Adapting Gigabit Ethernet For The Industrial Manufacturing Environment

A Discussion of Cable Constructions and Applications

With the advancement of computer and data transmission technologies, systems formerly reserved for the office environment are now critical components of the manufacturing floor. The demands of factory automation, in addition to computer hardware and software, have brought the wire and cable networking products that interconnect these technologies into the industrial setting as well.

With the vast differences between an office and an industrial environment, networking cables such as gigabit Ethernet have had to adapt to these harsh new surroundings, not only from a physical perspective but from a performance perspective as well, in order to function reliably.

The industrial manufacturing environment presents many challenges for networking products not found in an office setting.

These include:

- The ability to resist dirt, dust, solvents, oils, fuels, etc.
- The ability to resist abrasion
- The need to function in flex applications, such as C-Tracks, rolling flex applications, or robotics
- The need to be flexible for routing around equipment or other similar obstacles
- The ability to resist environmental noise such as EMI (Electro Magnetic Interference)

In response to these challenges, cable designers have developed industrial grade Ethernet products. These ruggedized Ethernet constructions utilize stranded conductors and successfully meet the requirements of 10, 100, and 1000 Base T applications to the specified distance applicable for each construction. For 26 AWG stranded constructions, designed for continuous flex applications, that distance equates to 60 meters, while for 24 AWG, designed to provide flexibility for routing, the distance rises to 80 meters.

Both distances far exceed most length related requirements for industrial networks.

Before we begin a discussion of industrial gigabit Ethernet construction particulars, it is important to note here that the characteristics of ‘flex life’ and ‘flexibility’ are not necessarily synonymous in all cases. Some cable constructions may appear to possess limited flexibility, but perform very well in continuous flex applications, such as robotics. Other cables may seem to enjoy maximum flexibility, yet possess a very limited life when it comes to continuous flexing applications. For the purpose of our discussion, we will use the term ‘flexibility’ to represent a characteristic of the cable that makes it easy to route during installation. We will use ‘flex life’ to represent the ability to function reliably over time in a continuous flex application.

The importance of matching the cable construction to the application cannot be understated.

The differences in construction between Ethernet products designed for an office environment, and industrial grade gigabit Ethernet products constructed to perform reliably in harsh manufacturing environments lie in three main areas:

Conductor Construction: A very basic rule of thumb for summarizing the relationship between flexibility, flex life, and conductor stranding is simply this – All things equal, the higher number of strands a conductor has the more flexible it will be and the longer it will survive in a flexing application. Standard longer distance Ethernet cable products found in most office settings are comprised of solid copper conductors. While providing some transmission advantages relative to distance, from a flexibility/flex life perspective this solid conductor construction is a major disadvantage. Industrial gigabit Ethernet addresses this dilemma by substituting stranded conductors ranging in count from 7 strands to 19 strands, depending on the product. These stranded components provide industrial grade gigabit Ethernet the ability to be both flexible, as in the case of both the 24 AWG and 26 AWG constructions, while providing the increased flex life required for continuous flex applications, as in the case of the 26 AWG constructions.

Shielding: While most office environments are ‘quiet’ from the perspective of EMI interference that cannot be said for the manufacturing floor. The many motors and generators found in most industrial settings create a level of potential interference that cannot be ignored. Left unchecked, EMI can degrade the quality of the signal being carried by the cabling to the point where equipment can begin to malfunction due to data errors. To defend against EMI, gigabit Ethernet cables employ braid shields constructed from multiple copper strands. In addition to protecting the cable’s signal from external noise, this shielding also offers a degree of physical protection should the cable jacket be cut or damaged during use.

Jacket Materials: By offering various jacketing options, including PVC, TPE, and Polyurethane, the gigabit Ethernet product family offers users the opportunity to select both the agency certifications required for their application and some options relative to the price point for the product they require. While all materials provide resistance to oils, solvents, dirt, etc., to various degrees, the TPE and Polyurethane options also provide higher degrees of abrasion and cut-through resistance.

Other versions of gigabit Ethernet products also exist, such as those with inner jackets (sometimes called 'belts') that lock the conductor pairs into place. While not as prevalent as other constructions, this type of product may be appropriate for an environment where the cabling is susceptible to crushing.

While the ability of cable engineers to modify gigabit Ethernet to not only survive but also function reliably in manufacturing environments, none of these design solutions would be relevant if these industrial Ethernet products were not compatible with standard termination methods. All gigabit Ethernet constructions discussed in this document, and summarized in Appendix A, are compatible with the most common Ethernet connector systems.

As factory automation products and systems continue to advance, the need for networking cables, such as industrial gigabit Ethernet, will continue to rise. The challenge for cable designers will be to produce products that meet the new system requirements for increased signal transmission speed while simultaneously ruggedizing these sophisticated interconnect product such that they can survive the challenges of the industrial manufacturing environment.

APPENDIX A

C&M Part Number	Gauge	Stranding	Shielding	Jacket Material	Agency Certifications	Applications	Nominal OD	Maximum Installation Distance
50978	26	19	Braid	PVC	AWM, CM	C-Track, Rolling Flex Applications, Robotics	0.265	60 Meters
50977	26	19	Braid	TPE	AWM	C-Track, Rolling Flex Applications, Robotics	0.265	60 Meters
50976	26	19	Braid	Polyurethane	AWM	C-Track, Rolling Flex Applications, Robotics	0.265	60 Meters
50974	24	7	Braid	PVC	AWM, CM	Flexible Networking	0.305	80 Meters
50973	24	7	Braid	TPE	AWM	Flexible Networking	0.305	80 Meters
50972	24	7	Braid	Polyurethane	AWM	Flexible Networking	0.305	80 Meters