Circular M8/M12 Interconnect Solutions for Industrial applications

By Kevin Oursler, Dir. Marketing and Business Development at ERNI Electronics

Challenges in Industrial Automation today are being supported by both standardized hardware as well as customized solutions depending on the application. Industrial Ethernet offers cost improvements based on more standardized solutions while accommodating transmission speed improvements over many other technologies, including Fieldbus. The continued development and expansion of more sophisticated industrial automation environments, such as Industry 4.0, is pushing the boundaries on increased performance and integrity of signals at higher data rates within ever demanding and denser packaging and connectivity objectives. Bandwidth, signal integrity, varying transmission lengths, reliable connections and the ability to reliably communicate secure data are becoming familiar performance requirements in the smart factory of today

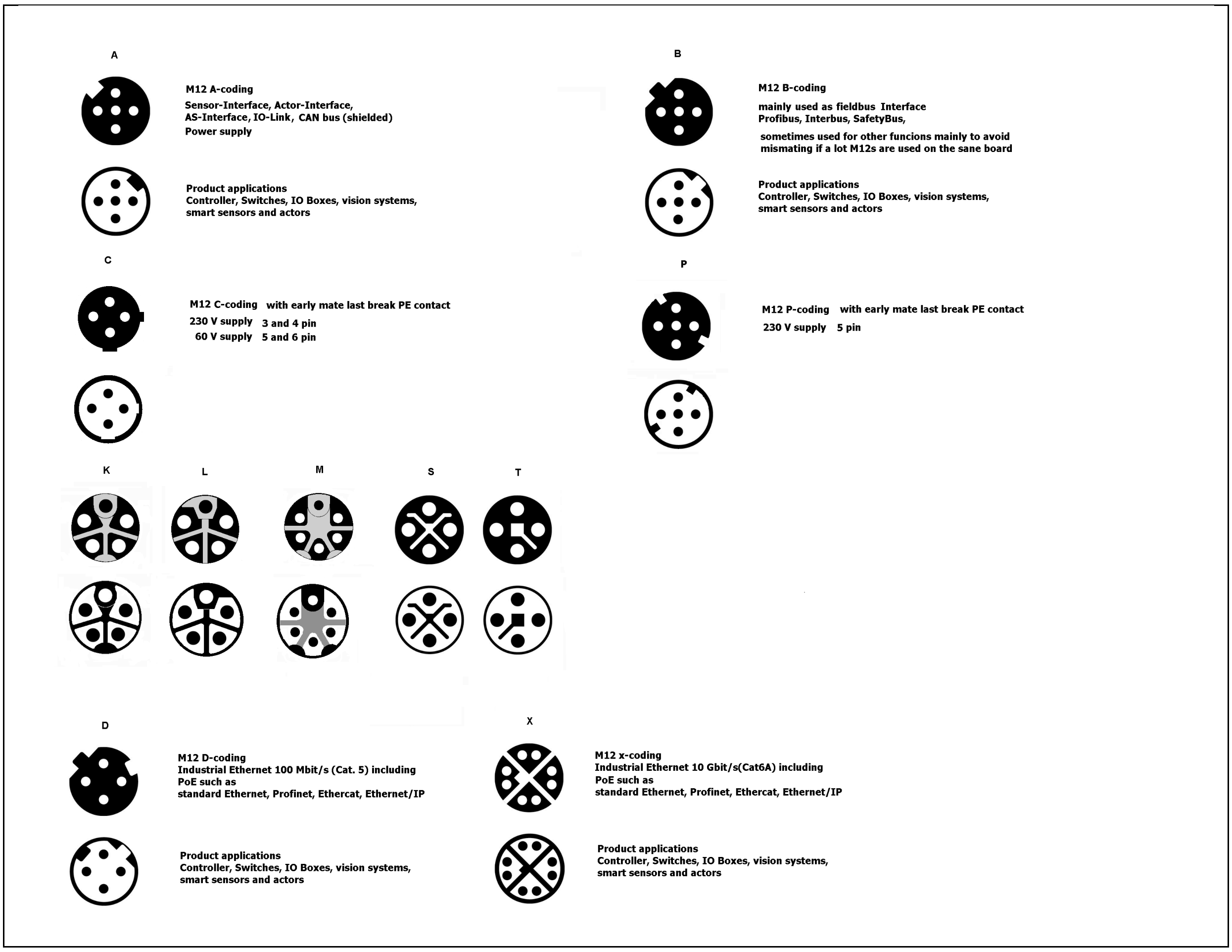
Modular Jack I/O solutions that dominated the traditional networking segments are often employed in industrial Ethernet applications and other I/O requirements where appropriate. But the factory floor and challenges mentioned above compromise using these more legacy I/O connection points that remain prone to damage during handling and installation. Designers are faced with extending reliable connectivity and sub-networks to perform at a more local level without compromising secure data transmission within the network. This often includes new I/O challenges as well as less traditional design requirements that are inside the system or enclosure. Consequently a more diverse set of mechanical and electrical design constraints that support or enhance these delicate tradeoffs continue to be scrutinized; options are a designer's requisite in order to ensure meeting these ever stringent design goals. Critical is implementing a well-designed network of industrial devices and achieving interoperability throughout. This includes the reality that most industrial applications feature harsh conditions of some kind. Whether it be signal integrity demands knowing inherent and often unforeseen noise effects throughout the network, or environmental challenges such as dust and moisture contaminants, extreme temperatures, or shock and vibration. Connectors both inside the system/enclosure and certainly the I/O interfaces must be ruggedized for the applications in which they are employed.

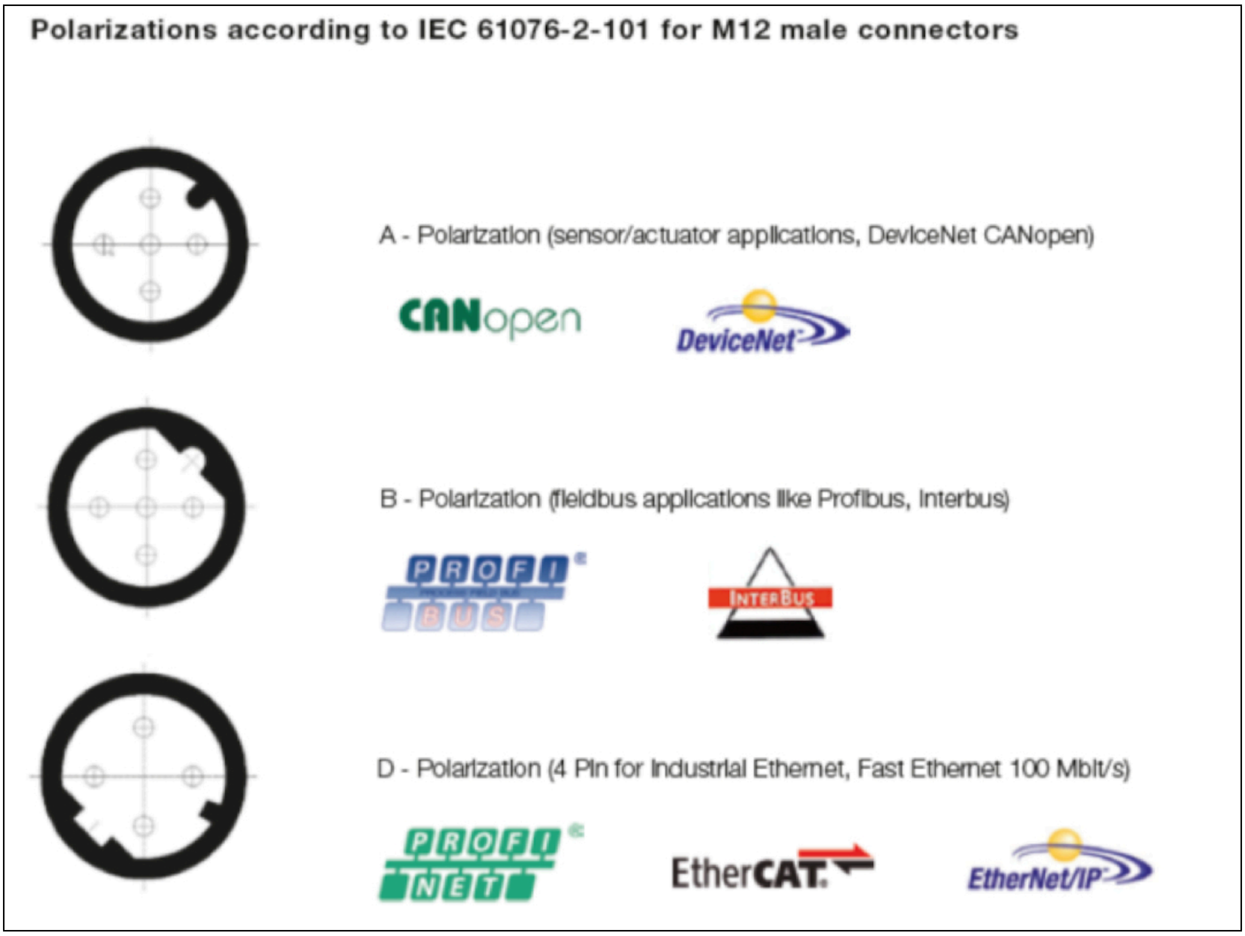
The evolution of the M8 or M12 connector systems has enabled this standardized interface to grow as the widely accepted I/O solution. The metric reference to these standardized solutions defines an 8mm or 12mm threaded connector interface. As early as 1992 [EN 60947-5-2] applications that enabled this interface to grow in popularity included control circuit devices and switching elements as well as proximity sensors(switches) - where the M12 connector is the specified sensor male . Other primary (but not all) connector related specifications include:

- IEC 61076-2-104 for the M8 form factor,
- IEC 61076-2-101 for the M12 series and Polarization (coding) specifications
- IEC 61076-2-109, Circular connectors – detail specification for connectors M 12 x 1 with screw-locking and for data transmissions with frequencies up to 500 MHz
- IEC 61076-2-111, Circular connectors - detail specification for power connectors with M12 screw-locking mechanisms.

Albeit the industrial hardware designer may not be privy to the exact details and requirements of these industry standard interfaces, the confidence when choosing such an I/O solution is supported by these specifications and others that enable specific applications through mechanical coding mechanisms built into the connector housing.

Examples of some of the current polarization/coding schemes and applications segments are shown below. The M8 is available in A-coding and B-coding types only.





M12 connectors and cable plant have been employed in the past in CanBus systems where mixed signal and power are available, via a M12 A-code interface and cable construction accepting wire gauge for higher current. Recent and newer additions to the M12 interface standard include the L-code, K-code and X-code.

IEC 61076-2-111 supporting power applications has included an L-code polarized connector to accommodate more stringent and higher current ratings. This L-code series is dedicated for 63V applications with up to 16A current requirements. There is an inverted contact reserved for FE (functional earth) which also makes the connector more secure for correct mating via this integrated polarization feature. L-code pin configurations are 4+FE, 3+FE and 2+FE.

Likewise, the K-code addition is enabling higher voltage and current applications (630V and 12A) extending to 7.5kW, making this proven interconnect family a true motor/drive connector. Like the L-code, there is an inverted contact employed in the K-code version, but it is connected to PE (protected earth) to avoid electric shocks to operators/handlers if an insulation failure were to occur.

As stated earlier, more demanding e-performance requirements are also challenging new designs in this stalwart interface. The X-coded series is specified for GbE applications. This addition is enhancing the mechanical and electrical benefits in industrial applications where the before mentioned ModJack option has limitations.

Other challenges that have pushed connector density to their respective limits are 8 positions in the M8 series to further accommodate sensor safety designs, and 17 positions in the M12 series for parallel wiring I/O modules and applications that require even more signaling in the same space. The 17 pin extension is also used to integrate different functions with the primary interface (communication, service functions, various signalling/detect and power supply control).

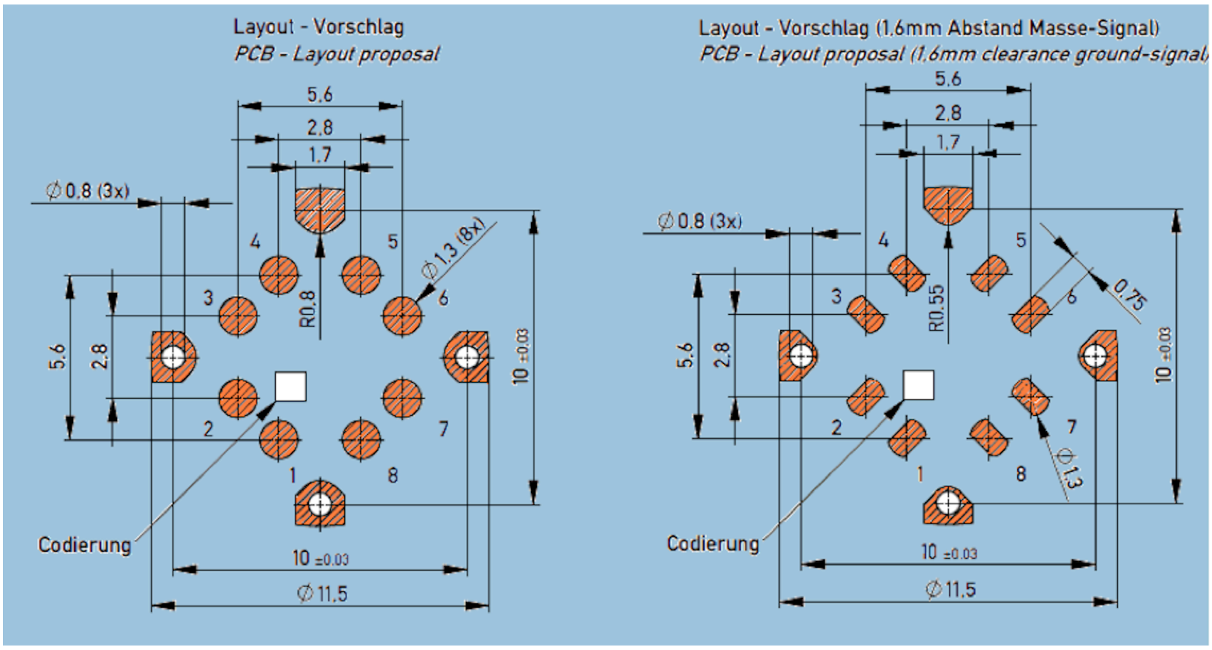
Multiple applications are driving toward a horizontal mount configuration. Sensors applications that challenge packaging and size constraints can now utilize horizontal connector designs that mitigate height constraints without compromising mechanical or electrical performance. Likewise, industrial systems/enclosures can benefit from this innovative connector solution where space is a premium and cable exit challenges can be more easily accommodated.

New 8-position M12's offer more density and are being driven to utilize this space saving form factor in applications that require even more throughput but in height constrained packaging objectives. Not unique to the M12 series, the M8 horizontal mount configuration is also being accepted in the standard 3,4 and 5 pin shielded and non shielded offerings. A sensor version and versions for industrial systems/enclosures will be available in the near future.

Balancing Density and Reliability

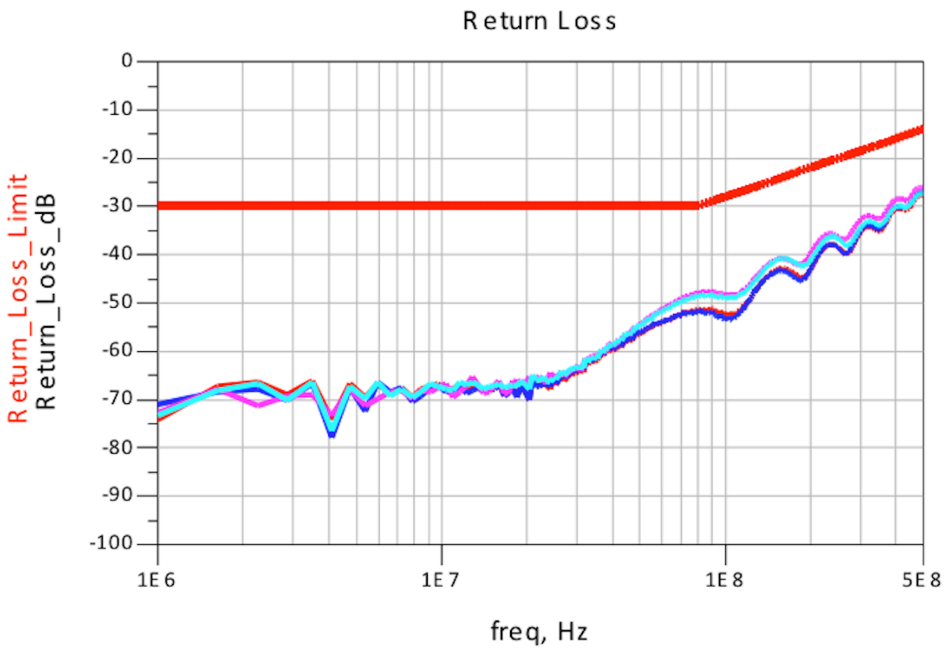
Density remains a growing demand on any connector platform, especially in the I/O offerings such as M8/M12. Open-pinfield connector options accommodating 12 and 17 positions are one way of optimizing your networking design requirements, while requiring fewer connectors and linear board space. When GbE applications are required, the IEC 61076-2-109 specifies target electrical compliance for the connector. Look for maximum shielding between differential pairs as well as improved conductivity between the panel and the board ground plane to enhance your overall design targets.

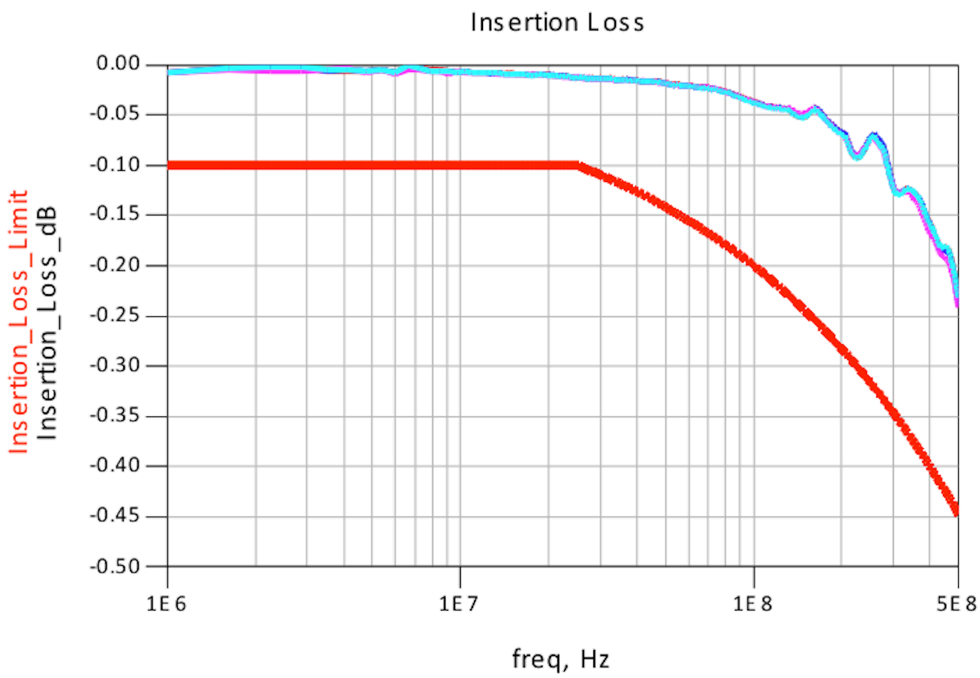
Likewise, the connector footprint and layout are important. Today's dense packaging objectives means valuable real estate on both sides of the pcba. Consider a SMT (surface mount termination) connector design to use more board area on both sides of the pcb, better achieve isolation requirements and minimize stub effects caused by through-hole terminations in higher performing applications.



These SMT termination options and well designed strain relief mechanisms prove beneficial not only in mechanical reliability and optimizing signal integrity, but they are preferred in manufacturing / assembly of the host boards or passive boxes where often employed. These pick-n-place SMT connector options enable optimization of the design and processing requirements.

A properly designed M12 connector will minimize the effects on signal integrity, to include crosstalk objectives, when driving high data rate differential signals. The images below are measured results, mapped to compliance curves that are specified and represent e-performance thresholds by which the connector and/or transmission path should perform.





Proven signal and shield terminations will enhance the design and provide the confidence that is required over the life of the product installed in a factory environment. These enhanced contact designs enable increased throughput (signal density) while maintaining signal integrity performance and reliability. This equates to a budget (signal losses) friendly connector design that allows for longer transmission lengths due to less signal degradation caused by the connector interface or through-hole only footprint.

Conclusion

The defacto-standard M8/M12 connector series has long been used in industrial environments. The evolution of this connector series includes coding features to service specific industrial communications applications. Newer and timely additions include density and higher pincount options. Finally, achieving longer transmission lengths even at increased data rates can now be realized with improved shielding designs and a focus on maintaining signal integrity. Industrial Ethernet applications are growing, so too should your connector choices and options.

For more information, visit:
https://www.erni.com/en/industries/industrial-connector/