DATA CABLE SOLUTIONS FOR THE FLOURISHING SMART FACTORY

WHITE PAPER

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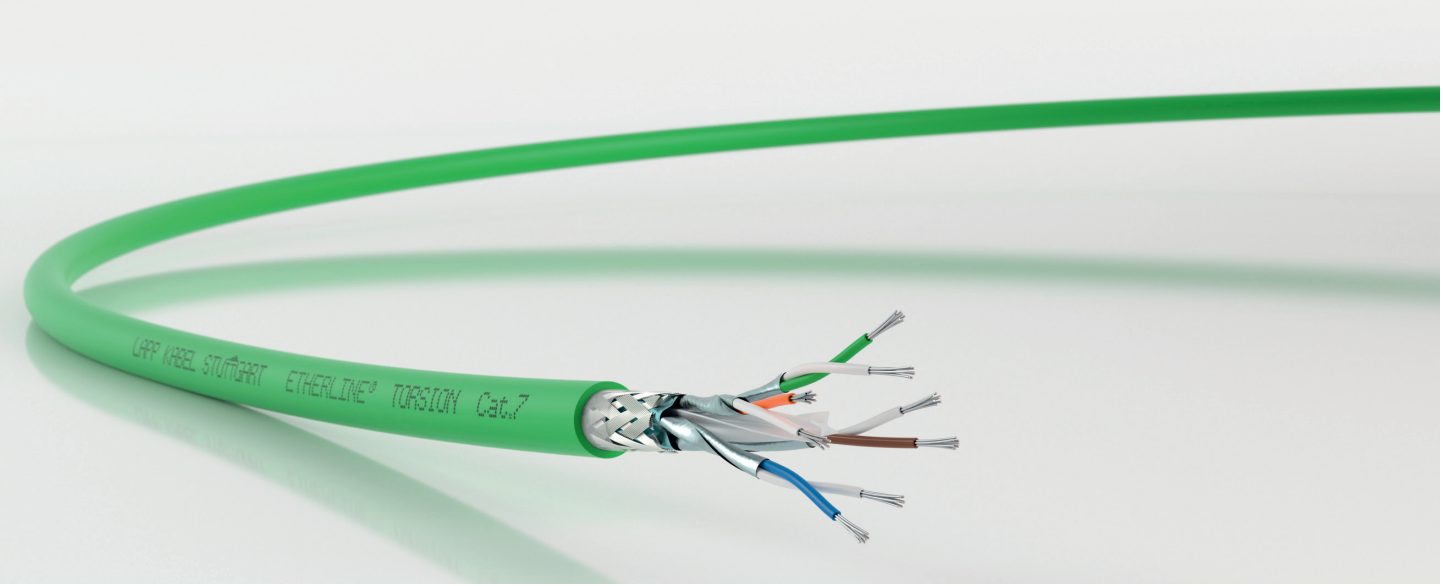
Automation is continuing to increase on the factory floor, creating a growing need for more data exchange over sophisticated, high-performance networks. These new developments, known conceptually as the Internet of Things (IoT), are placing new demands on Ethernet cables, which are the backbone of the smart factory environment. These system-specific cables must be able to hold their own in harsh factory environments while still supporting high data rates.

Because it can be a challenge to combine the design requirements of robustness, flexibility and high data rates all in one cable, it's important to know what your options are when selecting data cables for your factory.

ROBUST FACTORY CONSTRUCTION

In many ways, data cables need to be constructed the same way as other industrial cabling, ensuring they can withstand the harsh environment of the factory floor. Ethernet cables in plant-floor equipment must be able to tolerate a wider range of vibration and electrical noise than equipment installed in offices or information-technology areas, for example. The cables must also be oil resistant, withstand high temperatures and function reliably and durably in a cable track.

These requirements lend themselves to certain design considerations, which are universal to all cables:



Cable jacketing. Cables with jacketing made from thermoplastic elastomer (TPE) or polyvinyl chloride (PVC), for example, will be resistant to oil and chemicals. For increased mechanical and chemical resistance, also consider cables with robust polyurethane (PUR) outer jackets. PVC and TPE jackets are ideally suited for applications, such as food and beverage, that require strict compliance with hygienic standards. Bacteria and other microbes can feed on a cable's polymeric components, causing contamination and degradation of the cable's insulation.

Shielding. Shielded cables are necessary to have on the factory floor, where there is generally a high concentration of power and power/control cables in one contained environment. Most industrial Ethernet cables have foil and/or copper braid shields, which are constructed by crossing layers of individual copper strands. Braid shields provide both structural integrity and room for flexibility–a necessary balancing act, especially in applications where data cables are exposed to stress or torsion. Some industrial Ethernet cables, such as the ETHERLINE® Cat.7 cables, have individually foil-shielded pairs to ensure transmission reliability in environments with high electromagnetic interference.

THE FACE OF THE SMART FACTORY

The Internet of Things links cyber-physical systems–"smart" machines with embedded hardware and software–in a global network. The phenomenon, which is already in motion, is set to become even more important for industrial production in the coming years. The world of factory automation, which is largely based on electrical engineering and hierarchical structures, will transform into smart factory networks, in which production plants can communicate with one another.

Bend radii. The smaller the bend radius, the more a cable can be bent without inducing damage. Minimum bend radii will be dependent on the type of cable being used and the application style of the cable's installation. For example, a continuous flexing cable used in a continuous flexing application where cables are rolling back and forth in a linear motion will have a larger bend radius than if it was being used in a stationary application. This is due to the significantly higher amount of stress in the former over the latter.

TRANSMISSION COMPARISON

Category	Max. Transmission Rate	Service
Cat.5/5e	Up to 100 MHz	• Fast Ethernet (100Mbit) • Gigabit Ethernet
Cat.6	Up to 250 MHz	• Fast Ethernet • Gigabit Ethernet
Cat.6$_A$	Up to 500 MHz	• 10 Gigabit Ethernet
Cat.7	Up to 600 MHz	• 10 Gigabit Ethernet
Cat.7$_A$	Up to 1 GHz	• 10 Gigabit Ethernet

A FLEXIBLE EDGE

The importance of bend radii in cabling lends itself to a larger discussion of data cable flexibility–and how a data cable should be constructed based on if and how a machine moves. When a cable is designed for a special flexing application, it has to be manufactured on a unique cabling machine that minimizes the back-twist on the cable conductors. Types of cable motion include:

- **Continuous flex.** The cable is rolling or flexing back and forth in a linear motion. These cables are typically used in cable track applications.
- **Torsional flex.** The cable is being twisted clockwise and counterclockwise with angles varying from 90 to 360 degrees. This type of flexing usually occurs on robotic equipment that is constantly being twisted or flexed for long periods of time.
- **Bending flex.** Known as a "tick tock" motion, the cable is being flexed back and forth while one end remains stationary. The majority of the stress on the cable is on the two focal points where the bend and load are being applied.

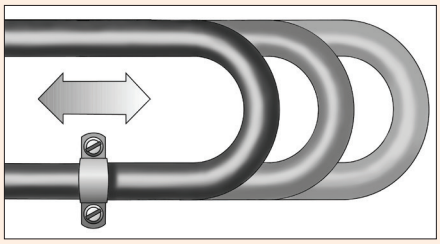
In terms of their construction, continous flexing and torsion cables can have fine stranding up to 19 wires, allowing for greater flexibility. They also undergo rigorous testing to ensure they can survive the demands of harsh industrial environments. The ETHERLINE® TORSION Cat.7 cable, for example, is suitable for high-torsion stress and is tested with up to 5 million bending cycles, as well as a right/left movement of 180 degrees per meter.

TYPICAL MOTIONS FOR FLEXING CABLES

The motion type and application of the cable will determine how the cable is manufactured. When the cable is designed with a special flexing application, the cable has to be manufactured on a unique cabling machine that will minimize and back-twist on the cable core.

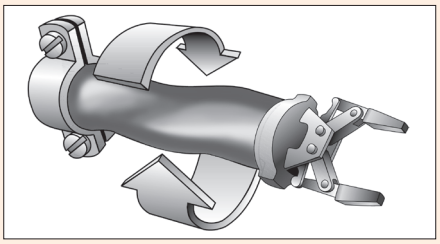
CONTINUOUS FLEX

The cable is rolling/flexing back and forth in a linear motion. Usually these cables are used in cable track applications where the bend radius is designed for 10 x the cable diameter or less.



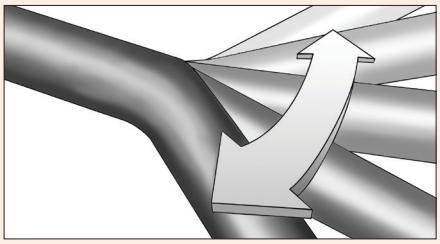
TORSIONAL FLEX

The cable is being twisted clockwise and counter clockwise with angles varying from 90 to 360 degrees. This type of flexing usually occurs on robotic equipment that is being twisted and flexed constantly for a long period of time.



BENDING FLEX

The cable is being flexed back and forth with one of the ends being stationary. This is referred to in the industry as a tick tock motion. Majority of the stress on the cable is on the two focal points where the bend and load are being applied.



ETHERLINE® Ethernet Cat.7 cable's robust PUR outer jacket is highly resistant to mineral oils and abrasion, and its double-shielding ensures transmission reliability.

DATA CABLES AND FACTORY MONITORING

Data cables are increasingly being used to create more information transparency within factories, allowing raw sensor data to be easily and quickly pieced together into higher-value context information. Previously, pinpointing the source of a machine malfunction was a time-consuming process. Now, the ability to continuously monitor equipment and receive feedback on their status helps avoid the potential pitfalls of downtime.

DEMANDS FOR HIGHER DATA

Industrial Ethernet cables must be able to balance robust jacketing and high flexibility without compromising demands for high data rates. The ETHERLINE® Cat.7 series of cabling is ideal for EtherCAT and EtherNet/IP applications that require data rates up to 10 Gbit/s, such as wiring machines and control cabinets. The cable's robust PUR outer jacket is highly resistant to mineral oils and abrasion, and its double-shielding ensures transmission reliability in factories that have a lot of electrical noise. Because of its small cable diameter and bend radius (4 x the outer diameter in a fixed installation), this cable lends itself to industrial environments that have limited space.

In terms of data rate capabilities, compare Cat.7 cables to other industrial cables on the market (see "Transmission Comparison Chart"). Currently, engineers are moving away from Cat.5e cables, which have a transmission rate of up to 100 MHz, to the currently popular Cat.6A cables, which can transmit up to 500 MHz. Over time, the need for industrial cabling with higher data rates will continue to climb.

For more information, including technical specifications, visit www.lappusa.com.