.0000-65.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 64.0000-65.0000 sec 99.5 MBytes 835 Mbits/sec 69276 70979 pps
[*1] 65.0000-66.0000 sec 50.0 MBytes 419 Mbits/sec 0.030 ms 0/35669 (0%) -/-/-/- ms 35664 pps
[1] 65.0000-66.0000 sec 50.0 MBytes 419 Mbits/sec 0/0 35666 pps
[FD1] 65.0000-66.0000 sec 100 MBytes 839 Mbits/sec 69273 71328 pps

[*1] 66.0000-67.0000 sec 49.8 MBytes   417 Mbits/sec   0.014 ms 171/35672 (0.48%) -/-/-/- ms 35501 pps
[1] 66.0000-67.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 66.0000-67.0000 sec 99.8 MBytes   837 Mbits/sec 69101   71164 pps
[*1] 67.0000-68.0000 sec 50.0 MBytes   419 Mbits/sec   0.025 ms 13/35663 (0.036%) -/-/-/- ms 35653 pps
[1] 67.0000-68.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 67.0000-68.0000 sec   100 MBytes   839 Mbits/sec 69082   71314 pps
[*1] 68.0000-69.0000 sec 49.8 MBytes   418 Mbits/sec   0.010 ms 132/35669 (0.37%) -/-/-/- ms 35536 pps
[1] 68.0000-69.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[FD1] 68.0000-69.0000 sec 99.8 MBytes   837 Mbits/sec 68953   71200 pps
[*1] 69.0000-69.9979 sec 49.5 MBytes   416 Mbits/sec   0.042 ms 314/35593 (0.88%) -/-/-/- ms 35350 pps
[*1] 0.0000-69.9979 sec 3.41 GBytes   419 Mbits/sec   0.042 ms 2694/2496613 (0.11%) -/-/-/- ms 35628 pps
[1] 69.0000-70.0000 sec 50.0 MBytes   419 Mbits/sec 0/0   35666 pps
[1] 0.0000-70.0001 sec 3.42 GBytes   419 Mbits/sec 0/0   35666 pps
[1] Sent 2496615 datagrams
[FD1] 69.0000-70.0001 sec 99.5 MBytes   834 Mbits/sec 68568   0 pps
[FD1] 0.0000-70.0001 sec 6.83 GBytes   838 Mbits/sec 4936813   71293 pps
---- EOF OF IPERF TEST -----------------
---- DMESG at start of run -------------
[262877.389257] audit: type=1400 audit(1677512260.600:81): apparmor="STATUS" operation="profile_replace" profile="unconfined" name="snap.snap-store.snap-store" pid=11064 comm="apparmor_parser"
[262877.470823] audit: type=1400 audit(1677512260.680:82): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap-update-ns.snap-store" pid=11063 comm="apparmor_parser"
[262878.139351] audit: type=1400 audit(1677512261.348:83): apparmor="STATUS" operation="profile_replace" profile="unconfined" name="snap.snap-store.ubuntu-software" pid=11068 comm="apparmor_parser"
[262878.140733] audit: type=1400 audit(1677512261.352:84): apparmor="STATUS" operation="profile_replace" profile="unconfined" name="snap.snap-store.ubuntu-software-local-file" pid=11069 comm="apparmor_parser"
[262878.996691] audit: type=1400 audit(1677512262.208:85): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap-update-ns.firefox" pid=11071 comm="apparmor_parser"
[262879.335064] audit: type=1400 audit(1677512262.544:86): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap-update-ns.snapd-desktop-integration" pid=11070 comm="apparmor_parser"
[262879.355214] audit: type=1400 audit(1677512262.564:87): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap.snapd-desktop-integration.hook.configure" pid=11074 comm="apparmor_parser"
[262879.356201] audit: type=1400 audit(1677512262.568:88): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap.snap-store.hook.configure" pid=11073 comm="apparmor_parser"
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[262879.382389] audit: type=1400 audit(1677512262.592:90): apparmor="STATUS" operation="profile_replace" info="same as current profile, skipping" profile="unconfined" name="snap.firefox.firefox" pid=11076 comm="apparmor_parser"
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14. ABSTRACT
The NASA Engineering and Safety Center (NESC) was requested to examine the performance of Ethernet in space vehicle configurations at the physical layer and develop guidance for system designers to ensure correct Ethernet operation in these systems. The objective of the assessment was to develop guidance and requirements for Ethernet cable and connectors for spaceflight environments and make recommendations for Ethernet systems used in flight-critical space applications. This report contains the results of the NESC assessment.

15. SUBJECT TERMS
Ethernet; Cables; Connectors; NASA Engineering and Safety Center

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