MARINE ENVIRONMENT COPPER CABLING SOLUTIONS

Introduction

Panduit is a leading supplier of networking infrastructure solutions. These solutions find extensive use in the enterprise, supporting Ethernet communications at ever increasing data rates. The deployment of these solutions into environmentally rigorous applications such as shipping and offshore platforms brings additional considerations that must be factored into the overall offered solution.

Panduit is cognizant of the rigorous performance requirements for structured cabling used in marine applications. This Technology Brief seeks to identify some of the considerations that have been made to support the choice of cabling and connectivity for high data rate marine applications. Specifically, this brief discusses 10GBASE-T cabling solution options for marine applications and explains why the PSM7004 type cable is recommended for use in the horizontal cabling links in marine environments.

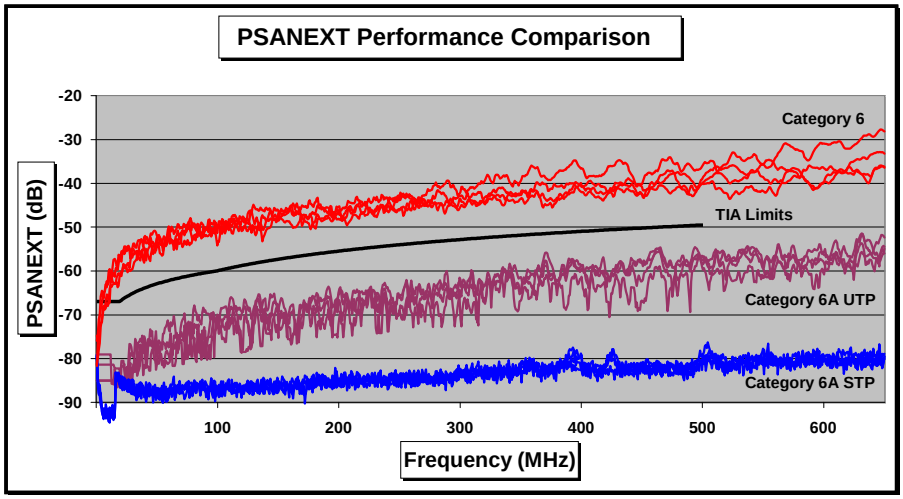
The Panduit Category 7 marine environment S/FTP cable (part number PSM7004IG-KED) and Panduit Mini-Com® TX6A ™ 10Gig™ Shielded Jack Modules provide an extremely high performance structured cabling solution fully meeting and exceeding the performance requirements called for in 10GBASE-T applications and offering superb shielding performance for effective mitigation of unwanted electromagnetic interference (EMI). In addition, the cabling system is fully designed to meet the stringent marine board certification requirements invoked in the shipping industry. The channels will fully meet the requirements of ANSI/TIA-568-C.2 Category 6A channel performance and IEC/ISO 11801 Edition 2.1, 2008 Class E_A channel performance.

Alien Crosstalk

In 10GBASE-T applications, the noise source that most limits the ability to transmit 10 GbE over copper cabling is alien crosstalk. Because the 10GBASE-T receiver cannot detect and compensate for noise from adjacent channels, this effect must be suppressed within the cabling system to ensure reliable data transmission. This noise is measured as Power Sum Alien Near-End Crosstalk (PSANEXT) and as Power Sum Alien Attenuation to Crosstalk Ratio at the Far-End (PSAACRF).

In Category 6A UTP cabling, Panduit Laboratories designed innovative features to reduce alien crosstalk into both the cable, such as increased separation between cables and tighter twist rates; and the connectors, such as crosstalk suppression within the printed circuit boards. These enhancements help the system comply with TIA/EIA standard PSANEXT and PSAACRF specifications for achieving 100 meters reach. A Category 6 UTP system that does not incorporate the improvements of Augmented Category 6 will not meet the alien crosstalk limits required for 100 meters of 10GBASE-T transmission (see Figure 1).

Figure 1. 100-Meter Channel PSANEXT Performance Characteristics



For properly installed and bonded STP cabling, foil screens within the cable prevent signals from coupling, which reduces alien crosstalk well below required performance levels. This impact is similar whether the cable is comprised of individual shields around each pair, as in U/FTP and S/STP cables, or of a single foil around all pairs, as in F/UTP cables. Testing performed by Panduit Laboratories indicates that STP cabling systems provide significant margin over the IEEE 802.3an-2006 specifications for 10GBASE-T PSANEXT (see Figure 1) and PSAACRF, resulting in enhanced alien crosstalk performance. Due to the increased suppression of ANEXT and AACRF by STP cable, the need for cumbersome and time-consuming field-testing of alien crosstalk is eliminated.

Shielded Cable

When choosing a shielded cable type, there are several different options to consider. The diagrams below show the three major categories of shielded cables.

- Screened unshielded twisted pair cable includes an overall foil around the pairs
- Shielded twisted pair cable includes a shield around each individual pair
- Screened shielded twisted pair cable includes an overall shield, or braid, around all pairs with an additional foil around each individual shield

Each of these cables offers benefits and drawbacks. Cable designs that include a single foil around all pairs, such as F/UTP, sufficiently reduce alien crosstalk between cables in a channel, although Panduit Laboratories has found that the influence of the overall shield makes it more difficult to meet internal performance requirements as frequencies increase with higher bandwidth requirements.

Figure 2. Shielded Cable Types

Alien Crosstalk Performance

With a U/FTP cable design, each individual pair includes a shield. This design provides superior Alien NEXT performance, internal NEXT, ELFEXT and Return Loss, as there is no source of crosstalk between pairs since the pairs are individually shielded. U/FTP typically costs more than F/UTP cable due to the individually shielded pairs.

An S/FTP cable design incorporates a single foil/braid around all pairs and an additional foil around each individual pair(s). This design also delivers superior Alien NEXT performance and offers the benefit of superior structural integrity; reduced low frequency external interference to ensure exceptional cable performance at all swept frequency levels. This cable is typically slightly larger in diameter to allow for the dual shields, resulting in slightly more difficult cable termination and cable management.

EMI and RFI Performance

In addition to providing superior alien crosstalk performance, shielded copper cabling is excellent at suppressing electromagnetic interference (EMI) and radio frequency interference (RFI). EMI/RFI can degrade network performance and can emanate from common devices such as high power ship-to-shore transmitters, electrical machinery, fluorescent lighting fixtures, cellular phones, and a variety of other sources. A properly grounded STP cabling system gives a high level of immunity against EMI/RFI emissions and should be used in noisy environments or locations where equipment is particularly sensitive to EMI. The use of S/FTP cable with shielding both around each pair of conductors and around the overall four pairs ensures the highest degree of protection in an uncertain EMI environment.

Marine Environment Cabling

Panduit has examined closely the demands of the environments encountered in these types of applications, and how these can be best addressed by a particular cabling solution. Based on this research, Panduit has identified the following additional factors which must be taken into account when deploying structured cabling systems in marine environments:

1. A typical cable installation in the ship or marine application will often follow a particular deployment. In the case of a cabling run from a switch port to a work station located at a remote point from the main data center processing area on the vessel, the cabling channel will comprise typically a patch cord leading from the switch to a patch panel arrangement in a relatively benign, essentially office type environment. The horizontal run of cable will lead from the patch panel to a remote cross connect (Intermediate Distribution Frame, or IDF). The work station will be connected to the patch panel within the IDF. The work station, also, is usually deployed in a relatively benign office type environment. The horizontal cable will often run through areas that are much less environmentally controlled. The cable by necessity of standards organizations such as the American Bureau of Shipping (ABS), Det Norske Veritas (DNV), etc. must satisfy rigorous flame propagation and smoke generation requirements, and the cabling jacket must meet stringent fire resistant standards.

2. There is a very high risk of corrosion of cabling conductors and connections due to the presence of moist or wet conditions combined with salt, which are inevitable in marine environments. Even though horizontal cabling may be used in areas that are much less environmentally controlled than office-type environments, the use of a durable externally rated jacket on the cabling effectively prevents corrosion problems from arising. Areas where conductors are exposed (for example in the jacks and plugs used in patch panels and patch cords, respectively) normally are located in environmentally controlled areas so that corrosion risks are mitigated.

   Particular attention must be paid, however, to the way the cabling is brought into the climate controlled areas; this typically is addressed by using a well designed and installed cable transit in the bulkhead separating the different environments. It is also recommended that thorough visual examination of the cabling be performed after the installation process. If the jacket is penetrated, this could give a path for moisture to ingress into the cabling. This could give rise to corrosion risks on the conductors, or even create an opportunity for moisture to wick along the cabling between the inside of the jacket and the conductors to an area where there are exposed conductors, such as at the connection of the cabling to the jack.

3. The same areas that are of consideration in the flame propagation and smoke generation are also those areas where the cabling can more frequently be exposed to diesel oil and gasoline. For that reason, Panduit cabling offered for the marine applications are tested and specified to meet requirements for oil and gasoline exposure.

4. Vibration in marine environments has been recognized by organizations assuring safety of personnel and equipment at sea, such as the American Bureau of Shipping. Cables and wires are discussed in the ABS Rules for Building and Classing Mobile Offshore Drilling Units, and Part 4, Chapter 3, Section 4, Sub-heading 13 entitled ‘Cables and Wire’ specifically calls out the requirement that conductors are to be copper and stranded in all sizes. It is recognized that the vibration performance of multi-stranded conductors are superior to those of solid conductor types.

Cabling Deployment with Cable Transits

Deployment of cabling in shipboard applications will frequently require the cable to be passed through rigid metallic bulkheads that are used in modern day, multi-compartment floating vessels. The way that the cabling is passed through the bulkhead is of particular concern for aspects such as flame and smoke propagation, preservation of the integrity of the compartment and resistance, and EMI performance. The most common approach to securing the cable through the bulkhead is to employ a high performance cable transit. The transit is essentially a bushing that fits securely, yet without deforming the cable and is capable of being attached into an aperture cut in the bulkhead. Leading suppliers of cable transit solutions will supply a plate that can be rigidly attached to the bulkhead together with transit inserts that can be configured to support the particular cabling being passed through the bulkhead.

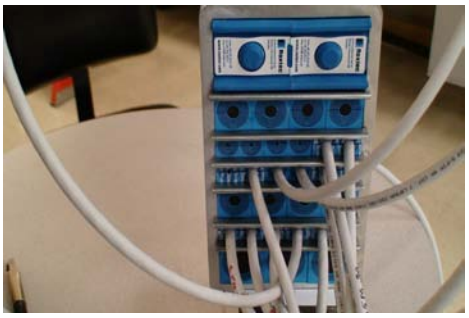


Figure 3a. Test set-up showing shielded copper cabling passing through cable transits.

A comprehensive test program was devised and carried out to demonstrate that in a correctly installed system, that there is no significant effect on cabling performance when installing the cable transits around the cabling. The conclusion is supported by a series of measured plots taken before installation of the cable transits and after installation of the cable transits.

The top of Figure 3 shows at the top, the test set-up showing the TX7000 ™ Shielded Copper Cabling passing through the cable transits. For completeness, a combination of standard transits as well as transits capable of being bonded to the cabling outer shield for superior EMI performance was tested.

The bottom of Figure 3 shows one plot of the Near End Cross-Talk (NEXT) of a 50 meter permanent link measured both before installation and after installing into the transits. No discernible performance change is observed.

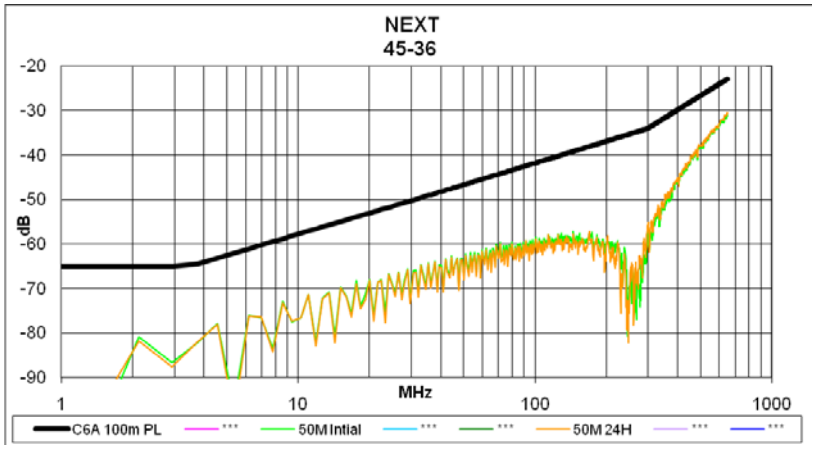


Figure 3b. Comparison of NEXT for the 50m permanent link before and after installation of the cabling into cable transits.

Diameter Comparison

In installations involving a large number of switch ports, the diameter of the cable can become an important concern. A large number of cables can pose serious problems with managing the cable bundles with the space allocated for cabling within the equipment cabinets, and even in the cabling pathways which are installed either under-floor or overhead in the enterprise, but generally in the marine environment will be overhead.

The diameter of the Panduit 10 Gigabit UTP cabling is one of the smallest in the data communications industry. This cable leads to a variety of advantages in the real-life deployment. Cable routing and management within the cabinet and pathway become an easier proposition. The reduced size of the cable bundle reduces the overall envelope of cabling, reduces the blocking of air flow and consequently improves equipment efficiency and reliability. The diameter of Panduit TX6A™ 10Gig ™ UTP Copper Cable ranges between 7.5 and 7.9 mm nominal depending upon which jacket type is used (e.g. plenum, riser, low smoke zero halogen, etc).

By contrast, the nominal diameter of the Category 7 cabling that will be used for marine environments is 8.1 mm, only slightly larger than the UTP solution. This small diameter cable can be expected to give the same benefits in high density deployments as other small diameter cable types. At first sight, it may be surprising that the diameters of the UTP and S/FTP cables are so similar. After all, the S/FTP employs foil over each of the pairs and an overall braid screen which would be expected to increase the diameter. This apparent dichotomy is resolved when it is remembered that the UTP cabling employs a cross web that separates each of the twisted pairs by a small amount allowing cross talk specifications to be met, and the inclusion of this cross web increases the diameter slightly in the UTP case.

Because of the foil shield, the cross web is not required in the S/FTP cabling case. Because of the shielding, both the foil and the overall braid, used in the STP cabling, the cross-talk both within the cable and Alien cross-talk performance is superb ensuring that data transmission performance will be met in the rigorous environments encountered in most shipboard applications.

Termination and Installation

Although STP cabling systems have superior alien crosstalk and EMI/RFI suppression, installers, contractors, and IT managers may not be familiar with proper termination and installation of STP cabling. Installation time may take longer for STP cabling over UTP.

For the Panduit termination methodology, both UTP and STP jack modules are identical, except for cable preparation. As shown in the photograph in Figure 3 below, the braid conductors in an S/FTP cable which is used for the Panduit PSM7004IG-KED copper cable must be pulled back over the exterior of the cable end prior to terminating in order to make a continuous connection for effective

grounding. On each of the twisted pairs of conductors, the foils need to be peeled back and unused foils trimmed. On average, it takes approximately 50 seconds more time to terminate a Panduit STP Jack Module over an UTP Jack Module for S/FTP cable.

Figure 3. Cable preparation for termination of Panduit TX6A™ 10Gig™ Shielded Copper Cabling System

Panduit recommends that shielded jack modules are used to terminate the shielded marine cabling. Use of shielded modules allows proper and effective grounding and bonding of the cable braid screen, providing optimal shielding performance, reducing the effects of unwanted electromagnetic interference and Alien cross-talk. The improvement in performance outweighs the slightly longer time for installation. In addition, the testing of Alien performance is not required. This not only saves time, but also eliminates the need to provide additional installation training to carry out Alien Crosstalk testing. Since these test procedures have really only been recently introduced, many installers may not be familiar with them. In addition, there is further capital costs savings since the test instruments required to perform the Alien cross-talk tests in the field are not required.

Bonding and Grounding Requirements

It is essential to implement proper structured grounding processes in order to protect personnel and expensive equipment. The overall integrity of the bonding and grounding system in the facility must be sound in order to realize the full performance benefits of the system. Panduit can provide assistance to ensure proper bonding and grounding for STP and UTP installations.

For UTP systems, cabling connectivity does not require complete system bonding, but careful attention must be given to the integrity of the grounding of the patch panels and racks to the common grounding point in order to protect the infrastructure. For STP systems, the additional step of bonding cable to the connectivity components is essential to ensure proper performance. The Panduit TX6A™ 10Gig™ Shielded Copper Cabling System has been designed for consistent seamless bonding when used with the Panduit StructuredGround™ Grounding Solutions. The components essentially are self-grounding with minimal additional cost.

The Importance of Proper Grounding for STP Cabling Systems

For 10GBASE-T data transmission, an STP cabling system has some key electrical characteristics to consider when planning a new installation for 10 GbE traffic. When using an STP cabling system, attention needs to be given to the implementation of the power and grounding system that the copper data cable system resides in. If the power or cabling system is not properly designed and/or installed, transients or an electrical potential difference could result in a spike or ground loop, which would likely cause data rate errors. Since 10GBASE-T applications are very sensitive to noise, potential differences in electrical grounds can cause bit-error-rates high enough to effect 10 GbE traffic. Therefore, up front design and installation are very important for the power and grounding system to ensure data rate integrity. If there are data transmission issues within a STP cabling data network, an audit should be performed to check for proper bonding and grounding as well as the overall design of the power and ground system.

The Panduit Laboratories recommendation for bonding a cabling solution is provided in Figure 4 below. In summary:

Step1. Cable preparation and termination to jack module

- Remove outer cable jacket and prepare foil, braid, or drain wire to be bonded to the jack module
- Establish a metal-to-metal bond between the shielded cable and shielded jack module (360 degree conductive cover offers the best protection)

Step 2. Bond the jack module to the patch panel

- Establish metal-to-metal contact points between the jack module and the patch panel
- Alternatively, establish a metal-to-metal bond between the jack module and the rack/cabinet with wire straps

Step 3. Bond the patch panel to the rack/cabinet

- Establish metal-to-metal contact points between the patch panel and rack
- Since most patch panels and/or racks are powered painted, thread-forming screws should be used to remove paint from the thread holes of the equipment mounting rails as it is installed. The screw heads or washers should also have serrations to remove paint from the patch panel during installation

Step 4. Bond the rack/cabinet to the common bonding network

- Rack rails of rack or cabinet are to be bonded to the ground structure on that floor through the main grounding bar or via a mesh common bonding network (MCBN)
- It is not recommended to "daisy-chain" racks together with bonding straps as it creates a single point of failure for an entire lineup and it routes currents directly through racks

In addition to properly bonding and grounding the structured cabling system, it is also important to construct the equipment-bonding network to minimize any electrical potential differences. Recommendations include:

- Bonding equipment to racks/cabinets
- Bonding each rack/cabinet to the telecommunications main grounding busbar-TMGB (may be done via a mesh common bonding network)
- Bonding the TMGB to the serving electrical panel in the room

A frequently asked question is whether the installer should bond one-end or both-ends of a cable link. When both-ends of the link are bonded, there is the potential for a ground current loop if there is an electrical potential ground difference between the two ends of the channel (i.e., having the cable shield be the only metallic connection between different AC power services). However, with only one-end of a cable link bonded, the risk of a ground current loop is eliminated. The benefit though of bonding both-ends of the link is increased levels of protection against external Alien NEXT, EMI, and RFI noises.

Therefore, to ensure maximum electrical performance in data center and telecommunication room applications, Panduit Laboratories recommends that both-ends of the cable link be bonded provided:

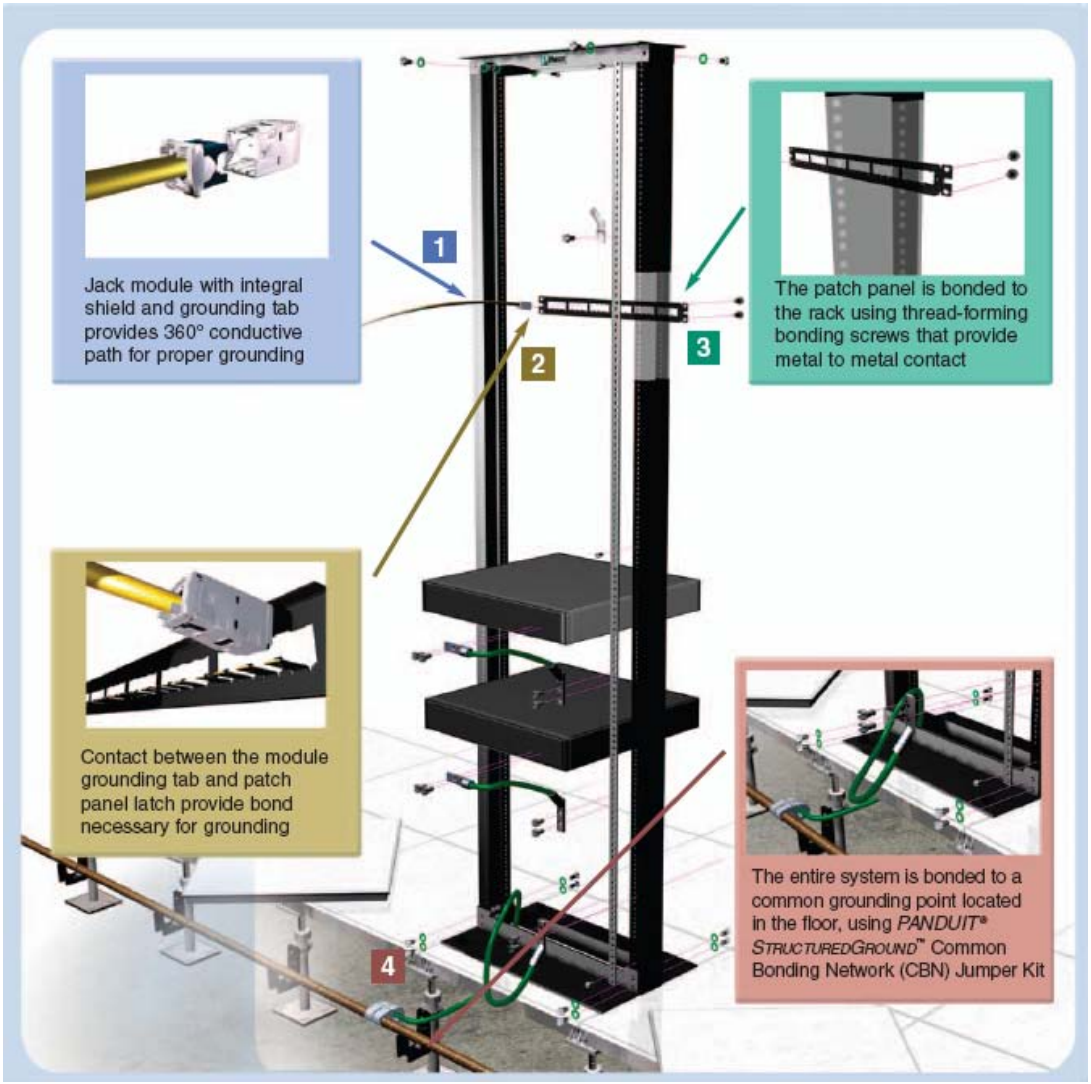
- Any multiple serving AC power systems are intersystem bonded to reduce any ground voltage differences (as required by the NEC)
- Shielded cable channels are contained in the same building

For workstation applications, it is recommended that the cable link be bonded only through the normal process in the telecommunication room and through the patch cord at the workstation, which provides the proper path to ground via the computer's AC power plug.

Economics

To make UTP cabling components 10GBASE-T compliant, several robust design features such as filler material, larger cable, sophisticated twists and strand schemes have been incorporated into the solution. These enhanced cable design features have made the cost delta between an UTP and STP

Figure 4. Panduit Seamless 4-Step Bonding Process



10GBASE-T cabling system close to parity (pricing differences depend on the cable flame rating and the particular network channel configuration).

During installation, an STP solution will take longer to terminate jack modules and properly bond the structured cabling system. Therefore, it is expected that installation costs will add a little more to overall installed cost. On the other hand, the overall installed cost savings of a UTP cabling system will depend on the percentage of field-testing for alien crosstalk required by the end-user, which can take anywhere from 20 to 40 minutes per link.

Summary

The deployment of structured cabling in marine applications places additional demands on the cabling that can be most satisfactorily addressed by deployment of high performance S/FTP marine environment Category 7 cabling.

The main advantage of using a STP cabling system is the dramatic suppression of alien crosstalk and mitigation of unwanted and damaging EMI interference effects. The containment of this noise in consideration of alien crosstalk helps ensure better signal integrity than can be achieved with a UTP cabling system.

The advantages of the Panduit Category 7 shielded S/FTP cabling system together with shielded Category 6A connectivity results in a 10 Gb/s high performance cabling infrastructure that will withstand the rigors of the harsh environments encountered in marine and other offshore applications while conforming to certification requirements required by the world's leading marine certification bodies. The reasoning behind the advantages explained in this Technology Brief identify how Panduit understands the harsh and often unpredictable environments into which the 10 Gb/s cabling infrastructure is installed, and demonstrates how performance, quality and reliability will be met.

About Panduit

Panduit is a world-class developer and provider of leading-edge solutions that help customers optimize the physical infrastructure through simplification, increased agility and operational efficiency. Panduit's Unified Physical Infrastructure (UPI) based solutions give Enterprises the capabilities to connect, manage and automate communications, computing, power, control and security systems for a smarter, unified business foundation. Panduit provides flexible, end-to-end solutions tailored by application and industry to drive performance, operational and financial advantages. Panduit's global manufacturing, logistics, and e-commerce capabilities along with a global network of distribution partners help customers reduce supply chain risk. Strong technology relationships with industry leading systems vendors and an engaged partner ecosystem of consultants, integrators and contractors together with its global staff and unmatched service and support make Panduit a valuable and trusted partner.

www.panduit.com · cs@panduit.com · 800-777-3300