# Lapp Cable Guide

LAPP GROUP


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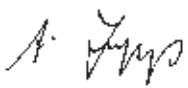
# Contents

## Foreword

We have developed the Lapp Cable Guide to help make your work easier when it comes to the day-to-day handling of our products. It is a comprehensive reference work for using Lapp cables, connectors and accessories.

The product information provides detailed descriptions of the relevant applications, construction data and special features. The Technical Tables include information about markings, load carrying capacity, chemical resistance and protection systems.

Finally, you will find an extensive technical glossary containing all the most important terms used in electrical engineering. The Lapp Cable Guide is a clearly laid out source of information for industry specialists, students, trainees and anyone else with an interest in this area.



Andreas Lapp

## The Lapp Group: At Your Service

In 1957, the company's founder Oskar Lapp developed ÖLFLEX®, the world's first industrially produced control cable. Today, 2,800 employees contribute their dedication, knowledge and ideas to the Lapp Group every day.

Our range includes cables, accessories, cable handling systems and pre-assembled cables. Based on our coordinated systems, our range of products and services has been continuously expanded over the years. In order to offer you optimum quality, our products are constantly being tested in Lapp's own test centres.

The Lapp Group offers a unique range of products, services and manufacturing expertise worldwide.

## Brand quality from Stuttgart

**ÖLFLEX®**

**Power- and control cables**

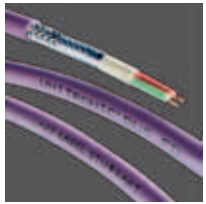
The world's first brand cable is available in the most varied of versions to match maximum requirements.

**Key features:** Oil-resistant, flexible and available to match almost any requirement or environmental condition – also free of halogens.

**Fields of application:** Universal application. Special versions also available for the renewable energy sector.

**UNITRONIC®**

**Data communication systems**



The ideal brand for fast, trend-setting and reliable data transfer.

**Key features:** UNITRONIC® are not only data lines, but also bus lines, which together with active sensor/actuator modules or gateways provide a perfect system for automation.

**Fields of application:** Measurement, control, regulation, bus or LAN networks.

**ETHERLINE®**

**Data communication systems for ETHERNET-Technology**

The brands for network solutions, safety systems and firewalls in the industrial networking sector.

**Key features:** Integral system consisting of hardware (switches, routers, cables, plugs etc.), software, consulting, network design and support.

**Fields of application:** Factory automation.

**HITRONIC®**

**Optical transmission systems**

The brand for split-second, fault-free, intercept-free data transport.

**Key features:** The HITRONIC® product range includes fibre optic cables in the most varied of versions, along with suitable accessories such as splice boxes, wall distributors or couplings.

**Fields of application:** Office and industrial sector.

## Brand quality from Stuttgart

**EPIC®**

**Industrial connectors**

The brand for strong and reliable connections.

**Key features:** Robust square and circular connectors. Flexible system consisting of housings, inserts, contacts and accessories – for every requirement, the tailor-made solution. Similarly, EPIC® SOLAR plugs for photovoltaics are also part of the extensive product range.

**Fields of application:** Mechanical and systems engineering, drive technology and energy production.

**SILVYN®**

**Protective cable conduit- and cable carrier systems**

The brand for all-round cable protection.

**Key features:** The product range includes SILVYN® cable protection hoses for perfect protection against mechanical and chemical loads, along with SILVYN® CHAIN energy supply chains for highly-dynamic applications.

**Fields of application:** Everywhere that cables have to be additionally protected or routed.

**SKINTOP®**

**Cable glands**

The brand for multipurpose cable entries in line with the following: quickly fastened, centred and hermetically sealed.

**Key features:** Large clamping areas, optimum strain reliefs, the most diverse of versions such as SKINTOP® CLICK, COLD or CUBE.

**Fields of application:** Everywhere, where cables must be fastened reliably and quickly.

**FLEXIMARK®**

**Cable marking products**

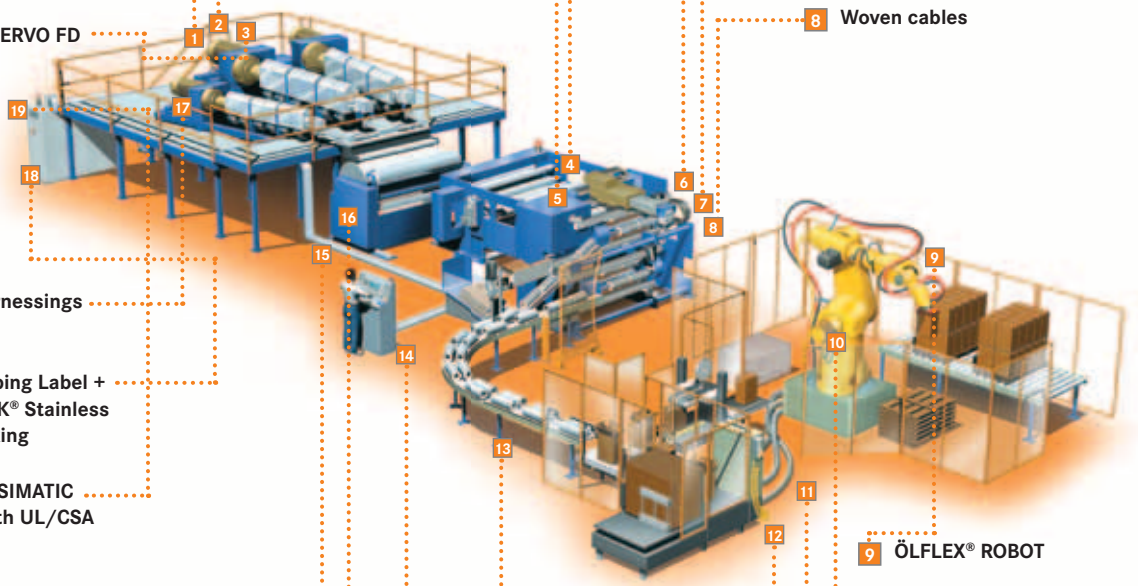
The brand for permanent, clearly-arranged cable markings.

**Key features:** Comprehensive range – from manual labelling solutions onto digital identification. Withstands high chemical, thermal and mechanical loads.

**Fields of application:** All cable, single cores, control cabinets.

## The Lapp Group – The System Supplier

Our brands are adjusted exactly to your workflow.
We have got the appropriate product for every application.




1 **EPIC® CIRCON LS1**

2 **FLEXILABEL LFL**

3 **ÖLFLEX® SERVO FD**

4 **EPIC®**

5 **Cable systems and cable harnessing**

6 **Power chain systems**

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19 **Frontplug SIMATIC S7-300 with UL/CSA**

## An overview of our fields of application

### Mechanical and systems engineering

As suppliers, this is where we are traditionally at home. Ever since we started out, our competence has concentrated on providing solutions for machines and systems. There can hardly be an industrial application anywhere that we have not already equipped in some way:

- Automation and network engineering
- Measurement and control technology
- Electrical installation technology
- Chemical and pharmaceutical industries
- Oil and gas industry
- Maritime and aeronautics
- Food & beverage
- Lifts & handling
- Commercial vehicles
- Robotics
- Lighting and stage technology

### Power generation

Wherever power is generated, cables are required to take it to the users. The efficient distribution of electrical energy is a field known only too well to us. This is why Lapp has been a highly sought after partner for decades to the energy sector.

### Renewable energies

We recognised at an early stage the significance of green energies. Bearing this in mind, we have built up a special proficiency in this area and developed product ranges for our customers. This is why we are accepted as a supplier on equal footing. Be it a wind turbine installation, solar farm or photovoltaic installation for “domestic usage”, we are involved.

### e-Mobility

Tomorrow’s cars will fill up with electricity. And we are already in the pole position for this future market. We supply special system solutions for hybrid vehicles from both German and American manufacturers.

## Cable finding made easy

**In our online-catalogue you can choose from more than 40,000 products. This poses the query: what can we offer you in addition to that, to ensure that you don't get your wires crossed when looking for cables or plugs?**

### Cable Finder

Make short work of searching for cables. You can configure a product online to suit your own requirements, by searching through all the cables, lines and optical fibres available in the online-catalogue as "material sold by the metre". "NEW filter" presents you with an overview of all the innovations from the past twelve months.

**www.lappgroup.com/cablefinder**

### Connector Finder

Configure your EPIC® square, circular or solar plugs online, with only a few clicks of the mouse. Enter the technical parameters and then select the suitable plug socket – the ideal housing package is then automatically suggested. Choose it, look for the matching counterpart, done!

**www.lappgroup.com/connectorfinder**

### CAD Product Catalogue

Design time costs money. Our CAD Product Catalogue enables developers and planners to save both. You can import all the relevant CAD data (e.g. cover sizes, clamping areas, article numbers, etc.) for SKINTOP® cable glands, EPIC® industrial connectors and SILVYN® protective cable conduit systems in your CAD system. We can provide you with all the customary output formats.

**www.lappgroup.com/3d-data**



## Bespoke cable systems

The more complex the application, the more customised cables and lines have to be. When it comes to customer-specific cable systems and spiral cables, Lapp Systems is your specialist. We offer a complete one-stop automation solution for everything to do with cables and cords, from development through logistics to production. In Germany for instance, you will find us at four major regional locations: Cologne, Dresden, and Stuttgart.

**System solutions for:**

- Mechanical and plant engineering and construction
- Telecommunications
- Medical electronics
- Transport
- Elevators and platforms

**Our product offering:**

- Customised cable systems
- ÖLFLEX® Spiral cables made to order
- Pre-assembled cable carrier systems
- Woven cables
- Pre-assembled servo line systems
- Spiralised conduits with single cores and/or wires
- Spiral cable for commercial vehicles
- Pre-assembled HITRONIC® fibre optic cables

## We put quality through a tough test

Multimillion bending cycles at maximum speeds and minimum bending radii. This is only one of many tests that a highly-flexible line has to withstand to be accepted into our standard product range.

Next to what in part are brute-force tests and stringent endurance tests, radiological methods are also used. For example, the special X-ray method EDX, with which the mineral content of human bone tissue is measured. We use EDX to trace any possible toxic substances or RoHS substances in cables and other products.

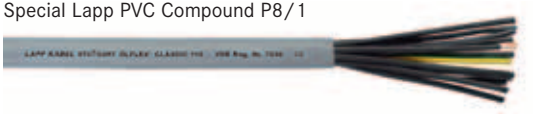
With this in mind: You are very welcome to put your own products through their paces in our trial and test centre.




## ÖLFLEX® CLASSIC 100/110

The Power and Control Cable with coloured cores
Special Lapp PVC Compound P8/1

The Power and Control Cable with numbered cores
Special Lapp PVC Compound P8/1



**Application range**

- Plant engineering and construction
  Industrial machinery
  Air conditioning installations
  Power station
- Fixed installation as well as occasional flexing at free, non-continuously recurring movement without tensile load
- Dry or damp interiors under medium mechanical load conditions

**Product features**

- Flame retardant according to IEC 60332-1-2
- Good chemical resistance see Appendix T1

Photographs are not to scale and do not represent detailed images of the respective products.



## ÖLFLEX® CLASSIC H halogen-free

**Application range**

- Public buildings
- Airport, railway station
- Plant engineering and construction
- Industrial machinery
- Air conditioning installations
- Particularly where human and animal life as well as valuable property are exposed to high risk of fire hazards

Shielded versions:

- In EMI critical environment (electromagnetic interference)

**Product features**

- Flame retardant according to IEC 60332-1-2 or IEC 60332-2-3-24
- Halogen-free according to IEC 60754-1 (amount of halogen acid gas)
  Corrosiveness of combustion gases according to IEC 60754-2 (degree of acidity)
- Flexible up to -30°C

Shielded versions:

- High coverage degree of the screen low transfer impedance (max. 250 Ω/km at 30 MHz)

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ÖLFLEX®

## ÖLFLEX® HEAT 180 SiHF

Silicone cables with high temperature range
-50 °C up to +180 °C

## ÖLFLEX® STATIC SC black

Single core for fixed, unprotected installation
UV-resistant, double insulated


## Cable for sensor/ actuator components

Data transmission cables to connect to M8, M12 connectors
Combination cables to connect sensor/actuator distribution boxes

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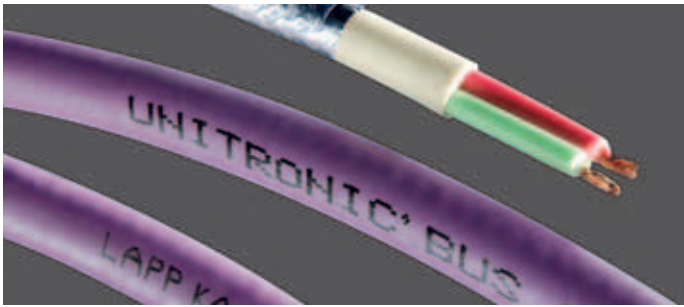
# UNITRONIC®

**Data communication systems**



## UNITRONIC® 100

Data cables low frequency

## UNITRONIC® 100 CY

**Application range**

These control and signal cables are used in the milli-ampere range for computer systems, electronic control equipment, office machines, scales etc. and wherever the thinnest possible control cables are required.

**Product features**

**UNITRONIC® 100**

- Robust, flexible and resistant outer sheath
- Small external diameter despite high number of cores
- Flame retardant according to IEC 60332-1-2

**UNITRONIC® 100 CY**

- Robust, flexible and resistant outer sheath
- Small external diameter despite high number of cores
- Cable similar to UNITRONIC® 100, but with copper braid
- Flame retardant according to IEC 60332-1-2

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## UNITRONIC® FD

## UNITRONIC® FD CY

Highly flexible data transmission cable with copper braiding for power chain use

**Application range**

- Automated production processes require data transmission cables of ever more flexibility and durability
- UNITRONIC® FD series cables are especially suited for power chain use

**Product features**

- The PVC outer sheath prevents mutual adhesion between several cables in the power chain
- Flame retardant according to IEC 60332-1-2
- Please observe the Installation Guidelines in Table T3.

Photographs are not to scale and do not represent detailed images of the respective products.



UNITRONIC®

## UNITRONIC® DeviceNet

Highly flexible and UL/CSA approved

**Application range**

- DeviceNet™ connects industrial devices e. g. limit switches, photoelectric switches, variable frequency drives, valve islands, motor starters, PLCs, etc.

**Product features**

- Based on proven CAN (Controller Area Network) technology.
- Permissible cable lengths vary with the data rate and the cable thickness
- Further details: see Data Sheet

## UNITRONIC® BUS CAN

## UNITRONIC® BUS CAN FD P

**Application range**

**UNITRONIC® BUS CAN**

- Stationary application

**UNITRONIC® BUS CAN FD P**

- For highly flexible applications

**Product features**

- Maximum bit rate: 1 Mbit/s for 40 m segment length
- Larger conductor cross-section necessary with increasing length
- Flame retardant according to IEC 60332-1-2

Photographs are not to scale and do not represent detailed images of the respective products.



## UNITRONIC® BUS ASI

**Application range**

- Communication at Sensor/Actuator level
- UNITRONIC® Fieldbus sensor-/actuator wiring requirements
- Fixed installation as well as occasional flexing at free, non-continuously recurring movement without tensile load
- PUR version has an oil resistant outer sheath for use in industrial environments (e. g. wet areas in automotive industry, processing centres, also in connection with coolants/lubricants) which are mixed with water.

**Product features**

- Data and energy are transmitted both via an un-screened, geometrically coded two-core flat cable (protection against polarity reversal).
- The conductor is contacted by “piercing technology” within the ASI-modules.
- Connection of sensors to the ASI module (coupling module) is carried out using round cables (connection cables).

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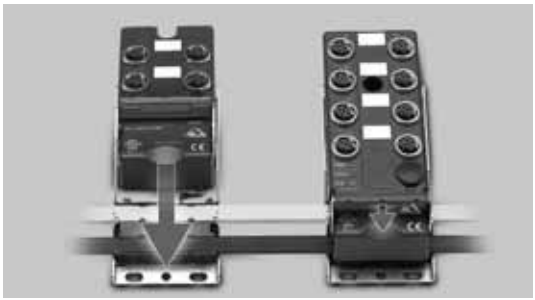
UNITRONIC®

## Fieldbus Systems



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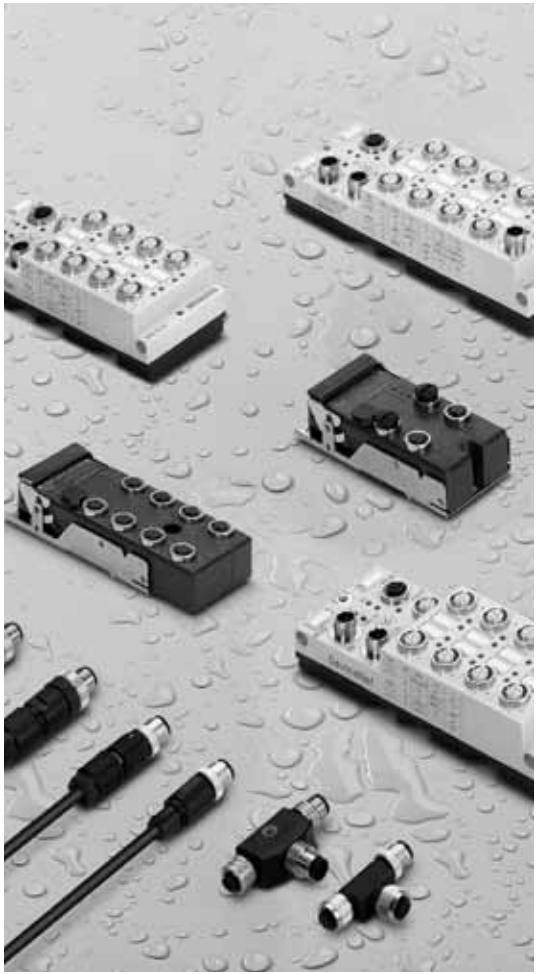

Photographs are not to scale and do not represent detailed images of the respective products.



UNITRONIC®

## UNITRONIC® BUS PB

**Application range**

- For stationary installation of Bus Systems
- Maximal electromagnetic screening
- Dry and damp indoors

**Product features**

- These bus cables can be used for PROFIBUS-DP as well as for PROFIBUS-FMS and FIP
- The stated bit rates allow the following cable lengths (maximum) according of PROFIBUS User Organisation of one bus segment (Type A cable, PROFIBIS-DP):
  93.75 kbit/s = 1200 m
  187.5 kbit/s = 1000 m
  500 kbit/s = 400 m
  1.5 Mbit/s = 200 m
  12.0 Mbit/s = 100 m

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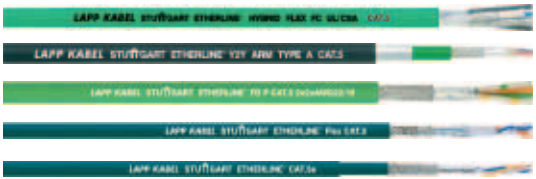
# ETHERLINE®

**Data communication systems for ETHERNET-Technology**

## ETHERLINE® 2-pairs CAT.5/5e



**Benefits**

- ETHERNET with the globally accepted TCP/IP protocol will most probably either provide a connection to the established “Fieldbus World” or the Sensor-Actuator level.
  Either via a gateway to the “Fieldbus World” or straight through down wards to the lowest com munication level. The transmission rates are presently either 10 Mbit/s (ETHERNET) or at least 100 Mbit/s = LAN CAT.5 requirements (Fast Ether-net = Industrial Ethernet) respectively CAT.6a or CAT.7 requirements.
- With regard to transmission rates, the “ETHERNET world” is cut into:
- ETHERNET = 10 Mbit/s
- FAST ETHERNET = 100 Mbit/s
- GIGABIT ETHERNET = 1000 Mbit/s

**Product features**

- In order to reach 100 m link length (like in the office area acc. to ISO 11801) for flexible and highly flexible cable types a cross section of AWG22 is necessary.
- All ETHERLINE® cables with a cross section of AWG22 are PROFINET® compliant.

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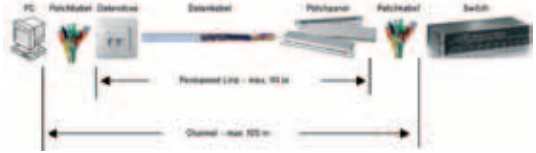
## Structured cabling



If a channel is continuously installed with CAT.5e components, the cabling is according to class E. So far only one component (e.g. patch cable) does not fulfill CAT.5e, the whole system is not conform to class E anymore!

**Application classes for copper cabling (100 Ohms)**

| Application class | Category | Frequency | Service |
|---|---|---|---|
| Class A | – | up to 100 kHz | Telephone, ISDN |
| Class B | – | up to 1 MHz | Telephone, ISDN |
| Class C | CAT.3 | up to 16 MHz | Telephone, ISDN, Token Ring, Ethernet |
| Class D | CAT.5 | up to 100 MHz | 10/100 Base-T |
| Class E | CAT.5e | up to 125 MHz | 10/100/1000 Base-T |
| – | CAT.6 | up to 250 MHz | 10/100/1000 Base-T |
| Class Ea | CAT.6a | up to 500 MHz | 10/100/1000/10G Base-T |
| Class F | CAT.7 | up to 600 MHz | 10/100/1000/10G Base-T |
| Class $F_A$ | CAT.$7_A$ | up to 1 GHz | 10/100/1000/10G Base-T |
| | | up to 1.2 GHz | 10/100/1000/10G Base-T |

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ETHERLINE®

## Overview installation lengths for ETHERNET

| | Medium | Cable | Installation length |
|---|---|---|---|
| ETHERNET | AUI | - | 50 m |
| | 10 Base2 | Thin ETHERNET | 185 m |
| | 10 Base5 | Thick ETHERNET | 500 m |
| | 10 Base-T | Twisted Pair | 100 m |
| | 10 Base-FL | 62.5 µm, 50 µm Multimode LWL | 2,000 m |
| Fast ETHERNET | 100 Base-TX | Twisted Pair | 100 m |
| | 100 Base-FX | 62.5 µm, 50 µm Multimode LWL FDX | 412 m |
| | | 62.5 µm, 50 µm Multimode LWL HDX | 2,000 m |
| Gigabit ETHERNET | 1000 Base-CX | Twinax STP (150 Ohm) | 25 m |
| | 1000 Base-T | Twisted Pair | 100 m |
| | 1000 Base-SX 850 nm | 62.5 µm Multimode LWL | 275 m |
| | | 50 µm Multimode LWL | 550 m |
| | 1000 Base-LX 1300 nm | 62.5 µm Multimode LWL | 550 m |
| | | 50 µm Multimode LWL | 550 m |
| | | Singlemode LWL | 5,000 m |
| 10 Gigabit ETHERNET | 10G Base-T | Twisted Pair | 100 m |
| | 10G Base-LX4 WWDM | Singlemode LWL | 10,000 m |
| | 10G Base-LX4 WWDM | Multimode LWL | 300 m |
| | 10G Base-SR/SW 850 nm | 62.5 µm Multimode LWL | 26 m |
| | | 50 µm Multimode LWL | 84 m |
| | 10G Base-LR/LW 850 nm | Singlemode LWL | 10,000 m |
| | 10G Base-ER/EW 1550 nm | Singlemode LWL | 40,000 m |

**The optical transmission of messages in FOC operates according to the principle of „total internal reflection." The reflection is created by the fact that an optically thinner cladding is placed around the light conducting core on whose interface the light totally reflects and is thereby conducted through the FOC.**
**Although the principle of optical message transmission has been known for a long time, not until recent years was one able to develop, produce and commercially use low loss FOCs. In a time when the need for rapid and secure communications networks is continually growing we can neither imagine a world without the transmission medium FOC nor can it be replaced.**

## Advantages of fibre optics over copper-based transmission

- Protection against electromagnetic interferences, i.e. cable routing can carried out without consideration of possibly occurring sources of ectromagnetic interference
- rapid made-to measure preparation of plastic FOC, simple on-site plug-in connector installation
- Potential separation, that is potential delays are not possible
- No crosstalk and high security against listening in
- Small dimensions and minimal weight (up to 2.2 mm outside diameter and/or 4g/m for plastic FOC in Simplex model)

Among fibre optic cables there is a difference based on the material used between plastic fibres (POF), fibres made of silica glass with optical plastic cladding (PCF) and fibres made of pure silica glass (glass fibre or GOF).

Mainly for use in the industrial area, Lapp Kabel offers FOCs made of glass or plastic and/or hybrid cables.





A portion of these cables is constructively laid for heavy deployment in the energy supply chain. The overall concept of your data transmission line determines whether glass or plastic fibre optic cables are used. We offer you suitable plug-in connectors, tools and pre-fabricated FOC patch cables that match the cables being used.

**Typical deployment areas for POF and PCF FOCs:**
- Bus systems in automatisation
- Machine construction and plant engineering

**Because of their special characteristics POF-FOC are used**
- High demands at data security
- For conditions where space is limited
- For short data transmission distances (up to around 70 m)

**Typical application areas for GOF FOCs:**
Everywhere where large amounts of data must be transmitted at high speed over distances of approx. 60 m to several kilometres. For example in
- Local Area Networks (LAN)
- Metropolitan Area Networks (MAN)
- Wide Area Networks (WAN)

## UNITRONIC® DeviceNet

## HITRONIC® HYBRID FD P DESINA®

## HITRONIC® BUS PCF DUPLEX indoor + outdoor

## HITRONIC® HQN Outdoor Cable



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## Optical transmission systems

**Two different connection types are used with fibre optic cables:**

- Detachable connections realised with plug connectors. In this case it is necessary to attach a plug to a glass fibre. This calls for trained personnel and expensive special tools.
- Non-detachable connections created by directly splicing two glass fibres together. To do this requires highly trained personnel and very expensive equipment. If the necessary resources are used only occasionally, the investment is very unlikely to pay for itself.



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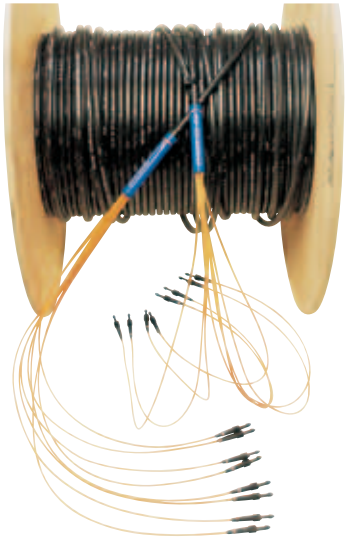

**Advantages**

Using a trunk system offers you the following advantages:

- No costs of special equipment
- No need for highly trained personnel
- Uniform quality thanks to manufacture under laboratory conditions
- Installation is quick, thereby saving costs
- No need to carry out measurements on the cable run, comes with OTDR test certificate
- Fan-out elements also available in IP67

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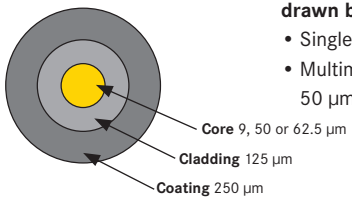
HITRONIC®

## Fibre Optical cables F.O.

**Advantages of Fibre Optical Cables**

- high resistance to tapping
- no EMC interference
- no EMC testing required
- long range
- no potential transfer
- no cross-talk
- little space required
- low cable weight
- can be installed in a potentially explosive environment

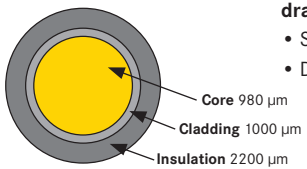
**GOF – Glass Optical Fibre**




**A distinction is drawn between GOF:**

- Singlemode Fibre SM 9 µm
- Multimode Fibre MM 50 µm or 62.5 µm

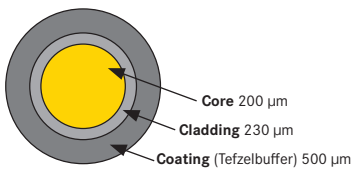
**POF – Polymer Optical Fibre**




**A distinction is drawn between GOF:**

- SIMPLEX (one Fibre)
- DUPLEX (two Fibres)

**PCF – Plastic Cladded Fibre**




HITRONIC®

| Fibre type | max. attenuation [dB/km] | | | | Numerical aperture |
|---|---|---|---|---|---|
| | 660 nm | 850 nm | 1300 nm | 1550 nm | |
| POF | 160 | | | | 0.47 |
| PCF | 10.0 | 8.0 | | | 0.37 |
| GOF MM 50 µm OM2 | | 2.7 | 0.9 | | 0.20 |
| GOF MM 50 µm OM3 | | 2.7 | 0.9 | | 0.20 |
| GOF MM 62.5 µm OM1 | | 3.2 | 0.9 | | 0.27 |
| GOF SM | | | 0.36 | 0.2 | 0.10 |

| Fibre type | max. transfer size [m] | | | |
|---|---|---|---|---|
| | 660 nm | 850 nm | 1300 nm | 1550 nm |
| POF | 100 Mbit/s: 60 | | | |
| PCF | 100 Mbit/s: 550 | | | |
| GOF MM 50 µm OM2 | | 100 Mbit/s: 2.000<br>1 Gbit/s: 550 | 100 Mbit/s: 2.000<br>1 Gbit/s: 550 | |
| GOF MM 50 µm OM3 | | 10 Gbit/s: 300 | 10 Gbit/s: 300 | |
| GOF MM 62.5 µm OM1 | | 100 Mbit/s: 2000<br>1 Gbit/s: 275 | 100 Mbit/s: 2000<br>1 Gbit/s: 550 | |
| GOF SM | | | 1 Gbit/s: 5.000 | 1 Gbit/s: 80.000<br>10 Gbit/s: 40.000 |

**OM3-Fibre, 10 Gbit/s Ethernet Systems**

In these systems the data rates are so high that a length of just 84 m is achieved with conventional multi-mode fibres. This performance is just sufficient for the reliable operation of 1GB/s lines. The differences in running time for the multi-mode fibres was minimized for the OM3 fibre with special processes in the core area. This enables transmission distances of up to 300 m. With the OM3 fibre, costs are considerably reduced by using the simpler, less expensive Mulrimid terminal devices and installation-friendlier termination.

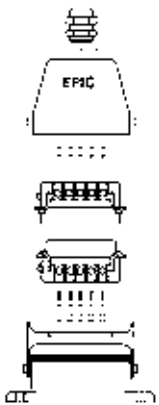


## EPIC® Rectangular Connectors

Quality, functionality and safety.
Three attributes, one brand name: EPIC® rectangular industrial connectors are renowed for their innovative electrical design and physical characteristics.

**Solutions for many applications:**

- Number of poles from 2 up to 216
- Currents up to 82A
- Voltages up to 1000V
- protection class IP 65
- modular for current supply, signal and data
- housings variations for cable connection and for the assembly at devices
- Termination technologies: solder, screw, crimp, cage clamp
  For inserts with screw termination please use the processing tool (Chapter Accessories)
- H-A 3: Zinc die-casting, thermoplastic
- H-A 10-48; H-B 6-48: Aluminium die-casting




1. Cable gland
2. Hood
3. Pin and sleeve insert
4. Base

## Industrial Connectors

**1. Cable gland**
For hoods, coupler hoods and surface mount bases for sealing, strain relief and to provide the cable with EMC protection. A selection of glands are available depending on the application.

**2. Hood**
The hood can be combined at will with either a panel or surface mount base, or a cable coupler hood for cable to cable connection.

**3. Pin and sleeve insert**
The pin and sleeve insert accommodates the individual contact elements and provides insulation at the same time.

Available connector variations include screw, crimp and spring cage clamp terminated connectors.

Photographs are not to scale and do not represent detailed images of the respective products.

**4. Base housing**
There is a choice of three different base housing depending on the application:

**Surface mount base:**
For wall mounting

**Panel mount base:**
For panel lead-throughs

**Cable coupler hood:**
For cable to cable connections

There are two housing series with different housing sizes (width). Series EPIC® H-A is the narrower series. The increased housing width of the EPIC® H-B usually allows the use of inserts with higher voltages for the same number of contacts.

Photographs are not to scale and do not represent detailed images of the respective products.

## Technical Data

| Series | Rated voltage | Rated current | Termination type |
|---|---|---|---|
| **EPIC® H-A 10 – 48**<br>**EPIC® H-A 3/4**<br>**Compact design** | VDE: 250 V<br>VDE: 400 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>VDE: 10 A<br>UL: 10/14 A<br>CSA: 10/16 A | Screw |
| **EPIC® H-Q5 5+PE**<br>**The small format** | VDE: 230 V/400 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL: 16 A<br>CSA: 16 A | Crimp |
| **EPIC® STA 6 – 40**<br>**Low voltage connector** | VDE: 60 V<br>UL: 48 V<br>CSA: 48 V | VDE: 10 A<br>UL: 10 A | Screw<br>Solder |
| **EPIC® H-BE 6 – 48**<br>**Standard inserts** | VDE: 500 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL: 16 A<br>CSA: 16 A | Screw<br>Crimp |
| | VDE: 500 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL: 16 A<br>CSA: 16 A | Spring cage |
| **EPIC® H-EE 10 – 92+PE**<br>**Inserts for high crimp contact density** | VDE: 500 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL 16 A<br>CSA: 16 A | Crimp |
| **EPIC® H-BS 6 – 12**<br>**Inserts for high currents** | VDE: 690 V<br>UL: 600 V<br>CSA: 600 V | VDE: 35 A<br>UL: 35 A<br>CSA: 35 A | Screw |
| **EPIC® H-BVE 3 -10**<br>**High voltage cage inserts** | VDE: 630 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL: 16 A<br>CSA: 16 A | Screw (spring HBVE) |

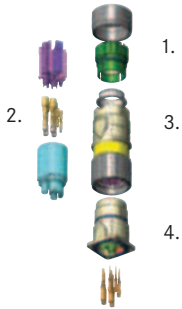
## Technical Data

| Series | Rated voltage | Rated current | Termination type |
|---|---|---|---|
| **EPIC® H-D 7 – 128 For high contact density** | VDE: 42/250 V<br>UL: 250 V | VDE: 10 A<br>UL: 10 A | Crimp |
| **EPIC® H-DD 24 – 216 For higher contact density** | VDE: 250 V<br>UL: 600 V<br>CSA: 600 V | VDE: 10 A<br>UL: 8.5 A<br>CSA: 10 A | Crimp |
| **EPIC® MC 3 – 280 Modular system** | VDE: 30-1000 V<br>UL: 100-600 V<br>CSA: 100-600 V | VDE: 1-82 A<br>UL: 4-40 A<br>CSA: 4-25 A | Crimp<br>Screw<br>Spring cage |
| **EPIC® TB-H-BE 6-24 Term. adapter** | VDE: 500 V<br>UL: 600 V<br>CSA: 600 V | VDE: 16 A<br>UL: 16 A<br>CSA: 16 A | Screw |





## EPIC® Circular connectors




**1. Cable gland**
An integral EMC cable gland in the hood, panel mount or cable coupler housing gives built-in protection from electromagnetic radiation.

**2. Insert**
The inserts can accommodate contacts with crimp or solder terminations.

**3. Hood**
The top housing (cable plug) can be freely combined with a panel mount, coupler or surface mount base.

**4. Identification ring**
The unique marking system uses coloured identification clips to provide clear marking. Alternatively connectors can be marked with individually writable labels that are simple, abrasion resistant and will not get lost.

**5. Housing base**
Three different types of housing are available:
Panel mount base:
For panel feed-throughs
Feed-through housing: For wall feed-throughs with wall fixing Coupler connector:
For cable to cable connections

**EPIC® CIRCON LS 1 – Power connector featuring:**
- IP 68 (10h/1m)
- Unique marking system
  a) using coloured identification clips
  b) or alternatively with individually writable labels
- Clearly visible and tactile-matching when connecting
- Contact connector to DIN EN 61984

Photographs are not to scale and do not represent detailed images of the respective products.

**Electrical data 5 + PE**

| | |
|---|---|
| Rated current | 2 mm contacts: 22 A at 2.5 mm² |
| Rated voltage | 2 mm contact: 630 V |
| Rated surge voltage | 2 mm contact: 6 kV |
| Pollution severity | 3 (≥ IP54) |
| Overvoltage category | 3 |
| Termination sizes | |
| Power | 0.5 – 2.5 mm² crimp<br>AWG 14 – 20 crimp |

**Electrical data 3 + PE + 4**

| | |
|---|---|
| Rated current | 1 mm contacts: 7 A at 1.0 mm² |
| Rated current | 2 mm contacts: 22 A at 2.5 mm² |
| Rated voltage | 2 mm contacts: 630 V |
| Rated surge voltage | 1 mm contacts: 4 kV |
| Rated surge voltage | 2 mm contacts: 6 kV |
| Pollution severity | 3 (≥ IP54) |
| Overvoltage category | 3 |
| Termination size/type | 1 mm contact:<br>0.14 – 1.0 mm² crimp<br>AWG 18 – 24 crimp |
| Termination size/type | 2 mm contact:<br>0.5 – 2.5 mm² crimp<br>AWG 14 – 20 crimp |

**Electrical data 5 + PE/3 + PE + 4**

| | |
|---|---|
| Protection class | IP 68 (10h/1m) |
| Temperature range | -25 °C to +125 °C |
| Mating cycles | 500 |
| Cable diameter | 7.5 – 15.5 mm |
| Resistance | Corrosion resistant<br>Mechanically resistant |





## EPIC® POWERLOCK A1 C

**Benefits**

- Resistant to mechanical influences in harsh environmental conditions
- Connectors in harmonized colours according to European standards
- Every colour different coded to prevent incorrect plugging
- US colours on request

**Application range**

- For Renewable Energy Plants e.g. Wind power
- For mobile and stationary power distribution
- For the connection of motors, transformers and generators
- Light & Sound technology

Photographs are not to scale and do not represent detailed images of the respective products.

## EPIC® POWERLOCK D6 C

### Benefits

- Resistant to mechanical influences in harsh environmental conditions
- Connectors in harmonized colours according to European standards
- Every colour different coded to prevent incorrect plugging
- US colours on request

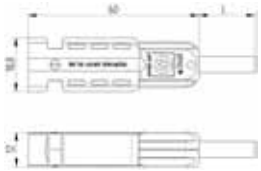
### Application range

- For Renewable Energy Plants e.g. Wind power
- For mobile and stationary power distribution
- For the connection of motors, transformers and generators
- Light & Sound technology

Photographs are not to scale and do not represent detailed images of the respective products.



## EPIC® SOLAR 4 THIN M pre-assembled



### Benefits

- Unresistant cable connection for efficient power transmission
- Innovative, patented pending contact system, current leaves the connection cool
- High reliability and longevity by welded bonding
- Extra Thin 12 mm for high density packing

### Application range

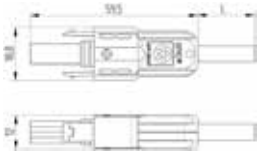
- Pre-assembled connector cables for weather proof cabling of Photovoltaic systems

### Product features

- 4 mm connector system with double hook
- Pre-assembled with 100% automatic control
- Wide range of wire sizes from 1.5 mm² up to 6 mm²
- TÜV Rheinland certified
- UL in preparation

Photographs are not to scale and do not represent detailed images of the respective products.

## EPIC® SOLAR 4 THIN F pre-assembled



**Technical data**

- Rated voltage in V
  1000 V AC/DC
- Rated impulse Voltage
  8 kV
- Contact resistance
  < 0.2 m Ohm

**Degree of protection**

- IP68 (10 h/1 m)
- Protection class II
- Cycle of mechanical operation 100

**Range of temperature**

- -40 °C ... +105 °C

Photographs are not to scale and do not represent detailed images of the respective products.



## SKINTOP® CLICK/SKINTOP® CLICK BS

SKINTOP® cable glands polyamide metric

SKINTOP® CLICK

SKINTOP® CLICK BS

### Benefits

**SKINTOP® CLICK**

- Fewer parts, counter nut no longer needed
- Up to 70% time saving due to innovative CLICK system
- Vibration protection
- No thread required

**SKINTOP® CLICK BS**

- Reliable bending protection for cable conservation and functional reliability
- Up to 70% time saving due to innovative CLICK system
- No thread required
- To protect flexible cables
- Fewer parts, counter nut no longer needed

### Application range

**SKINTOP® CLICK**

- Automation technology
- Solar applications
- Switch cabinet building
- Measurement, control and electrical applications
- Air conditioning technology

**SKINTOP® CLICK BS**

- Cables for electrical appliances and machinery, which are moved under normal use, must be protected against excessive bending, as required in accordance with VDE 0730.
- Robotics industry
- Flexing machine parts
- Apparatus construction
- Light and sound applications

Photographs are not to scale and do not represent detailed images of the respective products.



## SKINTOP® K-M ATEX plus/ SKINTOP® KR-M ATEX plus

SKINTOP® cable glands polyamide metric

SKINTOP® K-M ATEX plus

SKINTOP® KR-M ATEX plus

### Benefits

**SKINTOP® K-M ATEX plus**
**SKINTOP® KR-M ATEX plus**

- High degree of protection
- Dynamic strain stability
- High strain relief
- Large, variable clamping ranges
- Permanent vibration protection

### Application range

**SKINTOP® K-M ATEX plus**

- Devices, machines of type of protection enhanced safety “e”
- Equipment group II/ Category 2G+1D
- Mobile offshore and marine applications
- Chemical and petrochemical industry

**SKINTOP® KR-M ATEX plus**

- With reducing seal insert, to seal cables with smaller outer diameters.

Photographs are not to scale and do not represent detailed images of the respective products.



SKINTOP®

## SKINTOP® MS-M ATEX/ SKINTOP® MSR-M ATEX

SKINTOP® cable glands nickel plated brass metric

SKINTOP® MS-M ATEX

SKINTOP® MSR-M ATEX

**Benefits**

SKINTOP® MS-M ATEX
SKINTOP® MSR-M ATEX

- Dynamic strain stability
- High strain relief
- Large, variable clamping ranges
- Anti Static
- Maximum reliability

**Application range**

SKINTOP® MS-M ATEX

- Devices, machines of type of protection enhanced safety “e”
- Equipment group II/ Category 2G+1D
- Mobile offshore and marine applications
- Chemical and petro-chemical industry

SKINTOP® MSR-M ATEX

- With reducing seal insert, to seal cables with smaller outer diameters.

Photographs are not to scale and do not represent detailed images of the respective products.



## SKINTOP® MS-M BRUSH

SKINTOP® cable glands nickel plated brass metric

**Benefits**

- Faster, easier screen contact
- Optimal low-resistance 360° screen contact
- Faster than any other comparable system
- Uncomplicated and reliable
- Maximum assembly and adjustment possibility

**Application range**

- For EMC compliant earthing of the copper braiding and copper shaft sheath
- Automotive systems
- Conveyor technology
- High power drives
- Frequency converters

Photographs are not to scale and do not represent detailed images of the respective products.



SKINTOP®

## SKINTOP® CUBE

SKINTOP® Cable Bushing System

SKINTOP® CUBE MODULE

SKINTOP® CUBE SKINTOP® CUBE FRAME

**Benefits**

Various clamping range

- Vibration safe fixed modules
- Strain relief
- Oil resistance
- Simplified service due to easy assembling and disassembling

**Application range**

- For installation of harnessed cables
- Everywhere where cables must be safely inserted into housings.
- Apparatus and switch cabinet construction
- Electronic installations
- Automation technology

CE RoHS

Photographs are not to scale and do not represent detailed images of the respective products.





## Extraction of the SILVYN® range

**Plastic cable conduits**

**SILVYN® SI**
PVC cable conduit – protection against dust + humidity.

**SILVYN® SP**
PVC conduit with a reinforced PVC spiral.

**Cable conduits with PVC spiral**

**SILVYN® EL**
A flexible PVC conduit with a reinforced PVC spiral, UL approved.

**SILVYN® ELÖ**
Oil resistant PVC conduit with a reinforced PVC spiral.

**Highly flexible cable conduits**

**SILVYN® FPS**
A highly flexible PUR conduit with an insulated steel spiral.

**SILVYN® FD-PU**
Highly flexible PUR conduit for the toughest demands, with insulated steel spiral.

Photographs are not to scale and do not represent detailed images of the respective products.



Extraction of the SILVYN® range

**Polyamide cable conduits, corrugated**

**SILVYN® RILL PA 6**
A polyamide cable conduit for the toughest demands.

**SILVYN® FPAS**
Polyamide conduit for the toughest demands.

**Protective cable conduits for subsequent installation**

**SILVYN® RILL PA 6 SINUS**
Polyamide 6 protective conduit, resistant against oil, gasoline and chemicals, with sinusodial cut.

**SILVYN® SPLIT**
Polyamide 6 protective conduit, resistant against oil, gasoline and chemicals, divisible.

**Metal cable conduits for heavy mechanical stresses**

**SILVYN® AS**
Steel conduit for high mechanical stresses.

**SILVYN® AS-P**
Steel conduit, fluid-tight, with a PVC outer sheath.

Photographs are not to scale and do not represent detailed images of the respective products.



SILVYN®

## Extraction of the SILVYN® range

**Steel cable conduits, highly flexible with a plastic sheath**

**SILVYN® LCC-2**
A highly flexible steel conduit with a plastic sheath.

**SILVYN® LCCH-2**
A highly flexible steel conduit with a plastic sheath, halogen-free.

**SILVYN® SSUE**
A highly flexible stainless steel conduit.

**SILVYN® UI511**
Anaconda cable conduit, stainless steel.

**Anaconda cable conduits in steel and plastic**

**SILVYN® CNP**
Anaconda conduit, non-metallic, watertight, UL approved.

**SILVYN® HTDL**
Steel protective conduit with PVC outer sheet, liquid-tight, UL approved.

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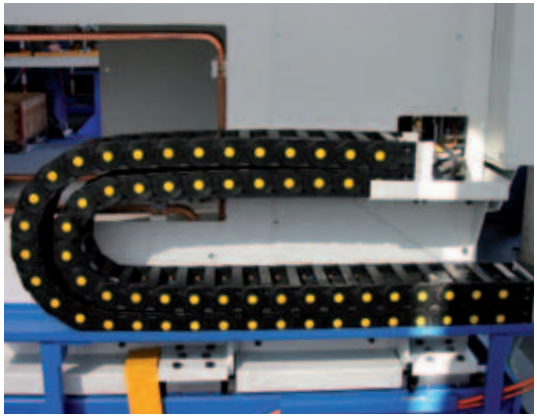
## SILVYN® CHAIN Series Medium



All purpose, due to its single pin, also for higher mechanical requirements. Specially for small and medium-size chains. Available closed or with foldable lid.

**Characteristics**
- Standard applications
- Tongue/groove system with yellow pin
- Inner hight 18 – 76 mm
- 12 types, many widths

**Application areas**
- Automation
- Handling equipment
- CNC machines
- Medium sliding applications

Photographs are not to scale and do not represent detailed images of the respective products.

## SILVYN® CHAIN Series Sliding

Specialist for operation on very long travelling distances up to 400 meters. Chain links with shoes made of low-friction, low-wear plastics. System-completing channel constructions available for supporting and guiding the chain.

**Characteristics**

- Long sliding distances
- Tongue/groove system with yellow tripple pin
- Inner hight 30 – 70 mm
- 12 types, many frame versions: Nylon, Aluminium, Inox

**Application areas**

- Sliding with high speed and high charge weight
- Long life-cycle applications (very long lifetime)

Photographs are not to scale and do not represent detailed images of the respective products.



## SILVYN® CHAIN Series Steel

The hardliner. For all applications not allowing the use of a plastic chain, for example in steel works, foundries, on machine tools and oil-rigs. Made of galvanized steel with drilled aluminium frames or steel separators (adjustable separators). Available in stainless steel AISI 316 if required.

**Characteristics**

- Highest load capacity
- Highest chemical resistance
- Tongue/groove system in metal
- Inner hight 32 – 182 mm
- 5 standard types
- Customised versions

**Application areas**

- Steel mills/steel works
- Off-Shore
- Long-travel machining centers
- Heavy duty environment

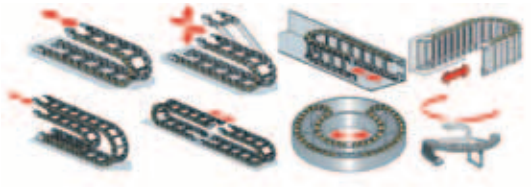
Photographs are not to scale and do not represent detailed images of the respective products.



SILVYN®

## SILVYN® CHAIN Installation types

Horizontal



Vertical

Photographs are not to scale and do not represent detailed images of the respective products.





| How? / What? | | BASIC SYSTEM<br>Ready made to deliver for each environment | CUSTOMIZED SYSTEM<br>Your demand – we deliver |
|---|---|---|---|
| CABLE | Outdoor & Indoor |  MINI & MAXI & HOLDERS PTE<br>  STAINLESS STEEL<br>  COLLARS TS & HF & MARKING TAGS<br>  SHRINK TUBES<br>  COLLARS FOR CABLE TIES & MARKING TAGS |  STAINLESS STEEL<br>  CABLE MARKING<br>  COLLARS FOR CABLE TIES & MARKING TAGS<br>  TEXT COLLARS PTET |
| | Indoor |  LABEL CARDS AND BLOCKS<br>  DYMO® printer |  SHRINK TUBE MARKING<br>  CABLE TIE MARKING FKBB |
| WIRE | before mounting the wire |  FLEXIPART<br>  PA MARKING RINGS |  SHRINK TUBE MARKING<br>  FLEXIPART<br>  MARKING RINGS |
| | after mounting the wire |  SNAP-ON COLLARS & MARKING TAGS<br>  PC MARKING RINGS |  SNAP-ON COLLARS & MARKING TAGS |
| COMPONENT | Device marking |  MLM MOUNTING PROFILES & MINI<br>  PGS CHARACTER HOLDERS |  ENGRAVED MARKING |
| | Terminal |  TERMINAL BLOCK<br>  DYMO® printer |  TERMINAL BLOCK |
| | Sensor | | |

Photographs are not to scale and do not represent detailed images of the respective products.



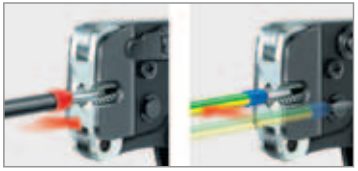
| How? / What? | | DATA MARKING<br>Laser office printer | Flexisoft with ePLAN® and WS-CAD interface | Thermal transfer printers |
|---|---|---|---|---|
| CABLE | Outdoor & Indoor |  COLLARS FOR CABLE TIES LFL 4.2<br>  FLEXILABEL LFL & HOLDERS PTET/LAB |  FLEXILABEL TFL & HOLDERS PTEF/LAB<br>  COLLARS FOR CABLE TIES & MARKING TAGS TMB |
| | Indoor |  LCK/LCFK LABELS<br>  CABLE LABEL LFL & TIES<br>  TAG TIES & LA/LB LABELS |  CABLELABEL LTFL & TIES<br>  TCK LABELS<br>  FLEXIMARK® flat shrink tube<br>  TAG TIES & TA LABELS |
| WIRE | before mounting the wire |  FLEXIPRINT LF<br>  COLLARS TS/HF & FLEXILABEL LFL 4.2 |  FLEXIPRINT TF<br> SHRINKING TUBES SHRINK MARK SM |
| | after mounting the wire |  LCFK/LCK LABELS<br> BRADY® FLAG LABELS B-425 |  TCK LABELS<br> FLAG LABELS<br> SNAP-ON COLLARS & MARKING TAGS |
| COMPONENT | Device marking |  LA LABELS<br> LFL LEXEL/ THORSMAN |  TA LABELS<br> BRADY® EPREP<br> MLM MOUNTING PROFILES & TFL 9.5 |
| | Terminal |  LA LABELS |  TERMINAL BLOCK |
| | Sensor |  CLIP-ON COLLARS & LFL |  BRADY® DURASLEEVE<br> CLIP-ON COLLARS & MARKING TAGS |

Photographs are not to scale and do not represent detailed images of the respective products.

# Cable Accessories

## PEW 8.87

Front crimp pliers with a large range of diameters from 0.08 to 10 mm$^2$



## EASY STRIP 2

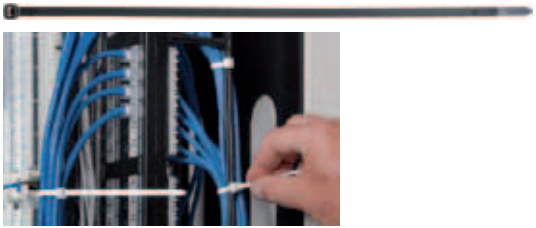
Self-adjusting cutting and stripping tool with an increased stripping range and for different materials

X cassette: 0.02-10 mm$^2$
XL cassette: 0.1-4 mm$^2$

Please see our Main Catalogue for further details.

Photographs are not to scale and do not represent detailed images of the respective products.

## Twist Tail™ cable tie



Twist Tail™ cable tie

- Industry cable ties for quick and secure assembly.
- General purpose applications, indoor and outdoor

## LS steel cable ties

LS steel cable ties

- LS one piece steel cable ties can be used outdoors and under extreme conditions, e.g. high corrosion risk.

Photographs are not to scale and do not represent detailed images of the respective products.





## TY-GUN ERG 120 cable tie pliers/ TY-GUN ERG 50

TY-GUN ERG 120 cable tie pliers/TY-GUN ERG 50

**Benefits**

- Cable tie tool TY-GUN allows quick and economical binding, fixing and mounting of cable ties.

**Application range**

- For plastic cable ties
- Installation pistol

Photographs are not to scale and do not represent detailed images of the respective products.

## Introduction to Cable Engineering

Continuous supply of electric power, or faultless data transfer respectively, provided mostly through wiring, are a primary requirement affecting virtually all areas of our life. This results in tough requirements for production, installation and operation of cables. To be able to design the cables suitably and to install them correctly, it is necessary to have good knowledge in various fields, e.g. physics, electrical engineering, mechanic and other applied engineering sciences.

Cable failure can be caused, for example, by mechanical action or electrically by overvoltage, by insulation ageing, corrosion, sneak currents, as well as by unqualified installation or by incorrectly or badly dimensioned design. What is also important is technically correct elaboration of a wiring project and proper crosscheck of all installation work. Then, in operation, it is necessary to observe relevant operating conditions, a cable was designed for.

Employees of the Lapp Group are prepared anytime to help you professionally in preventing any and all consequences, which may be caused by a wiring failure.



## The Fundamentals of Cable Engineering

### 1. What cables and conductors are required for

- Electric power transmission – for power supply

- Transmission of data, signals or impulses – for data communication

Generally, the term of electric cable means a route for transmission of el. power, data or signals betweeen a source and an appliance (for data cables → transmitter and receiver).

### 2. Explanation of general terms

**2.1 Conductor**

Conductor (conductive core) represents a conductive route of electric power and together with insulation it forms a wire. Several wires form a core. A sheath protects a cable from external actions.

Metals are conductors of the 1st class. Conductance of metals is related to the number of electrons in their outer layer. The most often used conductor materials are as follows:

- Copper (Cu) (in more than 99 % of all applications)
- Aluminium (Al)
- Silver (Ag)

Conductors can be bare or treated (tinned, silver-coated, gold-coated).

Photographs are not to scale and do not represent detailed images of the respective products.

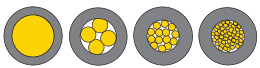

Classification according to design:

- Compact core: of a single wire (up to 16 mm²) or of multiple wires
- Stranded core: made of 7 to several hundreds of thin single wires (VDE 0295/ IEC 602258).

Classes of stranded cores are specified in VDE 0295, or from 0.5 mm² in compliance with IEC 60228 respectively. Max. diameter of a single wire and max. conductor resistance are critical for the core design. The larger cross-sectional area, the lower resistance; the larger length, the higher resistance (similarly as for water supply piping).

**Stranded core classes**

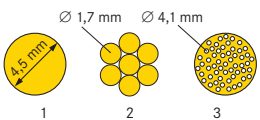
Class 1: compact
Class 2: made of multiple wires
Class 5: made of fine wires
Class 6: made of extra-fine wires




Example of a conductor with nominal cross-sectional area of 16 mm²

$A = \pi r^2$ or $A = \pi d^2/4$
A = geometric cross-sectional area
r = radius
d = diameter

1: solid wire (1 x 4.5 mm)
2: multiple wires (7 x 1.7 mm)
3: fine wires (122 x 0.41 mm)

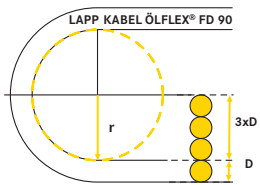



Photographs are not to scale and do not represent detailed images of the respective products.



**Minimum bending radius**

It is a characteristic value, which gives you a degree of possible cable bending without its damaging. It is absolutely necessary to respect this value, when using a cable in tow chains („FD“ cables in the Lapp Group programme). Only maximum outside diameters are shown for highly flexible cables; tolerance is possible only downwards.




D = Cable outside diameter

## 2.2 Insulation

Insulation is electrically non-conducting protective layer around the conductor. Insulating materials are applied on conductors by extrusion. The mostly used insulating materials are compounds of organic elements.

C, H2, O2, N2, S, e.g.:

- Thermoplastics: PVC, PE, PP, PTFE
- Elastomers (rubber): CR, SR
- Thermoplastic elastomers: PUR, TPE-E

An insulated conductor is called a wire.

## 2.3 Twisting

While producing a multiwire cable the wires are twisted together.

A cable of wires, a bundle of wires or a twisted bundle (cable core) is created.

**Reasons for twisting are:**

- Lower need for space → smaller outer diameters
- Circular form
- Flexibility


Photographs are not to scale and do not represent detailed images of the respective products.

## 2.4 Identification of wires (wire identification code)

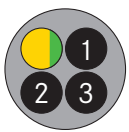
To be able to connect the wires correctly, they must be uniquely identified.

### Numbering

- All wires are identified by numbers in ascending order from 1 to ...
- Mostly by white digits on black background (insulation)
- The only exception is a protective conductor, which is always green-yellow

### Numbered wires

Protective green-yellow wire
Colour ratio 70:30

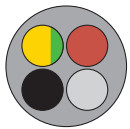



### Colour code

- All wires are differentiated by different colours of insulation
- Individual colours are specified in the „Wire Identification Code“
- e.g. according to DIN VDE 0293-308/HD 308 S2

### Coloured wires

Protective green-yellow wire
Colour ratio 70:30



## 2.5 Protection, screening, armouring

It has 2 main functions:

- Mechanical protection by braiding made of steel wires protected from „S“ oxidation, e.g. ÖLFLEX® CLASSIC 100 SY

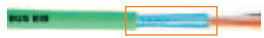
- Electromagnetic protection (EMC) by braiding made of tinned copper „C“ wires, e.g. ÖLFLEX® CLASSIC 110 CY black 0.6/1 kV

Photographs are not to scale and do not represent detailed images of the respective products.



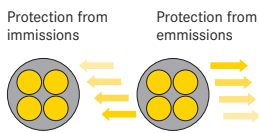
- or by braiding made of copper „D“ wires, e.g. ÖLFLEX® ROBOT 900 DP

- or by braiding made of metallized foil (e.g. aluminium bonded (steamed) polyester sheet), e.g. UNITRONIC® BUS EIB



## 2.6 Sheath

The sheath is a closed cover protecting elements laying under the sheath from external actions (mechanical, thermal, chemical or physical damages). Correct selection of sheath material is decisive.




**Mechanical actions:**
abrasion, impact, bending, tension, twisting (torsional swinging)...
Examples of protections:
braiding of steel wires, bearing members, supporting braiding, protective hoses

**Chemical actions:**
acids, caustics, oils, solvents, water (from 50 °C)
Examples of protections:
sheath materials, such as TEFLON, ROBUST, PUR; protective hoses

**Thermal actions:**
cold, heat
Examples of protections:
mixture with thermal stabilisers, teflon, silicone

**Physical actions:**
UV radiation, radioactive radiation
Examples of protections:
mixture with UV stabilisers

The mostly used sheath materials are as follows: PVC, PUR, SR, CR.

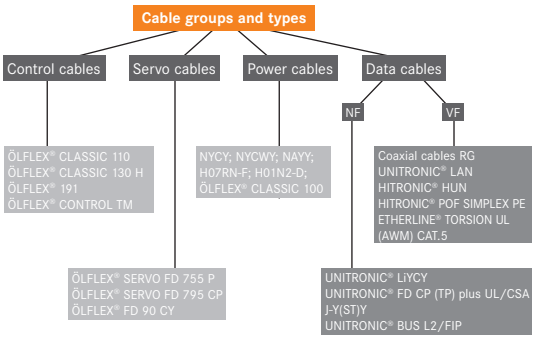
Photographs are not to scale and do not represent detailed images of the respective products.

## 3. Labelling products of the Lapp Group programme

**ÖLFLEX® CLASSIC 110 4 G 1.5 mm²**

1 2 3 4

1. Brand, identification
2. Number of wires
3. G with a protective conductor or X without a protective conductor (green-yellow)
4. Cross-sectional area or diameter (J-Y(St)Y 4 x 2 x 0.6 mm) ... and relevant quantity




## 4. Selection criteria

Which criteria are important?

1. What is the purpose of use?
   Description of application
2. What nominal voltage is required?
   $U_o/U$
   300 V, 500 V,
   600/1000 V ...
3. Where the cable will be used?
   Environment
   Indoor or outdoor
   - Thermal resistance
   - UV radiation resistance
   - Weather resistance
4. How the cable will be laid?
   Way of laying
   Fixed or movable, in a tow chain, positively guided (pulleys...)
   - minimum bending radius, reversed bending cycles, tensile forces

   In open or closed cable systems (troughs, pipes...)
   - Current-carrying capacity, reduction factors

   In the vicinity of interference fields (EMC)
   - Screening by copper braid
5. What requirements for norms should be fulfilled?
   National norms, e.g. VDE, HAR, UL, CSA, NOM...
6. Other requirements
   Behaviour in case of fire/ Non-halogenity
   Chemical actions:
   free of compounds harming varnish wettability, free of lead, resistance to oils, acids, water
   Mechanical actions:
   resistance to torsional strain, to abrasion, to extension strain

## 5. Standards, approbations, norms

Approbation is a defined special standard for cables issued by an authorised body including description of design (compositions, materials, diameters, etc.) and the use. (see Table T6 and T18).

LAPP GROUP

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For static and occasional flexing use | ÖLFLEX® CLASSIC 100 | ÖLFLEX® CLASSIC 100 Yellow | ÖLFLEX® CLASSIC 100 CY | ÖLFLEX® CLASSIC 100 SY | ÖLFLEX® CLASSIC 100 BK POWER 0.6/1 KV | ÖLFLEX® CLASSIC 110 | ÖLFLEX® CLASSIC 110 Cold | ÖLFLEX® CLASSIC 110 Orange | ÖLFLEX® CLASSIC 110 CY | ÖLFLEX® CLASSIC 110 SY | ÖLFLEX® CLASSIC 110 Black | ÖLFLEX® CLASSIC 110 CY Black | ÖLFLEX® CLASSIC 115 CY |
| **Application** | | | | | | | | | | | | | |
| Excepted circuits remain energized acc. IEE 60204-1 § 5.3.5 | | | | | | | | ● | | | | | |
| For intrinsically safe circuits in hazardous locations to/VDE 0165 | see EB-cables | | | | | | | | | | | | |
| Hand tools and lamps on worksites | | | | | | | | | | | | | |
| Oil resistant to UL + CSA specification | | | | | | | | | | | | | |
| Oil resistant to VDE | | | | | | | | | | | | | |
| Bio oil resistant | | | | | | | | | | | | | |
| Cables resistant to chemicals | see separate selection Table T1 and T2 | | | | | | | | | | | | |
| Cables resistant to ultra-violet light | | | | | ● | | | | | | ● | ● | |
| Cold-flexible cables | | | | | | | ● | | | | | | |
| Servomotors/ Motive pow. engineering | | | ● | | | | | | ● | | | ● | |
| **Standards** | | | | | | | | | | | | | |
| Based on VDE/HAR/DIN | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● |
| As per Standard with VDE certification | | | | | | | | | | | | | |
| with VDE registration | | | | | | ● | ● | | ● | ● | | | |
| with HAR certification (HAR) | | | | | | | | | | | | | |
| with UL certification | | | | | | | | | | | | | |
| with CSA certification | | | | | | | | | | | | | |
| **Temperature range** | | | | | | | | | | | | | |
| +105 °C | | | | | | | | | | | | | |
| +90 °C | | | | | | | | | | | | | |
| +80 °C | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| +70 °C | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| +60 °C | | | | | | | | | | | | | |
| -5 °C | ■ | ■ | ■ | ■ | | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| -10 °C | | | | | | | | | | | | | |
| -15 °C | | | | | | | | | | | | | |
| -25 °C | | | | | | | | | | | | | |
| -30 °C | | | | | ■ | | ■ | | | | □ | □ | □ |
| -40 °C | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | | | |
| -50 °C | | | | | | | | | | | | | |
| -55 °C | | | | | | | | | | | | | |



LAPP GROUP



| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For static and occasional flexing use | ÖLFLEX® CLASSIC 100 | ÖLFLEX® CLASSIC 100 Yellow | ÖLFLEX® CLASSIC 100 CY | ÖLFLEX® CLASSIC 100 SY | ÖLFLEX® CLASSIC 100 BK POWER 0.6/1 KV | ÖLFLEX® CLASSIC 110 | ÖLFLEX® CLASSIC 110 Cold | ÖLFLEX® CLASSIC 110 Orange | ÖLFLEX® CLASSIC 110 CY | ÖLFLEX® CLASSIC 110 SY | ÖLFLEX® CLASSIC 110 Black | ÖLFLEX® CLASSIC 110 CY Black | ÖLFLEX® CLASSIC 115 CY |
| **Laying** | | | | | | | | | | | | | |
| Outdoor, only indirectly in the ground (conduit) UV-protected, static | | | | | ● | | | | | | ● | ● | |
| Indoor, on surface, in conduit, in ducting, in partition walls, static | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Outdoor, protected against UV light, static laying | ● | ● | ○ | ○ | ● | ● | ● | ● | ○ | ○ | ● | ● | ○ |
| Outdoor, unprotected in the open, low flexing | | | | | ● | | | | | | ○ | ○ | |
| Indoor, static & low flexing application | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| **Bending radius, low flexing** | | | | | | | | | | | | | |
| 5 x D | | | | | | | | | | | | | |
| 10 x D | | | | | | | | | | | | | |
| 12.5 x D | | | | | | | | | | | | | |
| 15 x D | ● | ● | | | ● | ● | ● | ● | | | ● | | |
| 20 x D | | | ● | ● | | | | | ● | ● | | ● | ● |
| **Nominal voltage** | | | | | | | | | | | | | |
| 250 V | | | | | | | | | | | | | |
| 300/300 V | | | | | | | | | | | | | |
| 300/500 V | ● | | ● | ● | | ● | ● | ● | ● | ● | | | ● |
| 600 V acc. to UL/CSA | | | | | | | | | | | | | |
| 450/750 V | ● | ● | ● | ● | | | | | | | | | |
| 600/1000 V | ○ | | ○ | ○ | ● | | | | | | ● | ● | |

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  For static and occasional flexing use | ÖLFLEX® CLASSIC 100 | ÖLFLEX® CLASSIC 100 Yellow | ÖLFLEX® CLASSIC 100 CY | ÖLFLEX® CLASSIC 100 SY | ÖLFLEX® CLASSIC 100 BK POWER 0.6/1 KV | ÖLFLEX® CLASSIC 110 | ÖLFLEX® CLASSIC 110 Cold | ÖLFLEX® CLASSIC 110 Orange | ÖLFLEX® CLASSIC 110 CY | ÖLFLEX® CLASSIC 110 SY | ÖLFLEX® CLASSIC 110 Black | ÖLFLEX® CLASSIC 110 CY Black | ÖLFLEX® CLASSIC 115 CY |
| **Make-up** | | | | | | | | | | | | | |
| Fine-wire VDE class 5, copper stranded conductors | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Superfine wire VDE class 6, copper stranded conductors | | | | | | | | | | | | | |
| Ultra fine wire VDE class 6, copper stranded conductors | | | | | | | | | | | | | |
| Polyurethane core insulation | | | | | | | | | | | | | |
| Rubber core insulation | | | | | | | | | | | | | |
| PVC/special PVC | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| PE/PP core insulation | | | | | | | | | | | | | |
| Halogen free core insulation | | | | | | | | | | | | | |
| Number printing | | | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| Colour code to VDE 0293 | ● | ● | ● | ● | ● | | | | | | | | |
| ÖLFLEX® colour code | ● | | ● | ● | | | | | | | | | |
| Screening on the forn of copper braiding | | | ● | | | | | | ● | | | ● | ● |
| Common inner sheath under overall protection/braiding | | | ● | ● | | | | | ● | ● | | ● | |
| Steel wire braiding | | | | ● | | | | | | ● | | | |
| PVC sheath | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| PUR sheath, wear resistant, cutting resistant | | | | | | | | | | | | | |
| Halogen free outer sheath | | | | | | | | | | | | | |
| Bio oil resistant outer sheath P4/11 | | | | | | | | | | | | | |
| Outer sheath of synthetic rubber | | | | | | | | | | | | | |
| Outer sheath of Neoprene® rubber | | | | | | | | | | | | | |
| Outer sheath of rubber compound acc. to standard | | | | | | | | | | | | | |

Neoprene® is a registered trademark of DuPont de Nemour

- ● = Principal application
- ○ = Application not customary, but possible, or alternative design available in the range
- ■ = Temperature range for flexible laying
- ◪ = Temperature range for static and flexible laying
- □ = Temperature range for static laying





| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  For static and occasional flexing use | ÖLFLEX® EB | ÖLFLEX® EB CY | ÖLFLEX® 140 | ÖLFLEX® 140 CY | ÖLFLEX® 150 | ÖLFLEX® 150 CY | ÖLFLEX® 191 | ÖLFLEX® 191 CY | ÖLFLEX® CONTROL TM | ÖLFLEX® CONTROL TM CY | ÖLFLEX® Tray II | ÖLFLEX® Tray II CY | ÖLFLEX® SF |
| **Application** | | | | | | | | | | | | | |
| Excepted circuits remain energized acc. IEE 60204-1 § 5.3.5 | | | | | | | | | | | | | |
| For intrinsically safe circuits in hazardous locations to/VDE 0165 | ● | ● | see EB-cables | | | | | | | | | | |
| Hand tools and lamps on worksites | | | | | | | | | | | | | |
| Oil resistant to UL + CSA specification | | | | | ● | ● | ● | ● | ● | ● | ● | ● | |
| Oil resistant to VDE | | | ● | ● | ● | ● | ● | ● | | | | | |
| Bio oil resistant | | | | | | | | | | | | | |
| Cables resistant to chemicals | see separate selection Table T1 and T2 | | | | | | | | | | | | |
| Cables resistant to ultra-violet light | | | | | | | | | ○ | ○ | ● | ● | |
| Cold-flexible cables | | | | | | | | | | | | | ● |
| Servomotors/ Motive pow. engineering | | | | ● | | ● | | ● | | ● | | ● | |
| **Standards** | | | | | | | | | | | | | |
| Based on VDE/HAR/DIN | ● | ● | | | | | ● | ● | | | | | |
| As per Standard with VDE certification | | | ● | ● | ● | ● | | | | | | | ● |
| with VDE registration | | | | | | | | | | | | | |
| with HAR certification (HAR) | | | ● | ● | ● | ● | | | | | | | |
| with UL certification | | | | | ● | ● | ● | ● | ● | ● | ● | ● | |
| with CSA certification | | | | | ● | ● | ● | ● | ● | ● | ● | ● | |
| **Temperature range** | | | | | | | | | | | | | |
| +105 °C | | | | | | | | | ◪ | ◪ | □ | □ | |
| +90 °C | | | | | | | | | | | | | |
| +80 °C | □ | □ | | | | | | | | | | | |
| +70 °C | ■ | ■ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | | | | | |
| +60 °C | | | | | | | | | | | | | ■ |
| -5 °C | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| -10 °C | | | | | | | | | | | | | |
| -15 °C | | | | | | | | | | | | | ■ |
| -25 °C | | | | | | | | | | | □ | □ | |
| -30 °C | | | | | | | | | | | | | |
| -40 °C | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | | | |
| -50 °C | | | | | | | | | | | | | |
| -55 °C | | | | | | | | | | | | | |

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For static and occasional flexing use  | ÖLFLEX® EB | ÖLFLEX® EB CY | ÖLFLEX® 140 | ÖLFLEX® 140 CY | ÖLFLEX® 150 | ÖLFLEX® 150 CY | ÖLFLEX® 191 | ÖLFLEX® 191 CY | ÖLFLEX® CONTROL TM | ÖLFLEX® CONTROL TM CY | ÖLFLEX® Tray II | ÖLFLEX® Tray II CY | ÖLFLEX® SF |
| **Laying** | | | | | | | | | | | | | |
| Outdoor, only indirectly in the ground (conduit) UV-protected, static | | | | | | | | | | | ● | ● | |
| Indoor, on surface, in conduit, in ducting, in partition walls, static | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| Outdoor, protected against UV light, static laying | | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| Outdoor, unprotected in the open, low flexing | | | | | | | | | | | | | ○ |
| Indoor, static & low flexing application | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ● |
| **Bending radius, low flexing** | | | | | | | | | | | | | |
| 5 x D | | | | | | | | | | | | | |
| 10 x D | | | | | | | | | | | | | ● |
| 12.5 x D | | | ● | | ● | | | | | | | | |
| 15 x D | ● | ● | | | | | ● | | ● | | | | |
| 20 x D | | | | ● | | ● | | ● | | ● | | | |
| **Nominal voltage** | | | | | | | | | | | | | |
| 250 V | | | | | | | | | | | | | |
| 300/300 V | | | | | | | | | | | | | |
| 300/500 V | | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 600 V acc. to UL/CSA | | | | | ● | ● | ● | ● | ● | ● | ● | ● | |
| 450/750 V | | | | | | | | | | | | | |
| 600/1000 V | | | | | | | | | | | | | |

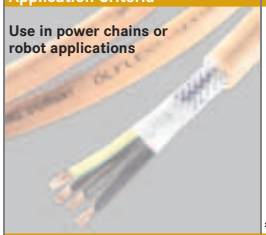




| Application Criteria | Cable and Lead Designation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For static and occasional flexing use  | ÖLFLEX® EB | ÖLFLEX® EB CY | ÖLFLEX® 140 | ÖLFLEX® 140 CY | ÖLFLEX® 150 | ÖLFLEX® 150 CY | ÖLFLEX® 191 | ÖLFLEX® 191 CY | ÖLFLEX® CONTROL TM | ÖLFLEX® CONTROL TM CY | ÖLFLEX® Tray II | ÖLFLEX® Tray II CY | ÖLFLEX® SF |
| **Make-up** | | | | | | | | | | | | | |
| Fine-wire VDE class 5, copper stranded conductors | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | |
| Superfine wire VDE class 6, copper stranded conductors | | | | | | | | | | | | | |
| Ultra fine wire VDE class 6, copper stranded conductors | | | | | | | | | | | | | ● |
| Polyurethane core insulation | | | | | | | | | | | | | |
| Rubber core insulation | | | | | | | | | | | | | |
| PVC/special PVC | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| PE/PP core insulation | | | | | | | | | | | | | |
| Halogen free core insulation | | | | | | | | | | | | | |
| Number printing | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| Colour code to VDE 0293 | | | | | | | | | | | | | ● |
| ÖLFLEX® colour code | | | | | | | | | | | | | |
| Screening on the forn of copper braiding | | ● | | ● | | ● | | ● | | ● | | ● | |
| Common inner sheath under overall protection/braiding | | | | ● | | ● | | ● | | | | | |
| Steel wire braiding | | | | | | | | | | | | | |
| PVC sheath | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| PUR sheath, wear resistant, cutting resistant | | | | | | | | | | | | | |
| Halogen free outer sheath | | | | | | | | | | | | | |
| Bio oil resistant outer sheath P4/11 | | | | | | | | | | | | | |
| Outer sheath of synthetic rubber | | | | | | | | | | | | | |
| Outer sheath of Neoprene® rubber | | | | | | | | | | | | | |
| Outer sheath of rubber compound acc. to standard | | | | | | | | | | | | | |

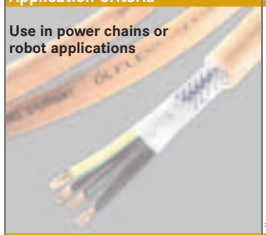
Neoprene® is a registered trademark of DuPont de Nemour

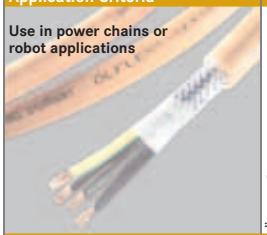
● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 750 P | ÖLFLEX® SERVO FD 755 P | ÖLFLEX® SERVO FD 755 CP | ÖLFLEX® SERVO FD 760 CP | ÖLFLEX® SERVO FD 770 CP | ÖLFLEX® SERVO FD 781 CY | ÖLFLEX® SERVO FD 781 P | ÖLFLEX® SERVO FD 781 CP | ÖLFLEX® SERVO FD 785 P | ÖLFLEX® SERVO FD 785 CP | ÖLFLEX® SERVO FD 790 CP | ÖLFLEX® SERVO FD 795 P |
| **Application** | | | | | | | | | | | | |
| For industrial machinery to EN 60204 part 1/VDE 0113 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For frequency-converter driven servo drives | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For servo motor, low capacitance | | ● | ● | | ● | ● | ● | ● | ● | | ● | ● |
| For encoders, feedback systems, sensors | | | | ● | ● | | | | | | | |
| For free arm robots/torsion load | | | | | | | | | | | | |
| Restricted guidance over rollers, motor drums | | | | | | | | | | | | |
| For indoor application | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For outdoor application | | ● | ● | ● | ● | | ● | ● | ● | ● | | ● |
| For field bus systems | | | | | | | | | | | | |
| For video transmission, RGB signal transmission | | | | | | | | | | | | |
| For North America with UL + CSA approvals | | | | | | | | | | | ● | ● |
| For use in oily environments, enhanced oil resistance | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For use in areas with bio oils | | | | | | | | | | | | |
| **Temperature range** | | | | | | | | | | | | |
| +105 °C | | | | | | | | | | | | |
| +90 °C | | □ | □ | | | | | | □ | □ | | |
| +80 °C | | ■ | ■ | □ | □ | □ | □ | □ | ■ | ■ | ◪ | ◪ |
| +70 °C | ◪ | | | ■ | ■ | ■ | ■ | ■ | | | | |
| +60 °C | | | | | | | | | | | | |
| +5 °C | | | | | | | | | | | | |
| -5 °C | | | | | | ■ | | | | | | |
| -10 °C | ■ | | | | | | | | | | ■ | |
| -20 °C | | | | | | | | | | | | |
| -30 °C | □ | | | | | | ■ | ■ | | | | |
| -40 °C | | ■ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | □ | ■ |
| -50 °C | | □ | □ | □ | □ | | | | □ | □ | | □ |





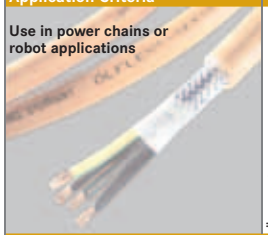
| Application Criteria | Cable and Lead Designation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 750 P | ÖLFLEX® SERVO FD 755 P | ÖLFLEX® SERVO FD 755 CP | ÖLFLEX® SERVO FD 760 CP | ÖLFLEX® SERVO FD 770 CP | ÖLFLEX® SERVO FD 781 CY | ÖLFLEX® SERVO FD 781 P | ÖLFLEX® SERVO FD 781 CP | ÖLFLEX® SERVO FD 785 P | ÖLFLEX® SERVO FD 785 CP | ÖLFLEX® SERVO FD 790 CP | ÖLFLEX® SERVO FD 795 P |
| **Minimum bending radius factor for continuous flexing** | | | | | | | | | | | | |
| 5 x D | | ● | | | | | | | ● | | | ● |
| 6.5 x D | | | | | | | | | | | | |
| 7.5 x D | | | ● | | | ● | ● | ● | | | | |
| 10 x D | | | | | | | | | | | | |
| 12.5 x D | ● | | | ● | ● | | | | | | ● | |
| 15 x D | | | | | | | | | | | | |
| 20 x D | | | | | | | | | | | | |
| **Laying** | | | | | | | | | | | | |
| For chains with small radii | ○ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For chains with restricted space | ○ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For low cable weight in the chain | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For 24-hour operation at high numbers of cycles | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For high acceleration values > 10 m/s² | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For very high acceleration up to 50 m/s² | | | | | | | | | | | | |
| For travel speeds up to 5 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 10 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 5 m/s, up to 100 m travel length | ○ | ● | ● | ● | ● | | | | ● | ● | ○ | ● |
| **Nominal voltage** | | | | | | | | | | | | |
| 350 Vss | | | | ● | ● | | | | | | | |
| 30/300 V AC | | | | | | | | | | | | |
| 300/500 V AC | | | | | | | | | | | | |
| 600/1000 V AC | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | ● |
| 600 V acc. to UL/CSA | | | | | | | | | | | ● | ● |

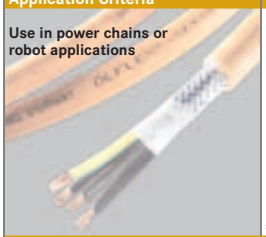
| Application Criteria | Cable and Lead Designation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 750 P | ÖLFLEX® SERVO FD 755 P | ÖLFLEX® SERVO FD 755 CP | ÖLFLEX® SERVO FD 760 CP | ÖLFLEX® SERVO FD 770 CP | ÖLFLEX® SERVO FD 781 CY | ÖLFLEX® SERVO FD 781 P | ÖLFLEX® SERVO FD 781 CP | ÖLFLEX® SERVO FD 785 P | ÖLFLEX® SERVO FD 785 CP | ÖLFLEX® SERVO FD 790 CP | ÖLFLEX® SERVO FD 795 P |
| **Make-up** | | | | | | | | | | | | |
| Fine wire VDE class 5, copper stranded conductor | | | | | | | | | | | | |
| Superfine wire VDE class 6, copper stranded conductor | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Ultra fine wire VDE class 6, copper stranded conductor | | | | | | | | | | | | |
| PVC/special PVC, core insulation | ● | | | | | | | | | | ● | |
| Elastomer core insulation | | | | | | | | | | | | |
| PE/cellular PE/cellular PE foam skin | | | | | | | | | | | | |
| Polyethylene/Polypropylene | | | | | | ● | ● | ● | | | | ● |
| TPE core insulation | ● | ● | ● | ● | ● | | | | ● | ● | | ● |
| Special TPE (P4/11) core insulation | | | | | | | | | | | | |
| Halogen free compound | | | | | | | | | | | | |
| Number printing | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | ● |
| VDE colour code | | | | | | | | | | | | |
| DIN 47100 colour code/ special colour code | | | | ● | ● | | | | | | | |
| Pair screening PiCY/PiMF/STP | ● | ● | ● | | ● | | | | | | ○ | ○ |
| Total screening | | | ● | ● | ● | ● | | ● | | ● | ● | |
| Special PVC sheath | | | | | | ● | | | | | | |
| PUR sheath, wear resistant, cutting resistant | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● |
| Rubber sheath | | | | | | | | | | | | |
| TPE (P4/11) sheath bio oil resistant | | | | | | | | | | | | |
| Halogen free compound | | | | | | | | | | | | |

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying



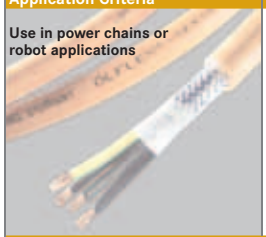


| Application Criteria | Cable and Lead Designation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 795 CP | SERVO-cable. acc. Indramat Standard INK | ÖLFLEX® FD CLASSIC 810 | ÖLFLEX® FD CLASSIC 810 CY | ÖLFLEX® FD CLASSIC 810 P | ÖLFLEX® FD CLASSIC 810 CP | ÖLFLEX® FD 820 H | ÖLFLEX® FD 820 CH | ÖLFLEX® FD ROBUST | ÖLFLEX® FD ROBUST C |
| **Application** | | | | | | | | | | |
| For industrial machinery to EN 60204, part 1/VDE 0113 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For frequency-converter driven servo drives | ● | ● | | ● | | ● | | ● | | ● |
| For servo motor, low capacitance | | | | | | | | | ● | ● |
| For encoders, feedback systems, sensors | | ● | | | | | | | | |
| For free arm robots/torsion load | | | | | | | | | | |
| Restricted guidance over rollers, motor drums | | | | | | | | | | |
| For indoor application | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For outdoor application | ● | ● | | | | | | | ● | ● |
| For field bus systems | | | | | | | | | | |
| For video transmission, RGB signal transmission | | | | | | | | | | |
| For North America with UL + CSA approvals | ● | ● | | | | | | | | |
| For use in oily environments, enhanced oil resistance | ● | ● | | | ● | ● | | | ● | ● |
| For use in areas with bio oils | | | | | | | | | ● | ● |
| **Temperature range** | | | | | | | | | | |
| +105 °C | | | | | | | | | ◪ | ◪ |
| +90 °C | | | | | | | | | | |
| +80 °C | ◪ | □ | □ | □ | □ | □ | ◪ | ◪ | | |
| +70 °C | | ■ | ■ | ■ | ■ | ■ | | | | |
| +60 °C | | | | | | | | | | |
| +5 °C | | | ■ | ■ | | | | | | |
| -5 °C | | | | | ■ | ■ | | | | |
| -10 °C | | | | | | | | | | |
| -20 °C | | | | | | ■ | ■ | | | |
| -30 °C | | ■ | | | | | | | | |
| -40 °C | ■ | | □ | □ | □ | □ | □ | □ | ■ | ■ |
| -50 °C | □ | □ | | | | | | | □ | □ |

| Application Criteria | Cable and Lead Designation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 795 CP | SERVO-cable. acc. Indramat Standard INK | ÖLFLEX® FD CLASSIC 810 | ÖLFLEX® FD CLASSIC 810 CY | ÖLFLEX® FD CLASSIC 810 P | ÖLFLEX® FD CLASSIC 810 CP | ÖLFLEX® FD 820 H | ÖLFLEX® FD 820 CH | ÖLFLEX® FD ROBUST | ÖLFLEX® FD ROBUST C |
| **Minimum bending radius factor for continuous flexing** | | | | | | | | | | |
| 5 x D | | | | | | | | | | |
| 6.5 x D | | | | | | | | | | |
| 7.5 x D | ● | | ● | ● | ● | ● | ● | ● | ● | ● |
| 10 x D | | ● | | | | | | | | |
| 12.5 x D | | | | | | | | | | |
| 15 x D | | | | | | | | | | |
| 20 x D | | | | | | | | | | |
| **Laying** | | | | | | | | | | |
| For chains with small radii | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For chains with restricted space | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For low cable weight in the chain | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For 24-hour operation at high numbers of cycles | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For high acceleration values > 10 m/s² | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For very high acceleration up to 50 m/s² | | | | | | | | | | |
| For travel speeds up to 5 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 10 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 5 m/s, up to 100 m travel length | ● | ● | ○ | ○ | ○ | ○ | ○ | ○ | ● | ● |
| **Nominal voltage** | | | | | | | | | | |
| 350 Vss | | ● | | | | | | | | |
| 30/300 V AC | | | | | | | | | | |
| 300/500 V AC | | | ● | ● | ● | ● | ● | ● | ● | ● |
| 600/1000 V AC | ● | ● | | | | | | | | |
| 600 V acc. to UL/CSA | ● | ● | | | | | | | | |





| Application Criteria | Cable and Lead Designation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® SERVO FD 795 CP | SERVO-cable. acc. Indramat Standard INK | ÖLFLEX® FD CLASSIC 810 | ÖLFLEX® FD CLASSIC 810 CY | ÖLFLEX® FD CLASSIC 810 P | ÖLFLEX® FD CLASSIC 810 CP | ÖLFLEX® FD 820 H | ÖLFLEX® FD 820 CH | ÖLFLEX® FD ROBUST | ÖLFLEX® FD ROBUST C |
| **Make-up** | | | | | | | | | | |
| Fine wire VDE class 5, copper stranded conductor | | | | | | | | | | |
| Superfine wire VDE class 6, copper stranded conductor | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Ultra fine wire VDE class 6, copper stranded conductor | | | | | | | | | | |
| PVC/special PVC, core insulation | | | ● | ● | ● | ● | | | | |
| Elastomer core insulation | | | | | | | | | | |
| PE/cellular PE/cellular PE foam skin | | | | | | | | | | |
| Polyethylene/Polypropylene | ● | ○ | | | | | | | | |
| TPE core insulation | ● | ○ | | | | | | | | |
| Special TPE (P4/11) core insulation | | | | | | | | | ● | ● |
| Halogen free compound | | | | | | | ● | ● | | |
| Number printing | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| VDE colour code | | | | | | | | | | |
| DIN 47100 colour code/special colour code | | ● | | | | | | | | |
| Pair screening PiCY/PiMF/STP | ○ | ● | | | | | | | | |
| Total screening | ● | ● | | ● | | ● | | ● | | ● |
| Special PVC sheath | | | ● | ● | | | | | | |
| PUR sheath, wear resistant, cutting resistant | ● | ● | | | ● | ● | | | | |
| Rubber sheath | | | | | | | | | | |
| TPE (P4/11) sheath bio oil resistant | | | | | | | | | ● | ● |
| Halogen free compound | | | | | | | ● | ● | | |

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
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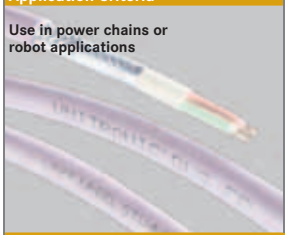
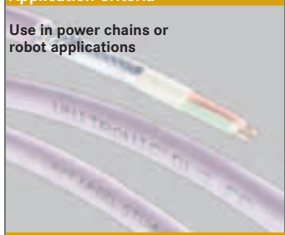
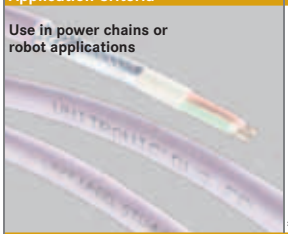
| Application Criteria | Cable and Lead Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® FD 855 P | ÖLFLEX® FD 855 CP | ÖLFLEX® FD 90 | ÖLFLEX® FD 90 CY | UNITRONIC® FD | UNITRONIC® FD CY | UNITRONIC® FD P plus | UNITRONIC® FD CP plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® BUS PB FD P |
| **Application** | | | | | | | | | | | |
| For industrial machinery to EN 60204, part 1/VDE 0113 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For frequency-converter driven servo drives | | ○ | | ● | | | | | | | |
| For servo motor, low capacitance | ● | ● | | | | | | | | | |
| For encoders, feedback systems, sensors | ○ | ○ | | | ○ | ● | ○ | ● | ● | ● | ● |
| For free arm robots/torsion load | | | | | ○ | | | | | | |
| Restricted guidance over rollers, motor drums | | | | | | | | | | | |
| For indoor application | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For outdoor application | ● | ● | | | | | | | ● | ● | |
| For field bus systems | | | | | | | | | ○ | ○ | ● |
| For video transmission, RGB signal transmission | | | | | | | | | | | |
| For North America with UL + CSA approvals | | | ● | ● | | | ● | ● | | ● | ● |
| For use in oily environments, enhanced oil resistance | ● | ● | ● | ● | | | ● | ● | ● | ● | ● |
| For use in areas with bio oils | | | | | | | | | | | |
| **Temperature range** | | | | | | | | | | | |
| +105 °C | | | | | | | | | | | |
| +90 °C | | | ◪ | ◪ | | | | | | | |
| +80 °C | ◪ | ◪ | | | | | | | | □ | ◪ |
| +70 °C | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| +60 °C | | | | | | | | | | | |
| +5 °C | | | | | | | | | | | |
| -5 °C | | | ■ | ■ | ■ | ■ | | | | | |
| -10 °C | | | | | | | | | | | |
| -20 °C | | | | | | | | | | | |
| -30 °C | | | | | | | | | | | ■ |
| -40 °C | ■ | ■ | □ | □ | | | ■ | ■ | ■ | ■ | □ |
| -50 °C | □ | □ | | | | | | | | | |





| Application Criteria | Cable and Lead Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® FD 855 P | ÖLFLEX® FD 855 CP | ÖLFLEX® FD 90 | ÖLFLEX® FD 90 CY | UNITRONIC® FD | UNITRONIC® FD CY | UNITRONIC® FD P plus | UNITRONIC® FD CP plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® BUS PB FD P |
| **Minimum bending radius factor for continuous flexing** | | | | | | | | | | | |
| 5 x D | ● | | | | ● | | ● | | | | |
| 6.5 x D | | | | | | | | | | | |
| 7.5 x D | | ● | ● | ● | | ● | | ● | ● | ● | ● |
| 10 x D | | | | | | | | | | | ● |
| 12.5 x D | | | | | | | | | | | |
| 15 x D | | | | | | | | | | | ● |
| 20 x D | | | | | | | | | | | |
| **Laying** | | | | | | | | | | | |
| For chains with small radii | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For chains with restricted space | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For low cable weight in the chain | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For 24-hour operation at high numbers of cycles | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For high acceleration values > 10 m/s² | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For very high acceleration up to 50 m/s² | | | | | | | | | | | |
| For travel speeds up to 5 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 10 m/s, up to 10 m travel length | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For travel speeds up to 5 m/s, up to 100 m travel length | ● | ● | ○ | ○ | ● | ● | ● | ● | ● | ● | ● |
| **Nominal voltage** | | | | | | | | | | | |
| 350 Vss | | | | | ● | ● | ● | ● | ● | ● | |
| 30/300 V AC | | | | | | | | | | | ● |
| 300/500 V AC | ● | ● | | | | | | | | | |
| 600/1000 V AC | | | ● | ● | | | | | | | |
| 600 V acc. to UL/CSA | | | ● | ● | | | | | | | |

| Application Criteria | Cable and Lead Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Use in power chains or robot applications  | ÖLFLEX® FD 855 P | ÖLFLEX® FD 855 CP | ÖLFLEX® FD 90 | ÖLFLEX® FD 90 CY | UNITRONIC® FD CY | UNITRONIC® FD CY | UNITRONIC® FD P plus | UNITRONIC® FD CP plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® BUS PB FD P |
| **Make-up** | | | | | | | | | | | |
| Fine wire VDE class 5, copper stranded conductor | | | | | | | | | | | |
| Superfine wire VDE class 6, copper stranded conductor | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Ultra fine wire VDE class 6, copper stranded conductor | | | | | | | | | | | |
| PVC/special PVC, core insulation | | | ● | | ● | ● | | | | | |
| Elastomer core insulation | | | | | | | | | | | |
| PE/cellular PE/cellular PE foam skin | | | | | | | | | | | ● |
| Polyethylene/Polypropylene | | | | | | | | | | | |
| TPE core insulation | ● | ● | | | | | | | | | |
| Special TPE (P4/11) core insulation | | | | | | | | | | | |
| Halogen free compound | | | | | | | ● | ● | ● | ● | |
| Number printing | ● | ● | | | | | | | | | |
| VDE colour code | | | | | | | | | | | |
| DIN 47100 colour code/ special colour code | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| Pair screening PiCY/PiMF/STP | | | | | | | | | | | |
| Total screening | | ● | | | | ● | | ● | ● | ● | ● |
| Special PVC sheath | | | ● | ● | ● | ● | | | | | |
| PUR sheath, wear resistant, cutting resistant | ● | ● | | | | | ● | ● | ● | ● | ● |
| Rubber sheath | | | | | | | | | | | |
| TPE (P4/11) sheath bio oil resistant | | | | | | | | | | | |
| Halogen free compound | | | | | | | | | | | |

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying





| Application Criteria | Cable and Lead Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | ÖLFLEX® CRANE | ÖLFLEX® LIFT F | ÖLFLEX® CRANE F | ÖLFLEX® CRANE CF | ÖLFLEX® LIFT | ÖLFLEX® LIFT T | ÖLFLEX® LIFT S | ÖLFLEX® CRANE 2S | ÖLFLEX® CRANE NSHTÖU | ÖLFLEX® CRANE VS (N)SHTÖU | ÖLFLEX® CRANE PUR |
| **Temperature range** | | | | | | | | | | | |
| +90 °C | | | | | | | | | | | |
| +80 °C | ■ | | ■ | ◪ | | | | | | | ◪ |
| +70 °C | | ◪ | | | ■ | ■ | ■ | ■ | | | |
| +60 °C | | | | | | | | | ■ | ■ | |
| +5 °C | | | | | | | | | | | |
| 0 °C | | ■ | | | | | | | | | |
| -5 °C | | | | | | | | | | | |
| -10 °C | | | | | | | | | | | |
| -15 °C | | ■ | | | ■ | ■ | ■ | ■ | | | |
| -20 °C | | | | | | | | | | | |
| -25 °C | ■ | | ■ | ◪ | | | | | ■ | ■ | |
| -30 °C | | | | | | | | | | | |
| -40 °C | □ | □ | | | | | | | □ | □ | ◪ |
| **Standards** | | | | | | | | | | | |
| Based on VDE/HAR/DIN | ● | ● | ● | ● | | | ● | ● | | ● | ● |
| With VDE approbation | | | | | | | | | ● | | |
| With VDE-Registrierung | | | | | ● | ● | | | | | |
| With HAR-Approbation | | | | | | | | | | | |
| Flame retardant acc. to IEC 60332.1-2 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| **Application** | | | | | | | | | | | |
| For cable trolley guide systems | ● | ● | ● | ● | | | | | | | |
| Positive guidance over rollers, motor drums | | | | | | | | | | | |
| Reeling re-routing under tension | | | | | | | | | | | |
| For freely suspended application in lift/conveying system | ○ | ○ | | | ● | ● | ● | | | | |
| For freely suspended application with additional load | ● | | | | | | | ● | | ○ | ○ |
| For indoor application | ● | ○ | ● | ● | | | | ○ | ● | ● | ● |
| For short travel distances indoors | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| For short travel distances outdoors | ● | ● | ● | ● | | | | ● | ● | ● | ● |
| For use in power chains | | | | | | | | | | | |

| Application Criteria | Cable and Lead Designation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | ÖLFLEX® CRANE | ÖLFLEX® LIFT F | ÖLFLEX® CRANE F | ÖLFLEX® CRANE CF | ÖLFLEX® LIFT | ÖLFLEX® LIFT T | ÖLFLEX® LIFT S | ÖLFLEX® CRANE 2S | ÖLFLEX® CRANE NSHTÖU | ÖLFLEX® CRANE VS (N)SHTÖU | ÖLFLEX® CRANE PUR |
| **Bending radius** | | | | | | | | | | | |
| 5 x D | | | | | | | | | ● | | |
| 6.5 x D | | | | | | | | | ● | | |
| 7.5 x D | | | | | | | | | ○ | ● | ● |
| 10 x D | | ● | ● | ● | | | | | | | |
| 12.5 x D | ● | | | | | | | | | | |
| 15 x D | | | | | | | | | | | |
| 20 x D | | | | | ● | ● | ● | ● | | | |
| **Nominal voltage** | | | | | | | | | | | |
| 300/500 V | ● | ● | ● | ● | ● | ● | ● | ● | | | |
| 450/750 V | | ● | | | | | | | | | |
| 600/1000 V | | | | | | | | | ● | ● | ● |
| **Make-up** | | | | | | | | | | | |
| PVC | | ● | | | ● | ● | ● | ● | | | |
| Rubber | ● | | ● | ● | | | | | ● | ● | |
| Support core: hemp rope/ textile rope | ● | | | | ● | ● | | | | | |
| Support core: steel rope, internal | | | | | | | ● | | | | |
| Support core: steel rope, external | | | | | | | | ● | | | |
| Support core: Kevlar rope | | | | | ● | ● | | | | ● | |
| Outer sheath supporting braid | | | | | | | | | ● | ● | ● |
| PVC sheath | | ● | | | | | | | | | |
| PVC sheath cold fl exible | | ● | | | ● | ● | ● | ● | | | |
| Rubber sheath | ● | | ● | ● | | | | | ● | ● | |

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○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying





| Application Criteria | | Cable and Lead Designation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | ÖLFLEX® CRANE NSHTÖU | ÖLFLEX® CRANE VS (N)SHTÖU | ÖLFLEX® CRANE PUR | ÖLFLEX® CRANE | ÖLFLEX® CRANE CF | ÖLFLEX® CRANE 2S | ÖLFLEX® LIFT | ÖLFLEX® LIFT T | ÖLFLEX® LIFT S | ÖLFLEX® CRANE F | ÖLFLEX® LIFT F |
| Festoons |  | | | | ● | ● | | | | | ● | ● |
| Cable winding reels light stress level (Monospiral installation – stacked) |  | ● | ○ | ● | | | | | | | | |
| Cable winding reels medium stress level (Multispiral installation – single-layer) |  | ● | ○ | ● | | | | | | | | |
| Cable winding reels high stress level (Multispiral installation – multi-layer) |  | | ● | ● | | | | | | | | |
| Cable winding reels vertical laying |  | | ● | ● | | | | | | | | |
| Cable tender systems (horizontal) |  | | ● | ● | | | | | | | | |
| Cable tender systems (vertical) |  | | | ● | | | | | | | | |
| Guide pulley systems |  | | ● | ● | | | | | | | | |
| Push buttons |  | | ● | ● | | | ● | | | | | |
| Power chains |  | ○ | ○ | ● | ○ | | | | | | ○ | ○ |
| Elevator/Lift | | | | | | | | ● | ● | ● | ● | ● |

● = Main application ○ = Suitable application

| Application Criteria | UNITRONIC® LiYY | UNITRONIC® LiYCY | UNITRONIC® LiYY (TP) | UNITRONIC® LiYCY (TP) | UNITRONIC® PUR CP | UNITRONIC® PUR CP (TP) | UNITRONIC® LiHH | UNITRONIC® LiHCH | UNITRONIC® LiHCH (TP) | UNITRONIC® 100 | UNITRONIC® 100 CY | UNITRONIC® LiYCY-CY | UNITRONIC® LiFYCY (TP) | UNITRONIC® CY PiDY (TP) | UNITRONIC® LiYD11Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Application** | | | | | | | | | | | | | | | |
| Additional control/time recording systems (ZK/ZE) | | | | ○ | | ○ | | | ○ | | | | | | ● |
| Operating data acquisition (BDE) | | | | ○ | | ○ | | | ○ | | | | | | |
| Clock systems | | | | | ○ | ○ | | | | | | | | | |
| Forced entry alarm systems (EMA) | ○ | ○ | | ○ | | | ○ | ○ | ○ | | | ○ | | | ● |
| Fire alarm systems (BMA) | | | | | | | | | | | | | | | ○ |
| Telephone extension systems | | | | | | | | | | | | | | | ○ |
| Interphone/Duplex systems | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | | | ○ | ○ | | ○ |
| Electroacoustic systems (ELA/PA) | | | | | | | | | | | | | | | ○ |
| Sound studio cable/ microphone cable | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ |
| Printer/Plotter | | | | ○ | | ○ | | | ○ | | | | ● | | ○ |
| Direct current stepping motors | | | | ● | | ● | | | ● | | | | | | |
| Encoder | | | | ● | | ● | | | ● | | | | | ○ | |
| Industrial sensors, U < 50 Veff | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● |
| Industrial actuators, U < 50 Veff | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● |
| Measurement and control system, analog (MSR) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● |
| MSR, digital | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | | ○ | ○ |
| In electronic instruments | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| For cutting/clipping technology (0.34 mm²/AWG 22) | ● | ● | | | ● | ● | ● | ● | | ● | ● | | | | |
| **Temperature range** | | | | | | | | | | | | | | | |
| +80 °C | □ | □ | | | | | | | | □ | □ | | □ | | |
| +70 °C | ■ | ■ | □ | □ | ■ | ■ | □ | □ | □ | ■ | ■ | □ | | □ | ■ |
| +60 °C | | | | | | | | | | | | | | | |
| -5 °C | ■ | ■ | | | ■ | ■ | | | | ■ | ■ | | | | ■ |
| -20 °C | | | | | | | | | | | | | | | |
| -30 °C | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | |
| -40 °C | | | | | | | | | | | | | | | |





■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range

Further halogen free cables and leads on request.

| Application Criteria | UNITRONIC® LiYY | UNITRONIC® LiYCY | UNITRONIC® LiYY (TP) | UNITRONIC® LiYCY (TP) | UNITRONIC® PUR CP | UNITRONIC® PUR CP (TP) | UNITRONIC® LiHH | UNITRONIC® LiHCH | UNITRONIC® LiHCH (TP) | UNITRONIC® 100 | UNITRONIC® 100 CY | UNITRONIC® LiYCY-CY | UNITRONIC® LiFYCY (TP) | UNITRONIC® CY PiDY (TP) | UNITRONIC® LiYD11Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Laying** | | | | | | | | | | | | | | | |
| For static laying outdoors | | | | | | | | | | | | | | | ○ |
| For direct laying underground | | | | | | | | | | | | | | | |
| For static installation (indoors) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| For flexible laying (indoors) occasionally | ● | ● | ○ | ○ | ● | ○ | ● | ● | ○ | ● | ● | ○ | ○ | ○ | ● |
| For continuous flexible laying (indoors/outdoors) | | | | | | | | | | | | | | | |
| **Make-up** | | | | | | | | | | | | | | | |
| Halogen free | | | | | | | ● | ● | ● | | | | | | |
| Flame retardant, self extinguishing | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | |
| For electr. symmetrical signal transmission (TP), twisted pair | | | ● | ● | | ● | | | | | | | ● | ● | |
| For high end coupling of the pairs, screened | | | | | | | | | | | | | | ● | |
| For electrical screening effect, total screening | | ● | | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● |
| For low attenuation transmission, low capacitance | | | | | | | | | | | | | | | |
| With individually screened cores | | | | | | | | | | | | ● | | | |
| With combined core pairs/ individual conductors | | | | | | | | | | | | | | | |
| With colour code DIN 47100 | ● | ● | ● | ● | ● | ● | ● | ● | | | | ● | ● | ● | ● |
| With UNITRONIC® colour code | | | | | | | | | | ● | ● | | | | |
| With industrial electronics colour code VDE 0815 | | | | | | | | | | | | | | | |
| With star-quad colour code "BD" to VDE 0815/0816 | | | | | | | | | | | | | | | |
| With pair colour code "LG" to VDE 0815 | | | | | | | | | | | | | | | |
| With special colour code | | | | | | | | | | | | | | | |
| With numbered cores | | | | | | | | | | | | | | | |
| With PVC/special PVC outer sheath | ● | ● | ● | ● | | | | | | ● | ● | ● | ● | ● | |
| With PUR sheath, wear resistant, cutting resistant | | | | | ● | ● | | | | | | | | | ● |
| With PE outer sheath (not flame-retardant) | | | | | | | | | | | | | | | |

| Application Criteria | UNITRONIC® ST | UNITRONIC® FD | UNITRONIC® FD CY | UNITRONIC® FD P plus | UNITRONIC® FD CP plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® Li2YCY(TP)-Li2YCYv (TP) | UNITRONIC® Li2YCY PiMF | JE-Y(ST)Y | JE-LiYCY (TP) | Telephone indoor cable J-Y(ST)Y | Fire alarm cable J-Y(ST)Y red | UNITRONIC® J-2Y(ST)Y | Telephone outdoor cable |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Application** | | | | | | | | | | | | | | |
| Additional control/time recording systems (ZK/ZE) | ● | | | | | | | | ● | ● | ● | | ● | ○ |
| Operating data acquisition (BDE) | ● | | | | | | | | ● | ● | ● | | ● | ○ |
| Clock systems | | | | | | | | | ● | ● | ● | | ● | ○ |
| Forced entry alarm systems (EMA) | | | | | | | ○ | ○ | ○ | ○ | ● | | ● | ○ |
| Fire alarm systems (BMA) | | | | | | | ○ | ○ | | | ○ | ● | ○ | ○ |
| Telephone extension systems | | | | | | | ○ | ○ | | | ● | | ● | ● |
| Interphone/Duplex systems | | | | | | | ● | ● | ○ | ○ | ● | | ● | ● |
| Electroacoustic systems (ELA/PA) | | | | | | | ● | ● | ○ | | ● | | ● | ● |
| Sound studio cable/ microphone cable | | | | | | | ● | ● | | | | | | |
| Printer/Plotter | | ● | ○ | ● | ○ | ○ | ● | ● | | | | | | |
| Direct current stepping motors | | | | | | ● | ● | ● | | ○ | | | | |
| Encoder | | | | | | ● | ● | ● | | ○ | | | | |
| Industrial sensors, U < 50 Veff | | ● | ● | ● | ● | ● | ● | ● | ○ | ○ | | | | |
| Industrial actuators, U < 50 Veff | | ● | ● | ● | ● | ● | ● | ● | | ○ | | | | |
| Measurement and control system, analog (MSR) | | ● | ● | ● | ● | ● | ● | ● | ○ | ○ | | | ○ | ○ |
| MSR, digital | | ● | ● | ● | ● | ● | ● | ● | | ○ | | | ○ | ○ |
| In electronic instruments | | ● | ● | ● | ● | ● | ● | ● | | | | | | |
| For cutting/clipping technology (0.34 mm²/AWG 22) | ● | ● | ● | | | | ● | ○ | ● | ● | ● | ● | ● | ● |
| **Temperature range** | | | | | | | | | | | | | | |
| +80 °C | □ | □ | □ | □ | □ | □ | | | | | | □ | □ | |
| +70 °C | | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | | | □ |
| +60 °C | | | | | | | | | | | | □ | | |
| -5 °C | | ■ | ■ | | | | | | | | □ | | | □ |
| -20 °C | | | | | | | | | | | | | □ | |
| -30 °C | □ | □ | □ | | | | □ | □ | □ | □ | | | | |
| -40 °C | | | | ■ | ■ | ■ | | | | | | | | |

■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range

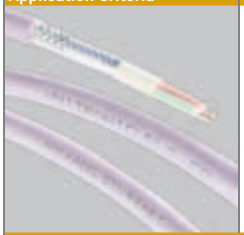
Further halogen free cables and leads on request.





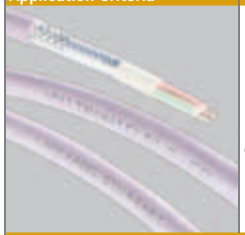


| Application Criteria | UNITRONIC® ST | UNITRONIC® FD | UNITRONIC® FD CY | UNITRONIC® FD P plus | UNITRONIC® FD CP plus | UNITRONIC® FD CP (TP) plus | UNITRONIC® Li2YCY(TP)-Li2YCYv (TP) | UNITRONIC® Li2YCY PiMF | JE-Y(ST)Y | JE-LiYCY (TP) | Telephone indoor cable J-Y(ST)Y | Fire alarm cable J-Y(ST)Y red | UNITRONIC® J-2Y(ST)Y | Telephone outdoor cable |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Laying** | | | | | | | | | | | | | | |
| For static laying outdoors | | | | | | | ○ | | | | | | | ● |
| For direct laying underground | | | | | | | | | | | | ● | | ○ |
| For static installation (indoors) | ● | ○ | ○ | ● | ● | ● | ● | | ● | ● | ● | | ● | |
| For flexible laying (indoors) occasionally | | ● | ● | ○ | ○ | ○ | ● | ● | | ○ | | | | |
| For continuous flexible laying (indoors/outdoors) | | | | ● | ● | ● | | ● | | | | | | |
| **Make-up** | | | | | | | | | | | | | | |
| Halogen free | | | | ● | ● | ● | | | | | | | | |
| Flame retardant, self extinguishing | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ○ |
| For electr. symmetrical signal transmission (TP), twisted pair | | | | | | ● | ● | ● | ● | ● | ○ | | | |
| For high end coupling of the pairs, screened | | | | | | | | ● | | | | | | |
| For electrical screening effect, total screening | ● | | ● | | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| For low attenuation transmission, low capacitance | | | | ● | ● | ● | ● | ● | | | | | ● | |
| With individually screened cores | | | | | | | | | | | | | | |
| With combined core pairs/ individual conductors | | | | | | | | | | | | | | |
| With colour code DIN 47100 | | ● | ● | ● | ● | ● | ● | ● | | | | | | |
| With UNITRONIC® colour code | | | | | | | | | | | | | | |
| With industrial electronics colour code VDE 0815 | | | | | | | | | ● | ● | | | | |
| With star-quad colour code "BD" to VDE 0815/0816 | | | | | | | | | | ○ | ○ | | ● | ● |
| With pair colour code "LG" to VDE 0815 | | | | | | | | | | | | ○ | ○ | |
| With special colour code | ● | | | | | | | | | | | | | |
| With numbered cores | | | | | | | | | | | | | | |
| With PVC/special PVC outer sheath | ● | ● | ● | | | | ● | ● | ● | ● | ● | ● | ● | |
| With PUR sheath, wear resistant, cutting resistant | | | | ● | ● | ● | | | | | | | | |
| With PE outer sheath (not flame-retardant) | | | | | | | | | | | | | | ● |

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | UNITRONIC® BUS IBS | UNITRONIC® BUS IBS FD P | UNITRONIC® BUS IBS Yv | UNITRONIC® BUS IBS P COMBI | UNITRONIC® BUS IBS FD P COMBI | UNITRONIC® BUS IBS Yv COMBI | UNITRONIC® BUS LD | UNITRONIC® BUS LD FD P | UNITRONIC® BUS PB | UNITRONIC® BUS PB FD P | UNITRONIC® BUS PB Yv | UNITRONIC® BUS PB 7-W | UNITRONIC® BUS PB COMBI 7-W |
| **Application** | | | | | | | | | | | | | |
| suitable for network type to: | | | | | | | | | | | | | |
| IEEE 802.3 (Ethernet) | | | | | | | | | | | | | |
| IEEE 802.4 (MAP) | | | | | | | | | | | | | |
| IEEE 802.5 (IBM) | | | | | | | | | | | | | |
| ISDN 64 K Bit | | | | | | | | | | | | | |
| IBM 3270, 3600, 4300 | | | | | | | | | | | | | |
| IBM AS 400, 36, 38 | | | | | | | | | | | | | |
| IBM PC Network | | | | | | | | | | | | | |
| 10 base 5 Ethernet | | | | | | | | | | | | | |
| 10 base 2 Cheapernet | | | | | | | | | | | | | |
| 10 base T (UTP) 100 Ohm | | | | | | | | | | | | | |
| Token Ring (STP) 150 Ohm | | | | | | | | | | | | | |
| Token Bus | | | | | | | | | | | | | |
| Radio/TV | | | | | | | | | | | | | |
| Video BAS/FBAS | | | | | | | | | | | | | |
| Video RGB Monitors | | | | | | | | | | | | | |
| EIA RS 232/V.24 | | | | | | | ○ | ○ | | | | | |
| EIA RS 422/V.11 | | | | | | | ○ | ○ | | | | | |
| EIA RS 485 | | | | | | | ● | ● | | | | | |
| EIA RS 232/20 mA (TTY) | | | | | | | | | | | | | |
| **Standards** | | | | | | | | | | | | | |
| PROFIBUS | | | | | | | | | ● | ● | ● | ● | ● |
| INTERBUS (Phoenix Contact) | ● | ● | ● | ● | ● | ● | | | | | | | |
| BITBUS (Intel) | | | | | | | ● | ● | | | | | |
| For LAN installations (IBM, Ethernet etc.) | | | | | | | | | | | | | |
| With IBM reference approval | | | | | | | | | | | | | |
| Acc. to DEC specification | | | | | | | | | | | | | |
| **Temperature range** | | | | | | | | | | | | | |
| +205 °C | | | | | | | | | | | | | |
| +90 °C | | | | | | | | | | | | | |
| +80 °C | | | | □ | | □ | | | | | | | |
| +70 °C | □ | ■ | □ | | ■ | | □ | □ | □ | | □ | □ | □ |
| +60 °C | | | | | | | | | | | | | |
| -5 °C | | | | | | | | | | | | | |
| -20 °C | | ■ | | | ■ | | | ■ | | ■ | | | |





| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | UNITRONIC® BUS IBS | UNITRONIC® BUS IBS FD P | UNITRONIC® BUS IBS Yv | UNITRONIC® BUS IBS P COMBI | UNITRONIC® BUS IBS FD P COMBI | UNITRONIC® BUS IBS Yv COMBI | UNITRONIC® BUS LD | UNITRONIC® BUS LD FD P | UNITRONIC® BUS PB | UNITRONIC® BUS PB FD P | UNITRONIC® BUS PB Yv | UNITRONIC® BUS PB 7-W | UNITRONIC® BUS PB COMBI 7-W |
| **Temperature range** | | | | | | | | | | | | | |
| -30 °C | □ | | □ | □ | | □ | □ | □ | | ◪ | □ | ◪ | |
| -40 °C | | | | | | | | | | □ | | | |
| -50 °C | | | | | | | | | | | | | |
| -190 °C | | | | | | | | | | | | | |
| **Characteristic impedance** | | | | | | | | | | | | | |
| ≥ 150 Ohm | | | | | | | | | ● | ● | ● | ● | ● |
| ≥ 120 Ohm | | | | | | | | | | | | | |
| ≥ 100 Ohm | ● | ● | ● | ● | ● | ● | ● | ● | | | | | |
| ≥ 93 Ohm | | | | | | | | | | | | | |
| ≥ 75 Ohm | | | | | | | | | | | | | |
| ≥ 60 Ohm | | | | | | | | | | | | | |
| ≥ 50 Ohm | | | | | | | | | | | | | |
| **Capacity category** | | | | | | | | | | | | | |
| CAT.5 ≤ 100 MHz | | | | | | | | | | | | | |
| CAT.6 ≤ 250 MHz | | | | | | | | | | | | | |
| CAT.7 ≤ 600 MHz | | | | | | | | | | | | | |
| **Make-up** | | | | | | | | | | | | | |
| PVC sheath | | | ● | | | ● | ● | | ● | | ● | ● | ● |
| Halogen free sheath | | | | | | | | | | | | | |
| PE sheath | | | | | | | | | | | | | |
| PUR sheath, wear resistant; cutting resistant | ● | ● | | ● | ● | | | ● | | ● | | | |
| Flourpolymer outer sheath | | | | | | | | | | | | | |
| **Laying** | | | | | | | | | | | | | |
| Outdoor laying in air | | ● | | | ● | | | | | ● | | | |
| indirectly in the ground | | ● | | | ● | | | | | ● | | | |
| Indoor use laid directly | ● | | ● | ● | | ● | ● | ● | ● | | ● | ● | ● |
| directly in the ground | | | ● | | | ● | | | | | ● | | |

Halogen free types see Selection Table A4 in the Main Catalogue.

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying

**Legend**

| | | |
|---|---|---|
| 7-W | = | 7-wire strand |
| AS-I | = | AS-INTERFACE |
| COMBI IBS | = | Installation remote bus cable for INTERBUS |
| DN | = | Device Net |
| EIB | = | European Installation Bus |
| FD | = | suitable for power chains |
| FRNC | = | Flame Retardant Non Corrosive |
| G | = | rubber outer sheath (EPDM |
| H | = | Halogen free material |
| IBS | = | Remote bus cable for INTERBUS |
| L2 | = | Abbreviation for SINEC® L2-DP |
| LD | = | Long distance |
| P | = | Polyurethane outer sheath |
| PB | = | **P**rofi **B**us |
| PE | = | Polyethylene outer sheath |
| PROFIBUS-DP | = | **D**ecentralized **P**eriphery |
| PROFIBUS-FMS | = | **F**ieldbus **M**essage **S**pecification |
| PROFIBUS-PA | = | **P**rocess **A**utomation |
| TPE | = | thermoplastic Elastomer |
| Yv | = | Wire for outdoor use/direct burial with reinforced PVC outer sheath |
| YY | = | double PVC outer sheath |

**For detailed product information, please consult our current Main Catalogue or our homepage www.lappgroup.com.**





| | Characteristics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Protection class IP/NEMA | Connection thread metric | Connection thread PG | Connection thread NPT | for round cables | for fl at cables | Metal | Plastic | Angle | Strain relief |
| **Cable glands** | | | | | | | | | | |
| SKINTOP® ST-M/STR-M/ST(R) M ISO | 68/69K | ● | | | ● | | | ● | | ● |
| SKINTOP® CLICK/CLICK-R | 68 | | | | ● | | | ● | | ● |
| SKINTOP® CLICK BS | 68 | | | | ● | | ● | | | ● |
| SKINTOP® COLD/COLD-R | 68 | ● | | | ● | | ● | | | ● |
| SKINTOP® CUBE | 64 | | | | ● | | | ● | | ● |
| SKINTOP® ST and STR | 68 | | ● | | ● | | | ● | | ● |
| SKINTOP® ST (NPT) and STR (NPT) | 68 | | | ● | ● | | | ● | | ● |
| SKINTOP® ST-HF-M | 68 | ● | | | ● | | | ● | | ● |
| SKINTOP® BS-M/BS M ISO | 68 | ● | | | ● | | | ● | | ● |
| SKINTOP® BS | 68 | | ● | | ● | | | ● | | ● |
| SKINTOP® BS (NPT) | 68 | | | ● | ● | | | ● | | ● |
| SKINTOP® BT and BT-M | 68 | ● | ● | | ● | | | ● | | ● |
| SKINTOP® MS-M and MSR-M/ MS-M-XL and MSR-M-XL | 68/69K NEMA 4/ NEMA 6x | ● | | | ● | | ● | | | ● |
| SKINTOP® MS and MSR | 68 | | ● | | ● | | ● | | | ● |
| SKINTOP® MS (NPT) and MSR (NPT) | 68 | | | ● | ● | | ● | | | ● |
| SKINTOP® MS-IS-M | 68 | ● | | | ● | | ● | | | ● |
| SKINTOP® MS-SC-M | 68 | ● | | | ● | | ● | | | ● |
| SKINTOP® MS-M BRUSH/ BRUSH plus | 68/69K | ● | | | ● | | ● | | | ● |
| SKINTOP® MS-SC | 68 | | ● | | ● | | ● | | | ● |
| SKINTOP® K-M ATEX plus/plus blue | 68 | ● | | | ● | | | ● | | ● |
| SKINTOP® KR-M ATEX plus/plus blue | 68 | ● | | | ● | | | ● | | ● |
| SKINTOP® MS-M ATEX/ MS-M-XL ATEX | 68 | ● | | | ● | | ● | | | ● |
| SKINTOP® MSR-M ATEX | 68 | ● | | | ● | | ● | | | ● |
| SKINTOP® MS-M BRUSH ATEX/ SKINDICHT® SHVE-M ATEX | 68 | ● | | | ● | | ● | | | ● |

VITON® is a registered trademark of DuPont de Nemour

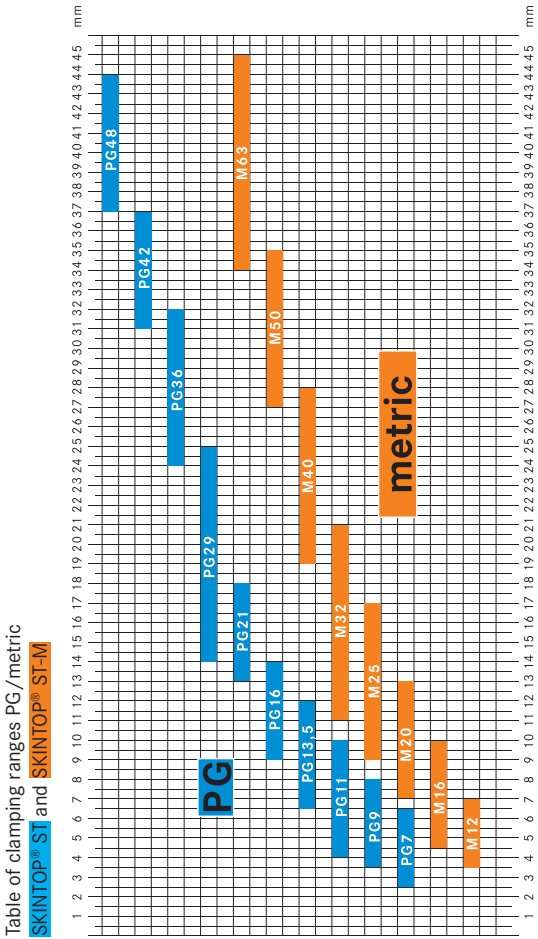
| Cable glands | Vibration protection | Antikink protection | Screen connection | Use for hazardous areas | Halogen free | Approvals |
|---|---|---|---|---|---|---|
| SKINTOP® ST-M/STR-M/ST(R) M ISO | ● | | | | | cULus, cURus, TÜV, VDE, DNV |
| SKINTOP® CLICK/CLICK-R | ● | | | | | VDE, cULus, cURus, DNV |
| SKINTOP® CLICK BS | ● | ● | | | | VDE, cULus, cURus, DNV |
| SKINTOP® COLD/COLD-R | | | | | | VDE |
| SKINTOP® CUBE | ● | | | | | |
| SKINTOP® ST and STR | ● | | | | | UL, UR, CSA, TÜV |
| SKINTOP® ST (NPT) and STR (NPT) | ● | | | | | UL, UR, CSA |
| SKINTOP® ST-HF-M | ● | | | | ● | VDE |
| SKINTOP® BS-M/BS M ISO | ● | ● | | | | cULus, cURus, VDE, DNV |
| SKINTOP® BS | ● | ● | | | | UL, UR, CSA |
| SKINTOP® BS (NPT) | ● | ● | | | | |
| SKINTOP® BT and BT-M | ● | ● | | | | |
| SKINTOP® MS-M and MSR-M/ MS-M-XL and MSR-M-XL | | | | | | cULus, cURus, VDE, DNV |
| SKINTOP® MS and MSR | | | | | | |
| SKINTOP® MS (NPT) and MSR (NPT) | | | | | | UL, UR, CSA |
| SKINTOP® MS-IS-M | | | | | | |
| SKINTOP® MS-SC-M | | | ● | | | cULus, cURus, DNV |
| SKINTOP® MS-M BRUSH/ BRUSH plus | | | ● | | | VDE, cULus, DNV |
| SKINTOP® MS-SC | | | ● | | | |
| SKINTOP® K-M ATEX plus/plus blue | ● | | | ● | | DNV, ATEX |
| SKINTOP® KR-M ATEX plus/plus blue | ● | | | ● | | DNV, ATEX |
| SKINTOP® MS-M ATEX/ MS-M-XL ATEX | | | | ● | | cULus, cURus, DNV, ATEX |
| SKINTOP® MSR-M ATEX | | | | ● | | cULus, cURus, DNV, ATEX |
| SKINTOP® MS-M BRUSH ATEX/ SKINDICHT® SHVE-M ATEX | | | ● | ● | | ATEX, DNV |

VITON® is a registered trademark of DuPont de Nemour



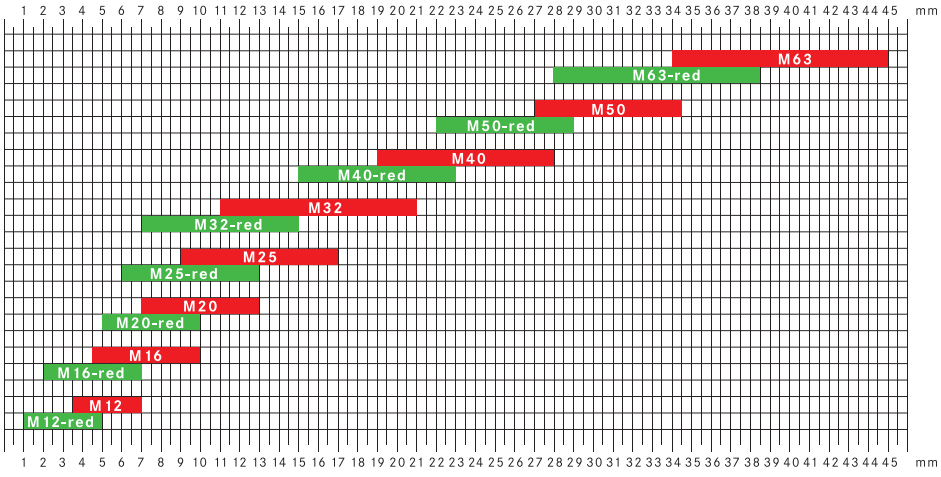


Table of clamping ranges PG/metric
SKINTOP® ST and SKINTOP® ST-M



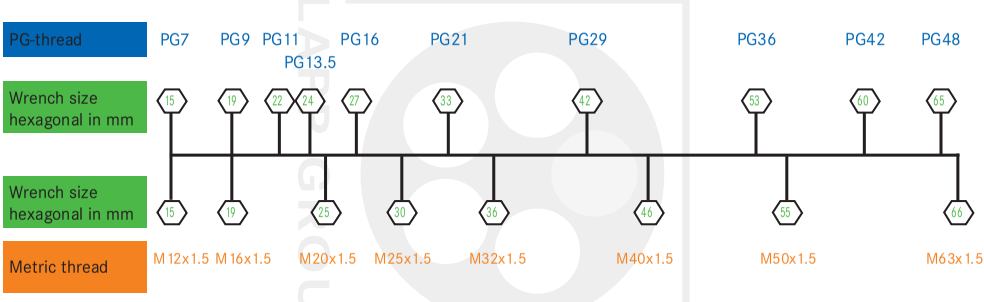
## Clamping ranges SKINTOP® metric

SKINTOP® ST-M and SKINTOP® STR-M






## SKINTOP® ST/SKINTOP® ST-M
## Comparison and classification of cable glands spanner size PG/metric



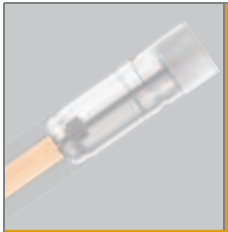
| Cable Designation | Application | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | UL approved | Highly flexible | Heat resistant | Limited UV resistant | Heavy duty | Halogen free | Energy and data transmission | INTERBUS | PROFIBUS | Bidirectional data transmission systems | Unidirectional data transmission systems | SERCOS interface |
| **Lapp Kabel HITRONIC® fibre optic (POF) program – fibre type, part number** | | | | | | | | | | | | |
| HITRONIC® POF SIMPLEX PE-PUR POF 980/1000, Part No. 2185 030 | | | | ● | | ● | | | | | ● | |
| HITRONIC® POF SIMPLEX PVC POF 980/1000, Part No. 2185 201 | ● | | | | | | | | | | ● | |
| HITRONIC® POF SIMPLEX S PE-PUR POF 980/1000, Part No. 2185 205 | | | | ● | | ● | | | | | ● | ● |
| HITRONIC® POF SIMPLEX S PA-PUR POF 980/1000, Part No. 2185 204 | | | | ● | ● | ● | | | | | ● | ● |
| HITRONIC® POF SIMPLEX PE POF 980/1000, Part No. 2185 001 | | | | ● | | ● | | | | | ● | |
| HITRONIC® POF SIMPLEX FD PE-PUR POF 980/1000, Part No. 2185 207 | | ● | | ● | | ● | | | | | ● | |
| HITRONIC® POF DUPLEX FD PE-PUR POF 980/1000, Part No. 2185 213 | | ● | | ● | | ● | | ● | ● | ● | | |
| HITRONIC® POF SIMPLEX 105 °C XPE POF 980/1000, Part No. 2185 202 | | | ● | ● | | ● | | | | | ● | |
| HITRONIC® POF DUPLEX PE POF 980/1000, Part No. 2185 010 | | | | ● | | ● | | ● | ● | ● | | |
| HITRONIC® POF DUPLEX HEAVY PE-PUR POF 980/1000, Part No. 2185 211 | | | | ● | ● | ● | | ● | ● | ● | | |
| HITRONIC® POF DUPLEX PE-PVC POF 980/1000, Part No. 2185 209 | | | | | | | | ● | ● | ● | | |
| HITRONIC® POF DUPLEX PVC-PVC POF 980/1000, Part No. 2185 210 | | | | | | | | ● | ● | ● | | |
| HITRONIC® POF DUPLEX PE-PUR POF 980/1000, Part No. 2185 040 | | | | ● | | ● | | ● | ● | ● | | |
| HITRONIC® POF MULTI FIBRE PE-PVC, Part No. 3036 010 | | | | ● | | | | ● | ● | ● | ● | |
| HITRONIC® FD P **DESINA®** 4x1.5 + 2xPOF 980/1000, Part No. 2186 001 | | | | ● | | ● | ● | | | ● | | |





| Cable Designation | Application | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | UL approved | Highly flexible | Heat resistant | Limited UV resistant | Heavy duty | Halogen free | Energy and data transmission | INTERBUS | PROFIBUS | Bidirectional data transmission systems | Unidirectional data transmission systems | SERCOS interface |
| **Lapp Kabel HITRONIC® fibre optic (PCF) program** | | | | | | | | | | | | |
| HITRONIC® BUS PCF DUPLEX indoor, Part No. 2185 311 | | | | | | | | ● | ● | ● | | |
| HITRONIC® BUS PCF DUPLEX outdoor, Part No. 2185 302 | | | | | | | | ● | ● | ● | | |
| **Lapp Kabel HITRONIC® fibre optic (GOF) program** | | | | | | | | | | | | |
| HITRONIC® HQN Outdoor Cable (A-DQ(ZN)B2Y) | | | | ● | | ● | | | | | | |
| HITRONIC® HIH Indoor Cable (J-D(ZN)H) | | | | | | ● | | | | | | |
| HITRONIC® HUN Universal Cable (J/A-DQ(ZN)BH) | | | | | | ● | | | | | | |
| HITRONIC® HRH Breakout Cable (AT-V(ZN)HH) | | | | | | ● | | | | | | |
| HITRONIC® HDH Mini-Breakout Cable (J-V(ZN)H) | | | | | | ● | | | | | | |
| HITRONIC® FD Mobile Cable (AT-VQ(ZN)11Y) | | ● | | | | | | | | | | |

A12: Applicability of Servo Cables in Power Drive Systems (PDS)



| Cable type | Type of service | Power Drive Systemes | | SEW | | SIEMENS | | INDRAMAT | | LENZE | | Heidenhain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Line | Motor | Power | Signal | Power | Signal | Power | Signal | Power | Signal | Power | Signal |
| ÖLFLEX® SERVO 700 | static run or flexing | ● | ● | | | | | | | | | | |
| ÖLFLEX® SERVO 700 CY | | | ● | | | | | | | | | | |
| ÖLFLEX® SERVO 709 CY | | | ● | | | | | ○ | | | | | |
| ÖLFLEX® SERVO 720 CY | | | | | | | | | | | | | ○ |
| ÖLFLEX® SERVO 730 | | ● | | | | | | | | | | | |
| ÖLFLEX® SERVO 730 CY | | | ● | | | | | | | | | | |
| ÖLFLEX® SERVO 2YSLCY low Capacitance | | | ● | | | | | | | ○ | | | |
| ÖLFLEX® SERVO 9YSLCY low Capacitance | | | ● | | | | | | | ○ | | | |
| Servo-Ltg. acc. to SEW Standard static | | | | ● | | | | | | | | | |
| SERVO-cable acc. to Siemens FX5 Serie | | | | | | ● | ● | | | | | | |

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range

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**For more assemblies, refer to Main Catalogue. For detailed product information, please consult our current Main Catalogue or our homepage www.lappgroup.com.**





A13: Cables for expanded ambient temperatures

| Application Criteria | Cable and Lead Designation | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ÖLFLEX® HEAT 105 MC | ÖLFLEX® HEAT 145 MC | ÖLFLEX® HEAT 145 C MC | ÖLFLEX® HEAT 180 SiHF | ÖLFLEX® HEAT 180 H05SS-F EWKF | ÖLFLEX® HEAT 180 MS | ÖLFLEX® HEAT 180 C MS | ÖLFLEX® HEAT 180 EWKF | ÖLFLEX® HEAT 180 EWKF C | ÖLFLEX® HEAT 180 GLS | ÖLFLEX® HEAT 205 MC | ÖLFLEX® HEAT 260 MC | ÖLFLEX® HEAT 260 C MC | ÖLFLEX® HEAT 260 GLS | ÖLFLEX® HEAT 350 MC | ÖLFLEX® HEAT 1565 MC |
| **Application** | | | | | | | | | | | | | | | | |
| External and internal cabling of machinery | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Internal wiring in cabinets | | | | | | | | | | | | | | | | |
| In dry rooms | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| In dry and damp rooms | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● | | | |
| For outdoor use, fixed installed and mech. protected | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● | | | |
| Highest chemical resistance | | | | | | | | | | | ● | ● | ● | ● | | |
| In EMI critical areas | | | ● | | | | ● | | ● | | | | ● | | | |
| Suitable for the use in paint shop lines | | | | | | | | | | | ○ | | ● | ● | | |
| **Temperature range** | | | | | | | | | | | | | | | | |
| +1565° C | | | | | | | | | | | | | | | | ☒ |
| +400° C | | | | | | | | | | | | | | | | □ |
| +350° C | | | | | | | | | | | | | | | □ | |
| +300° C | | | | | | | | | | | | ☒ | ☒ | ☒ | | |
| +260° C | | | | | | | | | | | | ◪ | ◪ | ◪ | | |
| +200 °C | | | | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ◪ | | | | | |
| +180 °C | | | | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | | | | | | |
| +145 °C | | ☒ | ☒ | | | | | | | | | | | | | |
| +125 °C | | ■ | ■ | | | | | | | | | | | | | |
| +105 °C | ☒ | | | | | | | | | | | | | | | |
| +90 °C | □ | | | | | | | | | | | | | | | |
| -20 °C | □ | | | | | | | | | | | | | | | |
| -35 °C | | ■ | ■ | | | | | | | | | | | | | |
| -50 °C | | □ | □ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | | | | | □ | |
| -80 °C | | | | | | | | | | | ■ | | | | | |
| -100 °C | | | | | | | | | | | □ | | | | | |
| -140 °C | | | | | | | | | | | | ■ | ■ | ■ | | |
| -190° C | | | | | | | | | | | | □ | □ | □ | | □ |

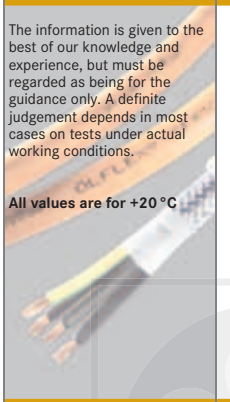
| Application Criteria | ÖLFLEX® HEAT 105 MC | ÖLFLEX® HEAT 145 MC | ÖLFLEX® HEAT 145 C MC | ÖLFLEX® HEAT 180 SiHF | ÖLFLEX® HEAT 180 H05SS-F EWKF | ÖLFLEX® HEAT 180 MS | ÖLFLEX® HEAT 180 C MS | ÖLFLEX® HEAT 180 EWKF | ÖLFLEX® HEAT 180 EWKF C | ÖLFLEX® HEAT 180 GLS | ÖLFLEX® HEAT 205 MC | ÖLFLEX® HEAT 260 MC | ÖLFLEX® HEAT 260 C MC | ÖLFLEX® HEAT 260 GLS | ÖLFLEX® HEAT 350 MC | ÖLFLEX® HEAT 1565 MC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nominal voltage** | | | | | | | | | | | | | | | | |
| 300/500 V | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 450/750 V | | ● | ● | | | | | | | | | | | | | |
| 600/1000 V | | ○ | ○ | | | | | | | | | | | | | |
| 10 kV | | | | | | | | | | | | | | | | |
| 600 V according UL/CSA | | | | | | ● | ● | | | | | | | | | |
| **Standards** | | | | | | | | | | | | | | | | |
| Halogen free according IEC 60754-1 | | ● | ● | ● | ● | ● | ● | ● | ● | ● | | | | | | |
| Low smoke density according IEC 601034 | | ● | ● | | | | | | | | | | | | | |
| Low smoke toxicity according NES 02-713 | | ● | ● | | | | | | | | | | | | | |
| Flame retardant according IEC 60332-1-2 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ● | ● |
| Low flame propagation according IEC 60332.3 | | ● | ● | | | | | | | | | | | | | |
| Based on VDE/HAR/DIN | ● | | | ● | | | | ● | ● | ● | ● | ● | ● | | ● | ● |
| With HAR certification | | | | | ● | | | | | | | | | | | |
| With UL/CSA certification | | | | | | ● | ● | | | | | | | | | |
| With GL resp. DNV certification | | ● | ● | | | | | | | | | | | ● | | |





| Application Criteria | ÖLFLEX® HEAT 105 MC | ÖLFLEX® HEAT 145 MC | ÖLFLEX® HEAT 145 C MC | ÖLFLEX® HEAT 180 SiHF | ÖLFLEX® HEAT 180 H05SS-F EWKF | ÖLFLEX® HEAT 180 MS | ÖLFLEX® HEAT 180 C MS | ÖLFLEX® HEAT 180 EWKF | ÖLFLEX® HEAT 180 EWKF C | ÖLFLEX® HEAT 180 GLS | ÖLFLEX® HEAT 205 MC | ÖLFLEX® HEAT 260 MC | ÖLFLEX® HEAT 260 C MC | ÖLFLEX® HEAT 260 GLS | ÖLFLEX® HEAT 350 MC | ÖLFLEX® HEAT 1565 MC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Make-up** | | | | | | | | | | | | | | | | |
| Solid conductor according VDE 0295 Class 1 | | | | | | | | | | | | | | | | |
| Fine wired according VDE 0295 Class 5 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| PVC core insulation/ sheath, heat resistant | ● | | | | | | | | | | | | | | | |
| Halogen free special core insulation/sheath | | ● | ● | | | | | | | | | | | | | |
| Silicone core insulation/sheath | | | | ● | ● | ● | ● | ● | ● | ● | | | | | | |
| Silicone, notch resistant (EWKF) sheath | | | | | ● | | | ● | ● | | | | | | | |
| Fluoropolymer core insulation/sheath (FEP/PTFE) | | | | | | | | | | | ● | ● | ● | ● | | |
| Glass fibre insulation/sheath | | | | | | | | | | | | | | | ● | ● |
| Core number printing according VDE 0293 | | ● | ● | ● | | ● | ● | ● | ● | ● | | | | | | |
| Core colour code according VDE 0293-308 | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Individual colours | | | | | | | | | | | | | | | | |
| Common copper screening | | | ● | | | | ● | | ● | | | | ● | | | |
| Steel wire armouring | | | | | | | | | | ● | | | | ● | | |

● = Principal application
○ = Application not customary, but possible, or alternative design available in the range
■ = Temperature range for flexible laying
◪ = Temperature range for static and flexible laying
□ = Temperature range for static laying
☒ = Temperature range for static laying (short-term)




| | Cable and Lead Designation | | | | |
|---|---|---|---|---|---|
| | | ÖLFLEX® CLASSIC 100, -110, -115 CY, ÖLFLEX® SERVO 700, -700 CY, -2YSLCY, -720, -730, -730 CY, UNITRONIC® 100, -EB, -9YSLCY | ÖLFLEX® FD 90, FD 90 CY, ÖLFLEX® 140, 140 CY, ÖLFLEX® FD 891/891 CY, Tray II, ÖLFLEX® SERVO 709 CY, ÖLFLEX® SERVO FD 781 CY, ÖLFLEX® CONTROL TM/TM CY, SERVO cables acc. SEW, SIEMENS FX 5008 Standard | ÖLFLEX® CLASSIC 110 SY, ÖLFLEX® CLASSIC 100 CY, ÖLFLEX® CLASSIC 110 SY, -110 CY | ÖLFLEX® CLASSIC 400 P, -400 CP, -415 CP, -440 P, -440 CP, -450 P, -500 P, -540 CP, -540 P, -550 P, ÖLFLEX® SERVO FD 750, -755, -755 CP, 760, -770, -785, -790 CP, 795 P/CP |
| **Inorganic chemicals** | **Conc.** | | | | |
| Alums | cs. | □ | □ | □ | |
| Aluminium salts | a.c. | □ | □ | □ | |
| Ammonia, aqu. | 10 % | □ | □ | □ | □ |
| Ammonium acetate, aqu. | a.c. | □ | □ | □ | |
| Ammonium carbonate, aqu. | a.c. | □ | □ | □ | ■ |
| Ammonium chloride, aqu. | a.c. | □ | □ | □ | □ |
| Barium salts | a.c. | □ | □ | □ | □ |
| Boric acid, aqu. | | □ | □ | □ | ◪ |
| Calcium chloride, aqu. | cs. | □ | □ | □ | ◪ |
| Calcium nitrate, aqu. | cs. | □ | □ | □ | |
| Chromium salts, aqu. | cs. | □ | □ | □ | □ |
| Potassium carbonate, aqu. (potash) | | □ | □ | □ | |
| Potassium chlorate, aqu. | cs. | □ | □ | □ | |
| Potassium chloride, aqu. | cs. | □ | □ | □ | ■ |
| Potassium dichromate, aqu. | | □ | □ | □ | ◪ |
| Potassium jodide, aqu. | | □ | □ | □ | |
| Potassium nitrate, aqu. | cs. | □ | □ | | |
| Potassium permanganate, aqu. | | ◪ | ◪ | ◪ | ◪ |
| Potassium sulfate, aqu. | | □ | □ | □ | □ |
| Copper salts, aqu. | cs. | □ | □ | □ | □ |
| Magnesium salts, aqu. | cs. | □ | □ | □ | ◪ |
| Sodium bicarbonate, aqu. (soda) | | □ | □ | □ | ◪ |
| Sodium bisulphite, aqu. | | □ | □ | □ | □ |
| Sodium chloride, aqu. (cooking salt) | | □ | □ | □ | □ |
| Sodium thiosulphate, aqu. (fixing salt) | | □ | □ | □ | ◪ |
| Nickel salts, aqu. | cs. | □ | □ | □ | □ |
| Phorsphoric acid | 50 % | □ | □ | □ | ■ |
| Mercury | 100 % | □ | □ | □ | □ |

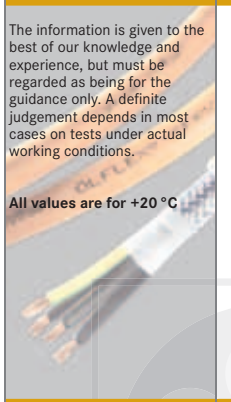
aqu. = in aqueous solution
a.c. = any concentration
cs. = cold saturated

□ = good resistant
◪ = moderate resistant
■ = less/not resistant

□ = no to slight reaction
◪ = slight to average reaction
■ = average to strong reaction








| | Cable and Lead Designation | | | | |
|---|---|---|---|---|---|
| | | ÖLFLEX® CLASSIC 100, -110, -115 CY, ÖLFLEX® SERVO 700, -700 CY, -2YSLCY, -720, -730, -730 CY, UNITRONIC® 100, -EB, -9YSLCY | ÖLFLEX® FD 90, FD 90 CY, ÖLFLEX® 140, 140 CY, ÖLFLEX® FD 891/891 CY, Tray II, ÖLFLEX® SERVO 709 CY, ÖLFLEX® SERVO FD 781 CY, ÖLFLEX® CONTROL TM/TM CY, SERVO Kabel nach SEW, SIEMENS FX 5008 Standard | ÖLFLEX® CLASSIC 110 SY, ÖLFLEX® CLASSIC 100 CY, ÖLFLEX® CLASSIC 110 SY, -110 CY | ÖLFLEX® CLASSIC 400 P, -400 CP, -415 CP, -440 P, -440 CP, -450 P, -500 P, -540 CP, -540 P, -550 P, ÖLFLEX® SERVO FD 750, -755, -755 CP, 760, -770, -785, -790 CP, 795 P/CP |
| **Inorganic chemicals** | **Conc.** | | | | |
| Mercury salts, aqu. | cs. | □ | □ | □ | □ |
| Nitric acid | 30 % | ■ | ■ | ■ | ■ |
| Hydrochloric acid | conc. | ■ | ■ | ■ | ■ |
| Sulphur | 100 % | □ | □ | □ | □ |
| Sulphur dioxide, gaseous | | □ | □ | □ | |
| Carbon disulphide | | ■ | ■ | ■ | ■ |
| Hydrogen sulphide | | □ | □ | □ | |
| Sea water | | □ | □ | □ | □ |
| Silver salts, aqu. | | □ | □ | □ | □ |
| Hydrogene peroxide | 3 % | □ | □ | □ | □ |
| Zinc salts, aqu. | | □ | □ | □ | ■ |
| Stannous chloride | | □ | □ | □ | |
| **Organic chemicals** | | | | | |
| Ethyl alcohol | 100 % | ■ | ■ | ■ | ◪ |
| Formic acid | 30 % | ■ | ■ | ■ | ■ |
| Gasoline | | ■ | ■ | ■ | □ |
| Succinic acid, aqu. | cs. | □ | □ | □ | □ |
| Acetic acid | 20 % | ◪ | ◪ | ◪ | ◪ |
| Hydraulic oil | | ■ | ■ | ■ | ◪ |
| Isopropyl alcohol | 100 % | ■ | ■ | ■ | ■ |
| Machine oil | | ◪ | □ | ◪ | □ |
| Methyl alcohol | 100 % | ◪ | ◪ | ◪ | ◪ |
| Oxalic acid, aqu. | cs. | □ | □ | □ | |
| Cutting oil | | ◪ | □ | ◪ | □ |
| Vegetable oil and fats | | ◪ | □ | ◪ | □ |
| Tartaric acid, aqu. | | □ | □ | □ | |
| Citric acid | | □ | □ | □ | ◪ |

The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions.

**All values are for +20 °C**

| | | Cable and Lead Designation | | | | |
|---|---|---|---|---|---|---|
| | | ÖLFLEX® FD CLASSIC 810 P, -810 CP, -855 P, -855 CP, ÖLFLEX® FD 891 P, -891 CP, ÖLFLEX® Robot 900, -F1, UNITRONIC® FD P, ÖLFLEX® CRANE PUR, UNIRONIC® LiYD11Y, UNITRONIC® FD CP, UNITRONIC® FD CP (TP), HITRONIC® POF with PUR-sheath, UNITRONIC® FD plus types, UNITRONIC® PUR, SERVO cables acc. SIEMENS Standard FX7, Fx8 PLUS Standard | ÖLFLEX® CRANE round and flat | ÖLFLEX® LIFT T, LIFT S, ÖLFLEX® CRANE 2S, ÖLFLEX® LIFT F, ÖLFLEX® SF, Single core LiFY | Halogen-free cables and leads UNITRONIC® H-(ST)H, NHXMH, ÖLFLEX® 120 H, 120 CH, 130 H, 135 CH, 130 H BK 0,6/1 KV, 135 CH BK 0,6/1 KV, ÖLFLEX® FD 820 H |
| **Inorganic chemicals** | **Conc.** | | | | | |
| Alums | cs. | | □ | □ | □ | |
| Aluminium salts | a.c. | | □ | □ | □ | ◪ |
| Ammonia, aqu. | 10 % | □ | □ | □ | | ■ |
| Ammonium acetate, aqu. | a.c. | | | □ | | |
| Ammonium carbonate, aqu. | a.c. | ■ | □ | □ | | |
| Ammonium chloride, aqu. | a.c. | □ | □ | □ | | |
| Barium salts | a.c. | □ | □ | □ | | ◪ |
| Boric acid, aqu. | | ◪ | □ | □ | | ◪ |
| Calcium chloride, aqu. | cs. | ◪ | □ | □ | | ◪ |
| Calcium nitrate, aqu. | cs. | | □ | □ | | ◪ |
| Chromium salts, aqu. | cs. | □ | □ | □ | | |
| Potassium carbonate, aqu. (potash) | | | ◪ | □ | | |
| Potassium chlorate, aqu. | cs. | | □ | □ | | |
| Potassium chloride, aqu. | cs. | ■ | □ | □ | | ◪ |
| Potassium dichromate, aqu. | | ◪ | □ | □ | | |
| Potassium jodide, aqu. | | | □ | □ | | ◪ |
| Potassium nitrate, aqu. | cs. | | | | | ◪ |
| Potassium permanganate, aqu. | | ◪ | □ | ◪ | | |
| Potassium sulfate, aqu. | | □ | □ | □ | | ◪ |
| Copper salts, aqu. | cs. | □ | □ | □ | | ◪ |
| Magnesium salts, aqu. | cs. | ◪ | □ | □ | | ◪ |
| Sodium bicarbonate, aqu. (soda) | | ◪ | □ | □ | | |
| Sodium bisulphite, aqu. | | □ | ■ | □ | | |
| Sodium chloride, aqu. (cooking salt) | | □ | □ | □ | | ◪ |
| Sodium thiosulphate, aqu. (fixing salt) | | ◪ | □ | □ | | |
| Nickel salts, aqu. | cs. | □ | □ | □ | | ◪ |
| Phorsphoric acid | 50 % | ■ | □ | □ | | |
| Mercury | 100 % | □ | □ | □ | | □ |

aqu. = in aqueous solution
a.c. = any concentration
cs. = cold saturated

= good resistant
= moderate resistant
= less/not resistant

= no to slight reaction
= slight to average reaction
= average to strong reaction

□ ◪ ■





The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions.

**All values are for +20 °C**

| | | Cable and Lead Designation | | | | |
|---|---|---|---|---|---|---|
| | | ÖLFLEX® FD CLASSIC 810 P, -810 CP, -855 P, -855 CP, ÖLFLEX® FD 891 P, -891 CP, ÖLFLEX® Robot 900, -F1, UNITRONIC® FD P, ÖLFLEX® CRANE PUR, UNIRONIC® LiYD11Y, UNITRONIC® FD CP, UNITRONIC® FD CP (TP), HITRONIC® POF with PUR-sheath, UNITRONIC® FD plus types, UNITRONIC® PUR, SERVO cables acc. SIEMENS Standard FX7, Fx8 PLUS Standard | ÖLFLEX® CRANE round and flat | ÖLFLEX® LIFT T, LIFT S, ÖLFLEX® CRANE 2S, ÖLFLEX® LIFT F, ÖLFLEX® SF, Single core LiFY | Halogen-free cables and leads UNITRONIC® H-(ST)H, NHXMH, ÖLFLEX® 120 H, 120 CH, 130 H, 135 CH, 130 H BK 0,6/1 KV, 135 CH BK 0,6/1 KV, ÖLFLEX® FD 820 H |
| **Inorganic chemicals** | **Conc.** | | | | | |
| Mercury salts, aqu. | cs. | □ | □ | □ | ◪ | |
| Nitric acid | 30 % | ■ | ■ | ■ | ■ | |
| Hydrochloric acid | conc. | ■ | ■ | ■ | ■ | |
| Sulphur | 100 % | □ | □ | □ | □ | |
| Sulphur dioxide, gaseous | | | □ | □ | | |
| Carbon disulphide | | ■ | ■ | ■ | ■ | |
| Hydrogen sulphide | | | □ | □ | | |
| Sea water | | □ | □ | □ | ◪ | |
| Silver salts, aqu. | | □ | □ | □ | ◪ | |
| Hydrogene peroxide | 3 % | □ | □ | □ | | |
| Zinc salts, aqu. | | ■ | □ | □ | ◪ | |
| Stannous chloride | | | □ | □ | ◪ | |
| **Organic chemicals** | | | | | | |
| Ethyl alcohol | 100 % | ◪ | □ | ■ | ■ | |
| Formic acid | 30 % | ■ | □ | ■ | ■ | |
| Gasoline | | □ | ◪ | ■ | ■ | |
| Succinic acid, aqu. | cs. | □ | □ | □ | | |
| Acetic acid | 20 % | ◪ | □ | ◪ | ■ | |
| Hydraulic oil | | ◪ | ■ | ■ | ■ | |
| Isopropyl alcohol | 100 % | ◪ | □ | ■ | | |
| Machine oil | | □ | ◪ | ◪ | ■ | |
| Methyl alcohol | 100 % | ◪ | □ | ◪ | ◪ | |
| Oxalic acid, aqu. | cs. | | ◪ | □ | ◪ | |
| Cutting oil | | □ | ◪ | ◪ | ■ | |
| Vegetable oil and fats | | □ | ◪ | ◪ | ■ | |
| Tartaric acid, aqu. | | | □ | □ | ◪ | |
| Citric acid | | ◪ | □ | □ | ◪ | |

## ÖLFLEX® FD- and UNITRONIC® FD Cables in Power Chain Systems

1. The choice of the power chain system (also cable track system) must be made in accordance with the needs of the required cables.

   **Note:** It is very recommendable not to make use of cables with multi-layer construction if possible, e.g. > 25 cores, but to assign the necessary cores to a higher number of cables.

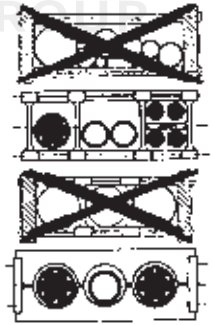
2. The minimum permissible bending radii of the cables must be strictly adhered to (please, find further appropriate information in the Technical Data of our Catalogue under bending radius for flexible use).

3. The cables must be laid out without twisting into the power chain system. Therefore, please, never pull off one cable end overhead from drums and coils which rest on their sides, but unroll the cables from the drum or the coil and lay them out or suspend them, if necessary. For the use in power chain systems, we recommend only to withdraw cables directly from drums standing or hanging vertically.

   **Warning:** Along the cables, the imprints run gently spirally around their surfaces, conditionally of manufacturing. Therefore, the printing cannot be used as an indicator of the twist-free straightening of the cables. When the cables are drawn in, the chains should be laid out longitudinally. Afterwards, the power chains loaded with cables can be brought into operating position.

4. The cables must lie loosely next to each other in the chain stays. As far as possible they should be arranged individually, disjoined via separators and placed within individual holders in the neutral zone of the chain. The free space for the cables in the chain stay should be at least 10 per cent of the cable diameter. Arranging cables one above the other without using separators should be avoided.

   **Note:** In case of a vertically suspended chain arrangement more free space must be provided regarding the height of the chain stay, because the cables are extended during operation. After a short period of operation, the length adjustment of the cables must be checked and, if necessary, corrected.







## ÖLFLEX® FD- and UNITRONIC® FD Cables in Power Chain Systems

5. The cables **must not be fixed or tied together** in the chain.

6. The cables should be connected at both ends of the chain. In the case of long power chains with top trunks lying on and rubbing against bottom trunks, the cables may only be connected at the driven. The bending of the cables must not include their connection points. The distance between the end point of the bending movement and the connection point should be as large as possible (in the case of ÖLFLEX® SERVO FD 750 P, -760 CP and UNITRONIC® FD minimum 20 times the cable diameter. In the case of ÖLFLEX® FD CLASSIC, ÖLFLEX® FD, ÖLFLEX® SERVO FD 755 P -795 P and ÖLFLEX® FD ROBUST minimum 10 times the cable diameter).

SKINTOP® cable glands to be tightened by hand only (without using a tool).
**Avoid bruising of the cables.**

7. Please, make sure, that the cables can move absolutely freely in the bending section of the power chain. Compulsory guide of the cables via the power chain must be excluded, so that relative movement of the cables with respect to each other and to the guide is possible. It is recommendable to check the position of the cable after a brief period of operation. This inspection must take place after thrust and tension movement.

8. If a power chain breaks, the cables must also be replaced, because damage due to excessive stretching cannot be ruled out.

9. In case your horizontally installed power chain will be long enough to have the top trunk gliding on top of the bottom trunk it is very important to allocate the cables within the chain in a way that horizontally symmetric distribution of the total weight of the cables is guaranteed. Only by respecting this rule, it is assured, that the top trunk will not cant in the bottom trunk through torsion of the top trunk as a consequence of one-sided weight distribution inside of it. Disregarding of this advice dramatically reduces cycle life of the power chain system.

September 2009

## ÖLFLEX® CRANE NSHTÖU, ÖLFLEX® CRANE VS (N)SHTÖU and ÖLFLEX® CRANE PUR

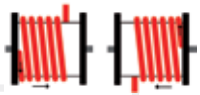
1. The delivery drum should be transported as close as possible to the installation site. It should be also avoided to roll the drum needlessly over longer distances. If the drum can't be mounted closely enough on the plant or equipment it is necessary to unreel the cable with the aid of idler pulleys by using a drag rope and a cable holding sleeve.

2. During unreeling process the cable may only pulled off straight from the top of pivot-mounted revolving drums. High tensile forces must be avoided and also the cable may not deflected or dragged over sharp edges. The c able temperature may not be below +5 °C during this procedure (normative reference to VDE 0298).

3. Before cable assembling the whole cable installation length must be completely laid-out and stretched. It is very important not to rewind the cable directly from the shipping drum on the equipment drum. (see also chapter 4). When the cable is in laid position S-bends or other deflections must beavoided.

incorrect incorrect

4. The cable must be reeled on the reeling drum without any twists. It is also very important to avoid torsion during connection and fastening to the infeed. The core layer design of reelable ÖLFLEX® CRANE cables is manufactured with a S-stranding direction of the cores. Depending on the position of the cable infeed resp. junction at the winding reel body it is highly recommended to observe the correct cable winding direction on the reeling drum as displayed on the illustration below:



5. If the infeed point is passed over during operation it will be necessary to use a compensating pulley of appropriate diameter carrying 1 – 2 cable windings. If the infeed is underground below the surface it will be necessary to provide a diverting funnel above the compensating pulley.

6. It is essential to use sufficiently proportioned clamps or cable holding sleeves (length ≥ 4 x D) for fastening the cable at the end of the travel length in order to prevent crushing. The length of cable left unreeled before the fastening point must be at least 40 x D but it is advisable to use also here a compensating pulley.

7. At least 2 cable windings must remain on the equipment drum when the cable has been completely run out by reaching the maximum travel distance.

8. For ÖLFLEX® CRANE NSHTÖU cables with an outside diameter of up to 21.5 mm the inner bending diameter should not be less then 10 times and above that figure 12.5 times the cable diameter. With ÖLFLEX® CRANE VS (N)SHTÖU

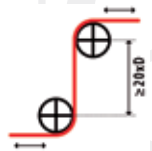




## ÖLFLEX® CRANE NSHTÖU, ÖLFLEX® CRANE VS (N)SHTÖU and ÖLFLEX® CRANE PUR

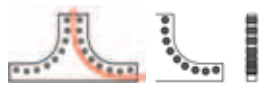
the inner bending diameter must generally be at least 15 times the cable diameter. With ÖLFLEX® CRANE PUR the inner bending diameter should not be less than 15 times the cable diameter. The minimum bending radius is specified on the corresponding Catalogue page resp. in the product data sheet.

9. S-bends in the cable must be avoided. However if this proves impossible in the case of cables with an outside diameter of up to 21.5 mm the center spacing of the two idlers must be at least 20 times and for those above 21.5 mm at least 25 times the cable diameter.

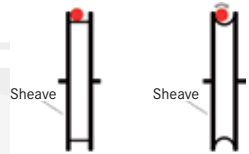



10. The permissible reeling speed may be up to v = 2 m/sec at an acceleration of up to a = 0.4 m/sec$^2$.

11. The static continuous tension load should not exceed 15 N/mm$^2$ of the total copper cross-section and the dynamic peak tensile force may not exceed 25 N/mm$^2$. For cables with very thick outer diameters it is recommended to use guide rollers to reduce high friction of the cable jacket during directional change.



Using sheaves the inner contact face may not have a concave shape to avoid cable twisting which can be caused due to permantent extensive jacket contact with the inner sheave surface. To ensure correct cable running the inner width of the guiding groove must be 10 – 15 % larger than the outer diameter of the cable.




correct incorrect

12. The actual current rating (I) in continuous operation depends on
- the conductor cross-section ($I_{max}$)
- the ambient temperature ($f_1$)
- the amount of cable reeled on the drum ($f_2$)

The maximum permissible strain imposed on the installed cable is obtained from the following formula:

$I = I_{max} \times f_1 \times f_2$

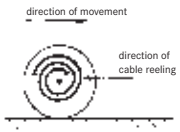
13. The cables fulfil the requirements of VDE 0250. Further stress will limit the service life of the cable.

## Lift Control Cables Type ÖLFLEX® LIFT, ÖLFLEX® LIFT T, ÖLFLEX® LIFT S

### A General Notes

1. Cables installation should be done twist-free and at temperatures not below +5 °C. Power ampacity: see VDE 0298-4 / Lapp Table T12-1 column C.
2. The inner bending radius of the cable must not be less than 40 times cable diameter.
3. Maximum suspension height depends on the carrying core (see specifications). The maximum load must not be exceeded by more then 10 per cent.
4. The transporting drum should be driven to the application place. If possible, avoid rolling the drum. Otherwise the drum must be rolled on the floor only in the direction given in Figure 1.

Fig. 1




### B Suspending the Cables

1. When suspending the cables in the shaft, unreel them tangentially. Unreeling axially leads to cable torsion and interferences with the core twisting. This results in disturbances during operation (see Figure 2).
2. In order to guarantee torsion-free suspension, the cable must be loosely suspended in the shaft before final installation. This can be done best by installing the cable from the shaft bottom.
3. The free space between lift cabin and shaft bottom must be sufficiently large. It has to be used for the cable loop (see Figure 3).

Fig. 2



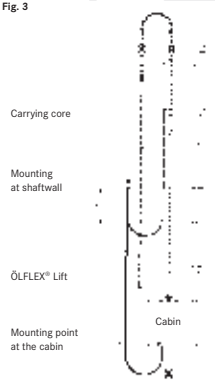



## Lift Control Cables Type ÖLFLEX® LIFT, ÖLFLEX® LIFT T, ÖLFLEX® LIFT S

### C Installing the Cables

1. It is indispensable to use large clamps for cable installation (for example Lapp wedged clamps type EKK or DKK). With suspension heights of 50 m and more the carrying core has to be damped separately.
2. The cable must be mounted to the shaft wall at least 2 m above half the driving length.
3. In case of unsteady movement, i.e. leaving the drop line during operation, the control cable must be twisted slightly at one of the mounting points until proper cable movement has been achieved.
4. If several control cables have to be installed in the lift device, it is recommended for technical reasons to install the cables in a way that the loops have height distances about 15 cm (stepwise suspension).

Fig. 3



## Control Cables

□ □ □ □ □ □ □ x □
1 2 3 4 5 6 7 8

**1. Basic type**
- N VDE standard
- (N) or X as per VDE

**2. Insulation material**
- Y Thermoplastic resins
- X Crosslinked thermoplastic resins
- G Elastomers
- HX Halogen-free materials

**3. Cable designation**
- A Cored cable
- D solid wire
- AF Fine wire cored cable
- F Socket core
- L Fluorescent tube cable
- LH Connecting cable light mechanical load
- MH Connecting cable medium mechanical load
- SH Connecting cable heavy mechanical load
- SSH Connecting cable special load
- SL Control cable/welding cable
- S Control cable
- LS Light control cable
- FL Flat cable
- Si Silicone cable
- Z Twin calbe
- GL Glass filament
- Li Stranded core to VDE 0812
- LiF Stranded core to VDE 0812, superfine wire

**4. Special features**
- T Support wire
- Ö Enhanced oil resistance
- U Flame-retardant
- w Heat resistant, weather resistant
- FE Insulation retained for a limited time
- C Screen braiding
- D Screening as envelope with copper wire
- S Steel wire braid as mechanical protection

**5. Sheaths**
as point 2. Insulating material
P/PUR polyurethane

**6. Protective conductor**
- -O without protective conductor
- -J with protective conductor

**7. Number of cores**
... No. of cores

**8. Conductor cross-section**
in mm²

Example: **NSHTÖU 24G 1.5**
ÖLFLEX® CRANE NSHTÖU – VDE approved, 24-core with protective conductor, cross-section 1.5mm²





## Harmonised Cables

□ □ □ □ □ - □ □ □ □
1 2 3 4 5 6 7 8 9

**1. Basic type**
- H harmonised type
- A national type

**2. Rated voltage**
- 01 100/100Volt
- 03 300/300Volt
- 05 300/500Volt
- 07 450/750Volt

**3. Insulation material**
- V PVC
- V2 PVC +90 °C
- V3 PVC cold-flexible
- B Ethylenpropylen rubber
- E PE Polyethylene
- X XPE, crosslinked PE
- R Rubber
- S Silicone rubber

**4. Outer/inner sheath material**
- V PVC
- V2 PVC +90 °C
- V3 PVC cold-flexible
- V5 PVC with enhanced oil resistance
- R Rubber
- N Chloroprene rubber
- Q Polyurethane
- J Glass fibre braid
- T Textile braid

**5. Special features**
- C4 Copper screen braiding
- H Flat cable, separable
- H2 Flat cable, not separable
- H6 Flat cable, not separable, for lifts
- H8 Helical/spiral cable

**6. Conductor type**
- U Single wire
- R Multi-wire
- K Fine wire (static)
- F Fine wire (flexible)
- H Superfine wire
- Y Tinsel wire
- D Fine wire core for welding cable
- E Superfine core for welding cable

**7. Number of cores**
... No. of cores

**8. Protective conductor**
- X without protective conductor
- G with protective conductor

**9. Conductor cross section**
in mm²

Example: **H05 VV-F 3G 1.5**
medium PVC sheathed cable 3-core with protective conductor, cross-section 1.5 mm²

## Telephone Cables and Leads

□ □ - □ □ □ □ x □ x □ □ □

1 2 3 4 5 6 7 8 9 10

**1. Basic type**
- A Outside cable
- G Mine cable
- J Installation cable
- Li Rubber sheathed cable
- S Jumper cable

**2. Additional information**
- B Lightning protection make-up
- J Induction protection
- E Electronics

**3. Insulation material**
- Y PVC
- 2Y Polyethylene
- O2Y Cellular-PE
- 5Y PTFE
- 6Y FEP
- 7Y ETFE
- P Paper

**4. Make-up features**
- F Petroleum jelly filling
- L Aluminium sheath
- LD Corrugated Al sheath
- (L) Aluminium strip
- (ST) Metal foil screen
- (K) Copper strip screen
- (C) Copper braid screen
- (Z) Steel wire braid
- W Corrugated steel sheath
- M Lead sheath
- Mz Special lead sheath
- b Armouring
- c Jute sheath + ground
- E Ground layer + strip

**5. Sheath material**
(see 3. insulation)

**6. Number of elements**
... number of stranding elements

**7. Stranding elements**
- 1 Single core
- 2 Pair

**8. Conductor diameter**
... in mm

**9. Stranding element**
- F star-quad (railway)
- St star-quad (phantom)
- StI star-quad (trunk cable)
- StIII star-quad (local cable)
- TF star-quad for TF
- S signal cable (railway)
- PiMF screened pair

**10. Type of stranding**
- Lg twisted in layers
- Bd twisted in bundles

Example: **A2Y(L)2Y 6 x 2 x 0.8 Bd**
Telephone cable for local network with
PE insulation and composite layer sheath





## Fibre optic cables complying with VDE 0888

□ □ - □ □ □ □ x □ x □ □ □ □

1 2 3 4 5 6 7 8 9 10 11

**1. Basic type**
- A Outdoor cable
- AT Outdoor cable, divisible
- I Indoor cable

**2. Fibres**
- D Bundled cores, filled
- V Full core
- H Loose tube, unfilled
- W Loose tube, filled
- B Bundled cores, unfilled

**3. Other structural elements**
- F Petroleum jelly filling
- Q Swelling tape
- S Metal element in cable core

**4. Sheath**
- 2Y PE sheath
- (L)2Y Layered sheath
- (D)2Y PE sheath with plastic barrier layer
- (ZN)2Y PE sheath with non-metallic strain relief elements
- (L)(ZN)2Y Layered sheath with non-metallic strain relief elements
- (D)(ZN)2Y PE sheath with plastic barrier layer and non-metallic strain relief elements
- B Armouring
- BY Armouring with PVC casing
- B2Y Armouring with PE casing

**5. Number of fibres**

**6. Fibre type**
- G Gradient fibre glass/glass
- E Monomode fibre glass/glass
- S Stepped fibre glass/glass
- K Stepped fibre glass/plastic

**7. Fibre core diameter**

**8. Fibre sheath diameter**

**9. Attenuation coefficient in dB/km**

**10. Optical window**
- A 650 nm
- B 850 nm
- F 1300 nm
- H 1550 nm

**11. Bandwidth in MHz and dispersion in ps/nm/km**

## Colour code for ÖLFLEX® cables

Applicable for the following cables with 6 or more cores: ÖLFLEX® CLASSIC 100, ÖLFLEX® CLASSIC 100 CY, ÖLFLEX® CLASSIC 100 SY and ÖLFLEX® CLASSIC 100 BK Power 0.6/1 KV. It contains colours and colour combinations of up to 102 cores and consists of 11 basic colours. The variations in the basic colours are made by one or two 2 mm wide colour spirals.In this way each core can be distinguished easily from the others. For cables with up to 5 cores see T9.

**Basic colours**

| | |
|---|---|
| 0 | green-yellow |
| 1 | white |
| 2 | black |
| 3 | blue |
| 4 | brown |
| 5 | grey |
| 6 | red |
| 7 | violet |
| 8 | pink |
| 9 | orange |
| 10 | transparent |
| 11 | beige |

**Basic colours with white spiral**

| | |
|---|---|
| 12 | black-white |
| 13 | blue-white |
| 14 | brown-white |
| 15 | grey-white |
| 16 | red-white |
| 17 | violet-white |
| 18 | pink-white |
| 19 | orange-white |
| 20 | transparent-white |
| 21 | beige-white |

**Basic colours with black spiral**

| | |
|---|---|
| 22 | blue-black |
| 23 | brown-black |
| 24 | grey-black |
| 25 | red-black |
| 26 | violet-black |
| 27 | pink-black |
| 28 | orange-black |
| 29 | transparent/black |
| 30 | beige-black |

**Basic colours with blue spiral**

| | |
|---|---|
| 31 | brown-blue |
| 32 | grey-blue |
| 33 | red-blue |
| 34 | pink-blue |
| 35 | orange-blue |
| 36 | transparent-blue |
| 37 | beige-blue |

**Basic colours with brown spiral**

| | |
|---|---|
| 38 | grey-brown |
| 39 | red-brown |
| 40 | violet-brown |
| 41 | pink-brown |
| 42 | orange-brown |
| 43 | transparent-brown |
| 44 | beige-brown |

**Basic colours with grey spiral**

| | |
|---|---|
| 45 | red-grey |
| 46 | violet-grey |
| 47 | pink-grey |
| 48 | orange-grey |
| 49 | transparent-grey |
| 50 | beige-grey |

**Basic colours with red spiral**

| | |
|---|---|
| 51 | orange-red |
| 52 | transparent-red |
| 53 | beige-red |

**Basic colours with violet spiral**

| | |
|---|---|
| 54 | pink-violet |
| 55 | orange-violet |
| 56 | transparent-violet |





## Colour code for UNITRONIC®100 cables

This contains colours and colour combinations up to 102 cores and consists of 10 basic colours. The variation in the basic colours is achieved by one or two 2 mm wide colour spirals or by ringmarking. In this way each core is easily distinguishable from the others.

**Basic colours**

| | |
|---|---|
| 0 | green-yellow |
| 1 | black |
| 2 | blue |
| 3 | brown |
| 4 | beige |
| 5 | yellow |
| 6 | green |
| 7 | violet |
| 8 | pink |
| 9 | orange |
| 10 | transparent |

**Basic colours with white spiral**

| | |
|---|---|
| 11 | red-white |
| 12 | blue-white |
| 13 | yellow-white |
| 14 | green-white |
| 15 | violet-white |
| 16 | orange-white |
| 17 | brown-white |

**Basic colours with red spiral**

| | |
|---|---|
| 18 | blue-red |
| 19 | yellow-red |
| 20 | green-red |
| 21 | white-red |
| 22 | orange-red |
| 23 | brown-red |

**Basic colours with black spiral**

| | |
|---|---|
| 24 | red-black |
| 25 | blue-black |
| 26 | yellow-black |
| 27 | green-black |
| 28 | violet-black |
| 29 | white-black |
| 30 | orange-black |
| 31 | brown-black |

**Basic colours with green spiral**

| | |
|---|---|
| 32 | red-green |
| 33 | grey-green |
| 34 | violet-green |
| 35 | white-green |
| 36 | orange-green |
| 37 | brown-green |

**Basic colours with yellow spiral**

| | |
|---|---|
| 38 | red-yellow |
| 39 | blue-yellow |
| 40 | violet-yellow |
| 41 | white-yellow |
| 42 | brown-yellow |

**Basic colours with blue spiral**

| | |
|---|---|
| 43 | red-blue |
| 44 | white-blue |
| 45 | orange-blue |
| 46 | brown-blue |

**Basic colours with violet spiral**

| | |
|---|---|
| 47 | yellow-violet |
| 48 | green-violet |
| 49 | white-violet |
| 50 | orange-violet |
| 51 | brown-violet |

**Basic colours black, variegated spiral**

| | |
|---|---|
| 52 | black-white |
| 53 | black-yellow |
| 54 | black-red |
| 55 | black-green |
| 56 | black-blue |
| 57 | black-violet |

T8: International Colour Codes for Extension and Compensating Cables

| Thermocouple | | DIN IEC 584 | | DIN 43710 | |
|---|---|---|---|---|---|
| | Material ⊕ ⊖ | Identification EXT | COM | Identification THL | COM |
| T | Cu – CuNi | TX | | | |
| U | Cu – CuNi | | | UX | |
| J | Fe – CuNi | JX | | | |
| L | Fe – CuNi | | | LX | |
| E | NiCr – CuNi | EX | | | |
| K | NiCr – Ni | KX | | | |
| K | NiCr – Ni | | KCA | | KCA |
| K | NiCr – Ni | | KCB | | |
| N | NiCrSi – NiSi | NX | NC | | |
| R S | PtRh13 – Pt PtRh10 – Pt | | RCB SCB | | RCB SCB |
| B | PtRh30 – PtRh6 | | | | |

EXT = Extension Cables
COM = Compensating Cables





T9: Core Ident Code according to VDE Colour Code

## VDE 0293-308/HD 308 S2 Conductor ident code for colour coded low voltage multiconductor cables and cords

Marking of the conductors of low-voltage multiconductor cables and cords of portable equipment as well as for electrical installation and distribution systems. 3a und 4a: for special applications only.

| 1 Number of con-ductors | 2 Cables and cords having protective conductor (Abbreviations: J or G) | 3 Cables and cords without protective conductor (Abbreviations: O or X) | 4 Cables having concentric conductor design |
|---|---|---|---|
| 2 | – | BU/BN | BU/BN |
| 3 | GNYE/BN/BU | BN/BK/GY | BN/BK/GY |
| 3a | – | BU/BN/BK | BU/BN/BK |
| 4 | GNYE/BN/BK/GY | BU/BN/BK/GY | BU/BN/BK/GY |
| 4a | GNYE/BU/BN/BK | | |
| 5 | GNYE/BU/BN/BK/GY | BU/BN/BK/GY/BK | BU/BN/BK/GY/BK |
| 6 and more | GNYE/BK having printed numbers | BK having printed numbers | BK having printed numbers |

## VDE0293 former Colour Code for Power Cables – (colour abbreviations are listed in IEC 60757)

Marking of the cores in multi-core and multi-wire cables for connecting mobile and portable equipment.

| 1 Number of con-ductors | 2 Cables with green-yellow identified core (harmonized) | 3 Cables without green-yellow identified core (not yet harmonized) | 4 Cables with concentric conductors |
|---|---|---|---|
| 2 | – | BN/BU | – |
| 3 | GNYE/BN/BU | BN/BU/BK | – |
| 3 | – | BN/BK/GY | – |
| 4 | GNYE/BK/BU/BN | BK/BN/BU/BK | – |
| 4 | GNYE/BN/BK/GY | BU/BN/BK/GY | – |
| 5 | GNYE/BK/BU/BN/BK | BK/BN/BU/BK/BK | – |
| 5 | GNYE/BU/BN/BK/GY | BU/BN/BK/GY/BK | – |
| 6 and more | GNYE/other cores black with numbering from inside beginning with 1, GNYE in the outer layer | Black cores with numbering, from inside beginning with 1. | – |

## VDE0293 former Colour Code for Power Cables – (colour abbreviations are listed in IEC 60757)

Marking of the cores in multi-core and multi-wire cables for static installation

| 1 Number of con-ductors | 2 Cables with green-yellow identified core (Abbreviations: J) | 3 Cables without green-yellow identified core (Abbreviations: O) | 4 Cables with concentric conductors |
|---|---|---|---|
| 2 | – | BK/BU | BK/BU |
| 3 | GNYE/BK/BU | BN/BU/BK | BK/BU/BN |
| 3 | – | BN/BK/GY | – |
| 4 | GNYE/BK/BU/BN | BK/BN/BU/BK | BK/BU/BN/BK |
| 4 | GNYE/BN/BK/GY | BU/BN/BK/GY | – |
| 5 | GNYE/BK/BU/BN/BK | BK/BN/BU/BK/BK | – |
| 5 | GNYE/BU/BN/BK/GY | BU/BN/BK/GY/BK | – |
| 6 and more | GNYE/other cores black with numbering from inside beginning with 1, GNYE in the outer layer | Black cores with numbering, from inside beginning with 1. | Black cores with numbering, from inside beginning with 1. |





## DIN 47100/January 1988 – Colour code for UNITRONIC® twisted pairs

Each pair comprises one a-core and one b-core. From 23 pairs upwards the marking repeats for the first time and from 45 pairs upwards for the second time. The first colour is always the basic colour of the core and the second colour is printed in rings.

| Pair No. | Colour a-core | Colour b-core |
|---|---|---|
| 1 | white | brown |
| 2 | green | yellow |
| 3 | grey | pink |
| 4 | blue | red |
| 5 | black | violet |
| 6 | grey/pink | red/blue |
| 7 | white/green | brown/green |
| 8 | white/yellow | yellow/brown |
| 9 | white/grey | grey/brown |
| 10 | white/pink | pink/brown |
| 11 | white/blue | brown/blue |
| 12 | white/red | brown/red |
| 13 | white/black | brown/black |
| 14 | grey/green | yellow/grey |
| 15 | pink/green | yellow/pink |
| 16 | green/blue | yellow/blue |
| 17 | green/red | yellow/red |
| 18 | green/black | yellow/black |
| 19 | grey/blue | pink/blue |
| 20 | grey/red | pink/red |
| 21 | grey/black | pink/black |
| 22 | blue/black | red/black |
| 23 – 44 | see 1–22 | see 1–22 |
| 45 – 66 | see 1–22 | see 1–22 |

## DIN 47100 Colour Code (but in contrast to DIN: without colour repetition after the 44th core)

Exception: 4-core cord: white, yellow, brown, green.

| Core No. | Colour | Core No. | Colour |
|---|---|---|---|
| 1 | white | 32 | yellow/blue |
| 2 | brown | 33 | green/red |
| 3 | green | 34 | yellow/red |
| 4 | yellow | 35 | green/black |
| 5 | grey | 36 | yellow/black |
| 6 | pink | 37 | grey/blue |
| 7 | blue | 38 | pink/blue |
| 8 | red | 39 | grey/red |
| 9 | black | 40 | pink/red |
| 10 | violet | 41 | grey/black |
| 11 | grey/pink | 42 | pink/black |
| 12 | red/blue | 43 | blue/black |
| 13 | white/green | 44 | red/black |
| 14 | brown/green | 45 | white/brown/black |
| 15 | white/yellow | 46 | yellow/green/black |
| 16 | yellow/brown | 47 | grey/pink/black |
| 17 | white/grey | 48 | red/blue/black |
| 18 | grey/brown | 49 | white/green/black |
| 19 | white/pink | 50 | brown/green/black |
| 20 | pink/brown | 51 | white/yellow/black |
| 21 | white/blue | 52 | yellow/brown/black |
| 22 | brown/blue | 53 | white/grey/black |
| 23 | white/red | 54 | grey/brown/black |
| 24 | brown/red | 55 | white/pink/black |
| 25 | white/black | 56 | pink/brown/black |
| 26 | brown/black | 57 | white/blue/black |
| 27 | grey/green | 58 | brown/blue/black |
| 28 | yellow/grey | 59 | white/red/black |
| 29 | pink/green | 60 | brown/red/black |
| 30 | yellow/pink | 61 | black/white |
| 31 | green/blue | | |

The first colour indicates the basic colour of the core insulation, the second colour indicates the colour of the printed ring.

Where three colours are indicated, the second and third colours are printed on the basic colour.





## Colour Code UNITRONIC® 300 & 300 CY (20 – 16 AWG)

| Core No. | Colour | Core No. | Colour |
|---|---|---|---|
| 1 | black | 26 | white/black/green |
| 2 | red | 27 | white/black/yellow |
| 3 | white | 28 | white/black/blue |
| 4 | green | 29 | white/black/brown |
| 5 | orange | 30 | white/black/orange |
| 6 | blue | 31 | white/black/gray |
| 7 | brown | 32 | white/black/violet |
| 8 | yellow | 33 | white/black/black |
| 9 | violet | 34 | white/red/black |
| 10 | gray | 35 | white/red/red |
| 11 | pink | 36 | white/red/green |
| 12 | tan | 37 | white/red/blue |
| 13 | red/green | 38 | white/red/brown |
| 14 | red/yellow | 39 | white/red/violet |
| 15 | red/black | 40 | white/green/black |
| 16 | white/black | 41 | white/green/red |
| 17 | white/red | 42 | white/green/green |
| 18 | white/green | 43 | white/green/blue |
| 19 | white/yellow | 44 | white/green/brown |
| 20 | white/blue | 45 | white/green/violet |
| 21 | white/brown | 46 | white/blue/black |
| 22 | white/orange | 47 | white/blue/red |
| 23 | white/gray | 48 | white/blue/green |
| 24 | white/violet | 49 | white/blue/blue |
| 25 | white/black/red | 50 | white/blue/brown |

## Colour Code UNITRONIC® 300 & 300 CY (24 – 22 AWG)

| Core No. | Colour | Core No. | Colour |
|---|---|---|---|
| 1 | black | 26 | white/black/violet |
| 2 | brown | 27 | white/black/gray |
| 3 | red | 28 | white/brown/red |
| 4 | orange | 29 | white/brown/orange |
| 5 | yellow | 30 | white/brown/yellow |
| 6 | green | 31 | white/brown/green |
| 7 | blue | 32 | white/brown/blue |
| 8 | violet | 33 | white/brown/violet |
| 9 | gray | 34 | white/brown/gray |
| 10 | white | 35 | white/red/orange |
| 11 | white/black | 36 | white/red/yellow |
| 12 | white/brown | 37 | white/red/green |
| 13 | white/red | 38 | white/red/blue |
| 14 | white/orange | 39 | white/red/violet |
| 15 | white/yellow | 40 | white/red/gray |
| 16 | white/green | 41 | white/orange/yellow |
| 17 | white/blue | 42 | white/orange/green |
| 18 | white/violet | 43 | white/orange/blue |
| 19 | white/gray | 44 | white/orange/violet |
| 20 | white/black/brown | 45 | white/orange/gray |
| 21 | white/black/red | 46 | white/yellow/green |
| 22 | white/black/orange | 47 | white/yellow/blue |
| 23 | white/black/yellow | 48 | white/yellow/violet |
| 24 | white/black/green | 49 | white/yellow/gray |
| 25 | white/black/blue | 50 | white/green/blue |



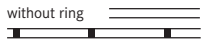


### VDE 0815 and 0816 Unit Twisted

**Colour Code for Cable Types J-2Y(ST)Y, A-2YF(L)2Y, A-2Y(L)2Y Star-quad bundles**

The marking of the cores is by means of rings quad of a unit.

Side 1
a-core without ring
b-core



Side 2
a-core
b-core

Basic colours of the core insulation for the 5 quads

Quad 1 red
Quad 2 green
Quad 3 grey
Quad 4 yellow
Quad 5 white

The number units are marked with red spirals.

### VDE 0815

**Colour Code for Indoor Telephone Cables J-Y(ST)Y ... LG (Pairs in layers, counting from outside to inside).**

a-core:
pairs in each layer red, by all other pairs white.

b-core:
blue, yellow, green, brown, black in continual repetition.

Supposition:
The two paired installation cable is star quad stranded.

Side 1 (pair 1):
a-core red
b-core black

Side 2 (pair 2):
a-core white
b-core yellow

### VDE 0815

**Colour Code for Industrial Electronic Cables JE-... Marking:**

The cores of these pairs are marked by the basic colours of the insulating sheath, which are repeated in the same sequence in each unit:

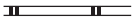
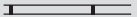
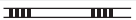
Basic colours of the pairs:

| Pair | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| a-core | blue | grey | green | white |
| b-core | red | yellow | brown | black |

The units are marked in groups with the colour of the rings on the core insulation sheaths and the arrangement of the coloured rings. The ring groups are spaced approximately 60 mm apart.

In cables with more than 12 units the 13th and the subsequent units have coloured spirals.

T10: Core Ident Code: VDE Colour Code for Telephone Cables

| Unit | Ring colour | Ring group | Unit spiral |
|---|---|---|---|
| 1 | pink |  | – |
| 2 | pink |  | – |
| 3 | pink |  | – |
| 4 | pink |  | – |
| 5 | orange |  | – |
| 6 | orange |  | – |
| 7 | orange |  | – |
| 8 | orange |  | – |
| 9 | violet |  | – |
| 10 | violet |  | – |
| 11 | violet |  | – |
| 12 | violet |  | – |
| 13 | pink |  | blue |
| 14 | pink |  | blue |
| 15 | pink |  | blue |
| 16 | pink |  | blue |
| 17 | orange |  | red |
| 18 | orange |  | red |
| 19 | orange |  | red |
| 20 | orange |  | red |





T11: Conductor Resistances and Conductor Make-up (metric)

## Conductor Resistances and Conductor Make-up (metric)

Conductor Resistances: for annealed-copper-conductors in single- and multi-core cables ≥ 0.5 mm² acc. to DIN EN 60228 (VDE 0295).

| Nominal cross-section in mm² | Conductor resistance for 20 °C for 1 km in Ω (maximum value) | | | |
|---|---|---|---|---|
| | of metal coated copper wire | | of bare copper wire | |
| | Class 2 | Class 5 + 6 | Class 2 | Class 5 + 6 |
| 0.08 | | 250.0 | | 243.0 |
| 0.14 | | 142.0 | | 138.0 |
| 0.25 | | 82.0 | | 79.0 |
| 0.34 | | 59.0 | | 57.0 |
| 0.5 | 36.7 | 40.1 | 36.0 | 39.0 |
| 0.75 | 24.8 | 26.7 | 24.5 | 26.0 |
| 1 | 18.2 | 20.0 | 18.1 | 19.5 |
| 1.5 | 12.2 | 13.7 | 12.1 | 13.3 |
| 2.5 | 7.56 | 8.21 | 7.41 | 7.98 |
| 4 | 4.70 | 5.09 | 4.61 | 4.95 |
| 6 | 3.11 | 3.39 | 3.08 | 3.30 |
| 10 | 1.84 | 1.95 | 1.83 | 1.91 |
| 16 | 1.16 | 1.24 | 1.15 | 1.21 |
| 25 | 0.734 | 0.795 | 0.727 | 0.780 |
| 35 | 0.529 | 0.565 | 0.524 | 0.554 |
| 50 | 0.391 | 0.393 | 0.387 | 0.386 |
| 70 | 0.270 | 0.277 | 0.268 | 0.272 |
| 95 | 0.195 | 0.210 | 0.193 | 0.206 |
| 120 | 0.154 | 0.164 | 0.153 | 0.161 |
| 150 | 0.126 | 0.132 | 0.124 | 0.129 |
| 185 | 0.100 | 0.108 | 0.0991 | 0.106 |
| 240 | 0.0762 | 0.0817 | 0.0754 | 0.0801 |
| 300 | 0.0607 | 0.0654 | 0.0601 | 0.0641 |
| 400 | 0.0475 | | 0.0470 | |
| 500 | 0.0369 | | 0.0366 | |
| 630 | 0.0286 | | 0.0283 | |
| 800 | 0.0224 | | 0.0221 | |
| 1000 | 0.0177 | | 0.0176 | |

**Examples of Conductor Make-up (metric)**

| Cross section in mm² | Multi-Wire Strands | Multi-Wire Strands | Fine-Wire Strands |
|---|---|---|---|
| 0.14 | | | |
| 0.25 | | | ~ 14 x 0.15 |
| 0.34 | | 7 x 0.25 | ~ 19 x 0.15 |
| 0.38 | | 7 x 0.27 | ~ 12 x 0.20 |
| 0.5 | 7 x 0.30 | 7 x 0.30 | ~ 16 x 0.20 |
| 0.75 | 7 x 0.37 | 7 x 0.37 | ~ 24 x 0.20 |
| 1.0 | 7 x 0.43 | 7 x 0.43 | ~ 32 x 0.20 |
| 1.5 | 7 x 0.52 | 7 x 0.52 | ~ 30 x 0.25 |
| 2.5 | 7 x 0.67 | ~ 19 x 0.41 | ~ 50 x 0.25 |
| 4 | 7 x 0.85 | ~ 19 x 0.52 | ~ 56 x 0.30 |
| 6 | 7 x 1.05 | ~ 19 x 0.64 | ~ 84 x 0.30 |
| 10 | 7 x 1.35 | ~ 49 x 0.51 | ~ 80 x 0.40 |
| 16 | 7 x 1.70 | ~ 49 x 0.65 | ~ 128 x 0.40 |
| 25 | 7 x 2.13 | ~ 84 x 0.62 | ~ 200 x 0.40 |
| 35 | 7 x 2.52 | ~ 133 x 0.58 | ~ 280 x 0.40 |
| 50 | ~ 19 x 1.83 | ~ 133 x 0.69 | ~ 400 x 0.40 |
| 70 | ~ 19 x 2.17 | ~ 189 x 0.69 | ~ 356 x 0.50 |
| 95 | ~ 19 x 2.52 | ~ 259 x 0.69 | ~ 485 x 0.50 |
| 120 | ~ 37 x 2.03 | ~ 336 x 0.67 | ~ 614 x 0.50 |
| 150 | ~ 37 x 2.27 | ~ 392 x 0.69 | ~ 765 x 0.50 |
| 185 | ~ 37 x 2.52 | ~ 494 x 0.69 | ~ 944 x 0.50 |
| 240 | ~ 37 x 2.87 | ~ 627 x 0.70 | ~ 1225 x 0.50 |
| 300 | ~ 61 x 2.50 | ~ 790 x 0.70 | ~ 1530 x 0.50 |
| 400 | ~ 61 x 2.89 | | ~ 2035 x 0.50 |
| 500 | ~ 61 x 3.23 | | ~ 1768 x 0.60 |
| 630 | ~ 91 x 2.97 | | ~ 2286 x 0.60 |

Single-Wire Strand | Multi-Wire Strands | Fine-Wire Strands

**Normative references:**
**Single-Wire** **Conductor ... (Class 1)**, see DIN EN 60228 (VDE 0295), Table 1
**Multi-Wire** **Conductor ... (Class 2)**, see DIN EN 60228 (VDE 0295), Table 2
**Fine-Wire** **Conductor ... (Class 5)**, see DIN EN 60228 (VDE 0295), Table 3





**Examples of Conductor Make-up (metric)**

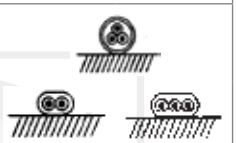
| Cross section in mm² | Super-Fine-Wire Strands | | | |
|---|---|---|---|---|
| 0.14 | ~ 18 x 0.10 | ~ 18 x 0.1 | ~ 36 x 0.07 | ~ 72 x 0.05 |
| 0.25 | ~ 32 x 0.10 | ~ 32 x 0.1 | ~ 65 x 0.07 | ~ 128 x 0.05 |
| 0.34 | ~ 42 x 0.10 | ~ 42 x 0.1 | ~ 88 x 0.07 | ~ 174 x 0.05 |
| 0.38 | ~ 21 x 0.15 | ~ 48 x 0.1 | ~ 100 x 0.07 | ~ 194 x 0.05 |
| 0.5 | ~ 28 x 0.15 | ~ 64 x 0.1 | ~ 131 x 0.07 | ~ 256 x 0.05 |
| 0.75 | ~ 42 x 0.15 | ~ 96 x 0.1 | ~ 195 x 0.07 | ~ 384 x 0.05 |
| 1.0 | ~ 56 x 0.15 | ~ 128 x 0.1 | ~ 260 x 0.07 | ~ 512 x 0.05 |
| 1.5 | ~ 84 x 0.15 | ~ 192 x 0.1 | ~ 392 x 0.07 | ~ 768 x 0.05 |
| 2.5 | ~ 140 x 0.15 | ~ 320 x 0.1 | ~ 651 x 0.07 | ~ 1280 x 0.05 |
| 4 | ~ 224 x 0.15 | ~ 512 x 0.1 | ~ 1040 x 0.07 | |
| 6 | ~ 192 x 0.20 | ~ 768 x 0.1 | ~ 1560 x 0.07 | |
| 10 | ~ 320 x 0.20 | ~ 1280 x 0.1 | ~ 2600 x 0.07 | |
| 16 | ~ 512 x 0.20 | ~ 2048 x 0.1 | | |
| 25 | ~ 800 x 0.20 | ~ 3200 x 0.1 | | |
| 35 | ~ 1120 x 0.20 | | | |
| 50 | ~ 705 x 0.30 | | | |
| 70 | ~ 990 x 0.30 | | | |
| 95 | ~ 1340 x 0.30 | | | |
| 120 | ~ 1690 x 0.30 | | | |
| 150 | ~ 2123 x 0.30 | | | |
| 185 | ~ 1470 x 0.40 | | | |
| 240 | ~ 1905 x 0.40 | | | |
| 300 | ~ 2385 x 0.40 | | | |
| 400 | | | | |
| 500 | | | | |
| 630 | | | | |

Single-Wire Strand | Super-Fine-Wire Strands

**Normative references:**
**Single-Wire** **Conductor ... (Class 1)**, see DIN EN 60228 (VDE 0295), Table 1
**Super-Fine-Wire** **Conductor ... (Class 6)**, see DIN EN 60228 (VDE 0295), Table 4

## Table 12-1: Power rating

Of wires & cables having nominal voltage up to 1000 V and heat resistant wire & cables, ambient temperature +30 °C

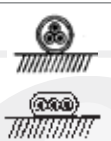
| Cable or lead category | | | |
|---|---|---|---|
| | **A**<br>**Single core cable**<br>• rubber insulated<br>• PVC insulated<br>• TPE insulated<br>• heat resistant | **B**<br>**Multi core cables and cords for home- and portable apparatus**<br>• rubber insulated<br>• PVC insulated<br>• TPE insulated | |
| **Method of installation** |  |  | |
| **Number of current carrying conductors** | **1**[3] | **2** | **3** |
| **Nominal cross section in mm²** | **Current rating in A** | **Current rating in A** | |
| 0.08[1] | 1.5 | - | - |
| 0.14[1] | 3 | - | - |
| 0.25[1] | 5 | - | - |
| 0.34[1] | 8 | - | - |
| 0.5 | 12[2] | 3 | 3 |
| 0.75 | 15 | 6 | 6 |
| 1.0 | 19 | 10 | 10 |
| 1.5 | 24 | 16 | 16 |
| 2.5 | 32 | 25 | 20 |
| 4 | 42 | 32 | 25 |
| 6 | 54 | 40 | - |
| 10 | 73 | 63 | - |
| 16 | 98 | - | - |
| 25 | 129 | - | - |
| 35 | 158 | - | - |
| 50 | 198 | - | - |
| 70 | 245 | - | - |
| 95 | 292 | - | - |
| 120 | 344 | - | - |
| 150 | 391 | - | - |
| 185 | 448 | - | - |
| 240 | 528 | - | - |
| 300 | 608 | - | - |
| 400 | 726 | - | - |
| 500 | 830 | - | - |
| Sources of current ratings of Table 12-1: | DIN VDE 0298-4, 2003-08 Table 11 Column 2 | DIN VDE 0298-4, 2003-08 Table 11 Column 3 + 4 | |





## Table 12-1: Power rating

Of wires & cables having nominal voltage up to 1000 V and heat resistant wire & cables, ambient temperature +30 °C

| Cable or lead category | | | |
|---|---|---|---|
| | **C**<br>**Multicore cables + cords, excl. home- + portable apparatus**<br>• rubber insulated<br>• PVC insulated<br>• TPE- insulated<br>• heat resistant | **D**<br>**Multicore heavy duty rubber cables**<br>≤ 0.6/1kV<br>**Single core special rubber cables**<br>0.6/1kV or 1.8/3kV | |
| **Method of installation** |  |  | |
| **Number of current carrying conductors** | **2** or **3** | **3** | **1**[3] |
| **Nominal cross section in mm²** | **Current rating in A** | **Current rating in A** | |
| 0.08[1] | 1 | - | - |
| 0.14[1] | 2 | - | - |
| 0.25[1] | 4 | - | - |
| 0.34[1] | 6 | - | - |
| 0.5 | 9[2] | - | - |
| 0.75 | 12 | - | - |
| 1.0 | 15 | - | - |
| 1.5 | 18 | 23 | 30 |
| 2.5 | 26 | 30 | 41 |
| 4 | 34 | 41 | 55 |
| 6 | 44 | 53 | 70 |
| 10 | 61 | 74 | 98 |
| 16 | 82 | 99 | 132 |
| 25 | 108 | 131 | 176 |
| 35 | 135 | 162 | 218 |
| 50 | 168 | 202 | 276 |
| 70 | 207 | 250 | 347 |
| 95 | 250 | 301 | 416 |
| 120 | 292 | - | 488 |
| 150 | 335 | - | 566 |
| 185 | 382 | - | 644 |
| 240 | 453 | - | 775 |
| 300 | 523 | - | 898 |
| 400 | - | - | - |
| 500 | - | - | - |
| Sources of current ratings of Table 12-1: | DIN VDE 0298-4, 2003-08 Table 11 Column 5 | DIN VDE 0298-4, 2003-08 Table 15 Column 4 + 2 | |

**Note:**
Design of Tables 12 to 13 deviates from VDE 0298-4 design. In case of doubt, appliance of the current issue of the DIN VDE 0298-4 is obligatory. Table 12-1 values have to be taken into consideration of further applicable converting/derating factors:

- Other ambient temperatures: Table 12-2
- more then 3 current carrying cores of multiconductor cables up to 10 mm²: Table 12-3
- Ambient temperatures > 50 °C of heat resistant wire & cables: Table 12-4
- for winded, spooled cables: Table 12-5
- Grouping of singe core & multi core cables in conduits, raceways, wire ways, floor & ceiling: Table 12-6
- Grouping of multi core cables in cable trays: Table 12-7
- Grouping of single core cables in cable trays: Table 12-8

**Table 12-1 Column A – D, Cable Categories:**

A: Singe cores: LiY, LiYCY-EA, H05V-K, H07V-K, H07V2-K, H07Z-K, Multi-standard wiring cable, ÖLFLEX® HEAT 105, -145, ÖLFLEX® HEAT 180 and ÖLFLEX® HEAT 205/260 wires/single core cables.

B: Multicore cables & service cords for home- and portable apparatus: ÖLFLEX® CLASSIC 100, H05VV-F, 450 P, 500 P 540 P, H05RR-F , H05RN-F, H05BQ-F, H07BQ-F

C: Multi core power and control cables excluding home and portable apparatus: All ÖLFLEX®-, ÖLFLEX® CRANE-, ÖLFLEX® HEAT-, ÖLFLEX® HEAT 180-, ÖLFLEX® HEAT 205/260- cables,

D: Multi core heavy duty rubber cables U0/U ≤ 0.6/1kV: ÖLFLEX® CRANE NSHTÖU, ÖLFLEX® CRANE VS, NSHTÖU, NSSHÖU, ÖLFLEX® HEAT-Multicore cables.
Single core special rubber cable U0/: 0.6/1kV or 1.8/3 kV: NSGA FÖU, NSHXAFÖU; ÖLFLEX® HEAT® 145 single core cables.

**Current (power) ampacity of other cables:**
Copper earthing cable ESUY see VDE 0105 part 1
H07RN-F/A 07RN-F/H07BQ-F for industrial use: see Catalogue Table T12-9.
Welding cable H01N2-D see Catalogue Table T12-10.
Cables for building wiring: NYM, NHXMH, NYY, NYCY, NYCWY, NHXHX see VDE 0298-4, 2003-08, Table 3 & 4.
Cables & wires in machines: see DIN EN 60204-1/VDE 0113-1 Cabels & wires in machines for USA: see National Electrical Code & NFPA 79, Table 13

[1] VDE 0891-1 -borrowed current ratings for conductor sizes < 0.5mm² (0.08 – 0.34 mm²)

[2] In terms of VDE 0298-4, 2003-08, Table 11 column 2 extended range for size 0.5 mm².

[3] Clustering of single core cables in touch to each other or bundled cables:

- on surfaces: Current rating values of Table 12-1 column A or D,
  - for 1~A.C. or – or D.C.-circuits a derating factor of 0.76
  - for 3~A.C. circuits a derating factor of 0.67 have to be applied before applying conversion factor of Table 12-6
- free in air or on cable trays: Current rating values of Table 12-1 column A or D,
  - for 1~A.C. – or D.C. circuits a derating factor of 0.8
  - for 3~A.C. circuits a derating factor of 0.7 have to applied be fore applying conversion factor of Table 12-8
- Attention: Single cores (wires) installed in conduits or pipes in or attached to walls (Installation Methode A1 or B1) in buildings see VDE 0298, Tables 3 or 5, column 2, 3, 6, or 7 & Table 21

## Table 12-2: Correction Factors

For ambient temperatures different to 30 °C. For heat resistant cables and wires see Table T12-4 (in accordance to DIN VDE 0298-4, 2003-08, Table 17).

| Rated temperature of the conductor of wire or cable (See product page of the Catalogue, Technical Data, Temperature range: upper value for static and/or flexing) | | | | | |
|---|---|---|---|---|---|
| | 60 °C | 70 °C | 80 °C | 85 °C | 90 °C |
| Ambient temperature in °C | Correction factor, applicable to current value of T12-1 | | | | |
| 10 | 1.29 | 1.22 | 1.18 | 1.17 | 1.15 |
| 15 | 1.22 | 1.17 | 1.14 | 1.13 | 1.12 |
| 20 | 1.15 | 1.12 | 1.10 | 1.09 | 1.08 |
| 25 | 1.08 | 1.06 | 1.05 | 1.04 | 1.04 |
| **30** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** |
| 35 | 0.91 | 0.94 | 0.95 | 0.95 | 0.96 |
| 40 | 0.82 | 0.87 | 0.89 | 0.90 | 0.91 |
| 45 | 0.71 | 0.79 | 0.84 | 0.85 | 0.87 |
| 50 | 0.58 | 0.71 | 0.77 | - | 0.82 |
| 55 | 0.41 | 0.61 | 0.71 | - | 0.76 |
| 60 | - | 0.50 | 0.63 | - | 0.71 |
| 65 | - | 0.35 | 0.55 | - | 0.65 |
| 70 | - | - | 0.45 | - | 0.58 |
| 75 | - | - | 0.32 | - | 0.50 |
| 80 | - | - | - | - | 0.41 |
| 85 | - | - | - | - | 0.29 |

## Table 12-3: Correction Factors

for multiconductor cables and cords, having condcutor size up to 10 mm² (DIN VDE 0298-4, 2003-08. Table 26).

| Number of current carrying conductors | Correction factors for cables in free air | Correction factors for cables in earth (burial) |
|---|---|---|
| 5 | 0.75 | 0.70 |
| 7 | 0.65 | 0.60 |
| 10 | 0.55 | 0.50 |
| 14 | 0.50 | 0.45 |
| 19 | 0.45 | 0.40 |
| 24 | 0.40 | 0.35 |
| 40 | 0.35 | 0.30 |
| 61 | 0.30 | 0.25 |





## Table 12-4: Correction factors of heat resistant cables and wires

| Cables and wires classified according to its rated temperature of the conductor (See product page of the Catalogue "Technical Data, Temperature Range, for upper value for static and/or flexing use"). | | | | |
|---|---|---|---|---|
| | ÖLFLEX® HEAT 105 H07V2-K ÖLFLEX®-FD ROBUST H07Z-K 90 °C | Halogen free single core H07Z-K 110 °C | ÖLFLEX® HEAT 145 | ÖLFLEX® HEAT 180 Silicone rubber |
| Ambient temperature in °C | Correction factors, applying to current value of Table 12-1, column A, C or D for heat resistant wires and cables (Source: DIN VDE 0298-4, 2003-08, Table 18) | | | |
| up to 50 | **1.00** | **1.00** | **1.00** | **1.00** |
| 55 | 0.94 | **1.00** | **1.00** | **1.00** |
| 60 | 0.87 | **1.00** | **1.00** | **1.00** |
| 65 | 0.79 | **1.00** | **1.00** | **1.00** |
| 70 | 0.71 | **1.00** | **1.00** | **1.00** |
| 75 | 0.61 | **1.00** | **1.00** | **1.00** |
| 80 | 0.50 | **1.00** | **1.00** | **1.00** |
| 85 | 0.35 | 0.91 | **1.00** | **1.00** |
| 90 | - | 0.82 | **1.00** | **1.00** |
| 95 | - | 0.71 | **1.00** | **1.00** |
| 100 | - | 0.58 | 0.94 | **1.00** |
| 105 | - | 0.41 | 0.87 | **1.00** |
| 110 | - | - | 0.79 | **1.00** |
| 115 | - | - | 0.71 | **1.00** |
| 120 | - | - | 0.61 | **1.00** |
| 125 | - | - | 0.50 | **1.00** |
| 130 | - | - | 0.35 | **1.00** |
| 135 | - | - | - | **1.00** |
| 140 | - | - | - | **1.00** |
| 150 | - | - | - | **1.00** |
| 155 | - | - | - | 0.91 |
| 160 | - | - | - | 0.82 |
| 165 | - | - | - | 0.71 |
| 170 | - | - | - | 0.58 |
| 175 | - | - | - | 0.41 |

## Table 12-5: Correction factors

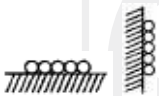
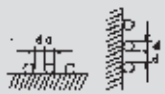
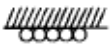
of spooled/winded cables (DIN VDE 0298-4, 2003-8. Table 27)

| Number of layers on spool, reel or drum | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Correction factor | **0.80** | **0.61** | **0.49** | **0.42** | **0.38** |

For helix-type coiled/winded cables (spiral in one layer) the correction factor is 0.8.

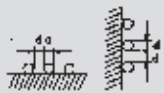
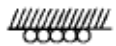
## Table 12-6: Correction factors

Grouping on the wall, floor, ceiling in conduits or closed wire ways (in accordance to DIN VDE 0298-4, 2003-08, Table 21).

| Number of current-carrying multicore cables or number of groups of 2- or 3-phase A.C. circuits single core cables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Type of installation (method)** | **Correction factor, applicable to the current value of Table 12-1** | | | | | | | |
| On floors or walls with contact between each other bunched directly as well as in conduits or in wireways.  | 1.00 | 0.80 | 0.70 | 0.65 | 0.60 | 0.57 | 0.54 | 0.52 |
| In touch between each other, directely attached to walls or floors in one layer.  | 1.00 | 0.85 | 0.79 | 0.75 | 0.73 | 0.72 | 0.72 | 0.71 |
| With clearance of “d” between each other, directely attached to walls or floors in one layer.  | 1.00 | 0.94 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| In touch between each other, directely attached to cealings.  | 0.95 | 0.81 | 0.72 | 0.68 | 0.66 | 0.64 | 0.63 | 0.62 |
| With clearance of “d” between each other, directely attached to cealings in one layer.  | 0.95 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |





| Number of current-carrying multicore cables or number of groups of 2- or 3-phase A.C. circuits single core cables | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 9 | 10 | 12 | 14 | 16 | 18 | 20 |
| **Type of installation (method)** | **Correction factor, applicable to the current value of Table 12-1** | | | | | | |
| On floors or walls with contact between each other bunched directly as well as in conduits or in wireways.  | 0.50 | 0.48 | 0.45 | 0.43 | 0.41 | 0.39 | 0.38 |
| In touch between each other, directely attached to walls or floors in one layer.  | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| With clearance of “d” between each other, directely attached to walls or floors in one layer.  | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| In touch between each other, directely attached to cealings.  | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |
| With clearance of “d” between each other, directely attached to cealings in one layer.  | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |

○ = Symbol of one single core or one multicore cable.
Notice: Correction factors can be applied only to similar loaded cables of a similar type of installation (wiring methode) and nominal cross sections differ one step only.

## Table 12-7: Correction factors

for grouping/clustering of multi conductor cables in cable trays (in accordance to DIN VDE 0298-4, 2003-08, Table 22).

| Cable arrangement | | Number of cable trays | Number of multi conductor cables | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 6 | 9 |
| | | | Correction factors | | | | | |
| Cable tray, non punched | in touch | 1 | **0.97** | **0.84** | **0.78** | **0.75** | **0.71** | **0.68** |
| | | 2 | 0.97 | 0.83 | 0.76 | 0.72 | 0.68 | 0.63 |
| | | 3 | 0.97 | 0.82 | 0.75 | 0.71 | 0.66 | 0.61 |
| | | 6 | 0.97 | 0.81 | 0.73 | 0.69 | 0.63 | 0.58 |
| Cable tray, punched (ventilated) | in touch | 1 | **1.00** | **0.88** | **0.82** | **0.79** | **0.76** | **0.73** |
| | | 2 | 1.00 | 0.87 | 0.80 | 0.77 | 0.73 | 0.68 |
| | | 3 | 1.00 | 0.86 | 0.79 | 0.76 | 0.71 | 0.66 |
| | | 6 | 1.00 | 0.84 | 0.77 | 0.73 | 0.68 | 0.64 |
| | with space | 1 | **1.00** | **1.00** | **0.98** | **0.95** | **0.91** | – |
| | | 2 | 1.00 | 0.99 | 0.96 | 0.92 | 0.87 | – |
| | | 3 | 1.00 | 0.98 | 0.95 | 0.91 | 0.85 | – |
| | in touch | 1 | **1.00** | **0.88** | **0.82** | **0.78** | **0.73** | **0.72** |
| | | 2 | 1.00 | 0.88 | 0.81 | 0.76 | 0.71 | 0.70 |
| | with space | 1 | **1.00** | **0.91** | **0.89** | **0.88** | **0.87** | – |
| | | 2 | 1.00 | 0.91 | 0.88 | 0.87 | 0.85 | – |
| Cable tray, ladder type | in touch | 1 | **1.00** | **0.87** | **0.82** | **0.80** | **0.79** | **0.78** |
| | | 2 | 1.00 | 0.86 | 0.81 | 0.78 | 0.76 | 0.73 |
| | | 3 | 1.00 | 0.85 | 0.79 | 0.76 | 0.73 | 0.70 |
| | | 6 | 1.00 | 0.83 | 0.76 | 0.73 | 0.69 | 0.66 |
| | with space | 1 | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | – |
| | | 2 | 1.00 | 0.99 | 0.98 | 0.97 | 0.96 | – |
| | | 3 | 1.00 | 0.98 | 0.97 | 0.96 | 0.93 | – |

**Note:** Correction factors are applicable to similar loaded cables of a similar type of installation (wiring methode) of groups of cables, lying in one-layer only, as shown at this page. Correction factors are not applicable to cables lying on top to each other as well as if minimum distance required according that Table is not guaranteed. In such cases correction factors of this Table have to be additional corrected too. I.e according Table 12-6.





## Table 12-8: Correction factors

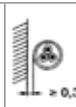
for grouping/clustering of single core cables in cable trays. Applicable to current values of Table 12-1 (Origin of T12-8 = DIN VDE 0298-4 2003-08, Table 23).

| Cable arrangement | | Number of cable trays | Number of 3-phase circuits comprising single core cables | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | Applicable as a multiplier of the rated values of: |
| | | | Correction factor | | | |
| Cable tray, punched (ventilated) | in touch | 1 | **0.98** | **0.91** | **0.87** | three cables, horizontal array, one-layer configuration |
| | | 2 | 0.96 | 0.87 | 0.81 | |
| | | 3 | 0.95 | 0.85 | 0.78 | |
| | in touch | 1 | **0.96** | **0.86** | – | three cables, vertical array, one-layer configuration |
| | | 2 | 0.95 | 0.84 | – | |
| Cable tray, ladder type | in touch | 1 | **1.00** | **0.97** | **0.96** | three cables, horizontal array, one-layer configuration |
| | | 2 | 0.98 | 0.93 | 0.89 | |
| | | 3 | 0.97 | 0.90 | 0.86 | |
| Cable tray, punched (ventilated) | | 1 | **1.00** | **0.98** | **0.96** | three cables, horizontal array, delta-configuration |
| | | 2 | 0.97 | 0.93 | 0.89 | |
| | | 3 | 0.96 | 0.92 | 0.86 | |
| | | 1 | **1.00** | **0.91** | **0.89** | three cables, vertical array, delta-configuration |
| | | 2 | 1.00 | 0.90 | 0.86 | |
| Cable tray, ladder type | | 1 | **1.00** | **1.00** | **1.00** | three cables, horizontal array, delta-configuration |
| | | 2 | 0.97 | 0.95 | 0.93 | |
| | | 3 | 0.96 | 0.94 | 0.90 | |

**Note:** Correction factors are applicable to similar loaded cables of a similar type of installation (wiring methode) of groups of single core cables, lying in one-layer or delta configuration only, as shown at this page. Conversion factors are not applicable to cables lying on top to each other as well as if minimum distance required according that Table is not guaranteed. In such cases correction factors of this Table have to be additional corrected too. I.e according Table 12-6. In cases where a splitting into certain numbers of parallel groups of cables is needed, each group of 3 current carrying cables is considered as being one entire circuit.

## Table 12-9: Power rating of rubber cables

H07RN-F and A07RN-F in industrial application usage (in accordance with DIN VDE 0298-4, Aug. 2003 Table 13).

| Rated temperature at the conductor | 60 °C | | | |
|---|---|---|---|---|
| Ambient-temperature | 30 °C | | | |
| Installation-methode **Free in air** |  |  |  |  |
| Number of current carrying conductors | 2 | 3 | 2 | 2 |
| **Conductors nominal cross- section in mm²** | **Current rating in A** | | | |
| 1 | - | - | 15 | 15.5 |
| 1.5 | 19 | 16.5 | 18.5 | 19.5 |
| 2.5 | 26 | 22 | 25 | 26 |
| 4 | 34 | 30 | 34 | 35 |
| 6 | 43 | 38 | 43 | 44 |
| 10 | 60 | 53 | 60 | 62 |
| 16 | 79 | 71 | 79 | 82 |
| 25 | 104 | 94 | 105 | 109 |
| 35 | 129 | 117 | - | 135 |
| 50 | 162 | 148 | - | 169 |
| 70 | 202 | 185 | - | 211 |
| 95 | 240 | 222 | - | 250 |
| 120 | 280 | 260 | - | 292 |
| 150 | 321 | 300 | - | 335 |
| 185 | 363 | 341 | - | 378 |
| 240 | 433 | 407 | - | 447 |
| 300 | 497 | 468 | - | 509 |
| 400 | 586 | 553 | - | - |
| 500 | 970 | 634 | - | - |
| 630 | 784 | 742 | - | - |
| **Correction factors for:** | | | | |
| Other ambient temperatures | see Table T 12-2 | | | |
| Grouping/Clustering | – | T12-8 | | |
| Spooled/ winded cables | – | – | | |
| Multi conductor cables | – | | | |





## Table 12-9: Power rating of rubber cables

H07RN-F and A07RN-F in industrial application usage (in accordance with DIN VDE 0298-4, Aug. 2003 Table 13).

| Rated temperature at the conductor | 60 °C | | |
|---|---|---|---|
| Ambient-temperature | 30 °C | | |
| Installation-methode **Free in air** |  |  |  |
| Number of current carrying conductors | 3 | 3 | 3 |
| **Conductors nominal cross- section in mm²** | **Current rating in A** | | |
| 1 | 12.5 | 13 | 13.5 |
| 1.5 | 15.5 | 16 | 16.5 |
| 2.5 | 21 | 22 | 23 |
| 4 | 29 | 30 | 30 |
| 6 | 36 | 37 | 38 |
| 10 | 51 | 52 | 54 |
| 16 | 67 | 69 | 71 |
| 25 | 89 | 92 | 94 |
| 35 | 110 | 114 | - |
| 50 | 138 | 143 | - |
| 70 | 172 | 178 | - |
| 95 | 204 | 210 | - |
| 120 | 238 | 246 | - |
| 150 | 273 | 282 | - |
| 185 | 309 | 319 | - |
| 240 | 365 | 377 | - |
| 300 | 415 | 430 | - |
| 400 | - | - | - |
| 500 | - | - | - |
| 630 | - | - | - |
| **Correction factors for:** | | | |
| Other ambient temperatures | see Table T 12-2 | | |
| Grouping/Clustering | T12-7 | | |
| Spooled/ winded cables | T12-5 | | |
| Multi conductor cables | T12-3 | – | |

## Table 12-10: Power ratings & conditions of arc-welding cables

H01N2-D and H01N2-E (in accordance to DINVDE 0298-4, 2003-08, Table 16)

| Rated temperature at the conductor | 85 °C | | | | | | |
|---|---|---|---|---|---|---|---|
| Ambient temperature | 30 °C | | | | | | |
| Applying condition of the cable | in free air  | | | | | | |
| Number of current carrying conductors | 1 | | | | | | |
| **Mode of operation** | **Conti-nuous** | **Interrupt** | | | | | |
| Operating periode | – | 5 min | | | | | |
| Operating factor OF | 100 % | 85 % | 80 % | 60 % | 35 % | 20 % | 8 % |
| **Nom. cross section copper conductor mm²** | **Rating in A** | | | | | | |
| 10 | 96 | 97 | 98 | 102 | 114 | 137 | 198 |
| 16 | 130 | 132 | 134 | 142 | 166 | 204 | 301 |
| 25 | 173 | 179 | 181 | 196 | 234 | 293 | 442 |
| 35 | 216 | 226 | 229 | 250 | 304 | 384 | 584 |
| 50 | 274 | 287 | 293 | 323 | 398 | 508 | 779 |
| 70 | 341 | 360 | 368 | 409 | 510 | 655 | 1011 |
| 95 | 413 | 438 | 448 | 502 | 632 | 816 | 1266 |
| 120 | 480 | 511 | 523 | 588 | 745 | 966 | 1502 |
| 150 | 557 | 594 | 609 | 687 | 875 | 1137 | 1771 |
| 185 | 638 | 683 | 700 | 793 | 1012 | 1319 | 2059 |
| **Mode of operation** | **Conti-nuous** | **Interrupt** | | | | | |
| Operating periode | – | 10 min | | | | | |
| Operating factor OF | 100 % | 85 % | 80 % | 60 % | 35 % | 20 % | 8 % |
| **Nom. cross section copper conductor mm²** | **Rating in A** | | | | | | |
| 10 | 96 | 96 | 96 | 97 | 102 | 113 | 152 |
| 16 | 130 | 131 | 131 | 133 | 144 | 167 | 233 |
| 25 | 173 | 175 | 176 | 182 | 204 | 244 | 351 |
| 35 | 216 | 220 | 222 | 233 | 268 | 324 | 477 |
| 50 | 274 | 281 | 284 | 303 | 356 | 439 | 654 |
| 70 | 341 | 352 | 358 | 387 | 463 | 578 | 872 |
| 95 | 413 | 430 | 438 | 478 | 582 | 734 | 1117 |
| 120 | 480 | 503 | 513 | 564 | 692 | 880 | 1348 |
| 150 | 557 | 586 | 597 | 661 | 819 | 1046 | 1609 |
| 185 | 638 | 674 | 688 | 765 | 955 | 1226 | 1892 |
| Other ambient temperatures | Table T12-2 | | | | | | |





## Table 13-1: Power ampacity to single core and multi core cables acc. to NEC (USA)

**Abstract of NEC Tabelle 310-16**
Allowable ampacity (in Ampere) of insulated conductors, rated 0 – 2000 Volts, 60 °C to 90 °C, (140 ° to 194 °F). NOT MORE THAN THREE CONDUCTORS in raceway or cable ore Earth (direct burial), based on ambient temperature of 30 °C (86 °F).

**Abstract of NEC Tabelle 310-17**
Allowable Ampacity ( in Ampere) of SINGLE INSULATED CONDUCTORS, rated 0 – 2000 Volts, in free air, based on ambient temperature of 30 °C.

| Con-ductor size | Temperature Rating of Conductor | | | Con-ductor size | Temperature Rating of Conductor | | |
|---|---|---|---|---|---|---|---|
| AWG or kcmil (MCM) | 60 °C (140 °F) | 75 °C (167 °F) | 90 °C (194 °F) | AWG or kcmil (MCM) | 60 °C (140 °F) | 75 °C (167 °F) | 90 °C (194 °F) |
| 18 | – | – | 14 | 18 | – | – | 18 |
| 16 | – | – | 18 | 16 | – | – | 24 |
| 14 | 20* | 20* | 25* | 14 | 25* | 30* | 35* |
| 12 | 25* | 25* | 30* | 12 | 30* | 35* | 40* |
| 10 | 30 | 35* | 40* | 10 | 40* | 50* | 55* |
| 8 | 40 | 50 | 55 | 8 | 60 | 70 | 80 |
| 6 | 55 | 65 | 75 | 6 | 80 | 95 | 105 |
| 4 | 70 | 85 | 95 | 4 | 105 | 125 | 140 |
| 3 | 85 | 100 | 110 | 3 | 120 | 145 | 165 |
| 2 | 95 | 115 | 130 | 2 | 140 | 170 | 190 |
| 1 | 110 | 130 | 150 | 1 | 165 | 195 | 220 |
| 1/0 | 125 | 150 | 170 | 1/0 | 195 | 230 | 260 |
| 2/0 | 145 | 175 | 195 | 2/0 | 225 | 265 | 300 |
| 3/0 | 165 | 200 | 225 | 3/0 | 260 | 310 | 350 |
| 4/0 | 195 | 230 | 260 | 4/0 | 300 | 360 | 405 |
| 250 | 215 | 255 | 290 | 250 | 340 | 405 | 455 |
| 300 | 240 | 285 | 320 | 300 | 375 | 445 | 505 |
| 350 | 260 | 310 | 350 | 350 | 420 | 505 | 570 |
| 400 | 280 | 355 | 380 | 400 | 455 | 545 | 615 |
| 500 | 320 | 380 | 430 | 500 | 515 | 620 | 700 |
| 600 | 355 | 420 | 475 | 600 | 575 | 690 | 780 |

* **Note:** Unless otherwise specifically permitted elsewhere in the NEC, the overcurrent protection for conductor types market with an * shall not exceed 15 amperes for AWG 14, 20 amperes for AWG 12 and 30 amperes for AWG 10, after any correction factors for ambient temperature and numbers of conductros have been applied.

## Table 13-1: Power ampacity to single core and multi core cables acc. to NEC (USA)

| Correction factors for ambient temperatures other than 30 °C | | | | Correction factors for more than three current-carrying conductors in a raceway or cable | |
|---|---|---|---|---|---|
| Ambient temperature in °C | 60 °C | 75 °C | 90 °C | Number of current-carrying conductors | Correction factor |
| 21 – 25 | 1.08 | 1.05 | 1.04 | 4 up to 6 | 0.80 |
| 26 – 30 | 1.00 | 1.00 | 1.00 | 7 up to 9 | 0.70 |
| 31 – 35 | 0.91 | 0.94 | 0.96 | 10 up to 20 | 0.50 |
| 36 – 40 | 0.82 | 0.88 | 0.91 | 21 up to 30 | 0.45 |
| 41 – 45 | 0.71 | 0.82 | 0.87 | 31 up to 40 | 0.40 |
| 46 – 50 | 0.58 | 0.75 | 0.82 | 41 and more | 0.35 |
| 51 – 55 | 0.41 | 0.67 | 0.76 | | |
| 56 – 60 | – | 0.58 | 0.71 | | |
| 61 – 70 | – | 0.33 | 0.58 | | |
| 71 – 80 | – | – | 0.41 | | |

**Note:** Power ampacity of cables & wires in industrial machinery, see chapter 12 of the NFPA 79 Edition 2007.





Only for the basic materials. Variations are possible depending on application/design. See the relevant Catalogue page.

| Material | Parameter | | | |
|---|---|---|---|---|
| | Abbreviation | VDE symbol | working temperature | dielectric constant ($10^{-3}$) |
| Bio-oil resistant material | Lapp type: P4/11 | – | -40 +120 | 2.4 |
| Polyvinylchloride | PVC | Y | -30 +70 | 4.0 |
| Polyvinylchloride heat resistant | PVC | Y | -20 +90 | 3.5 |
| High pressure Polyethylene | LDPE | 2Y | -50 +70 | 2.3 |
| Low Pressure Polyethylene | HDPE | 2Y | -50 +100 | 2.3 |
| Polyurethane | PUR | 11Y | -40 +90/100 | 4.0 – 6.0 |
| Polyamide | PA | 4Y | -40 +80 | 3.5 – 7.0 |
| Polybutylene terephtalate | PBTP | – | -60 +110 | 3.0 – 4.0 |
| Polytetrafluorethylene | PTFE | 5Y | -190 +260 | 2.1 |
| Tetrafluorethylene Hexafluorpropylene Copolymere | FEP | 6Y | -100 +200 | 2.1 |
| Ethylene-tetrafluorethylene | ETFE | 7Y | -100 +150 | 2.6 |
| Perfluoralkoxy-polymer | PFA | – | -190 +260 | 2.1 |
| Chloropren rubber | CR | 5G | -40 +100 | 6.0 – 8.0 |
| Silicone rubber | SI | 2G | -60 +180 | 2.8 – 3.2 |
| Ethylene vinyl acetate | EVA | 4G | -30 +125 | 5 – 7 |
| Ethylene propylen rubber | EPM/EPDM | 3G | -30 +120 | 3.2 |
| Thermoplastic polyolefin elastomer | TPE-O | – | -40 +120 | 2.7 – 3.6 |
| Thermoplastic polyester elastomer | TPE-E | 12Y | -70 +125 | 3.7 – 5.1 |
| Styrene triple block copolymer | TPE-S | – | -75 +105/140 | 2.2 – 2.6 |

T15: Properties of insulating and sheathing materials

| Material | Parameter | | | | |
|---|---|---|---|---|---|
| | Abbreviation | volume resistivity (Ω x cm) | tensile strength N/mm² MPa | Elongation % | Water absorption (20 °C) % |
| Bio-oil resistant material | Lapptype: P4/11 | $10^{15}$ | 10 – 20 | 450 – 550 | 1 – 2 |
| Polyvinylchloride | PVC | $10^{12}$ – $10^{15}$ | 10 – 25 | 150 – 300 | 0.4 |
| Polyvinylchloride heat resistant | PVC | $10^{12}$ – $10^{15}$ | 10 – 25 | 150 – 300 | 0.4 |
| High pressure Polyethylene | LDPE | $10^{17}$ | 20 – 30 | 500 | 0.1 |
| Low Pressure Polyethylene | HDPE | $10^{17}$ | 30 | 800 | 0.1 |
| Polyurethane | PUR | $10^{12}$ | 30 – 45 | 300 – 600 | 1.5 |
| Polyamide | PA | $10^{14}$ | 50 – 180 | 200 – 300 | 1 – 2 |
| Polybutylene terephtalate | PBTP | $10^{16}$ | 50 – 100 | 50 – 300 | 0.5 |
| Polytetrafluorethylene | PTFE | $10^{18}$ | 14 – 40 | 240 – 400 | 0.01 |
| Tetrafluorethylene Hexafluorpropylene Copolymere | FEP | $10^{18}$ | 20 – 25 | 250 – 350 | 0.01 |
| Ethylene-tetrafluorethylene | ETFE | $10^{16}$ | 40 – 50 | 100 – 300 | 0.01 |
| Perfluoralkoxy-polymer | PFA | $10^{15}$ | 30 | 300 | 0.01 |
| Chloropren rubber | CR | $10^{13}$ | 25 | 450 | 1 |
| Silicone rubber | SI | $10^{15}$ | 5 – 10 | 200 – 350 | 1.0 |
| Ethylene vinyl acetate | EVA | $10^{13}$ | 5 | 200 | 0.01 |
| Ethylene propylen rubber | EPM/EPDM | $10^{14}$ | 5 – 25 | 200 – 450 | 0.02 |
| Thermoplastic polyolefin elastomer | TPE-O | 5 x $10^{14}$ | ≥ 6 | ≥ 400 | 1.5 |
| Thermoplastic polyester elastomer | TPE-E | $10^{12}$ | 3 – 25 | 280 – 650 | 0.3 – 0.6 |
| Styrene triple block copolymer | TPE-S | $10^{16}$ | 9 – 25 | 500 – 700 | 1 – 2 |





T15: Properties of insulating and sheathing materials

| Material | | | | |
|---|---|---|---|---|
| | Weather resistance | Fuel resistance | Oil resistance | Flammability |
| Bio-oil resistant material | very good | good | Bio-oil resistant very good | flammable |
| Polyvinylchloride | moderate | moderate | good | self-extinguishing |
| Polyvinylchloride heat resistant | moderate | moderate | good | self-extinguishing |
| High pressure Polyethylene | good | poor | moderate | flammable |
| Low Pressure Polyethylene | moderate | poor | moderate | flammable |
| Polyurethane | very good | good | good | self-extinguishing* |
| Polyamide | good | moderate | good | flammable |
| Polybutylene terephtalate | good | good | good | flammable |
| Polytetrafluorethylene | very good | very good | very good | non-flammable |
| Tetrafluorethylene Hexafluorpropylene Copolymere | very good | very good | very good | non-flammable |
| Ethylene-tetrafluorethylene | very good | very good | very good | non-flammable |
| Perfluoralkoxy-polymer | very good | very good | good | non-flammable |
| Chloropren rubber | very good | poor | good | self-extinguishing |
| Silicone rubber | very good | poor | moderate | less flammable |
| Ethylene vinyl acetate | good | poor | poor | flammable |
| Ethylene propylen rubber | good | poor | poor | flammable |
| Thermoplastic polyolefin elastomer | very good | moderate | moderate | flammable |
| Thermoplastic polyester elastomer | very good | good | very good | flammable |
| Styrene triple block copolymer | moderate | good | poor | flammable |

* only with additional flame retardener

## US dimensions for cables – comparison with metric dimensions

In North America the cross section of cables are mostly stated in AWG sizes (American Wire Gauge) or for bigger cross sections (higher than AWG 4/0) in the dimension 'kcmil'. The respective standards for rating the cable according the ampacity also refer to these dimensions.

Hence multi standard cables have to fulfil the requirements of the metric system, stating the cross section in mm² as well as the requirements of the AWG system, in the following these systems are compared on the basis of their nominal sizes.

**Please consider that there are no definite equivalents,** because the requirements of both systems regarding cross section and conductor resistance differ to each other. The following Table should help to find the right nominal cross section. The respective standards for the project planning, e.g. UL1581 or IEC 60228 (VDE 0295) have to be applied accordingly.

For choosing the appropriate matching parts, e.g. conductor end sleeves, always the **effective** size or cross section has to be regarded. This dimension is stated on the respective Catalogue page of the product itself.

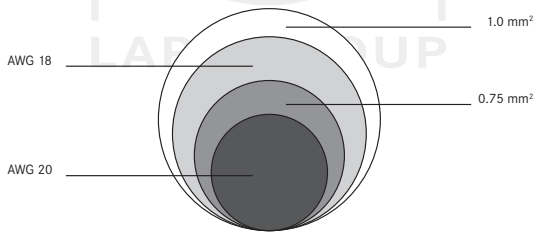
| column 1a | 1b | 2 | 3 | column 4 | 5a | 5b |
|---|---|---|---|---|---|---|
| Required North-american dimension | | Geo-metrical convers-ion | Metrical nominal cross section, which fulfils the electrical requirements | Required metrical cross section | Northamerican dimension, which fulfils the electrical requirements | |
| AWG | kcmil | mm² | mm² | mm² | AWG | kcmil |
| | **750** | 380.03 | **400** | 400 | | 800 |
| | **500** | 253.35 | **300** | 300 | | 750 |
| | 450 | 228.02 | **240** | 240 | | 500 |
| | **400** | 202.68 | | | | 450 |
| | 350 | 177.35 | **185** | 185 | | 400 |
| | **300** | 152.01 | | | | 350 |
| | **250** | 126.68 | **150** | 150 | | 300 |
| **4/0** | | 107.22 | **120** | 120 | | 250 |
| **3/0** | | 85.01 | **95** | 95 | 4/0 | |
| **2/0** | | 67.43 | **70** | 70 | 3/0 | |
| **1/0** | | 53.49 | | | 2/0 | |
| **1** | | 42.41 | **50** | 50 | 1/0 | |
| **2** | | 33.62 | **35** | 35 | 1 | |
| 3 | | 26.67 | | | 2 | |
| **4** | | 21.15 | **25** | 25 | 3 | |
| 5 | | 16.77 | | | 4 | |
| **6** | | 13.30 | **16** | 16 | 5 | |
| 7 | | 10.55 | | | 6 | |





| column 1a | 1b | 2 | 3 | column 4 | 5a | 5b |
|---|---|---|---|---|---|---|
| Required North-american dimension | | Geo-metrical convers-ion | Metrical nominal cross section, which fulfils the electrical requirements | Required metrical cross section | Northamerican dimension, which fulfils the electrical requirements | |
| AWG | kcmil | mm² | mm² | mm² | AWG | kcmil |
| **8** | | 8.37 | **10** | 10 | 7 | |
| 9 | | 6.63 | | | 8 | |
| **10** | | 5.26 | **6** | 6 | 9 | |
| 11 | | 4.17 | | | 10 | |
| **12** | | 3.31 | **4** | 4 | 11 | |
| 13 | | 2.62 | | | 12 | |
| **14** | | 2.08 | **2.5** | 2.5 | 13 | |
| 15 | | 1.65 | | | 14 | |
| **16** | | 1.31 | **1.5** | 1.5 | 15 | |
| 17 | | 1.04 | | | 16 | |
| **18** | | 0.82 | **1** | 1 | 17 | |
| 19 | | 0.65 | **0.75** | 0.75 | 18 | |
| **20** | | 0.52 | | | 19 | |
| 21 | | 0.41 | **0.5** | 0.5 | 20 | |
| **22** | | 0.33 | **0.34** | 0.34 | 21 | |
| 23 | | 0.26 | | | 22 | |
| **24** | | 0.20 | **0.25** | 0.25 | 23 | |
| 25 | | 0.16 | | | 24 | |
| **26** | | 0.13 | **0.14** | 0.14 | 25 | |

**Schematic diagram of the cross section dimensions**



## Table 17-1: Example 'Copper'

**The copper price**
In Germany and some other countries, copper cables, -leads and piece-goods containing copper may sold at daily copper prices (DEL). The DEL is the Stock Exchange Quotation for German electrolytic copper conducting purpose, i.e. 99.5% pure copper. The DEL is expressed in Euro per 100 kg. It appears in the commercial section of the daily papers under the heading "Commodity Markets".

Example: DEL 247.75 means: 100 kg copper (Cu) cost 247.75 Euro.
Currently a 1 % procurement surcharge is added to the daily quotation for cables, leads and piece-goods.

**The copper price basis**
In the list price of many cables, almost all leads and piece-goods, a proportion of the copper price is already included.
It is also expressed in Euro per kg.

- Euro 150,-/100 kg for almost every flexible cable and leads (e.g. ÖLFLEX® CLASSIC 100) and piece-goods (e.g. ÖLFLEX® SPIRAL 540 P)
- Euro 100,-/100 kg for telephone cables and -cords (e.g. J -Y(St)Y)
- Euro 0.00/100 kg for cables (e.g. NYY, NYCY, NYCWY), an exclusive copper cost pricing.

Copper basis is indicated at each relevant page of this Catalogue, below the article Table.

**The copper index**
The copper index (copper number) is the calculated copper weight (kg) of a cable per lengts (km) of a cable or lead, for piece-goods per (1000) piece(s) and is indicated for each Catalogue article.

**Example for how to calculate the copper price supplement for cables:**
Flexible cable ÖLFLEX® CLASSIC 100, 3G1.5 mm², Copper index per Catalogue: 43 kg/km. Therefore the calucated copper weight is 43 kg per 1 km.

$$\text{Copper index (kg/km)} \times \frac{\text{(DEL +1 \% procurement surcharge)} - \text{copper price basis}}{1000} = \text{copper supplement cost in Euro/100 m}$$

ÖLFLEX® CLASSIC 110, 3G1.5 mm².
DEL: 247.75 Euro/100 kg. Cu base 150.- Euro/100 kg.
Cu index: 43 kg/km

$$43\ \text{kg/km} \times \frac{(247.75+2.48) - 150.00}{1000} = 4.31\ \text{Euro/100 m}$$

In the case of a DEL-quotation of 247.75 Euro/100 kg, this is the additional copper price supplement for 100 m ÖLFLEX® CLASSIC 110 3G1.5 mm².

**Other Metals**
This proceeding is applied for other metals sameway, e.g. "Aluminium".
The term "Copper" is then to be replaced by "Aluminium". General: "Metal".

**Price including copper:**
Copper price supplement is accounted separately at the invoice. Your net price (without tax) is calculated as follows:
Catalogue/(gross-) price minus your discount (%) + copper supplement.





Because of their outstanding characteristics, many of our products have been tested and authorized by the following approval organisations. Please find the certification marks on the individual product pages – if appliable.

UNDERWRITERS LABORATORIES INC.

LISTED COMPONENT MARK FOR CANADA AND UNITED STATES

INSTITUTO ITALIANO DEL MARCHIO DI UALITÁ

LLOYD'S REGISTER OF SHIPPING

CANADIAN STANDARDS ASSOCIATION

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT

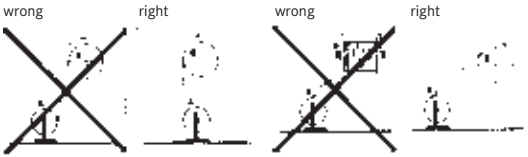
ZERTIFIKAT GERMANISCHER LLOYD

VERBAND DEUTSCHER ELEKTROTECHNIKER

SCHWEIZERISCHER ELEKTROTECHNISCHER VEREIN

GGVS Gefahr-Gut-Verordnung-Straße EN 220500 ff.

„Gost R" Certification for Russia




Unreeling and dereeling of cables

Cables must be selected according to the laying and operating conditions involved. They must be protected against mechanical, thermal, or chemical effects, and against penetration of moisture from the cable ends.

Insulated power cables must not be laid underground. Temporary covering of tough rubber sheathed cable NSSHÖU or cable runs with earth, sand or similar, for example on construction sites, is not deemed to constitute underground laying.

Cables ties or supports must not cause any damage to fixed wiring and cables. If cables or wires running horizontally along walls or ceilings are fastened with clips the following reference figures apply for the clip spacing:

For non-reinforced cables and wiring, 20 x cable diameter.

These spacings also apply for mounting positions where installation is on cable trays and staging. For vertical installation the clip spacings can be widened, depending on the type of cable or clip involved.

Flexible cables (e.g. ÖLFLEX® cables, UNITRONIC® cables) must be installed with stack when connected to mobile equipment and must be protected against twisting and buckling. The outer sheathing of cables must not be damaged at the feed points, or by the strain relief devices. Flexible PVC cables in the standard versions are not designed for open air use.

Flexible rubber-sheathed cables (e.g. ÖLFLEX® CRANE cables) are only suitable for permanent use in the open air if the outer sheathing is based generally on a compound of polychloroprene (NEOPRENE®). Special cables must be used for permanent underwater use.

**Thermal stresses**

The temperature limits for the respective types of cables are listed in the relevant Technical Data. The upper temperature limits must not be exceeded as a result of heat built-up in the cables or the ambient thermal conditions. The lower limits denote the lowest permissible ambient temperature.

**Tensile stresses**

The tensile stress imposed on the conductor should be as low as possible. The following tensile stresses for the conductor must not be exceeded in the case of cables:

- Flexible cables 15 N/mm² during installation of cables, subjected for flexible use only. Screening, concentric conductors and divided protective conductors not being included in the above figures. In the case of cables subjected to dynamic stresses in operation, e.g. in crane installations involving high rates of acceleration of power chain systems subject to frequent movement, suitable measures must be taken, e.g. increased bending radi in the individual case. Due account must be taken of the possibility of service life being reduced.
- Cables for static usage. When laying permanent cables 50 N per mm² of conductor cross-section.
- Fibre optical, BUS, LAN and Industrial Ethernet cables Please take into consideration its individual tensile strengths limitations. These values are given at products datasheet, or on demand.

Neoprene® is a registered trademark of DuPont de Nemour

## Definition of the protection category acc. to EN 60529 (DIN 0470) and DIN 40050

The protection category is mentioned as a short mark which consists of two unvarying letters IP and ratios for the protection level, for example IP 54.

**Protection Classes for protection against foreign bodies**

| First figure | Designation | Scope of protection – explanation |
|---|---|---|
| 0 | No protection | |
| 1 | Protection against large foreign bodies > 50 mm ⌀ | Protection against accidental, large-surface contact with active or internal moving parts, e.g. with the hand, but no protection against deliberate access to these parts. Protection against penetration of solid foreign bodies with a diameter larger than 50 mm. |
| 2 | Protection against medium-sized foreign bodies > 12.5 mm ⌀ | Protection against contact by the fingers with active or internal moving parts. Protection against penetration of solid foreign bodies with a diameter larger than 12 mm. |
| 3 | Protection against small foreign bodies > 2.5 mm ⌀ | Protection against contact with active or internal moving parts with tools, wires, etc. of a thickness greater than 2.5 mm. Protection against penetration of solid foreign bodies with a diameter larger than 2.5 mm. |
| 4 | Protection against granula foreign bodies > 1.0 mm ⌀ | Protection against contact with active or internal moving parts with tools, wires, etc. of a thickness greater than 1 mm. |
| 5 | Protection against accumulation of dust | Complete protection against contact with live or internal moving parts, protection against harmful dust accumulations. The penetration of dust is not completely prevented, but the dust may not penetrate in such quantities that the mode of operation is restricted. |
| 6 | Protection against ingress of dust | Complete protection against contact with live or internal moving parts. Protection against the ingress of dust. |





**Protection Classes for water protection**

| Second figure | Designation | Scope of protection – explanation |
|---|---|---|
| 0 | No protection | |
| 1 | Protection against dripping water falling vertically | Water drops which fall vertically must not have any harmful effect. |
| 2 | Protection against dripping water falling at an angle | Water drops which fall at any angle from 15° to the vertical, may not have any harmful effect. |
| 3 | Protection against sprayed water | Water which falls at any angle up to 60° to the vertical, must not have any harmful effect |
| 4 | Protection against splashed water | Water which splashes from all directions onto the equipment must not have any harmful effect. |
| 5 | Protection against water jet | A water jet from a nozzle, which is directed from any direction against the equipment, must not have any harmful effect. |
| 6 | Protection against flooding | In the event of temporary flooding, e.g. in heavy seas, water may not penetrate into the equipment in harmful quantities. |
| 7 | Protection against immersion | Water may not penetrate in harmful quantities when the equipment is immersed in water under the prescribed pressure and time conditions. |
| 8 | Protection against submersion | Water may not penetrate in harmful quantities if the equipment is submerged under water. |
| 9K | Protection against high pressure/cleaning with high pressure cleaner | Water under high pressure and from any direction may not cause damage to the housing. |

**Example:** Identifying letters IP 65

- Second figure: Protection against liquids.
- First figure: Protection against contact penetration of foreign bodies.

| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | |
|---|---|---|---|---|---|---|
| | | at temp +°C | Polyamide PA 6 | Polyamide PA 6.6 | Polyamide PA 12 | Thermoplastic Polyurethane PU |
| **Reagens** | **concentration** | | | | | |
| Exhaust gases, containing carbon dioxide | any | 60 | | | | |
| Waste gas, containing $SO_2$ | low | 60 | | | | |
| Acetaldehyde | 40% | 20 | ◪ | ◪ | ■ | |
| Acetone | 100% | 20 | ■ | ■ | ■ | □ |
| Acrylic acid | 100% | > 30 | □ | □ | □ | |
| Alums, hydrous | dilute | 40 | | | | |
| Allyl alcohol | 96% | 20 | ◪ | ◪ | ■ | ■ |
| Aluminum chloride, hydrous | dilute | 40 | | | | |
| Aluminum sulphate, h. | dilute | 40 | | | | |
| Formic acid, hydrous | 10% | 20 | ◪ | ◪ | ■ | |
| Ammonia solution, h. | saturated | 20 | 20 % ■ | 20 % ■ | 20 % ■ | |
| Ammonium chloride, h. | saturated | 60 | | | | 3 % ◪ |
| Ammonium nitrate, h. | dilute | 40 | | | | |
| Ammonium sulphate, h. | dilute | 40 | | | | |
| Aniline, pure | 100% | 20 | ◪ | ◪ | ◪ | |
| Anilin hydrochloride, h. | saturated | | | | | |
| Benzaldehyde, hydrous | saturated | 20 | pure ◪ | pure ◪ | pure ◪ | |
| Benzine | 100% | 20 | ■ | ■ | ■ | |
| Benzoic acid, hydrous | any | 40 | 20 % ◪ | 20 % ◪ | | |
| Benzole | 100% | 20 | ■ | ■ | ■ | |
| Bleaching liquor | 12.5 Cl | 20 | □ | □ | ◪ | 3 % □ |
| Drilling oil | any | 20 | □ | □ | □ | |
| Chrome alum, hydrous | dilute | 40 | | | | |
| Cyclohexanol | – | 20 | ■ | ■ | ■ | |
| Diesel fuel | | 85 | ■ | ■ | ■ | 20 °C ■ |
| Potassium chloride, hydrous | 10% | 20 | ■ | ■ | ■ | |
| Acetic acid | 100% | 20 | | | | |
| Ethanoic acid | 10% | 20 | ◪ | ◪ | ■ | 3 % ◪ |
| Ehtyl alcohol, hydrous | 10% | 20 | 40 Vol% ■ | 40 Vol% ■ | 40 Vol% ■ | |
| Ethyl dichloride | 100% | 20 | | | | |
| Ethylenoxid | 100% | 20 | | | | |
| Ehtyl ether | 100% | 20 | | | | |
| Ferric cyanide, hydrous | saturated | 60 | | | | |

h. = hydrous





| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | |
|---|---|---|---|---|---|---|
| | | at temp +°C | Polyamide PA 6 | Polyamide PA 6.6 | Polyamide PA 12 | Thermoplastic Polyurethane PU |
| **Reagens** | **concentration** | | | | | |
| Fluorine | 50% | 40 | pure □ | pure □ | pure □ | □ |
| Formaldehyde, hydrous | dilute | 40 | pure ■ | pure ■ | pure ◪ | |
| Glucose, hydrous | any | 50 | | | | |
| Urea, hydrous | to 10% | 40 | 20 % ■ | 20 % ■ | 20 % ■ | |
| Hydraulic fluid hardly inflammable | 80% | 80 | ■ | ■ | ■ | |
| Hydraulic oil H and HL (DIN 51524) | 100% | 100 | ■ | ■ | ■ | |
| Hydroxylamine sulphate, hydrous | to 12% | 30 | | | | |
| Caustic soda lye, hydrous | 50% | 20 | ■ | ■ | ■ | |
| Potassium bromide, hydrous | any | 20 | 10 % ■ | 10 % ■ | 10 % ■ | |
| Potassium chloride, hydrous | 10% | 20 | ■ | ■ | ■ | |
| Potassium dichromate, hydrous | 40% | 20 | 5 % ◪ | 5 % ◪ | 5 % ◪ | |
| Potassium nitrate, hydrous | any | 20 | 10 % ■ | 10 % ■ | 10 % ■ | |
| Kaliumpermanganat, hydrous | saturated | 20 | | | | |
| Hydrosilicofluoric acid, h. | to 30% | 20 | □ | □ | | |
| Carbon dioxide, dry | 100% | 60 | | | | |
| Carbon dioxide | 100% | 60 | ■ | ■ | ■ | |
| Cresol, hydrous | to 90% | 20 | pure □ | pure □ | | |
| Cooling liquids DIN 53521 | | 120 | ◪ | ◪ | | |
| Copper monochloride, h. | saturated | 20 | | | | |
| Copper sulphate, hydrous | saturated | 60 | | | | |
| Magnesium carbonate, h. | saturated | 100 | | | | |
| Magnesium chloride, h. | saturated | 20 | 10 % ■ | 10 % ■ | 10 % ■ | |
| Methyl alcohol | 100% | 20 | ■ | ■ | ■ | |
| Methylene chloride | 100% | 20 | ◪ | ◪ | ◪ | |
| Lactic acid, hydrous | to 90% | 20 | 10 % ■ | 10 % ■ | 10 % ■ | 3 % ◪ |
| Mineral oil | | | ■ | ■ | ■ | |
| Sodium chlorate, hydrous | saturated | 20 | 10 % ◪ | 10 % ◪ | 10 % ◪ | |
| Caustic soda, hydrous | 10% | 20 | ■ | ■ | ■ | 3 % ◪ |
| Nickel chloride, hydrous | saturated | 20 | 10 % ◪ | 10 % ◪ | 10 % ◪ | |
| Nickel sulphate, hydrous | saturated | 20 | 10 % ◪ | 10 % ◪ | 10 % ◪ | |

| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | |
|---|---|---|---|---|---|---|
| | | at temp +°C | Polyamide PA 6 | Polyamide PA 6.6 | Polyamide PA 12 | Thermoplastic Polyurethane PU |
| **Reagens** | **concentration** | | | | | |
| Nitro glycerin | dilute | 20 | ■ | ■ | ■ | |
| Oil and grease | | 20 | ■ | ■ | ■ | |
| Oleic acid | – | 20 | ■ | ■ | ■ | |
| Oxalic acid | any | 20 | 10 % ◪ | 10 % ◪ | 10 % ◪ | 3 % ◪ |
| Ozone | pure | | □ | □ | □ | |
| Kerosine | 100% | 80 | ■ | ■ | ■ | |
| Phosgene, gaseous | 100% | 20 | | | | |
| Phosphoric acid, hydrous | dilute | 20 | 10 % □ | 10 % □ | 10 % □ | 3 % ◪ |
| Phosphorus pentoxide | 100% | 20 | | | | |
| Mercury | pure | 20 | ■ | ■ | ■ | |
| Nitric acid, hydrous | 50% | 20 | □ | □ | □ | 3 % □ |
| Hydrochlorid acid, hydrous | 30% | 20 | 20 % □ | 20 % □ | 20 % □ | 3 % □ |
| Lubricating grease, base diester oil | | 110 | ◪ | ◪ | | |
| Lubricating grease, base polyphenyl ester | | 110 | ■ | ■ | ■ | |
| Lubricating grease, base silicon oil | | 110 | ■ | ■ | ■ | |
| Carbon bisulphide | 100% | 20 | ■ | ■ | ■ | |
| Sulphuric sodium, liquid | dilute | 40 | | | | |
| Sulphuric acid, hydrous | 10% | 20 | □ | □ | □ | 3 % □ |
| Sea water | | 40 | ■ | ■ | ■ | 20 °C ■ |
| Soap solution, hydrous | any | 20 | dilute ■ | dilute ■ | dilute ■ | ■ |
| Carbon tetrachloride | 100% | 20 | ■ | ■ | ■ | |
| Toluene | 100% | 20 | ■ | ■ | ■ | □ |
| Trichloroethylene | 100% | 20 | ◪ | ◪ | ◪ | |
| Vinyl acetate | 100% | 20 | | | | |
| Hydrogen | 100% | 60 | 20 °C ■ | 20 °C ■ | 20 °C ■ | |
| Xylene | 100% | 20 | ■ | ■ | ■ | |
| Zinc chloride, hydrous | dilute | 60 | 10 % ◪ | 10 % ◪ | | |
| Zinc sulfate, hydrous | dilute | 60 | | | | |
| Zinc chloride, hydrous | dilute | 40 | | | | |
| Citric acid | to 10% | 40 | 20 °C ■ | 20 °C ■ | 20 °C ■ | 3 % ◪ |

h. = hydrous





| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Polypropylene PP | Polyethylene HD-PE | Polyethylene LD-PE | Polystyrole PS | Nitrile Butadiene rubber NBR |
| **Reagens** | **concentration** | | | | | |
| Exhaust gases, containing carbon dioxide | any | | ■ | ■ | | |
| Waste gas, containing $SO_2$ | low | | ■ | ■ | | |
| Acetaldehyde | 40% | ■ | | | | 20 °C ■ |
| Acetone | 100% | ■ | ◪ | ◪ | | □ |
| Acrylic acid | 100% | | | | | □ |
| Alums, hydrous | dilute | ■ | ■ | ■ | ■ | 20 °C ■ |
| Allyl alcohol | 96% | ■ | ■ | 20 % ■ | | |
| Aluminum chloride, hydrous | dilute | ■ | ■ | ■ | ■ | 20 °C ■ |
| Aluminum sulphate, hydrous | dilute | ■ | ■ | ■ | ■ | 20 °C ■ |
| Formic acid, hydrous | 10% | ■ | ■ | | ■ | |
| Ammonia solution, hydrous | saturated | ■ | ■ | ■ | 25 % ■ | |
| Ammonium chloride, hydrous | saturated | ■ | ■ | ■ | | 20 °C ■ |
| Ammonium nitrate, hydrous | dilute | ■ | ■ | ■ | ■ | 20 °C ■ |
| Ammonium sulphate, hydrous | dilute | ■ | ■ | ■ | | □ |
| Aniline, pure | 100% | ■ | ■ | ■ | □ | |
| Anilin hydrochloride, h. | saturated | ■ | ◪ | ◪ | | |
| Benzaldehyde, hydrous | saturated | ■ | | | □ | □ |
| Benzine | 100% | ◪ | ■ | ◪ | □ | ■ |
| Benzoic acid, hydrous | any | ■ | ■ | ■ | ■ | □ |
| Benzole | 100% | ◪ | ◪ | ◪ | □ | □ |
| Bleaching liquor | 12.5 Cl | ■ | ■ | ■ | ■ | □ |
| Drilling oil | any | □ | □ | □ | □ | □ |
| Chrome alum, hydrous | dilute | ■ | ■ | ■ | | 20 °C ■ |
| Cyclohexanol | – | ■ | ■ | ■ | ■ | ■ |
| Diesel fuel | | 20 °C ■ | 20 °C ■ | 20 °C ■ | | |
| Potassium chloride, h. | 10% | ■ | ■ | ■ | ■ | ■ |
| Acetic acid | 100% | ■ | ■ | ■ | | ◪ |

| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | |
|---|---|---|---|---|---|---|
| | | Polypropylene PP | Polyethylene HD-PE | Polyethylene LD-PE | Polystyrole PS | Nitrile Butadiene rubber NBR |
| **Reagens** | **concentration** | | | | | |
| Ethanoic acid | 10% | ■ | ■ | ■ | ◪ | |
| Ehtyl alcohol, hydrous | 10% | | ■ | | ■ | |
| Ethyl dichloride | 100% | ◪ | □ | □ | | □ |
| Ethylenoxid | 100% | ◪ | | | | |
| Ehtyl ether | 100% | ◪ | | | | ◪ |
| Ferric cyanide, hydrous | saturated | ■ | ■ | ■ | | |
| Fluorine | 50% | □ | □ | | | |
| Formaldehyde, hydrous | dilute | 40 % ■ | 40 % ■ | 40 % ■ | 30 % ■ | 20 °C ◪ |
| Glucose, hydrous | any | ■ | ■ | ■ | | |
| Urea, hydrous | to 10% | ■ | ■ | ■ | ■ | |
| Hydraulic fluid hardly inflammable | 80% | | | | | |
| Hydraulic oil H and HL (DIN 51524) | 100% | | | | | |
| Hydroxylamine sulphate, hydrous | to 12% | ■ | | | | |
| Caustic soda lye, hydrous | 50% | ■ | ■ | ■ | ■ | |
| Potassium bromide, hydrous | any | ■ | ■ | ■ | ■ | |
| Potassium chloride, hydrous | 10% | ■ | ■ | ■ | ■ | ■ |
| Potassium dichromate, hydrous | 40% | ■ | ■ | ■ | | ■ |
| Potassium nitrate, hydrous | any | ■ | ■ | ■ | ■ | ■ |
| Kaliumpermanganat, hydrous | saturated | ■ | | | ■ | |
| Hydrosilicofluoric acid, hydrous | to 30% | ■ | ■ | ■ | | |
| Carbon dioxide, dry | 100% | ■ | ■ | ■ | 50 °C ■ | 20 °C ■ |
| Carbon dioxide | 100% | | | | | 20 °C ■ |
| Cresol, hydrous | to 90% | ■ | ■ | ◪ | ◪ | □ |
| Cooling liquids DIN 53521 | | | | | | |
| Copper monochloride, h. | saturated | ■ | ■ | ■ | | ■ |
| Copper sulphate, hydrous | saturated | ■ | ■ | ■ | | 20 °C ■ |

h. = hydrous





| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | Cable and lead designation | | | | | |
|---|---|---|---|---|---|---|
| | | Polypropylene PP | Polyethylene HD-PE | Polyethylene LD-PE | Polystyrole PS | Nitrile Butadiene rubber NBR |
| **Reagens** | **concentration** | | | | | |
| Magnesium carbonate, hydrous | saturated | ■ | | | 50 °C ■ | |
| Magnesium chloride, hydrous | saturated | ■ | ■ | ■ | ■ | ■ |
| Methyl alcohol | 100% | 40 °C ■ | ■ | ■ | ■ | ■ |
| Methylene chloride | 100% | ◪ | ◪ | □ | | |
| Lactic acid, hydrous | to 90% | ■ | ■ | ■ | 80 % ■ | ■ |
| Mineral oil | | 20 °C ■ | 20 °C ■ | 20 °C ■ | | |
| Sodium chlorate, hydrous | saturated | ■ | ■ | ■ | | |
| Caustic soda, hydrous | 10% | ■ | ■ | ■ | ■ | |
| Nickel chloride, hydrous | saturated | ■ | | | ■ | ■ |
| Nickel sulphate, hydrous | saturated | ■ | ■ | ■ | | ■ |
| Nitro glycerin | dilute | | □ | □ | | |
| Oil and grease | | ◪ | | | | |
| Oleic acid | – | ■ | ■ | ■ | ■ | ◪ |
| Oxalic acid | any | ■ | ■ | ■ | ■ | ◪ |
| Ozone | pure | ◪ | ◪ | ◪ | | |
| Kerosine | 100% | 20 °C ■ | 20 °C ■ | 20 °C ◪ | □ | |
| Phosgene, gaseous | 100% | ◪ | ◪ | ◪ | | |
| Phosphoric acid, hydrous | dilute | ■ | ■ | ■ | 86 % ■ | □ |
| Phosphorus pentoxide | 100% | ■ | | | | |
| Mercury | pure | ■ | ■ | ■ | ■ | ■ |
| Nitric acid, hydrous | 50% | ◪ | ◪ | ◪ | 30 % ■ | □ |
| Hydrochlorid acid, hydrous | 30% | ■ | ■ | ■ | 15 % ■ | ◪ |
| Lubricating grease, base diester oil | | | | | | |
| Lubricating grease, base polyphenyl ester | | | | | | |
| Lubricating grease, base silicon oil | | | | | | |
| Carbon bisulphide | 100% | ■ | ◪ | ◪ | □ | □ |
| Sulphuric sodium, liquid | dilute | ■ | ■ | ■ | | |
| Sulphuric acid, hydrous | 10% | 50 % ■ | 50 % ■ | 50 % ■ | ■ | □ |
| Sea water | | ■ | ■ | ■ | ■ | 20 °C ■ |

T24: Chemical resistance of plastic materials

| The information is given to the best of our knowledge and experience, but must be regarded as being for the guidance only. A definite judgement depends in most cases on tests under actual working conditions. | | Cable and lead designation | | | | |
|---|---|---|---|---|---|---|
| | | Polypropylene PP | Polyethylene HD-PE | Polyethylene LD-PE | Polystyrole PS | Nitrile Butadiene rubber NBR |
| **Reagens** | **concentration** | | | | | |
| Soap solution, hydrous | any | ■ | ■ | | ■ | |
| Carbon tetrachloride | 100% | □ | ◪ | □ | □ | |
| Toluene | 100% | | ◪ | ◪ | ◪ | □ |
| Trichloroethylene | 100% | ◪ | ◪ | □ | | |
| Vinyl acetate | 100% | ■ | | | | |
| Hydrogen | 100% | ■ | ■ | ■ | | 20 °C ■ |
| Xylene | 100% | □ | ◪ | ◪ | □ | □ |
| Zinc chloride, hydrous | dilute | ■ | ■ | ■ | 50 °C ■ | 20 °C ■ |
| Zinc sulfate, hydrous | dilute | ■ | ■ | ■ | | 20 °C ■ |
| Zinc chloride, hydrous | dilute | ■ | ■ | ■ | □ | 20 °C ■ |
| Citric acid | to 10% | ■ | ■ | ■ | ■ | 20 °C ■ |

□ = not consistent
◪ = provisory consistent
■ = consistent

**Absorption**

Cause for attenuation of a fibre optic cable.

**ACR**

Abbreviation for Attenuation to Crosstalk Ratio. The ACR value indicates the relationship between the near-end crosstalk and the attenuation at a certain frequency.

**Address bus**

System of associated cables, to which address bits can be transferred.

**Adhesion**

Adhesive, cohesive and density property of the outer sheath of a cable. “Low adhesion” property important e. g. for drag chain use in order to avoid the cables from sticking to each other.

**Aging**

The change in the properties (predominantly tensile strength and expansion) of a material over time under specific conditions such as temperature, UV radiation, ozone influence, chemical and thermal loads, etc.

**Aging resistance**

As cables are often subject to environmental influences over decades (life cycle), i. e. chemical, electrical and climatic exposure, it is these properties that are to be tested. Here, all the materials found in cables are briefly tested under extreme conditions. All materials should have a very high aging resistance.

**Alternating current**

The alternating current is produced by linking three alternating currents with identical oscillation values and frequencies. Also known as multi-phase alternating current.

**Aluminium sheath**

The aluminium sheath is lighter than the lead sheath, has better conductivity and greater resistance, however must include a plastic sheath to protect against corrosion.

**American wire gauge**

Cables or cores according to American cross-sections/ dimensions. High AWG number → small cross-section, low AWG number → large cross-section (see Table T16).





**Ampacity**

Maximum permitted current that can be transmitted under defined conditions. VDE0298, Part 4.

**Ampere**

The strength of an electric current that flows through a conductor. Unit of measurement for the electric current (A).

**Analog signal transmission**

Transmission of continuously variable signals with which the light output is modulated.

**Angle of beam spread**

Half the vertical angle of the cone within which the injected power in a light waveguide with uniform illumination is equal to a specified fraction of the total injected power.

**ANSI**

Abbreviation for the American National Standards Institute. An American committee which, similar to the German DIN, develops and publishes standards.

**Antenna cable**

Antenna cables are coaxial high-frequency cables for receiver connections, domestic distribution grids and single antenna installations. They are mainly

used in receiving and distribution stations for sound and television broadcasting. They must guarantee a low-reflection signal transmission.

**Anti-kink cable glands**

Mechanism that is part of a cable gland and provides additional protection if a flexible cable is frequently subjected to bending (e. g. SKINDICHT® SR-SV-M at Lapp).

**Antioxidant, Oxidation inhibitor**

As antioxidants may colour rubber compounds, they are generally only ever used for dark compounds. They prevent the compounds from becoming brittle too early.

**Approved cables**

Approved control and data network cables with certification, standards such as VDE, UL/CSA.

**Armouring**

Also known as reinforcement. Armouring is a mechanical protection for cables. It is produced in a variety of ways and using a wide range of materials, depending on the expected loads on the cable.





It can be made of steel wire braiding, circular or flat steel wires, strip iron or combinations of these materials.

**Armouring types**

Commonly used are the flat steel wire, steel band, profile steel wire and round steel wire armouring with outer protective cover. There are also steel wire armourings with an anti-twist tape (steel band), however without an outer protective cover (for interior spaces).

**Armouring, armour**

A special electromechanical or mechanical protection against external stresses, for the improvement of the reduction factor and for the absorption of tensile forces. Plastic fibres are used instead of metallic armouring for fibre optic cables.

**AS**

Abbreviation for Australian Standard

**ASI (Actor-Sensor-Interface)**

Bus system for the lowest level of automation. Facilitates the simple connection of sensors, actuators and integrated systems to the first

control level. See → Master-Slave principle. Up to 248 binary inputs and outputs per grid, one cable for information and energy, reverse-polarity protected connection technology, 100 m cable length or up to 300 m with repeaters, open tree structure of grid, protection class up to IP 67, cycle time <5 ms, high immunity to interference and fault tolerance.

**ASME** Abbreviation for the American Society of Mechanical Engineers (USA).

**Assembly** A ready-to-install cable. It is cut to the appropriate length and fitted with connecting elements (plugs, cable lugs, etc.) at the ends.

**ASTM** Abbreviation for the American Society of Testing and Materials.

**ATEX approval** This approval is required for the intended use of devices and protection systems in areas at risk to explosions.





**Attenuation** Attenuation is the reduction of the signal amplitude during transmission to a medium. It increases with the rising frequency and cable length. The signal level is impaired in the process.

**Attenuation a** The reduction of the optical signal power between two cross-sectional surfaces of a fibre optic cable due to losses. The unit of measurement is decibels (dB).

**Attenuation coefficient a** The attenuation relative to the length of a fibre optic cable. The standard unit of measurement is decibel/kilometre (dB/km).

**Automotive cable** Vehicle cables are cores and cables used in passenger cars and trucks (e. g. ÖLFLEX® TRUCK at Lapp).

**AWG** Abbreviation for American Wire Gauge. Standard expression for the wire diameter. The smaller the AWG value, the bigger the wire diameter. The actual values (mm) depend on

the core resolution, regardless of whether a fixed conductor or a strand is used.

**AWM** UL marking for Appliance Wiring Material.

**Backbone** Backbone or secondary wiring is the connection between the building distributor and the individual floor distributors in a structured wiring system.

**Backscatter** A small fraction of the light that is deflected from its course due to dispersion travels in a reverse direction, i. e. in the light waveguide back to the transmitter. By observing the chronological progression of the backscattered light using a beam splitter on the transmitter, it is possible to measure not only the length and damping of an installed light waveguide from one end but also local irregularities, e. g. light losses in splices.

**Backtwist** The term relates to the stranding process. The technical design of the stranding machine twists the





elements to be processed into a strand without torsion.

**BALUN** Balun is a term combining “balanced” and “unbalanced”. Baluns are used for adjusting impedance and symmetry in the various transmission media in copper grids.

**Banding** Wrapping a bundle of wires with relatively narrow paper, textile, plastic or metal strips.

**Bandwidth** Frequency range of a fibre optic cable within which data can be transmitted within a particular time frame. The greater the bandwidth, the more data that can be transmitted. The transmission speed depends on the bandwidth of the entire network.

**Bandwidth product** The bandwidth product is what results when the bandwidth of a glass fibre cable is multiplied with the length of the measured section.

**Bandwidth-length product** Measurement for the frequency range that can be transmitted by a fibre optic cable one kilometre in length. It is a constant value.

**BASEC**

Abbreviation for the British Approvals Service for Cables. Certification body – Great Britain and Northern Ireland.

**Basic raw materials**

In addition to the basic raw material, synthetic materials contain a range of other components such as stabilisers, softeners, filler and colour.

**Batteries Act**

The Battery Act came into force in 2009 and also covers the registration and return of batteries.

**Battery cables**

Link between battery and generator in the engine. They are developed, manufactured and delivered in accordance with customer requirements/product specifications.

**Baud**

Unit for a modulation rate in the transmission of communications. One step per second. 1 bit/s = baud, 1Mbit/s = 1 Mbaud → see Bit

**Bel**

1 Bel = 10 decibels. In high-frequency technology, the common unit of measurement for attenuation and, like decibel, a dimensionless ratio.





**Bending capacity**

The bending capacity indicates how far a product can bend without forfeiting function.

**Bending cycle**

Number of bends repeated in the drag chain (How often was a cable actively stressed during testing or during application?)

**Bending radii**

Permissible radius for occasional or constant bending of cables. The bending radius is defined as a multiple of the cable diameter. The construction of the cables determines the minimum permissible bending radius, which allows it to be increased or reduced. The permissible bending radii must be adhered to when laying power lines and cables. The standard values are between 15 x D and 30 x D, depending on construction type and regulation. D is the outer diameter of the cable. (At Lapp: ÖLFLEX® FD with 5 x D or 7.5 x D).

**Bending test at low temperature**
Cold flexibility test for cables. A cold cable is wrapped around a pin and no cracks may occur in the insulation.

**Binary**
Property restricted to just two values.

**Bit**
The smallest unit for representing binary data, significance either 0 or 1. It is the basic unit for transmission information in digital systems. A byte is a group of 8 bits.

**Bit error rate, BER**
Ratio of error bits to the overall number of bits received during a specific period.

**Blue cable**
Cable for intrinsically safe systems in hazardous locations. The compulsory colour code here is blue, RAL 5015. (For Lapp, ÖLFLEX® EB. These cable types are also available with shielding, e. g. ÖLFLEX® EB CY, UNITRONIC® EB CY).

**Braid angle**
Variation in degrees between the longitudinal axis and the wire routing within the braid.





**Braiding**
Arrangement of interlaced wires or threads forming part of the structure of a cable. Copper wire braiding is used for screening, while braiding made of textile, plastic thread or steel wire performs supporting or carrying, i. e. mechanical, functions. Braiding can be close or wide meshed (coverage density in percent) with different angles of twist.

**Breakdown**
This refers to electrical breakdown between two conductors or a conductor in water during the testing process, when the insulation can no longer withstand the constantly increasing voltage (breakdown voltage) or if a fault in the insulation results in a breakdown within a specified time at a constant voltage.

**Breaking load, ultimate load**
The product of nominal cross-section and tensile strength is the breaking load.

**British Standard Wire Gauge**
Also known as NBS (New British Standard), SWG (Standard Wire Gauge), Legal Standard and

Imperial Wire Gauge. A modified version of the Birmingham Wire Gauge, a standard from Great Britain valid for all wires.

**Broadband**

Transmissions in which the signals are transmitted by a high number of oscillations per second (glass fibre technology).

**BS**

Abbreviation for British Standard. Standards body for Great Britain, similar to VDE in Germany.

**BSI**

Abbreviation for British Standard Institution – Great Britain.

**Bundle**

Several cores or pairs that are stranded into a group and in turn make up one element of a strand assembly.

**Bus system**

The bus system is a system of cables that transmits information and data.

**Cable**

Combination of several cores with protective layers (sheath) or sheathing of a single core. The sheathing protects the cores against all kinds of harmful





influences. Cables are used to transport electric current (power cables), transmit information using an electric current (data cables) or to transfer information using light waves (light waveguide cables). The term line is also commonly used, depending on the application. It is not possible to exactly delineate the two terms. In general, the term “cable” is used for installations outside buildings. In practice, however, the terms are used interchangeably.
Combination of any number of cores under a sheath.

**Cable carrier**

An assembly of linked, hinged support elements for directional, dynamic routing of all types of flexible bending power cables.

**Cable data**

The cable type file is part of the CAE software from ePLAN®. The cable type file defines the number of cores, their colour code, the PE core and the screening for all cables. In the Lapp item master data for ePLAN®, the cable type is assigned to the relevant item. This means that

when a Lapp item is selected, each core is automatically assigned the appropriate colour code in the ePLAN® circuit diagram.

**Cable gland**

The brand name is SKINTOP® at Lapp. A cable gland is a device that is designed to guide a cable or an insulated conductor into a sheath and provides a seal and a restraint mechanism. It can also have other functions, e. g. kink prevention, strain relief, potential equalisation, earthing, insulation or a combination of these.

**Cable gland size**

The following sizes are currently defined in EN 60562:
M 12 x 1.5; M 16 x 1.5;
M 20 x 1.5; M 25 x 1,5;
M 32 x 1.5; M 40 x 1.5;
M 50 x 1.5; M 63 x 1.5;
M 75 x 1.5;
M 90 x 2; M 110 x 2.
M stands for metric.

**Cable print**

Coloured marking on the outer sheath of individual elements or cables using symbols, names and other markings.





**Cable set-up**

Describes (from inside to out) the materials used for cables, their design and properties and the position of the individual elements.

**Cable tree**

Combination of individual cores or cables tied together with nylon ties, spirals or hose sheathing. The form of the harness is created when joining the wires, as the various consumers in the device and system circuits are physically separated and the connection with the individual cables makes constant branches necessary.

**Cable type letter code**

Identification of cables according to their design, nominal cross-section and number of cores, nominal voltage and conductor shape, which results in specific combinations of predetermined letters and numbers. For rules and standards, each of the letters and numbers has a specific meaning.

**Cables for hand-held machinery**

Handheld device cables are connecting and extension cables for power tools used in the open air or in enclosed spaces (e. g. ÖLFLEX® 540 P/CP, ÖLFLEX® 550 P, ÖLFLEX® 400, ÖLFLEX® 500 P, ÖLFLEX® SF... at Lapp).

**Caloric load values**

Caloric load is the energy that is released when cables and other building materials are burned.

**Campus**

The campus or primary wiring establishes the connection between the various buildings within a structured wiring system.

**CAN**

Controller Area Network. Result-controlled communication system. As a generator of information, this reports to all connected nodes.

**Canadian Electrical Code**

See → CEC

**Capacity**

Electrical unit of measure, measured in Farad, or electrical unit of measure V x A = Watts.





**Carrier frequency**

The frequency of the oscillation whose amplitude, phase or frequency is influenced by a signal.

**Carrier frequency, hook-up wire**

In carrier frequency systems, they are used to transmit signals. Up to 120 carrier frequency channels can be simultaneously transmitted in a cable.

**CCC**

Abbreviation for China Compulsory Certificate. Products requiring certification can only be imported to China, sold in China or used in Chinese business activities after the relevant CCC certification has been requested and granted.

**CE**

Abbreviation for Communauté Européenne (European Community).

**CE marking**

Comprises the “CE” symbol and indicates a product’s compliance with all applicable EU directives. CE indicates that the natural or legal entity which carries out or initiates the connection is satisfied that the product meets the requirements of all

relevant harmonised standards and has been subjected to all mandatory conformity assessment procedures.

**CEBEC** Abbreviation for Comité Electronique Belge – Belgian certification body.

**CEC** Abbreviation for the Canadian version of the US National Electrical Code (NEC).

**CEE** Mark for the European standards institution: International Commission on Rules of Electrical Equipment.

**CEI** Abbreviation for Commission Electrotechnique Internationale – International.

**CENELEC** Abbreviation for Comité Européen de Normalisation Electrotechniques (Europe).

**Central element** See → Core.

**Central filler** The core is a design element onto which the other design elements are attached.





**Characteristic impedance** Apparent impedance of an electronic quadrupole; it is made up of the Ohmic resistance and the frequency-dependent resistances of inductances and capacitances.
The impedance of a cable represents the ratio of the voltage waves advancing in a direction to the current wave moving in the same direction. Common values are 100, 120 and 150 Ohm. It is important that the impedance of the cable corresponds to the input/output impedance of the connected equipment.

**Chromatic dispersion** Grouping of wavelength-dependent effects which lead to a bandwidth limitation, such as waveguide dispersion and sheath dispersion.

**Circular Mil (CM)** Measurement for conductor cross-sections in 1/1000 inch (0.001") from circuit diameter.

**Cladding** Cladding is the glass layer which surrounds the core of the fibre optic cable.

**Clamping range**

Cable diameter range for which the assured properties of a cable gland apply.

**CNOMO**

Abbreviation for Comité de Normalisation des Moyens de Production. Commission for the standardisation of machine tools and tools used in the French automotive industry.
With fibre optic cables, the plastic layer on the surface of the sheath for preserving the original surface condition.

**Coating**

Coating is a form of mechanical surface protection. It is a primary plastic layer which is applied directly to the sheath glass for fibre optic cables.

**Coaxial cable**

Concentric pair of conductors consisting of an inner conductor and an outer conductor, which completely surrounds the inner conductor. Coaxial cables are suitable for low-attenuation and distortion free transmission of high bandwidth signals. Because of their self-screening construction, they are much less sensitive to external interference (e. g. RG coaxial cable at Lapp). Coaxial cables are used in high frequency telecommunications systems (cable TV, Ethernet applications) for transmission of high frequency signals.





**Colour code**

For uniform marking of metallic cables and waveguides, various institutions including the EIA, DIN and IEC, have developed a standardised colour coding system. The colour codes for metallic cores assign totally different colours to the insulation of the pairs of cores for the individual standards. In addition to these standards, which are not consistently applied by manufacturers, colour codes specific to the manufacturer are often used.

**Colour print**

Sheaths and insulation covers are usually printed with colour, using a metallic disc whose lettering is engraved inversely on its periphery. Using a scraper,

the excess colour can be scraped away.

**Communication**

Interaction between two independent systems. Used for one-way or two-way exchange of messages in the form of voice, text, images or data.

**Compensating cable**

Compensating cables are used together with a thermal element for temperature measurements. (Thermal elements such as Fe/CuNi iron-constantan (blue); NiCr/Ni nickel-chromium-nickel (green); PtRh/Pt platinum-rhodium-platinum (white). A thermal element consists of two conductors made from different materials, between which there is an electric potential depending on temperature. A compensating cable transmits this potential from the thermal element to a cold junction. There, based on the value of the potential, the temperature can be assigned at the point of measurement.





**Composite layer, composite sheath**

The combination of an aluminium foil with the plastic/polyethylene sheath of a cable. The foil covers the core of the cable lengthways and overlapping, while the plastic part is placed on the outside. The outer sheath extruded onto it forms a homogeneous connection with the foil due to the effect of temperature, resulting in an interconnected “laminated” aluminium foil sheath. Used in outdoor telecommunications cables.

**Compound**

A material compound of polymer plastics with filler. Polymers are often compounded with colours, processing aids, fibres and other fillers.

**Concentric conductor**

The concentric conductor (e. g. NYCWY) may be used as a PE or PEN wire and can also act as the screening.

**Conditioning**

Division of production length of cables into storage or delivery lengths. Standard forms include coils with lengths of 50, 100

and 250 m and drums with 250, 500 and 1,000 m, depending on weight.

**Conductance**

The electrical conductivity is the inverse of the electrical resistance.

**Conductor**

Single-conductor cables are single- or multi-wire cables, used mainly for fixed laying with rubber or plastic insulation (ground wire).
A non-insulated wire of a material whose high number of free electrons makes it suitable for carrying electric current (particularly copper and aluminium).
Component allowing a connection that is easy to break and reestablish between two light waveguides. The insertion loss from a connector is normally higher than that from a splice. In signal and power engineering, connectors are used for connecting cables with different numbers of poles and in a variety of different designs. Because of the associated ease of service compared to fixed cable connections, connectors are being used





in an increasing number of applications. (e. g. EPIC® at Lapp).
Plugs are components that enable electrical conductors to be connected and are designed to create detachable electrical connections with an appropriate counterpart. Plugs may not be inserted or removed during proper use (under electrical voltage). A distinction is made between free and fixed plugs according to the mounting. The plug is made up of the plug housing and the contact elements. (e. g. EPIC® brand from Contact at Lapp).
Central component for star-shaped passive light waveguide networks. It connects numerous transmitters and receivers and distributes the signal light output supplied by a connected transmitter evenly to all connected receivers.

**Contact voltage**

Part of an error voltage which may be contacted by members of the general public.

**Control cable**

The Lapp ÖLFLEX® brand is synonymous with connecting and control cables. The key features

of control cables are: Bare or tin plated fine copper wire conductors, PVC insulation, stranding of cores with back twist, special PVC compound outer sheath. Different ÖLFLEX® designs include:

a) Different coloured cores,
b) Numbered cables. ÖLFLEX® cables have the following properties: Flexible, largely resistant to all kinds of oils, alkalis and acids. ÖLFLEX® are used in the following areas: As control cables in machine tool manufacture and general engineering, plant construction, in all kinds of industrial plants, in measurement and control engineering, process engineering, data processing etc. ÖLFLEX® control cables are highly recommended for these applications due to their excellent flexibility, the good general chemical resistance, the clear core coding and the problem-free compatibility with multi-pole machine connectors.





**Copolymere** Mixture which polymerises from two or three monomers to form a chain.

**Copper** The best material for producing electrical conductors. Excellent conductivity of heat and electricity. In addition, copper (Cu) has very good ductility and good strength properties.

**Copper base** The monetary value used to value the copper contained in cables in the price.

**Copper weight** It expresses the mass of the copper contained in the cables.

**Copper-clad aluminium wire** This wire is made up of an aluminium core and a copper sheath.

**Core** The optical core in glass fibre cable technology.

**Core check, response at increased temperature** In order to determine the influence of heat on the mechanical properties of, for example, insulating covers, a test item is placed in a device for heat pressure testing which has already reached the testing tempera-

ture. The wall thickness of the test item determines the test load. After a specific storage period in the heating cabinet and subsequent cooling, the impression depth is measured with the reading microscope.

**Core check, response with thermal shock**

The core insulating cover is checked for thermal shock by wrapping the cores or strips from the insulating cover around a defined mandrel and storing them in a heating cabinet for approx. 1 hour at 150 °C. After removing the cores/strips and cooling them to room temperature, these test items should not display any visible cracks.

**Core diameter**

The core diameter is the diameter of the central light-carrying section of a light waveguide.

**Core group**

For the transmission of signals or energy, two or more stranded cores are required. Using two cores, it is possible to form a circuit that can transmit energy or signals.





**Core Ident Code**

VDE-DIN-colour code for colour-coded low-voltage cables according to VDE 0293-308/HD 308 S2.

**Core identification**

Coloured or numbered identification of single cores. A Lapp development: The internationally proven ÖLFLEX® colour code is based on the colour-coded identification of the single cores. Ten basic colours are combined with 2 mm wide colour spirals. This results in 102 colour variations. This colour marking is particularly advantageous compared to cores printed with numbers, as it means the cores can be assigned much more quickly in a device (saving time).

**Core joint**

Core joints combine synthetically insulated signal cable and telecommunication cores in a conductor diameter range of 0.35 – 0.9 mm. The cores are pressed together using a special core-joining pliers and thus placed solderless into the connection sleeve.

**Core print**

In the manufacture of cables, cores are principally identified by four methods:

1. Cores can be manufactured in one primary colour.
2. Marked with various colour codes.
3. Printed.
4. A combination of the different colour codes with printing. It must be noted that only earth conductors are to be green-yellow in colour and that these colours may not be used if there is any risk of confusion with other cables.

**Core stranding**

Without stranding, wires positioned parallel to one another would deform when bent. The outer wires would be overstretched and the inner wires compressed. The individual wires are twisted together in a spiral to maintain the flexibility and mobility of the conductor. The result is known as core stranding.

**Core stranding with more than four cores**

When constructing a cable, the best layer structure of the stranding elements is always selected, to obtain cables that are as





circular as possible. Gaps in the layer structure are filled with insulated fillers or central cores (filling elements). In flat cables, the structural elements (groups or cores) are parallel to one another and can be stranded.

**Core wrapping**

Core wrappings are used to protect the insulating covers of rubber-insulated cables. They are mainly made from foil or fabric tape.

**Core, conductor, insulated wire**

Individually insulated conductor, e. g. made of single- or multi-wire copper or aluminium. Core = conductive component of cables with insulation coloured or marked numerically.

**Corrosion**

Degradation of minerals and materials due to mechanical and chemical environmental influences.

**Coupler**

Passive optical components for transmission of light between a light source and a light waveguide or between several light waveguides. Couplers that allow light waveguide networks for

connecting multiple transmitters and receivers to be set up are of particular importance (see → T coupler).

**Crane cables**

Crane cables are supply cables for cranes in the open air or indoors (e. g. ÖLFLEX® CRANE at Lapp).

**Crimp connection**

Mechanical joining technology. When joining, for example, coaxial connectors with a coaxial cable using a crimping tool, a metal sleeve is pulled over the shielding and pressed together.

**Cross-linked**

The term refers to a manufacturing process for elastomers, thermoplastics and duroplastics. It describes the fact that particular chemicals are used to change the original linear alignment of the macromolecules from planar to solid structures. The materials used include sulphur compounds for rubber and peroxides for thermoplastics and duroplastics. Cross linking is carried out under the influence of heat and pressure, and high energy rays for thermoplastics. Cross linking





is a permanent and irreversible process and plays a critical role in determining the actual material properties (it gives rubber its permanent elasticity and improves the thermal, mechanical and electrical properties of polyethylene).

**Cross-linked polyethylene XLPE**

Cross-linked polyethylene.

**Cross-linking agent**

Cross-linking agents or vulcanising materials in rubber compounds are either sulphur (for natural or synthetic rubber) or peroxide (for silicone, EPDM). Sulphur cross linking begins at room temperature and intensifies as the temperature is increased. With peroxide cross linking, oxygen is released for cross linking at a specific temperature.

**Cross-section**

Cross-sectional area of the conductor. A distinction is made between the geometrically defined nominal cross-section and the conductive cross-section, which is derived from the electrical → resistance. A certain maxi-

mum resistance is assigned to the nominal cross-section, within which the conductor structure is specified. The cross-section is normally specified in $mm^2$. However, for certain types of cables, which are always made up of single-core conductors (telecommunications cables), the conductor diameter is used for marking or description.

**CSA** Abbreviation for "Canadian Standards Association". Canadian standards and testing body. Similar to VDE in Germany.

**Current** Electrical unit, measured in Amperes. Current = Voltage/ Resistance.

**D.C.** Abbreviation for direct current.

**Dark current** Current at the output of an optical receiver if no radiation is present.

**Data bus** A system of associated cables, to which data bits are transferred.





**Data transmission cable** Cables whose structure make them suitable for transmitting electric data processing pulses with minimum errors. Simple (pair) or more complex (screening) constructions are required depending on the susceptibility of the data pulses to faults (brand: UNITRONIC® at Lapp). Computer cables (Li2YCY-PIMF) or other, at least twisted in pairs, normally screened and often individually screened cables, e. g. UNITRONIC® LIYCY (TP), UNITRONIC® BUS; UNITRONIC® LAN, telephone cable, also light waveguide cables. TP = Twisted pair.

**Data transmission rate** Unit of measure for the transmission speed of a data transmission. It is measured in bit/s or byte/s.

**Data transmission, data transfer** Optical data transmission is always serial. Before data transmission, pending parallel data is always prepared for serial transfer and is post-processed to a parallel form after the transmission. We also refer to bit serial data transmission, as all of

this data is always transferred as digital signals.

**Decibel**

A decibel is the logarithmic ratio of two levels (e. g. input level to output level). The unit of measure has no dimension and is specified in dB.

**Degrees of protection**

Protection of electrical equipment by housing, covers etc. Protection of equipment against the ingress of foreign bodies and water.

**DEL**

Abbreviation for Deutsches Elektrolytkupfer für Leitzwecke (German electrolyte copper for conduction) DEL is the stock market code for 99.5% pure copper in Euro/100 kg (see T17).

**DEMKO**

Abbreviation for Danmarks Elektriska Materialkontroll – Danish standards and testing body, testing and certification body, tasks similar to VDE/UL.

**Density**

Ratio of the mass to the volume of a body. If the mass is M and the volume is V, the radio is the density d = M : V.





**Density unit**

Result of the density of a body relative to the density of water (= 1). Corresponds to the specific weight.

**Designation label**

Fixing elements with which single wires, bundles, cables and cables on machine parts or walls can be permanently fixed in place. They are transparent or coloured, usually made from nylon and can display indelible information about their content.

**DESINA®**

The Verein Deutscher Werkzeugmaschinenfabriken e. V. (VDW) [German Machine Tool Manufacturing Federation] developed **DESINA®** (**DE**centralised and **S**tandardised **IN**stAllation technology), a comprehensive overall concept for standardisation of electrical installation of equipment and machinery.

Colour codes of cables:

- Servo cable, screened: Sheath colour orange RAL 2003
- Cable for measuring systems, screened: Sheath colour green RAL 6018

Power cable, unscreened: Sheath colour black RAL 9005

24 Volt control cable, unscreened: Sheath colour grey RAL 7040 (similar to 7001)

Field bus hybrid cable, Cu and light waveguide: Sheath colour violet RAL 4001

Sensor/actuator cable, unscreened: Sheath colour yellow RAL 1021

**DeviceNet™**

Simple CAN-based communication system for networking of industrial automation equipment (limit transmitters, photo sensors, motor starters, frequency controlled drives, control terminals and similar) with master control equipment. Two screened twisted pairs of conductors within a cable are used as the transmission medium. One is used for communication (with transmission rates of 125, 250 or 500 kBit/s for cable lengths of 500 m, 250 m or 100 m) and the other to supply power to the connected equipment (max. 8 A for 24 V DC voltage).





**Dielectric**

Dielectric refers to the characteristic of certain substances to be electrically non-conductive – therefore insulating. Any electrically insulating material in which an external electrical field (e. g. between the plates in a capacitor) builds up an opposing field is referred to as dielectric. A dielectric causes a static electrical field to be retained even without a continuous supply of electric charge.

**Dielectric constant (DC)**

A material constant for a dielectric. The dielectric constant specifies how many times greater the capacitance of the capacitor will be if the insulating material is used as the dielectric instead of air. Multiplying the DC of the empty space by the dielectric constant gives the DC of the dielectric.

**Diffusion**

The primary cause of attenuation in a light waveguide. It is the result of microscopic fluctuations in the density of the glass, which deflect part of the

guided light sufficiently from its course that it actually leaves the light waveguide. With light wavelengths above 1600 nm, this effect is very weak, however it increases at short wavelengths by the wavelength to the power of four (Rayleigh dispersion).

**Digital signal transmission**

Transmission of a signal using binary light pulses in a period time pattern.

**Dimension**

A term for the geometric size of a wire or strand, expressed as a diameter or cross-section. Often used in conjunction with the number of cores, e. g. 18 x 1.5 $mm^2$.

**DIN**

Abbreviation for Deutsches Institute für Normung [German Standardisation Institution]. It is based in Berlin, Germany.

**DIN EN**

European standard added to the German body of standards.

**Direct line, connecting cable**

A connecting cable is a cable that has a coupling connector through which the network connection is established. The fixed connection is found inside the





device. The device is portable. The coupling connector contains earthed contacts and is thermoplastically moulded to the cable. Connecting cables are, for example, used to connect portable telephones.

**Dispersion**

Dispersion of the signal running time in a light waveguide. It is made up of various components: mode dispersion, material dispersion and waveguide dispersion. As a result of its dispersion, a light waveguide acts as a low-pass filter for the signals to be transmitted (see → Transmission function).

**DKE**

Abbreviation for Deutsche Kommission Elektrotechnik und Elektronik Informationstechnik [German Electrical Engineering, Electronics and Information Technology] in DIN und VDE. It is a branch of the DIN and its agency the VDE (Electrical Engineering, Electronics and Information Technology Federation). As a national organisation for formulating standards in electrical engineering and information

technology, the DKE deals with important interdisciplinary issues such as safety, EMC, components and performance of conventional electric circuits, mobile wireless communication, software and Internet protocols. DKE is the German member of the European and global standardisation organisations. The DKE implements and publishes the results of standardisation work by the → IEC, → CELENEC and → ETSI in national standards.

**Drag chain cables**

Drag chain cables are cables used in power chains (e. g. ÖLFLEX® FD, ÖLFLEX® SERVO FD, UNITRONIC® FD plus at Lapp).

**Drain wire**

Single- or multi-wire non-insulated conductor that is run in close metallic contact under a screening.

**Ductility, flexibility**

As all cables and cores are liable to mechanical stress, they are also checked for flexibility, i. e. bent several times around various bending radii. There may be no visible damage to the cables, sheaths, inner or outer protective covers after testing. All stranded elements, braidings and wrappings must also remain correctly in place. In addition to the diameter of the strand assembly and the number of elements to be stranded, the length of lay plays a significant role in the flexibility of a cable. Based on the following principle: The shorter the length of lay, the more flexible the strand assembly.

**Dummy**

If there are “openings” detected in the cable, dummy elements or dummy cores are inserted and stranded together with the cable assembly. Dummy elements are generally made from cheap, inferior materials such as polyethylene twine, spun rayon and cotton. They are usually the same size as the real stranding elements.

**Duplex operation**

Transmission of two independent signals over a particular distance.

**Duroplastic**

In contrast to thermoplastics, after heating duroplastics cannot be deformed by heating them again. Duroplastics are required in the cable industry, e. g. as cable fittings or connectors.

**Earth connection**

Earthing of a point of the circuit, such as the neutral point, neutral conductor, midpoint or outer conductor.

**Earth electrocode, ground system**

Conductor that provides a conductive connection to earth. For example, it can be embedded in the ground or have a large area in contact with the ground.

**Earthing**

Earthing guarantees a clear reference potential for screening the active and passive components of a network.

**ECAD**

The ECAD component standard is a manufacturer-independent standard for describing item and engineering data in electrical engineering, specifically for machine and equipment manufacture.





**EIA**

Abbreviation for Electronic Industries Associations.

**Elastomere**

Elastomers are widely used for sheathing and insulating cables because of their excellent electrical and mechanical properties. Elastomers are high-molecular materials, whose elasticity depends on the degree of cross-linking. The biggest difference between elastic and plastic materials lies in loading and relief. After relief, an elastic material reverts to its original shape.

**Electric circuits**

In a cable, circuits with different voltages can be operated if they are insulated for the maximum voltage that occurs – VDE 0113 Part 1 and VDE 0100 Part 520.

**Electric diameter of conductors**

Determined on cables by electrical resistance measurements.

**Electric Field**

When voltages are applied to cables, electrical fields are formed, which can take on different shapes depending on the cable construction. In the low voltage

range, up to approx. 1 kV, electrical fields have only a negligible influence on the dimensions of the insulating walls. To guarantee operational safety, there are high demands on the materials and dimensions in the high voltage range. An electrical field is represented by field lines. The density of these field lines indicates the force that exists between the two points on a field line (voltage).

**Electric resistance** Resistance with which an electric circuit opposes the passage of the current. Resistance is specified and measured in Ohms.

**Electricity** Form of energy based on the flow of free electrons. Electricity is produced in generators.

**Electromagnetic protection** Protection against faults that could affect the cable from outside (immisions). Protection against faults caused by the cable (emissions). Braid, e. g. copper (tin plated) → flexible → coverage. Protection against external influences: mechanical,





e. g. cables over edges; stepping on; pulling of cables; chemical: e. g. oils; thermal: heat, cold.

**Element** Individual component of cables, a collective term for cores, pairs, bundles and carrier organs.

**Elongation at break, ultimate elongation** Elongation at break is the ratio of the elongation to the initial length when a break occurs.

**Elongation, extension, stretch** Extension of a body by mechanical forces. In the cable industry, it is tested using a mechanical testing method to determine the tensile strength of all components.

**ELOT** Hellenic Organization for Standardization. Certification body for Greece.

**EMC** Abbreviation for Electromagnetic Compatibility. The ability of a system, machine or item of equipment to work satisfactorily in the electromagnetic environment without itself causing any electromagnetic interference

that would be unacceptable for all systems, machines or equipment in that environment.

**EMK** Abbreviation for electromotive force.

**EMS** Abbreviation for Electromagnetic Susceptibility. This is the functional resistance of a specific object to electromagnetic interference factors.

**EN** Abbreviation for European Standards.

**EPDM** Abbreviation for Ethylene Propylene Dien Monomer rubber. Chemically cross-linked elastomer with good electrical insulating properties and outstanding flexibility at low and high temperatures.

**EPIC®** Abbreviation for Environmental Protected Industrial Connector. Registered trademark, a robust industrial connector from Contact.





**ePLAN®** ePLAN® is the leading CAE software for planning electrical designs and documentation in machine and plant construction. The Lapp item data and the cable type file enable the individual cores in the ePLAN® circuit diagram to be assigned automatically. ePLAN® is produced by ePLAN® Software & Service GmbH & Co.KG.
See www.eplan.de

**EPR** Abbreviation for Ethylene Propylene Rubber.

**Ethylene-Propylene-Rubber** See → EPDM

**ETSI** Abbreviation for European Telecommunication Standards Institute. Its duties include developing harmonised standards for an integrated European communication system.

**Explosive atmospheres** See VDE 0165 Part 1. Cables with a thermoplastic, duroplastic or mineral insulated metal sheath can be used for fixed rou-

ting. There may not be any cavities in the core bundle (not hose cable). The extruded embedding material and the fillers, if used (press extruded), must be "non-hygroscopic". Flame retardant in compliance with IEC 60332-1. Cables for mobile and transportable equipment must have connecting cables with an outer sheath made of heavy-duty polychloroprene or an equivalent synthetic elastomer or a heavy-duty rubber insulated cable or connecting cables with a comparably robust construction.

**Extension cord**

A mobile cable assembled with a coupling connector and socket. The couplings are integrally moulded onto the cable using thermoplastics and contain protective contacts.

**Extrusion line**

It is powered by a motor and coils through a cylinder in a spiral. The filler is made up of thermoplastic prepared in the form of granules. Granules, i. e. a free-flowing mixture of





grains of equal size, are the delivery form of various plastics for cable manufacture; in other words, an extruder is a system in which a continuous supply of granules is heated, compressed, mixed and homogenised.

**Farad**

Unit of measurement for electrical capacitance.

**FDDI**

Abbreviation for Fibre Distributed Data Interface. Network type made up of a double ring with a 100 Mbit/s transmission rate and using waveguides as the transmission medium.

**Fibre cover**

Made up of one or more materials and is used to mechanically insulate the fibres and to protect them against damage.

**Fieldbus technology**

Sensors and actuators are conventionally connected to a controller or evaluation unit using an analogue 4 – 20 mA signal. With this technology, a 2-core cable is necessary for each connection between the sensor or actuator and the controller. In

addition, an input/output circuit (I/O) must be provided for each sensor and actuator in the controller (normally a PLC or PC). The picture looks very different when using a field bus system. In this case, all devices are connected to a bus cable (2, 4 or 5 cores depending on the field bus system). An interface card is used instead of the input/output circuits. This saves on I/O cards, reduces the space required in the control cabinet and permanently cuts the wiring costs. In conventional systems, information (e. g. measured values or a fault signal) can only be transmitted in one direction and in very limited amounts. This can be from the sensor to the controller or from the controller to the actuator. By contrast, in a field bus system information can be exchanged bidirectionally via the digital bus. As well as the actual process data such as measured values (e. g. temperature) and control variables (e. g. speed), parameters such as the measuring range, measuring





point codes (TAG), filter properties, maintenance or fault signals etc. can be transmitted. The advantages that this brings are obvious. Commissioning and maintenance are simplified and the flexibility of the system (e. g. with central measuring range selection) is improved. This normally also enables cost benefits to be achieved compared to conventional solutions.

**Filler**

Used as a component of insulating and sheathing compounds. The fillers in rubber compounds, for example, mesh directly into the rubber molecules and give them good mechanical abrasion resistance. Important fillers include siliceous chalk, soot and aluminium oxide.

**Filler wire**

Usually a tin-coated copper wire which should have contact with the aluminium layer of the screen along the entire cable length. In order to ensure the filler wire doesn‘t break when the cable bends, it must lie very loosely (undulating) on the cable

core. The filler wire should be able to pass over any possible breaks in the screen.

**Filler, valley sealer** Filler or support element in individual stranding layers in cables.

**Fire behavior** Property which describes the behaviour of the cable when on fire (in particular, fire propagation).

**Fire resistant** Property of materials used for insulation and sheathing that are slow to catch fire when exposed to heat and are self-extinguishing when the heat source is removed (→ hard to inflame).

**Flame retardant** Thermoplastic and elastomer compounds for insulation and sheathing are influenced by additives so that they are slow to catch fire when heat acts on them.

**Flat cable** Ribbon cable in which the individual strands are welded together to form a ribbon (often





with multiple colours) and normally with small cross-sections (0.08, 0.14 or 0.25). The individual cores can normally be separated. Application: In electronics, for connecting circuit boards.

**Flat type cable** Several individually insulated conductors in parallel with a sheath for mechanical protection, produced in such a way as to give a rectangular cable cross-section. Used in crane systems (ÖLFLEX® – Crane F).

**Flexibility** A product (relating to cables in this case) is flexible if it can be moved around without impairing its functionality (e. g. lift cable or robot cable).

**Fluorethylenpropylen (FEP)** Product from the TEFLON® series. A plastic for high temperatures, with excellent chemical resistance and excellent electrical properties but not economical. TEFLON® is a registered trademark of the company Du Pont de Nemours.

**Foil**

Plastic foil, metal foil and metal clad plastic foil are used for different purposes. Plastic foil provides mechanical protection, e. g. as padding under a screening braid or around the cores below when stripping to protect against incisions. Metal foil is used for electrical screening.

**Frequency**

Number of changes of polarity in an alternating current per second; the unit of measure is Hertz (Hz).

**FTP**

Abbreviation for Foil Shielded Twisted Pairs; in these cables the twisted pairs of cores are screened by a common plastic clad aluminium foil.

**Full duplex**

Full duplex transmission allows simultaneous transmission and reception of signals.

**GAEB**

Abbreviation for “Gemeinsamer Ausschuss Elektronik im Bauwesen” [Joint Committee for Electronics in Construction] and describes the data format in





which engineering and planning offices create specifications and tenders for industry, infrastructure and building services projects.
Lapp tender texts in the common formats GAEB 90 (*.d81) and GAEB 2000 (*.p81) are available for download from www.lappkabel.de.

**General cable tie**

General cable ties are coloured or transparent fixing elements (normally made of nylon) that can be used to secure individual wires or cables in a bundle. The teeth on the inside provide a permanent connection.

**Glass fibre cable**

Used to transmit data. They use light as the transmission medium rather than electric current. Dielectric waveguide, used to transmit signals using light waves. Also known as a fibre.

**GOST**

Standards institute in Russia (comparable with the VDE in Germany, British Standards in the UK, IMQ in Italy and UTE in France)

**Gradient fibre** Light waveguide with a gradient profile, i. e. with a → refraction index profile that constantly changes across the cross-sectional area of the light waveguide. The profile of standard gradient fibres can be approximated as 1 < g < 3 by an exponent profile.

**Grid** The exact spacing between the conductors in a ribbon cable.

**Gusset** Cavities that inevitably occur between the cores twisted into a strand due to their circular cross-section. When using sector-shaped conductors, practically no gussets occur.

**Halogen free** Refers to materials that do not contain any halogens such as chlorine (Cl), bromine (Br), iodine (I) or fluorine (F).

**HAR** Quality mark for a harmonised cable complying with CENELEC HD standards, issued only by HAR testing bodies, e. g. VDE, USE, BASEC, USE, SEV.





**Hardness** See → Shore

**Harmonizing key** → See Table T6.

**HD** Abbreviation for harmonisation document. In the EU, HDs have the status of a harmonised European standard (like ENs).

**Heat of combustion** The temperature or heat released when a cable is burned (see → Thermal load).

**Hertz** Unit of measure for the frequency of an alternating current (in Germany 50 Hz for mains cables).

**Hood** The upper section of the housing can have a straight or lateral cable outlet. The hood can be freely combined with an externally mounted, surface mounted or coupling housing.

**Hood termination** The insides of the end plates are coated with a thermoplastic adhesive. The end plates are used for sealing pressure

monitored, moisture-resistant cables and tubes with a diameter of 5 to 10 mm.

**Hybrid cable**

Cable with different transmission media, such as light waveguide, copper conductor, HF conductor.

**ICEA**

Abbreviation for Insulated Cable Engineers' Association. A subcommittee of NEMA – USA.

**IEC**

Abbreviation for International Electrotechnical Commission. Standards committee for international standardisation of electrical materials and international commission for standardisation in the electrical engineering and electronics sector.

**Imprinting**

Marking of cables using a relief imprint (no colour). This technique is only possible when the sheath is warm as the marking is impressed into the material positively or negatively.





**Industrial machinery for USA**

The following general rules apply to construction and operation of machinery in the USA: The machinery must comply with federal safety laws issued by the Occupational Safety and Health Administration (O.S.H.A.: www.osha.gov) and the applicable national codes (statutory regulations) at the installation location. Machinery is only classed as safe if it has been designed and manufactured in compliance with applicable standards (NFPA 70, NFPA 79....) and its safety has been tested and declared safe by a Nationally Recognized Testing Laboratory (N.R.T.L., www.osha.gov/dts/otpca/nrtl/).

**Insertion loss, insertion attenuation**

Attenuation caused by inserting an optical component into an optical transmission system.
The attenuation that is caused in an optical transmission system by inserting an optical component, e. g. a plug or a → coupler.

**Insulation**

Preventing the passage of electrical currents using non-conductive materials. Materials are non-conductive (suitable for use as insulators) if they do not contain conduction electrons or only isolated electrons. These materials include various plastics, rubber, ceramic, porcelain, glass, paper, resin. (Insulation in capacitors and radio frequency cables is referred to as → dielectric).

**Insulation resistance**

The electrical resistance of a non-metallic material between two electrodes, measured using a DC voltage.

**Intensity**

Power density at a surface through which radiation penetrates, e. g. at the radiating surface of a light source or at the cross-sectional area of a light waveguide (standard unit $W/cm^2$).

**Interactive**

Property of two systems to influence one another in order to exchange messages.





**Interbus**

At the lowest level of the automation hierarchy model, there are particular requirements for a communication system. Connection costs, real time capability and short cycle times are of crucial importance. The data to be transmitted, normally measured and control values, are typically only a few bits in length. INTERBUS-S, standardised in DIN E 19258, has a summation frame protocol and is designed specifically to meet these requirements. With a clock speed of 500 Kbit/s and a net data rate of approx. 50%, even time-critical controllers can be implemented using a bus system. With around 1,000,000 INTERBUS-S nodes in use worldwide, the system is one of the leading field bus systems. In some areas, e. g. networking of frequency converters and drive technology, it is actually the market leader.

**Interface**

Connecting point in a technical system that has particular properties enabling connection to another technical system.

**Internet**
Worldwide virtual data network.

**Intrinsically safe**
Electrical installation that is, in its own right, safe from the point of view of risk of explosion, i. e. no ignitable sparks can occur in the installation. All parts, including the cables, should be blue (RAL 5015) – e. g. at Lapp ÖLFLEX® EB, ÖLFLEX® EB CY, UNITRONIC® EB CY).

**IP Code**
A system of designations used to indicate the degree of protection provided by a housing against access to hazardous components, ingress of solid foreign bodies and/or water and to provide additional information relating to this protection (e. g. EN 602529).

**ISDN**
Abbreviation for Integrated Services Digital Network. Integrated service digital telecommunications network. Suitable for transmission of voice, text, images and data.





**ISO**
Abbreviation for International Organisation for Standardisation. Committee that develops internationally recognised standards.

**Joint**
Interconnection point between (data) transmission paths.

**Kink**
The cable has been forcefully bend over a sharp edge, causing plastic deformation of the individual strands and wires. This results in grooves that promote breakages on the individual wires.

**kV**
Abbreviation for Kilovolts. 1 kilovolt equals 1,000 Volts.

**LAN**
Abbreviation for Local Area Network. Physically limited network used for communication within a building or company.

**Laser-printer, ink-jet printer**
With this method, small production batches can be printed at low cost as there is no need for a print wheel to be made.

The downside, however, is that it produces a print result of lesser quality.

**Laying temperature**

When installed, the cable temperature should not be below +3 °C. Cables with sheathing and insulation are sensitive to bending and impacts when exposed to cold.

**Leading protective ground**

The PE contact in a plug establishes the first contact and is the last to disconnect, and is marked as the protective earth symbol.

**Leakage current**

Leakage current is the current that flows via the functional insulation of a consumable to earth or an external conductive part. It can appear as a pure active current or as an active current with a capacitive value. In VDE 0700-1 “Household and Similar Electrical Appliances – Safety”, the following leakage currents are specified:

- For devices of protection class 0 and 0I 0.5 mA
- For portable devices of protection class I 0.75 mA
- For non-portable motorised equipment of protection class I 3.5 mA
- For non-portable heating equipment of protection class I 0.75 mA or 0.75 mA/kW, max. 5 mA
- For devices of protection class II 0.25 mA
- For devices of protection class III 0.5 mA

When taking leakage currents for an entire system (also important for residual current protective equipment) into consideration, both the leakage current (residual current) of the cables and the leakage current of the consumable must be accounted for.

**Length of lay, length of twist**

The twist length is the distance (measured in the direction of the longitudinal axis) covered by the elements of a layer after being twisted by 360°, e. g. 40 mm. It is usual to specify the number of twists per metre, e. g. 40 mm = 25 twists.

**Lever series**

To lock the EPIC® rectangular connector, there are single or central levers available for the one-handed locking of upper and lower housing sections, the double levers are used for the two-hand locking.

**Li2YCY**

Polyethylene screened individual cores.

**Li5YCY**

TEFLON® PTFE screened individual cores. TEFLON® is a brand name of the company DuPont de Nemours.

**Lift cable**

Lift cables are control cables with strain relief used for lifts, gantry cranes, teach pads, etc. (e. g. ÖLFLEX® LIFT, ÖLFLEX® CRANE at Lapp).

**Link**

A link represents a complete section of cabling from the floor distribution board to the data terminal input. It includes all connecting sockets and plugs, installation cables and patch cables. The quality of a link is defined using classes, the quality of the individual components using categories.





**LiY**

Individual cores (strand) predominantly 0.14 and 0.25 $mm^2$ LiYv: Tin plated individual cores (strand).

**LiYCY**

Individual cores with copper screening (C stands for copper).

**LiYY**

Multi-core stranded cable (ÖLFLEX®, UNITRONIC®).

**Longitudinal water tightness**

Achieved by filling the gaps between the core arrangements with various kinds of filler (e. g. petroleum jelly filling).

**Loss factor**

The loss factor depends on frequency, temperature and capacitance. This factor is the ratio of effective power to idle power with a sinusoid voltage.

**Machine set-up for core insulation – Extrusion**

The following single units have mainly conventional extrusion lines for core and insulating covers: Overend take-off, wire straightener, wire pre-heater, capacitance bridge, extruder, embossing or marking device, cooling section, eccentr-

icity measuring device, diameter scanner, high-voltage testing device, double roller haul-off machine, accumulator and double bobbin winder.

**Master** Central bus subscriber that controls bus access. All other subscribers operate as slaves (see → ASI).

**Master-Slave principle** The master element issues instructions and the slave elements follow them. With decentralised bus control, for example, an automation device acts as the master element and issues access rights for the other components (slave elements – see → ASI).

**Material dispersion** With a non-monochromatic light source, the dispersion that results from the dependency of a material's refraction index n on the wavelength and from the light velocity in that material.





**Mica powder** Natural mineral product that is pulverised and used as a separating agent and lubricant either on its own or mixed with talcum. In the form of foils and strips, mica is also used for insulating conductors exposed to high thermal loads.

**Microbending** Bending of fibres that have local axial deviations of a few micrometers and physical wavelengths of a few millimetres, for example. Microbending causes light losses and thus increases the → attenuation of the fibres.

**Mode** Discrete light wave forms that can propagate in a light waveguide.

**Mode dispersion** The signal distortion in a light waveguide caused by overlapping modes with different running times.

**Modem** Device for adapting digitally operating data stations for analogue telecommunications channels.

**Modulation**

A network signal to be transmitted is modified by a carrier signal.

**Monomode fibre**

Light waveguide with small → core diameter in which only one mode, the basic mode, can be propagated. This fibre type is particularly suitable for broadband transmission over long distances as its → transmission bandwidth is only limited by → chromatic dispersion.

**Motor cable**

Motor cables are supply cables for electric motors (e. g. ÖLFLEX® SERVO FD at Lapp).

**Multimode fibre**

Light waveguide whose core diameter is large compared to the light wavelength and in which a large number of modes can therefore be propagated. A gradient profile (→ gradient fibre) allows the → mode dispersion to be kept low, allowing large transmission bandwidths to be achieved, although these can be exceeded using → monomode fibres.





**Mutual capacity, operating capacity**

For four, pair or phantom cable circuits: the capacity between the cores a and b of these cable circuits. With one core: the capacity between a conductor and all remaining interconnected conductors of a cable.

**Nanosecond**

Billionth of a second. Time unit for the internal switching speed of computers.

**Near-end crosstalk, far end crosstalk**

In multi-pair data cables, the field effect of the signal transmission for one pair induces an interference signal in adjacent pairs. Crosstalk does not depend on the length and is greater as the frequency increases. The difference between the effective signal and the interference signal measurable at the adjacent pair is referred to as crosstalk attenuation and is specified in dB. We differentiate between: NEXT (Near End Crosstalk) and FEXT (Far End Crosstalk).

**NEC**

Abbreviation for National Electrical Code. Group of standards for the safety of electrical equip-

ment, e. g. electrical equipment installations in the low voltage range up to 600 V – USA.

**NEMA**

Abbreviation for National Electrical Manufacturers' Association. The NEMA works in conjunction with the IECA to produce and promote standards for cables – Washington D.C., USA.

**NEMCO**

Norwegian testing body, similar to the VDE in Germany.

**Neoprene®**

Trade name of the company DuPont de Nemours for synthetic chloroprene rubber.

**Network**

Cable network used to create connections between data stations.

**Neutral conductor**

Neutral conductors, where used, may not have a smaller cross-section than the outer conductor, see VDE 0100 Part 520, Section 524.2.

**NFPA**

Abbreviation for National Fire Protection Association. Issuer of NFPA standards and NEC – USA.





**NFPA 79**

NFPA 79 is the section of the National Electric Code (NEC®) which includes the requirements for electrical wiring of industrial machinery. NFPA 79 generally applies to electrical components used in individual machines and machine configurations operating together (machine groups). The National Fire Protection Association (www.nfpa.org) is the issuer of this important standard. NFPA 79 applies to all electrical and electronic components in machinery with a maximum nominal voltage of 600 V. NFPA 79 was revised in 2006. The aim of this revision was to harmonise NFPA 79 with its European counterpart IEC/EN 60204.

**Nominal voltage**

The nominal voltage is the voltage to which the structure of the cable relates in terms of its electrical properties. The nominal voltage is expressed by specifying two AC voltages U0/U in V : U0 = Effective value between an outer conductor and earth (non-insulating environment). U =

Effective value between two outer conductors in a multi-core cable or a system of single-core cables.

**Norms**

The German Federal Supreme Court gave the following statement on engineering rules on 14.05.1998: Recognised engineering rules are those that are recognised as correct by the theory and have demonstrated their effectiveness in practice. By contrast, according to the BGH DIN standards are only private engineering regulations with the nature of recommendations, which do reflect the recognised engineering rules but lag behind them or could actually be incorrect.

**Numeral identification**

See → Colour codes/Numerical identification

**Numerical aperture**

Sine of the maximum possible launch angle of a light waveguide.

**NYM**

These cables (standard cable for fixed installation) are designed for installation above, on and





below ground, in dry, damp and wet areas and within walls and concrete, except for direct embedding in shaken, vibrated or compressed concrete.

**Ohmic resistance**

The resistance per unit length records the losses in the metallic conductors. The conductor dimensions, material and the temperature determine the DC resistance Ro'. Because of skin effect, the conductor resistance increases as the frequency rises. It also shows a linear increase as the cable length increases.

**ÖNORM-Format**

Austrian format for invitations to tender.

**Operating supplies**

All objects needed when using electrical energy, e. g. switch, motors and cables.

**Operating temperature range**

The range between the lower (lowest permissible temperature) and upper (highest permissible temperature) limit temperature that may be utilised by the operator.

**Operating voltage**
The actual voltage in a grid. This can fluctuate by up to 5%, caused by the alternating use of consumers.

**Opposite direction of lay**
See → Stranding

**Order length**
The length of cable ordered by the customer.

**OTDR**
Measuring method for testing glass fibres for faults or transmission quality. OTDR stands for Optical Time Domain Reflectometer.

**Outdoor cable**
Cables suitable for outdoor laying in the ground, in pipes, in the air, in rivers and lakes, in mines, on ships, for interior spaces or the most varied of industrial plants, etc. The design of the cable depends on the electrical, thermal, mechanical and chemical laying and operating conditions.

**Outer conductor**
Conductors that connect current sources with consumables. For example, C1, C2 or C3 in a three-phase system but not conductors come from the midpoint or neutral point. The conductor is arranged concentrically around the inner conductor of a coaxial pair.

**Outer diameter**
Diameter of the smallest circle that will enclose the surface of the sheath.

**Outer sheath**
Enclosed cover for protection of the elements underneath.

**Outer sheath**
On the one hand, refers to the outer covering of a cable. On the other hand, it is the entire optically transparent material in a light waveguide, excluding the core.

**Overcurrent**
If the permitted ampacity is exceeded, this is referred to as overcurrent.

**Overcurrent protection devices**
Overcurrent protection devices break the current supply in case of overcurrent. They include overcurrent protective switches and safety fuses.

**Oxygen index**

Percentage oxygen content in the ambient air that is necessary to maintain combustion after removal of a flame. As the natural oxygen content in the air is approx. 23%, materials with an oxygen index of greater than 24 are generally self-extinguishing when the flame is removed. This term comes up primarily in connection with halogen free cables.

**Pad**

Non-conductive element made of insulating material (PVC) or textile, used to fill up gaps in a strand group. Also known as a dummy core.

**Pair**

Two stranded → cores within a larger strand group (see → Element). The inductive coupling of two parallel conductors is reduced by twisting the two cores together as tightly as possible (→ twist length).

**Panel mount base**

Panel mount bases are designed for the feeding through of cables from below. The panel mount base is mounted to control cabinet walls for connecting control or power cables.





**Patch cable**

Patch cable complying with EN 50173/ISO IEC 11801 is used to provide a flexible connection between ports in patch fields and the connection to telecommunication sockets.

**Patch field**

A patch field is the switching device that is used to set up, establish and route connections.

**PE**

Abbreviation for polyethylene.

**Photodiode**

Semiconductor diode that absorbs light and feeds the charged particles released to an external circuit as a photoelectric current. A distinction is made between PIN photodiodes and avalanche photodiodes.

**Photovoltaic**

Photovoltaics refers to the direct conversion of solar energy into electrical energy using solar cells. Photovoltaics is a branch of solar technology, which includes other technical uses of solar energy.

**Pigtail**

Short part of a fibre optic cable on a laser diode or connector. The pigtail is the coupling link between a component and transmission fibre and is permanently fixed to the component.

**PiMF**

Abbreviation for pairs in metal foil.

**Pollution level**

Numerical value specifying the anticipated pollution of the micro-environment. Pollution levels 1, 2 and 3 are used. The pollution level is used to assign air gaps and creep distances. In industrial environments, the pollution level is typically 3.

**Polyamide**

Polyamide is a polymer. Polyamide is cold resistant with impact loads, impact resistant and abrasion resistant.

**Polycarbonate**

The prerequisite for resistance is that no aggressive components such as emollients (PVC) or solvents attach the polycarbonate. The material swells up, which can lead to stress cracks.





**Polychloroprene-rubber**

Synthetic rubber is resistant to solvents, has very good strength properties and is flame resistant, however very expensive (high-quality rubber cables, Pattex glue).

**Polyethylene**

Polyethylene is a halogen-free plastic, but is highly flammable. By adding additional materials, PE can be made flame retardant and smokeless.

**Polyuretane**

Extremely impact resistant, difficult to strip, strong reset forces. (PUR, 11Y, Q ).

**Polyvinylchloride**

Polyvinylchloride is a halogenated plastic. The halogens are chlorine, bromine, fluorine, iodine and astatine. Chlorine and fluorine are used to make plastics flame retardant and more resistant to external influences. Cables with PVC sheathing are flame retardant. Halogenated plastics produce highly toxic gases when they burn, which form aggressive acids when they mix with extinguishing water and can, in turn, cause extremely severe corrosion damage.

**Power dissipation factor** Power that is converted into heat or other energy losses.

**Preform** Glass rod from which the glass fibres for light waveguides are drawn. When drawing the glass fibres, the ratio of core glass to shell glass is maintained.

**Print wheel** This procedure is generally only a cost-effective option for average or large batches as a new print wheel is required for every change made to the print. Print wheels can, however, be used for geometrical logos and inverse printing. Print wheel results are also relatively easy to remove and wipe away.

**Profibus** The Profibus network is based on the principle of master-slave communication. A central controller – the field bus master – cyclically reads the information from the field devices – the field bus slaves – and writes their output values. In a Profibus DP network, a high-speed transmission rate of up to 12 Mbit/s is possible. It is based on the European standard EN 50170.





**Protective conductor** (Symbol PE) A conductor that is necessary for certain protective measures against shock currents to create the electrical connection to subsequent parts. The protective conductor is marked in green/yellow (GNYE) in cables.

**PTFE** Abbreviation for polytetrafluoroethylene, TEFLON® plastic (PTFE); a trade name of the company Du Pont de Nemours.

**PUR** Abbreviation for polyurethane; a ductile, abrasion resistant thermoplastic alternative to rubber, e. g. in ÖLFLEX® 400P, ÖLFLEX® 540P.

**PVC** Abbreviation for polyvinylchloride.

**PVC-powder additive** Additives are added to PVC mixtures as matting agents, lubricants, colour pigments, wax for smooth surfaces.

**Quad** Stranding type in which the four individual cores are twisted into a quad (telecommunications cables).

**RAL**

The RAL colours with four-digit numbers have been a yardstick in colouring for more than 70 years. The collection of colours currently includes more than 200 colours. The basic collection for mat shades is the RAL 840-HR register. The collection for gloss shades is the RAL 841-GL register. The basic collections are continuously updated in line with the requirements of industry. These collections cover a wide range of applications. The registers provide a colour template for designs, but also include safety and signal colours and comply with the colour specifications in DIN standards.

**Rated current**

Current determined by the manufacturer, primarily at an ambient temperature of 40°C, which the connector can carry on a permanent basis and which simultaneously flows though all contacts which are connected to the largest possible conductor. In the process, not exceeding the upper limit temperature.





**Rated voltage**

Value of a voltage, measured according to the connector assembly and referring to specific operating conditions.

**REACH**

REACH directive (EC) No, 1907/2006 on registration, evaluation, authorisation and restriction of chemical substances With the REACH directive, the EU created a harmonised system for the registration, evaluation, authorisation and restriction of chemicals – referred to as REACH for short. The purpose of the directive is to ensure a high level of protection for human health and the environment.

**Receiver sensitivity**

The light output required by the receiver for low interference signal transmission. For digital signal transmission, the average light output (in W or dBm) required to achieve a bit error rate of 10 – 9 is normally specified.

**Receiver, optical**

Assembly for converting optical signals into electrical signals. It consists of a photodiode with a connecting fibre and plug and a low-noise amplifier and electronic signal processing circuits. Where possible, the main components of the receiver are normally combined into a compact sub-unit known as the reception module.

**Reel**

To keep setup times and transport costs down, the cable industry tries to supply large cables and long cable lengths on reels. In addition, this saves on connecting points and the associated fittings with longer cable lengths. The length supplied is limited by various factors, including the tensile strength and flexibility of the cable and the mass or cable volume. There are a large number of different reel sizes in the cable industry.





**Reel size choice**

Most winding systems in the cable industry now have tables showing the capacity and the product lengths and bending radii that can be wound, ensuring that the correct choice of reel can be made.

**Reel structure**

Reels consist of a circular core, which is bounded on both sides by flanges of larger diameter. The flange diameter is also the nominal size of the reel. Steel sockets are fitted in the centre of the reel flanges to hold the drive axes or barrels. These prevent damage to the reel flanges when winding and unwinding. On one reel flange (up to 1800 mm nominal size) there is a through hole for inserting one end of the cable; on larger reels, an inlet spiral is fitted to hold the end of the cable. This means that both ends of the wound length of cable are accessible and final inspection of the cable length can be carried out. Shipping reels are normally made of pine or spruce wood.

**Reeling**

This refers to the ability of cables to withstand constant winding and unwinding over a long period of time without sustaining damage. For mobile consumers (e. g. a crane), the cable length required for the different working positions is carried on a reel. Constant winding and unwinding makes high demands on the cable construction, which means that only special cables are suitable.

**Reference earth**

Part of earth considered as conductive that lies outside the zone of influence of any earthing arrangement.

**Reflexion**

Signal reflections occur at coupling points between components such as plugs and cables and, in copper networks, can be attributed to different characteristic impedances: In cases of extreme differences in characteristic impedance, this leads to signal distortion.





**Refractive index**

The factor n, by which the light velocity in an optically dense medium (e. g. glass) is smaller than in free space. More accurate term: Phase refraction index.

**Refractive index distribution, index profile**

Progression of the refractive index n across the cross-sectional area of a fibre optic cable.

**Resistance**

Resistance = Voltage/Current: “Obstruction” of the current flow, expressed in Ohm. The lower the cross-section, the greater the resistance. The more Ohms, the weaker the current flow.
See also → Corrosion resistance, ozone resistance, radiation-resistant cables.

**Resistant**

The cable has a resistance to certain substances, i. e. they do not destroy it.

**Retention of cable glands**

The ability of a cable gland to limit the movement of a secured cable under static load.

**RFID**

RFID stands for Radio Frequency Identification and means that data can be transmitted with no contact or line of sight.

**RJ45**

An RJ45 connection is an eight-pin miniature connector system, e. g. for patch cables. The connector is standardised to comply with the ISO/IEC 11801 cabling standard.

**RoHS**

The EC directive 2002/95/EC for limiting the use of certain hazardous substances in electrical and electronic equipment governs the use of hazardous substances in equipment and components. Along with the applicable implementation in national law are referred to by the abbreviation RoHS (Restriction of (the use of certain) hazardous substances ).

**Route warning tape**

In excavations, the greatest damage occurs on cables already laid in the ground. For this reason, route warning tapes are laid around 40 cm above the laid cables, which draws the attention of excavator drivers to the cable route when excavating.





**Rubber insulated cable**

Cable with rubber sheathing. For example, H05 RR/RN, H07 RR/RN at Lapp (previously: NMHöu/NSHöu).

**S-FTP**

The structure of shielded foil and braid twisted pair (S-FTP) cables is made up of a foil screen over all pairs, over which an additional screen of tin plated copper braiding is placed.

**Same direction of lay**

See → Stranding

**Sample test, screening**

Testing of production lengths or production parts in relation to production quantity.

**Screened cable**

Cables with screen in outer layer, over the cores or in double sheath. The screen can be made from braiding, foil or solid metal. With the foil version, a drain wire from the filler strand is used. Identified with a “C”, and with “CY” for additional PVC sheathing if copper braiding used.

**Self-extinguishing** Property of a (synthetic) material to extinguish itself when a flame is removed from the material.

**SEMCO** Swedish testing body, similar to the VDE.

**Semi-conductor** Materials whose electrical conductivity depends on various influences, e. g. current direction, temperature, incidence of light. By mixing with conductive materials (carbon, graphite), insulating materials (PVC) can be modified to give semiconductor properties.

**Semiconductor bandgap** Energetic distance between the valence band and the conduction band of a semiconductor.

**Separating layer** Foils positioned between the individual layers on the cable core to prevent harmful influences.

**Separator** Polyethylene terephthalate foils are used in the cable industry as insulating foils. They have excellent dielectric and mechanical properties. They are used as





separating foils in PVC insulated cables.

**SEV** Abbreviation for Schweizerischer Elektrotechnischer Verein [Swiss Electrical Engineering Association], testing body similar to the VDE.

**Sheath print** The customer receives information about the printing of cable sheaths regarding design, testing- and operation-related markings, colour codes, customer-specific markings and manufacturer markings. The prints are created using laser and ink-jet printers or print wheels. They are, however, of inferior quality to the embossed letters as they wear away relatively quickly or can be rubbed off.

**Sheathed cable** Designation for NYM and other sheathed cables.

**Shielding** A cover made of conductive material that is placed over an individual core, a group of cores or all cores in a cable. Screening is used to protect the cable against penetration by electrical

and/or magnetic fields and to prevent electrical interference from escaping from a cable. Screening takes various forms: a copper wire braid or → covering, copper or aluminium foil wrapping or enclosed tubular copper or aluminium bodies. For the screening, the covering density is defined in percent, relative to the area located below the braiding.

**Shipping reels**

The correct choice of shipping reel is a crucial factor in the quality of a cable from winding to installation. The reel size and thus the winding volume is determined by the diameter and length of the material to be wound and the mass of the cable. The delivery agreement between the manufacturer and the customer is determined by the diameter and mass from the production design and the product length. It is critical that the bending radius of the cable, which determines the size of the reel core, is maintained.





**Shore**

Hardness of the cable sheath. The definition is: The resistance to penetration by another body, which is measured without exception before the occurrence of damage. Shore A test is used for soft plastics, Shore D test for harder plastics.

**SIA**

Swiss format for invitations to tender.

**Signal cable**

Signal cables are used to control the accuracy and precision of electric motors. (For example, ÖLFLEX® connecting and control cables, ÖLFLEX® SERVO, UNITRONIC® data cables at Lapp).

**Single conductor**

Conductor which, unlike a strand, consists of just a single wire. A rigid wire is suitable for fixed installation.

**Single wire**

See → Cable, single-wire.

**Single-mode fibre**

Waveguide in which only a single mode can be propagated at the operating wavelength.

**Single–wired conductor** A single-wire conductor consists of just one wire.

**Skin effect** The higher the frequency of the effective or interference signal, the more the high frequency current is pushed towards the surface. The skin effect is the property of an alternating or high frequency current in a conductor to move towards the surface due to field line induction processes. This limits the penetration depth of an external electromagnetic field into the object and thus its effectiveness inside.

**Slave** Subscriber in a network that can only communicate in data exchange when addressed by the master (see → ASI).

**SNA** Abbreviation for System Network Architecture. Network architecture concept that enables data to be transmitted between different types of computer.

**Specific volume resistance** The specific volume resistance [Ohm m] results from the measured volume resistance [Ohm] multiplied by the measuring area [$m^2$] divided by the sample length [m]. VDE 0207, Part 4 and VDE 0303, Part 30.

**Speed of signal propagation** Signals propagate in all cables at a speed that is always lower than the speed of light. The NVP value specifies the ratio of this speed to the propagation speed of light.

**Spiral cable** Flexible cables that are formed into a “spiral spring”. The cable is wound onto a mandrel. The addition of heat (tempering) reduces the tensions in the plastic caused by the winding process, which means that the cable retains the spiral shape in a stress free condition after cooling. When expanded, the spiral extends and, when the force is no longer acting upon it, returns to its original condition.

**Splice** Connection of two light waveguides created by melting their ends.
Fixed connection between two light waveguides. A distinction is made between bonded and wel-

ded splices (→ Welded light waveguide connection).

**Stabiliser**

a) A component used in some plastics to obtain certain physical and chemical properties during processing and the usage time.
b) Additives (e. g. lead, tin or cadmium salts) for plastics. They delay or counteract the decomposition and aging process that occurs when exposed to thermal loads.

**Step index fibre**

Light waveguide with a stepped profile, i. e. with a refraction index profile that is characterised by a constant refraction index within the core and a sharp decline in the refraction index at the boundary of the core and the sheath.

**STP**

In twisted pair cables with foil screening of the individual pairs and an overall braided screening (STP = Individually Screened Foil





and Braid Twisted Pair), the cores are twisted in pairs and individually screened with a metallic foil, to achieve exceptionally low near end crosstalk. An additional overall screen is then added.

**Strain relief of cable glands**

The ability of a cable gland to limit the movement of a secured cable under a dynamic and torsional load.

**Strand**

The individual wires in a conductor combined into a bundle; the number and individual wire thickness varies according to the desired cross-section. The individual wires are either bundled by stranding or by twisting. Individual cores, e. g. LiY, H05V-K, H07V-K

**Stranding**

The individual elements of cables are wound parallel around a central element. The elements can be the individual wires in a conductor or the cores or groups

of cores themselves. Depending on requirements, the elements are twisted or stranded with different twist lengths. This is done in concentric layers, one on top of another, according to the number of elements. If the subsequent layer of the element is stranded in the same direction as the preceding layer, this is known as parallel lay stranding, as opposed to cross lay (reversed lay) stranding, where each subsequent layer is stranded in the opposite direction to the previous one. The stranding has an "S" lay if the stranding direction runs to the left as an observer looks at it, or a "Z" lay if the stranding runs to the right: A distinction is also made between stranding techniques with and without back twist.

**Stranding machine, twister**

Stranding machines are used to strand the components of a cable. Different types of stranding machines include single twist, double twist, multiple twist, high-speed, basket, SZ and universal stranding machines.





**Strip line**

Strip lines are used as fixed signal transmission cables in control and steering technology, measurement and data processing technology. They can contain up to 40 cores which lie parallel to each as a result of the welded insulating cover. Single cores can be separated from the strip line, without causing any damage to the insulating cover. Their flat arrangement means they can be guided through narrow slots or openings. They are fixed in place using brackets or adhesive.

**Styrol**

Is used as an insulating material for telecommunication cables (→ Dielectric). It has a good strength value, however is not resistant to solvents.

**Super conduction**

The property of metals and oxides to lose their electrical resistance due to cooling when a so-called transition temperature is reached.

**Supporting cable**

Because of their small dimensions, they are used for installation in small and miniature equipment.

**Supporting core**

Strands of hemp, steel or plastic are incorporated into the construction as supporting elements or to absorb tensile forces. In most cases, the carrier organ is positioned next to the core, i. e. in the middle of cables. However, there are also constructions in which one or two steel strands are positioned outside the bunch of cores but below a shared outer sheath.

**Surface mount base**

Lower housing sections with an enclosed base are referred to as surface-mounted. Surface mounted bases are available with a cable outlet on the right-hand side or on both sides of the housing.

**Synthetic india rubber**

Butyl synthetic rubber has a high resistance to ageing and lower gas permeability. It is highly resistant to chemicals.





**T-Coupler**

Optical component for combining the light from two light waveguides (see also → Coupler). Conversely, it can also be used to split the light output in one light waveguide into two outgoing light waveguides.

**Take-up system**

Sheathed cables are generally wrapped around wooden or process drums. The most common types of winding devices are bottom roller winders, axial winders and barrel winders. Depending on their flexural loading, tensile strain, torsional strain, design, storage, mechanical load and transport, cables are individually wrapped and delivered on drums, bobbins, in coils or barrels.

**Talcum**

Talcum is a mineral, slightly fatty natural product. It is used in powder form as a separating agent or lubricant. It is also used when mixed with mica. When sheathing a strand of cores, to prevent the sheathing material

that is applied when hot from sticking to the core insulation, the strand is dusted with talcum first. As well as the separating effect, this greatly reduces the friction between the individual elements of the cable and thus promotes flexibility and stripping.

**Tape**

The stranded assembly, comprising several cores, is surrounded by the tape. Generally, the tape is made from one or several synthetic or paper band layers.

**Tape wrapping**

Cables can be wrapped in a variety of different insulating materials. The tape is always helically wrapped around the cable as the taping machine operates in a rotary motion and the pull-off movement is always in a longitudinal direction.
Several layers of paper or plastic tape are wrapped around the cable stranding or the cable core.





**TDR**

The Time Domain Reflectometry measuring method is used to locate faults in copper cables. The running time and shape of a reflected pulse enables the possible location of the fault to be determined relatively accurately. For PVC insulated cores, this value is approx. 0.541.

**Telephone cord**

Cables to or in telecommunication devices which have a high flexural loading or flexibility.

**Temperature range**

If the specified minimum temperature range is not reached, no mechanical forces may act on the cable as otherwise the insulation will break (rigidity of polymer chains). If the maximum temperature is exceeded, the insulation begins to melt (decomposition of polymer chains). Important! With every change of temperature, the resistance of the conductor also changes.

**Tensile load**

The maximum force with which a cable can be loaded under defined conditions.

**Test voltage**

The voltage applied to a test specimen to demonstrate a particular electrical strength.

**Tex**

The fineness of fibres is determined using the “fineness in Tex” system. This is a physical variable. 1 Tex = a fibre that has a mass of 1g at a length of 1000 m. Example: Polyester silk has a rating of 7 Tex = 1000 m of silk weighs 7 g.

**Thermal splice**

A thermal splice is a connection between light waveguides created by fusing the ends of the conductors.

**Thermoplastics, thermoplastic materials**

Thermoplastics are non-cross linked macromolecular compounds. By heating, it is possible to transfer them repeatedly to a plastic condition. They are primarily used for sheathing and insulation of cables.





**Thomson measuring bridge for resistance measurement**

Primarily used to measure very low resistances. The measuring range is between 10-6 and one Ohm. It is independent of voltage changes. The measured result is not falsified by the resistance of the measuring lead and other transition resistances (see also → Electrical resistance).

**Tight buffer tube**

Fibre type used in light waveguides, with a solid plastic layer attached directly to the outer glass.

**Tin**

Tin is used for tin plating copper wires.

**Torsion**

Twisting of the cable about the longitudinal axis. VDE0298, Part 300, Section 5.4.4: Flexible cables are not generally intended for torsional loads. In cases where this kind of torsional load cannot be avoided, the construction of the cable and the type of installation must be agreed between the user and the cable manufacturer.

**Tracer thread**

A thread whose structure, colour or colour combination is registered and protected as a trademark by a cable manufacturer. It provides information about the manufacturer of the relevant cables (at Lapp, the colour is ochre yellow).

**Train signal cable**

Designed for voltages up to 600 V. Depending on their purpose, the cores are twisted in fours or layers. They are PE insulated. Because of the strong electromagnetic fields on railways, an effective copper screen and steel tape armouring must be fitted under the outer sheath.

**Transceiver**

This is the active component of an Ethernet LAN for connection of terminals to the electrical bus cable with collision detection and signal adaptation functions. Transceiver is a combination of the words transmitter and receiver. The transceiver performs transmitting, monitoring, reception and interference functions.





**Transfer impedance**

Measure for the quality of the screening, defined as the ratio of the voltage along the screening in the system subject to interference to the current of the system causing the interference.
The transfer impedance (coupling resistance) is the key variable for the quality of the screen and depends on the frequency. It is the ratio of the voltage drop along a screen on the side with interference (outside) to the interference current on the other side (inside) of the screen. The coupling resistance is determined by the construction of the screen, the skin effect and the capacitive coupling.

**Transfer rate**

The frequency at which the level of the transmission function of a light waveguide has reduced to half of its value at a frequency of zero, i. e. at which the signal attenuation has increased by 3 dB. As the transmission bandwidth of a light waveguide is approximately the reciprocal of its length (mode mixing), the

bandwidth/length product is often specified as a quality feature.

**Transmission function**

A light waveguide acts as a low-pass filter for the signals to be transmitted. While only continuous wave attenuation is important for low signal frequencies (see also → Attenuation), higher signal frequencies are also attenuated as a result of the dispersion in the light waveguide. The transmission function of a light waveguide makes this a complex issue; however the phase distortion is normally so low that it is sufficient to specify the figure for the function.

**Transmitter, optical**

Assembly for converting electrical signals into optical signals. It consists of a transmission diode with connecting fibre, plug and driver amplifier and other electronic circuits. Particularly in laser diodes, a photodiode with control amplifier is required for monitoring and stabilising the radiated power. In many cases, a





temperature sensor and a Peltier cooler are also required to stabilise the operating temperature. Where possible, the main components of the transmitter are normally combined into a compact sub-unit known as the transmission module.

**Triaxial cable**

Three-conductor cable that is made up of three connected axes. It consists of one conductor in the centre, the second conductor concentric around the first and the third conductor is isolated from the first two, normally by insulation, a braid and an outer sheath.

**Trimming**

Cables are reeled at standard lengths of, for example, 50 m, 100 m and 500 m on cable drums or coils (single cores) and placed in storage. Should a customer require a length shorter than the standard length, the cable is cut to size. The customer is then charged for this adjustment.

**TTP**

Time Triggered Protocol systems in data technology communicate continuously at predefined time intervals. The bandwidth is 5 Mbit/s asynchronous and 25 Mbit/s synchronous (see also CAN bus system).

**Tube cable**

Coaxial carrier frequency cable with copper inner conductor, PE discs as spacers, a tube-shaped bend copper tape as the outer conductor and a lead or aluminium sheath. They are used as long-distance cables for transmission of TV signals and communications.

**Twist protection**

Protection of light waveguide connectors against twisting. Without this protection, the end faces of the light waveguide would be next to one another and become scratched, significantly increasing attenuation.

**Type test**

Test to be performed periodically that includes all parameters that can influence the result. This test must be performed again if advancements or new developments have been





made or the material, technology or design has been changed. The frequency of type tests is set out in legislation, contracts or operationally.

**UL**

Abbreviation for Underwriters Laboratories. American testing body, similar to the VDE in Germany.

**UL Approbation for cable glands**

Approval is particularly required if the machinery or system in which the cable gland has been used is to be exported to the USA. Approval is granted after a test complying with UL 514B and is confirmed by a certificate. The number of this certificate is known as the “file number” (e. g. E 79903).

**UL listing mark for listed cables & wires**

Cables intended for use as fixed wiring in buildings used for residential, commercial or industrial purposes. Listed cables not only have to meet individual UL product standards, but must also comply with the relevant articles of the National Electrical Code (NEC). Listed cables and wires can be used both for factory

wiring of electrical equipment, devices, appliances and machines as well as for field wiring of industrial machinery and systems in accordance with NFPA 79. Approval marking on the product: (UL) = UL Listing mark.

**UL recognition mark for AWM cables and wires**

Appliance wiring material or "AWM" comprises cables intended solely for use in factory-wired electrical equipment, devices, appliances, control cabinets and industrial machinery as part of a "listed assembly".
AWM is not intended for field wiring purposes. Cables with UL AWM style labelling must be used for the applications stipulated by the individual style designation.

**Ultraviolet radiation**

This invisible radiation is the section of the electromagnetic spectrum that is next to the visible range (UV radiation).





**Underground cable**

Cables are often designated according to their usage conditions. Underground telecommunication cables include outdoor cables designed to be routed underground.

**Unit conductor of power cables**

Unit conductors are solely used as large conductors, from approx. 400 square millimetres. In order to reduce the large amount of heat required during welding, the bundles are separated into subconductors during assembly and rejoined again in a new stranding procedure.

**Unit cores of fiberoptic cables**

Several coated fibre optic cables lightly undulating and loose in small plastic pipes which are filled with Vaseline or swelling powder.

**Unit of wires**

Bare wire bundles are the initial product for copper strands. They are also used as copper strands in wire screens (non-insulated product).

**UTE** Abbreviation for Union Technique de l'Electricité (France).

**Vagrancy currents** Currents that do not flow through the electrical mains (L1, L2, L3, N) are referred to as vagrancy currents.

**VDE** Abbreviation for Verband Deutscher Elektrotechniker e.V., [German Electrical Engineering Federation], VDE testing and certification institute – VDE testing body.

**VDE Approbation for cable glands** Approval is granted after a test complying with DIN/EN 50262 and is confirmed by an approval certificate,

**VDEW** Abbreviation for Vereinigung Deutscher Elektrizitätswerke [Association of German Electricity Plants].

**Velocity of propagation** Transmission speed of the electrical energy in a length of the cable compared to the light speed in free space. Usually expressed as a percentage.





**Vibrator, chopper** A pole reversal of medium power for generation of an AC voltage from a DC voltage.

**Volt** Electrical unit of measure for voltage. 1 Volt is the voltage produced by a current of 1 A with a resistance of 1 Ohm. Voltage = Resistance x Current

**Volt meter** Instrument for measuring voltage.

**Voltage-level classes** We refer to four voltage levels. Everything that is < 1000 Volt (< 1 kV) belongs to the low voltage class. Voltages > 1 kV are classed as high voltage. In practice (no statutory specification), the high voltage class is divided into: Medium voltage 1 kV – 30 kV, high voltage 50 kV – 150 kV, extremely high voltage 150 kV – 400 kV. There are several different voltage levels within these classes.

**Voltage, tension** Electrical unit of measure, measured in Volts, i. e. Voltage = Resistance x Current.

**VSWR (Voltage Standing Wave Ratio)** Ratio of the transmitted signal voltage to the reflecting signal voltage measured along the transmission path.

**Vulcanising** Technological process in which temperature, pressure and the use of sulphur compounds, for example, cause the molecules in rubber to form cross linkages. It is this process that gives rubber its permanent elasticity and makes it suitable for industrial use (see → Cross linking).

**Wall thickness** The thickness of the insulation or sheath.

**WAN** WAN is the abbreviation for Wide Area Network. This is a large network, which can extend worldwide. WANs normally connect LANs (Local Area Networks) via telephone cables. Routers and gateways connect the LANs using different technologies. WAN is a wide area transmission network for connecting distance users to a central network using public cables.





**Watt** Electrical unit of measure for power V x A = Watts (VA).

**Wave lengths** Length of a full wave oscillation (period). In optical signal technology, three wavelength ranges are normally used – 850 nm, 1300 nm and 1550 nm.

**Waveguide dispersion** The dispersion that occurs with non-monochromatic light sources because the a/l relationship and, as a result, field distribution and group speeds of the modes in a light waveguide are wave dependent (a is the core radius, l is the light wavelength). In practice, waveguide dispersion always acts in conjunction with material dispersion; its overall effect is referred to as chromatic dispersion.

**Wear resistance** The characteristic of a cable, wire or material to withstand surface wear.

**WEEE directive** Under electrical and electronic equipment legislation (ElektroG in Germany), the WEEE directive governs the withdrawal of electrical and electronic products.

**Wire drawing**

Cold forming process, in which a sequence of increasingly small drawing dies (carbide cores or diamonds) gradually reduce the cross-section of pressed wire or wire rod.

**Wire termination technique**

Depending on the application, different wire termination methods can be chosen. Where ease of service and maintenance is required, a screw fitting is used. If large numbers of plug connectors with a reliable connection method are required, crimping is the best choice. A cage clamp combines ease of service with reliable wire termination, although the space required per contact for the wire termination is the highest of all the methods described here.

**Wire–wrap connection**

This is an electrical connection made without soldering. The contact is made by wrapping a bare copper wire around a square rod made of bronze, brass or silver under high tension (also known as cold welding).





**Wiring cable**

Cable for wiring equipment, control cabinets etc.

**Wiring system**

Wiring systems are made up of a variety of individual elements, such as cable sheathing, contact plugs, connector shells, seals, fixing elements, etc. In a car, the wiring system connects the electromechanical and electrical components and guarantees the transmission of information from and between the control units, as well as for the supply of energy to the consumers (engine, relay, lighting, etc.).

**Working current, service current**

The maximum permissible current that may be transmitted.

**Woven cable**

Several conductors running parallel which are held together using a thin sheath. See also → Flat cable.

**Zinc**

In the cable industry, galvanised steel tape or steel wire are used as the armouring material (→ Armouring) to protect against corrosion.

**ZVEH**

Abbreviation for Zentralverband der Deutschen Elektrohandwerke e.V. [Central Association of German Electrical Trades] (Germany).

**ZVEI**

Abbreviation for Zentralverband der Elektrotechnik- und Elektronik Industrie e.V. [Central Electrical Engineering and Electronics Industry Association] (Germany).





| | |
|---|---|
| Absorption | See Glossary |
| ACR | See Glossary |
| Actor Sensor Interface | ASI |
| Address bus | Adressbus |
| Adhesion | Adhäsion |
| Aging | Alterung |
| Aging resistance | Alterungsbeständigkeit |
| Alternating current | Drehstrom |
| Aluminium sheath | Aluminiummantel |
| American wire gauge | AWG, AWG-Leitungen, AWG-Adern |
| Ampacity | Strombelastbarkeit |
| Ampere | See Glossary |
| Analog signal transmission | Analogsignalübertragung |
| Angle of beam spread | Öffnungswinkel |
| ANSI | See Glossary |
| Antenna cable | Antennenkabel |
| Anti-kink cable glands | Knickschutz von Kabelverschraubungen |
| Antioxidant | Alterungsschutzmittel |
| Approved cables | Approbierte Leitungen |
| Armour | Bewehrung |
| Armouring | Armierung, Panzerung, Bewehrung |
| Armouring types | Bewehrungsarten |
| AS | AS |
| ASME | See Glossary |
| Assembly | Konfektionierte Leitung |
| ASTM | See Glossary |
| ATEX approval | ATEX-Zulassung |
| Attenuation | Dämpfung |
| Attenuation a | Dämpfung A |
| Attenuation coefficient a | Dämpfungskoeffizient a |
| Automative cable | Fahrzeugleitungen |
| AWM | See Glossary |
| Backbone | See Glossary |

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|---|---|
| Backscatter | Rückstreuung |
| Backtwist | Rückdrehung |
| BALUN | See Glossary |
| Banding | Bandierung |
| Bandwidth | Bandbreite |
| Bandwidth product | Bandbreitprodukt |
| Bandwidth-length product | Bandbreiten-Längenprodukt |
| BASEC | See Glossary |
| Basic raw materials | Basisrohstoffe |
| Batteries Act | Batteriegesetz – BattG |
| Battery cables | Batterieleitungen |
| Baud | See Glossary |
| Bel | See Glossary |
| Bending capacity | Biegefähigkeit |
| Bending cycle | Biegezyklen |
| Bending radii | Biegeradien |
| Bending test at low temperature | Kältewickelprüfung |
| Binary | Binär |
| Bit | See Glossary |
| Bit error rate, BER | Bitfehlerrate |
| Blue cable | Blaue Leitung |
| Braid angle | Flechtwinkel |
| Braiding | Geflecht |
| Breakdown | Durchschlag |
| Breaking load | Bruchlast |
| British Standard Wire Gauge | See Glossary |
| Broadband | Breitband |
| BS | See Glossary |
| BSI | See Glossary |
| Bundle | Bündel |
| Bus-system | Bus-System |
| Cable | Kabel, Leitung |
| Cable carrier | Energieführungskette |
| Cable data | Kabeltypendatei |
| Cable gland | Kabelverschraubung |





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|---|---|
| Cable gland sizes | Kabelverschraubungsgrößen |
| Cable print | Aufdruck |
| Cable set-up | Kabelaufbau |
| Cable tree | Kabelbaum |
| Cable type letter code | Leitungskurzbezeichnung |
| Cables for hand-held machinery | Handgeräteleitungen |
| Caloric load values | Brandlast |
| Campus | See Glossary |
| CAN | See Glossary |
| Canadian Electrical Code | See Glossary |
| Capacity | Kapazität, Leistung |
| Carrier frequency | Trägerfrequenz, Trägerfrequenzschaltung |
| CCC | See Glossary |
| CE | See Glossary |
| CE marking | CE-Kennzeichnung |
| CEBEC | See Glossary |
| CEC | See Glossary |
| CEE | See Glossary |
| CEI | See Glossary |
| CENELEC | See Glossary |
| Central element | Seele |
| Central filler | Kern |
| Characteristic Impedance | Impedanz, Wellenwiderstand |
| Chopper | Zerhacker |
| Chromatic dispersion | Chromatische Dispersion |
| Circular Mil (CM) | See Glossary |
| Cladding | See Glossary |
| Clamping range | Klemmbereich der Kabelverschraubung |
| CNOMO | See Glossary |
| Coating | Beschichtung |
| Coaxial cable | Koaxial-Kabel |
| Colour code | Farbcode |
| Colour print | Bedrucken mit Farbe |

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|---|---|
| Communication | Kommunikation |
| Compensating cable | Ausgleichsleitung, Kompensationsleitung |
| Composite layer | Schichtenmantel |
| Composite sheath | Schichtenmantel |
| Compound | See Glossary |
| Concentric conductor | Konzentrischer Leiter |
| Conditioning | Aufmachung |
| Conductance | Konduktanz |
| Conductor | Aderleitung, Leiter, Ader |
| Connecting cable | Anschlussleitung |
| Connector | Stecker, Steckverbinder, Sternkoppler |
| Contact voltage | Berührungsspannung |
| Control cables | Steuerleitungen |
| Copolymere | Copolymer |
| Copper | Kupfer |
| Copper base | Kupferbasis |
| Copper weight | Kupferzahl |
| Copper-clad aluminium wire | Verbunddraht – Aluminium/Kupfer |
| Core | Ader, Blindader |
| Core check, response at increased temperature | Aderprüfung, Verhalten bei erhöhter Temperatur |
| Core check, response with thermal shock | Aderprüfung, Verhalten bei Wärmeschock |
| Core diameter | Kerndurchmesser |
| Core group | Adergruppe |
| Core Ident Code | Ader-Ident-Code |
| Core identification | Aderidentifizierung |
| Core joint | Aderverbinder |
| Core print | Bedruckung – Adern |
| Core stranding | Verseilverband, Verseilverbund |
| Core stranding with more than four cores | Verseilverband aus mehr als vier Adern |
| Core wrapping | Aderumhüllungen |





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|---|---|
| Corrosion | Korrosion |
| Coupler | Koppler |
| Crane cables | Kranleitungen |
| Crimp connection | Crimpen |
| Cross-linked | Vernetzung |
| Cross-linked polyethylene XLPE | VPE |
| Cross-linking agent | Vernetzer |
| Cross-section | Querschnitt |
| CSA | See Glossary |
| Current | Stromstärke |
| D.C. | See Glossary |
| Dark current | Dunkelstrom |
| Data bus | Datenbus |
| Data transfer | Datenübertragung |
| Data transmission | Datenübertragung |
| Data transmission cable | Datenübertragungskabel, Datenkabel |
| Data transmission rate | Datenübertragungsrate |
| Decibel | Dezibel |
| Degrees of protection | Schutzarten |
| DEL | See Glossary |
| DEMKO | See Glossary |
| Density | Dichte |
| Density unit | Dichtezahl |
| Designation label | Beschriftungsbinder |
| DESINA® | See Glossary |
| DeviceNet™ | See Glossary |
| Dielectric | Dielektrikum |
| Dielectric constant (DC) | Dielektrizitätskonstante (DK) |
| Diffusion | Streuung |
| Digital signal transmission | Digitalsignalübertragung |
| Dimension | Abmessung |
| DIN | See Glossary |
| DIN EN | See Glossary |
| Direct line | Anschlussleitung |

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|---|---|
| Dispersion | See Glossary |
| DKE | See Glossary |
| Drag chain cables | Schleppkettenleitungen |
| Drain wire | Beidraht |
| Ductility | Biegbarkeit |
| Dummy | Blindelement |
| Duplex operation | Duplexbetrieb |
| Duroplastic | Duroplaste |
| Earth connection | Betriebserdung |
| Earth electrocode | Erder |
| Earthing | Erdung |
| ECAD-Bauteilenorm | See Glossary |
| EIA | See Glossary |
| Elastomere | Elastomer |
| Electric circuits | Stromkreise |
| Electric diameter of conductors | Elektrischer Leiterquerschnitt |
| Electric Field | Elektrisches Feld |
| Electric resistance | Elektrischer Widerstand |
| Electricity | Elektrizität |
| Electromagnetic protection | Elektromagnetischer Schutz |
| Element | See Glossary |
| Elongation | Dehnung |
| Elongation at break | Bruchdehnung |
| ELOT | See Glossary |
| EMC | EMV |
| EMK | See Glossary |
| EMS | See Glossary |
| EN | See Glossary |
| EPDM | See Glossary |
| EPIC® | See Glossary |
| ePLAN® | See Glossary |
| Ethylene-Propylene-Rubber | Ethylen-Propylen-Kautschuk |
| Explosive atmospheres | Explosionsfähige Atmosphäre |
| Extension | Dehnung |
| Extension cord | Verlängerungsleitung |





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|---|---|
| Extrusion line | Extruder |
| Fibre cover | Faserhülle |
| Fieldbus technology | Feldbustechnik |
| Filler | Füllstoff, Blindader, Beilauf |
| Filler wire | Beilaufdraht |
| Fire behavior | Brennverhalten |
| Fire resistant | Flammwidrigkeit |
| Flame retardant | Schwer entflammbar |
| Flat cable | Flachbandleitung |
| Flat type cable | Flachkabel |
| Flexibility | Flexibilität, Biegbarkeit |
| Foil | Folie |
| Frequency | Frequenz |
| Full duplex | Vollduplex |
| General cable tie | Universalkabelbinder |
| Glass fibre cable | Lichtwellenleiter (LWL), Lichtleiter-Kabel |
| Gradient fibre | Gradientenfaser |
| Grid | Raster |
| Ground system | Erder |
| Gusset | Zwickel |
| Halogen free | Halogenfrei |
| Hardness | Härte |
| Harmonizing key | Harmonisierungsschlüssel |
| Heat of combustion | Verbrennungswärme |
| Hood | Tüllengehäuse |
| Hood termination | Endkappen |
| Hook-up wire | Trägerfrequenzschaltung |
| Hybrid cable | Hybridkabel |
| Imprinting | Prägung |
| Index profile | Brechzahlprofil |
| Industrial machinery for USA | Industrielle Maschinen in den USA |
| Ink-jet printer | Bedruckung – Kabelmäntel und Leitungen – Laser- und Tintenstrahldrucker |

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|---|---|
| Insertion attenuation | Einfügungsdämpfung |
| Insertion loss | Einfügungsdämpfung |
| Insulated wire | Ader |
| Insulation | Isolation |
| Insulation resistance | Isolationswiderstand |
| Intensity | Intensität |
| Interactive | Interaktiv |
| Interface | Schnittstelle |
| Intrinsically safe | Eigensicher |
| Joint | Knoten |
| Kink | Knick |
| Laser-printer | Bedruckung – Kabelmäntel und Leitungen – Laser- und Tintenstrahldrucker |
| Laying temperature | Verlegetemperaturen |
| Leading protective ground | Schutzkontakt, voreilend |
| Leakage current | Ableitstrom |
| Length of lay | Schlaglänge |
| Length of twist | Schlaglänge |
| Lever series | Bügelarten |
| Lift cable | Hängekabel |
| Longitudinal water tightness | Längswasserdichtigkeit |
| Loss factor | Verlustfaktor |
| Machine set-up for conductor insulation – Extrusion | Anlagenaufbau für Isolierhüllen – Extrusion |
| Master-Slave principle | Master-Slave-Prinzip |
| Material dispersion | Materialdispersion |
| Mica powder | Glimmer |
| Microbending | Mikrokrümmungen |
| Mode | Moden |
| Mode dispersion | Modendispersion |
| Monomode fibre | Monomodefaser |
| Motor cable | Motorenkabel |
| Multimode fibre | Multimodefaser |
| Mutual capacity | Betriebskapazität |





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|---|---|
| Nanosecond | Nanosekunde |
| Near-end crosstalk, far end crosstalk | Next, Fext (Nebensprechdämpfung) |
| Neoprene® | Neopren® |
| Network | Netzwerk |
| Neutral conductor | Erdleiter, Neutralleiter |
| Nominal voltage | Nennspannung |
| Norms | Normen |
| Numeral identification | Ziffernbedruckung |
| Numerical aperture | Numerische Apertur |
| Ohmic resistance | Leiterwiderstand |
| Operating capacity | Betriebskapazität |
| Operating supplies | Betriebsmittel |
| Operating temperature range | Betriebstemperatur |
| Operating voltage | Betriebsspannung |
| Opposite direction of lay | Gegenschlag |
| Order length | Bestelllänge |
| Outdoor cable | Außenkabel |
| Outer conductor | Außenleiter |
| Outer diameter | Manteldurchmesser |
| Outer sheath | Außenmantel, Mantel |
| Overcurrent | Überstrom |
| Overcurrent protection devices | Überstromschutzorgane |
| Oxidation inhibitor | Alterungsschutzmittel |
| Oxygen index | Sauerstoffindex |
| Pad | Füller |
| Pair | Paar |
| Panel mount base | Anbaugehäuse |
| Patch cable | Patchkabel |
| Patch field | Patchfeld |
| Photovoltaic | Photovoltaik |
| Pigtail | Anschlussfaser |
| Pollution level | Verschmutzungsgrad |
| Polyamide | Polyamid |

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|---|---|
| Polycarbonate | Polycarbonat |
| Polychloroprene-rubber | Chloropren-Polymerisate, Kunstkautschuk |
| Polyethylene | Polyethylen (PE) |
| Polyuretane | Polyurethan |
| Polyvinylchloride | Polyvinylchlorid |
| Power dissipation factor | Verlustleistung |
| Preform | Vorform |
| Print wheel | Bedruckung – Kabelmäntel und Leitungen – Druckrad |
| Protective conductor | Schutzleiter |
| PVC-powder additive | PVC-Pulver-Additive |
| Quad | Vierer |
| Rated current | Bemessungsstrom |
| Rated voltage | Bemessungsspannung |
| Receiver sensitivity | Empfängerempfindlichkeit |
| Receiver, optical | Empfänger, optischer |
| Reel | Trommel |
| Reel size choice | Trommelauswahl |
| Reel structure | Trommelaufbau |
| Reeling | Trommelbar |
| Reference earth | Bezugserde |
| Refraction index | Brechungsindex, Brechzahl |
| Refractive index distribution | Brechzahlprofil |
| Resistance | Beständigkeit, Widerstand |
| Resistant | Resistent |
| Retention of cable glands | Rückhaltevermögen von Kabelverschraubungen |
| Route warning tape | Trassenwarnband |
| Rubber insulated cable | Gummischlauchleitung |
| Same direction of lay | Gleichschlag |
| Sample test | Auswahlprüfung |
| Screened cable | Abgeschirmte Leitungen |
| Screening | Auswahlprüfung |
| Self-extinguishing | Selbstverlöschend |
| Semiconductor | Halbleiter |





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|---|---|
| Semiconductor bandgap | Bandabstand |
| Separating layer | Trennschicht |
| Separator | Trennfolien, PETP-Folien |
| Service current | Betriebsstrom |
| Sheath print | Bedruckung – Kabelmäntel und Leitungen |
| Sheathed cable | Mantelleitung |
| Shielding | Abschirmung |
| Shipping reels | Versandtrommeln |
| Signal cable | Geberleitungen |
| Single conductor | Massivleiter |
| Single wire | Eindrähtig |
| Single-mode fibre | Einmodenfaser |
| Single–wired conductor | Leiter, eindrähtig |
| Skin effect | Skin-Effekt |
| Specific volume resistance | Spezifischer Durchgangswiderstand |
| Speed of signal propagation | Signalausbreitungs-geschwindigkeit (NVP) |
| Spiral cable | Spiralkabel |
| Splice | LWL-Schweißverbindung, Spleiß |
| Stabiliser | Stabilisator |
| Step index fibre | Stufenfaser |
| Strain relief of cable glands | Zugentlastung von Kabelverschraubungen |
| Strand | Litze |
| Stranding | Verseilung |
| Stranding machine | Verseilmaschine |
| Stretch | Dehnung |
| Strip line | Bandleitung |
| Styrol | Butadien-Styrol-Kunstkautschuk |
| Super conduction | Supraleitung |
| Supporting cable | Tragarmleitung |
| Supporting core | Tragorgan |
| Surface mount base | Sockelgehäuse |
| Synthetic india rubber | Butyl Kunstkautschuk |

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|---|---|
| T-Coupler | T-Koppler |
| Take-up system | Aufwickelanlagen, allgemein |
| Talcum | Talkum |
| Tape | Bebänderung |
| Tape wrapping | Bewickeln mit Bändern |
| Taped wrapping | Bewicklung, Lapping, Taping |
| Telephone cord | Apparateleitung |
| Temperature range | Temperaturbereich |
| Tensile load | Zugbelastung |
| Tension | Spannung |
| Test voltage | Prüfspannung |
| Thermal splice | Thermospleiß |
| Thermoplastic materials | Thermoplaste |
| Thermoplastics | Thermoplaste |
| Thomson measuring bridge for resistance measurement | Thomson-Messbrücke zur Widerstandsmessung |
| Tight buffer tube | Vollader |
| Tin | Zinn |
| Tracer thread | Kennfaden |
| Train signal cable | Eisenbahn-Signalkabel |
| Transfer impedance | Transferimpedanz, Kopplungswiderstand |
| Transfer rate | Übertragungsbandbreite |
| Transmission function | Übertragungsfunktion |
| Transmitter, optical | Sender, optischer |
| Triaxial cable | Triaxial Kabel |
| Trimming | Ablängen |
| Tube cable | Tubenkabel |
| Twist protection | Verdrehschutz |
| Twister | Verseilmaschine |
| Type test | Typprüfung |
| UL listing mark for listed cables & wires | UL Listing Mark für „listed cables & wires“ |
| UL recognition mark for AWM cables and wires | UL Recognition Mark für „AWM cables and wires“ |





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|---|---|
| UL-Approbation for cable glands | UL-Zulassung für Kabelverschraubungen |
| Ultimate elongation | Bruchdehnung |
| Ultimate load | Bruchlast |
| Ultraviolet radiation | Ultraviolette Strahlung |
| Underground cable | Erdkabel |
| Unit conductor of power cables | Bündelleiter von Starkstromkabeln |
| Unit cores of fiberoptic cables | Bündeladern von Lichtwellenleitern |
| Unit of wires | Drahtbündel |
| Vagrancy currents | Vagabundierende Ströme |
| Valley sealer | Beilauf |
| VDE Approbation for cable glands | VDE-Zulassung für Kabelverschraubungen |
| Velocity of propagation | Ausbreitungsgeschwindigkeit |
| Vibrator | Zerhacker |
| Volt meter | Voltmeter |
| Voltage | Spannung |
| Voltage Standing Wave Ratio | VSWR |
| Voltage-level classes | Spannungsebenen |
| Vulcanising | Vulkanisation |
| Wall thickness | Wanddicke |
| Wave lengths | Wellenlänge |
| Waveguide dispersion | Wellenleiterdispersion |
| Wear resistance | Abriebbeständigkeit |
| WEEE directive | WEEE-Richtlinie |
| Wide Area Network | WAN |
| Wire drawing | Drahtziehen |
| Wire termination technique | Leiteranschlusstechnik |
| Wire–wrap connection | Wickelverbindung |
| Wiring cable | Verdrahtungsleitung |
| Wiring system | Bordnetze |
| Working current | Betriebsstrom |
| Woven cable | Bandkabel |
| Zinc | Zink |

## The safe use of our products

### Cables and cords

The use of cables and cords is particularly diverse and is regulated accordingly in the various standards organizations (IEC, EN, NEC etc.) by a large number of application standards.

Here the international standard IEC 60204-1:1997, (Electrical Equipment of Machines – Part 1: General Requirements) with reference to cables and cords and their conditions for use serves as an example.

The fulfillment of these general requirements makes it absolutely necessary that a professional check is conducted by the user to determine whether a specific product standard with other/expanded requirements exists, which has precedence.

The product pages in the Catalogue with product and application standards provides assistance. For example: ‚oil-resistant according to VDE0472, Part 803' or ‚railway applications: EN 50306-2'.

For the area of harmonized low-voltage power cables (e.g. H05VV5-F/ÖLFLEX® 140), DIN VDE 0298-300 provides a list of requirements and criteria under Pt. 4-7. In most cases, these can also be applied to other low-voltage cables and provide information on recommended uses.

In the following, a selection of important aspects for using cables and lines is summarized.

### General information

Conductors, cables and cords must be selected so that they are suitable for the operating conditions which occur (e.g. voltage, current, protection against electric shock, accumulation of cables and cords) and for external influences (e.g. ambient temperature, presence of water or corrosive substances, mechanical loads, including loading during installation, fire hazards).

### Electrical voltage

The control and connection cables listed in the Catalogue are subject to 73/23/EEC – ‚Low-Voltage Directive' for electrical operating equipment with a nominal voltage between 50 and 1,000 volts (alternating voltage) and between 75 and 1,500 volts (direct voltage). The nominal voltage is the reference voltage for which the cables and cords are designed and tested. The nominal voltage of cables and cords for use in alternating-current power supplies must be greater than or equal to the nominal supply voltage.

With a direct-current power supply, the nominal supply voltage must not be higher than 1.5 times the nominal voltage of the cable. The continuous operating voltage of alternating-current and direct-current power supplies may exceed their nominal voltage by 10%.

The nominal voltage of cables and lines is expressed in volts by the ratio $U/U_0$; here:

$U_0$ is the effective value of the voltage between an external conductor and ground (metallic casing/(shielding) off the line or surrounding medium)

U is the effective value of the voltage between two external conductors of a multi-core line or of a system of single-core cables.

The dielectric strength of the insulation of conductors, cables and cords must be sufficient for the required test voltage. For cables and cords operated with voltages above 50 VAC or above 120 VDC, the test voltage is at least 2,000 VAC for a period of 5 min. For alternating voltages with a maximum of 50 V and direct voltages with a maximum of 120 V (typically SELV or PELV systems), the test voltage must be at least 500 VAC for a period of 5 min.

The test alternating voltages are listed on the individual product pages in the Catalogue under ‚Technical Data', and also enables a selection of cables for which $U/U_0$ cannot practically be named.

**Tensile strains**

Up to a maximum value of 1,000 Newtons for the tensile strain of all conductors, the following applies:

Max. 15N per $mm^2$ conductor cross-section (without calculating in shields, concentric conductors and divided-up protective conductors) with static tensile strain in the operation of moving/flexible cables and cables for/in fixed installation.

Max. 50 N per $mm^2$ conductor cross-section (without calculating in shields, concentric conductors and divided-up protective conductors) with static tensile strain for the installation of cables for/in fixed installation.

**Cables for applications in power chains (see Selection Table A2)**

These cables are marked with the addition ‚FD' in the product name.

In addition to the generally applicable information on installation and configuration in the Technical Table T3, especially those specifications must be observed which refer to individual cables and are listed on the related product pages in the Catalogue.

In particular, these are:

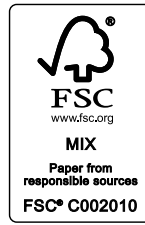
- Restrictions of the travel length (e.g.: ...up to 10 meters')
- Restriction of the minimum bending radius for flexible applications.
- The radius designed with the power chain must not be below the minimum bending radius of the cable!
- The inner radius to the surface of the curved cables is defined as the minimum bending radius.

**Transport and storage**

Cables and cords that are not intended for outdoor use must be stored in dry indoor rooms and must also be protected from exposure to direct sunlight there. With outdoor storage, the ends of cables and cords must be closed off to prevent the entry of moisture.

The ambient temperature during transport and storage is to be in the range from -25°C to +55°C (max. +70°C for not longer than 24 hours). Especially in the range of low temperatures, mechanical loading through vibration, shock, bending and twisting is to be avoided. This especially applies to PVC-insulated cables and lines.

## Notices

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