

The Role Standards Play in Selecting Industrial Ethernet Components

Today in the US industrial sector, the focus is on being as cost conscious, lean, and value-rich as possible. This focus starts with efficient production. Whether the business model requires sustained production or multiple start-up and finishing processes, the differing design and maintenance requirements on the equipment and infrastructure are many. This affects the designs of new systems, the system integrators that maintain them, and the private network owners who own those systems.

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What are the standards?

There are several things to consider when designing and installing structured cabling in an industrial production environment. Most importantly, stick to the basics and adhere to the ANSI/TIA/EIA-568-C design and installation standards. Standards are created to govern the rules and recommend performance measurements to validate that the rules are being followed.

The TIA standards govern the cable's maximum length, bend radius, and quality of terminations for the telecommunications installations. The basics help ensure ample headroom, continuity, and a stable backbone for the inevitable adds, moves, and changes in any network. The ANSI/TIA/EIA-568-C standards that specify installation of communications cable and performance of the data center include addendums for use in industrial Ethernet settings.

In addition to the following topics:

- Setting the standard for 2-pair cabling systems;
- Defining an automation island;
- Defining automation outlets and cables;
- Stating that Category 6 or better cabling is to be used for the automation islands and;
- Defining environmental concerns

The industrial standard has two notable variations from enterprise standards. One, it acknowledges the needs of separate network spurs and the concept of different areas within a plant floor having various levels of environmental severity. Second, it increases the allowable number of connections from 4 to 6 in a channel as a cabling run moves from severe to a more moderate environment, both electrically and environmentally.

What are the industrial components?

Most important to design requirements are using correctly hardened components. These differ significantly from common data center components in specifications, regulations, and cost. It is important to understand any external machinery noise issues when deciding upon UTP, FTP, STP or fiber-optic components. In addition, protective cabling should be used in any areas with repetitive motion where a link might be stepped on or crushed. Many cable manufactures offer specific cabling with boots and/or advanced engineered material cable jackets specifically for harsh environments. In areas with extreme temperature swings, high humidity, or chemical or high-pressure washes, consider robust connectors and components with protective boots. The RJ45 style connector is key for connectivity, but is not rated for extremes in humidity and in higher density areas the IP67 rated booted RJ45 is not feasible. In this situation, the small form-factor M12 connector is preferred. M12 Ethernet is suited for industrial environments and protects against dirt, water, vibration/shock, and temperature extremes.

The M12 is a popular 4-pin connector with a ½" threaded barrel with a diameters ranging from 6.0 mm to 6.3 mm. It has been used in industrial and production environments to transmit power and signals to optical sensors for decades. In newer installations with faster data rates, it is also being used for bidirectional communications similar to Cat 5e or 100 Mhz with the D-coded connector style. Fast Ethernet (100Base-T) employs one data pair for sending and one data pair for receiving, both at a transmission rate of 100 Mbps. The D-Coded 4-pin M12 connectors are perfectly adequate for Fast Ethernet transmission. There is also an 8-pin design found in networks requiring higher transmission rates such as Gigabit Ethernet (1000Base-T) which transmits at 1000 Mbps. All four wire pairs are used to send and receive in full-duplex mode. The standard design and connector style for the M12 8-pin is yet to be ratified.

System Integrators and Contractors who are proficient in the installation of Ethernet in office settings can adapt their expertise to the industrial world. However two major factors contribute to this new environment: lack of climate control and the presence of close electrical equipment. When designing an industrial network, pay close attention to using the right level of hardened components in the right automation island. The industrial addendum to the ANSI/TIA/EIA-568-C the TIA 1005-1 provides a recognizable framework for any System Integrator installing and testing the cabling. Another difference is the physical consolidations points and high prevalence of motor-control cabinets. In the industrial setting, these cabinets are often used as interconnects for electrical systems. This is a convenient physical location, but not the best place for low-voltage cabling due to the harsh and dynamic electrical environment. Special retrofitting and or separate interconnects may be needed.

Who needs to care about industrial standards and components?

Most Automation or Control Engineers who are required to design systems that accurately manufacture their company's product, must also understand the standards to which their designs must comply. Understanding the priority of communications for what is under production is key. The performance characteristic is a prime consideration for any design. Design considerations are important and vary depending on the production environment. In a production environment much lower bandwidth has been sufficient compared to that required for the office environment. It is more important for the data to reach a process system rather than to require all parts of a file received. For example, sending 2 kb sized communication command requesting a temperature reading is more important than a receiving a complete 2 Mb photo and being able to see it clearly. For example in the food and beverage industry, when packaging soup, having the containers move at just the right jitter sequence reduces splashing, yet if the timing commands were affected by any network speed issues, the soup would fall into the trough and scrap would be incurred. In many production environments, Cat 5e transmission requirements are efficient for today's commands, as well as tomorrow's requirements.

The pharmaceutical industry, whose process is similar to that of a brewery, provides a good example. One key element that was designed into the system after the original installation was a cleaning in-place process. This allowed for cost and labor savings by automating the process, only start commands and control room oversight were required instead of a manual flushing that was a daylong process. The cleaning in-place process was designed to run on the same cabling, thus increasing the data rates and required Cat 6 installation components. Conveniently, they had installed cabling with enough headroom to allow the infrastructure to support new systems.

In summary, the factors to remember for the Ethernet media for industrial applications must be carefully selected to meet application requirements. There are many considerations for selecting the proper Ethernet connectors and cabling for any particular application. When you select infrastructure, you need to be certain it meets the most severe conditions at any point along its length.

Will the cables and connectors be subject to any of the following:

- Shock and vibration
- Crushing, pulling
- Bending or twisting
- Dust and dirt
- Water, oils or other liquids
- Corrosive gasses or chemicals
- Humidity
- Solar radiation
- Electrostatic discharge
- Radiated RF
- EMI
- Electrical transients

Consider when selecting cable:

- What are the bandwidth requirements for the application?
- Will the application require shielded or unshielded cable?
- Will the application require two pair or four pair cabling?
- Determine the severity conditions where the cables will be installed
- Are there any additional considerations for the cabling and connectors?

Considerations when selecting connectors:**RJ45**

An IP-rated RJ45 is generally a larger connector designed to perform in harsh industrial environments. It is available in several different connector styles and provides protection from temperature extremes, contact with oils and other fluids, dirt, UV radiation, EMI, shock and vibration.

M12

The M12 connector is available in both 4 and 8 positions. It has been gaining favor as an excellent alternative for the RJ45 in industrial applications. Its smaller form factor and robust design provides a connector that provides excellent protection against, water and most other fluids, dust and dirt, corrosion, EMI/RFI, vibration and shock, UV radiation, and temperature extremes.

So which type of cabling and connector is best suited to fit all industrial Ethernet installations? This is a question end users and installing System Integrators need to address on a case-by-case basis, as neither M12 nor RJ45 represent a connection solution that will suit all Ethernet systems at all levels.

How to ensure your installation meets any industrial environmental needs:

- Design to the standards
- Understand the priority of communications
- Use the right components

In the future, industrial Ethernet networks will increasingly combine RJ45 and M12 connection technologies to suit the requirements at hand.

Contact Fluke Networks: Phone **800-283-5853** (US/Canada) or **425-446-4519** (other locations). **Email: info@flukenetworks.com**.

Contact Phoenix Contact USA: Phone **800-888-7388**. **Email: info@phoenixcon.com**.

NETWORK SUPERVISION

Fluke Networks
P.O. Box 777, Everett, WA USA 98206-0777

Fluke Networks operates in more than 50 countries worldwide. To find your local office contact details, go to www.flukenetworks.com/contact.

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