Industrial Data Communication: Importance of Cable Properties

Hans Euler
Product Manager Data Cables
LAPP KABEL
Schulze-Delitzsch-Str.25
70565 Stuttgart, Germany

1. Introduction

Automation and robotics technologies: specific requirements on data cables

Data cables for these industrial application areas have to meet specific electrical, mechanical, chemical and thermal requirements.

The aim is to use high-sophisticated technology/products of non-industrial areas (e.g. network technology) for industrial applications where critical environmental conditions occur, i. e. especially torsion, reversed bending, mechanical stress a.s.o.

Consequently cables for these applications must have a special cable make-up to meet the requirements. Finally a high service life is the ultimate goal.

2. Application areas

First of all we differentiate simple requirements and more complex configurations. In the following we only want to look at more complex configurations, i. e.

1. Bus systems such as INTERBUS, PROFIBUS, CAN, DeviceNet, AS-INTERFACE a. o. with different topologies
   ⇒ *focus on electrical requirements*
2. Robotics - different kinds e. g.
   a) Multi-axis robotics
   b) SCARA robotics (e.g. insertion machines)
   c) Linear handling systems (e.g. power chains)
   ⇒ *focus on mechanical requirements*

Bus technology:
Bus systems are applied with cabling
either ◆ for fixed installation
or ◆ for continuous flexing (power chains etc.) and torsion
or ◆ for outdoor use resp. direct burial

Robotics:
Robotics are applied with cabling suitable for continuous flexing, bending and torsion.

Conclusion: Cables for bus systems and robotics are far more loaded than other cables for data communication.

Consequence: cable properties which exceed average level.

3. Cables for industrial data communication

Now we go into detail and look at different parameters which make cables suitable for industrial application:

a) Cable make-up (design)

The cable make-up is decisive whether a cable is suitable for application under certain conditions (flexing, torsion, bending, oil resistance, chemical resistance, flame resistance and more) resp. for high frequencies and high transmission rates. Furthermore whether a defined existing screening prevents electro-mechanical interferences (EMI).

b) Insulation and outer sheath materials

The *insulation material* essentially determines electrical values.
On the other hand specific insulation materials (e.g. TPE, Teflon, polystyrene) enable easy movement of the cores within the cable during continuous flexing, torsion, bending a.s.o.

The *outer sheath material* has to withstand harsher conditions in industry, i.e. in many cases it has to be highly flexible and has to meet enhanced mechanical, chemical and thermal requirements. Where high flexibility is important very elastic polyurethane outer sheaths are often used.

c) Mechanical aspects

Besides the mechanical loading capacity of the respective cable surface the kind of cable movement decisively determines service life of cables in industrial environment.

We differentiate:

◆ torsion + bending	⇒	multi-axis robotics
◆ mainly torsion	⇒	SCARA robotics (e.g. insertion machines)
◆ mainly bending	⇒	linear handling systems (e.g. power chains)

Conclusion: Particular requirements lead to a particular cable make-up

Torsion
Long lay-up of cores
Same lay stranding (incl. stranded wire)
Adhesion free insulation material (similar Teflon)
Separator (wrapping) between outer sheath and cores

Bending
Short lay-up of cores
Reverse lay stranding
Separator (wrapping) between outer sheath and cores

Fact: Movements *torsion* and *bending* require a different cable make-up.

d) Electrical aspects

Cables for industrial data communication are selected for a *certain application with specific requirements*. Electronically controlled systems therefore require *fixed electrical parameters* such as impedance, mutual capacitance, attenuation, NEXT (near end crosstalk attenuation) a.s.o. to ensure operational security. These electrical values should not change even after millions of bending cycles or torsion movements.

Symmetrical twisted pair cables (TP) and interfaces RS 485 are often used to reach *EMC* (electro-magnetic compatibility). Furthermore *screenings* (foil, braiding, wrapping of copper wire) to prevent *EMI* (electro-magnetic interferences) are applied.

e) Importance of system conform and certified cables

Among other points the operational security of a system depends on the extent the cable parameters correspond to the parameters of the systems used, i.e. the cable properties should be *system conform*.

Cables certified by a neutral institution (third party) offer the advantage for the planner resp. end-user that they meet in any case the specific requirements of a certain system. Thus time and cost consuming inquiries are unnecessary. These cables stand for a *certified security*.

f) Hybrid cables (copper/fibre optic or copper/copper)

In the narrower sense hybrid cables are the combination of copper cores (mainly for power supply) and fibre optic cores (for data transmission) under one common outer sheath.

Sometimes the combination copper/copper is also named as hybrid cable by planners or end-users to describe a configuration of a cable with cores having different cross sections resp. diameters or AWG sizes.

4. Some facts about *LAPP KABEL*

The success story began with ÖLFLEX® - the world´s first industrially manufactured control cable. Today the company is one of the leading suppliers of cables, cable accessories and communication technology. Trademarks like ÖLFLEX® (control cable), UNITRONIC® (data cable), SKINTOP® (cable glands), HITRONIC® (fibre optic products) and FLEXIMARK® (cable marking) stand for products „state-of-the-art“.

The product range and production facilities expanded substantially. Approximately 1700 employees in 30 LAPP companies worldwide offer now their knowledge and experience to the customer. Philosophy of *LAPP KABEL* is to develop and supply products in close contact and cooperation with our customers, and also with manufacturers of bus systems, to meet the requirements of the market.

5. Future cabling - trends and facts

Most likely hybrid cables will gain a substantial share in the near future. The reasons are manifold: cost effective cabling, time-saving assembly, higher data transmission rates, broader bandwidths, better prevention against electro-magnetic interferences (EMI), technology „state-of-the-art“. Moreover cable developments, e. g. of network technology and other high sophisticated fields will influence cable technology. Challenge for R&D: development of appropriate hard- and software and accessories like connectors a.s.o.