



Next-Generation High-Speed Transport Systems for Data Center and Enterprise Networking

**Category 6A UTP Cabling System Delivers Reliable 10 Gb/s Performance
with Improved Space Savings, Power Efficiency, Thermal Management**

WHITE PAPER

Research by PANDUIT Laboratories continues to address cabling technology and deliver comprehensive networking solutions for markets from finance and health care to government and education. The latest PANDUIT achievement is a smaller diameter Category 6A unshielded twisted pair cable that conserves valuable pathway real estate while exceeding TIA/EIA and ISO 10 Gb/s performance standards.

Introduction

The deployment of Category 6A copper cabling system has been increasing rapidly as enterprises enable their physical infrastructure with 10 Gb/s capacity to support Data Center server virtualization, I/O consolidation, switch-up links for parallel processing, and convergence of back-bone links applications. While the use of Category 6A cabling has been growing significantly, a number of deployment challenges remain which impede broad market acceptance of Category 6A cabling systems.

These challenges include larger, heavier cables that are difficult to manage, restrict proper air flow in pathway spaces, and add additional stress to the infrastructure due to their added weight. End-users also have questions regarding the overall robustness and reliability of Category 6A cabling systems: can these systems provide alien crosstalk performance beyond industry requirements, support both short and long links, be co-mingled with other copper category cables, and support Power over Ethernet (PoE) applications?

This white paper discusses how the next-generation *PANDUIT® TX6A™ 10GiG™* UTP Copper Cabling System utilizes innovative cable matrix tape technology and advanced connector compensation techniques to yield revolutionary channel performance. The next-generation UTP cabling system addresses these concerns by offering:

- **Enhanced performance:** The system delivers significant margin on all Category 6A electrical parameters with improved alien crosstalk performance, while being unaffected by cable phasing effects. These improvements eliminate the need for burdensome alien crosstalk testing and provide network stakeholders with the confidence the system is reliably achieving the advertised 10 Gb/s performance.
- **Increased data center flexibility:** The system supports both long (100 m) four-connector channel configurations and short (3 m) two-connector permanent link configurations to support a wide range of data center architectures and applications. This innovative system allows for co-mingling with Category 5e and 6 cables, while providing a clear migration path from 1000BASE-T to 10GBASE-T applications.
- **Improved space savings, thermal management:** The lighter, smaller-diameter Category 6A cable enables efficient use of pathway spaces for improved airflow through racks and cabinets. Furthermore, the system supports advanced PoE applications at extended operating temperatures.

The Challenge of Achieving Reliable 10 Gb/s Performance over UTP

The TIA/EIA-568-B.2-10 and ISO 11801 standards define Category 6A copper cabling systems to support 10GBASE-T transmissions. To allow designers to achieve compliance with 10GBASE-T guidelines, the standard bodies increased the allowable cable diameter beyond that of Category 6 (0.250 inch) up to 0.354 inch. Initially, vendors took full advantage of this allowable diameter to increase pair twist, incorporate filler materials or thick cable jackets to help keep signals from coupling between cables (especially alien crosstalk). As a result, it has been necessary for current adopters of Category 6A technologies to work with cabling vendors and integrators to overcome installation and management challenges associated with thicker cable designs.

Another challenge to achieving 10GBASE-T standards compliance is associated with meeting bandwidth specifications. Per the IEEE 802.3an standard, the usable bandwidth required to achieve 10 Gb/s data rates is beyond 400 MHz. Active equipment vendors achieved this high bandwidth level in part by the use of Digital Signaling Processing (DSP) technology in active semiconductor chips to suppress internal cable channel noise (PSNEXT, PSFEXT and RL) through compensation techniques. However, this noise filtering technology requires power to operate the active electronics in the switches and servers, driving up both system power and cooling costs.

Various Category 6A cable designs have emerged into the marketplace to address cable management and system performance challenges. However, these new designs sacrifice electrical performance in exchange for a smaller cable size and introduce cable systems with little or no margin on alien crosstalk. The next evolutionary design step is a Category 6A solution that meets industry demand for improved UTP performance at a smaller diameter.

PANDUIT Next-Generation Category 6A UTP Cabling System

The **PANDUIT**® **TX6A**™ **10GiG**™ UTP Copper Cabling System offers an innovative cable design and advanced connector compensation techniques to improve pathway capacity up to 30% without compromising alien crosstalk performance.

PANDUIT Laboratories has incorporated a patent pending, revolutionary technology into its Category 6A UTP horizontal copper cable addressing the need for a smaller diameter cable while simultaneously exceeding alien crosstalk specifications and improving system robustness in terms of signal to noise ratio (SNR) and channel bandwidth.

The end-to-end system has been engineered to enable long and short cable channels, meet the requirements of the highest density data center applications, operate in advanced PoE applications, and allow for the co-mingling of other category cables. The key to this technology is a tape placed directly beneath the outer jacket on which small, discontinuous metallic elements are positioned in a matrix pattern (see Figure 1). The innovative matrix tape technology suppresses both electric and magnetic coupling between adjacent cables while reducing Category 6A UTP cable cross section area by nearly 20%. This new cable design also incorporates a barrier film beneath the matrix tape which improves overall attenuation performance of the cable while minimizing coupling between the twisted pairs and tape.

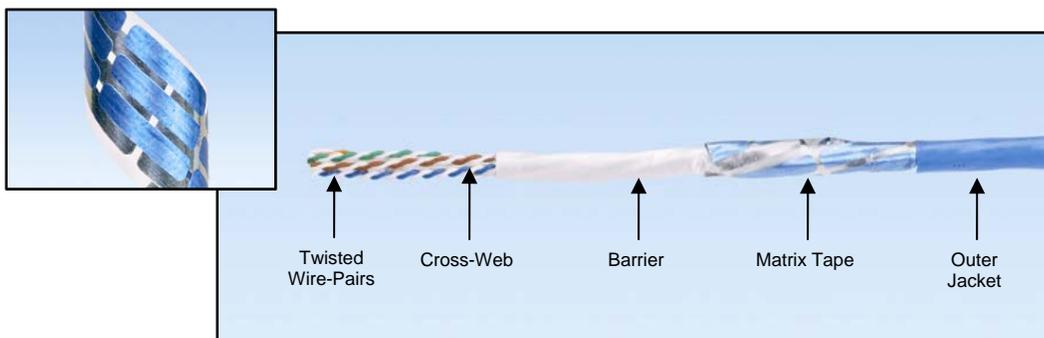


Figure 1. PANDUIT® **TX6A**™ Category 6A cable with matrix tape (inset) and barrier film exposed.

As part of the end-to-end TX6A™ Category 6A system, PANDUIT Laboratories has developed a next-generation Category 6A connector using patented electrical compensation technology in the areas of noise reduction, common mode rejection and impedance matching. The connector utilizes foil technology for superior alien crosstalk performance to enable the highest density installation (see Figure 2).

Furthermore, matrix tape technology has been incorporated into Category 6A UTP stranded patch cords to provide exceptional alien crosstalk and signal attenuation performance. This feature enables compliant UTP Category 6A patch cords with 24 AWG stranded conductors for added flexibility, improved patch cord fill capacity, and easier cable routing.

The complete system yields leading edge overall channel performance in the highest density structured cabling environments (48-ports in a 1RU space). The improved channel margin provides superior channel bandwidth performance (see Figure 3) and a significant improvement in SNR, reducing the need for DSP technology to filter noise. This results in reduced power draw in servers and switches for increased power efficiency and overall system cost savings.

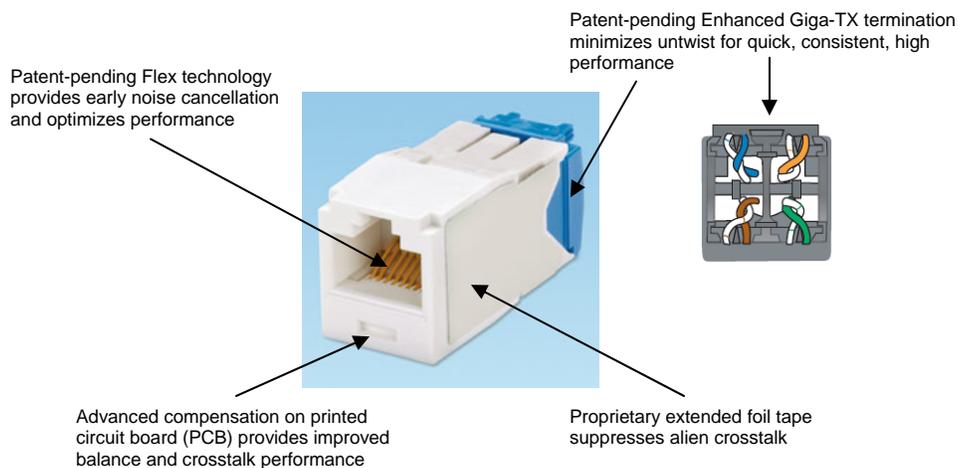


Figure 2. PANDUIT® TX6A™ Category 6A connectors deliver superior electrical performance at high frequency levels (>300 MHz) for reliable 10 Gb/s channel performance in highest density applications.

Leading Edge Channel Alien Crosstalk Performance

The most important electrical requirement of a 10GBASE-T cabling system is its alien crosstalk performance. Alien crosstalk is identified in the standards as both Power Sum Alien Attenuation Crosstalk Ratio at Far End (PSAACRF) and Power Sum Alien Near End Crosstalk (PSANEXT). The amount of PSAACRF and PSANEXT margin above the standard requirements determines the effectiveness of a Category 6A cabling system. PSAACRF and PSANEXT are equally important because together they determine the full contribution of alien crosstalk along the entire length of the channel.

Advanced DSP technology is effective at maximizing the internal bandwidth of a structured cabling system by providing significant noise cancellation for noise sources generated within the cable itself. However, PSANEXT and PSAACRF are noise sources that are generated due to signal coupling from adjacent cables, and the ability of DSP technology to suppress alien crosstalk is limited due to the random and unpredictable nature of the external noise source. Hence, the burden is on the structured cabling system to minimize alien crosstalk.

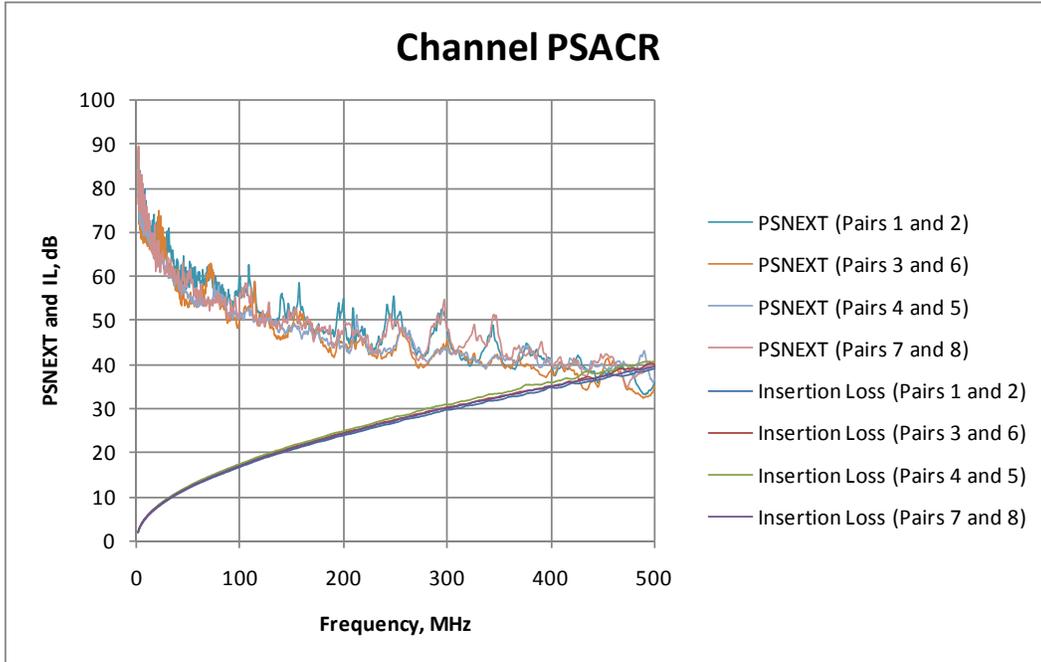


Figure 3. The *PANDUIT® TX6A™* Category 6A System provides more than 200 MHz channel bandwidth beyond 10GBASE-T standard requirements.

With innovative matrix tape technology positioned beneath the cable jacket and advanced compensation techniques designed into connectors, the *PANDUIT® TX6A™ 10GIG™* UTP Copper Cabling System provides alien crosstalk channel performance (PSANEXT and PSAACRF) that is superior to traditional UTP solutions (see Figure 4). These features enable network stakeholders to design and deploy 10 Gb/s UTP channels which achieve electrical performance levels approaching those of shielded cabling solutions without the time and cost associated with deploying a shielded system.

Having ample PSANEXT and PSAACRF headroom is extremely important as field-testing of 10 Gb/s performance over twisted-pair cabling presents a challenge in terms of complexity and time. *PANDUIT* Laboratories conservatively estimated that it takes approximately 15 minutes to measure 96 pair-to-pair crosstalk combinations between one target cable and six disturbing cables and then calculate PSANEXT and PSAACRF under optimal field conditions. Therefore, for a 24-cable bundle, the time to test one target link against all 23 disturber cables would be at least 60 minutes, and the time to test an entire 24-port patch panel would be close to 24 hours.

Labor costs also can climb due to any extra time required to correctly identify the cables to be tested. Even with well-labeled cabling, it takes time for field technicians to identify the right cables to be tested in bundles of 12 to 24, and poorly-labeled cabling adds to the potential for human error. Clearly, for installations comprised of hundreds or thousands of links, testing every cable in every bundle is an unacceptable strain on time and budget.

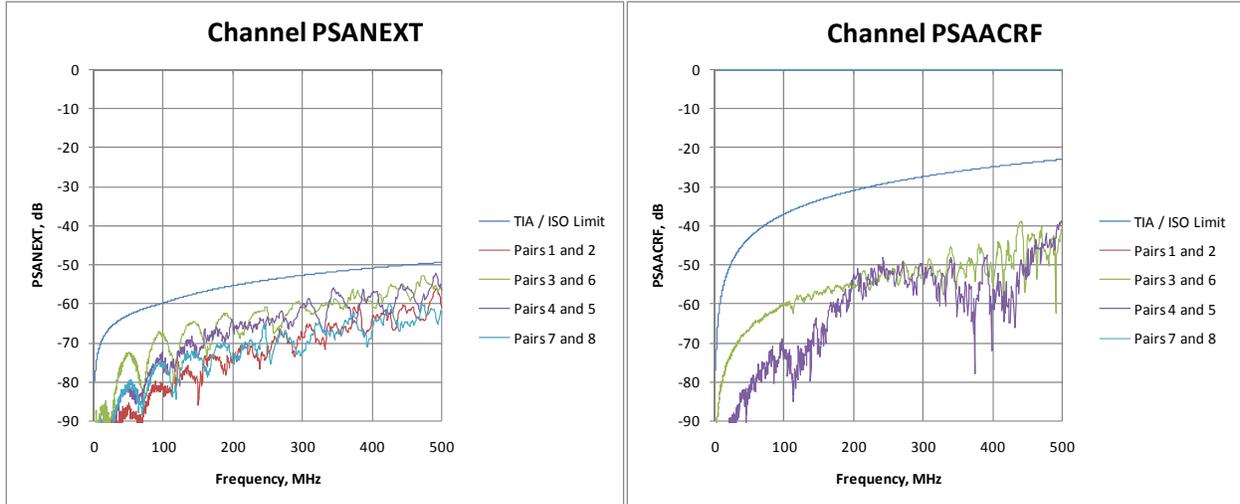


Figure 4. The PANDUIT® TX6A™ Category 6A System provides ample margin beyond 10GBASE-T standard requirements for PSAACRF and PSANEXT.

An additional yet key performance benefit of next-generation PANDUIT® TX6A™ 10Gig™ UTP Copper Cabling System is that the cable design makes it immune to electrical phasing effects. In most Category 6A UTP cable installations, alien crosstalk performance will vary based on small changes of the longitudinal alignment (or phasing) of between adjacent cables within a bundle or in a cable tray. These phasing effects can be significant even if cables are skewed by a very small amount (less than an inch), causing alien crosstalk performance to vary with moves, adds, and changes that occur in a data center. However, the barrier and matrix tape provide protection against cable phasing effects, drastically reducing signal coupling between cables and eliminating the impact of phasing on system performance.

Improved Electro-Magnetic Immunity and Emission Performance

Overcoming signal interference from electro-magnetic noise can be as challenging as overcoming alien crosstalk because it too cannot be compensated for by DSP technologies. The two parameters generally control the electro-magnetic performance in copper cabling systems: the balance of the cabling system (differential mode to common mode or vice-versa) and the amount of common mode energy (either absorbed or ready to radiate) within the system. The magnitudes of these parameters usually depend upon the construction of the Category 6A cable and connector used.

With PANDUIT's next-generation Category 6A matrix tape technology, the discontinuous metallic elements positioned on the tape attenuate the electromagnetic field that emanates from the cable. Since the metallic elements are not connected, cables are incapable of supporting a longitudinal current and hence resist electromagnetic interference at the same level as conventional UTP cables. Test results indicate that next-generation PANDUIT next-generation Category 6A cable performs as well as existing shielded (F/UTP) cable designs in the marketplace (see Figure 5).

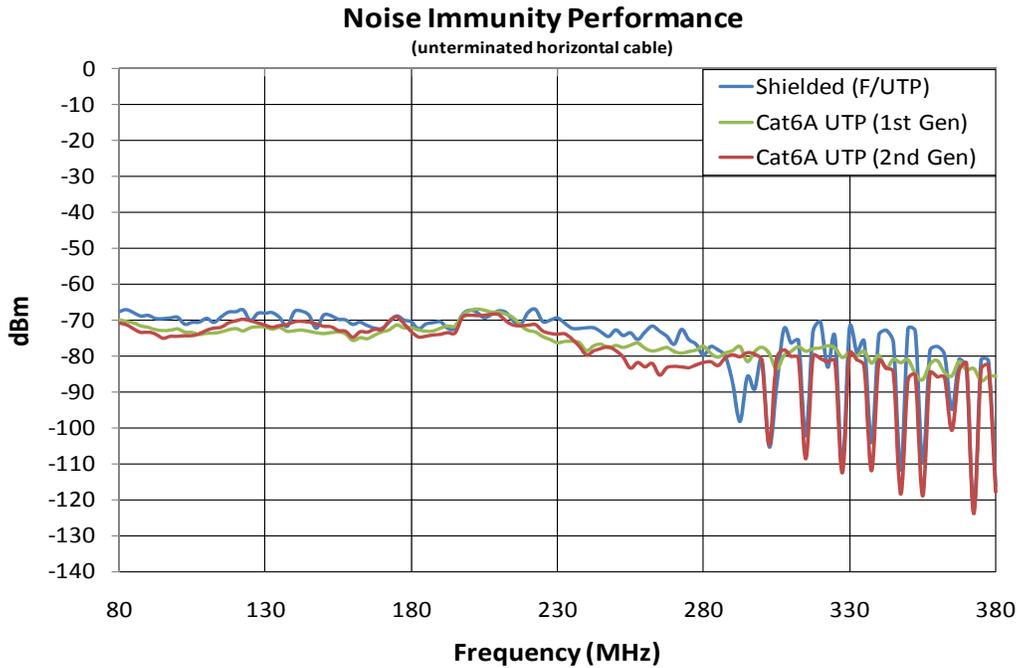


Figure 5. Received noise spectra from three different 10GBASE-T cabling systems indicate that the **PANDUIT® TX6A™** next-generation Category 6A cable offers improved electromagnetic immunity when compared to both traditional Category 6A and shielded (F/UTP) cables.

Benefits Beyond Electrical Performance

The benefits of the **PANDUIT® TX6A™ 10GIG™** UTP Copper Cabling system extend beyond channel performance, enabling data center stakeholders to specify a Category 6A copper cabling system that achieves superior electrical performance while maximizing power efficiency. Specifically, the slimmer cable helps optimize pathway fill and enable thermal efficiency, while the robust cable design delivers an operating temperature that enables the deployment of PoE applications that draw up to 25 W (see Table 1).

Table 1. Summary of Twisted Pair Cabling Solutions for 10 Gb/s Applications

Parameter	Category 6A UTP (1st Gen)	Category 6A STP	Category 6A UTP (2nd Gen)
Cable Diameter*	0.330 in.	0.305 in.	0.295 in.
Cable Weight (lb/1,000 ft)	50	44	44
Pathway Fill Capacity (# of cables at 40% fill rate)**	586	678	738
Headroom/Margin	Good	Superior	
Bonding/Grounding Req.	No	Yes	No
Max. Operating Temp.	60°C		75°C
Total Installed Cost	\$\$	\$\$\$	\$\$

* Nominal, Plenum.

** Using 21" x 6" Cable Tray.

More Efficient Use of Pathway Capacity

One of the main points of concern when deploying a Category 6A cabling system is the overall cable diameter, as traditional Category 6A copper cables can complicate traditional routing and management schemes. Extra thick cabling designs fill vertical pathways more quickly, and existing cable trays and pathways may not be adequate to accommodate the larger cable size. Also, the larger cable bundles can severely impact airflow through enclosures containing the equipment, which creates cable congestion and air flow restrictions that can affect switch reliability and facility uptime.

With the introduction of the new *PANDUIT® TX6A™ 10GiG™* Copper Cabling system, network stakeholders can take advantage of smaller cables to achieve space efficiencies throughout the data center without sacrificing electrical performance. The smaller sized, round cable improves fill capacity by as much as 30%, enabling greater flexibility and scalability along all pathways, from vertical spaces within cabinets to under floor baskets and trays.

The smaller diameter makes *TX6A™ 10GiG™* Copper Cable quicker and easier to install than traditional Category 6A systems, and the reduced weight of the cable (more than 12%) lowers the mechanical stress on the cabling infrastructure, reducing risk of downtime due to equipment damage. This slimmer Category 6A cable also achieves in-cabinet and under floor pathway efficiencies throughout the data center, which maximizes valuable real estate and helps optimize airflow to support thermal management goals.

For example, air exhaust pathways in server cabinet vertical spaces and behind active equipment can more easily be kept clear to provide maximum airflow and enhance equipment cooling. Also, large quantities of copper cabling deployed in switching environments can be routed and managed more easily while allowing for proper airflow to network switches, which are often cooled using side-to-side airflow. In patching environments, high-density angled modular patch panels can be used with high capacity vertical cable managers to deploy and manage hundreds of 10 Gb/s links while conserving valuable real estate. Overall such improvements will result in greater energy efficiency and a reduced time to install and maintain, lowering overall operating costs.

Installers also are increasingly called upon to deploy Category 6A solutions alongside legacy Category 5e, 6, and traditional 6A systems. This can be a challenge due to concerns over co-mingling of cable type within the same pathway or conduit. This concern is minimized with the *PANDUIT® TX6A™ 10GiG™* UTP Copper Cabling System, because the revolutionary cable design significantly mitigates signal coupling effects between cables of different types. Specifically, the discontinuous metallic elements on the matrix tape prevent coupling energy emitted from the *TX6A™* cables from interfering with the electrical performance of adjacent cable bundles of any type.

Finally, since the cabling system exceeds standards-based 10 Gb/s alien crosstalk performance levels, IT managers no longer have to worry about how Category 6A UTP cables are dressed in pathways to help mitigate alien crosstalk or cable phasing effects, or selecting a shielded cabling system that requires grounding. Instead, installers have the ability to neatly dress or comb the bundles, which conserve valuable pathway space.

PoE over Next-Gen Category 6A Cabling Systems

The IT industry is increasingly deploying Power over Ethernet (PoE) over enterprise networks to supply power to IP-enabled endpoint devices. The success of the PoE protocol is due to its ability to transfer DC power effectively over copper Ethernet cabling, thus reducing or eliminating the need and associated cost of providing power remotely to each device. For appliances such as VoIP phone, wireless access points, and security cameras that are commonly placed in hard-to-reach locations, these savings are considerable.

By decreasing the diameter of the cable and utilization of *PANDUIT's* matrix tape, the thermal resistance of the cable is reduced (from the copper of the wire pairs to the jacket). A lower cable thermal resistance results in lower temperature rise within the cable, including the outer jacket temperature, which is advantageous for deploying high-power PoE applications where temperature controls of cable bundles is important.

In addition, the new cable design utilizes an advanced outer jacket material that allows it to withstand temperatures up to 75°C. This material has significant benefits for PoE applications when combined with the matrix tape technology: first, more power can be transmitted via the cable system; and second, the amount of power transferred in a channel bundle does not need to be de-rated a function of ambient temperature.

The improved operating temperature of *PANDUIT® TX6A™ 10GIG™* UTP Copper Cabling System enables network stakeholders to deploy more power hungry devices such as motorized (i.e., point-tilt-zoom) network cameras, electro-magnetic door strikes, proximity sensors, electronic door locks, and other building controls or security apparatus that may require up to 25W per device to operate.

Conclusion

PANDUIT Laboratories has designed a next-generation *PANDUIT® TX6A™ 10GIG™* UTP Copper Cabling System which utilizes innovative cable matrix tape technology and advanced connector compensation techniques to yield revolutionary channel performance. This new UTP cable design addresses customer's preference for smaller and round shaped Category 6A cable without compromising performance.

The new *PANDUIT® TX6A™ 10GIG™* UTP Copper Cabling System significantly reduces the cost of ownership of a 10GBASE-T cabling system by:

- Lowering the DSP active chip power requirements through superior internal bandwidth performance
- Eliminating the need to field test for alien crosstalk due to significant headroom margin
- Improving energy efficiency with better airflow management due to a smaller, round shaped cable
- Allowing for the implementation of advanced PoE application through an elevated temperature rated cabling system
- Allowing for extra design flexibility through the co-mingling of other copper category cabling and insensitivity to nearby metallic surfaces

The *PANDUIT® TX6A™ 10GIG™* UTP Copper Cabling System ultimately provides better risk management throughout the enterprise by achieving operational cost efficiencies and reducing downtime. *PANDUIT* Laboratories has developed this advanced copper cabling system for mission critical data center and enterprise applications. This highly reliable and scalable infrastructure solution will increase network availability, mitigate risk and minimize power consumption.

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.

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