

WHITE PAPER

DESIGNING RELIABLE AND SAFE INDUSTRIAL AUTOMATION SYSTEMS

How M8/M12 Connectors and TE Safety Solutions Enable Reliable Communication in Harsh Industrial Environments

INDUSTRIAL





The industrial automation landscape is undergoing a rapid transformation, driven by the demand for higher data transfer rates; increasing requirements for safety, reliability, and modularity; and real-time communication across machines and systems. As a result, discrete, hybrid, and process automation technologies are evolving.

Connectivity solutions are the building blocks at the heart of this transformation. They provide the crucial link to safely and reliably ensure communication in a wide range of industrial environments and beyond.

The future of connectivity will be driven by ever-changing technologies to meet Industry 4.0 demands, including artificial intelligence, miniaturization, Single Pair Ethernet, and modular systems.

Learn more about the key trends in industrial automation and control applications and the critical role that connectivity and safety solutions play in enabling this evolution while safeguarding equipment and personnel.

INDUSTRIAL CONNECTIVITY TRENDS AND CHALLENGES

Modern industrial environments are becoming more complex, with a growing number of networked sensors and a strong push toward automation to improve throughput and efficiency. This presents challenges for ensuring reliable and safe communication between machines, control systems, and operators. Such factors as harsh environmental conditions, the need for high-speed data transmission, and the imperative to minimize downtime all contribute to the complexity of designing robust communication networks. The following six trends are influencing the engineering and design of automation systems:



INDUSTRY 4.0: This concept encompasses the digitization of manufacturing and related industries, integrating technologies like the Industrial Internet of Things (IIoT), cloud computing, AI, and big data to create “smart factories” with increased automation, efficiency, and flexibility.



INDUSTRIAL INTERNET OF THINGS: IIoT is a key driver in the evolution of industrial automation, fostering the collection, processing, and transfer of machine asset data at the edge. This enables improved production monitoring, condition monitoring, and shop floor visibility by ensuring that operational technology device data is accessible in the cloud.



DECENTRALIZATION: Factories and industrial facilities are moving away from centralized control systems that use a single control node in favor of distributed intelligence, where each device and machine has its own monitoring and control — and is connected to the cloud. This trend enables greater flexibility and scalability for quicker responses to changing conditions and increased efficiency.



MINIATURIZATION: As systems become more decentralized and autonomous, the cabinets housing these systems become more populated with components and cables. This drives the need for smaller components, bringing miniaturization to the forefront.



HIGH-SPEED DATA TRANSMISSION: Due to the rising demand for real-time communication across more machines, systems, and processes, there is a growing need for higher data transmission rates and higher signal integrity. This need is also fueled by the growing emphasis on preventative maintenance, production effectiveness, and streamlining the management of manufacturing infrastructure, all of which rely on the swift and accurate transfer of large volumes of data.



INTEGRATED SAFETY: In industrial environments where automated systems and human operators work in proximity, ensuring reliable and safe communication is paramount, especially as systems become more autonomous. This increases the need to integrate safety measures into the design of automation ecosystems.

ENSURING PROPER SYSTEM DESIGN

Because connectors are essential to automation system design, it is important to choose connectors and cable solutions that offer reliable and safe performance. Effective system design must balance the following factors:

ENVIRONMENT

The automation system must be able to withstand the rigors of its environment, including dust, vibration, moisture, and other challenges present in industrial facilities.

SYSTEM PURPOSE

The system design should fit the application's purpose and desired outcomes, and the design should be as simple as possible. If there are specific end user pain points to address, more sophisticated solutions are available and should be considered.

AVAILABLE SPACE AND CONNECTOR PLACEMENT

Structural considerations, such as mechanical fit, dimensions, and tolerances, are all important in system design. These include any space limitations.

EASE OF ASSEMBLY

Look for solutions that are designed for easy installation and service. This will help save downtime and costs over the life of the system.

COMMUNICATION PROTOCOLS

Many connectors are agnostic and can use a wide range of communication protocols, from Modbus and CAN bus to Ethernet. Some connectors are specifically designed for high-speed Ethernet.

DATA AND POWER DELIVERY THROUGH ONE CABLE

In industrial environments, modern connectors are designed to support both power and signal transmission through the same cable, streamlining installation and reducing the need for separate wiring. This integration minimizes cable clutter, saves space, and simplifies maintenance while ensuring reliable delivery of data and power — even in demanding conditions.



M8 AND M12 CONNECTORS DELIVER RELIABILITY

TE Connectivity has a wide range of connectors that enable reliable, high-speed, and rugged performance for industrial automation applications. The M8 and M12 connector systems provide a full solution that includes connectors, IO modules, and cable assemblies. With a circular form factor, they offer high sealing and vibration resistance to maintain connectivity in even the harshest industrial conditions. This means they can be deployed on the factory floor and are not limited to inside cabinets or locations with perfect conditions.

TE also develops a broad range of products with various codings that can help end users move through different phases of automation. Options range from A-coded to X-coded connectors (some of which can support higher bandwidth needs of up to 10 Gb/s) to Single Pair Ethernet (SPE) options that support power and data transmission.

TE's M8 and M12 connectors also deliver high signal integrity thanks to advanced shielding and precision design. This is especially key in applications such as Gigabit Ethernet, which is growing in use in many industrial facilities.

M8/M12 – THE CODINGS



A-CODING

Actuator-sensor plug connections for DeviceNet, IO link, and Profibus



B-CODING

Fieldbus connections for Profibus and Interbus



D-CODING:

Industrial Ethernet, Profinet, Ethernet/IP, and EtherCat



S-CODING:

Motor, frequency-converters, motor-operated switches, PSUs for Power, 620 V, 12 A



T-CODING:

Fieldbus comp, passive distribution boxes, motors, PSUs for Power, 63 V, 12 A



X-CODING:

Cat6A, high-speed 10 Gbit rugged industrial Ethernet applications IEC 61076-2-109



M8 AND M12 SYSTEM DESIGN OPTIONS

Choosing the right design will enable longer system life, reduce maintenance, provide more reliability, and be more efficient. Different connector designs offer trade-offs in space, cost, flexibility, and robustness. TE engineers can help users choose the best fit for their specific application.

M8 and M12 connector integration options include the following:



PANEL MOUNT WITH WIRES

This is a popular choice from a design and assembly perspective because it offers flexibility and ease of installation. The connector and cables can use offboard wiring, which is suitable for field installations and can be easily replaced. If the machine will need frequent maintenance, this system design is a good choice. However, this design uses more wires and requires a larger footprint.



PCB MOUNTED

This design reduces the number of necessary cables and therefore saves space and improves signal integrity. It is a good option for high-volume manufacturing but is not well-suited to more customized, low-volume manufacturing. With this design, it is more difficult to repair or replace connectors.



CONTACT CARRIERS/INSERTS

These designs are also known as push-fit connectors. They mount to a panel or chassis hole and often require a separate connector to mate with a PCB. They are well-suited for very small automation systems designed for high manufacturing volume.



CORDSETS

M8 and M12 cordsets are durable, preassembled cables designed for quick and reliable connections in industrial environments. Available in various lengths and configurations, they combine rugged connectors with high-quality cables to transmit power, signals, or data. Their molded design offers excellent protection against dust, moisture, and mechanical stress, making them ideal for automation, robotics, and sensor applications where flexibility, reliability, and ease of installation are key.

SAFE AND SMART SOLUTIONS

Integrating safety measures into these systems is critical as their use grows in industrial environments and more components and equipment use automation. Safety must be considered in tandem with — and just as important as — reliability, efficiency, and performance when designing industrial automation systems. TE's Safety Range solutions include safety light curtains, which are designed to ensure the protection of humans, machinery, and the environment.

The deployment of M8 and M12 systems helps ensure that safety light curtains are easily integrated. Installation is fast and simple with a plug-and-play design, thanks to the M12 connectors and the use of unshielded cables. No programming is necessary, making installation and replacement simple.

Safety light curtains offer reliable sensing and monitoring of functional safety. They use a combination of an emitter and a receiver. If no objects or people are blocking the beam between the emitter and receiver, the machine is in a secure state and is allowed to operate. If any portion of the light beam is blocked by a human finger, hand, or body, the machine determines the situation to be hazardous and turns off the output of the receiver to stop the machine. TE's Safety Range also mitigates risks with color-coded, reliable connectors that meet safety standards and resist harsh conditions. TE safety products integrate with automation systems to form cohesive, standards-compliant, and fail-safe industrial safety networks. This helps industrial operations meet increasingly stringent safety regulations and avoid costly accidents or production delays.



PREPARING FOR THE FUTURE OF INDUSTRIAL AUTOMATION

With the rise of Industry 4.0 and IIoT, facilities must meet increasing demands for data connectivity, automation, and edge computing. They must be prepared to integrate existing legacy machines and equipment with newer, interconnected systems: deploying automation with room to grow but without overcomplicating the system when it is not needed.



TE can be your partner in this evolving landscape of industrial automation, delivering solutions that help facilities increase productivity and safety on the floor and throughout production. Our M8 and M12 connector portfolios and safety range solutions enable a safer, more efficient, and more connected

industrial future. TE supports engineers with tools, data, and expert guidance to integrate M8 and M12 connectors confidently and effectively — ensuring quality and performance through rigorous design, automated manufacturing, extensive testing, and global standards compliance.

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