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Ethernet Cable: A Guideline to Implementing Solid or Stranded Cables

White Paper - W1003

With businesses becoming increasingly more communication-centric, virtually every industry is now relying on industrial Ethernet technology to network critical devices and control systems as well as to enhance process automation and improve efficiency. As one of the most widely used networking technologies, Ethernet connects more than 85 percent of LAN connected PCs and workstations, providing a flexible solution that delivers real-time data and status updates to ensure constant information accessibility and instantaneous data transfer.

In order to utilize these communication capabilities, Ethernet cables are required to provide the necessary connectivity. These cables are used to connect devices, such as PC, switches and routers, to transmit and receive data. To ensure proper cabling installation, organizations such as the American National Standards Institute, Telecommunications Industry Association and Electronic Industries Association provide clear, concise instructions and standards that assist users in setting up reliable Ethernet connections.

Along with understanding the correct regulations, selecting the appropriate cable for an application is equally important. Identifying the various cable categories, classes and types and their distinctions is critical, as cables are separated into distinct categories, such as 5, 5e and 6, classes like C, D, E and F and are defined as solid or stranded. By recognizing these classifications, as well as the uses and purposes for stranded and solid cables, users can select the ideal cable to meet their application requirements.

CABLE STANDARDS

The Telecommunications Industry Association (TIA) and Electronic Industries Association (EIA) were developed to describe uniform wiring system requirements. These standards provide useful guidelines for implementing cabling systems in networking applications. Outlining how to design, build and manage cabling systems, these standards are designed to direct users through creating a uniform cabling system. By providing user-friendly instruction, as well as topology, connection points, termination points and media definitions, users can wire a building without prior knowledge or special skill.

ANSI/TIA-568, a family of telecommunication standards, provide the requirements for twisted-pair, optical fiber and coaxial cabling, with the purpose of establishing performance and technical criteria for cabling system configurations to access and connect components. To attain this goal and aid users in creating reliable networking connections, these standards define transmission and mechanical requirements, electromagnetic compatibility for cabling, installation procedures, connector termination techniques and field testing.

Performance Testing

In order to ensure cable connections are properly made, ANSI/TIA/EIA-568-C.2 provides performance testing guidelines that must be done on cables prior to use to ensure the cabling system will operate as expected. Generally, testing is a two-phase process, consisting of an opens test and a shorts test. In the first phase (opens test),

a cable tester is used to verify all the intended connections exist and are good. The second phase (shorts test) is performed in order to ensure there are no unintended connections. Unintended connections can either indicate a short circuit, which is when the connection is short, or signify miswiring, which occurs when a connection goes to the wrong place.



Bend Radius

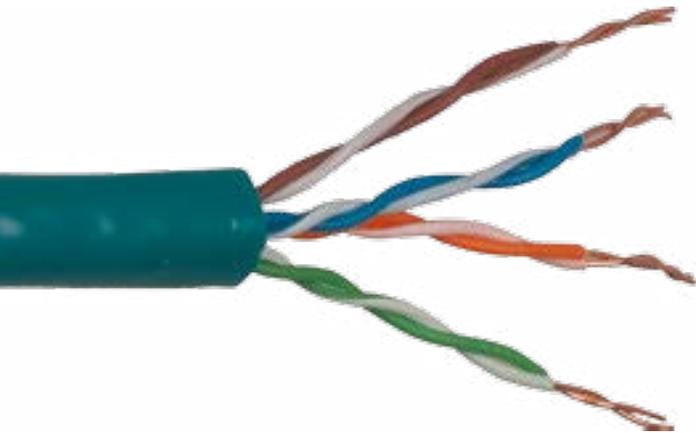
Cabling standards also outline the appropriate bend radius for each cable. Bend radius is the minimum extent a cable can be bent without kinking, suffering damaging or shortening the cable's life span. The minimum bend radius is five times the cable diameter for stationary cables and 10 times for moving/flex cables. When cabling is bent beyond this pre-determined minimum bend radius, it can cause transmission failures. All pathways must maintain the minimum bend radius wherever the cable makes a bend.

CABLE CATEGORIES

Common cabling types used for Ethernet connections are twisted-pair cables, which can improve the signal quality and cable flexibility. There are several different categories and classes of cable to indicate their specific performance parameters. These include Category 5, 5e, 6 and 7, and each encompasses a different type of twisted pair cable that has unique properties which define how much signal it can carry and transmission limitations. This white paper primarily focuses on Category 5 and 6 cables.

According to the ANSI/TIA/EIA standard for category 5e copper cable, the maximum length for a cable segment is 100 meters (or 328 feet). Category 5e cable is capable of transmitting data at speeds of up to 1000 Mbps—1 Gigabit per second. The specifications for 10BASE-T networking specify a 100-meter length between active devices. This allows for 90 meters of fixed cabling, two connectors and two patch leads of 5 meters, one at each end.

Category 6 cable was designed to perform at frequencies of up to 250 MHz and offers higher performance for better transmission of data at speeds up to 1000 Mbps, with fewer errors for 100BASE-TX and 1000BASE-T applications. For additional data transfer requirements, some Category 6 cables can support 10 Gigabit speeds, however, they may suffer length limitations. Category 6 cabling, with its larger conductors, internal dividers, and tighter twist lengths would be analogous to a high-end model, delivering better performance and more capacity.



SOLID VS. STRANDED CABLING

Solid and stranded cables each have their individual purposes and benefits, and knowing when and where they should be used will improve networking performance and efficiency. Though they feature similar capabilities, each serves a distinct function and offers specific advantages.

Solid

Solid Ethernet cables are made up of a single, solid conducting wire. Featuring larger wires, solid cables are physically stronger and easier to work with. Further, the larger wires provide superior electrical characteristics capable of remaining stable over a wider range of frequencies. This makes solid cables better suited to new and emerging high-speed Ethernet applications.

Due to their large copper diameter, solid conductor cables have a lower DC resistance and a lower susceptibility to high frequency effects. Solid cables are able to support longer transmission, receiving longer runs and higher data rates than stranded cables. However, while solid cables have a “larger” core, they are also more vulnerable to

breakage. This limits their flexibility, as they cannot be repeatedly flexed or bent without breaking or causing performance inefficiencies. This inherent stiffness makes solid cables the ideal solution for horizontal cabling within a system infrastructure.

For example, solid Cat5e cables are well-suited for networking applications such as running from room to room in an office building, due to the higher distance needed. For runs over 100 feet, solid cables will perform better and more reliably than stranded cables.

Stranded

With stranded cabling, the inside features twisted pairs of a stranded cable, with each individual conductor made up of a bundle of smaller-gauge wire strands. Stranded cable is arranged in a way that several wires surround a single wire in the bundle’s center. For Category cables, the number of surrounding strands is six, with one in the middle. This stranded arrangement forms a conductor that ends up with a diameter similar to a solid cable. However, the conducting area of a



stranded cable is smaller than that of a solid cable due to the smaller diameters of each individual wire strand. Stranded cables are a type of cable that users often have more familiarity with and handle directly.

The stranding of the wire conductor not only protects the cable, but it also enhances its flexibility. The longer the cable is, the more times each strand is twisted around the center. As a result, when a stranded cable is bent, each strand bends as though it is independent of the entire strand. This construction enables these cables to move easily and frequently without harm or risk of performance failure.

While they are not as reliable as solid cables for long-distance runs, their flexibility makes stranded Cat 5 cables ideal for short distances. Since they are pliable by nature, stranded cables deliver the mobility necessary to perform well in applications such as patch cabling, as they will be constantly

plugged, unplugged, bent or installed. A patch is used to provide connectivity between any two RJ45 jacks. Common patch cabling applications are connecting patch panel ports to other patch panel ports or to switch ports, and for connecting the work area outlet (jack) to the computer or other networked device.

CONCLUSION

As networking continues to be a necessary component of businesses in virtually any industry, understanding the types, standards and purposes of various Ethernet cable options is crucial to ensuring reliable network performance and continuous access to important data. By using ANSI/TIA/EIA-568 as a guideline, users can install, test and maintain the cabling required for their networking applications.