TE connectivity

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/ WIRED TOGETHER:

HOW AUTOMATION SYSTEMS POWER THE INDUSTRIAL INTERNET OF THINGS

Introduction

Automation control is becoming increasingly more prevalent in our daily lives, from driver assistance in automobiles that provide comfort and safety, to smart home devices that allow remote control and monitoring of appliances and lights, to warehouses and factory floors that have robots moving and assembling products.

All of this automation requires control systems. In an industrial setting, monitoring and control are paramount to maintaining safety standards and uninterrupted operation. Critical to the success of this digital future is reliable data transfer interfaces that can withstand the harsh environments where communication between PLCs, sensors, actuators and motors takes place.

The growing need for industrial control places renewed focus on data collection in order that factories, suppliers and customers can share their digital knowledge. From process control and automotive assembly, to robotics and the food and beverage industry, the concept behind Industry 4.0 touches all industries. Critical to the success of this digital future are reliable wired interfaces that can withstand the harsh environments where data communication between PLCs, sensors, actuators and motors takes place.

Over the past few years there has been a steady trend toward Ethernet-based industrial networks and a move away from traditional fieldbus technologies. 2018 saw installed industrial Ethernet nodes overtake fieldbus networks for the first time, with all indications showing that the trend will continue [1]. Compared to fieldbus protocols, Ethernet provides a high-speed, low jitter and deterministic solution that is easily implemented on current Ethernet hardware. This makes it highly suitable for motor control applications in particular.

Ethernet/IP, the fastest growing technology, and CIP networks still dominate the market but there is a clear trend towards Ethernet/IP. PROFIBUS, Modbus-RTU and CC-Link remain the dominant fieldbus protocols, followed by CANopen and DeviceNet and, despite the general trend to Ethernet, there is still annual growth in the number of nodes being installed.

The Best Connector Solution for the Task at Hand

Selecting the optimum connector for the chosen network is a task fraught with challenges. The considerations start with the number of connections required and the voltages and currents that will need to flow across the connector. Additionally, it is necessary to consider how often the connector will have to be inserted and removed, and whether this process may need to be done blind. Environmental conditions will also influence the decision, requiring the industrial engineer to review the temperature of the operating environment along with the potential impact of liquids, as well as electromagnetic compatibility challenges.

Even when all these considerations have been made, there is also the issue of handling during installation or cable manufacture. Connectors offer a range of construction options, from crimped and screwed pins to piercing and solder, to name but a few. If connectors will need to be installed on-site at your client's facility, especially if the location is challenging, such as up a ladder at ceiling level or hidden in a cabinet, the choices made here could have a significant impact on installation time and reliability of the final installed result.

Wired Connectivity Options for Automation Control

Ethernet connectivity provides various challenges in industrial settings. The classic RJ45 connector is reasonably robust, with its molded latch providing both an audible and tactile click when properly mated with the receptacle. Blind insertion is supported by the polarization of the system, while an elastomeric boot may be included to protect the latch mechanism from catching on other cables or being accidentally broken off. However, the RJ45 connector was not originally developed with industrial applications in mind and, if the opportunity arises to start with a clean slate, there are alternative approaches.

With industrial control applications being built into compact housings, and reliability of prime concern, the industry standard Industrial Mini I/O connectors provide a range of benefits compared to RJ45. Industrial Mini I/O retains the keyed form factor, easing insertion when operating blind, but additionally saving space, being just 25% the size of an RJ45 jack **(figure 1)**. The all-metal construction provides tighter tolerances on all axes, while the range includes a true SMD pick-and-place receptacle that can withstand 98 N of pull force. Unlike the single beam, single contact point of RJ45, the Industrial Mini I/O series offers double beam, double contact points. In vibration testing of 20 ns discontinuities (following IEC 60603-7-5), the Industrial Mini I/O range outperforms almost all RJ45 solutions, even after 375 mating cycles and subjection to humidity and environmental stress (mixed flow gas, MFG).

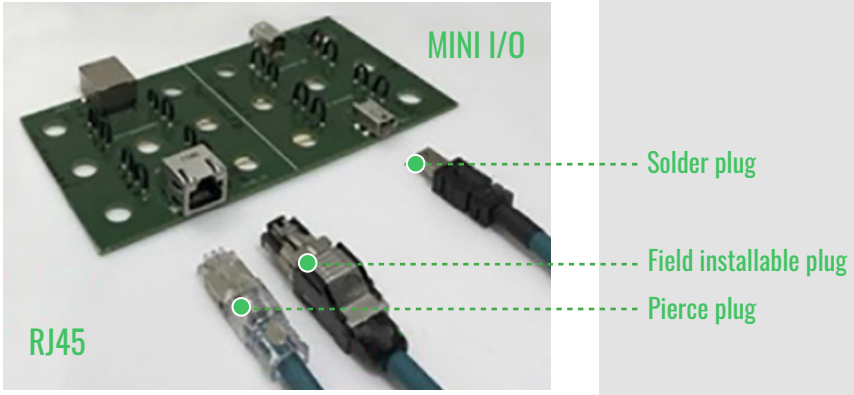

Figure 1: In-depth testing of Industrial Mini I/O has shown it to be especially robust against vibration with excellent EMI performance when compared to RJ45 for Ethernet applications.

Electromagnetic interference (EMI) is another concern, especially as the industry moves beyond 100 Base-T. In measurements made within a triaxial cell (according to IEC 62153-4- 15) the Industrial Mini I/O range outperforms RJ45 solutions all the way up to 125 MHz, the frequency range of interest for gigabit Ethernet. PCB receptacles are available in either vertical or right-angle solutions **(#2294415-1)** while plugs are provided with both wire piercing or solder **(#2013595-1)** options.

If the application demands the use of an RJ-45 connector, you will want a robust, uncomplicated solution. On-site cable confection has to be all about simplicity and speed, and the latest generation of robust RJ45 plugs offer just this. Solutions such as **#2120892-1** provide a tool- less RJ45 plug for Cat. 6A cables **(figure 2)**. A broad range of wires, from AWG 26 to AWG 22, both solid and stranded, can be accommodated. Having removed the cable jacket, the individual wires are guided into place before closing the two metal flanges. This step, which can be executed with a tool or by thumb, automatically cuts off the excess wire length.

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The flanges robustly latch together and, once the thermoplastic housing with sturdy stainless-steel latch is slid into position, a clean and sturdy Ethernet connector is ready for use. In the unlikely event that the initial assembly did not go to plan, two further attempts to fit the connector to the same cable can be made.

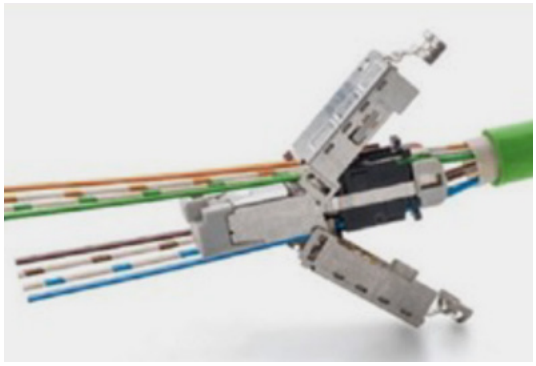

Figure 2: Industrial Ethernet installation need not be complex. #2120892-1 provides a robust but simple RJ45 connector solution.

Some connector choices are already given, leaving us to choose a solution that is more suited to the environment. In the case of USB, the standard connectors are neither especially robust, nor do they provide any protection in harsh environments. A slight tug on a USB cable is all that is required to remove it from the industrial PC to which it is connected. If accidental removal is the primary challenge being faced, latched connectors, such as #20137998-1, are the ideal solution for tethered USB devices. The latching connector provides 40 N of retention force but is also interoperable with existing USB type A receptacles. This enables users to debug any connectivity or software issues on a standard PC. The connectors support the USB 2.0 data rates of 480Mbit/s and provide solder pins for manufacturing.

For more demanding environments there are also USB 2.0 type A and type B plugs and through- panel receptacles that are rated to IP67. These provide protection against the ingress of both dust and water at a depth of 1 m for 30 minutes. The USB type A plug **#2058362-1** matches with the USB type A receptacle **#2058364-1** using a quarter-turn bayonet coupling, available both in thermoplastic and metal housing options **(figure 3)**.

Figure 3: Circular sealed usb 2.0 connectors provide protection to IP67 thanks to their 1/4 turn bayonet coupling ring and seal.

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Options for M12 and M8 Connectors

The M12 standard of connectors are well known for their robustness, having been in use since the 1980s. These and the smaller M8 connector were standardized under IEC 61076-2-101 and have since been adopted almost universally in industrial control systems. Originally offered in 3- and 4-pin formats and an IP67 rating, their usefulness has seen the range expand to provide versions with 12 pins or more and ratings of IP65, IP68 and IP69K. This enables their integration in environments where high-pressure washdown processes are in use.

Each new usage case that results in a new pinning option is standardized, ensuring that the benefits can be realized industry-wide and that the connector can be widely sourced.

CODING	USAGE
A-code	Primarily sensors and actuators; DeviceNet, IO Link and PROFIBUS
B-code	Fieldbus connections for PROFIBUS and INTERBUS
D-code	100Mbit Industrial Ethernet, PROFINET, Ethernet/IP and EtherCAT
S-code	Motors, frequency-converters, motor operated switches, PSUs for Power (620V, 12A)
T-code	Fieldbus comp, passive distribution boxes, motors, PSUs for Power (63V, 12A)
X-code	10Gbit, Cat. 6A high-speed Ethernet

Figure 4: Various coding options for M12 and M8 connectors.

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 convertors, 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 10Gbit	 

Figure 5: The various coding options for M8/M12 connectors as well as their primary applications.

The coding options **(figures 4 and 5)** provide standard pinning and connector keying targeted to specific applications. This ensures that the standard size connector can only be used in conjunction with the matching receptacle.
As well as a range of field installable straight and right-angle connectors and PCB mount solutions, TE Connectivity also offers a range of cable assemblies in lengths of up to 10 m. These include connector-to-connector solutions, pigtail, single- end cables, and Y-cables. Finally, I/O Modules are also available, enabling a range of M8 or M12 equipped sensors and actuators to be connected to a pre-configured distribution box.

Dealing with out of the Ordinary Situations

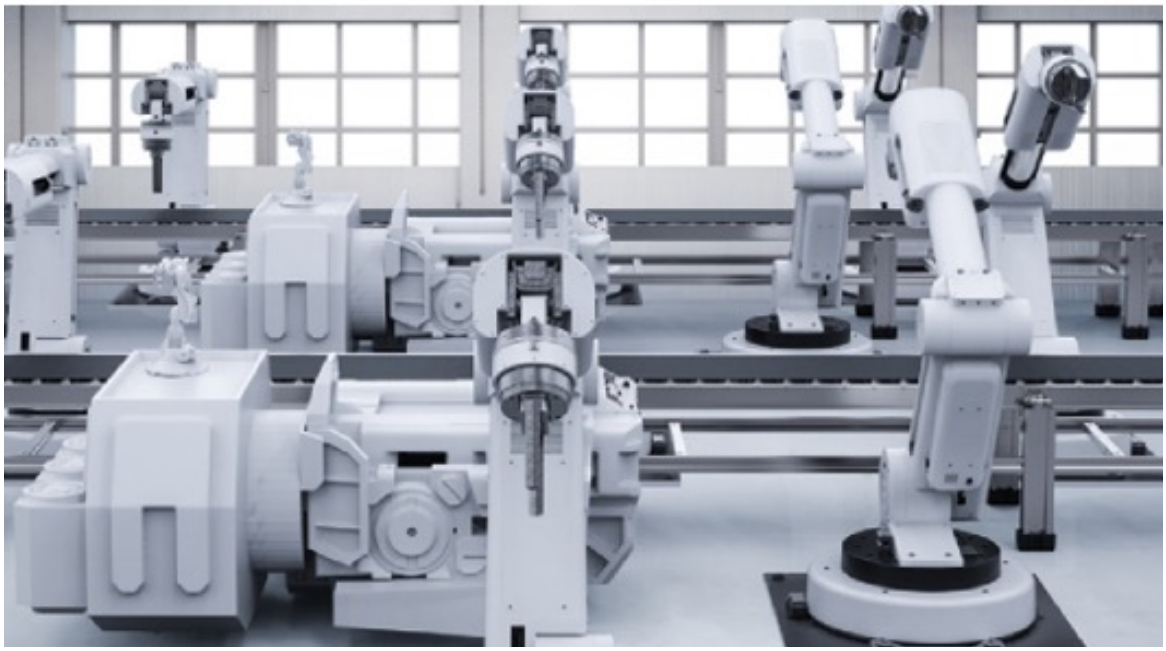
Standards are useful for typical situations, but occasionally industrial engineers are confronted with connectivity challenges that don't fully conform to a given standard. Space may be at a premium resulting in the need to integrate power, signals and data into a single connector, or environmental conditions may demand a unique connector solution. In such cases, products such as the Heavy-Duty Connector (HDC) range provide a robust but highly configurable solution (figure 6). Their modular construction makes them ideal for robotics and automation applications, allowing the industrial engineer to combine power with industry standard interfacing technologies to a total of 216 pins in a single connector. The docking frame also supports blind mating in spaces with limited visibility, enabling easier installation.

The HDC range supports bulkhead and surface mounting, as well as cable to cable and through-panel approaches. The hoods and housings offer both vertical and right-angle cable orientation and protection from IP65 through to IP69k. The anti- corrosion series also provides protection against corrosion due to its hard-anodic oxidation layer. The modular frame supports a range of inserts including power, signals, pneumatic, RJ45, D-Sub and Quintax.

- Cable gland
- Hood
- Male contacts
- Males inserts
- Female inserts
- Bulkhead mounting housings

Figure 6: The HDC range provides industrial engineers the flexibility to provide power, signal and data connectivity in a robust connector solution.

The inserts themselves then offer a range of terminal options from screw to crimp and spring. Screw terminals are suited to heavy gauge wires for power transfer in the range 14 AWG to 5 AWG. Lower power supplies, signals and data can be handled by crimp terminals in the range 20 AWG to 12 AWG, while spring terminals are suited to 26 AWG to 14 AWG wiring.



Motor Applications are Changing, so are their Connectors

Motors today are increasingly compact, yet house more functions that ever. And given the increased volume of data involved, such as monitoring speed, temperature, power consumption and even vibration, it is essential to have absolutely reliable connections. The data is not only used for control and monitoring; with industrial control it can also be integrated into preventative and predictive maintenance applications.

Packaging machines, as well as woodworking and food processing plants, are increasingly moving to decentralized servo motors. These are typically connected to a deterministic control system via Ethernet and fed power via a separate cable. Up until recently this has meant two sets of cables and connectors are required for each servo. The Motorman Hybrid Connector offers a solution to integrate both power and data into a single connector, simplifying design, installation and maintenance.

Figure 7: Diagnostic access is erased with an easy-to-open side panel on the Motorman Hybrid Connector series.

Available in both a metal and plastic shrouded version, the connector provides a useful side access panel, making the individual wires accessible if signals need to be measured. The power pins offer a crimped fitting rated at up to 900 V and 20 A, while two Cat 5e interfaces are fed across gold plated crimped pins (AWG 22 cable). The solution provides protection against dust and water (IP65), integrates 156 N of strain relief, withstands 50 g of physical shock, and provides electromagnetic compatibility (EMC) when using the metal housing.

Summary

Wired connectivity will continue to be the primary technology underpinning industrial control, getting power and data accurately, safely and reliably around industrial environments, and is critical to realizing the potential of smart manufacturing. Connectors have continually developed to meet the demands industrial control applications by adapting to these changing networking trends. This has resulted in wired connectivity solutions that have evolved to integrate power, signals and data while also fulfilling the demands of harsh industrial working environments.

Reference

1. https://www.anybus.com/about-us/news/2018/02/16/industrial-ethernet-is-now-bigger-than-fieldbuses