

Choosing the right cable

Ethernet is galloping into the industrial world at a remarkable pace. But the factory environment belongs to a different, more demanding world and the infrastructure must move forwards at high speed if it is to keep up. **Heinz-Hermann Thelken**

Industrial Ethernets are beginning to replace the specialised wiring schemes used to connect sensors, actuators and the various smart devices used in industrial automation systems. This move towards standardisation reduces dependency on proprietary, single-purpose wiring harnesses and enhances configuration flexibility. But it also demands that physical components such as cables and con-

nectors must be upgraded or hardened to withstand heat, the action of corrosive chemicals, shock and vibration.

Getting the basics right

Although there are minor differences in standards promoted by individual organisations, the basic theme of industrial strength Ethernet is shared by all.



PROFINET cable – hybrid design with four conductors for power

The most widely used cable type for office Ethernet is Category 5 (or 5e) unshielded twisted pair (UTP) cable connected via RJ-45 connectors. Industrial-grade Category 5/5e Ethernet cables have the same electrical and data-handling characteristics as ordinary UTP cable but with advanced shielding or jacket designs that make them more suitable for harsh environments. Higher-rated cables (Category 6 or 7) are becoming available. These have the advantage in supporting the data rates of gigabit Ethernet: installing them now will future-proof the cable installation. It should be noted though that most industrial sensors and actuators produce relatively modest amounts of data and are adequately served by 10Mbps communication channels.

Twisted-pair cables are limited to runs of no more than 100m between active components. For longer distances, fibre optic cables and equipment are the preferred choice since these offer near perfect EMC resistance and greater bandwidth.

Cable makers have responded to the demands for industrial grade Ethernet cabling by introducing a variety of different cable solutions with properties suited to different industrial environments. Our own company has seen rapid growth in demand for Industrial Ethernet cables to PNO specification. Over the last two years, LSC has more than doubled its portfolio of Ethernet industrial cables. We make 18 dedicated types, including cables for shipboard use, that can between them cope with high temperatures, repeated flexing, oil mist and/or grease.

Although the basic configuration of the data transmission elements remain basically the same – twisted pair or quad – the difference comes with the packaging details. Cable design engineers have access to a huge toolbox of different conductor qualities, a range of shielding techniques and a big choice in determining the insulation characteristics for both individual conductors and the outer jacket of the entire cable. Mixing and matching



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these ingredients results in long-lasting cable tailored precisely to the job for which it was designed. It forms part of the bottom line for infrastructure lifetime, minimal downtime and, ultimately, a reduction in total cost of ownership.

Conductor configuration

Conductor considerations involve the balance of electrical transmission properties and mechanical considerations. These in turn affect cost, size and conductor composition. For low cost and good conductivity, copper is the material of choice for conductors – also in Ethernet cabling. While unplated copper is widely used in standard cables, more advanced cable designs may use plated conductors for greater chemical stability. For applications that involve repeated flexing and/or elevated operating temperatures, high-strength alloy conductors, sometimes with silver plating, are specified.

A major design element relates to the strand count and size of strands per conductor. Ethernet cables for stationary applications (ie, with no movement after installation) will use solid copper conductors, while cabling with occasional movement after installation (patch cords, etc) requires a more flexible configuration. Here, stranded copper conductors such as AWG 22/7 would be appropriate.

High strand counts are used to increase the flex-life of cables. For cable chain applications, LSC has recently developed an extremely flexible Industrial Ethernet trailing patch cable that features fine-strand conductors. Designed for a lifespan of more than five million bending cycles, this cable has two by four by 26AWG conductors, each with 19 strands. This high-flex LAN cable can withstand a bending radius of just four times its outside diameter.

Shielding suppresses the induction, generation and propagation of interference and electrical noise. Inductive coupling can also occur when Ethernet cables and power lines are installed close to each other in tight cable tracks or cramped ducts.

Proper shielding protects the signal integrity and keeps the error rate down. We use design options that include braided shields and foil. For trailing cables, aluminised bonded fleece foil provides good EMI performance even under high bending stress.

Picking the right jacket

The cable jacket provides the first line of defence to hazards of the industrial world. Challenges come from extreme temperature, mechanical stress, corrosive chemicals, grease, oil and even weld spatter. Cables for outdoor installations additionally require UV radiation resistance. Flame resistance is another key requirement for the outer jacket: flame retardance and halogen-free composition are required in a growing number of applications. Flammability and combustion properties are checked and tested against specifications set by national and international bodies such as UL.

While basic versions of cable for fixed installation are protected by PVC jacketing, the cable maker relies on polyurethane (PUR) for cables used in high-flex Ethernet applications. With this material's combination of mechanical strength and resistance to hydraulic fluids, fuels and mineral oils, PUR offers the ideal jacketing solution for factory use. PUR jacketing can be adjusted to specific needs, such as extreme abrasion resistance or flame retardance by mixing in additives. Such cables can be made halogen-free and self-extinguishing.

Alternative materials such as polyethylene can also be used for the outer jacket: High density polymer primary insulation helps to reduce cable diameter without sacrificing electrical or mechanical properties.

Bringing power to the job

Power over Ethernet is now becoming an industrial reality. There are devices (sensors, actuators, etc.) for which it is convenient to have data connections and power supply rails packaged together in the same cable. In some cases, the power can be provided through an unused twisted-pair set. For more demanding situations, there are hybrid cables that combine twisted pair data wires with conductors optimised for power transmission. The advantages can be instantly recognised: hybrids require less space and are easier to install than bundles of (separate) conventional cabling.

Heinz-Hermann Thelken is marketing manager with Leoni Special Cables GmbH

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Features	PNO	IAONA	ODVA
Conductor Cross-Section	AWG 22	AWG 22/24 (permanent installation) AWG 24/26 (flexible cables)	AWG 24
Shielding of cables and connectors	Mandatory	Mandatory	Optional, depending on EMI/RFI conditions
Optional power distribution	With Hybrid cables and connectors		Via data line

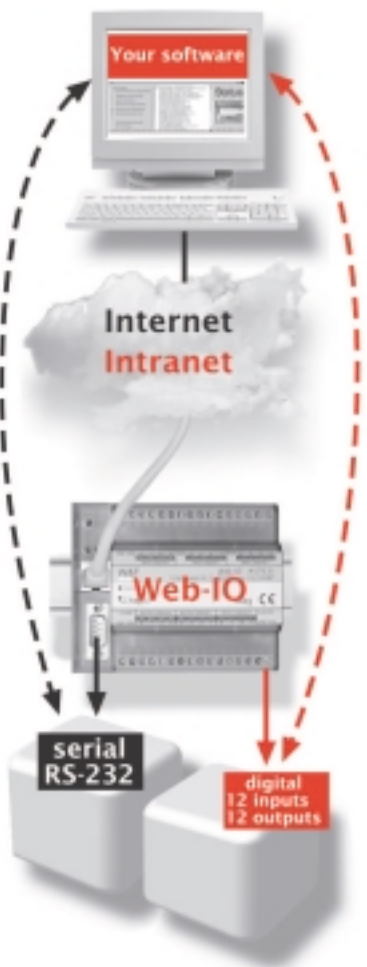
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